June 6, 1933. E. J. SVENSON 1,912,737

ADJUSTABLE DISPLACEMENT GEAR PUMP

Filed Feb. 24, 1930 2 Sheets-Sheet 1

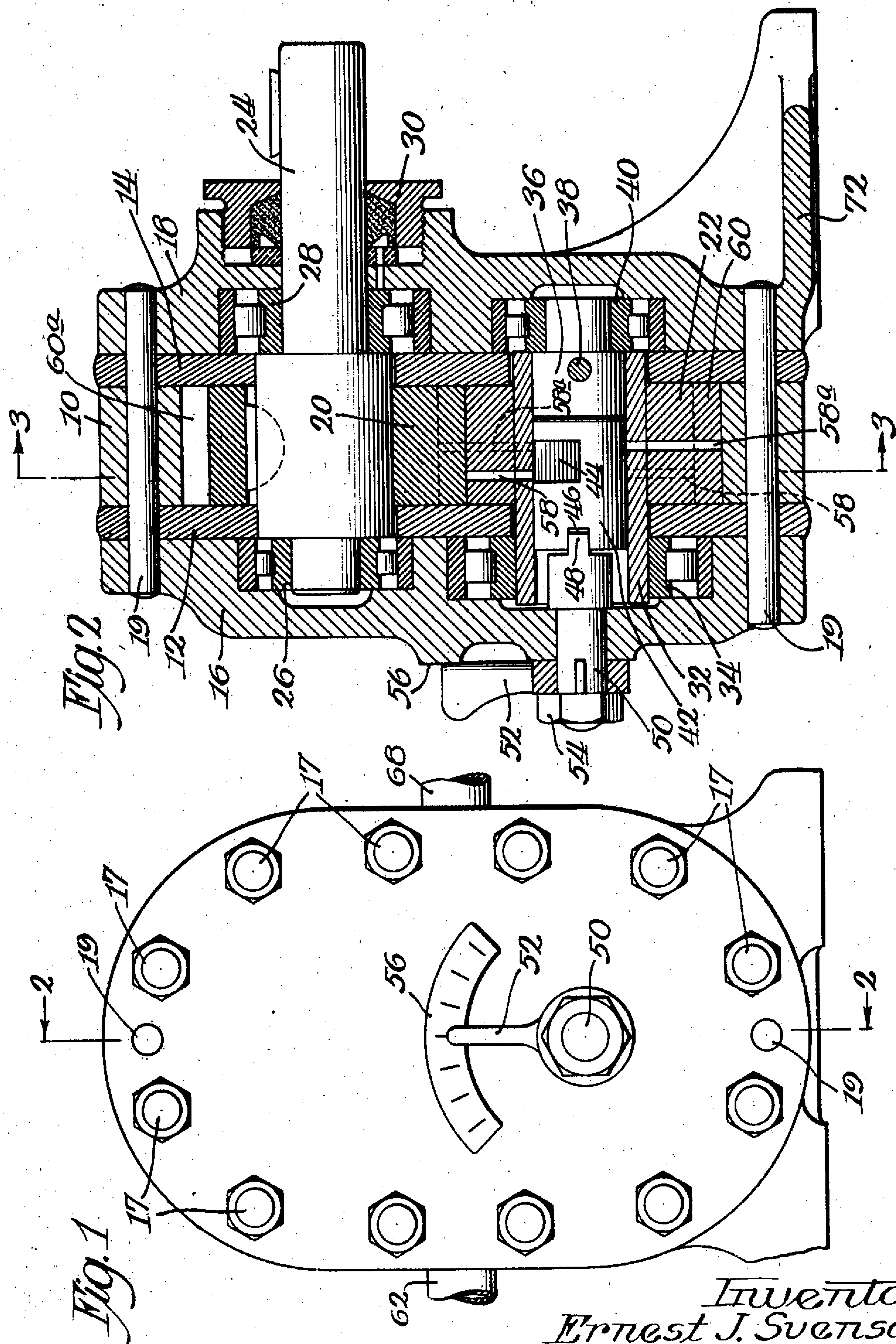

Fig. 2

Fig. 1

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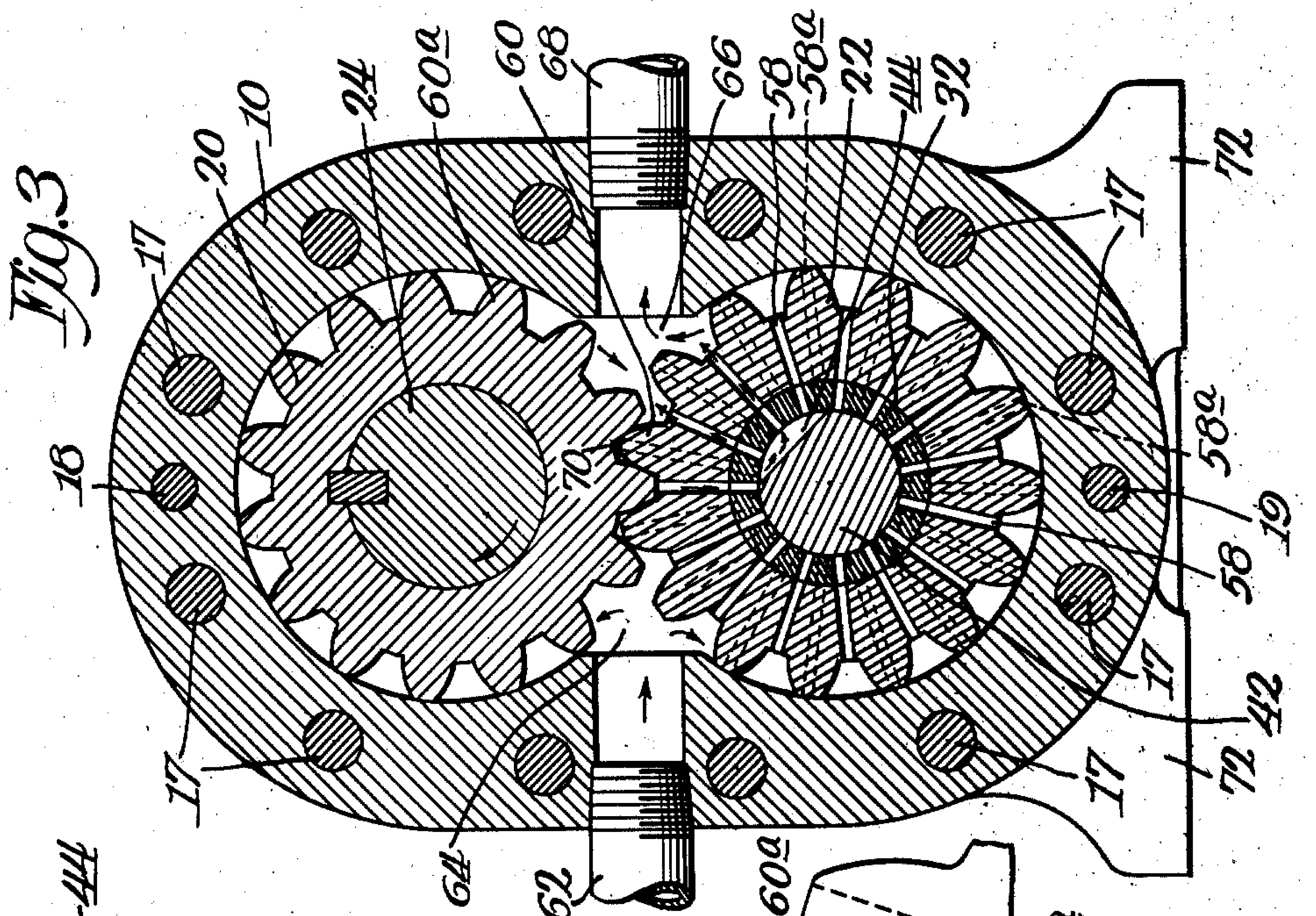

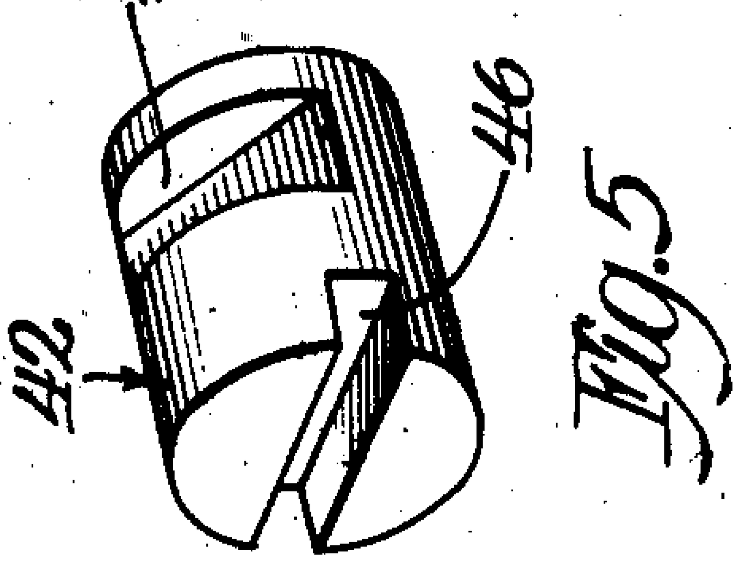

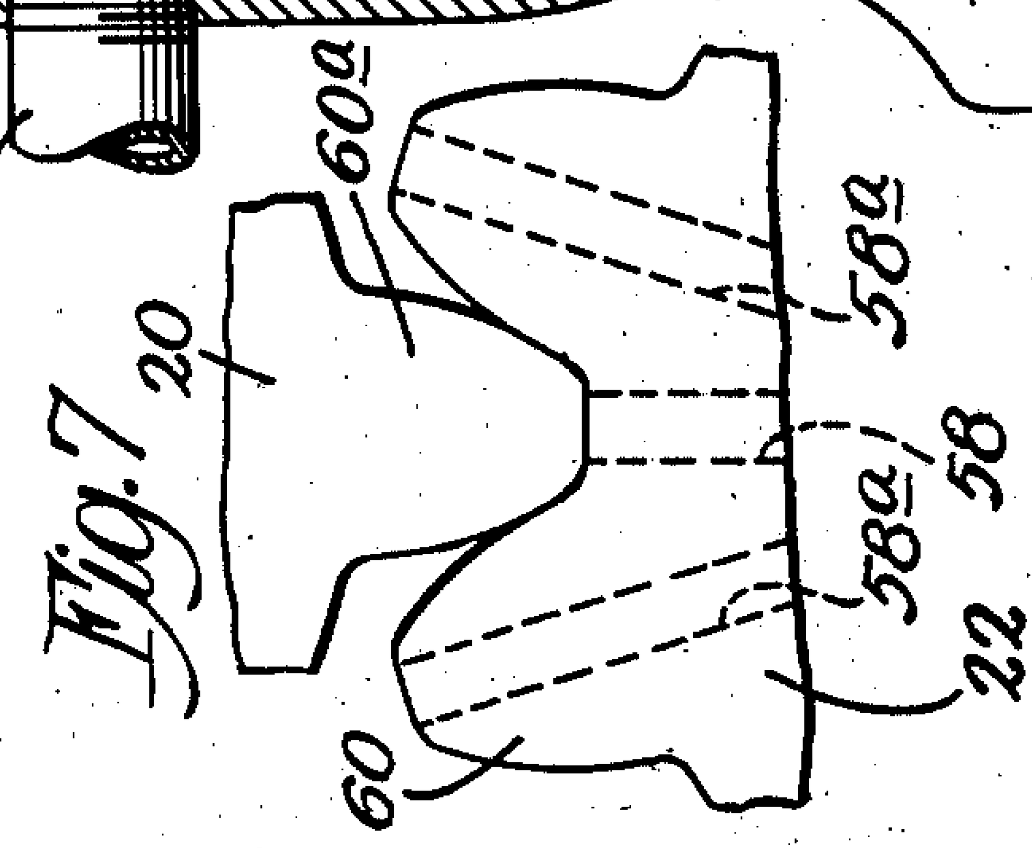

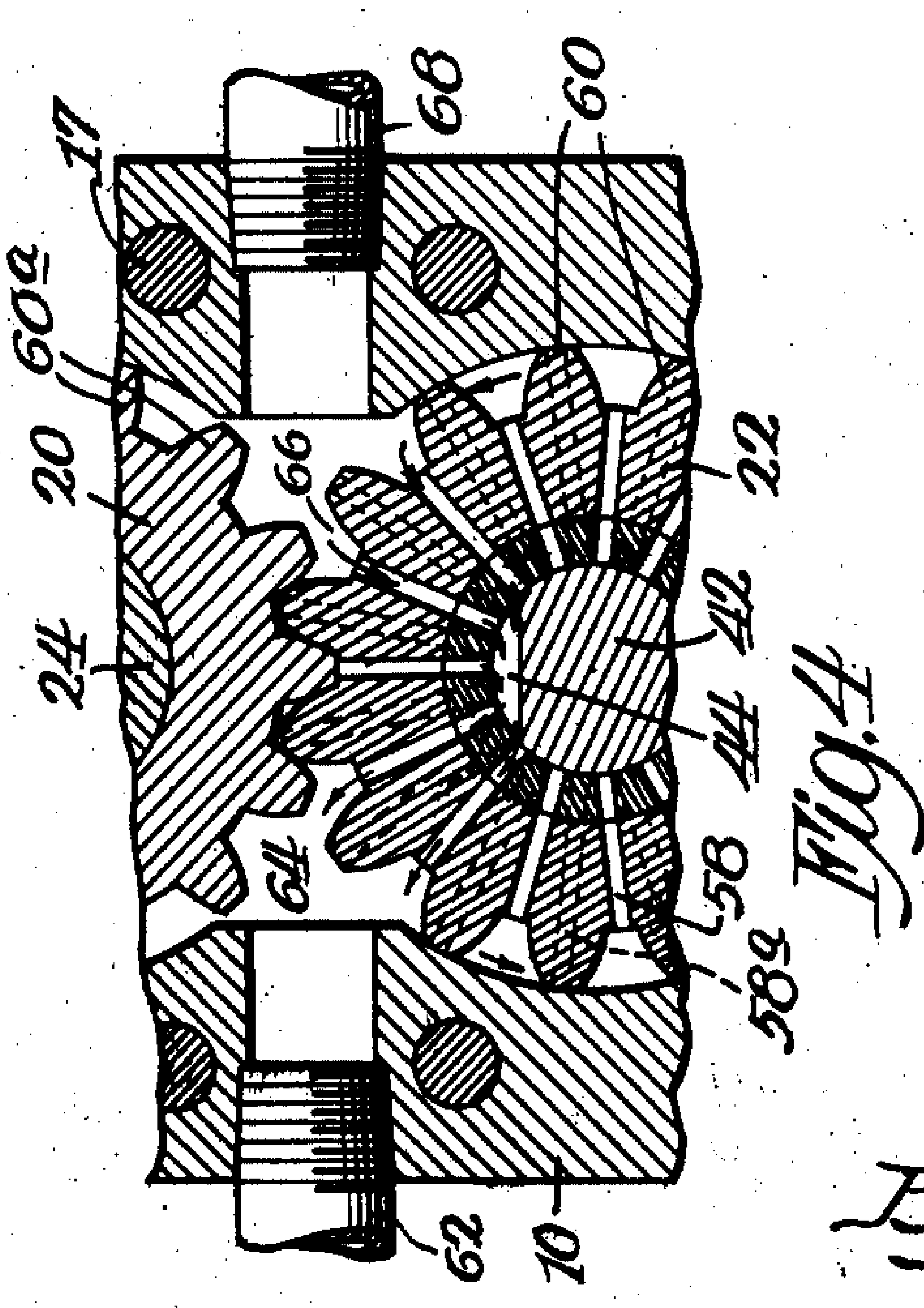

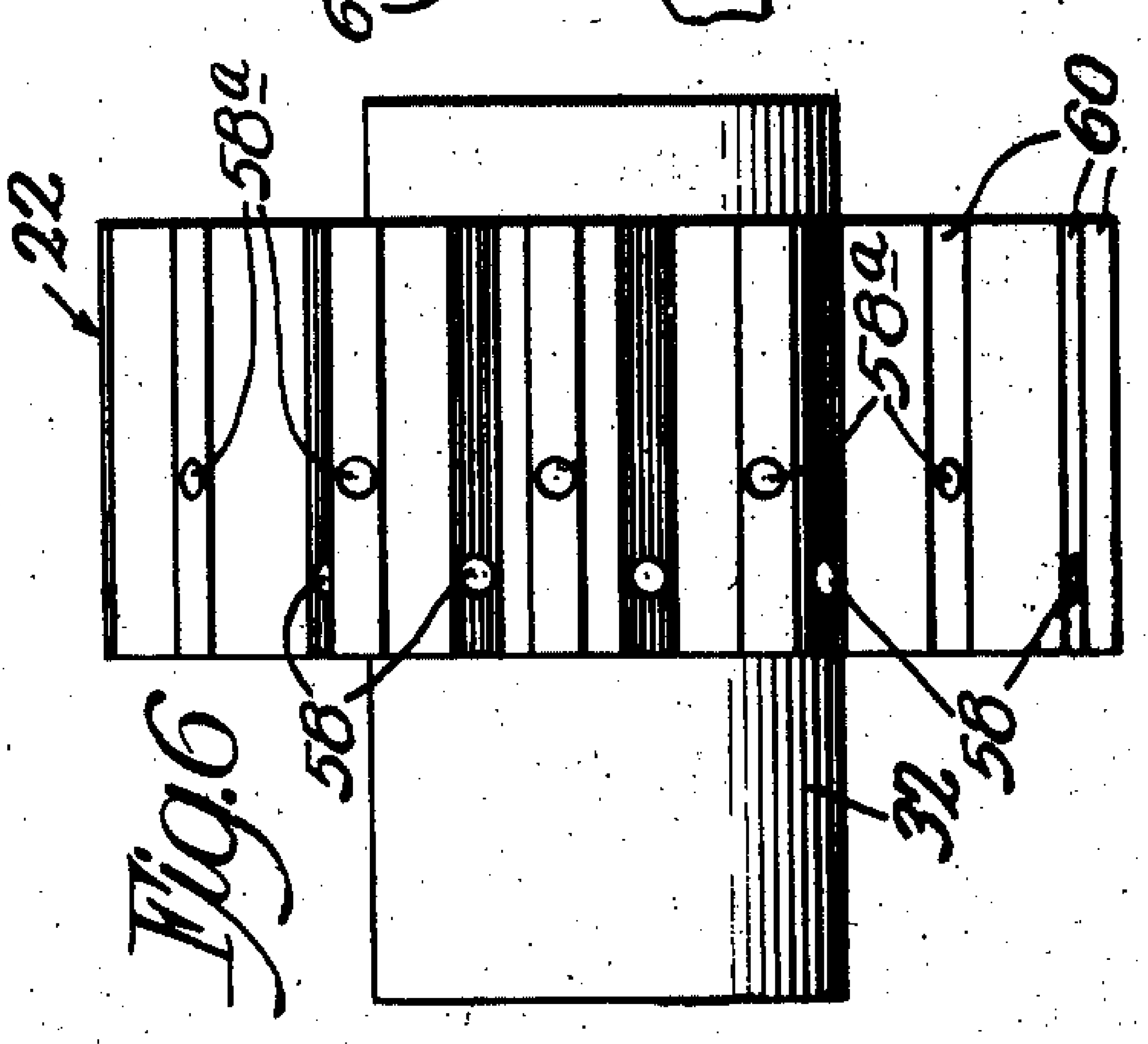

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Patented June 6, 1933

1,912,737

UNITED STATES PATENT OFFICE

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ADJUSTABLE DISPLACEMENT GEAR PUMP

Application filed February 24, 1930. Serial No. 430,868.

My invention relates generally to fluid propelling mechanisms and more particularly to mechanisms of the gear pump type.

One of the most serious problems which is presented in connection with the operation of fluid propelling devices, such as gear pumps, is that of fluid heating. In using devices which have been known heretofore, it has been found that the pressure to which the fluid is subjected between the meshing teeth of the gears causes a decided increase in the fluid temperature. In fact, it has been the common practice in many instances, in order to reduce this heating effect, to configurate the gear teeth so that sufficient clearance will be presented between the meshing teeth to permit the slippage or passage of fluid from the high pressure side back to the low pressure side. Configurating the gear teeth in this manner does not eliminate the above mentioned deleterious heating effects, but, in fact, does cause a reduction in the propelling efficiency of the pumping device, as a result of the continuous leakage or slippage of fluid between the teeth. This decrease in propelling efficiency is particularly noticeable when such gear pumps are operated to produce relatively high pressures for such pumps, because the slippage or by-passing increases as the pressure of the fluid increases.

One of the important objects of my present invention is to provide a fluid propelling mechanism of the gear pump type which will be free from the above mentioned and other disadvantages which have been experienced heretofore.

More specifically, my invention contemplates the provision of a fluid propelling mechanism of the above mentioned type, in which means is provided for relieving against the development of fluid pressure between the gear teeth which causes increases in fluid temperature, and to this end I propose to provide passageways in one of the rotating members for directing the fluid away from the teeth.

Another object of my invention is to provide a gear pump which may be adjusted to vary the fluid displacement without varying the operating speed thereof.

Still another object of my invention is to provide a fluid propelling device as above set forth, in which the pressure of the fluid at the delivery side of the device may be varied, and to this end I propose to provide means, whereby varying amounts of the fluid under pressure may be diverted or returned to the low pressure side.

A further object of my invention is to provide a fluid gear pump in which the suction at the intake side of the pump is materially increased, and I propose to accomplish this by eliminating any leakage or slippage of fluid from the high pressure side to the low pressure side when such conditions are required.

A still further object is to provide a gear pump in which the teeth make perfect and continuous contact during the meshing thereof, the usual clearance at the outer end of the teeth being omitted.

In addition to the above mentioned advantageous structural characteristics, my invention contemplates the provision of a gear pump in which one of the gears is provided with a central valve, said valve serving as a means to properly direct fluid trapped between the meshing teeth in such a manner as to positively preclude the development of heat and to effectively control the displacement of the pump.

These and numerous other objects and advantages will be more apparent from the following detailed description when considered in connection with the accompanying drawings, wherein

Figure 1 is an elevational view of a fluid propelling device which represents one embodiment of my invention;

Figure 2 is a central vertical sectional view taken substantially along the line 2—2 of Figure 1;

Figure 3 is a transverse vertical sectional view taken substantially along the line 3—3 of Figure 2;

Figure 4 is a fragmentary sectional view similar to Figure 3, disclosing the position occupied by the valve when fluid is being directed thereby from the high pressure side to the low pressure side of the pump;

Figure 5 is a perspective view of the valve;

Figure 6 is an elevational view of the detached lower gear of Figures 2 to 4 inclusive, said view being shown to more clearly disclose the relative position of the fluid conducting passages therein; and

Figure 7 is an enlarged elevational view of the meshing teeth of the gears to disclose the continuous tooth contact which eliminates back lash, and also to disclose the manner in which I am able to eliminate clearance which is usually present at the outer extremity of gear teeth.

Referring now to the drawings more in detail, wherein like numerals have been employed to designate similar parts throughout the various figures, it will be seen that one embodiment of my invention comprises a gear pump mechanism, which includes a central housing or casing section 10, a pair of spacer plates 12 and 14, and casing or end sections 16 and 18. The spacer plate 12 is interposed between the casing section 10 and the section 16, while the spacer plate 14 is interposed between the section 10 and the section 18. The spacer plates and associated casing sections are secured together by means of suitable screws 17 and dowel pins 19. These spacer plates 12 and 14 are employed to insure the proper spacing of the parts for mounting a pair of meshing gears 20 and 22.

The gear 20, which is the driving gear, is keyed to a suitable shaft 24. The inner extremity of this shaft 24 is mounted within an anti-friction bearing 26, which is supported by the end casing section 16, as clearly shown in Figure 2. The portion of the shaft 24 passing through the casing section 18 is also mounted within an anti-friction bearing 28 carried by said casing section 18, and said shaft extends through a suitable stuffing box 30, which has a threaded mounting within the casing section 18. This stuffing box prevents leakage of oil along the drive shaft 24 from within the pump chamber. The outer extremity of the drive shaft 24 is adapted to be connected with any suitable driving mechanism (not shown).

The driven gear 22 is mounted upon a sleeve 32 which extends beyond each side of the gear, as clearly shown in Figures 2 and 6. This sleeve 32 is journaled within an anti-friction bearing 34 which is carried by the casing or housing section 16, Figure 2, and the opposite extremity of the sleeve 32 is secured to a stub shaft 36 by means of a locking pin 38. This stub shaft extends beyond the sleeve 32 and is mounted within a suitable anti-friction bearing 40. Thus it will be apparent that the driven gear 22 is journaled within the anti-friction bearings 34 and 40 through the agency of the sleeve 32 and the stub shaft 36.

Positioned within the sleeve 32 and abutting the inner end of the stub shaft 36 is a valve member 42 which is provided with a transversely extending valve port 44, Figures 2 and 5. The valve member is provided with a transverse slot 46 which is adapted to receive a companion tongue 48 on a shaft 50, which is mounted within the housing section 16. The outer end of this shaft 50 carries a lever 52 and a nut 54 to prevent the displacement of said lever. This lever 52 is keyed or otherwise secured to the shaft 50 and may be manually shifted to effect the rotative adjustment or displacement of the valve 42. Suitable graduations which are provided on a housing projection 56, Figure 1, serve to indicate the degree of adjustment of the lever 52.

Attention is now directed to the radial passages 58 and 58*a* which are provided in the driven gear 22. It will be noted that the passages 58 extend radially to a point midway between the teeth 60 in the gear 22, while the passages 58*a* extend radially through the teeth 60. Assume that the gears 20 and 22 are being rotated in the direction indicated by the arrows in Figure 3, and that fluid is being introduced through the intake pipe line 62 which communicates with the intake or low pressure chamber 64 of the pump. The action of the gear teeth is such as to carry fluid along a circular path to the discharge or high pressure chamber 66 which communicates with a high pressure pipe line 68. Each time one of the teeth 60 of the gear 22 meshes with a companion tooth 60*a* of the gear 20 a certain amount or volume of fluid is trapped between the outer end of the tooth 60 and the adjacent portion of the tooth 60*a*. One of these areas is designated by the numeral 70 in Figure 3. It will be apparent that fluid from within the area or space 70 is free to flow downwardly through the companion passage 58*a* and into the valve port 44 when the valve occupies the position shown in Figure 3. The port 44 communicates with a plurality of the passages 58 and 58*a* and thus permits the return of the trapped fluid to the high pressure chamber 66. In like manner fluid, which is gathered or trapped between the outer end of the teeth 60*a* and the adjacent portions of the teeth 60, is directed through the radial passages 58 into the valve port 44 and thence into the high pressure chamber 66.

If it were not for the presence of the passages 58 and 58*a* in the gear 22, the fluid which is gathered between the meshing teeth would be subjected to tremendous pressure, and, as a consequence thereof, to a corresponding increase in heat. In other words, the gear passages 58 and 58*a* permit fluid from between the meshing gears to be returned to the high pressure chamber without experiencing any increase in heat. It is to be noted that the meshing teeth 60 and 60*a* make continuous contact, and that the teeth of each gear are adapted to extend completely into the bottom of the space between the teeth in the other gear, as clearly shown in Figure 7. In other words, my invention enables the use of a gear tooth construction which does not have the usual clearance and which is free from back lash. By means of my improved construction, all of the fluid from the high pressure chamber 66, which is gathered between the meshing teeth, may be returned to said chamber. The continuous contact of the meshing teeth, together with the absence of the above mentioned clearance, precludes the possibility of slippage or leakage of fluid between the meshing gear teeth from the high pressure chamber 66 to the low pressure chamber 64.

By eliminating the by-passing of fluid from the high pressure side to the low pressure side of the pump, I am able to develop a very high suction in the chamber 64, and this high suction serves to increase the operating efficiency of the pump materially. The tooth construction just described should be clearly distinguished from tooth constructions which have been employed heretofore. In these conventional gear pump devices it has been found necessary to configurate the teeth so that a certain amount of fluid slippage or by-passing would take place between the high pressure side and low pressure side of the pump in order to counteract the development of high temperatures in the fluid. Obviously, the provision of increased clearance between the meshing teeth of the gears not only materially reduces the fluid propelling power of the gears as a result of the fluid slippage, but also presents a structural defect in the form of undesirable back lash. Gear teeth constructed in accordance with the teachings of my invention eliminate the disadvantage of having an undesirable amount of back lash, and positively prevent fluid slippage without subjecting said fluid to an increase in temperature.

As above mentioned, the valve 42 may be adjusted so as to vary the position of the valve port 44 with respect to the passages 58 and 58*a*. Thus, for example, said valve may be shifted from the position shown in Figure 3 to the position shown in Figure 4. When said valve occupies the position shown in Figure 4, fluid from the high pressure chamber 66 will be returned to the low pressure chamber 64, as indicated by the directional arrows in Figure 4. In other words, the fluid displacement may be varied by merely rotating the valve 42. A maximum displacement may be obtained by positioning the valve as shown in Figure 3, at which time none of the fluid which passes through the radial passages 58 and 58*a*, is returned to the intake or low pressure chamber 64. As the valve is rotated in a counter-clockwise direction, Figure 3, and communication is established between these radial passages and the chamber 64, obviously the fluid displacement decreases. When the valve 42 has been shifted to the position shown in Figure 4, the fluid merely circulates from the chamber 64 to the chamber 66 and thence back to the chamber 64 through the radial passages and the valve port 44. Accurate and sensitive adjustment of the valve 42 may be made by manually manipulating the control lever 52.

From the foregoing it will be apparent that my invention contemplates the provision of a fluid propelling mechanism of the gear pump type, whereby a decided increase in fluid displacement over gear pumps employed heretofore may be obtained. This increase in displacement results from the unique and practical arrangement of the gear teeth and radial passages.

My improved propelling mechanism is very compact and rigid in construction, and may be radially attached to or detached from a mounting. The parts comprising the pump are few in number and are so arranged as to reduce to a minimum the necessity for repairs and replacements. As a result of the elimination of slippage between the gear teeth, my device is capable of developing very high pressures, and these are practically constant from a certain minimum up to a definite maximum, as compared with the variation of pressures in the conventional gear pumps which have been used. The conveniently operable mechanism for varying the fluid displacement makes it possible to govern momentarily the variation in displacement without altering the speed. As already set forth above, the gear tooth construction is such as to eliminate the heating of the fluid by allowing the fluid from the meshing teeth to pass back through the radial passages or orifices to the high pressure chamber. The gear teeth are so constructed as to enable the continuous contacting of each tooth with its companion tooth, and this construction, together with the elimination of the usual clearance at the tooth extremity, prevents the slippage of fluid from one chamber to another. In this manner a maximum suction is obtained within the intake chamber 64 and maximum pressure within the chamber 66. In order to facilitate the mounting of the device a bracket 72 is formed integral with the end casing 18, as clearly shown in Figure 2. The mechanism is of very small bulk and is comparatively light in weight, thereby rendering the same conveniently portable and particularly adaptable for use in instances where relatively small compact pumping devices must be used.

As stated above the gear teeth are so constructed as to continuously contact along the entire axial extent thereof and thereby make a rolling contact over the entire meshing surface from the root to the outer extremity. It will be apparent from Fig. 7 that when one of the teeth, as for example the tooth 60*a* shown in this figure, completely meshes within the bottom of the adjacent gear, a three-point contact is established, namely a contact along the adjacent surfaces of the two gear teeth 60 and along the surface at the bottom of the space between these teeth 60. This contacting of the gear teeth precludes any possibility of slippage along the meshing surfaces of the teeth. It will also be apparent from Fig. 7 as well as Figs. 3 and 4 that the gear teeth partake of a modified involute form and that the width of the root of each tooth is substantially three times the width of the outer end of the tooth. This type of tooth not only adds considerable strength to the pump structure but greatly facilitates the proper meshing and rolling together of the teeth so as to provide a seal against leakage from the high pressure chamber 66 to the intake or suction chamber 64.

While I have shown one particular arrangement of the passages in the driven gear member, as well as a specific valve construction, it should be understood that various other arrangements and modifications may be employed without departing from the spirit and scope of my invention.

In a separate application filed June 20, 1930, Serial No. 462,466, I am disclosing and claiming the specific involute tooth construction which may be employed in gear pumps of the type shown in the present application. Attention is also directed to the fact that my improved gear pump will operate very efficiently at high and low pressure, and the pressure of the fluid will not vary when the speed of the pump is increased. In the types of gear pumps which have been employed heretofore, it has been necessary to operate the same at relatively high speeds when a relatively high pressure is required. My improved pumping mechanism can be made considerably smaller in size than the conventional gear pumps without impairing the amount of fluid displacement. In other words, in my improved gear pump construction, the by-passing of fluid is eliminated, and hence the fluid propelling efficiency of the device is correspondingly increased.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A fluid propelling mechanism including a fluid propelling rotary member, a second fluid propelling rotary member peripherally meshing with the first member, a housing for said members, at least one of said rotary members having passageways therein for relieving against fluid pressures otherwise occasioned between said rotary members, an intake chamber in said housing for directing fluid to the periphery of said rotary members, an outlet chamber for directing fluid under increased pressure away from the periphery of said rotary members, and a shiftable valve axially positioned with respect to the rotary member having the passageway for volumetrically controlling fluid from said passageways.

2. A fluid propelling mechanism including a pair of meshing gears, a housing therefor having an intake chamber on one side of said gears and a compression chamber on another side thereof, said chambers communicating directly with the periphery of each gear, one of said gears being provided with a plurality of fluid conducting passages, and an adjustable valve for controlling the fluid from said passages.

3. A fluid propelling mechanism including a pair of meshing gears, a housing therefor presenting fluid intake and outlet chambers communicating with the periphery of each gear, one of said gears having fluid conducting passages positioned between the sides thereof which terminate at the outer end of the gear teeth, and means including a fluid directing passage within one of said gears for receiving and controlling the fluid displaced from said passages.

4. A fluid propelling meachanism including a pair of meshing gears, a housing therefor presenting fluid intake and outlet chambers communicating directly with the periphery of each gear, one of said gears having a plurality of radial passages enclosed within and positioned between the sides of said gear, certain of which terminate at the outer extremity of the gear teeth and certain others which terminate between the gear teeth, and means located within one of said gears for receiving and controlling the fluid displaced from said passages.

5. A fluid propelling mechanism including a fluid propelling rotary member, a second fluid propelling rotary member meshing with said first member, a housing for said members which presents a fluid intake chamber and a fluid outlet chamber, and fluid controlling means within at least one of said rotary members including radial passages and a central located passage adapted to communicate with only the radial passages in the vicinity of the meshing zone for effecting the transfer of fluid from said outlet to said inlet chamber, whereby to affect the fluid propelling effectiveness of said rotary members.

6. A fluid propelling mechanism including a pair of meshing gears, a housing for said gears presenting an intake chamber on one side of said gears and an outlet chamber on the opposite side thereof, and adjustable means within at least one of said gears for establishing communication between said intake and outlet chambers, whereby the volume of fluid discharged from the outlet chamber by said gears may be controllably

varied without altering the speed of operation of said gears.

7. A fluid propelling mechanism including a pair of meshing gears, one of said gears having fluid conducting passages, an intake chamber for directing fluid to the periphery of said gears, an outlet chamber for directing fluid away from said gears, and a valve around which the gear having the passages is rotatable, said valve being adjustable to controllably vary the flow of fluid from said passages.

8. A fluid propelling mechanism including a fluid propelling rotary member, a second fluid propelling rotary member driven by said first member, a housing for said members, said second member having a fluid conducting passageway, an intake chamber for directing fluid to the periphery of said members, an outlet chamber for directing fluid away from said members, and shiftable valve means for volumetrically controlling the flow of fluid from said passageway.

9. A fluid propelling mechanism including a pair of meshing gears providing a compression chamber at the point where the teeth advance toward each other and an oppositely disposed intake chamber, and a housing for said gears, the outer ends of the teeth of each gear being adapted to extend completely within and thereby substantially fill the bottom of the companion space in the other gear, whereby to effect the complete ejection of fluid from that vicinity, at least one of said gears having passages terminating at the outer ends of and between the teeth for receiving and salvaging said ejected fluid.

10. A fluid propelling mechanism including a pair of meshing gears, a housing for said gears presenting inlet and outlet chambers, the outer ends of the teeth of each gear being adapted to extend completely within and thereby substantially fill the bottom of the companion space in the other gear, whereby to effect the complete ejection of fluid from that vicinity, one of said gears being provided with a plurality of radial passages communicating with the outer and lower portions of the gear teeth, and means for receiving and directing the ejected fluid, said latter means being located within one of said gears.

11. A fluid propelling mechanism including a pair of meshing gears having teeth with no back lash, and a housing for said gears, the outer ends of the teeth of each gear being configurated to extend completely within and thereby substantially fill the bottom of the companion space in the other gear, whereby the passage of fluid between said meshing teeth is prevented, one of said gears having passages communicating with the outer extremities of the teeth and passages communicating with the bottom of the space between said teeth to direct fluid away from said teeth, and means located within one of said gears for receiving fluid from said passages.

12. A gear pump including a pair of meshing gears, a housing for said gears presenting an intake chamber on one side of the gears and an outlet chamber on the opposite side thereof, passageways in at least one of said gears for conducting fluid away from the meshing teeth thereof, and a valve within one of said gears and having a peripheral port adapted to communicate with said passageways, whereby fluid from the discharge side of the pump may be conducted through said passageways and said valve port to the intake side of the pump for the purpose of varying the displacement of said pump.

13. A gear pump including a pair of meshing gears, a housing for said gears presenting an intake chamber on one side of the gears and an outlet chamber on the opposite side thereof, passageways in at least one of said gears for conducting fluid away from the meshing teeth thereof, and a valve coaxially associated with one of said gears and having a peripheral port adapted to communicate with said passageways, whereby fluid from the discharge side of the pump may be conducted through said passageways and said valve port to the intake side of the pump for the purpose of varying the displacement of said pump, said valve being oscillatable about its axis to variously position said peripheral port.

14. A fluid propelling mechanism including a pair of meshing gears, a housing for said gears, the outer ends of the teeth of each gear being adapted to extend completely within and thereby substantially fill the bottom of the companion space in the other gear, whereby to effect the complete ejection of fluid from that vicinity, one of said gears having passages for receiving said ejected fluid, and an adjustable valve for controlling the flow of fluid from said passages.

15. A fluid propelling mechanism including a pair of meshing gears, a housing for said gears, the outer ends of the teeth of each gear being adapted to extend completely within and thereby substantially fill the bottom of the companion space in the other gear, whereby to effect the complete ejection of fluid from that vicinity, one of said gears having passages for receiving said ejected fluid, and an adjustable valve adapted to communicate with and receive fluid from said passages, whereby fluid from said passages may be delivered either to the intake or the discharge side of the pump.

16. A gear pump including a pair of meshing gears, a housing therefor, one of said gears having a plurality of radial passages, means for directing fluid to said gears, means for directing fluid under increased pressure away from said gears, certain of said pas-

sages terminating at the outer extremity of the gear teeth and certain others terminating between said gear teeth, said passages being enclosed within and positioned between the ends of said gear, and means within one of said gears for directing fluid away from said passages.

17. A gear pump of the class described including a housing, a pair of meshing gears in said housing, an intake chamber positioned in the vicinity of the diverging gear teeth, an outlet or compression chamber positioned in the vicinity of the converging gear teeth, fluid conducting passages in at least one gear, and fluid conducting means mounted within the gear housing and adapted to communicate contemporaneously with only the passages located in the vicinity of the meshing zone for varying the volumetric delivery of fluid from the outlet chamber of said gear.

18. A gear pump of the class described including a housing, a pair of meshing spur gears mounted within said housing, an intake chamber positioned in the vicinity of the diverging gear teeth, and a discharge chamber positioned in the vicinity of the converging gear teeth, each surface of one tooth being adapted to make unbroken rolling contact with the surface in the companion tooth of the other gear from the root to the outer end of the tooth, each of said teeth being free from clearance at the outer extremities, whereby to substantially fill the space presented between adjacent teeth in the companion gear and radial passages in at least one of said gears terminating at the outer ends of and between said teeth for receiving the fluid ejected when the gear teeth mesh, and means for controlling the flow of fluid from said radial passages.

19. In a gear pump construction, a housing, a pair of meshing spur gears within said housing, an intake chamber for receiving fluid on one side of said gears, a discharge or compression chamber on the other side of said gears, each of the teeth in said gears having a width at the root thereof which is substantially three times the width at the outer end thereof, radial passages in one of said gears for conducting fluid away from the meshing teeth to relieve against fluid pressure, and means located within one of said gears for receiving and controlling the flow of fluid from said passages.

20. A gear pump of the class described including a housing, a pair of meshing gears within said housing, an intake and discharge chamber within said housing, a sleeve rotatable with and providing a support for one of said gears, the gear on said sleeve being provided with radial passages to relieve against fluid pressure between the meshing teeth, and an adjustable valve member mounted within said sleeve for controlling the flow of fluid from said passages.

21. A gear pump of the class described including a housing, a pair of meshing gears within said housing, an intake chamber for delivering fluid to the periphery of said gears, an outlet chamber for receiving fluid under pressure from the periphery of said gears, a plurality of radial passages in one of said gears for relieving against fluid pressure between the meshing teeth, a central valve member extending within the gear having the radial passages for controlling the flow of fluid from said passages, and control means positioned externally for manual manipulation and connected with said valve whereby said valve may be conveniently adjusted from a point external of the gear pump.

22. A gear pump of the class described including a housing, a pair of meshing gears within said housing, an intake chamber for delivering fluid to the periphery of said gears, a discharge chamber for receiving fluid under pressure from the periphery of said gears, at least one of said gears having fluid conducting passages, a shiftable valve member extending within one of said gears and having a port adapted to communicate with said passages for establishing communication between the inlet and the outlet chamber for controlling the volumetric delivery of fluid from the discharge chamber, and means connected with said valve and positioned externally of the pump housing for manual manipulation whereby to effect the convenient shifting of the valve to vary the volumetric delivery of the pump.

23. A pumping mechanism including a housing, a pair of meshing gears within said housing for receiving fluid along the periphery thereof at a given pressure and for subjecting said fluid to increased pressure, said gears having associated therewith passageways capable of conducting trapped fluid contemporaneously away from a plurality of spaces between the meshing teeth of both gears to relieve against fluid pressure, and an adjustable valve for controlling the fluid discharged from said passageways, the teeth of said gears meshing along lines of contact extending axially of the gears to seal against fluid leakage between said meshing teeth.

24. A fluid propelling mechanism including a pair of meshing gears, a housing therefor having an intake chamber for directing fluid to the periphery of each gear, and a compression chamber for receiving fluid under increased pressure from the periphery of said gears, one of said gears being provided with a plurality of radial passages, said teeth meshing along unbroken lines of contact extending axially of the gears to seal against fluid leakage between said teeth, said passages being disposed to conduct trapped fluid contemporaneously from a plurality of spaces between the meshing teeth of both

gears, and a valve for volumetrically controlling the flow of fluid from said radial passages.

25. A gear pump including a pair of meshing gears, a housing for said gears presenting an intake chamber on one side of the gears and an outlet chamber on the other side thereof, at least one of said gears having fluid conducting passages, and a valve extending within one of said gears and adapted to communicate with said passages, whereby fluid from the discharge side of the pump may be conducted through the passages and said valve to the intake side of the pump and thereby affect the volumetric flow of fluid from the discharge side of said pump.

In witness whereof, I have hereunto subscribed my name.

ERNEST J. SVENSON.