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(54) VARIABLE GEOMETRY TURBOCHARGER

TURBOLADER MIT VERSTELLBAREN LEITSCHAUFELN

TURBOCOMPRESSEUR A GEOMETRIE VARIABLE

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Description

BACKGROUND OF THE INVENTION

Field of the Invention:

[0001] This invention relates generally to the field of turbochargers having variable turbine inlet geometries. More particularly, the present invention provides a simplified structural arrangement for positioning multiple aerodynamic vanes in the inlet nozzle of the turbine housing and an integrated actuator for control of the vane position.

Description of the Related Art:

[0002] In a turbocharger it is often desirable to control the flow of exhaust gas into the turbine to improve the efficiency or operational range. Various configurations of variable nozzles have been employed to control the exhaust gas flow. Multiple pivoting vanes annularly positioned around the turbine inlet and commonly controlled to alter the throat area of the passages between the vanes is an approach which has been successfully used in prior turbochargers. Various approaches to this method for implementing a variable nozzle are disclosed in US Patent numbers 4,679,984 to Swihart et al. entitled "Actuation System for Variable Nozzle Turbine" and 4,804,316 to Fleury entitled "Suspension for the Pivoting Vane Actuation Mechanism of a Variable Nozzle Turbocharger" having a common assignee with the present application.

[0003] In more detail, US 4,679,984 discloses a turbocharger having a variable nozzle vane assembly. A plurality of pivotable vanes are mounted between the turbocharger backplate and unison ring on one side, and an annular side wall independent of the turbine housing, on the other side. Each vane includes a drive pin which pivots the vane in response to rotational movement of the unison ring. In order to achieve this, the unison ring has a plurality of slots on its inner radial surface, each slot receiving a vane drive pin.

[0004] While multiple vane variable nozzle turbochargers have significantly increased the overall efficiency and capability of turbochargers, the complexity of support and actuation structures for the vanes have increased manufacturing costs and occasionally created maintenance issues. It is therefore desirable to reduce the complexity and parts count of variable nozzle structural arrangements and improve the actuation systems to increase reliability and reduce manufacturing cost for turbochargers employing them.

SUMMARY OF THE INVENTION

[0005] A variable geometry turbocharger according to the present invention includes a turbine housing having a standard inlet for exhaust gas and an outlet to the exhaust system of the engine. A volute is connected to the inlet and an integral outer nozzle wall is incorporated in the turbine housing casting adjacent the volute. A center housing is attached to the turbine housing A center bore in the center housing carries a bearing assembly. A compressor housing having an air inlet and a compressed air outlet is attached to the center housing.

[0006] A turbine wheel is carried within the turbine housing and attached to a shaft extending through the center housing, supported by the bearing assembly. The shaft is attached distal the turbine wheel, to a compressor impeller carried within the compressor housing.

[0007] A plurality of vanes having rotation posts extending from a first surface substantially parallel to the outer nozzle wall provide the variable nozzle. The posts are received in circumferentially spaced apertures in the outer nozzle wall. The vanes further have actuation tabs extending from the opposite (i.e. second) surface of the vanes distal the first surface. A unison ring is engaged between the center housing and the vanes and has a plurality of profiled slots equal in number to the vanes. The slots are oriented obliquely to a circumference of the unison ring and receive the tabs. The profiled surfaces of the slots engage the substantially flat sides of the tabs on different surfaces during the translation to provide optimum control and wear reduction, the slots being configured to provide extended engagement between the substantially flat sides and the inner surfaces of the slots.

[0008] Actuation of the unison ring is accomplished by a radial slot in the unison ring and a crank shaft having a pin engaging the radial slot The crank shaft is movable continuously from a first position to a second position, causing the pin to translate in the radial slot and impart force perpendicular to the radial slot to urge rotational motion of the unison ring. The rotational motion of the unison ring causes the tabs to traverse the actuation slots from a first end of the slots to a second end of the slots. The oblique orientation of the slots causes a continuously variable rotation of the vanes from a first open position to a second closed position. Preferably, the actuation slots incorporate a profile predetermined to provide maximum engagement of a first side of each tab with the tab located at the first end and second end of the slot, and maximum engagement of a second side of each tab with the tab located in the slot intermediate the first and second end.

[0009] An integral hydraulic actuator typically provides the actuation mechanism for the crank shaft. Mounted in a boss in the center housing, the actuator uses a piston and piston rod attached by a rack and pinion to the crank shaft for position control of the vanes. Hydraulic pressure to operate the piston is provided by a solenoid operated multiport valve with direct feedback through a cam mounted on the crank shaft adjacent the pinion gear.

[0010] In more detail, the moving means comprised within the variable geometry turbocharger according to the present invention preferably comprises a hydraulic actuator integral with the center housing and having a piston received in a boss integrally cast in the center housing for reciprocating motion perpendicular to the crank shaft. A piston rod is attached to the piston at a first end. Also included are means for attaching the piston rod to the crank shaft, the attaching means converting reciprocating motion of the rod to rotational movement of the shaft. In addition, the hydraulic actuator comprises means for controllably varying hydraulic pressure on opposing sides of the piston to induce motion from a first position corresponding to the first position of the crank shaft, to a second position corresponding to the second position of the crank shaft.

[0011] More preferably, the above-described attaching means for attaching the piston rod to the crank shaft comprises a gear rack on the piston rod and a pinion gear on the crank shaft.

[0012] Also more preferably, the above-described means for controllably varying the hydraulic pressure comprises a hydraulic valve stem having multiple ports and which is movable by a variable current electric solenoid balanced by a bias spring. The varying means additionally comprises a hydraulic pressure source in communication with a first port with the stem in a first position, and a second port with the stem in a second position, and also a hydraulic drain in communication with a third port with the stem in a first position, and a fourth port with the stem in a second position. Also comprised within the varying means is a first conduit communicating with a first side of the piston and communicating with the first port with the stem in the first position, and the fourth port with the stem in the second position. A second conduit is also included, which communicates with a second side of the piston and also with the third port with the stem in the first position, and the second port with the stem in the second position. Finally, also comprised within the varying means is a cam located on the crank shaft, which operatively engages the bias spring.

[0013] In a further preferred embodiment according to the present invention, the variable geometry turbocharger comprises actuation slots which are blind, and further comprises an annular channel in the center housing closely receiving the unison ring, and means for supplying air pressure to the channel to urge the unison ring into close contact with the second surface of the vanes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The details and features of the present invention will be more clearly understood with respect to the detailed description and drawings in which:

Fig. 1 is an exploded view of an embodiment of a turbocharger according to the present invention;
Fig. 2 is a side section elevation showing the turbine housing, center housing and compressor back plate with the turbine shaft wheel assembly and compressor impeller as supported by the bearing system;
Fig. 3 is an end section elevation through the center housing showing an embodiment of the present invention comprising an integral actuation valve arrangement;
Fig. 4 is a partial view of an alternate valve piston arrangment;
Fig. 5a is a view along line G-G of Fig. 3 and with Figs. 5b-c provides section views of the crank shaft assembly extending from the actuation valve to the unison ring engaging the nozzle vanes;
Figs 6 a-e are end views of the unison ring and nozzle vanes demonstrating the variable vane positions and the actuation structural arrangement;
Fig. 7 is a reverse end view of an alternative embodiment of the unison ring showing a blind relief design for pressure compensation;
Fig. 8 is a schematic side view of the unison ring of Fig. 7 and vanes as mounted in the turbine housing to demonstrate the pressure compensation for vane tolerance control; and
Figs. 9a-e are schematic side views of the actuation valve porting and piston structure for control of the vane position.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to the drawings, the embodiment of the invention shown in Fig. 1 includes a compressor housing 10 which is connected to a backplate 12 using two or more clamps 14 secured by bolts 16. The backplate is attached to a center housing 18 with multiple bolts 20 and a seal ring 22. A turbine housing 24 is connected to the center housing using multiple clamps 26 secured by bolts 28. A turbine wheel and shaft assembly 30 is carried within the turbine housing. Exhaust gas or other high energy gas supplying the turbocharger enters the turbine housing through inlet 32 and is distributed through the volute in the turbine housing for substantially radial entry into the turbine wheel through a circumferential nozzle entry 34.

[0016] Multiple vanes 36 are mounted to a nozzle wall 38 machined into the turbine housing using posts 40 extending from the vanes for rotational engagement within holes 42 in the nozzle wall. Actuation tabs 44 extend from the vanes to be engaged by slots 46 in unison ring 48 which acts as the second nozzle wall. The configuration of the tabs, slots and unison ring will be explained in greater detail subsequently. An actuator crank 50 terminates at a first end in a lever arm 52 carrying a pin 54 to engage elliptical slot 56 in the unison ring for rotation of the ring as will be later explained. The crank extends into a boss 58 in the center housing casting through a bushing 60 and a gear 62 which is secured to the crank by a pin 64 and is received into an end bearing 66 which mates with aperture 68 in the crank boss. An O-ring 70 seals the end bearing and a snap ring 72 secures the end bearing into the aperture 68.

[0017] A bearing system having two journal bearings 74 and a bearing spacer 76 support the shaft wheel assembly in the center housing center bore 78. The shaft further extends through a thrust collar 80 which engages a thrust bearing 82 carried between the center housing and compressor back plate. A piston ring 84 seals the thrust collar with the shaft bore in the back plate. The stack up of the shaft wheel assembly within the turbine housing, center housing and back plate is best seen in Fig. 2. The unison ring and vanes are not shown for clarity. The compressor impeller 160 is attached to the shaft wheel assembly.

[0018] Referring again to Fig. 1, the integrated actuator for the turbocharger is housed in an actuator boss 82 in the casting of the center housing 18. A solenoid valve 84 is mounted in an aperture at one end of the boss while the actuating components are mounted in a second aperture at the opposite end of the boss. The actuating components include a piston 86 that incorporates a rod 88 having a rack gear 90 engaging the gear 62 mounted on the crank shaft 50. A ring seal 92 surrounds the piston circumference sealing the piston in the bore of the actuator boss. Additional ring seals 94 and 96 seal the piston rod to a rod bore of smaller diameter than the piston bore. The piston bore is sealed with a piston end 98 held in the bore with a snap ring 100. A bolt 102 is inserted into a threaded hole in the piston end for use in manipulating the piston end. An additional ring seal 104 seals the piston end to the bore. Alternatively, a freeze plug 106 is employed as a replacement for the piston end. The solenoid valve is secured to the boss with a bracket 108 held by a bolt 110. Bore plugs 112 and 114 seal the blind ends of actuation passages in the actuator boss while steel balls 116 are employed to seal other actuation passages, described in greater detail subsequently.

[0019] Fig. 2 is a side sectional elevation of the turbocharger showing the assembled turbine housing, center housing and compressor back plate with the turbine shaft wheel assembly and compressor impeller supported by the bearing assembly.

[0020] Fig. 3 is an end sectional view through the actuator boss and assembled actuator components. Fig. 4 shows the alternative freeze plug arrangement for sealing the piston bore.

[0021] As best seen in Fig. 2, the center housing includes a main casting portion and a turbine housing back plate 120 for attachment of the center housing to the turbine housing using bolts, as previously described. Fig. 5a is a sectional view showing the crank shaft assembly with the gear 62 bushing 60 mounted in the main casting portion of the center housing with the crank shaft extending across the air gap between the main casting portion and the turbine housing back plate and into an aperture in the back plate. Fig. 5b shows the details of the crank shaft sealing arrangement in the back plate aperture. A first metalic ring seal 122 having a first diameter is employed to seal an inner diameter of the aperture 124, while a second metalic ring seal 126 is employed in combination with the first seal to seal a second larger diameter 128 of the aperture. This arrangement allows continued sealing during uneven thermal expansion of the main casting portion and the back plate during operation. Fig. 5b demonstrates the configuration during operation, with the temperature of the back plate exceed the main portion, with resulting greater expansion while Fig. 5c, shows the arrangement with nominal tolerance at a common temperature for the main casting portion and the back plate.

[0022] The nozzle vanes36 in the turbine inlet nozzle are operated by the unison ring 48. Fig. 6a shows the unison ring engaged by the end pin 54 of the crank shaft 50 in a radial slot 130. Rotation of the crank shaft causes the offset end pin to traverse the radial slot resulting in rotation of the unison ring. The vanes, mounted for rotation on pins 40 which extend into receiving holes 42 in the nozzle wall of the turbine housing, have guide tabs 132 which are received in the slots 46 in the unison ring. As the unison ring rotates, the motion of the slots causes the tabs to traverse from one end of the slot to the other resulting in rotation of the vanes from a first fully open position, through a neutral position, shown in Fig. 6a, to a fully closed position. Fig. 6b shows in phantom the fully open, neutral and fully closed positions of the vanes with tab positioning in the slots. Fig. 6c is an enlarged view of the unison ring slot with the tab shown in multiple positions. The tab incorporates substantially, flat sides 134 and 136 which provide extended engagement of the slot wall by the tab to reduce point wear on the tab. The profile of the slot, not purely oval, is predetermined to provide maximum engagement with the tab, while engaging first side 134 of the tab at the open and closed end points with maximum area and the second side 136 during the intermediate positioning of the vanes.

[0023] For the embodiment shown in the drawings, Fig. 6d shows the fully open and fully closed positions of the vanes. A 22 degree rotation of the vanes is provided.

[0024] In certain applications, pressure balancing of the mounting of the vanes in the nozzle is desirable. Fig. 7 shows one embodiment of the unison ring 48 that incorporates blind slots 46 while providing a blind relief 138 on the reverse side of the ring with pressure ports 140 machined into the relief. Fig. 8 is a detail side section of the relieved unison ring engaging the vanes in the nozzle. For the arrangement shown, pressure of the exhaust gas entering the nozzle pressurizes the relieved back portion 138 of the unison ring through gap 142 provided by tolerancing of the mounting channel 144 in the back plate 120, through ports 140. Alternatively, a feed hole 146 is provided through the back plate into the unison ring mounting channel proximate the location of the ports 144. Total pressure of the exhaust gas urges the unison ring against the vanes, which are in turn urged against the nozzle surface 38 in the turbine housing. Holes 42 receiving the vane pins 40 are provided with sufficient depth to allow the vanes to be maintained in close contact with the nozzle surface and unison ring for minimum vane leakage.

[0025] Actuation of the vanes is initiated by the solenoid valve 84 and actuation components previously described. Figs. 9a through 9e show the various states of the actuation piston 86 and its piston rod 88 driving gear 62 through rack 90. The solenoid valve is reacted by a spring 150 having a cap 152 engaging a cam 154 machined into the gear body. Various ports, as will be described are then opened and closed, hydraulically positioning the piston which, through the mechanical closed loop of the rack and gear provides positive control on the position of the crank shaft and, therefore, the unison ring.

[0026] The solenoid valve is a proportional servo 4-way hydraulic actuator control valve. As shown in Fig. 9a, if no current is applied to the solenoid, port A is open, port B (top of the piston) is connected to drain port D. As shown in Fig. 9b, when oil pressure is applied from the engine on which the turbocharger is mounted, oil pressure is directed through port A into the bottom of the piston, placing the vanes in a fully open position. When current is applied to the solenoid, port A is closed, port A (bottom of the piston) is connected to drain, port B opens and oil pressure is directed to the top of the piston, moving the piston to the left starting to close the vanes.

[0027] Fig. 9c shows the condition of the actuation systems with a balanced state low current in the solenoid. Port A is closed, port B is closed and the vanes are positioned as a function of the applied current. If the current is increased, Fig. 9d shows that port B is opened directing oil pressure to the top of the piston. Port A is connected to the drain and the piston moves to the left, moving the vanes in the closed direction. After some finite time, the system stabilizes in a balanced state with high current as shown in Fig. 5e with port A closed, port B closed and the vanes positioned as a function of the applied current. Full current applied to the solenoid results in port B being closed, oil pressure being directed to the top of the piston while port A is connect to the drain and the piston moves to the left until a full closed vane position is achieved. Removing current from the solenoid returns the actuation system to the state shown in Fig. 9a with the vanes fully open.

[0028] Having now fully described the invention as required by the patent statutes, those skilled in the art will be able to ascertain modifications and alterations to the specific embodiments disclosed herein. Such modifications and alterations are within the scope of the invention as defined in the following claims.

Claims

1. A variable geometry turbocharger comprising:

   a turbine housing (24) having an inlet (32) for exhaust gas and an outlet, a volute connected to the inlet and an integral outer nozzle wall (38) adjacent the volute;
   a center housing (18) attached to the turbine housing and having a center bore (48) carrying a bearing assembly;
   a compressor housing (10) having an air inlet and a compressed air outlet, the compressor housing (10) attached to the center housing (18);
   a turbine wheel (30) carried within the turbine housing (24) and attached to a shaft (30) extending through the center housing (18), supported by the bearing assembly, the shaft attached distal the turbine wheel (30) to a compressor impeller (160) carried within the compressor housing (10);
   a plurality of vanes (36) having rotation posts (40) extending from a first surface substantially parallel to the outer nozzle wall, the posts received in circumferentially spaced apertures (42) in the outer nozzle wall, the vanes further having actuation tabs (44) extending from a second surface of the vanes distal the first surface;
   a unison ring (48) intermediate the center housing and the vanes, the unison ring having a plurality of slots (46) equal in number to the vanes, said slots oriented obliquely to a circumference of the unison ring and receiving the tabs, the unison ring further having a radial slot (56);
   a crank shaft (50) having a pin (54) engaging the radial slot, the crank shaft movable continuously from a first position to a second position, movement of the crank shaft (50) causing the pin (54) to translate in the radial slot (56) and impart force perpendicular to the radial slot to urge rotational motion of the unison ring (48), the rotational motion of the unison ring causing the tabs (44) to traverse the actuation slots (46) from a first end of the slots to a second end of the slots; and
   means for moving the crank shaft from the first position to the second position, **characterised in that** the tabs incorporate substantially flat sides to be received within the actuation slots, the slots being configured to provide extended engagement between the substantially flat sides and the inner surfaces of the slots (46).

2. A variable geometry turbocharger as defined in claim 1, wherein the actuation slots incorporate a file predetermined to provide maximum engage-

ment of a first side (134) of each tab with the tab located at the first end and second end of the slot and maximum engagement of a second side (136) of each tab with the tab located in the slot intermediate the first and second end.

3. A variable geometry turbocharger as defined in claim 1, wherein the moving means comprises a hydraulic actuator integral with the center housing and having

a piston (86) received in a boss (85) integrally cast in the center housing (18) for reciprocating motion perpendicular to the crank shaft (50);
a piston rod (88) attached to the piston at a first end;
means for attaching the piston rod (88) to the crank shaft (50), the attaching means converting reciprocating motion of the rod to rotational motion of the shaft; and
means for controllably varying hydraulic pressure on opposing sides of the piston to induce motion from a first position corresponding to the first position of the crank shaft (50) to a second position corresponding to the second position of the crank shaft (50).

4. A variable geometry turbocharger as defined in claim 3, wherein the attaching means comprises:

a gear rack (90) on the piston rod (88); and
a pinion gear on the crank shaft (50).

5. A variable geometry turbocharger as defined in claim 3, wherein the means for controllably varying the hydraulic pressure comprises:

a hydraulic valve stem having multiple ports and movable by a variable current electric solenoid (84) balanced by a bias spring (150);
a hydraulic pressure source in communication with a first port with the stem in a first position and a second port with the stem in a second position;
a hydraulic drain in communication with a third port with the stem in the first position and a forth port with the stem in the second postion;
a first conduit communicating with a first side of the piston and communicating with the first port with the stem in the first position and the forth port with the stem in the second position;
a second conduit communicating with a second side of the piston and communicating the third port with the stem in the first position and the second port with the stem in the second position; and
a cam on the crank shaft operatively engaging the bias spring.

6. A variable geometry turbocharger as defined in claim 1, wherein the actuation slots (46) are blind and further comprising:

an annular channel in the center housing closely receiving the unison ring; and
means for supplying air pressure to the channel to urge the unison ring into close contact with the second surface of the vanes.

Patentansprüche

1. Turbolader mit verstellbaren Leitschaufeln, mit:

einem Turbinengehäuse (24) mit einem Einlass (32) für Abgas und einem Auslass, einem an dem Einlass angeschlossenen Diffusor und einer an dem Diffusor angrenzenden, integralen äußeren Düsenwand (38),
einem Mittelegehäuse (18), das an dem Turbinengehäuse angebracht ist und eine mittlere Bohrung (68) aufweist, die eine Lageranordnung trägt,
einem Kompressorgehäuse (10) mit einem Lufteinlass und einem Druckluftauslass, wobei das Kompressorgehäuse (10) an dem Mittelgehäuse (18) angebracht ist,
einem Turbinenrad (30), das in dem Turbinengehäuse (24) getragen wird und an einer sich durch das Mittelgehäuse (18) erstreckenden Welle angebracht ist, die von der Lageranordnung gestützt wird, wobei die Welle distal zu dem Turbinenrad (30) an einem Kompressorlaufrad (160) angebracht ist, das in dem Kompressorgehäuse (10) getragen wird,
mehreren Leitschaufeln (36) mit Drehstäben (40), die sich von einer ersten, zu der äußeren Düsenwand im Wesentlichen parallelen Fläche weg erstrecken, wobei die Stäbe in in Umfangsrichtung beabstandeten Öffnungen (42) in der äußeren Düsenwand aufgenommen sind, wobei die Leitschaufeln weiterhin Betätigungsnasen (44) aufweisen, die sich von einer zweiten, zur ersten Fläche distalen Fläche der Leitschaufeln weg erstrecken,
einem Verstellring (48) zwischen dem Mittelgehäuse und den Leitschaufeln, wobei der Verstellring mehrere Schlitze aufweist, deren Anzahl gleich der Anzahl der Leitschaufeln ist, wobei die Schlitze schräg zu einem Umfang des Verstellrings ausgerichtet sind und die Nasen aufnehmen, wobei der Verstellring weiterhin einen radialen Schlitz (56) aufweist,
einer Kurbelwelle (50) mit einem Stift (54), der in den radialen Schlitz eingreift, wobei die Kurbelwelle kontinuierlich von einer ersten in eine zweite Position bewegbar ist, wobei die Bewe-

gung der Kurbelwelle (50) bewirkt, dass der Stift (54) in dem radialen Schlitz translatorisch bewegt wird und eine zu dem radialen Schlitz senkrechte Kraft ausübt, um eine Drehbewegung des Verstellrings (48) zu erzwingen, wobei die Drehbewegung des Verstellrings bewirkt, dass die Nasen (44) die Betätigungsschlitze (46) von einem ersten Ende der Schlitze zu einem zweiten Ende der Schlitze durchqueren, und
einem Mittel zum Bewegen der Kurbelwelle aus der ersten Position in die zweite Position,

dadurch gekennzeichnet, dass die Nasen im Wesentlichen flache, in den Betätigungsschlitzen aufzunehmende Seiten umfassen, wobei die Schlitze so konfiguriert sind, dass sie einen verlängerten Eingriff zwischen den im Wesentlichen flachen Seiten und den Innenflächen der Schlitze (46) bereitstellen.

2. Turbolader mit verstellbaren Leitschaufeln nach Anspruch 1, bei dem die Betätigungsschlitze ein Profil beinhalten, das dafür ausgelegt ist, einen maximalen Eingriff einer ersten Seite (134) jeder Nase, wenn die Nase sich am ersten Ende und zweiten Ende des Schlitzes befindet, und einen maximalen Eingriff einer zweiten Seite (136) jeder Nase, wenn die Nase sich in dem Schlitz zwischen dem ersten und zweiten Ende befindet, bereitzustellen.

3. Turbolader mit verstellbaren Leitschaufeln nach Anspruch 1, bei dem das Bewegungsmittel ein mit dem Mittelgehäuse integrales hydraulisches Stellglied umfasst, das Folgendes aufweist:

einen Kolben (86), der zur Hin- und Herbewegung senkrecht zu der Kurbelwelle (50) in einer integral in dem Mittelgehäuse (18) gegossenen Nabe (85) aufgenommen ist,
eine an dem Kolben an einem ersten Ende angebrachte Kolbenstange (88),
ein Mittel zur Befestigung der Kolbenstange (88) an der Kurbelwelle (50), wobei das Befestigungsmittel die Hin- und Herbewegung der Stange in eine Drehbewegung der Welle umwandelt, und
ein Mittel zum steuerbaren Variieren des hydraulischen Drucks auf gegenüberliegenden Seiten des Kolbens, um eine Bewegung aus einer ersten Position, die der ersten Position der Kurbelwelle (50) entspricht, in eine zweite Position, die der zweiten Position der Kurbelwelle (50) entspricht, zu bewirken.

4. Turbolader mit verstellbaren Leitschaufeln nach Anspruch 3, bei dem das Befestigungsmittel Folgendes umfasst:

eine Zahnstange (90) auf der Kolbenstange (88) und
ein Ritzel auf der Kurbelwelle (50).

5. Turbolader mit verstellbaren Leitschaufeln nach Anspruch 3, bei dem das Mittel zum steuerbaren Variieren des hydraulischen Drucks Folgendes umfasst:

einen hydraulischen Ventilschaft, der mehrere Öffnungen aufweist und durch einen durch eine Vorbelastungsfeder (150) im Gleichgewicht stehenden Elektromagneten (84) mit variablem Strom bewegbar ist,
eine hydraulische Druckquelle in Verbindung mit einer ersten Öffnung, wenn sich der Schaft in einer ersten Position befindet, und einer zweiten Öffnung, wenn sich der Schaft in einer zweiten Position befindet,
einen hydraulischen Abfluss in Verbindung mit einer dritten Öffnung, wenn sich der Schaft in der ersten Position befindet, und einer vierten Öffnung, wenn sich der Schaft in der zweiten Position befindet,
eine erste Leitung in Verbindung mit einer ersten Seite des Kolbens und in Verbindung mit der ersten Öffnung, wenn sich der Schaft in der ersten Position befindet, und der vierten Öffnung, wenn sich der Schaft in der zweiten Position befindet,
eine zweite Leitung in Verbindung mit einer zweiten Seite des Kolbens und in Verbindung mit der dritten Öffnung, wenn sich der Schaft in der ersten Position befindet, und der zweiten Öffnung, wenn sich der Schaft in der zweiten Position befindet, und
einem Mitnehmer an der Kurbelwelle, der mit der Vorbelastungsfeder in Wirkeingriff steht.

6. Turbolader mit verstellbaren Leitschaufeln nach Anspruch 1, bei dem die Betätigungsschlitze (46) nicht durchgehend sind und weiterhin mit:

einem ringförmigen Kanal in dem Mittelgehäuse, der den Verstellring eng aufnimmt und
einem Mittel zur Zuführung von Druckluft zu dem Kanal, um den Verstellring in engen Kontakt mit der zweiten Fläche der Leitschaufeln zu drängen.

Revendications

1. Turbocompresseur à géométrie variable comprenant :

un carter de turbine '(24) comprenant une entrée (32) pour les gaz d'échappement et une

sortie, une volute connectée à l'entrée et une paroi extérieure de buse intégrale (38) adjacente à la volute ;
un carter central (18) fixé au carter de turbine et comportant un alésage central (68) portant un ensemble de palier ;
un carter de compresseur (10) comprenant une entrée d'air et une sortie d'air comprimé, le carter de compresseur (10) étant fixé au carter central (18) ;
une roue de turbine (30) portée dans le carter de turbine (24) et fixée à un arbre (30) s'étendant à travers le carter central (18) et porté par l'ensemble de palier, l'arbre étant fixé à l'extrémité distale de la roue de turbine (30) à une roue à aubes (160) portée dans le carter de compresseur (10) ;
une pluralité d'ailettes (36) comprenant des axes de rotation (40) s'étendant à partir d'une première surface substantiellement parallèle à la paroi extérieure de buse, les axes étant accueillis dans des ouvertures espacées sur la circonférence (42) dans la paroi extérieure de buse, les ailettes comprenant en outre des pattes d'actionnement (44) s'étendant à partir d'une deuxième surface des ailettes distale de la première surface ;
une bague d'union (48) en position intermédiaire entre le carter central et les ailettes, la bague d'union comportant une pluralité d'encoches (46) égales en nombre aux ailettes, lesdites encoches orientées obliquement par rapport à une circonférence de la bague d'union et accueillant les pattes, la bague d'union comportant en outre une encoche radiale (56) ;
un arbre de manivelle (50) comprenant un axe (54) engagé dans l'encoche radiale, l'arbre de manivelle se déplaçant continuellement d'une première position à une deuxième position, le mouvement de l'arbre de manivelle (50) conduisant l'axe (54) à se déplacer dans l'encoche radiale (56) et à appliquer une force perpendiculaire à l'encoche radiale pour produire un mouvement rotatif de la bague d'union (48), le mouvement rotatif de la bague d'union conduisant les pattes (44) à traverser les encoches d'actionnement (46) d'une première extrémité des encoches à une deuxième extrémité des encoches ; et
un moyen pour déplacer l'arbre de manivelle de la première position à la deuxième position, **caractérisé en ce que** les pattes comportent des côtés substantiellement plats qui sont accueillis dans les encoches d'actionnement, les encoches étant configurées pour fournir un engagement étendu entre les côtés substantiellement plats et les surfaces intérieures des encoches (46).

2. Turbocompresseur à géométrie variable selon la revendication 1, dans lequel les encoches d'actionnement comportent un profil prédéterminé pour fournir l'engagement maximum d'un premier côté (134) de chaque patte avec la patte située à la première extrémité et à la deuxième extrémité de l'encoche et un engagement maximum d'un deuxième côté (136) de chaque patte avec la patte située dans l'encoche en position intermédiaire entre la première et la deuxième extrémités.

3. Turbocompresseur à géométrie variable selon la revendication 1, dans lequel le moyen de déplacement comprend un actionneur hydraulique intégral au carter central et comprenant :

un piston (86) accueilli dans un bossage (85) coulé intégralement dans le carter central (18) pour produire le mouvement alternatif perpendiculaire à l'arbre de manivelle (50) ;
une tige de piston (88) fixée au piston à une première extrémité ;
un moyen pour fixer la tige de piston (88) à l'arbre de manivelle (50), le moyen de fixation convertissant le mouvement alternatif de la tige de piston en mouvement rotatif de l'arbre ; et
un moyen pour faire varier de façon contrôlée la pression hydraulique sur les côtés opposés du piston pour produire un mouvement d'une première position correspondant à la première position de l'arbre de manivelle (50) à une deuxième position correspondant à la deuxième position de l'arbre de manivelle (50).

4. Turbocompresseur à géométrie variable selon la revendication 3, dans lequel le moyen de fixation comprend :

une crémaillère d'engrenage (90) sur la tige de piston (88) et
un pignon d'engrenage sur l'arbre de manivelle (50).

5. Turbocompresseur à géométrie variable selon la revendication 3, dans lequel le moyen servant à faire varier de façon contrôlée la pression hydraulique comprend :

une queue de soupape hydraulique comportant des orifices multiples et pouvant être déplacée par un solénoïde à courant électrique variable (84) équilibré par un ressort de rappel (150) ;
une source de pression hydraulique en communication avec un premier orifice quand la queue de soupape est à une première position et avec un deuxième orifice quand la queue de soupape est à une deuxième position ;
un drain hydraulique en communication avec

un troisième orifice quand la queue de soupape est à la première position et avec un quatrième orifice quand la queue de soupape est à la deuxième position ;

un premier conduit communicant avec un premier côté du piston et communiquant avec le premier orifice quand la queue de soupape est à la première position et avec le quatrième orifice quand la queue de soupape est à la deuxième position ;

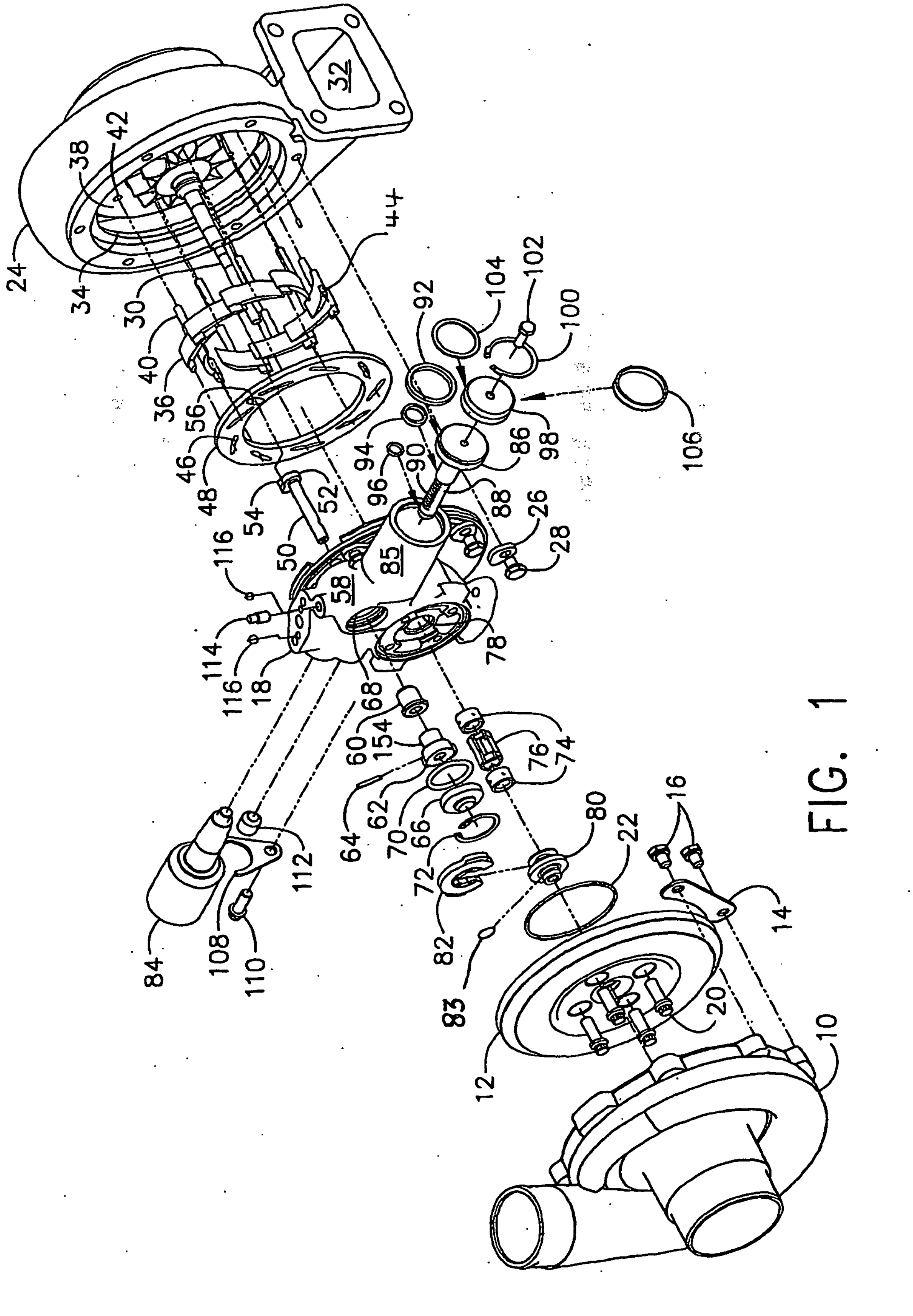
un deuxième conduit communicant avec un deuxième côté du piston et communiquant avec le troisième orifice quand la queue de soupape est à la première position et avec le deuxième orifice quand la queue de soupape est à la deuxième position ; et

une came sur le bras de manivelle s'engageant en fonctionnement avec le ressort de rappel.

6. Turbocompresseur à géométrie variable selon la revendication 1, dans lequel les encoches d'actionnement (46) sont aveugles et comprennent en outre :

un canal annulaire aménagé dans le carter central accueillant étroitement la bague d'union ; et

un moyen pour alimenter la pression d'air au canal pour forcer la bague d'union en contact étroit avec la deuxième surface des ailettes.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84
108
110
112

FIG. 1

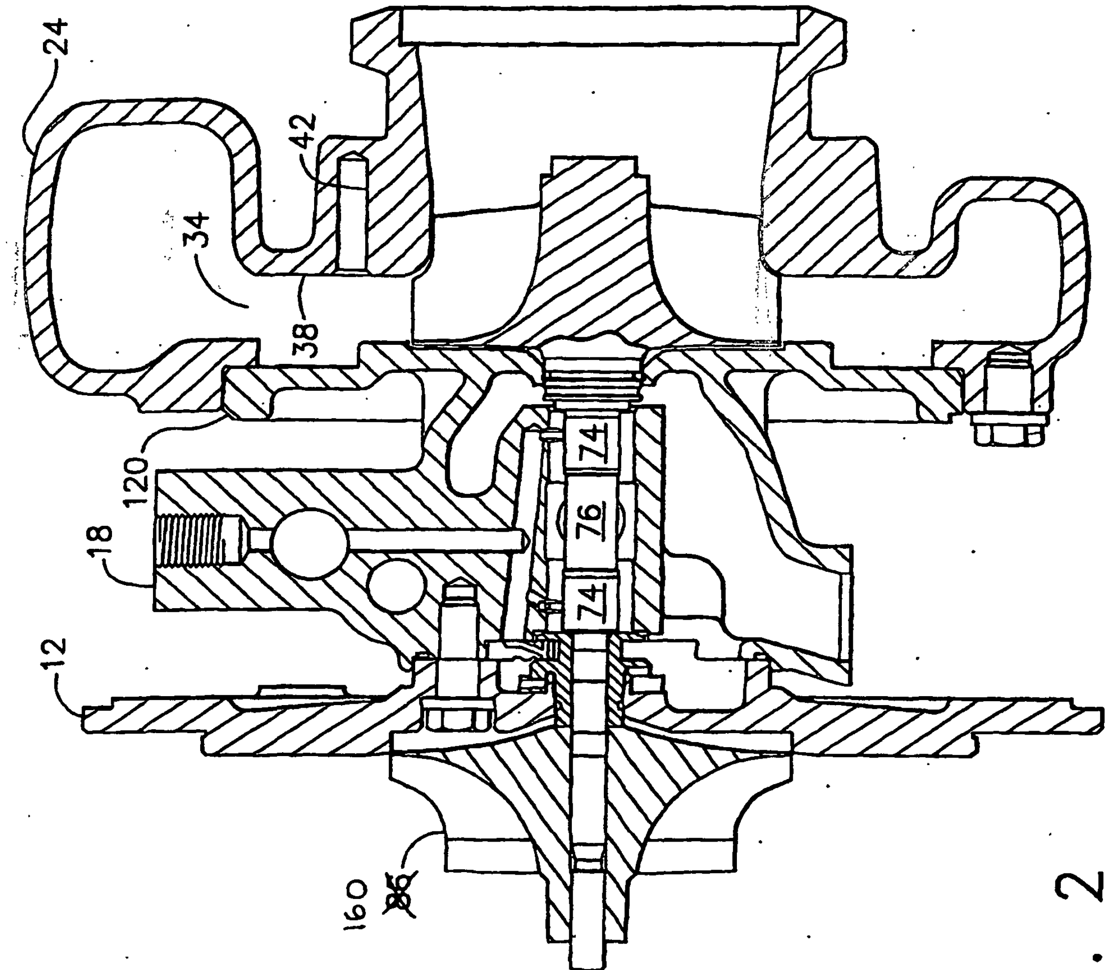


FIG. 2

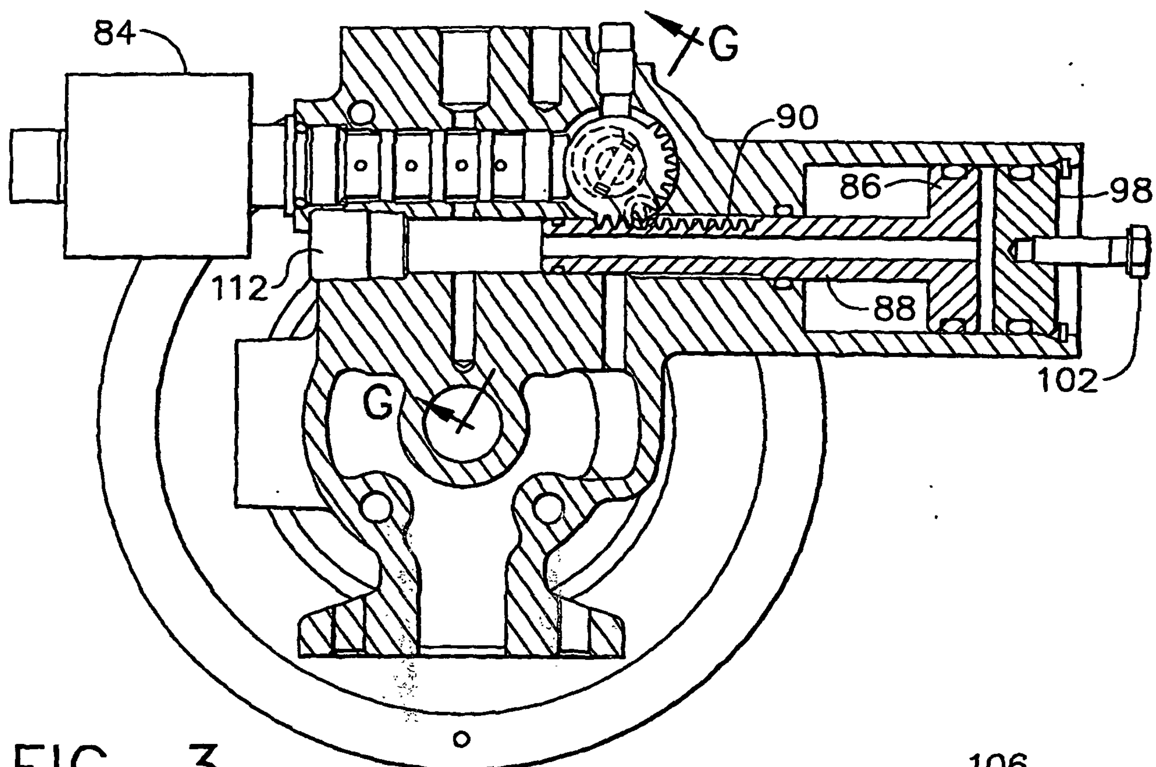


FIG. 3

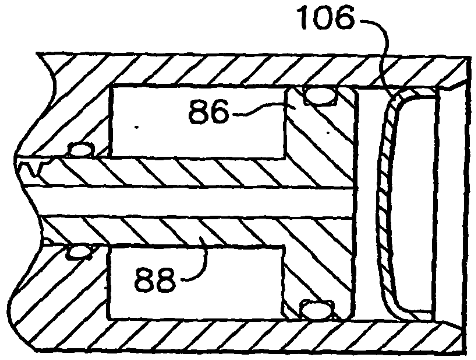


FIG. 4

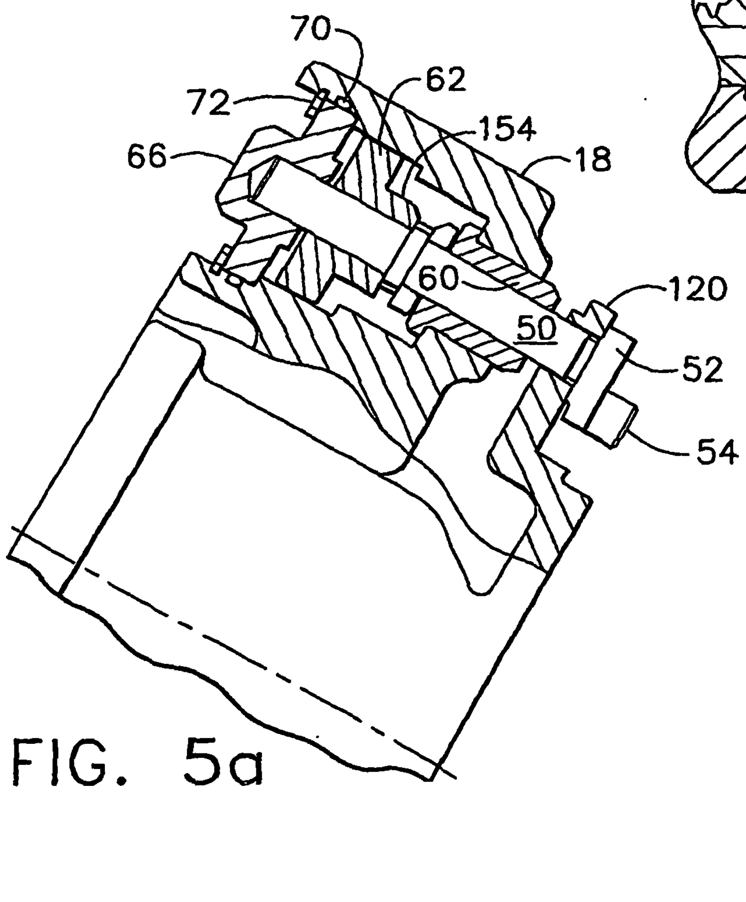


FIG. 5a

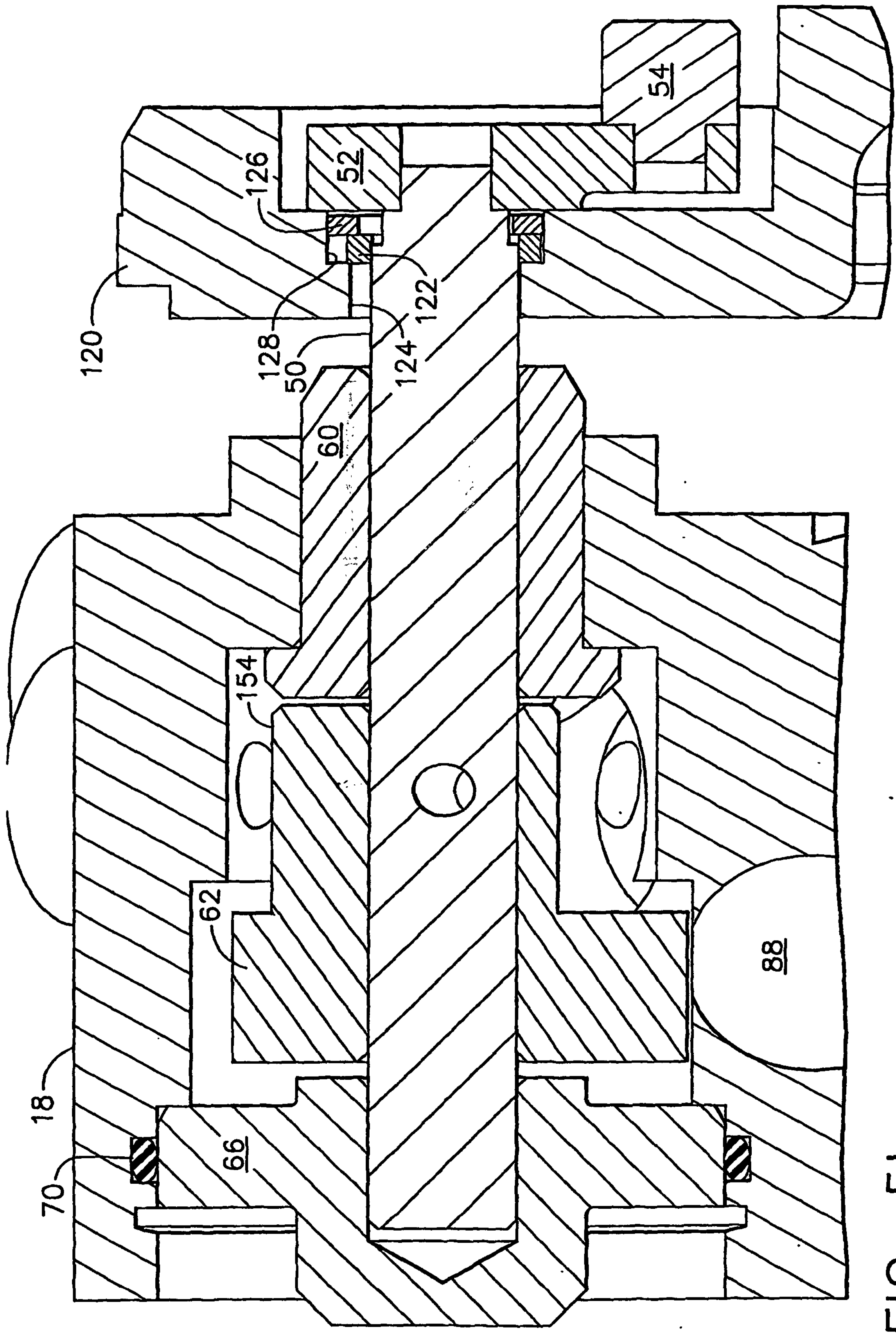


FIG. 5b

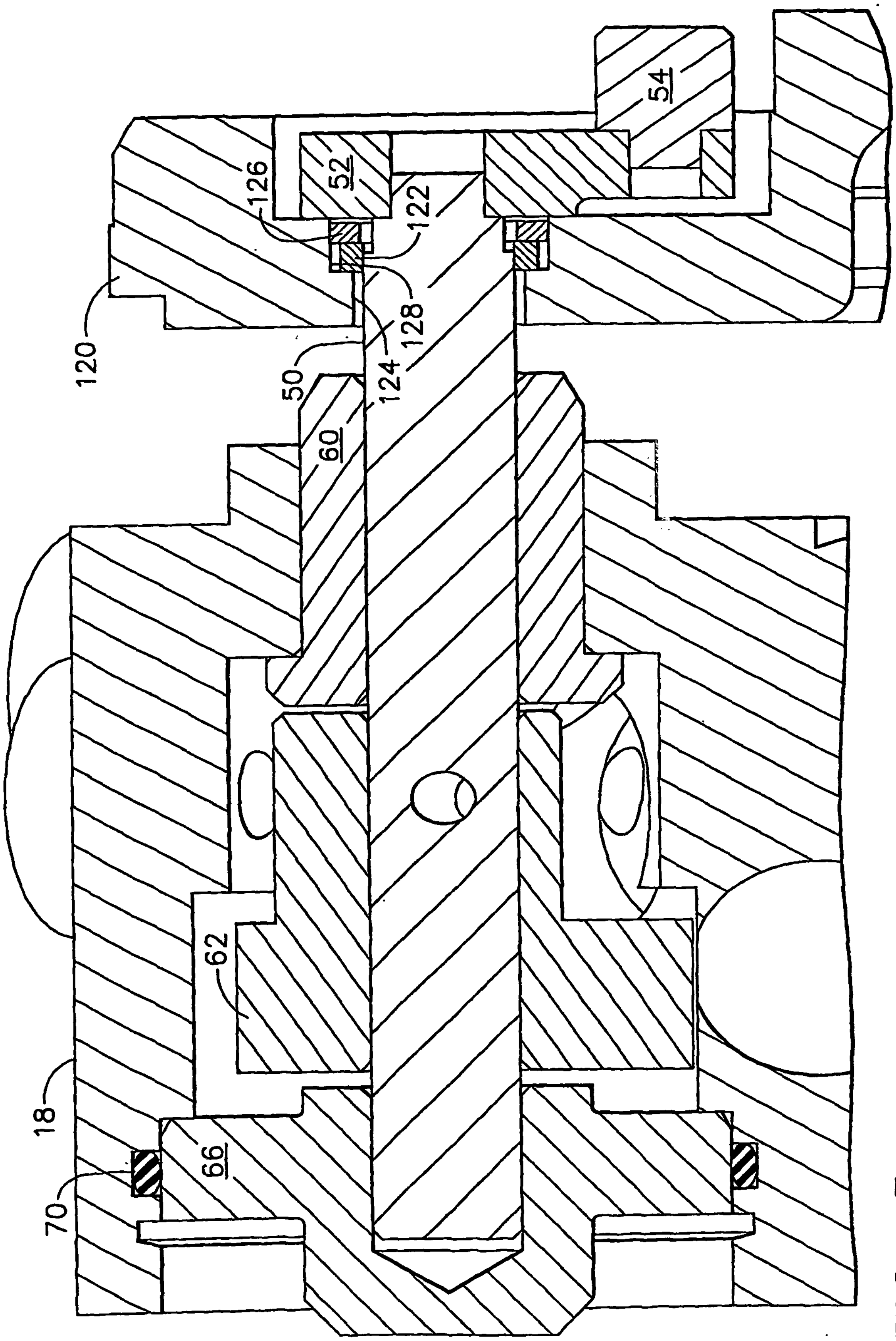


FIG. 5c

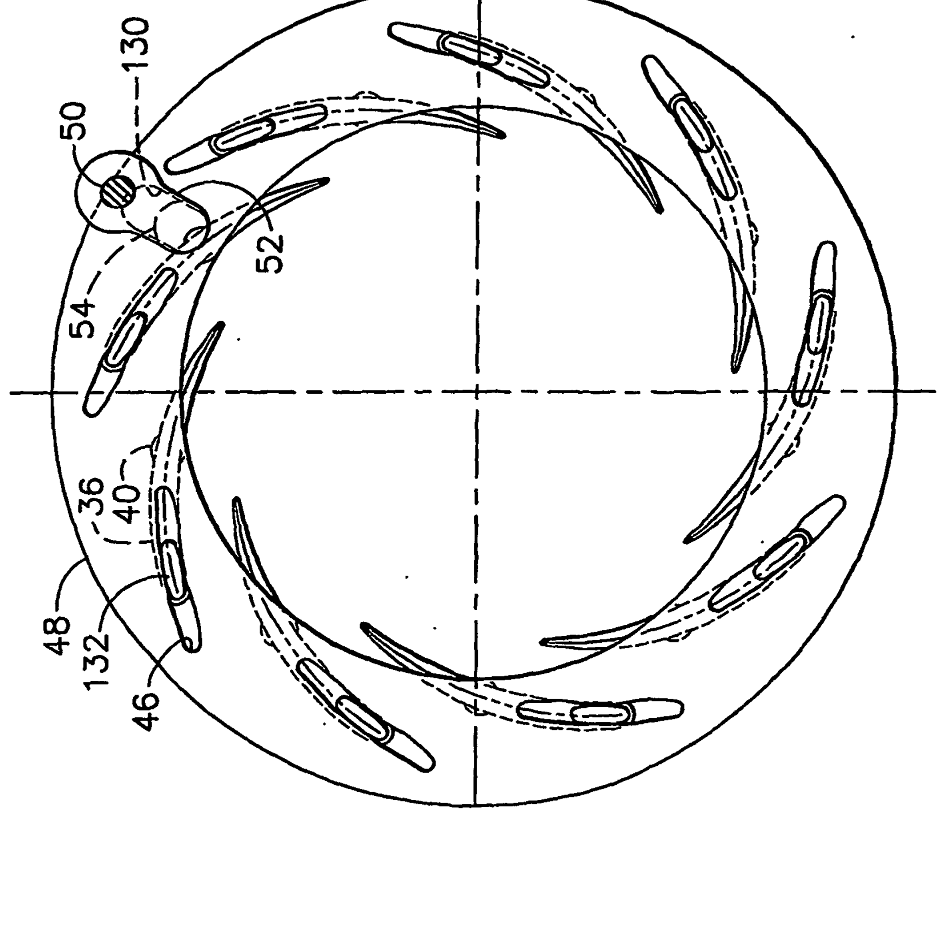


FIG. 6a

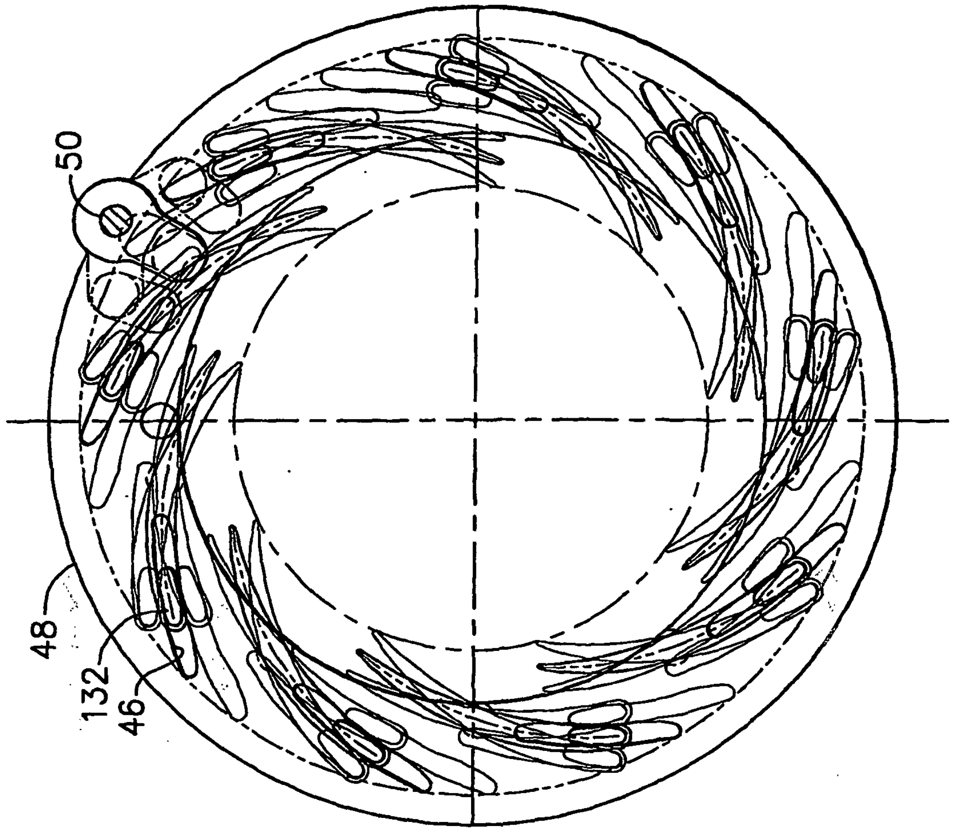


FIG. 6b

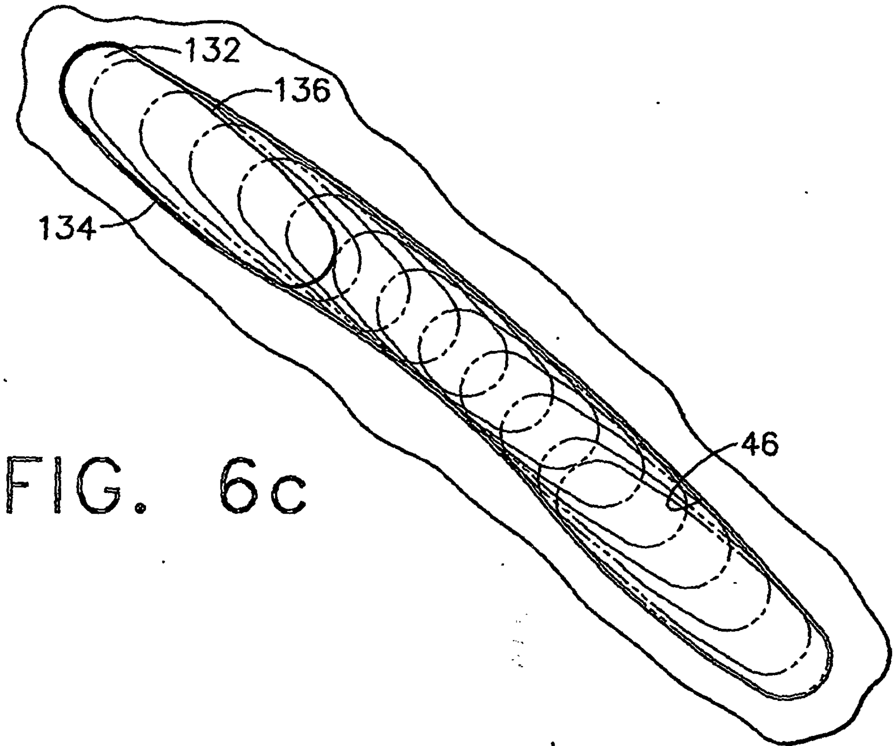


FIG. 6c

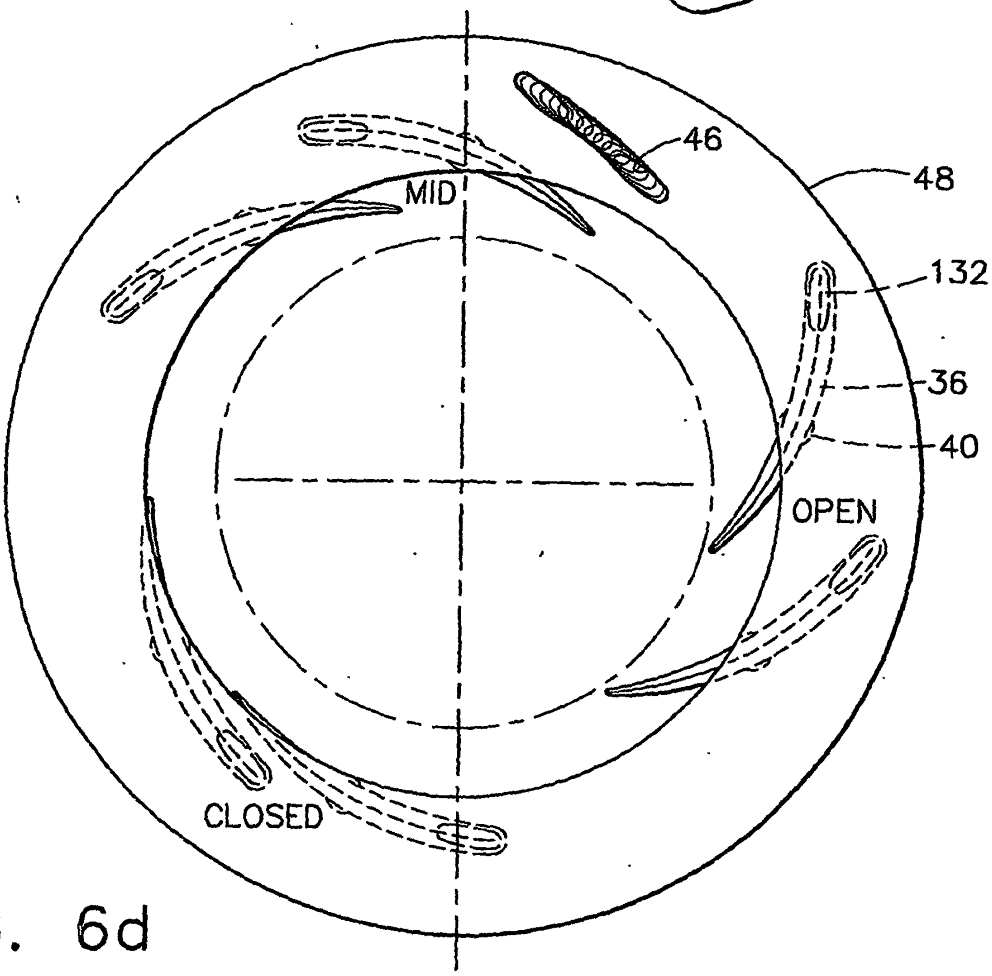


FIG. 6d

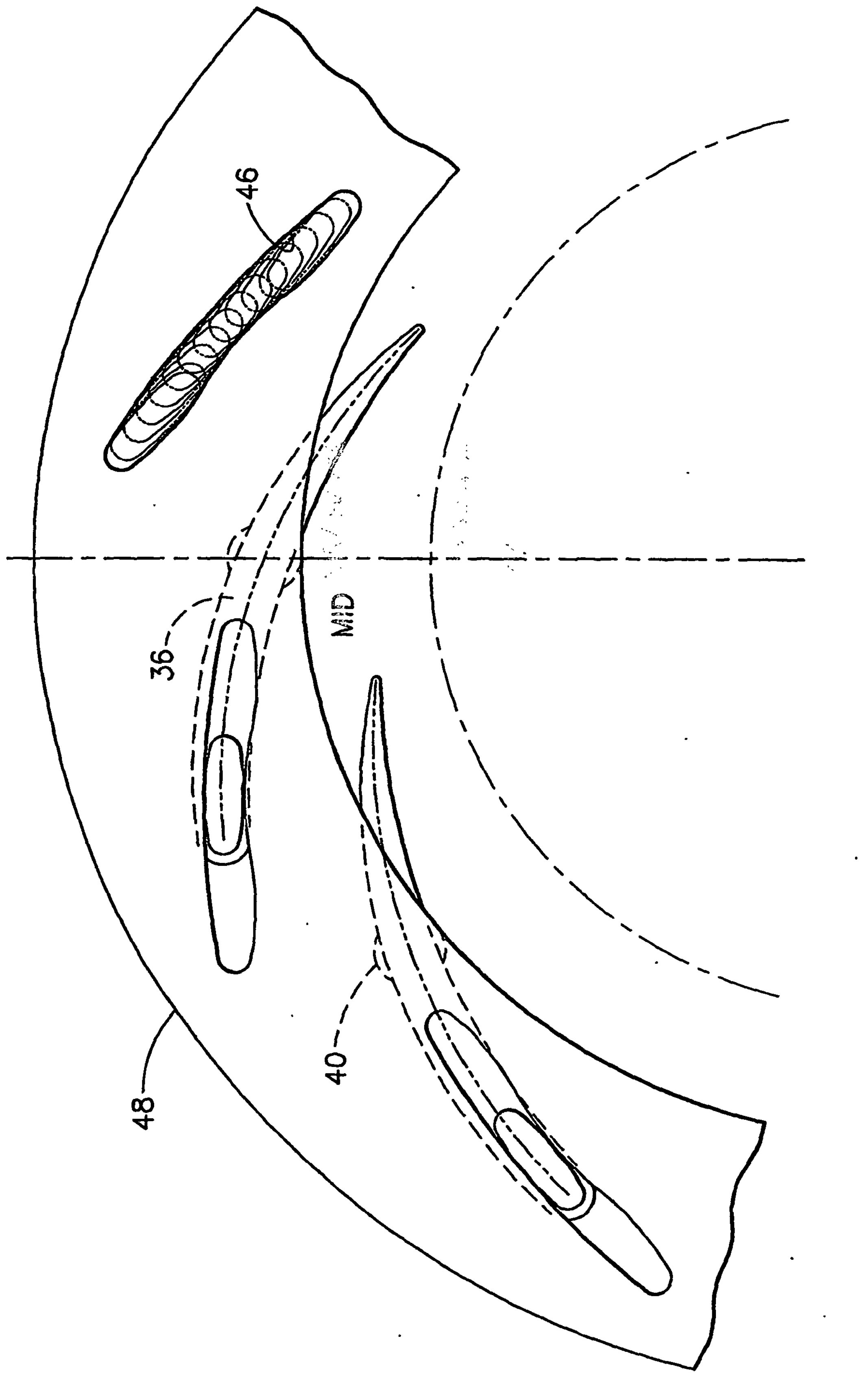


FIG. 6e

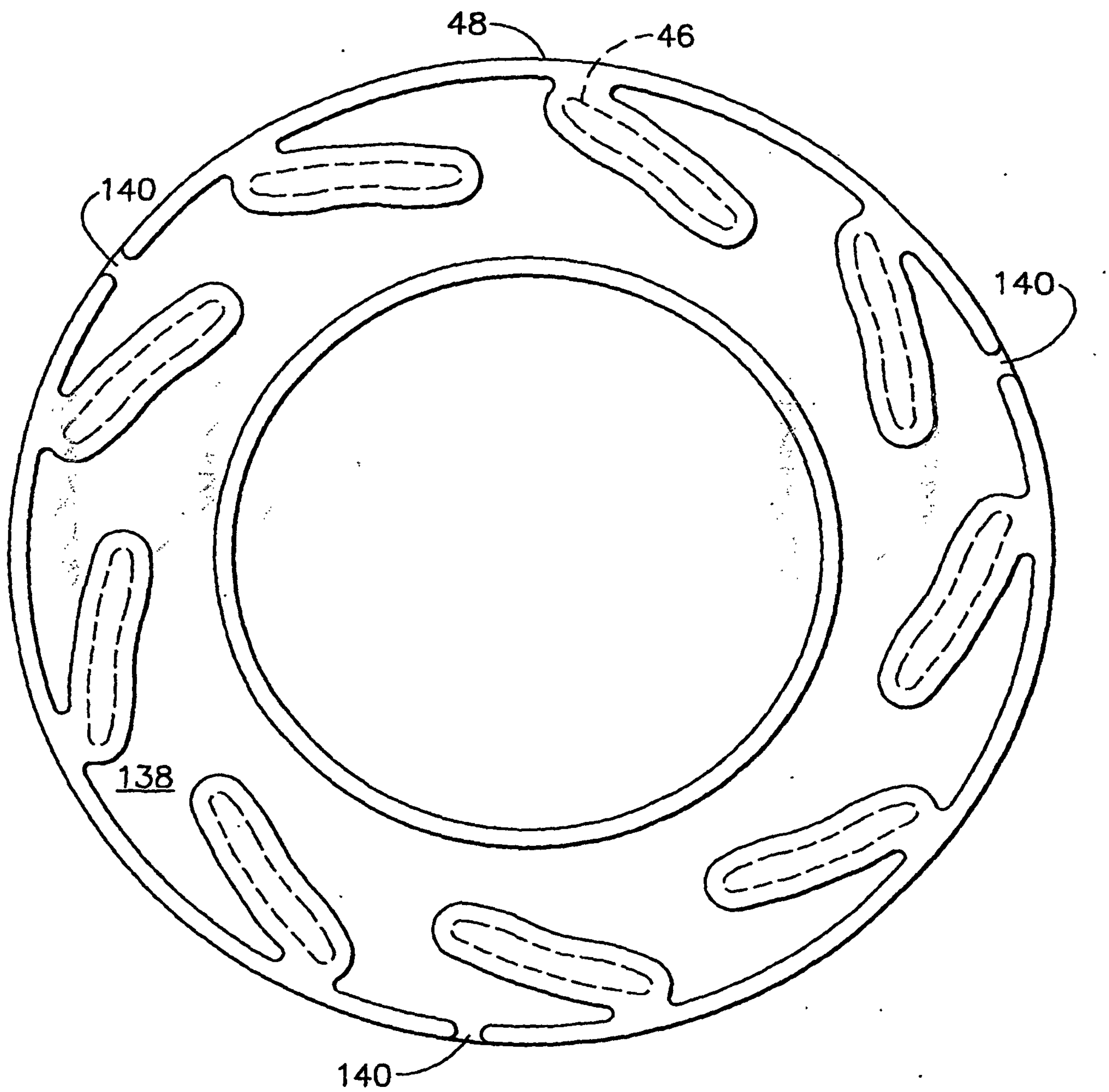
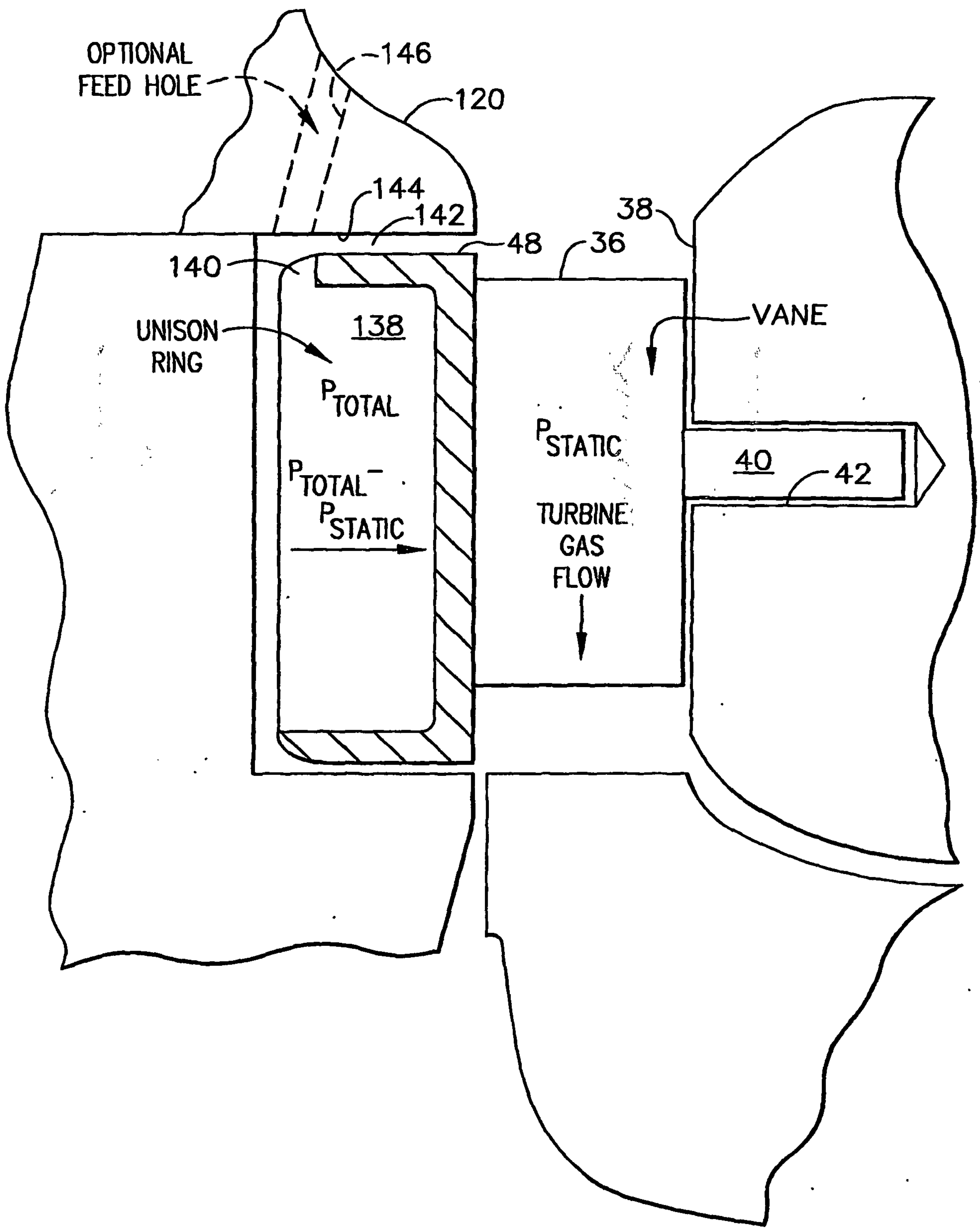


FIG. 7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138
UNISON
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VANE
P TOTAL
P STATIC
40
42
P TOTAL -
P STATIC
TURBINE
GAS
FLOW

FIG. 8

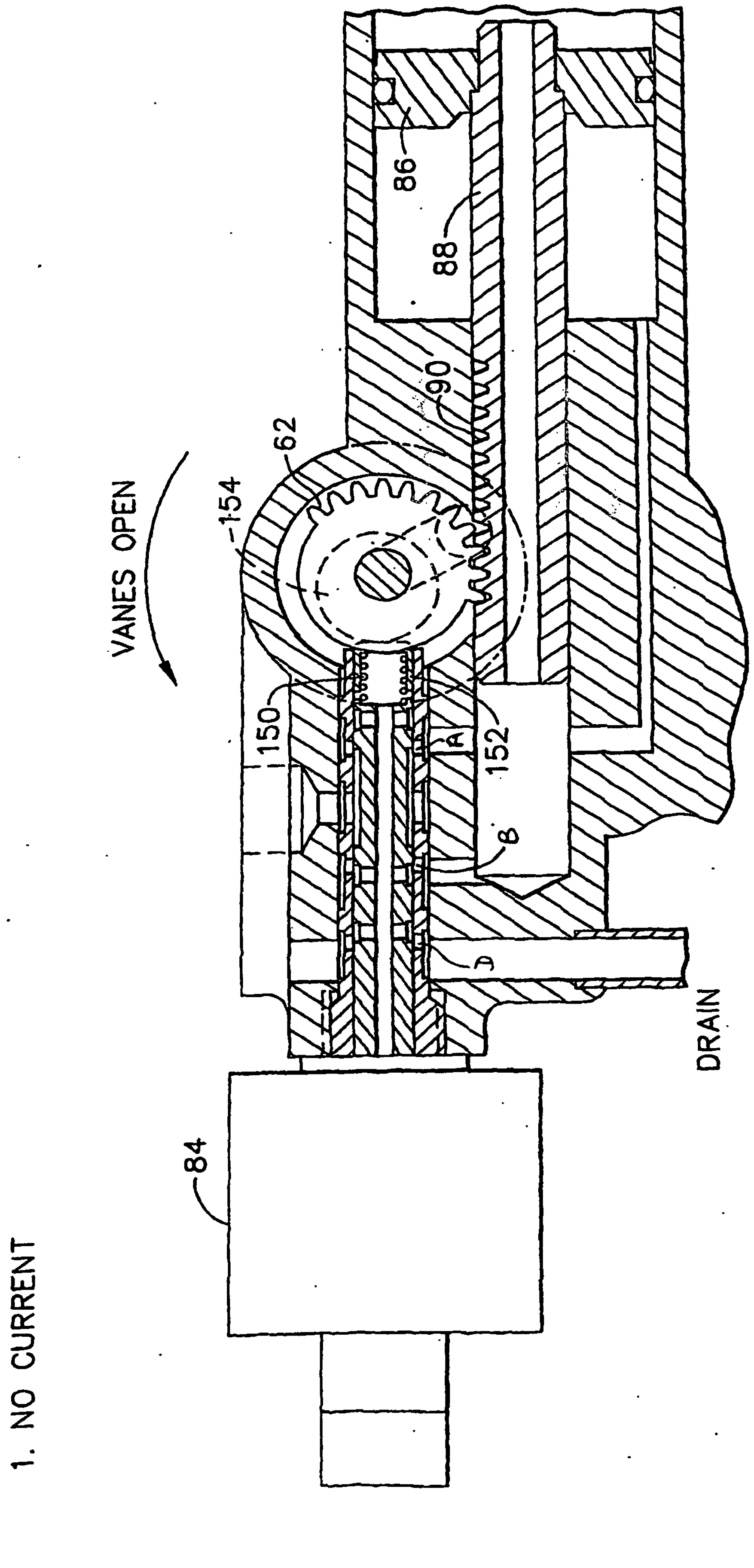

FIG. 9a

2. LOW CURRENT IN SOLENOID

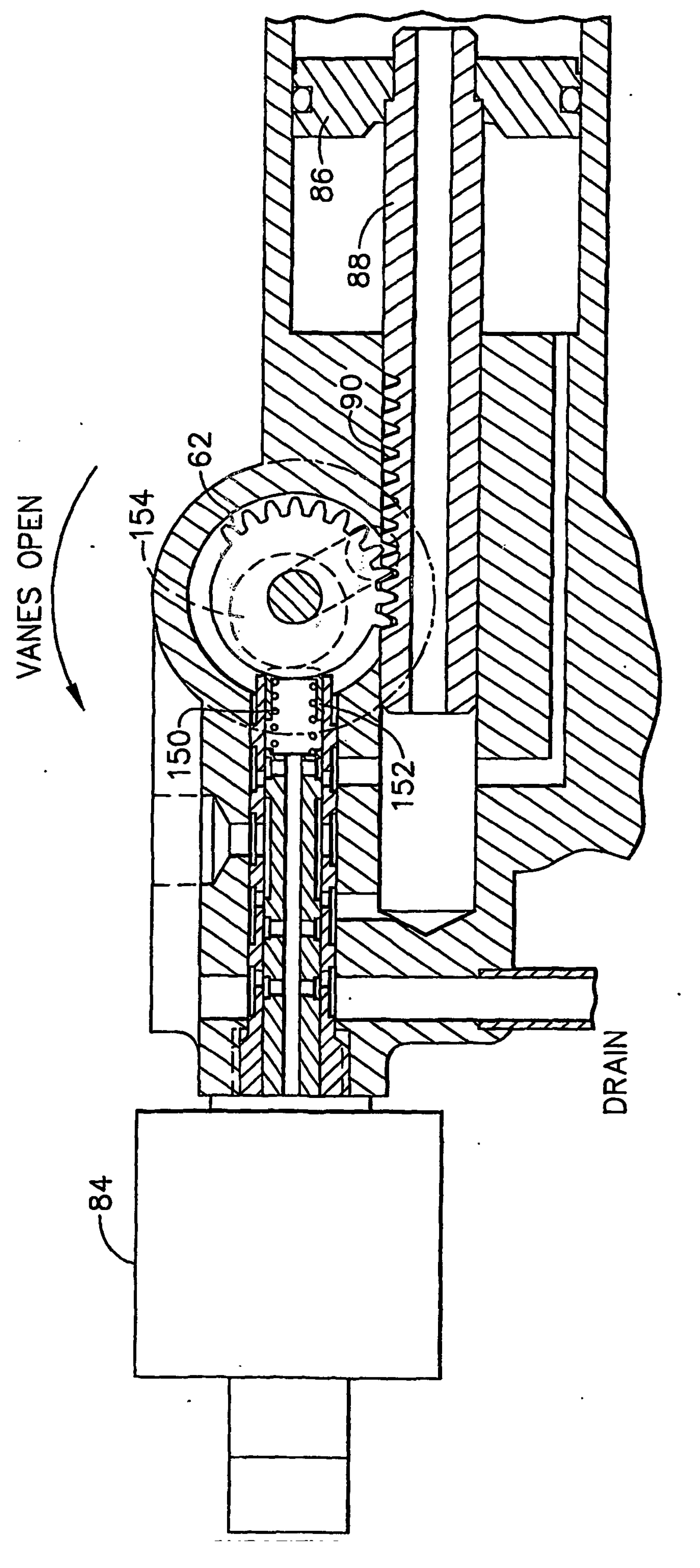

FIG. 9b

3. BALANCED STATE LOW CURRENT

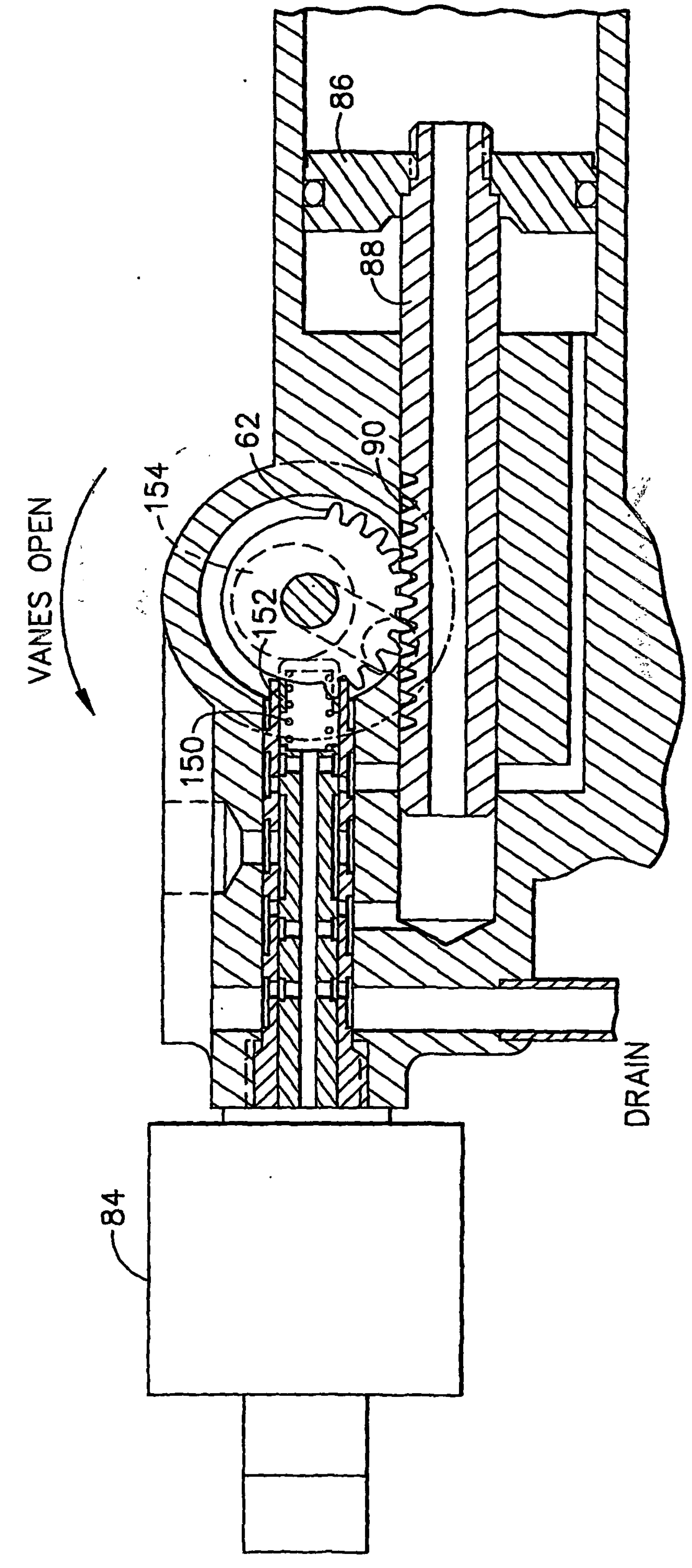

FIG. 9c

4. CURRENT INCREASED AGAIN

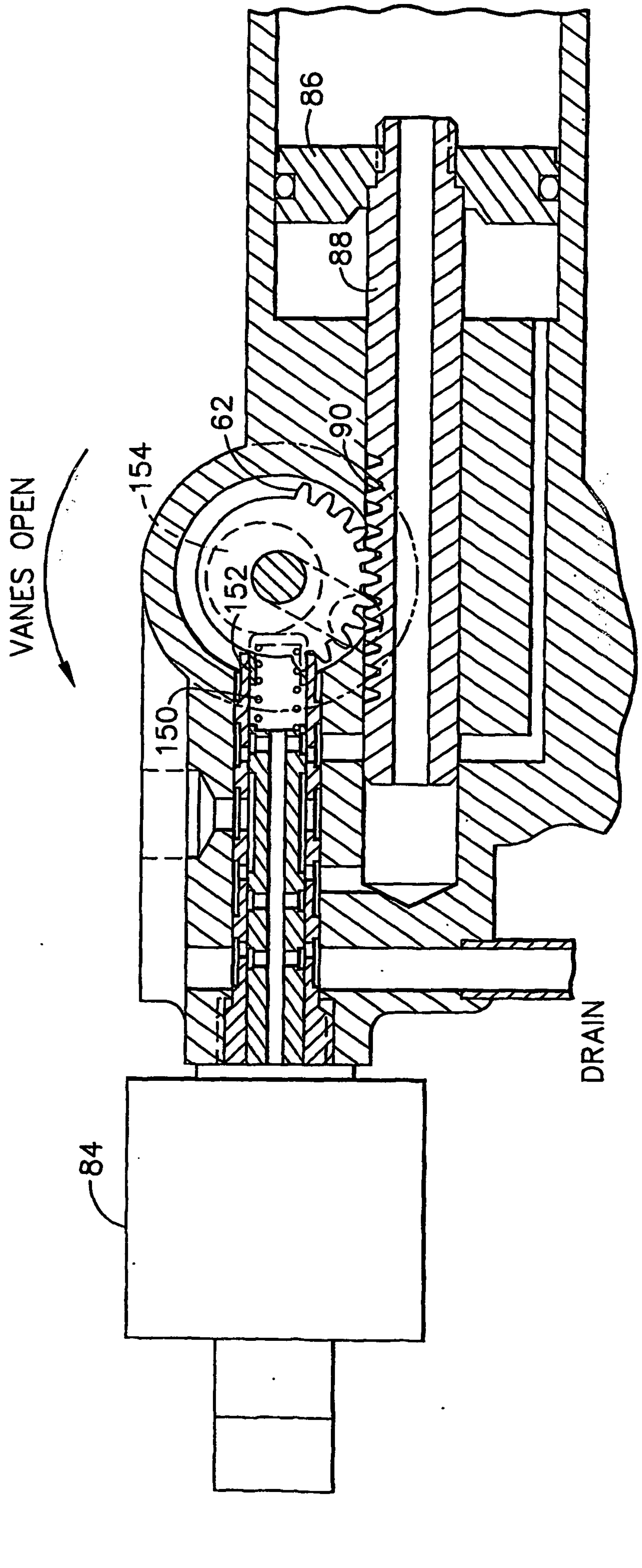

FIG. 9d

5. BALANCED STATE HIGH CURRENT

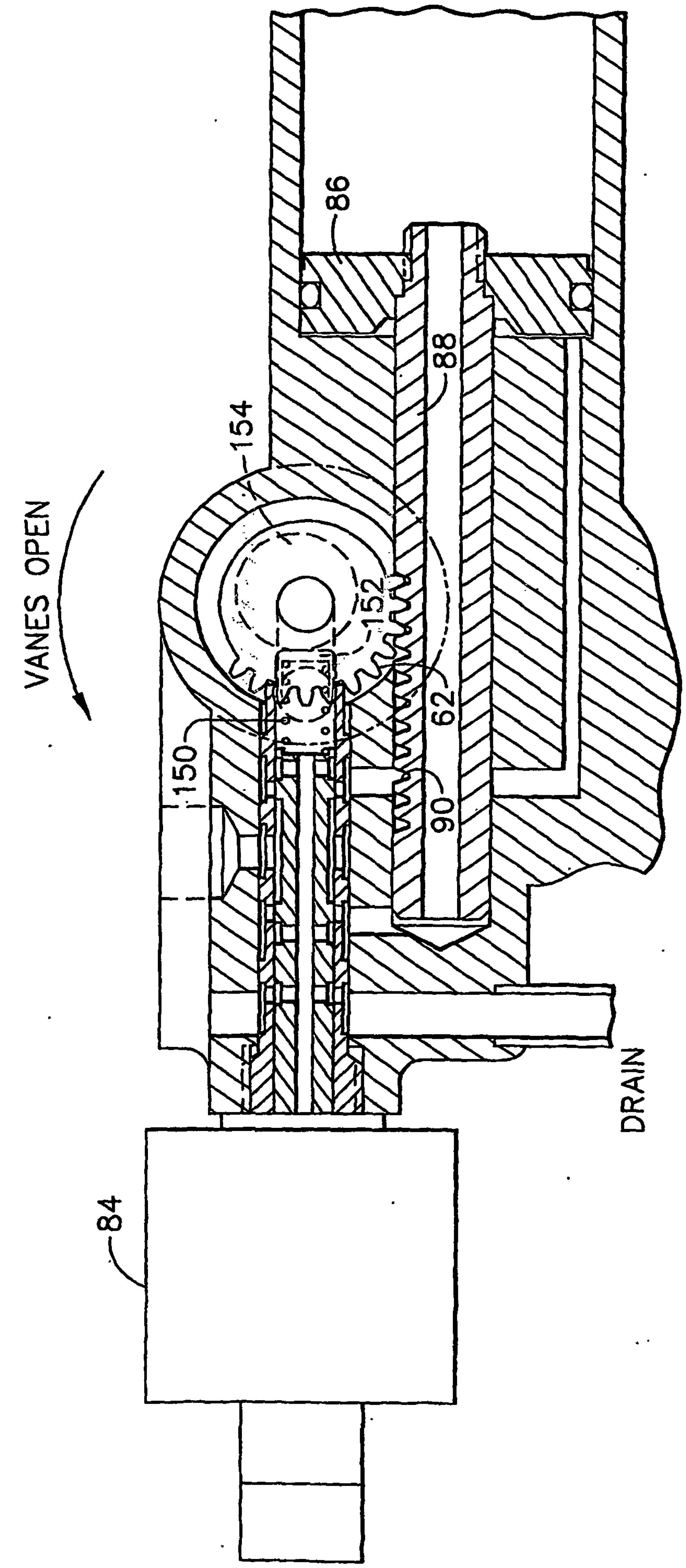

FIG. 9e