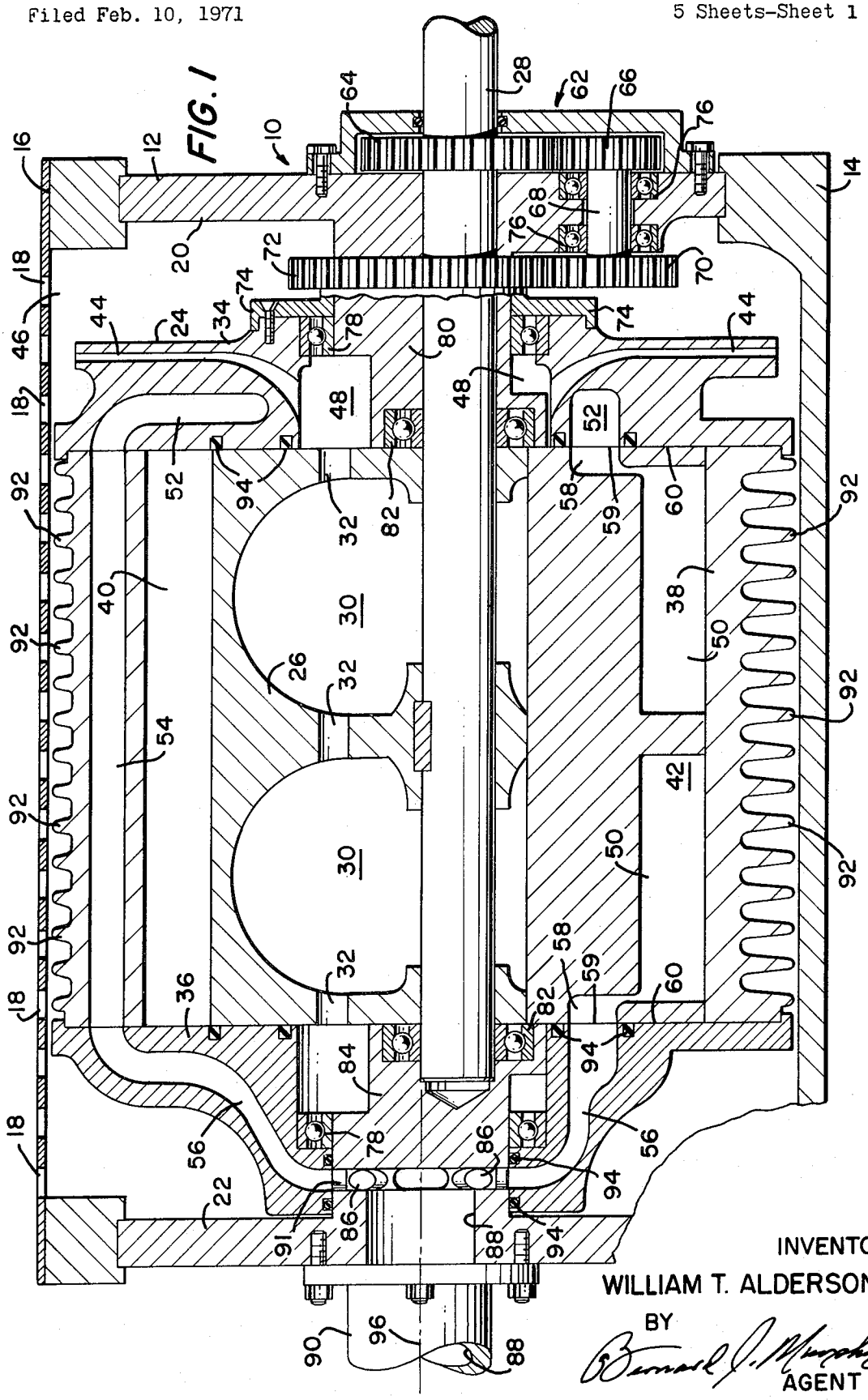
June 20, 1972 W. T. ALDERSON 3,671,146

FLUID ENERGY MACHINE

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FIG. 1



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FIG. 2

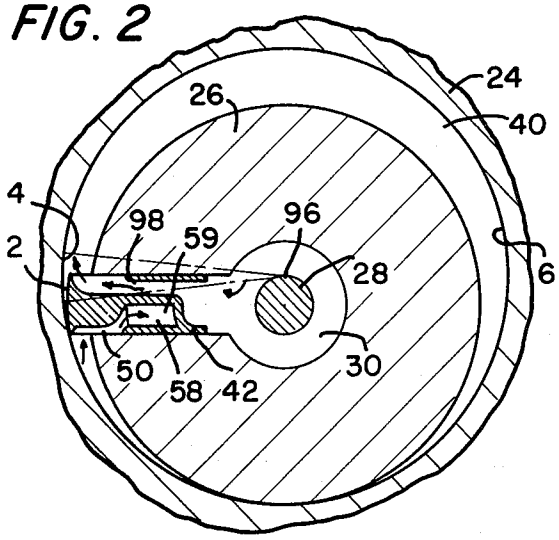


FIG. 3C

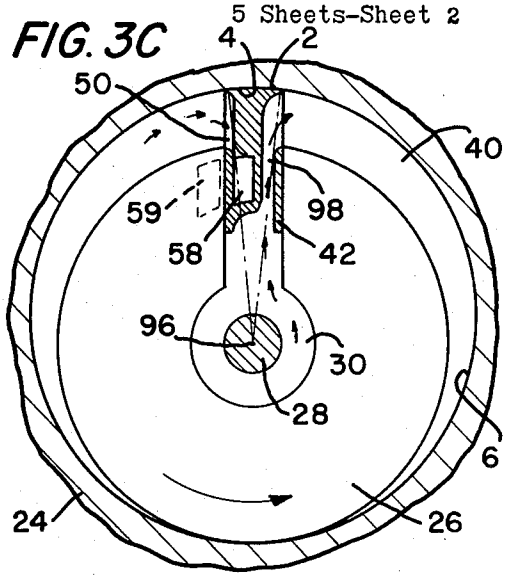
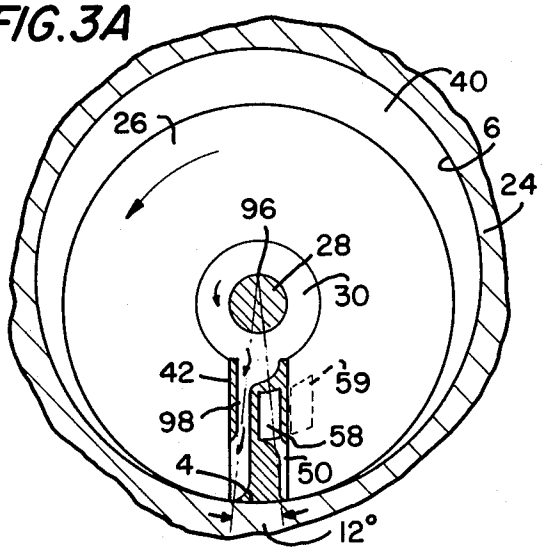


FIG. 3A



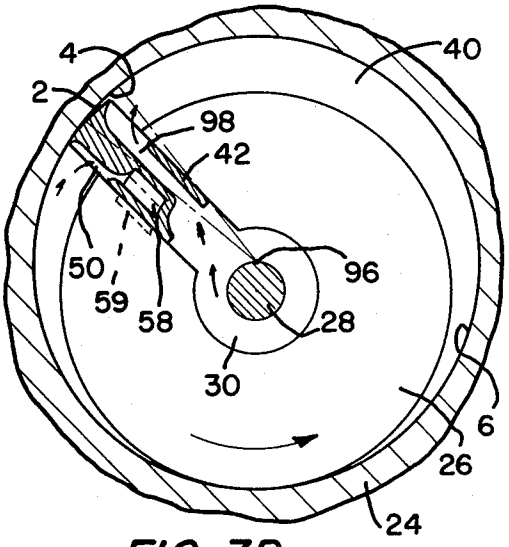


FIG. 3D

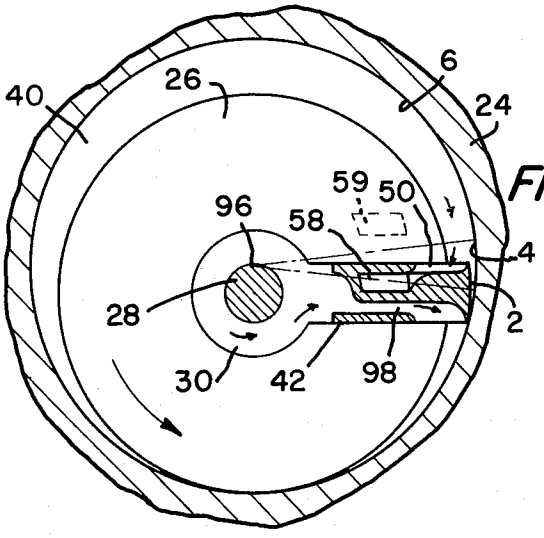


FIG. 3B

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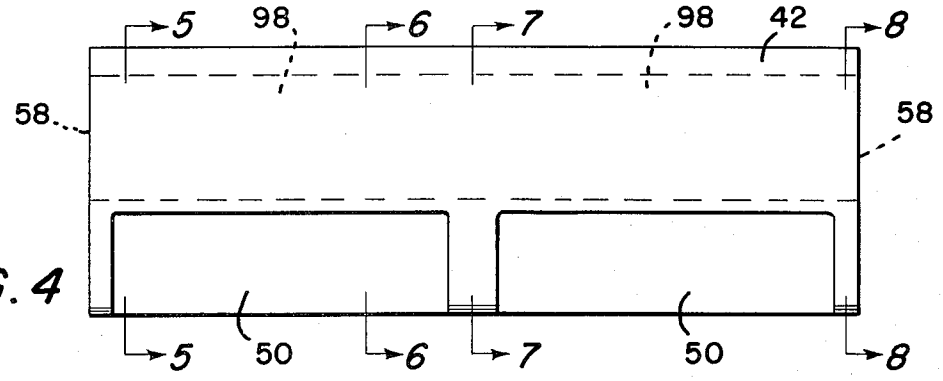


FIG. 4

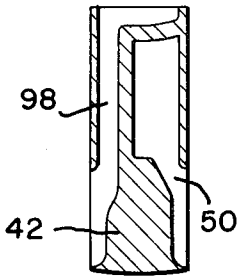


FIG. 5

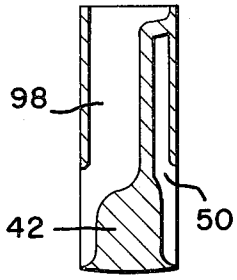


FIG. 6

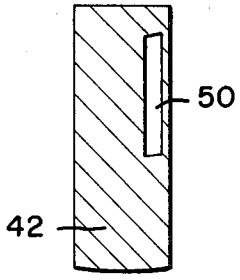


FIG. 7

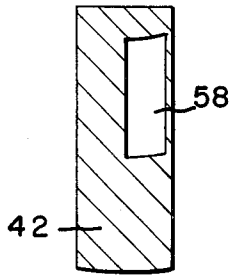


FIG. 8

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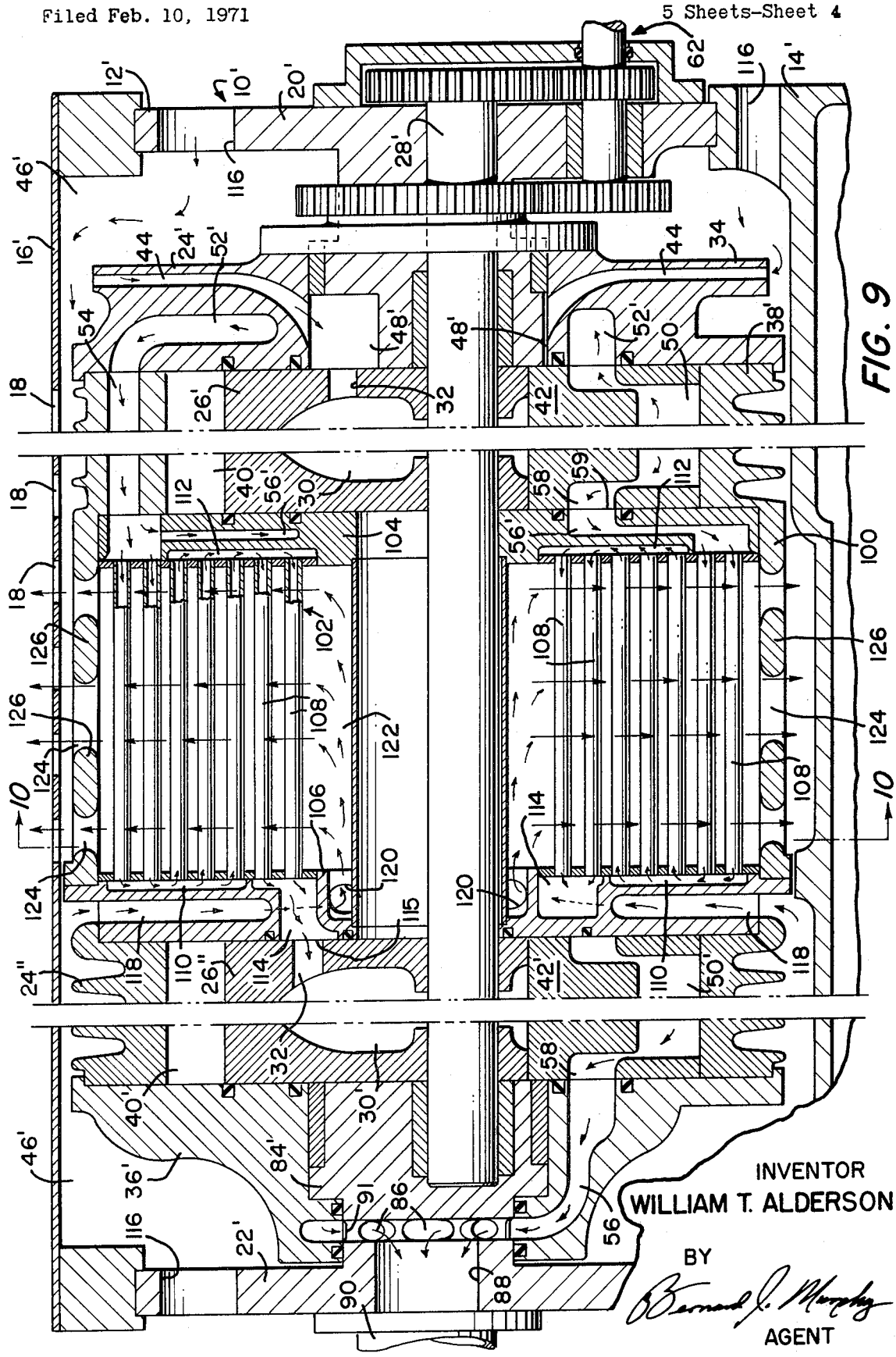


FIG. 9

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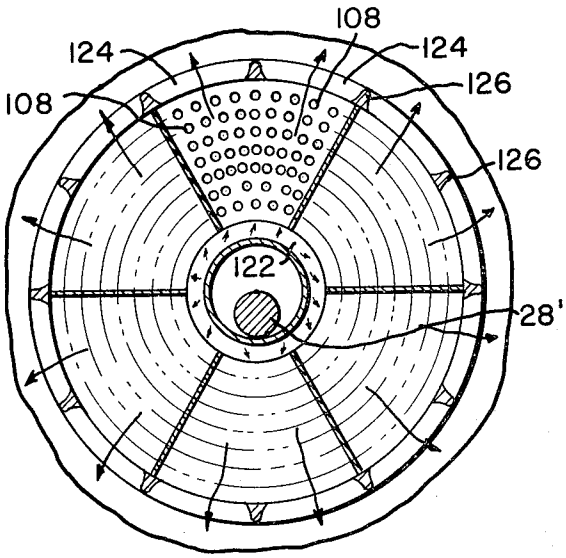


FIG. 10

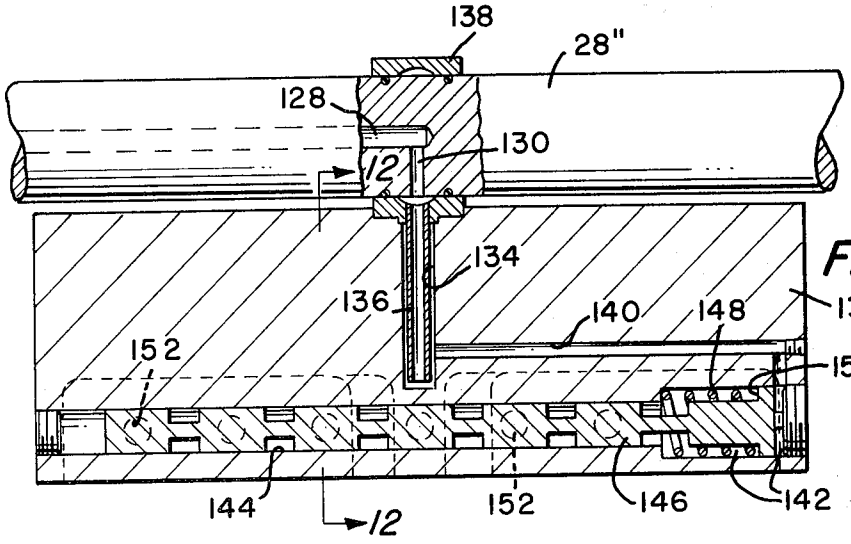


FIG. 11

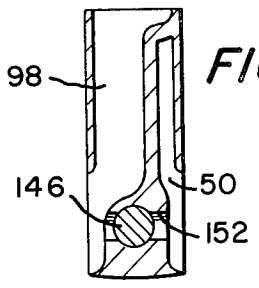


FIG. 12

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3,671,146

FLUID ENERGY MACHINE

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Int. Cl. F01c 1/00; F03c 3/100; F04c 17/00
U.S. Cl. 417—243 21 Claims

ABSTRACT OF THE DISCLOSURE

A gas compressor, of the sliding vane-type, having at least one vane slidably mounted in a rotor. The rotor, is rotatable within a rotary cylinder on an axis offset from the cylinder axis. The cylinder and rotor are in synchronism, that is, they rotate at the same angular velocity, and the vane is slidably movable therebetween. The vane is channeled, and cooperates with inlet and outlet cylinder ports for admission and discharge of the gas being compressed.

The invention pertains to fluid energy machines such as gas compressors, fluid pumps, air motors, internal combustion engines, and the like, which receive fluid to energize same, or receive energized fluid, and in particular to such machines having means, such as a sliding vane, movably disposed within a cylindrical chamber for sealing between chamber inlet and outlet ports and for conveying fluid between such ports.

Machines of the type noted, especially of the vane type, are limited by considerations of practical vane tip speeds, high friction loss, and loading and unloading difficulties.

It is an object of this invention to teach an improved fluid energy machine of a structure which avoids the limitations known in such machines in the prior art.

Another object of this invention is to teach an improved fluid energy machine which substantially reduces vane tip speed relative to components in contact with the vane.

Another object of this invention is to teach a fluid energy machine comprising means defining a chamber having inlet port means and outlet port means spaced therefrom to permit a conveying of fluid into and out of the chamber; first means, movably disposed within said chamber, effective both for fluid sealing said inlet port means from said outlet port means and for conveying chamber-admitted fluid between said port means; second means coupled to said first means for enabling movement of said first means, cyclically, within said chamber; and third means intercoupling said second means and said chamber for enabling movement of said chamber only in synchronism with said first means; and wherein said first means includes means movable therewith which, in response to movement of said first means within said chamber, engages a surface of said chamber to effect said fluid sealing; and said surface engaging means and said surface effect a sliding and reciprocative relative movement therebetween, with each cycle of cyclical movement.

A feature of this invention comprises a fluid energy machine, according to one embodiment thereof, comprising a gas compressor of the sliding vane type having at least one vane slidably mounted in a rotor. The rotor is rotatable within a rotatable cylinder, the two being in synchronism, that is, rotating at the same angular velocity, the vane and cylinder effecting slidable movement therebetween. The vane, of novel configuration, is channeled to cooperate with inlet and outlet ports in the cylinder for admitting gas into, and for venting gas from the machine.

Further objects and features of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying figures, in which:

FIG. 1 is an axial, cross-sectional view of a gas compressor of the sliding vane type embodying the inventive structure;

FIG. 2 is a cross-sectional view, and FIGS. 3*a* through 3*b* are substantially diagrammatical views of the rotor, vane, and a fragment of a cylinder showing gas inlet and outlet flow relationships in differing angular positionings;

FIG. 4 is a front (i.e., the "pressure" side) elevation view of the vane incorporated in the gas compressor embodiment of the foregoing figures, and

FIGS. 5 through 8 are sectional views taken along sections 5—5, 6—6, 7—7, and 8—8 of FIG. 4, showing the gas inlet and outlet channeling of the vane;

FIG. 9 is an axial, cross-sectional view of a two-stage compressor, according to my invention, with an integral, rotatable heat exchanger;

FIG. 10 is a cross-sectional view of the heat exchanger of the FIG. 9 embodiment, taken along section 10—10 of FIG. 9, showing the tubes and fluid-moving blades about the outer periphery of the exchanger housing;

FIG. 11 is a cross-sectional view in elevation of a novel, modified vane for use in the machine of my invention for unloading of the machine;

FIG. 12 is a cross-sectional view, taken along section 12—12 of FIG. 11, illustrating the unloading cross ports formed in the modified vane.

As shown in FIG. 1, my novel compressor 10 comprises a housing 12 formed of a cradle 14 in the lower end of the machine which may also function as an oil reservoir, and a surmounting cover 16. Cover 16 has a number of perforations 18 formed therein to accommodate the admittance and venting of air therethrough. Cover 16 and cradle 14 are closed at either ends thereof by closures 20 and 22 to define a whole unit.

A cylinder 24 is enclosed within the housing and, in turn, confines a rotor 26 therewithin. The rotor is keyed to a rotor shaft 28 and has cored areas 30 formed therewithin for conducting gas therethrough. A number of passageways 32 are also formed in the rotor to communicate with the areas 30. The cylinder 24 is defined by an end panel 34 and another end panel 36 which are joined to either ends of a cylindrical shell 38. Shell 38 and panels 34 and 36 cooperatively define a chamber 40 therewithin for the conduct of air therethrough by the vane 42. Vane 42 is slidably mounted in the rotor 26, according to practices well known in the prior art.

A plurality of radially-extending inlet passageways 44 are formed in end panel 34 and communicate, at one end thereof, with an inlet plenum 46 (defined by shell 38 and panels 34 and 36) and at the other end thereof with a first annular chamber 48 formed by an inside diameter of panel 34. The radial disposition of passageways 44, in cooperation with the rotation of the cylinder 24, causes the passageways 44 to function as centrifugal separators which prohibit the ingestion of particulate and other foreign matter by the machine. Vane 42, of novel configuration, has an outlet conduit 50 formed thereacross and therewithin which communicates at two ends with a second annular chamber 52 formed within end panel 34. Chamber 52 communicates, via one opening therein, with an axial passageway 54 formed through shell 38. This passageway 54, in turn, communicates with a first passage 56 formed in the panel 36.

The arrangement of my fluid energy machine, as exemplified by this compressor, is such that conduit exits 58 in the two ends of outlet conduit 50 communicate with cylinder ports 59, which open on chamber 52 and a second passage 56, only once during each cycle of rotation of the machine. More of this novel arrangement is explained in the ensuing text.

The rotor **26** has formed therein the one slot **60** within which the vane **42** slides with each rotation cycle. A gear train and stub shaft assembly **62** provides for the rotation of cylinder **24** and the rotor **26**. The assembly comprises a spur gear **64** which is fixed to shaft **28** and which meshes with a first pinion gear **66**. Gear **66** is joined, by means of a stub shaft **68**, to a second pinion gear **70**. Gear **70** meshes with a power gear **72** which in turn causes rotation of cylinder **24**. Gear **72** is bolted to cylinder end panel **34** by means of a ring plate **74** to effect rotation of the latter.

The ratio between gears **64** and **66** is the same as between gears **72** and **70**. Accordingly, both the rotor **26** and the cylinder **24** are caused to rotate at the same, angular velocity. Roller element-type bearings **76** support the stub shaft **68** in closure **20**, and bearings **78** of the roller element type support the cylinder **24** at either ends thereof, relative to shaft **28**. The inner race of one bearing **78** is disposed about a first bearing block **80**, which is an inwardly-extending portion of closure **20**. A bearing **82** of the roller-type supports rotor shaft **28** within a recess formed in a second bearing block **84**, which is an inwardly-extending portion of closure **22**, block **78** also supporting thereupon the second bearing **78**.

Vent ports **86** are formed in block **84** and open at one end on a vent channel **88** defined within closure **22**. A vent pipe **90** is bolted to closure **22** and extends channel **88**, to exhaust the fluid product from the machine. The ports **86** open at the other end on an annular recess **91** which, in turn, communicates with the passages **56**.

The cylinder is defined with a multiplicity of heat exchange radial vanes **92**, and O-rings **94** are used throughout the machine to fluid-seal between relatively movable or separable components.

As can be seen from the relative mounting of rotor **26** and cylinder **24**, the rotor **26** has an axis (defined by shaft **28**) parallel to and distinct from the axis **96** of cylinder **24**. Accordingly, with each cycle of rotation, vane **42** will be caused to slide inwardly and outwardly, relative to the rotor **26**, advancing and compressing the fluid disposed therebefore it for exhaust thereof from the cylinder **24**.

Vane **24** is of nonconventional configuration in that, for instance, it is especially broad (i.e., "thick") and has a plurality of conduits formed therein. It is shown in FIG. 1 that vane **42** has an outlet conduit **50** formed therein for admitting fluid therethrough from the cylinder **24** for venting from the machine. As FIG. 2 illustrates the vane further has inlet conduits **98** (only one of which is shown) for admitting fluid (from the inlet plenum **46**, passageways **44**, and chamber **48**; FIG. 1) from the cored areas **30**, through these conduits **98**, and into chamber **40**. The sequence of positionings shown in FIG. 2 and FIGS. 3A through 3D illustrates how it is that, with the cylinder **24** and rotor **26** having a common, angular velocity, but having different dimensions, conduit exit **58** is aligned with the cylinder ports **59** for only one brief time during each cycle of the rotation, and cylinder ports **59** are sealed off by rotor **26** through the remainder of each cycle. So also it can be seen that, for half of the cycle, a given surface area of cylinder **24** leads the vane **42** in the cyclical movement, and lags the vane during the other half of the cyclical movement. The benefit from this feature is a limitation of the incident friction which would normally obtain in the conventional vane-type compressor. As can be appreciated from study of FIG. 2 and FIGS. 3A through 3D, the vane **42** defines, at the cylinder-engaging end thereof, an arcuately surfaced pad **2** the curvature of which corresponds with that of the surface of the rotor and defines a maximum interface with the surface of the cylinder for only two instants during a cycle of movement.

Pad **2**, as those skilled in this art will appreciate, could be configured with an arcuate surface exactly corresponding with that of the surface of the cylinder to define, thereby, a total interface with the cylinder surface during

the aforementioned two instants. However, this would yield no greater efficiency from the machine and, on the contrary, would lessen the amount of frictional relief, for the leading and trailing pad surfaces, which my embodiment teaches. During those two instants, pad **2** engages the cylinder surface **6** with an area thereof intermediate of the pad leading and trailing surfaces, the one or the other of these surfaces gradually coming into engagement with the cylinder surface **6** thereafter.

The "thick" dimension of pad **2** corresponds to an arcuate segment **4** of the surface **6** of the cylinder **24**, and segment **4** and pad **2** effect a maximum engagement only when the vane **42** is in the instantaneous positionings shown in FIGS. 3A and 3C. At all other times pad **2** engages the surface **6** of the cylinder with either its leading portion or its trailing portion; "leading" and "trailing," as used herein, take their meaning from the counterclockwise rotation of the cylinder **24** and rotor **26** contemplated for this embodiment and signified by the arrows. Further, it will be noted that the leading or trailing portion of the vane pad **2** engages contiguous trailing or leading portions of segment **4**.

To accommodate for the conduits **50** and **98**, and the exits **58**, and assure adequate structural strength, my teaching is of a vane "thickness," such that corresponds with a cylinder segment **4**, of approximately twelve degrees of arc relative to axis **96**. It is considered ill-advised to fabricate such a vane having a "thickness" corresponding with a segment **4** of less than ten degrees of arc. Of course, though, the broad teaching of my invention can be otherwise practiced, markedly to reduce vane thickness. The embodiment depicted is preferred, but my invention contemplates a vane having only the conduits **50** formed therein. As the gas input is constant, and needs only to be admitted to the "rear," i.e. the trailing surface of the vane, gas input channeling for the vane, such as conduits **98**, can be dispensed with. Thus, wall "metal" for conduits **98** would not have to be provided and a thinner vane could be delayed.

Now then, considering the foregoing discussion of the engaging/disengaging of pad **2** and segment **4** surfaces and the "lead" and "lag" occurrences, it is to be seen that this machine of my invention is not subject to high vane tip speed wear, and the only movement between the tip, comprising the pad **2**, and the cylinder segment **4**, is one of rolling and sliding movement fore and aft, and with each cycle of movement even this movement engagement is borne alternately on different portions of the pad and the cylinder surfaces.

In FIG. 4 is illustrated in a front view (i.e. the "leading" or "pressure" side) the novel vane **42** which makes possible the admittance and venting of fluid into and from the machine. In the FIGS. 5 through 8 it will be seen that the inlet conduit **98** extends across the inner rear of the vane, from both ends of the vane (only one end thereof being shown) except for an intermediate portion thereof, as FIG. 7 shows, where the conduit is interrupted. Also the exhaust conduit **50** extends from both ends of the vane **42** and rises therewithin to open on two side openings or exits **58** at each end of the vane.

What has been explained thus far is the teaching of my invention as practiced in a single stage compressor arrangement. Clearly, my teaching can be just as readily applied to a two-stage compressor such as that illustrated in FIG. 9. In FIG. 9, a two-stage compressor **10'** comprises substantially two compressor stages, according to the FIG. 1 embodiment, coupled together with an integral heat exchanger therebetween. Numbers used for the indexing of parts shown in FIG. 9, which are similar to or correspond with numbers used in FIG. 1, are representative of same or similar components. The two stage compressor shown in FIG. 9, again, comprises a housing **12'** defined by a cradle **14'** and a cover **16'** which cover has a plurality of perforations **18** for admitting ambient air therethrough. The machine is unitized by end

wall-type closures 20' and 22' and has rotatable cylinders 24' and 24'' therewithin. In this embodiment, in that there are first and second stages of compression, there are the two cylinders and two rotors 26' and 26''. Both rotors are fixed to the rotor shaft 28' and also have similarly cored areas 30 and passageways 32 formed therewithin for admitting air into the respective rotors and from the cored areas to the vanes 42 and 42'. The cylinder 24' is comprised by a cylinder end panel 34, and a cylindrical shell 38'. The first and second stages define chambers 40 and 40' through which the vanes 42 and 42' advance and compress the fluid. Air is admitted into the inlet plenum 46' and passes through the inlet passageways 44 for the communication with a first annular chamber 48' which is defined by an inside diameter of panel 34. The vanes have the same outlet conduit 50 (and 50'); conduit 50 communicates, at one end thereof, with a second annular chamber 52' for conduct of the compressed air to an axial passageway 54 formed in cylinder 24'.

Panel 34 incorporates therewith a heat exchanger shroud 100 which encloses a heat exchanger 102. The exchanger comprises tube sheet assemblies 104 and 106 at either axial ends thereof between which are sealingly disposed a plurality of heat exchanger tubes 108. Conduit exit 58 of the first stage of compression, during one time in a cycle of movement, moves into juxtaposition with cylinder port 59 and passes the fluid product into an outlet passage 56' formed in assembly 104. The product is conducted through a first, outer group of tubes 108 to a return chamber 110 which is formed in assembly 106, is passed through a second, intermediate group of tubes 108 to a return chamber 112 formed in assembly 104, conducted through a third, inner group of tubes 108, and then vented to a plurality of vent plenums 114 formed in assembly 106.

From vent plenums 114 this fluid product from the first stage is admitted through a plurality of ports 115 (only one of which is shown) to the rotor of the second stage, by way of passageways 32, for communication with the cored area 30', and vane 42', and is passed therefrom through outlet conduit 50', conduit exit 58, and into a single outlet passage 56.

This embodiment of my invention differs somewhat from the first embodiment shown in FIG. 1 in that ambient air ports 116 are formed in closures 20' and 22'. Also, the tube sheet assembly 106 has an annular trough 118 for admitting ambient air through a plurality of radially extending coolant passageways 120, which are formed in assembly 106 in between plenums 114, for admitting coolant air into a rotor plenum 122. From rotor plenum 122, the cooling air is passed between the tubes 108 and vented therefrom by voids 124 which are formed between peripheral fan blades 126.

As can be better seen in FIG. 10 fan blades 126 arrayed about the periphery of the heat exchanger shroud or housing 100, revolve and cooperate to direct air between the tubes 108.

In FIG. 11 there is illustrated a novel arrangement for loading and unloading my inventive machine. Here, the rotor shaft 28'' has an axially drilled passageway 128 and a radial bore 130 which cooperate for conducting pressured fluid therethrough. In this arrangement I teach the use of a modified vane 132 which has a transverse bore 134 extending part way thereinto. Bore 134 slidably receives a hollow quill 136 which is fixed to and extends from a collar 138 mounted to the shaft 28''. A longitudinal passage 140 is drilled through the very end of one-half of the vane, where it is then plugged, and defines a dog leg at the longitudinal end thereof to open on a variable volume piston chamber 142. Chamber 142 defines the termination of a drilled passage 144 which passage slidably receives a plunger 146. The plunger has successive enlarged and diminished portions, the large portions being provided to serve the function of sealing or closure plugs. An expansion spring 148 is disposed within chamber 142 and resiliently constrains the piston end 150 of plunger 146 in a given position in which throughgoing ports 152, formed in vane 132, are sealed off by the enlarged plug portions of the plunger 146. As can be better seen in FIG. 12, the throughgoing ports 152 when unplugged, communicate the "pressure" side of the vane with the "intake" side. So that, according to my teaching, it is only necessary, by means well known in the art (none being shown here), to communicate the compressed fluid product of the machine with the axially drilled passageway 128 to cause a displacement of plunger 146, open ports 152, and accordingly unload the machine. When compressed fluid is shunted from passageway 128 the spring 148 will return the piston end 150 of the plunger to the position shown in FIG. 11, whereupon the machine becomes loaded again.

While I have described my invention in connection with specific embodiments thereof it is to be clearly understood that this is done only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. A fluid energy machine, comprising:
means defining a chamber having inlet port means and outlet port means spaced therefrom to permit a conveying of fluid into and out of the chamber;
first means movably disposed within said chamber, effective both for fluid sealing said inlet port means from said outlet port means and for conveying chamber-admitted fluid between said port means;
second means coupled to said first means for enabling movement of said first means, cyclically, within said chamber; and
third means intercoupling said second means and said chamber for enabling movement of said chamber only in synchronism with said first means; and wherein
said first means includes means movable therewith which, in response to movement of said first means within said chamber, engages a surface of said chamber to effect said fluid sealing;
said surface-engaging means and said surface effect a sliding and reciprocative relative movement therebetween with each cycle of cyclical movement;
said chamber-defining means comprises a cylinder having a given diameter, and which is rotatable about a first rotary axis;
said first means comprises a rotor having a diameter less than said given diameter, and which is rotatable about a second rotary axis parallel to said first axis;
said surface-engaging means comprises at least one vane slidably mounted in said rotor;
said rotor has an internally cored area;
said inlet port means comprises at least one inlet passageway formed in one axial end of said cylinder, said one inlet passageway opening at one end thereof externally of said cylinder and opening at the other end thereof internally of said rotor on said cored area;
said outlet port means comprises an annular chamber formed in at least one axial end of said cylinder, said annular chamber having one outlet port which opens on said rotor; and wherein
said vane has at least one outlet conduit formed therein which opens at one end thereof internally of said cylinder, the other end of said outlet conduit defining an exit opening which forms an interface with, and communicates with, said outlet port for one short time interval during each cycle of rotation, said exit opening being closed off from said outlet port for the remaining time of each cycle.

2. A machine, according to claim 1, wherein:
said second means and said third means comprise means

for rotating said first means and said chamber at only one, common, angular velocity in one direction.

3. A machine, according to claim 1, further including:
a housing;
said housing enclosing said cylinder;
said housing having vent channel means for conducting fluid therethrough; and wherein
said cylinder has an axial passageway formed therein opening at opposite ends thereof for fluid flow communication with said vent channel means and with another end of said annular chamber.

4. A machine, according to claim 3, wherein:
said housing comprises a plurality of portions,
one portion of said plurality thereof defines a substantially U-shaped cradle, for use as a lubricant reservoir, and another portion of said housing comprises a cover overlying said cradle, said cover having perforations formed therethrough for the passage of ambient air therethrough.

5. A machine, according to claim 1, further including:
a housing enclosing said cylinder; and wherein
said second means comprises a rotor shaft rotatably supported in said housing;
said rotor is fixed to said shaft; and
said third means comprises a train of intermeshing gears, including a gear-supporting stub shaft, a power gear fixed to said cylinder, and a spur gear fixed to said stub shaft; and wherein
at least one said shafts extendably projects from said housing.

6. A machine, according to claim 5, wherein:
said rotor shaft and said cylinder are rotatably supported in said housing, and said stub shaft is rotatably supported in said housing, by roller-type bearings; and further including
means interposed between said rotor and said cylinder, and between said cylinder and said housing, for sealing against fluid leakage thereat.

7. A machine, according to claim 5, wherein:
said rotor shaft and said cylinder are rotatably supported in said housing, and said stub shaft is rotatably supported in said housing, by sleeve-type bearings.

8. A machine, according to claim 1, wherein:
said cylinder defines said surface thereon, and said surface is arcuately defined;
said vane has means defining an arcuately surfaced pad for effecting a contacting engagement with an arcuate segment of said chamber surface;
said pad effects a maximum contacting engagement with said segment only for two instants in each cycle of movement; and
said arcuate surface of said pad contactingly engages said cylinder surface with only a portion of said pad arcuate surface which lies intermediate of leading and trailing portions of said pad arcuate surface.

9. A machine, according to claim 8, wherein:
said second means and said third means enable movement of said pad and said segment, respectively, only at disperate velocities, to cause said segment to lead said pad during a given quarter cycle movement of said first means and said chamber, and to cause said segment to lag said pad during another quarter cycle of movement of said first means and said chamber.

10. A machine, according to claim 8, wherein:
said pad is radially aligned, relative to said axis, only during said two instants in each cycle of movement.

11. A machine, according to claim 8, wherein:
said leading portion both removes from and closes upon said segment during a given half cycle of rotary movement of said first means; and
said trailing portion both removes from and closes upon said segment during the other half cycle of rotary movement of said first means.

12. A machine, according to claim 11, wherein:
said cylinder surface has a leading portion contiguous with said segment and a trailing portion contiguous with said segment; and wherein
said trailing portion of said pad surface moves into engagement with said trailing portion of said cylinder surface during a given half cycle of rotary movement of said first means; and
said leading portion of said pad surface moves into engagement with said leading portion of said cylinder surface during the other half cycle of rotary movement of said first means.

13. A machine, according to claim 12, wherein:
said leading portion of said pad surface is spaced from said cylinder surface when said trailing portion of said pad surface is engaged with said cylinder surface, and said trailing portion of said pad surface is spaced from said cylinder surface when said leading portion of said pad surface is engaged with said cylinder surface, except for two instants in each cycle of movement at which time both said leading and trailing portions of said pad surface are spaced from said cylinder surface.

14. A machine, according to claim 1, wherein:
said cylinder has panels at either axial ends thereof and fixed thereto;
said rotor has an internally cored area;
said inlet port means comprises a plurality of inlet passageways formed in one of said end panels, each passageway of said plurality opening at one end thereof externally of said one end panel and opening at the other end thereof internally of said rotor and on said cored area; and
said passageways extend substantially radially of said cylinder axis for cooperation with said third means to define a centrifugal separator.

15. A machine, according, to claim 14, wherein:
said one vane has a plurality of separate conduits formed therein;
conduits of one pair of conduits, of said plurality thereof, each open at one end thereof internally of said rotor on said cored area and the other end of each opens internally of said cylinder;
said outlet port means comprises a pair of passage means, one of each passage means being formed in one of said end panels, said passage means each having extended fluid conducting means which define a cylinder port, at one end thereof, which opens on said rotor; and
another conduit of said plurality opens at one end thereof internally of said cylinder and other ends thereof each communicates with one of said cylinder ports of said fluid conducting means for one short time interval during each cycle of rotation, and are closed off from said cylinder ports for the remaining time of each cycle.

16. A machine, according to claim 1, wherein:
said one vane has at least one relieved area formed therein for conveying fluid therethrough to communicate cylinder areas to either sides of said vane; and further including
means carried by said one vane operative for opening and closing said one relieved area, respectively, to unload and load said machine.

17. A machine, according to claim 16, wherein:
said operative means comprises a plunger, carried by said one vane, movably interpositioned within said relieved area;
said plunger has enlarged plug means for closing off said relieved area; and further comprises
resilient means constrained against said plunger normally disposing said plug means in a relieved area-closure attitude.

18. A machine, according to claim 16, wherein:
said one vane has a plurality of apertures formed therethrough, said apertures extending transverse to said axes, for conveying fluid therethrough to com-

municate cylinder areas to either sides of said vane, and a hole formed in said vane, extending parallel with said axes, which bisects said apertures; and wherein

said operative means comprises a plunger, slidably mounted in said hole, with a plurality of spaced-apart plug means for closing said apertures,

a spring, constrained against said plunger, effective for normally disposing said plug means in aperture-closure attitude, and

variable-volume chamber means, formed in said one vane, having means for admitting pressured fluid thereinto for bearing upon said plunger, in opposition to said spring, to cause said plunger to slide along said hole to open said apertures.

19. A machine, according to claim **1**, wherein:

said chamber-defining means defines a plurality of cylinders having a substantially common given diameter;

said plurality comprises at least one pair of fluid-compression cylinders, and at least one heat exchanger housing-type cylinder;

said housing-type cylinder is interposed between said pair of compression cylinders and is in throughgoing fluid-flow relationship with said pair, in having coupled thereto separate, spaced-apart, chambered tube sheet means for admitting fluid therewithin, from one compression cylinder of said pair, and for exhausting fluid therefrom into the other compression cylinder of said pair;

said one compression cylinder has said inlet port means, and said other compression cylinder has said outlet port means;

said first means comprises at least one pair of rotors, each rotor thereof having a diameter less than said given diameter;

each of said compression cylinders has one of said rotors disposed therewithin;

said plurality is rotatable, in common, about a first rotary axis;

said rotors are rotatable, in common, about a second rotary axis parallel to said first axis; and

said surface-engaging means comprises at least one vane slidably and radially mounted in each of said rotors.

20. A machine, according to claim **19**, wherein:

said housing-type cylinder is formed with a plurality of fluid-moving fan-type blades on the outer surface thereof;

said blades have a longitudinal dimension which extends parallel with said axes, and

said housing-type cylinder has voids formed therethrough, intermediate of said blades, for accommodating a conduct of coolant therethrough.

21. A machine, according to claim **19**, further including:

a plurality of spaced-apart heat exchanger tubes open at either ends and supported by said tube sheet means within said housing-type cylinder.

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