April 2, 1957 S. M. UDALE 2,787,224

FUEL PUMP

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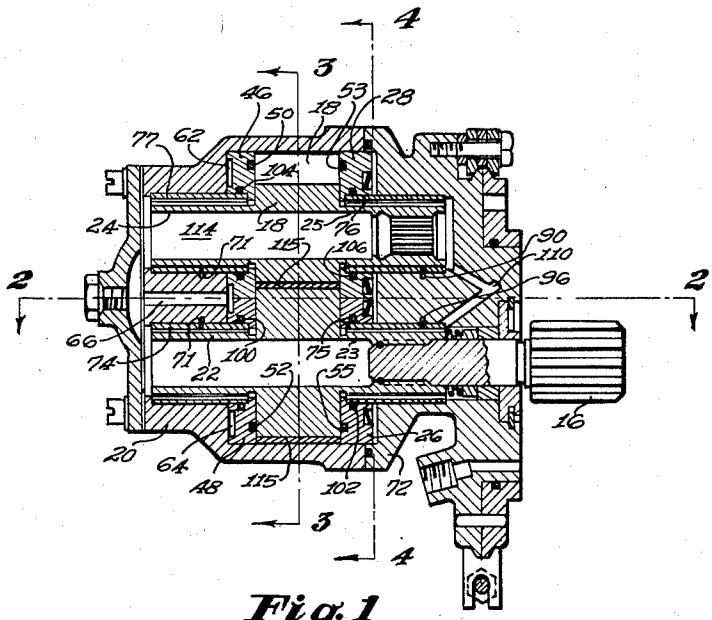


Fig. 1

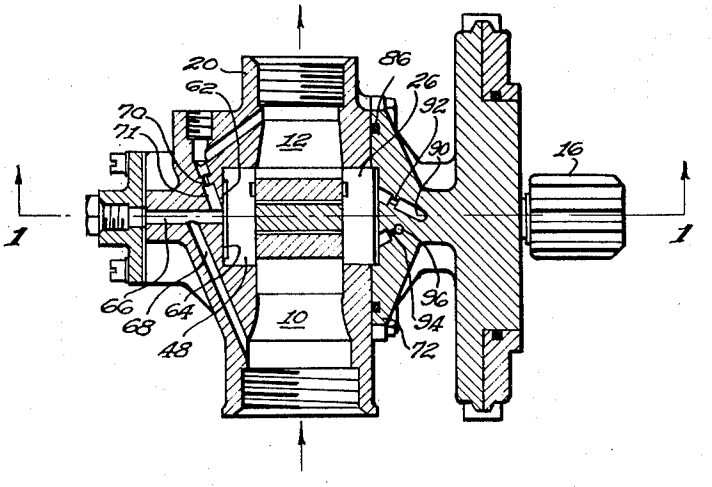


Fig. 2

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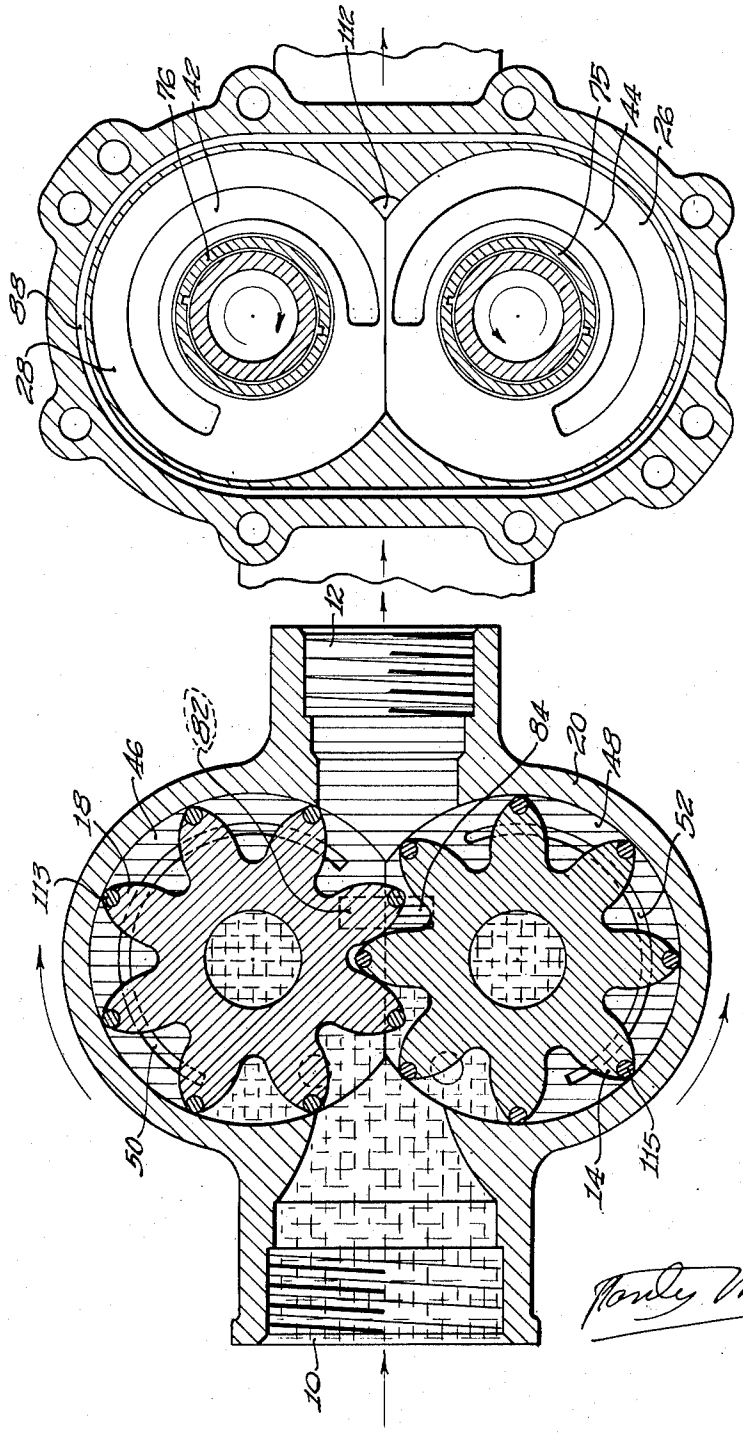


Fig. 4

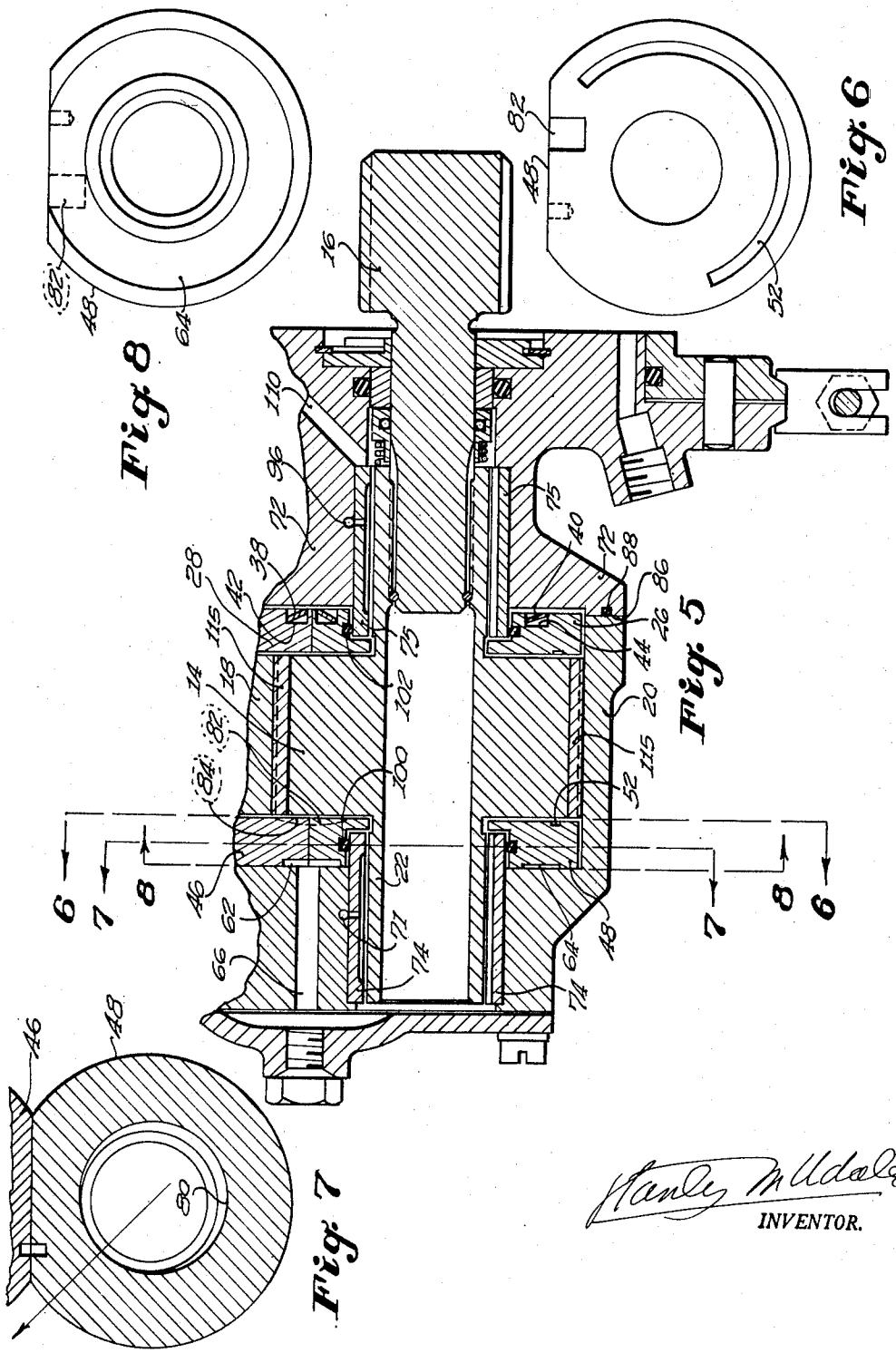
Fig. 5

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2,787,224

FUEL PUMP

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Application August 4, 1953, Serial No. 372,329

1 Claim. (Cl. 103—126)

The object of this invention is to generate high pressures from a gear pump without shortening its life too much.

The ordinary gear pump when generating high pressure (over 350 p. s. i.) has a tendency to shift slightly the centers of the gears within the limitations of the bearing clearances. Eventually, if these clearances are sufficient, the gears touch on the entrance side and the ends of the teeth will wear into the cylindrical walls of the pump housing. By providing freely rotating rollers at the very tips of the teeth, this wear can be reduced so as to give a commercially reasonable life to the pump.

Figure 1 shows a cross-sectional elevation of the pump taken on plane 1—1 of Figure 2.

Figure 2 shows a cross-sectional plan view of the pump taken on plane 2—2 of Figure 1.

Figure 3 shows a cross-sectional elevation of the pump taken on plane 3—3 of Figure 1.

Figure 4 shows a cross-sectional elevation of the pump taken on plane 4—4 of Figure 1.

Figure 5 is an enlarged view of the lower half of Figure 1.

Figure 6 is a view taken on plane 6—6 of Figure 5.

Figure 7 is a view taken on plane 7—7 of Figure 5.

Figure 8 is a view taken on plane 8—8 of Figure 5.

In the figures:

10 is the low pressure fuel entrance (see Fig. 3).

12 is the high pressure fuel exit. The driving gear 14, with integral support shafts, is driven by the splined shaft 16. 18 is the driven gear also with integral support shafts. 20 is the outboard pump housing provided with two overlapping cylindrical cavities into which fit the two gears 14 and 18 and the end plates 26, 28, 46 and 48. 72 is the inboard pump housing into which the inboard shaft from the gears 14 and 18 extend. This has two shallower overlapping cylindrical cavities of the same diameter as those in outboard pump 20 to provide means for dowelling the casing 20 to the casing 72. O section seal 86, in groove 88 (Fig. 4), prevents liquid from escaping between the faces of casings 20 and 72 when they are bolted together.

Four journal bearings 74, 75, 76 and 77 are fixed in the outboard and inboard pump housings 20 and 72 to receive the supporting shafts of the gears. These journals are separated from the four end seal plates 26, 28, 46 and 48. Outboard and inboard housings 20 and 72 are dowelled together so that the bores receiving journals 74, 75, 76 and 77 may be line bored after which journals 74, 75, 76 and 77 are shrunk or pressed into place with an interference fit of approximately 0.001 inch per inch of journal outside diameter. The journals 74, 75, 76 and 77 are provided with lubrication slots in a conventional manner. Metered high pressure fluid is transferred to the lubrication slots in journals 74 and 77 by means of lines 71 and restrictions 70. Line 90 and restriction 92; and line 96 and restriction 94 furnish metered high pressure fluid to the lubrication slots in journals 76 and 75.

In order to subject the inboard end seal plates 26—28 to the high pressure, a passage 112 (Fig. 4) is provided in the inboard casing 72. Through this passage high pressure is transmitted to the right hand side of the two inboard end seal plates 26—28 (Fig. 5). Low pressure is transmitted to the left hand side of the two outboard end plates 46—48 through the inclined passage 68 (Fig. 2), the central passage 66, through the opening 114 (Fig. 1) inside the gear 18. Low pressure is also transmitted to the inboard journals 75 and 76 through the inclined passage 110 (Figs. 1 and 5) which passage is connected to the passage 114. In Fig. 3 the broken square cross-hatching indicates low inlet pressure. The vertical lines represent the high pressure in the fuel outlet.

On the outboard end of the two overlapping cylindrical bores in the outboard housing 20 are the two outboard end seal plates having exactly the same thickness, 46 and 48. A narrow groove 52 (Figs. 3, 5 and 6) is located on the face of end seal plate 48 contacting the rotating end face of gear 14. A similar groove 50 is located on the similar face of end seal plate 46. These grooves extend from the pressure side of the pump around to within some whole multiple (usually one) of the angular tooth spacing from the pump inlet to establish definite areas of high and low pressure around the faces of the end seal plates 46 and 48 in contact with the gears as shown in Fig. 3. Similar grooves 53 and 55 in the end seal plates 26 and 28 are provided for similar purposes. The non-gear contact faces of end seal plates 46 and 48 have wider grooves 62 and 64 which are vented to inlet pressure through passages 66 and 68. Pressure relief ports 82 and 84 are provided on the faces of end seal plates 46 and 48 in contact with the gear end faces of 18 and 14 to allow the escape of fluid and prevent a pressure building up in the gear tooth intermesh region where the trapped fluid volume changes from a minimum to a maximum. These ports are located so that they are just being closed as the fluid trapped between the meshing gear teeth reaches a minimum volume.

In Figs. 6, 7 and 8 the outboard seal 48 is shown with an eccentric bore 80. Fig. 11, to effect a seal between the end seal plates 46 and 48 and the journal bearings 74 and 77 (Figs. 1 and 7), is given an angular loading in the direction of the arrow. The actual eccentricity is very small and Fig. 11 is distorted for illustrative reasons. The O rings 100 and 102 thus fit into the groove eccentrically provided in the plates 26 and 48. Similar eccentric grooves for similar O rings are provided in plates 28 and 46.

For one configuration, the outside diameter of the nitralloy gears 14 and 18 is 1.9995. The inside diameters of the aluminum housing 20 are 2.0005. The outside diameter of the gear shafts is .748 inch and the inside diameter of the copper lead journals 74, 75, 76 and 77 is .075 inch. The outside diameter of the copper lead end seal plates is 1.999 inches. These dimensions give clearances such that when the gear shafts move in their appropriate journals toward the inlet side of the pump, the rollers 113 and 115 on the tips of the gear tooth contacts the cylindrical bores in housing 20 on the pump inlet side and effect a seal. This gives a rough idea of the clearances tolerated if gasoline is to be pumped at 400 to 700 pounds per square inch without inside lubrication.

The four pressure end plates which act to seal the pump and are in two pairs; one pair 26 and 28 and the other pair 46 and 48, one of which (46 and 48) are shown in Fig. 7 forced together by the eccentricity of the two O rings 100 and 104 and by the resultant of these two O rings laterally to the left to seal the high pressure in the exit 12 leaking to the low pressure in the entrance 10 are the subject of a co-pending application, our Case

658, Serial No. 157,070, by Andrew Wm. Orr, Jr. for Fuel Pump and filed April 20, 1950, now Patent No. 2,682,836.

The novel feature in this application resides in the provision of the ground steel rollers **113** and **115** located in the tips of the teeth in the gears **14** and **18**.

Operation

Before the pump is started, the pumping elements are in definite positions. Springs **38** and **40** (Figs. 1 and 7) urge end seal plates **26** and **28** into contact with the inboard end faces of gears **14** and **18**. The outboard end faces of gears **14** and **18** are urged into contact with the inboard faces of end seal plates **46** and **48** which urges the non-gear contact or outboard faces of end seal plates **46** and **48** into sealing contact with the outboard vertical faces of the overlapping cylindrical bores in outboard pump housing **20**. The eccentrically cut grooves for O ring seals **100**, **102**, **104** and **106** position the end seal plate combination **46** and **48** and the end seal plate combination **26** and **28** so that they are urged toward each other and toward the inlet side of the pump. These measures effect a preliminary seal for fluid leakage from high to low pressure at all points except across the gear tooth tips and their rollers **113** and **115**.

Immediately after the pump starts, pressure built up in the exit **12** and the leakage across the gear end face back to entrance **10** is reduced by the end pressure of the inboard seal plates **26** and **28** against the sides of the two gears **14** and **18**. This pressure is transmitted against the two outboard seal plates **46** and **48**. The left side of outboard end plates **46** and **48** (Fig. 5) is maintained at the low pressure in the fuel entrance **10** as shown by the broken square cross-hatching (Fig. 3) which holds these against the vertical face of outboard housing **20**.

The areas of the four end plates **26**, **28**, **46** and **48** are subjected on their inner faces to the high pressure generated by the gear teeth displacing liquid. Four narrow grooves **50**, **52**, **53** and **55** (Fig. 3) equalize this pressure over the faces of the end plates.

Figure 3 also shows the hydraulic loads imposed upon the gears. When these are combined with the gear tooth loads the net load on the gears **14** and **18** is such as to force them toward each other and toward the inlet side of the pump. This effects a close seal between the rollers **113** and **115** on the gear tooth tips and the housing **20** and minimizes leakage.

What I claim is:

In a high pressure pump having a pair of intermeshing gears having formed teeth on one gear which roll over the similar teeth on the other gear, a housing for such gears, inlet and outlet passages, two supporting shafts for each gear and four bearings for said shafts projecting into the walls of said housing, individual rollers mounted into the outer tips of the ends of the teeth of said intermeshing gears, said rollers being quite small relative to the teeth so that the rollers on one gear never engage with the rollers on the other gear, said shafts being mounted in said bearings with sufficient clearance between to permit the rollers in the tips of the teeth on the gears to barely touch the walls of the housing proximate the inlet in response to the high outlet pressure created in the outlet passage by the interaction of the teeth of the gears reacting against the low inlet pressure, whereby the said gears are urged toward the inlet side of said housing.

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