

March 27, 1934.

E. W. BEIDLER ET AL

1,952,834

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2 Sheets-Sheet 1

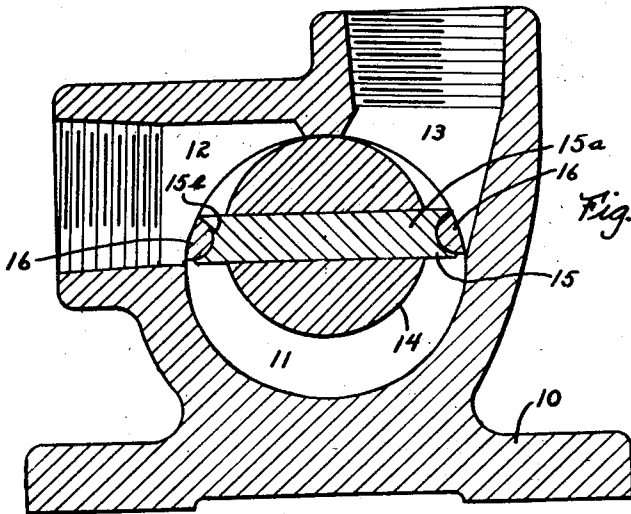


Fig. 1

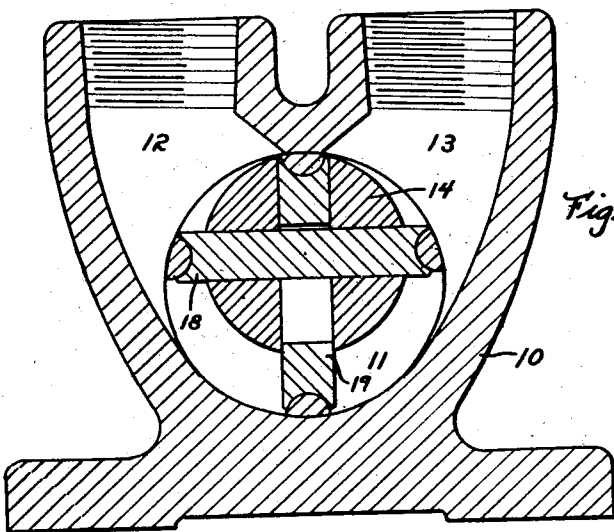


Fig. 2

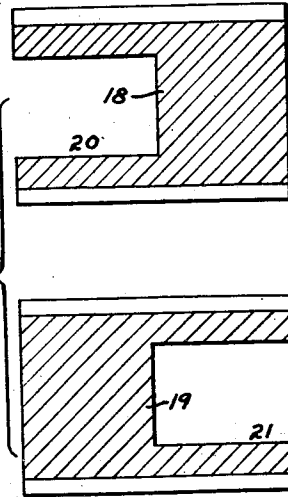


Fig. 3

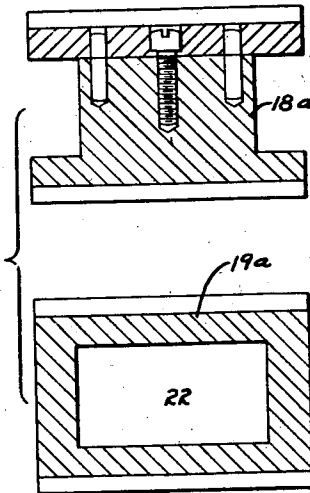


Fig. 4

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2 Sheets—Sheet 2

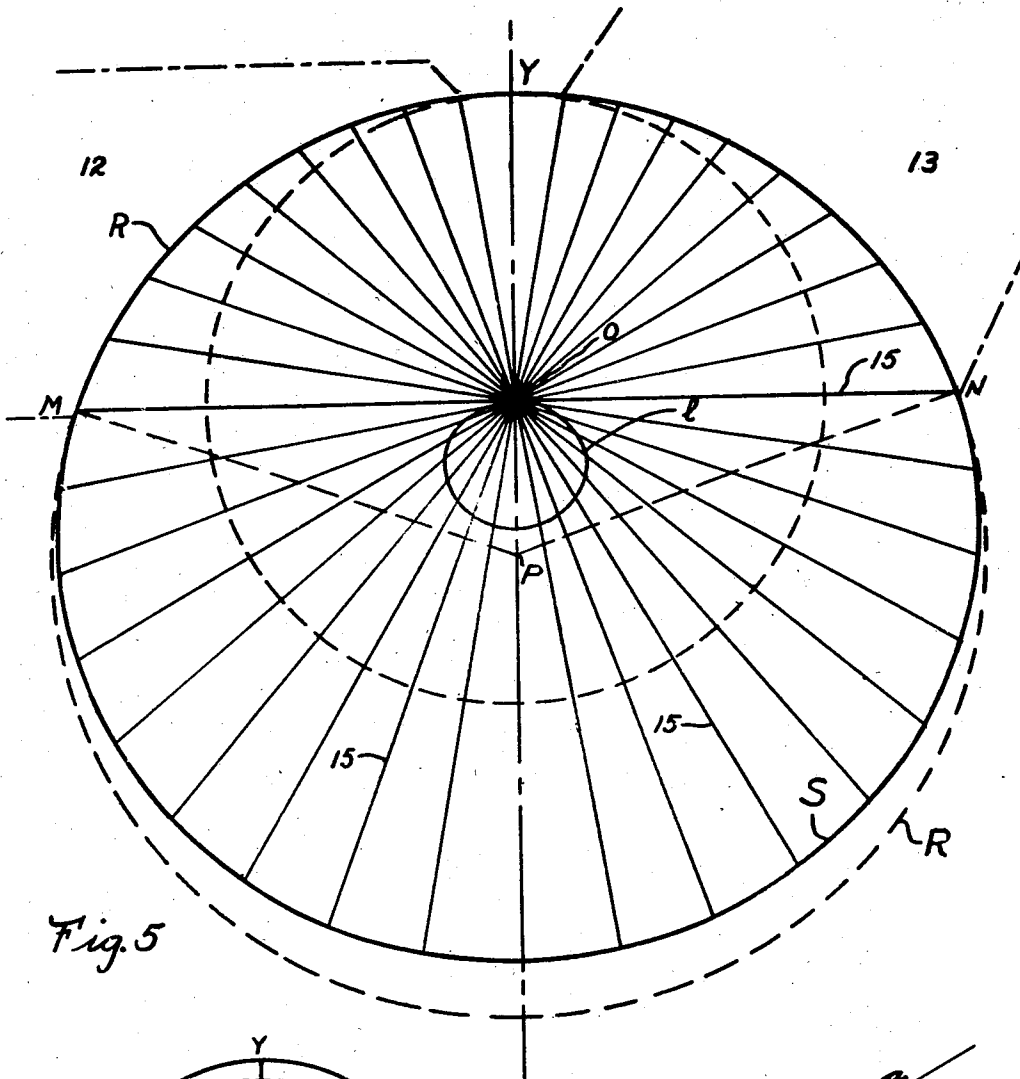


Fig. 5

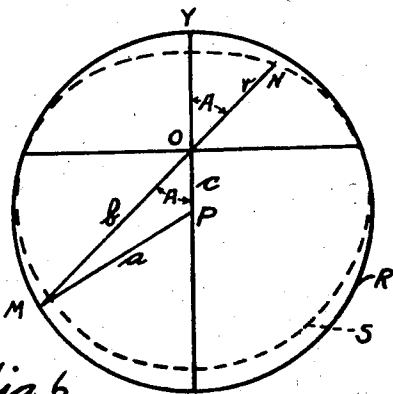


Fig. 6

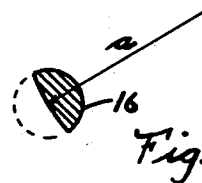


Fig. 7

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UNITED STATES PATENT OFFICE

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Application August 26, 1932, Serial No. 630,566

2 Claims. (Cl. 103—137)

This invention relates to a sliding vane type of rotary pump and has for its principal object to provide a more efficient pump which is less likely to stick or to wear excessively in the region of the outlet port.

A further object is to provide such a pump having a vane provided with rockers at the end thereof affording an extended area of contact with the wall of the pump chamber, maintaining a constant effective length and reducing to a minimum the pressure exerted on the rockers by the fluid passing through the pump.

Other and more limited objects will become apparent from the following description when taken in connection with the accompanying drawings in which Fig. 1 is a transverse section taken through a pump embodying our invention; Fig. 2 is a similar section of a modified form employing two vanes at right angles; Fig. 3 is a view showing one method of constructing the vanes in the modification of Fig. 2 and Fig. 4 is a similar view showing another method of constructing said vanes; Fig. 5 is a schematic diagram showing the outline of the cross section of the pump chamber in comparison with the circle an arc of which forms a portion thereof, the various positions of the vane or vanes and the locus of the center of the vane or vanes; Fig. 6 is a diagram showing in full line the circle which is shown partially in dotted lines in Fig. 5 and showing in dotted line the path traced by one end of the vane when the other end follows said circle as well as construction lines used in developing the equation of the dotted line curve; and Fig. 7 is a diagrammatic view showing one of the rockers in cross section and indicating the radii of the two curved surfaces of which it is made up.

Referring now to the drawings, the numeral 10 indicates the body of the pump having formed therein a pump chamber 11 and inlet and exhaust ports 12 and 13 communicating with the chamber 11 in the region of the portion of said chamber which is circular in cross section. Journal bearings at the ends of the chamber 11 is a rotatable member 14 having a slot therein receiving slidably a vane 15. It will be understood that the member 14 is connected with a suitable shaft extending to the outside of the pump body at one end through a suitable packing gland for connection to a prime mover.

The vane 15 is made up of a central portion 15^a which extends nearly entirely across the chamber 11 at all times but no part of which ever actually contacts the wall thereof. At each end of the central portion 15^a is provided a part cylindrical socket 15^b which receives a rocker 16. Each

of the rockers 16, as will be clear from Fig. 7, has two curved surfaces one of which is partially cylindrical and received in a socket 15^b of the same curvature while the other has the curvature of the circular portion of the chamber 11. That is, the radius of curvature of the rocker 16 which engages the wall of the chamber 11 has a length, a , (Fig. 6) equal to the radius of the guide circle R. The curved surface of the rocker which is received in the socket 15^b has its center of curvature in or substantially in the other curve. In this way, we attain a constant effective vane length and no clearance need be allowed to compensate for the different positions of the rockers with respect to the central portion of the vane. Inasmuch as the point of greatest tendency to wear is in the region of the exhaust port 13 where more than half of the central vane portion is on the other side of the center of rotation, the resultant centrifugal force on the central vane portion in that region will be transmitted to the chamber wall through the rocker at the other end and the rocker traversing the wear region will be urged by its own centrifugal force only into contact with the wall of the chamber. By employing a very light rocker we are able to secure a minimum of friction due to centrifugal force and by the special construction of the rocker as already explained, we may employ the minimum of clearance whereby an exceedingly close working relation of the parts is secured.

By making the pump chamber 11 of a special cross-sectional shape hereinafter described we are able to secure a low rate of change of the angle of the rockers 16 with respect to the vane portion 15^a in the region of the exhaust port where greatest wear occurs in pumps of this general type and a low total change of angle over this region. While we have shown a chamber having a cross section comprising a composite curve made up of a circle arc less than a semi-circle and a portion of another curve tangent thereto at its ends, it is to be understood that we may employ a portion of another similar curve instead of the circle arc such as, for example, a portion of an ellipse whose major and minor axes do not differ greatly, and wherever the terms "circular", "circle arc" or the like are employed herein, they are to be understood as including such other similar curves and not to be read in a literal sense. It is our belief that the true circle arc is the best curve to employ since it overcomes the sticking which sometimes occurs in pumps having a limaçon cross section at the same

time increasing the capacity of the pump. Any further decrease in rocker movement over the working region would be at the expense of pump capacity.

- 5 Prior to our invention the most successful pump of this type, so far as we are aware, had a bore the cross section of which was defined by the polar equation,

$$r = a - b \cos A,$$

- 10 where r is the distance from the origin, A is the angle from the axis of reference, and a and b are constants. This equation is that of a limaçon.

- 15 The polar equation defining the cross section of our improved pump will now be derived, having reference to Fig. 6, wherein the line MN represents the vane 15 having a length d , the circle R is a hypothetical guide circle along which if one end of the vane moves the other will trace the curve S, the point O is the center about which the vane rotates, being free to slide longitudinally of itself, r is the distance of the end N of the vane from the origin, A is the angle between the vane MN and the reference axis Y, P is the center of the circle R, b is a variable equal to d minus r , a is the radius of the circle R and c is the distance between O and P.

- 25 In any triangle the relation between the sides a , b and c and the angle A opposite the side a is expressed by the equation,

$$a^2 = b^2 + c^2 - 2bc \cos A$$

known as the cosine law. Applying this law to the triangle MOP in Fig. 6,

- 35
$$a^2 = b^2 + c^2 - 2bc \cos A$$

Transposing,

$$b^2 = a^2 - c^2 + 2bc \cos A \quad (1)$$

40 But,

$$b = d - r \quad (2)$$

- With the aid of Equations (1) and (2) it is possible to plot the curve S. Equations (1) and (2) may be combined to give a less convenient but more illuminating equation.

$$\sqrt{(1)} \quad b = \sqrt{a^2 - c^2 + 2bc \cos A}$$

$$\therefore d - r = \sqrt{a^2 - c^2 + 2c(d - r) \cos A}$$

- 50 and
$$r = d - \sqrt{a^2 - c^2 + 2cd \cos A - 2cr \cos A}$$

- It will be noted that this equation contains only the two variables, r and A , and that it is in as nearly as possible comparable form to the equation for the limaçon,

$$r = a - b \cos A$$

from which it differs radically.

- 60 The center of the vane in a limaçon type of pump always traces a true circle whereas in our pump it traces the path indicated at L, a composite curve closely related to the cross section of the chamber 11.

- 65 In Figs. 2, 3 and 4 we have illustrated a double vane type of pump in which the body portion 10 is provided with a chamber 11 similar to that shown in Fig. 1 and with which communicate ports 12 and 13. The rotor of this type differs

in that the member 14 is provided with intersecting slots receiving slidable vanes 18 and 19 of the same construction as that of the vane 15 with the exception of means for accommodating the vanes to each other. In Fig. 3, the vanes 18 and 19 have oppositely extending slots 20 and 21 while in the form shown in Fig. 4 the vane 18^a is made in two parts affording a restricted central portion while screw 19^a is provided with a central opening 22.

80 While we have shown and described illustrative embodiments of our invention, we wish it understood that we are not limited to the details thereof but only in accordance with the spirit and scope of the appended claims.

Having thus described our invention, what we claim is:

1. In a pump, a body having formed therein a right, composite, cylindrical cavity provided with inlet and outlet ports, an eccentrically mounted rotor in said cavity provided with a sliding vane having extended surface contact with opposed portions of said cavity in all positions, said vane being of constant length and made up of a unitary central portion of a length just short of enough to contact the wall of said cavity at both ends having sockets formed in its ends and rockers received in said sockets and having a working fit with the curved wall of said cavity, said cavity having a cross section made up of a circle arc less than a semicircle and a portion of a curve tangent to said arc at its ends, and said rockers each having a wall engaging face of curvature substantially that of said circle arc and a cylindrical socket engaging face curved about a center lying in said wall engaging face.

2. In a pump, a body having formed therein a right, composite, cylindrical cavity provided with inlet and outlet ports, an eccentrically mounted rotor in said cavity provided with a sliding vane having extended surface contact with opposed portions of said cavity in all positions, said vane being of constant length and made up of a unitary central portion of a length just short of enough to contact the wall of said cavity at both ends having sockets formed in its ends and rockers received in said sockets and having a working fit with the curved wall of said cavity, said cavity having a cross section made up of a circle arc less than a semicircle and a portion of a curve tangent to said arc at its ends, said curve being of the form

$$r = d - \sqrt{a^2 - c^2 + 2cd \cos A - 2cr \cos A}$$

where r is the distance of one end of the vane from its center of rotation, d is the length of the vane, a is the radius of the circle arc, c is the distance of the center of rotation of the vane from the center of said arc and A is the angle between said vane and a reference axis passing through the center of rotation of the vane and the center of said arc, and said rockers each having a wall engaging face of curvature substantially that of said circle arc and a cylindrical socket engaging face curved about a center lying in said wall engaging face.

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