GEAR FUEL PUMP

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This application is a division of our parent application Serial No. 636,772, filed January 28, 1957.

The present invention relates generally to positive displacement and centrifugal pumps and more particularly relates to a mixed flow multiple pump wherein a centrifugal impeller and one or more gear pump units are combined in a single casing, a common driving means being provided for improved coupling means to insure uninterrupted operation of a maximum number of pump units despite failure of one of the pump units and further including improved bushing means for improving the operational characteristics of the pump.

It is an object of the present invention to provide a multiple pump with a safety coupling and driving mechanism having flangeless portions to prevent jamming or seizure of the entire pump in case of one of the pump units fails.

Another object of the present invention is to provide a multiple pump incorporating both positive displacement and centrifugal stages wherein the respective stages rotate at different speeds and wherein the speed-changing means are mounted in the casing independently of the pumping units.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings in which a preferred embodiment of a gear fuel pump incorporating the features of the present invention is shown by way of illustrative example.

On the drawings, the figure is a cross-sectional view with parts shown in elevation showing a gear fuel pump incorporating the features of the present invention.

As shown on the drawing:

The multiple pump of the present invention is indicated generally at 10 and comprises a casing 11 which has an end section 12 connected to the casing 11 by a plurality of fasteners 13. A cover member 14 is connected to the end section 12 by a plurality of fasteners 16.

At the opposite end of the casing 11, there is provided an end section 17 formed with an inlet 18. A bore 19 projects outwardly from the casing 11 and has formed therein passages 20 connected to pump discharge porting to the outlet of the pump.

The casing 11, together with the end sections 12 and 17, forms a pump housing for the multiple pump 10 in which is contained a first centrifugal pumping stage indicated generally at 21 in series with a positive-displacement pumping stage consisting of two gear pump units indicated generally at 22 and 23, respectively. Each of the gear pump units 22 and 23 is similar in structural and functional characteristics and like reference numerals will be applied in describing the components to clarify the understanding of the present invention.

Fluid at the inlet 18 is initially pressurized by the centrifugal stage 21 and is supplied for further pressurization to the positive-displacement stage 22, 23 for subsequent discharge through the outlet 20.

The cover member 14 is provided with usual seal and bearing assembly indicated generally at 24 thereby to support a rotatable driving member indicated at 26 and including a splined shaft portion 27 adapted to be connected to a source of power supply, for example, the accessory drive of an aircraft jet engine if the pump 10 is employed as the fuel pump for the jet engine fuel system.

The driving member 26 extends inwardly of the pump housing and has a thrust flange 28 formed thereon concentrically surrounding a bore 29 which is partially splined as at 30 to couple with the complementary splines formed on the end of a first shaft member formed as a tubular quill shaft and indicated at 31.

The driving member 26 is further provided with a generally cylindrical collar 32, the walls of which surround a bore 33 which is, in effect, a counterbore relative to the bore 29.

The bore 33 has formed in the walls thereof a splined portion indicated at 34 which forms a coupling for the external splines formed on a shaft extension 36 on a driver gear 37 of the gear pump unit 23 inwardly adjacent the driving member 26.

The collar 32 is provided with a first reduced shear neck 38 outwardly of the spline connection between the collar 32 and the shaft extension 36. By virtue of such provision, any abnormal force resulting from jamming or seizure of the gear pump unit 23 will effect torsional yielding of the reduced shear neck 38, thereby interrupting further operation of the gear pump unit 23.

The driver gear 37 is formed with a hollow bore 39 extending therethrough. Thus, the tubular quill shaft 31 extends inwardly through the bore 39 and has formed on the end thereof external splines 40 which mate with complementary internal splines formed in the bore 41 of a gear shaft extension 42 on the driver gear 43 of the gear pump unit 22.

The tubular quill shaft 31 is formed with a reduced shear neck 44 outwardly of the splined connection between the shaft 31 and the driver gear 43. Thus, if any abnormal force results from jamming or seizure of the gear pump unit 22, the shear neck 44 will yield torsionally to interrupt operation of the gear pump unit 22 without affecting or interrupting operation of the other pump components. It should also be noted in this regard that the shear neck 44 is so located as to be positioned substantially between the gear pump units 22 and 23. Thus, any broken pieces adhering to the shaft 31 will not interfere with the operation of the gear pump unit 23. Moreover, the shaft 31 enjoys a rather large clearance in the bore 39 except for complementary bearing portions shown at 46 in Figure 1 and located between the shaft 31 and the shaft extension 47 of the driver gear 37 closest to the driver gear 43 of the gear pump unit 22. Thus, if the coupling portion of the shaft 31 breaks off at the reduced shear neck 44, the shaft 31 is supported for rotation at the bearing portion 46.

The end section 17 of the pump housing has a bore 48 formed therein in which is received a bearing sleeve 49 for journaling a shaft portion 50 provided on gear 51.

The gear 51 forms part of a speed proportioning means comprising a gear train rotatable in a gear chamber 52 formed in the end of the casing 11. The gear 51 is further steadied in its rotation by an axial bearing ring 53 supported by a radially inwardly extending strut 54 carried by the end section 17 of the pump housing.

A bore extends through the gear 51 and its shaft portion 50 and is provided with splines 56 mating with a complementary plurality of external splines on the end of a second shaft member 57. The second shaft member extends through a hollow bore 58 formed in the driver gear 43 of the gear pump unit 22 and extends into a bore 59 formed in the tubular shaft member 31.
Radially inwardly of the bearing section 46, the shaft 31 is provided with internal splines and the shaft member 57 is provided with external splines as shown at 60, thereby to couple the shaft members 31 and 57 for rotation.

The end section 17 of the pump housing is formed with a volute pumping chamber 61 in which is rotated a centrifugal impeller 62. The impeller 62 is keyed as at 63 and locked as at 64 to a shaft member 66 journalized in a plate-type insert 67 fastened in the end section 17 of the pump housing and providing both radial and axial bearing surfaces. At the end of the shaft member 66, there is provided a gear 68 meshing with the gear 51.

For greatest efficiency, the centrifugal impeller 62 should be rotated at higher speed than the gear pump units 22 and 23. Accordingly, the gear 51 is much larger in diameter than the gear 68, thereby permitting the gear train to function as a speed-proportioning means within the gear case 52 and thereby permitting the centrifugal impeller 62 to rotate in unison with the gear pump units 22 and 23 but at a much greater rotational speed.

The shaft member 57 is formed with a third reduced shear neck 70 intermediate the spline connection of the shaft 31 and the spline connection of the shaft 57 with the gear 51. In this particular embodiment, it will be noted that the reduced shear neck 70 is located outwardly of the shear neck 44. By virtue of such provision, any abnormal force resulting from jamming or seizure of the centrifugal impeller 62 will cause the shear neck 70 to yield torsionally, thereby interrupting the further operation of the impeller 62 without interrupting the continued operation of the gear pump units 22 and 23.

It will be noted that each of the reduced shear necks including the shear neck 38, the shear neck 44 and the shear neck 70 is in register with the opening in the end of the pump closed by the cover member 14. Thus, separate parts can be conveniently replaced without requiring disassembly of the entire pump 10 since the broken parts can be conveniently removed from the pump merely by removing the cover member 14 at the end of the casing.

As shown on the drawings, a fixed or stationary bushing member 71 is provided for each of the gears of the gear pump unit 22 and a similar fixed bushing member 71 is provided for each of the gear members of the gear pump unit 21. A retainer ring 72 is attached to the casing 11 by a plurality of fasteners indicated at 73, thereby confining the gear pump units within the pumping cavities formed within the casing member 11 of the pump housing.

Each gear is further associated with a movable pressure-loaded bushing indicated generally at 73. For details of construction of the bushing members 71 and 73, reference can be advantageously made to our acknowledged parent application.

Although various minor structural modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

We claim as our invention:

1. A multiple pump having three longitudinally spaced coaxially aligned rotatable members including a driving member, a first driver gear inwardly adjacent thereto, and a second driver gear inwardly adjacent said first driver gear, respectively, a collar connecting said driving member and said first driver gear and having a first reduced shear neck formed therein outwardly of its connection to said first driver gear, a first shaft member connected to said second driver gear and extending outwardly through said driving member outwardly of said first shear neck, said first shaft member having a second reduced shear neck formed therein intermediate its connection to said driving member and said second driver gear, a fourth rotatable centrifugal impeller member inwardly adjacent said second driver gear, and means forming a coupling and driving connection between said driving member and said second driver gear, said fourth rotatable centrifugal impeller member including a second shaft member operatively connected to said centrifugal impeller member and extending outwardly through said second driver member to rotate said second shaft member outwardly of said second reduced shear neck, said second shaft member having a third reduced shear neck formed therein outwardly of said second reduced shear neck, said second shaft member having formed therein an inlet and an outlet volute pumping chamber for said centrifugal impeller member, a gear train driver having said shaft portion journaling said gear train driver in said casing section independently of said coupling and driving connection and gear train member corotatable with and carried by said centrifugal impeller member and said end casing section, said gear train driver meshing with said centrifugal impeller at a speed greater than said gear train gears, said second shaft member having a splined connection with said gear train driver to effect said operative connection with the centrifugal impeller.

2. A multiple pump comprising a casing having an opening at one end, a cover on said casing for said opening, at least three longitudinally spaced coaxially aligned rotatable members including a first driving member extending through said casing, a first driver gear inwardly adjacent said driving member and said second driver gear inwardly adjacent said first driver gear, respectively, a centrifugal impeller, a collar connecting said driving member and said first driver gear, said collar having a reduced shear neck formed therein outwardly of its connection to said first drive gear member providing a first frangible coupling, said drive gears having bores extending therefrom and a shaft connected to said second drive gear in the bore thereof extending outwardly through said bore of said first drive gear and being connected to said driving member outwardly of said first frangible coupling, said being coupled to said second drive gear, said centrifugal impeller being journalized in said casing inwardly of said second drive gear, said shaft having a second reduced shear neck formed therein outwardly of said second drive gear, and a second shaft member operatively connected to said centrifugal impeller and extending through said bore of said second drive gear for connection to said first mentioned shaft outwardly of said second reduced shear neck, said second shaft member having a third reduced shear neck formed therein intermediate the ends thereof, said shear necks yielding torsionally upon binding or seize of a corresponding driver gear or centrifugal impeller, said casing having an end casing section journaling said centrifugal impeller member and having formed therein an inlet and a volute pumping chamber for said centrifugal impeller member, a gear train driver having a shaft portion journaling said gear train driver in said end casing section independently of said driver gears, and a gear train driven member corotatable with and carried by said centrifugal impeller member in said end casing section, said gear train driven member meshing with said gear train driven member to rotate said centrifugal impeller at a speed greater than said driver gears, said second shaft member having a splined connection with said gear train driver to effect said operative connection with the centrifugal impeller.

3. A multiple pump comprising a casing having an opening at one end, a cover on said casing for said opening, an end casing section at the opposite end of said
casing, a first gear pump unit journaled in said casing adjacent said cover, a second gear pump unit journaled in said casing inwardly adjacent said first gear pump unit, reduction gear means journaled in said end casing section inwardly adjacent said second gear pump unit, driving means including shaft means for rotatably driving said gear pump units, coupling means comprising a shaft member separate from said shaft means and extending between said reduction gear means and said gear pump units to drive said pump units and said reduction gear means in unison, and a centrifugal impeller journaled in said end casing section and corotatably connected to said reduction gear means for unison rotation with said gear pump units but at an increased rotational speed, both said centrifugal impeller and said reduction gear means being mounted in said end casing section separate from said casing and supported on journals independently of the driving connections effected by said coupling means, and means for rotatably driving said gear pump units and including means forming shear neck connections in said separate shaft member and for said gear pump units to yield upon binding or seizure of a corresponding gear pump unit or centrifugal impeller.

4. A pump comprising a casing having an inlet and an outlet, said casing including a pumping chamber for a gear pump unit and an end section separate from the rest of said casing and forming a volute chamber at one end of said casing for a centrifugal pumping unit, a pair of intermeshing gears in said pumping chamber, a centrifugal impeller rotatable in said volute pumping chamber and journaled in said end section independently of the casing, duct means in said casing connecting said centrifugal and gear pumping units in series staging relation, thereby to move fluid from said inlet to said outlet, said gear pumping unit including a driver gear having a hollow bore extending therethrough, driving means for said pump including a first shaft member extending through said hollow bore of said driving gear towards said centrifugal pumping element and said one end of said casing, a bearing means in said end section at said one end of said casing, speed proportioning means including a gear means journaled in said bearing means in said end section at said one end of said casing independently of the gears and corotatable with said centrifugal impeller, and means comprising a second shaft member separate from said first shaft member coupling said gear means to said driving means whereby both of said pumping units will be driven in unison but at proportionally different speeds, said driving means including shear neck connections for each gear and centrifugal pumping unit to yield upon binding or seizure of a corresponding unit.

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