PATENT SPECIFICATION (11) 1 590 089

1 590 089

(21) Application No. 43667/77 (22) Filed 20 Oct. 1977
(23) Complete Specification filed 19 May 1978
(44) Complete Specification published 28 May 1981
(51) INT. CL.³ B65H 5/10
(52) Index at acceptance
B8R 652 653 663 664 741 AL

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(19)

(54) WORKPIECE FEED MECHANISM

(71) We, TOOL PRODUCTION & DESIGN CO., LIMITED a British Company of Lichfield Road Industrial Estate, Tamworth, Staffs, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:–

This invention relates to a feed mechanism for transferring workpieces from a loading station to an unloading station, of the kind comprising carrier means which is operable to grip a workpiece at the loading station and to support the workpiece during its transference to the unloading station.

According to the present invention, there is provided a feed mechanism for transferring workpieces from a loading station to an unloading station, comprising carrier means operable to grip a workpiece during its transference to the unloading station, a frame with respect to which the carrier means is movable horizontally between first and second positions corresponding to the loading and unloading stations for the workpiece, moving means operable to move the carrier means upwardly and downwardly relative to the frame, and a cam mechanism controlling operation of the moving means, the cam mechanism including a cam which is moved in response to the carrier means reaching either of said first and second positions and a cam follower which is arranged to cause operation of the moving means as it moves onto or off a predetermined portion of the cam.

Preferably, the carrier means is movable vertically upwardly and downwardly relative to the frame, so that it can be raised or lowered vertically into engagement each workpiece at the loading station. In this manner, when the workpieces are stored in a stack at the loading station, or where the workpieces are of differing heights, the carrier means can be lowered vertically into engagement with each workpiece, and the workpiece will always be correctly deposited at the unloading station.

Desirably, means is selectively operable to restrict operation of the cam mechanism so that the moving means only either raises or lowers the carrier means in each of the first and second positions of the latter.

Conveniently, the cam follower is arranged to cause operation of the moving means in one direction as it moves onto said predetermined portion of the cam and in the opposite direction as it moves off said predetermined portion. In one particular arrangement, the cam is reciprocable (preferably, angularly so), and stop means is provided which can be positioned so as to limit movement of the cam in one direction or the other and thereby prevent the cam follower from moving off a respective end of said predetermined portion of the cam.

A detection device can be provided which is arranged to detect when the workpiece is not successfully received from the carrier means at the unloading station, and/or a sensing device can be provided which is arranged to detect when more than one workpiece has been gripped by the carrier means at the loading station. Preferably, the detection device and the sensing device are constituted by one and the same construction.

The feed mechanism advantageously also comprises a slide movable rectilinearly relative to the frame, the carrier means being mounted on the slide for horizontal movement therewith relative to the frame and being movable upwardly and downwardly relative thereto. Alternatively, however, the carrier means can be pivotable relative to the frame about a vertical pivot axis, no such slide being provided.

Embodiments of the present invention will now be described by way of example, with reference to the accompanying drawings, in which:–

Figure 1 is a schematic side view, partly in section of a feed mechanism according to the present invention, for transferring plate-like workpieces from a stack to a forming machine;

Figure 2 is a schematic plan view, partly in section of the feed mechanism of Figure 1;

Figure 3 is a similar view to Figure 1 showing the feed mechanism in a different position;

Figure 4 is a schematic side view of part of the feed mechanism which has been omitted from Figures 1 to 3 for clarity;

Figure 5 is a side view of a cam mechanism which forms part of the feed mechanism shown in Figures 1 to 3;

Figure 6 is a side view of the cam mechanism when in a different position to that illustrated in Figure 5;

Figure 7 is a schematic side view of a further part of the feed mechanism shown in Figures 1 to 3;

Figure 8 is a view in the direction of arrow VIII in Figures 1 and 2 of a stripping mechanism forming part of the feed mechanism;

Figure 9 is a view in the direction of arrow IX in Figures 1 and 2 of a detection device forming part of the feed mechanism;

Figure 10 is a section taken along the line X-X in Figure 9;

Figure 11 is a side elevation of an interlock mechanism which preferably forms a part of the feed mechanism shown in Figures 1 to 10;

Figures 12 and 13 are side views of respective parts of a modified form of feed mechanism according to the present invention;

Figure 14 is a sectional plan view of a part of another modified form of feed mechanism according to the present invention;

Figure 15 is a section taken along the line XV-XV in Figure 14;

Figure 16 is a side view of part of a further modified form of feed mechanism according to the present invention;

Figures 17 and 18 are sectional side views of one form of carrier device for use in a feed mechanism according to the present invention, showing the carrier device in two different positions;

Figure 19 is a sectional side view of a second form of carrier device; and

Figure 20 is a plane view of a third form of carrier device.

Referring first to Figures 1 and 2, the feed mechanism is designed to transfer workpieces from a loading zone L to an unloading zone U, and comprises generally a frame 10, a slide 11 movable rectilinearly relative to the frame 10, and carrier means 12 mounted on the slide 11 for movement therewith relative to the frame 10. In use, the frame 10 is attached to a bed 13 of a press the unloading zone U being defined by a lower press tool of the press (illustrated diagrammatically at 14), the slide 11 being reciprocable horizontally towards and away from the press. The level of the frame 10 relative to the press can be adjusted by means of a manually rotatable wheel 15.

The slide 11 is reciprocated in use by means of a double-acting pneumatic piston and cylinder assembly 16 which is pivotally mounted on the frame 10. A piston rod 17 of the assembly 16 is connected to a crank 18 which is in turn mounted for pivotal movement about a shaft 19 secured to the frame 10. A pivotal link 20 operatively interconnects a radially outer end of the crank 18 and the slide 11. A buffer or shock-absorber 21 is provided on the frame 10 so as to be engageable by the slide 11 at the end of its movement away from the press. A further buffer or shock-absorber 21*a* is mounted on the frame 10 adjacent the crank 18 (See Figure 4) and is engageable by a stop 21*b* mounted on the crank 18 when the slide 11 reaches an extreme forward position. The buffer 21*a* thus acts to limit movement of the slide 11 towards the press.

An interlock mechanism is provided for arresting movement of the slide 11, and comprises a lever 22 pivotally mounted on the frame 10 at a point 23 and movable into and out of the path of movement of the slide 11 by means of a double acting pneumatic piston and cylinder assembly 24. For the sake of clarity, the interlock mechanism has been omitted from Figures 1 and 3.

The carrier means 12 is mounted on the slide for vertical movement relative thereto, such movement being effected by means of a piston rod 26 of a pneumatic piston and cylinder assembly 27. The carrier means 12 comprises generally a body 28, a sideways-cranked arm 29 extending forwardly from the body 28, and a carrier device 30 mounted on the forward end of the arm 29. The carrier means 12 is constrained to move vertically relative to the slide 11 by means of a pillar 31 and a guide 32 on the latter, the pillar 31 passing through a bore 33 in the body 28 and the guide 32 being engaged on opposite sides by respective rollers 34 carried by the rear end of the body 28. A cross-member 35 interconnecting the upper ends of the pillar 31 and the guide 32 is provided for rigidity and serves to limit upward movement of the body 28. The body 28 has a recess 36 in its underside in which an actuating member 37 on the upper end of the piston rod 26 can engage.

Operation of the piston and cylinder assembly 27 is controlled by a driven cam mechanism which is shown in detail in Figures 5 and 6. The cam mechanism includes a linear cam 39 having a raised central portion 40, the cam 39 being carried by a plate 40*a* and being reciprocable in its direction of extent relative to the plate under the action of a double-acting piston and cylinder assembly 41. The cam 39 is constrained to such movement by a pair of guides 41*a* mounted on the plate 40*a* and disposed one on each side of the cam portion 40, a stop 41*b* being provided at each end of the cam 39 to limit the movement of the latter by engagement with the respective guide 41*a*. A cam follower, comprising a roller 42 on an end of a pivotable arm 43 is carried by the frame 10

and is urged into engagement with the cam 39, the arm 43 being arranged to operate an actuating device 44 when the roller 42 engages the raised portion 40 of the cam 39. As will be explained in detail later, the device 44 when so operated de-pressurizes the piston and cylinder assembly 27 so as to allow the actuator member 37 to descend. When the device 44 is not thus operated, pressurized air is supplied to the piston and cylinder assembly 27 so as to move the actuator member 37 upwardly.

Operation of the piston and cylinder is controlled by an actuator device 46 mounted on the frame 10 adjacent the crank 18. This is shown to advantage in Figure 7. A side ways-extending projection 47 on the crank 18 is received in an arcuate slot 48 in a control plate 49 and is arranged to move along the slot 48 as the crank 18 is rotated about the shaft 19 under the action of the piston and cylinder assembly 16. The control plate 49 is mounted on the shaft 19 for limited pivotal movement, and the angular extent of the slot 48 is arranged to be slightly less than the throw of the projection 47 so that, at the end of the movement of the crank 18 in either direction, the projection 47 engages a respective end of the slot 48 and causes the control plate 49 to pivot about the shaft 19. This action brings a respective one of two operating arms 50 on the plate 49 into engagement with the actuator device 46, thereby operating same. The detailed operation of this arrangement will be described later.

Operation of the piston and cylinder assembly 16, which reciprocates the slide 11, is controlled by two actuator devices 52, 53 disposed so as to be operable by an actuator member 54 extending sideways from the body 28 of the carrier means 12 (see Figure 2). Each actuator device 52, 53 has a respective pivotable operating member 55, 56 associated therewith which is arranged to be engaged by the actuator member 54. In use, rotation of the operating member 55, 56 in one direction causes a respective pivotable lever 57, 58 to actuate the device 52, 53, rotation in the other direction being ineffective to actuate the device 52, 53. The operation of the actuator devices 52 and 53 will be described in detail below.

Disposed alongside the slide 11 is a stripping mechanism 60 which is operable by an abutment, in the form of a bolt 61 in screw-threaded engagement with the body 28 of the carrier means 12, to cause a workpiece to be released or stripped from the carrier device 30. The stripping mechanism 60 is shown to advantage in Figure 8 and comprises an actuator device 62 which is fixed relative to the frame 10, a lever 63 which is pivotable relative to the frame 10 about a pivot 64, and an abutment surface 65 on the lever 63. The abutment surface 65 is positioned so as to be engaged by the lower end of the bolt 61 when the slide 11 is in its extreme forward position and the carrier means 12 is descending. The point during the descent of the carrier means 12 at which the surface 65 is thus engaged can be adjusted by adjusting the bolt 61 relative to the body 28 or by adjusting the height of the mechanism 60 relative to the frame 10, thereby giving a measure of control on the level at which the workpiece is released. Engagement of the bolt 61 with the surface 65 causes the lever 63 to rotate about the pivot 64 and operate the actuator device 62, thereby causing stripping of the workpiece from the carrier device 30.

The operation of the feed mechanism thus far described is as follows. Initially, the interlock mechanism holds the slide 11 against movement relative to the frame 10 at a small distance forward of its extreme rearward position, so that an operator can stack workpieces at the loading station L. This action is assisted by the carrier device 30 being offset from the centreline of the slide 11. The piston and cylinder assembly 24 is then operated so as to release the interlock, and the piston and cylinder assembly 16 (which is pressurised at this time) causes the slide 11 to move rearwardly into engagement with the buffer 21. Although this action causes the actuator member 54 on the carrier means 12 to engage the operating member 55 and rotate the latter anticlockwise (as viewed in Figure 1), as mentioned above this does not cause actuation of the actuator device 52.

As the slide 11 reaches its extreme rearward position, the control plate 49 is caused to pivot about the shaft 19 in the manner described previously, thereby bringing the lefthand arm 50 of the plate 49 into engagement with the actuator device 46. Such engagement actuates the device 46 so as to cause pressurization of the piston and cylinder assembly 41, thereby moving the cam 39 to the right from the position shown in Figure 5. The roller 42, which at this time is disposed off the raised portion 40 of the cam 39, then rides onto one end of the raised portion 40 causing the lever 43 to pivot and operate the actuator device 44. Operation of the device 44 causes depressurisation of the piston and cylinder assembly 27, as mentioned above, and the carrier means 12 descends until the carrier device 30 comes into engagement with the top workpiece on the stack and grips same. Vertical movement of the carrier means 12 is thereby arrested, and continued depressurisation of the piston and cylinder assembly 27 causes the actuator member 37 to disengage from the recess 36 in the body 28 of the carrier means 12. The actuator member 37 continues to descend until it reaches a bottom position, whereupon the feed mechanism is in the position illustrated

in Figure 1.

During pressurisation of the piston and cylinder assembly 27, the cam 39 continues in its movement. The rate at which the cam 39 moves is so arranged relative to the rate of descent of the actuator member 37 that the roller 42 rides off the other end of the raised portion 40 of the cam 39 only after the member 37 has reached its bottom position. Such riding off of the roller 42 causes the lever 43 to pivot and de-actuate the actuator device 44, thereby causing the piston and cylinder assembly 27 to be pressurised. Actuator member 37 then moves upwardly back into engagement with the recess 36, whereupon the carrier means 12 moves upwardly also. Movement of the cam 39 is halted when the left-hand stop 41*b* engages the left-hand guide 41*a*, whereupon the cam mechanism is in the position illustrated in Figure 6.

As the carrier means 12 moves into its uppermost position (wherein further upward movement is prevented by the cross-member 35), the actuator member 54 engages the operating member 55 and rotates the latter clockwise, thereby moving the lever 57 so as to actuate the actuator device 52. The piston and cylinder assembly 16 then becomes pressurised in the opposite direction, and the slide 11 is advanced into its extreme forward position. The feed mechanism is then in the position illustrated in Figure 3. As the slide 11 moves into its extreme forward position, the actuator member 54 on the carrier means 12 engages the operating member 56 and rotates the latter clockwise. However, as mentioned above, this action does not cause the actuator device 53 to be actuated.

As the slide 11 reaches its extreme forward position, the control plate 49 is caused to pivot so as to bring its right-hand arm 50 into engagement with the actuator device 46. Such engagement causes the actuator device 46 to pressure the piston and cylinder assembly 41 in the opposite direction so as to move the cam 39 to the left, as viewed in Figure 6. When the roller 42 rides onto the raised portion 40 of the cam 39, the actuator device 44 is operated as before to depressurise the piston and cylinder assembly 27. The carrier device 12 then descends until the bolt 61 engages the abutment surface 65 of the stripping mechanism 60, whereupon the actuator device 62 is actuated as described above to release the workpiece from the carrier device 30 onto the press tool 14.

The press tool 14 is advantageously provided with location pins 67 for locating the workpiece correctly thereon. The stripping mechanism 60 is then adjusted so that the workpiece is not released from the carrier device 30 until it is at a level below the upper ends of these pins 67. In this way, correct location of the workpiece on the press tool 14 is ensured. Also, in the event that the workpiece is mis-located on the press tool 14, it will engage the upper ends of the location pins 67 and prevent the carrier means 12 from descending fully. This in turn will prevent the bolt 61 from moving sufficiently far downwardly to actuate the stripping mecahnism 60, so that the workpiece is not released from the carrier device 30.

When the roller 42 rides off the raised cam portion 40, the actuator device 44 is de-actuated and the piston and cylinder assembly 27 is repressurised so as to move the carrier means 12 upwardly. As the carrier means 12 reaches it uppermost position, the actuator member 54 thereon engages the operating member 56 and rotates the latter anticlockwise, thereby pivotting the lever 58 and actuating the actuator device 53. The piston and cylinder assembly 16 is then pressurised so as to move the slide 11 back into its extreme rearward position. The cycle of operations is then repeated.

As the slide 11 returns to its extreme rearward position, a block 68 mounted on the crank 18 (see Figure 4) engages an operating member 69*a* pivotally carried by the frame 10 and rotates the latter anticlockwise. This in turn moves a pivotal lever 69*b* to operate an actuator device 69*c*, whereupon the press is operated to perform a pressing of the like operation on the workpiece. The finished component produced from the workpiece can be arranged to be ejected from the press by the arm 29 of the carrier means 12 during the following forward stroke of the feed mechanism. It will be manifest that the actuator device 69*c* is not operated during forward movement of the slide 11, since the block 68 at this time rotates the operating member 69*a* clockwise, i.e. away from the pivotal lever 69*b*.

Operation of the feed mechanism can be terminated at any time, particularly when the stack of workpieces at the loading station L has been exhausted, by actuating the interlock mechanism.

The feed mechanism further comprises a device 70 for detecting its correct operation. The detection device 70 is shown to advantage in Figures 2 and 9, and includes a base 71 mounted on the frame 10, a pair of jaws 72 carried by an arm 72*a* which is pivotable relative to the base 71 about a vertical pivot 73 and a horizontal pivot 73*a*, and an actuator device 74 which is arranged to be actuated by pivotal movement of the arm 72*a* relative to the base 71 about the vertical pivot 73. The actuator device 74 includes a pivotable actuating arm 75 having a roller 76 at one end, the roller 76 engaging a cam 77 which is pivotable relative to the base 71 with the jaws 72. The cam 77 includes a cut-out portion 78 (see Figure 10) with which the roller 76 normally engages, pivotal move-

ment of the arm 72*a* relative to the base 71 about the vertical pivot 73 causing the roller 76 to ride out of the cut-out portion 78 and pivot the actuating arm 75 so as to actuate the device 74. Actuation of the device 74 automatically brings the interlock mechanism into operation to arrest the slide 11.

The jaws 72 are disposed so that the workpiece must pass therebetween as it is moved from the loading station L to the unloading station U at the press. The jaws 72 have a predetermined clearance therebetween which is set to slightly less than two workpiece thicknesses. The jaws are each pivotable relative to the arm 72*a* about a respective horizontal axis perpendicular to the direction of movement of the workpiece, and are each provided with a chamfered leading edge so as to provide a lead-in for the workpiece. The upper jaw 72 is disposed in the path of movement of the workpiece so that the latter will contact the upper jaw during forward movement of the slide 11. However the chamfered leading edge and the pivotal mounting of that jaw enable it to pivot and allow the workpiece to pass thereby without operating the actuator device 74. In addition, the play between the jaws 72 caused by their pivotal mounting allow slightly distorted workpieces to pass therebetween without operating the actuator device.

In use, if more than one workpiece is inadvertently picked up by the carrier device 30, they will collide with the jaws 72, and being unable to pass therebetween, will cause the jaws 72 to pivot relative to the base 71 and actuate the actuator device 74 so as to stop operation of the feed mechanism. If, on the other hand, only one workpiece is picked up by the carrier device 30 but is not successfully released therefrom at the unloading station, the workpiece will collide with the non-chamfered edge of the upper jaw 72 as the carrier device 30 moves back to the loading station, and being unable to pass therebetween, will pivot the jaws 72 in the opposite direction relative to the base 71, thereby actuating the device 74 and arresting the slide 11. This effect can be enhanced by balancing the arm 72*a* so that it is normally tilted about the horizontal pivot 73*a*.

In order to ensure than an upper press tool (not shown) of the press cannot descend to perform a pressing operation on a workpiece while the arm 29 is in its forward position, an interlock mechanism of the type shown in Figure 11 can be provided. The interlock mechanism comprises a stand 80 mounted on the bed 13 of the press, and a support 81 which is mounted on the stand 80 and which is vertially adjustable relative thereto by means of a bolt 82 on the support 81 engaging in an elongate shot 83 in the stand 80. A bell crank lever 84 is pivotably mounted on an upper end of the support 81 and carries rollers 85 and 86 on its arms, respectively. The roller 85 engages a member 87 which is movable vertically with a ram of the press, and the roller 86 engages a forward end of the arm 29. Thus, in the event that the arm 29 is not retracted from the press when the upper press tool commences its descent, the member 87 bears against the roller 85 and pivots the lever 84 so that the roller 86 pushes the arm 29 out of the way. The force exerted on the arm 29 in this manner is arranged to be sufficient to overcome the pneumatic pressure in the piston and cylinder assembly 16.

The interlock mechanism described previously comprising the lever 22 and the piston and cylinder assembly 24 is provided for arresting the slide at a point where there is no danger of the upper press tool descending and damaging the arm 29. Insofar as the interlock mechanism shown in Figure 11 also prevents the arm being damaged in this way, the former interlock mechanism can be dispensed with when the latter interlock mechanism is provided.

In the feed mechanism described above, the carrier means 12 is lowered and raised again in both the extreme forward and extreme rearward positions of the slide 11. The operation of the feed mechanism can, however, be modified according to the function it is to perform so that the carrier means 12 is raised only when the slide 11 is in its extreme forward position and is lowered only when the slide 11 is in its extreme rearward position. In this form, the feed mechanism is suitable, for example, for advancing a length of strip through the press in stages, the strip being advanced during each forward stroke of the carrier means in its lowered position, or for feeding cup-shaped workpieces where it is necessary to lower the carrier device 30 into the workpiece at the loading zone and raise the carrier device out of the workpiece at the unloading zone.

Such operation of the feed mechanism is achieved by replacing the operating member 55, pivotable lever 57 and actuator device 52 by the assembly illustrated in Figure 12 (corresponding parts being accorded the same reference numerals, but primed), and by mounting a block 90 on the cam 39 adjacent the left-hand stop 41*b*. The block 90 is illustrated in chain dotted line in Figure 5.

As the slide 11 moves into its extreme rearward position with the carrier means 12 raised, the actuator device 46 is operated as before to move the cam 39 to the right, as viewed in Figure 5. During such movement of the cam 39, the roller 42 rides onto the raised cam portion 40, thereby operating the actuator device 44 so as to depressurise the piston and cylinder assembly 27 and lower the carrier means 12. Further movement of the cam 39 to the right is prevented by

engagement of the block 90 with the left-hand guide 41*a*, so that the roller 42 remains in engagement with the raised cam portion 40 and the piston and cylinder assembly 27 remains depressurised. As the carrier means 12 reaches its lowermost position, the actuator member 54 thereon strikes the operating member 55' in a downward direction and rotates the latter anticlockwise, thereby pivoting the lever 57' and operating the actuator device 52'. Such operation of the actuator device 52' causes the slide 11 to be moved forwardly, the carrier means 12 being held in its lowermost position during this movement.

As the slide 11 reaches its extreme forward position, the actuator device 46 is operated so as to move the cam 39 to the left, as viewed in Figure 5. This causes the roller 42 to ride off the raised cam portion 40, thereby de-actuating the device 44 and causing repressurisation of the piston and cylinder assembly 27, so as to raise the carrier means 12. As the carrier means 12 reaches its uppermost position, the actuator member 54 strikes the operating member 56' from below, thereby rotating the latter clockwise so as to pivot the lever 58' and operate the actuator device 53'. This in turn causes the slide 11 to be moved rearwardly, whereupon the cycle of operating recommences. It will be manifest that during this cycle of operations the roller 42 moves onto and off the same end i.e. the right-hand end of the raised cam portion 40.

The operation of the feed mechanism can also be modified so that the carrier means 12 is raised only when the slide 11 is in its extreme rearward position and is lowered only when the slide 11 is in its extreme forward position. In this form, the feed mechanism is particularly suited to the feeding of workpieces which are flanged at or adjacent their upper ends, in which case the carrier device (which may consist merely of a plate having a slot therein which opens onto the forward end of the plate) is engaged with the workpiece from below so that the workpiece is supported thereon by its flange, and is disengaged therefrom by lowering the carrier device beyond the point where the workpiece comes to rest on the lower press tool.

Such operation of the feed mechanism is achieved by replacing the operating member 55, pivotable lever 57 and actuator device 52 by the assembly illustrated in Figure 13 and by mounting a block 91 on the cam 39 adjacent the right-hand stop 41*b*, as shown in chain dotted lines in Figure 6. Operation of the feed mechanism is similar to that described immediately above, *mutatis mutandis*. It will be manifest that the roller 42 will now ride onto and off the raised cam portion 40 at the left-hand end thereof.

By these simple alterations, the feed mechanism is given great versatility in the manner in which it can be operated with a minimum of modification.

Using the arrangement of the actuator member 54, the operating members 55, 56 and the levers 57, 58 as described above, it is necessary for the carrier means 12 to move sufficiently for vertically to ensure the appropriate pivotal movement of the members 55 and 56 for proper actuation of the actuator devices 52 and 53. An arrangement which requires only a minimum of vertical movement of the carrier means is illustrated in Figures 14 and 15. In this arrangement, the actuator member 54 is replaced by an actuating device 100 which comprises a first arm 101 mounted on the body 28 of the carrier means 12 for pivotal movement about a vertical pivot 102, and a second arm 103 mounted on the arm 101 for pivotal movement relative thereto about a vertical pivot 104. The arm 101 is biassed anti-clockwise (as viewed in Figure 14) by a spring 105, but rotation thereof under this bias is limited by engagement of a shoulder 106 on the arm 101 with an abutment 107 on the carrier body 28. The arm 103 is biassed clockwise relative to the arm 101 by a spring 108 interposed therebetween, but rotation thereof under this bias is limited by engagement of an abutment 109 on the arm 103 with a shoulder 110 on the arm 101.

Each of the actuator devices 52 and 53 is now mounted so that an actuator pin 111 thereof is disposed in the path of the actuating device 100 as the carrier means 12 is moved along the frame 10 in its raised position. The arrangement of the actuator device 53 is as illustrated in Figure 15, it being understood that the actuator device 52 is arranged similarly thereto. As the slide 11 is moved into its extreme forward position, the arm 101 comes into engagement with the side of the actuator pin 111 of the actuator device 53 and is pivoted anti-clockwise thereby against the action of the spring 105. Upon subsequent lowering of the carrier means 12, the arm 101 moves beyond the lower end of the pin 111, whereupon it springs back to its starting position under the action of the spring 105. As the carrier means 12 is raised after the unloading of a workpiece, the arm 101 is now in a position to depress the pin 111 when the carrier means 12 moves into its fully raised position, thereby actuating the actuator device 53 and initiating rearward movement of the slide 11.

The same sequence of events occurs *mutatis mutandis* with the actuator device 52 as the slide 11 moves into its extreme rearward position, except that the arm 101 remains stationary and instead the arm 103 pivots about the pivot pin 104 under the control of the spring 108.

The actuator device 100 thus ensures proper raising and lowering of the carrier

means 12 at each end of the travel of the slide 11 in the same manner as the actuator member 54, but the amount by which it is necessary to move the carrier means 12 vertically for this purpose is only that sufficient to clear the end of each actuator pin 111.

It is possible to alter the arrangement shown in Figures 14 and 15 so as to accommodate for the different functions of the feed mechanism described previously. This is done by securing a bracket 112 (shown in broken lines) to the forward-facing side of the arm 101, and by using a bolt 113 to mount a bracket 114 (also shown in broken lines) on the frame 10 in the vicinity of the actuator device 52 or 53, as the case may be, so that the bracket 114 is pivotable about the bolt 113. One end of the bracket 114 is disposed for engagement with the actuator pin 111 of the actuator device 52 or 53, the other end thereof having a bolt 115 adjustably mounted thereon for engagement with the bracket 112. When the carrier means 12 is lowered, the bracket 112 engages the bolt 115 and pivots the bracket 114 anti-clockwise about the bolt 113 (as viewed in Figure 15), thereby depressing the pin 111 and operating the actuator device 52 or 53 to reverse the movement of the slide 11.

It will be manifest that the bracket 114 is mounted adjacent the actuator device 53 when it is desired to lower the carrier means 12 only at the forward end of the slide travel and to raise the carrier means only at the rearward end thereof, and is mounted adjacent the actuator device 52 when it is desired to lower the carrier means only at the rearward end of the slide travel and to raise the carrier means only at the forward end thereof. The point during the lowering of the carrier means 12 at which the slide is moved in the reverse direction can be adjusted by suitable adjustment of the bolt 115. The blocks 90 and 91 associated with the cam 39 are, of course, used appropriately in conjunction with the brackets 112 and 114.

Using the arrangement shown in Figures 14 and 15, the feed mechanism can again be given great versatility in the manner in which it is operated with a minimum of modification.

The feed mechanisms described above make use of a linear cam 39. However, it is also possible to use a rotatable cam, for example in the manner shown in Figure 16. In this Figure, the rotatable cam (referenced 120) comprises a sector-shaped portion 121 whose circumferential ends are chamfered, and an arm portion 122 which is pivotally connected to a piston rod of the piston and cylinder assembly 41. The cam 120 is rotatable about the centre of curvature of the sector-shaped portion 121, and this portion is arranged to engage the roller 42 on the arm 43 during a part of the rotation of the cam so as to pivot the arm 43 and thereby operate the actuating device 44.

Where the feed mechanism is operated so that the carrier means is lowered and raised at both the forward and rearward ends of the slide travel, rotational movement of the cam 120 is limited by a pair of bolts 123 and 124 positioned as illustrated. The cam is then free to rotate sufficiently far to allow the roller 42 to disengage from both circumferential ends of the sector-shaped portion 121. Where it is desired to operate the feed mechanism so that the carrier means is lowered only at the forward end of the slide travel and is raised only at the rearward end thereof, the bolt 123 is moved from its illustrated position into an adjacent bolt hole 125. Clockwise rotation of the cam 120, as viewed in Figure 16, is then arrested before the roller 42 can disengage from the respective end of the cam portion 121, but the cam 120 is still free to rotate sufficiently far in the anti-clockwise direction to permit the roller 42 to disengage from the other end of the portion 121. Where the feed mechanism is to be operated so that the carrier means is raised only at the forward end of the slide travel and is lowered only at the rearward end thereof, the bolt 123 is left in its illustrated position and the bolt 124 is moved into an adjacent bolt hole 126 to limit anti-clockwise rotation of the cam 120 in a similar manner. Such moving of the bolts 123, 124 will of course be performed in conjunction with suitable modification of the operating elements for the actuator devices 52 and 53 as described above.

A variety of carrier devices 30 can be used in the feed mechanisms described above, one form of the carrier device having already been described above. Three other forms of carrier devices are illustrated in Figures 17 to 20.

The carrier device shown in Figures 17 and 18 is of a magnetic type, and comprises a housing 130 which is mounted on a forward end of the arm 129 of the carrier means 12, and one or more magnets 131 secured to the arm 29 by a bolt 132 and spaced therefrom by a spacer 133 which surrounds the bolt 132. The housing 130 defines a cylinder therein which a hollow piston 134 made of non-magnetic material is slidably disposed. The piston 134 surrounds the magnet 131 and a spring 135 is located between the piston 134 and the magnet 131 so as to urge the piston 134 into a position in which it is retracted with the housing 130 and in which it does notproject beyond the magnet 131. A small clearance is provided between the outer periphery of the magnet 131 and the piston 134 to enable the magnet to tilt slightly relative to the housing 130, thereby ensuring that the full contact area of the magnet is used where the workpiece is slightly distorted.

When the carrier device reaches the loading zone L, it is in the condition shown in Figure 17, wherein the piston 134 is retracted. The magnet 131 is thus able to engage the uppermost workpiece W on the stack and hold same on the carrier device. The workpiece will, of course, be made of magnetisable material.

When the carrier device reaches the unloading zone U, pressurised air is supplied *via* a port 136 to the space above the piston 134 so as to move the piston downwardly against the action of the spring 135. This brings the piston 134 into engagement with the workpiece, whereupon further downward movement of the piston 134 disengages the workpiece from the magnet 131, thereby releasing the workpiece W from the carrier device onto the press tool 14, as illustrated in Figure 18. The space above the piston 134 is then exhausted to permit the piston to retract into the housing 130 under the action of the spring 135.

In an alternative embodiment (not illustrated), the or each magnet is provided with a downwardly extending projection for locating in an opening or recess in the workpiece where the workpiece is suitably shaped.

The carrier device illustrated in Figure 17 and 18 is particularly useful where more than one magnet 131 is used. Where only one such magnet is provided, a carrier device of the form shown in Figure 19 can be utilized. The carrier device comprises a hollow body 140 within which a non-magnetic piston 141 is slidable, a stem 142 of the piston extending slidably through a central hole in a magnet 143. The magnet 143 is loosely fitted in a recess 144 in the body 140 and is retained therein by means of bolts 145 on the body 140 which engage a flange 146 on the magnet 143. The magnet 143 is thus able to tilt relative to the body 140 to compensate for any slight distortion of the workpiece, as before. The workpiece can be disengaged from the magnet by introducing pressurised air through a port 147 into the space above the piston 141, thereby moving the piston 141 downwardly relative to the magnet 143.

The carrier device illustrated in Figure 20 can be used to carry certain workpieces of non-flat configuration, and comprises a plate 150 in which a hole 151 is provided and an arm 152 pivotally mounted on the plate 150 and biassed towards the hole 151 by a torsion spring 153. In use, a part of the workpiece is received within the hole 151 while the arm 152 is held away therefrom by a pin 154 (shown in broken lines) at the loading zone. Upon movement of the carrier means away from the loading zone, the arm 152 is urged by the spring 153 into engagement with said part of the workpiece so that the latter is gripped between the arm 152 and an opposed edge of the hole 151. Release of the workpiece from the carrier device is performed by a pin 155 (also shown in broken line) at the unloading zone which engages the arm 152 to pivot the latter away from the hole 151.

As an alternative to the above-described forms of carrier device, a suction-type device (not illustrated) can be used which comprises a cup engageable with the workpiece and means for applying a vacuum to the cup so as to hold the workpiece thereon. When the carrier device reaches the unloading station, the vacuum is temporarily released from the cup and a blast of air is passed therethrough. Not only does the blast of air assist in the release of the workpiece from the cup, but also clears the cup of any dirt or the like which may have been taken up from the workpiece.

In an alternative construction (not illustrated) to those described above, the slide 11 is dispensed with and the carrier means 12, instead of being movable rectilinearly relative to the frame, is mounted thereon for pivotal movement about a vertical pivot axis so that the carrier device 30 moves through a predetermined distance along an arc of a circle. Most preferably, the carrier means is arranged to pivot about the pillar 31. In this construction, appropriate modifications are made to the positioning of the actuator devices 52 and 53, the stripping mechanism 60, and the detection device 70, for example, and the piston and cylinder assembly 16 is arranged to drive the carrier means directly along its pivotal path. The carrier means is again movable vertically relative to the frame.

Previous designs of feed mechanism make use of a pivotable arm which is pivotable upwardly and downwardly about a horizontal pivot axis into engagement with each workpiece to be transported, where the workpieces are stacked at the loading station, in order to ensure that each workpiece is gripped at the same position, it has been necessary to provide complicated machinery to push the stack of workpieces progressively upwardly so that the top workpiece in the stack is always at the same level for engagement by the pivotable arm.

In contrast to this, each of the feed mechanisms described above utilises an arm which is movable vertically relative to the frame. Thus, where the workpieces are stored in a stack at the loading station, the point of engagement of the arm with successive workpieces in the stack will always be the same relative to the direction of horizontal travel of the carrier means 12, and this ensures that each workpiece is correctly deposited on the press regardless of the height of that workpiece within the stack. This will also be true where the workpieces are not stacked but are differing heights.

Each of the feed mechanisms described above can also easily deal with the stack of workpieces which are not completely flat, for example, which have lugs or protuberances thereon. This is advantageous over those conventional mechanisms for feeding workpieces from a stack, in which the workpieces are fed one at a time through a constriction from the bottom of the stack, because the lugs etc., prevent the workpieces from being removed easily from the bottom of the stack.

In addition, because of the carrier means is arranged to move horizontally relative to the frame between fixed stops (defined by shock absorbers), the feed mechanism is easily set and its operation is very accurate.

Moreover it is necessary to make only minimum modifications to an existing press to fit the feed mechanism thereto, and the only additional equipment required is a plate with vertical locations thereon for fitting to the bed of the press. Furthermore, a finished component produced by the press tools from the workpiece can be arranged to be ejected from the press by the forward movement of the carrier means.

WHAT WE CLAIM IS:–

1. A feed mechanism for transferring workpieces from a loading station to an unloading station, compirsing carrier means operably to grip a workpiece during its transference to the unloading station, a frame with respect to which the carrier means is movable horizontally between first and second positions corresponding to the loading and unloading stations for the workpiece, moving means operable to move the carrier means upwardly and downwardly relative to the frame, and a cam mechanism controlling operation of the moving means, the cam mechanism including a cam which is moved in response to the carrier means reaching either of said first and second positions and a cam follower which is arranged to cause operation of the moving means as it moves onto or off a predetermined portion of the cam.

2. A feed mechanism as claimed in Claim 1, wherein the carrier means is movable vertically upwardly and downwardly relative to the frame.

3. A feed mechanism as claimed in Claim 1 or 2, wherein means is selectively operable to restrict operation of the cam mechansim so that the moving means only either raises or lowers the carrier means in each of the first and second positions of the latter.

4. A feed mechansim as claimed in Claim 1, 2 or 3, wherein the cam follower is arranged to cause operation of the moving means in one direction as it moves onto said predetermined portion of the cam and in the opposite direction as it moves off said predetermined portion.

5. A feed mechanism as claimed in Claim 4, wherein the cam is reciprocable, and stop means is provided which can be positioned so as to limit movement of the cam in one direction or the other and thereby prevent the cam follower from moving off a respective end of said predetermined portion of the cam.

6. A feed mechanism as claimed in Claim 5, wherein the cam is angularly reciprocable.

7. A feed mechanism as claimed in any preceding claim, further comprising a detection device arranged to detect when the workpiece is not successfully released from the carrier means at the unloading station.

8. A feed mechanism as claimed in Claim 7, wherein the detection device includes a member positioned so as to obstruct passage of the workpiece during movement of the carriage means from said second position to said first position, and actuating means arranged to arrest movement of the carrier means in response to such obstruction.

9. A feed mechanism as claimed in Claim 8, wherein said member is disposed in the path of movement of the workpiece during movement of the carrier means between said first and second positions, has a chamfered edge which is presented to the workpiece only during transference of the latter to the unloading station, and is arranged to be moved out of the path of the workpiece by engagement of the latter with said chamfered edge.

10. A feed mechanism as claimed in Claim 9, wherein said member is pivotable about an axis transverse to the direction of movement of the workpiece.

11. A feed mechanism as claimed in Claim 8, 9 or 10, wherein the detection device also includes a base with respect to which said member is arranged to move when it obstructs the workpiece, a cam mounted for movement relative to the base with said member, and a cam follower engaged with the cam and arranged to operate the actuating means in response to such movement of the cam.

12. A feed mechanism as claimed in Claim 11, wherein the cam and said member are mounted on the base for pivotal movement relative thereto about an axis transverse to the direction of movement of the workpiece.

13. A feed mechansim as claimed in any preceding claim, further comprising a sensing device arranged to detect when more than one workpiece has been gripped by the carrier means at the loading station.

14. A feed mechanism as claimed in Claim 13, wherein the sensing device includes a pair of jaws having a predetermined clearance therebetween and disposed so that the workpiece must pass through said clearance when being transferred to the unloading station, said clearance being determined such that the jaws obstruct the

passage therebetween of more than one workpiece at a time, and actuating means arranged to arrest movement of the carrier means in response to such obstruction.

15. A feed mechanism as claimed in Claim 14, wherein each of the jaws is pivotable about an axis transverse to the direction of movement of the workpiece and has a chamfered leading edge.

16. A feed mechanism as claimed in Claim 14 or 15, wherein the sensing device also includes a base with respect to which the jaws are arranged to move when they obstruct said workpieces, a cam mounted for movement relative to the base with the jaws, and a cam follower engaged with the cam and arranged to operate the actuating means in response to such movement of the cam.

17. A feed mechansim as claimed in Claim 16, wherein the jaws and the cam are mounted on the base for pivotal movement relative thereto about an axis transverse to the direction of movement of the workpiece.

18. A feed mechansim as claimed in Claim 13 when appended to Claim 7, wherein the detection device is constituted by the sensing device.

19. A feed mechansim as claimed in any preceding claim, wherein the carrier means includes a magnetic carrier device which comprises a magnet and a non-magnetic member movable relative to the magnet so as to engage the workpiece and disengage the latter from the magnet in use.

20. A feed mechanism as claimed in Claim 19, wherein the non-magnetic member is in the form of a fluid-actuated piston.

21. A feed mechanism as claimed in Claim 19 or 20, wherein the magnet is mounted for tilting movement relative to the remainder of the carrier means to compensate for distortion of the workpiece.

22. A feed mechansim as claimed in any one of claims 1 to 18, wherein the carrier means includes a member having a hole therein and an arm biassed towards the hole, the workpiece being gripped in use between the arm and an opposed side of the hole.

23. A feed mechanism as claimed in any preceding claim, further comprising a slide movable rectilinearly relative to the frame, the carrier means being mounted on the slide for horizontal movement therewith relative to the frame and being movable upwardly and downwardly relative thereto.

24. A feed mechanism as claimed in any one of Claims 1 to 22, wherein the carrier means is pivotable relative to the frame about a vertical axis.

25. A feed mechanism as claimed in any preceding claim, wherein the carrier means is moved horizontally relative to the frame by moving means whose operation is controlled by a pair of actuator devices, each actuator device being disposed so as to be operated by actuator means on the carrier means as the carrier means is moved into one of a raised or lowered position when in its first and second positions respectively.

26. A feed mechanism as claimed in Claim 25, wherein each actuator device has a pivotable operating member associated therewith and is arranged to be operated by pivoting of the operating member in one direction only, and the actuator means is arranged to engage and pivot the operating member in the opposite direction when the carrier means is moved into the respective one of said first and second positions in said one of the raised and lowered positions.

27. A feed mechanism as claimed in Claim 26, wherein each operating member is reversibly mounted with respect to its associated actuator device so that the direction in which it pivots to operate the latter can be reversed.

28. A feed mechanism as claimed in Claim 25, wherein each actuator device is operable by depression of a respective actuator pin, and the actuator means comprises first and second arms pivotably mounted on the carrier means, the first arm being biassed towards a position in which it can depress the actuator pin of one of the actuator devices when the carrier means is in a respective one of said first and second positions, the second arm being biassed towards a position in which it can depress the actuator pin of the other actuator device when the carrier means is in the other of said first and second positions, each arm being arranged to engage the respective actuator pin and to be pivoted thereby against the action of its bias when the carrier means is moved into the respective one of said first and second positions in said one of its raised and lowered positions.

29. A feed mechanism as claimed in Claim 28, further comprising a bracket which can be pivotably mounted on the frame for engagement with the actuator pin of one of the actuator devices, the bracket being engageable by the actuator means so as to depress said actuator pin when the carrier moves into the other of said raised and lowered positions in the respective one of said first and second positions.

30. A feed mechanism for transferring workpieces from a loading station to an unloading station, substantially as hereinbefore described with reference to Figures 1 to 11 and Figures 17 and 18 or 19 or Figure 20 of the accompanying drawings.

31. A feed mechanism for transferring workpieces from a loading station to an unloading station, substantially as hereinbefore described with reference to Figures 1 to 11 as modified by Figures 12 and 13 or as modified by Figures 14 and 15 of the accom-

panying drawings.

32. A feed mechanism for transferring workpieces from a loading station to an unloading station, substantially as hereinbefore described with reference to Figures 1 to 11 as modified by Figure 16 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1981. Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1590089 COMPLETE SPECIFICATION

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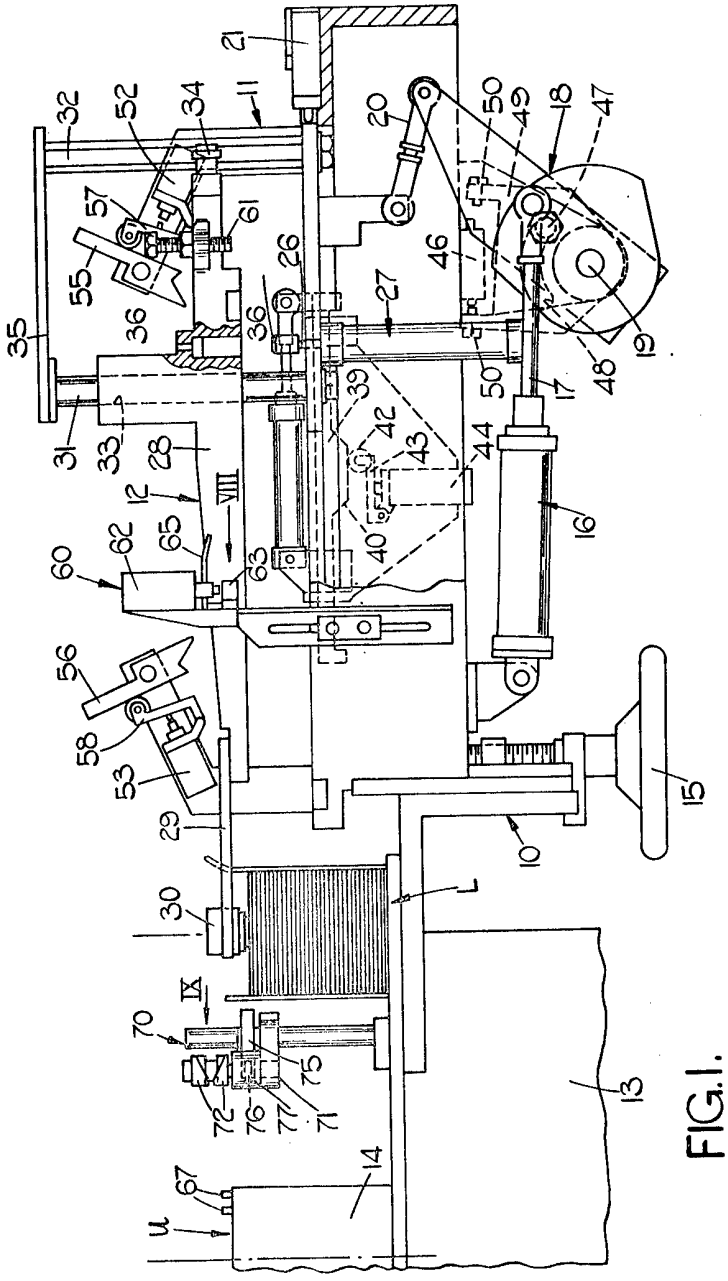

FIG.1.

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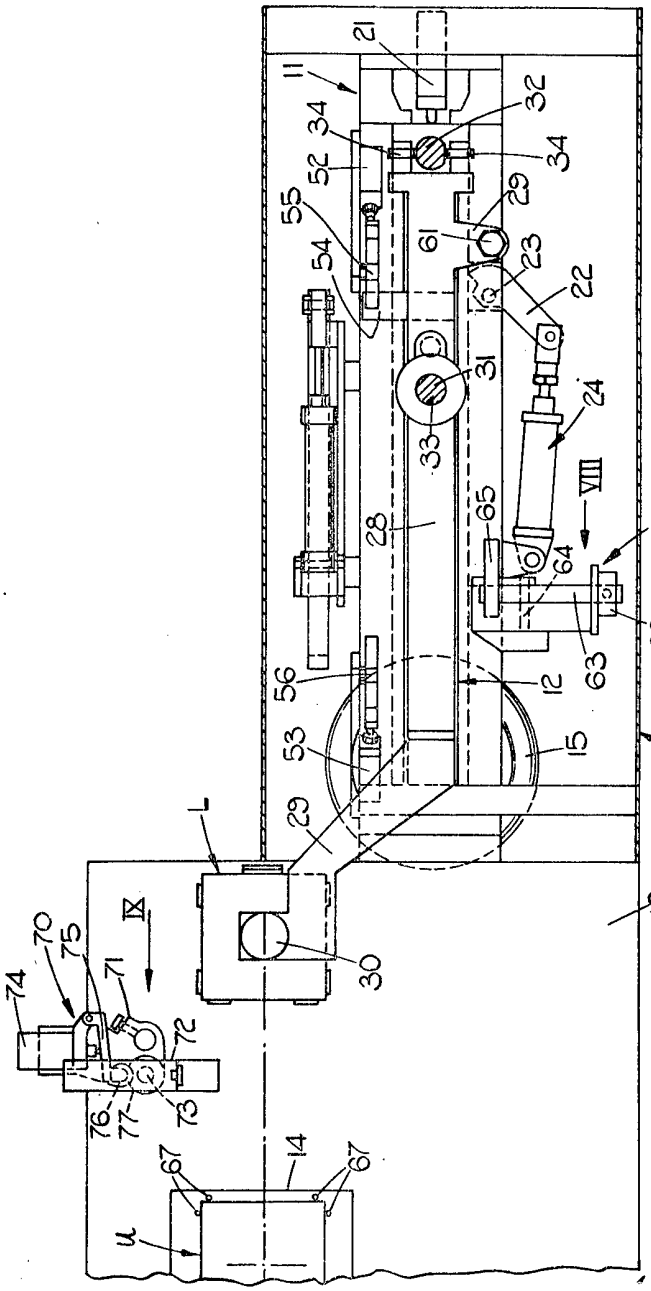

FIG.2.

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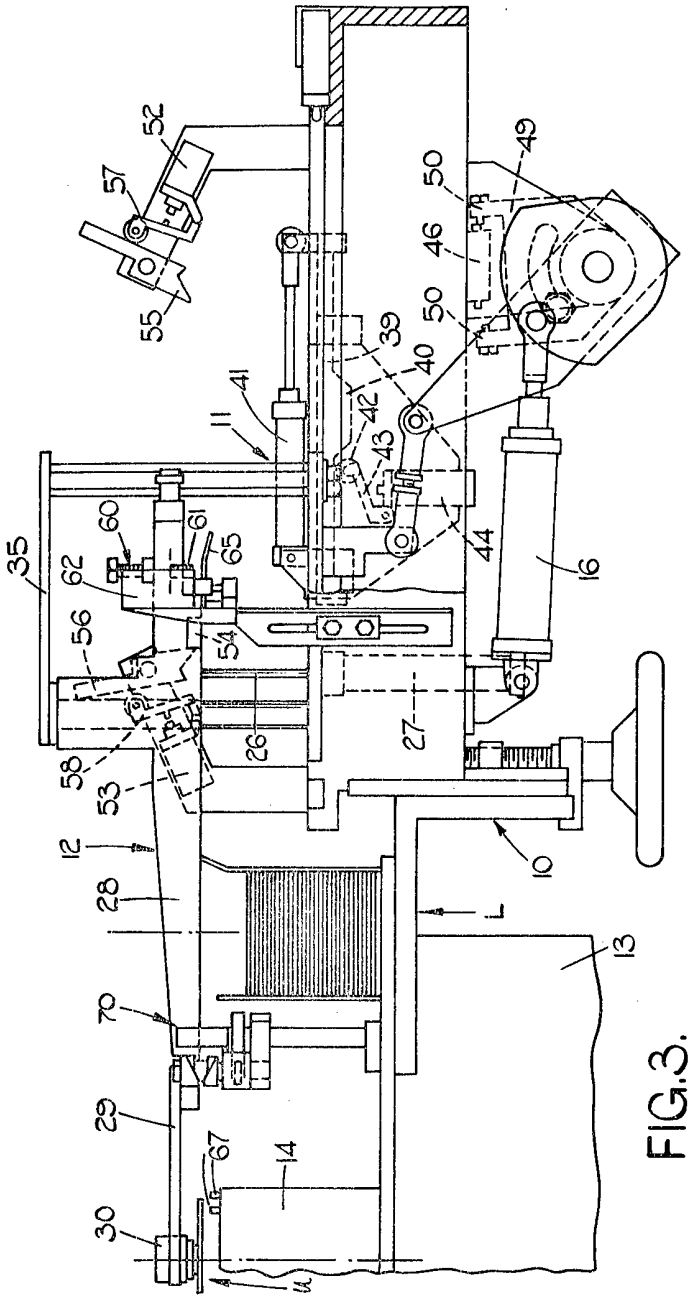

FIG.3.

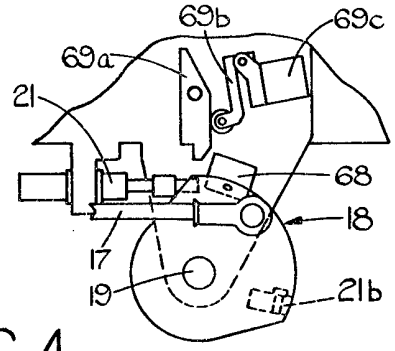

FIG. 4.

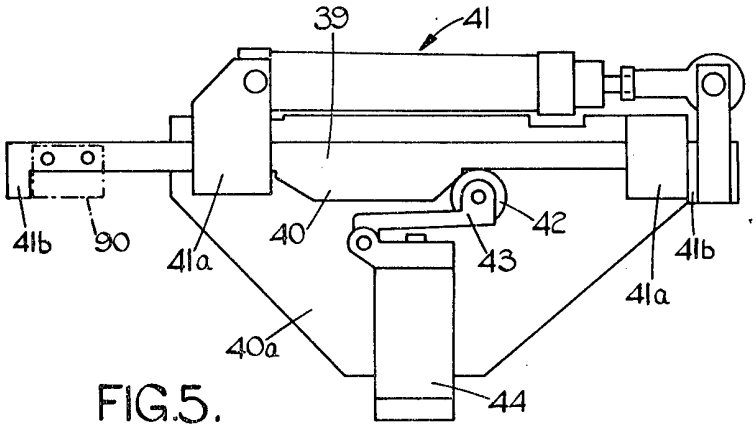

FIG. 5.

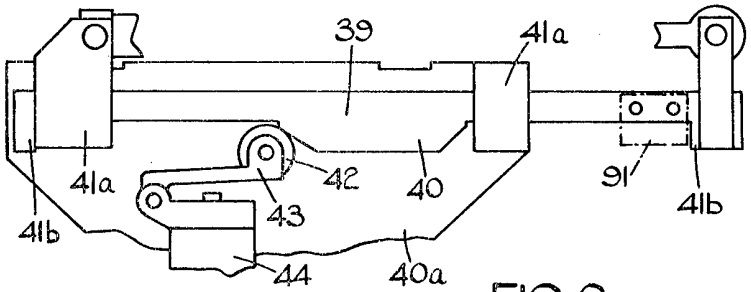

FIG. 6.

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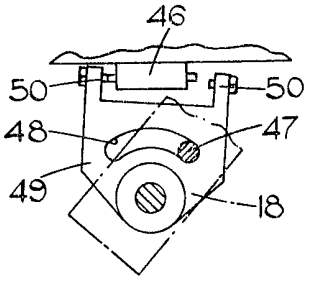

FIG.7.

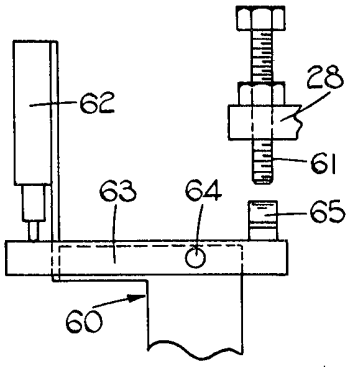

FIG.8.

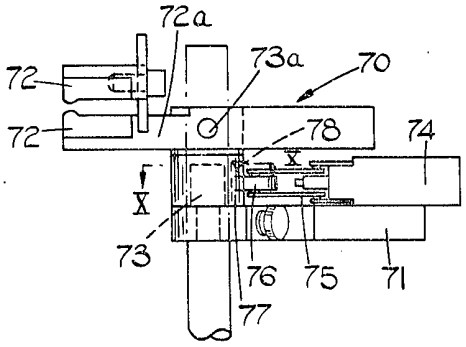

FIG.9.

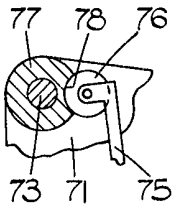

FIG.10.

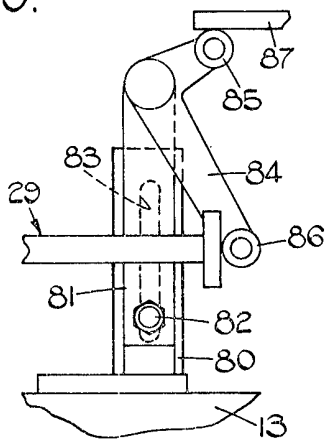

FIG.11.

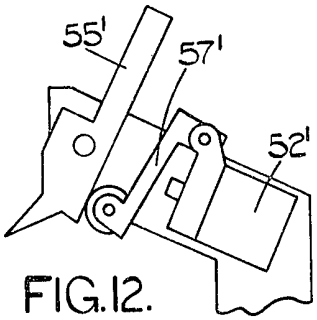

FIG.12.

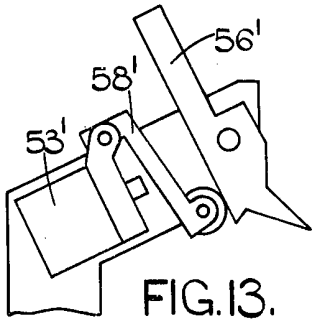

FIG.13.

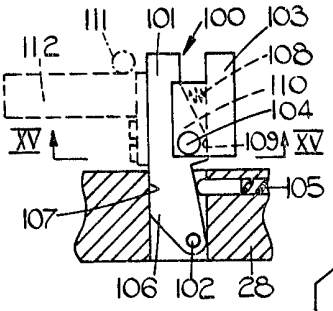

FIG.14.

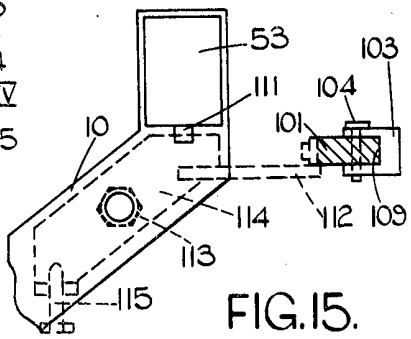

FIG.15.

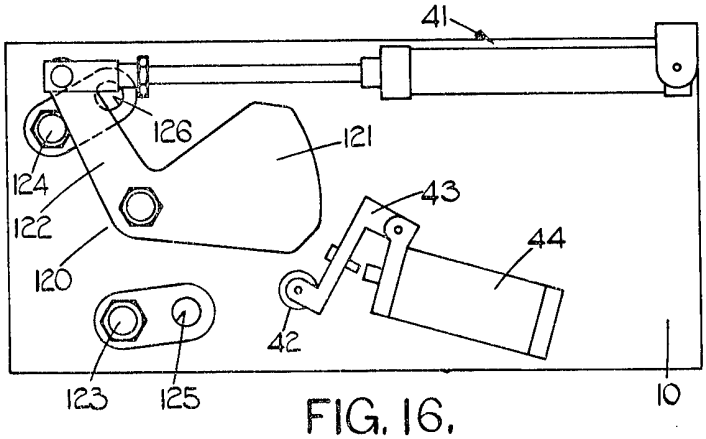

FIG. 16.

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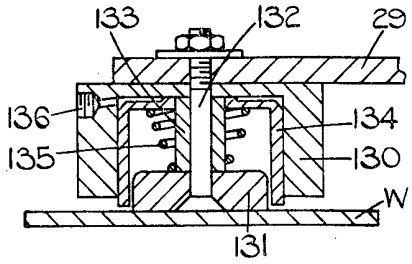

FIG.17.

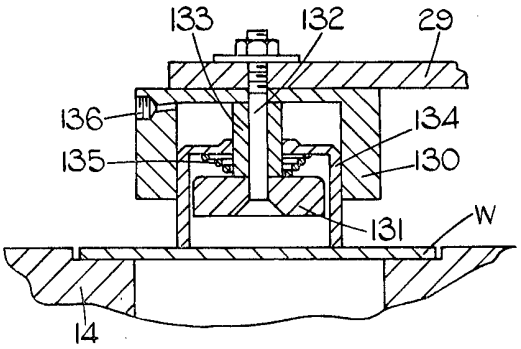

FIG.18.

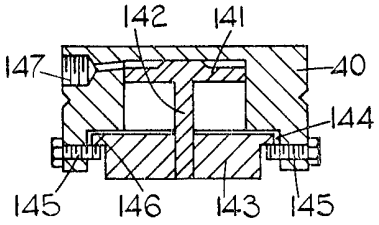

FIG.19.

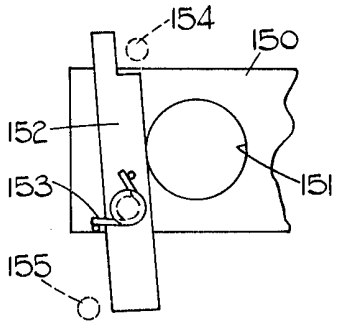

FIG.20.