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(54) A loading device for loading workpieces into a machine tool

(57) A loading device for loading workpieces into a continuously running machine tool 1 has a carriage 10 which takes workpieces singly from the end of a magazine 8 and is then accelerated up to the speed of a work-piece holding fixture 3. The workpiece is then lowered by an inserter slide 40 which slides up and down relative to the carriage on two parallel guide rods on sealed bearings to lower the workpiece into the fixture. Once the workpiece has been released, the carriage returns to its starting point. Safety devices are provided to switch off the machine tool 1 in the event of either a horizontal or a vertical excessive force occurring between the fixture 3 and the carriage 10.

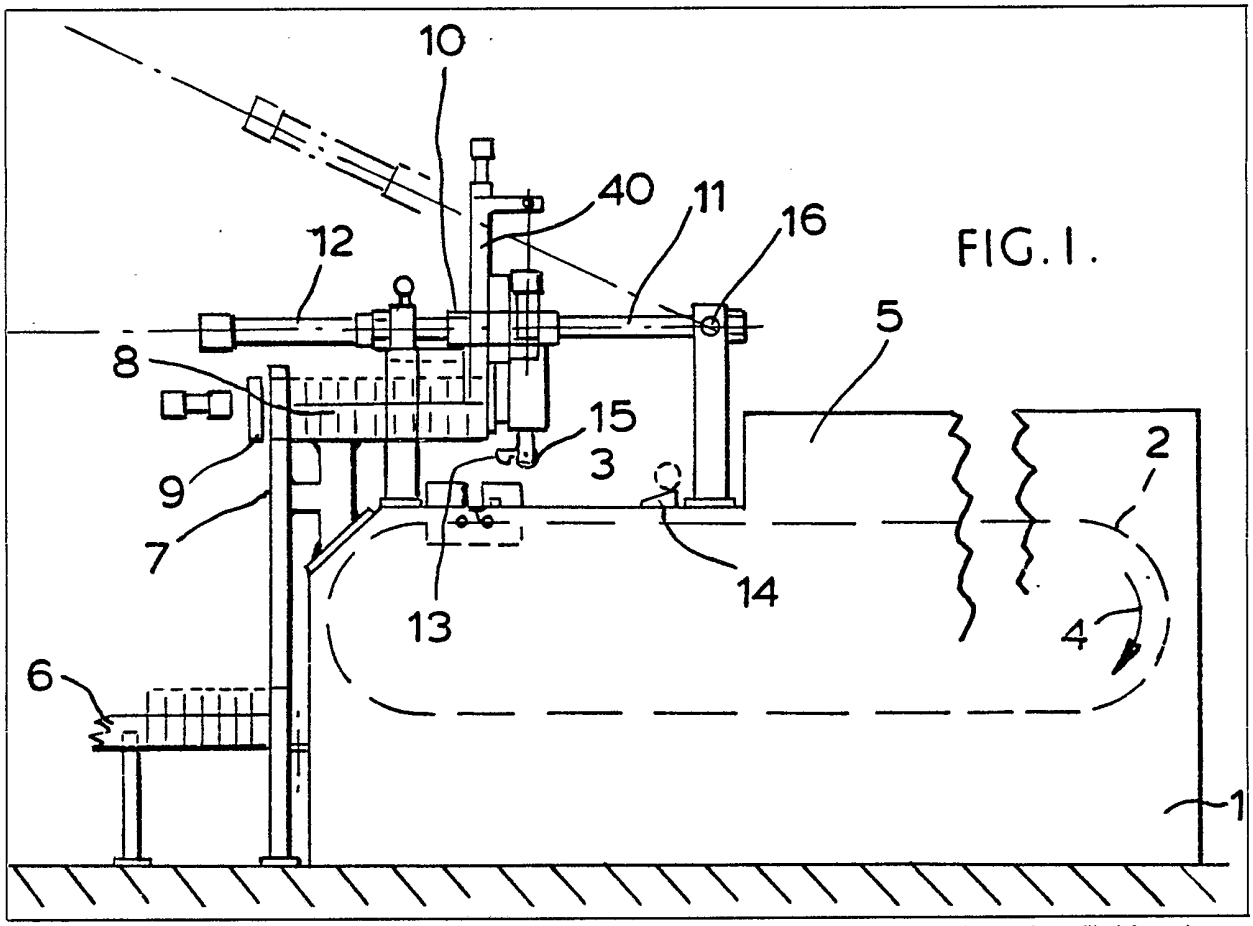

FIG. 1.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

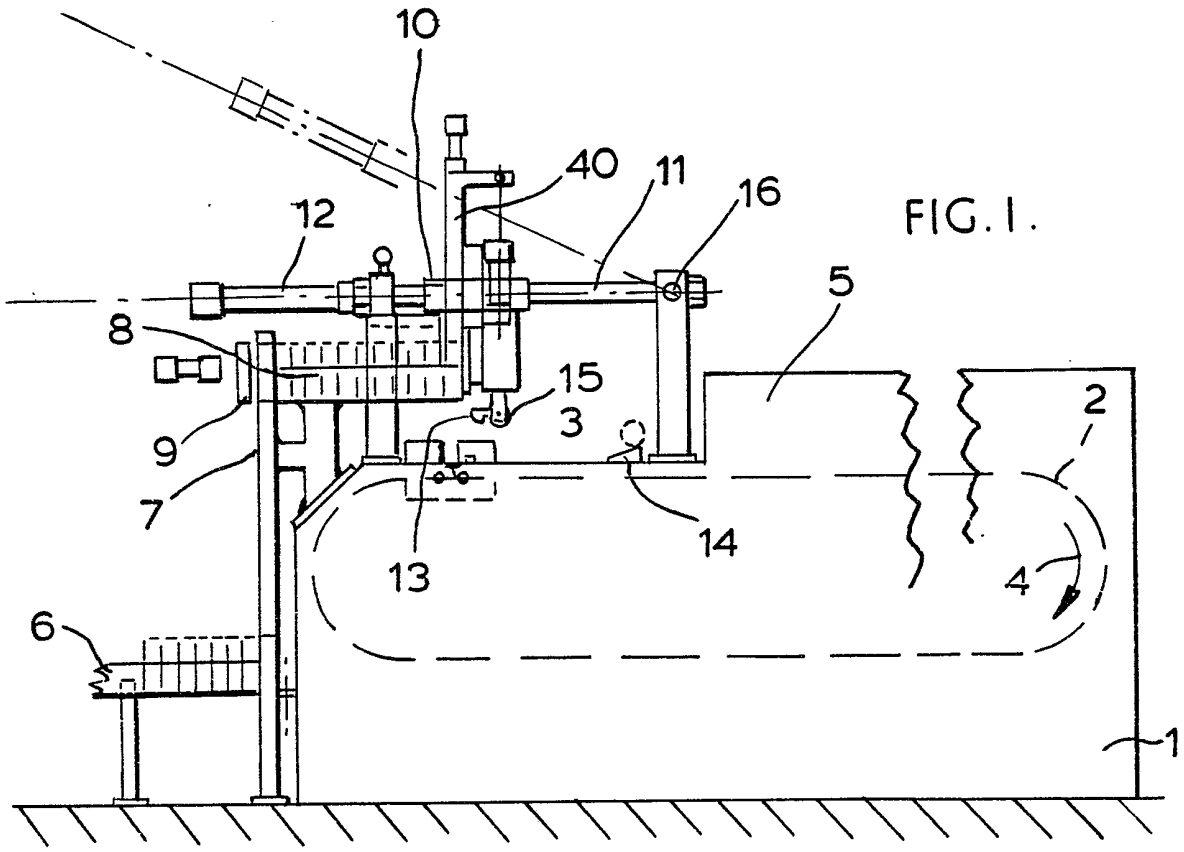
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FIG. 1.

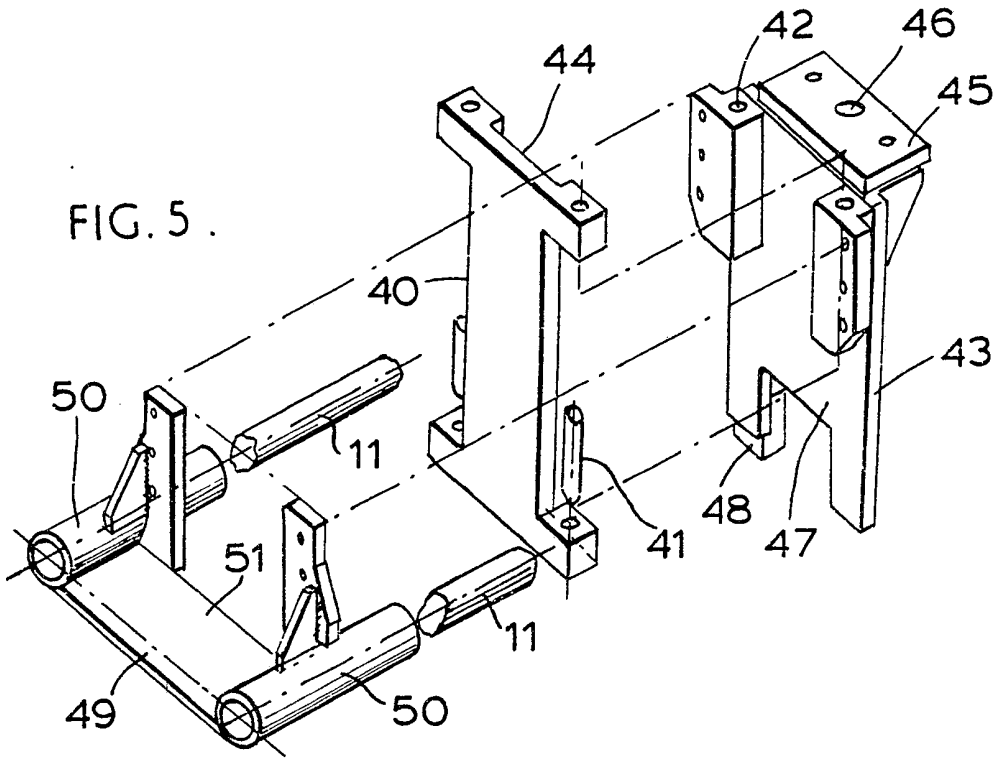
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FIG. 5.

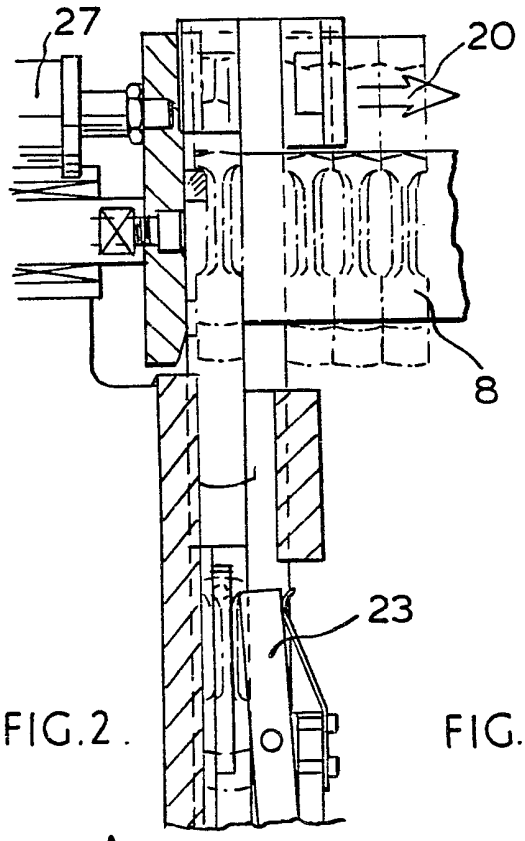


FIG. 2.

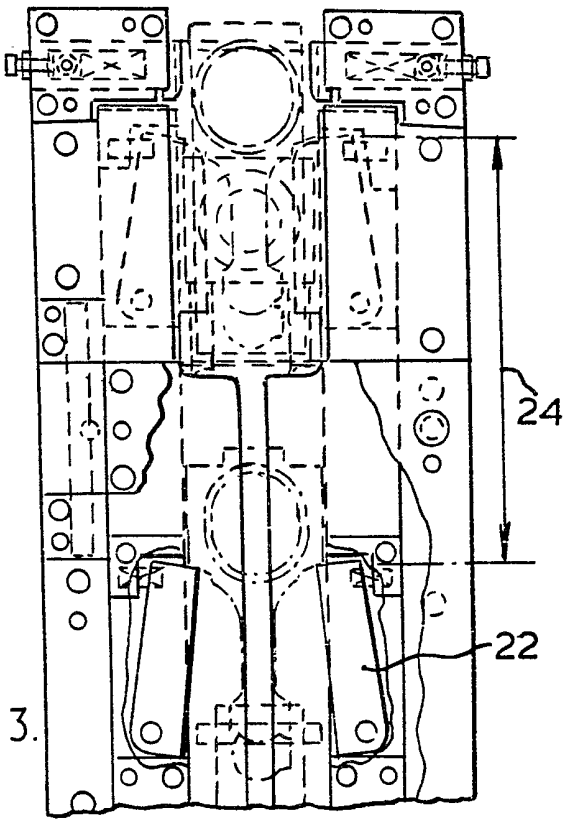
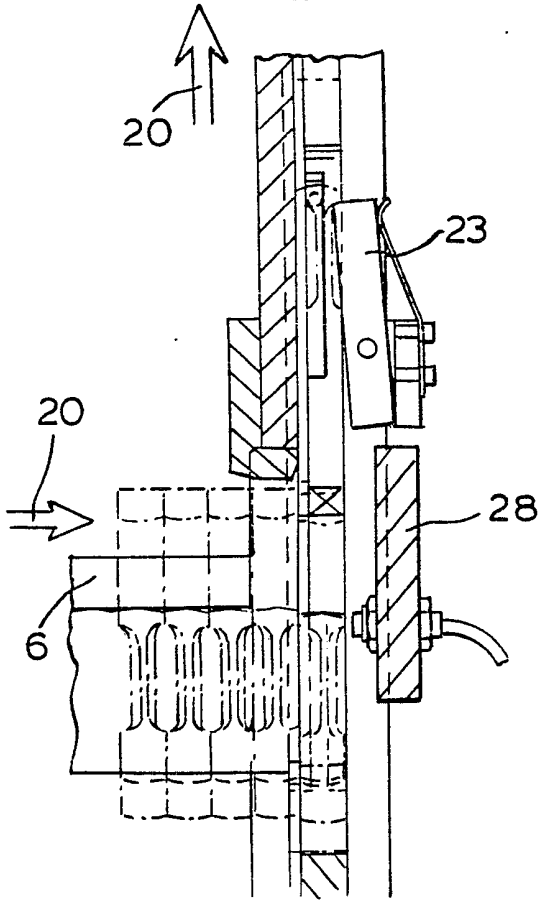
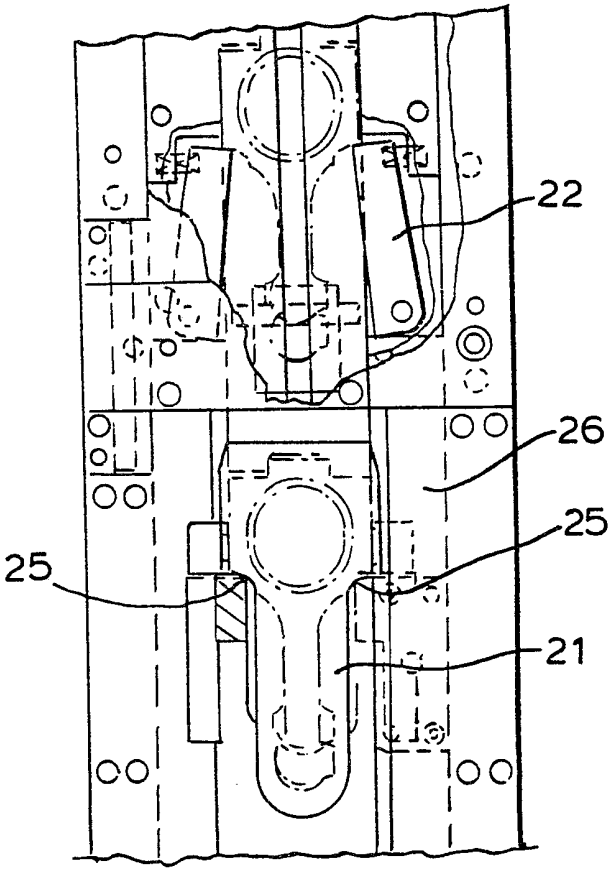


FIG. 3.





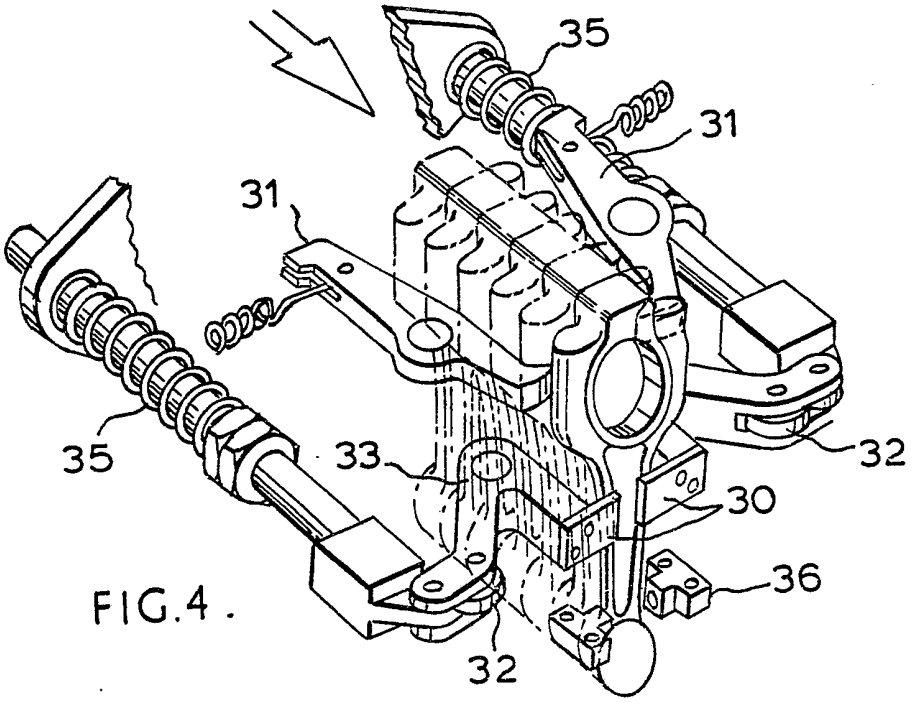


FIG.4.

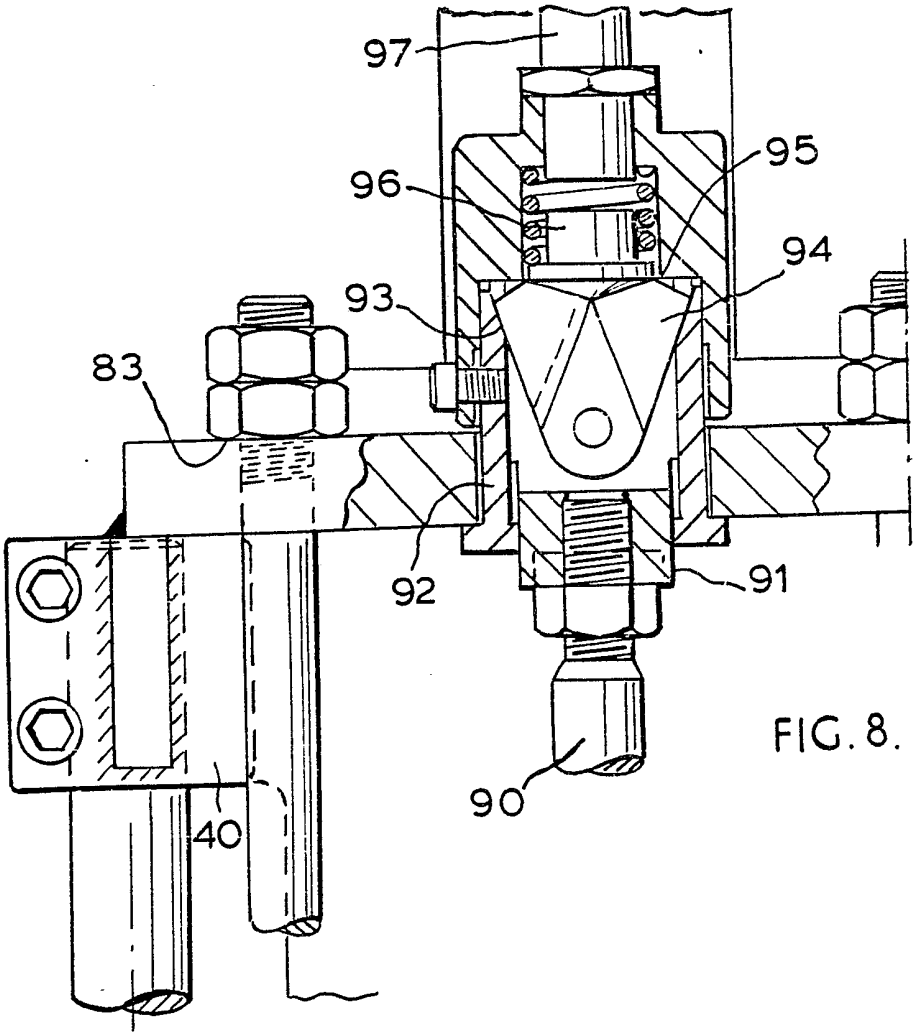


FIG.8.

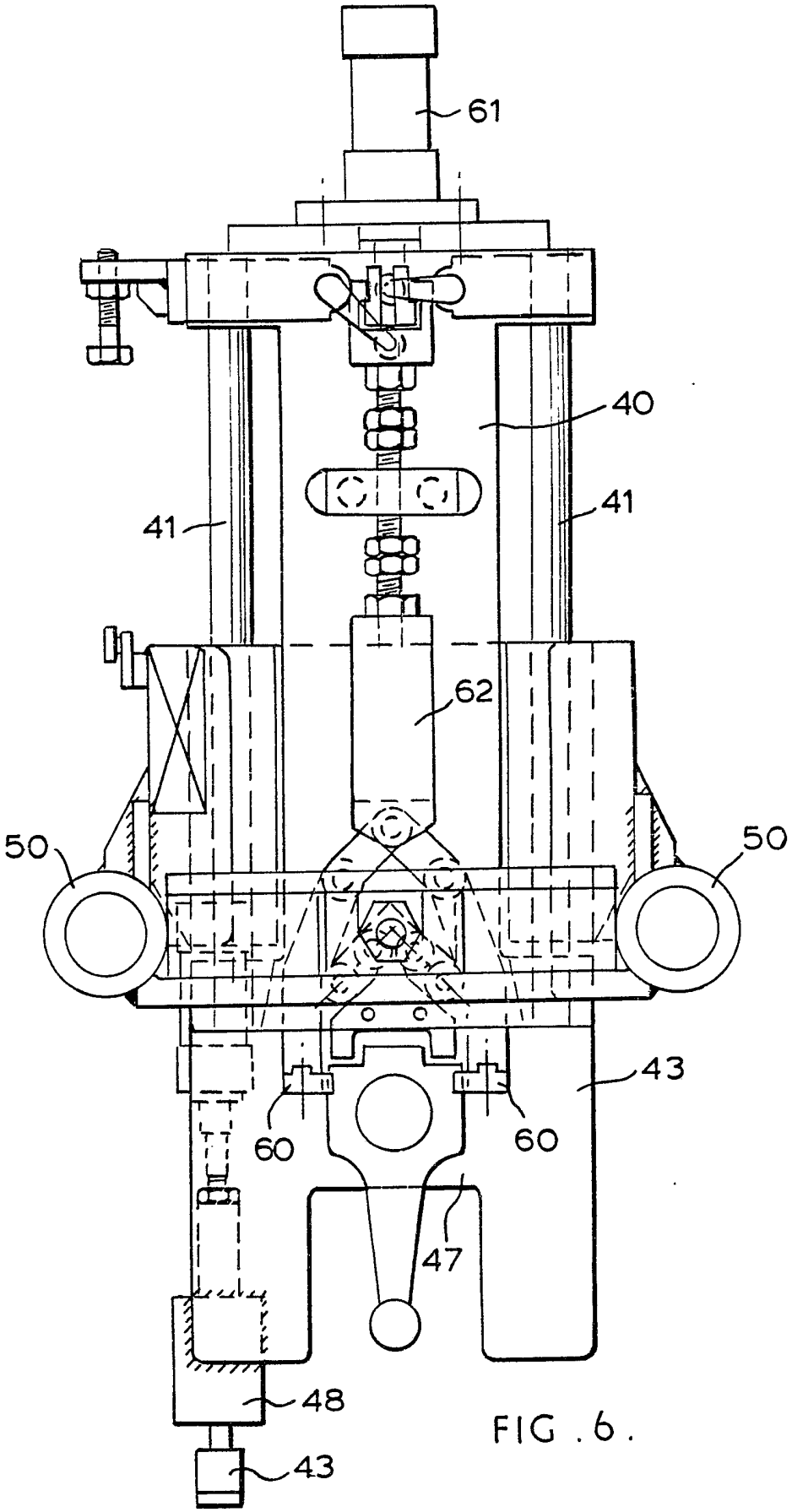


FIG. 6.

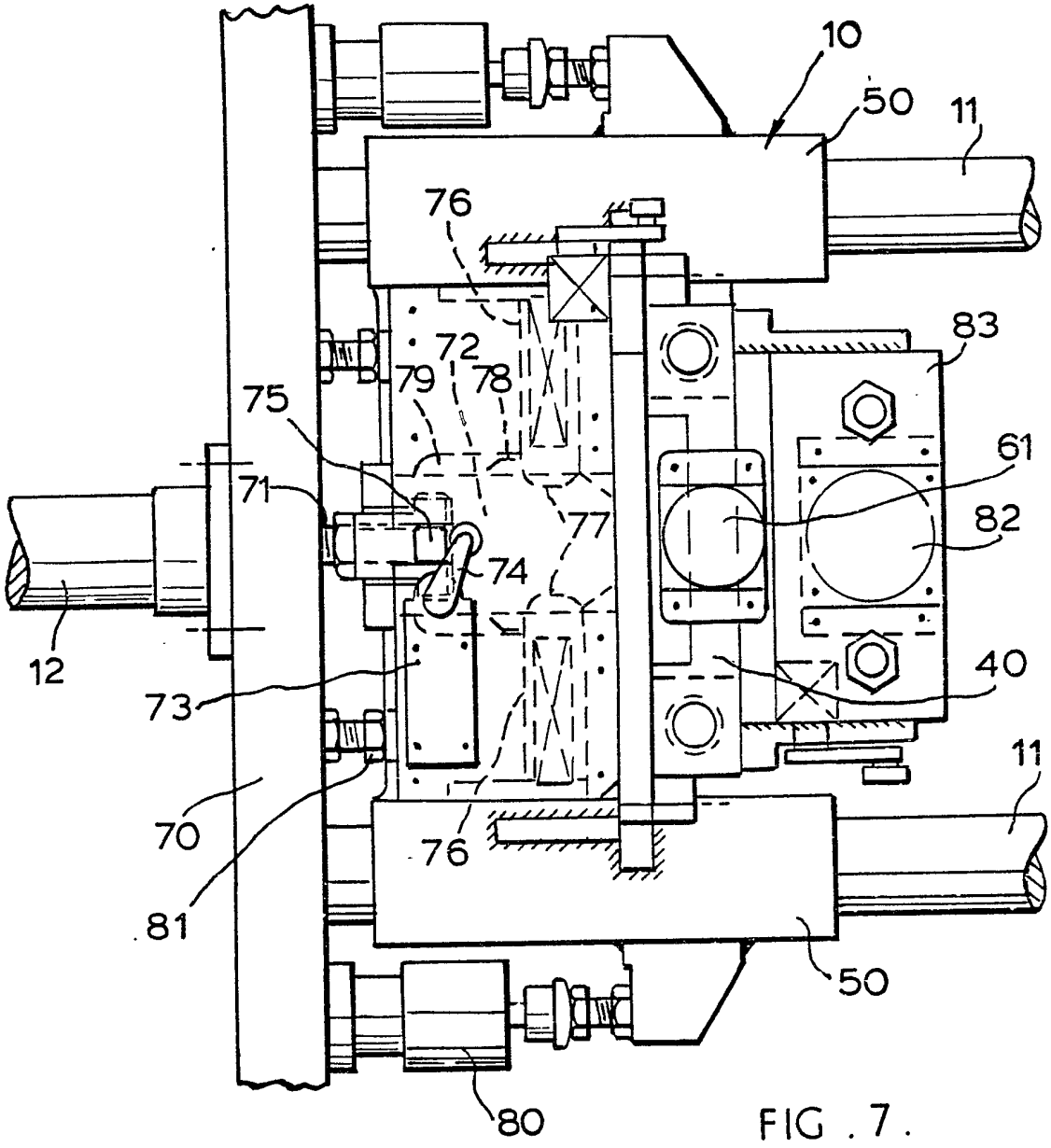


FIG . 7 .

SPECIFICATION

A loading device for loading workpieces into a machine tool

This invention relates to a loading device for loading workpieces into a machine tool which has a continuously moving, workpiece-holding fixture. For example, the device can be used for loading workpieces such as motor vehicle connecting rods into a chain broach machine.

In the use of machine tools it is most important to avoid damaging the machine which can lead to expensive repairs and lengthy downtime. It is therefore desirable to incorporate safety devices (which can conveniently be associated with the loading device) to stop the machine whenever a workpiece is wrongly positioned in its fixture.

It is also important to minimise initial investments in equipment cost and later repair and servicing costs.

According to the present invention, there is provided a loading device for loading workpieces into a machine tool which has a continuously moving, workpiece-holding fixture, the loading device having a magazine for storing workpieces to be loaded and a movable carriage adapted to take a workpiece from the magazine and to load it into the fixture, the carriage including a carriage body and an inserter adapted to hold a workpiece, first driving means for driving the carriage body in the same direction and at the same speed as the machine tool fixture and second driving means for driving the inserter for movement relative to the carriage body and towards the fixture, the inserter being mounted between end plates of the carriage body and being movable relative to the carriage body on a first set of parallel guide rods.

The use of guide rods for the movement of the inserter (this movement would normally be in a vertical direction) makes for a cheap construction and an easy to maintain guidance system.

Sealed, recirculating ball bearings may be used both between the relatively moving surfaces on the inserter and the first guide rods and between the relatively moving surfaces of the carriage and a second set of parallel guide rods along which the carriage slides.

The carriage can conveniently be of fabricated construction, to keep down its cost.

The loading device is preferably provided with safety devices to stop the machine tool in the event of a "horizontal" overload and in the case of a "vertical" overload. Although the device is not limited to any particular orientation, for ease of description the term "horizontal" will be applied to movement of the carriage along the second set of guide rods and the term "vertical" will be applied to movement of the inserter along the first set of guide rods.

The horizontal safety release may be provided by an axially movable connector between the piston rod of a piston which moves the carriage horizontally and the carriage itself. The connector may be held in the carriage body in such a way that in normal operation it remains in one place, but in abnormal operation the excessive force can displace the connector relative to the carriage body. This displacement is sensed by a sensor which operates a switch to shut off the machine tool immediately.

Excessive loads in a vertical direction are dealt with in a similar way using a connection between the inserter driving means and the inserter itself which is held in a normal position by spring pressure but under abnormal conditions overcomes the spring pressure to cause movement of a component, which movement is picked up by a sensor which can operate a switch to stop the machine tool.

To ensure that the carriage and the machine tool fixture are moving at the same speed during the insertions, they are temporarily connected by a latch. This latch must be disengaged at the end of each loading stage. Should the latch disengagement mechanism fail to operate correctly, an inclined ramp can be placed beside the path of movement of the fixture, so that as the fixture passes the ramp the latch fixed to the carriage rides up the ramp and is forcibly disengaged from the fixture.

Because the level of the fixtures of a chain broach machine is usually well above the ground, it may be necessary to provide a means for raising the workpieces from a conveyor to the correct height to be stored in the magazine. This raising movement is preferably done by a vertically arranged shuttle mechanism. A vertical arrangement requires less space than an inclined arrangement, and a door can be arranged in a front face to permit easy access to the mechanism in the event of a malfunction.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side view of a chain broach machine with a loading device in accordance with the invention mounted thereon;

Figures 2 and 3 are respectively side and front views of the vertical shuttle arrangement for raising workpieces from a conveyor to a magazine;

Figure 4 is a perspective view of the magazine showing components that control the flow of workpieces along the magazine;

Figure 5 is an exploded view of the carriage;

Figure 6 shows gripping means for gripping workpieces;

Figure 7 is a plan view of the carriage in one end position; and

Figure 8 is a section through the top of the

carriage showing the vertical safety release feature.

In Fig. 1 a chain broach machine is shown schematically at 1. The machine has a chain 2 which extends around a path indicated by dotted lines. On the chain are a number of workpiece holding fixtures 3, only one of which is shown in the figures. In practice however such fixtures are mounted at spaced intervals all around the chain 2.

The fixture 3 shown in Fig. 1 is just about to be loaded with a workpiece. This loading is done while the chain continues to move to the right as shown by the arrow 4. Once the workpiece has been loaded, it is carried by the fixture 3 into the broaching tunnel 5 where the broaching operation is carried out. At a position downstream from the tunnel 5, the broached workpiece is ejected from the fixture 3 which then returns to the loading position at the upper left hand part of the machine to receive another workpiece.

Although the following description will relate specifically to a chain broach machine, the invention is not limited to this particular machine tool, but could also be applied to other machine tools.

The workpieces (in this particular case connecting rods) travel along a walking beam conveyor 6 to the bottom of a vertical shuttle 7. The workpieces are then raised by this vertical shuttle to a magazine 8. A piston/cylinder unit 9 is mounted at the end of the magazine 8 and pushes the workpieces in the magazine to the right.

At the right hand end of the magazine 8, a carriage 10 is mounted for sliding movement on two parallel rails 11. A pneumatic piston/-cylinder unit 12 moves the carriage 10 backwards and forwards along the rails 11, in a horizontal direction.

In use, the carriage 10 picks up a workpiece at the right hand end of the magazine and then begins to move to the right in synchronism with the movement of the fixture 3 whilst at the same time lowering the workpiece into the jaws of the fixture. By the time the carriage has reached the right hand end of its travel (as determined by the length of the piston rod of the unit 12), the workpiece is fully located in the jaws of the fixture 3 and has been released by the carriage which then returns to its left hand end starting position which is shown in Fig. 1.

Components of the magazine and of the carriage will be described in more detail in connection with the following figures of the drawings. Before leaving Fig. 1 however, two further points should be noted; firstly the carriage includes a latch 13 which is lowered to engage a corresponding detent on the fixture 3, to ensure that the carriage moves at the same speed as the fixture whilst the loading process takes place. At the right hand end of the travel of the carriage, a ramp 14 is provided. A wheel 15 mounted on the latch 13 rides up this ramp to ensure that the latch 13 disengages from the fixture before the fixture enters the tunnel 5. Normally the control system of the device will by this stage already have raised the latch 13, and so the ramp 14 is present purely as a safety device to operate in the case of malfunction of the control system.

Secondly, the rails 11 on which the carriage 10 is mounted are pivotably supported at the right hand end on a post 16. The rails 11 and carriage can thus be raised to the position shown in phantom lines in Fig. 1. This assembly will be raised in this way to obtain access to the broach machine should this be required. It should however be noted that the assembly is quite heavy, and too heavy for its freedom of movement about it axis on the post 16 to be effective in preventing possible damage to the machine in the event of high vertical loadings.

Figs. 2 and 3 show the shuttle mechanism 7 in more detail. In Fig. 2, the progress of the workpieces through the shuttle is indicated by hollow arrows 20. The workpieces (which will from now on be referred to as components) are raised by a reciprocating slide 26 which has a pocket 21 at the bottom for receiving a component from the conveyor 6 and spring loaded pawls 22 at various positions along the length of the shuttle. At the back of the shuttle, there are spring-loaded hold-up pawls 23. The stroke of the reciprocating slide is indicated at 24.

The leading component is pushed forward by the flow of the rods along the conveyor 6 into the pocket 21, where it rests at the points indicated by 25 in Fig. 3. The pocket 21 is formed in the slide 26 which is reciprocated by a rotatary actuator (not shown). Looking now to Fig. 2, the upward motion of the slide 26 lifts the lowermost component until it is high enough for the lowermost hold-up pawl 23 to engage the back of the component. At this point the component is sandwiched in an enclosed track. Once the hold-up pawl 23 has engaged (and similar pawls up the length of the track will all have engaged with a new component), the slide is lowered so that it can receive the next component in the pocket 21 and so that a pair of spring lifting pawls 22 will move down past the big end of the connecting rod and will then spring in below the lower shoulders so that when the slide 26, on which the lifting pawls 22 are mounted, rises again, the component will be lifted once more.

A horizontal pusher 27 pushes the components in the magazine 8 to the right. As each raising movement of the slide 26 brings another component into the uppermost position, the pusher must move back to make room for the introduction of the new rod. This is done by a conventional sequence control.

The shuttle shown in these figures also includes a "part-present" switch 28 which detects whether components are arriving at the bottom of the shuttle. The same shuttle can be used for connecting rods of different sizes, and two different lengths of rod are shown in Figs. 2 and 3.

The right hand end of the magazine 8 (as seen in Fig. 1) is shown in Fig. 4. The components which actually support the row of connecting rods in the magazine have been omitted. The leading connecting rod is held back by twin gates 30. These gates prevent the connecting rod from dropping from the magazine into the machine before the machine is ready to accept it. Spring loaded pawls 31 hold back the second and subsequent components when the gates 30 are opened to allow the first rod to be removed. The gates 30 are mounted on arms 32 pivoted on fixed pivot points 33. On the other side of these pivot points, there are rollers 34 and when the carriage 10 is moved to its extreme left hand position, it contacts these rollers, pushing them back against the force of compression springs 35 and opening the gates 30. At this moment, the leading component is held between an end plate on the carriage and the second component in the magazine.

The first component is then removed from the magazine by the gripping mechanism about to be described. Once it has been removed and the carriage has moved on carrying it, the gates 30 close again and the pusher 27 at the left hand end of the magazine advances the components in the magazine one place and will push the component marked 2 in Fig. 4 through the pawls 31 to take up the first position at the right hand end of the magazine.

Also shown in this Figure is a "part-present" switch 36.

The exploded view of the carriage body shown in Fig. 5 shows the three basic parts. Chain dotted lines in this Figure indicate how the parts fit together. The central part 40 is the inserter plate which moves up and down to lower the components into the machine fixtures. Two parallel guide rods 41 extend between upper and lower lugs on the plate 40 and pass through bushings 42 on the end plate 43. Sealed, recirculating ball bearings are used between the guide rods 41 and the inner surfaces of the bushings 42.

The inserter place 40 has a cavity 44 on one face, and this cavity accommodates a gripper which grips the components and picks them up from the magazine. This gripper will be described in more detail in connection with the next Figure.

The end plate 43 has an upper flange 45 on which is mounted a piston/cylinder unit which raises and lowers the inserter plate 40. This cylinder is not shown in Fig. 5, but is mounted below the flange 45 with piston rod passing up and working through the hole 46. The piston rod works against a similar flange bolted to the top of the inserter plate 40 and again not shown in this Figure.

The lower half 47 of the end plate 43 forms an end face which supports each component as it is extracted from the magazine and lowered into the machine fixture. Also mounted on the end plate 43 is a support 48 for a piston/cylinder unit which lowers the latch 13 into engagement with a detent on the fixture 3.

The left hand part 49 carries bushes 50 which slide on the guide rails 11. Again, sealed recirculating ball bearings are used between the bushes 50 and the rods 11. Various components are mounted on the bridge 51 between the bushings 50. These components are not shown in Fig. 5 but will be described with reference to the later drawings.

Fig. 6 shows a view of the carriage 10 looking from the magazine, with the inserter plate 40 raised. This Figure shows the gripper jaws 60 and the piston of the cylinder unit 61 by which they are operated. The operation of the jaws will not be described in detail because the jaws are in themselves known. Actuation of the cylinder 61 however causes the jaws 60 to approach one other to grip a component which at this stage is found between them. Once the component is gripped, continued operation of the unit 61 slightly raises the component to bring it free of the supporting rails of the magazine.

Also seen in this Figure (behind the inserter plate 40) is the cylinder 62 which is used to raise and lower the inserter plate (with the gripper jaws 60) relative to the rest of the carriage body.

Fig. 7 is a view from above showing the means by which the carriage 10 is recipocated along the rails 11. A pneumatic cylinder 12 is mounted on a fixed plate 70 with its piston rod 71 extending through the plate. The piston rod 71 ends in a T-nut which is received in a corresponding cavity within a connector 72. The T-nut connection allows for some degree of misalignment between the axis of the piston rod 71 and the centre line of the carriage 10.

The connector 72 is mounted on the web 51 and is sandwiched between upper and lower plates. On the upper plate, a switch 73 is mounted. This switch has a switch arm 74 biassed against an abutment 75 formed on the T-nut at the end of the piston rod 71. The upper plate (onto which one is looking in Fig. 7) is formed with an aperture to allow the abutment 75 to project upwards.

Should the T-nut and thus the abutment 75 move to the left relative to the carriage 10, the switch arm 74 will move to operate the switch 73 resulting in shut down of the

machine tool. Such movement may occur when an overload is produced on the carriage, for example if a component jams between the fixture 3 on the machine tool and between the carriage 10. In this event the chain of the machine tool will tend to carry the component to the right and try to drag the carriage with it. Should this occur however the forces imposed will tend to drag the connector 72 out of its socket in the carriage, and the switch 73 will be operated through movement of the abutment 75 and arm 74. To ensure that this movement occurs at the desired moment, the connector 72 is held in the carriage 10 by means of two spring-loaded plungers 76 which extend laterally into detents 77 in the body of the connector 72. Since the sides of the detents 77 are inclined, it will be seen that a strong pull on the carriage to the right, when the piston rod 71 will move no further, will cause the plungers 76 to be pushed back into their sockets against their biasing springs allowing the connector to move.

To prevent the connector 72 becoming completely detached from the carriage 10, its rearward travel is limited by lugs 78 moving in grooves 79. Resulting of the connector position once the argument between the fixture and the carriage has been resolved is thus relatively simple since it is only necessary to firmly push the connector 72 back into position.

In addition to the components so far described, Fig. 7 also shows shock absorbers 80 which cushion the rapid return movement of the carriage along the rails 11, and stops 81 which determine the final left hand end position of the carriage.

This Figure shows the top end of the inserter slide 40 with the cylinder 61 which operates the gripper jaws and the cylinder 62 which acts between the flange 45 on the end plate 43 and a flange 83 which can now be seen mounted on the top of the inserter plate 40. This cylinder 62 raises and lowers the inserter plate relative to the rest of the carriage.

Fig. 8 shows the connection between the piston rod of the cylinder 62 which raises and lowers the inserter plate 40 (the piston rod has the reference 90 in Figure 8) and the top flange 83 of the inserter plate 40. This connection is designed to respond when there is an unduly large vertical force between the inserter plate and the rest of the carriage caused, for example, by the lower end of the component missing the opening between the jaws of the fixture 3. It should be remembered that the piston rod 90 shown in Fig. 8 pulls downward to move the inserter plate 40, and its flange 83, downward to lower the component held in the gripping jaws 60.

Attached to the top of the piston rod 90 is a component 91 which slides inside a collar 92 which has an internally tapered seat 93. The component 91 carries two concentrically pivoted blades 94 and 95. These blades have outer surfaces which, as can be seen in Fig. 8, mate with the internal tapered seat 93. Their top faces form a seat for a spring-loaded button 96 which has a conical lower face which acts to spread apart the blades 94 and 95 into the position shown.

When all the components are in the position shown in Fig. 8, a downward force on the piston rod 90 causes a force to be transmitted through the outer edges of the blades 94 and 95 onto the tapered seat 93, and this causes the inserter 40 to be pulled down. However should there be some resistance to this downward movement, the blades 94 and 95 will tend to pivot towards one another thus slipping down the tapered surface 93. Because of the configuration of their top faces, they will push the button 96 upwards against the force of the biasing spring. Above the button 96, a proximity switch 97 is mounted. This switch detects movement of the button 96 either towards or away from the switch and provides a signal which can be used to shut down the machine tool until the fault condition has been rectified.

Rapid movements of the carriage are essential if the necessary synchronism with the machine fixture is to be achieved. For example, on a chain broach machine to which a loading device as described was attached, loading has to be accomplished in about three and a half seconds, whilst the fixture moves a distance of about 30 cm. In order to be able to guarantee the necessary rapidity of movement, in particular the retraction of 35 the carriage between each step, pneumatic cylinders rather than hydraulic cylinders are used to perform the main translation functions.

CLAIMS

1. A loading device for loading workpieces into a machine tool which has a continuously moving, workpiece-holding fixture, the loading device having a magazine for storing workpieces to be loaded and a movable carriage adapted to take a workpiece from the magazine and to load it into the fixture, the carriage including a carriage body and an inserter adapted to hold a workpiece, first driving means for driving the carriage body in the same direction and at the same speed as the machine tool fixture and second driving means for driving the inserter for movement relative to the carriage body and towards the fixture, the inserter being mounted between end plates of the carriage body and being movable relative to the carriage body on a first set of parallel guide rods.

2. A loading device as claimed in Claim 1, wherein the carriage is mounted for sliding movement on a second set of parallel rods, and the relatively movable surfaces between the carriage and the second guide rods and

between the inserter and the first guide rods are provided with sealed bearings.

3. A loading device as claimed in Claim 2, wherein the bearings are recirculating ball bearings.

4. A loading device as claimed in any preceding claim, wherein the carriage is of fabricated construction.

5. A loading device as claimed in any preceding claim, wherein the carriage is connected to the first driving means by a connector which is fitted in the carriage and is capable of axial movement relative to the carriage but in normal operation is restrained against such axial movement by restraining means, the restraining effect of the restraining means being overcome in abnormal operation, and wherein a sensor is connected between the connector and the carriage to sense relative axial movement between the carriage and the connector so that the machine tool can be switched off immediately such movement takes place.

6. A loading device as claimed in Claim 5, wherein the sensor is a switch mounted on the carriage with a switch arm biassed against the connector.

7. A loading device as claimed in Claim 5 or Claim 6, wherein the restraining means comprise spring-loaded plungers which engage laterally in detents in the sides of the connector.

8. A loading device as claimed in any preceding claim, wherein a load sensing mechanism is associated with the inserter, to sense loads above a predetermined level occuring in the direction of insertion movement of the inserter, so that the machine tool can be switched off immediately a load above the predetermined level is sensed.

9. A loading device as claimed in Claim 9, wherein the load sensing mechanism comprises a component spring-biassed into a load-transmitting position and arranged so that when a load above the predetermined level occurs, the component moves against the spring biassing to cause a switch to operate.

10. A loading device as claimed in any preceding claim, wherein workpieces are raised to the magazine by a vertical shuttle.

11. A loading device for loading workpieces into a machine tool, substantially as herein described with reference to the accompanying drawings.

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