(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 142 227**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 84305742.3

(22) Date of filing: 22.08.84

(51) Int. Cl.⁴: E 21 D 11/08

(30) Priority: 22.08.83 GB 8322524

(43) Date of publication of application:
22.05.85 Bulletin 85/21

(84) Designated Contracting States:
AT DE FR GB IT

(71) Applicant: THYSSEN (GREAT BRITAIN) LIMITED
Heol Y Bwlch Bynea
Llanelli Dyfed SA14 9SU(GB)

(72) Inventor: Draper, Andrew Roger
Honeyside Golf Drive
Camberley Surrey(GB)

(72) Inventor: Smith, Brian
3 Gravel Hill Lane Whitley Bridge
Nr. Goole North Humberside(GB)

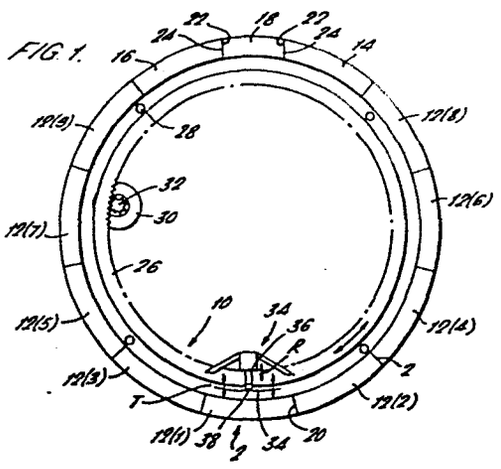
(74) Representative: Bayliss, Geoffrey Cyril et al,
BOULT, WADE & TENNANT 27 Furnival Street
London EC4A 1PQ(GB)

(54) Tunnelling machines.

(57) A tunnelling machine has a tunnel lining stage 10 including a pick-up device 34 for picking up concrete lining segments 12 from the floor of the tunnel and placing them in position radially around the tunnel.

In order not to damage the segments when picking them up and in order to enable the pick-up device 34 place the segments directly in position butted up against already placed segments, the pick-up device comprises at least one suction pad (40) adapted to engage the segments and means for evacuating the suction pad to hold the segment against the segment.

FIG. 1.



EP 0 142 227 A2

0142227

TUNNELLING MACHINES

This invention relates to tunnelling machines for digging tunnels which are lined with rings of arcuate tunnel lining segments of concrete, each ring being formed by, for example, twelve such segments.

A known tunnelling machine has at the head thereof an excavator within a tunnelling shield which is advanced through the ground as digging proceeds. Immediately behind the excavator and shield stage of the machine, there is provided a tunnel lining stage, which includes an assembly rotatable about the axis of the tunnel having a pick-up head. In operation, segments are fed along the tunnel and placed on the floor of the tunnel at the tunnelling lining stage. The assembly is rotated so that the pick-up head is adjacent the segment, and the segment is then picked up by the pick-up head. The assembly is then rotated to swing the segment to the desired position around the ring of segments being constructed and the pick-up head is moved radially outwardly to place the segment in position against the tunnel wall. The segment is

held in position and the pick-up head is then released from the segment. Further segments are then picked up from the bottom of the tunnel and put in place to complete the ring.

In the known machine, the pick-up head comprises a pair of movable jaws which are hydraulically operated to grip the segment by its edges therebetween at the floor of the tunnel and which are released when the segment has been positioned against the tunnel wall. The jaws are then moved away from the segment, and the final position of the segment is adjusted.

In the present invention at least one suction pad is used instead of the movable jaws, and accordingly the present invention provides a tunnelling machine having a tunnel lining stage for installing a ring of arcuate tunnel lining segments to line the tunnel, the tunnel lining stage comprising an assembly supported for rotation about a longitudinal axis of the machine, and a pick-up device mounted on the assembly for picking up such tunnel lining segments from the floor of the tunnel and, after rotation of the assembly and installation of each segment, releasing the segment, the pick-up device comprising at least one suction pad facing generally radially outwardly from said longitudinal axis and adapted to engage the concave

surface of the segment so that the suction pad and segment form a sealed cavity, and means being provided to evacuate the cavity to hold the segment against the suction pad.

The machine according to the invention overcomes two main problems found in the known machines. Firstly, in the known machines the force with which the jaws grip the segment must be carefully controlled. If gripped too hard, the segment crumbles, and, if not gripped with sufficient force, the segment will slide from the jaws. Especially when using segments having a bitumen coating, it has sometimes been found impossible to pick up the segments without crumbling. In the case of the present invention, substantially more lifting force than is necessary can be applied to the segments without adverse effects. Secondly, when using the known machine, the final position of the segments has to be adjusted after the jaws had been removed. In the case of the present invention, there are no lifting jaws at the edges of the segments to hinder the positioning of the segments, and thus the segments can be installed in one stage in their proper position.

A specific embodiment 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 view of the lining stage of a tunnelling machine in a tunnel after installation of a ring of lining segments, looking in the direction of advance of the machine but not showing the excavator and shield stage of the machine;

Figure 2 is a schematic plan view of the pick-up head of the machine, looking in the direction 2 in Figure 1;

Figure 3 is an end view of part of the pick-up head;

Figure 4 is a partial section end view of the pick-up head taken along the section line 4-4 in Figure 2;

Figure 5 is a partially sectioned elevation of a modified suction pad;

Figure 6 is a plan view of the modified pad;

Figure 7 is a rear view of a modified pick-up head; and

Figure 8 is a sectioned elevation of the modified pick-up head.

Referring to the drawings, the lining stage 10 of the machine is used to instal a ring of arcuate cast concrete tunnel lining segments. The ring consists of nine identical segments 12, and three further segments 14, 16, 18. The edges 20, of the segments extend in the longitudinal direction of the tunnel, whereas one edge 22 each of segments 14, 16 is tapered to form half-wedge segments, and both edges 24 of the upper segment 18 are correspondingly tapered to form a full-wedge key segment. The method of installation of the ring is to position segment 12 (1) on the tunnel floor, to lift segment 12 (2) from the tunnel floor

into position and hold it there temporarily by a hydraulic ram, and sequentially to lift into position and temporarily hold segments 12 (3) to 12 (9), 14 and 16. The key segment 18 is then slid longitudinally into position to lock the ring in place. The hydraulic rams temporarily holding segments 12, 14, 16 can then be released.

The lining stage 10 which carries out the operation described above comprises an annular member 26 mounted for rotation about the axis of the tunnel, for example by guide rollers 28 mounted on the machine chassis. The member 26 is located slightly forwardly of the ring of segments to be installed. A motor 30 is provided to rotate the annular member 26 as desired, in either direction for example by means of a pinion 32 engaging internal toothing on the member 26. A pick-up device is mounted on the rotatable member 26. The pick-up device comprises a part cylindrical plate 34, the axis of which is generally coincident with the tunnel axis. The plate is mounted by means of a hydraulic ram 36 which can move the plate radially as denoted by the arrow R and also by means of a joint 38 which permits a limited small amount of free tilting movement of the plate 34, denoted by the arrow T.

Referring now more particularly to Figures 2

to 4, two suction pads 40 are mounted on the convex side of the plate 34. Each suction pad comprises a rectangular sheet 42 of rubber having a peripheral flange-like lip 44 projecting away from the plate 34. The sheet 42 is sandwiched between the plate 34 and a further plate 46, and this sandwich is held together by fasteners extending therethrough. Each pad 40 is provided with a port 48, which ports are both connected to a common vacuum pump.

In order to install a segment 12, 14, 16, the segment is conveyed to the tunnel floor beneath the pick-up device 34 with the concave surface of the segment uppermost. The ram 36 is then extended so that the lips 44 of the suction pads engage the concave surface of the segment and so that each pad forms with the segment a sealed cavity. The cavity is then evacuated by operation of the vacuum pump so that the segment is held against the suction pads. The ram 36 is then retracted, lifting the segment clear of the tunnel floor, and the motor 30 is operated to swing the segment to the desired angular position around the ring. The ram 36 is then extended to instal the segment against the tunnel wall, where it is temporarily held, as described above. The suction is then released; the ram 36 is retracted and the pick-up device is

returned to the lowermost position ready to lift a further segment.

A typical segment may weigh about 350lb (160kg). With such a segment, it has been found satisfactory to use suction pads which apply suction to the concave surface of the segment over a total area of about 70in^2 (450cm^2). When operating at a pressure of 10lb/in^2 (0.7kg/cm^2) below atmospheric pressure, the suction pads can cause a lifting force of a little under 700lb (320kg) to be applied to the segment. It will be noted that the suction pads must not only be able to overcome the weight of the segment when the machine is in the angular position shown in Figure 1, but also be able to prevent sliding of the segment from the pads when the member 26 has been rotated by 90° from that position.

The pick-up head may be modified, for example by using a single suction pad or more than two suction pads.

Referring now to Figures 5 and 7, there is shown a modified suction pad 40, comprising a generally square dished rubber moulding 50 bonded to a plane metal back-plate. The sealing lip 44 of the moulding is wider than that shown in Figure 4 and is formed with a series of four peripheral grooves 52 which improve the seal which can be obtained. A vacuum port 48 is formed

through the back-plate 34 and rubber moulding, and a threaded hole 54 is provided in the back-plate 34 by which the suction pad can be attached to the pick-up head.

Referring now to Figures 7 and 8, there is shown a modified pick-up head including a pair of suction pads 50 as shown in Figures 5 and 6. The pick-up head comprises upper and lower elongate members 56, 58 and three upright members 60 which are welded together to form a framework 64 of two side-by-side squares in which the suction pads 50 are located. Two pairs of plates 62 extend rearwardly from the framework to provide mountings for the suction pads 50. A bearing block 66 is pivotally mounted between each pair of plates 62 and a support shaft 68 extending rearwardly from each suction pad 50 is slidably mounted in a respective one of the bearing blocks 66. Each support shaft 68 is held captive in the respective bearing block 66 by a nut 70 and washer, and a compression spring 72 is mounted on each shaft 68 between the respective bearing block 66 and the back-plate 34 of the respective suction pad.

The springs 72 urge the suction pads normally to a position to the left of that shown in Figure 7 so that the sealing lips of the pads stand proud of the framework 64 and can engage the concrete lining

blocks. As the pads are brought into engagement with the lining blocks, the pads can retract into the framework to a position where the sealing lips are flush with the framework and the framework engages the lining block. Further pressure applied by the pick-up head on the lining block is then transmitted by the framework rather than by the suction pads and thus the framework protects the rubber lips of the suction pads from damage during application of the pick-up head to the concrete block.

CLAIMS:

1. A tunnelling machine having a tunnel lining (10) stage for installing a ring of arcuate tunnel-lining segments to line the tunnel, the tunnel lining stage comprising an assembly (26) supported for rotation about a longitudinal axis of the machine, and a pick-up device (34) mounted on the assembly for picking up such tunnel lining segments from the floor of the tunnel and, after rotation of the assembly and installation of each segment, releasing the segment, characterised in that the pick-up device comprises at least one suction pad (40) facing generally radially outwardly from said longitudinal axis and adapted to engage the concave surface of the segment so that the suction pad and segment form a sealed cavity, and means (48) being provided to evacuate the cavity to hold the segment against the suction pad.

2. A machine as claimed in Claim 1, wherein at least two such suction pads are provided to engage respective portions of the concave surface of the segment.

3. A machine as claimed in Claim 1 or 2, wherein the or each suction pad has a resilient

peripheral lip (44) to engage and seal against the concave surface of the segment.

4. A machine as claimed in any preceding claim wherein the pick-up device further comprises a part-cylindrical backing plate, the axis of which is generally coincident with the longitudinal axis of the machine, and the or each suction pad being mounted on the backing plate.

5. A machine as claimed in any preceding claim wherein the pick-up device further comprises a part-cylindrical backing plate, the axis of which is generally coincident with the longitudinal axis of the machine, and the or each suction pad being mounted on the backing plate.

6. A machine as claimed in any preceding claim, wherein the pick-up device further comprises a framework (64) encircling the or each suction pad, the pad being arranged to stand proud of the framework and being mounted (at 66) so as to be able to retract to a position in which the suction pad is flush with the framework.

FIG. 1.

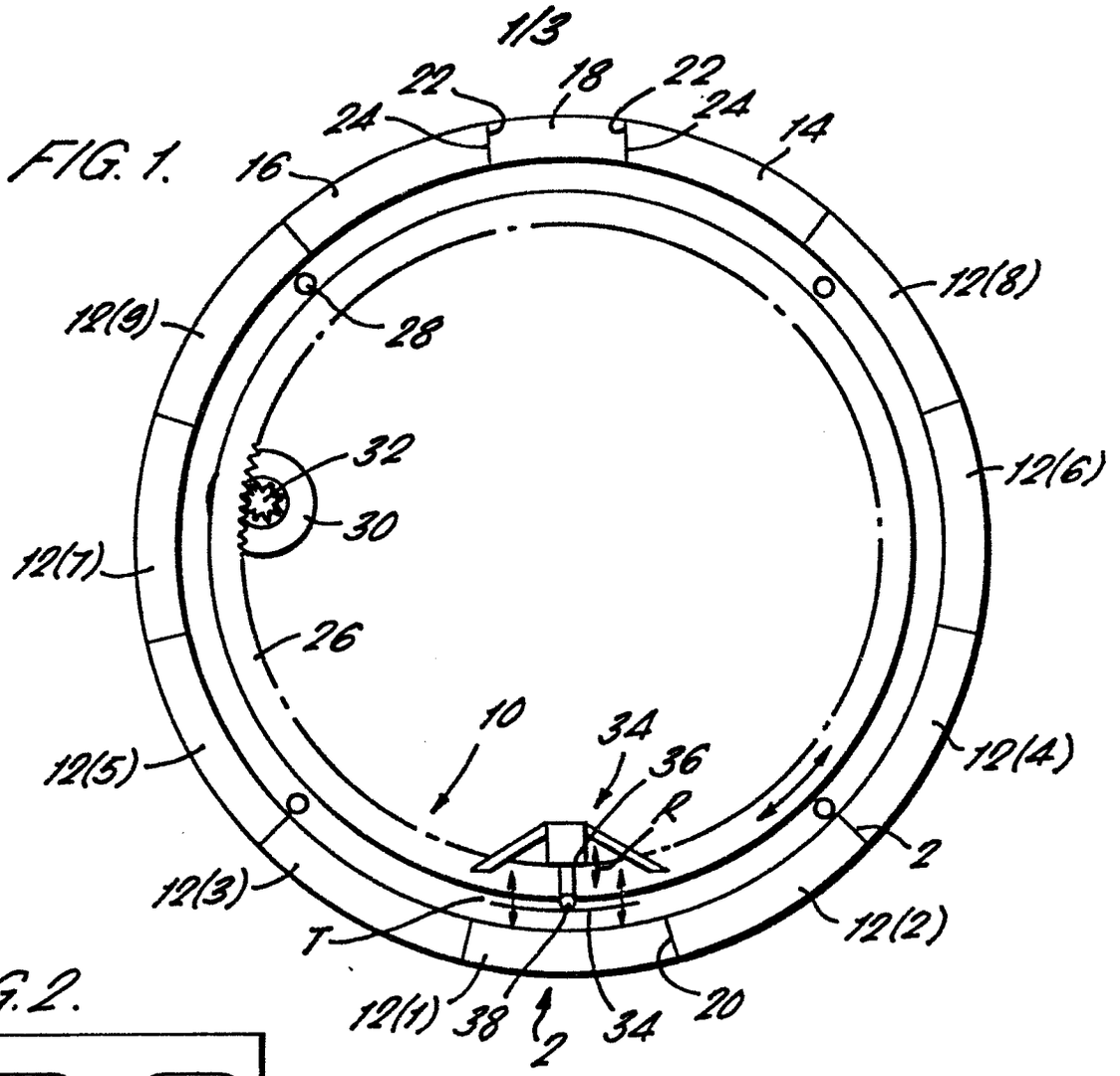


FIG. 2.

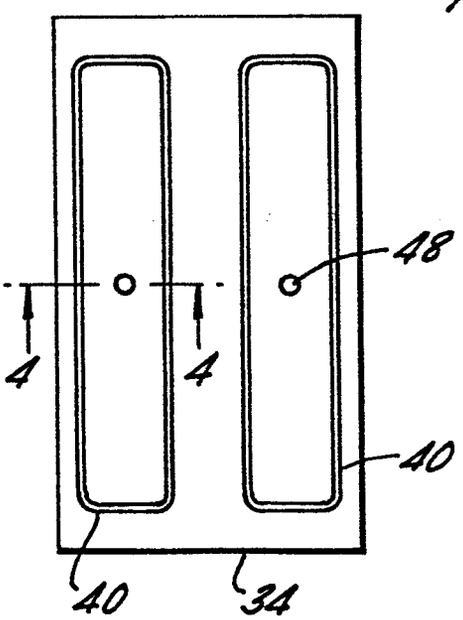


FIG. 3.

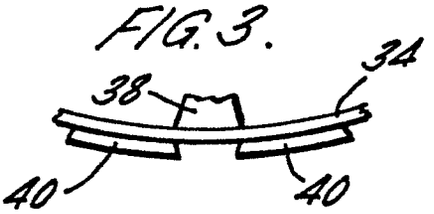
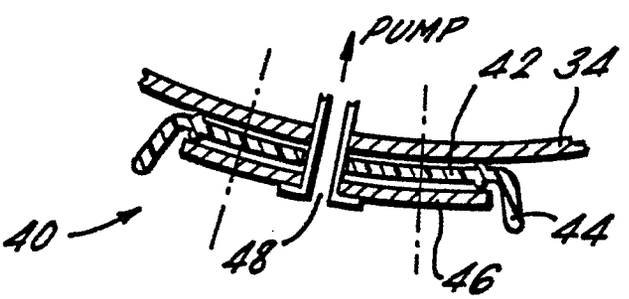


FIG. 4.



0142227

FIG. 5.

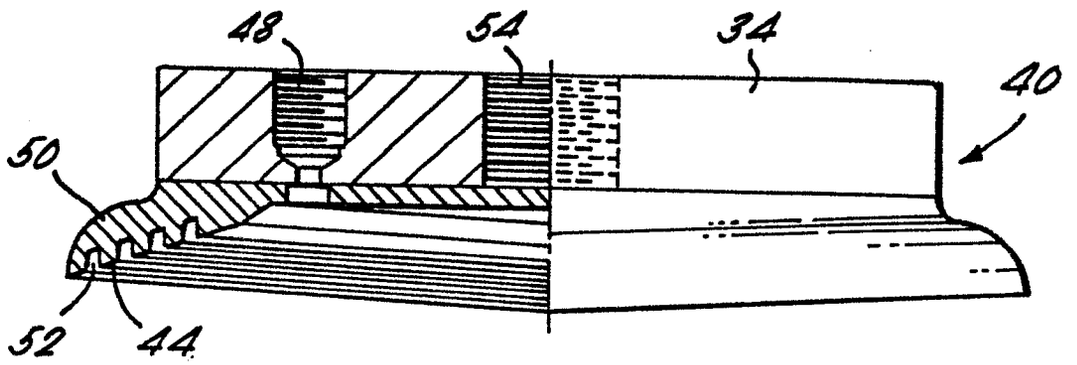


FIG. 6.

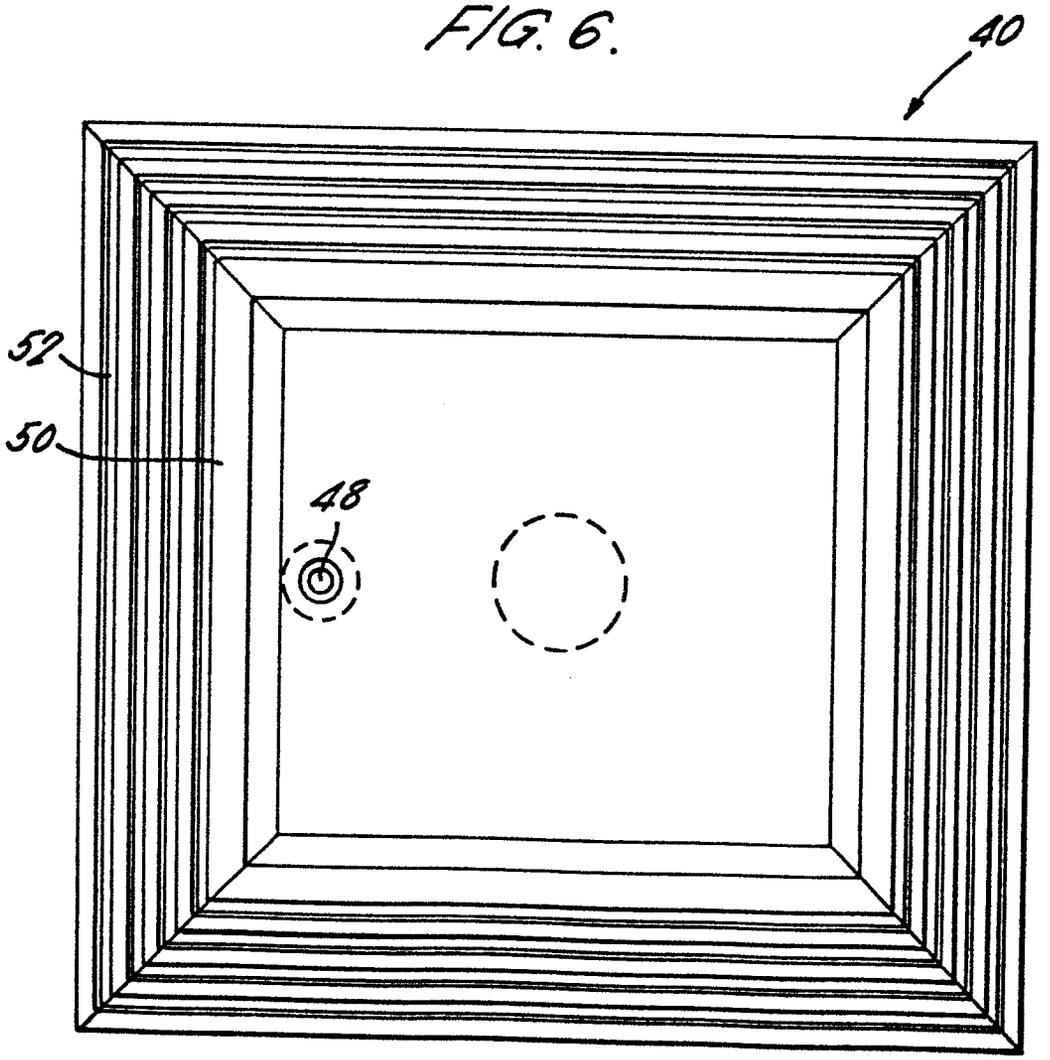


FIG. 7.

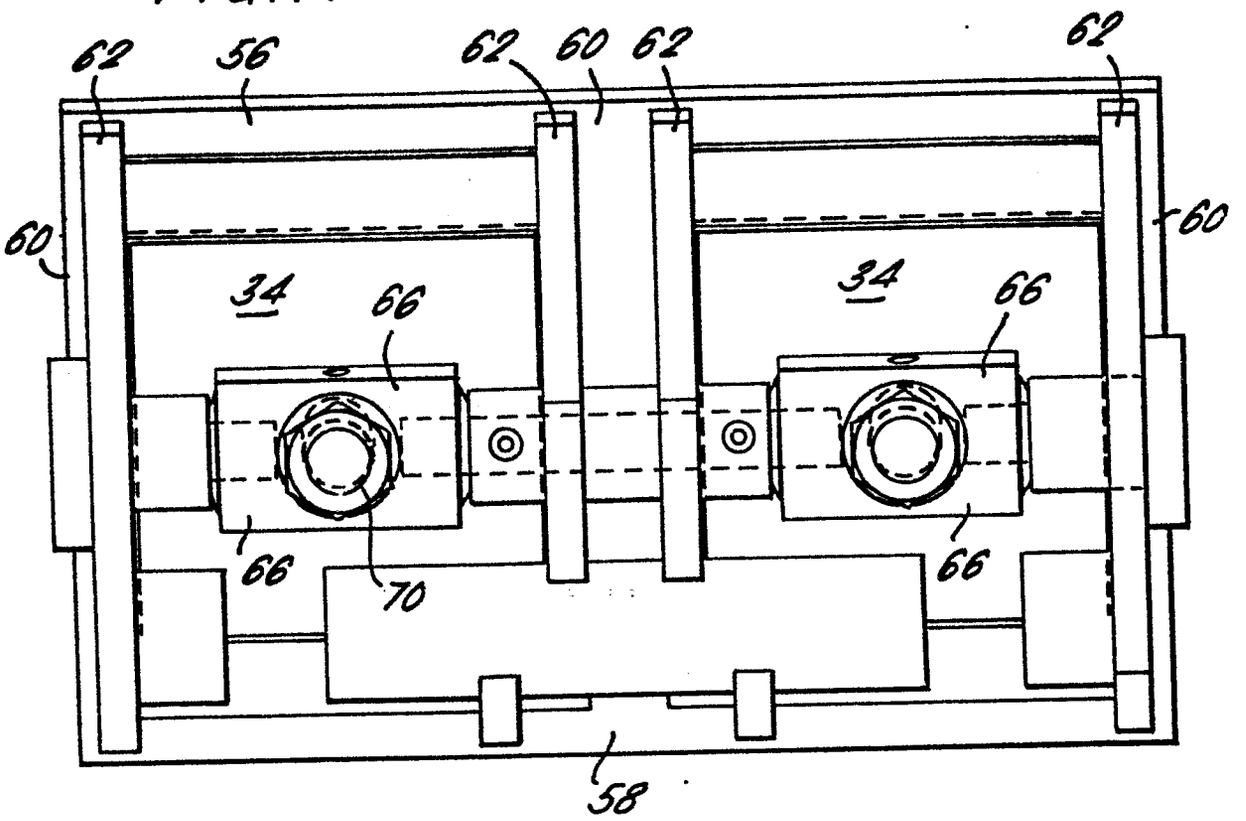
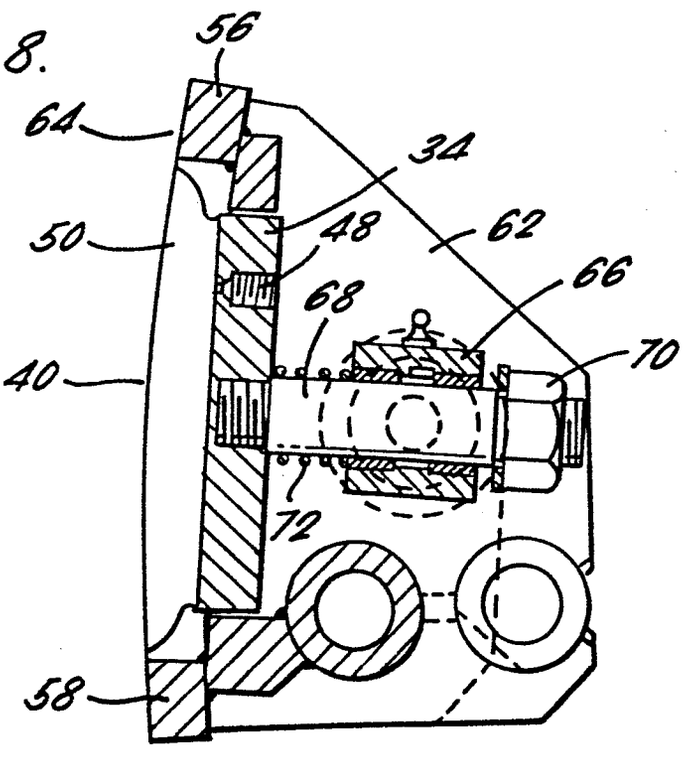

62
56
62
60
62
62
60
60
34
66
34
66
66
66
70
58

FIG. 8.


56
64
34
50
48
62
66
68
70
40
72
58