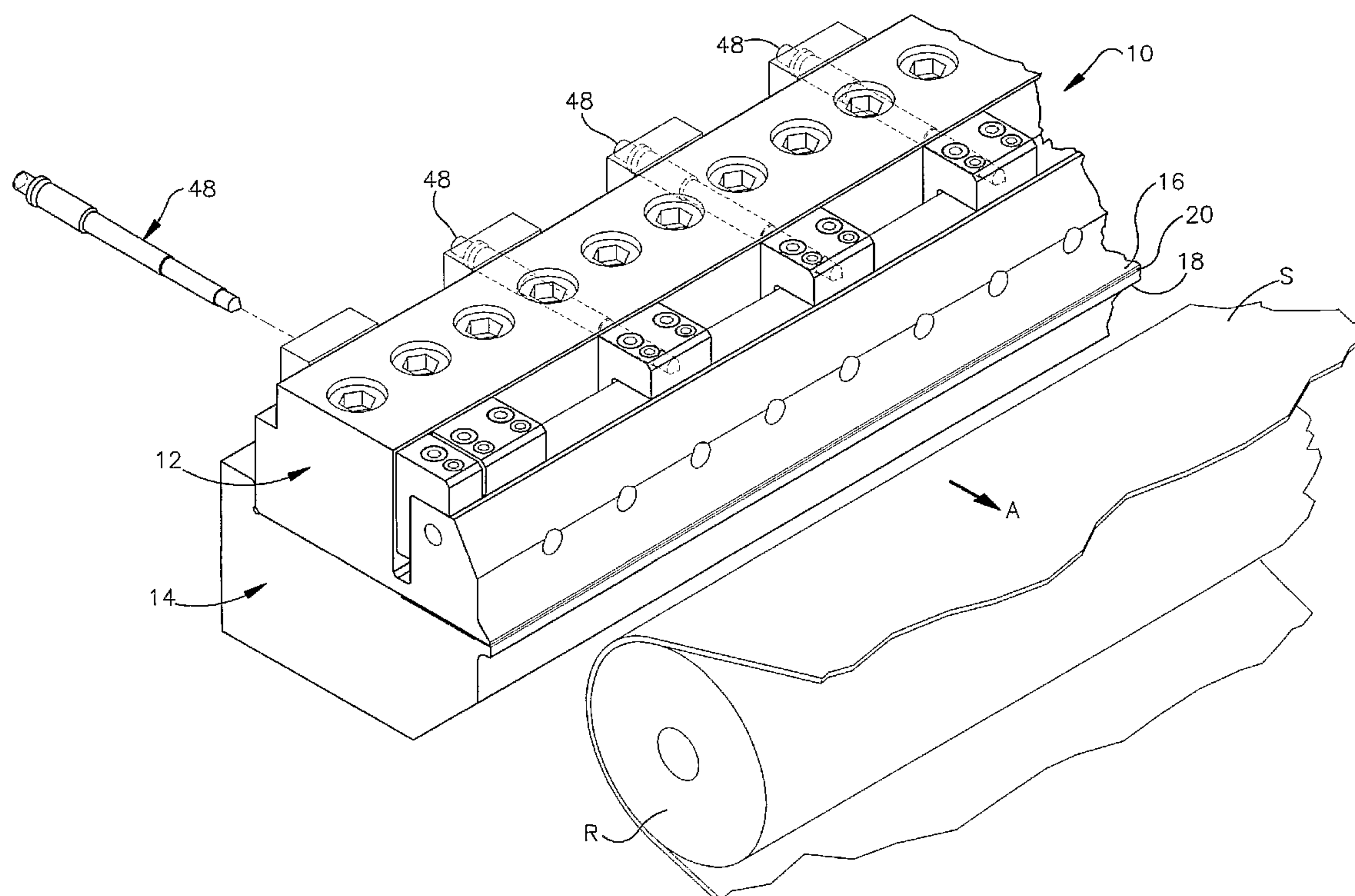




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(57) **Abrégé/Abstract:**

A die assembly (10) having a first die part (12), which includes a first lip (16) that, in combination with a second lip (18), defines a feed gap (20). The first die part (12) also includes a rear portion (22), a front portion (24), a slot (26) between these portions (22,24), and a gap-setting device (28) that is mechanically movable within the slot (26) so as to enable the movement of the front portion (24) relative to the rear portion (22). The first lip (16) is carried by the front portion (24), whereby movement of the front portion (24) in one direction moves the first lip (16) relative to the second lip (18), thereby adjusting the feed gap (20). The geometries of the slot (26) and the gap-setting device (28) are such that movement in a second opposite direction is limited to a known position, thereby providing a registration position for the front portion (24) of the first die part (12) and thereby providing a registration position for the first lip (16).

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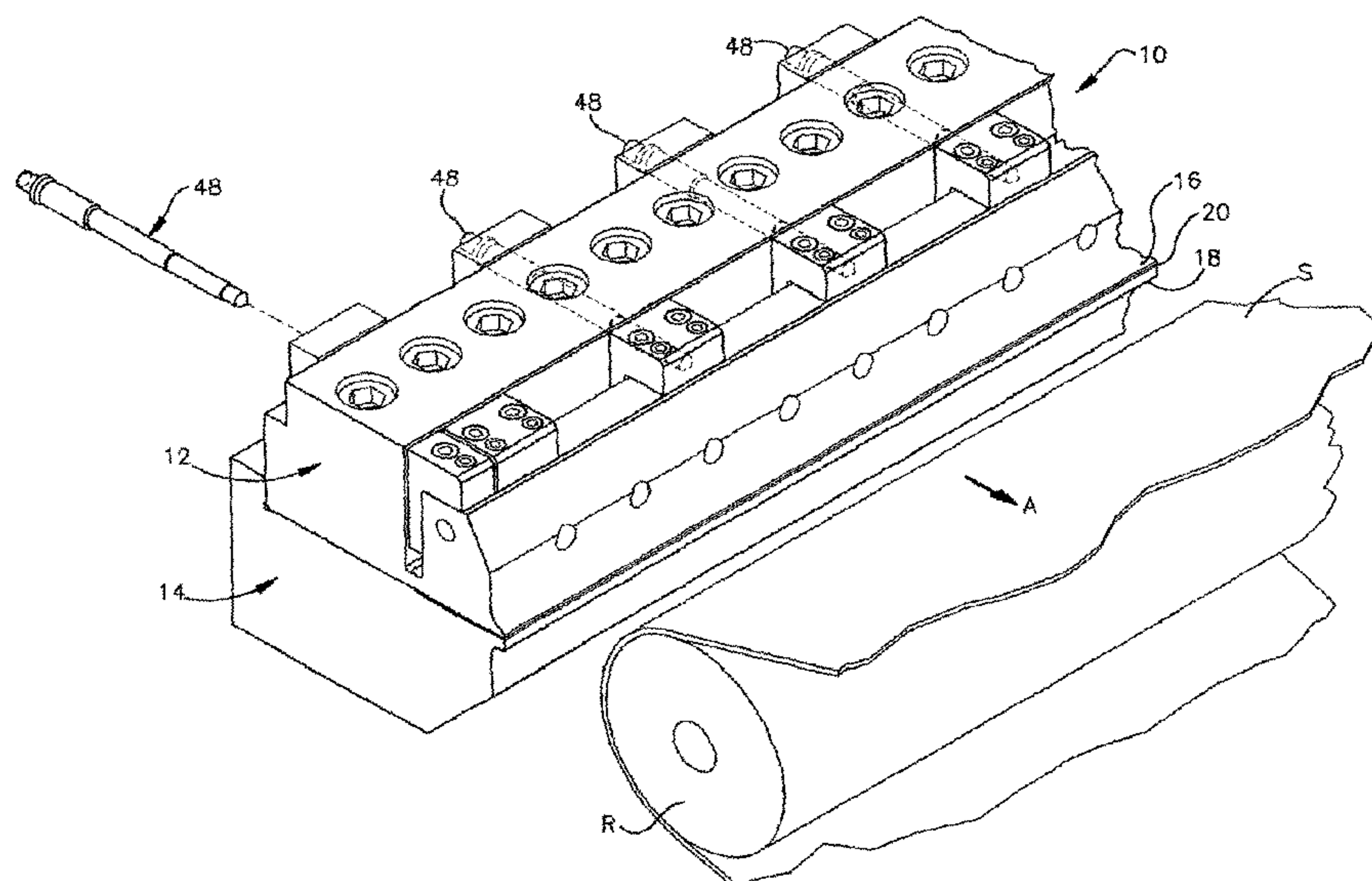
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(54) Title: DIE ASSEMBLY



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Title: DIE ASSEMBLYFIELD OF THE INVENTION

This invention relates generally, as indicated, to a die assembly and, more particularly, to a die assembly with a device to adjust the thickness of the feed gap.

BACKGROUND OF THE INVENTION

A die assembly can be modular and, in any event, is typically assembled from
5 a plurality of parts and then set in a die station as an integral device. For example, a die assembly can comprise a first die part and a second die part, which together form the components that allow the fluid to enter the assembly and be properly emitted therefrom. The first die part includes a first lip and the second die part includes a second lip, these lips defining a feed gap therebetween that determines
10 the thickness of the fluid film emitted therefrom.

A die assembly can have a fixed feed gap or a flexible feed gap. With a fixed feed gap, the lips are not movable relative to each other, whereby the thickness of the feed gap will always be of the same known dimension. With a flexible feed gap, one lip is movable relative to the other lip so as to enable the adjustment of the feed
15 gap along the width of the assembly. A flexible feed gap is typically accomplished by assembling the first die part so that it contains a flexible web between its rear portion and its front portion (to which the first lip is attached), as well as means for moving the front portion in localized areas. Movement of the front portion results in the adjustment of the position of the lip relative to the other lip and, thus, the
20 thickness of the feed gap in the relevant localized area.

In flexible feed gap operations, localized adjustments of the feed gap can usually be accomplished with conventional die assembly designs in order to accommodate a particular run. However, once initial adjustments are made (*i.e.*, once the movable lip is moved from its original adjustment), returning the lip to a
25 known position is not so easily done, if it is even possible. Also, without a clean die and specialized equipment, it is impossible to adjust a feed gap on an industry standard flex die to a known precision gap opening.

摘要

SUMMARY OF THE INVENTION

The present invention provides a die assembly, which can be easily adjusted to a known precision gap opening by returning a movable lip to a known registration position.

5 More particularly, the present invention provides a die assembly comprising a first die part and a second die part, which together form components that allow a fluid to enter the assembly and be properly emitted therefrom. The first die part includes a first lip and the second die part includes a second lip, these lips defining a feed gap therebetween that determines the thickness of the fluid emitted
10 therefrom. The first die part also includes a rear portion, a front portion, a slot between the rear portion and the front portion, and a gap-setting device mechanically movable within the slot for movement of the front portion relative to the rear portion. The first lip is carried by the front portion, whereby movement of the front portion in one direction moves the first lip relative to the second lip, thereby
15 adjusting the feed gap. The geometries of the slot and the gap-setting device are such that movement in a second direction, opposite the first direction, is limited to a known position, thereby providing a registration position for the front portion of the first die part and thereby providing a registration position for the first lip.

These and other features of the invention are fully described and particularly
20 pointed out in the claims. The following description and drawings set forth in detail certain illustrative embodiments of the invention, which are indicative of but a few of the various ways in which the principles of the invention may be employed.

DRAWINGS

Figure 1 is a schematic illustration of a die assembly according to the present
25 invention.

Figure 2 is a perspective view of the die assembly.

Figure 3 is a close-up side view, partially in section, of the first and second die parts.

Figure 3A is a sectional view of the first die part as seen along line 3A-3A in
30 Figure 3.

Figure 4 is a schematic view of the interaction between certain components of the first die part.

Figure 5 is a view similar to Figure 3, with a modified gap-setting device.

Figure 6 is a view similar to Figure 3, with another modified gap-setting device.

DETAILED DESCRIPTION

5 Referring now to the drawings, and initially to Figure 1, a die assembly 10 according to the present invention is shown. The illustrated assembly 10 is a slot die assembly and is shown in position to coat a substrate S traveling in the direction of arrow A around a roll R. The die assembly 10 and the substrate S typically will have substantially equal widths, whereby the entire width of the substrate S can be
10 coated in one pass. The die assembly 10 could instead be any slot die, a curtain die, an extrusion die or any other device wherein control of the feed gap is necessary or desired. Additionally or alternatively, a multi-layer die (forming multiple feed gaps) is also possible with, and contemplated by, the present invention. Specifically, the one or more of the feed gaps in such a die assembly could be made
15 flexible via this invention.

The die assembly 10 can be modular so that it can be assembled from a plurality of parts and then set in a die station as an integral device. In the illustrated embodiment, the die assembly 10 comprises a first (upper) die part 12 and a second (lower) die part 14. (An assembly having more die parts can, of course, be used
20 instead.) The die parts together form the conventional components of a die assembly, allowing the fluid to enter the assembly and be properly emitted therefrom. The first die part 12 includes a first lip 16 and the second die part 14 includes a second lip 18. The lips 16 and 18 define a feed gap 20 therebetween that determines the thickness of the fluid emitted therefrom. (This is shown more
25 clearly in Figure 3.)

Referring now to Figure 2, the die assembly 10 is illustrated in more detail. As shown, the first die part 12 includes a rear portion 22, a front portion 24, a slot 26 between the portions 22 and 24, a flexible web 27 that is formed below the slot 26, and a gap-setting device 28 positioned within the slot 26. The rear portion 22
30 and the front portion 24 can be integrally formed (as shown) or can comprise different components assembled together. In the illustrated embodiment, the first die part 12 includes a lip element 30 (which contains the lip 16) secured to the front

portion 24. The use of such a separate lip element allows easy replacement/ repair; however, that being said, a lip integrally formed with the front portion 24 could be used instead. Fasteners (e.g., bolts, not shown) can be used to secure the lip element 30 to the front portion 24.

5 The second die part 14 includes a main body portion 32 and a lip element 34 (containing the lip 18) secured thereto. In the illustrated embodiment, the second lip 18 remains stationary and only the first lip 16 is moved to adjust the feed gap. However, assemblies wherein both lips are movable is certainly possible with, and contemplated by, the present invention. For example, the second die part 14 could
10 be designed to also include the flex-allowing components of the first die part 12 or any components that would allow selective movement of the lip 18.

 The gap-setting device 28 comprises a plurality of gap-setting elements 36, each of which is mechanically movable within the slot 26 to move the front portion 24 at corresponding localized areas. The first lip 16 is carried by the front portion
15 24 (via the lip element 30 in the illustrated embodiment), whereby movement of the front portion 24 moves the first lip 16 relative to the second lip 18, thereby adjusting the feed gap 20. As explained in more detail below, the geometries of the slot 26 and the gap-setting device 28 are such that movement in a second direction, opposite the first direction, is limited to a known position. This provides a
20 registration position for the front portion 24 of the first die part 12, and thereby provides a registration position for the first lip 16 and, ultimately, a registration for a known feed gap thickness.

 Referring now to Figures 3 and 3A, the first die part 12 and the second die part 14 are shown in detail. Fasteners 40 (e.g., bolts) are used to secure the gap-
25 setting element 36 to the front portion 24. If the die assembly 10 is designed to accommodate heated die operations (e.g., hot melt), the die part 12 could also include a cartridge heater (not shown) within its rear portion 22, a longitudinal heater 46 within its front portion 24, and/or additional auxiliary heaters. (For example, as can be seen by referring briefly back to Figure 2, auxiliary heaters 47 in a form
30 resembling the shape of gap-setting element 36 could be placed at each end of the slot 26.) For non-heated operations (e.g., room temperature operations), such heaters would not be necessary. In any event, if heating is necessary, the rear portion 22 and the front portion 24 can be heated using electrical resistance heaters,

oil, steam, water, etc. It may be noted that the illustrated front portion 24 is well suited to accept a longitudinal bore capable of having a tubular heater inserted, or allowing the passage of oil, water, steam, etc.

Movement of the gap-setting device 28 is caused by motion-causing means
5 48, which can be any mechanical, electrical, magnetic, or other motivation that accomplishes controlled movement. Preferably, each gap-setting element 36 has its own means 48 so that localized adjustments of the feed gap 20 are possible. In the illustrated embodiment, the motion-causing means 48 comprise a bolt 50, which extends rotatably through the rear portion 22 and a nut 52. The bolt 50 is threadably
10 mated with the gap-setting element 36 on one end and is threadably mated with the nut 52 on its opposite end. When the bolt 50 is turned in one direction (e.g., clockwise), the front portion 24 is moved in a first direction, and when the bolt 50 is turned in an opposite direction (e.g., counter-clockwise), the front portion 24 moves in a second direction. The bolt 50 has differently pitched threads so that it can be
15 placed in tension or compression, depending upon the desired direction of movement. A retainer 53 is provided to restrain rotation of the nut 52 during rotation of the bolt 50 (see Figure 3A).

As is best seen by referring collectively to Figures 2 and 3, the slot 26 is defined by a series of slot-defining surfaces, which define a roughly rectangular-
20 shaped cavity. One surface, surface 54, is oriented adjacent to the rear portion 22 and is substantially perpendicular to the plane of the fluid flow direction. The gap-setting elements 36 each have a roughly block-shaped portion 56, and one of the walls of block 56, wall 58, abuts precisely against the slot-defining surface 54 to limit movement in the second direction once the registration position is reached. The
25 illustrated elements 36 also include a leg portion 60 extending perpendicularly outward from the block-shaped portion 56 to form a generally L-shaped element.

Referring now collectively to Figure 3 and Figure 4, the interaction between the front portion 24, the slot 26, the gap-setting element 36, and the bolt 50 is schematically (and exaggeratedly) shown. When the bolt 50 is retracted
30 (tensioned), the block's wall 58 is abutted precisely against the slot-defining surface 54, and the front portion 24 is positioned so that the first lip 16 is in a registration position defining a known thickness for the feed gap 20. (Figure 3.) When the bolt 50 is extended (compressed), the block portion 56 pushes the front portion 24

downward, thereby decreasing the distance between the first lip 16 and the second lip 18 and reducing the thickness of the feed gap 20. (Figure 4.) Upon subsequent retraction of the bolt 50, the front portion 24 returns to the position shown in Figure 3, and the registration position is re-instated.

5 Thus, in flexible feed gap operations, localized adjustments of the feed gap 20 can be accomplished to accommodate a particular run. Additionally, once these adjustments are made, the front portion 24 can be returned to a known registration position. In this manner, the die assembly 10 can be used for a fixed feed gap operation and/or can have a known starting point when adjustments must be made
10 for a subsequent flexible feed gap operation. It may be noted again that conventional flex-die assemblies cannot accommodate fixed feed gap operations.

Referring now back to Figure 3, the die assembly 10 of the present invention may further comprise a sensor 62, which senses the position of the gap-setting element 36. The sensor 62 can comprise a mechanical, optical, inductive,
15 capacitive and/or another suitable proximity-sensing component that is able to sense the distance between the slot's stop surface 54 and the rear wall 58 of the gap setting element 36. This sensed distance can be correlated to the thickness of the feed gap 20. (The die part 12 can be designed and the sensor 62 positioned so that there is a one-to-one correlation between the sensed distance and the
20 thickness of the feed gap 20.) A controller 64 can be provided which, based on the sensed position, automatically sets a specified feed gap 20 in a corresponding localized area. The controller 64 can also control the motion-causing means in feedback to a sensor measuring coating thickness, coatweight, mass, etc. with the preferable cascading of the feed gap control to the coating thickness, coatweight,
25 or mass, etc. control in order to adjust uniformity, coating thickness, mass, etc.

Referring now to Figure 5, the first die part 12 is shown with a replacement gap-setting element 36. The element 36 is also mechanically movable within the slot 26 to move the front portion 24, but has a geometry such that movement in the second direction is not so limited. In this manner, the precision gap-setting
30 element(s) 36 can be replaced with the gap-setting element(s) 36 to convert the die assembly 10 into a mode suitable for a conventional flexible feed gap operation.

Referring now to Figure 6, an additional or alternative conversion of the die assembly 10 is schematically shown. In this conversion, a spacer 68 is positioned

between the gap-setting element 36 and one of the slot-defining surfaces (the surface 54 in the illustrated embodiment). The spacer 68 is sized/shaped to provide (in combination with the gap-setting element 36) a known feed gap thickness less than that acquired in the registration position, in effect creating a precise secondary
5 registration position. A series of spacers 68 of different dimensions can be provided to allow a variety of different feed gap thicknesses to be achieved.

Although in the illustrated embodiment, the spacer 68 takes the form of simple shim fitted between the slot-defining surface 54 and the block's wall 58, other arrangements are possible with, and contemplated by, the present invention. For
10 example, a groove could be formed (e.g., an upside-down U shaped groove milled around the edges and/or central groove) in one of the slot-defining surfaces and/or the gap-setting device 28. The spacer(s) 68 could be sized and shaped to fit within such a groove to provide the desired feed gap dimension. If the spacer 68 fit entirely within the groove, this would result in the feed gap dimension being the
15 same as if only the gap-setting device 28 was used. If the spacer 68 protruded from the groove, this would define a different (smaller) feed gap dimension.

The setting of the spacer 68 can be achieved by moving the gap-setting element 36 in the first direction to a position that provides clearance between it and the adjacent slot-defining surface 54, inserting the spacer 68 into the clearance and
20 then moving the gap-setting element 36 in the second direction in order to accurately set the feed gap 20. Alternatively, a thinner or thicker gap setting element 36 could be fabricated so as to create secondary registration positions of greater or lesser feed gap thickness.

Although the invention has been shown and described with respect to certain
25 preferred embodiments, it is evident that equivalent and obvious alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification. The present invention includes all such alterations and modifications, and is limited only by the scope of the following claims.

ARTICLE 19

AMENDED CLAIMS

received by the International Bureau on 06 December 2004 (06.12.2004)
original claims 1-23, replaced by claims 1-23

1. A die assembly (10), comprising a first die part (12) and a second die part (14), which together form components that allow a fluid to enter the assembly (10) and be properly emitted therefrom;

5 the first die part (12) including a first lip (16) and the second die part (14) including a second lip (18), these lips defining a feed gap (20) therebetween that determines the thickness of the fluid emitted therefrom;

the first die part (12) also including a rear portion (22), a front portion (24), and a flexible web (27) between the rear portion (22) and the front portion (24) that allows the front portion (24) to be pivoted relative to the rear portion (22);

10 the first lip (16) being carried by the front portion (24), whereby movement of the front portion (24) moves the first lip (16) relative to the second lip (18) thereby adjusting the feed gap (20);

motion-causing means (48) for causing the front portion (24) to move in a first direction to reduce the feed gap (20) and in a second direction to increase the feed gap (20);

characterized by:

a gap-setting device (28) which limits movement of the front portion (24) in the second direction and thereby sets the first portion (24) in a registration position corresponding to a known thickness for the feed gap (20).

2. A die assembly (10) as set forth in the preceding claim, wherein the slot (26) is defined by a series of slot-defining surfaces and wherein the gap-setting device (28) abuts precisely against one of the slot-defining surfaces (54) so as to stop movement in the second direction.

25 3. A die assembly (10) as set forth in claim 1, wherein the gap-setting device (28) comprises a plurality of gap-setting elements (36) positioned along the width of the feed gap (20) and wherein each gap-setting element (36) can be mechanically moved independently within the slot (26), thereby enabling movement of the front portion (24) at one location.

4. A die assembly (10) as set forth in the preceding claim, wherein the gap-setting elements (36) are secured to the front portion (24).

5. A die assembly (10) as set forth in either of the two preceding claims, wherein the slot (26) is defined by a series of slot-defining surfaces, and
5 each of the gap-setting elements (36) has a series of walls defining its shape, and wherein one wall (58) of the gap-setting member (36) abuts precisely against one of the slot-defining surfaces (54) so as to limit movement in the second direction.

6. A die assembly (10) as set forth in the preceding claim, wherein the
10 slot-defining stop surface (54) is located adjacent to the rear portion (22).

7. A die assembly (10) as set forth in the preceding claim, each gap-setting element (36) has its own motion-causing means (48).

8. A die assembly (10) as set forth in any of the preceding claims, wherein the motion-causing means (48) comprise a bolt (50) which, when turned
15 in one direction, moves the front portion (24) in the first direction and, when turned in an opposite direction, moves the front portion (24) in the second direction.

9. A die assembly (10) as set forth in the preceding claim, wherein the bolt (50) extends rotatably through the rear portion (22).

20 10. A die assembly (10) as set forth in any of claims 6 - 9, wherein the slot-defining stop surface (54) is oriented substantially perpendicular to the plane of fluid flow direction.

11. A die assembly (10) as set forth in any of the preceding claims, wherein the slot-defining surfaces define a roughly rectangular-shaped cavity and

AMENDED SHEET (ARTICLE 19)

wherein each of the gap-setting elements (36) has a roughly block-shaped portion (56).

12. A die assembly (10) as set forth in the preceding claim, wherein each of the gap-setting elements (36) has a leg portion (60) extending
5 perpendicularly outward from the block-shaped portion (56) to form a generally L-shaped element.

13. A die assembly (10) as set forth in any of the preceding claims, wherein the second lip (18) remains stationary.

14. A die assembly (10) as set forth in any of the preceding claims,
10 further comprising a sensor (62) that senses the position of the gap-setting device (28), whereby the thickness of the feed gap (20) can be determined.

15. A die assembly (10) as set forth in the preceding claim, wherein the sensor (62) senses the distance of the gap-setting device (28) relative to a slot-defining surface.

16. A die assembly (10) as set forth in either of the preceding claims
15 when they depend from claim 3, wherein each gap-setting element (28) comprises a sensor (62) for sensing its position.

17. A die assembly (10) as set forth in any of claims 14-16, wherein a controller (64) controls the motion-causing means (48), based on the sensed
20 position, to set a feed gap (20) in the corresponding localized area.

18. A die assembly (10) as set forth in any of the preceding claims, further comprising another gap-setting device (66), which is mechanically movable within the slot (26) to move the front portion (24) and which has a geometry such that movement in the second direction is not so limited, whereby
25 the precision gap-setting device (28) can be replaced with this other gap-setting

device (66), thereby converting the die assembly (10) to a dual-movement die assembly.

19. A die assembly (10) as set forth in any of the preceding claims, further comprising a spacer (68) of a known thickness, which is positionable between one of the slot-defining walls and the gap-setting device (28), to position the front portion (24) in a known position so as to acquire a known feed gap (20).

20. A die assembly (10) as set forth in the preceding claim, comprising a series of such spacers (68), at least some of which may be of different thicknesses in order to provide different known distances of movement of the front portion (24).

21. A method comprising the steps of:

providing a die assembly (10) as set forth in any of the preceding claims with the front portion (24) in its registration position, whereby the feed gap (20) is of the known thickness;

mechanically moving the front portion (24) in the first direction to adjust the feed gap (20);

operating the die assembly (10) to emit the fluid from the adjusted feed gap (20); and

mechanically moving the front portion (24) in the second direction until it reaches the registration position in order to return the feed gap (20) to the known dimension prior to any subsequent feed gap (20) adjustments.

22. A method as set forth in the preceding claim when it depends directly or indirectly from claim 3, wherein said mechanical movement steps comprise:

mechanically moving at least some of the plurality of gap-setting elements (36) in the first direction in order to adjust the feed gap (20) at certain locations along its width; and

mechanically moving the previously moved gap-setting elements (36) in the second direction in order to return them to the registration position.

AMENDED SHEET (ARTICLE 19)

23. A method as set forth in either of the preceding two claims, further comprising the step of operating the die assembly (10) when the front portion (24) is in its registration position to emit fluid from the feed gap (20) of the known thickness.

AMENDED SHEET (ARTICLE 19)

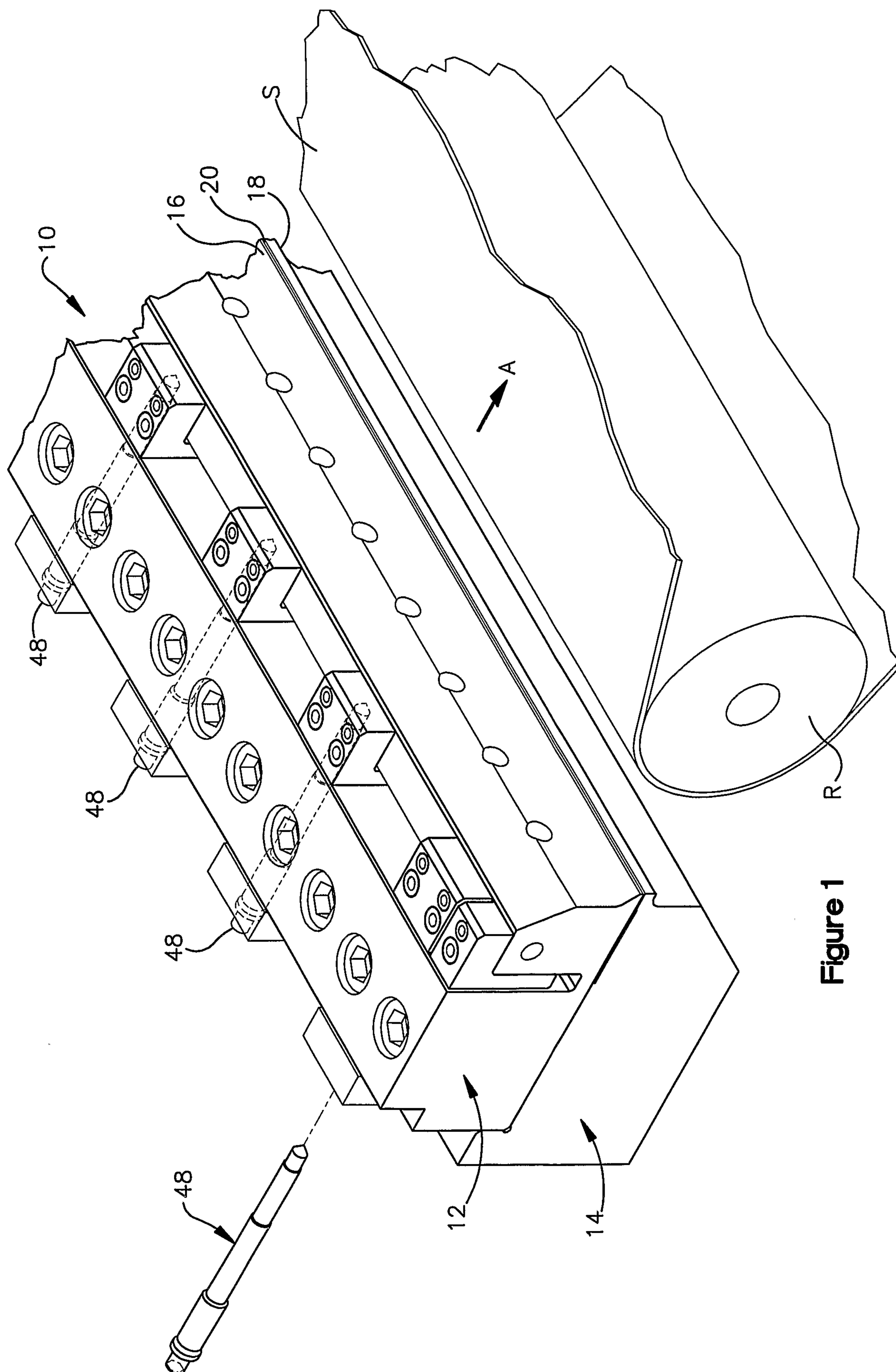


Figure 1

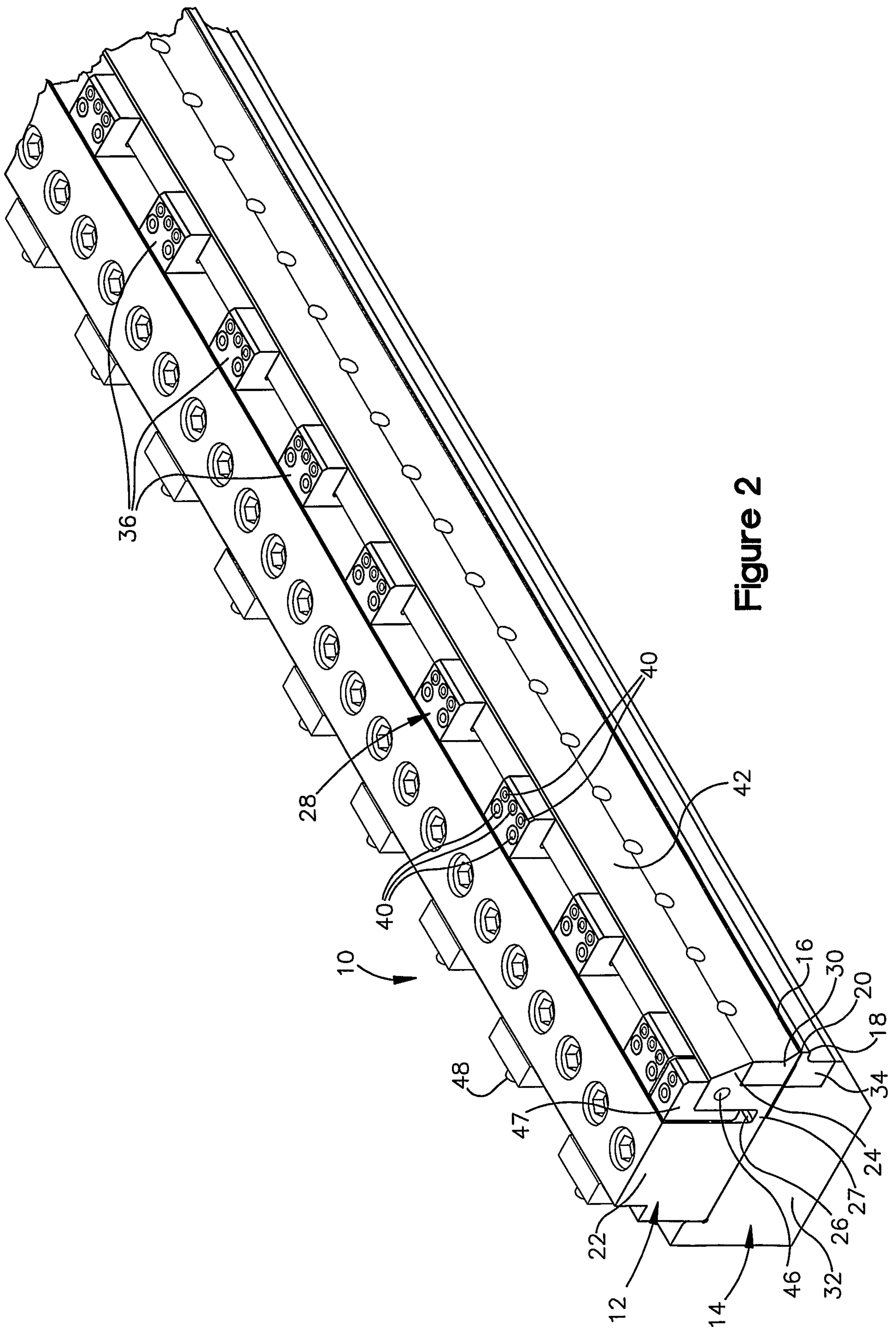


Figure 2

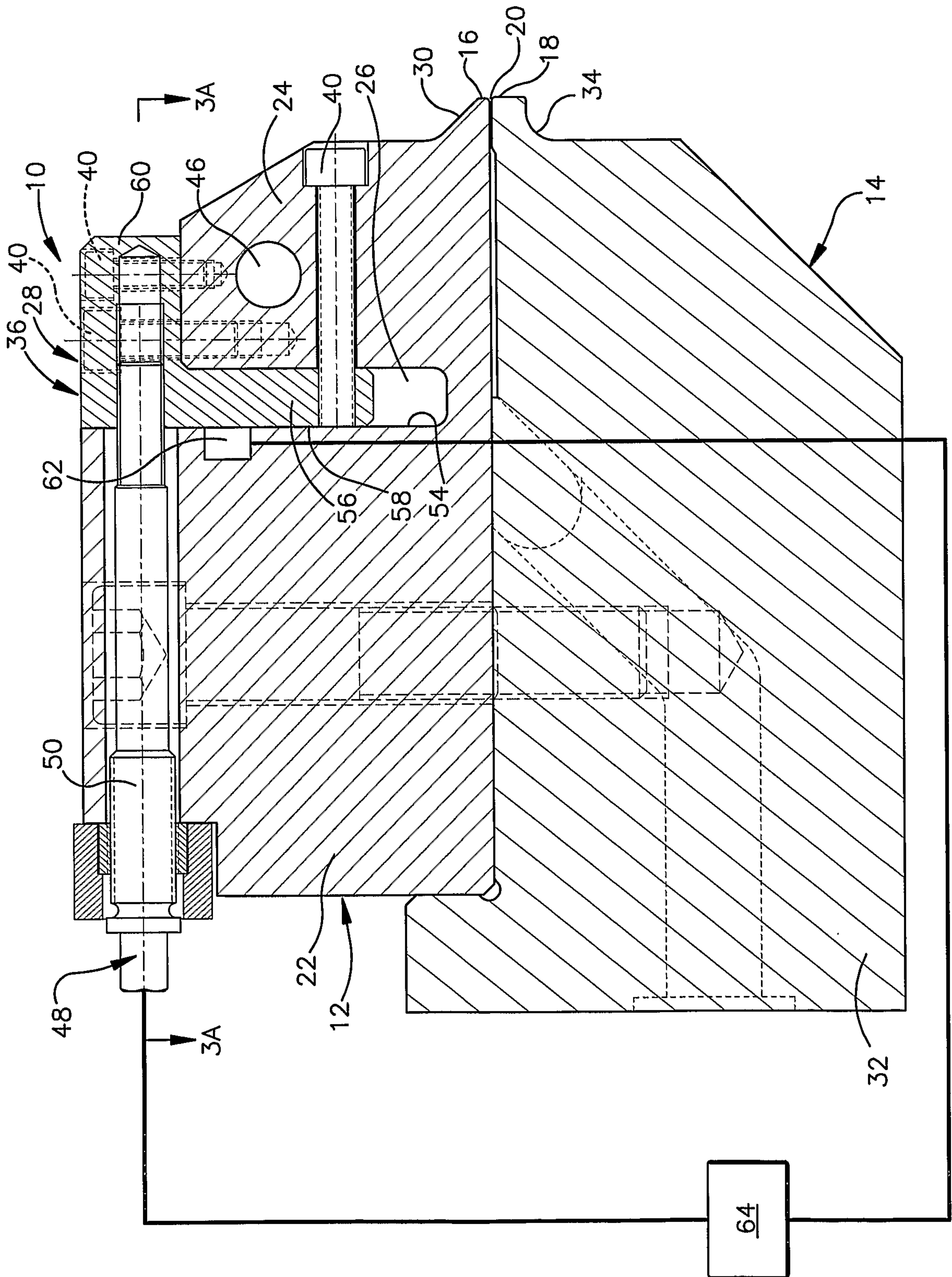
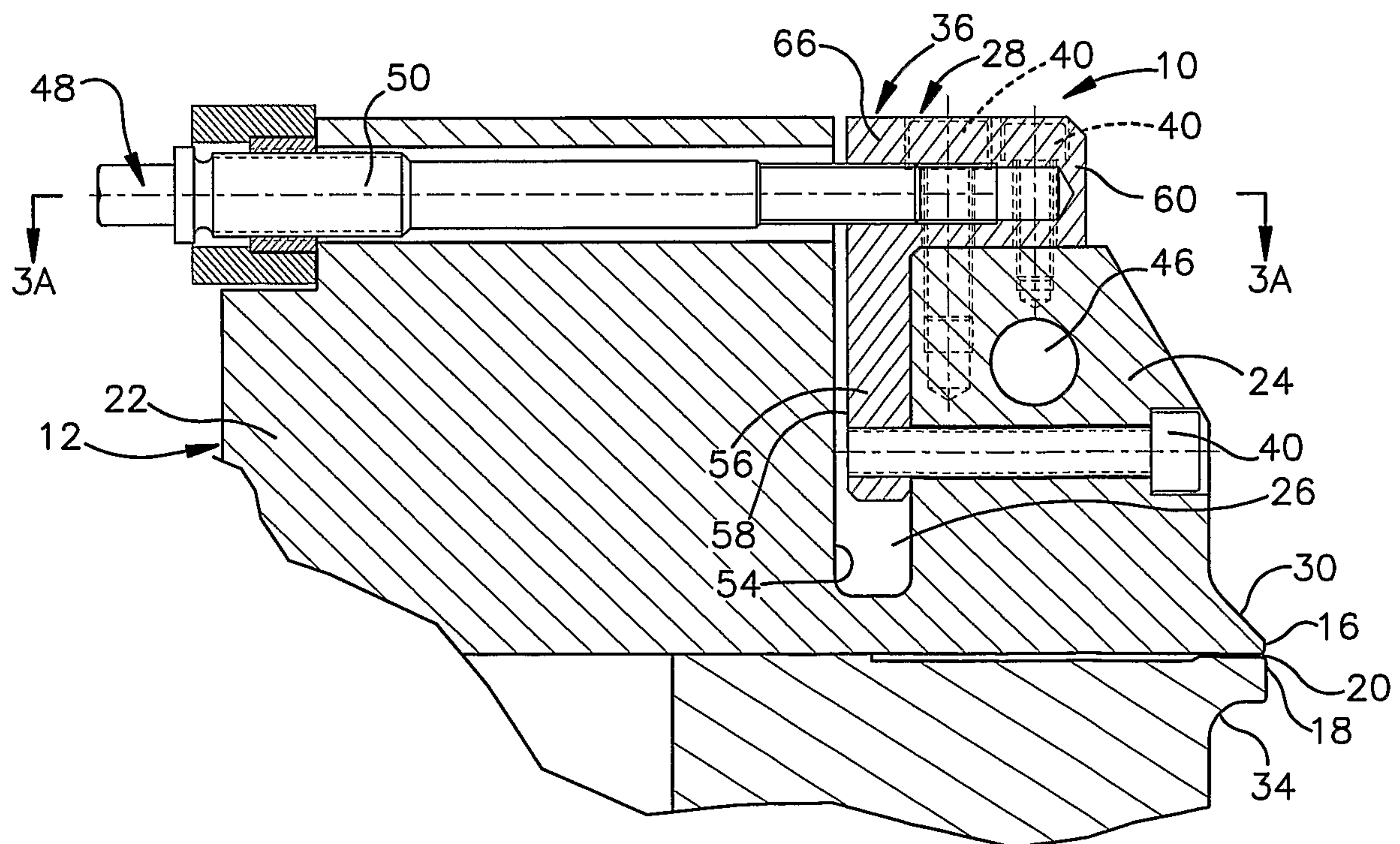
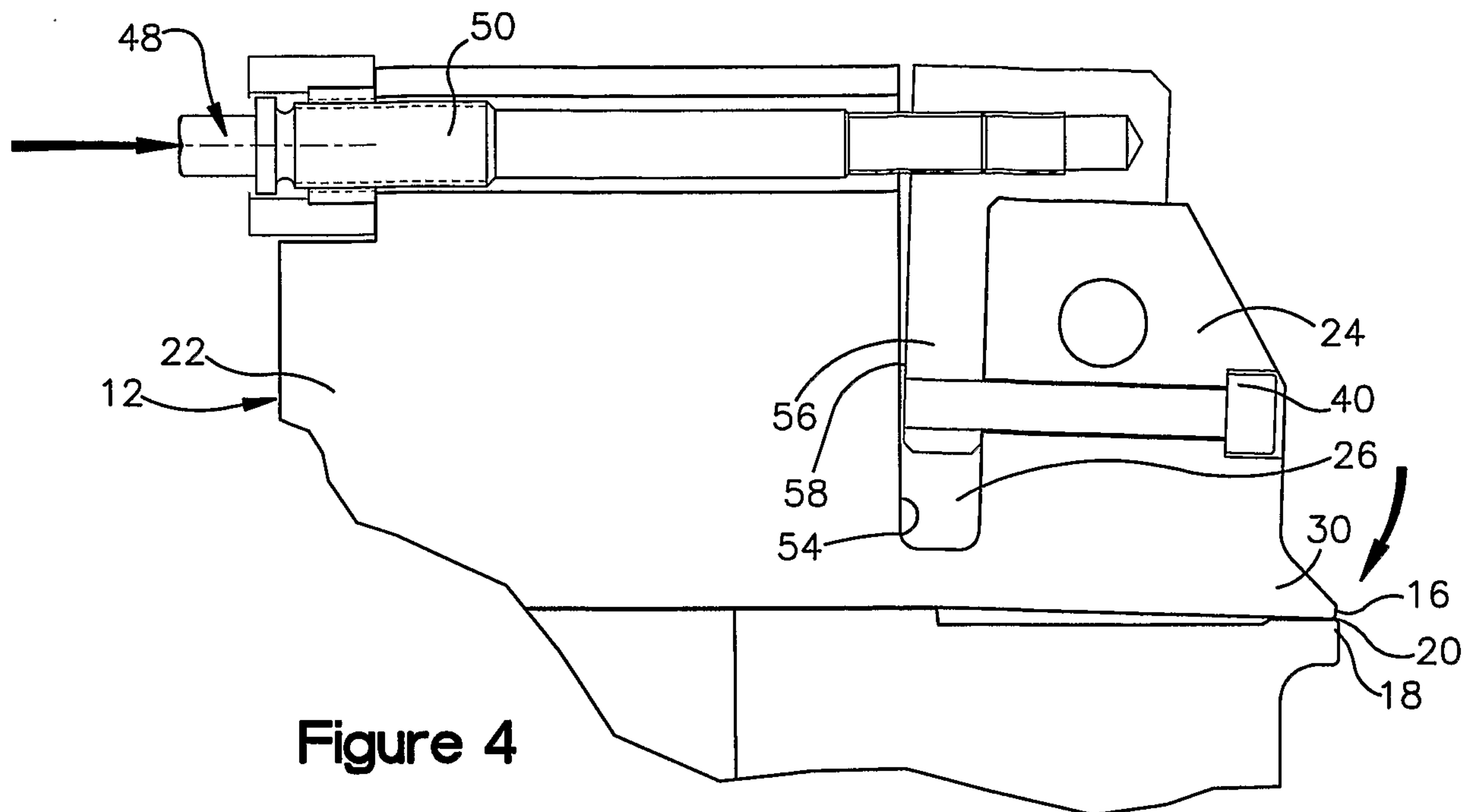
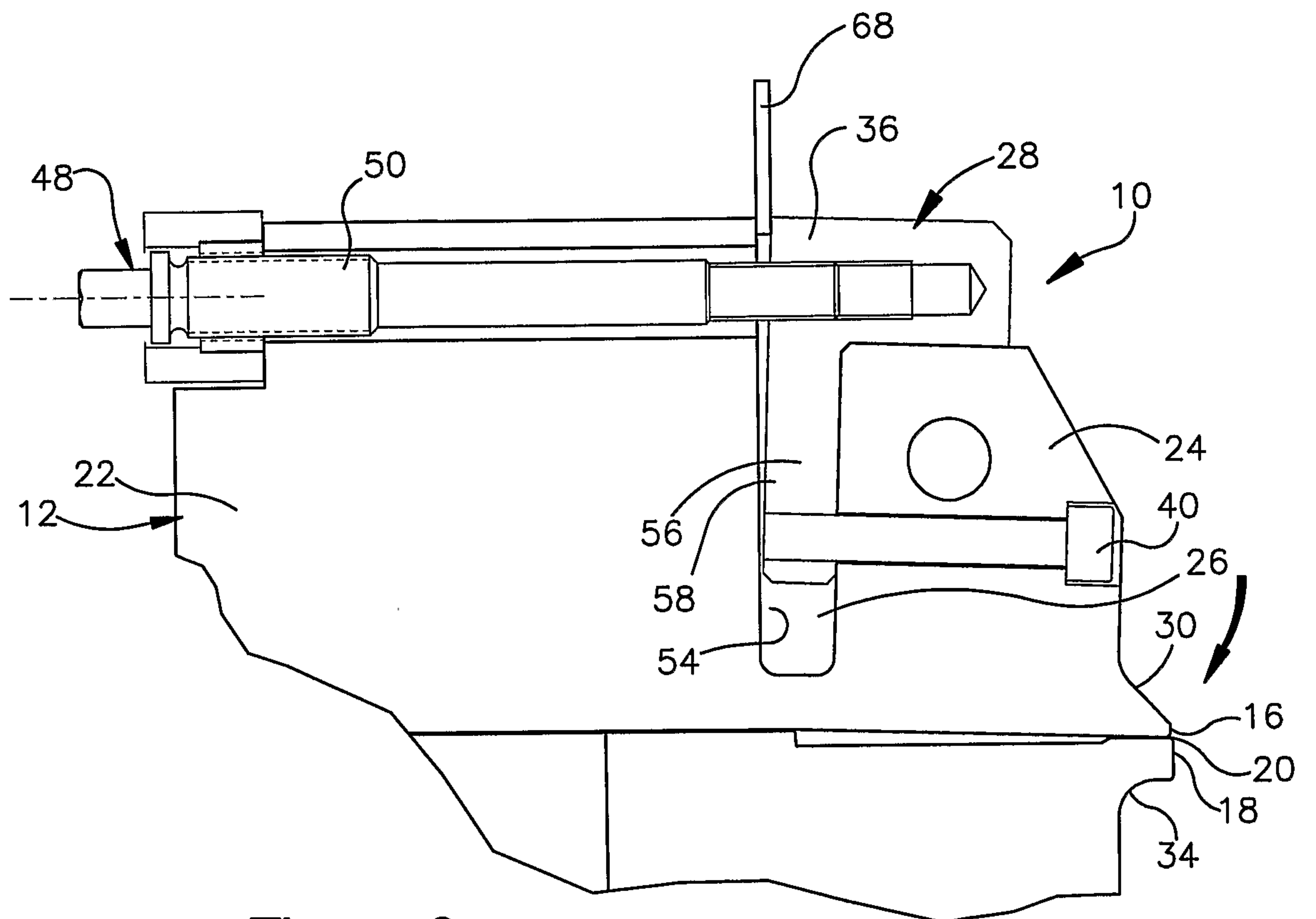


Figure 3



**Figure 6**

