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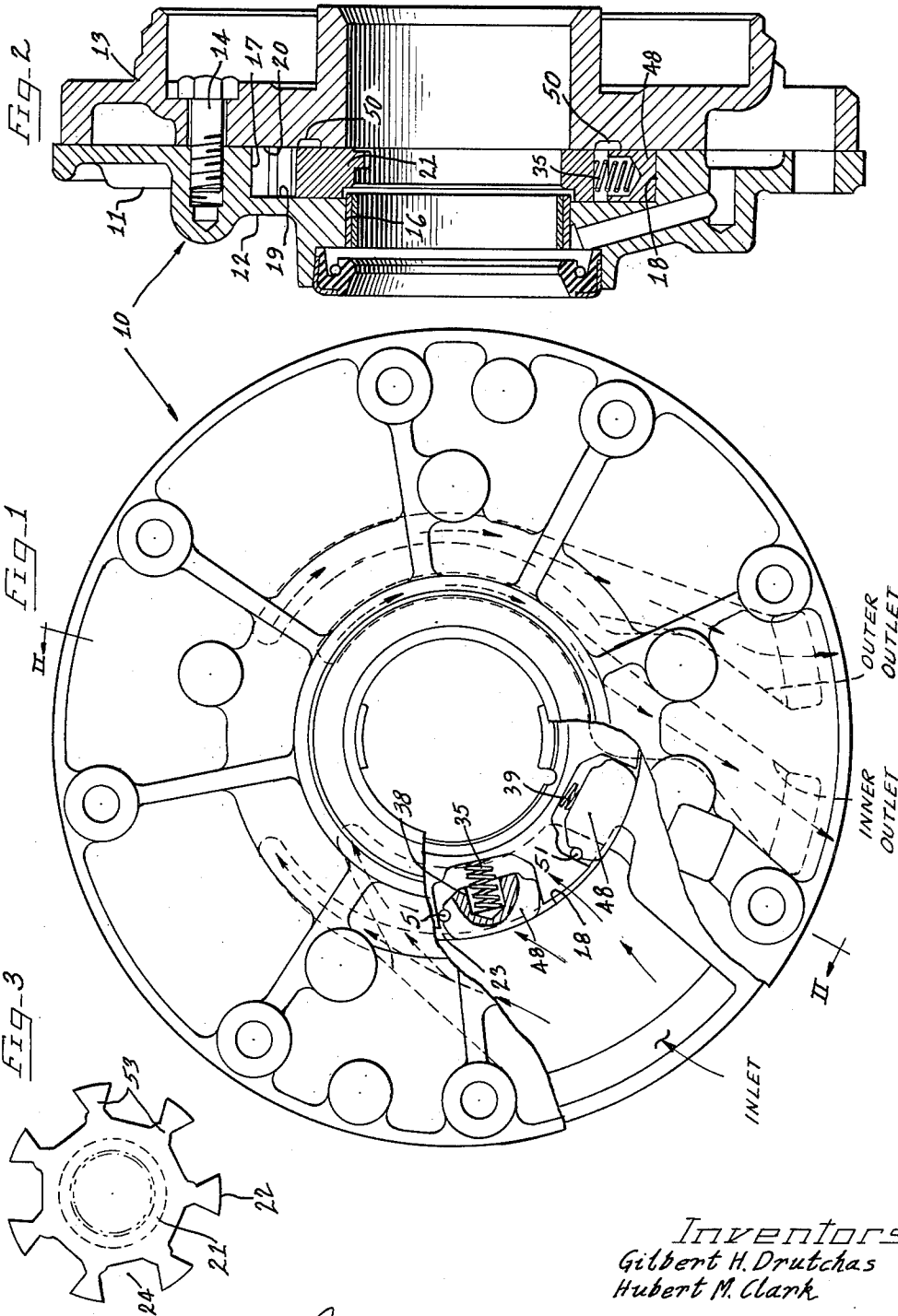
G. H. DRUTCHAS ETAL

3,081,706

SLIPPER SEALING MEANS FOR A DUAL ACTING PUMP

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3 Sheets-Sheet 1



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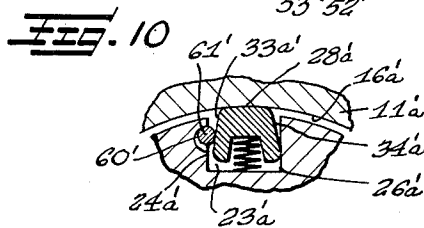
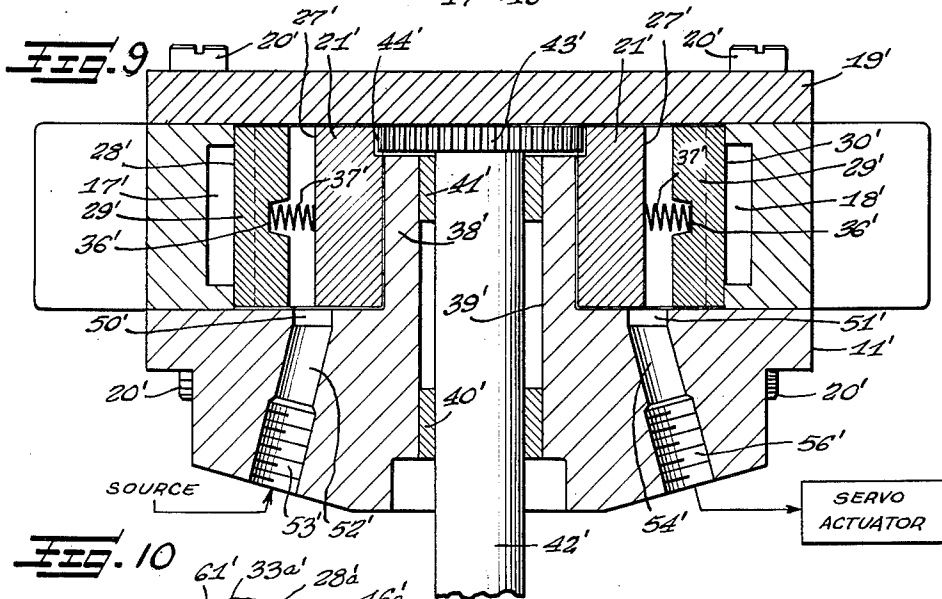
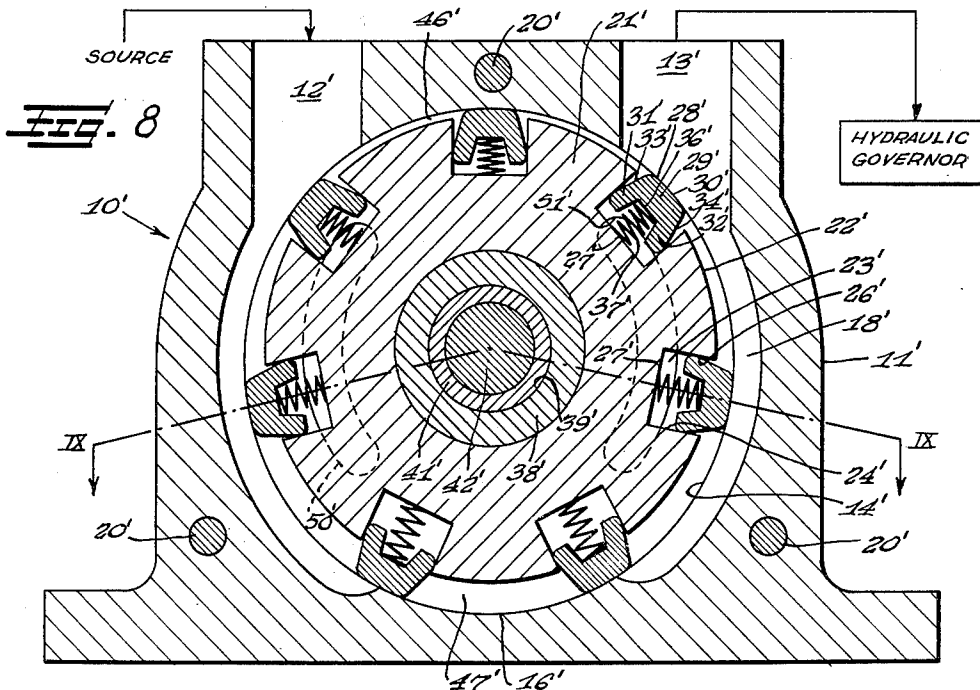
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SLIPPER SEALING MEANS FOR A DUAL ACTING PUMP

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3 Sheets-Sheet 3



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3,081,706

SLIPPER SEALING MEANS FOR A DUAL ACTING PUMP

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13 Claims. (Cl. 103-4)

This disclosure constitutes a continuation-in-part of our copending application Serial No. 814,516, filed May 20, 1959, the disclosure of which has now been combined herewith. Said application Serial No. 814,516 has been abandoned but the disclosure thereof has not been abandoned and has been combined with the instant application.

This invention relates generally to slipper piston pumps and more particularly to a slipper-type pump wherein a sealing pin operable as a balancing check valve balances differences of pressure peaks between the circuits to assure a more uniform noise level.

It is an object of the present invention to provide a slipper-type pump wherein a sealing pin is utilized in such a manner as to afford the use of a lower ratio of vane section output to slipper piston output without appreciably reducing the physical strength of the rotor.

Another object of the present invention is to provide a sealing pin arrangement for a slipper-type pump wherein the sealing pin is energized by the action of centrifugal force to effect an efficient seal between the slipper and the adjoining rotor wall.

Yet another object of the present invention is to provide an optimum pin action angle for a pin-sealed slipper-type pump wherein the resistance to the self-energized sealing force will be minimized.

Yet another object of the present invention is to provide a pump construction having two separate pumping circuits and utilizing a directional check valve means between circuits.

A still further object of the present invention is to provide a check valve means for a double circuit type pump wherein the check valve means includes a sealing pin interposed between the adjoining side walls of a rotor notch and a slipper-type pumping element.

Another object of the present invention is to provide a check valve action in a two-circuit-type pump which is dynamically responsive enough to balance differences of pressure peaks between the circuits, thus assuring a more uniform pump noise level between sections.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings in which a preferred structural embodiment of a pump incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

FIGURE 1 is an end elevational view of a pump incorporating the principles of the present invention and having portions thereof broken away to illustrate the general operating environment of a rotor and slipper embodying the inventive improvements disclosed;

FIGURE 2 is a cross-sectional view taken generally on line II-II of FIGURE 1;

FIGURE 3 is a reduced elevational view of the rotor incorporated in the pump of FIGURES 1 and 2;

FIGURE 4 is an enlarged side elevational view of a slipper provided in accordance with the principles of the present invention;

FIGURE 5 is a plan view of the slipper of FIGURE 4;

FIGURE 6 is a fragmentary cross-sectional view show-

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ing a slipper in cross-section and illustrating the relationship thereof to the rotor of the present invention; and

FIGURE 7 is a fragmentary view showing details of construction of the rotor notch provided in accordance with the principles of the present invention.

FIGURE 8 is a cross-sectional view of a slipper-type pump incorporating the principles of the present invention;

FIGURE 9 is a cross-sectional view with parts shown in elevation taken generally on line IX-IX of FIGURE 8; and

FIGURE 10 is a fragmentary cross-sectional view illustrating a modified embodiment of a slipper-type pumping element construction in accordance with the principles of the present invention.

As shown on the drawings:

The pump of the present invention is shown generally at 10 and comprises a casing 11 having a first housing part 12 connected to a second housing part 13 by a plurality of fasteners 14.

The housing part 12 has formed therein a bore 16 counterbored as at 17 to form a pumping chamber having an outer cylindrical bore wall 18 and a radial side wall 19.

The housing part 13 provides on the other side of the pumping chamber 17 a radial end wall 20.

A rotor 21 is provided which has an outer cylindrical peripheral surface 22 of lesser diameter than the bore wall 18 and the rotor 21 is rotatable within the pumping chamber 17 on a rotational axis which is offset from the axis of the pumping chamber 18, thereby to form a crescent-shaped working chamber in the pumping chamber 18 which is indicated at 23 in FIGURE 1.

As shown in FIGURE 3, the rotor is an essentially cylindrical element having formed therein a plurality of peripheral notches 24, the exemplary form of the invention herein disclosed utilizing a rotor 21 having seven notches formed in the periphery thereof. Each notch is shown in specific detail in FIGURE 7. It will be noted the notch 24 has a first side wall 26 and spaced therefrom in generally parallel relation therewith is a second side wall 27. A bottom wall 28 is provided which merges with the side wall 27 via an angularly inclined portion 29, while the bottom wall 28 merges with the side wall 26 via an irregularly-shaped portion 30 forming a stop shoulder.

A slipper indicated generally at 31 is provided for each notch 24. Each slipper has a curved outer sealing surface 32 which is contoured to be severally complementary to the bore wall 18 and which will, therefore, engage the bore wall with a surface contact. The slipper sealing surface being of a slightly smaller radius than the bore wall, the contact between the surfaces will be in effect, a land contact.

At one side of the slipper 31, there is provided an end wall 33 which curves generally outwardly of the sealing surface 32 and terminates in an inwardly directed wall 34. As shown in FIGURE 6, the wall 33 of the slipper 31 is adapted to sealingly engage the adjoining side wall 26 of the notch 24 in the rotor 21.

The inwardly directed wall 34 terminates in a shoulder 36 which is disposed between the wall 34 and a flat end wall 37 in which is formed a recess 38 for bottoming one end of a coil spring 35, the other end of which is bottomed against the bottom wall 28 of the notch 24, thereby to continuously bias the slipper 31 generally outwardly of the notch 24.

At the opposite side of the slipper 31, there is formed a pair of wing sections 39 and 40, each of which providing a curved overhanging retaining surface 41 forming the upper boundaries of a recess 42 which extends inwardly of a side wall 43 on the slipper 31.

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Spaced from the retaining surface 41 and on the opposite side of the recess 42 from the retaining surface 41 is a surface 44 which is inclined generally outwardly, thereby to form what will be referred to hereinafter as a pin action surface 44.

Between the wing portions 39 and 40, there is formed an enlarged recess provided by an inwardly directed wall 46 which includes an offset portion 47 intersecting the wall 37.

The slipper 31 is also provided with flat parallel ends shown at 48 and 49, respectively.

As will be noted upon inspecting FIGURE 6, the spacing dimension between the wall 33 and the wall 43 on the slipper 31 is somewhat less than the spacing dimension between the wall 26 and the wall 27 of the notch 24.

There is thus provided in accordance with the principles of the present invention, a sealing means between the wall 43 and the wall 27. By virtue of such sealing means, the pump 10 is particularly adapted to develop a dual pumping action characterized by the provision of inner and outer pumping circuits. Thus, the pump is suitably ported with inlet and outlet ports communicating with the working chamber 23 so that a first pumping circuit will be established outwardly of the sealing means between the wall 43 and the wall 27. Additionally, the pump is ported, for example, by means of side wall ports shown at 50 in FIGURE 2 adapted to communicate with the inner portions of the notches 24, thereby to establish a second pumping circuit inwardly of the sealing means.

In this particular form of the invention, the sealing means takes the form of a cylindrical pin 51 having a length corresponding to the spacing dimension between the ends 48 and 49 of the slipper 31 and having a peripheral sealing surface 52 which is adapted to engage against the wall 27 and against the slipper 31, thereby to sealingly isolate the inner and outer pumping circuits of the pump 10. It will be understood that the term "sealing pin" as employed herein refers to a sealing means of any suitable shape and particularly other shapes of pin sections.

In accordance with the principles of the present invention, the sealing pin 51 is positioned in the recess 42 extending inwardly of the side wall 43 and in the slipper 31. By using this arrangement instead of placing the pin in a recess formed within the wall 27 of the notch 24, it is possible to use a lower ratio of vane section output to slipper piston output without appreciably reducing the physical strength of the rotor, particularly in the critical strength section shown at 53 in FIGURE 3.

The sealing pin 51 is energized by the action of centrifugal force upon rotation of the rotor 21, thereby effecting a good sealing action between the slipper 31 and the wall 27 of the rotor 21.

In order to enhance the self-energizing sealing force, the present invention contemplates the provision on the slipper 31 of the action surface 44 engageable with the peripheral surface 52 of the pin 51. Although the pin action angle need not be selected with critical analysis, it is contemplated by the present invention that the pin action angle be adjusted to give the least or minimal resistance to the self-energizing sealing force. Thus, in the illustrative embodiment herein disclosed, the pin action angle, as indicated on FIGURE 6 at 54 is approximately 30°.

In a dual acting pump of the type herein disclosed, it is possible that the pressure in the outer pumping circuit might be greater than the pressure within the inner pumping circuit. If such differential exists, it is possible that the pin 51 would be unrestrained by the side walls 43 and 27, which lack of restraint might result in the pin being physically displaced out of proper position.

In accordance with the principles of the present invention, the pin means 51 is particularly adapted to act as a one directional check valve. This advantageous function is developed by forming on the wing sections 39 and 40 the restraining surfaces 41 which in part overlie the recess

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42 cut away into the side wall 43 of the slipper 31 and thereby serve to confine the pin 51 within the recess. Thus, the pin 51 normally seals in the direction of the outer pumping circuit and will continue to do so as long as the inner pumping circuit pressure is greater than the pressure in the outer pumping circuit. With the reverse true, however, the outer pumping circuit pressure will force the pin 51 inwardly against the restraining surfaces 41, thereby insuring that equal pressure will exist in both pumping circuits.

Moreover, by utilization of the pin 51 as a check valve an improved degree of noise control can be achieved. It has been determined that vehicular pump noise is closely related to pressure peaking. The check valve action of the sealing pin 51 is dynamically responsive enough to balance differences of pressure peaks between the pumping circuits, thus assuring a more uniform noise level between the sections. The stop 30 positioned in register with the pin 51 prevents overtravel of the seal pin 51 inwardly.

The pump shown in FIGURES 8, 9 and 10 is indicated generally at 10' and comprises a casing 11' forming a housing for the pump in which is formed an inlet 12' and an outlet 13'.

A pumping chamber 14' is formed in the housing 11' and includes a generally cylindrical bore formed by a bore wall 16' recessed on one side of the pump to provide an inlet recess 17' and recessed on the opposite side of the pump to provide an outlet recess 18'.

The casing forming the housing 11' is closed by a cover member 19' retained in firm assembly with the housing 11' by a plurality of fasteners indicated at 20'.

In order to develop a pumping action between the inlet 12' and the outlet 13', there is provided a generally cylindrical rotor 21' having an outer peripheral surface 22' which is of a diameter less than the inside diameter of the bore wall 16'.

The rotor 21' is particularly characterized by the formation in the peripheral surface 22' of a plurality of circumferentially spaced notches, recesses, or slots herein indicated at 23' and which may be rectangular in cross-sectional configuration as prescribed by spaced apart side walls 24' and 26' extending radially inwardly from the outer peripheral surface 22' and terminating in a bottom wall 27'.

Each slot 23' receives a slipper-type pumping element indicated generally at 28' which is free to move radially and to rock angularly. As shown in FIGURES 8, 9 and 10, each slipper-type pumping element 28' is of a generally U-shaped configuration in cross-sectional configuration including a bight portion 29' forming a surface contact area 30' for engaging against the bore wall 16'. Each slipper-type pumping element further includes spaced leg portions indicated at 31' and 32', respectively, the side wall of the leg 31' being indicated at 33' and the side wall of the leg 32' being indicated at 34'. The side walls 33' and 34' diverge somewhat in an outward direction and terminate in end portions adapted to slidably engage against the adjoining walls 24' and 26' of a corresponding slot 23'.

Bottomed against the inside of the bight portion 29', as indicated at 36', is a coil spring 37' having its opposite end engaged against an adjoining bottom wall 27' of a corresponding slot 23'. Thus, the slipper-type pumping element 28' is preloaded in radially outwardly extending direction.

In order to rotate the rotor 21' on a rotational axis offset from the center axis of the pumping chamber 14', there is provided a boss 38' formed in the housing 11' through which extends a shaft passage 39' carrying a pair of spaced bearings 40' and 41' which, in turn, rotatably support a shaft indicated at 42'. The shaft 42' has connected therewith a coupling member 43' splined as at 44' to the rotor 21'.

The rotational axis of the shaft 42' is eccentrically off-

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set with respect to the center axis of the bore wall 16', thereby providing between the housing 11' and the rotor 21' a sealing area 46' extending between the inlet and the outlet 12' and 13' and further forming a crescent-shaped working area 47' which extends from one side of the pump adjacent the inlet 12' and its corresponding inlet recess 17' and the outlet 13' and its corresponding outlet recess 18' on the other side of the pump. Thus, when the rotor 21' is rotatably driven by the shaft 42', the slipper-type pumping elements 28' which are continuously biased into engagement with the bore wall 16', will follow the contour prescribed by the bore wall 16' and the rotation of the rotor 21' in the eccentric housing bore 14' causes an expansion and contraction of the volume between adjacent slipper-type pumping elements 28' as the elements 28' traverse the crescent-shaped working area 47'. Accordingly, a pumping action will be developed between the inlet 12' and the outlet 13'.

In accordance with the principles of the present invention, the housing 11' is particularly characterized by the formation therein of an arcuate inlet slot 50' on the inlet side of the pump and an arcuate outlet slot 51' on the outlet side of the slot. The inlet slot 50' and the outlet slot 51' are formed to be disposed generally radially inwardly of the slipper-type pumping elements 28', but extend at least partially radially outwardly of the bottom wall 27' of each respective notch or slot 23'.

The housing 11' further includes a passage 52' communicating the inlet slot 50' with a topped opening 53' whereby the inlet 50' may be connected to a pumping circuit indicated by legend as comprising a source of fluid pumping medium.

The housing 11' further includes a passage 54' which connects the outlet slot 51' to a tapped opening indicated at 56' adapted to be connected by appropriate means to a point of utilization.

As is clearly indicated in the drawings, when the notches of the rotor 21' are opposite the sealing area 46', the clearance dimension between the peripheral surface 22' and the bore wall 16' are at a minimum and, accordingly, the corresponding slipper-type pumping element 28' is depressed against the continuous biasing means provided by the coil spring 37' and the pumping element is retracted into the slot 23', thereby to minimize the volume thereof.

As the rotor 21' carries a pumping element 28' past the inlet side of the pump, the pumping element starts to move radially outwardly as the inner portions of the slot 23' come adjacent the inlet slot 50' and the volumetric area defined between the bottom of the slot 23' and a slipper-type pumping element 28' increases.

As the pumping elements 28' are carried past the outlet side of the pump, the volumetric area again decreases. Accordingly, the rotation of the rotor 21' imparts a radial in and out pumping action to the slipper-type pumping elements 28' and develop a pumping action between the inlet 50' and the outlet 51'.

In order to assist in developing an adequate seal between the pumping circuits 12', 13' and 50', 51', the pumping elements of the present invention may be provided as shown in the embodiment of FIGURE 10. In that arrangement, a notch or slot is indicated at 23a' and one of the side walls such as the wall 24a' is recessed as at 60', thereby to receive a pin 61', herein shown as being of cylindrical configuration and of a length corresponding in length to a slipper-type pumping element shown at 28a'.

The pin 61' fits in the recess 60' and has a portion extending outwardly of the wall 24a' into the slot 23a', thereby to engage against the side wall 33a' of the pumping element 28a'. Thus, the pumping element 28a' is free to conformably engage the bore wall 16a' of the housing 11a' and the pumping element 28a' is free to move radially in the slot 23a', as well as to rock angularly. However, because the opposite leg 34a' of the pumping element 28a' engages against the wall 26a' of the slot

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23a', the pin 61' assists in controlling leakage between the separated pumping circuits existing between the inlet 12' and the outlet 13', and between the inlet 50' and the outlet 51'.

The pump of the present invention is particularly useful in a transmission application wherein one of the pumping circuits can be used for servo actuation and the other for an hydraulic governor. Thus, as illustrated diagrammatically herein, the inlet 12' is shown connected to a source of fluid pumping medium while the outlet 13' is shown delivering fluid to an hydraulic governor. The other separate pumping circuit, as illustrated in FIGURE 9, indicates the inlet 50' connected to a suitable source and the outlet 51' discharging to a servo actuator.

Although minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

We claim as our invention:

1. A pump comprising a casing having a cylindrical bore wall forming a pumping chamber, a rotor rotatable on an offset axis in said pumping chamber, means forming a peripheral axially extending recess in said rotor having generally parallel side walls and a bottom wall, a slipper in said recess having a radial outer sealing surface curved to engage the adjoining bore wall with surface contact and including first and second side walls disposed adjacent said side walls of said recesses, said first and second side walls being shaped to permit said slipper to rock and to move inwardly and outwardly of said recess in following said bore wall, said first side wall of said slipper engaging the adjoining side wall of said recess, means forming a sealing pin interposed between said second side wall of said slipper and the other side wall of said recess, and radially outer and inner porting means in said casing respectively communicating with said pumping chamber radially outwardly of said sealing pin to form a first pumping circuit and with said recess radially inwardly of said sealing pin to form a second pumping circuit,
2. A pump comprising a casing having a cylindrical bore wall forming a pumping chamber, a rotor rotatable on an offset axis in said pumping chamber, means forming a peripheral axially extending notch in said rotor having generally parallel side walls and a bottom wall, a slipper in said notch having a radial outer sealing surface curved to engage the adjoining bore wall with surface contact and including first and second side walls disposed adjacent said side walls of said notch, said first and second side walls being shaped to permit said slipper to rock and to move inwardly and outwardly of said notch in following said bore wall, said first side wall of said slipper engaging the adjoining side wall of said notch,

means forming a sealing pin carried by said slipper at said side wall and engageable with the adjoining side wall of said notch,
 radially outer and inner porting means in said casing respectively communicating with said pumping chamber radially outwardly of said sealing pin to form a first pumping circuit and with said notch radially inwardly of said sealing pin to form a second pumping circuit,
 said slipper side wall having a pin recess formed therein receiving said sealing pin,
 said pin recess having an action surface converging radially outward from the recess towards the notch side wall,
 the inward extent and form of the pin recess being such to permit movement inwardly away from said notch side wall of the sealing pin out of sealing relation in response to excess pressures to relieve high pressures in the first pumping circuit and to permit movement outwardly of the sealing pin against said notch side wall and said action surface in response to centrifugal force to retain pressure in the second pumping circuit.

3. For use in a pump of the type having inner and outer pumping circuits, a peripherally notched rotor, a pumping element of a width and a thickness sufficiently less than the width and depth of the notch in the rotor so that said pumping element is free to move radially and rock angularly,
 said pumping element having a side wall formed with a recess therein,
 said recess having an action surface inclined generally outwardly at a converging angle to the adjoining side wall of the rotor notch,
 and a sealing means in said recess and engaging said action surface and an adjoining surface of said rotor during rotation and wedging against said surfaces in response to centrifugal force to retain pressure in the inner pumping circuit and to move inwardly out of sealing relation with said surfaces to relieve excessive pressure in the outer pumping circuit.

4. In a pump of the type having inner and outer pumping units having radially inner and outer pumping circuits,
 a peripherally notched rotor,
 a pumping element in said rotor of a width and a thickness sufficiently less than the width and depth of the notch in the rotor so that said pumping element is free to move radially and rock angularly,
 said pumping element developing a pumping action in both said inner and outer circuits,
 and means including said rotor forming a check valve means between said inner and outer circuits to balance the circuits and to balance differences of pressure peaks in said circuits,
 said check valve means including a movable check valve element and a recess between the adjoining walls of said pumping element and the notched rotor and further including
 means forming an action surface converging radially outwardly from the recess,
 whereby said movable valve element will be moved inwardly out of sealing relation with said action surface and an adjoining surface of said rotor in response to high pressures in the outer circuit and will move outwardly against said surfaces in sealing relation in response to centrifugal force to retain pressure in the inner circuit.

5. In a pump of the type having inner and outer pumping units having inner and outer pumping circuits with a peripherally notched rotor,
 a pumping element in said rotor of a width and a thickness sufficiently less than the width and depth of the notch in the rotor so that said pumping element is free to move radially and rock angularly for developing a pumping action in both the inner and

outer circuits and means including said rotor forming a check valve means between said inner and outer circuits to accommodate flow from the outer to the inner circuit when the pressure in the outer circuit exceeds the sealing pressure on the check valve means thereby to balance the circuits and to balance differences of pressure peaks in said circuits,
 said check valve means comprising means forming a side wall in said pumping element having an outwardly inclined action surface converging towards the adjoining notch side wall and a cylindrical pin movable toward and away from sealing engagement with said action surface and with said notch side wall in response to centrifugal force and excess pressure in the outer circuit, respectively,
 said side wall including inwardly inclined portions spaced from said action surface and together therewith forming a confining recess for said pin.

6. In combination,
 a pump rotor having a peripheral notch including side walls outwardly of the rotor axis,
 a slipper in said notch of a width and a thickness sufficiently less than the width and depth of the notch in the rotor so that said slipper is free to move radially and rock angularly,
 and a sealing pin confined between said slipper and one of said side walls,
 means forming sealing surfaces radially outwardly of said pin on said rotor and on said slipper,
 said sealing pin being energized by the action of centrifugal force upon rotation of said rotor to engage said surfaces and thereby produce a self-energizing sealing force between the slipper and the rotor,
 means forming a sealing pin recess between said slipper and said one of said walls,
 said sealing surface on said slipper being disposed in angularly inclined relation to the adjoining notch side wall and extending outwardly from said recess to accommodate movement of said pin inwardly into said recess out of sealing relation with said surfaces in response to excess pressures to relieve high pressures outwardly of the pin.

7. For use in a slipper-type pump,
 a casing having a bore forming a pumping chamber,
 a peripherally notched rotor,
 a slipper having a curved outer radial sealing surface for effecting surface sealing engagement with an adjoining bore wall of a pumping chamber,
 said slipper being of a width and a thickness sufficiently less than the width and depth of the notch in the rotor so that said slipper is free to move radially and rock angularly,
 a first side wall on said slipper for engaging the adjoining side of a rotor notch.
 and a second side wall on said slipper recessed to form an outwardly inclined surface and having clearance with the adjoining rotor side wall,
 and a cylindrical sealing pin energized by the action of centrifugal force upon rotation to seal against said inclined surface and the adjoining rotor side wall of the notch,
 said second side wall having wing portions at opposite sides thereof formed with curved recesses complementary to the shape of the pin,
 thereby to retain the pin for a check valve action between inner and outer pumping circuits in the pump.

8. A slipper-type pump comprising a housing having a working chamber formed with an inlet and an outlet, a rotor having a notch formed therein with radially extending side walls and being rotatable on an axis eccentrically offset in said chamber,

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a slipper having side walls and received in said notch, said slipper being of a width and thickness sufficiently less than the width and depth of the notch so that said slipper is free to move radially and to rock angularly while following and engaging the walls of the working chamber to move fluid from the inlet to the outlet,

biasing means bottomed in said notch and engaging said slipper to preload said slipper radially outwardly,

said housing having means forming a second inlet and a separate second outlet at the respective inlet and outlet sides of the pump and communicating with the innermost portions of said notch,

said slipper being radially reciprocable in said notch and completing a stroke between said second inlet and said second outlet to develop a second pumping action,

and sealing means interposed between the side walls of said slipper and said notch comprising a recess formed in one of said side walls providing an action surface converging radially outwardly towards the other of said side walls adjoining said one side wall, said pin moving outwardly into sealing engagement with said surface and the adjoining rotor wall in response to centrifugal force, the inward extent and form of said recess being such to permit movement of the sealing means inwardly out of sealing contact with either or both said surface and said adjoining rotor wall to relieve pressures in the outer circuit higher than the pressures in the inner circuit,

thereby to balance differences of pressure peaks in said circuits.

9. In a pump, a rotor having a rectangularly shaped peripheral slot, a slipper-type pumping element in said slot, said slot and said pumping element having side walls of corresponding width and depth dimensions proportioned so that said pumping element is free to move radially and to rock angularly while following the contour of an adjoining pumping chamber wall, said rotor having a longitudinally extending recess formed in the walls of said slot,

and a sealing pin in said recess and extending into said slot to engage the adjoining portion of said slipper-type pumping element to assist in sealing the pumping element in the rotor,

the inward extent and form of said recess being such to permit radially inward movement of said pin out of sealing relation with either or both said pumping element and said rotor in response to excessive pressures radially outwardly of the sealing pin and moving radially outwardly into sealing engagement with said pumping element and with the adjoining portions of said rotor in response to centrifugal force.

10. In a pump, a rotor having a rectangular slot in the periphery thereof,

a slipper-type pumping element in said slot comprising a U-shaped member having a bight portion extending outwardly of said slot to engagingly follow the contour of an adjoining pumping chamber wall, said U-shaped member further including leg portions spaced apart sufficiently less than the width of the slot and the corresponding depth dimension of the slot and the pumping element being such that said pumping element is free to move radially and to rock angularly,

and a sealing pin corresponding in length with said pumping element and interposed between one of said leg portions of said pumping element and an adjoining wall of said slot to assist in sealing the pumping element in the rotor,

said wall having a pin recess formed therein,

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the inward extent and form of said recess being such to permit radially inward movement of said pin out of sealing relation with either or both said pumping element and said rotor in response to excessive pressures radially outwardly of the sealing pin and moving radially outwardly into sealing engagement with said pumping element and with the adjoining portions of said rotor in response to centrifugal force.

11. In a pump as defined in claim 10, a coil spring bottomed against said rotor and said slot and engaging against the inside of said bight portion to load said slipper-type pumping element radially outwardly.

12. In a hydraulic transmission,

a slipper pump having a housing formed with separate inner and outer inlets and outlets,

a peripherally notched rotor, slipper means in the notch of said rotor of a width and thickness sufficiently less than the width and depth of the notch that the slipper means is free to move radially and to rock angularly while following the contour of the adjoining housing wall.

means forming a pumping chamber between said outer inlet and outlet,

whereby fluid is pumped therebetween upon rotation of said rotor in said housing,

means in said housing communicating said inner inlet and outlet with the portions of said peripherally notched rotor radially inwardly of said slipper means, whereby fluid is pumped therebetween by the radial reciprocation of said slipper means in said rotor, servo actuating means connected to one of said outlets, and hydraulic governor means connected to the other of said outlets,

and sealing means interposed between said slipper means and an adjoining side wall of said notch, said sealing means having a recess and a pin received therein, said recess being of a form and inward extent to permit movement of the pin out of sealing relation with said adjoining side wall of said notch and with said slipper means in response to excessive pressures radially outwardly of the pin, said pin being movable radially outwardly into sealing engagement with said adjoining side wall of said notch and with said slipper means in response to centrifugal force to retain pressure radially inwardly of the slipper means.

13. In a pump,

a casing having a pumping chamber formed with a wall,

a rotor having a rectangular slot in the periphery thereof,

a slipper-type pumping element in said slot comprising a U-shaped member having a bight portion extending outwardly of said slot to engagingly follow the contour of the adjoining pumping chamber wall, said U-shaped member further including leg portions spaced apart sufficiently less than the width of the slot and the corresponding depth dimension of the slot and the pumping element being such that said pumping element is free to move radially and to rock angularly,

a pin correspondingly in length with said pumping element and interposed between one of said leg portions of said pumping element and an adjoining wall of said slot,

and means forming first and second pumping circuits disposed, respectively, inwardly and outwardly of said pin,

whereby said pumping element will develop a dual pumping action,

one of said legs of said U-shaped member having a recess formed therein,

an action surface converging radially outwardly from the recess towards the adjoining side wall of the slot,

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the inward extent of the recess being such to permit movement of the pin out of sealing relation with said adjoining wall of said slot and with said one of said legs of said U-shaped member in response to excessive pressures outwardly of the pin, 5
 said pin being movable outwardly into sealing engagement with said adjoining wall of said slot and with said one of said legs of said U-shaped member in response to centrifugal force.

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