Nov. 18, 1941. J. P. JOHNSON 2,263,092

GEAR LUBRICATING DEVICE

Filed Feb. 20, 1939 2 Sheets-Sheet 1

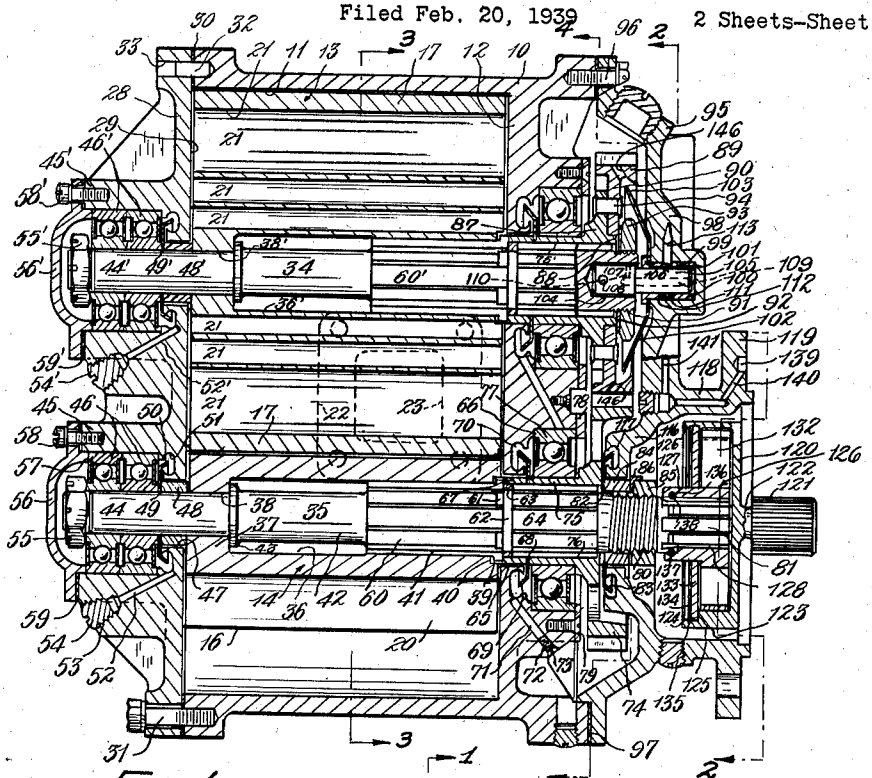


FIG. 1

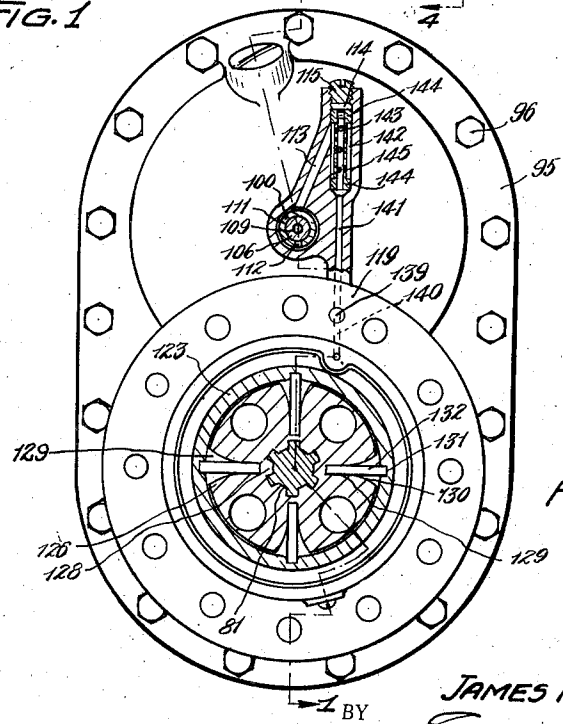


FIG. 2

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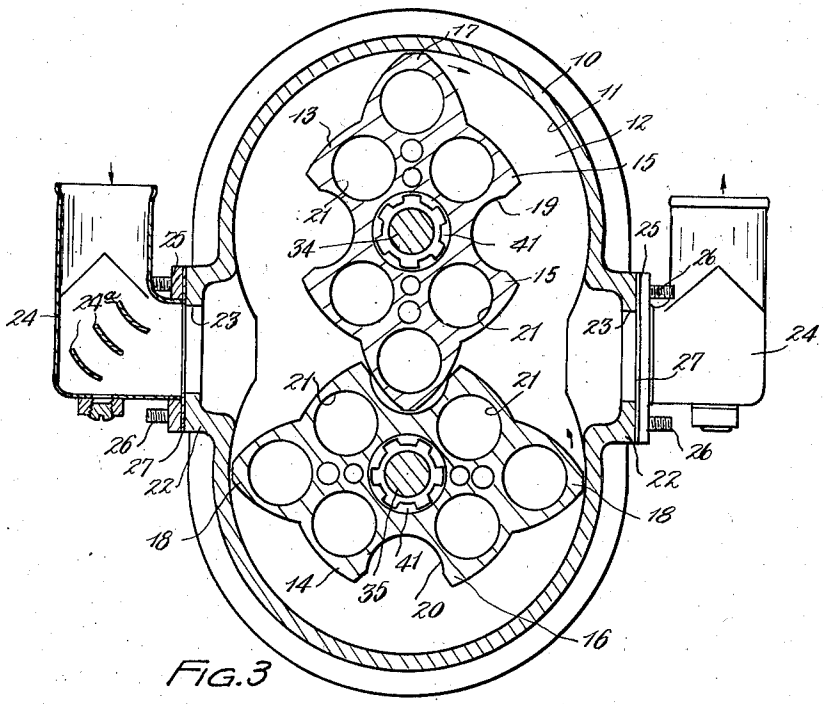


FIG. 3

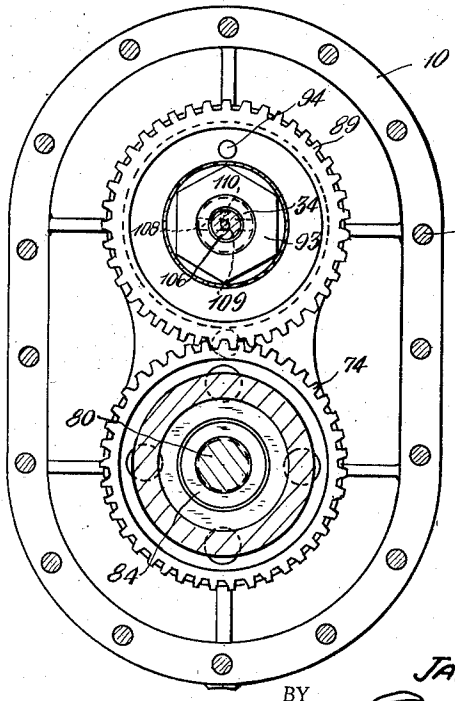


FIG. 4

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Patented Nov. 18, 1941 2,263,092

UNITED STATES PATENT OFFICE

2,263,092

GEAR LUBRICATING DEVICE

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Application February 20, 1939, Serial No. 257,548

1 Claim. (Cl. 184—6)

This invention relates to improvements in air pumps and more particularly to that type of pump capable of discharging clean dry air under pressure and in desired volume, especially adapted for use on aircraft for operating de-icing equipment and supercharged cabins for altitude flights.

An object of the present invention is to provide a pump of the type referred to having cooperating pumping gears which are not in contact but in which the running clearance is at a minimum so as to maintain a high degree of efficiency.

Another object of the present invention is to provide a construction wherein the running clearances are effectively maintained irrespective of temperature changes.

Another object of the present invention is to provide adequate lubrication for the operating elements of the pump but to so direct the lubricant that it does not, detrimentally, combine with the air handled by the pump.

A further object of the present invention is to predetermine the running clearances between the cooperating pumping gears and thereafter effect positive relative rotation of the latter to insure maintenance of the running clearance irrespective of the speed of rotation thereof.

Another object of the present invention is to provide a pump structure which is simple in production and assembly, efficient in operation, and relatively inexpensive to manufacture.

With the objects above indicated and other objects hereinafter explained in view, a preferred embodiment of my invention consists in the construction and combination of elements hereinafter described and claimed.

Referring to the drawings,

Figure 1 is a vertical longitudinal sectional view of a pump embodying the present invention and taken approximately along line 1—1 in Figure 2 to illustrate different portions of the structure.

Figure 2 is a transverse elevational view partly in section to more clearly illustrate details of the structure and taken approximately along line 2—2 of Figure 1.

Figure 3 is a transverse vertical sectional view showing the pumping gears and other details of the pump structure, and taken along line 3—3 in Figure 1.

Figure 4 is a transverse vertical sectional view showing the driving and driven gears operatively associated with the pumping gears to maintain the running clearances between the latter and taken approximately on line 4—4 in Figure 1.

In the drawings I have illustrated an air pump embodying the present invention and while particularly adapted for use on aircraft, the novel features may be otherwise incorporated as will be readily apparent to those skilled in the art.

The pump comprises a housing proper 10, preferably an aluminum casting for lightness, which has a bore 11 extending inwardly from one end thereof and terminating in a transversely disposed wall 12 at the other end providing a pump chamber. The pumping means is in the form of cooperating rotatable impellers 13 and 14 although, it will be obvious, that other types may be employed if desired, but the type illustrated has the desirable features of simplicity in production and the maintenance of close running clearances for high efficiency. The impellers are of identical construction comprising body portions 15 and 16 of aluminum material generally circular in cross section, the respective axes being disposed in spaced parallel relation, the adjacent peripheral surfaces having a close running clearance for a purpose to be later described. Each impeller is further provided with a pair of extensions or teeth 17 and 18 projecting outwardly on diametrically opposite sides which have their outer ends slightly flattened or rounded for close running relation with the inner peripheral surface of the bore 11 but likewise slightly spaced therefrom. The impellers are further provided with a pair of recesses 19 and 20 on diametrically opposite sides disposed in a plane substantially at right angles to said teeth, the recesses being formed and relatively disposed to receive the teeth of the opposite impeller there being provided a close running clearance therebetween. Each impeller extends longitudinally throughout the depth of the bore but has a running clearance with the wall 12 and the peripheral surfaces are so formed as to have slight clearance during relative rotation thereof. The impellers are further provided with a plurality of longitudinally extending openings 21, to reduce the weight thereof which are equally disposed with respect to the axis so as to maintain proper balance during rotation.

The housing proper 10 has a pair extensions 22 projecting outwardly on diametrically opposite sides thereof the end walls of which are provided with centrally disposed openings 23 preferably in alignment with and in communication with the opposite sides of the pump chamber. The pump is adapted for operation in either direction and the openings 23 function respectively as inlet and outlet openings depending upon the direction of rotation. Elbows 24 have attaching flanges 25 at their inner ends detachably connected to the end walls of the extensions 22 by bolts 26, a gasket 27 being disposed therebetween to effect a sealed joint. Baffle-plates 24a are disposed within the elbows to suitably direct the flow of air and the outer ends of the elbows project laterally outwardly and are adapted for connection with instrumentalities to be actuated.

A cover member 28 is detachably connected to the open end of the housing proper 10 and has a flat inner surface 29 disposed in close relation

to the adjacent ends of the impellers 13 and 14. A gasket 30 is disposed between the cover member and housing proper adjacent their outer edges to provide a sealed joint and bolts 31 project through openings in the cover member and screwthreadedly cooperate with aligned screwthreaded openings in the housing proper 10. Provision is made for properly positioning the cover member on the housing proper by means of a pin 32 having one end embedded in the housing proper and its other end projecting outwardly for insertion into an opening 33 provided in the cover member as more clearly shown in Figure 1.

Rotation is imparted to the impellers 13 and 14 by means of shafts 34 and 35, the latter being the drive shaft. The construction and mounting of the shafts is identical and a detailed description of the drive shaft mounting will suffice for a clear understanding. The impeller 14 has an axial bore 36 extending from its inner end outwardly and terminating in an end wall 37, the latter being provided with an axial opening 38 of smaller diameter than said bore. The inner end of the bore communicates with a circular recess 39 of slightly larger diameter to provide a shoulder 40. The inner end of the bore 36 has inwardly projecting radially disposed spaced teeth 41 extending longitudinally outwardly from the shoulder 40 to substantially midway of the bore for a purpose to be later described. The drive shaft 35, preferably of steel, is disposed coaxially of the impeller and has a portion 42 extending longitudinally within the bore 36. The shaft has a circumferential flange 43 outwardly from the portion 42 and abutting the adjacent end wall 37 to maintain the shaft against axial movement. The shaft has an outer end portion 44 of reduced diameter which projects through the opening 38 and is rotatably mounted in any desirable manner in the cover member 26. In the present instance the cover member 26 has a tubular coaxial extension 45 projecting outwardly within which the outer races of a pair of antifriction bearings 46 are securely fitted. The inner races of the bearings are tightly fitted upon the projecting end portion 44 of the shaft and balls are mounted between the races in the usual manner. The cover member is provided with an axial opening 47 through which the end portion 44 of the shaft projects, of a size to accommodate a sleeve 48 tightly fitted but axially movable upon the latter and in abutting engagement with the adjacent end of the impeller. A disc 49 has a central opening through which the shaft projects and is securely clamped between the outer end of the sleeve 48 and the adjacent inner race, the outer portion of the disc being formed with an inwardly angularly extending marginal flange 50 for a purpose to be later described. The cover member has an annular recess 51 within which the flange 50 freely projects and a passageway 52 communicates with the recess at one end and a screwthreaded opening 53 at its opposite end normally closed by means of a removable screwthreaded plug 54. The outer end of the shaft 35 is screwthreaded to receive a nut 55 which when tightened secures the shaft and its cooperating elements in rigid assembled relation for unitary rotation. A cap 56 extends across the open end of the tubular extension 45 and has an annular flange 57 abutting the adjacent outer race of the bearings. Bolts 58 project through openings provided in the marginal portion of the cap and screwthreadedly cooperate with aligned openings provided in the adjacent end of the tubular extension and a gasket 59 is disposed between the cap and extension to provide a sealed joint.

The shaft 35 is further provided with radially disposed spaced teeth 60 which extend longitudinally thereof and are arranged for cooperative engagement with the teeth 41 at the end of the bore 36 to produce a splined connection whereby rotation of the shaft is imparted to the impeller. The inner ends of the teeth 60 are formed with lateral extensions 61 disposed in circumferential alignment to provide a flange positioned within the circular opening 39 but in spaced relation to the adjacent surfaces thereof. The shaft is formed with a circumferential groove 62, inwardly of the extensions 61, to receive a resilient ring 63 of neoprene ruber composition or other suitable sealing material. Inwardly of the ring 63 the shaft is provided with radially disposed spaced teeth 64 extending in longitudinal alignment with the teeth 60. The end wall 12 of the housing proper has a circular opening 65 extending therethrough and through which the shaft projects. A bore 66 is provided on the outside of the wall 12 which extends inwardly and communicates with the opening 65. A steel sleeve 67 is tightly fitted but axially movable over the outer end of the teeth 64 and the ring 63 and has its outer end in abutment with the adjacent portion of the lateral extensions 61. A disc 68 has a central opening through which the teeth 64 of the shaft project, the outer portion being formed with an outwardly angularly extending marginal flange 69 for a purpose to be later described. The end wall 12 has an annular recess 70 adjacent the bose of the bore 66 within which the flange 69 freely projects and a passageway 71 communicates at one end with the recess and at its opposite end with a screwthreaded opening 72 normally closed by a screwthreaded plug 73.

An external gear 74 preferably of steel is disposed outwardly of the end wall and has a cylindrical hub portion 75 projecting rearwardly, the inside of the hub portion being provided with radially disposed spaced teeth 76 extending longitudinally and mounted upon the teeth 64 of the shaft. The free end of the hub portion 75 abuts the adjacent portion of the disc 68 and the inner race of an antifriction bearing 77 is tightly fitted upon the outer peripheral surface of the hub portion. The outer race of the bearing is tightly fitted within the bore 66 and balls are mounted between the races in the usual manner. A retaining ring 78 is positioned upon the outer side of the wall 12 in overlapping relation with respect to the outer race of the bearing 77 and detachably secured to the end wall by means of bolts 79.

The inner end of the shaft 35 has a portion of reduced diameter adjacent the teeth 64 which has a tapering screwthread 80 and a splined free end portion 81. A disc 82 has a circular opening through which the reduced portion of the shaft projects, the outer portion being formed with an inwardly angularly extending marginal flange 83. A steel sleeve 84 fits tightly but axially movable over the reduced portion of the shaft and abuts the adjacent face of the disc 82 to maintain it in engagement with the gear 74. A nut 85 screwthreadedly cooperates with the threaded portion 80 of the shaft and when secured tightly in place maintains the cooperating elements in rigid relation and in abutment with

the lateral extension 61 whereby all will rotate in unison. A washer 86 is disposed between the nut and sleeve and has a tongue bent over into engagement with the former to prevent accidental removal.

For a clearer understanding of the construction, where the structural features and mounting of the driven shaft 34 are identical with that of the drive shaft 35 heretofore described and it is desirable to refer to such elements, they will be indicated by the "'" of the corresponding reference numeral on the drawings.

The hub 75' which is mounted upon the inner end of the driven shaft 34 preferably of steel, has a lateral circumferentially extending flange 87 disposed slightly inwardly from its inner end to provide a circular extension 88. An external gear 89 of steel and of the same pitch diameter as the external gear 74 is disposed in meshing engagement with the latter whereby positive rotation of the drive gear 74 is imparted to the driven gear 89 and inasmuch as these gears are directly connected to their respective shafts and the latter directly connected with their respective impeller, the latter are positively rotatable at the same speeds. To effect the desired running clearances between the impellers during relative rotation the web 90 of the gear 89 is provided with an axial opening to permit mounting of the latter upon the circular extension 88 and initially being adjustable angularly relative thereto. The inner free end of the shaft 34 is exteriorly screwthreaded at 91 and a washer 92 freely encircles the latter and abuts the adjacent face of the web 90. A nut 93 is screwed onto the end of the shaft and when tightened forces the web 90 and flange 87 into unitary engagement. By this construction the gear 89 can be independently adjusted angularly upon the circular extension 88 until the desired running clearance between the impellers has been effected whereupon aligned openings are provided in the flange and web and securely connected for unitary rotation by a pin 94 having its opposite ends upset to provide heads.

At the inner end of the housing proper 10 there is a cover member 95, preferably of aluminum material, which extends across and encloses the elements disposed outwardly of the wall 12 for a purpose that will later be more obvious. The cover member 95 is substantially elliptical in shape, conforming to the outer contour of the housing proper, and is detachably connected to the latter by a plurality of bolts 96 which project through marginally spaced openings in the cover member and screwthreadedly engage aligned openings in the adjacent portions of the housing proper as more clearly shown in Figures 1 and 2. A gasket 97 is disposed between the adjacent portion of the cover member and housing proper to provide a sealed joint. The end wall of the cover member 95 projects outwardly at 98 in the region of the gear 89 and is provided with a bore 99 on its inner side in axial alignment with the axis of the shaft 34. A bronze bushing 100 is tightly fitted within the bore 99 and has a lateral flange 101 at its outer end. A disc 102 is disposed between the flange 101 and the adjacent face of the cover member and has a central opening to accommodate the bushing, the outer portion of the disc being formed with an inwardly angularly extending marginal flange 103 the peripheral edge of which is disposed in close proximity to the web 90 of the gear 89. The free end of the shaft 34 has a bore 104 extending axially inwardly and of a diameter slightly greater than the inner diameter of the bushing 100. An oil metering pin 105 has a portion 106 which rotatably fits in the bushing 100 and a portion 107 which projects into the bore 104 being secured to the adjacent end of the shaft by means of a cross pin 108 more clearly shown in Figure 4. The opposite ends of the pin 105 are spaced from the ends of the respective bores and said pin has a central passageway 109 extending inwardly from the end portion 106 communicating with a laterally extending discharge port 110 in the portion 107 inwardly from the end of the shaft. The clearance between the portion 107 and the bore 104 determines the quantity of oil discharged and this may be varied as desired by substituting metering pins having the required running clearance.

The bushing 100 has a circumferential groove 111 in its outer periphery substantially midway of its ends and a transverse opening 112 establishing communication between the inside of the bushing and the groove. The projecting portion 98 of the cover member 95 has a passageway 113 in communication at its lower end with the groove 111 and at its upper end with an oil inlet opening 114 (Fig. 2) interiorly screwthreaded and normally closed by a plug 115. By this arrangement oil may be introduced from a source other than the engine pad, a manner that will be later described.

The lower portion of the end wall of the cover member 95 projects inwardly at 116 in close proximity to the gear 74 and has an axial opening encircling the sleeve 84 in spaced relation. On the inner face of the portion 116 is a circular recess 117 into which the flange 83 of the disc 82 freely projects. The end wall of the cover member 95 is further provided with an annular extension 118 concentric with the axis of the shaft 35, which terminates in a lateral circumferentially extending flange 119 forming an attaching plate whereby the pump can be attached to and supported by the engine in a well known manner. The splined end 81 of the shaft 35 is flexibly connected to the engine drive in any desirable manner but preferably as illustrated in the drawings. The connection comprises a circular end plate 120 having an outwardly projecting axially disposed pinion 121 connected to the former by a portion 122 of reduced section to provide a weakened joint for breaking in case of excessive strains. The plate 120 has a lateral rearwardly extending marginal flange 123, the inner peripheral surface t ing slightly enlarged at 124 to provide an abutment 125. A driven member indicated generally at 126 (Fig. 1) has a circular flange 126a disposed in spaced relation to the inner peripheral surface of said flange 123, the inner adjacent faces of the flange 126a and the plate 120 likewise being in spaced relation, and an axially disposed hub portion 127 having splined teeth 128 which are adapted for mounting upon the splined end 81 of the drive shaft 35.

The flange 126 is provided with radially disposed slots 129 extending longitudinally therethrough, the adjacent faces being flared outwardly relatively as indicated at 130. The flange 123 is also provided with radially disposed slots 131 upon its inner periphery in alignment with the slots 129. A plurality of short flat lengths of spring steel 132 arranged in superposed relation are disposed in each adjacent pair

of slots 129 and 131 in such a manner as to permit relative angular flexible movement between the flanges 123 and 125. Such a flexible connection is a decided advantage in that it relieves the pump elements of excessive strains and stresses imparted from the engine. The spring elements are maintained in operative position by means of a closure disc 133 which fits tightly within the peripheral surface 124 in abutment with the shoulder 125, the disc having a central opening through which the hub portion 127 freely projects. A snap ring 134 is disposed within a groove 135 formed on the inner peripheral surface outwardly of the disc. The hub portion 127 is likewise provided with a groove 136 on its inner peripheral surface to receive a snap ring 137 which contracts into a groove 138 formed upon the outer surface of the splined end 31.

In order to supply oil to lubricate the rotatable pump elements, the attaching flange 119 is provided with an oil inlet opening 139 adapted to be positioned in alignment with a similar opening on the engine pad mounting for supplying oil thereto. A passageway 140 extends through the annular extension 118 communicating at one end with the inlet opening 139 and at the opposite end with an upwardly extending passageway 141 provided in the projecting portion 98. The upper end of the passageway 141 communicates with the lower end of the bore 142 which in turn communicates with the upper end of the passageway 113 as more clearly shown in Figure 2. A tubular member 143 has lateral flanges 144 at its opposite ends removably disposed within the bore 142, the walls of the tubular member being provided with a plurality of transverse openings 145 spaced longitudinally to permit the flow of oil therethrough. It will be apparent therefore that the incoming oil will from this point flow through the passageway 113, into the groove 111, through the opening 112, into the interior of the bushing 100, through the central passageway 109, and be discharged through the port 110 into engagement with the inside of the bore 104. As previously stated the quantity of oil discharged may be predeterminately effected by selecting the proper clearance between the portion 107 of pin 105 and the bore 104. The discharged oil is thrown against the disc 102 where it is directed by the tapered flange 103 toward and into engagement with the web of the external gear 89 where it flows through openings 146 between the adjacent teeth and thereby lubricates the external meshing gears.

The ball bearing races are also supplied with lubricant in any desirable manner through the lubricant passageways provided and the lubricant is prevented from entering the pump chamber and commingling with the pumped air by the several discs as here provided.

In the operation of the pump, the pinion 121 of the drive shaft 35 is operatively connected to the engine or other source of power for imparting rotation thereto. Assuming that the drive shaft 35 is driven in a clockwise direction as indicated by the arrows in Figure 3, the elbow 24 on the left hand side of Figure 3 becomes the inlet and is connected with the air source while the elbow on the right becomes the outlet and is connected with the instrumentalities to which clean dry air is to be supplied. As the drive shaft 35 is rotated it in turn imparts rotation to the impeller 14 to which it is directly connected. The other impeller 15 which is rotatably mounted in cooperative relation without actual contact as previously described, is rotated by the driven shaft 34 on which it is mounted. Rotation of the driven shaft 34 is effected by the use of the external meshing gears 89 and 74 secured respectively upon the driven shaft 34 and the drive shaft 35. These gears 89 and 74 are of such relative pitch diameters that both shafts are rotated so that the impellers 14 and 15 will be driven in a manner to draw the air into the inlet side of the pump and discharge the same under pressure from the outlet side of the pump.

The materials used and the construction provided are such that the running clearances necessary in the operation of the pump, particularly at high speeds, can be maintained. This is effected particularly by definitely maintaining predetermined clearances at one end and permitting expansion and contraction at the other end, that is the spline end of the shafts, brought about by temperature changes.

While I have described the preferred embodiment of the invention it is to be understood that I am not to be limited thereto inasmuch as changes and modifications may be resorted to without departing from the spirit of the invention as defined in the appended claim.

I claim:

In a gear lubricating construction including a driven shaft rotatably mounted in a housing and having a gear thereon adapted to mesh with another gear, the end of said driven shaft adjacent said gear mounted thereon having a bore extending axially inwardly, a metering pin having one end disposed within said bore in spaced relation with respect to the wall thereof and connected for rotation with said driven shaft, the opposite end of said metering pin being rotatably mounted in a bearing supported in an adjacent portion of said housing, said metering pin having a central passageway extending inwardly from the outer end thereof and branching outwardly adjacent said bore for discharging lubricant into said bore, passageways formed in said housing and communicating with said central bore for supplying lubricant to said metering pin, said driven gear on said shaft being formed with a circular lubricant collecting channel located in the underside of the toothed portion thereof and facing radially inwardly, said toothed portion being formed with passages leading from said channel to said teeth, and means for directing lubricant thrown centrifugally outwardly from said bore in the end of said shaft to said lubricant collecting channel, said means comprising a disc-like lubricant baffle guide formed with a radially outwardly extending central base portion mounted on said housing adjacent the outer end of said bore in spaced relation thereto and an inwardly turned radially outwardly located wall portion projecting into said lubricant collecting channel for directing lubricant thereto.

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