Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2601838 A1 2008/03/14

(21) 2 601 838

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(22) Date de dépôt/Filing Date: 2007/09/13

(41) Mise à la disp. pub./Open to Public Insp.: 2008/03/14

(30) Priorité/Priority: 2006/09/14 (US60/844,584)

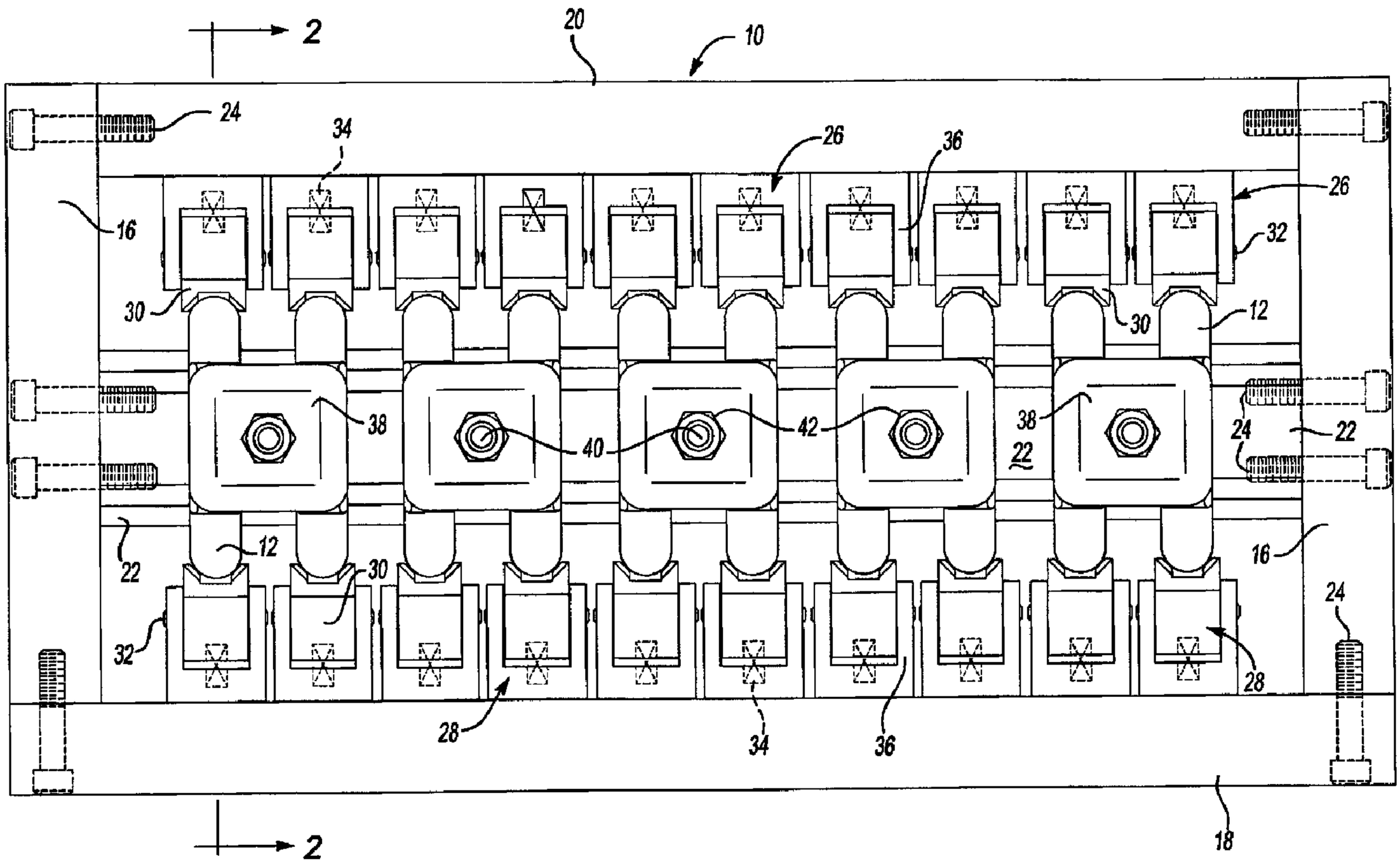
(51) Cl.Int./Int.Cl. *B23Q 3/06* (2006.01),
B23B 41/12 (2006.01), *F16C 35/00* (2006.01)

(71) Demandeurs/Applicants:
NAJARIAN, RICHARD T., US;
MCKOWN, JEFFREY A., US

(72) Inventeurs/Inventors:
NAJARIAN, RICHARD T., US;
MCKOWN, JEFFREY A., US

(74) Agent: MACRAE & CO.

(54) Titre : DISPOSITIF DE RETENUE POUR L'USINAGE DE CHAPEAUX DE PALIER
(54) Title: HOLDING FIXTURE FOR MACHINING BEARING CAPS



(57) Abrégé/Abstract:
A holding fixture is disclosed for machining bearing caps that have a generally semi-cylindrical bearing bore on an interior surface and bolt shoulders on opposite sides that are bored to receive bolts. The holding fixture comprises a fixture frame to which a mandrel is attached that receives the bearing caps with the bearing bore centered relative to the mandrel. A plurality of clamps engage an exterior portion of the bearing caps to retain the bearing caps on the mandrel. A method of manufacturing a bearing cap is also disclosed using a fixture that has a mandrel that is received in the bearing bore and clamps that engage the outer surface of

CA 2601838 A1 2008/03/14

(21) 2 601 838

(13) A1

(57) Abrégé(suite)/Abstract(continued):
the bearing caps. A pair of bolt shoulders of the bearing caps are machined and a bolt hole is bored in each of the bolt shoulder portions. The bearing bores are subsequently machined with the bearing caps being located based upon the location of the bolt holes to form a plurality of finished bearing caps.

ABSTRACT OF THE DISCLOSURE

A holding fixture is disclosed for machining bearing caps that have a generally semi-cylindrical bearing bore on an interior surface and bolt shoulders on opposite sides that are bored to receive bolts. The holding fixture comprises a fixture frame to which a mandrel is attached that receives the bearing caps with the bearing bore centered relative to the mandrel. A plurality of clamps engage an exterior portion of the bearing caps to retain the bearing caps on the mandrel. A method of manufacturing a bearing cap is also disclosed using a fixture that has a mandrel that is received in the bearing bore and clamps that engage the outer surface of the bearing caps. A pair of bolt shoulders of the bearing caps are machined and a bolt hole is bored in each of the bolt shoulder portions. The bearing bores are subsequently machined with the bearing caps being located based upon the location of the bolt holes to form a plurality of finished bearing caps.

HOLDING FIXTURE FOR MACHINING BEARING CAPS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to fixtures for holding wheel bearing caps or other bearing caps in a CNC work center.

2. Background Art

Bearing caps are used to secure a bearing that journals a shaft. Bearing caps are used in vehicles to retain axles on a vehicle frame and wheel bearings for a wheel assembly. Bearing caps may also be provided to retain crankshaft bearings on an engine and may also be used in other types of machinery. Bearing caps generally have a semi-circular body portion and flanges for receiving bolts that are used to secure the bearing cap to a supporting member or second part of a bearing retaining assembly. Bearing caps must be machined to close tolerances to avoid assembly problems and excessive scrap and salvage expense.

Bearing caps may be formed in a casting operation in which tolerances are typically required to be held to ± 0.030 inches for castings having a distance between measured points of between 0 and 3 inches and $\pm .045$ between 3 and 8 inches. Castings are normally formed with a draft angle that is required to remove the casting from the casting mold. The unusual shape of a bearing cap makes it difficult to properly fixture one or more bearing caps as they are machined.

Bearing caps normally must be machined after casting to provide uniformity from part to part. For example, at one machining center location, a bearing cap may be fixtured while bolt holes are drilled and counterbored on the fastener shoulders of the bearing cap with the end faces of the bearing cap being milled to a tolerance of ± 0.010 inches.

The relatively broad tolerance for a cast bearing cap is three times the tolerance allowed for machining surfaces which makes it difficult to fixture cast bearing caps for initial machining operations. After initial machining operations are performed on the bearing cap, accurately machined surfaces are available to locate the bearing cap for subsequent machining operations.

There is a need for a fixture for machining a plurality of bearing caps simultaneously at a work center that allows the bolt hole locations and machined surfaces to be accurately located. The above problems and needs are addressed by Applicant's invention as summarized below.

SUMMARY OF THE INVENTION

According to one aspect of the invention, a holding fixture for machining a plurality of bearing caps is provided that is easy to load and precisely fixtures the bearing caps to form bolt holes and milled surfaces.

According to another aspect of the invention, a holding fixture for a bearing cap is centered relative to a generally semi-cylindrical surface of the rough "as cast" part. The generally semi-cylindrical surface may be the bearing bore of a bearing cap. The bearing bore engages a mandrel of the holding fixture that has a center that corresponds to the center of the bearing to be retained by the bearing cap. Clamps engage the outer surface of the fixtured bearing cap to retain them on the mandrel. The bolt holes and machined surfaces are located relative to the partially cylindrical surface corresponding to the inner bore of the bearing cap that receives the bearing.

According to another aspect of the invention, a holding fixture for machining a bearing cap is provided that permits a plurality of bearing caps to be fixtured relative to the cast radiused ends of the bearing cap. Floating V-blocks that are pivotable and shiftable may, in one embodiment, locate the ends of the bearing cap. The floating V-blocks may be spring loaded to move up and down and pivot

to compensate for draft angle and cast part tolerances. The floating V-blocks facilitate loading and also increase uniformity part-to-part for machining operations.

According to other aspects of the present invention, the bearing caps are retained by clamping plates that lock the bearing cap into the holding fixture prior to performing the desired machining operations. The clamping plates locate the bearing caps in the fixture at predetermined locations, and in particular, hold the bearing caps on the semi-circular central cast radius at the desired circumferential orientation relative to the mandrel.

According to another aspect of the invention, a method is disclosed for manufacturing bearing caps using an improved fixture for "as cast" parts. A rough bearing cap is cast in a mold that has an as cast semi-cylindrical bearing bore and an outer surface. A plurality of bearing caps are assembled into a first fixture that has a mandrel that is received in the bearing bore. The bearing caps are assembled onto the first fixture with clamps that engage the outer surface of the bearing caps. A pair of bolt shoulder portions of the bearing caps are machined and a bolt hole is bored into each bolt shoulder portion. The bearing caps are removed from the first fixture and are subsequently machined while being located using the bolt holes to form the finished bearing caps.

These and other features and advantages will be better understood in view of the attached drawings and following detailed description of the illustrated embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a front elevation view of a fixture for machining bearing caps in a CNC work center shown with the bearings clamped in the fixture according to one embodiment of the present invention;

FIGURE 2 is a cross-sectional view taken along the line 2-2 in Figure 1;

FIGURE 3 is a cross-sectional view similar to Figure 2 showing a bearing cap prior to assembly to the fixture;

FIGURE 4 is an exploded, perspective view of a floating V-block made in accordance with one embodiment of the present invention;

FIGURE 5 is a diagrammatic cross-sectional view showing the degrees of freedom of movement of the floating V-block;

FIGURE 6 is a fragmentary exploded, perspective view of a mandrel and a clamp according to one aspect of the present invention;

FIGURE 7 is a perspective view of a cast, unmachined bearing cap; and

FIGURE 8 is a perspective view of a partially machined bearing cap.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring to Figure 1, a fixture 10 for retaining a plurality of bearing caps 12 is shown with ten bearing caps assembled to the fixture 10. The fixture 10 includes two side plates 16, a base plate 18 and a top plate 20. The fixture 10 is generally in the form of an open frame that permits machining operations to be performed on two sides of the bearing caps 12 while assembled to the fixture 10. A mandrel 22 extends between the side plates 16 and parallel to the base plate 18 and top plate 20. The plates and mandrel of the frame are assembled together by dowel pins (not shown) and socket head screws 24.

An upper floating V-block assembly 26 is assembled to the top plate 20 of the fixture 10. A lower V-block clamp assembly 28 is assembled to the base plate 18 of the fixture 10. Each of the V-block assemblies 26, 28 include a jaw 30 that is mounted on a pin 32. A spring 34 resiliently biases the jaw 30 relative to a

V-block retainer 36. The pin 32 is journalled within the V-block retainer 36 to support the jaw 30 in a movable relationship relative to the V-block retainer 36.

A tie-down bolt 40 and nut 42 are used to secure a mandrel clamp 38. The tie-down bolt 40 extends through the mandrel 22 between two adjacent bearing caps 12 so that a single clamp 38 may be used to engage the two adjacent bearing caps 12 to retain the bearing caps 12 in the fixture 10.

Referring to Figures 2 and 3, the relationship of the bearing cap 12, mandrel 22 and upper and lower V-block assemblies 26, 28 is illustrated. The mandrel 22 is secured between the side plates 16. The tie-down bolt 40 is retained by a backing plate 44 that holds the tie-down bolt 40 securely within the bolt head receptacle 46. The bolt head receptacle 46 is configured to receive the head of the tie-down bolt 40 in a non-rotational relationship. The tie-down bolt 40 is received in a bolt hole 48 formed in the mandrel 22. The tie-down bolt 40 is also received in a center bore 50 of the mandrel clamp 38. Mandrel clamp 38 includes locating fingers 52 that engage a step 54 that is formed on a reinforcing rib 56 of the bearing cap 12. A tubular extension 58 is formed on the mandrel clamp 38 and is received in a clamp receptacle opening 59. The clamp receptacle opening 59 may have a polygonal configuration, such as a square that locates the clamp 38 in a non-rotative manner.

A pin receptacle 60 is provided in the V-block retainer 36 which receives the pin 32 and holds the pin 32 stationary relative to the V-block retainer 36. A slot 64 is provided in the jaw 30. The slot is elongated in the vertical direction. The term "vertical direction" as used herein is the direction defined by a line that extends perpendicular to the base plate 18 and top plate 20. The jaw 30 receives the pin 32 in the slot 64 so that the jaw 30 may move vertically and pivot relative to the V-block retainer 36. The spring 34 is received in a spring seat 66 formed in the V-block retainer 36 and a spring receptacle 68 formed in the jaw 30. The spring 34 biases the jaw 30 towards the mandrel 22.

A locating face 70 of the jaw 30 is oriented to engage an outer surface 72 of the bearing cap 12. The outer surface 72 is formed with a draft angle in the casting process in which the bearing cap 12 is initially cast. The jaw 30 is pivotable relative to the V-block retainer 36 and is also vertically movable relative to the V-block retainer 36 to accommodate variations as a result of normal tolerances in the size and shape of the bearing cap 12.

When the bearing cap 12 is fixtured, the bearing cap is engaged by the upper V-block assembly 26 and the lower V-block assembly 28 that retain the bearing cap relative to the mandrel 22 with the bearing bore 76, as cast, engaging cylindrical surfaces 78 that are formed on the mandrel 22. After the bearing cap 12 is positioned between the upper and lower V-block assemblies 26, 28 and the mandrel 22, the mandrel clamp 38 is placed on the tie-down bolt with the locating fingers 52 engaging the steps 54 of the bearing cap 12. The nut 42 is then used to secure the mandrel clamp 38 to the tie-down bolt 40. The tubular extension 58 of the mandrel clamp 38 is received in the clamp receptacle opening 59.

Referring to Figure 4, the structure and function of the upper V-block assembly 26 is described in greater detail. It should be understood that the lower floating clamp assembly 28 has the same structure and function as the upper V-block assembly 26. The upper V-block assembly 26 is assembled to the top plate 20. In Figure 4, two V-block retainers 36 are shown secured to the top plate 20. One jaw 30 is shown oriented ready for assembly to the V-block retainer 36 with a second jaw 30 being shown assembled to the V-block retainer 36. The spring 34 is received in the spring seat 66 that is formed in the V-block retainer 36. Dowel 32 extends through the dowel holes 60 formed in the V-block retainer 36. Dowel 32 also extends through the slot 64 formed in the jaw 30. The locating face 70 of the jaw 30 is oriented to engage an outer surface 70 of the end 74 of the bearing cap 12, as previously described.

Referring to Figure 5, the movable mounting arrangement of the jaw 30 is shown to illustrate the available degrees of freedom of movement of the jaw 30. The V-block retainer 36 is secured to the top plate 20. The jaw 30 is secured

to the V-block retainer 36 by the dowel 32. The circular dowel 32 allows for limited rotational movement of the jaw 30 relative to the V-block retainer 36. Longitudinal or vertical movement of the jaw 30 is permitted by means of the elongated slot 64 formed in the jaw 30. When the bearing cap 12 is initially inserted into the fixture, the outer surface 72 of the bearing cap 12 is received by the locating face 70 of the jaw 30. The jaw 30 may move rotationally and vertically to accommodate variations in the bearing cap 12. The jaws 30 initially retain the bearing cap 12 adjacent the mandrel 22. Spring 34 provides a biasing force against the outer surface 72 of the bearing cap 12.

Referring to Figure 6, the mandrel 22 and mandrel clamp 38 are illustrated to show how the mandrel clamps 38 are secured to the mandrel 22. The mandrel 22 has bolt head receptacles 46 that receive the head of the tie-down bolt 40 so that it cannot rotate after insertion into the bolt head receptacle 46. The tie-down bolt 40 is held in the mandrel 22 by backing plate 44 that is secured by bolts 24 to the mandrel 22. As shown in Figure 6, one tie-down bolt 40 is shown secured within the mandrel and a second tie-down bolt 40 is shown partially assembled to the mandrel 22 with the backing plate 44 being oriented for assembly to the mandrel 22.

As shown in Figure 6, the mandrel clamp 38 is oriented for assembly to the tie-down bolt 40. The mandrel clamp 38 has locating fingers 52 that are oriented to engage a step 54 on the bearing cap 12. A center bore 50 is drilled through the mandrel clamp 38 that extends through the tubular extension 58 of the mandrel clamp 38. The tie-down bolt 40 receives the mandrel clamp 38 so that the tie-down bolt extends through the center bore 50.

Referring to Figure 7, a bearing cap 12 is shown in its as cast configuration. The bearing cap 12 includes a reinforcing rib 56 on which a step 54 is formed that is engaged by the locating fingers 52 of the mandrel clamp 38. Two faces 74 are cast on opposite ends of the bearing 12. Outer surfaces 72 of the bearing cap 12 engage the locating face 70 of each of the jaws 30. Machine stock 80 is provided on the bearing cap 12 that is machined in the CNC work center with

a face mill, or the like, to form a machined parting line 82. The bolt shoulders 74 are also machined while on the fixture with a bolt hole 84 being formed through the bolt shoulder 74. A counterbore 86 is formed on the bolt shoulder 74 to provide a machined surface that is concentric with the bolt hole 84 on the opposite side of the bearing cap 12 from the cast parting line 80. The bolt hole 84 and counterbore 86 may be formed in a single step with an appropriate combination drill.

Referring to Figure 8, a machined bearing cap 12′ is illustrated. The machined bearing cap 12′ is machined with the mill from the cast parting line 80 to the desired machined parting line 82. The machined bearing cap 12′ has also been machined on the opposite side from the parting line by boring a bolt hole 84 through the bolt shoulder 74 and by counterboring the counterbore 86.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A holding fixture for machining a plurality of bearing caps, the bearing caps having a generally semi-cylindrical bearing bore on an interior surface thereof, the bearing bore having a central axis, and first and second bolt shoulders on opposite sides of the bearing bore that are bored to receive bolts and are machined to provide a parting line surface, the holding fixture comprising:

a fixture frame;

a mandrel attached to the fixture frame, the mandrel receiving the bearing caps and locating the bearing caps with the bearing bore centered relative to the mandrel; and

a plurality of clamps engaging an exterior portion of the bearing caps to retain the bearing caps on the mandrel.

2. The holding fixture of claim 1 wherein the fixture frame is a box shaped member having oppositely oriented open sides to permit opposites sides of the bearing caps to be machined while remaining in the holding fixture.

3. The holding fixture of claim 1 wherein the plurality of clamps include a set of central clamps that engage a central portion of the bearing caps.

4. The holding fixture of claim 3 wherein the set of central clamps are each adapted to engage two parts and retain the two parts on the mandrel at a selected circumferential orientation relative to the mandrel.

5. The holding fixture of claim 4 further comprising a plurality of links that each further comprise an elongated fastener that extends through an opening the mandrel, the fastener being received by one of the central clamps that secures one of the parts on a first side of the central clamp and another of the parts on a second side of the central clamp.

6. The holding frame of claim 1 wherein the plurality of clamps include a first end clamp and a second end clamp that engage opposite ends of the bearing caps.

7. The holding frame of claim 6 wherein each of the first and second end clamps are each secured to the fixture for pivotal movement about a first and a second pivot axis, respectively, wherein each of the pivot axes is parallel to a bearing bore axis that is disposed between the first and second ends.

8. The holding frame of claim 6 wherein a spring is operatively attached to the fixture and the first and second end clamps to bias each of the first and second end clamps toward the mandrel and wherein the first and second end clamps are adapted to be displaced away from the mandrel against the biasing force of the springs when the parts are assembled to the fixture assembly.

9. The holding frame of claim 6 wherein the first and second end clamps each have a fixed portion and a movable portion, the movable portion having an elongated slot extending toward and away from the mandrel, further comprising a pin attached to the fixed portion, wherein the pin is also received in each of the slots whereby the movable portion moves toward and away from the mandrel and is guided by the pin sliding relative to the slot.

10. A fixture assembly for machining a plurality of parts having a concave cylindrical surface, a first end and a second end on opposite ends of the part and an outer surface that is radially spaced from the cylindrical surface, the fixture assembly comprising:

a fixture;

a mandrel attached to the fixture, the mandrel defining a receiving surface that engages the cylindrical surface of each of the parts;

a plurality of clamps that engage the outer surface of the parts;

a plurality of links that secure the clamps to the mandrel to retain the parts on the mandrel;

a plurality of first end clamps that engage the first end of the parts;

a plurality of second end clamps that engage the second end of the parts; and

wherein the parts are secured to the fixture with the clamps holding the parts against the mandrel and the first and second end clamps holding the first and second ends of the parts transversely across the mandrel.

11. The fixture of claim 10 wherein the concave cylindrical surface of the parts is a bearing bore of a bearing cap that has an axis that extends transversely relative to a line extending through the first and second ends, and wherein the fixture assembly holds the parts as holes are drilled between the first and second ends and the bearing bore.

12. The fixture of claim 11 wherein the fixture assembly holds the parts during a milling operation on a parting line of the parts.

13. The fixture of claim 10 wherein the clamps are each adapted to engage two parts and retain the two parts on the mandrel at a selected circumferential orientation relative to the mandrel.

14. The fixture of claim 13 wherein the links each further comprise an elongated fastener that extends through an opening the mandrel, the fastener being received by one of the clamps that secures one of the parts on a first side of the clamp and another of the parts on a second side of the clamp.

15. The fixture of claim 10 wherein each of the first and second end clamps are each secured to the fixture for pivotal movement about a first and a second pivot axis, respectively, that is parallel to a bearing bore axis that is disposed between the first and second ends.

16. The fixture of claim 10 wherein a spring is operatively attached to the fixture and the first and second end clamps to bias each of the first and second end clamps toward the mandrel and wherein the first and second end

clamps are adapted to be displaced away from the mandrel against the biasing force of the springs when the parts are assembled to the fixture assembly.

17. The fixture of claim 10 wherein the first and second end clamps each have a fixed portion and a movable portion, the movable portion having an elongated slot extending toward and away from the mandrel, further comprising a pin attached to the fixed portion, wherein the pin is also received in each of the slots whereby the movable portion moves toward and away from the mandrel and is guided by the pin sliding relative to the slot.

18. The fixture of claim 10 wherein the parts are bearing caps and the cylindrical surface is a cast bearing bore, and wherein the parts are attached to the mandrel to be located centered relative to the cylindrical axis of the cylindrical surface, whereby the clamps and the first and second end clamps may engage the bearing caps at locations that may accommodate part variations because the parts are located centered relative to the cylindrical axis.

19. A method of manufacturing a bearing cap comprising:

casting a rough bearing cap in a mold, the rough bearing cap having an as cast semi-cylindrical bearing bore and an outer surface;

assembling a plurality of bearing caps into a first fixture, the first fixture having a mandrel that is received in the bearing bore;

clamping the bearing caps onto the first fixture with clamps that engage the outer surface of the bearing caps;

machining a pair of bolt shoulder portions of the bearing caps and boring a bolt hole in each bolt shoulder portion;

removing the bearing caps from the first fixture; and

machining the bearing bores with the bearing caps being located based upon the location of the bolt holes to form a plurality of finished bearing caps.

20. The method of claim 19 wherein the step of clamping the bearing caps onto the first fixture further comprises securing a clamping element to the mandrel with a link that is disposed between to a pair of bearing caps.

21. The method of claim 19 wherein the step of clamping the bearing caps onto the first fixture further comprises inserting the bearing caps into spring biased end clamps that engage first and second ends of the bearing caps at diametrically opposed locations on opposite sides of the mandrel.

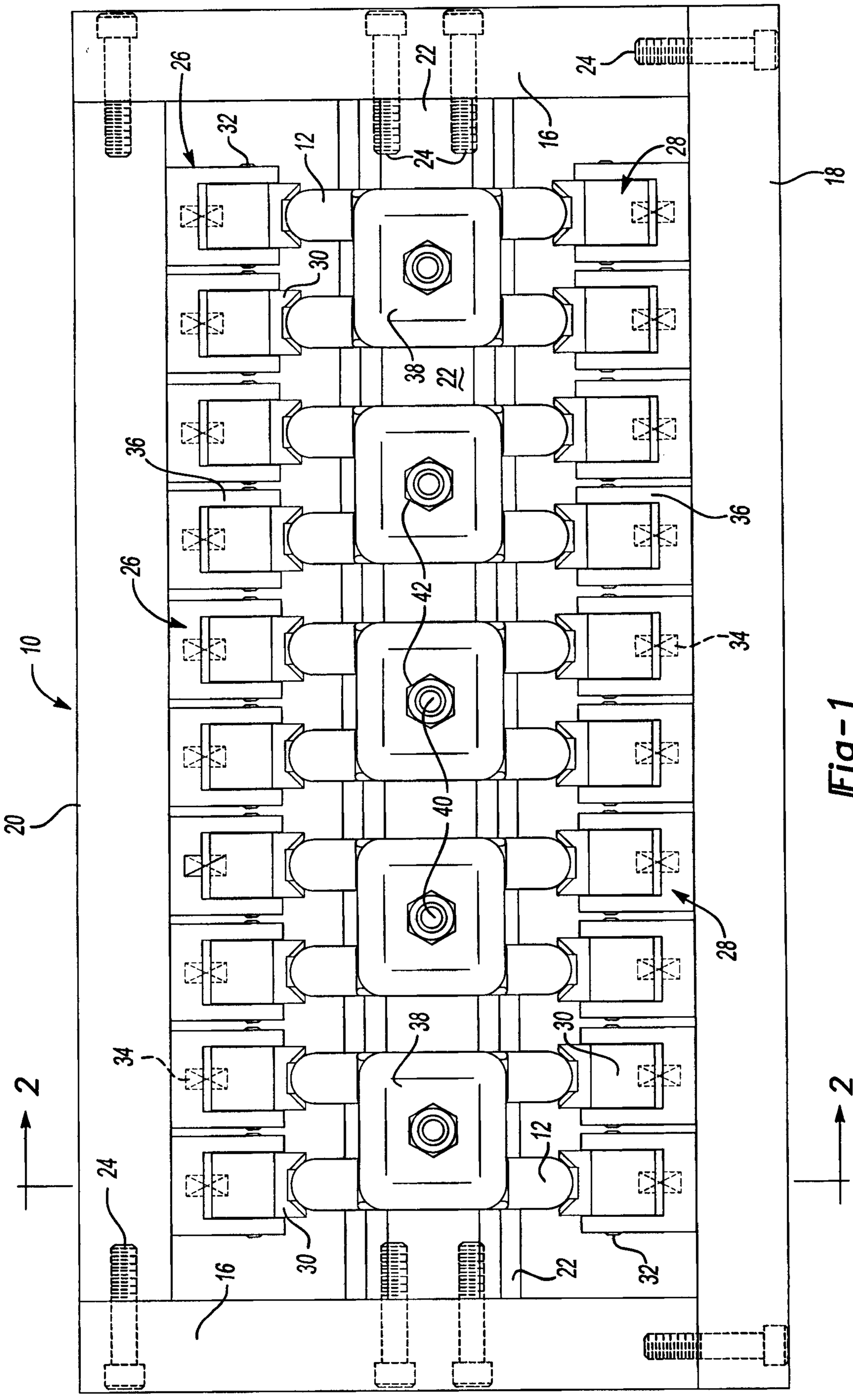


Fig-1

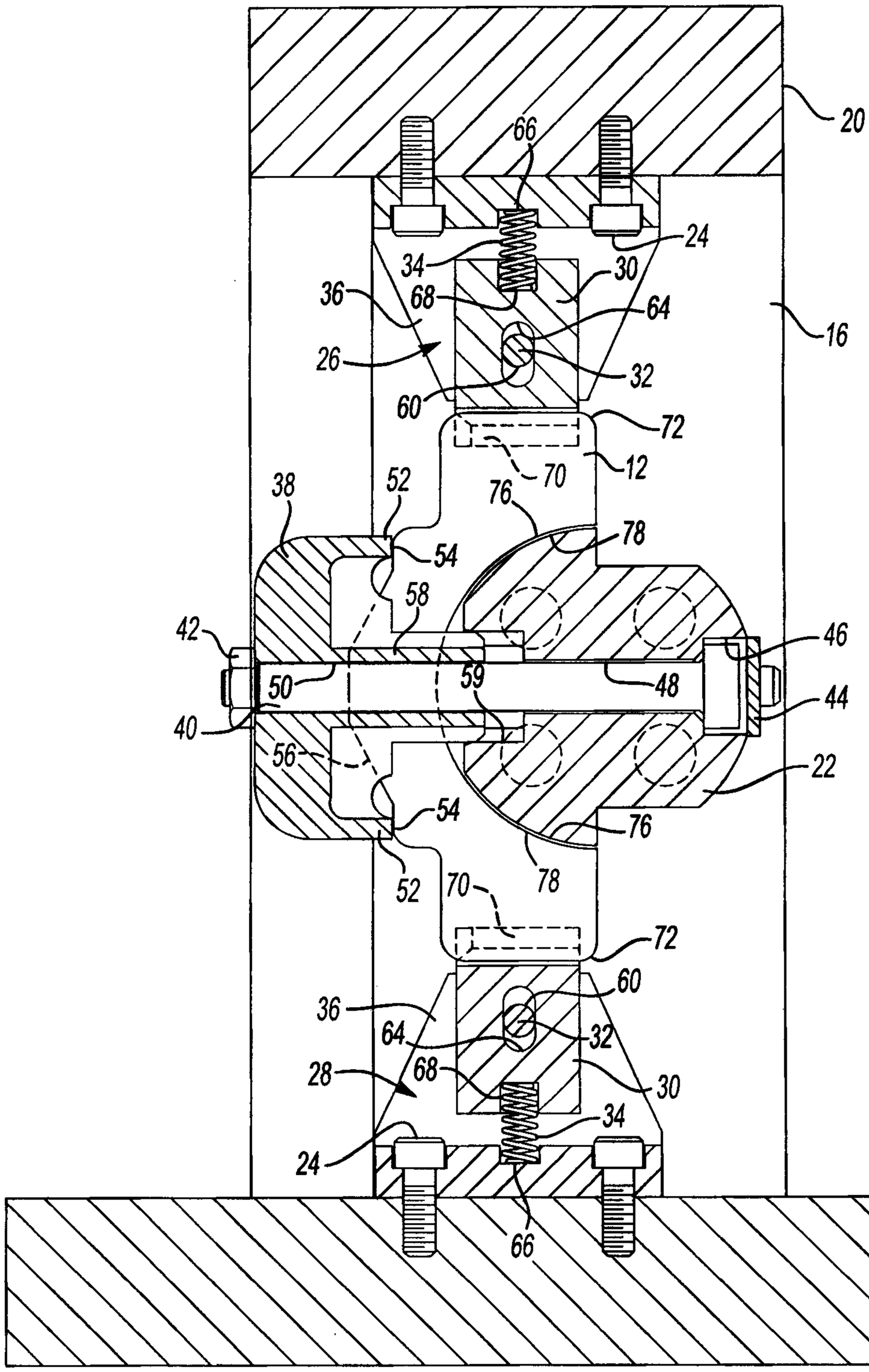

20
66
24
34
30
36
68
64
26
32
16
60
72
70
12
38
52
76
78
54
58
42
46
50
59
48
44
40
56
22
54
76
52
70
78
72
36
60
64
32
28
68
30
34
24
18
66

Fig-2

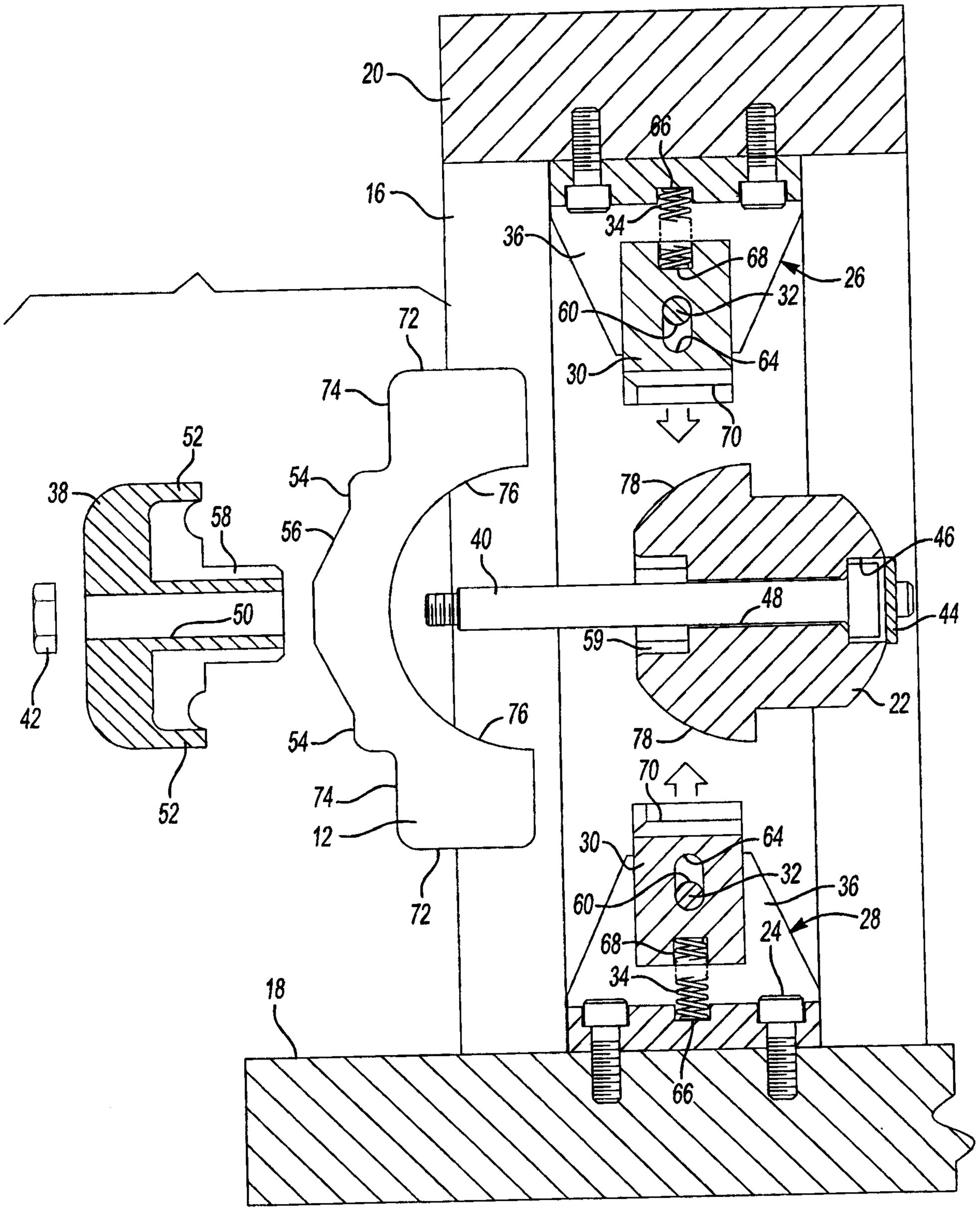

20
66
16
34
36
68
26
32
60
64
30
72
74
70
52
54
38
58
56
76
78
40
46
48
50
44
59
42
22
52
54
76
74
70
12
30
64
32
60
36
28
72
68
24
34
18
66

Fig-3

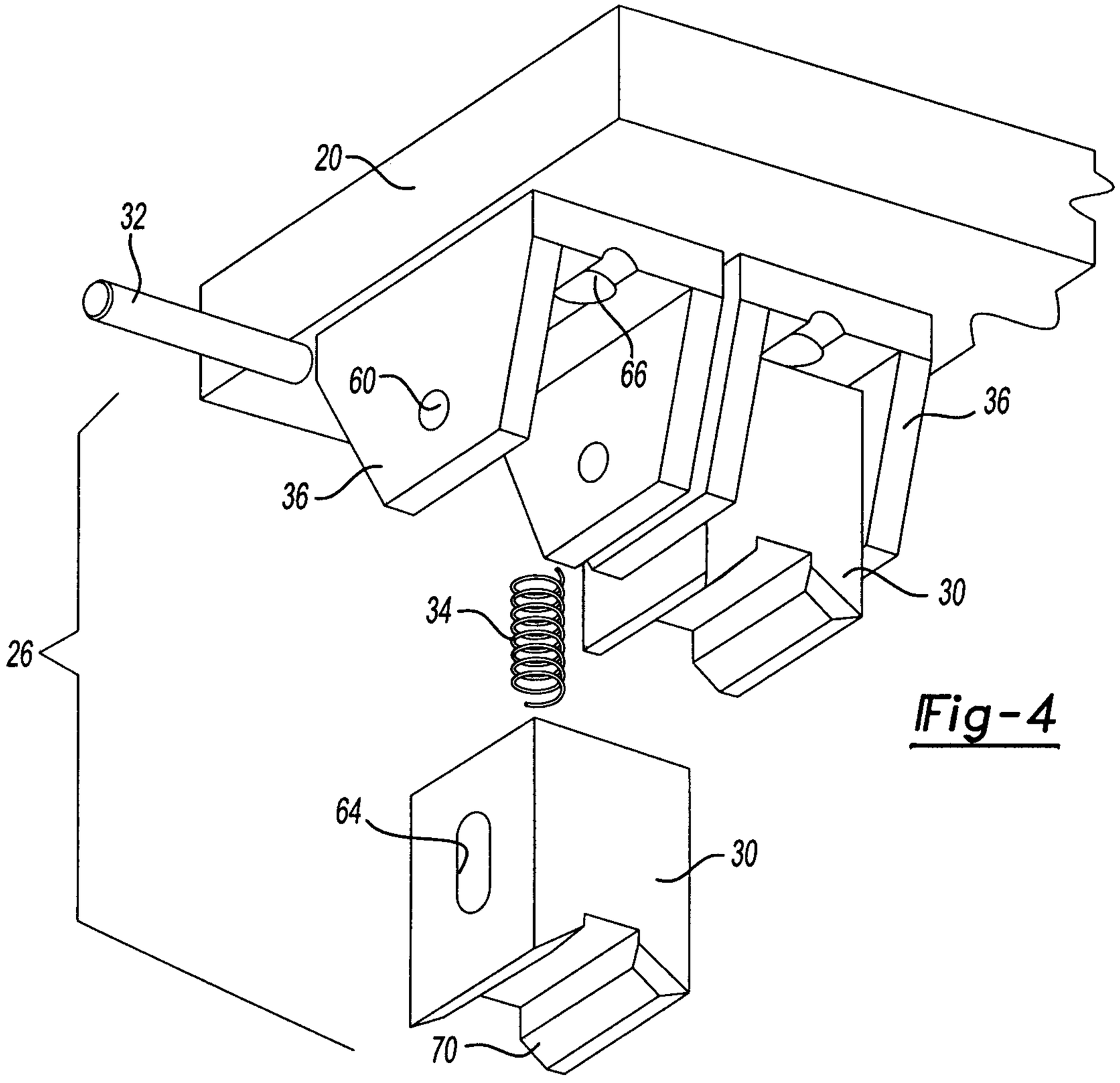

20
32
60
66
36
36
34
30
26
64
30
70

Fig-4

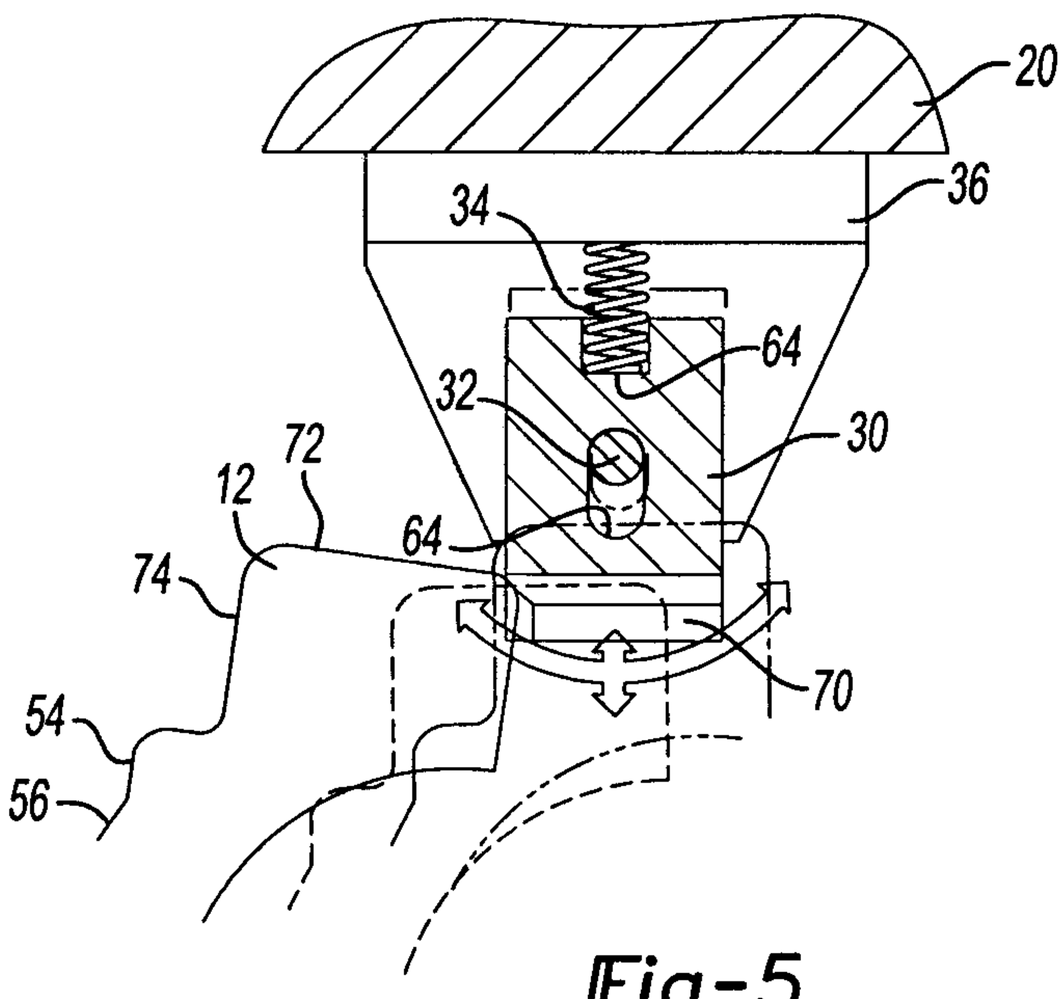

20
36
34
64
32
30
72
12
64
74
70
54
56

Fig-5

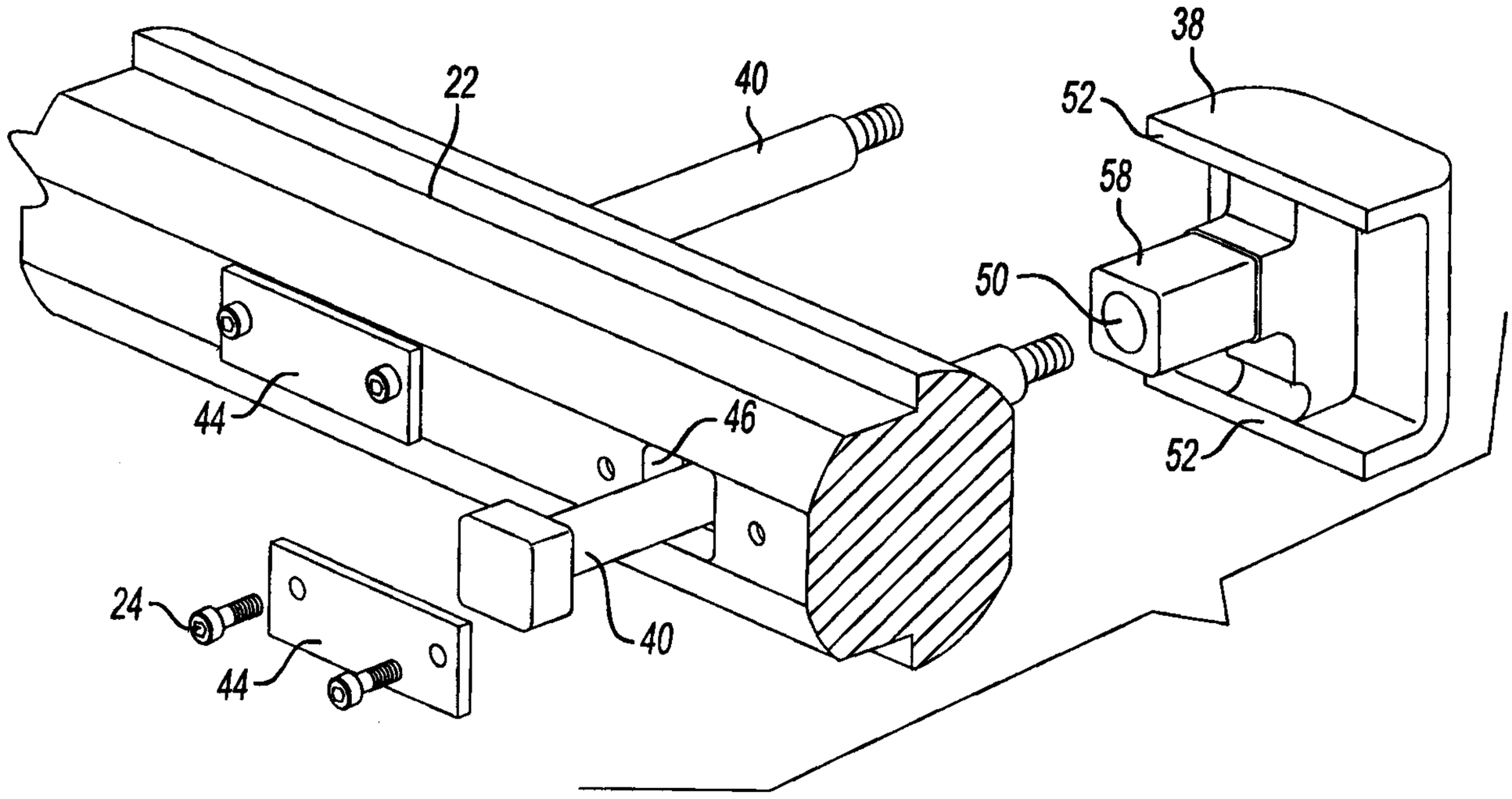


Fig-6

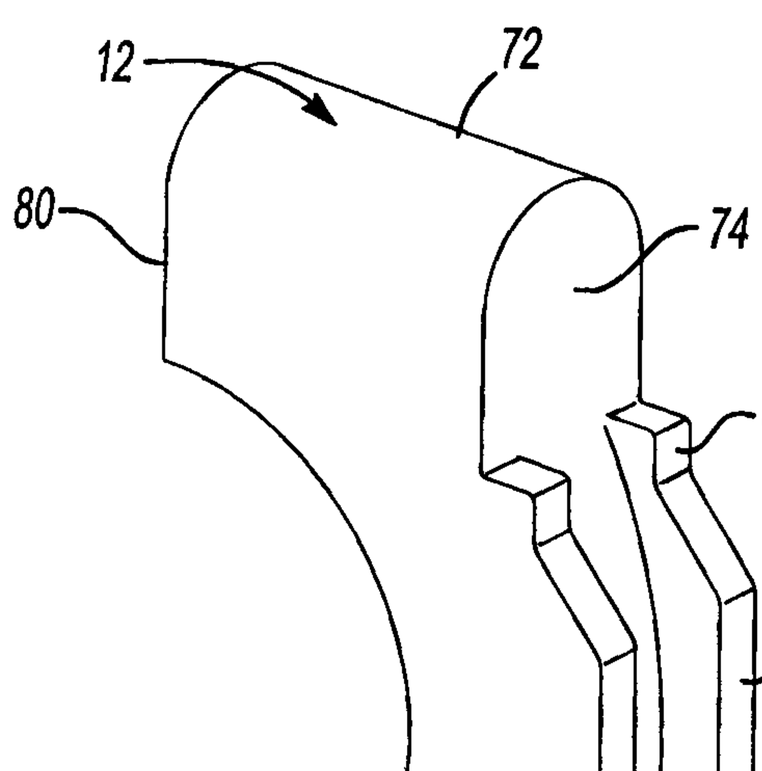


Fig-7

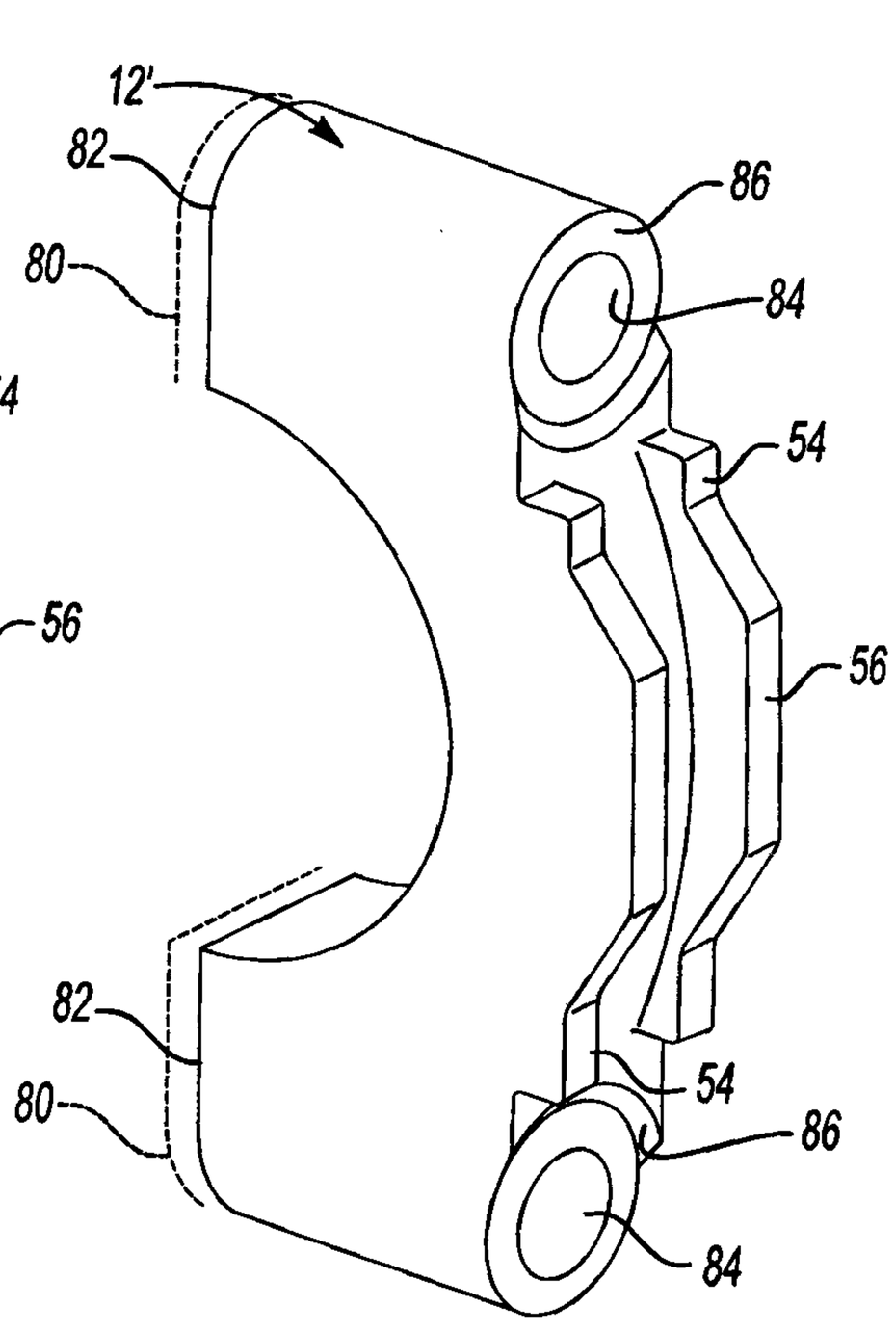
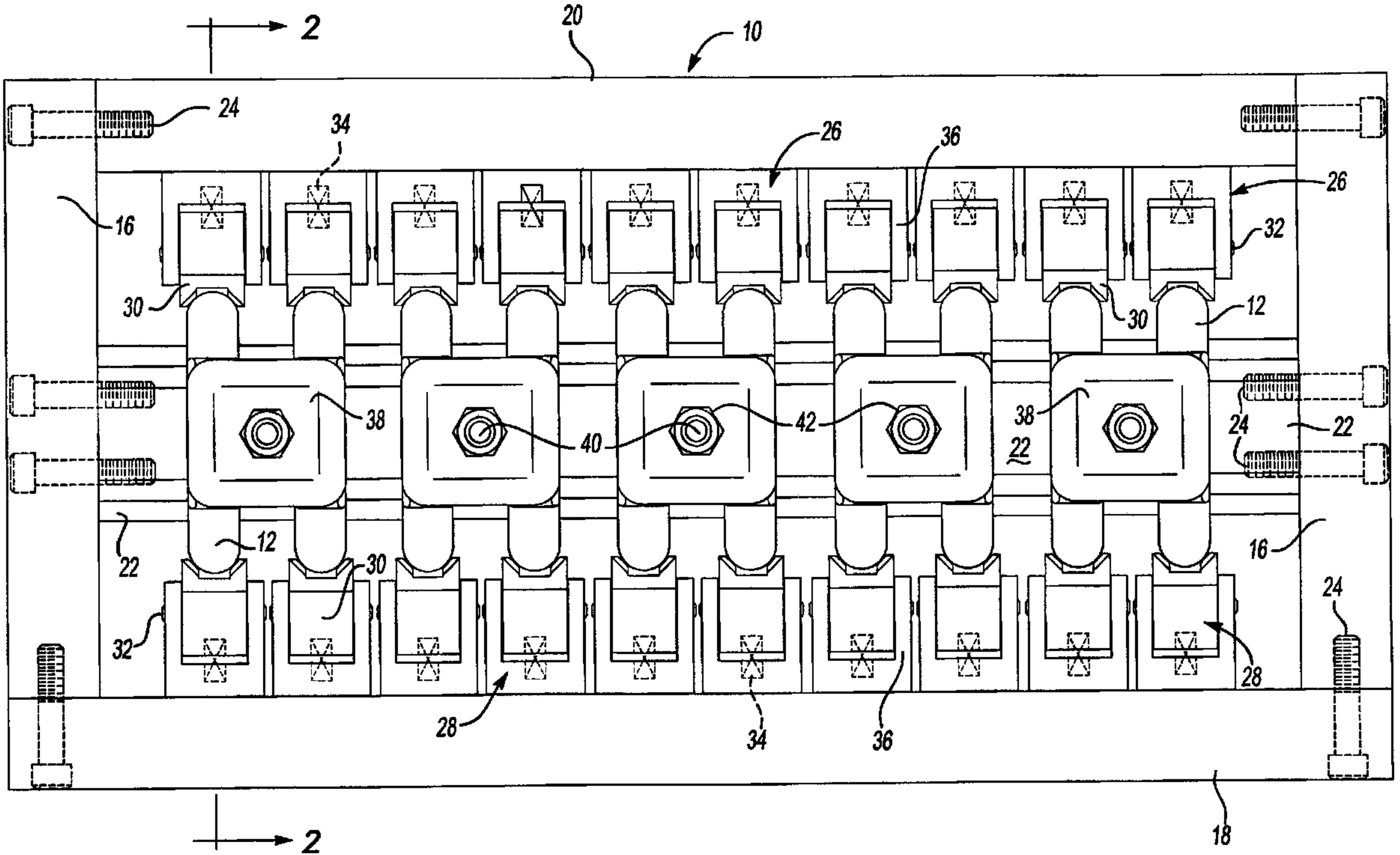


Fig-8


2
20
10
24
34
26
36
26
16
32
30
30
12
38
40
42
38
22
24
22
12
22
16
30
32
24
28
28
34
36
18
2