Oct. 19, 1943. R. A. SWANSON ET AL 2,332,411

PUMP

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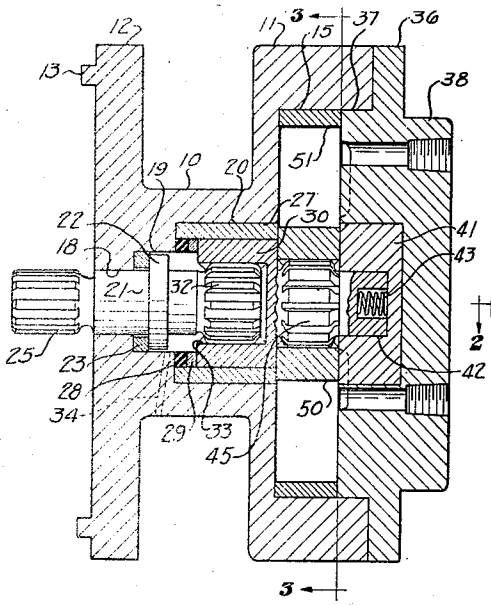


Fig. 2

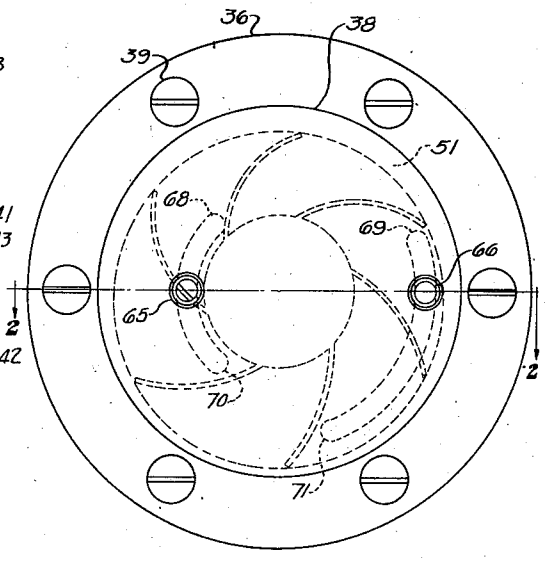


Fig. 1

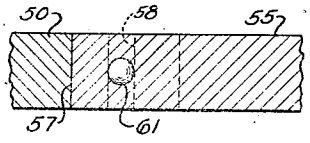


Fig. 4

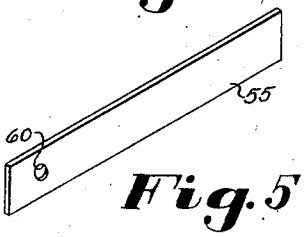


Fig. 5

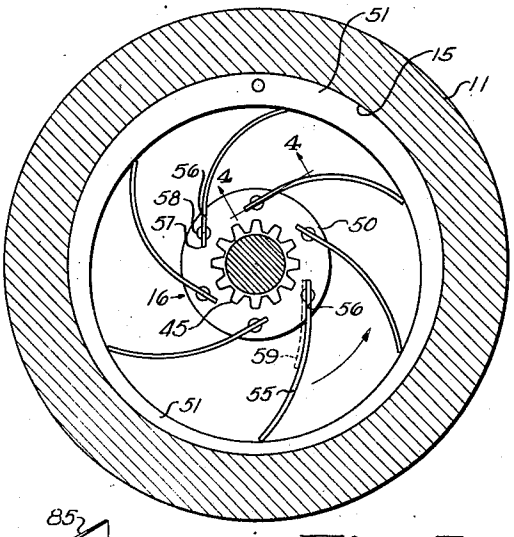


Fig. 3

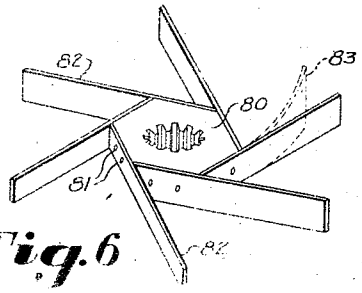


Fig. 6

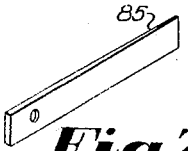


Fig. 7

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PUMP

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2 Claims. (Cl. 103—117)

This invention relates, generally, as indicated to pumps, and has reference more specifically to a rotary fluid pump adapted for use as a fuel pump for internal combustion engines and particularly adapted for use as a fuel pump in conjunction with aircraft power units of the gasoline engine type.

Fuel pumps hitherto used in conjunction with aircraft gasoline engines are large, bulky and comprise many parts. Due to the large quantities of fuel contained and operated upon within such pumps, the numerous vigorous internal currents set up within the fuel, the irregularities of the interior surface of the pump, and also due to the ease with which gasoline volatilizes at high altitudes, bubbles or pockets of gasoline vapor appear and accumulate in such proportions as to render the pump inefficient, whereupon an insufficient volume of or no fuel is delivered to the carburetor. This frequently causes disastrous results. When this inefficiency occurs, and is due to the presence of vapor within the pump, it is said to be "vapor-locked."

Existing pumps of the type described comprise a cylindrical housing having eccentrically mounted therein a rotor with stiff blades projecting therefrom to the housing. These blades have been heretofore resiliently bodily movable, as by a spring, in and out with respect to the rotor, so that their outer edge constantly contacts the housing. This construction results in an absolute displacement pump and requires suitable separate valve mechanism for preventing the fuel from being delivered to the carburetor above a predetermined maximum pressure. The drawback of such separate valve mechanism is that it necessarily enlarges and provides added interior surface irregularities, thereby aggravating the above said undesirable creation of vapor.

The primary object of this invention has been to provide an aircraft internal combustion engine fuel pump in which the tendency of the fuel to vaporize is reduced to a minimum.

Another object has been to provide a pump of the character described which, without jamming, will cease to deliver fuel against a predetermined back pressure.

Another object has been to provide a rotor, the parts of which can be readily disassembled.

Still another object has been to design a pump which produces adequate "dry lift."

A still further objective has been to produce a pump, the use of which eliminates the necessity for a special attachment or connection for a supercharger.

Further objects have been to arrive at a pump of the type described which is simple in design, jam-proof, compact, comprised of a minimum number of parts, economical to manufacture, light, and efficient in operation.

Other objects of the invention will become apparent from the drawing and the following description and are summarized in the claims.

While the invention has been developed chiefly for aircraft use, it is adapted to other uses where a need is had for the performance of a similar function.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the annexed drawing and the following description setting forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a front view of a pump embodying this invention;

Fig. 2 is a view taken along the line 2—2 of Fig. 1;

Fig. 3 is a view taken along the line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragmentary view taken along the line 4—4 of Fig. 3;

Fig. 5 is an isometric view of a rotor blade;

Fig. 6 is an isometric view of a rotor embodying a modification of this invention; and

Fig. 7 is an isometric view of a modification of a rotor blade.

Referring now to the drawing wherein like reference characters will be used to designate like parts and having reference more particularly to Fig. 2, it will be seen that the pump shown comprises a housing, preferably made of a lightweight metal such, for example, as aluminum, having a body portion 10 and two flanges 11 and 12 extending therefrom. An annular boss 13 projects axially from flange 12 and mates with a complementary recess provided on the engine for properly aligning the pump.

The body 10 has an axial opening 18 extending therethrough which is counterbored to provide enlarged bores or recesses 19, 20 and 15.

The motor to which this pump is connected drives the rotor by means of a shaft 21. The shaft is freely journalled in opening 18 and has freely disposed within bore 19 a radially extending flange 22. This flange takes the end thrust in one direction, which is to the left of Fig. 2,

where it bears against annular washer 23. The body of the shaft freely fits or floats in this washer. The body of the washer is made of bronze, with the surface thereof which bears against flange 22 silver coated or otherwise treated so that it is adapted to "run dry."

The left end 25 of the shaft is splined and is coupled to the motor by means of a mating similar driving element.

Within the bore 20 a bushing 27 is press fitted or shrunk and freely or floatingly accommodates a coupling 30 which couples the shaft and the rotor, as will be hereinafter revealed.

Resting against the shoulder formed by the junction of bore 19 and largest bore 20 is a washer 28 of rubber, fiber or other ductile material, which is in contact with a bronze washer 29 which constitutes a thrust bearing for the left end of the coupling.

This end of the coupling is hollow as at 33 and is adapted to freely or floatingly engage or mate with the splined right end 32 of the shaft (see Fig. 2). A hole 34 is provided through which lubricant may be supplied to or drained from spline 32, washers 23 and 29.

The rotor is sealed within the recess 15 by means of a cap 36, either end of which is flanged axially, as at 37 and 38, so that its central portion is the thickest.

The flange 37 fits snugly within the recess 15 and is maintained therein by a suitable means, such as a number of screws 39 which pass through the cap and threadingly engage the housing. Coaxial with the openings of the housing is a bushing 41 which is press or shrunk fitted into the cap.

Journalled in the inner surface of this bushing is the right end 42 of the coupling 30. This end has an opening which accommodates a spring 43 which is under compression for insuring an urge of the coupling to the left of Fig. 2. Thus the fluid being pumped cannot seep into bore 19, due to the seal created by the coupling and the washers 28 and 29.

The coupling is splined, as at 45, to the body 50 of the rotor 16 and completes the connection between the rotor and the shaft.

It is to be noted that the rotor and annular axial recess 15 are co-axial. To permit the rotor axis to be eccentric to the space within which it rotates, there is provided within the recess 15 a ring 51, the interior of which is eccentric with respect to its exterior, and is chromium plated to reduce wear and friction. Thus, the rotor is not coaxial with the interior of the ring.

The same eccentric result can be had by making the recess 15 eccentric with respect to the other openings of the housing and cap. If such were the construction employed, the ring 51 could be eliminated or made cylindrical. The scraping effect of the blades upon the surface with which they are in contact causes such surface to wear. The use of a ring permits easy replacement or recoating of the surface.

Having reference, now, more particularly to Figs. 3 to 5, it will be seen that depending from the body 50 of the rotor and extending therefrom to the eccentric ring 51 is a plurality of blades 55. In order to attach the blades to the body of the rotor, there is provided for each blade a slot 56, which may be radial but is preferably otherwise. Each slot extends through and slightly beyond, as at 57, a larger substantially cylindrical opening 58. The segment of each blade which occupies the opening 58 has therein a circular opening 60 equal or slightly less in diameter than the opening 58. A ball 61 fits into both openings 58 and 60 and is of such size that the blades float with respect to the rotor body. Thus, the blades have bodily non-axial movement which is limited by the ball which is larger than the slots. Slight bodily axial movement of the blades is permitted and is restricted by the radial surface of the recess 15 and by the interior of the cap 36.

The blades are resilient or elastic and function well when made of spring steel. Rubber or other flexible, resilient or spring-like material could also be used. As is illustrated in Fig. 3, each blade is at least as great and is preferably somewhat greater in length than the greatest distance between the inner end 57 of each slot and the ring so that each blade will be flexed more or less depending on the radial distance at any instant between the slot end 57 and the ring.

It will be obvious that as the rotor rotates, a portion of each blade moves in and out and bends and straightens out and that the outer end of each blade is in constant contact with the ring. This action of the blades causes the space or volume bounded by two adjacent blades, the body of the rotor and the ring to breath or expand and contract. Each expansion creates a vacuum and tends to suck fluid in. Each contraction creates a compression and tends to force out or eject fluid. From this it should be clear that by properly designing and locating ports the pump is complete.

The ports are best seen in Figs. 1 and 2. To secure the fullest possible advantage of centrifugal force we have located an inlet 65 in the cap 36 close to the axis of rotation and an outlet 66 remote from the axis of rotation. With this arrangement centrifugal force has a greater tendency to throw off fluid at the outlet than at the inlet. It is to be understood that the ports could be located elsewhere, as in the housing, and open into the recess 15, but we have found fabrication simpler by locating the same in the cap.

The space between two adjacent blades contracts for 180° and then expands for the remaining 180° of the 360° cycle. For this reason the most efficient arrangement of the ports would seem to be to have each one communicating with the space between two adjacent blades for 180°, but this would result in the inlet and the outlet ports being simultaneously open to the same space between two adjacent blades, because there would be 360° of port openings. This would be undesirable because since the back pressure is greater than the inlet pressure, the fluid already pumped could back up resulting in inefficiency.

We have located our inlet and outlet on a line connecting the two points of maximum displacement of the blades. Extending along the inner face of the cap and communicating with each port is an arcuate slot, but it is to be noted that the end 68 of the inlet port and the end 69 of the outlet port are so spaced that there is always at least one blade therebetween so that one port is never in direct communication with the other port. The same is true of the other ends 70 and 71.

With any given speed and resiliency of the blades a predetermined pressure in the outlet will not be exceeded because, when such pressure is reached, the blades will bend away from and break contact with the ring. When this happens the pump ceases to act as an absolute displace-

ment unit and any remaining pressure is due to the centrifugal force which results from the rotation and churning of the fluid. When the outlet pressure (back pressure) is sufficiently relieved the blades will spring back into contact with the ring and the friction of absolute displacement pumping is resumed.

It is to be noted that the pump rotates clockwise, but that the outer ends of the blades normally trail and that the direction of rotation is counter-clockwise, as indicated by the arrow in Fig. 3. The invention, however, is well adapted for clockwise rotation. Thus, if the motor kicks back a few revolutions, no damage will result.

If, for any reason, it is desired to deliver fuel to the motor without operating the pump, a pressure is built up, as by a manual pump which is customarily found in most aircraft, in the inlet sufficient to flex the blades and permit the fluid to flow through the outlet while the rotor remains stationary. If the rotor is free to rotate, the pressure necessary to be built up by the manual pump will be less because the rotor will rotate without flexing the blades away from ring. Thus the by-pass conventional with pumps hitherto used is eliminated, due to the by-pass which is inherent in this pump.

In the alternative rotor construction shown in Fig. 6, we have illustrated a hexagonal rotor body **80** similar to the rotor body **50** except that the latter is round. Secured to each of the six faces, as by riveting, welding or bolting **81**, so as to be either rigidly or floatingly secured thereto, is a blade **82**. The blades **82** are similar in composition and structure to blades **55** and the dotted line **83** indicates the flexed condition of one of the blades after the rotor is inserted into the housing.

In Fig. 3 there is shown in dotted lines a buffer blade **59** which may be used for preventing injury to blades which buckle or flex unduly at and adjacent the outer axial ends of slots **56**. The buffer blade has an opening corresponding to the openings **60** of blades **55** and the ball **61** retains both blades **55** and **59** in the slots.

Fig. 7 illustrates an alternative blade **85** with a flat shank having a hole corresponding to holes **60** of blades **55** and then a gradual taper. This prevents injurious bending of the blade at the outer end of the slot **56** where its greatest tendency to exceed the elastic limit occurs and still permits the use of a single blade with physical qualities similar to those of blades **55**.

In Figs. 3 and 6 we have shown six blades, but do not wish to be bound by any specific number of blades, inasmuch as the pump will function with a number of blades other than six. The exact number of blades and spacing thereof is a matter of mechanical design and to some extent affects the efficiency.

The elimination of auxiliary valve mechanism and a chamber therefor reduces the area of surface and surface irregularities in contact with the fuel.

Many of the parts of a pump embodying this invention freely float and the outer ends of the blades trail, which tends to result in a jam-proof device even when the back pressure is beyond a predetermined quantity.

Due to blades having contact with the radial and axial portions of recess **15** and with the cap **36**, there is provided adequate dry lift.

The absence of relief valves, which are necessarily vented to atmospheric pressure in a device incorporating the instant disclosure eliminates the necessity for a special attachment or connection for a supercharger.

We claim:

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

We therefore particularly point out and distinctly claim as our invention:

1. In a rotary pump, a housing having a cylindrical interior, a rotor disposed in and concentric with said interior, an eccentric ring interposed between said housing and said rotor, said rotor having resilient blades extendiing to the inner surface of said ring, said housing having a generally axially directed inlet port and a generally axially directed outlet port, said inlet port being closer to the axis of said rotor than said outlet port.

2. In a rotary pump, a housing having a cylindrical interior, a rotor disposed in and concentric with said interior, an eccentric ring interposed between said housing and said rotor, said rotor having spring-like metallic blades extending to the inner surface of said ring, said housing having a generally axially directed inlet port and a generally axially directed outlet port, said inlet port being closer to the axis of said rotor than said outlet port.

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