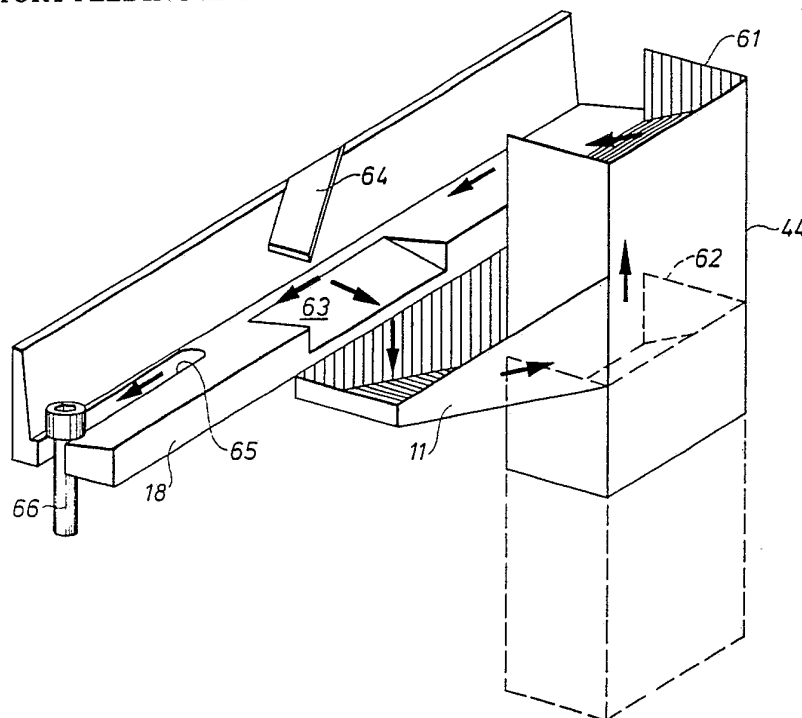




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(21) International Application Number: PCT/SE87/00144 (22) International Filing Date: 20 March 1987 (20.03.87) (71) Applicant (for all designated States except US): ATLAS COPCO AKTIEBOLAG [SE/SE]; S-105 23 Stockholm (SE). (72) Inventors; and (75) Inventors/Applicants (for US only) : BERGKVIST, Hans [SE/CH]; Chemin de la Cocarde 19, CH-1024 Ecublens (CH). GUBBIOTTI, Luciano [IT/CH]; TIR-Fédéral 16, CH-1204 Ecublens (CH). HOSTETTLER, Marcel [CH/CH]; Route d'Yverdon 3, CH-1028 Préverenges (CH). LOCK, Franz [DE/CH]; Chemin du Vuichardaz 8, CH-1030 Bussigny (CH). PIGUET, Jean-Claude [CH/CH]; Les Vergers de la Gottaz 25, CH-1110 Morges (CH).		(74) Agents: MOLIN, Alexis et al.; Atlas Copco AB, Patent Department, Fack, S-105 23 Stockholm (SE). (81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US. Published <i>With international search report.</i>

(54) Title: VIBRATORY FEEDING AND ORIENTING APPARATUS**(57) Abstract**

Apparatus for feeding parts from a reservoir position to a delivery position (12) comprising a base (13), a carrier (14), which is connected to a base by means of a vibratory mechanism (15, 41, 16, 17), a first feeding track (18, 31) provided with a number of sorting and orienting means clamped to the carrier (14). Along said track parts are transported by means of a vibratory motion towards said delivery position (12). A second feeding track (11, 47, 105, 106) is arranged so that parts sorted out from said first track (18, 31) by means of gravitation are caused to fall onto said second track (11, 47, 105, 106) for subsequent feeding towards said reservoir position. An elevator is arranged to transport the parts between the reservoir position and said first feeding track (18, 31).

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VIBRATORY FEEDING AND ORIENTING APPARATUS

5 Technical Field

This invention relates to vibratory feeding and orienting apparatuses and more particularly to the straight line or linear type of such feeders.

10

Background Art

In connection with automatic assembly systems in which for instance a robot assembles a product from
15 different separate units, there is a need for feeding the robot with parts like screws, nuts, washers and so on. These parts must be made accessible to the robot within its working area and moreover in such a way that each particular part is delivered to the robot
20 at predetermined coordinates within the working area. Each part must also have a predetermined orientation and be delivered to said coordinates with a certain lowest frequency.

25 A work station for robotic assembly, according to the above, may thus need several feeding apparatuses for delivering details from a respective reservoir to the corresponding coordinates.

30 For this kind of application, heretofore vibratory feeders of the bowl type have to a great extent been used. This type of feeder is adapted to serially delivered articles up an inclined spiral shelf-track on the inner surface of a bowl from a reservoir at the
35 bottom of the bowl to a delivery position at the edge of the bowl.

Linear vibratory feeding and orienting apparatuses are also previously known. US-A-3224 553 discloses such an

apparatus, in which two feeding tracks are arranged to feed the parts in opposite directions. One of the feeding tracks has at a first end portion a delivery position, e.g. for a robot. At this position correct parts are delivered having the correct orientation. To this effect a number of sorting and orienting mechanisms are arranged along the track. Incorrect or not correctly oriented parts are sorted out and such parts fall down, through the influence of gravitation, on the other feeding track which is arranged below the first one. The latter is designed as a ramp, the lower portion of which receives the parts which are sorted out. The vibratory motion of the feeding track causes the transport of the parts along the track up the ramps towards the upper end portion where the parts are transferred to the second end portion of the first mentioned track.

The transport capacity of the second track, in the form of a ramp, is obviously dependent on the slope of the ramp, the characteristics of the vibration as well as the form of the parts, their size, weight and so on. In order to guarantee that the feeding apparatus could handle all parts of interest, the slope of the ramp must be made small. This means that the entire feeding apparatus must be made more extensive in the horizontal plane than would have been necessary in respect of other functions. The floor surface required by a work station in which a robot is surrounded by several feeding apparatuses according to the above is consequently dependent on the length of the feeding tracks.

35 Disclosure of the invention

One object of the present invention is to provide a compact linear vibratory feeder by means of which robotic assembly work stations requiring a

considerably reduced floor surface could be designed.

Another object of the invention is to provide means for efficient control of the flow of parts sorted out from the horizontal feed track back to the initial position on this track, thereby minimising the wear on the tracks and the parts.

A further object of the invention is to provide a vibratory feeder which in a very short time could be converted to feeding another type of parts. This feature requires that the apparatus could be cleared quickly from parts currently processed and that the horizontal sorting and orienting tracks could be easily changed.

A further object of the invention is to provide a feeding apparatus for which the feeding speed on the forward feeding track is stable and not influenced by the working conditiong e.g. the present number of, i.e. the weight of, parts in the reservoir. This means that the combined return track-reservoir could be designed having a considerable volume.

Another object is to provide a feeding apparatus by which the feeding speed on the forward and return tracks could be independently controlled.

A still further object is to provide a feeder apparatus having adjustable sorting and orienting mechanisms making it possible to use the same forward feeding track for different types and sizes of objects.

35

Brief description of the figures

Other objects and advantages of the invention will be apparent from the following description and claims

taken in conjunction with the accompanying drawing in which

- 5 Figure 1 shows a side view of a feeding apparatus according to the invention,
- Figure 2 shows a perspective view of part of the apparatus without the return tracks,
- 10 Figure 3 shows a rear view of the apparatus according to figure 1,
- Figure 4 is a part view corresponding to figure 1 on a larger scale and partly in section,
- 15 Figure 5 is a part view corresponding to figure 3 on a larger scale and partly in section,
- Figure 6 shows the clamping of a feeding track of the apparatus,
- 20 Figure 7 is a front view according to 6-6 in figure 6,
- 25 Figure 8 is a schematic illustration showing the operation of one embodiment of the feeding and orienting apparatus,
- Figure 9 shows three alternative feeding tracks,
- 30 Figure 10 shows a perspective view of a part of the apparatus without the forward feeding tracks and their suspension,
- 35 Figure 11 shows a perspective view of one embodiment of the invention having forward and return feeding tracks,
- Figure 12 shows the arrangement of a number of

parallel feeding apparatuses which supply a robot with different objects,

5 Figure 13 shows a portion of a forward feeding track having adjustable sorting means.

Detailed description of the invention

10 The inventive concept will be described below by means of especially compact embodiments having two symmetric feeding devices arranged side by side on the same base.

15 One and the same vibratory mechanism is in one of embodiments used for all four feeding tracks of the two halves of the apparatus. It would be possible to use one and the same base for even three or more feeding devices according to the invention.

20 The feeding apparatus which is shown in figure 1 thus comprises a common base and a carrier 14. This carrier is connected to the base by means of a vibratory mechanism comprising two springs 16, 17, an
25 electromagnetic driver 15 arranged on the base 13 and an armature 41 arranged on the carrier. Two horizontal feeding tracks 18, 31 for the feeding direction to the left in figure 1, and two feeding tracks in the form of ramps 11, 47 for the opposite feeding direction are
30 arranged, clamped and mounted on the carrier 14, respectively.

The amplitude of the vibratory movement of the armature 41 can be adapted to, for instance, the
35 weight of the parts to be fed and to the friction between the parts and the feeder tracks. This feature will, however, not be shown more in detail. The apparatus is provided with two elevators 44, 45, one for each functional half of the same. These elevators

are arranged for lifting parts from the lowest portion of the return tracks 11, 47 on to the forward feeding tracks 18 and 31 respectively. The said lowest portion close to the respective elevator constitutes a
5 reservoir for unsorted parts. After having been subjected to sorting and orienting procedures carried out on the tracks 18, 13 the parts are delivered at the forward end 12 of those tracks. From the reservoir the parts fall into a compartment of the elevator when
10 this is in its lower position, as shown by elevator 45 in figure 3. The elevators are raised and lowered by means of pneumatic cylinders 42, 43. It would of course be possible to use other fluid powered cylinders or, e.g. electric motors. The two elevators
15 are raised and lowered independently with frequencies adapted to the relative needs of parts to be fed by the two feeder tracks 18, 31. In this way unnecessary wear of the tracks and the objects fed is avoided. The control of the cylinders is now shown in detail, but
20 could be of any usual type. The feeder tracks 18, 31 are clamped to the carrier 14 by means of handles 22, 46, as described below.

When the parts have come onto the feeder tracks 18, 31
25 they are moved by means of the vibrations along the respective track towards the forward end of the tracks where they are held accessible, e.g. for a robot. In the embodiment shown in figure 1 the transport of the parts on the return track 11, 47, formed as a ramp, is
30 caused by gravitation and forces created by the vibratory movement of the track.

As shown in figure 4, the elevator 44 comprises a shell to which plates 49, 50 are secured. The plates
35 49, 50 are interconnected by rods 51, 52 which are guided by elements 53, 54 secured to the base 13. The piston rod 48 of cylinder 42 is connected to plate 49 for the upward-downward movements of the elevator. The elevator is provided with an inclined plate 56, cf.

figures 2 and 5, which normally hangs on the upper edge of the shell 44. when the elevator is in its lower position, parts fall from the reservoir onto plate 56. When the elevator is raised to the position shown in figure 5, the parts fall from plate 56 onto the feeder track 18. When it is desirable to use the feeding apparatus for feeding other types of parts, the reservoir can be cleared quickly.

10 In order to clear the apparatus, the plate 56 is removed. When the elevator thereafter reaches its lower position, the parts from the reservoir fall onto plate 55 and out of the elevator through the opening 60 where they can be collected in a suitable
15 container.

As an alternative, the apparatus can be arranged for automatic clearance. This could be achieved by the provision of a third position for the elevator. In
20 this third clearance position, which would suitably be the uppermost, a tunnel through the elevator shell will be brought to the level of the reservoir. As in the case above, the reservoir will be emptied into a suitable container while an operator changes the
25 forward feeding track.

As shown in figures 6 and 7, the feeder track 18 is provided with a projection 20 which is inclined in the longitudinal direction of the feeder track. This
30 projection is situated at a distance from the clamping end 19 of the track. The distance between the projection 20 and the clamping end 19 is irrelevant as long as the track 18 becomes firmly secured to the carrier 14. The carrier is provided with a recess 21
35 having a surface 10 which is inclined for cooperation with the projection 20. In order to guide the track laterally, the track 18 is provided with a pin 25 which is guided by a slot 24 in the carrier 14. It would, of course, be possible to use the inversion of

this arrangement, i.e. having a cut-out in the feeder track which cooperates with a jut on the carrier. In such a case it is also suitable to arrange the slot in the track and the pin on the carrier. The carrier is provided with a bracket 26 to which a pair of mounting plates 27 has been secured. A handle 22 is journaled on these plates for rotation about an axis 28. A screw 30 is journaled in handle 22 at 29. A conical nut 23, for cooperation with an inclined surface 35 at the clamping end 19, is mounted on the screw 30, and is possible to adjust. The feeder track 31 of the other half of the apparatus is provided with a pin 33 for cooperation with slot 32 in carrier 14. This latter feeder track is mounted in parallel with track 18 in the same way.

In order to clamp a feeder track to the carrier the track is laid on the carrier in such a way that the projection 20 enters the recess 21 and pin 25 enters slot 24. The screw 30 with the conical nut 23, suitable adjusted, is moved through a slot in the carrier approximately to the shown position. Handle 22, which together with nut 23 forms a clamping means, is actuated by moving it to the shown position. When the handle is operated the projection 20 is forced in contact with surface 10 and the feeder track is clamped to the carrier at the corresponding end of the track. At the same time, the track is also clamped to the carrier at its other end because the nut 19 presses this end of the track downwards. In the shown position the centre line of screw 30 is situated to the left of the axis 28.

As can be understood from the above and in connection with figure 12, which shows a robotic work station, it will be possible for an operator to clear a feeder apparatus according to the invention and change the feeding track without interfering with the robot, due to the fact that every measure which has to be taken

will be carried out from the remote end of the feeding apparatus seen from the robot.

5 In the above part of the description the feeder track has been shown schematically only. In order to orient an object into a correct position for further use, the forward feeder track must be adapted to the type of object to be fed. This is the reason why it should be possible to change the forward feeding track in a quick and easy way. The schematic perspective view of figure 8 shows how the feeding of a screw 66 is obtained. The movement of screws are indicated by arrows. Elevator 44 is lowered to position 62. Screws from the vibrating reservoir fall into the elevator 10 which is then raised to position 61, at which they move onto track 18. The vibratory movements of the track moves the screws towards the slot 65 at the forward end of said track. In order to reach the slot 65, the screws must lie along the vertical wall of the feeding track. Screws in other positions are sorted 15 out either because the centre of gravity is in such a position that the respective screw moves down the slope 63 or because the screw is pushed down by the projection 64. When a screw manages to pass the obstacles it reaches the slot 65. The narrow end of the screw swings down so that the screw takes the position shown in the figure, ready to be picked up by 20 the robot.

30 Figure 9 shows three examples of forward feeding tracks. The left one corresponds to the one shown in figure 8. The middle one is provided with a slope 72, a projection 73 and a channel 74. This track is adapted to feeding objects 75 having two cylindrical parts. The right feeding track 81 is provided with a 35 slope 82, a projection 83 and a channel 84. This track is adapted to the feeding of rings, e.g. O-rings or washers. The three tracks work principally in the same way. They require that the centre of gravity is in a

correct position and that no parts of the object extend beyond a certain limit. As a matter of fact, it is possible by means of a limited number of specific types of segments along the track to handle a great variety of different parts to be fed. The exact dimensions of a particular segment is of course dependent on the envisaged object. Once the object is defined by means of certain parameters, as well as the final position of the object, it is even possible by means of a CAD-program to design a suitable feeding track.

One way to reduce the number of forward feeding tracks would be to provide the different segments of the track with adjustable means. An example of such a track is shown in figure 13. A unit 99 provided with a slope is adjustably mounted as part of the track. According to the above, the width of the niche 104 is critical and has to be carefully adjusted to give the envisaged function. For this purpose, an index and a scale 102 could be arranged on the track. The same goes for the positioning of the units, 100, 101 and 103. Alternatively, it is possible to carry out the adjustments automatically on an universal track according to the above e.g. by means of a robot to obtain a suitable operation for a specified object.

Figure 10 shows a perspective view of a further embodiment of the invention. Two feeding apparatuses are, as above, arranged on the same base. In this embodiment the forward feeding tracks have a common vibration mechanism, as shown in figure 2. Moreover, the return tracks 105, 106 are provided with a separate, common vibration mechanism 107, 108 of the same type as for the forward tracks. Two side walls 109, 110 of the return tracks are mounted together by means of brackets 111, 112, 113 so that the return tracks and brackets form a unit. This unit is, by means of rubber springs 114, mounted on the base. For

the sake of clarity, the return track 106 has been illustrated transparent. When the rest of the apparatus, i.e. the carrier 14 and the forward feeding tracks 18, 31 with the associated vibration mechanisms have been mounted the apparatus looks like in figure 11.

In this embodiment the return track is not designed as a ramp, but has a horizontal bottom portion. This means on the one hand that this track must be provided with a separate vibration mechanism, otherwise the parts in the reservoir would pile up at the left hand portion of the track, according to figure 10. On the other hand, a horizontal bottom portion gives the reservoir a considerable larger volume, which in this embodiment is favourable because the weight on the return track does not influence the feeding speed on the forward track. The separate vibration mechanisms raise the flexibility of the apparatus because it is possible by means of separate frequency and/or amplitude control to find, in combination with the control of the delivery rate of the elevator optimum operation conditions.

Another feature of the return track, illustrated in figures 10 and 11, is the rounded profile of the bottom portion of track 105, 47. When the apparatus processes elongated objects there is a tendency with a flat bottom portion and certain lengths of the objects that the objects pile up somewhere on the track, which means that the flow to the elevator will be cut off. By means of the rounded profile, the objects closest to the bottom will be oriented along the track, which eliminates the said problem. Other profiles, as for instance a V-profile, also shows similar effects.

In order to increase the feeding capacity of the tracks, the surfaces could be provided with a rubber coating or a mohair-type of coating having oriented surface fibres.

CLAIMS

5

10 1. Apparatus for feeding parts from a reservoir
position to a delivery position (12) comprising a
base (13), a carrier (14), which is connected to
the base by means of a vibratory mechanism (15, 41,
15 16, 17), a first feeding track (18, 31) provided
with a number of sorting and orienting means
clamped to the carrier (14) and along which track
parts by means of a vibratory motion are
transported towards said delivery position (12), a
second feeding track (11, 47, 105, 106) arranged so
20 that parts sorted out from said first track (18,
31) by means of gravitation are caused to fall onto
said second track (11, 47, 105, 106) for subsequent
feeding towards said reservoir position.

25 characterised in that

an elevator means is arranged to transport the
parts between the reservoir position and said first
feeding track (18, 31).

30

2. Apparatus according to claim 1,

characterised in that

35 said second feeding track (11, 47) is mounted on
the carrier (14).

3. Apparatus according to claim 1,

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characterised in that

5 said second feeding track (105, 106) is mounted on
the base by means of a second vibration mechanism
(107, 108, 111, 112, 113, 114).

4. Apparatus according to any of the preceding claims

10 characterised in that

said elevator means operates in a vertical plane.

5. Apparatus according to anyone of the claims 2 and
4.

15 characterised in that

20 at least one additional pair of feeding tracks (31,
47) is mounted on the same carrier (14) in the same
way as the tracks (18, 11) and that at least one
additional elevator means (45) is arranged on the
base (13) in the same way as the elevator means
(44).

25 6. Apparatus according to anyone of the claims 3 and 4

characterised in that

30 at least one additional feeding track (31) is
mounted on the same carrier (14) in the same way as
track (18), that at least one additional track
(105) is mounted on the base (13) by means of the
second vibration mechanism (107, 108, 111, 112,
113, 114) and that at least one additional elevator
35 means (45) is arranged on the base (13) in the same
way as the elevator means (44).

7. Apparatus according to anyone of the claims 5 and 6

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15

characterised in that

said elevator means (44, 45) are arranged to operate independently.

5

8. Apparatus according to any of the preceding claims

characterised in that

10 said feeding track (18, 31) is provided with a projection (20) or a cut-out, inclined in a longitudinal direction of the feeding track, situated at a distance from the clamping end (19),
15 said carrier (14) is provided with a recess (21) or a jut, having a surface (10) which is inclined for cooperation with said projection or cut-out and that a clamping means (22, 23) is arranged at the clamping end (19) for clamping the track (18, 31) to the carrier (14), whereby actuation of said
20 clamping means forces said projection (20) or cut-out into cooperation with said surface (10) to clamp the feeding track (18) to the carrier (14) both a distance from the clamping end (19) and at the clamping end.

25

9. Apparatus according to claim 8

characterised in that

30 the feeding track (18) at a distance from the clamping end (19) is laterally guided on the carrier (14) by means of a pin (25) and a slot (24).

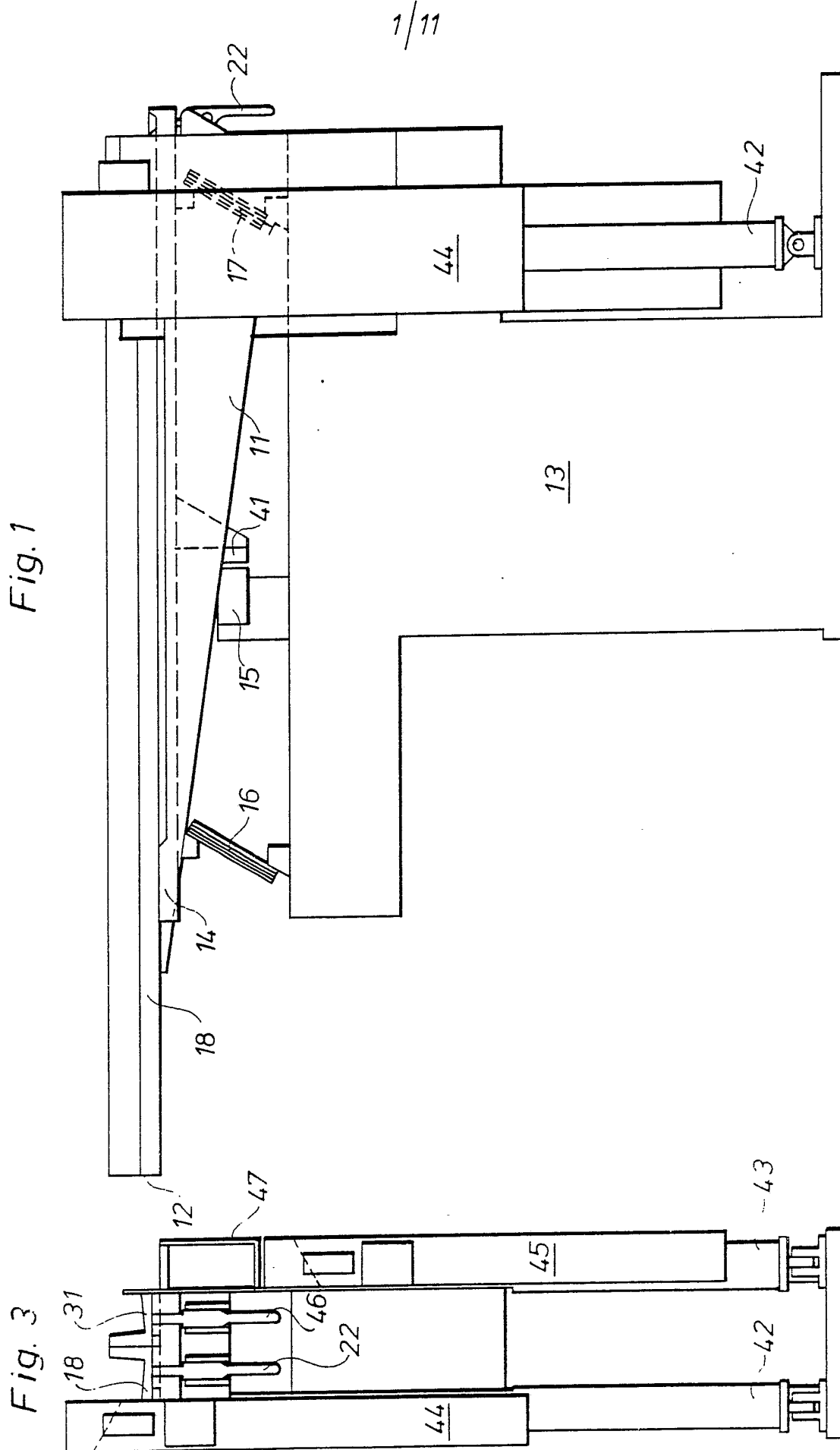
35 10. Apparatus according to claim 8 or 9

characterised in that

the feeding track (18) at the clamping end (19) is

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provided with an inclined surface (35) for cooperation with a nut (23) of the clamping means.



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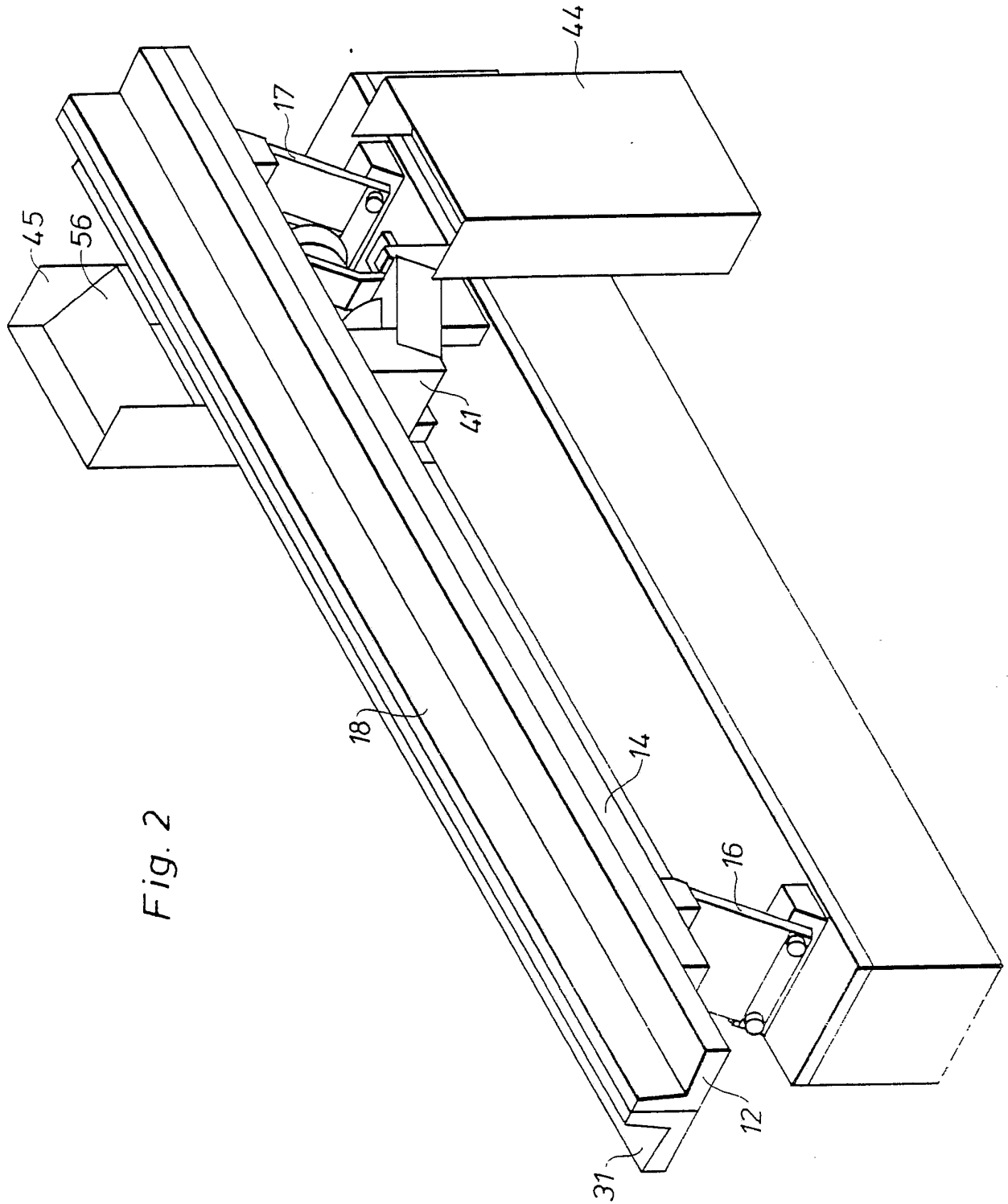
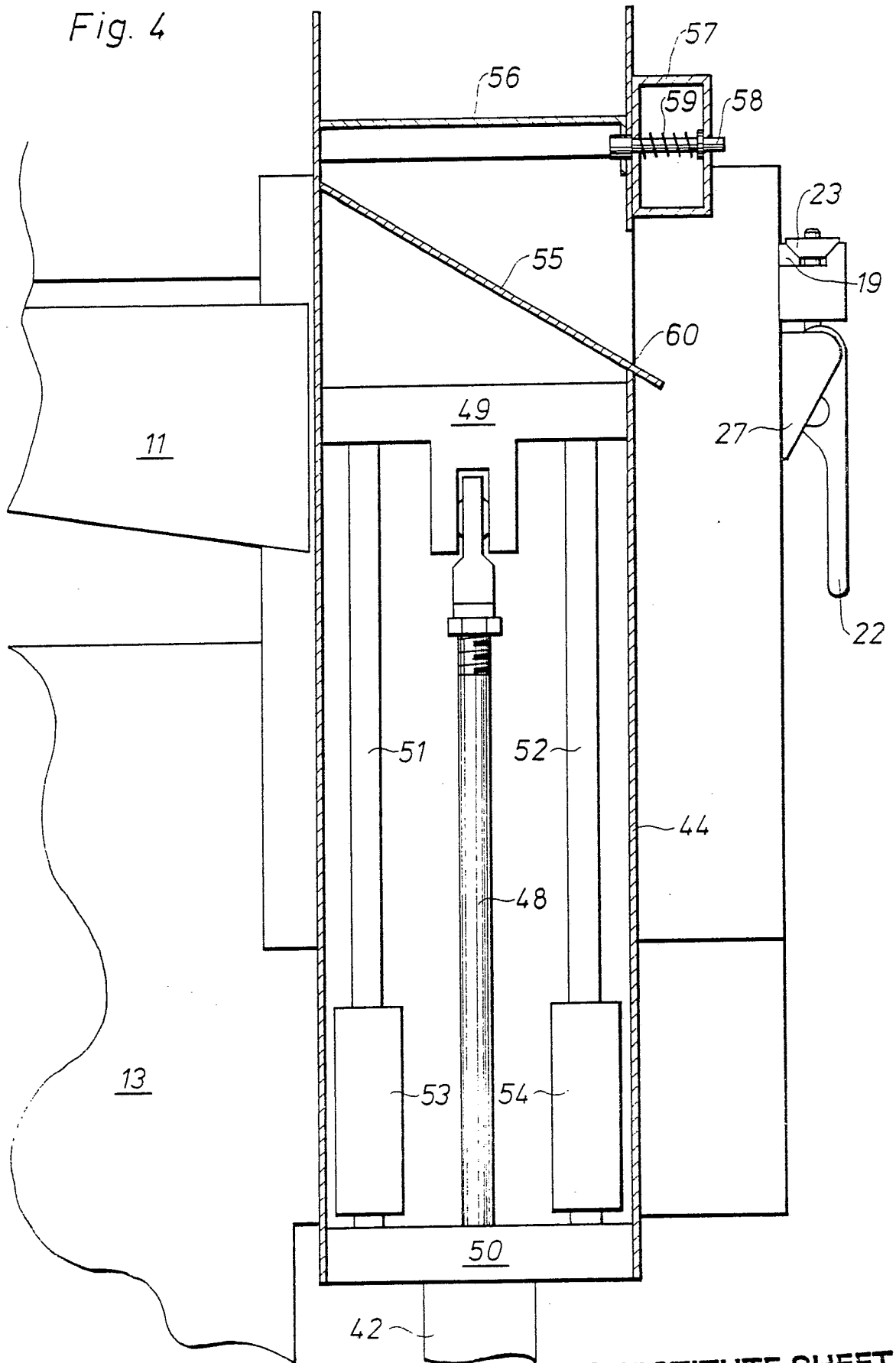


Fig. 2

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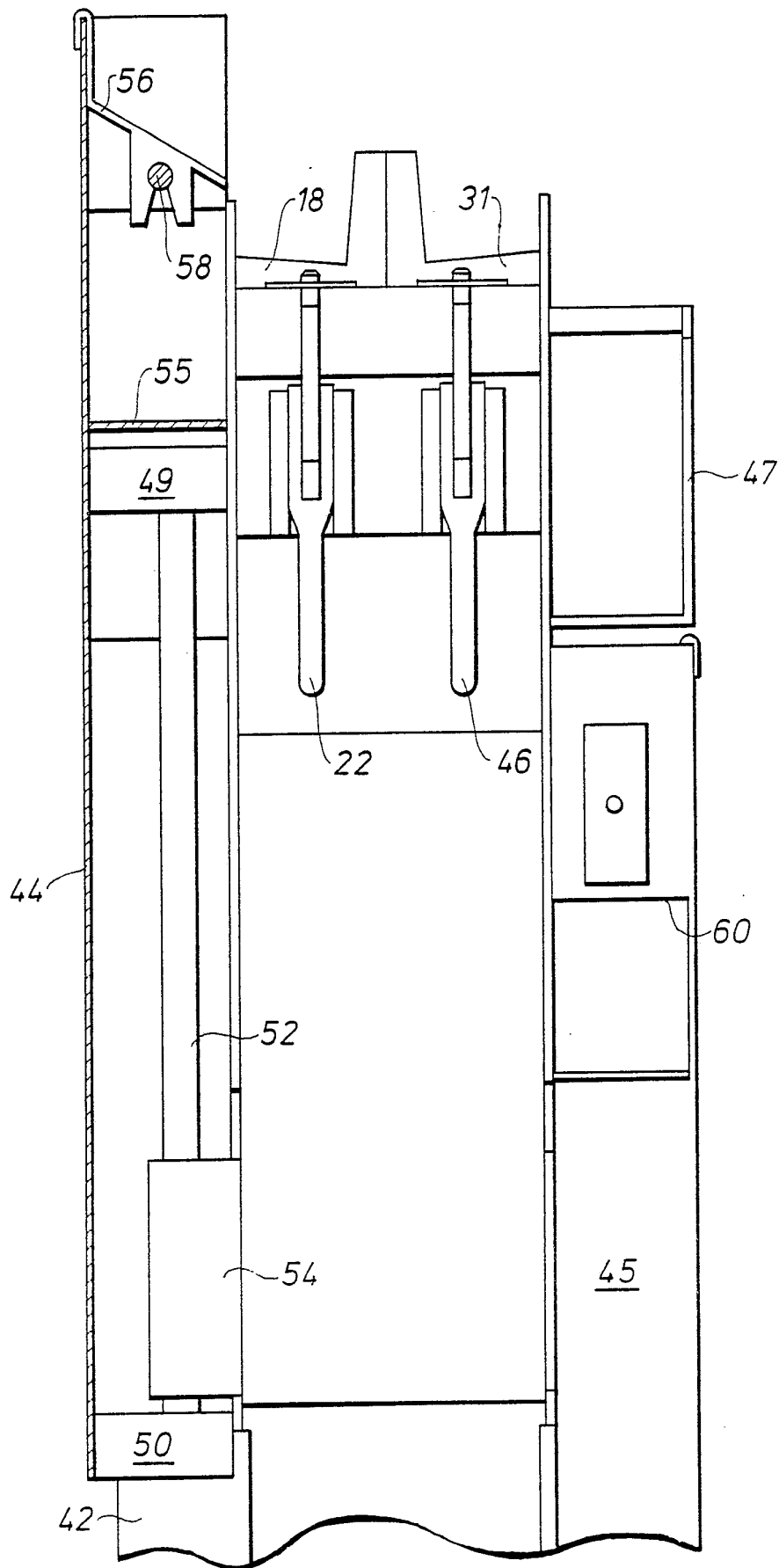
Fig. 4



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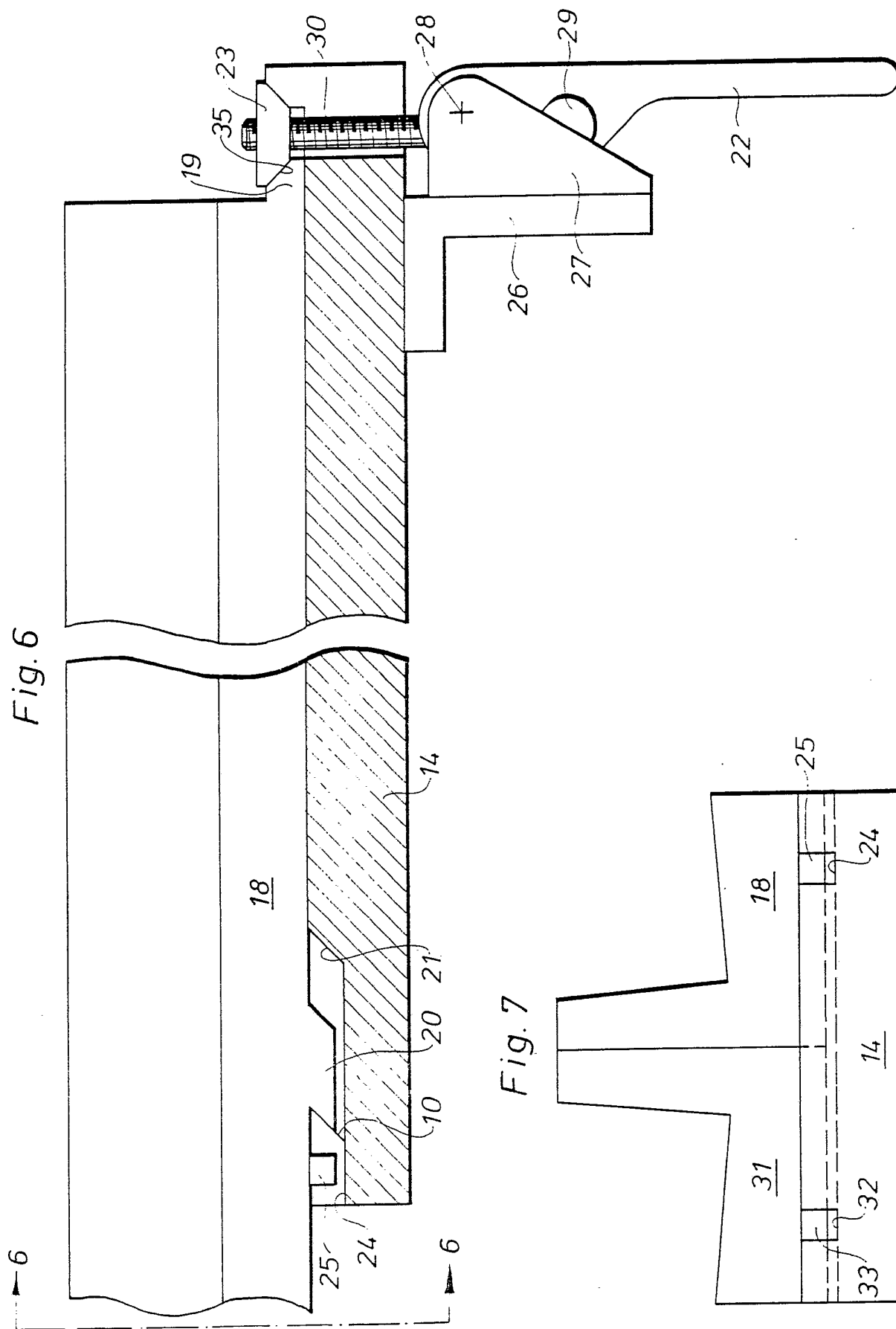
Fig. 5

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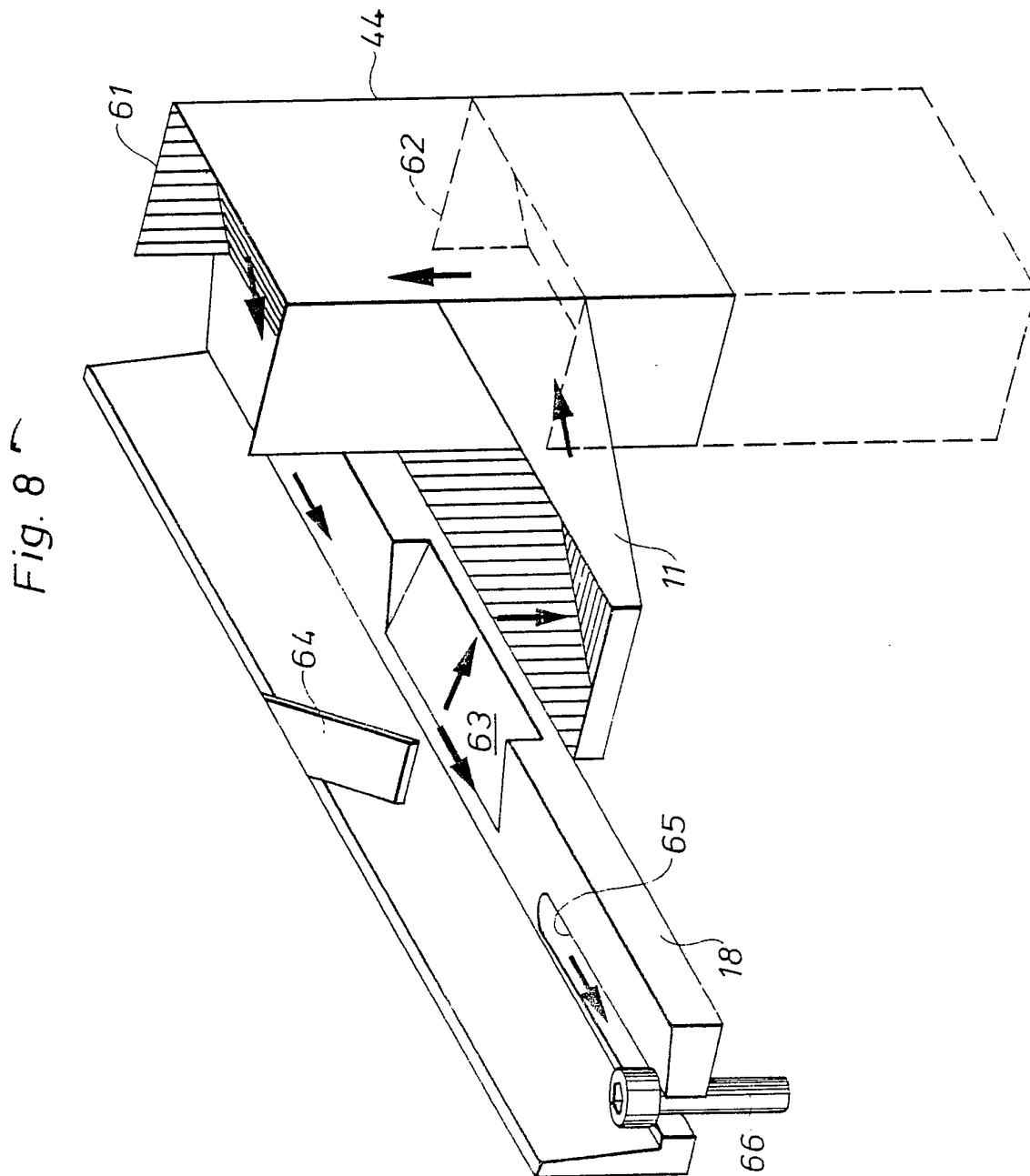


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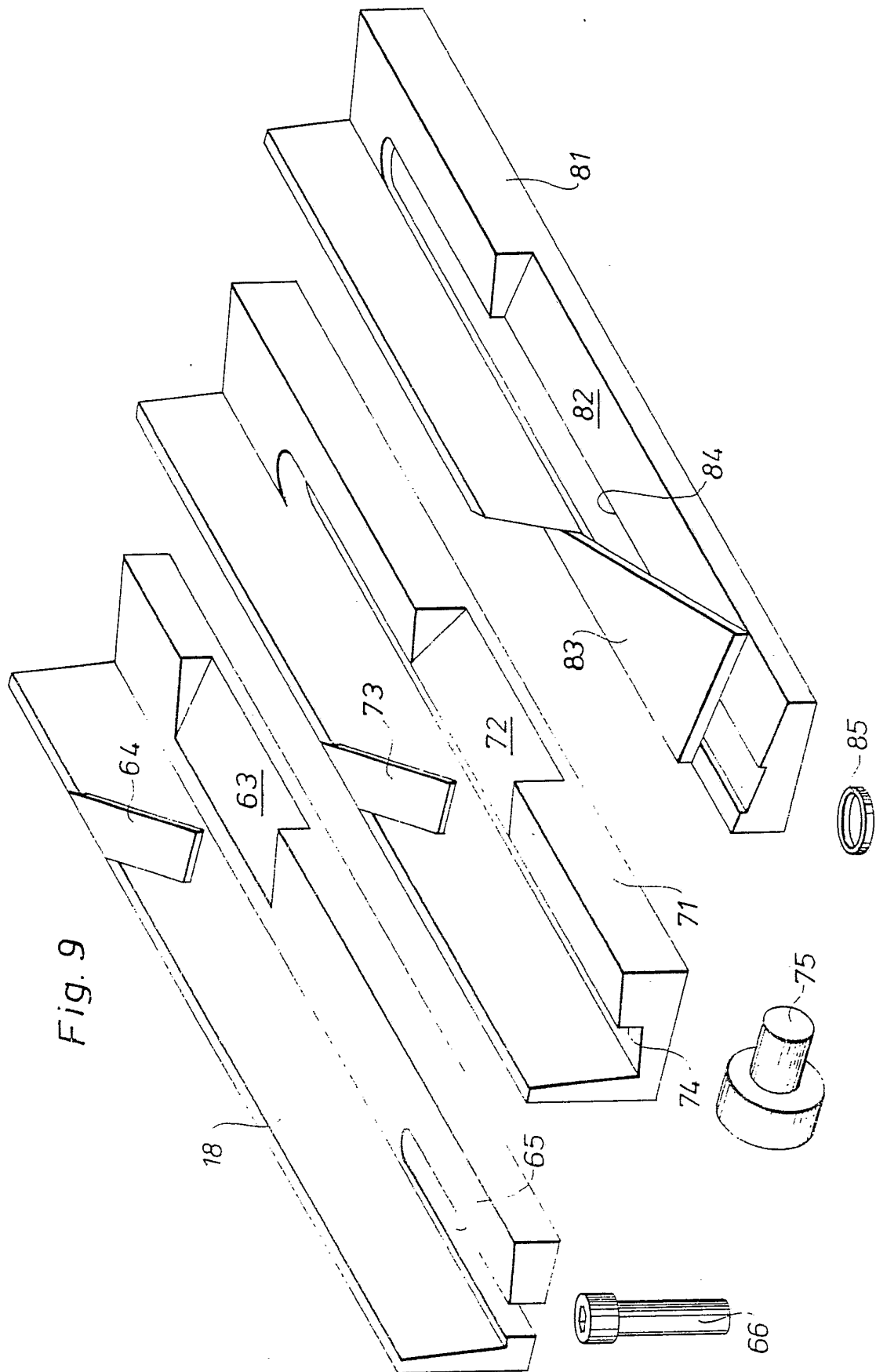


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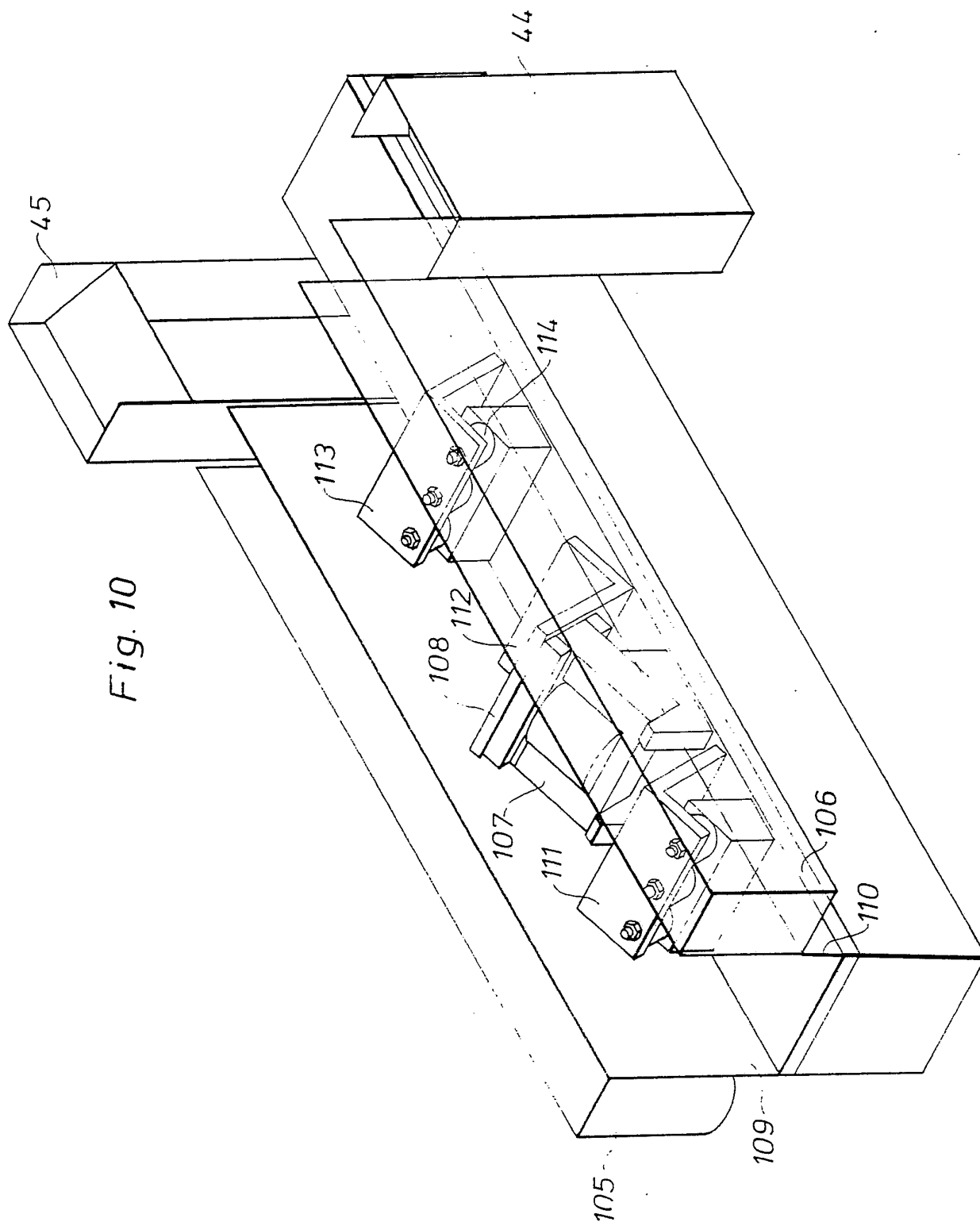
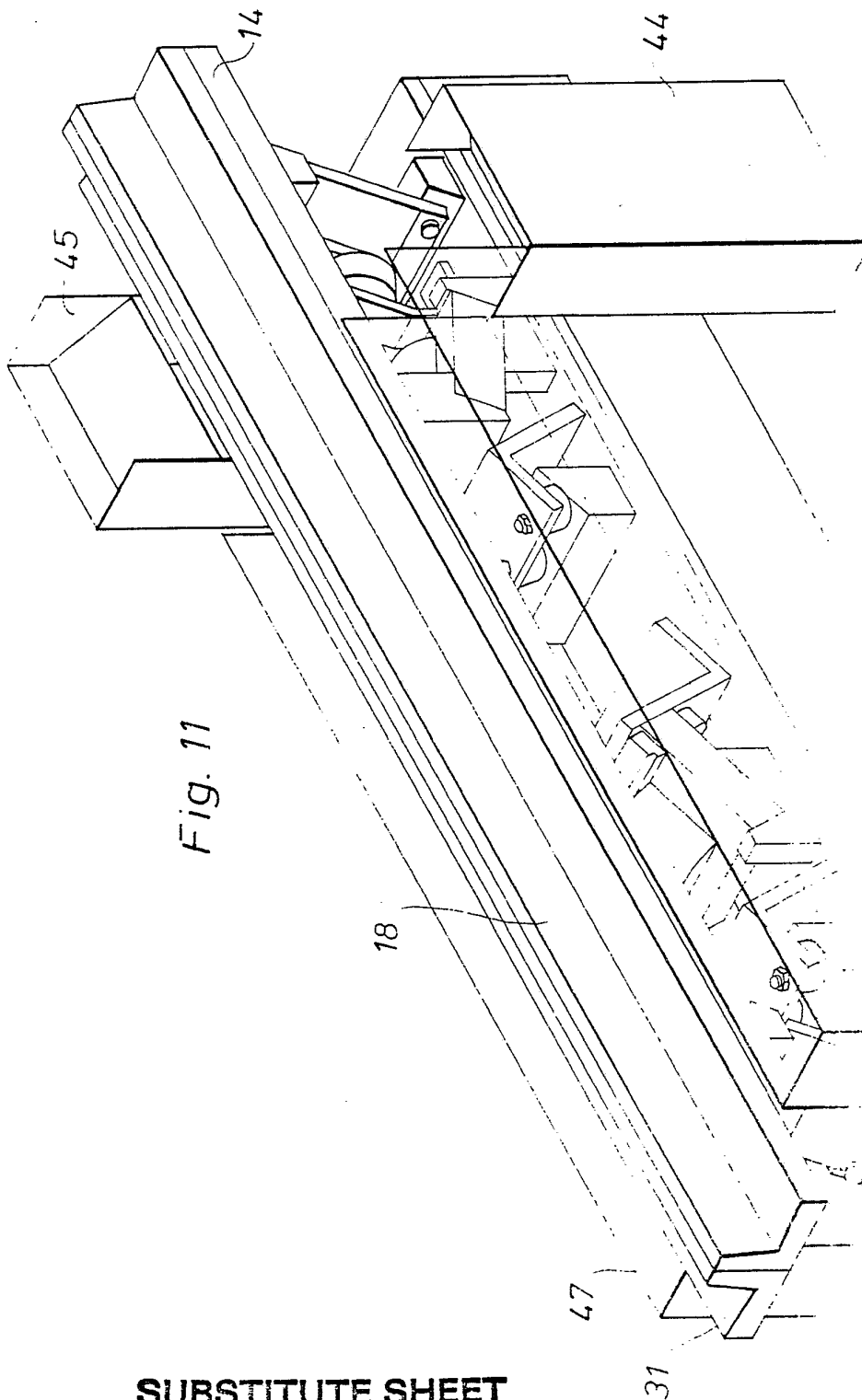


Fig. 10

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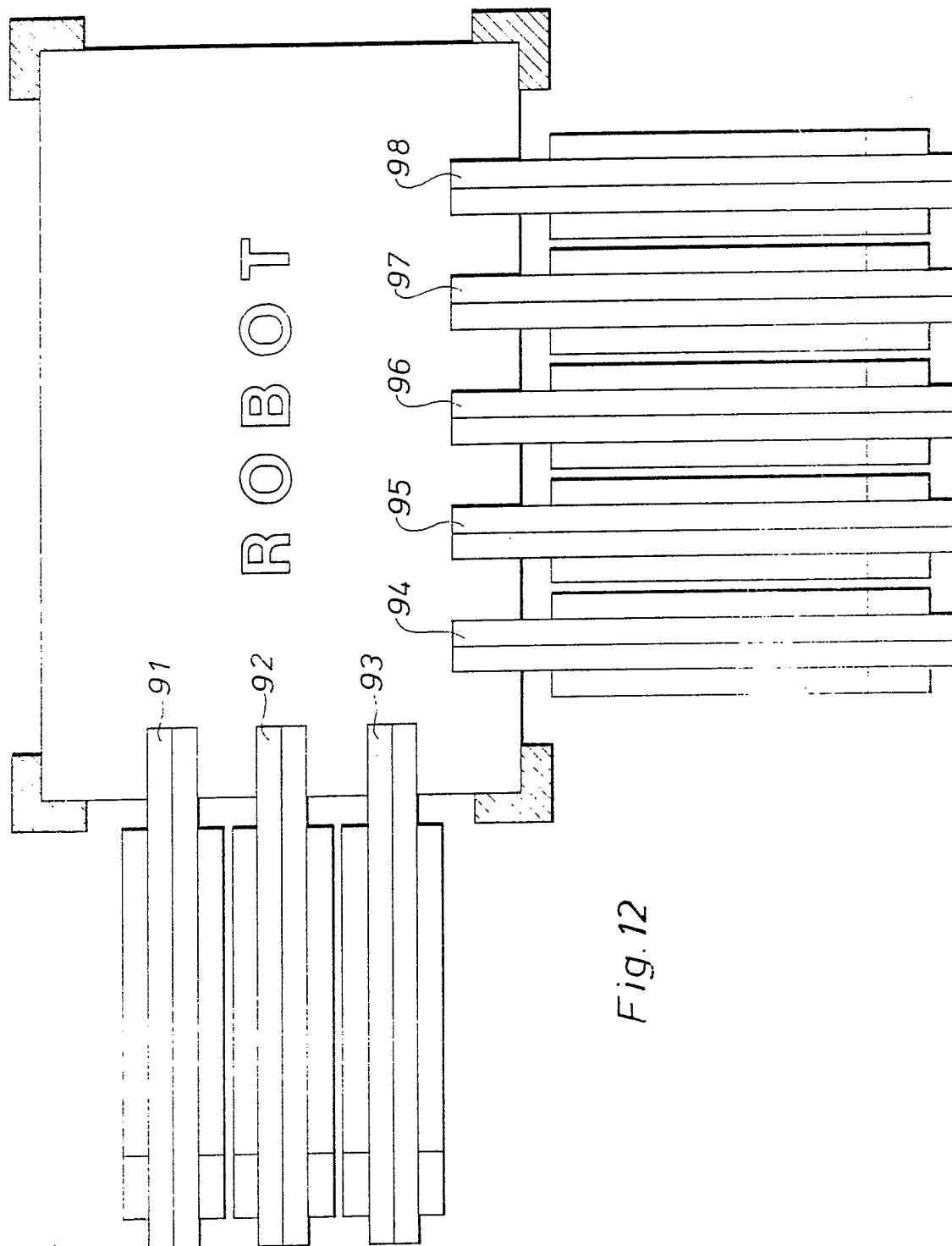
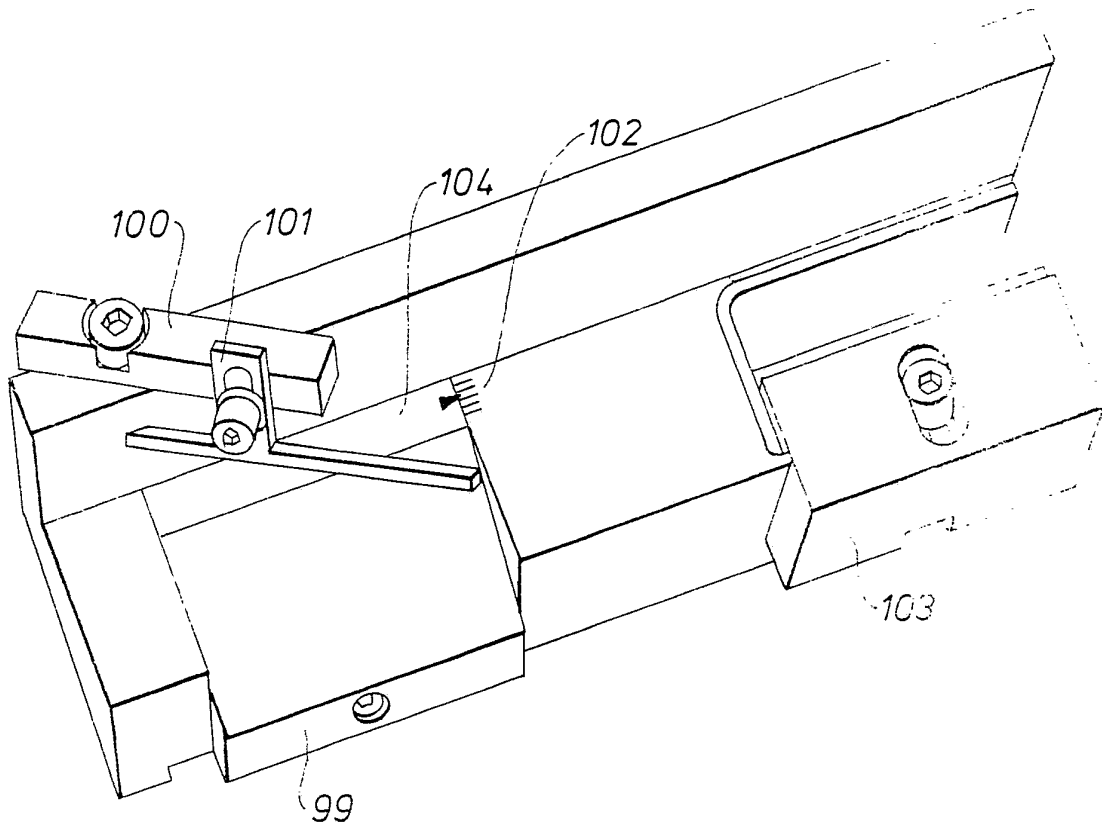


Fig. 12

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Fig. 13



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INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00144

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC B 65 G 47/14, 27/04														
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">IPC 4</td> <td style="padding: 5px;">B 65 G 27/00, /04, /06, /08, /34, 47/14, /18, /22, /24, /56, /57, /66</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">Nat Cl</td> <td style="padding: 5px;">81e: 51, 54, 55, 57 .../...</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸</div> <div style="text-align: center; padding: 10px 0;">SE, NO, DK, FI classes as above</div>			Classification System	Classification Symbols	IPC 4	B 65 G 27/00, /04, /06, /08, /34, 47/14, /18, /22, /24, /56, /57, /66	Nat Cl	81e: 51, 54, 55, 57 .../...						
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III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category ⁹</th> <th style="width: 70%; border-bottom: 1px solid black;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 20%; border-bottom: 1px solid black;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">DE, A1, 3 503 102 (STICHT, WALTER, ATTNANG-PUCHHEIM) 8 August 1985</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1, 2, 4, 5</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">X</td> <td style="padding: 5px;">US, A, 3 224 553 (MILFORD A. CAMPBELL) 21 December 1965</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1, 2, 4</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">GB, A, 2 174 378 (REINERS & FURST) 5 November 1986</td> <td></td> </tr> </table>			Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	DE, A1, 3 503 102 (STICHT, WALTER, ATTNANG-PUCHHEIM) 8 August 1985	1, 2, 4, 5	X	US, A, 3 224 553 (MILFORD A. CAMPBELL) 21 December 1965	1, 2, 4	A	GB, A, 2 174 378 (REINERS & FURST) 5 November 1986	
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X	US, A, 3 224 553 (MILFORD A. CAMPBELL) 21 December 1965	1, 2, 4												
A	GB, A, 2 174 378 (REINERS & FURST) 5 November 1986													
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </div> </div>														
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of the Actual Completion of the International Search 1987-10-16</td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of Mailing of this International Search Report 1987-10-20</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;">International Searching Authority Swedish Patent Office</td> <td style="border-bottom: 1px solid black; padding: 5px;">Signature of Authorized Officer Björn Salén</td> </tr> </table>			Date of the Actual Completion of the International Search 1987-10-16	Date of Mailing of this International Search Report 1987-10-20	International Searching Authority Swedish Patent Office	Signature of Authorized Officer Björn Salén								
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International Searching Authority Swedish Patent Office	Signature of Authorized Officer Björn Salén													

L.E.

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II

Fields Searched (cont).

US C1 198: 382-384, 388-391, 393, 396,
752-754, 758, 759

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.