

May 31, 1966

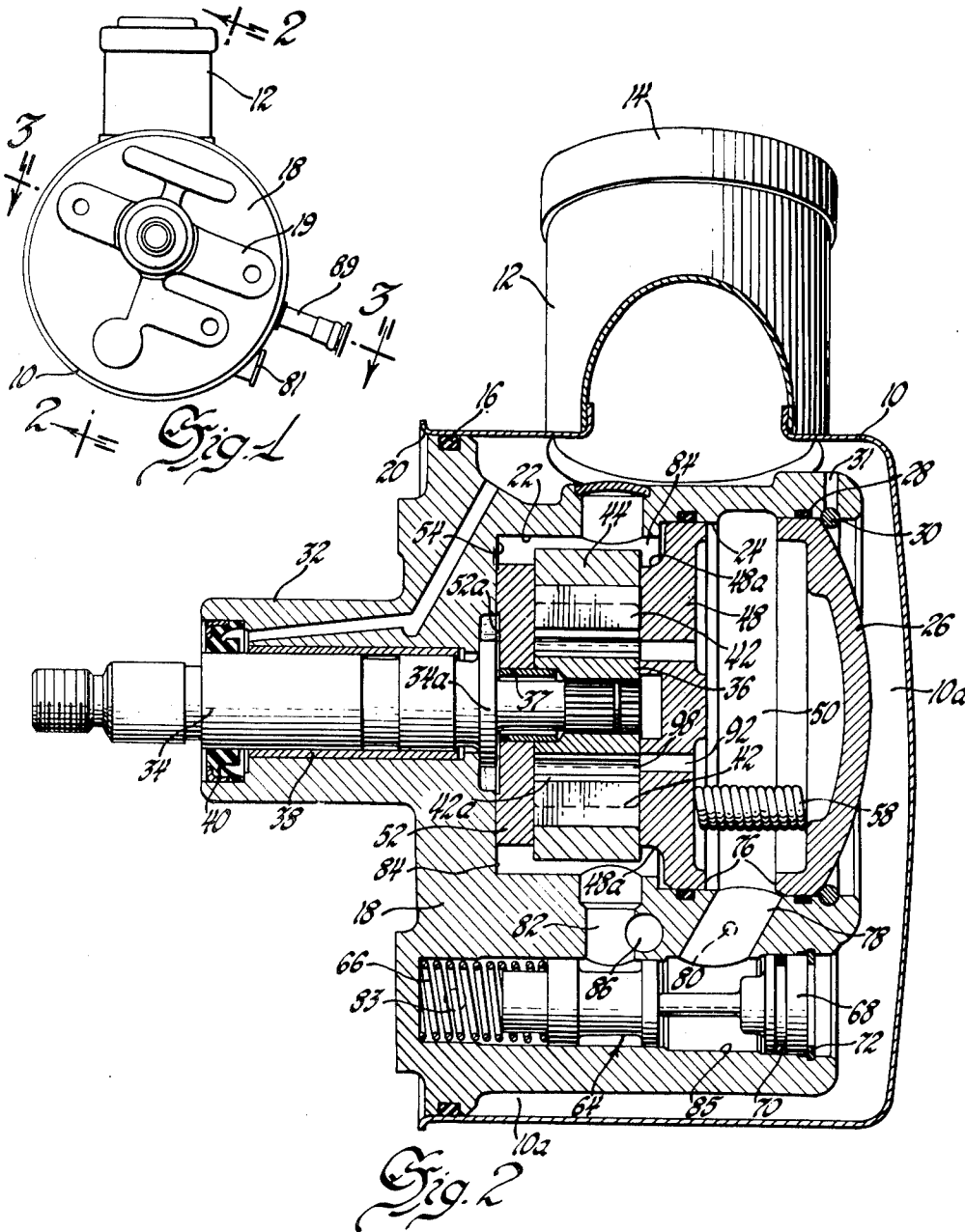
P. B. ZEIGLER ETAL

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3 Sheets-Sheet 1



INVENTORS
Robert P. Rohde,
William B. Thompson &
BY Philip B. Zeigler
a. m. Neiter
ATTORNEY

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P. B. ZEIGLER ET AL

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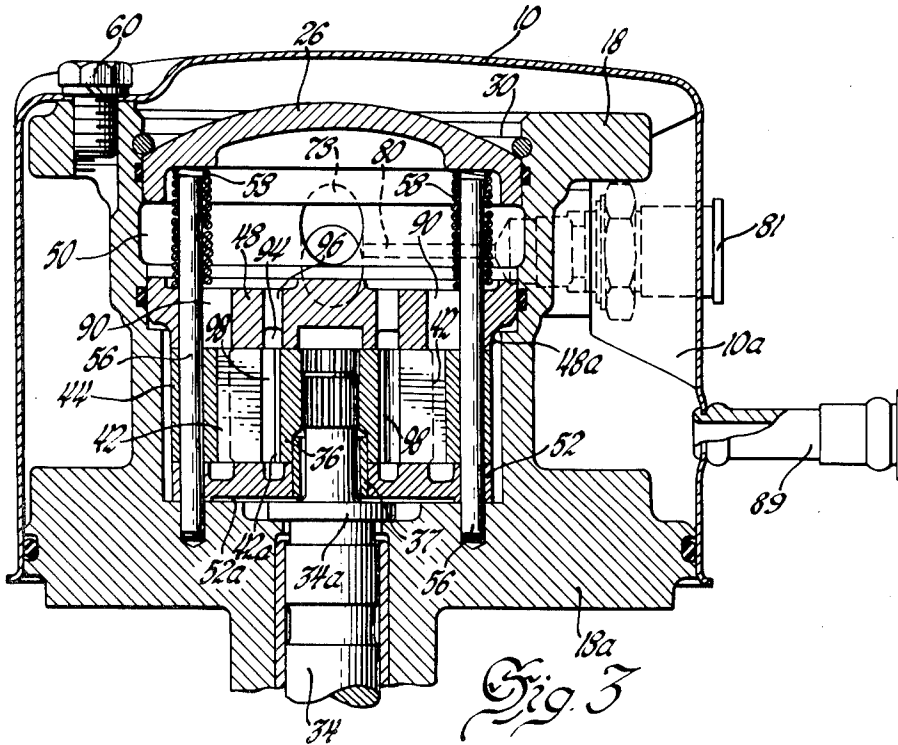
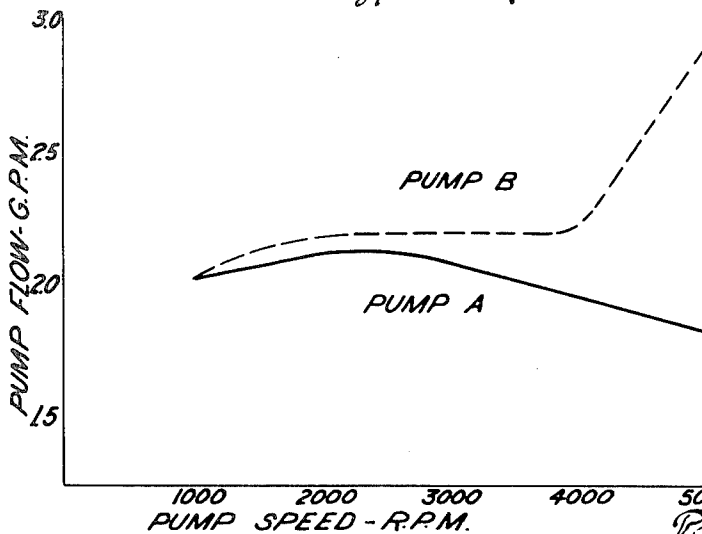


Fig. 6

INVENTORS
Robert P. Rohde,
William B. Thompson
& Philip B. Zeigler
BY *a. m. Meiter*
ATTORNEY

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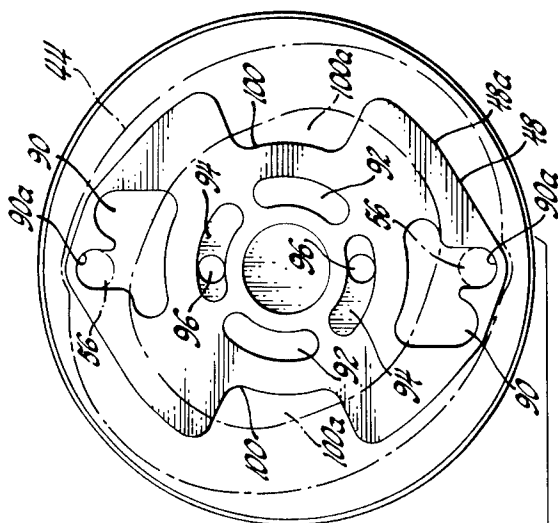
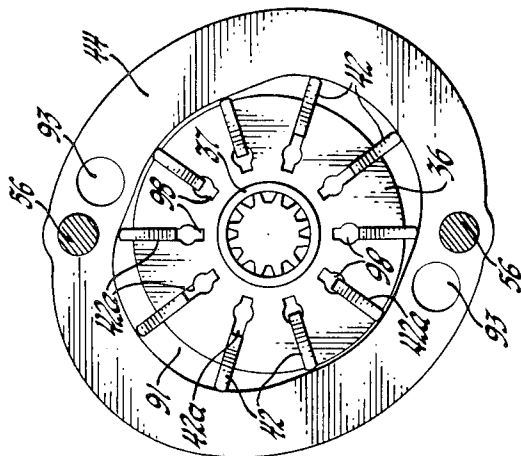
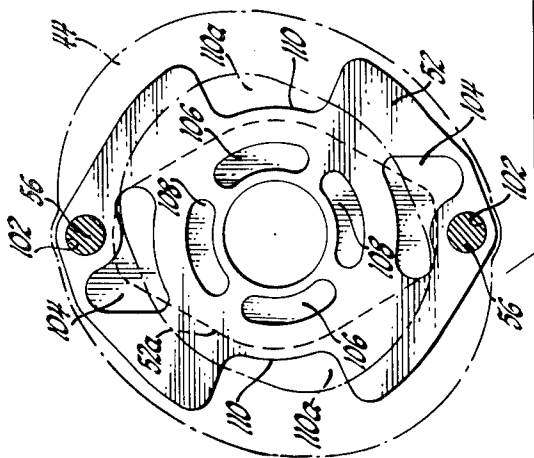


Fig. 4

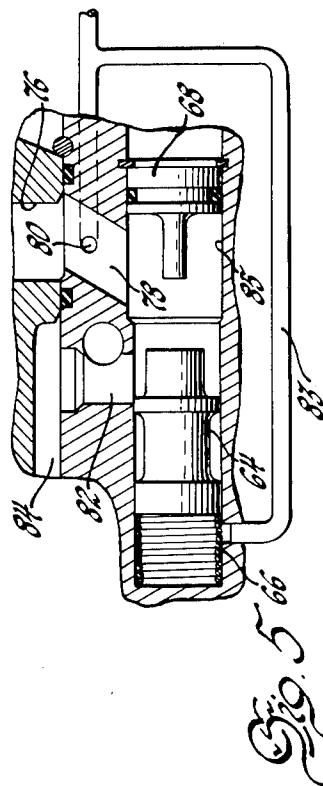


Fig. 5

INVENTORS
Robert P. Rohde,
William B. Thompson
BY Philip B. Zeigler
a. m. Meiter
ATTORNEY

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Philip B. Zeigler, Saginaw, William B. Thompson, Frank-
enmuth, and Robert P. Rohde, Saginaw, Mich., assignors
to General Motors Corporation, Detroit, Mich., a cor-
poration of Delaware

Original application Sept. 19, 1958, Ser. No. 762,162.
Divided and this application May 27, 1963, Ser. No.
283,298

8 Claims. (Cl. 103—42)

This application is a division of applicants' application
Serial No. 762,162, filed September 19, 1958, now aban-
doned, which was continued as application Serial No.
283,219, filed May 27, 1963, now Patent No. 3,027,077.
This invention relates to fluid pumps and in its most
specific aspect has relation to constant or fixed displace-
ment vane pumps which in use are operated at varying
speeds. The vane pump widely employed in power steer-
ing apparatus is exemplary of pumps of this category,
and the invention will be particularly described with refer-
ence thereto.

Still other problems exist in providing an easily assem-
blable pump structure, relieving parts of the assembled
structure of excessive stress during pump operation, main-
taining alignment between pump parts prone to misalign-
ment and guarding against foreign matter accumulation
restricting fluid flow.

An object of the invention is to provide in a vane
pump having a pressure plate and a thrust plate on op-
posite sides of a cam ring enclosed rotor carrying the
vanes with the plates having a pair of ports in circum-
ferential alignment, the cam ring and pressure plate hav-
ing a pair of aligned ports circumferentially spaced from
the first-mentioned pair of ports, recesses in the plates
facing the rotor communicating with the last-mentioned
pair of ports, a discharge passage connected to the last-
mentioned pair of ports and an intake chamber surround-
ing the cam ring open to the first-mentioned pair of ports
with the porting arrangement and recesses providing for
radial and axial pressure balance of the rotor.

Another object of the invention is to provide a vane
pump having a shaft driven vane carrying rotor in a cam
ring with a plate at each side of the rotor with pins ex-
tending through the cam ring and plates and a bearing sup-
porting the shaft on one plate whereby the pins center
the shaft to maintain proper rotor alignment relation to
the cam ring and plates to correct for any shaft mounting
misalignment.

Another object of the invention is to provide in a pump
housing a bore having located therein a rotor, a pressure
plate engaging the rotor and a closure plate spaced from
the pressure plate providing a discharge chamber to pro-
vide an easily assemblable pump structure with the clo-
sure member being retained by a retaining ring whose
seating force is aided by pump discharge pressure.

Now to identify the accompanying drawings illustrat-
ing the invention in a preferred embodiment:

FIGURE 1 is an end elevation;

FIGURE 2 is a sectional view on the line 2—2 in FIG-
URE 1;

FIGURE 3 is a section on the line 3—3 in FIGURE 1;

FIGURE 4 illustrates the relative disposition of certain
of the pump parts;

FIGURE 5 is a generally diagrammatic representation
of the flow control and anti-cavitation system and shows
a slight modification of the FIGURE 2 valve structure;
and

FIGURE 6 is a graph reflective of the operation of the
pump.

Referring first to FIGURES 1—3, the numeral 10 de-

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notes a reservoir desirably formed of sheet metal and
encircling the pump proper. The reservoir will be seen
as comprising a filler tube 12 having a cap 14.

A seal 16 accommodated in an annular recess in the
pump casing 18, which carries a mounting piece 19, pre-
vents leakage around the rim portion 20 of the reservoir.

Casing 18 is of one-piece construction, with inner and
outer recesses 22 and 24, respectively. A cover piece 26
is encircled by a seal 28 and shoulders against a snap ring
30, both the seal and ring finding accommodation in an-
nular recesses formed in casing 18. It is important to
note that due to the rounded contour of cover 26 and
the fact that the ring 30 is circular in section, the forces
subsequently to be mentioned which tend to displace the
cover 26 outwardly or rightwardly (FIGURE 2) do not
tend to shear the ring, as would be the case if it were of
rectangular section. Rather, such forces tend merely to
more securely seat the ring in its groove. The ring is
easily removed when necessary through the use of a punch
inserted through the hole 31.

Extending through a journal boss 32 integral with cas-
ing 18 is a drive shaft 34 splined at its inner end for op-
erable connection to a rotor 36. Outward of the rotor,
the shaft, which has an integral flange 34a taking thrust
loads, is surrounded by a bushing 38 and a seal 40.

Rotor 36 carries a plurality of vanes 42 (note FIG-
URE 4) which in operation of the pump are caused to
reciprocate radially in slots 42a by a cam ring 44 within
which the rotor is confined.

A pressure plate 48 at the right side of the rotor (FIG-
URE 2) and abutting the cam ring 44 forms a dis-
charge chamber 50 with the cover 26. The inner face
of this plate is relieved at 48a. At the opposite or left
side of the rotor and abutting the corresponding side
of the cam ring 44 is a thrust plate 52 having a recessed
portion 52a. As shown, this plate encircles the drive shaft
34 and bears against the wall 54 of the recess 22.

Cam ring 44 is supported within the casing 18 by pins
56 (FIGURE 3). Such pins extend through the pressure
plate 48 and the thrust plate 52, as well as the cam ring,
and are received within blind bores formed in the flange
portion 18a of the casing 18. Outward of the pressure
plate 48 the pins serve as guides for springs 58 which
react against the inside of cover 26.

A feature of the arrangement involving the dowel pins
56 resides in a sleeve 37 preferably press fitted into the
rotor 36 and having a close bearing fit with relation to
the thrust plate 52. Such sleeve allows the rotor to par-
take of the alignment provided by the dowel pins and
corrects for misalignments of the shaft 34.

Bolts 60, seen in FIGURE 3, secure the reservoir 10
to casing 18.

As illustrated by FIGURES 2 and 5, casing 18 out-
ward of its center line is bored and counterbored to pro-
vide a cavity 85 for the reception of a flow control valve
64. Such valve is biased rightwardly by a spring 66, the
limit of the rightward movement being set by a plug
member 68 which is provided with a seal 70 and should-
ers against a snap ring 72.

Chamber 50, previously mentioned as formed by pres-
sure plate 48 and cover 26, receives the pump discharge.
Such chamber opens to a short passage 76, in turn open-
ing to a relatively long passage 78 of lesser diameter,
these passages providing the connected discharge passage
for conveying the pump discharge from chamber 50.
Extending from passage 78 is a branch discharge passage
80 of much smaller diameter than passage 78. Passage
80, which is actually an orifice determinative of the flow
rate of the pump, communicates with the pump's out-
let or exhaust port and the fixture 81 seen in FIGURE 3.

As shown by FIGURES 2 and 5, passage 78 opens to

the previously mentioned cavity housing valve 64. Also opening to such cavity is a passage 82 extending downwardly from an annular chamber 84 which surrounds thrust plate 52, cam ring 44 and the relieved portion 48a of pressure plate 48.

A passage 86, connecting with passage 82, is at all times open to the chamber 10a of the reservoir 10 and constitutes the inlet or intake port of the pump. Fluid returned to the reservoir from the system served thereby enters the reservoir via a tube 89 seen in FIGURE 3. A conduit 83 opening to the cavity 85 leftward (FIGURE 2) of the valve 64 connects with the orifice passage 80 as shown in FIGURE 5.

Going now to FIGURE 4, it will be observed that the relieved portion 48a of the pressure plate 48 is of symmetrical free-form outline and that the plate is provided with a pair of diametrically opposed openings 90. It is through these openings that the pump discharge passes into the chamber 50. Portions 90a of openings 90 accommodate the previously mentioned pins 56 affording support to the cam ring 44.

Radially inward of openings 90 are a pair of arcuate openings 92 and a pair of arcuate recesses 94 within which are holes 96. The purpose of openings 92 is to allow for the passage of fluid at discharge pressure from chamber 50 to cavities 98 (located at the innermost reaches of slots 42a) as the vanes 42 move radially outwardly. This assures proper engagement of the outer edges of the vanes with the inner contour of the cam ring 44.

Holes 96 are so placed with reference to the inner contour of cam ring 44 that they meter the flow of fluid from cavities 98 to chamber 50 as the vanes move radially inwardly. In this way, such movement of the vanes is cushioned and the life thereof extended.

The re-entrant portions 100 at the periphery of the relief 48a (plate 48) extend inwardly of the adjacent inner edge of the cam ring to provide intake ports 100a open to intake chamber 84.

From FIGURE 4, it will be observed that thrust plate 52 is supplied with holes 102 allowing for the passage therethrough of the pins 56. Inward of such holes are recesses 104 conforming in outline with the effective portions of openings 90 in pressure plate 48. These recesses 104 are in circumferential alignment with the openings 90 and communicate therewith through the intervane chambers 91 and holes 93 in cam ring 44. Similarly, arcuate recesses 106 are in circumferential alignment with arcuate openings 92 and arcuate recesses 108 are in circumferential alignment with arcuate recesses 94.

As should be readily apparent, the periphery of thrust plate 52 matches that of the relieved portion of 48a of plate 48. Thus, since recesses 104 circumferentially register with openings 90 as described, it follows that the re-entrant portions 110 circumferentially register with the re-entrant portions 100. The re-entrant portions 110, like portions 100, extend inwardly of the inner contour of cam ring 44. Accordingly, a second pair of intake ports 110a leftward (FIGURE 4) of such ring is provided.

To describe now the general operation of the pump and referring particularly to FIGURES 2 and 4, with the rotor 36 turning clockwise, fluid is drawn into the intervane chambers 91 from intake chamber 84 via ports 100a and 110a and is discharge into the discharge chamber 50 via ports 90. As the vanes move radially outwardly, discharge fluid entering the cavities 98 through openings 92 operates, as previously explained, to insure engagement of the outer ends of the vanes with the cam ring. The filling of the intervane chambers during the suction stages is made fast and complete by reason of the head of fluid in chamber 84 with which ports 100a and 110a communicate at all times.

As should be evident from FIGURE 4, the diametri-

cally opposed relation of the suction and pressure chambers as set by the cam ring maintains the rotor 36 in radial balance. Less evident, perhaps, is the fact that the rotor is in substantial axial balance, this being the purpose of the several recesses or pockets in thrust plate 52. It is to be noted that discharge fluid entering recesses 104 passes to chamber 50 via holes 93 in cam ring 44 and ports 90 in the pressure plate.

An important feature of the construction of the thrust plate 52 goes to the recess 52a which permits of slight deflection of the plate from the force of the fluid pressure to which it is subject. This slight deflection operates to promote egress to the intake chamber 84 or the pressure chamber 50 of any foreign matter which might otherwise tend to accumulate in the recesses in the plate.

The discharge fluid, as aforementioned, leaves the pump via the passage or orifice 80 branching from passage 78. Assuming the pump is being used for power steering and is operating at minimum speed, i.e., assuming that the engine of the vehicle carrying the pump is idling, all of the discharge fluid normally passes through the orifice 80 and out the conduit 81 to the system, valve 64 under the indicated condition being in its closed position shown. The flow rate set by the orifice 80 is, of course, a function of the diameter and length thereof. In most installations these factors are calculated to give a flow rate of from 2-3 gallons of fluid per minute, such flow rate having been found sufficient to provide adequate assist with the engine idling and with the steering resistance maximum, as obtains during parking.

Let it be assumed now that the vehicle carrying the pump is traveling at highway speed. Since the pump rotor is turning at corresponding speed a pressure build-up naturally occurs in the chamber 85 because of the restriction 80. As a consequence, valve 64 is displaced leftwardly (FIG. 2 and FIG. 5) against the resistance of the spring 66 and the fluid at system pressure contained within the spring chamber, so that the passages 78 and 82 become interconnected. Spring 66, of course, is carefully selected or gaged to yield under the indicated conditions. A relief valve, not shown, responsive to the pressure in the spring chamber and opening to intake chamber 84 when such pressure reaches a predetermined value is normally included in the system.

As the bypass oil courses passage 82 it attains substantial velocity. Under Bernoulli's principle, the kinetic energy thus developed is translated in substantial part into static pressure in the chamber 84. Since the magnitude of the static pressure is a function of the velocity in passage 82 and since such velocity is in turn a function of the pump speed, cavitation with its undesirable manifestations is effectively prevented.

Heretofore, with the pump bypassing as described, the discharge to the system rose abruptly at a pump speed of from 3500-4000 r.p.m., note pump B in FIGURE 6, wherein pump speed is plotted as abscissae and flow rate as ordinates. Such condition, as noted in the foregoing, caused excessive heating of the fluid and the parts in contact therewith. Also, because of the increased flow rate through the system, leakage problems were prone to occur.

According to the invention, a flow rate is attained as illustrated by pump A in FIGURE 6. Thus, the flow rate is actually caused to fall off instead of increase at the higher pump speeds. Consequently, there is no heat build-up in the system such as previously experienced. This desideratum is achieved by careful control of the diameters of passages 76 and 78 relative to passage or orifice 80. Passage 78 being of lesser diameter than passage 76, fluid flow therethrough is commensurately more rapid. At a pump speed reflected by the graph of FIGURE 6, the fluid flowing through passage 78 begins to have a venturi-like effect with respect to the opening of the orifice 80 with the result that since the static pressure decreases at this point at the same rate as

velocity pressure increases according to Bernoulli's principle less fluid is permitted to pass said orifice because of the resulting decrease in static pressure drop across this orifice than is the case with the pump idling or operating at speeds reflective of parking conditions or low speed travel.

We claim:

1. A pump including a casing having inlet and outlet ports, a cam ring within said casing, a rotor within said cam ring carrying circumferentially spaced vanes, drive means extending into said casing and operably connected to said rotor to rotate the same at varying speed, such rotation being accompanied by radial reciprocation of said vanes induced by said cam ring, a pressure plate within said casing at one side of said rotor and abutting the corresponding side of said cam ring, a thrust plate within said casing at the other side of said rotor and abutting the corresponding side of said cam ring, said plates comprising re-entrant portions providing a pair of ports in circumferential alignment, said pressure plate and said cam ring comprising openings in the bodies thereof providing a pair of ports in circumferential alignment circumferentially spaced from said first-mentioned pair of ports, said plates having recesses facing said rotor open to said last-mentioned pair of ports, said casing having therein a discharge passage to which said last-mentioned pair of ports and said outlet port open, together with a bypass passage and a passage interconnecting said discharge and bypass passages, and being formed to provide an annular intake chamber to which said circumferentially aligned first-mentioned pair of ports and said inlet port open, and said intake chamber surrounding said cam ring and communicating with said bypass passage.

2. A pump including a casing having inlet and outlet ports, said casing having a bore with a small, an intermediate and a large diameter portion with the small diameter portion at one end and the large diameter portion at the other end, a cam ring within said intermediate diameter bore portion of said casing, a rotor within said cam ring carrying circumferentially spaced vanes, drive means extending through said small diameter bore portion into said casing and operably connected to said rotor to rotate the same at varying speed, such rotation being accompanied by radial reciprocation of said vanes induced by said cam ring, a pressure plate within said intermediate diameter portion of said casing at one side of said rotor and abutting the corresponding side of said cam ring and the step between the small and intermediate diameter bore, a thrust plate within said casing at the other side of said rotor and abutting the corresponding side of said cam ring located in said large diameter bore portion, said plates comprising re-entrant portions providing a pair of ports in circumferential alignment, said pressure plate and said cam ring comprising openings in the bodies thereof providing a pair of ports in circumferential alignment circumferentially spaced from said first-mentioned pair of ports, said plates having recesses facing said rotor on opposite sides open to said last-mentioned pair of ports, said casing having therein a discharge passage to which said last-mentioned pair of ports and said outlet port open, together with a bypass passage and a passage interconnecting said discharge and bypass passages, and being formed to provide an annular intake chamber to which said circumferentially aligned first-mentioned pair of ports and said inlet port open, said intake chamber surrounding said cam ring and communicating with said bypass passage, and a cover member sealing the open end of said large bore providing a discharge chamber communicating with said discharge passage.

3. A pump and fitting assembly including a casing having inlet and outlet ports, a reservoir within which said casing is housed, said reservoir being open to said inlet port, a cam ring within said casing, a rotor within said cam ring carrying circumferentially spaced vanes, a shaft

extending into said casing and operably connected to said rotor to rotate the same at varying speed, such rotation being accompanied by radial reciprocation of said vanes induced by said cam ring, a pressure plate within said casing at one side of said rotor and abutting the corresponding side of said cam ring, a thrust plate within said casing at the other side of said rotor and abutting the corresponding side of said cam ring, a plurality of pins extending through said ring and said plates and supported by said casing, a sleeve between said shaft and said rotor having a close bearing fit in one of said plates to maintain the rotor centered with respect to said ring, said plates comprising re-entrant portions providing a pair of ports in circumferential alignment, said pressure plate and said cam ring comprising openings in the bodies thereof providing a pair of ports in circumferential alignment circumferentially spaced from said first-mentioned pair of ports, said thrust plate and said pressure plate further comprising in the inner faces thereof recesses of similar outline in circumferential alignment open to said last-mentioned pair of ports, said casing having therein a discharge chamber and a discharge passage to which said last-mentioned pair of ports and said outlet port open, together with a bypass passage and a passage interconnecting said discharge and bypass passages, and being formed to provide an annular intake chamber to which said circumferentially aligned first-mentioned pair of ports open, said intake chamber surrounding said cam ring and communicating with said bypass passage, said discharge chamber having a cover, spring means holding said cover and said thrust plate in position.

4. A pump and fitting assembly including a casing having inlet and outlet ports, said casing having a bore with a small, an intermediate and a large diameter bore portion coaxially located with the small portion at one end and the large portion at the other end, a reservoir within which said casing is housed, said reservoir being open to said inlet port, a cam ring within said intermediate bore portion of said casing, a rotor within said cam ring carrying circumferentially spaced vanes, drive means extending through said small bore portion into said intermediate portion of said casing and operably connected to said rotor to rotate the same at varying speed, such rotation being accompanied by radial reciprocation of said vanes induced by said cam ring, a pressure plate within said intermediate bore portion of said casing at one side of said rotor and abutting the corresponding side of said cam ring and the step between the small and intermediate bore portions, a thrust plate within said large bore portion of said casing at the other side of said rotor and abutting the corresponding side of said cam ring, a plurality of pins extending through said ring and said plates and supported by said casing, a sleeve between said shaft and said rotor having a close bearing fit in one of said plates to maintain the rotor centered with respect to said ring, said plates comprising re-entrant portions providing a pair of ports in circumferential alignment, said pressure plate and said cam ring comprising openings in the bodies thereof providing a pair of ports in circumferential alignment circumferentially spaced from said first-mentioned pair of ports, said thrust plate and said pressure plate comprising in the inner faces thereof recesses of similar outline circumferentially aligned and open to said last-mentioned pair of ports, a closure closing said large bore portion of said casing to provide a discharge chamber to which said last-mentioned pair of ports and said outlet port open, together with a bypass passage and a passage interconnecting said discharge chamber and bypass passage, and being formed to provide an annular intake chamber to which said circumferentially aligned first-mentioned pair of ports open, and said intake chamber surrounding said cam ring and communicating with said bypass passage, stop and seal means, spring means biasing said closure and pressure plate into position abutting said stop and seal means.

5. A pump including a casing having inlet and outlet ports, said casing being housed within a reservoir to which said inlet port opens, a cam ring within said casing, a rotor within said cam ring carrying circumferentially spaced vanes, drive means extending into said casing and operably connected to said rotor to rotate the same, such rotation being accompanied by radial reciprocation of said vanes induced by said cam ring, a pressure plate within said casing at one side of said rotor and abutting the corresponding side of said cam ring, and a thrust plate within said casing at the other side of said rotor and abutting the corresponding side of said cam ring, said plates comprising re-entrant portions providing a pair of ports in circumferential alignment, said pressure plate and said cam ring comprising openings in the bodies thereof providing a pair of ports in circumferential alignment circumferentially spaced from said first-mentioned pair of ports, said thrust plate and said pressure plate having recesses in their inner faces facing said rotor and being in circumferential alignment and open to said last-mentioned pair of ports, said casing having therein a discharge passage to which said last-mentioned pair of ports and said outlet port open and being formed to provide an annular intake chamber communicating with said inlet port and to which said circumferentially aligned first-mentioned pair of ports open, said intake chamber surrounding said cam ring.

6. A pump including a casing having inlet and outlet ports, said casing being housed within a reservoir to which said inlet port opens, a cam ring within said casing, a rotor within said cam ring carrying circumferentially spaced vanes, drive means extending into said casing and operably connected to said rotor to rotate the same, such rotation being accompanied by radial reciprocation of said vanes induced by said cam ring, a pressure plate within said casing at one side of said rotor and abutting the corresponding side of said cam ring, and a thrust plate within said casing at the other side of said rotor and abutting the corresponding side of said cam ring, said plates comprising re-entrant portions providing a pair of ports in circumferential alignment, said pressure plate and said cam ring comprising openings in the bodies thereof providing a pair of ports in circumferential alignment circumferentially spaced from said first-mentioned pair of ports, said thrust plate and said pressure plate having therein recesses in circumferential alignment open to said last-mentioned pair of ports, said casing having therein a discharge passage open to said outlet port with which

said last-mentioned pair of ports and connected said recesses communicate and being formed to provide an annular intake chamber open to said inlet port and to which said first-mentioned pair of circumferentially aligned ports open, said intake chamber surrounding said cam ring.

7. In a pump of the class described comprising within a casing, a cam ring, a vane-carrying rotor circumscribed by said cam ring, a shaft for driving said rotor and a pair of plates one at either side of said ring, a plurality of pins extending through said ring and said plates and supported by said casing, and a sleeve element between said shaft and said rotor and having a close bearing fit in one of said plates whereby said rotor is maintained in centered relation with respect to said ring by said pins acting through said one plate.

8. A pump comprising a casing, a vane-carrying rotor within said casing, a cam ring circumscribing said rotor and a pair of plates one at either side of said cam ring, one of said plates being a thrust plate provided with a plurality of recesses in its inner face, the other being a pressure plate having a plurality of corresponding ports therein, said thrust plate being subject to the force of fluid at discharge pressure and having a reduced width opposite said rotor provided by a recess in the outer face of said thrust plate designed to flex slightly from such force whereby the removal of foreign matter from said recesses is promoted.

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MARK NEWMAN, *Primary Examiner.*

LAURENCE V. EFNER, DONLEY J. STOCKING,
Examiners.

G. M. THOMAS, W. J. KRAUSS, *Assistant Examiners.*