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# United States Patent [19]

Vaccaro et al.

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[54] **METHOD OF MAKING A SCROLL COMPRESSOR PUMP CARTRIDGE SUBASSEMBLY**

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[73] Assignee: **Carrier Corporation**, Syracuse, N.Y.

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**Related U.S. Patent Documents**

Reissue of:

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Issued: **Jan. 10, 1995**
Appl. No.: **43,416**
Filed: **Apr. 6, 1993**

[51] **Int. Cl.**[6] ..... **B23P 15/00**

[52] **U.S. Cl.** ..... **29/888.02**; 29/426; 29/428; 418/55.2

[58] **Field of Search** ..... 29/888.02, 426, 29/428; 418/55.1, 55.2; 417/366, 369

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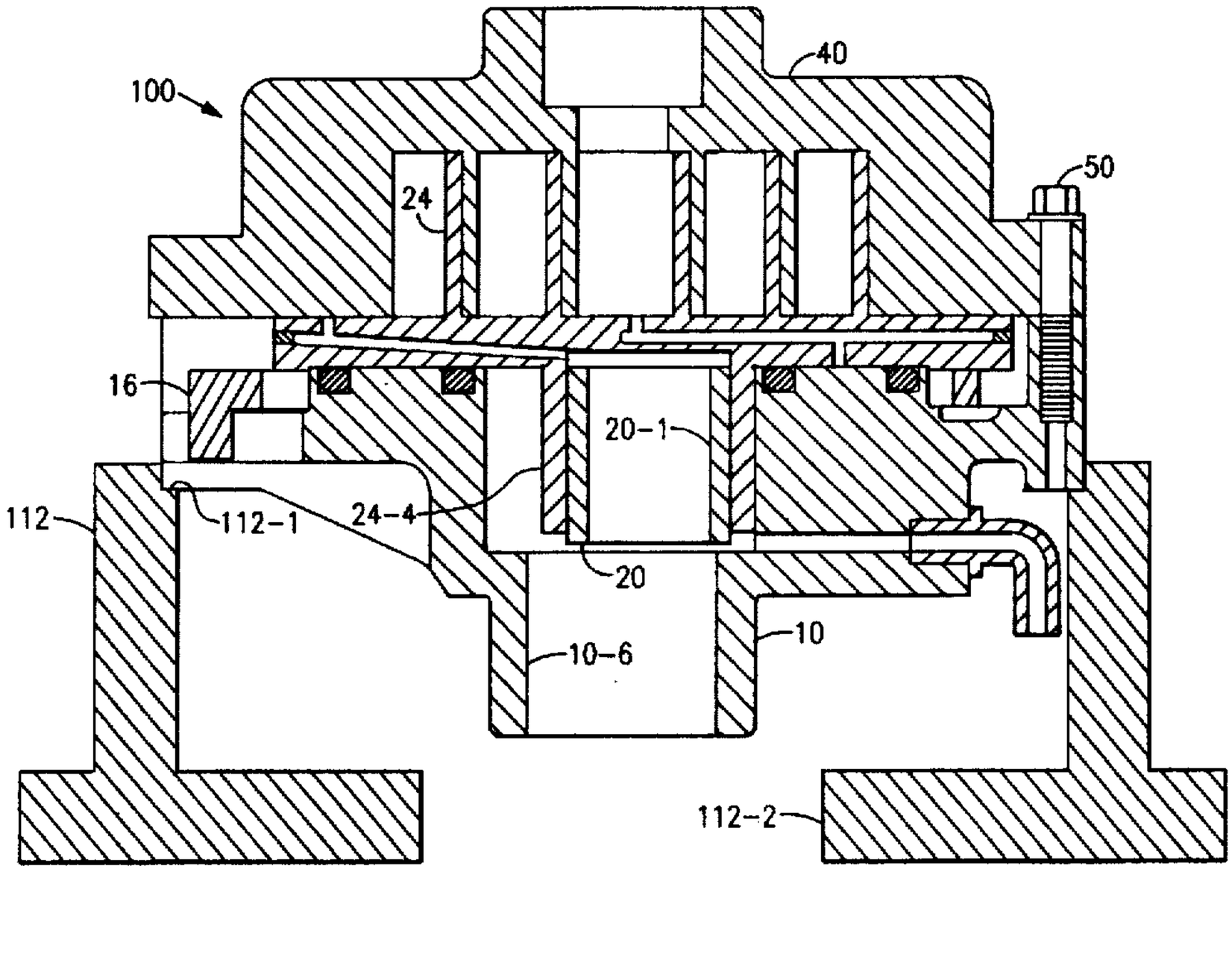
*Primary Examiner*—Irene Cuda

[57] **ABSTRACT**

The crankcase, fixed and orbiting scrolls and Oldham coupling are assembled to make a pump cartridge assembly as a subassembly of a scroll compressor. The pump cartridge assembly is tested to determine whether or not it operates satisfactorily. Upon successful testing, the pump cartridge assembly is installed in the shell of a hermetic compressor.

**16 Claims, 10 Drawing Sheets**



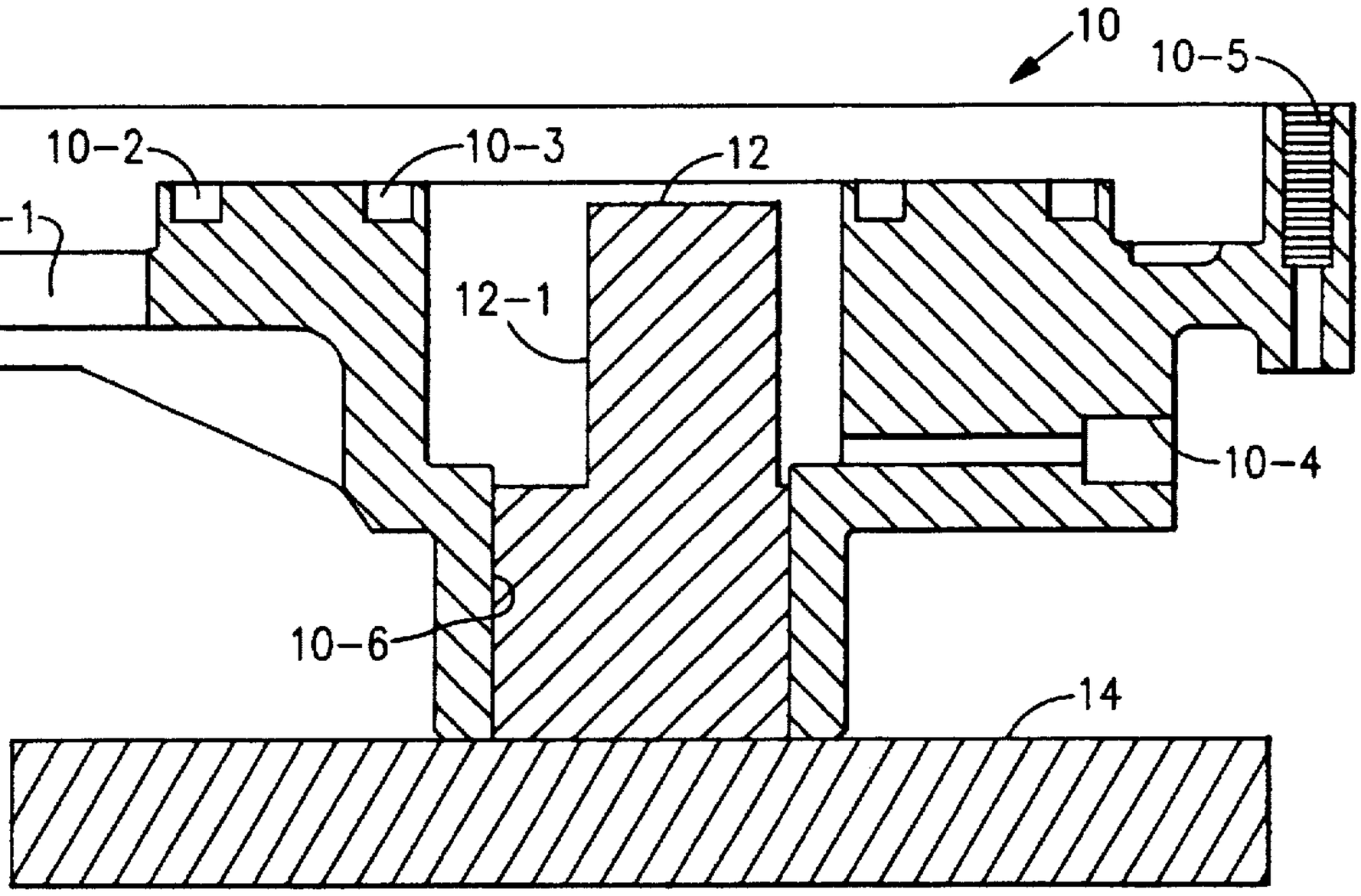



FIG.1

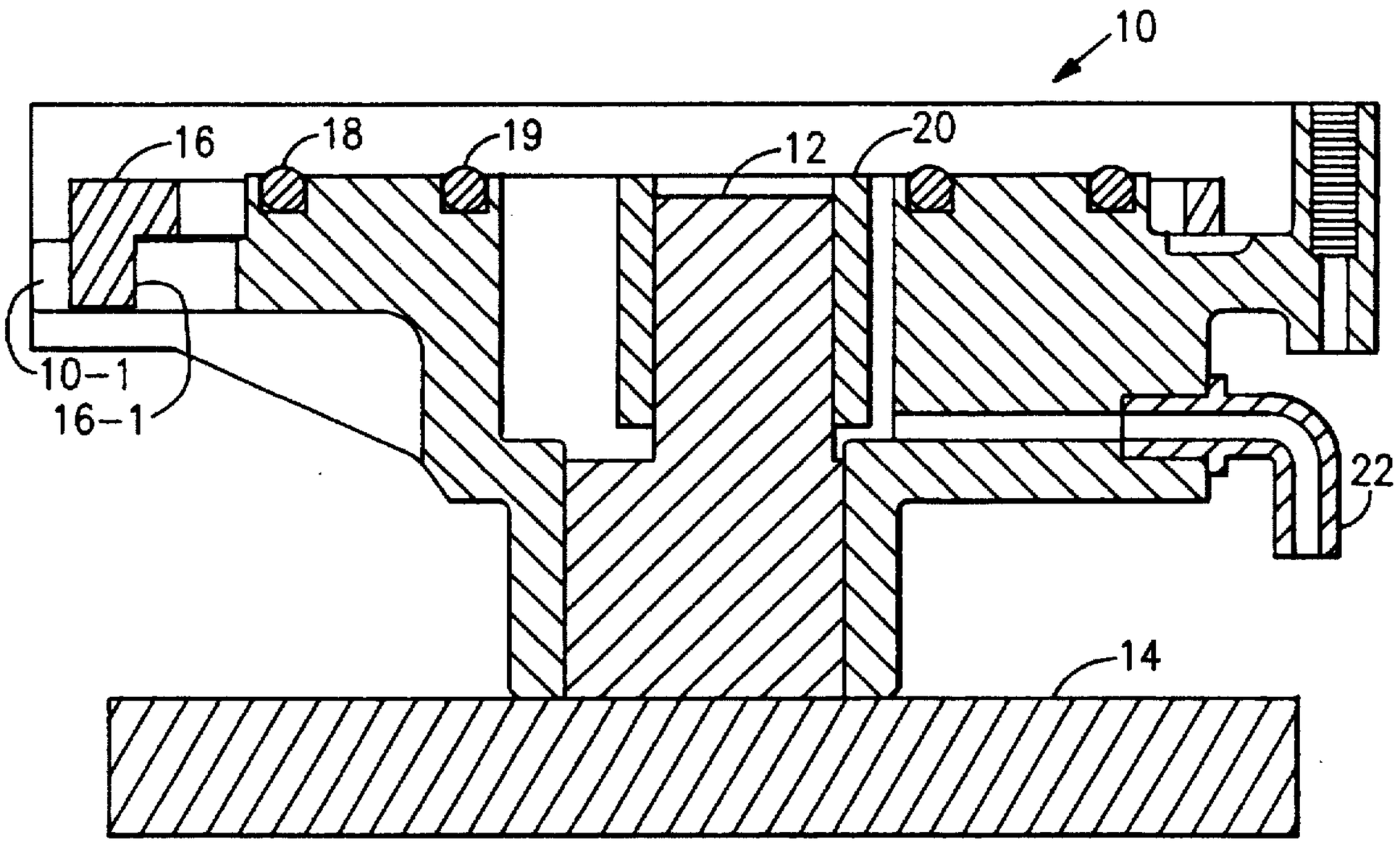



FIG.2

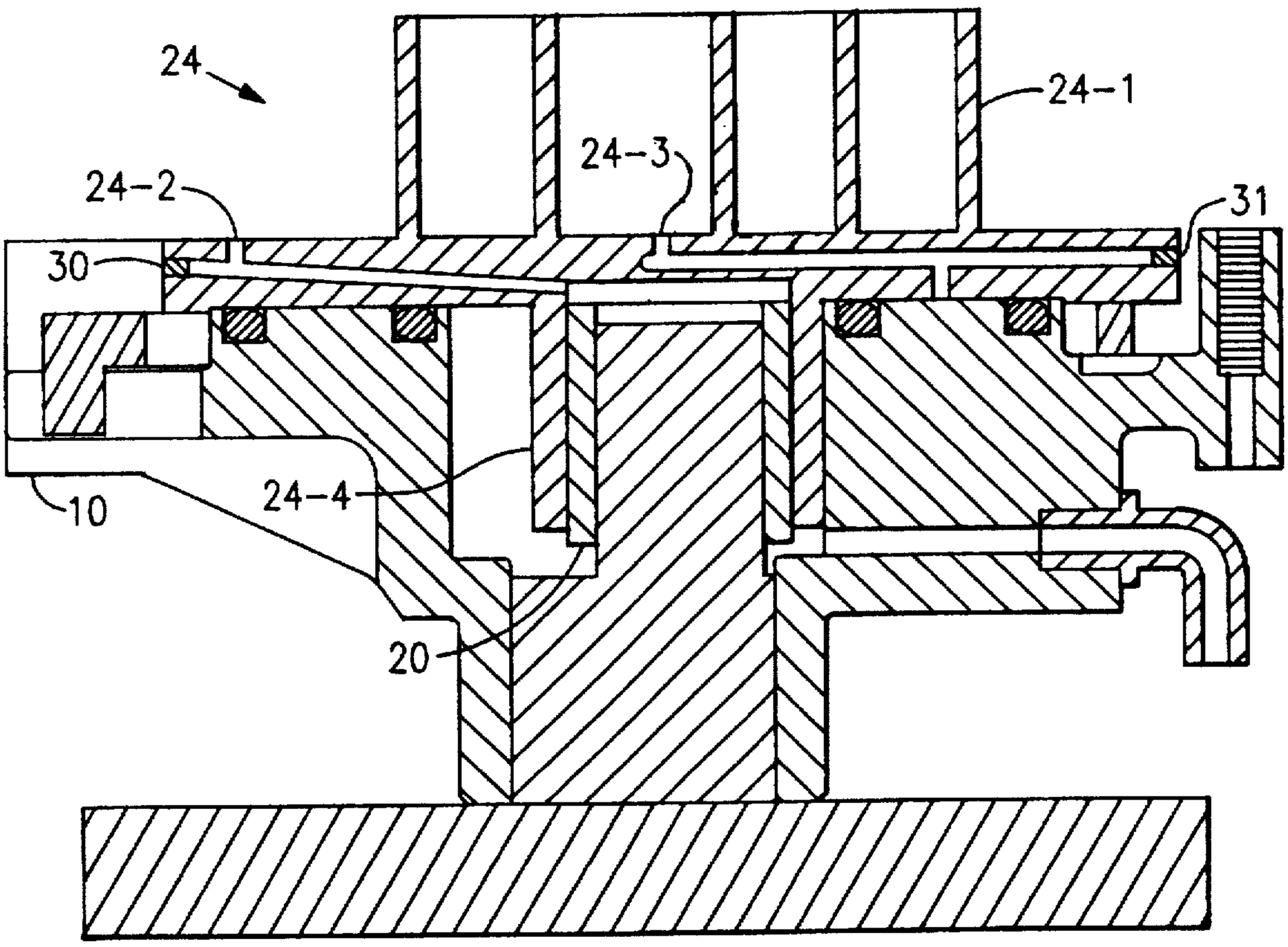



FIG.3

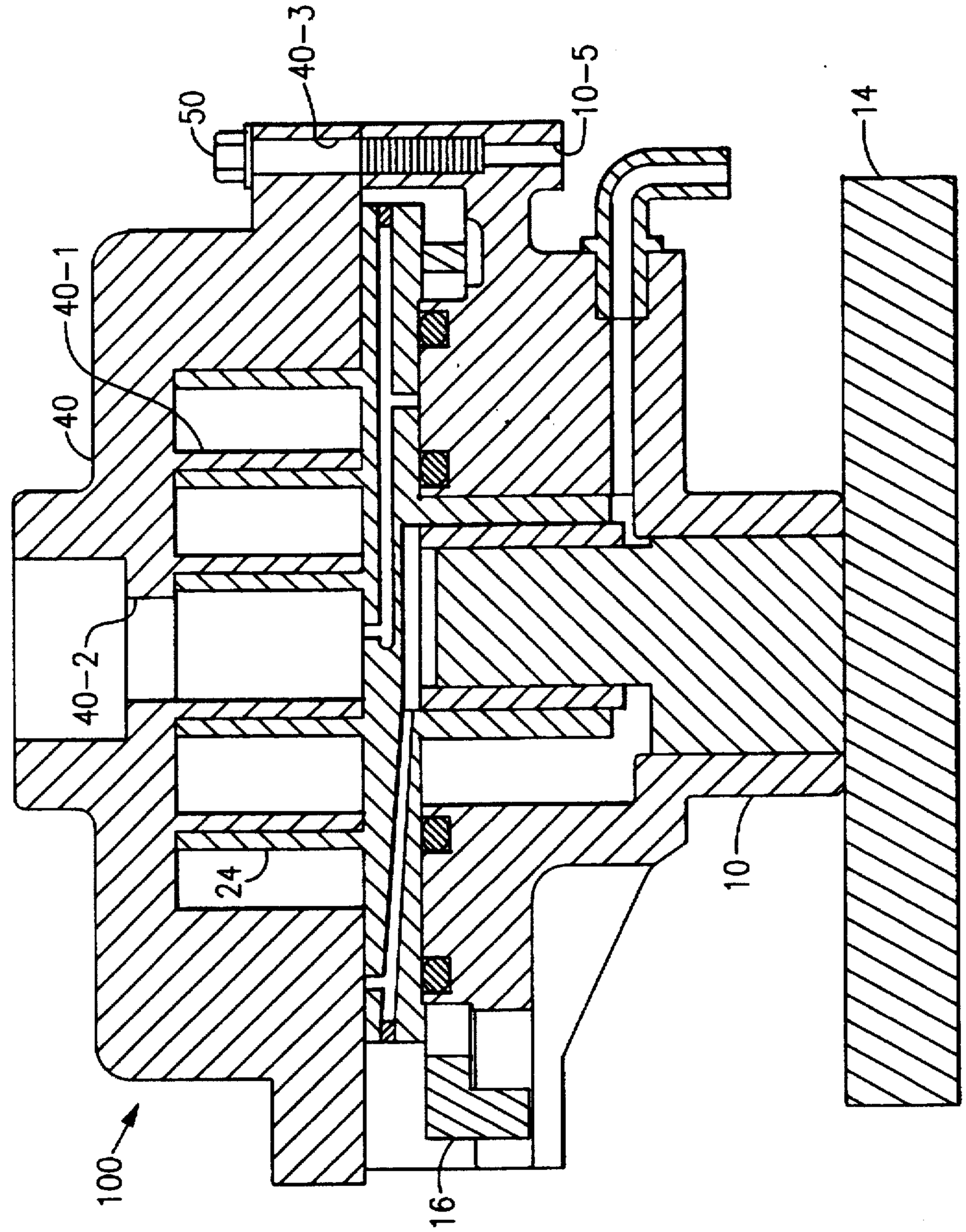



FIG.4

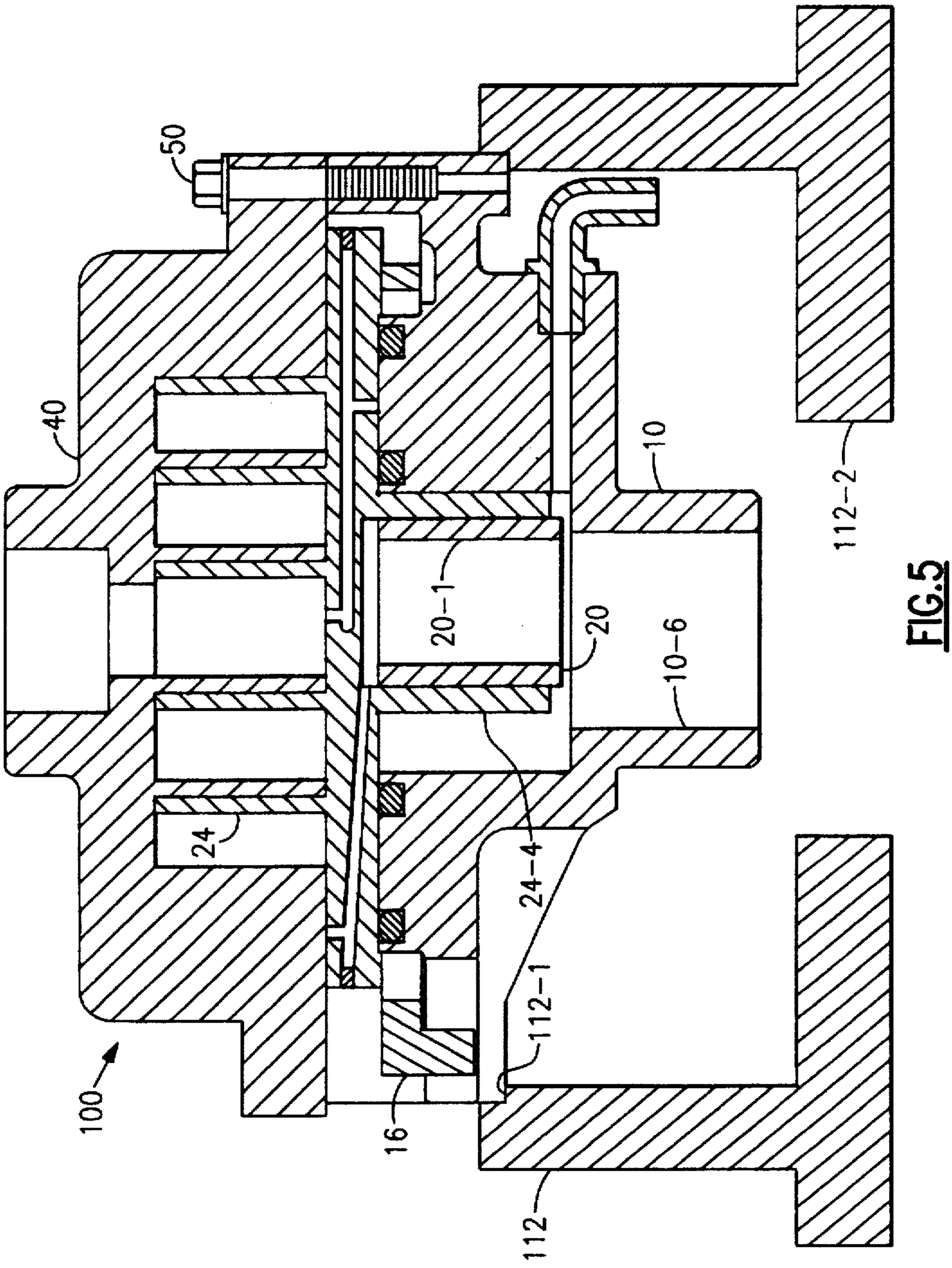
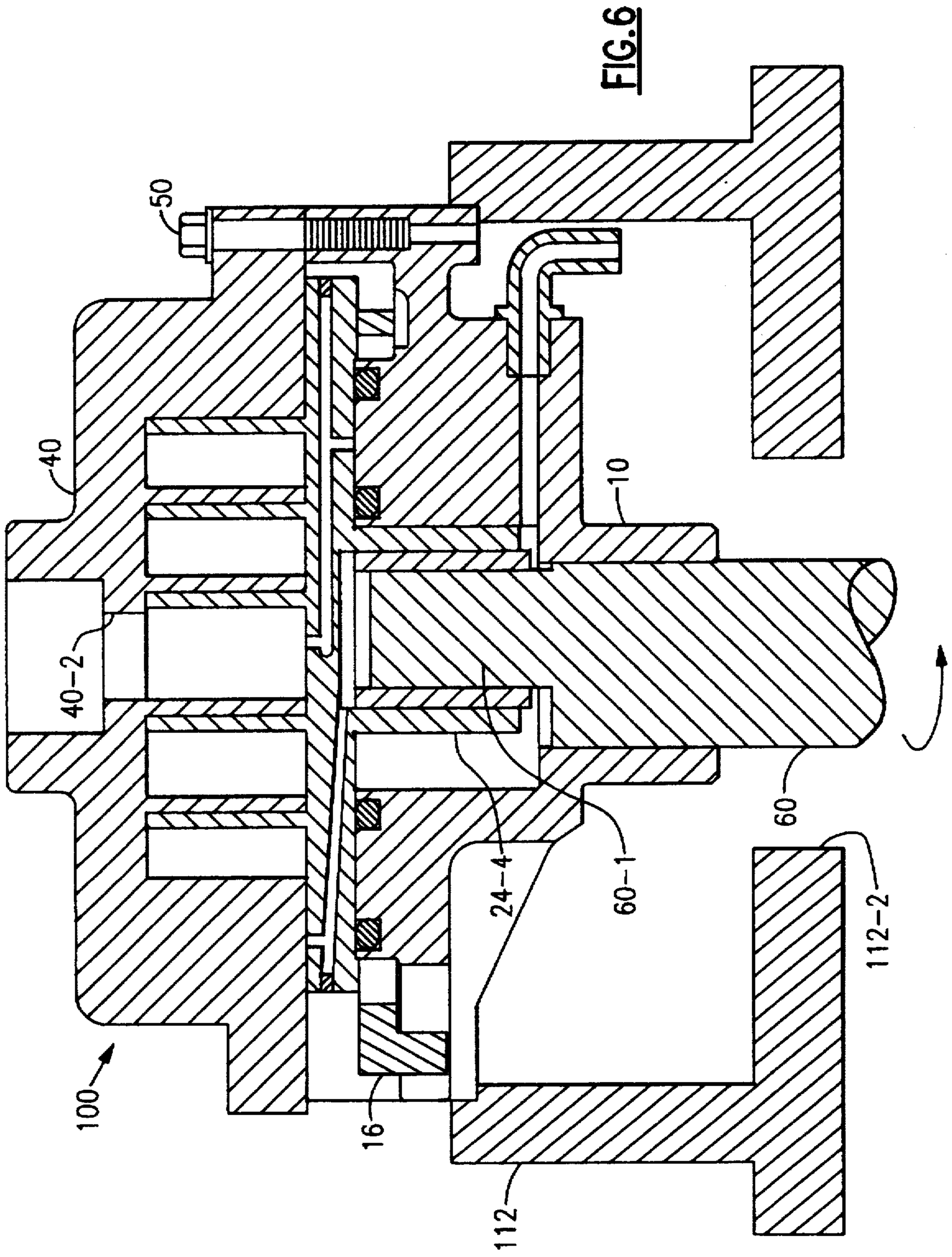



FIG.5

FIG.6



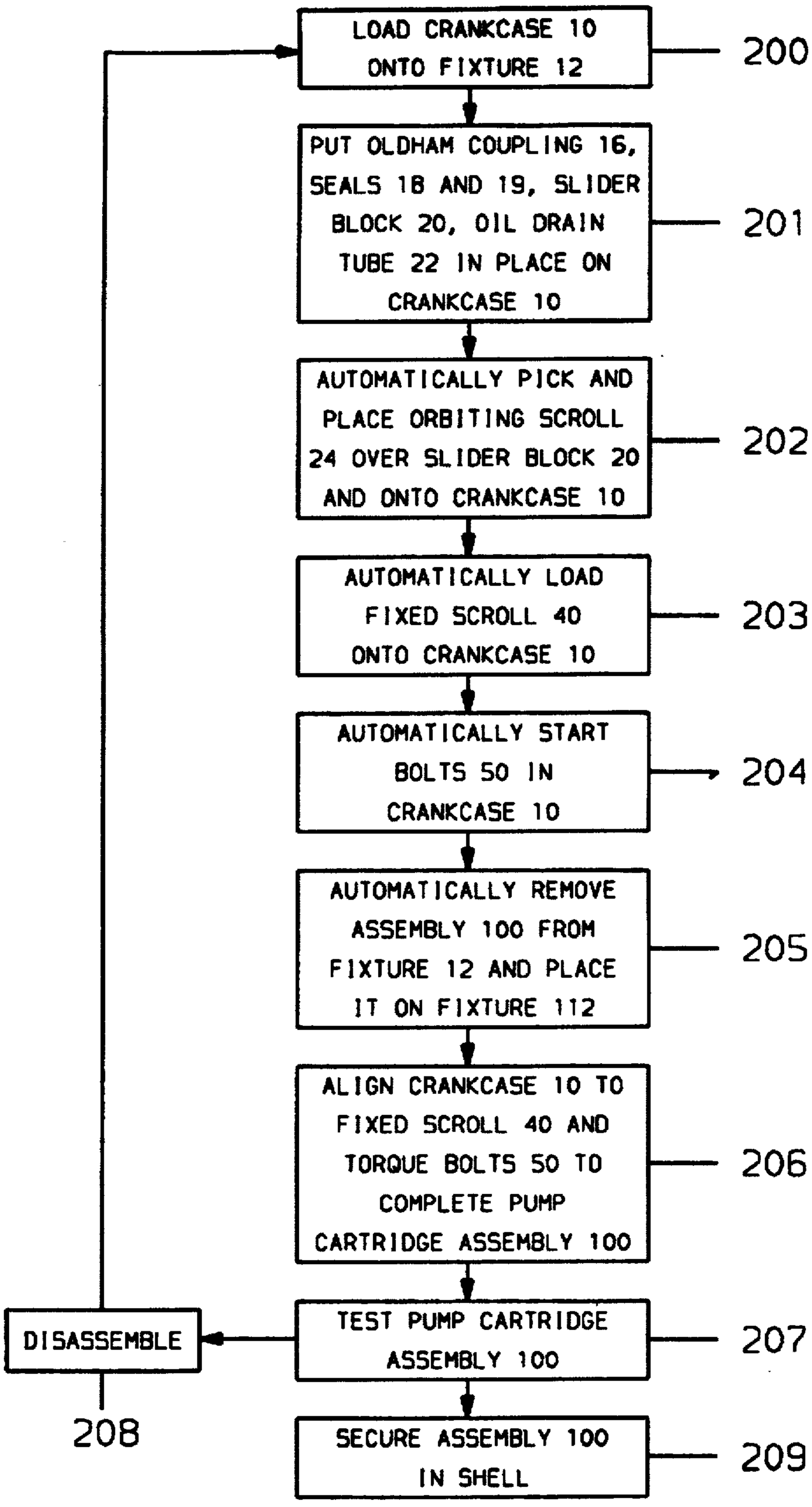

LOAD CRANKCASE 10 ONTO FIXTURE 12
200
PUT OLDHAM COUPLING 16, SEALS 18 AND 19, SLIDER BLOCK 20, OIL DRAIN TUBE 22 IN PLACE ON CRANKCASE 10
201
AUTOMATICALLY PICK AND PLACE ORBITING SCROLL 24 OVER SLIDER BLOCK 20 AND ONTO CRANKCASE 10
202
AUTOMATICALLY LOAD FIXED SCROLL 40 ONTO CRANKCASE 10
203
AUTOMATICALLY START BOLTS 50 IN CRANKCASE 10
204
AUTOMATICALLY REMOVE ASSEMBLY 100 FROM FIXTURE 12 AND PLACE IT ON FIXTURE 112
205
ALIGN CRANKCASE 10 TO FIXED SCROLL 40 AND TORQUE BOLTS 50 TO COMPLETE PUMP CARTRIDGE ASSEMBLY 100
206
TEST PUMP CARTRIDGE ASSEMBLY 100
207
DISASSEMBLE
208
SECURE ASSEMBLY 100 IN SHELL
209

FIG. 7

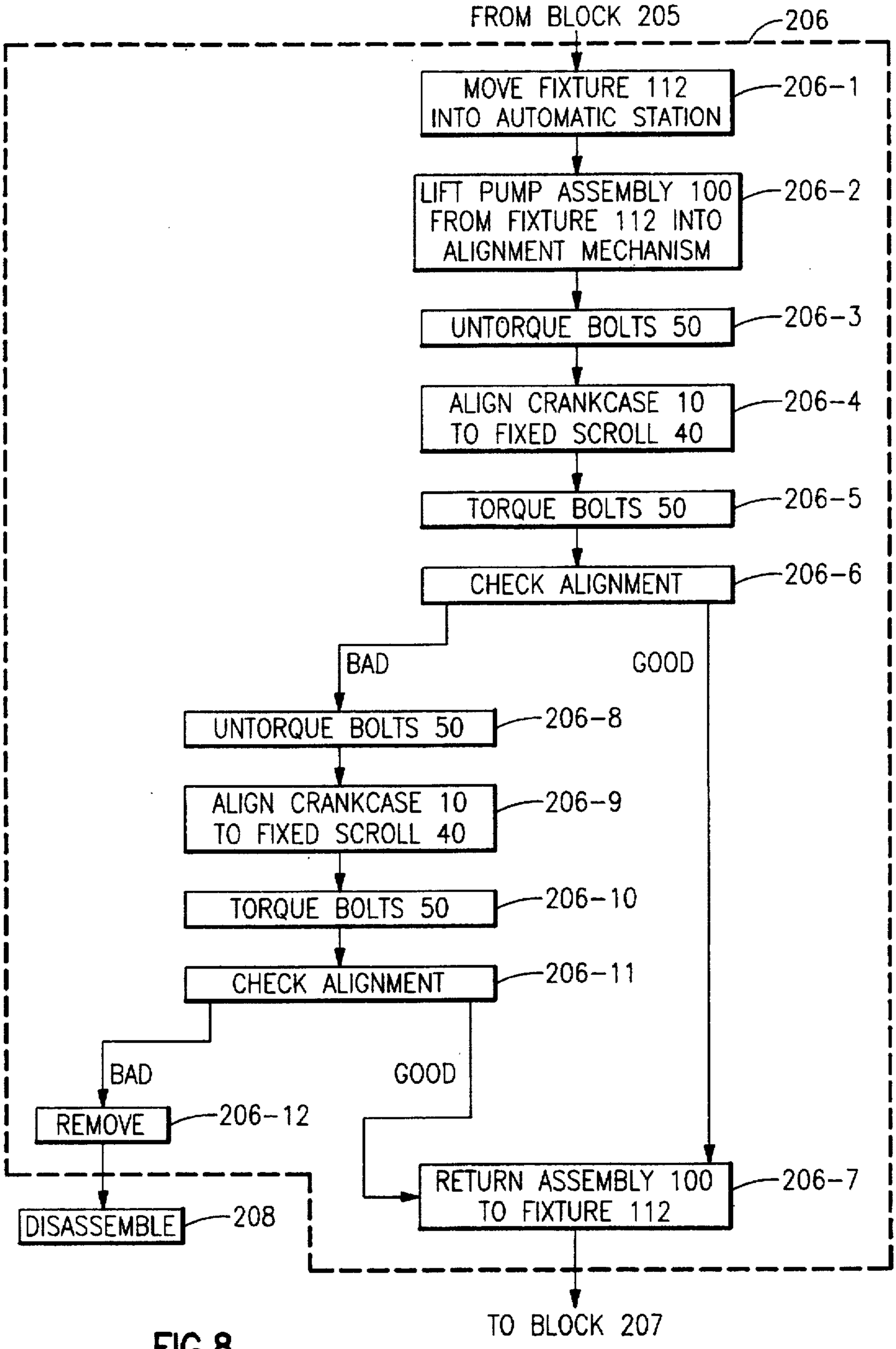

FROM BLOCK 205
206
MOVE FIXTURE 112 INTO AUTOMATIC STATION
206-1
LIFT PUMP ASSEMBLY 100 FROM FIXTURE 112 INTO ALIGNMENT MECHANISM
206-2
UNTORQUE BOLTS 50
206-3
ALIGN CRANKCASE 10 TO FIXED SCROLL 40
206-4
TORQUE BOLTS 50
206-5
CHECK ALIGNMENT
206-6
BAD
GOOD
UNTORQUE BOLTS 50
206-8
ALIGN CRANKCASE 10 TO FIXED SCROLL 40
206-9
TORQUE BOLTS 50
206-10
CHECK ALIGNMENT
206-11
BAD
GOOD
REMOVE
206-12
DISASSEMBLE
208
RETURN ASSEMBLY 100 TO FIXTURE 112
206-7
TO BLOCK 207

FIG.8

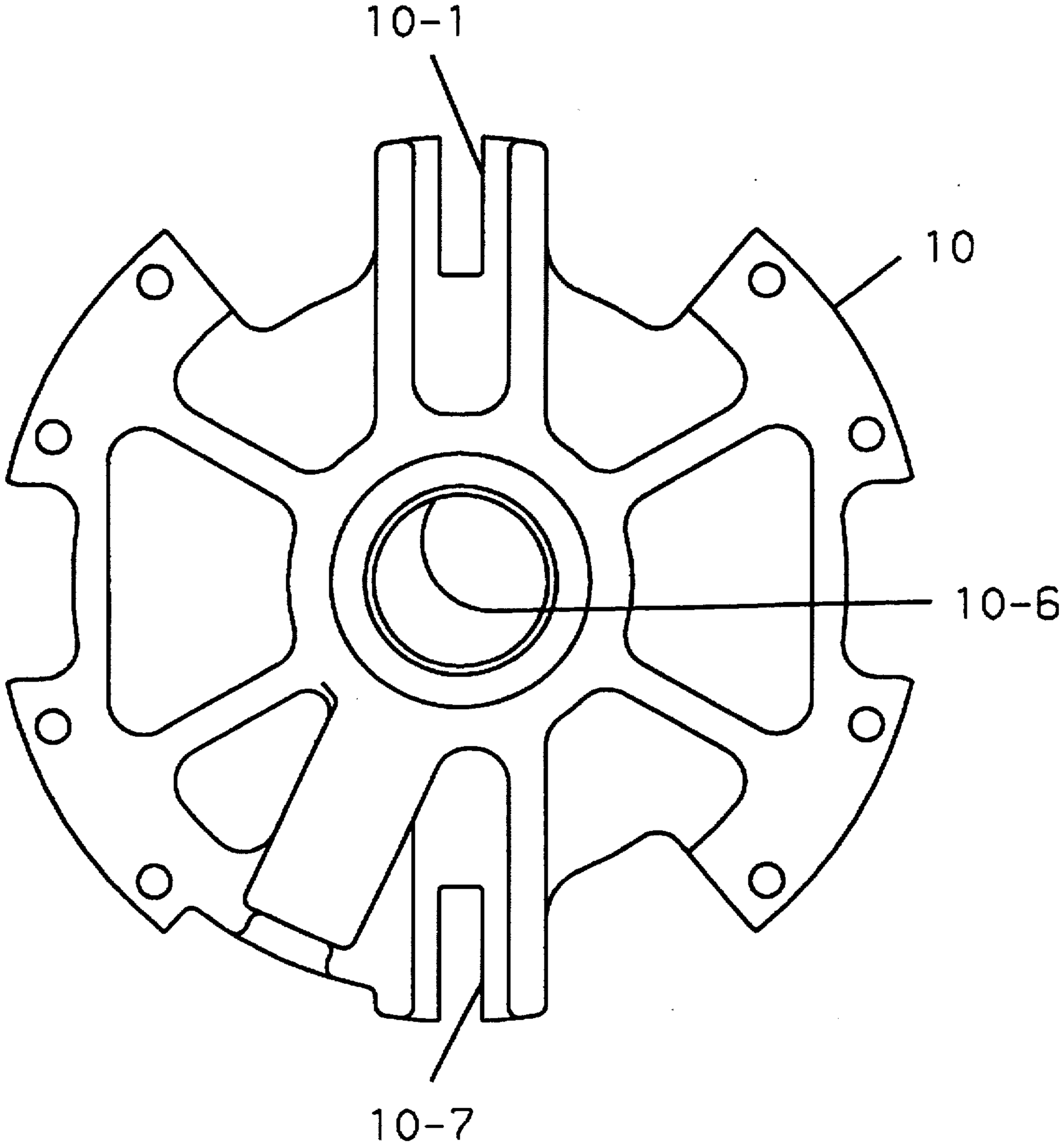
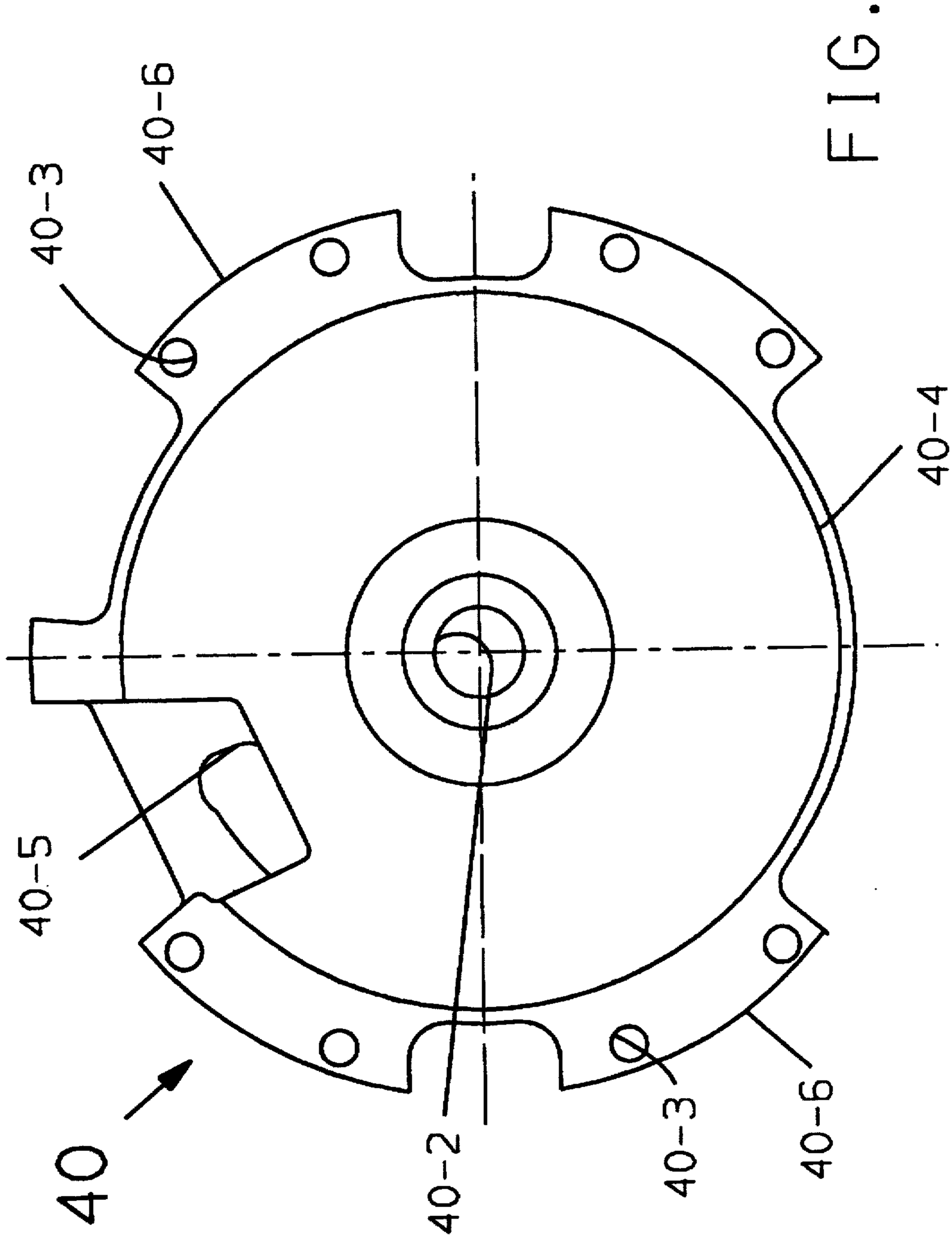



FIG. 9

FIG. 10



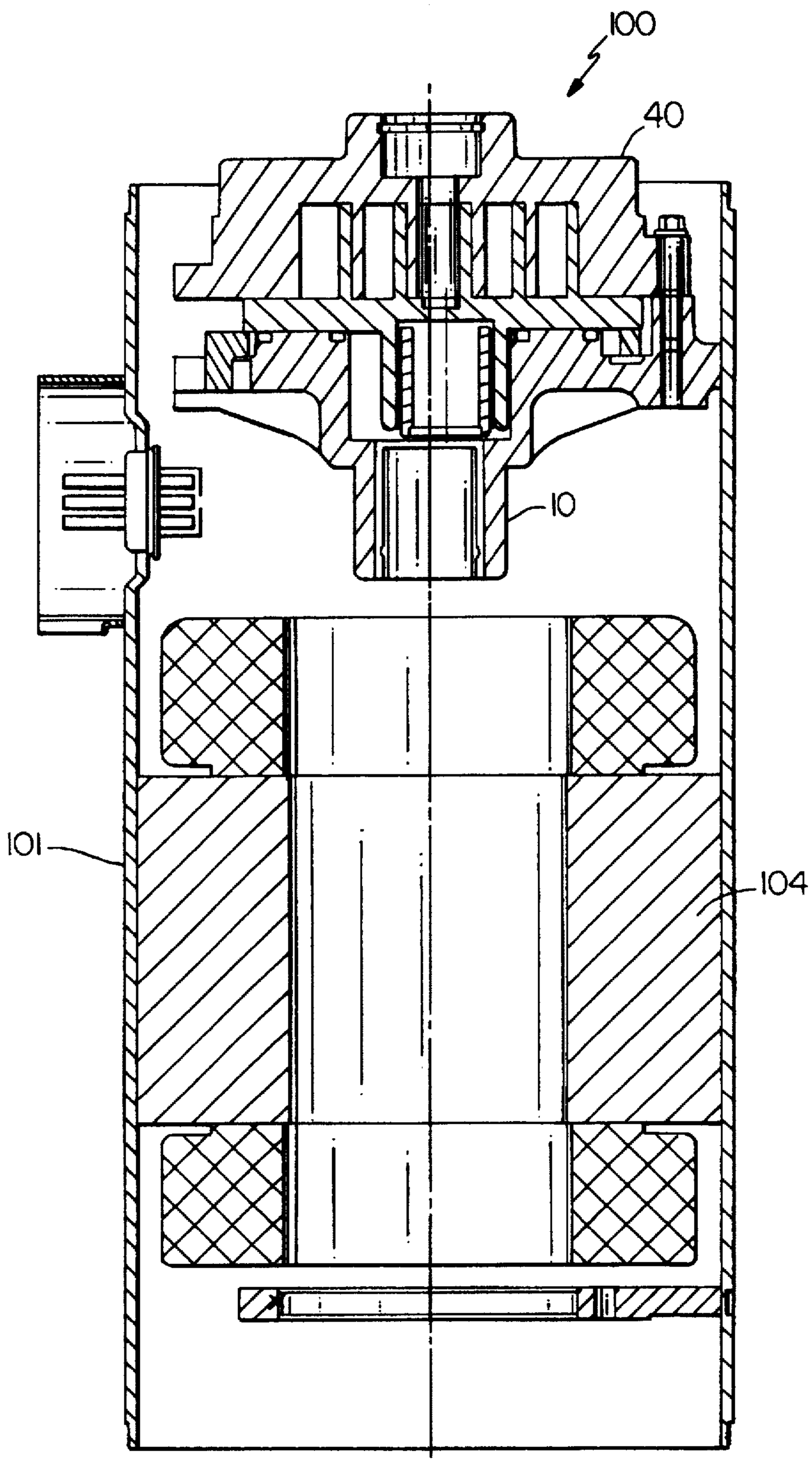



FIG.11

# METHOD OF MAKING A SCROLL COMPRESSOR PUMP CARTRIDGE SUBASSEMBLY

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

## BACKGROUND OF THE INVENTION

In assembling hermetic compressors in general and, specifically, hermetic scroll compressors, assembly is keyed to and takes place within the shell. Commonly assigned U.S. Pat. No. 5,042,150 discloses an assembly method where the stator of the motor is secured in place in the shell and then serves as a reference for locating and securing the upper and lower bearings. With the bearings secured in place, the other members can then be assembled in place. Assembling within the shell requires special fixtures, machining dowel holes, the use of dowels, etc. to permit assembly of the very accurately machined parts. Thus, the assembly that takes place within the shell requires a complicated system for automatic assembly.

## SUMMARY OF THE INVENTION

The present invention is directed to assembling a pump partridge as a subassembly of a scroll compressor. The pump cartridge is installed as a unit within the shell of the scroll compressor as part of the assembly of the scroll compressor. This permits easier automatic assembly of the very accurately made scroll members and a more precise alignment of the pump cartridge for more efficient and reliable operation of the scroll members. Further, since the pump cartridge includes the two scroll members, anti-rotation structure and crankcase, the pump cartridge can be tested prior to being installed in the shell.

It is an object of this invention to eliminate the need for machining dowel holes for the assembly of a scroll compressor pump.

It is an additional object of this invention to permit the testing of a pump cartridge assembly prior to its installation in the shell.

It is a further object of this invention to more precisely align a pump cartridge assembly for improved operation of the scroll members.

It is another object of this invention to assemble a scroll compressor pump as a subassembly of a hermetic scroll compressor. These objects, and others as will become apparent hereinafter, are accomplished by the present invention.

Basically, the fixed and orbiting scrolls, the crankcase and the anti-rotation structure are assembled to form a pump cartridge as a subassembly of a scroll compressor. The assembled pump cartridge is tested prior to its being placed in the shell of a scroll compressor as part of the assembly process.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the present invention, reference should now me bade to the following detailed description thereof taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a sectional view showing a crankcase located on a fixture;

FIG. **2** shows the addition of structural elements to the crankcase of FIG. **1**;



FIG. **3** shows the addition of the orbiting scroll to the structure of FIG. **2**;

FIG. **4** shows the addition of the fixed scroll to the structure of FIG. **3**;

FIG. **5** shows the subassembly of FIG. **4** located on a different fixture;

FIG. **6** shows the testing of the subassembly of FIG. **5**;

FIG. **7** is a flow diagram of the assembly process;

FIG. **8** is a detailed flow diagram of a block in the assembly process of FIG. **7**;

FIG. **9** is a view of the bottom a hub side of the crankcase;

FIG. **10** is a view of the outlet side of the fixed scroll; and

FIG. **11** is a sectional view of a partially assembled compressor according to the teachings of the present invention and U.S. Pat. No. 5,042,150.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. **1**, the numeral **12** designates a fixture corresponding to a crankshaft and which is secured to pallet **14**. Crankcase **10** is placed over fixture **12** onto pallet **14**. This properly orients and locates crankcase **10** for the automatic equipment. With crankcase **10** in place on fixture **12**, Oldham coupling **16** is set in place with key **16-1** being located in slot **10-1** and a diametrically located key (not illustrated) being located in a corresponding slot (**10-7**). It should be noted that solely for the Oldham coupling **16** and the associated slots the sectional view in the various figures is not taken along a diameter. Seals **18** and **19** are placed in grooves **10-2** and **10-3**, respectively, in crankcase **10** slider block **20** is placed on eccentric portion **12-1** of fixture **12** and drain tube **22** is secured in bore **10-4** of crankcase **10**. The assembly described so far is illustrated in FIG. **2**.

Orbiting scroll **24** has a wrap **24-1**, internal passages **24-2** and **24-3** and a hub **24-4**. Passage **24-2** provides a fluid path from the interior of hub **24-4** to the interface between the orbiting scroll **24** and the fixed scroll **40** and supplies lubricant delivered by the crankcase to the interface for lubrication thereof. Passage **24-3** is used to communicate intermediate pressurized fluid from the compression process to axial compliance structure defined in part by seals **18** and **19**. Plugs **30** and **31** seal drill holes made in forming passages **24-2** and **24-3**, respectively. As illustrated in FIG. **3**, hub **24-4** is placed over slider block **20** and is supported by crankcase **10** and seals **18** and **19**. Slots (not illustrated) receive keys (not illustrated) on Oldham coupling **16**, as is conventional.

Fixed scroll **40** has a wrap **40-1**, an outlet **40-2** and a plurality of circumferentially spaced bolt holes **40-3** corresponding to threaded bores **10-5** in crankcase **10**. Fixed scroll **40** is placed on crankcase **10** such that wrap **40-1** operatively engages wrap **24-1** and bolt holes **40-3** align with threaded bores **10-5**. Bolts **50** are placed in bolt holes **40-3** and started in threaded bores **10-5** to locate fixed scroll **40** with respect to crankcase **10**. The resultant pump cartridge assembly **100** is illustrated in FIG. **4**.

Oldham coupling **16** coacting with orbiting scroll **24** and crankcase **10** limits orbiting scroll **24** to an orbiting motion with respect to crankcase **10**. Accordingly, the movement of the hub **24-4** and the slider block **20** received therein is held to an orbiting motion such that slider block **20** does not align with crankshaft bore **10-6** and cannot drop from the hub **24-4** when assembly **100** is removed from fixture **12**. As illustrated in FIG. **5**, assembly **100** is removed from fixture **12** and placed in fixture **112**. Fixture **112** has a shoulder **112-1**

which supports crankcase **10** and thereby assembly **100**. Opening **112-2** in fixture **112** affords access to crankshaft bore **10-6** and slider block bore **20-1**.

At an automatic station, crankcase bore **10-6** is engaged through crankcase bore **112-2** and pump assembly **100** is lifted from fixture **112** into an align and torque device. The bolts **50** are untorqued. The align and torque device determines the location of fixed scroll features and crankcase features and moves the crankcase and fixed scroll to an aligned position and torques bolts **50** to secure crankcase **10** and fixed scroll **40** in their proper relative position.

When pump cartridge assembly **10** is assembled, fixture **112** is used to present pump cartridge assembly **100** for testing. Specifically, as shown in FIG. **6**, a crankshaft **60** is inserted in bore **10-6** such that eccentric pin portion **60-1** is received in bore **20-1** of slider block **20**. Crankshaft **60** is rotated causing slider block **20** to rotate therewith and causing orbiting scroll **24** to orbit, if the pump cartridge assembly **100** is properly assembled, thereby permitting evaluation of the assembly. If assembly **100** operates correctly, it can then be removed from fixture **112** and placed and secured in the shell of a hermetic scroll compressor. FIG. **11** shows pump cartridge assembly **100** secured in shell **101** according to the teachings of U.S. Pat. No. 5,042,150 which secures stator **104** in place in shell **101** and uses the stator as a reference for locating other members. If the assembly **100** does not operate correctly, it is removed from fixture **112** and disassembled and examined to determine the cause of the problem. Faulty parts are discarded and the other parts used to assemble other pump cartridges.

The assembly described with respect to FIGS. **1–6** is done with automatic equipment. The steps in assembling the pump cartridge assembly **100** are set forth in FIG. **7**. In block **200**, which corresponds to FIG. **1**, the crankcase **10** is loaded onto fixture **12**. Fixture **12** is located on pallet **14** and thereby provides a fixed, known location for automatically placing crankcase **10** which is automatically fed to the equipment placing crankcase **10** on fixture **12**. As indicated by block **201**, corresponding to FIG. **2**, with crankcase **10** located by fixture **12**, Oldham coupling **16**, seals **18** and **19**, slider block **20** and oil drain tube **22** may be automatically set in place. As indicated by block **202**, corresponding to FIG. **3**, the orbiting scroll **24** is then picked up and placed on crankcase **10** such that hub **24-4** receives slider block **20** and keys on Oldham coupling **16** are received in corresponding slots in orbiting scroll **24**. Fixed scroll **40** is then automatically placed on crankcase **10**, as indicated by block **203** which corresponds to FIG. **4**. In placing fixed scroll **40** on crankcase **10**, the wraps **24-1** and **40-1** of orbiting and fixed scrolls **24** and **40**, respectively, will be in engagement. With fixed scroll **40** properly located on crankcase **10**, bolt holes **40-3** are aligned with bores **10-5** and bolts **50** can be automatically started, as indicated by block **204**. The resulting pump cartridge assembly **100** can then be removed from the assembly fixture **12** and placed on the fixture **112** as indicated by block **205** which corresponds to FIG. **5**.

As indicated by block **206** bolts **50** are tightened thereby securing fixed scroll **40** to crankcase **10** and securing the orbiting scroll **24**, slider block **20**, Oldham coupling **16** and seals **18** and **19** in place. As shown in FIG. **8**, block **206** of FIG. **7** is made up of a plurality of steps indicated by blocks **206-1** and **206-12**. Initially, fixture **112** is moved into an automatic station, as indicated by block **206-1**, where pump assembly **100** is lifted from fixture **112** into an alignment mechanism, as indicated by block **206-2**. The bolts **50** are untorqued, as indicated by block **206-3**, to permit movement of the members, and crankcase **10** is aligned to fixed scroll **40**, as indicated by bloc **206-4**. With crankcase **10** aligned to fixed scroll **40**, bolts **50** are torqued, as indicated by block **206-5**, and the alignment is checked, as indicated by block **206-6**. If the alignment is good, assembly **100** is returned to fixture **112**, as indicated by block **206-7**. If the checking of the alignment, as indicated by block **206-6**, is bad, bolts **50** are untorqued, as indicated by block **206-8**, and crankcase **10** is again aligned to fixed scroll **40**, as indicated by block **206-9**. With crankcase **10** aligned to fixed scroll **40**, bolts **50** are torqued, as indicated by block **206-10**. The alignment is checked again, as indicated by block **206-11**. If the alignment is good, the assembly **100** is returned to fixture **112**, as indicated by block **206-7**. If the alignment is bad, assembly **100** is removed, as indicated by block **206-12**, and disassembled, as indicated by block **208**. With pump cartridge assembly **100** in place on fixture **112**, the eccentric pin **60-1** of crankshaft **60** may then be inserted into bore **20-1** of slider block **20**. When crankshaft **60** is rotated, hub **24-4** and thereby oribiting scroll **24** will be driven via slider bock **20** and will be held to an orbiting motion by Oldham coupling **16** if the parts are properly assembled. The pump cartridge assembly **100** is thus tested as indicated by block **207** which corresponds to FIG. **6**. Testing may include measuring the starting and running torque level and vibration (signature analysis). The test is stopped if torque exceeds a set level or if vibration is unacceptable. If the pump cartridge assembly **100** does not function properly during the test, it may be readily taken apart and reassembled, as indicated by block **208** and should be contrasted with a situation where the structure corresponding to the pump cartridge assembly is secured in the shell. If the pump cartridge assembly **100** operates properly during the test, crankcase **20** and thereby the structure which defines pump cartridge assembly **100** can be secured in the shell of a hermetic compressor as taught in U.S. Pat. No. 5,042,150, and illustrated in FIG. **11**, or by another suitable method as indicated by block **209**.

From the foregoing description, it should be evident that the precise positioning of the members consistent with the machining tolerances required for the scroll wraps, etc. requires structure to insure the proper positioning of the members. Referring to FIG. **9**, slots **10-1** and **10-7** coact with keys of the Oldham coupling **16** with slot **10-1** being precisely located and serving as a reference. Additionaly, bore **10-6** has a precise diameter. Referring now to FIG. **10**, fixed scroll **40** has a precision outer diameter represented by cylindrical surface **40-4** and a radial stop **40-5**. A plurality of lugs **40-6** are the locations for the bolt holes **40-3**.

In loading pump cartridge assembly **110** on fixture **112** as illustrated in FIG. **5** and represented by box **205** of FIG. **7**, centering and rotational positioning of crankcase **10** onto fixture **112** is achieved by locating the center of crankcase **10** through machined slot **10-1** and through the diameter of bore **10-6** which are referenced by the automated equipment. The fixed scroll **40** is positioned with reference to the precision outer diameter represented by cylindrical surface **40-4** and angularly located by radial stop **40-5**. Automatic equipment moves crankcase **10** and fixed scroll **40** to align the position of crankcase **10** and the position of fixed scroll **40**. The bolts **50** are then torqued to secure crankcase **10** in the proper position with respect to fixed scroll **40**. After torquing the bolts, the fixed scroll position is checked with reference to a true diametrical position to determine whether the parts are within an acceptable tolerance range.

Although a preferred embodiment of the present invention has been illustrated and described, other changes will occur to those skilled in the art. For example, although described in terms of a scroll compressor, it is suitable for other

hermetic compressor assemblies. It is therefore intended that the scope of the present invention is to be limited only by the scope of the appended claims.

What is claimed is:

**1**. A method of assembling a pump cartridge *as a subassembly* for insertion *of said subassembly* in a scroll compressor comprising the steps of:

removably locating a crankcase on an assembly fixture;

locating an Oldham coupling in operative engagement with the crankcase;

locating a slider block on the fixture;

locating an orbiting scroll in operative engagement with the slider block and Oldham coupling and supported by the crankcase;

locating a fixed scroll in operative engagement with the orbiting scroll and supported by the crankcase; and

securing the second scroll *directly* to the crankcase to form a pump cartridge assembly.

**2**. **[**The**]** *A* method of **[**claim **1** further including the steps of**]** *assembling a pump cartridge for insertion in a scroll compressor comprising the steps of*:

*removably locating a crankcase on an assembly fixture;*

*locating an Oldham coupling in operative engagement with the crankcase;*

*locating a slider block on the fixture;*

*locating a first scroll defining an orbiting scroll in operative engagement with the slider block and Oldham coupling and supported by the crankcase;*

*locating a second scroll in operative engagement with the orbiting scroll and supported by the crankcase;*

*securing the second scroll to the crankcase to form a pump cartridge assembly;*

removing the pump cartridge assembly from the assembly fixture;

placing the pump cartridge assembly on a test fixture;

engaging a drive shaft to the slider block;

rotating the shaft; *and*

determining if the pump cartridge assembly operates satisfactorily.

**3**. The method of claim **2** further including the step of securing a pump cartridge assembly which operates satisfactorily in a hermetic shell of a scroll compressor.

**4**. The method of claim **1** wherein the step of locating the **[**fixed**]** *second* scroll further includes the step of angularly positioning the **[**fixed**]** *second* scroll with respect to the crankcase.

**5**. A method of assembling a pump cartridge for insertion in a scroll compressor comprising the steps of:

removably locating a crankcase on an assembly fixture;

locating an Oldham coupling in operative engagement with the crankcase;

locating a slider block on the fixture;

locating *a first scroll defining* an orbiting scroll in operative engagement with the slider block and Oldham coupling and supported by the crankcase;

locating a **[**fixed**]** *second* scroll in operative engagement with the orbiting scroll and supported by the crankcase;

precisely aligning the **[**fixed**]** *second* scroll on the crankcase;

measuring the position of the crankcase and **[**fixed**]** *second* scroll;

relatively moving the crankcase and **[**fixed**]** *second* scroll to a desired position based on the measurement; and



securing the **[**fixed**]** *second* scroll to the crankcase to form a pump cartridge assembly.

**6**. The method of claim **5** further including the steps of:

removing the pump cartridge assembly from the assembly fixture;

placing the pump cartridge assembly on a test fixture;

engaging a drive shaft to the slider block;

rotating the shaft;

determining if the pump cartridge assembly operates satisfactorily.

**7**. The method of claim **6** further including the step of securing a pump cartridge assembly which operates satisfactorily in a hermetic shell of a scroll compressor.

**8**. The method of claim **5** wherein the step of locating the **[**fixed**]** *second* scroll further includes the step of angularly positioning the **[**fixed**]** *second* scroll with respect to the crankcase.

**9**. A method of assembling a pump cartridge *as a subassembly* for insertion *of said subassembly* in a scroll compressor comprising the steps of:

removably locating a crankcase on an assembly fixture;

locating an Oldham coupling in operative engagement with the crankcase;

locating an orbiting scroll in operative engagement with the Oldham coupling and supported by the crankcase;

locating a fixed scroll in operative engagement with the orbiting scroll and supported by the crankcase; and

securing the fixed scroll *directly* to the crankcase to form a pump cartridge assembly.

**10**. **[**The**]** *A* method of **[**claim **9** further including the steps of**]** *assembling a pump cartridge for insertion in a scroll compressor comprising the steps of*:

*removably locating a crankcase on an assembly fixture;*

*locating an Oldham coupling in operative engagement with the crankcase;*

*locating a first scroll defining an orbiting scroll in operative engagement with the Oldham coupling and supported by the crankcase:*

*locating a second scroll in operative engagement with the orbiting scroll and supported by the crankcase;*

*securing the second scroll to the crankcase to form a pump cartridge assembly;*

removing the pump cartridge assembly from the assembly fixture;

placing the pump cartridge assembly on a test fixture;

engaging a drive shaft to the pump cartridge assembly;

rotating the shaft; *and*

determining if the pump cartridge assembly operates satisfactorily.

**11**. The method of claim **10** further including the step of securing a pump cartridge assembly which operates satisfactorily in a hermetic shell of a scroll compressor.

**12**. The method of claim **9** wherein the step of locating the **[**fixed**]** *second* scroll further includes the step of angularly positioning the **[**fixed**]** *second* scroll with respect to the crankcase.

**13**. A method of assembling a pump cartridge for insertion in a scroll compressor comprising the steps of:

**[**a**]** removably locating a crankcase on an assembly fixture;

locating an Oldham coupling in operative engagement with the crankcase;

locating *a first scroll defining* an orbiting scroll in operative engagement with the Oldham coupling and supported by the crankcase;

locating a [fixed] *second* scroll in operative engagement with the orbiting scroll and supported by the crankcase;

precisely aligning the [fixed] *second* scroll on the crankcase;

measuring the position of the crankcase and [fixed] *second* scroll;

relatively moving the crankcase and [fixed] *second* scroll to a desired position based on the measurement; and

securing the [fixed] *second* scroll to the crankcase to form a pump cartridge assembly.

**14**. The method of claim **13** further including [he] *the* steps of:

removing the pump cartridge assembly from the assembly fixture;



placing the pump cartridge assembly on a test fixture;

engaging a drive shaft to the pump cartridge assembly;

rotating the shaft;

determining if the pump cartridge assembly operates satisfactorily.

**15**. The method of claim **14** further including the step of securing a pump cartridge assembly which operates satisfactorily in a hermetic shell of a scroll compressor.

**16**. The method of claim **13** wherein the step of locating the [fixed] *second* scroll further includes the step of angularly positioning the [fixed] *second* scroll with respect to the crankcase.

* * * * *