Sept. 29, 1953 O. E. ROSAEN 2,653,551

FLUID PUMP

Filed Dec. 22, 1947 2 Sheets-Sheet 1

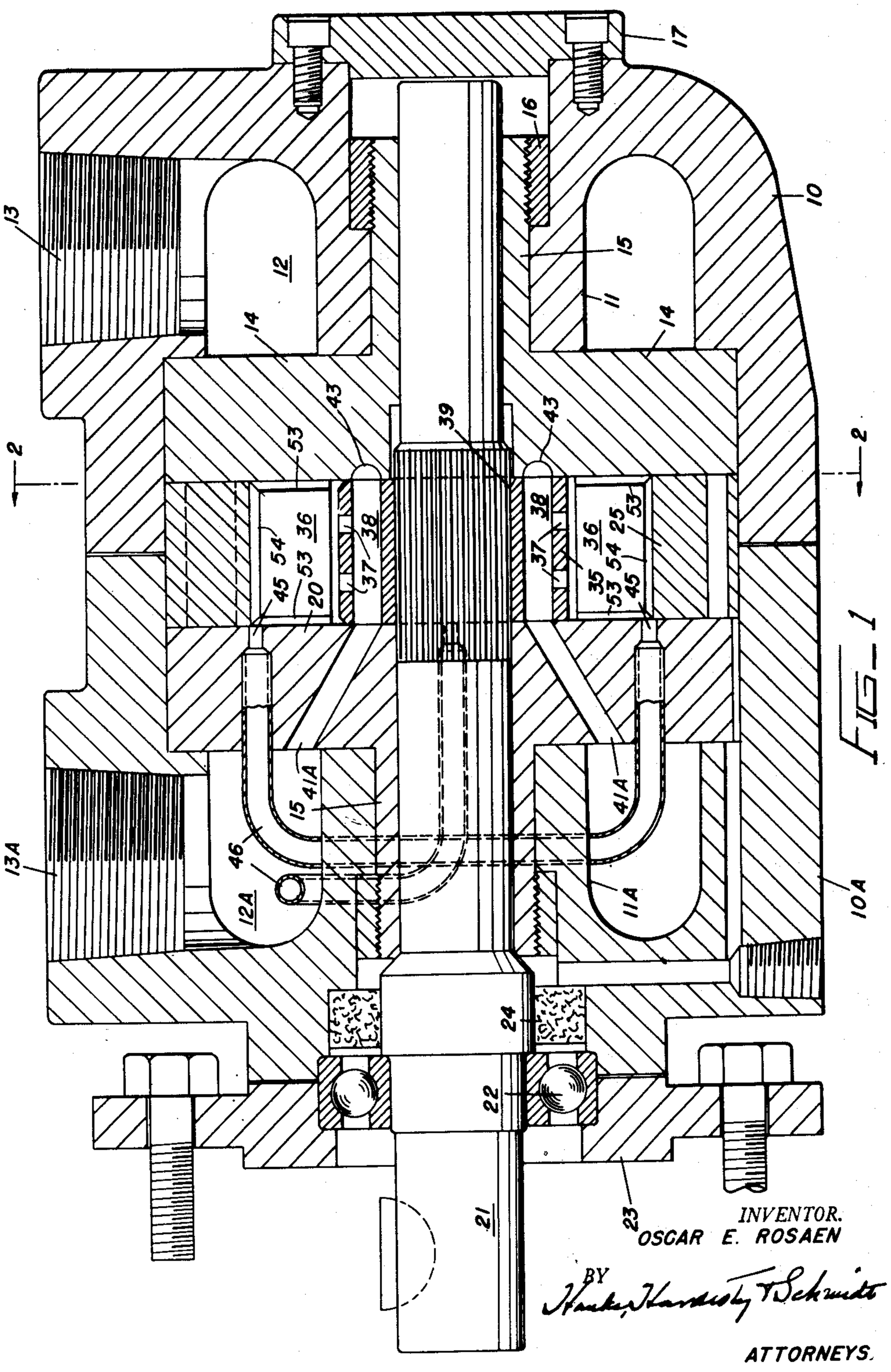

FIG. 1

INVENTOR.
OSCAR E. ROSAEN

BY Hauke, Kardosky & Schmidt

ATTORNEYS.

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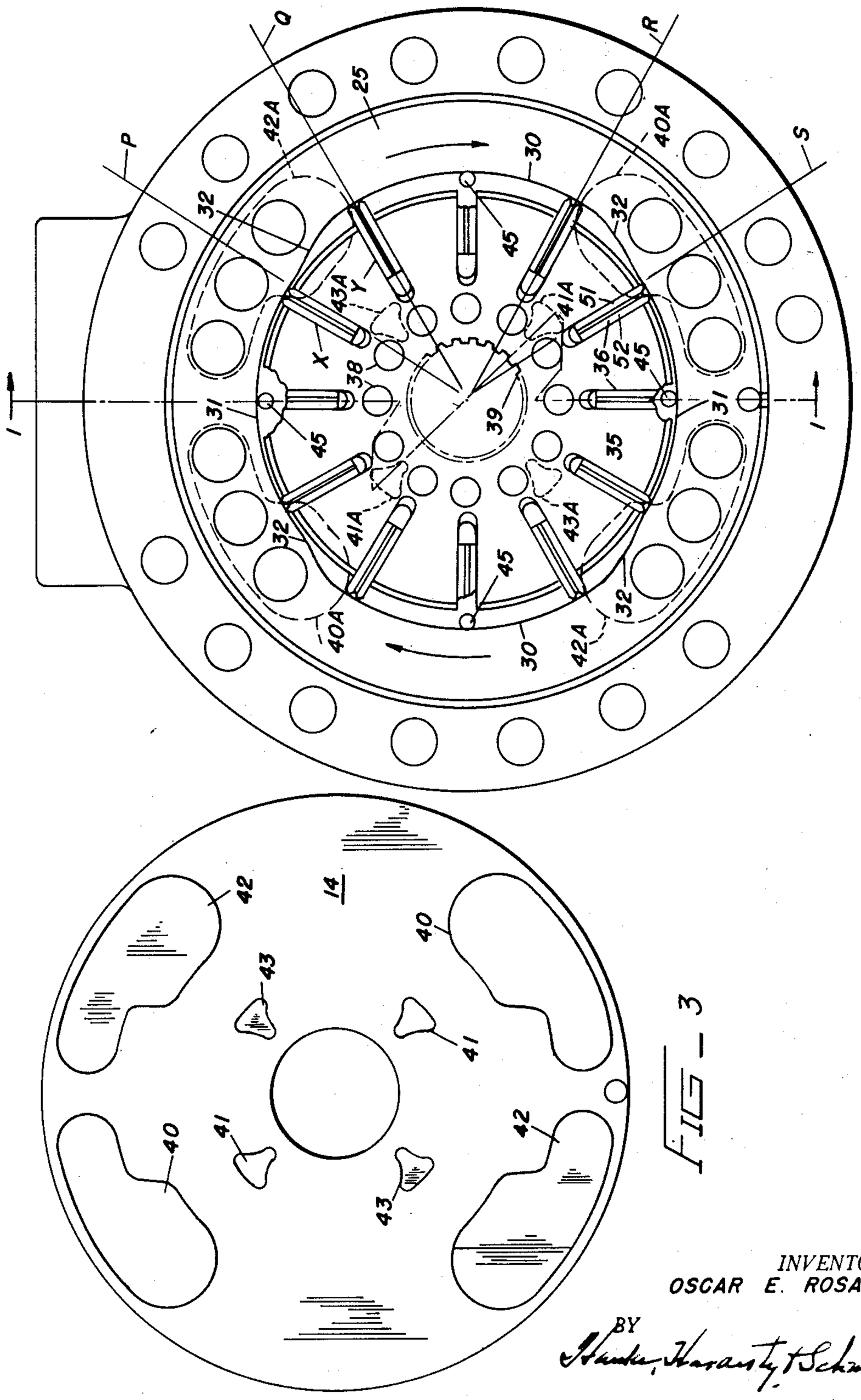

FIG_2

FIG_3

INVENTOR.
OSCAR E. ROSAEN

BY
Stanley, Hararty & Schmidt

ATTORNEYS.

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FLUID PUMP

Oscar E. Rosaen, Detroit, Mich., assignor, by direct and mesne assignments, to The New York Air Brake Company, New York, N. Y., a corporation of New Jersey

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4 Claims. (Cl. 103—136)

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The present invention relates to fluid pumps or motors of the vane type, that is, that type of pump or motor in which a rotor carrying radially movable vanes moves or is moved by the fluid.

Among the objects of the invention is to improve the efficiency of such devices by improved control of the vane movement.

Another object is to improve the efficiency of such devices by providing means for balancing the pressure of fluid in the pressure containing chambers.

Another object is to provide an improved construction of such devices.

Still other objects will readily occur to those skilled in the art upon reference to the following description and the accompanying drawings in which:

Fig. 1 is a longitudinal central sectional view of the pump or motor as if on line 1—1 of Fig. 2.

Fig. 2 is a view in elevation of that portion of the pump or motor to the left of line 2—2 of Fig. 1.

Fig. 3 is an elevational view of the right hand end plate of Fig. 1.

In the drawings, the pump or motor is shown as consisting of a divided housing made up of two members 10 and 10A. These members are each provided with a central internal boss 11 and 11A axially bored and providing annular chambers 12 and 12A opening to outlets (or inlets) 13 and 13A.

The housing member 10 is provided with a deep recess, opening toward the other housing member, for the reception of an end plate 14 which is provided with a central bore and an axial extension 15 adapted to fit in the bore of boss 11 and be held in place by a nut 16. The outer end of the bore in boss 11 will be countersunk to receive the nut 16 and be closed by a suitable cap 17.

The member 10A will also be provided with a deep recess to receive another end plate 20, this being a substantial duplicate of plate 14 and mounted therein by similar means.

Instead, however, of cap 17, the bore in boss 11A is open for the reception of the shaft 21, this extending through the housing and contained parts to terminate adjacent cap 17.

A suitable anti-friction thrust bearing 22 is provided and maintained in place by the plate 23. Further, a suitable packing 24 will also be provided.

Between end plates 14 and 20 and partially in the recesses of the housing members is a ring

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25, circular in its outer contour to fit tightly in said recesses and against the sides of which the end plates fit tightly so as to form fluid tight closures for the chamber within the ring.

The inner contour of ring 25, commonly called the track, is shown in Fig. 2. It is provided with two diametrically located concentric portions of one radius and two intermediate diametrically located concentric portions of a somewhat shorter radius.

The first of these portions 30 constitute pumping or driving zones while the other portions 31 are the idle vane zones. These portions are graduated into each other by smooth short intermediate inclined transition portions 32.

Located within the ring 25 is a rotor 35 of such thickness as to lie closely but with a slight clearance against the end plates 14 and 20. A good running fit is thus afforded.

This rotor is provided with radially arranged slots for the reception of vanes 36 adapted to slide out and in so as to maintain contact with the inner surface of ring 25. It is also of a slightly less diameter than the portions 31 of the ring 25.

The bottom of each of the vane slots communicates through two or more passages 37 with another passage 38 extending through the rotor in an axial direction.

The vanes 36 are preferably such as are described and claimed in U. S. Letters Patent No. 2,393,223 issued January 13, 1946 "Hydraulic Motors" and consist of two or more co-extensive leaves or plates 51, 52 in face to face relation and having their adjacent edges beveled along the sides of each leaf as shown at 53 and outer ends of each leaf, as shown at 54, so as to provide oil channels extending from the bottoms of the slots to the outer ends of the vanes. The beveled edges at the outer ends of a pair of leaves therefore provide small oil pockets in communication with the bottoms of the vane slots.

The rotor 35 is splined on the shaft 21, the splines 39 being of a relatively large number and involute in form.

The end plates 14 and 20 are substantially alike and as indicated in Figs. 2 and 3 are provided with diametrically located through passages 40 and 41, the passages 40 being located near the periphery and open to the chambers 12 and 12A and also for a part of their area to one end of the active zone of the space between the rotor 35 and ring 25.

The openings 41 are also open to chambers 12 and 12A and are located near the inner edge of

the face of the end plate and communicate with the passages **38** in the rotor.

Each of the plates **14** and **20** is also provided with a pocket or recess **42** of the same area and shape as passage **40** and other recesses or pockets **43** of the same shape and area as the passages **41**, and when in assembled relation, each passage will be opposed to its corresponding pocket in the other plate.

In addition to the passages **40** and **41**, the plate **20** will be provided with four small through passages **45** opening into the central part of the operating chamber or zone **30** and the central part of the idle zone **31** of the ring **25**. The two passages opening to zone **30** are connected by a tube **46** and the other two passages to zone **31** by a second tube **46**, the tubes passing around boss **11A** in chamber **12A**. There is an inherent tendency for pressures in the two zones **30** to equalize, and the same is true as to the two zones **31**. Hence the parts **45** and **46** can commonly be dispensed with; but they are considered desirable because they serve to equalize pressures in diametrically opposite intervane spaces, should these ever get out of balance, while out of communication with both inlet and discharge. Unlike prior art vane pumps, this pump has the inlet and discharge ports and the vanes relatively so spaced that successive vane slots are periodically isolated simultaneously from both inlet and discharge.

As indicated above, the structure may be utilized either as a pump or motor, and either of the chambers **12** and **12A** may be the pressure chamber. When used as a motor it is therefore reversible.

In operation, assuming a pumping operation, suitable power application will be made to rotate shaft **21**.

Oil or other fluid enters through inlet **13** to chamber **12** and then passes through openings **40** to the zones **30** of the space between the rotor **35** and ring **25**. At the same time the fluid enters openings **41** and flows to the passages **33** in the rotor and thence to the slots under the vanes.

In the starting of the pump, the vanes **36** will be moved out through centrifugal action, but, once the chambers are filled, centrifugal action plays little part.

As soon as pressure builds up in chamber **12A**, back pressure will positively force the vanes outwardly.

In Fig. 2, the opening **40A** is the outlet to chamber **12A** and is opposite a closed chamber **42** in plate **14**, while the closed chamber **42A** is opposite a passageway **40** of plate **14**, assuming, of course, rotation of rotor **35** in the direction of the arrow.

As the vanes move from the zone **31** to the zone **30** and from position X to position Y, fluid will be drawn into the space between the outer ends of the vanes and also through a passage **41** to the slots under the vanes, and will be moved around zone **30** to pass out of passages **40A** and the passages **41** in plate **20**. Pumping, therefore, is done by both the outer edges of the vanes and the piston action of the vanes in the slots.

Referring to Figs. 2 and 3, it will be noted that the passages **40** and **41** are substantially coextensive in their arcuate length and so located relatively to each other that they are both open only during the time that the vanes are moving in or out in the slots, for example, from the angular position P to the angular position Q and from R to S (Fig. 2).

As a result of this, the fluid in the vane slots is trapped during the time the vanes are moving through the pressure zone **30**, or from position Q to position R, and resists inward movement.

Further, little or no outward pressure is exerted on the vanes as they pass through the idle zone **31**.

While the drawings illustrate a rotor having twelve vanes, the use of a greater or even less number is contemplated, but in any case, the parts should be so related that at least two vanes in a zone will be held by the static pressure of the trapped fluid at all times. More than two are desirable in some cases but, as a rule, experience indicates that an arrangement giving a minimum of two is best.

Where, as in the usual prior art arrangement, a single vane separates vanes loaded at inlet pressure and vanes loaded at outlet pressure, and the outer end of the vane has line contact with the track, as is usual, the tendency toward leakage is great, and the change between two widely different vane loading pressures is abrupt and violent. As a consequence, prior art pumps subjected their tracks and vanes to severe recurrent shocks, slot pressures for protruding the vanes were high over needlessly long arcs, and mechanical injury and wear of vanes and track were frequent. This has been the chief limiting factor in the use of vane pumps and motors.

This invention involves an appreciation of the fact that all vane pumps and motor are subject to "slip" or leakage past vanes, and that this slip can be employed usefully. By causing the slip between the high and the low hydraulic pressures to occur serially past several vanes not heavily loaded outward, a desirably gradual pressure transition is attained.

The laminated vane, of my prior patent, above identified, exposes its full transverse area to pressure acting outward within the vane slot, and a rather smaller area to the same pressure acting oppositely in the end groove, these two pressure areas being connected by the slender side bevels which form restricted equalizing ports.

Hence the vanes are each subject only to a moderate outward bias hydraulically developed. This bias is related to the pressure acting on each vane and tends to be graduated as the pressures in the intervane spaces are graduated.

Thus in a pump, for example, the vanes are biased lightly outward by inlet pressure while moving between an idle zone and the next working zone and are loaded more heavily but not severely by discharge pressure as they move inward at the end of the working zone preparatory to travel through the next idle zone. While traversing the idle zones and the working zone, and through remarkably large arcs the vanes are hydraulically retained in contact with the track, but are not heavily loaded hydraulically.

In the working zone the graduation of pressure by slip prevents sudden changes of vane loading. The fact that pressure fluid is admitted to the slots only while the ends of the vanes traverse the transition inclines of the track, and are then under the same pressure as the liquid which acts upon the protruding portions of the vanes minimizes vane friction and prevents the vanes from hammering the track. The beneficial effect is not merely local to the pump. Smooth vane action nearly eliminates pressure pulsation so that the whole system is benefited.

I claim:

1. An expansible chamber device of the vane type comprising in combination, a cylindrical rotor having spaced generally radial vane slots; rotor-enclosing structure having inlet and discharge connections and comprising means affording a rotor-encircling vane-track and side members which embrace the sides of the rotor, said structure defining diametrically opposite arcuate pump zones, diametrically opposite arcuate idle zones and interposed transition zones formed as inclines on the track, said structure having inlet ports and discharge ports connected with the inlet and discharge connections respectively and arranged in alternation circumferentially and each approximately coextensive with successive transition zones and with the vane-slot interval on the rotor, said structure also having loading ports dimensioned and located to connect the inner ends of individual vane slots with the inlet connection when the slot passes an inlet port and with the discharge connection when the slot passes a discharge port, and to close such connections at other times; and laminated vanes reciprocable in said slots so as to follow said track, said vanes having beveled outer ends on two laminae to afford two spaced line contacts with the track and an intervening groove, and means forming a passage connecting said groove with the bottom of the vane slot in which the vane is mounted, whereby the vane has a limited outward bias developed by hydraulic loading pressure in the slot, the number and spacing of the vane slots and the ports being such that between each inlet port and the next discharge port there is always a minimum of two vanes whose loading ports are closed.

2. The combination defined in claim 1 in which there are respective pressure-equalizing passages connecting diametrically opposite pump zones and connecting diametrically opposite idle zones, approximately at mid-length thereof.

3. A rotary pump of the vane type comprising in combination, a cylindrical rotor having spaced generally radial vane slots; rotor-enclosing structure having inlet and discharge connections and comprising means affording a rotor-encircling vane-track and side members which embrace the sides of the rotor, said structure defining diametrically opposite arcuate pump zones, diametrically opposite arcuate idle zones and interposed transition zones formed as inclines on the track, said structure having inlet ports and discharge ports connected with the inlet and discharge connections respectively and arranged in alternation circumferentially and each approximately coextensive with successive transition zones and not longer than the vane-slot interval on the rotor, said structure also having loading ports dimensioned and located to connect the inner ends of individual vane slots freely with the inlet connection when the slot passes an inlet port and with the discharge connection when the slot passes a discharge port, and to close such connections at other times; and laminated vanes reciprocable in said slots so as to follow said track, said vanes having beveled outer ends on two laminae to afford two spaced line contacts with the track and an intervening groove, and means forming a passage connecting said groove with the bottom of the vane slot in which the vane is mounted, whereby the vane has a limited outward bias developed by hydraulic loading pressure in the slot, the number and spacing of the vane slots and the ports being such that between each inlet port and the next discharge port there is always a minimum of two vanes whose loading ports are closed.

4. An expansible chamber device of the vane type comprising in combination, a cylindrical rotor having spaced generally radial vane slots; rotor-enclosing structure having inlet and discharge connections and comprising means affording a rotor-encircling vane-track and side members which embrace the sides of the rotor, said structure defining diametrically opposite arcuate pump zones, diametrically opposite arcuate idle zones and interposed transition zones formed as inclines on the track, said structure having inlet ports and discharge ports connected with the inlet and discharge connections respectively and arranged in alternation circumferentially and each approximately coextensive with successive transition zones and with the vane-slot interval on the rotor, said structure also having loading ports dimensioned and located to connect the inner ends of individual vane slots with the inlet connection when the slot passes an inlet port and with the discharge connection when the slot passes a discharge port, and to close such connections at other times; and vanes reciprocable in said slots so as to follow said track, said vanes each including means providing a groove along its outer end to afford two contact lines with arcuate portions of the track and means providing a passage connecting said groove with the bottom of the vane slot in which the vane is mounted, whereby the vane has a limited outward bias toward arcuate portions of the track developed by hydraulic loading pressure in the slot, the number and spacing of the vane slots and the ports being such that between each inlet port and the next discharge port there is always a minimum of two vanes whose loading ports are closed.

OSCAR E. ROSAEN.

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