

May 16, 1933.

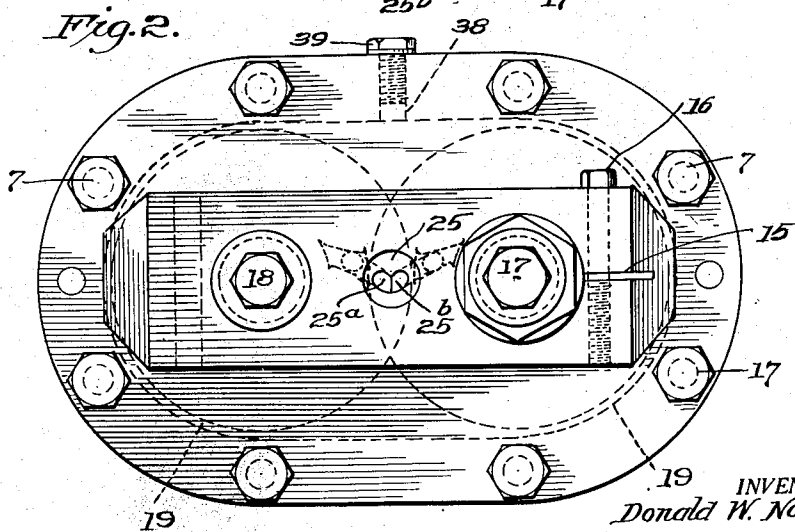
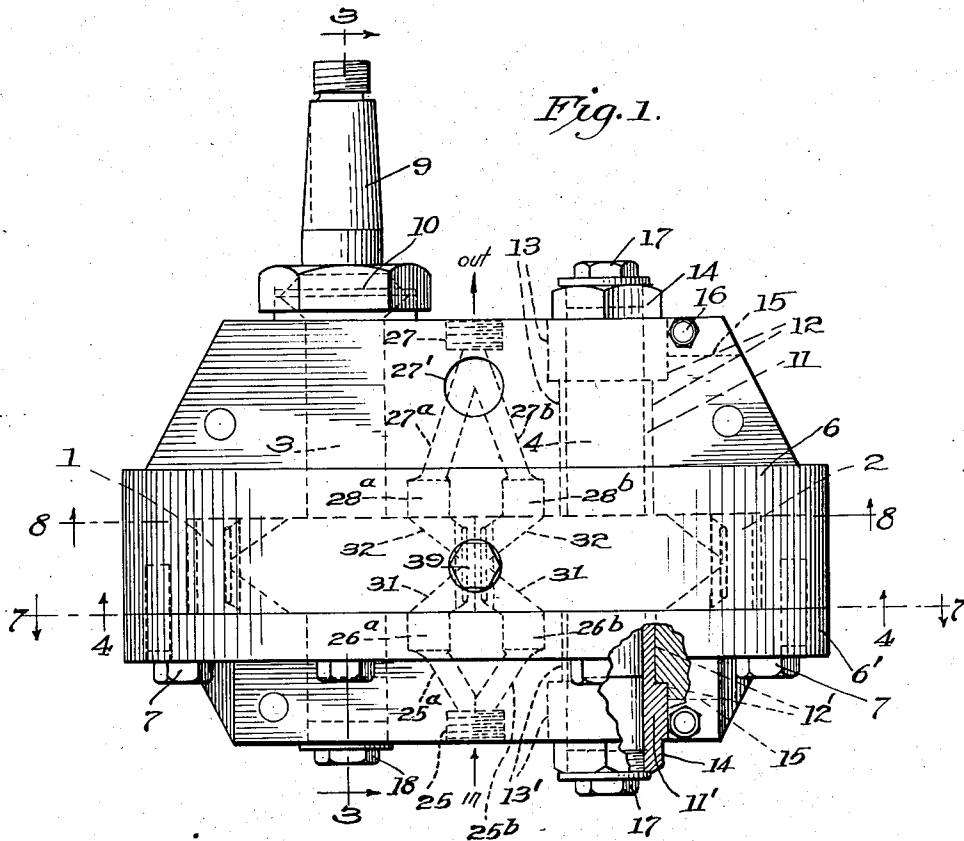
D. W. NORWOOD

1,909,418

ROTARY MACHINE

Filed Oct. 28, 1929

5 Sheets-Sheet 1



INVENTOR.
Donald W. Norwood,
BY Arthur P. Knight and
Alfred W. Knight
ATTORNEYS

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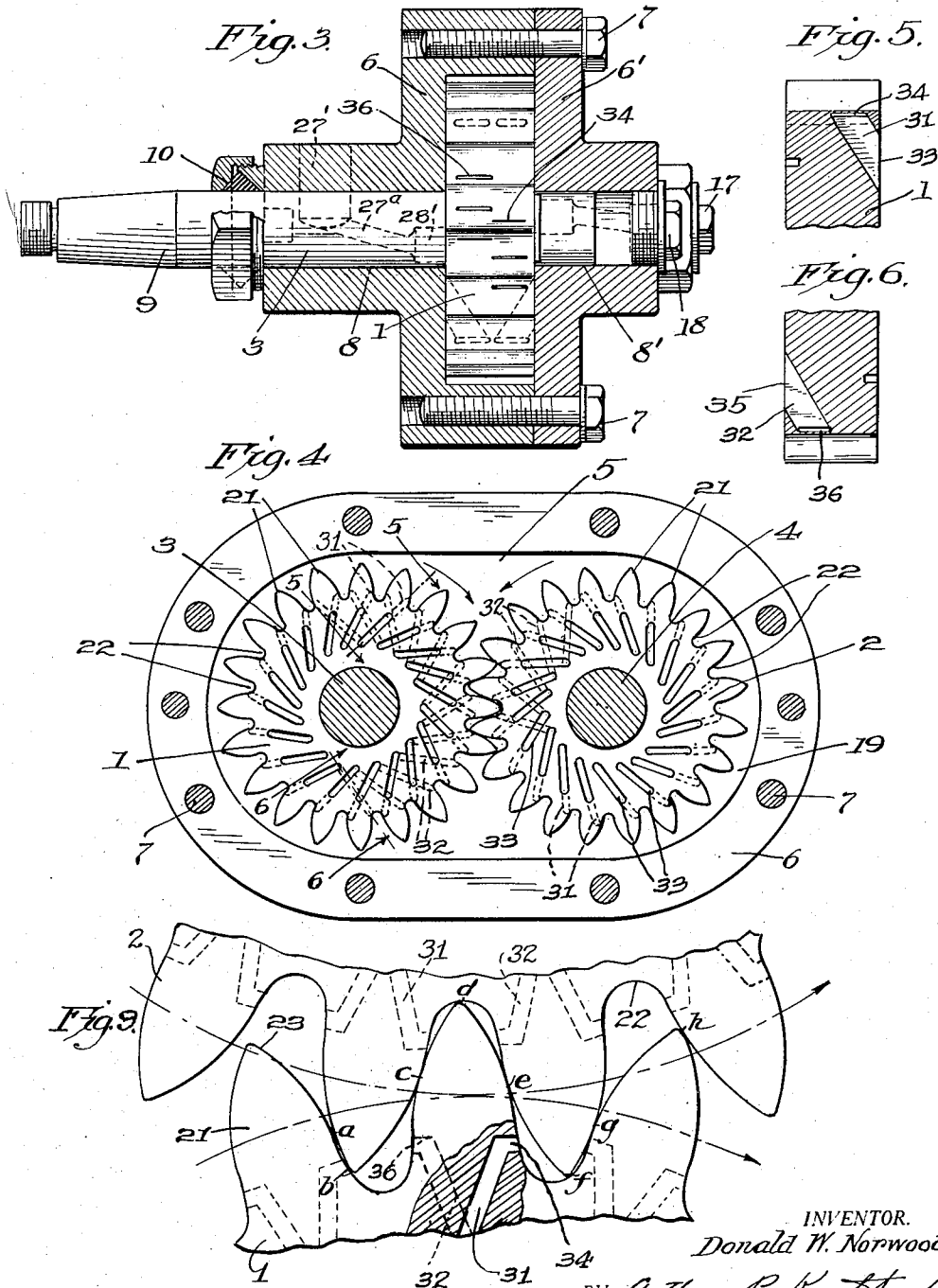
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Donald W. Norwood,
BY Arthur P. Knight and
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5 Sheets-Sheet 3

Fig. 7.

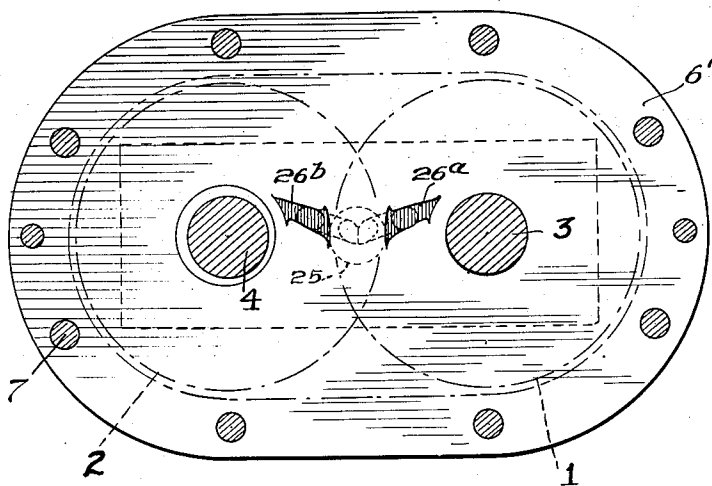
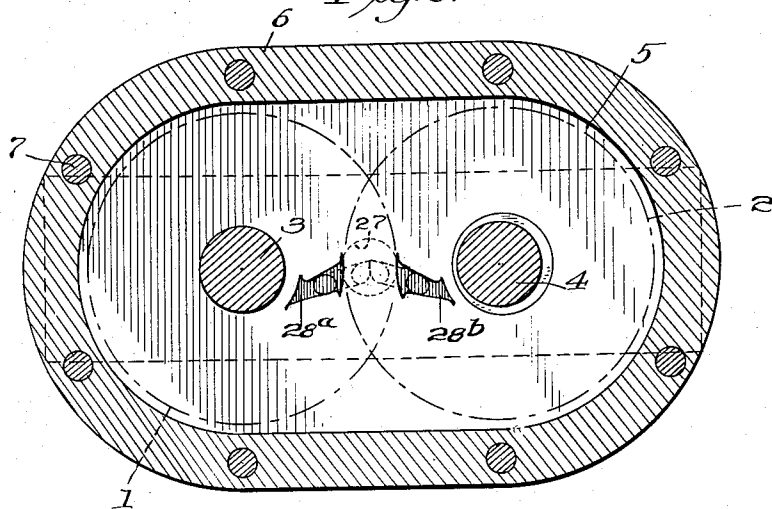


Fig. 8.



INVENTOR.
Donald W. Norwood.
BY *Arthur P. Knight and*
Alfred W. Knight
ATTORNEYS

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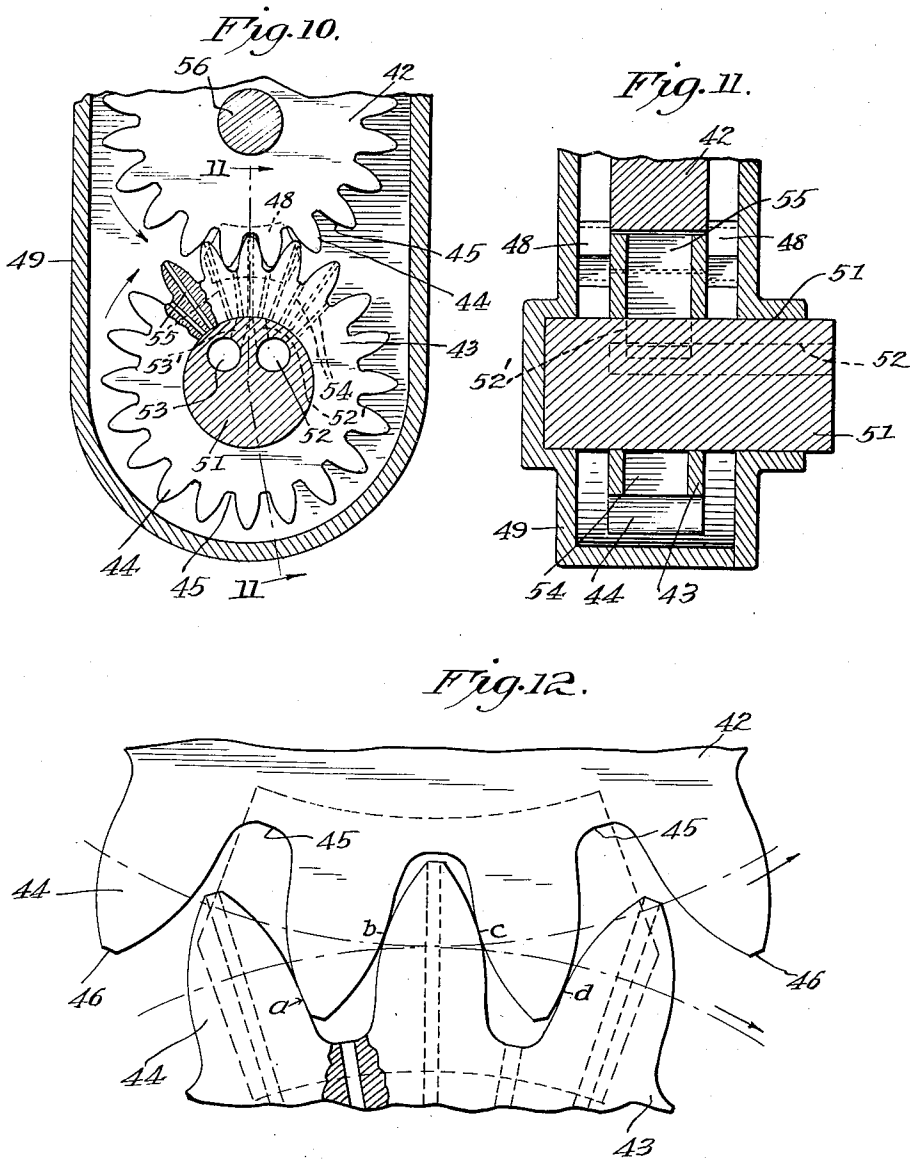
D. W. NORWOOD

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5 Sheets-Sheet 4



INVENTOR.
Donald W. Norwood.
 BY *Arthur P. Knight and*
Alfred W. Knight
 ATTORNEYS

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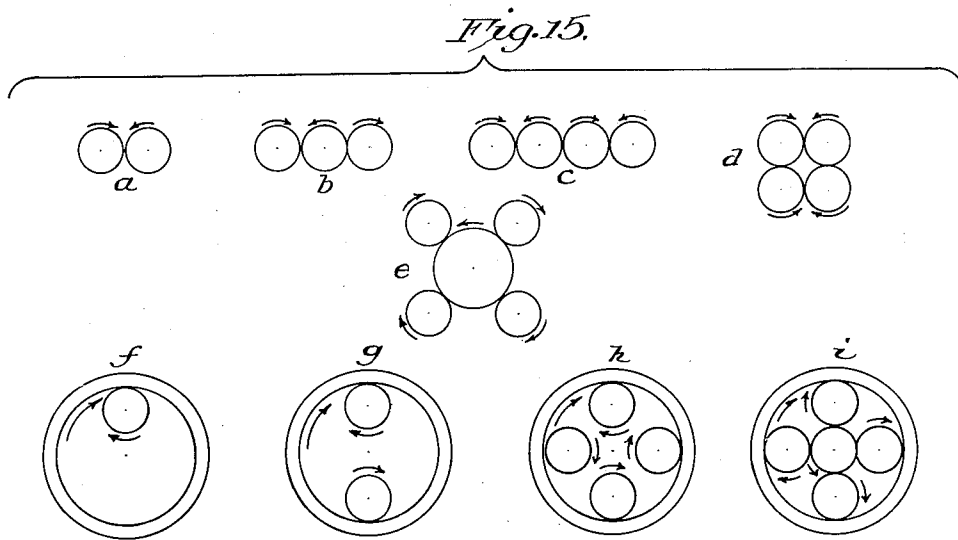
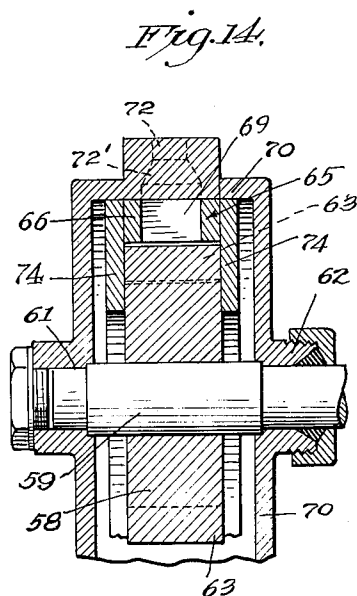
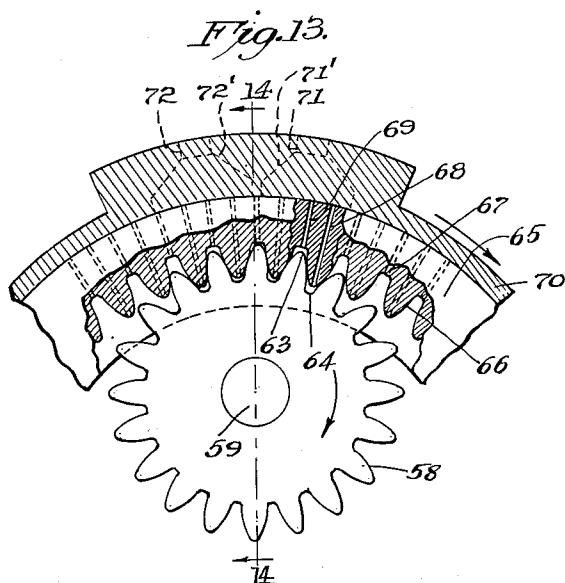
D. W. NORWOOD

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5 Sheets-Sheet 5



INVENTOR.
Donald W. Norwood,
BY *Arthur P. Knight and*
Alfred W. Knight,
ATTORNEYS

UNITED STATES PATENT OFFICE

DONALD W. NORWOOD, OF MARCH FIELD, CALIFORNIA

ROTARY MACHINE

Application filed October 28, 1929. Serial No. 403,018.

This invention relates to a rotary machine which is particularly adapted to function as a prime mover or motor operable by fluid pressure, but may also be used for other purposes, for example, as a fluid pump or as a brake.

When the device is used as a motor it will continuously convert the energy transmitted by a flow of fluid under pressure into mechanical energy transmitted by a rotating shaft, and conversely, when operated as a pump, it will continuously convert the mechanical energy transmitted by a rotating shaft into energy represented by the discharge of liquid at increased pressure. By connecting the device as a pump and partially or completely closing the outlet, it will function as a highly effective brake, since its pumping action is positive.

The principal object of the invention is to provide a simple rotary machine which will operate positively and efficiently as a fluid pressure motor. A further object of the invention is to provide a device of this type which is also adapted to operate as a pump, so that if desired, it may be made to act interchangeably as a motor or as a pump.

The device comprises essentially a plurality of rotary members each having a circumferentially arranged series of teeth providing alternate projections and depressions which are so designed that when said members are placed in proper relative positions the projections on each member will mesh with the depressions on one or more other members. These projections and depressions are also so designed that when they are in mesh with one another they form the partial boundaries of operating chambers, the boundaries of said chambers being completed by means providing suitable bounding surfaces at the opposite sides of said members, for example by the side walls of a suitable casing within which said rotary members are mounted. Furthermore, said projections and depressions are so designed that, when in full mesh with one another, each projection of each rotary member makes contact with a depression of the other rotary member in at least two positions so as to define at least one

separate operating chamber completely enclosed between such projection and depression and the casing walls or other bounding surface means. As the rotary members rotate on their axes, these operating chambers change uniformly in size in such manner that at any particular time certain chambers are becoming progressively larger and others are becoming progressively smaller; some of the chambers open up and lose their identity as such, while others are newly formed between the teeth as they come into mesh. With these completely enclosed operating chambers which progressively change volume as the rotary members turn on their axes, it is possible to cause rotation of such members by forcing a fluid under pressure through suitable passageways and ports into those chambers which are so positioned as to increase in volume upon such rotation while permitting outflow of fluid through suitable passageways and ports from those chambers which are in position to decrease in volume upon such rotation, thus operating the device as a fluid pressure motor. Conversely, by applying power to the shaft of one of the rotary members, so as to cause simultaneous rotation of all of said members due to their being geared together by the projections and depressions thereon, fluid may be drawn in through the aforesaid passageways and ports to the chambers which increase in size and may be discharged from the chambers which are decreasing in size, thus causing the device to operate as a pump.

The accompanying drawings illustrate a form of apparatus in accordance with this invention and referring thereto:

Fig. 1 is a plan view of a simple form of my rotary machine, which is adapted for use either as a motor or a pump.

Fig. 2 is a side elevation of the apparatus.

Fig. 3 is a section on line 3—3 in Fig. 1.

Fig. 4 is a section on line 4—4 in Fig. 1.

Figs. 5 and 6 are sections through one of the rotary members, on the lines 5—5 and 6—6 respectively in Fig. 4, showing the passageways therein for inflow and outflow of

fluid to and from the operating chambers.

Fig. 7 is a section on line 7—7 and Fig. 8 a section on line 8—8 in Fig. 1.

Fig. 9 is a partial side elevation of the intermeshing portions of the two rotary members.

Fig. 10 is a sectional view of a modified form of the invention.

Fig. 11 is a section on line 11—11 in Fig. 10.

Fig. 12 is a partial side elevation of the intermeshing portion of the two rotary members in this form of the invention.

Fig. 13 is a partial sectional view of another modification.

Fig. 14 is a section on line 14—14 in Fig. 13.

Fig. 15 indicates diagrammatically a few of the different arrangements of rotary members which may be used in carrying out this invention.

In the form of apparatus shown in Figs. 1 to 9, the rotary members are formed as discs indicated at 1 and 2, secured respectively to shafts 3 and 4. Said discs are mounted within a chamber 5 provided by a casing comprising two portions 6 and 6' which may be secured together in any suitable manner as by means of bolts 7. The shaft 3 is rotatably mounted in bearings 8 and 8' on said casing members, said shaft being extended through the bearing member 8 at one end as shown at 9 for connection of suitable means thereto for delivering mechanical energy from or to said shaft. A high pressure packing gland 10 is preferably provided around the projecting portion 9 of shaft 8 so as to prevent leakage into or out of the casing. The other shaft 4 is rotatably mounted in bearing members 11 and 11' respectively, whose cylindrical exterior surfaces 12 and 12' are eccentric with respect to the bearing openings therein. These eccentric members are rotatably mounted in recesses 13 and 13' in the casing members 6 and 6' respectively, so that by rotation thereof to different angular positions in said recesses, the disc 2 may be moved relatively toward or away from the disc 1 so as to provide the desired tightness of meshing between the teeth of said discs. Each of said bearing members may be provided with a projecting head for effecting angular adjustment thereof and said bearing members may be clamped in adjusted position by splitting the adjacent portion of the casing at one side thereof, as shown at 15 and providing means such as bolts 16 for clamping the casing together around said bearing members. The bearing recesses for shaft 4 are shown as extending entirely through the bearing members 11 and 11' and the outer ends of said recesses may be closed by plugs 17 threadedly engaging in said bearing members. Furthermore, the bearing recess for shaft 3 in casing member 6' is shown as extending en-

tirely through said casing member and the outer end of said recess may be closed by a plug 18 threadedly mounted in said casing member. The walls of discs 1 and 2 are so designed as to make a fairly snug running fit between the opposing side walls of casing members 6 and 6', but the chamber 5 is preferably of sufficient size in the plane of said discs to provide clearance between the peripheries of said discs and the walls of said chamber, as indicated at 19.

Each of the discs is provided at its periphery with a plurality of teeth forming alternate projections 21 and depressions 22 which are so designed as to mesh closely with one another when the discs are adjusted to proper relative positions. Referring particularly to Fig. 9, it may be seen that the teeth are furthermore so designed that the tip 23 of each projection will engage and move in contact with the surface of the corresponding depression of the other disc throughout a certain portion of the rotation of said discs and that the two side faces of each projection will also engage and move in contact with the side faces of the corresponding depression (or of the two adjacent projections) of the other discs. Thus, in this form of the invention, each projection contacts the opposing depression in three positions, causing two distinct operating chambers to be confined between that projection and depression and the walls of the casing. These several points of engagement or moving contact define the cross sectional areas of the several operating chambers, and it will be seen that as the discs rotate some of these cross sectional areas will increase while others will decrease, and the corresponding chambers will also increase or decrease. The several points of contact with the discs in the position shown in Fig. 9 are indicated at *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h*. With discs rotating in the direction shown by the arrows in this figure, the chambers defined between the rearward faces of the respective projections of each rotor and the rearward faces of the opposing depressions, whose cross-sectional areas are shown at *a—b*, *c—d*, *e—f*, and *g—h*, continually increase in size throughout the entire period of engagement of the projections and depressions between which said chambers are defined, while the chambers defined between the forward faces of the projections and the forward faces of the depressions, as indicated at *b—c*, *d—e*, and *f—g*, continually decrease in size throughout such period. In the position shown, the chamber *a—b* has just started to form, while the chamber *g—h* is about to open up and lose its identity. The chamber *f—g* is about to disappear entirely as the points *f* and *g* approach one another, while a new chamber is about to be formed to the left of point *a*.

For supplying fluid to those chambers

which are increasing in size and removing fluid from those chambers which are decreasing in size, the casing and the discs are provided with suitable passageways or ports.

5 The passageways in the discs communicate with these chambers at the peripheries of the discs, that is, at the faces of the respective depressions or projections, and are adapted to register with the passageways in the casing

10 ing at the proper time so as to deliver or receive fluid only at those portions of the peripheries of the discs which at any particular instant form the partial boundaries of these completely confined separate operating

15 chambers. Assuming a direction of rotation of the discs as indicated by the arrows in Fig. 4 and Fig. 9, the casing member 6' is shown as provided with an inlet passage 25 having two branches 25a and 25b, the inner

20 ends of said passages opening through the inner face of this casing member and providing inlet ports 26a and 26b which are in alignment with the solid portions of the respective discs. The casing member 6 is

25 provided with an outlet passage 27 having two branches 27a and 27b whose inner ends open through the inner face of this casing member and provide outlet ports 28a and 28b also positioned in alignment with the

30 solid portions of said discs but at the opposite sides thereof from the ports 26a and 26b. Each of the discs is also provided with a plurality of inlet passages 31 and a plurality of outlet passages 32, the number of

35 each of said passages corresponding to the number of teeth on said disc. The inlet passages 31 open at one end through ports 33 at the side of the discs which move over the inlet ports 26a and 26b in the casing, said

40 ports 33 being adapted to register successively with port 26a or 26b respectively, and said passages open at their other end through ports 34 at the periphery of the discs. These

45 ports 34 are shown as located at the rearward faces of the depressions 22 of the respective discs and in such position as to establish communication with each operating chamber substantially immediately upon formation of

50 such chamber and to continue such communication until such chamber loses its identity. It will be understood, however, that if desired these ports may be located at proper positions on the projections of the respective

55 discs instead of in the depressions thereof. Similarly, the outlet passages 32 open at one end through ports 35 at the side of the discs which move over the outlet ports 28a and 28b

60 of the discs, namely, at the forward faces of the depressions 22. The upper and lower edges of the inlet and outlet ports in the casing are shown as shaped to conform to the shape and position of the corresponding ports

65 33 and 35 in the discs so as to provide for es-

tablishing and breaking communication between said ports substantially instantaneously along the entire length of said ports, and thus insure the sharpest possible opening and closing of said ports.

70 The outlet passage 27 is shown as having another opening 27' through the top of the casing member 6 as well as the main opening 27 at the side thereof. It will be understood that suitable pipes or the like may be connected to the inlet passage 25 and to either

75 of the outlet passages 27 and 27', for conveying fluid to and from the machine. Which ever opening 27 or 27' is not thus connected may be closed by a suitable plug. It will

80 also be understood that any suitable means such as a pulley may be mounted on the extension 9 of shaft 3 for delivering mechanical power derived from rotation of the discs

85 when the machine is used as a fluid motor or for receiving power for rotation of said discs when the device is operated as a pump.

In the operation of the machine as a fluid motor, the working fluid, which may consist for example of a suitable liquid such as water

90 or oil, is delivered through inlet passage 25 and branches 25a and 25b to ports 26a and 26b and thence to the passages 31 which are at that time in register with said ports. Such

95 fluid then passes through ports 34 into the corresponding operating chambers, for example, the chambers a-b, c-d, e-f and g-h in Fig. 9. The pressure of this fluid will cause the discs to rotate in such direction

100 as to continually increase the volume of these chambers, that is, in the direction indicated by the arrows in said figure. Such rotation in turn causes the chambers b-c, d-e and

105 f-g, to continually decrease in volume and since the pressure at the outlet side of the machine is less than that at the inlet side, fluid will be exhausted from these chambers

110 through ports 36, passages 32, and thence through outlet ports 28 and 28b, passages 27a and 27b and main outlet passage 27 or 27'. It will be observed that in this operation

115 the fluid supplied to the working chambers of increasing volume empties eventually into the common chamber 5 around the discs and inside the casing, as said working chambers

120 successively open up, while a volume of fluid equivalent to that so discharged into this common chamber is trapped in the chambers of decreasing volume and passes thence through the outlet passages. The discs may

125 thus be caused to rotate at any desired speed, depending on the difference in pressure between the incoming fluid and the fluid exhausted from the machine.

The motor is reversible in its operation and

130 is perfectly symmetrical so that by reversing the relative positions of the inlet and outlet pipes or by means of suitable valve mechanism for reversing the direction of fluid flow through the machine, the direction of rota-

tion of the discs may be reversed. The machine may also be operated by means of a gaseous fluid instead of a liquid, and in that case the inlet ports in the casing are preferably shortened so as to provide the desired cut off, that is, to shut off communication from the inlet passage to each operating chamber somewhat before the time when said chamber reaches its maximum volume, and thus permit the gas to expand and reduce the pressure to substantially the pressure existing in the exhaust passages.

It will be readily apparent from the above description that the machine will also operate effectively as a pump, by delivering mechanical power through the spindle 9 to shaft 3 and thence to both of the intermeshed discs. The resulting rotation of said discs will cause fluid to be drawn in through one set of passageways and ports to the chambers which are increasing in volume and discharged from the chambers which are decreasing in volume through the other set of passageways and ports.

As in the case of operation as a motor, so also as a pump, the machine may operate on either a liquid or a gas. When used for compressing a gas, a suitable amount of "cut-off" should be provided; that is, the outlet ports should be so located that the gas trapped in each decreasing chamber will be compressed until its pressure equals the pressure at the outlet of the pump, before communication from such chamber to the outlet is established.

Since the operation of this machine as a pump is positive, there is no limit to the pressure against which it can be made to work, and it therefore lends itself to use as a brake, by partially or completely closing the outlet means. The same properties, when operated as a motor, permit the use of fluid at as high pressure as necessary so as to give any desired starting torque and low speed torque.

A possible modification of the apparatus, for use as a pump, consists in supplying the fluid directly to the chamber 5 in which the discs are mounted instead of supplying it to the chambers of increasing size between the teeth of the discs, since each of the operating chambers which is formed at maximum size and decreases in volume receives its charge of fluid from the general supply of fluid in said chamber 5, and it is not necessary in this case to maintain a positive supply of fluid to the chambers which increase in size. In order to permit operation of the device as a pump in the manner last described, the casing member 6 may be provided with an opening 38 leading into the chamber 5. When this opening is not used for supply of fluid to said chamber as above described, it may be closed by means of a suitable plug 39, but when it is desired to

operate in this manner said plug is removed and the fluid inlet pipe connected thereto instead of to the inlet opening 25, which may be plugged in any suitable manner. It will be understood of course that, if desired, the apparatus may be originally designed to operate only in the manner last described, in which case the inlet passages and ports above described may be entirely omitted. In either case the fluid delivered to the chamber 5 is trapped in each operating chamber which is formed at maximum size, and as said chamber decreases in size such fluid is discharged through the outlet passages in the same manner as before.

It is also possible to operate the device as a fluid pressure motor with only one set of passages and ports. In this case, however, these passages must be those which communicate with the operating chambers of increasing size, so as to serve as inlet passages through which the operating fluid is admitted to such chambers. The fluid in this case may be exhausted directly from the chamber 5 through an opening at the bottom of said chamber, instead of exhausting the same from the chambers of decreasing size between the teeth of the discs. For example, the plug 39 may be removed from opening 38 and the fluid exhausted through said opening. In that case the outlet openings 27 and 27' would both be closed by suitable plugs. In case the operating fluid consists of a liquid, the machine should be operated in an inverted position to that shown in Fig. 2 so as to permit ready outflow of liquid from the chamber 5 and prevent such liquid from accumulating in said chamber to such a level as to be trapped in the chambers of decreasing size, for when operated in this manner there is no provision for outlet of liquid from such chambers. The removal of liquid from chamber 5 may also be facilitated, if desired, by placing the outlet opening 38 at the bottom thereof under suitable suction. It will be understood that in this case also the machine may be made expressly for operation in the manner just described, in which case the outlet passages and ports shown in Fig. 1 may be omitted.

Modifications may be made in the shape of the teeth of the rotary members. In the particular form shown, the projections and depressions on the discs have their curves based on an involute curve, angle of obliquity 20°. Other angles of obliquity may be used, however; also other types of curves, such as cycloidal. There is a considerable latitude allowable in the designing of the curves which are to be used in laying out the projections and depressions on the discs. However, all must fulfill the condition that a plurality of completely separate closed chambers are formed by those portions of the discs which are in mesh aided by suitable means defin-

ing bounding surfaces at the sides of these chambers.

With the discs designed as shown in Fig. 9, two separate and distinct chambers are formed at the opposite sides of each projection when it is in mesh with the mating depression. It is also possible to so design the projections and depressions on the discs that only a single chamber will be formed between each projection and the mating depression, and the device may in that case also be made to operate either as a motor, a pump, or a brake, by providing suitable passages and valves for the working fluid medium.

An example of such a construction is shown in Figs. 10, 11 and 12. This device comprises as before two rotatably mounted discs 42 and 43, each provided with teeth or projections 44 meshing with corresponding depressions 45 on the other disc. In this case, however, the ends of the teeth are cut off as indicated at 46, so that no contact is made directly at the tip of the tooth. As indicated in Fig. 12, each tooth therefore makes contact at only two points with the mating depression, so that only a single chamber is formed therebetween. For example, with the direction of rotation as indicated by the arrows in Fig. 12 the operating chamber *a-b* is decreasing in size while operating chamber *c-d* is increasing in size, operating chamber *b-c* being at this time at substantially minimum volume. In this case the bounding surfaces at the sides of the operating chambers are shown as provided by two suitably shaped blocks 48 which engage the side faces of the meshing portions of the discs over only substantially the limited area at which the operating chambers are defined, the remaining portions of the discs rotating entirely freely within the housing 49, so that the remaining portions of the sides of the discs are substantially free from frictional engagement. The blocks 48 may be secured to said housing in any suitable manner. I have also indicated in these figures that the passages leading to all of the operating chambers may be provided in one of the rotary members only, instead of providing some of the passages in each rotary member as in the form of the invention first described, and that the fixed passages with which these passages in the rotary member pass into and out of register may be provided in a fixed shaft on which this rotary member rotates, instead of in the side walls of the housing. The disc 43, for example, is shown as rotatably mounted on a fixed shaft 51 which is provided with inlet and outlet passages 52 and 53 and passages or ports 52' and 53' communicating respectively with the passages 52 and 53, and opening through the outer face of said shaft at the position of disc 43. Said disc 43 is provided with a plurality of radial passages 54

extending from the inner face to the outer face of said disc and opening at their outer ends at the bottoms of the several depressions 45, and also with a plurality of passages 55 extending radially from the inner to the outer face thereof and opening at their outer ends substantially at the tips of the several projections 44. The other disc 42 may be secured to a drive shaft 56 which corresponds to the shaft 3 above described, and which may be rotatably mounted in any suitable manner and provided with suitable means for delivering mechanical power to or from said shaft.

In the operation of this form of the invention as a motor, fluid is supplied under pressure through passages 52 and 52' and through the passages 54 or 55 which are then in register with passages 52', to the operating chambers which have already passed beyond the point of minimum volume and are, therefore, in position to increase in size upon further rotation, such as the chamber *c-d* in Fig. 12. The supply of fluid under pressure to these chambers, therefore, causes the discs to rotate in such direction as to cause an increase in volume thereof, that is, in the direction indicated by the arrows. Simultaneously, the chambers which are in position to decrease in volume, such as chamber *a-b* in Fig. 12, will discharge fluid through the passages 54 or 55 leading therefrom, and thence through outlet passages 53' and 53. It will be evident that this device can also be operated as a pump by applying mechanical power to shaft 56 which will cause fluid to be drawn in through the inlet passages to the chambers of increasing size and to be discharged from the chambers of decreasing size through the outlet passages.

A further modification of the invention is shown in Figs. 13 and 14. In this case one of the rotary members comprises as before a disc 58 secured to a drive shaft 59 rotatably mounted in bearing means 61 and 62 and provided with suitable means for delivery of mechanical power thereto or therefrom, for example in the same manner as the shaft 3 above. Said disc is provided as before with a plurality of projections 63 and depressions 64 at the periphery thereof. In this case, however, the other rotary member is shown as comprising a ring-shaped member 65 whose internal diameter is somewhat greater than the external diameter of disc 58, and which is also provided with a series of projections 66 and depressions 67. Said ring is so disposed with respect to the disc, as to cause the projections and depressions of the respective rotary members to mesh with one another and define operating chambers therebetween. The teeth may in this case be either of the form shown in Fig. 9 or of the form shown in Fig. 12, but I have shown teeth of the latter shape, that is, flattened or

cut off at their ends, so as to define only a single chamber between each tooth and the mating depression. Communication with these operating chambers is in this case provided by means of passages 68 and 69 extending through the ring-shaped member 65 and opening at their inner ends respectively at the tips of the projections 66 and the bottoms of the depressions 67. A suitable fixed structure, such as for example the housing 70 which is shown as enclosing both the disc and the ring, is provided with inlet and outlet passages 71 and 72 having ports 71' and 72' respectively adjacent the periphery of ring 65 in position to register successively with the respective passages 68 and 69 upon rotation of said ring. With this combination of disc and ring, the bounding surfaces at the sides of the operating chambers may, as before, be provided by fixed walls or other members, but I have shown such bounding surfaces as provided by flanges 74 secured to and projecting inwardly from the ring-shaped member and embracing the sides of disc 58.

This form of the invention may be operated as a motor by delivering fluid through ports 71' and the passages 68 and 69 to the operating chambers at the right side of the point of tangency of the disc and ring so as to cause rotation in the direction indicated by the arrows in Fig. 13, that is, in such direction as to increase the size of said chambers, while permitting outflow of fluid from the chambers of decreasing size at the left of the point of tangency, through the corresponding passages 68 and 69 to the exhaust port 72', or it may be operated as a pump by forcibly rotating the disc 58 through the drive shaft 59, causing fluid to be drawn in through the inlet port 71' to the chambers of increasing size and to be discharged from the chambers of decreasing size through the exhaust port 72'.

The discs or other rotary members carrying the projections and depressions may be as thick or as thin as desired for any individual case, and there is no limit as to size, either great or small, of such members, within the limits of constructional possibilities.

Furthermore, while I have described above only the use of two discs of equal size and the use of a single toothed disc and a toothed ring meshing therewith, it should be understood that these are only two cases out of a large number of possible combinations. In Fig. 15 I have shown diagrammatically a number of these arrangements which are illustrative of the wide variety of combinations which may be made. The two disc combination is shown at *a*, while combinations of three and four discs are indicated at *b* and *c*. An alternative arrangement of four intermeshing discs is indicated at *d*, it being evident that such an arrangement provides four points of meshing, whereas the arrangement shown at *e* pro-

vides only three. At *e* I have shown one large disc with four smaller discs disposed at different positions about the periphery thereof and all meshing with the larger disc. The combination of one disc and a ring, as above described, is indicated at *f*, while *g* and *h* show the provisions of two and four discs, respectively, within and meshing with a single ring. By adding one more disc, the arrangement shown at *i* may be obtained, which produces four more points of meshing by the addition of this one disc.

It will be understood that the various shapes and arrangements of rotary members, the different provisions for inflow and outflow of fluid, the different shapes of projections and depressions, the different provisions for closing the sides of the operating chambers, as well as the other features shown in the various modifications, are not restricted to use in connection with the particular form of the invention in which they are shown, but may also be substituted in any of the other forms. It will also be understood that suitable means may be provided in any case for adjusting the axis of one of the rotary members toward or away from the axis of the other member so as to take up wear on the depressions and projections. An example of means for this purpose is shown by the eccentric bearing members 11 and 11' in the form of the invention first described but, other means may also be used for this purpose.

I claim:

1. A rotary machine comprising casing means, two rotary members mounted within said casing means and each having a circumferential series of alternate projections and depressions meshing with those of the other member, said projections and depressions being so formed that each projection, when in mesh with an opposing depression, cooperates with said depression and with the walls of said casing means to define two completely separate operating chambers, one at each side of said projection, one of which chambers continually increases while the other continually decreases in size, upon rotation of said members, throughout the period of engagement of said projection and opposing depression, each rotary member being provided with a set of separate passageways individual to said projections thereon and each opening through the face of said member at the position of the chambers of increasing size and with another set of separate passageways individual to said projections and each opening through the face of said member at the position of the chambers of decreasing size, and means establishing communication through said casing means to the respective sets of passageways in said members during only the time when said passageways are in position of communication with said completely separate chambers.

2. A rotary machine comprising casing means and two rotary members mounted within said casing means and each having a circumferential series of alternate projections and depressions, the projections of each of said rotary members meshing in the depressions of the other rotary member, said projections and depressions being so formed that each projection, when in mesh with an opposing depression, cooperates with said depression and with the walls of said casing means to define two completely separate operating chambers at the rearward and forward sides respectively of said projection, the chamber defined between the rearward face of each projection and the rearward face of the opposing depression continually increasing in size and the chamber defined between the forward face of each projection and the forward face of the opposing depression continually decreasing in size, upon rotation of said members, throughout the period of engagement of said projection and depression, each rotary member being provided with a set of separate passageways corresponding to the respective projections and opening through the peripheral face thereof in position to communicate with the respective chambers of increasing size and with another set of separate passageways corresponding to the respective projections and opening through the peripheral face thereof in position to communicate with the respective chambers of decreasing size, said casing means being provided with an inlet passage means positioned to register with the passageways of said first-named set when the corresponding projections are in meshing engagement and with outlet means positioned to register with the passageways of the second-named set when the corresponding projections are in meshing engagement.

3. A rotary machine as set forth in claim 2, the passageways of the first-named set opening through the rearward faces of the respective depressions of each rotary member, and the passageways of the second-named set opening through the forward faces of the respective depressions of each rotary member.

In testimony whereof I have hereunto subscribed my name this 22 day of October 1929.

DONALD W. NORWOOD.