

July 23, 1957

L. L. ASPELIN
VARIABLE VOLUME PUMP

2,800,082

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2 Sheets-Sheet 1

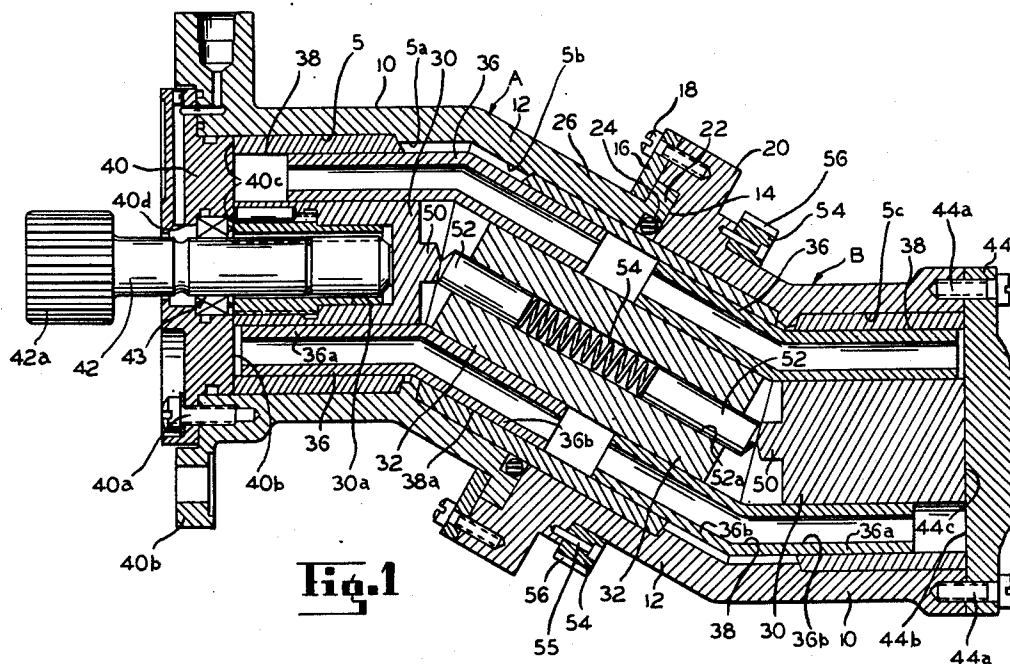


Fig. 1

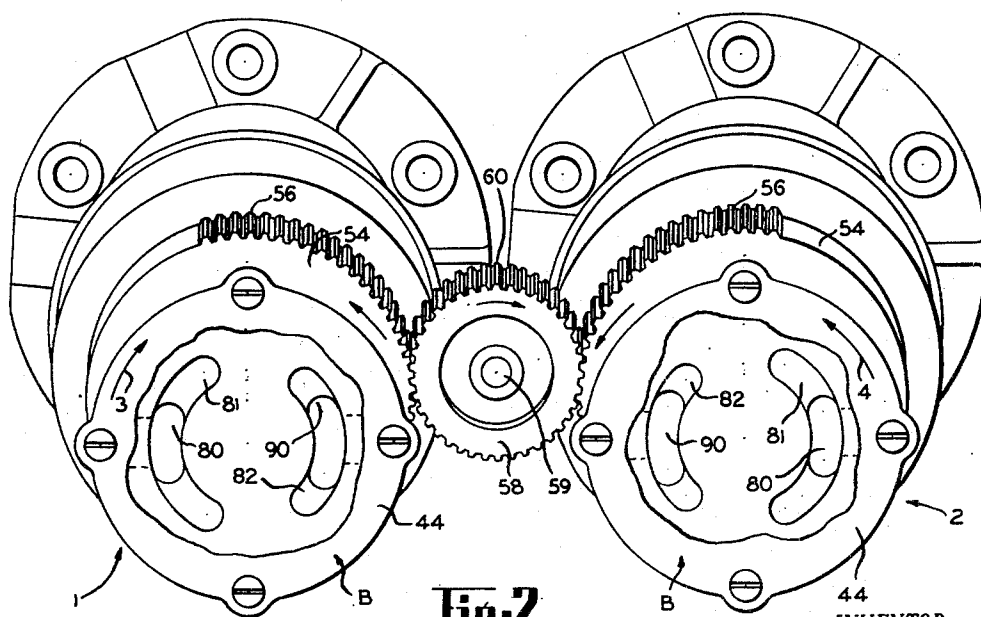


Fig. 2

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2 Sheets-Sheet 2

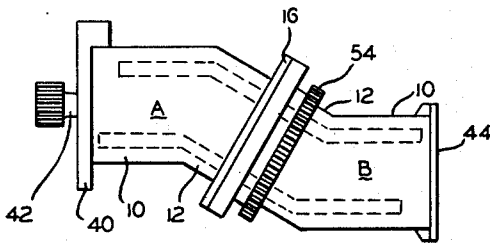


Fig. 3

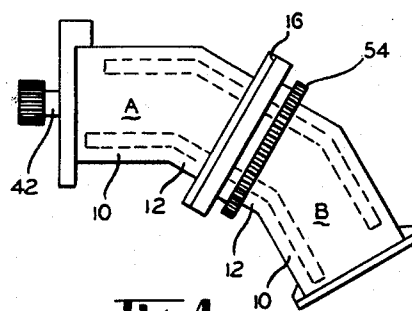


Fig. 4

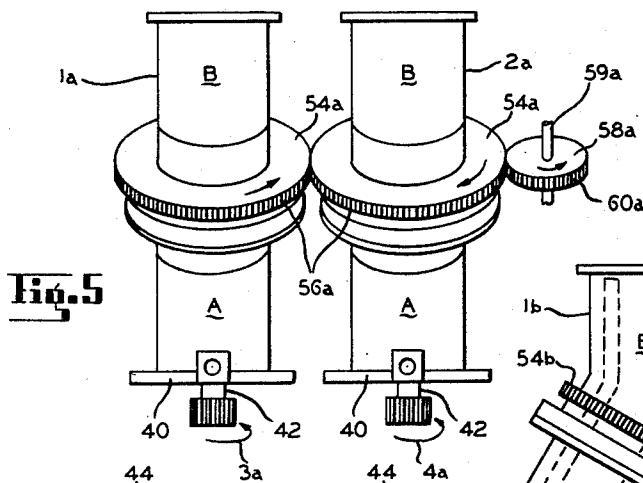


Fig. 5

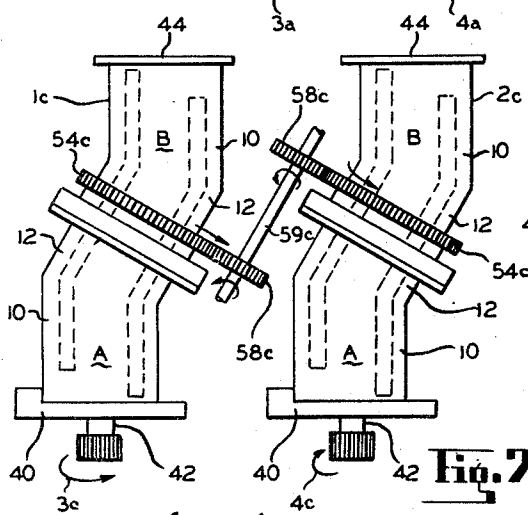


Fig. 6

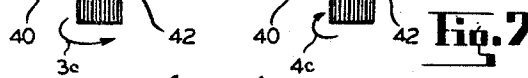


Fig. 7

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VARIABLE VOLUME PUMP

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17 Claims. (Cl. 103—37)

This invention relates generally to a hydraulic pump of the type including pairs of angularly offset rotors journaling reciprocable pistons or sleeve-like impellers and operated as a fuel pump in the fuel system of jet engines or other aircraft main propulsion means.

In the pumps of the type herein disclosed and heretofore provided, the displacement characteristics have been generally fixed for any given rated speed. According to the principles of the present invention, however, a hydraulic pump of the type including pairs of angularly offset rotors journaling reciprocable pistons or impellers includes means to selectively and variably adjust the volumetric discharge of the pump without changing the speed of rotation of the rotors.

It is an object of the present invention, therefore, to provide means for effecting variable delivery pumping operation by combining a plurality of pumping units and selectively changing the phase relation of the pumping cycles of related units.

Another object of the present invention is to provide a variable displacement means for a pumping apparatus of the type including pairs of angularly offset rotors journaling reciprocable impellers and including adjustably interrelating pumping units.

Yet another object of the present invention is to provide variable displacement for a pump of the type described by relative rotational adjustment of two associated pumping units coaxially mounted with respect to the center of rotation of adjacent rotor elements.

A further object of the present invention is to provide adjustment means whereby variable displacement adjustment may be effected with minimum effort.

A still further object of the present invention is to provide variable adjustment means for a multiple pump unit of the type herein described wherein rotational induced torques are automatically compensated.

Yet another object of the present invention is to provide a pumping apparatus embodying a plurality of variable displacement pumping units and means for effecting their joint adjustment whereby the effects of rotational torque induced by rotating elements of the pumps are substantially eliminated.

Many other objects, features and additional advantages 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 preferred structural embodiments illustrating the principles of the present invention are shown by way of illustrative example.

On the drawings:

Figure 1 is a longitudinal sectional view taken through a pump embodying the principles of my invention;

Figure 2 is an end elevational view of the pump of Figure 1;

Figures 3 and 4 are somewhat schematic longitudinal elevational views of the pump of Figure 1 with the parts being shown in a first position of adjustment providing minimum pumping capacity and in a second position of

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adjustment providing maximum pumping capacity, respectively;

Figure 5 is an elevational view showing a pump according to the present invention modified to include an alternative form of adjustment means;

Figures 6 and 7 are views similar to that of Figure 5 but showing alternative embodiments of adjustment means for the pump of the present invention.

As shown on the drawings:

The pumping apparatus of the present invention is of the type which includes at least a pair of angularly offset rotors journaling reciprocable impellers or pistons reciprocating upon rotation of the rotors to alternately produce a suction and a propulsion in the cylinder or bore of each rotor when the mouth of the cylinder or bore communicates with inlet and outlet portions of the pump, respectively.

In accordance with the general principles of the present invention, a pair of such pumping units are mounted in end-to-end or in line or tandem fashion with adjacent sections of the two casings being relatively coaxially disposed. The connection of the two casings is such that the two units are relatively rotatable about a common axis. The respective rotor elements of the two units are interconnected by a common rotor whereby both units are powered from a common source. Upon relatively rotating the two units, over all pumping displacement may be selectively varied, the two units being adjusted between a first position in which fluid displacements are additive and a second position in which the individual unit displacements tend to cancel one another out. In one form of the invention, two dual end-to-end pumping units are mounted for interrelated movement and are simultaneously regulated by common adjustment means. Thus, the induced rotational torque of each pumping unit is effectively cancelled out by the induced rotational torque of the other.

Referring now more particularly to the drawings, it will be noted that the pump of the present invention is indicated generally at P in Figure 1 and comprises a pair of casings sections A and B fastened together in adjustable end-to-end relation. Each casing section A and B comprises first and second cylindrical portions 10 and 12 disposed on angularly intersecting axes to provide respectively the housing for a dual pump unit of the type utilizing angularly offset rotors having angularly bent pistons or sleeves reciprocable therein. The adjacent portions 12 of the two casing sections A and B are coaxial and are relatively rotatable with respect to the plane of their mating surfaces indicated at 14. Such relative rotation is effected in the embodiment of Figure 1 by a retainer ring 16 secured by a plurality of screws 18 to an annular flange 20 of the casing section B and overlying an adjacent annular flange 22 of the casing section A. An O ring type sealing member 24 is carried in a recess 26 provided in the flange 22 to seal the mating surfaces of the casings A and B.

The casing sections A and B provide a housing which includes a cover member 44 fastened to the main body of the housing by a plurality of fasteners 44a. It will be understood that the cover member 44 be conveniently provided with appropriate mounting connections to facilitate connection of the pump to suitable conduits supplying fluid to an inlet 80 of the pump and carrying fluid from an outlet 90 of the pump, which inlet 80 and outlet 90 are formed in the cover member 44 in the usual manner as shown in Figure 2.

The opposite end of the housing provided by the casing sections A and B includes the closure member 40 which is held in firm assembly with the main body of the housing by a plurality of fasteners 40a. A flange 40b is also formed at the end of the casing section A to

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facilitate attachment of the pump P in a mounting assembly.

The cover members 40 and 44 also constitute end plate means for opposite ends of a bore 5 extending through the housing and including a first bore 5a, a second bore 5b and a third bore 5c. Each of the bores 5a, b and c is generally cylindrical in configuration. Moreover, the axes of the cylindrical bores 5a and 5c are angularly offset with respect to the axis of the bore 5b and are in intersecting relation with respect to one another so that there is formed in the interior of the housing two separate planes of intersection between the bores 5a and 5b and the bores 5b and 5c, respectively.

Within the bore 5a and within the bore 5c, there is provided a rotor 30 which is also cylindrical in configuration, being complementary in size and shape with respect to each respective bore 5a and 5b and journaled for rotation therein. The axis of the rotor 30 with respect to each corresponding bore is coincident with the axis of its associated bore. Radially outwardly of the axis of the rotors 30, 30 and circumferentially spaced with respect to one another are a plurality of axially extending cylinders or pumping chambers indicated at 38. The cylinders or pumping chambers 38 are formed by through openings extending through the rotors 30, 30.

Inwardly of the pumping chambers 26 in one of the rotors 30 (left hand side of Figure 1) and coincident with the axis thereof is an enlarged opening 30a in which is received a shaft member 42 having a splined connecting portion 42a extending outwardly of the pump housing for connection to a driving means. The shaft 40 is connected in driving assembly with the rotor 30 and is provided with additional journaling support by a bearing and seal assembly indicated at 43, surrounding the shaft 42 at the locale of the closure member 40.

In the bore 5b, there is provided a rotor 32 which is generally cylindrical in configuration being complementary in size and shape to the bore 5b and having its rotational axis coincident with the axis of the bore 5b.

The rotor 32 is also provided with a corresponding plurality of pumping chambers 38a similar in size and location to the pumping chambers 38 in the rotors 30, 30. A centrally disposed recess 52a is formed in the rotor 32 and houses a coil spring 54. At opposite ends of the coil spring 54, there is provided a loading pin 52 reciprocally slidable in the recess 52a. Each loading pin 52 reciprocates on the axis of the rotor 32 and has an action surface which engages an adjoining action surface formed on a pin portion 50 integral with each respective rotor 30, 30, also located on a corresponding axis of each respective rotor 30, 30. Thus, the continuous biasing force exerted by the coil spring 54 acts between the rotors 30, 30 and 32 and tending to retain the rotors in separated relation and loaded against the corresponding cover member 44 and 40.

In accordance with the usual arrangement in a pump of the type herein described, the cover member 44, for example, has an end plate surface indicated at 44b providing a land area which is intersected by a pair of circumferentially extending but spaced apart kidney-shaped ports constituting an inlet port and an outlet port shown in Figure 2 at 81 and 82.

The sealing surface 44b seals and engages against an adjoining end face 44c on the end of the adjoining rotor 30. The closure member 40 is likewise characterized by an end plate sealing surface indicated at 40b on which is formed a land area intersected by circumferentially spaced apart kidney-shaped ports including an inlet port and an outlet port. The adjoining rotor 30 has an end face 40c which seals and engages against the sealing surface 40b.

The closure member 40 also has a centrally disposed opening 40b to pass the shaft 42 and it will be further appreciated that both the closure member 40 and the

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cover member 44 may be suitably grooved to receive O ring seal members at various components of the pump P.

As will be evident from the drawings, the pumping chambers 38 in the rotors 30, 30 and the pumping chambers 38a in the rotor 32 are generally parallel with the corresponding axis of each rotor and each of the pumping chambers includes a mouth portion at the corresponding end face which communicates alternately with an adjoining inlet and outlet portion of the end plate sealing surfaces 40b and 44b as the respective rotors turn.

A piston or sleeve-like impeller 36 is provided for each respective pair of pumping chambers 38 and 38a in the rotors 30 and 32 and has angularly offset arm portions such as an arm portion 36a received in a corresponding pumping chamber 38 of one of the rotors 30, 30 and an arm portion 36b received in a corresponding pumping chamber 38a of the rotor 32. The angularly offset arms or arm portions 36a and 36b are journaled in the corresponding bores or pumping chambers 38 and 38a since the impeller and pumping chambers are complementary in size and shape to facilitate relative rotation and reciprocation between the parts.

It will be appreciated that the angle of offset of the arm portions 36a and 36b of each piston or sleeve-like impeller 36 corresponds to the angle of offset of the bores 38 and 38a and the axes of rotation of the rotors 30, 30 and 32. This angle offset can be varied anywhere between 90° and 180° in a pump of the type herein disclosed. Upon rotation of the shaft 42, the rotor 30 coupled thereto will rotate and the impellers 36 will effect a driving connection between that rotor 30 and the rotor 32 common to both of the end-to-end pumping units so that both of the rotors will rotate in unison. Moreover, the pistons or sleeve-like impellers 36 coupling the other end of the rotor 32 and the second rotor 30 will also insure unison rotation of all three impellers.

Upon rotation of the rotors 30, 30 and 32, the arm portions 36a and 36b of the impellers 36 will reciprocate in the corresponding pumping chambers 38 and 38a to alternately produce a suction and a propulsion in each respective bore when the mouth of the bore communicates with the inlet and outlet portions, respectively of the end plate means.

Each impeller 36 is preferably hollow and has an opening 36b extending therethrough to communicate the respective inlet ports and outlet ports at opposite ends of the pumping unit in the end plate means 40 and 44.

By virtue of the end-to-end relation of the two associated pumping units, variable displacement may be readily effected by angularly adjusting the two parts of the unit with respect to one another.

In this connection, it will be observed that the effective pumping chamber expansion of any particular pumping chamber extending the entire length of the pump occurs as the rotors 30, 30 and 32 rotate from a first position in which the pistons or sleeve-like impellers are disposed within the casing to provide a condition of minimum over-all length to a second position wherein the pumping chamber has a maximum over-all length and has an increased volumetric capacity. Thus, as the expansion in the effective volume chamber occurs, a suction stroke will be developed.

In the position of the pump components illustrated in Figure 1, it may be assumed that the lowermost piston 36 on the left-hand side is ready to begin a suction stroke whereas the lowermost piston 36 on the right-hand side is ready to begin a compression or propulsion stroke. Thus, as shown in Figure 1, the associated pairs of pistons 36, 36 have opposite pumping effects which tend to cancel one another out. The positioning of the components as illustrated in Figure 1 is similar to that of the components in Figure 3. In other words, the individual units at opposite ends of each pumping unit are, in effect, out of phase so that pumping displacement will be at a minimum.

In order to obtain maximum displacement, the individual units A and B are angularly adjusted to the position illustrated in Figure 4. In the position of Figure 4, the lowermost pistons 36 on both the left and the right-hand sides of pump P will be at the beginning of a suction stroke whereas both of the uppermost pistons 36 on the left and right-hand side of the pump P will be at the beginning of a compression or propulsion stroke. Thus, the combined effect of each related pair of pistons 36, 36 will be additive. In other words, the pumping effects of related pairs of pistons 36, 36 will be in phase.

The positioning of the parts as illustrated in Figure 4 represents a maximum pumping capacity position because the casing sections A and B are adjusted to a minimum angular relation. It will be manifest to those versed in the art, however, that the angular relation of the casing sections A and B may be infinitely varied between different positions between the minimum pumping position of Figure 3 and the maximum pumping position of Figure 4. Thus, by incrementally adjusting the relative alignment of the individual pump units the displacement characteristics of a single combined unit may be selectively adjusted.

In adjusting angularly the in line pumping units of a single combined structure, it will be understood that it is necessary to counteract induced rotational torque resulting from the simultaneous rotation of the rotors 30, 30 and the rotor 32.

It is contemplated according to the principles of the present invention, therefore, to place two double units in parallel with one another, the two double units being simultaneously adjusted by a common means of adjustment, thereby counteracting the induced rotational torque action. Since the parallel double units tend to balance out the torque, the adjustment can be made against a lesser force.

In the form of the invention illustrated in Figures 1 through 4, two dual unit pumps are arranged in side-by-side relation and are adjusted in unison by means of ring gears meshing with an intermediate pinion gear. For example, the casing section B has attached in firm assembly therewith a ring gear 54 having a plurality of circumferentially spaced teeth 56. Fastening means are indicated at 55 for attaching the ring gear 54 in firm assembly to the casing section B. The teeth 56 on each gear 54 need extend only slightly more than 180°, the maximum angular adjustment required to obtain any selective variation between minimum pump displacement and maximum pump displacement.

Interposed between the parallel units is a pinion gear 58 driven for angular adjustment by a pinion shaft 59 and having a plurality of peripheral gear teeth 60 meshing with the gear teeth 56 on the respective ring gears 54, 54.

It will be understood that the pinion shaft 59 can be rotatably driven by hand or by suitable power driven control means. Referring specifically to Figure 2, a pair of dual pump units is indicated in end elevation, the first dual pump unit being indicated at 1 and the second dual pump unit being indicated at 2. The rotors 30, 30 and 32 of the pump unit 1 are rotating in the direction of the arrow indicated at 3 while the rotors 30, 30 and 32 of the pump unit 2 are rotating in the direction of the arrow indicated at 4. Thus, the separate pump units 1 and 2 develop opposite rotational torques which tend to cancel one another out. Upon rotating the pinion gear 58 interposed between the ring gears 54, 54 in a clockwise direction as indicated by the arrow imposed on the pinion gear 58, the ring gear 54 on the pumping unit 1 will rotate in a counterclockwise direction as will the ring gear 54 on the pumping unit 2.

In the form of the invention illustrated in Figure 5, two pumping units 1a and 2a are again located in side-by-side relation with the bases of the pump units 1a and 2a

disposed in the same plane as in the embodiment of Figures 1 through 4. The ring gears are indicated at 54a on each of the pump units 1a and 2a and it will be noted that direct body engagement is effected through the ring gears 54a, 54a, a separate spur driving gear 58a mounted on a pinion shaft 59a being located to one side of the pumping unit 2a and having peripheral teeth 60a meshing with the corresponding peripheral teeth 56a on the adjoining ring gear 54a.

In the embodiment of Figure 5, it is contemplated that the rotating elements of the pumping units 1a and 2a are driven in a common rotational direction. Such direction is indicated by the arrows 3a and 4a. Assuming that the rotation of the pinion shaft 59a rotates the pinion gear 58a in a counterclockwise direction, however, it will be noted that the ring gear 54a on the pumping unit 2a will move in a clockwise direction and the gear ring 54 on the pumping unit 1a will move in a counterclockwise direction. Thus, the induced rotational torque will be effectively canceled out and angular adjustment of the respective pumping units can be effected with minimum resistance.

In the embodiment of Figure 6, the two pumping units are indicated at 1b and 2b and are disposed in in-line step-down relation with the bases or end planes of the pump units 1b and 2b offset. Ring gears 54b mesh with a spur gear 58b carried on a drive shaft 59b. In this embodiment, the pump unit 1b rotates in the direction of the arrow 3b while the pump unit 2b rotates in an opposite direction indicated by the arrow 4b. Because the spur gear 58b is interposed between the ring gears 54b, 54b, angular adjustment of the spur gear 58b upon rotation of the shaft 59b will rotate both of the ring gears 54b, 54b in a common angular direction. Thus, induced rotational torque is canceled out and adjustment of the pump units is effected with minimum resistance.

In the embodiment of Figure 7 a pair of dual unit in-line pumps are indicated at 1c and 2c respectively. The units 1c and 2c are in side-by-side relation with the bases of the pump units lying in the same plane, however, ring gears 54c are provided which are disposed in parallel spaced apart planes. A common drive shaft 59c carries a pair of spur gears 58c, 58c each meshing with a corresponding ring gear 54c.

In the arrangement of Figure 7, the rotating components including the rotors 30, 30 and 32 rotate in the direction of the arrow 3c and the rotatable components of the pump unit 2c rotate in the direction of the arrow 4c. Thus, the pump unit 1c rotates in opposite direction from the pump unit 2c, however, rotation of the drive shaft 59c results in adjustment of the ring gears 54c in a common direction.

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

I claim as my invention:

1. A sleeve pump comprising first and second pumps having a single common outlet and each including rotors disposed on angularly intersecting axes and having two sets of reciprocable angularly bent pistons slidably carried thereby and journaled therein, said pumps being disposed in end-to-end relation and having one of said rotors common to each pump, and means for selectively adjusting the angular alignment of said pumps between maximum and minimum pumping positions to selectively vary the volumetric displacement of the pump assembly at said outlet.

2. Pumping apparatus comprising a pair of dual pump units in side-by-side disposition, each said pumping unit comprising first and second pumps, each pump including rotors disposed on angularly intersecting axes and having

reciprocable angularly bent pistons slidably carried thereby and journaled therein, said pumps being disposed in end-to-end relation and having one of said rotors common to each pump, means for relatively angularly aligning said pumps between maximum and minimum pumping positions to selectively vary the volumetric displacement of each respective pump unit, and adjustment means to align both of said units simultaneously.

3. Pumping apparatus as defined in claim 2, said adjustment means comprising relatively movable casing means for each of said pump units including portions for said common rotor common to each respective pump, and driving means for moving said casing means including a ring gear fixed to the casing portions of one of said pumps of each of said dual pump units and an actuating shaft having a pinion gear thereon, said gears being in mesh with one another to adjustably align both of said units simultaneously upon rotation of said gears.

4. Pumping apparatus as defined in claim 3, said pinion gear being interposed between said ring gears and meshing therewith to adjust both of said pumping units in a common angular direction, the rotors of said dual pump units rotating in opposite directions to minimize induced rotational torque.

5. Pumping apparatus as defined in claim 3, both of said ring gears being in meshing relation with one another, said pinion gear being in mesh with only one of said ring gears to adjust said pumping units in different directions, said rotors of said dual pump units rotating in the same direction.

6. Pumping apparatus as defined in claim 3, said pumping units being disposed in side-by-side relation with the ends of said units offset in spaced generally parallel planes, said ring gears and said pinion gear being disposed in coplanar turning relation.

7. Pumping apparatus as defined in claim 6, said pinion gear being interposed between said ring gears and intermeshing therewith to adjust said pump units in a common direction, said rotors of said pumping units rotating in opposite directions.

8. Pumping apparatus as defined in claim 3, said ring gears being disposed in spaced apart generally parallel planes, said pinion gear including two separate pinion gear members on a common drive shaft and adjusting both of said ring gears simultaneously in a common direction, said rotors of said pump rotating in opposite directions.

9. A hydraulic pump, comprising a pair of relatively rotatable pumping structures each of a sleeve type having a rotor element means cooperable with angular piston sleeves operative to effect a pumping action including expansion and compression strokes, said pumping structures being disposed in end-to-end relation and operative upon relative rotational adjustment thereof to change the pumping phase relationship of pump actuation of the two pumping structures to thereby provide selective variations in overall pump displacement.

10. A hydraulic pump, comprising a pair of relatively rotatably connected casings each having angularly intersecting hollow cylindrical sections, rotor element means provided in each section of each said casing, said rotor element means being provided with longitudinally extending openings, means interconnecting associated openings of the rotor element means for effectuating a pumping action therein upon rotation of said rotor element means, the adjacent rotor element means of the two casings being operatively interconnected for joint rotation, means operatively interconnecting said two casings to interrelate their pumping delivery, said casings being relatively rotatable to provide selective variation in phase relation of the pumping cycle effected by each associated casing to provide variable displacement for said pump.

11. A hydraulic pump, comprising a pair of relatively rotatably connected casings each having angularly inter-

secting hollow cylindrical sections, rotor element means provided in the remote sections of the two casings and a common rotor element means being provided in the adjacent sections of the two casings, said rotor element means being provided with longitudinally extending openings, means interconnecting associated openings of the rotor element means for effectuating a pumping action therein upon rotation of said rotor element means, means operatively interconnecting said two casings to interrelate their pumping delivery, said casings being relatively rotatable to provide selective variation in the phase relation of the pumping cycle effected by each associated casing to provide variable displacement for said pump.

12. A hydraulic pump comprising an associated pair of variable displacement pumping units, each of said units comprising a pair of relatively rotatable pumping structures each of a type having a rotor element means operative to effect a pumping action including expansion and compression strokes, said pumping structures operative upon relative rotation thereof to change the pumping phase relationship of the two pumping structures of each pumping unit to thereby provide selective variations in overall pump displacement of each pumping unit, and means for effecting joint relative rotation of the pumping structures of the two pumping units to cancel induced rotational torque effected by rotation of said rotor element means in said pumping structures.

13. A hydraulic pump, comprising an associated pair of variable displacement pumping units, each of said units comprising a pair of relatively rotatably connected casings each having angularly intersecting hollow cylindrical sections, rotor element means provided in each section of each said casing, said rotor element means being provided with longitudinally extending openings, means interconnecting associated openings of the rotor element means of each pumping unit for effectuating a pumping action therein upon rotation of said rotor element means, the adjacent rotor element means of the two casings of each pumping unit being operatively interconnected for joint rotation, means operatively interconnecting said two casings of each pumping unit to interrelate their pumping delivery, said casings of each pumping unit being relatively rotatable to provide selective variation in the phase relation of the pumping cycle effected by each associated casing to provide variable displacement for each said pump unit, and means for effecting joint relative rotation of the casings of the two pumping units to cancel induced rotational torque effected by rotation of said rotor element means in said casings.

14. A hydraulic pump, comprising an associated pair of variable displacement pumping units, each of said units comprising a pair of relatively rotatably connected casings each having angularly intersecting hollow cylindrical sections, rotor element means provided in the remote sections of the two casings of each pumping unit and a common rotor element means being provided in the adjacent sections of the two casings of each pumping unit, said rotor element means being provided with longitudinally extending openings, means interconnecting associated openings of the rotor element means of each pumping unit for effectuating a pumping action therein upon rotation of said rotor element means, means operatively interconnecting said two casings of each pumping unit to interrelate their pumping delivery, said casings of each pumping unit being relatively rotatable to provide selective variation in the phase relation of the pumping cycle effected by each associated casing to provide variable displacement for each pumping unit, and means for effecting joint relative rotation of the casings of the two pumping units to cancel induced rotational torque.

15. A hydraulic pump, comprising a pair of relatively rotatably connected casings each having angularly intersecting hollow cylindrical sections, rotor element means

provided in each section of each said casing, said rotor element means being provided with longitudinally extending openings, means interconnecting associated openings of the rotor element means for effectuating a pumping action therein upon rotation of said rotor element means, the adjacent rotor element means of the two casings being operatively interconnected for joint rotation and having a longitudinal passageway, a pair of oppositely directed plungers carried in said passageway and biased outwardly by a coil spring carried therebetween, the plungers adapted to thrustingly engage the non-adjacent rotor element means to bias the same outwardly, means operatively interconnecting said two casings to interrelate their pumping delivery, said casings being relatively rotatable to provide selective variation in the phase relation of the pumping cycle effected by each associated casing to provide variable displacement for said pump.

16. A hydraulic pump, comprising a pair of relatively rotatably connected casings each having angularly intersecting hollow cylindrical sections, rotor element means provided in each section of each said casing, said rotor element means being provided with longitudinally extending openings, means interconnecting associated openings of the rotor element means for effectuating a pumping action therein upon rotation of said rotor element means, the adjacent rotor element means of the two casings being

operatively interconnected for joint rotation, driveable means carried by one casing concentric with the axis about which said casings relatively rotate, and means for drivingly engaging said driveable means for effecting relative rotation of the casings.

17. A hydraulic pump, comprising a pair of relatively rotatably connected casings each having angularly intersecting hollow cylindrical sections, rotor element means provided in each section of each said casing, said rotor element means being provided with longitudinally extending openings, means interconnecting associated openings of the rotor element means for effectuating a pumping action therein upon rotation of said rotor element means, the adjacent rotor element means of the two casings being operatively interconnected for joint rotation, gear teeth carried by one casing concentric with the axis about which said casings relatively rotate, and means for drivingly engaging said gear teeth for effecting relative rotation of the casings.

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