March 6, 1962 A. DE FEZZY ET AL 3,023,706

GEAR PUMP AND RELIEF VALVE

Filed March 24, 1960 2 Sheets-Sheet 1

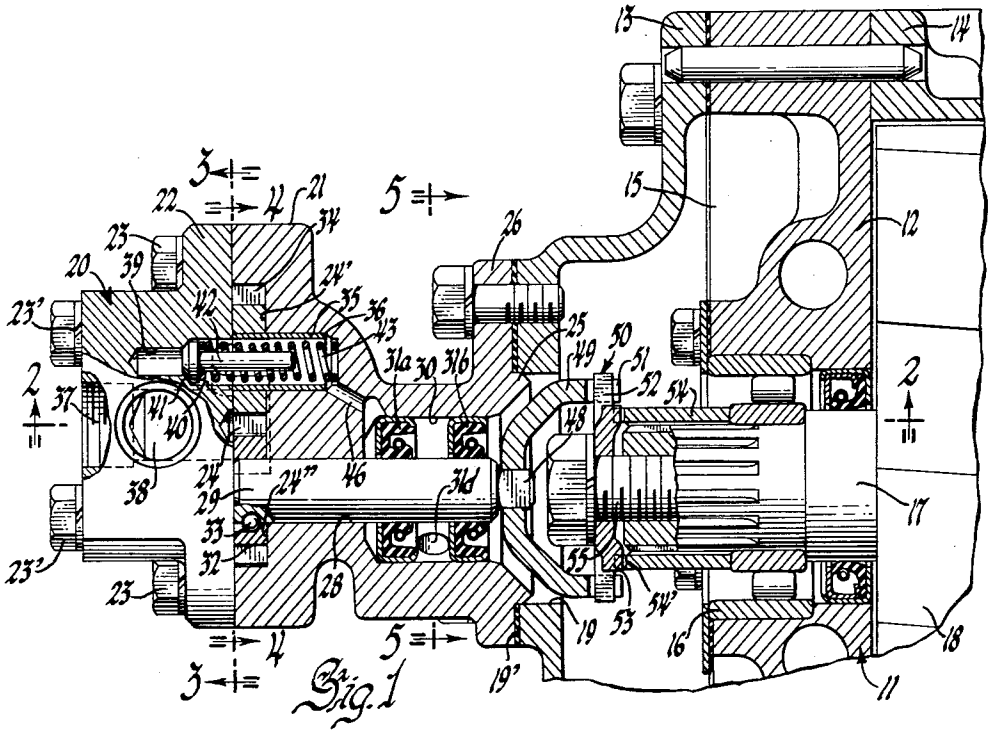

Fig. 1

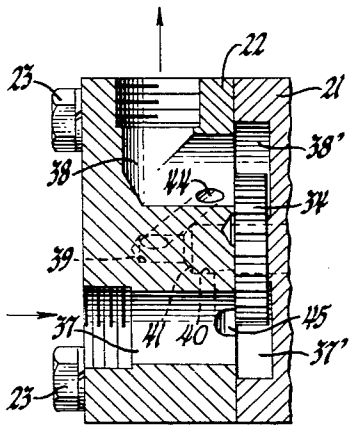

Fig. 2

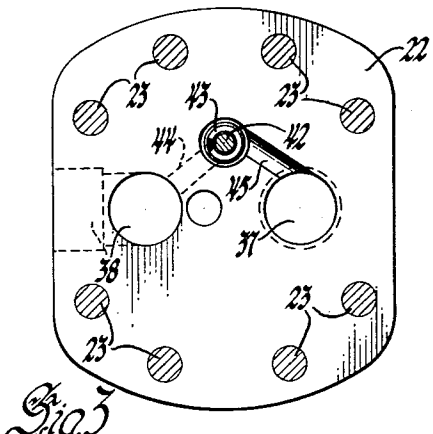

Fig. 3

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GEAR PUMP AND RELIEF VALVE

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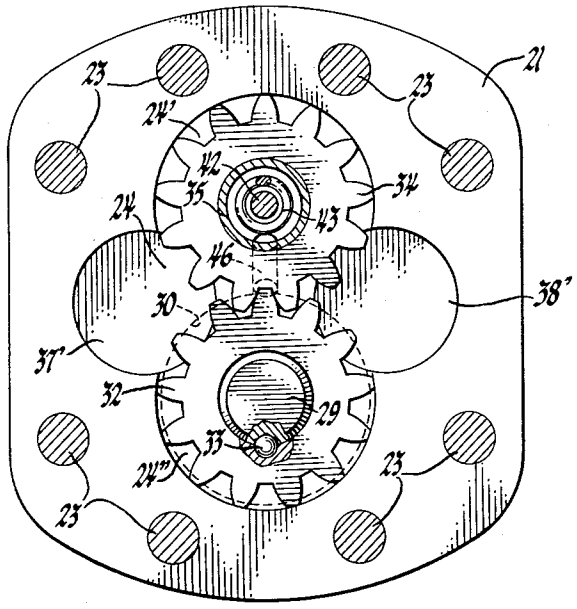

Fig. 4

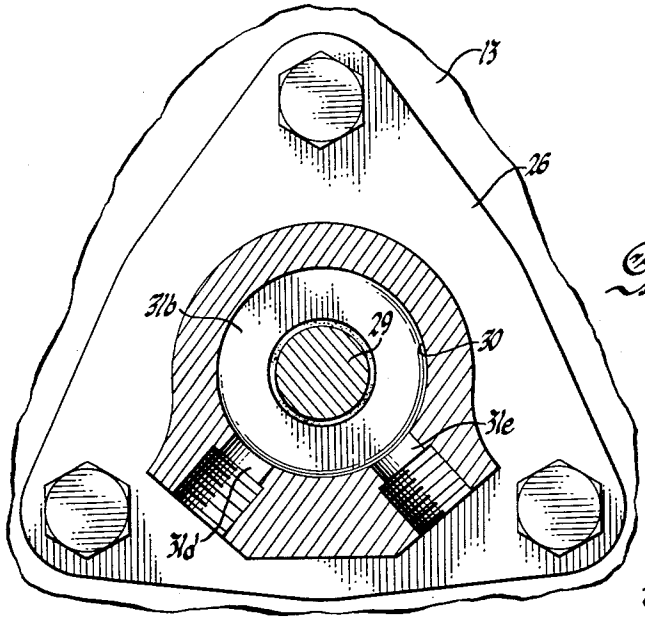

Fig. 5

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GEAR PUMP AND RELIEF VALVE

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This invention relates to a pump and more particularly to a gear-type pump for hydraulic fluids.

The invention contemplates a gear pump of relatively compact and inexpensive construction having an improved passage and gear mounting arrangement and an integral relief valve permitting the pump housing members to be precision cast as by die casting and used with a minimum of machining. In certain of its more specific aspects, the invention further contemplates a gear pump particularly adapted for use as a fuel circulating pump and capable of integration into a combined accessory drive mechanism including a positive displacement blower such as shown and described in copending United States patent application Serial No. 2,057, filed January 12, 1960, in the names of William R. Fox and Harvey G. Humphries and entitled "Combined Engine Accessory Drive and Housing Therefor."

The foregoing and other objects, advantages and features of the invention will be apparent from the following description of a preferred illustrative embodiment, reference being made therein to the accompanying drawings, in which:

FIGURE 1 shows a gear-type fuel pump which is constructed in accordance with the invention and mounted on and driven through a positive displacement blower, with portions of the gear pump and blower being broken away to show certain details of the pump construction and drive in longitudinal section;

FIGURE 2 is a fragmentary sectional view of the gear pump taken in the direction of the arrows and substantially in the plane of the line indicated at 2—2 of FIGURE 1;

FIGURE 3 is a sectional view taken in the direction of the arrows and substantially in the plane of the line indicated at 3—3 of FIGURE 1;

FIGURE 4 is a sectional view taken in the direction of the arrows and substantially in the plane of the line indicated at 4—4 of FIGURE 1; and

FIGURE 5 is a sectional view taken in the direction of the arrows and substantially in the plane of the line indicated at 5—5 of FIGURE 1.

Referring more particularly to the drawings, a fuel pump constructed in accordance with the invention is indicated generally at **20**. In the illustrative embodiment, the pump **20** is supported by and driven through a positive displacement blower, the housing of which is indicated by the reference numeral **11**. The blower housing includes an end plate member **12** which defines one end of the blower pumping chamber. The end plate **12** is secured between a cover member **13** and a second blower chamber defining member **14**. An oil receiving drive housing compartment **15** is defined between the end plate **12** and the cover member **13**. A bearing **16** is carried by the end plate **12** and rotatably supports a journal shaft **17** which is carried by the impeller **18** and projects into the compartment **15**. The blower end plate cover **13** is provided with a pump mounting bore or opening **19** which extends therethrough in substantial axial alignment with the impeller journal shaft **17**.

The housing of the pump **20** comprises a pump body member **21** and a cover member **22**. These housing members are secured together by suitable screws or bolts **23** and **23'** and define a pumping chamber **24** therebetween. The pumping chamber **24** is partially formed by two overlapping gear mounting counterbores **24'** and **24''** in the body member **21**. These gear mounting counterbores are overlapped by inlet and outlet chamber defining counterbores **37'** and **38'**. The end of the valve body member opposite the pumping chamber is provided with a pilot boss **25** and a mounting flange **26**. The pilot boss **25** is telescopically embraced by the opening **19** in the blower end plate cover member **13**, the flange **26** mating with and being secured by bolts **27** to a mounting face **19'** provided on the cover member **13** adjacent the opening **19**.

A bore **28** extends through the valve body member **21** and journals a shaft **29** in axial alignment with the impeller shaft **17**. A counterbore **30** is concentric of the bore **28** and spacedly embraces the portion of the shaft **29** adjacent the drive housing compartment **15**. Two seals **31***a* and **31***b* are spacedly mounted in the counterbore **30** and rotatively seal the drive end of the shaft. An impeller gear **32** is secured by a ball key **33** to the opposite end of the shaft **29** within the counterbore **24**. The impeller gear **32** drivingly meshes with a driven impeller gear **34**. The driven gear **34** is journaled on the projecting end of a stationary sleeve shaft **35** which is mounted in a bore **36** formed in the valve body in spaced parallel relation to the bore **28** and the drive shaft **29**.

The cover member **22** is provided with inlet and outlet ports or passages **37** and **38** which are connected to the inlet and outlet chambers **37'** and **38'**, respectively, of the pumping chamber **24** on opposite sides of the meshing engagement between the impeller gears **32** and **34**. Depending upon the installation requirements, these inlet and outlet passages may extend straight through the cover member as the inlet passage **37** shown or may be angled as the shown outlet passage **38**. The cover member **22** also has a bore and counterbore at **39** and **40**, respectively, which are in axial alignment with the sleeve shaft **35** and its mounting bore **36**. The stepped diameters of the bore **39** and the counterbore **40** provide a conical valve seating shoulder **41** extending therebetween. A poppet valve member **42** is mounted in and spacedly embraced by the chamber defined by the counterbore **40**, the sleeve shaft **35** and the closed end of the sleeve shaft mounting bore **36**. A spring **43** is compressively interposed between the end of the bore **36** and the head of the valve **42** and tends to bias the valve member into sealing engagement with the valve seat **41**. The bore **39** is connected by an obliquely extending passage **44** to the pressure discharge outlet passage **38** of the cover member **22**. This connection subjects the closed head of the valve **42** to the discharge pressure of the pump. The counterbore **40** behind the poppet valve and seating shoulder is connected to the fuel inlet chamber **37'** by a groove **45** opening on the pump chamber face of the cover member between the counterbore and the inlet passage **37**. The poppet valve **42** thus serves as a pressure relief or regulating by-pass valve interconnecting the pressure outlet of the pump with the fuel inlet chamber **37'** when the pressure in the outlet passage **38** has reached a desired operating level as determined by the preselected compressive loading of the valve spring **43**.

To prevent the build-up of fluid pressure on the shaft seal **31***a*, a drain passage **46** interconnects the space intermediate this seal and the closed end of the seal mounting counterbore **30** to the inlet or suction side of the pump through the by-pass valve mounting chamber and the by-pass groove **45** in the cover plate. Two drain ports **31***d* and **31***e* intersect the valve body member intermediate the seals **31***a* and **31***b*. Depending upon accessibility and the mounted position of the pump unit, one of these ports may be plugged. At least one of these ports, however,

and preferably the lower port may be connected to a suitable drain pipe, not shown. This seal and drain passage arrangement insures against leakage of fuel oil past the seal **31***b* and into the drive compartment **15** which would result in contamination of the engine lubricating oil. Any substantial flow of fuel through drain ports **31***d* or **31***e* and piping connected thereto signals the failure of the seal **31***a*. Similarly, any substantial flow of lubricating oil through these drain ports and piping signals any failure of the seal **31***a*.

The end of the shaft **29** projecting from the seal **31***b* is provided with a square spline at **48**. This spline provides a driving connection with the mating hub of a yolk member **49** of a universal drive connection **50** intermediate the fuel pump and the adjacent impeller journal shaft **17**. The arms of the yolked member drivingly engage radially extending slots **51** which are formed in a drive disc or plate **52**. The disc **52** is also provided with a plurality of stamped bosses **53** which are drivingly engaged by cooperating slots **54'** formed in the adjacent end of a drive sleeve member **54**. The sleeve member **54** is in turn drivingly splined to the impeller shaft **17** and is retained thereon by the disc **52** and a bolt **55** which passes therethrough and threadably engages the end of the shaft **17**. The drive connection **50** is thus adapted to accommodate limited lateral and angular misalignments occurring between the impeller shaft **17** and the pump drive shaft **29** as a result of manufacturing and assembly tolerances.

From the foregoing, it will be seen that the invention accomplishes the several objects and advantages stated above and provides a relatively simple, compact by-pass valve arrangement in the space normally occupied by the journalling of the driven impeller gear. This by-pass valve arrangement simplifies the fluid passages necessary in pump housing components and permits precision casting and use of such housing components with a minimum of cost increasing machining.

While the invention has been described with reference to a single illustrative embodiment, it will be appreciated that various changes and modifications might be made therefrom without departing from the spirit and scope of the invention, as defined in the following claims.

We claim:

1. A gear pump comprising a first body member having a first bore extending therethrough, a second bore therein extending in spaced parallel relation to said first bore and being closed at one end thereof, an end face opposite the closed end of said second bore and normal to the axes of said bores, two overlapping counterbores coaxial with said first and second bores and opening to said end face and defining the peripheral ends and one side of a pumping chamber, and having two shallow bores intersecting both of said counterbores on opposite sides thereof to define fluid inlet and outlet chambers; a second body member secured to said first body member and having an end face in mating relation with the end face of said first body member and closing said pumping chamber, said second body member having the first passage means therein for supplying fluid to said inlet chamber, a second passage means therein for discharging pressurized fluid from said discharge chamber, a bore and counterbore in alignment with the second bore of said first body member and defining an annular valve seating shoulder, a third passage means therein connecting the bore of said second body member with the discharge passage means therein, and a fluid passage defining groove therein opening to the pump chamber face thereof and extending between said first passage means and the counterbore of said second body member; a pump driving shaft rotatably mounted in the first bore of said first body member and projecting into said pumping chamber; an impeller gear drivingly secured to said driving shaft within said pumping chamber and having rotative fluid sealing clearances with the adjacent pump chamber defining surfaces; a sleeve telescopically and non-rotatably mounted in the second bore of said first body member, said sleeve projecting into said pumping chamber and cooperating with the counterbore of said second body member to define a valve mounting chamber; a second impeller gear journaled on the projecting end of said sleeve and having rotative sealing clearances with the adjacent pump chamber defining surfaces and fluid pumping gear tooth interengagement with said first impeller gear; a valve member mounted in said valve chamber and matable with said valve seating shoulder; and a valve spring compressively interposed between said valve member and the closed end of the second bore of said first body member, said spring being prestressed and of sufficient rate to maintain said valve member in seating engagement with the annular valve seat when the pump discharge pressure applied thereto through the discharge connected bore of the second body member is below a desired pressure level, said valve member being shiftable out of fluid sealing engagement when the fluid pressure applied thereto is above said desired level thereby providing fluid pressure venting communication between said inlet and discharge chambers.

2. A gear pump including a first body member comprising a pump housing portion at one end thereof, a hollow cylindrical flange portion extending from said housing portion and a mounting flange portion extending transversely of the cylindrical flange portion at the end thereof remote of said housing portion, said pump housing portion having a first bore extending therethrough in axial alignment with said cylindrical flange, a second bore therein extending in spaced parallel relation to said first bore and being closed at one end thereof, a passage connecting the closed end of said second bore to the interior of said cylindrical flange portion, an end face opposite the closed end of said second bore and normal to the axes of said bores, two overlapping counterbores coaxial with said first and second bores and opening to said end face and defining the peripheral ends and one side of a pumping chamber, and having two shallow bores intersecting both of said counterbores on opposite sides thereof to define fluid inlet and outlet chambers; a second body member secured to said first body member in mating relation with said end face and closing said pumping chamber, said second body member having a first passage therein mating with and connectable to supply fluid to said inlet chamber, a second passage therein mating with and connectable to discharge pressurized fluid from said discharge chamber, a bore and counterbore in alignment with the second bore of said first body member and defining a frusto-conical annular valve seating shoulder, a third passage means therein connecting the bore of said second body member with the discharge passage means therein, and having a groove therein opening to the pump chamber face thereof and extending to define a fluid passage between said first passage means and the counterbore of said second body member; a pump driving shaft journaled within the first bore of said first body member and projecting therefrom into said pumping chamber and axially of said flange portions; fluid sealing means interposed between said cylindrical flange portion and said shaft, in spaced relation to said housing portion, an impeller gear drivingly secured to said driving shaft within said pumping chamber and having rotative fluid sealing clearances with the adjacent pump chamber defining surfaces; a sleeve shaft telescopically and non-rotatably mounted in the second bore of said first body member in spaced relation to the closed end thereof, said sleeve shaft projecting into said pumping chamber and cooperating with the counterbore of said second body member to define a valve mounting chamber; a second impeller gear journaled on the projecting end of said sleeve shaft and having rotative sealing clearances with the adjacent pump chamber defining surfaces and fluid pumping gear tooth inter-engagement with said first impeller gear; a poppet valve member reciprocably mounted in said valve chamber and comprising a tapered head matable with said valve seating shoulder and

a stem extending longitudinally therefrom in spaced concentric relation to said valve mounting chamber, and a valve spring compressively interposed between said valve head and the closed end of the second bore of said first body member, said spring embracing said valve stem and being of a prestressed rate sufficient to maintain said valve head in fluid seating engagement with the annular valve seat when the pump discharge pressure applied thereto is below a desired pressure level, said valve member being shiftable out of fluid sealing engagement when the fluid pressure applied thereto is above said desired level thereby providing fluid communication between said inlet and discharge chambers.

3. A gear pump comprising two body members secured together and defining an oblate pumping chamber therebetween, one of said body members having a first bore extending therethrough from said pumping chamber, one of said body members having a second bore extending from said pumping chamber in spaced parallel relation to said first bore and being closed at its end opposite said pumping chamber and the other of said body members having a third bore and a counterbore therein defining an annular valve seating shoulder in alignment with said second bore, a sleeve telescopically and non-rotatably mounted in said second bore, said sleeve projecting into said pumping chamber and cooperating with the counterbore of said other member to define a valve mounting chamber, a first impeller gear journaled on said sleeve within said pumping chamber and having rotative fluid sealing clearances with the adjacent pump chamber defining surfaces, a pump driving shaft rotatably mounted in said first bore and projecting into said pumping chamber, a second impeller gear drivingly secured to said driving shaft within said pumping chamber and having rotative sealing clearances with the adjacent pump chamber

defining surfaces and fluid pumping gear tooth engagement with said first impeller gear, said gear tooth interengagement cooperating with and dividing the intermediate portions of said oblate pumping chamber to define a fluid inlet chamber and a fluid outlet chamber on opposite sides thereof, a first passage means defined by one of said body members and connectable to supply fluid to said inlet chamber, a second passage means defined by one of said body members and connectable to discharge pressurized fluid from said outlet chamber, a third passage means defined by said other body member and connecting said third bore with said outlet chamber, a fourth passage means defined by one of said body members and connecting said valve mounting chamber to said inlet chamber, a valve member mounted in said valve chamber and having a head thereon shiftable into fluid sealing engagement with said valve seating shoulder, and a valve spring compressively interposed between said valve head and the closed end of said second bore to maintain said valve head in fluid sealing engagement with the annular valve seating shoulder when the pump discharge pressure applied thereto through the third passage means is below a desired pressure level and said valve member being shiftable out of fluid sealing engagement when the fluid pressure applied thereto is above said desired level thereby venting the pumped fluid to said inlet chamber through said valve mounting chamber and said fourth passage means.

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