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ROTARY PUMP

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Fig. 1

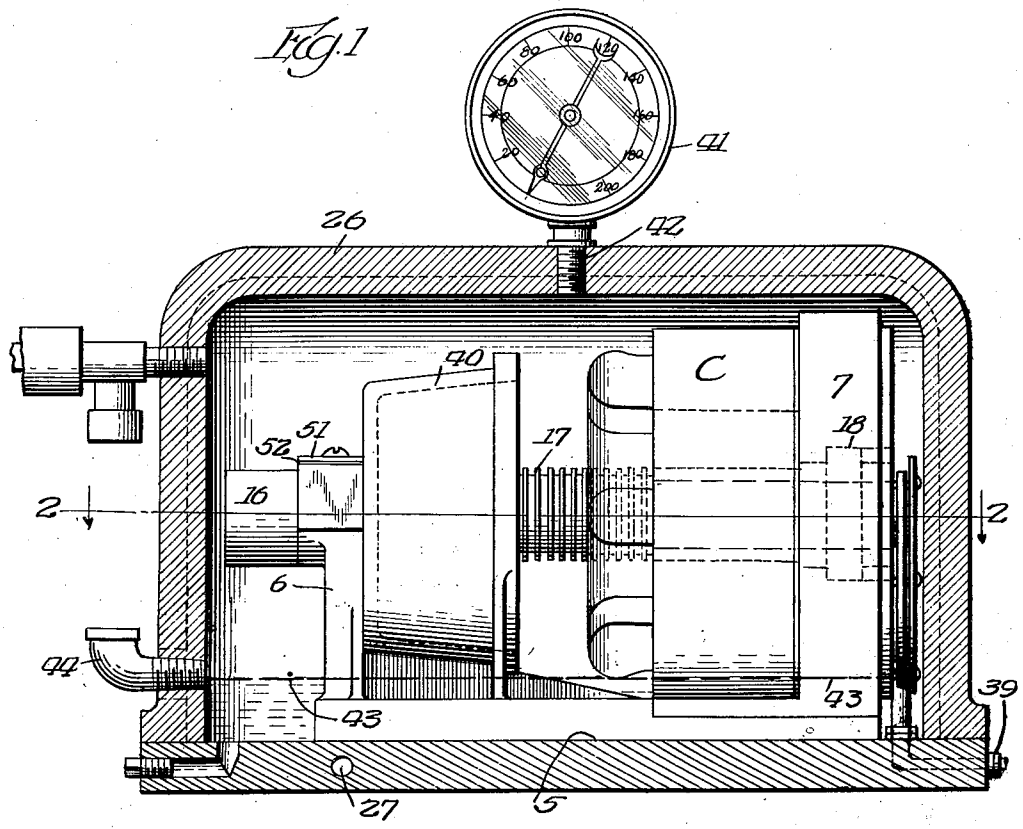
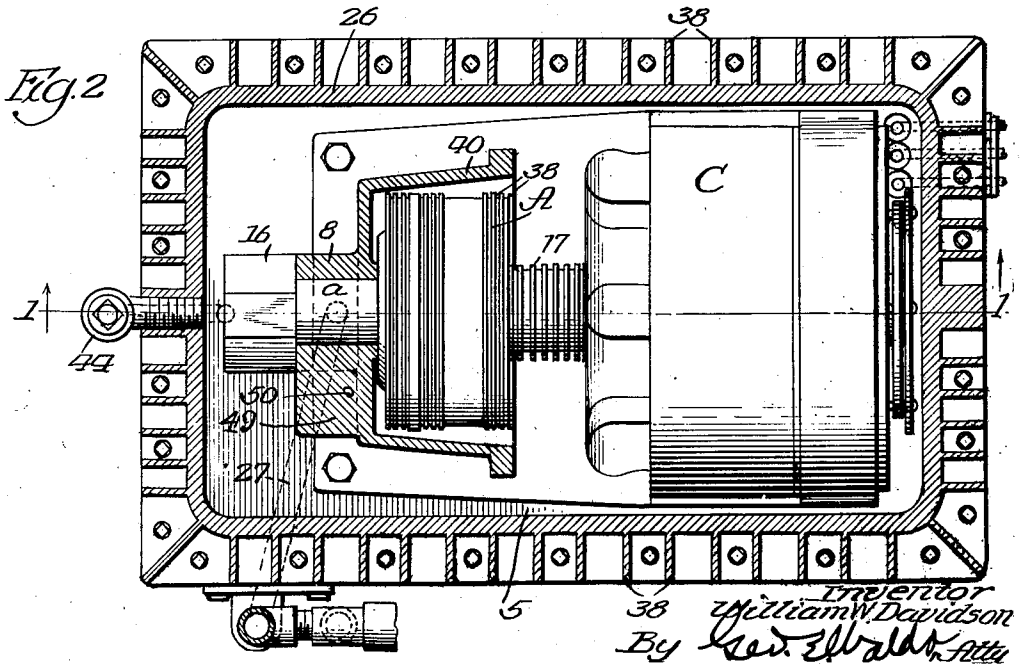


Fig. 2



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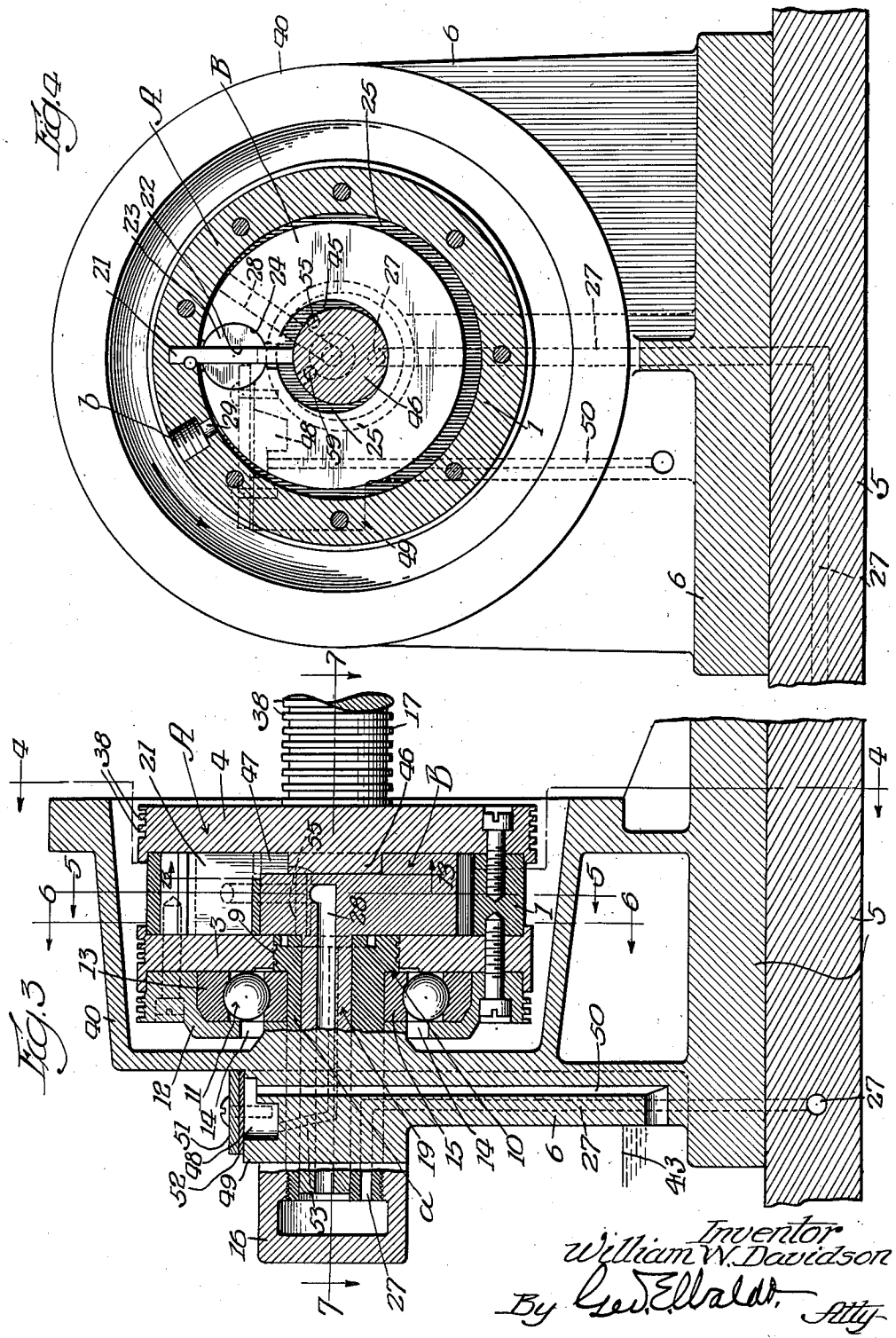


Fig. 4

Fig. 3

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Fig. 6

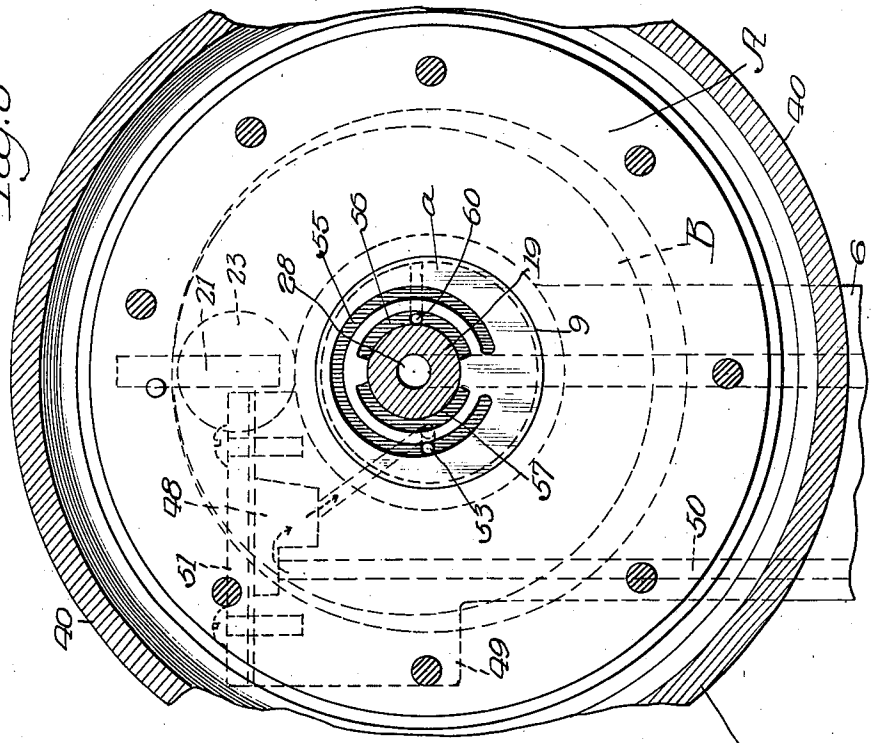
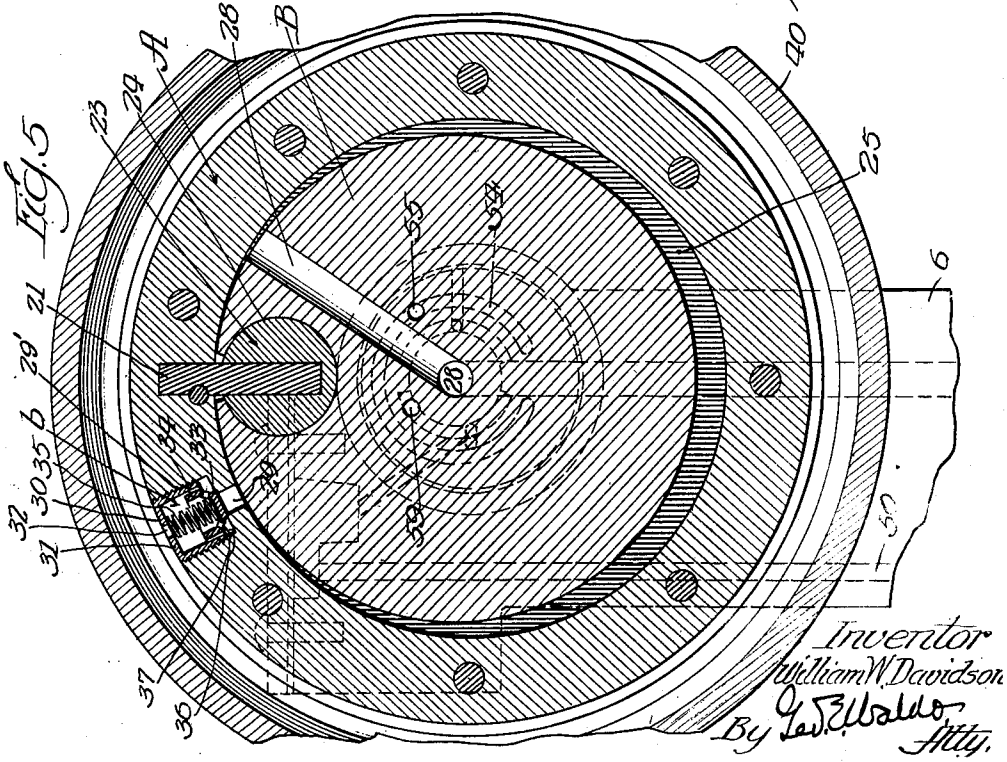


Fig. 5



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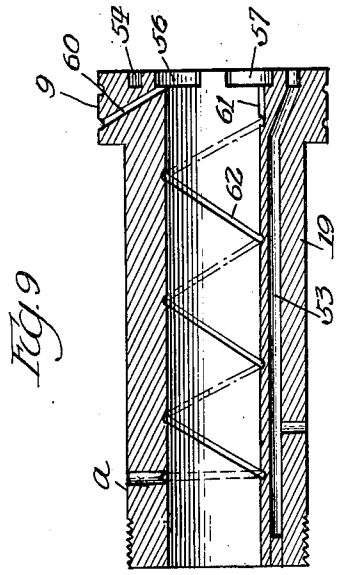


Fig. 9

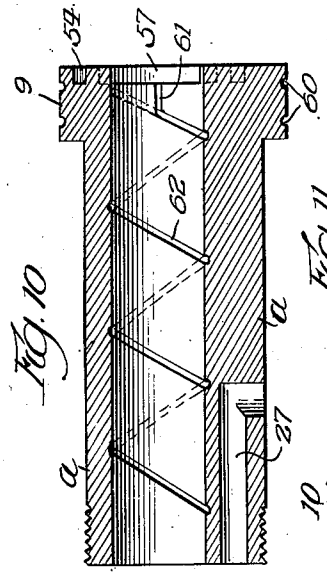


Fig. 10

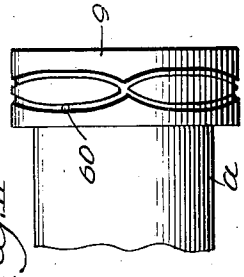


Fig. 11

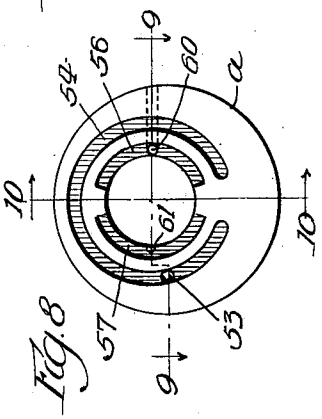


Fig. 8

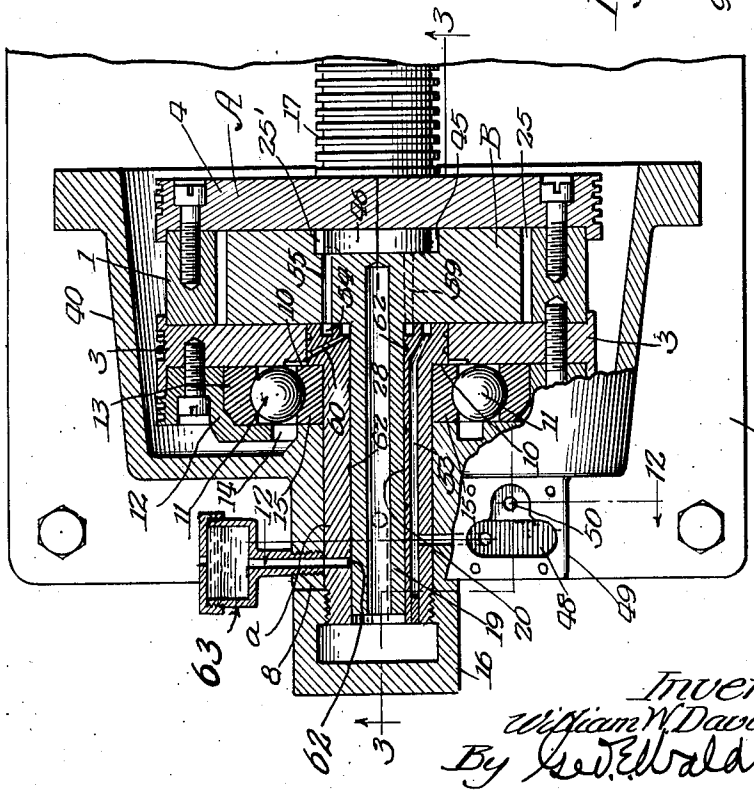


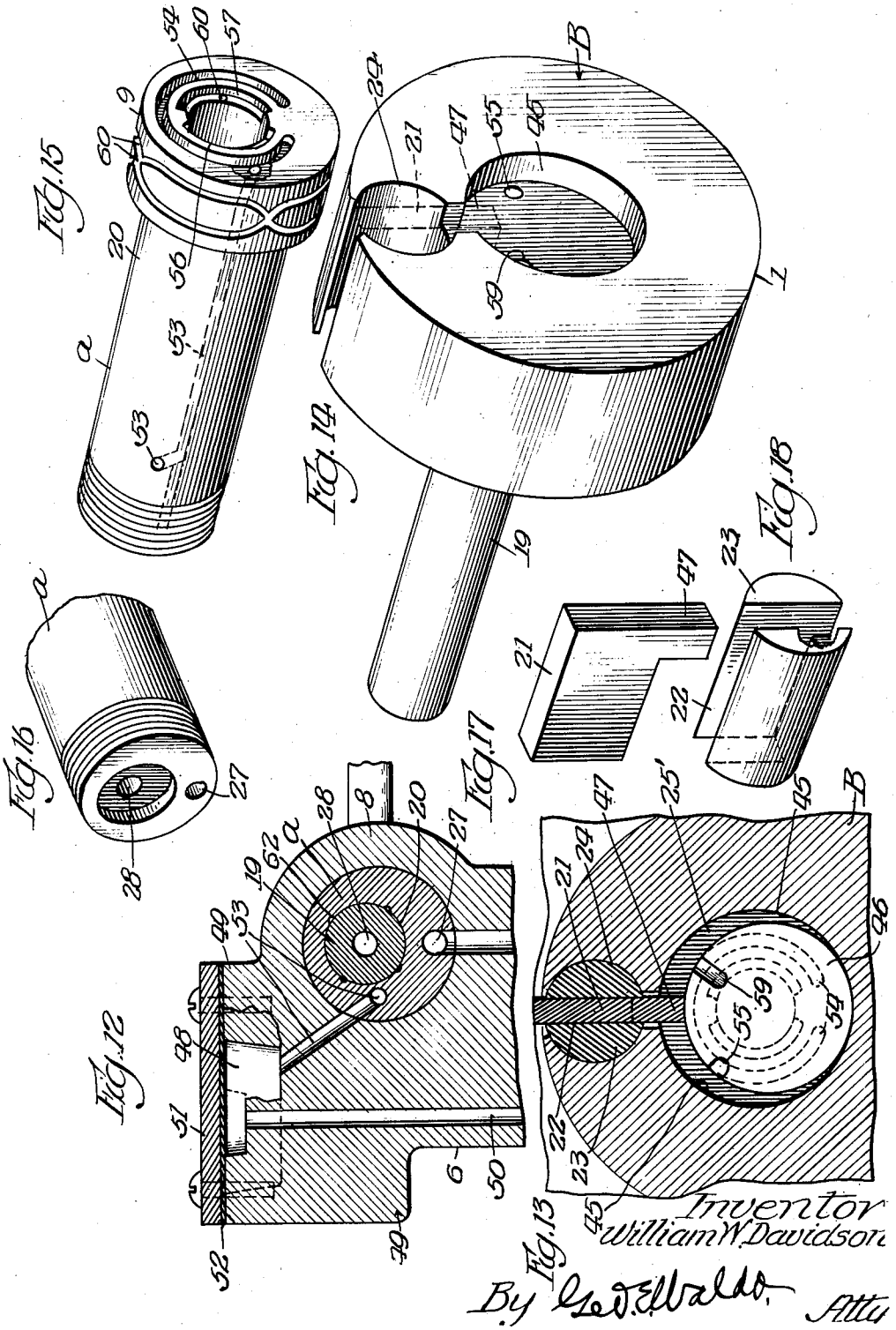
Fig. 7

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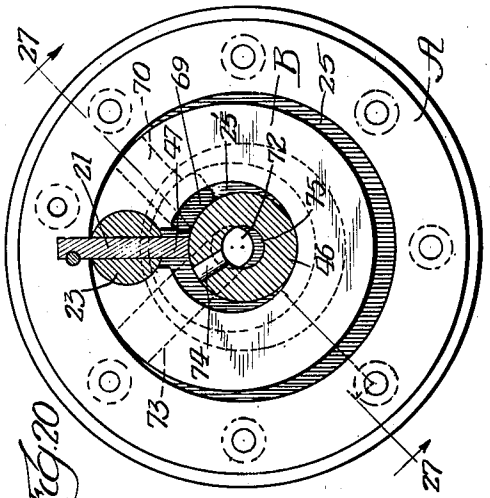


Fig. 20

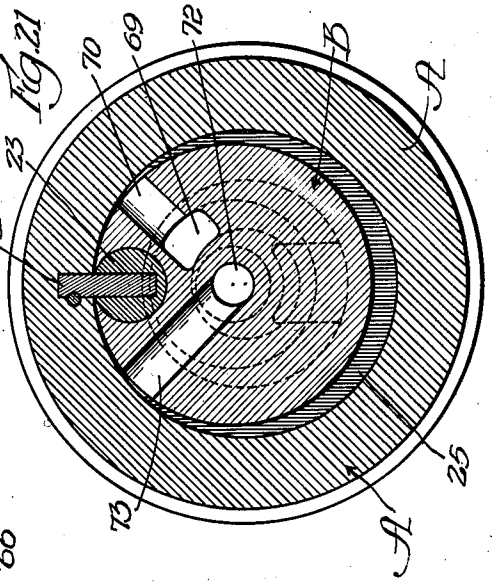


Fig. 21

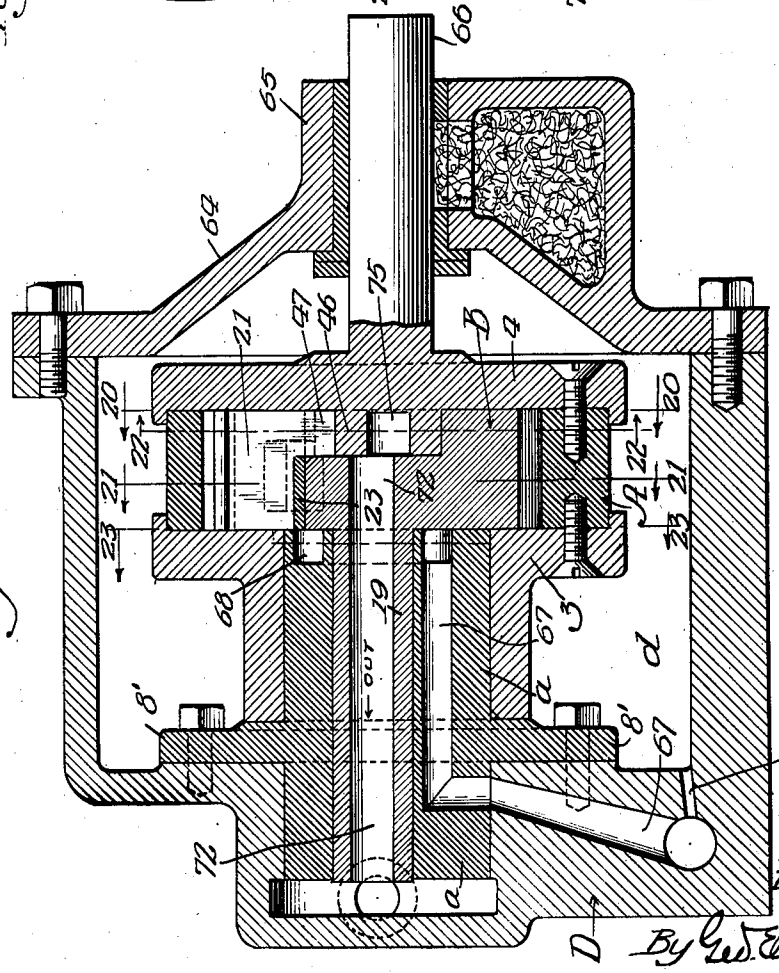


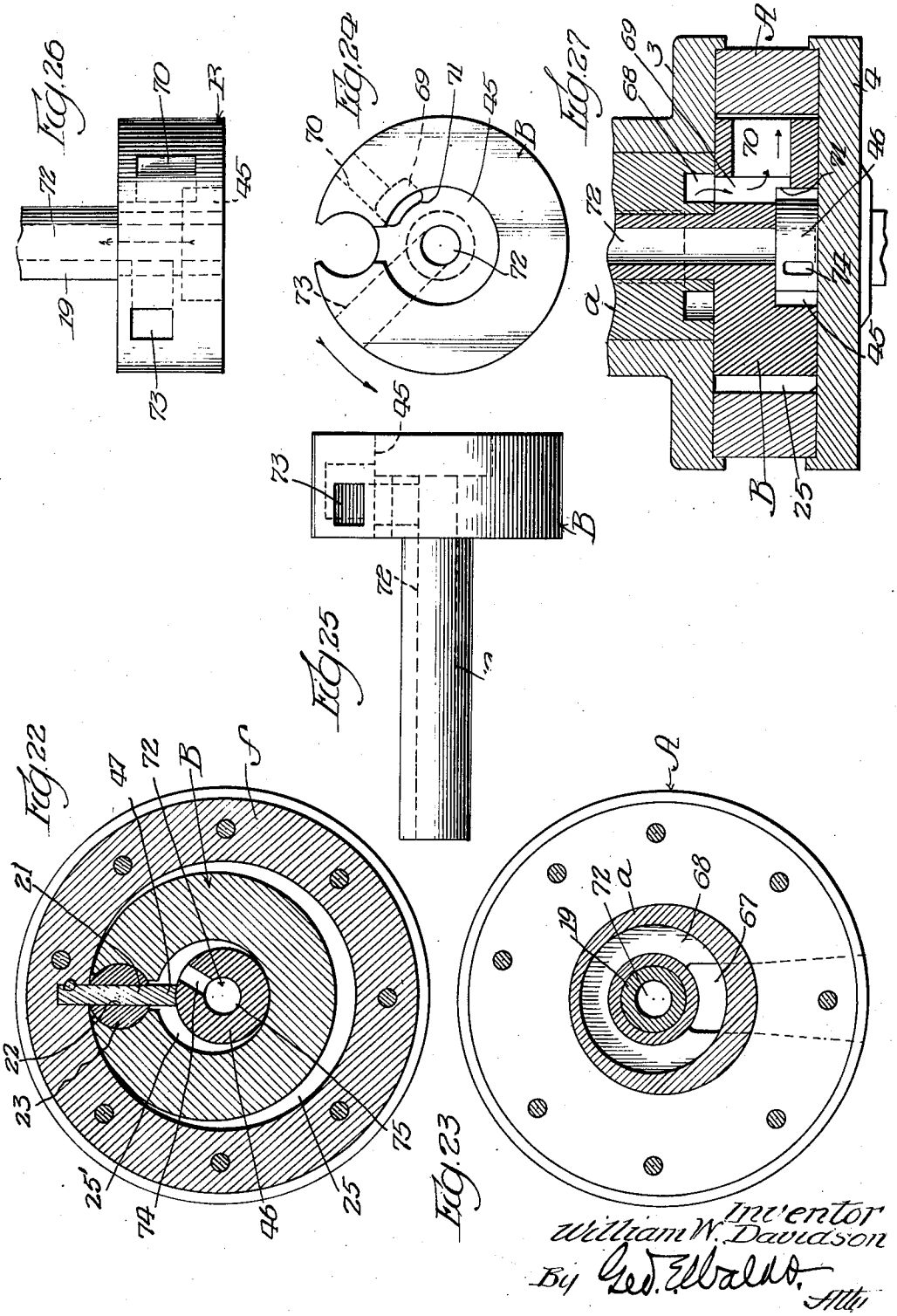
Fig. 19

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Patented June 17, 1941 2,246,274

UNITED STATES PATENT OFFICE

2,246,274

ROTARY PUMP

William Ward Davidson, Evanston, Ill.

Refiled for abandoned application Serial No. 688,169, September 5, 1933. This application February 6, 1936, Serial No. 62,874. Renewed September 25, 1937

12 Claims. (Cl. 103—121)

This invention relates to rotary pumps and this application is a refiling of my application filed Sept. 5, 1933, Ser. No. 688,169 which is now abandoned.

Objects of the invention are:

To provide an improved pump construction applicable to rotary pumps generally, adapted for increasing the efficiency of the pump in operation.

To provide a rotary pump which will subject air and other fluids to high pressures, which will be effective in operation, economical as regards power consumption, will retain its efficiency to a high degree over a long period of use, will be relatively free from vibration, and relatively inexpensive to manufacture.

To provide simple and improved means for effectively lubricating the bearings of rotary pumps, particularly when serving as air and gas compressors or as vacuum pumps, thereby greatly increasing their efficiency, particularly when driven at motor speed of approximately 1725 R. P. M., and for sealing with lubricant the clearances between opposed pump surfaces, thereby adding to the efficiency of the pump, and accomplishing these objects with the least possible power consumption.

To provide a pump for effectively handling liquids, which will be simple in construction and adapted for high speed operation and which will subject the liquid handled to pressure at all stages of rotation, thereby tending to reduce vibration and noise incident to intermittent compression.

To provide a rotary pump having the aforesaid desirable features which can be used in large sizes without unduly increasing vibration.

To provide means for operating a rotary pump for handling liquids without the necessity of heavily packing any moving member, thereby obtaining a dry running pump, free from outside leakage, and at the same time reducing the power consumption for operating the pump.

To provide what may be designated a duplex rotary pump, comprising a primary pump which may be of a type adapted for usual pumping purposes, or which may be particularly designed and adapted for subjecting air and other gaseous fluids to relatively high pressures—as air and gas compressors, which usually operate under fluid-tight domes—and a secondary pump operatively mounted in co-operative association with said primary pump and which is driven thereby and may be adapted either for lubricating the pump bearings subject to friction and wear in use, or for increasing the volumetric discharge from the pump unit; and

To provide a pump unit comprising a primary and secondary pump, the secondary pump of which is combined and co-ordinated with the primary pump in a manner to equalize the volumetric discharge therefrom, thereby preventing vibration in operation, and minimizing pulsation and surging of the pump in operation.

To attain the objects thereof, a pump unit embodying my invention and improvements, comprises the various features, combinations of features and details of construction hereinafter described and claimed.

In the accompanying drawings, in which the invention is fully illustrated,

Fig. 1 is a side view of a rotary pump embodying my invention and improvements enclosed in a dome, shown in sectional side view, substantially on the line 1—1 of Fig. 2.

Fig. 2 is a top plan view thereof, the dome and parts of the pump being shown in section, substantially in a plane indicated by the line 2—2 of Fig. 1.

Fig. 3 is an enlarged, sectional view of the pump proper, in planes indicated by the line 3—3, Fig. 7.

Fig. 4 is a sectional elevation of the pump proper, in a plane indicated substantially by the line 4—4 of Fig. 3.

Figs. 5 and 6 are enlarged, fragmentary, sectional views, respectively, in planes indicated substantially by the lines 5—5 and 6—6 of Fig. 3.

Fig. 7 is a plan view, partly in section, substantially in a plane indicated by the line 7—7, Fig. 3.

Figs. 8, 9, 10 and 11 are enlarged, detached, detail views.

Fig. 12 is an enlarged, fragmentary, detail sectional view, in a plane indicated, substantially, by the line 12—12, Fig. 7.

Fig. 13 is an enlarged, fragmentary, sectional view in a plane indicated, substantially, by the line 13—13 of Fig. 3.

Figs. 14 to 18, inclusive, are enlarged, detached perspective views of parts of a duplex pump, embodying my invention and improvements.

Fig. 19 is a longitudinal, vertical, central, sectional view of a duplex pump embodying my invention having fluid supply and discharge passageways arranged for pumping one kind of liquid only.

Fig. 20 is a sectional elevation on the line 20—20 of Fig. 19.

Fig. 21 is a sectional elevation in a plane in-

dicated, substantially, by the line 21—21, Fig. 19.

Fig. 22 is a sectional elevation in a plane indicated, substantially, by the line 22—22, Fig. 19.

Fig. 23 is a sectional elevation, in a plane indicated, substantially, by the line 23—23, Fig. 19.

Figs. 24, 25, and 26 are detached views of the rotor of a duplex pump of my invention, with supply and discharge connections arranged for pumping liquid only; and

Fig. 27 is a sectional view in a plane indicated, substantially, by the line 27—27, Fig. 20.

Describing the invention with reference to the drawings, I will first describe the primary pump, per se, and will then describe the secondary pump and what I now consider preferable means for combining and co-ordinating it with the primary pump, first, where used as an air or gas compressor, to lubricate the pump bearings, to seal its surfaces and, at the same time, to reduce vibration, and second, where used as liquid pump, to increase and equalize the volumetric discharge from the pump.

Referring now particularly to Figs. 1 to 18 of the drawings, in which I have shown my invention and improvements as embodied in a primary pump designed and adapted for compressing gaseous fluids, said primary pump comprises a cylinder and a rotor respectively designated as a whole A and B.

The cylinder A consists of an annular ring 1, opposite ends of which are closed by heads 3 and 4, which, as shown, form separate parts and are detachably secured to opposite ends of said cylindrical ring by screws or other suitable means.

The rotor B is cylindrical, its diameter being less than the diameter of the bore of the cylinder A and its axial length being proportioned to fit between the inner sides of the cylinder heads 3 and 4 with only operating clearance, to permit said cylinder and rotor to turn freely relative to each other under contemplated operating conditions. Also, said rotor is mounted in eccentric, tangential relation to the bore of the cylinder A, in a usual manner.

As assembled for operation, the cylinder A and rotor B are rotatably mounted on a suitable frame which, as shown, comprises a base 5 formed on which are spaced bearing supports 6 and 7. As shown, the means for mounting the cylinder A on the bearing support 6 consists of a journal member *a* secured in fixed position in a hole or opening in a boss 8 on said bearing support, as presently described, and which projects therefrom towards the bearing support 7 and has a circular enlargement 9 at its outer end, to which, as shown, a bearing in the cylinder head 3 is fitted to turn with only operating clearance, and which defines a shoulder 10 adjacent the outer end of said journal member, as shown. Said journal member *a* forms a fixed part of the pump frame.

Primarily, however, in order to reduce friction between the parts of the pump and thus power consumption in operation, the cylinder A is mounted on said journal member *a* by means of an anti-friction bearing 11—as shown, a ball bearing. As shown, said ball bearing is confined in a cage or housing 12 secured to the cylinder head 3 by screws or other suitable means, the axial dimension of said cage or housing being proportioned to clamp the outer ball race 13 to said cylinder head 3, and the wall of said housing being cut away to form a central opening 14 therein, to provide for clamping opposite ends of the inner ball race 15, as assembled for use, between the shoulder 10 on the journal member *a* and a rigid surface on the bearing support 6. As shown, the journal member *a* projects through the hole or opening in the boss 8 on the bearing support 6 to which it is fitted, and threaded to the projecting end thereof is a recessed nut 16, by which said journal member is drawn endwise to clamp it and also the inner ball race 15 in operative position on the bearing support 6.

As shown, the end of the inner ball race 15 which contacts with the shoulder 10 on the journal member *a* projects outwards so as to overlap the outer side of the cylinder head 3 and to insure that the end of said inner ball race will not contact with said cylinder head 3, said cylinder head is relieved or cut away, as shown, thus permitting the pump cylinder to turn freely.

As shown, the means for mounting the pump cylinder A also comprises a shaft 17 secured to the cylinder head 4, said shaft being rotatably fitted to a bearing in the bearing support 7, preferably by an anti-friction bearing indicated at 18. Said bearing may be of any desired or approved construction suitable for the purpose and can be purchased commercially or readily supplied by skilled workmen familiar with such bearings and need not, therefore, be either shown or described in detail. The pump is driven by direct connection of the pump cylinder with an electric motor C, see particularly Figs. 1 and 2, which may be of any usual or desired type suitable for the purpose, of which many different kinds may be purchased commercially.

As shown, the shaft 17 is the armature shaft of the motor C for driving the pump and, for convenience in assembling and dismantling the pump and motor, the bearing support 7 preferably forms a separate part and is detachably secured to the base 5.

As shown, the rotor B is mounted within the cylinder A in eccentric, tangential relation to the bore thereof, by a bearing shank 19, which is fitted to a bearing 20 formed lengthwise through the journal member *a*, and, in operation, rotation is imparted to said rotor with the cylinder by means of a vane 21 secured in fixed position to the wall of the cylinder A and preferably, also, to the cylinder heads 3 and 4. Due to its eccentric mounting relative to the cylinder A, the rotor B will have a slight oscillating movement relative to the cylinder and to permit this, the vane 21 slidably engages a slot 22 formed in a rock-member 23 rotatably fitted to an open-sided bearing 24 in the perimeter of the rotor B, in a familiar manner.

The arrangement of the fluid supply and discharge passageways to and from the pump chamber 25 defined by the pump cylinder and rotor, will vary considerably according to the use or service for which the pump is designed, but in any arrangement will include passageways which communicate with the pump chamber at opposite sides of and closely adjacent to the pump vane 21.

As shown in the drawings, see particularly Figs. 1 and 2, the entire pump structure and the motor for driving the same are enclosed in a dome or casing 26, the lower end of which is open and, as assembled for use, is secured to the base plate 5 by suitable means, as screws. When mounted in this manner, one of the circulating passageways of the pump preferably comprises a continuous passageway 27 formed in the pump base 5, bearing support 6 and journal member *a*, the

outer end of which communicates with a source of supply of gaseous fluids, and its inner end with a recess in the nut **16**, and a continuous unbroken passage **28** formed lengthwise in the bearing shank **19** for mounting the pump rotor, and radially through the rotor into open communication with the pump chamber **25**; and the other circulating passageway of the pump consisting of a hole **29** formed directly in the cylindrical wall of the pump cylinder, which communicates with the pump chamber **25** at the opposite side of the pump vane **21** from the passageway **28**, and is controlled by a check-valve designated as a whole *b*.

While I contemplate the use of any form of check-valve suitable for the purpose, what I now consider a preferable form of valve is best shown in Fig. 5 of the drawings, and consists of what may be designated a metallic shell **30** secured in an enlargement **29'** of the outer end of the hole **29**, the outer end of said shell being closed by a wall **31** provided with a hole or opening **32** through which said shell is in open communication with the space within the dome or casing **26**. Movably supported within the shell or casing **30** in co-operating relation to the valve seat **33**, is a valve member **34** which is maintained yieldingly in engagement with its seat by a spring **35** applied thereto, consisting, as shown, of a coil spring inserted between said valve member **34** and the wall **31** of the shell **30**. To reduce the weight thereof and to form a seat for the spring **35**, the outer end of the valve member **34** is recessed, as shown. As shown, also, the inner end of the shell **30** terminates short of the inner end of the hole or opening in which it is secured, forming a space **36** surrounding the movable valve member **34** outside of its seat in the wall of the pump cylinder, which, when said valve member **34** is seated, is in open communication with the interior of the dome or casing **26** through holes **37** formed therein and the hole or opening **32** in the shell **30**, whereby the pressure on opposite sides of said valve member **34** outside of said valve seat, is substantially equalized. Also, the spring **35** is calibrated to maintain the valve member **34** closed against the action of centrifugal force due to the rapid rotation of the pump cylinder in operation, whereby said valve will not open until the pressure in the pump chamber with which the hole or opening **29** communicates, exceeds the pressure in the dome or casing **26** by an amount corresponding to a predetermined difference in area between the surfaces of said valve member exposed in the pump chamber and in the dome or casing, respectively.

Obviously, premature opening of the valve **34**—through centrifugal action or from other cause—while the pressure in the dome or casing **26** exceeds the pressure in the pump cylinder, in certain positions of the pump cylinder and rotor as, for example, when in the relative position shown in Fig. 4, would cause gaseous fluid from the dome or casing **26** to blow through the pump chamber **25** and the fluid passageways **28** and **27**, necessitating that it be recompressed, thus causing loss of pressure, extra work and expense, and general loss of efficiency in the operation of the pump.

To reduce the tendency of the pump and associated parts to overheat, due to the high speed at which they operate and the high pressures which they are designed to produce, fins **38** are formed on the pump cylinder A, the armature shaft **17** and the dome or casing **26**, as shown, thus increasing their radiating surface and correspondingly reducing their tendency to overheat.

The electrical connections to the motor, not shown, are located entirely outside of the pump proper and can readily be supplied by skilled electricians without the exercise of invention.

It is found in practice, that if—when the pump is running at high speed, say 1725 R. P. M.—oil is delivered upon the cylinder A, it will be thrown off by centrifugal action, in the form of a very fine mist, which, when the pump is enclosed in a dome or casing, will be intermixed with and picked up by the gaseous fluid on which the pump is working, at any given time, which, in most cases, is objectionable and in practically all cases, undesirable.

In accordance with the present invention, I minimize this objectionable feature by enclosing the pump on all sides, excepting the side which faces away from the outlet from said dome or casing, with a shield or baffle having closed sides against which said oil spray or mist will be thrown and to which it will adhere and down which it will drain by gravity into the bottom of said dome or casing. As shown, see Figs. 1 to 7, said shield or baffle, designated **40**, is formed integral with the bearing support **6** and carries the boss or hub **8** in which the journal member *a* is secured.

The fluid pressure in the dome **26** may be indicated by a conventional pressure gauge **41**, the nipple **42** of which is in engagement with a hole formed in said dome.

In addition to usual packing of any desired kind, not shown, leakage of gaseous fluids, under pressure, from the dome **26** is prevented by means of an oil seal consisting, as shown, of a body of oil introduced into said dome, sufficient to fill the same to a level indicated approximately by the line **43**, which preferably will be entirely below the pump cylinder A and the armature of the motor; thus effectively preventing "churning" of the oil and the formation of oil spray or mist which, which, as heretofore explained, is objectionable.

For convenience in introducing oil into the dome or casing **26**, a fitting **44** is secured in a hole formed through said dome in such position that the designed oil level therein will be through the opening in said fitting, as shown in Fig. 1.

As the objects of the invention relate to the provision of means for lubricating the pump bearings and other parts and surfaces thereof subject to friction and wear, in operation, I attain said objects by means of a lubricating system consisting of what, for purposes of convenient reference, will be designated a secondary pump, arranged in co-operative relation to the primary pump, heretofore described, the suction side of which is connected by channels or passageways with the dome or casing **26** in which the primary pump is enclosed, below the designed oil level therein, and the pressure side of which is connected by other channels and passageways with the bearings, parts and surfaces of the primary pump to be lubricated and sealed.

What I now consider a preferable form of secondary pump is as follows: Formed in the end of the rotor B of the primary pump, proximate the cylinder head **4** thereof, and concentric with the axis of rotation of the rotor shank of said primary pump, is a cylindrical recess **45**, and formed on the cylinder head **4** of said primary pump,

concentric with the axis of rotation of the cylinder of said pump, is a cylindrical hub or boss **46**, the relation being such that said hub or boss will be tangent to the cylindrical wall of the recess **45**, and formed on the vane **21** of the primary pump is a lug or projection **47** which extends radially inwards through a cut-away portion of the bottom of the slot **22** in the rock member **23** of the primary pump, said lug being of such length that its inner end will abut the cylindrical surface of said hub or boss **46** and will form a tight joint therewith, being confined in this relation by fixed engagement of said pump vane **21** with the wall of the cylinder A of the primary pump, as heretofore described. With this construction, it is obvious that said vane **21** and hub or boss **46** will turn together as a unitary structure, both thereof being secured in fixed position on the primary pump cylinder.

The hub or boss **46** extends into the cylindrical recess **45** formed in the end wall of the rotor B of the primary pump, proximate the cylinder head **4** thereof, and said hub or boss and recess are so proportioned axially that, when assembled in the pump, the opposed end walls thereof will be separated by operating clearance only.

The recess **45** in the rotor B and the hub or boss **46** on the cylinder head **4** of the primary pump A, form the cylinder and rotor, respectively, of the secondary pump and define the pump chamber **25'** of said secondary pump, and the lug or projection **47** on the vane **21** of the primary pump forms the vane of the secondary pump.

With the relation shown and described, it is obvious that the radial dimensions of the pump chambers, **25**, **25'**, of the primary and secondary pumps, respectively, will be the same while the points of tangency of the cylinders or rotors of said primary and secondary pumps, respectively, will be positioned at 180° from each other, relative to their respective axes of rotation, from which relation, it follows that when the volumetric discharge from the primary pump is at maximum, that of the secondary pump will be at minimum, and vice versa.

What I now consider a desirable and preferable arrangement of passageways or channels for supplying lubricating oil to the pump chamber of the secondary pump and for discharging it therefrom to points of application, comprises what may be designated a well **48** formed in a thickened portion **49** of the bearing support **6** at a somewhat higher level than the axis of rotation of the primary pump cylinder A, said well being connected by a passageway **50** with the interior of the dome or casing **26** below the contemplated oil level **43** therein. As shown, said passageway **50** opens through a shoulder formed by a shallow lateral extension of the well **48**, as clearly shown in Figs. 3 and 12 of the drawings. The top of the well **48** is closed by a plate **51** secured to the flat top surface of the portion **49** of the bearing support **6** in which said well is formed, and leakage from the dome into said well under said plate is prevented by a packing gasket **52**.

Also communicating with the well **48** and, as shown, opening through the bottom thereof, is a passageway **53** formed partly in the bearing support **6** and partly in the journal member *a*, and which is in open communication with a segmental, circular groove **54**, formed in the end of the journal member *a* exposed within the primary pump cylinder A, concentric with the axis of rotation of the rotor B of the primary pump, the relation preferably being such that the closed ends of said groove will be positioned substantially symmetrically at opposite sides of a plane passing through the axis of rotation of the rotor B of the primary pump and the point of tangency of the cylinder and rotor of said primary pump, and below the axis of rotation thereof. As shown, also, the oil passageways and channels of the pump comprise a passageway **55** formed through the rotor B, one end of which is arranged to communicate with the groove **54** and its opposite end with the suction side of the secondary pump, which with the pressure in the dome **26**, will operate, in an obvious manner, to deliver oil from said dome to the suction side of said secondary pump.

In accordance with the invention, also, the oil distributing passageways of the pump comprise segmental grooves **56** and **57** formed in the end of the journal member *a* exposed within the cylinder of the primary pump, formed, as shown, by under-cut shoulder surrounding the rotor bearing formed therein, so that they will be in open communication therewith, and which are arranged symmetrically on opposite sides of the face of the journal member *a* exposed within the cylinder of the primary pump, as shown, which are adapted to be brought into communication with the pressure side of the secondary pump in continuous succession by rotation of the secondary pump in operation, through a passageway **59** formed in the rotor of said primary pump whereby oil under pressure will be supplied to said grooves **56** and **57** and from them distributed to points of use by suitable passageways comprising, as shown, a passageway **60** which connects the groove **56** with the bearing for the cylinder head **3** on the journal member *a*, which is provided with intersecting grooves as shown, see Figs. 11 and 15, and also to the anti-friction bearing for mounting the primary cylinder A, see particularly Figs. 6 and 7. Said distributing passageways also comprise a duct **61** which connects the groove **57** with the proximate end of a spiral groove **62** formed around the bearing **20** for the rotor shank **19**, see particularly Figs. 9 and 10.

Obviously, also, with oil under pressure trapped in the pump chamber of the secondary pump, oil will also be forced from said pump chamber into the bearing for the rock-member **23** and into the clearance spaces between the cylinder heads **3** and **4** of the primary pump and the opposed end walls of the rotor B, and also between said cylinder heads and the ends of the rock-member **23**, thereby, not only lubricating the pump surfaces, but also providing an effective oil seal between opposed pump surfaces which will prevent leakage between the chambers or recesses of the same or different pumps.

As shown in Fig. 7, an oil cup **63** is applied to the rotor shank bearing **20** in the journal member *a* which is connected by a hole formed in the machine frame with the outer end of the spiral oil duct **62** in said rotor shank bearing, and is provided with a hole in the top or cover thereof through which the interior of said oil cup is in open communication with the interior of the dome **26**. With this construction, it is obvious that, in operation, surplus oil forced through said oil duct **62** by the secondary pump will be delivered into said oil cup **63**. Thus, when pressure is built up in the dome **26** by operation of the

primary pump, oil in said cup will be subjected to pressure, which will tend to give a steady and proportional back pressure against the oil in the reservoir and so along the rotor shank bearing.

I do not, however, desire to limit myself or the protection of any patent granted on this application, to the arrangement of oil distributing passageways shown and described, nor to any particular arrangement of lubricating passageways and ducts, but desire to extend the protection of the patent to any arrangement of oil distributing passageways, when distribution is effected by a secondary pump mounted in co-operative association with the primary pump in accordance with my invention, as defined by the appended claims.

Attention is called to the fact that, with the relation shown and described, the axis of rotation of the rotor B of the primary pump is eccentric to the axis of rotation of the cylinder A, and the axis of rotation of the rotor of the secondary pump—the hub or boss **46**—is concentric with the axis of rotation of the cylinder of said primary pump, and the cylinder of said secondary pump—the recess **45**—is eccentric to the axis of rotation of the cylinder A of said primary pump. Also, the axes of rotation of both the rotor B of the primary pump and of the cylinder of the secondary pump—the recess **45**—are off-set above the axis of rotation of the cylinder A of the primary pump. With this relation, it is obvious that the point of tangency of the primary rotor B to the bore of the cylinder A of the primary pump will be at the top side of said cylinder, while the point of tangency of the rotor **46** of the secondary pump to the cylinder thereof—the recess **45**—will be at the bottom side thereof. Thus, while the primary pump vane **21** is passing the point of tangency of the cylinder and rotor of said primary pump—corresponding to minimum discharge of said primary pump—the vane of the secondary pump will be in a position 180 degrees from the point of tangency of the cylinder and rotor thereof, corresponding to maximum discharge from said secondary pump.

A duplex rotary pump comprising primary and secondary rotary pumps combined and co-ordinated in accordance with my invention, substantially in the manner hereinbefore described for pumping different kinds of liquids may readily be adapted for pumping one liquid only, so that each will supplement the other, and thereby increase and equalize the volumetric discharge from the pump unit, thus reducing vibration and minimizing pulsation and surging of the pump in operation, by changing the arrangement and also the size of the liquid supply and discharge passageways of the pump, so that each pump will execute the initial one-half of its pumping cycle, during which the quantity of liquid handled—either supply or discharge—is increasing, concurrently with the execution by the other pump of the final one-half of its pumping cycle—during which the quantity of liquid handled thereby is decreasing,—whereby the liquid supply to one pump will increase as that to the other decreases and vice versa, and the liquid discharge from one will increase as that from the other decreases, and vice versa.

A pump embodying the foregoing adaptation is shown in Figs. 19 to 27 of the drawings, and will now be described.

Excepting as regards the arrangement of the liquid supply and discharge passageways of the pump, including both the primary and secondary pumps, and that no anti-friction bearings are used for mounting the primary pump, and excepting also, as regards features and details hereinafter particularly described, the construction of said pump is substantially identical with that of the pump shown in Figs. 1 to 18 of the drawings and will readily be understood by mechanics familiar with the construction and operation of rotary pumps from an inspection of the drawings, particularly in connection with the foregoing description of my double duty pump, without a separate description thereof. Similar and corresponding parts will, therefore, be designated by the same reference characters as in the other figures of the drawings.

As shown, the operative parts of the pump are mounted on a frame designated as a whole D, which conveniently and preferably will be a casting and is provided with an open-sided cavity *d*, adapted to be closed by a plate **64** bolted or otherwise removably secured thereto, as shown, whereby said cavity forms a closed chamber into which leakage from the pump will drain. Formed on the plate **64** is a hub **65** which is provided with a bearing for a shank **66** secured to the cylinder head **4** of the primary pump and which we will assume is adapted to be coupled directly to the armature shaft of an electric motor, not shown, whereby the pump will be driven at motor speed, the bearing for said shaft **66** preferably being bushed, as shown.

For purposes of convenient reference, different parts of the pump are tabulated as follows: A is the cylinder of the primary pump; **3** and **4** the cylinder heads thereof; *a* the journal member for mounting the pump cylinder A at one side, which, as shown, is mounted in fixed position on the machine frame by means of a flange **8'** formed on said journal member secured to the rear wall of the frame D by screws or other suitable means; B the rotor of the primary pump; **19** the bearing shank for rotatably mounting said rotor in its bearing in the journal member *a*, in eccentric, tangential relation to the bore of the cylinder A; **21** the pump vane rigidly secured to the pump cylinder A; **23** the rock-member rotatably mounted in its bearing in the rotor B; **22** the slot therein to which the pump vane is slidably fitted; **45** the recess in the rotor B which forms the cylinder of the secondary pump; **46** the cylindrical boss on the head **4** of the primary pump, which forms the rotor of the secondary pump and is mounted in eccentric, tangential relation to the bore of the recess **45**; and **47** is the radial lug or projection on the vane **21** of the primary pump, which extends through the cut-away portion of the bottom of the slot **22** in the rock-member **23** with its end in contact with the boss **46** which forms the rotor of said secondary pump.

Still referring to Figs. 19 to 27, what I now consider a desirable and preferable arrangement of supply and discharge passageways to and from the chambers **25, 25'**, of the primary and secondary pumps, comprises a supply passageway **67** formed partly in the pump frame D and partly in the journal member *a*, the inner end of which is in open communication with an annular groove **68** formed in the face of the journal member *a* exposed within the cylinder A of the primary pump, and the outer end of which is adapted to be connected with a source of supply. Said supply passageways also comprise a passageway **69** formed in the rotor B of the primary pump, one end of which opens through the end of said rotor

proximate the face of the journal member *a* exposed within the pump cylinder A, in position to communicate with the groove 68, and which comprises a radial section 70 which opens through the perimeter of the rotor closely adjacent the pump vane 21 and which is also extended to communicate with the suction side of the cylinder 45 of the secondary pump, as shown at 71.

In accordance with what I now consider a preferable arrangement, the discharge passageways from the pump comprise a passageway 72 which extends lengthwise through the rotor B and its shank 19 and into the cylinder 45 of the secondary pump and which also comprises a radial section 73 which communicates with the longitudinal section of said passageway and which opens through the perimeter of the rotor B in position to communicate with the primary pump chamber 23 at the opposite side of the pump vane 21 from the supply passageway 70 and closely adjacent to said pump vane.

As shown, also, the secondary pump is provided with a discharge passageway 74 formed radially in the rotor 46 thereof and which connects the pressure side of the secondary pump chamber 25' with an opening 75 formed in the end of the rotor 46 remote from the cylinder head 4, and which is in open communication with the lengthwise section 72 of the discharge passageway 73, as shown.

As shown, discharge of liquid which drains into the cavity or chamber *d* is effected through a hole or passageway 76 which connects said chamber with the liquid supply passageway 67 in the pump frame.

Attention is called to the construction shown in Figs. 19 to 27 inclusive. The rotatable pump members are designed to operate under a housing rendered substantially air tight. This condition is obtained by having the pump frame a unit with a housing and by having the pump drive shaft extended therethrough, fitted to a bearing with only working clearance, which bearing is lubricated and to a sufficient extent sealed by lubricant applied to the shaft by waste material located in an oil pocket formed in the bearing wall of the housing frame.

Attention is further called to the fact that in operation the pump housing, which is connected to the suction side of the pump, will therefore be at least partly filled with the fluid which the pump is handling. It is therefore highly desirable to substantially seal the bearing of the pump member through which the discharge passageway is formed from the inner confines of the housing. In the construction shown in Fig. 19, the inner face of the stationary member *a* which is exposed within the cylinder, and the proximate face of the rotor are in frictional contact with one another, with the degree of such frictional contact being determined by the necessity of providing contacting surfaces which will give substantial sealing and yet allow the rotatable member to function against the stationary one. This desired frictional contact is obtained and maintained by the lateral positioning of the rotatable pump members. The pump members, in Fig. 19, are shown positioned in the proper manner.

Subject matter disclosed but not claimed herein is claimed in one or more of the following applications on which patents are issuing simultaneously with the patent on this application, namely Serial Nos. 36,877, 93,633, 105,958, 185,830, 351,360 and 351,359.

I claim:

1. In a rotary pump, the combination of a frame comprising a sealed housing, pump members therein comprising a cylinder and a rotor, heads which close the ends of the cylinder and are fixed thereto and one at least of which is detachable, one of said cylinder heads provided with an opening into which a portion of the pump frame extends, the relationship being such that the inner face of said extended portion of the pump frame is opposed to and parallel with the inner face of the other cylinder head, means for rotatably mounting said cylinder and rotor on the pump frame in eccentric, tangential relation, comprising a shank rigidly fixed to the rotor, said shank extending through said opening in a cylinder head, said shank being rotatably fitted to a bearing formed in the pump frame, a single vane secured to one pump member against radial sliding engagement therewith and which flexibly connects the cylinder and the rotor and has rocking engagement with one thereof, and means for rotating said pump members applied to the member to which the vane is so secured, said pump being provided with fluid supply and discharge passageways which communicate with the pump chamber at opposite sides of the pump vane, one of which passageways comprises a section formed in the bearing shank of the rotor and both of which passageways communicate with other passageways formed through the pump frame, the pump vane being secured against radial sliding engagement to the pump cylinder, and the means for mounting said cylinder consisting of an axial shank on one of the cylinder heads, which is rotatably fitted through a bearing in the pump frame, and to which power for driving the pump is applied directly, the relation being such that the bearing for said shank will be positioned between said cylinder head and the contemplated point of application of power thereto.

2. In a rotary pump the combination of a frame, pump members comprising a cylinder having an opening in one end thereof, and a rotor within said cylinder, means for rotatably mounting said cylinder and rotor on the pump frame, in eccentric tangential relation, comprising a shank rigidly fixed to one pump member and rotatably fitted to a bearing formed in the pump frame, a single vane secured to one pump member against radial sliding engagement therewith and which flexibly connects said pump members, said pump being provided with fluid supply and discharge passageways, a housing which encloses the opening in the end of the cylinder into which housing fluid leakage from the pump will drain, means for sealing said housing to render it air tight, said housing being in open communication with the fluid intake of the pump, and means for rotating said pump members, comprising a driving shank extended from the pump member in which the vane is secured against radial sliding engagement, said last named shank being fitted to a bearing formed outside of the inner confines of the housing into which fluid leakage will flow, a section of the discharge passageway being formed in one pump member and the shank rigidly fixed thereto.

3. The rotary pump specified in claim 2, in which the pump member in which the discharge passageway is formed has sealing contact with a portion of the housing of the pump.

4. The pump specified in claim 2, in which the shank through which a section of the discharge passageway is formed constitutes a bearing shank

which extends through the opening in the end wall of the cylinder.

5. The rotary pump specified in claim 2, in which the pump member having the discharge passageway formed therein has sealing annular contact with an inner portion of the pump housing, the relationship being such that said sealing contact is outside of and closely adjacent to the circumference of the shank rigidly fixed to the said pump member.

6. The pump specified in claim 2, in which the frame of the pump and air tight housing constitute a unit which encloses the rotatable pump members, and in which the drive shank extends through a wall of said unit and sealing means for said drive shank in said wall.

7. A duplex rotary pump comprising primary and secondary pumps, the primary pump comprising a cylinder and rotor rotatably mounted in eccentric, tangential relation, a pump vane secured to the primary pump cylinder against radial sliding engagement therewith, a rock-member rotatable in an open-sided bearing formed in the rotor of the primary pump provided with a slot to which the vane of the primary pump is slidably fitted and the secondary pump comprising a tangentially engaging cylindrical recess and boss formed respectively, in an end of the rotor and on the proximate cylinder head of the primary pump concentric, respectively, with the axes of rotation of the rotor and cylinder of the primary pump, and in tangential relation to each other, and a projection on the primary pump vane which extends through a cut-away portion of the bottom of the slot in the rock-member to which the primary pump vane is slidably fitted, the end of which contacts with the perimeter of the boss which forms the rotor of the secondary pump, and constitutes a vane which divides the secondary pump chamber into suction and discharge compartments, the relation being such that the suction compartments of said pumps are at all times separated within the confines of the cylinder of the primary pump, and means for rotating said pump members applied to the cylinder of the primary pump, said primary pump having a pump frame a portion of which frame is exposed through an opening in a primary cylinder head, and the fluid circulating connections of the secondary pump comprising a segmental groove formed in the portion of the pump frame so exposed, there being a passageway which connects the said groove with a source of fluid supply, there being also a passageway formed in the primary pump rotor which communicates with the suction side of the secondary pump, an end of which passageway opens through the wall of the rotor in position to communicate with said segmental groove; the distributing discharge passageways for the secondary pump comprising two segmental grooves formed in the portion of the pump frame exposed within the primary pump cylinder, said grooves being concentric with the axis of rotation of the primary pump rotor and at opposite sides thereof, there being a second passageway in the primary pump rotor one end of which communicates with the discharge side of the secondary pump and the other end of which opens through the end wall of the primary rotor opposite to the recess formed therein in position to communicate successively with the said distributing segmental grooves in continuous succession during operation of the pump, there being suitable ducts provided in the frame which lead from said distributing grooves to various points requiring lubrication.

8. In a compressor, pump members including a hollow cylinder and a piston, each rotatable about its own axis in tangential relation to the other, end plates closing the space between the members to form a pump chamber, a blade dividing the chamber into intake and discharge stages, the end plates and blade being rigidly secured to one of the members, the end plates having infinitesimal clearances with the other member, and the blade having a sliding and pivotal sealed connection in said other member, an auxiliary pump at least one member of which is rotatable with one of the first-named pump members, and means for delivering oil to said pump and from said pump to said clearances and to other parts needing lubrication including intake and discharge passages in a part of the rotating structure, and a stationary frame portion having conduits conveying said oil to different parts of the pump, and having a face which is radial with respect to the axis of rotation and which has a plurality of concentric grooves therein communicating with separate conduits and aligned with one of the passages to receive oil therefrom during different parts of the revolution of the rotating structure; the entire output of the auxiliary pump being confined successively to each of the separate conduits, except for flow through infinitesimal clearances.

9. In a compressor, pump members including a hollow cylinder and a piston, each rotatable about its own axis in tangential relation to the other, end plates closing the space between the members to form a pump chamber, a blade dividing the chamber into intake and discharge stages, the end plates and blade being rigidly secured to one of the members, the end plates having infinitesimal clearances with the other member, and the blade having a sliding and pivotal sealed connection in said other member, an auxiliary pump at least one member of which is rotatable with one of the first-named pump members, and means for delivering oil to said pump and from said pump to said clearances and to other parts needing lubrication including intake and discharge passages in a part of the rotating structure, and a stationary frame portion having conduits conveying said oil to different parts of the pump, and having a face which is radial with respect to the axis of rotation, which face has a plurality of concentric grooves therein communicating with separate conduits and aligned with one of the passages to receive oil therefrom during different parts of the revolution of the rotating structure, and which face has a third groove radially spaced from the first-named groove, aligned with the other of said passages and communicating with an oil reservoir to supply oil to said auxiliary pump.

10. In a compressor, an air-tight dome, pump members within the dome including a rotatable hollow cylindrical member, a core member mounted therein in eccentric tangential relation for rotation about its own center, and end plates rigidly secured to one of said members and having infinitesimally small end clearances with the other to form a pump chamber, means dividing the chamber into intake and discharge sections comprising a blade rigidly secured to the same member to which the end plates are secured and having a sealed fit with said member and said end plates, said blade having a sliding and rocking engagement with the other member, a dis-

charge port for the discharge section opening through the cylindrical member, and an intake port for the intake section, means for driving the blade through one of the elements rigid therewith to produce a pumping action, bearing supports for the pump members, and for at least one of said pump members on both sides thereof at points farther apart than the width of the pumping chamber, a lubricating and gas sealing system associated with the compressor including means adapted to deliver oil to said infinitesimal end clearances in sufficient quantity and at a pressure at least in excess of dome pressure to effectively seal said clearances against gas leakage and cause some oil to enter the pump chamber, and a stationary wall within the dome and positioned close to the cylindrical member substantially throughout the zone of discharge therefrom against which the fluid discharged from the cylindrical member impinges, whereby oil is separated from the compressed gas.

11. In a compressor, pump members including a rotatable hollow cylinder and a rotatable core mounted in eccentric tangential relation thereto, each being rotatable about its own center, end plates closing the space between the members to form a pump chamber, a blade dividing the chamber into intake and discharge sections, the end plates and blade being rigidly secured to one of the members, the end plates having infinitesimal clearances with the other member, and the blade sliding in a rocker in said other member and having at least a portion extending at all times at least to the pivotal axis of the rocker, means for driving the rigid assembly including the end plates and blade and through the blade driving said other member, bearings for each of said members, and for at least one of said members on both sides thereof, and means for sealing and lubricating said infinitesimal clearances including a secondary pump adapted to deliver oil to said infinitesimal clearances in sufficient quantity and at a pressure at least in excess of the pump chamber pressure to effectively seal said clearances against gas leakage, and supply passage means for supplying oil to the secondary pump from below the level thereof including an oil trap to maintain oil at least as high as the secondary pump for priming it.

12. In a compressor, pump members including a hollow cylinder and a piston, each rotatable about its own axis in tangential relation to the other, end plates closing the space between the members to form a pump chamber, a blade dividing the chamber into intake and discharge stages, the end plates and blade being rigidly secured to one of the members, the end plates having infinitesimal clearances with the other member, and the blade having a sliding and pivotal sealed connection in said other member, an auxiliary positive displacement pump at least one member of which is rotatable with one of the first-named pump members, and means for delivering oil to said pump and from said pump to said clearances and to other parts needing lubrication including intake and discharge passages in a part of the rotating structure, and a stationary frame portion having conduits conveying said oil to different parts of the pump, and having a face which is radial with respect to the axis of rotation and which has a plurality of concentric grooves therein communicating with separate conduits and aligned with one of the passages to receive oil therefrom during different parts of the revolution of the rotating structure; the entire output of the auxiliary pump being confined successively to each of the separate conduits, except from flow through infinitesimal clearances.

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