Fig. 1

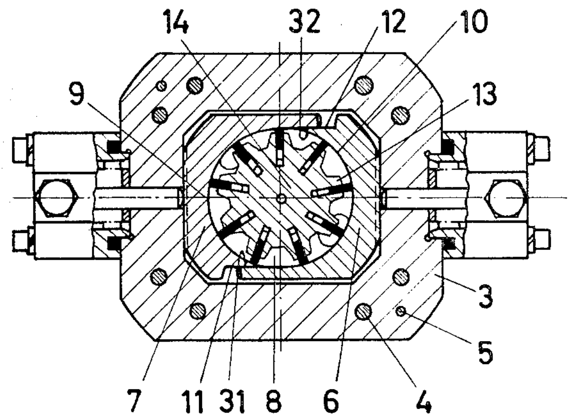

14
32
12
10
9
13
3
5
7
11
31
8
6
4

Fig. 2

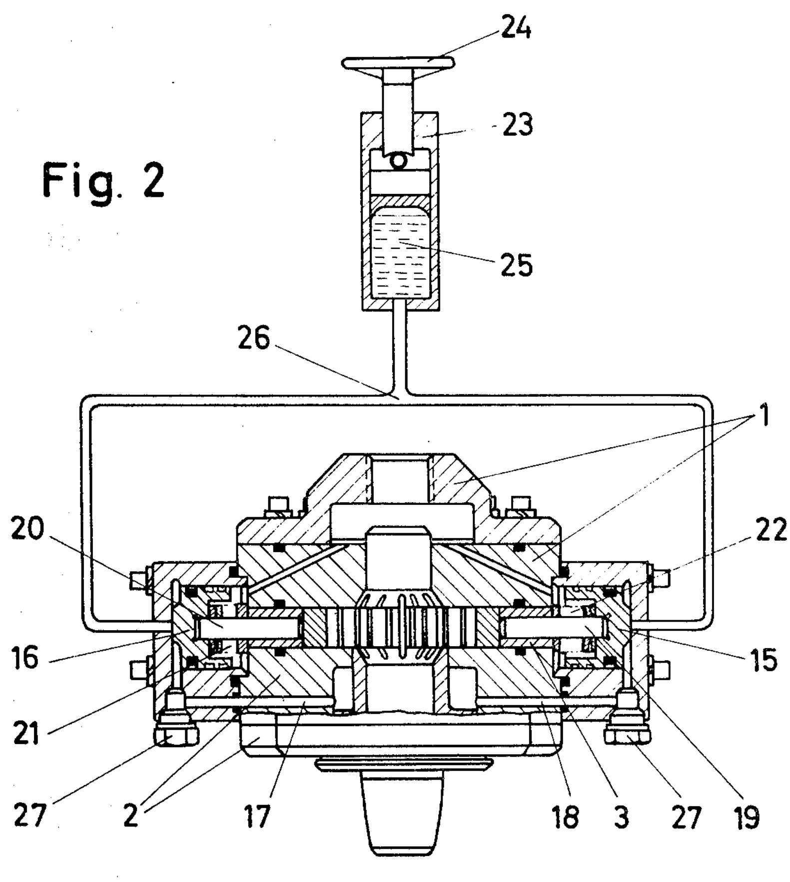

24
23
25
26
1
20
22
16
15
21
27
2
17
18
3
27
19

FIG. 3

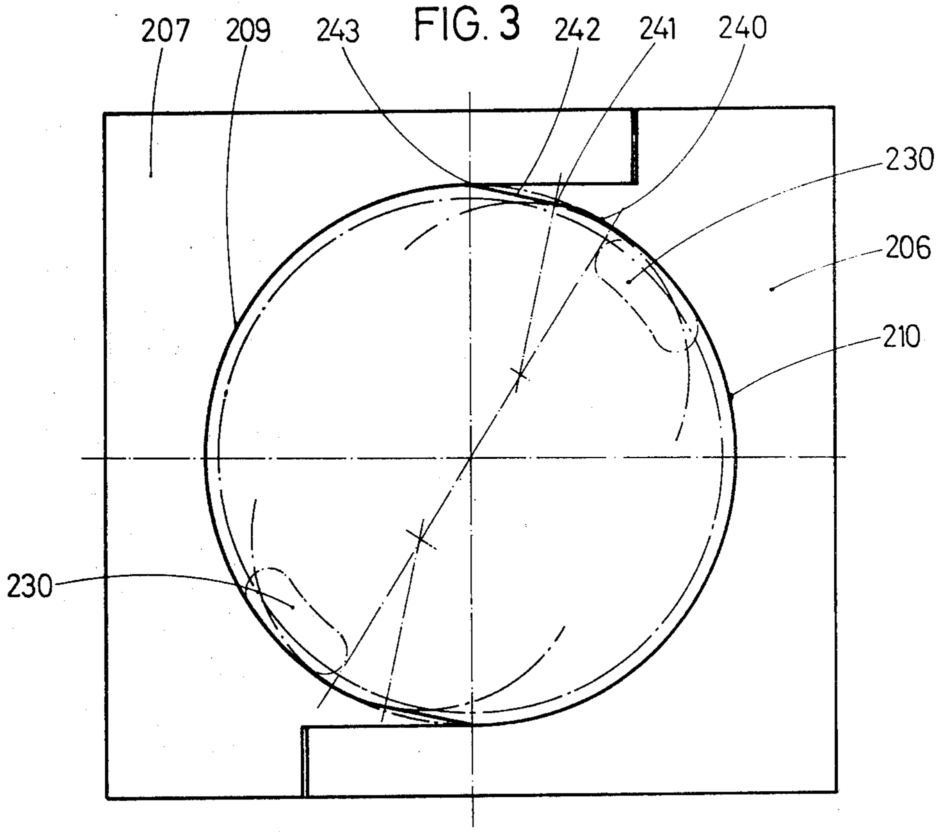
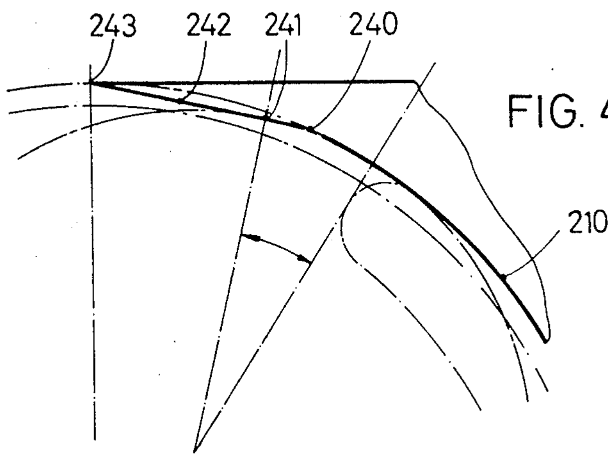


FIG. 4



ADJUSTABLE ROTARY PUMP WITH PRESSURE RELIEF

FIG. 5

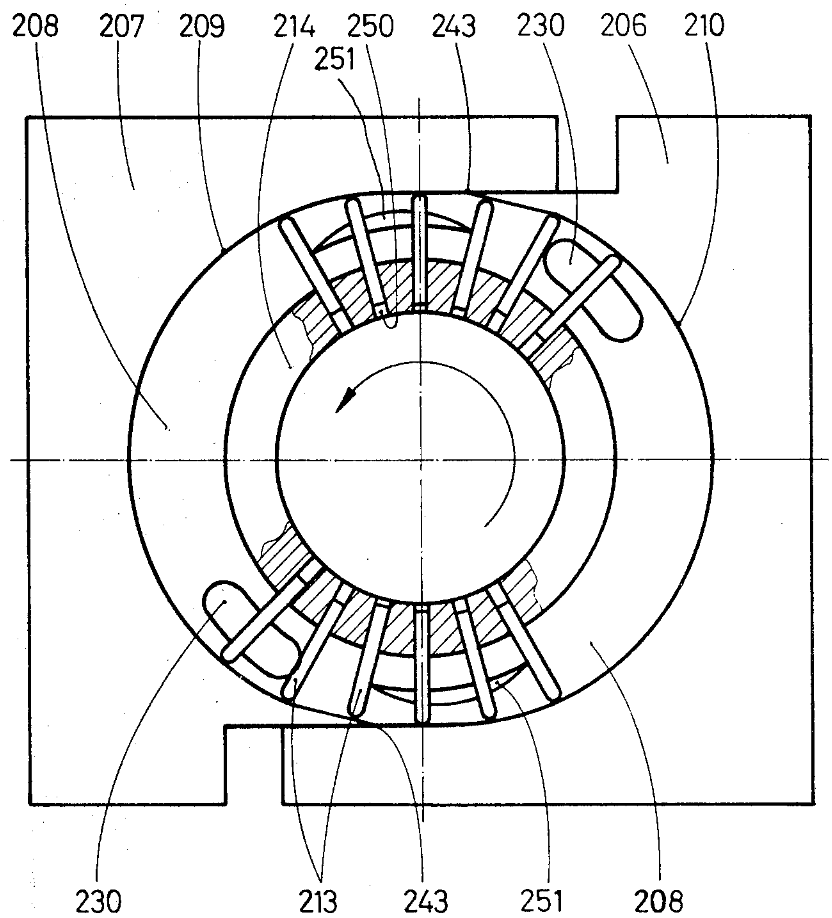


FIG. 6

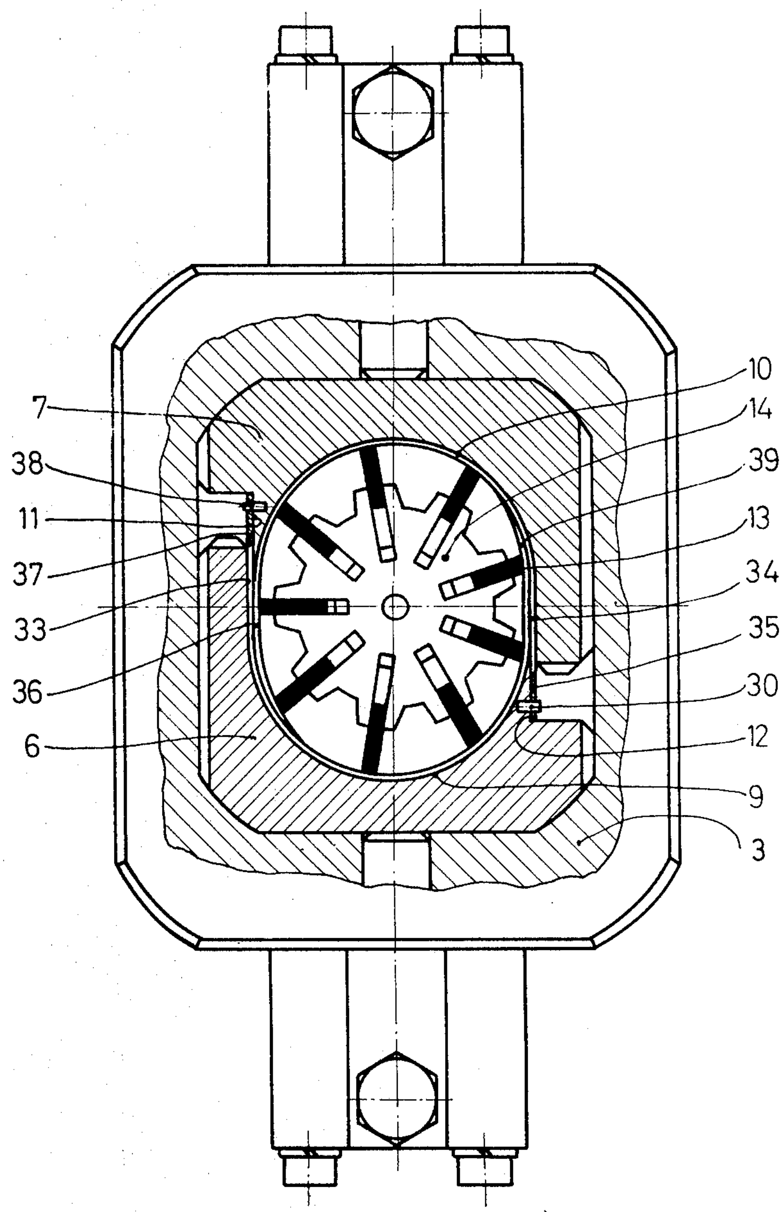


FIG. 7

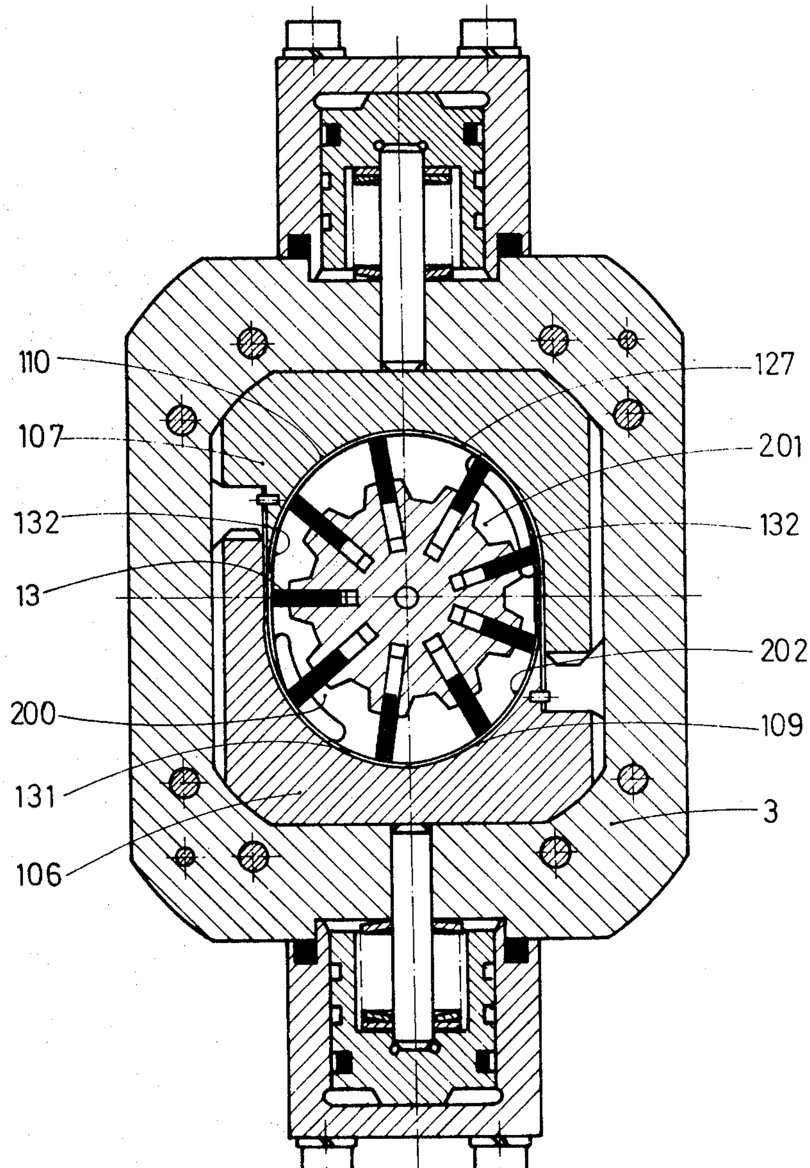
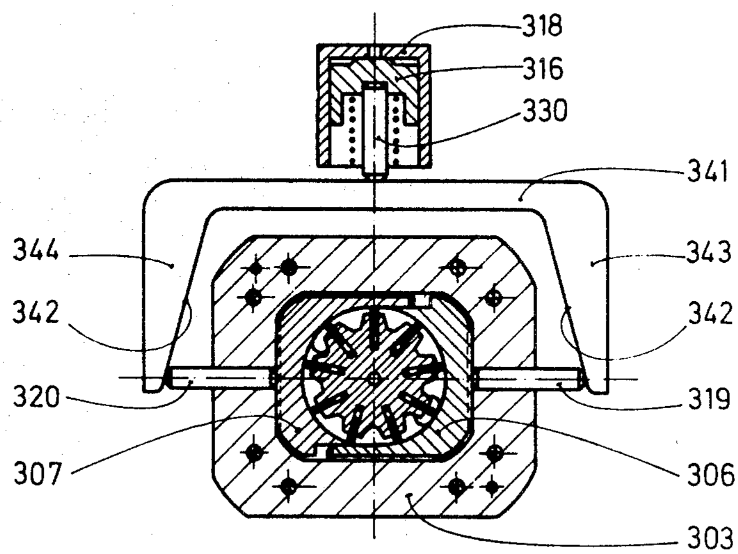


FIG. 8



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ADJUSTABLE ROTARY PUMP WITH PRESSURE RELIEF

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Int. Cl. F04c *15/02, 1/02, 5/00*
U.S. Cl. 418—24 11 Claims

ABSTRACT OF THE DISCLOSURE

A rotary pump which includes means for varying the size of the intake and discharge zones so as to facilitate adjustment in the delivery flow of the pump. Surrounding the rotor are two concavely shaped adjustable jaws which are positionable relative to each other and to the axis of rotation of the rotor. Relative movement of each of these jaws produces a corresponding change in the volume of the intake and discharge zones. Means are provided for initiating such movement within relatively close tolerances. The pump additionally includes a pressure relief groove which extends along the inner surface of the jaws adjacent the intake zone of the pump. This relief groove serves to provide a means of equalizing the pressure distribution across the impeller blades. In this manner the hammering which such blades subject to the walls defining the pump zones during their transition from high to low pressure zones is minimized.

BACKGROUND OF THE INVENTION

This invention generally relates to a rotary pump which includes improved adjustment features and a pressure relief means. The illustrated embodiment includes blades which are radially shifted with respect to the rotor body. The pump further includes adjustable jaws which are moveable along a defined path so as to permit ready adjustment of the size of the discharge zone.

Various types of pumps have been suggested which include elastic as well as radially adjustable bearing surfaces. Such devices usually include two dividers or abutments which separate the intake and discharge zones. One of these dividers is usually stationary while the other is radially adjustable. Alternately, prior pumps have included elastic parts which are unilaterally clamped and span the interstices. The blades move uniformly at any selected pump output. With respect to such an arrangement there are generally two abutments which are curved in shape and rest upon a stationary block. Due to the system elasticity there may occur a distortion of the discharge zone of the pump. If the pump is to be used in high pressure applications such elastic constructions are generally unsatisfactory as they do not permit accurate regulation of the delivery rate. Under such conditions the elastic elements of the pump often produce a continuous vibration, and therefore adversely effect the accuracy and regulation of the pump. Furthermore, with respect to such arrangements, the various mating surfaces must be machined and finished to very close tolerances. With respect to such arrangements the elastic ring may be caused to move from its null position between the stationary blocks and thus produce an annular slit. Such a condition greatly increases operating noise.

Conventional rotary pumps usually feature radially adjustable housing channels which are provided for conveying the pressurized oil; however, such arrangements reduce the space within the housing available for the

remaining components. Under high pressure conditions the oil flows across the channels and thus creates a lubricated surface across which the upper edges of the pumping blades, which become deformed within the suction zone, pass. In this manner a pressure relief path is created. In an effort to prevent such blade deformations and the resulting pressure relief the individual components of the blade must be of relatively large construction. Under such situations the weight and space requirements of the structure often become extremely large.

Additionally prior rotary pumps which include a complete elastic ring for use as a boundary for the delivery space frequently lose adjustment in use. Such arrangements are unsuitable for pumps delivering high pressure output and requiring close flow regulation. The illustrated embodiment overcomes such problems advantageously and includes means for assuring sufficient lubrication even at zero delivery rates. Further the hammering action of the delivery blades, which occurs occasionally under high pressure conditions is drastically reduced.

In accordance with the illustrated embodiment, a semicircular recess is defined by the running jaws and continues beyond the region of the outlet slits in the form of an Archimedes' spiral. The jaws may if desired be fabricated of cast plastic material. This spiral intersects with a straight edge to form a tangent thereto thereby forming a tapered end or tip. Additionally in the region adjacent each of such tips are pressure relief grooves which extend into the corresponding intake zone.

The illustrated embodiment of this invention includes straps which are arranged within recesses defined by the semicircular jaws. The straps are preferably fabricated of hardened spring steel or of a suitable resilient synthetic plastic, in a manner to facilitate replacement. The tips of the blades upon entering the pressure relief zones are forced outwardly against the internal surface of the surrounding walls. One end of the strap is attached to the gliding surface of the respective jaw, whereas the remaining end tapers forming a pointed tip. In this manner, noise is considerably reduced and transitional loads avoided.

The illustrated embodiment results in a substantial reduction in the cost of the adjustable jaws is incurred. The jaws need not be polished nor provided with any hardening treatment. Further, transitional radii at the recesses are not required as has been the case with respect to prior pumps. Further the features of the illustrated embodiment permit those parts which exhibit the greatest frictional wear to be easily replaced. The characteristics of the plastic material which is suggested for the construction is dictated by the quality of the pressurized fluid and its respective magnitude. The particular advantage of the illustrated embodiment is its light weight, and reduced frictional force.

An alternate embodiment of this invention includes a means for adjusting of the volume of the output zone in a manner which permits both jaws to be simultaneously and uniformly controlled by a single control piston and a single actuation member.

In accordance with the preferred embodiment, the piston rod acts upon a slidingly supported fork. The internal faces of the prongs of the fork are formed as inclined surfaces and function to radially position a pair of regulating pins. Thus the jaws may be adjusted by a simple mechanical means.

Other features and advantages of this invention will become apparent through reference in the following description and accompanying drawings.

FIG. 1 is a sectional view of a rotary pump illustrating certain features of this invention.

FIG. 2 is a sectional view taken along the line II—II of FIG. 1.

FIG. 3 is a schematic of the jaws in the null or zero pump position.

FIG. 4 is an enlarged fragmentary view of FIG. 3 illustrating the tip construction of the jaws.

FIG. 5 is a plan view of the jaws of the pump of FIG. 1 illustrating the development of the delivery chamber.

FIG. 6 is an enlarged partial sectional view along the horizontal plan of the embodiment illustrated in FIG. 1.

FIG. 7 is a full sectional view of a rotary pump illustrating an alternate embodiment of this invention.

FIG. 8 is a full sectional view of a rotary pump illustrating still another alternate embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With respect to the embodiment illustrated in FIG. 1, the rotary pump includes several sections which form an intake housing **1** at the intake side of the pump and form an exhaust housing **2** at the exhaust side thereof. Secured about the housings **1** and **2** is a delivery conveyer frame **3** secured by means of screws and alignment pins **5**. Within the frame **3** are a pair of mating jaws **6** and **7** which are arranged so that they may be radially shifted. The semicircular running surfaces **9** and **10** of the jaws **6** and **7** form an output zone **8**. The relative movement of the running jaws **6**, **7** produces an adjustment in the volume of the output zone **8**. Thus, it is appreciated that the zone **8** may be decreased or enlarged as the cross sectional area defined by the surfaces **9** and **10** varies between that of a circle and that of an oval as illustrated in FIG. 1. As the volume of the output zone **8** is varied, the pumping blades **13**, which are spring biased outwardly will be urged toward the center of the rotor body **14**. By this rather simple arrangement it is possible to selectively vary the volume of the output zone of the pump. The delivery rate can be easily adjusted by either varying the regulation of the pressure or by changing the driving power supplied to the pump. Serving this end, liquid pressure is applied to the control pistons **15** and **16** and then flows through the fluid tubes **17** and **18**. Radial movement of the pistons **15** and **16** produces a corresponding shift in the regulating pins **20** and **22** and in the jaws **6** and **7**.

The jaws **6** and **7** are similarly shaped and are shifted with respect to the rotor. During movement the jaws **6** and **7** provide mutual support by means of their mating guide surfaces **11** and **31**, and **12** and **32** respectively. The guide surfaces **31** and **32** are constructed as the tangential elongations of the one end of the semicircular surfaces **9** and **10**. The surfaces **11** and **12** extend tangentially from the outer surfaces of the opposite end of the jaws **6** and **7** respectively.

In order to reduce the weight of the pump, and also in order to increase the manufacturing feasibility, the running jaws are preferably fabricated of cast plastic. Such a material resists wear and tear, and exhibits a much lower specific gravity than suitable metallic materials. Further, such plastic materials can usually be cast within narrow dimensional tolerances, thus eliminating any refinishing operations. Serving to regulate output flow are spring groups **21** and **22**. The delivery rate is manually adjusted by means of a regulation means **23**. Rotary actuation of a handwheel **24** increases the pressure within a cylinder **25**. This pressure variation is transferred through conduits **26** to the pistons **15** and **16** and upon the regulation pins **19** and **20**. In this manner, the jaws **6** and **7** are caused to shift, thus razing the volume of the delivery zone and produce a regulating effect upon the output of the pump as previously mentioned. As illustrated in FIG. 2, adjustment of fluid flow through the channels **17** and **18** is accomplished by means of adjusting screws **27**.

With respect to FIGS. 3 and 4, the inwardly disposed semicircular recesses **209**, **210** of the jaws **206**, **207** are illustrated. The recesses extend along a major section of a curved face and thus extend fully across the intake and delivery zones. Proximate the discharge slit **230** of the delivery zone the path of the recesses **209**, **210** are formed into the arc of an Archimedes' spiral and extend to a point **241** at which a straight line **242**, extending from the run-out tip **243**, forms a tangent therewith. As a result of this particular development, the blades **213** are urged in a predetermined manner towards the center of the pump and in this way force the oil located in the chambers **250** (FIG. 5) of the rotor body **214** under pressure into the bushings. In this manner sufficient lubrication of the bushings is assured even though the jaws **206** and **207** are in their null position.

Under certain conditions a hammering condition may arise due to the development of a pressure differential across the impeller blades **213**. This condition arises when high outlet pressure which exists in the delivery chamber **250** is decreased before the impeller blade **213** has passed the transition point. In an effort to reduce such hammering, the transition point of the jaws **206** and **207** is located at the tips **243** wherein run out relief grooves **251** are provided for communication with the output spaces. The grooves **251** extend to the intake zone of the pump and sample up small amounts of oil which thus produces an immediate drop in pressure, the pressure differential.

Serving to reduce noise and to avoid the creation of transitional loads, a pair of running jaws **6** and **7** are provided as illustrated in FIG. 7. The jaws are provided with semi-circular recesses **9** and **10**. Each of the cutouts extends to force a tip with its respective surface **11** or **12**. Within the recesses **9** and **10** are located guide straps **33** and **34**. More particularly, the strap **34**, which is located within the cutout **10** of the running jaw **7**, is secured at one end **35**, by securing means **30** in the form of a bolt or alternatively adhesive to the sliding surface **12** of the running jaw **6**. The remaining end **36**, tapers to form a tip, and lies, due to its natural resiliency, against the strap **33**. Strap **33** includes an end **37** which is secured by securing means **38** to the sliding surface **11** of the running jaw **7**. The end **39** which is similarly formed with a taper lies against the strap **34**. It will be appreciated that the ends **36** and **39** of the straps extend so that their tapered ends follow in the direction of rotation of the impeller **14** thereby providing a stepless transition for the delivery blades **13**.

As the jaws **6**, **7** are shifted, the tapered ends **36**, **39** of the straps will slide along the internal surface of the opposite straps **33** and **34** respectively and thus facilitate adjustment of the delivery rate. In addition to those advantages previously listed, it should be noted that construction of the pump is greatly facilitated when compared to prior pumps since greater tolerances are acceptable and since a slight inaccuracy in the machinery of the sliding surfaces will not greatly reduce influence of the performance of the pump.

With respect to the embodiment of FIG. 7, the straps may be constructed of spring steel or of plastic. They are urged by the centrifugal force of the impeller blades against the jaws. The length of the straps **127** and **131** are selected on the following basis. The run-out tips **131** and **132** preferably extends into the pressure relief zones **200** and **201**, and then extend into the internal face **202** of the housing. In this rather simple manner a majority of the transitional stresses and strains upon the pump are avoided.

With respect to FIG. 8 the interior of a pump housing **303** is illustrated containing two jaws **306** and **307**, which are adjustable to facilitate variation in the volume of the output zone as determined by the position of the regulation pins **319** and **320**. The pins **319** and **320** are positioned with the aid of a sliding supported fork **341** including prongs **343** and **344**. The surfaces of the prongs **343** and **344** adjacent to the regulating pins **319** and **320** display inclined faces **342**.

For illustrative purposes it is assumed that the cylinder **318** and the piston **316** are actuated by hydraulic, pneumatic or mechanical means. As the piston rod **330** is moved in the direction of the delivery frame **303**, the movement is transferred across the fork **341** to the regulation pins **319**, and **320**. The pins then produce a readjustment in the position of the jaws **306** and **307**. This particular construction prevents the jaws from sliding disproportionately when the various adjustment steps are actuated. Both halves of the jaws, during such adjustments, are caused to change their positions simultaneously and in an identical manner. Although two embodiments of this invention have herein been shown and described, it will be uderstood that certain details of the construction shown may be altered without departing from the spirit and scope of this invention as defined by the following claims.

We claim:

1. An adjustable rotary pump having pressure and output zones and including rotor blades which are radially shiftable and further wherein the volume of the output zone may be selectably adjustable with the aid of slidable jaws, the improvement comprising symmetric semi-circular recesses upon the inwardly disposed surfaces of said jaws, means for shifting said recesses concentrically with respect to the rotor, a portion of the surfaces of said jaws being in sliding contact with each other and maintained within the housing of the pump wherein each of the jaws are developed in the region adjacent the delivery zone of the pump in the shape of an Archimedes' spiral so as to provide a tip at the point of intersection with the outwardly disposed edge of the jaw.

2. A rotary pump in accordance with claim **1** which further includes relief grooves within the inwardly disposed surfaces of said jaws adjacent said tips and which extend into the intake zone of the pump.

3. A rotary pump in accordance with claim **2** wherein the jaws are cast of a plastic synthetic material.

4. A rotary pump in accordance with claim **2** wherein the inwardly disposed surfaces of said jaws define longitudinal recesses and elongated resilient straps positioned within said recesses.

5. A rotary pump in accordance with claim **4** wherein the ends of said straps extend beyond the discharge zone and include a sharp edge which is in contact with the internal surface of the housing.

6. A rotary pump in accordance with claim **5** wherein one end of each of the straps is secured to the outwardly disposed surface of the jaws at a point adjacent

the point of sliding contact of the jaws and the remaining end of each strap tapers to form a tip.

7. A rotary pump in accordance with claim **1** which further includes a common steering piston for controlling the size of the delivery zone defined by said jaws in a simultaneous and uniform manner.

8. A rotary pump in accordance with claim **7** wherein said piston acts upon a fork, said fork being supported for movement with respect to said pump, said fork defining facing, inclined surfaces in sliding contact with respect to positioning means associated with said jaws so that relative movement between said fork and said pump will produce a corresponding relative movement of said jaws.

9. A rotary pump as set forth in claim **8** wherein the steering piston is driven by mechanical means.

10. A rotary pump as set forth in claim **1** which further includes a pair of jaws defining inwardly disposed semicircular guide paths and each jaw defining a first and second mating surface. said first mating surface of each of said jaws being in the form of a tangential extension of one end of the semicircular guide path and whereas said second mating surface of each jaw being an extension of the outside surface of the opposite end of the semicircular guide path.

11. A rotary pump as set forth in claim **1** which further includes a pair of adjusting pistons each of which is positioned for cooperative movement against one of said jaws, and a hydraulic means for actuating each of said pistons in a simultaneous uniform manner to permit uniform adjustment of said jaws, said hydraulic means including a fluid pressure source and fluid conducting conduits between said source and said piston.

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U.S. Cl. X.R.

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