Oct. 11, 1938. G. A. WAHLMARK 2,132,812

ROTARY ENGINE

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Fig. 1.

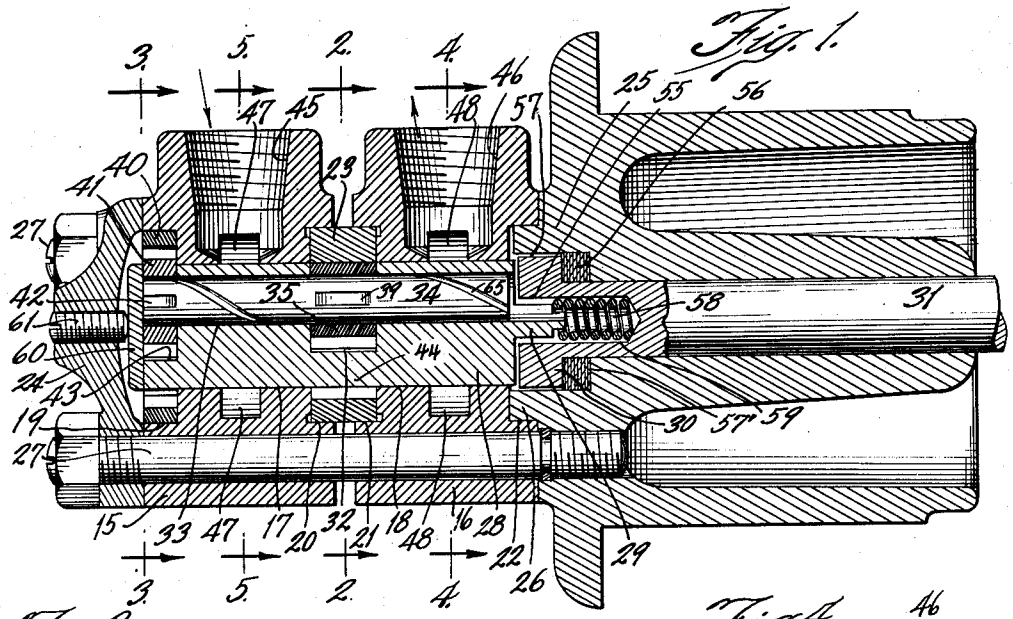


Fig. 2.

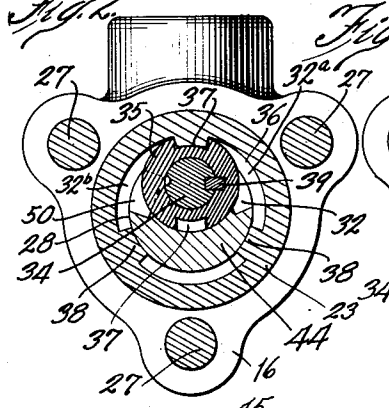


Fig. 3.

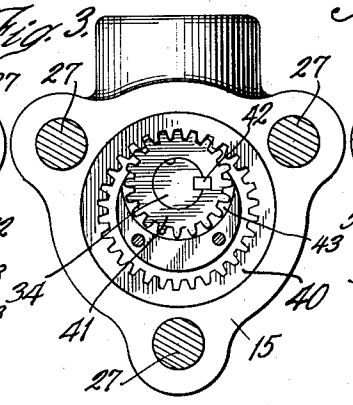


Fig. 4.

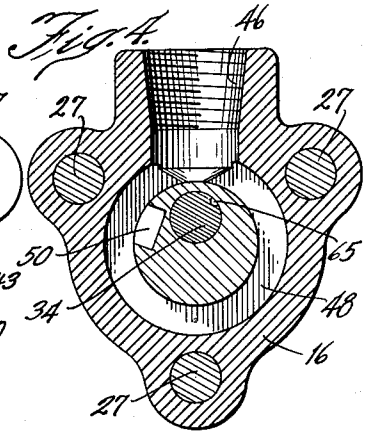


Fig. 5.

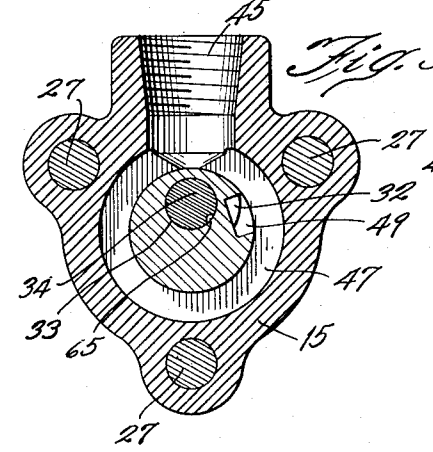
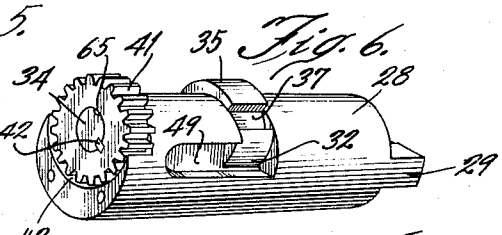


Fig. 6.



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ROTARY ENGINE

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Fig. 7.

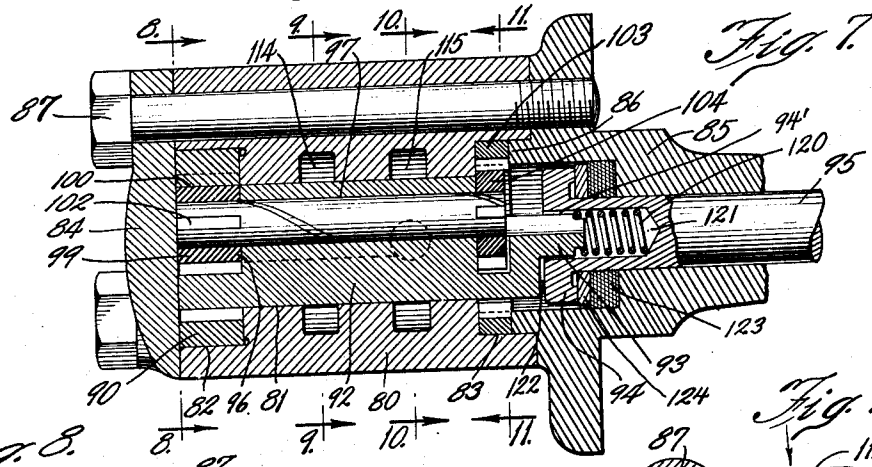


Fig. 8.

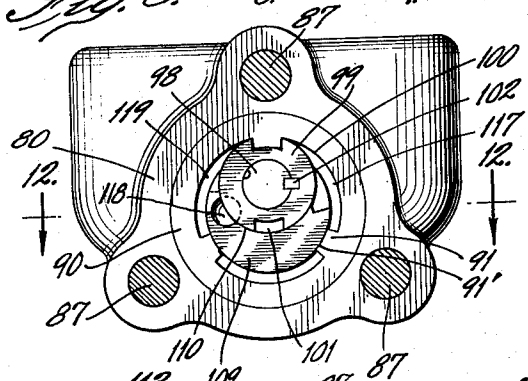


Fig. 9.

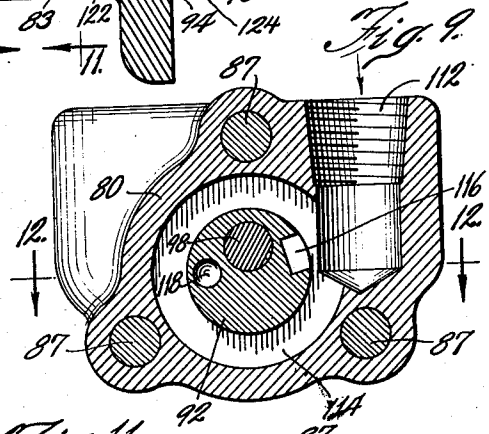


Fig. 10.

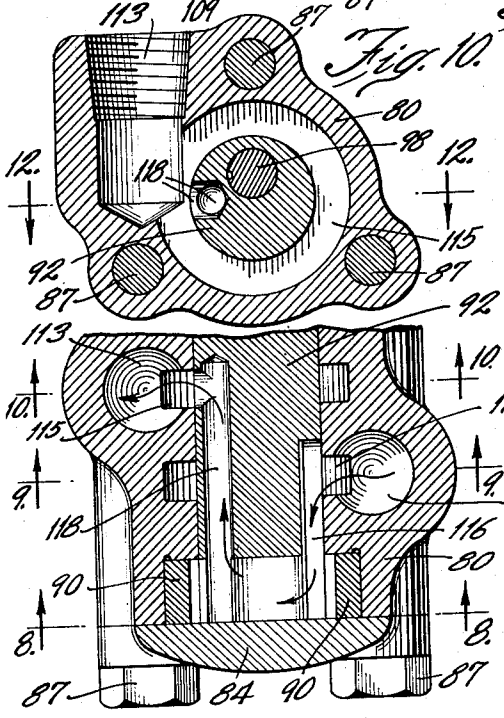


Fig. 11.

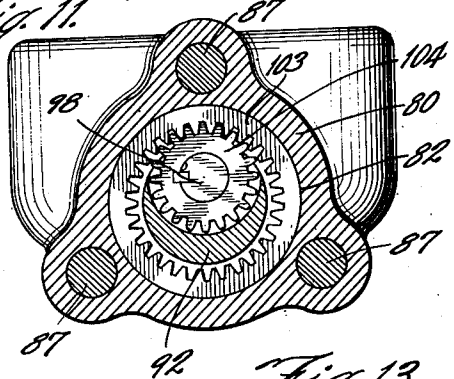


Fig. 13.

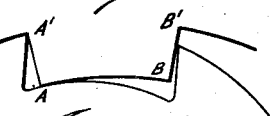


Fig. 12.

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UNITED STATES PATENT OFFICE

2,132,812

ROTARY ENGINE

Gunnar A. Wahlmark, Rockford, Ill.

Application April 28, 1933, Serial No. 668,315
Renewed April 21, 1938

3 Claims. (Cl. 103—143)

This invention relates to engines of the rotary type and has as an object the provision of a new and improved device which is simple in construction and efficient in operation.

Another object is to provide a new and improved rotary engine having an internally splined ring and a grooved roller which has a continuous rolling contact with the inner surface of the ring during operation.

Another object is to provide such a rotary engine having a stator and rotor together with bearings on both sides of the stator for supporting the rotor.

Another object is to provide a new and improved rotary pump constructed so as to facilitate the accurate finishing and the assembly of the parts.

A further object is to provide such a pump together with simple and efficient means for sealing the drive shaft end of the casing against leakage.

Another object is to provide a rotary pump in which the impelling members are self-emptying so as to eliminate trapping, back-surging and crushing of the pumped fluid which ordinarily set up stresses and result in pump wear, leakage and heating of the fluid being pumped, and to provide a positive uniform flow, together with high volumetric and mechanical efficiency.

Another object is to provide a rotary pump wherein the pressure producing contacts between the relatively movable parts of the pump are rolling in character so as to create a high vacuum in the intake and a high pressure in the outlet, the rolling seal eliminating friction and permitting the maintenance of the vacuum and pressure throughout the life of the pump.

Another object is to provide a pump embodying means for automatically limiting the maximum pressure of the fluid being pumped.

Further objects will become readily apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal central section through a preferred form of the invention.

Fig. 2 is a transverse section along the line 2—2 of Fig. 1.

Fig. 3 is a transverse section along the line 3—3 of Fig. 1.

Fig. 4 is a transverse section along the line 4—4 of Fig. 1.

Fig. 5 is a similar section along the line 5—5 of Fig. 1.

Fig. 6 is a perspective view of the rotor.

Fig. 7 is a longitudinal central section through a modified form of the invention.

Fig. 8 is a transverse section along the line 8—8 of Figs. 7 and 12.

Fig. 9 is a transverse section along the line 9—9 of Figs. 7 and 12.

Fig. 10 is a transverse section along the line 10—10 of Figs. 7 and 12.

Fig. 11 is a transverse section along the line 11—11 of Fig. 7.

Fig. 12 is a fragmentary horizontal section along the line 12—12 of Figs. 8, 9 and 10.

Fig. 13 is an enlarged diagrammatic illustration of the sealing contact between the roller and splined ring at the edge of a spline.

Although I have illustrated in the drawings and shall herein describe a preferred form of the invention, together with a modification thereof, particularly adapted for use as pumps, it is to be understood that I do not intend to limit the invention to pumps, or the specific forms and arrangements shown, but aim to cover all modifications and alternative constructions falling within the spirit and scope of the appended claims.

In the form illustrated in Figs. 1 to 6, the invention is shown as comprising a casing formed of a pair of members 15 and 16 provided with alined bores 17 and 18 extending therethrough, respectively, and annular recesses 19, 20, 21 and 22 formed in the ends thereof, surrounding and concentric with said bores. An internally splined ring or stator 23 is positioned intermediate the two members 15 and 16 and in the recesses 20 and 21 so as to surround the bore through the casing. A closure 24 forms one end of the casing, and a closure member 25 having a flanged portion 26 fitted in the recess 22 forms the other end, a plurality of screw devices 27 extending through the closure 24, casing members 15 and 16, and into threaded engagement with the closure 25 serving to hold the parts in assembled relation.

As illustrated herein a cylindrical rotor 28 extends through and is rotatably mounted in the bores 17 and 18 of the casing members 15 and 16, and is provided at its right-hand end (Fig. 1) with a diametrically extending tongue 29 adapted for driving engagement with the adjacent flanged end 30 of a drive shaft 31 which is rotatably mounted in the closure member 25 in axial alinement with the rotor 28. The rotor is provided with a transversely extending groove 32 which is alined with the stator 23 and of equal width therewith, and has a longitudinally

extending bore 33 positioned eccentrically therein. A shaft 34 is rotatably mounted in the bore 33 and carries a roller 35 which is positioned in the transversely extending groove 32 of the rotor and in rolling engagement with the inner surface 36 of the stator 23. The groove 32 is formed so as to leave a segmental guard portion 44 on the rotor which is in fluid sealing engagement with the periphery of the roller 35. The roller 35 is equal in length to stator 23 and is herein illustrated as having a pair of transversely extending grooves 37 arranged to mesh with internal splines 38 on the stator when the roller is rolled along the inner or splined surface 36 of the stator. The roller may be secured to the shaft 34 by means of a key 39. Preferably the ends of the splines 38 are curved to correspond with the bores 17 and 18 of the casing members, so that, if desired, the casing members and stator may be assembled after which the bores 17 and 18 and the ends of the splines may be finished accurately by a single operation.

Although it is within the scope of the invention to provide splines and recesses in the stator and roller so spaced about the peripheries of these parts that they will function to maintain the timing thereof, the invention, in the form illustrated in the drawings, makes provision for driving the roller 35 in timed relation to the rotation of the rotor. When the splines and recesses are too far apart to preserve the timing, as illustrated herein, an internal gear 40 may be secured to the casing member 15 in the recess 19 and arranged to mesh with a pinion 41 secured to the adjacent end of the shaft 34 by means of a key 42. The pinion 41 is positioned in a recess 43 in the end of the rotor 28. Thus when the rotor 28 is driven the pinion 41 is rolled around the internal gear 40 so as to rotate the shaft 34 and the roller 35 carried thereon, the gear 40 and pinion 41 being of such size as to roll the roller on the internal surface 36 of the stator and over the tops of the splines 38 without any sliding action.

In the preferred form of the invention the casing members 15 and 16 are provided with fluid passages 45 and 46 adapted for conduit connections, and have annular recesses 47 and 48 positioned substantially midway between the ends of the members, surrounding the bores 17 and 18 and communicating with the fluid passages 45 and 46, respectively. Assuming that the shaft 31 is driven in a clockwise direction when looking from the right-hand end thereof in Fig. 1, (the rotor 28 then turning counter-clockwise as viewed in Fig. 2), passage 45 would serve as the inlet and passage 46 would serve as the outlet for the pump. Fluid entering the inlet would pass through a connecting recess 49 in the rotor and into a suction chamber 32^a formed between the pump stator and roller 35 behind the roller. Fluid discharged from a pressure chamber 32^b formed between the stator and roller ahead of the roller, passes through a similar recess 50 (Fig. 4) in the opposite side of the rotor 28, which communicates at one end with the said chamber and at its other end with the recess 48.

It will be readily apparent that during operation of the pump and with the rotor 28 rotating in a counter-clockwise direction, as viewed in Fig. 2, a rolling seal is obtained not only between the periphery of the roller 35 and the inner surface 36 of the stator, but also between the bottom of the grooves 37 in the roller and the tops of the splines 38 of the stator. Preferably the bottoms of the grooves 37 in the roller are cylindrical with respect to the axis of the shaft 34, and the tops of the teeth 38 are cylindrical with respect to the axis of the rotor 28. As best shown in Fig. 13, the side faces of each groove are straight and substantially parallel, while the side faces of each spline are also straight but are inclined inwardly from the base to the top of the spline. This makes the top of the spline somewhat narrower than the groove at its base, thereby providing clearance so that the top of the spline may remain in contact with the bottom of the groove until the roller contacts the stator proper to provide a double or overlapping seal, as more fully described hereinafter. Furthermore there is no movement of the fluid peripherally across the stator surface 36. The discharge recess 50 communicates with the rotor groove 32 adjacent the roller 35 so that, as the roller rolls over the surface 36, the fluid passes out directly through the recess 50. This is also true on the suction side of the roller, the incoming fluid filling first into the lower portion of the chamber 32^a (Fig. 2) and then, as the rotor revolves, filling the intermediate and upper portions of the chamber 32^a. In this way the fluid is not brought into one end of the chamber and then forced through the chamber between the rotor and stator to fill the chamber. Furthermore the grooves 37 in the roller and splines 38 on the stator are so shaped that during operation of the pump no fluid is trapped between the splines and the bottoms of the grooves, all of the fluid being forced out. This eliminates crushing of the fluid together with its attendant heating, and provides a smooth uniform flow.

In order to prevent any thrust or distortion in the drive shaft from being transmitted to the rotor the tongue 29 of the rotor fits loosely in a diametrically extending groove 55 in the flanged end 30 of the drive shaft, the rotor having bearings in the bores 17 and 18 separate from the drive shaft which is mounted in the closure member 25. Preferably a packing material 56 is positioned in a chamber 57 intermediate the flange 30 of the drive shaft and a shoulder 57′ on the closure 25, and in order to maintain the flange of the drive shaft in sealing engagement with the packing a coiled spring 58 is positioned intermediate the bottom of a recess 59 in the drive shaft and the adjacent end of the tongue 29. At its opposite end the rotor 28 carries a hardened cap plate 60 which cooperates with a screw device 61 in the closure 24 to provide a thrust bearing for the rotor and to permit of adjusting the rotor axially of the stator. The inner end of the screw device 61 is preferably rounded so as to provide a relatively small contact area with the plate 60.

In order to relieve any pressure which might develop in the packing chamber 57, a spiral roove 65 is preferably formed in the periphery of the shaft 34. When the pump is used for pumping oil, the oil passing through this groove serves to lubricate the shaft 34 and then passes off into the chamber in which the timing gears 40 and 41 are located so as to lubricate said gears.

In the form illustrated in Figs. 7 to 12, a casing 80 is shown having a bore 81 extending therethrough and annular recesses 82 and 83 formed in the opposite ends thereof, surround-

ing and concentric with said bore. A closure 84 forms one end of the casing, and a closure and supporting member 85 forms the other end of the casing and has an annular flange 86 extending part of the way into the recess 83. A plurality of headed screw devices 87 extend through apertures in the closure 84 and casing 80 and into screw threaded engagement with the closure member 85 for the purpose of holding the parts in assembled relation.

In this form of the invention an internally splined ring or stator 90 is secured non-rotatably in the recess 82 of the casing and has splines 91 (Fig. 8), the top surfaces 91' of which have the same curvature as the bore 81. A cylindrical rotor 92 is rotatably mounted in the bore 81 and extends through the ring 90 and into engagement with the closure 84. Thus the bore 81, which forms spaced bearing surfaces for the rotor, and the top surfaces 91' of the splines may be finished simultaneously by means of a single rotary tool. At its right-hand end (Fig. 7) the rotor is provided with a diametrically extending tongue 93 adapted for driving engagement with the adjacent flanged end 94 of a drive shaft 95 which is rotatably mounted in the closure member 85 in axial alinement with the rotor 92. The flanged end of the shaft has a cross slot 94' in which the tongue 93 fits. At its left hand end the rotor is provided with a transversely extending groove 96 which is alined with the stator 90 and of equal width therewith, and also has a longitudinally extending bore 97 positioned eccentrically therein. A shaft 98 is rotatably mounted in the bore 97 and carries a roller 99 which is positioned in the groove 96 of the rotor and in rolling engagement with the inner surface 100 of the stator. The roller has a pair of transversely extending grooves 101 arranged to mesh with the internal splines 91 on the stator when the roller is rolled along the inner or splined surface 100 of the stator. The roller is preferably secured to the shaft 98 as by means of a key 102 so that it may be driven in properly timed relation by means of an internal gear 103 (Figs. 7 and 11) secured in the recess 83, and a pinion 104 keyed to the other end of the shaft. The transversely extending groove 96 in the rotor is formed so as to leave a segmental guard portion 109 having a curved surface 110 which is in constant sealing engagement with the periphery of the roller 99.

As illustrated in Figs. 7 to 12, the casing 80 is provided with fluid passages 112 and 113 adapted to receive conduit connections at their outer ends, and has annular recesses 114 and 115 surrounding the bore 81 and communicating with the inner ends of the fluid passages 112 and 113, respectively. Assuming that the shaft 95 is driven in a clockwise direction when looking from the right-hand end thereof in Fig. 7, passage 112 would serve as the inlet and passage 113 would serve as the outlet for the pump. Fluid entering the inlet would be conducted from the annular recess 114 to the pump stator by means of a port 116 formed in the rotor 92. This port communicates at one end with the suction chamber 117 (Fig. 8) formed between the stator and roller behind the roller, and at its other end with the annular recess 114. Fluid discharged from the stator would pass through a port 118 drilled longitudinally in the rotor 92, as illustrated most clearly in Figs. 9, 10 and 12, and which communicates at one end with a pressure chamber 119 (Fig. 8) formed between the stator and roller ahead of the roller, and at its other end with the annular recess 115.

As illustrated most clearly in Fig. 13, which is an enlarged diagrammatic illustration of the sealing contact between the roller and splined ring at the edge of a spline, the splines on the ring and the grooves in the roller are preferably formed so that the periphery of the roller at A' engages with the inner surface of the ring adjacent the bottom of the spline prior to the disengagement of the end of the spline at A with the bottom of the roller groove. Similarly the sealing contact at B' was not broken until after a sealing contact was formed at B, at the other side edge of the spline. Thus there is no breaking of the sealing contact between the roller and the stator during the intermeshing of the splines and grooves, but rather a momentary double seal due to the overlapping contact, with the result that a 360° rolling and sealing contact is obtained between the two parts. In this way a very uniform flow of fluid under pressure is obtained together with an extremely high vacuum on the suction end.

In the form illustrated in Figs. 7 to 12, means is provided for limiting the maximum pressure of the fluid discharged from the pump. This is accomplished by permitting longitudinal movement of the rotor 92 toward the right (Fig. 7) away from the closure 84 so that fluid in the pressure chamber 119 (Fig. 8) may pass around the end of the segmental guard portion 109 of the rotor and back into the suction chamber 117. The pressure at which such longitudinal movement of the rotor takes place is determined by a coiled spring 120 which is positioned in a recess 121 in the shaft 95, bearing at one end against the bottom of the recess and at its other end against the adjacent end of the rotor tongue 93. A space is provided at 122 between the end of the rotor and the end of the shaft so as to permit of a slight endwise movement, and preferably the pinion 104 is narrower than the internal gear 103 so as to permit the pinion to move with the rotor without projecting beyond the internal gear. This means for limiting or relieving the pressure is extremely simple in construction and efficient in operation.

In order to prevent leakage along the shaft 95 a suitable packing 123 may be provided in the end closure 85 surrounding the shaft, and a washer or collar 124 positioned intermediate the packing and the adjacent end of the flanged portion 94 of the shaft. This packing is automatically taken up by the spring 120 which not only acts to hold the rotor against the left hand closure 84 but also acts to press the shaft 95 out toward the right (Fig. 7).

The packing effectively seals against the closure and also against the shaft and is of such a nature that it gives slightly to adjust for any misalinement between the collar 124 and the flanged portion of the shaft.

It will be readily apparent to those skilled in the art that the invention is adapted not only for use in pumps for liquids, but that it is well adapted for use in air compressors, blowers, fluid and air motors, etc. The rolling action together with the 360° seal obtained thereby provides not only an exceptionally smooth pressure flow together with a minimum amount of slip, excellent suction and quiet operation, but also insures a long operating life, positive dis-

placement, easier running and power saving.

I claim as my invention:

1. A rotary engine having, in combination, a ring type member having inwardly extending splines and uninterrupted cylindrical surfaces intermediate said splines, said splines having cylindrical end surfaces and straight side faces inclined inwardly from the base to the top of the splines, a rotor and a roller carried eccentrically on said rotor and having grooves for meshing with said splines and uninterrupted cylindrical surfaces intermediate said grooves, said grooves having cylindrical bottom surfaces and straight substantially parallel side faces, the splines being received within said grooves so that when the roller is rolled around the inner periphery of said ring, the bottoms of said grooves roll on the ends of the splines and engage with the ends of the splines and remain in engagement therewith during the time that the contacts between the trailing uninterrupted cylindrical surfaces are transferred to the leading uninterrupted cylindrical surfaces so as to obtain a full 360° rolling contact seal.

2. A rotary engine having, in combination, a rotor, a stator, a roller mounted on one of said parts and arranged to roll over the periphery of the other of said parts, said other of said parts having splines with straight sides inclined inwardly toward the top and cylindrical end surfaces and uninterrupted cylindrical surfaces intermediate said splines, said roller having grooves with straight parallel sides and cylindrical bottom surfaces and uninterrupted cylindrical surfaces intermediate said grooves, the splines and grooves intermeshing when the roller rolls over the periphery of said other of said parts with the end of a spline making a sealing contact with the bottom of a groove prior to the disengagement of the periphery of the roller adjacent the groove with the periphery of said other of said parts, the periphery of the roller adjacent the opposite edge of the groove sealing against the periphery of said other of said parts prior to the disengagement of the end of the spline with the bottom of the groove so as to provide an overlapping sealing contact adjacent the edges of the splines to obtain a full 360° rolling contact seal.

3. A rotary engine having, in combination, a rotor, a stator, a roller mounted on one of said parts and arranged to roll over the periphery of the other of said parts, said roller and said other of said parts having peripherally spaced splines formed on the one and peripherally spaced grooves formed in the other for cooperating and intermeshing with the splines when the roller rolls over the periphery of said other part and each having uninterrupted cylindrical surfaces throughout the remainder of their peripheries, the splines having cylindrical end surfaces and straight side faces inclined inwardly from the base to the top of the spline, the grooves having cylindrical bottom surfaces and straight and substantially parallel side faces, the end of a spline making a rolling and sealing contact with the bottom of a groove prior to the disengagement of the uninterrupted cylindrical surface adjacent the trailing edge of the groove with the uninterrupted cylindrical surface adjacent the trailing edge of the spline, the uninterrupted cylindrical surface adjacent the leading edge of the groove sealing against the uninterrupted cylindrical surface on the leading side of the spline prior to the disengagement of the end of the spline with the bottom of the groove so as to provide overlapping sealing contact adjacent the edges of the spline and obtain a full 360° rolling seal.

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