

June 12, 1962

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PUMP

3,038,413

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3 Sheets-Sheet 1

FIG. 1

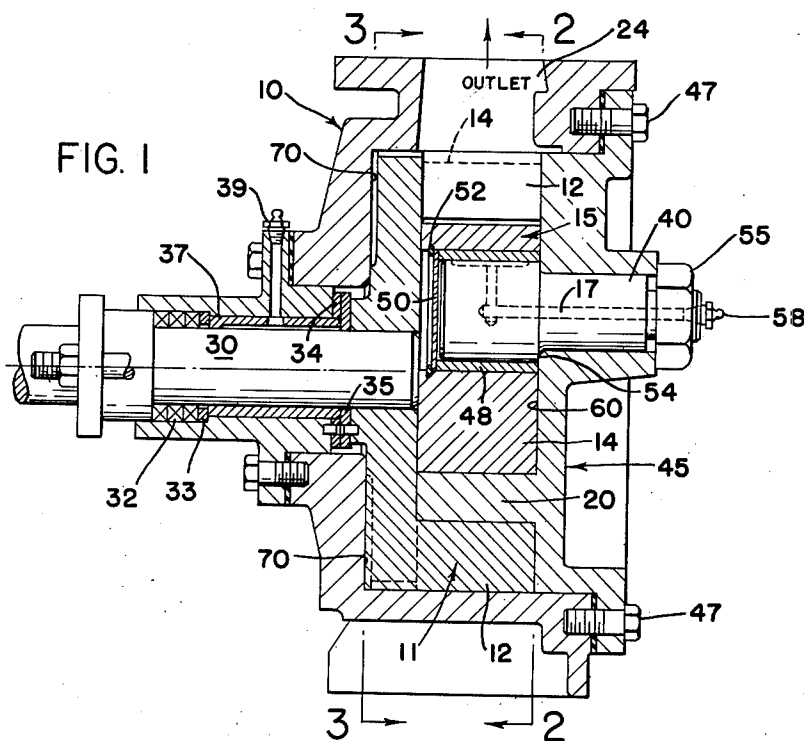
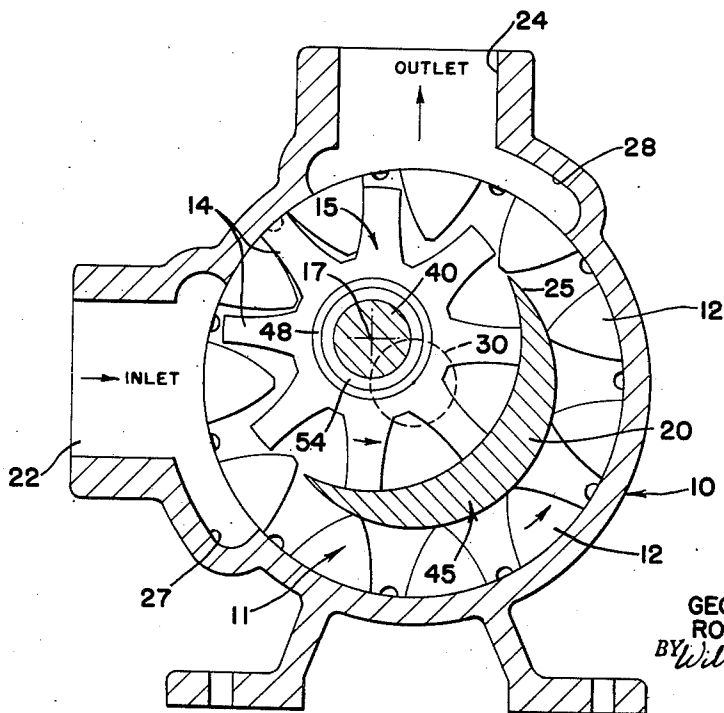


FIG. 2



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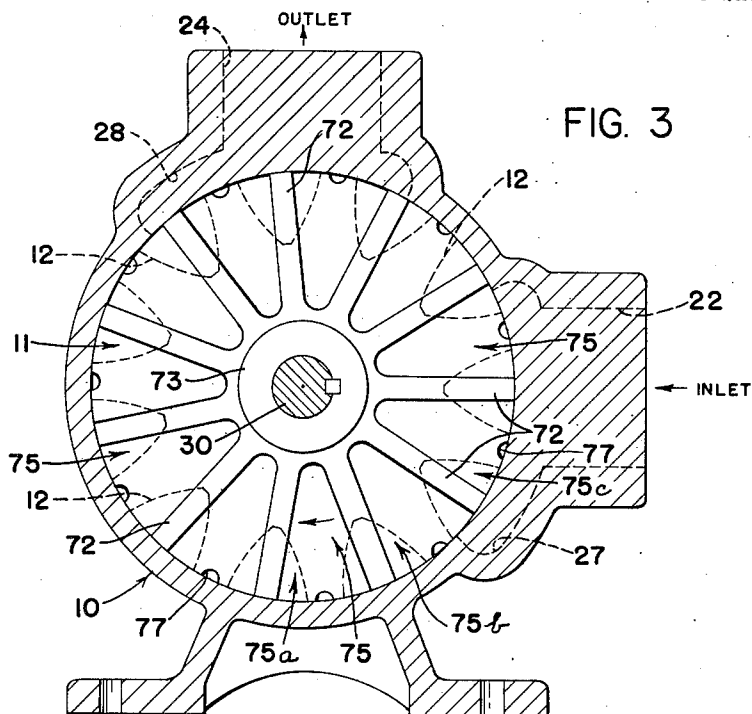


FIG. 3

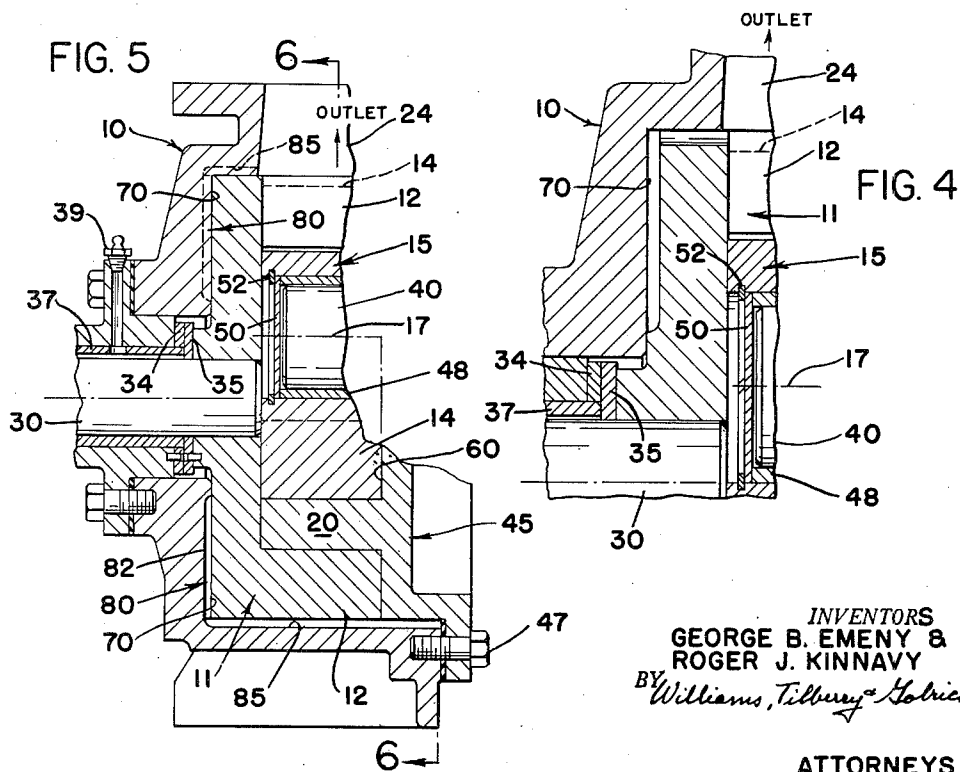


FIG. 5

FIG. 4

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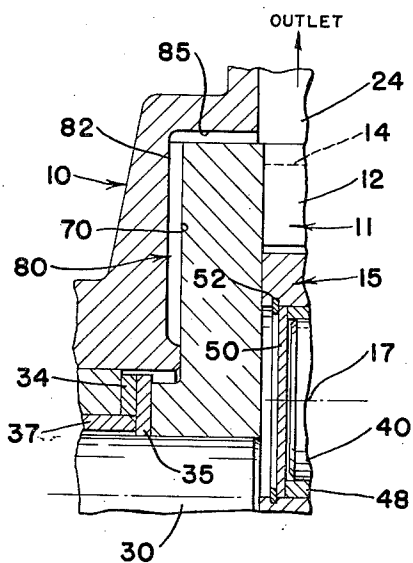
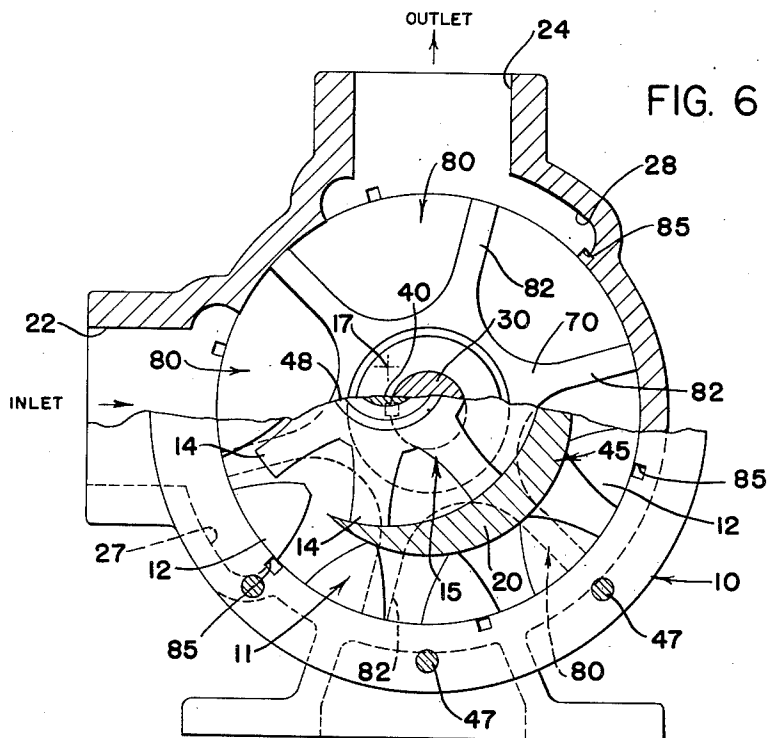


FIG. 7

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Filed Feb. 8, 1960, Ser. No. 7,244
4 Claims. (Cl. 103-126)

This invention relates to improvements in pumps, particularly rotary pumps of the type in which a driven external rotor and an internal idler, commonly referred to as gears in this type of pump, mounted eccentrically there-of cooperate together with a partition shaped as a crescent or a portion of a crescent disposed between the pinion and the rotor that separates them from each other during part of their rotative travel. Pumps of this type are well-known in the art but are subject to the problem of attaining a proper balance of axial forces arising from a variation of internal pressures during the pumping operation to produce maximum efficiency and life for the parts.

In such pumps, the pressure applied at the inlet is substantially low and gradually increases by increments until it reaches a maximum at the outlet. In particular, the pressure adjacent the outlet, being substantially greater than the pressure adjacent the inlet, tends to bend or cant the rotor on its shaft producing increased wear on the rotor shaft bearings and uneven wear at various points where the rotor makes contact with other pump parts during its rotation. Thus, a problem with this type of pump has been to secure an effective pressure balance of the so-called differential pressures in the pump so that while the pressure increments may vary along the rotor such pressure increments will be balanced with respect to the front and back of the rotor. In addition, in pumps as heretofore built, the total pressure on the front or pumping side of the rotor has been substantially different than the pressure on the back-side where the rotor rotates against the housing unless complicated and unsatisfactory methods were employed to overcome such difference.

The present invention is directed to the solution of these long existent problems in a simple and satisfactory manner heretofore not known. In essence, this is accomplished by maintaining between the back face of the rotor and the adjacent face of the housing a substantially continuous layer of the liquid being pumped and at the same time confining said liquid in a series of cavities of substantial area such that the pressure varies from cavity to cavity in accordance with the variation of the differential pressures on the opposite or front side of the rotor due to the pumping action taking place. In effect, this constitutes a liquid thrust bearing of constantly changing pressure characteristics.

A general object of the present invention, then, is to provide a balanced pump of the type described in which liquid pressures are set up in a series of increments on the back face of the rotor with each increment increasing and decreasing in pressure in accordance with the pumping pressures in the zones of the rotor on the opposite side thereof in the pumping zone. Other objects will become apparent from the following specification and are summarized in the claims.

The invention described herein is shown in the accompanying drawings in which:

FIGURE 1 is a vertical axial section through a pump embodying the present invention;

FIGURE 2 is a section, as indicated by the lines 2-2 on FIGURE 1, showing the rotor and idler construction;

FIGURE 3 is a section, as indicated by the lines 3-3 on FIGURE 1, showing one form of construction to provide the necessary cavities in the rotor;

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FIGURE 4 is a detail in the plane of FIGURE 1 enlarged to better show a portion of the pump construction adjacent the cavities referred to;

FIGURE 5 is a section corresponding to FIGURE 1 showing a part of a modified form of pump employing pressure cavities in the housing as distinguished from the rotor;

FIGURE 6 is a section through FIGURE 5, as indicated by the lines 6-6 thereon; and,

FIGURE 7 is an enlarged section in the plane of FIGURE 5 showing in enlarged detail the modified pressure cavity construction.

Referring now to the drawings and, particularly, to FIGURES 1 and 2 thereof, our improved pump is shown as comprising a housing 10 made of a casting of suitable shape and receiving within it a rotor 11. The rotor 11 is the general form as shown in FIGURE 2 including a series of teeth 12 of the general shape shown thereon.

Meshing with the teeth 12 of the rotor 11 are teeth 14 of an idler 15 mounted as shown. The shapes of the teeth 12 and 14 respectively are so arranged as to mesh properly together and provide a pumping action as hereafter described. The idler is mounted on an axis 17 that is parallel to but eccentric with respect to the rotor axis, as shown in FIGURE 2. Due to this eccentricity, there is provided between the outer periphery of the idler and the inner periphery of the rotor teeth a space that is substantially filled by a partition 20 shaped as a crescent or a portion thereof.

An inlet port is provided at 22, and an outlet port 24 is also provided in the housing with the inlet and outlet ports being so arranged that the latter is spaced circumferentially from the inlet in the direction of rotation of the rotor. In the preferred form of invention shown in the drawings this spacing is approximately 270°, although it will be understood that modifications in arrangement may be made without departing from our invention to include any such spacing between approximately 180° and 360°. It will be understood that the inlet port 22 and the outlet port 24 may occupy similar locations in the cover 45 (hereafter described) or partially in the cover and housing, as desired. Fluid is admitted at the inlet 22, and, as shown in FIGURE 2, fills the spaces between the teeth of the rotor and idler and by such teeth is carried to the forward end 25 of the crescent 20. At this point, in a manner well-known in the art, the teeth 12 and 14 begin to mesh together and reduce the volume available for liquid thereby forcing it under pressure out of the outlet 24. To facilitate ingress and egress of the liquid, the housing is relieved at 27 and 28, respectively, as shown in FIGURE 2.

The rotor 11 is driven through a shaft 30, as shown in FIGURE 1, which shaft is connected to a suitable source of power. Packing 32, packing seat 33, and thrust washers 34 and 35 are provided as is usual in this type of pump. One object of the invention is to relieve the end thrust from right to left (FIGURE 1) on the thrust washers due to pumping pressures in the pump. A housing bushing 37 is disposed between the packing and the thrust washers to permit lubrication through a fitting 39.

The idler 15 is mounted on an idler pin 40 that is carried in a cover plate 45 adapted to be removably secured by bolts 47 to the housing 10. The idler 15 is carried on a suitable idler bushing 48 with a grease retainer 50 held in place by a retaining ring 52. The idler pin 40 is held in the cover 45 by a shoulder 54 and an idler pin nut 55. Lubrication for the idler is provided at the grease fitting 58.

It will be seen from the description thus far that the housing 10 and the cover plate 45 define between them a chamber in which the rotor and the idler rotate with the latter being driven through gears 12 and 14 by the

former. The crescent partition 20 is formed as an integral part of the cover casting 45, as shown.

The cover 45 is provided with an internal plane face 60, generally unbroken except for the protruding crescent 20, which face is adapted to make sliding contact with complementary faces on the rotating idler and rotor. The plane of contact is normal to the axis of rotation. This face 60 frequently is relieved in the areas adjacent the inlet and outlet so the liquid can flow around the ends of the rotor teeth and then axially into or from the cavities between the teeth of the rotor and idler as the volumes of such cavities change to produce the pumping action.

On the rear side of the rotor 11, the housing 10 is also formed with a face 70 that in the preferred form of the invention is normal to the axis of rotation of the rotor and, in the embodiment of the invention shown in FIGURE 3, this face indicated is a plane.

The rear face of the rotor 11 that cooperates with the face 70 is provided with a series of sealing vanes 72 that extend radially outward from a hub 73 of the rotor. These vanes extend outwardly (to the left in FIGURE 1) and terminate in a common plane that is normal to the rotor axis of rotation and parallel to the plane 70 in the housing. It is contemplated that such surface and the face 70 need not be plane but may, for example, be conical, stepped, or curved so long as they provide a fluid seal between them.

The vanes are widely separated to provide between them a series of pressure equalizing cavities as indicated at 75. The construction is such that the projected area of the cavities toward the plane 70 is as nearly as possible equal to the area of said plane 70, being reduced in amount only by the width of the adjacent sealing vanes. This is very important to provide the maximum pressure equalizing action between the parts as hereafter described. To attain the desired result the projected area of the cavities is made greater than the projected area of the vanes.

In order to equalize the pressure on opposite sides of the rotor, namely, between the back side adjacent the plane 70 and the front side at which the pumping is taking place, there are provided in the outer periphery of the rotor 11 a series of passages or channels 77, as shown. If desired, these passages may take the form of holes cored or drilled inside the periphery of the rotor. Each channel extends axially of a respective tooth 12 across the rotor to provide communication between the front and back sides thereof as shown. Thus, it will be seen that as many cavities 75 are provided as there are teeth 12. Hence, the differential pressure set up by a particular tooth 12 is immediately neutralized as far as end thrust is concerned by transmission of pressure through adjacent channel 77 to adjacent cavity 75.

A study of the construction of our improved pump as described thus far will disclose that two important objects have been obtained by this apparently simple construction. In the first place, the cavities 75 supplied with liquid by the channels 77 result in a general over-all equalization of pressure between the front and back of the rotor. Thus, any end thrust, particularly against the thrust washers 34 and 35, is eliminated, and the rotor floats axially in its bearing. In addition to the achievement of this result, there is provided a balancing of the differential pressures that arise due to the pumping action of the parts. At the inlet the pressure is relatively low and at the outlet it is relatively high with various gradations of pressure at all points inbetween. By providing the series of cavities described, each fed by a channel 77, as shown, that bleeds from the front to the rear side of the rotor, it is possible to have liquid under one pressure in the cavity 75a, and under another pressure in the cavity 75b, and under still a different pressure in the cavity 75c, etc. Thus, while the overall front to back pressure of the rotor is balanced, it will be apparent that

the different local increments of pressure due to the pumping action also are balanced, thus eliminating any tendency of the rotor to bend or cant with respect to the housing.

A modified form of the invention is shown in FIGURES 5, 6 and 7. In this construction, it will be seen that the housing 10 and, particularly, the surface 70 thereof, is constructed to provide a series of cavities 80 in the housing separated by vanes or ribs 82 in the same manner that the cavities 75 and the vanes 72 are provided in the rotor in the first described form of the invention. In this modified form, the rear face of the rotor 11 is in the form of single plane surface just as the surface 70 of the housing was described as plane in the first embodiment of the invention. In effect, then, there is a reversal of parts and in the modified form the plane face of the combination is provided in the rotor, and the cavities and vanes are provided at 80 and 82 in the housing.

To assure communication between the cavities 80 and the front side of the rotor, as previously outlined, a series of pressure balancing channels 85 are provided in the housing that extend across the periphery of the rotor 11 to provide communication between each cavity 80 and the front or pumping side of the rotor.

Thus, it will be seen that in each embodiment of the invention there is separate communication between the front side of the rotor and each of the respective cavities 75 or 80 with separation between the cavities being provided by vanes 72 or 82.

In the same manner as previously described, the projected area of the cavities 80 is very much greater than the projected areas of the sealing vanes 82 and for the same purposes. It will be apparent that the modified construction shown also accomplishes the dual objects outlined above of providing an over-all balancing of pressures between the front and back of the rotor and at the same time a balancing of the differential pressures due to the pumping action of the pump.

It will be apparent to those skilled in the art that the disclosure herein is limited solely by the allowed claims and that minor modifications may be made without departing from the spirit of the invention.

We claim:

1. A pump of the type described, including a housing with a pumping chamber, an external rotor gear and an internal idler gear rotatably mounted in said housing pumping chamber eccentrically with respect to each other, the teeth of said gears meshing with each other during one portion of their rotative movement and separated from each other by a partition during another portion of their rotative movement, means to drive said gears, an inlet port in said pump housing to receive liquid under low pressure and an outlet port in said pump housing to transmit liquid under substantially higher pressure from said gears, a face formed in said housing and a cooperating opposed face formed on said rotor rearwardly of the teeth thereon, one of said faces having a sealing surface and the other of said faces having a plurality of radially extending vanes extending axially and terminating in a common second sealing surface such that said vanes make sealing contact with said first face when said rotor gear is rotated in said housing, said vanes being relatively narrow with respect to the space between them to provide a series of pressure balancing cavities of such size that the total area of said cavities is substantially equal to the area of the face having a sealing surface, and a series of passages affording communication between said respective cavities and the pumping chamber to equalize the pressure between respective cavities and that portion of the pumping chamber immediately adjacent thereto.

2. A pump as described in claim 1 in which the vanes and cavities are formed in the rotor.

3. A pump as described in claim 1 in which the vanes and cavities are formed in the face in said housing.

4. A pump of the type described, including a housing,

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an external rotor gear and an internal idler gear rotatably mounted in said housing eccentrically with respect to each other, the teeth of said gears meshing with each other during one portion of their rotative movement and separated from each other by a crescent-shaped partition during another portion of their rotative movement to define pumping chambers in each gear bounded by said partition and between adjacent teeth of each said gear, a radial plate-like element constituting part of said rotor and supporting said rotor teeth on one face thereof to define a pumping portion, means to drive said gears, an inlet port in said housing to receive liquid under low pressure and an outlet port in said housing lying between approximately 180° and 360° in the direction of gear rotation from said inlet port to transmit liquid under substantially higher pressure from said gears, a face formed in said housing and a cooperating opposed face formed on the plate-like element of said rotor rearwardly of the teeth thereon, one of said faces forming a plane surface and the other of said faces having a plurality of radially extending vanes extending axially and terminating in a common plane normal to the axis of rotation of said gear rotor such that said vanes effect a fluid seal with said first and planar face when said rotor gear is

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rotated in said housing, said vanes being relatively narrow with respect to the space between them to provide a series of pressure balancing cavities of such size that the total area of said cavities is substantially equal to the area of said face forming a plane surface, and a series of passages corresponding in number to the number of respective cavities between said vanes and affording communication between said cavities and the respective pumping chambers on the opposite side of said plate-like element to equalize the pressure between respective cavities and that portion of the pumping chamber immediately adjacent thereto.

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