Oct. 22, 1940. N. E. BRIGHAM 2,219,126

VARIABLE CAPACITY CONSTANT SPEED RECIPROCATING PUMP

Filed July 1, 1939 4 Sheets-Sheet 1

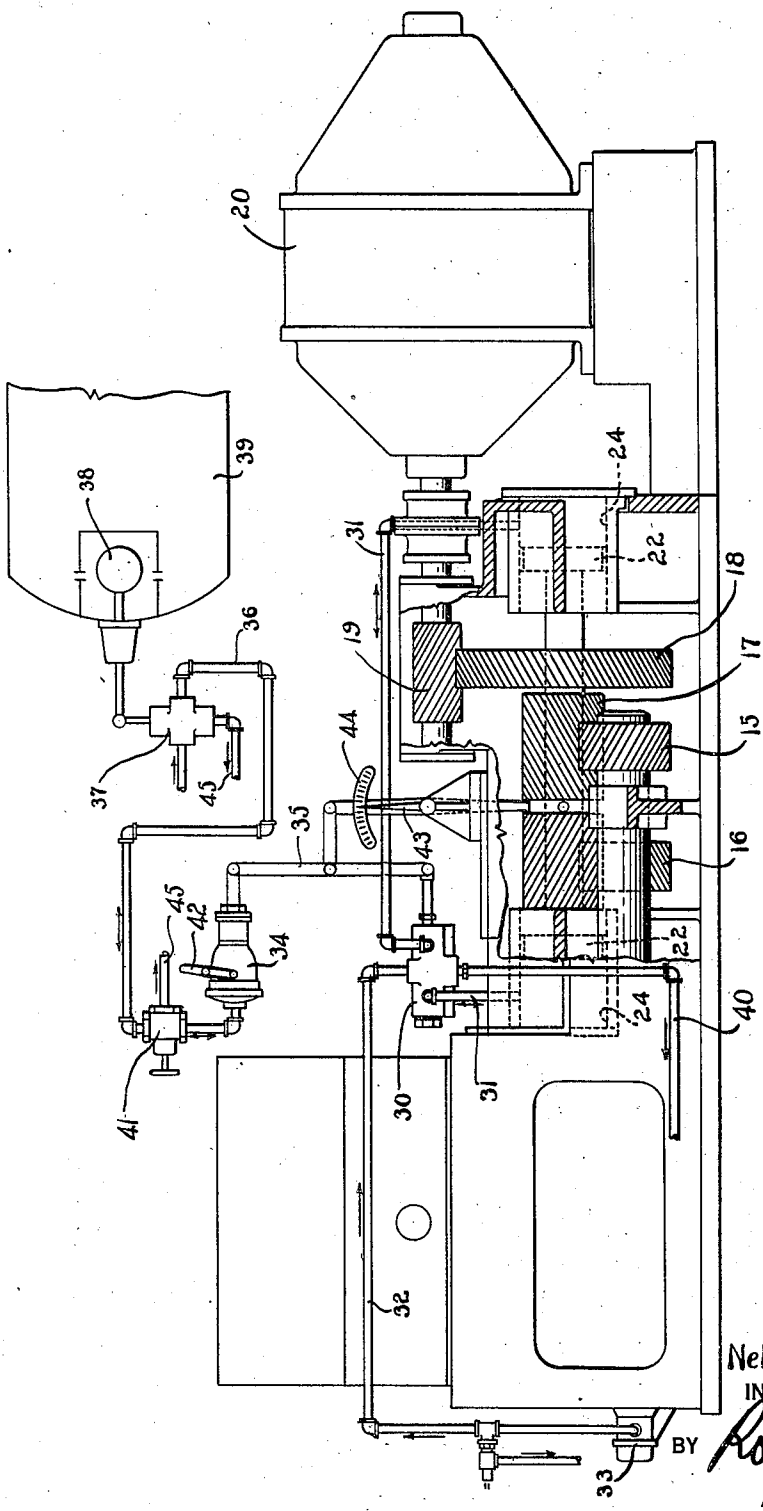


Fig. 1

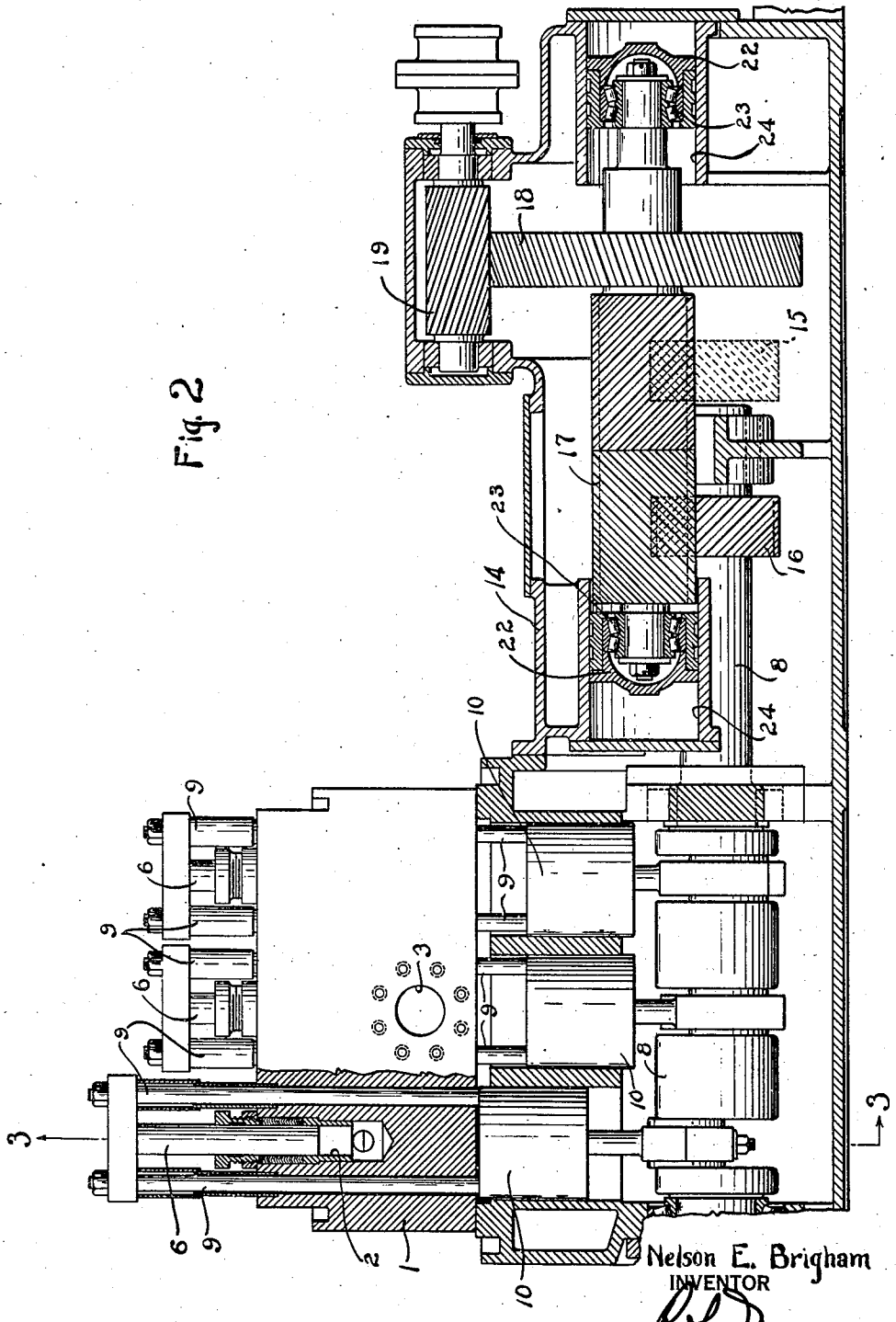
Nelson E. Brigham
INVENTOR
BY
ATTORNEY

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VARIABLE CAPACITY CONSTANT SPEED RECIPROCATING PUMP

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Fig. 2



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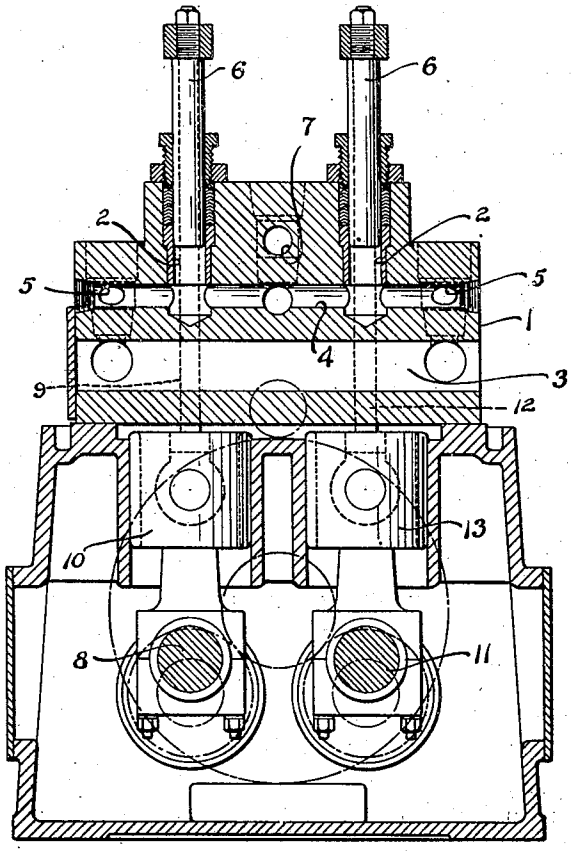
BY Robert Meyer
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VARIABLE CAPACITY CONSTANT SPEED RECIPROCATING PUMP

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Fig. 3



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VARIABLE CAPACITY CONSTANT SPEED RECIPROCATING PUMP

Filed July 1, 1939 4 Sheets-Sheet 4

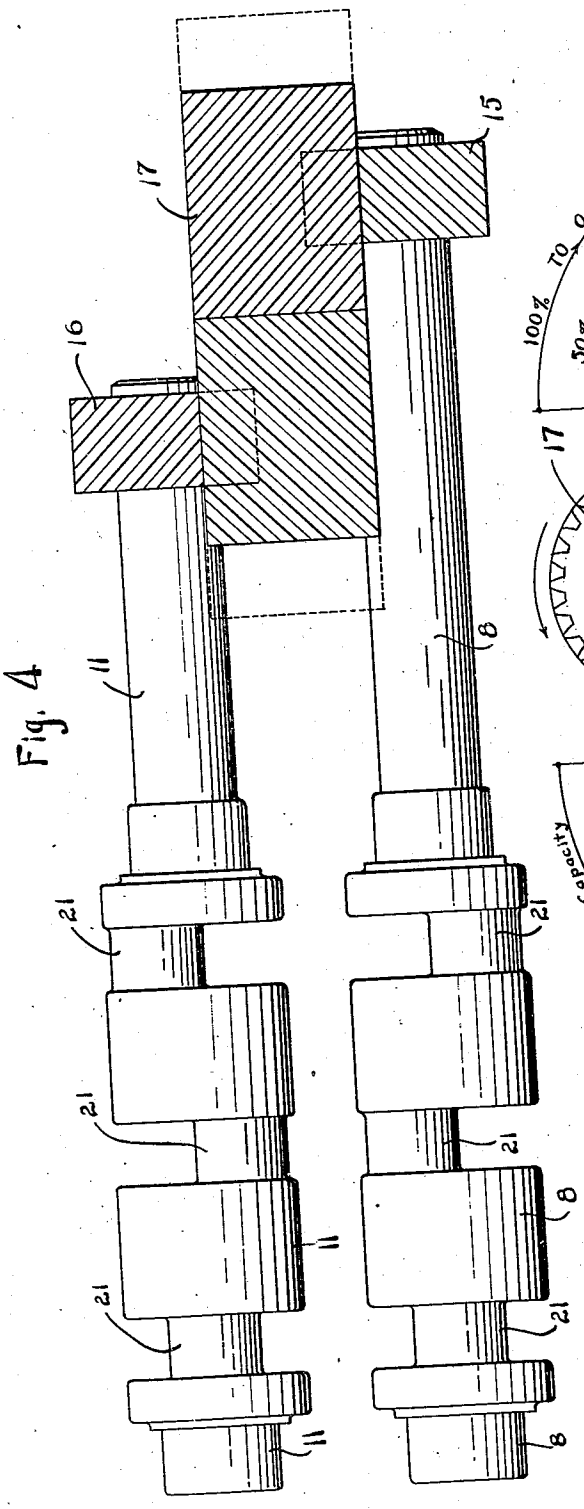


Fig. 4

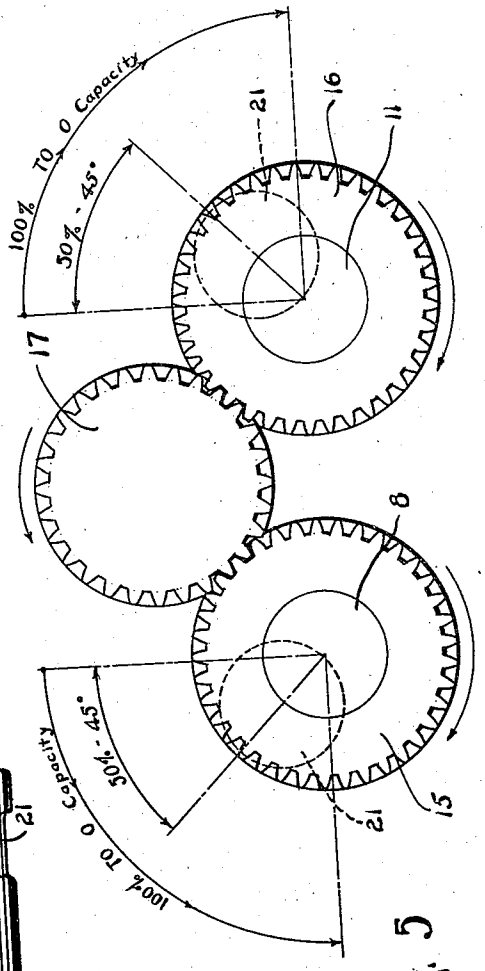


Fig. 5

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UNITED STATES PATENT OFFICE

2,219,126

VARIABLE CAPACITY CONSTANT SPEED RECIPROCATING PUMP

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Application July 1, 1939, Serial No. 282,347

11 Claims. (Cl. 103—37)

This invention relates to reciprocating pumps and more particularly to a variable capacity constant speed pump for high pressure service.

With the present tendency toward high pressure power plants in marine service, the operating conditions require a constant speed power pump in which the capacity may be varied from maximum to zero to meet the requirements for boiler feed water.

An object of the present invention is to provide a reciprocating pump capable of developing a high pressure, operating at a constant speed, which embodies means whereby the capacity of the pump may be varied at will from the maximum capacity the pump is capable of developing to zero capacity without varying the speed of operation of the pump and without varying the length of the stroke of the plungers or pistons of the pump.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing a variable capacity constant speed reciprocating pump of the preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a side elevation of the variable capacity constant speed reciprocating pump constructed in accordance with the present invention showing the control system for the pump diagrammatically and having parts of the pump casing broken away.

Figure 2 is a longitudinal section through the pump, showing part of its cylinders in side elevation.

Figure 3 is a vertical cross-section through the pump taken on the line 3—3 of Figure 2.

Figure 4 is a fragmentary top plan of the pump showing the crank shaft arrangement and means for varying the phase relation of operation of the pump plungers or pistons.

Figure 5 is a diagrammatic end view of the crank shaft and piston phase relation changing means.

Referring more particularly to the drawings, the pump proper comprises the cylinder block 1, provided with a plurality of cylinders 2 arranged in longitudinally extending sets, the cylinders of one set being arranged parallel to the corresponding cylinders of the other set, thereby forming pairs of cylinders corresponding to the number of cylinders in each set. The pump shown in the drawings is a six cylinder pump having three cylinders in each set. However, any desired or required number of cylinders, arranged in pairs, may be provided without departing from the spirit of the present invention. That is, a pump comprising only two cylinders, arranged in a pair, falls within the scope of the present invention, since the variation in the discharge capacity of the pump depends upon the phase relation of operation of the cylinders in each pair.

The cylinder block 1 has an inlet chamber 3 formed therein which has communication with the surge chamber 4 through valved ports 5, which valves are set to open during the suction strokes of the plungers or pistons 6 of the pump, while the discharge from the pump cylinder block 1 is through the discharge port or ports 7, which are likewise valve controlled in the usual manner. The valves which control the suction and discharge ports of the pump may be of any approved type of valve suitable for reciprocating pumps.

The plungers or pistons 6 of each set of plungers are connected to a single crank shaft. That is, the plungers 6 of the set of cylinders and plungers shown at the left-hand side of Figure 3 of the drawings are connected to the crank shaft 8 by suitable connecting rods 9 and cross heads 10, while the plungers or pistons 6 in the set of cylinders at the right-hand side of Figure 3 of the drawings are connected to a crank shaft 11 by suitable connecting rods 12 and cross heads 13.

The crank shafts 8 and 11 are disposed in parallel relation to each other and project into the housing extension 14 of the pump casing. The crank shaft 8 has a helical toothed pinion 15 on its outer end, while the crank shaft 11 has a helical toothed pinion 16 on its outer end. As clearly shown in Figures 2 and 4 of the drawings, the pinions 15 and 16 mesh with a herringbone pinion 17, one on each side of the transverse center of the herringbone pinion 17.

The pinion 14 has a helical gear 18 connected therewith which in turn meshes with a long helical pinion 19. The pinion 19 is directly connected to the prime mover 20, which is shown in Figure 1 of the drawings as an electric motor, but of course any suitable type of prime mover may be provided without departing from the spirit of the present invention.

The herringbone pinion 17 is carried by the housing 14 for longitudinal movement therein and consequently sliding movement relative to

the gears 15 and 16. Owing to the helical teeth of the gears 15 and 16 and the pinion 17, longitudinal movement of the pinion 17 will cause rotation of the crank shafts 8 and 11 and consequently variances in the relation of the cranks 21 of the two crank shafts. That is, longitudinal movement of the herringbone pinion 17 will change the phase relation of operation of the plungers in the pairs with equal or the same changes in all of the cranks 21 on each crank shaft. Thus by various degrees of longitudinal movement of the herringbone pinion 17 the relationship of the cranks 21 on the crankshafts 8 and 11 may be changed through 180°, that is, 90° on each side. Consequently the two plungers oppose each other in the cylinder. Namely the two plungers of each pair may be made to work together, under which condition maximum discharge capacity of the pump is provided, or to work opposite, at 180°, in which case no water will be pumped and the pump will operate at zero capacity, or at any point between such two maximum points of adjustment to vary the discharge capacity of the pump as desired, without any change in the length of the strokes of the plungers or pistons 6. Zero capacity is provided with the pump plungers operating opposite to each other, because the plungers in each pair have a common surge chamber 4, and the suction stroke of one plunger will coincide with the discharge stroke of the other plunger in the pair, resulting merely in the pumping of the liquid back and forth between the cylinders of each pair.

The herringbone pinion 17 is shown in the drawings as shifted or moved to vary the phase sequence of operation of the pairs of plungers by pressure actuated means, including pistons 22 connected to the pinion 17 through the medium of roller bearings 23, so as to allow the pinion to rotate independently of the pistons 22, while it moves longitudinally with the pistons. The pistons 22 are reciprocated in suitable cylinders 24.

Any suitable approved means may be provided for controlling the reciprocation of the pistons 22 in the cylinders 24. However, Figure 1 of the drawings shows both a manual and automatic control whereby the capacity of the pump may be regulated by the shifting of the pinion 17 under control of the demand on the pump.

In Figure 1 of the drawings a four-way valve 30 of any approved construction has connection through the pipes 31 with the cylinders 24 and with a suitable supply of pressure fluid through the pipe 32. In Figure 1 of the drawings the pressure fluid utilized is lubricating oil, which is circulated under pressure by a suitable pump 33 but pressure fluid from any suitable source may be utilized for operating the pistons 22 without departing from the spirit of the present invention.

The four-way valve 30 is of the reciprocating plunger valve type and is operated from a spring diaphragm automatic governor valve 34, of any approved construction, through the medium of a lever 35. The governor valve 34 is in turn pressure actuated, preferably by air pressure from any suitable source, which is delivered to the governor valve through the pipe 36. The pipe 36 has a three-way valve 37 of any approved construction therein which in turn is operated by a float valve 38 in the boiler or other point of discharge of the fluid pumped by the pump structure. Thus, when the liquid level in the boiler 39 falls below a predetermined level the float valve 38 will actuate the three-way valve 37, permitting pressure fluid to pass to the governor valve 34 and actuate the governor valve, for in turn actuating the four-way valve 30 to admit pressure fluid into one of the cylinders 24 to move the pinion 17 for increasing the capacity of the pump. When the level of liquid in the boiler 39 reaches the level set for normal capacity of operation of the pump, it causes operation of the governor valve 34 to in turn operate the four-way valve 30 to shift the pinion 17 to bring the pump to normal capacity. However, if the demand for liquid pumped decreases, the float valve 38 will actuate the three-way valve 37 controlling the delivery of pressure fluid to the governor valve so as to cause the governor valve to operate the four-way valve 30 in an opposite direction, resulting in the delivery of pressure fluid to the opposed or opposite cylinder 24, causing a shifting of the pinion to reduce the discharge capacity of the pump. The governor valve 34 and the three-way valve 37 are of such nature that the variations in the demand for liquid pumped between the maximum and minimum discharge capacities of the pump will result in operation of the governor valve 34 to control the four-way valve 30 in its movement to cause movement of the herringbone pinion 17 proportionate to the demand for regulating the discharge capacity of the pump to the direct demand.

The four-way valve 30 is also constructed so that when it is delivering pressure fluid to one of the cylinders 24 the other cylinder will be connected through the valve 30 and the outlet or discharge line 40 to the source of supply of the pressure fluid.

The construction shown in Figure 1 also provides for dual manual control of the discharge capacity of the pump by providing for manual control of the operation of the governor valve 34 through the medium of a hand-operated three-way valve 41 interposed in the line 36. Also the governor valve 34 has a hand control lever 42 associated therewith by means of which this diaphragm type governor valve may be manually operated to manually operate the four-way valve 30 and consequently control the capacity of the pump manually.

An indicator pointer 43 is shown connected to the pinion 17 and cooperates with a graduated scale 44 for indicating the position of the sliding or movable herringbone pinion 17 and consequently indicating the capacity at which the pump is operating.

Both the three-way valves 37 and 31 have exhaust pipes or lines 45 connected thereto to permit the exhausting of the pressure fluid from the control valve 34.

In the foregoing description the slideable pinion has been described and it is shown in the drawings as a herringbone pinion. However it is to be understood that if it is desirable two separate helical pinions having their teeth cut at opposite angles may be substituted for the single herringbone pinion without departing from the spirit of the present invention. That is, the pinion 17 may be cut on its longitudinal center line to form two pinions rather than one.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In a variable capacity constant speed reciprocating pump, in combination, a pair of pistons, a crank shaft for each of said pistons, a prime mover for driving said crank shafts, means connecting said prime mover and crank shafts whereby the phase relation of the cranks of the crank shafts may be changed for varying the discharge capacity of the pump, pressure operated means for operating said phase changing means, means controlled by the load demand on the pump for controlling operation of said pressure operated means and manually operable means for disconnecting said pressure operating means from said load demand control means and connecting it to a source of pressure supply to provide manual control of the phase changing means.

2. In a variable capacity constant speed reciprocating pump, in combination, a pair of pistons, a crank shaft for each of said pistons, a prime mover for driving said crank shafts, a helical gear on each of said crank shafts, the helical teeth on one gear being cut oppositely to the teeth on the other gear, a herringbone pinion meshing with said gears, means connecting said prime mover to said herringbone pinion for driving the crank shafts from the prime mover, and means for longitudinally shifting said herringbone pinion for changing the phase relation of said crank shafts.

3. In a variable capacity constant speed reciprocating pump, in combination, a pair of pistons, a crank shaft for each of said pistons, a prime mover for driving said crank shafts, a helical gear on each of said crank shafts, the helical teeth on one gear being cut oppositely to the teeth on the other gear, a herringbone pinion meshing with said gears, means connecting said prime mover to said herringbone pinion for driving the crank shafts from the prime mover, pressure actuated means for longitudinally shifting said herringbone pinion for changing the phase relation of said crank shafts, and means controlled by the load demand on the pump for controlling operation of said pressure actuated means.

4. In a variable capacity constant speed reciprocating pump, in combination, a pair of pistons, a crank shaft for each of said pistons, a prime mover for driving said crank shafts, a helical gear on each of said crank shafts, the helical teeth on one gear being cut oppositely to the teeth on the other gear, a herringbone pinion meshing with said gears, means connecting said prime mover to said herringbone pinion for driving the crank shafts from the prime mover, pressure actuated means for longitudinally shifting said herringbone pinion for changing the phase relation of said crank shafts, means controlled by the load demand on the pump for controlling operation of said pressure actuated means, and manually operable means operable independently of said load demand controlled means for controlling operation of said pressure actuated means.

5. In a variable capacity constant speed reciprocating pump, a plurality of pistons and cylinders arranged in sets, a crank shaft for all of the pistons in each set, the pistons in one set being arranged to form cooperating pairs with the corresponding piston in the other set, the cylinders in each pair being provided with a common surge chamber forming a common intake and discharge passage for the pairs of cylinders, a prime mover for driving said crank shafts, a helical gear on each of said crank shafts, the helical teeth on one gear being cut oppositely to the teeth on the other gear, a herringbone pinion meshing with said gears, said herringbone pinion being mounted for longitudinal movement relative to said helical gears, means for longitudinally shifting said herringbone pinion for changing the phase relation of said crank shafts and means connecting said prime mover to said herringbone pinion for driving the crank shafts from the prime mover.

6. In a variable capacity constant speed reciprocating pump, a plurality of pistons and cylinders arranged in sets, a crank shaft for all of the pistons in each set, the pistons in one set being arranged to form cooperating pairs with the corresponding piston in the other set, the cylinders in each pair being provided with a common surge chamber forming a common intake and discharge passage for the pairs of cylinders, a prime mover for driving said crank shafts, a helical gear on each of said crank shafts, the helical teeth on one gear being cut oppositely to the teeth on the other gear, a herringbone pinion meshing with said gears, means connecting said prime mover to said herringbone pinion for driving the crank shafts from the prime mover, and pressure actuated means connected to said herringbone pinion for longitudinally shifting the pinion for changing the phase relation of said crank shafts.

7. In a variable capacity constant speed reciprocating pump, a plurality of pistons and cylinders arranged in sets, a crank shaft for all of the pistons in each set, the pistons in one set being arranged to form cooperating pairs with the corresponding piston in the other set, the cylinders in each pair being provided with a common surge chamber forming a common intake and discharge passage for the pairs of cylinders, a prime mover for driving said crank shafts, a helical gear on each of said crank shafts, the helical teeth on one gear being cut oppositely to the teeth on the other gear, a herringbone pinion meshing with said gears, means connecting said prime mover to said herringbone pinion for driving the crank shafts from the prime mover, pressure actuated means connected to said herringbone pinion for longitudinally shifting the pinion for changing the phase relation of said crank shafts, and means controlled by the load demand on the pump for controlling operation of said pressure actuated means.

8. In a variable capacity constant speed reciprocating pump, in combination, a pair of pistons, a crank shaft for each of said pistons, a prime mover for driving said crank shafts, a gear on each of said crank shafts, a pinion meshing with said gears, means connecting said prime mover to said pinion for driving the crank shafts from the prime mover, pressure actuated means for longitudinally shifting said pinion for changing the phase relation of said crank shafts, and means controlled by the load demand on the pump for controlling operation of said pressure actuated means.

9. In a variable capacity constant speed reciprocating pump, in combination, a pair of pistons, a crank shaft for each of said pistons, a prime mover for driving said crank shafts, a gear on each of said crank shafts, a pinion meshing with said gears, an elongated pinion connected to said prime mover, a gear meshing with said elongated pinion and connected in driving connection with

said first named pinion for driving the crank shafts from the prime mover, and pressure actuated means for longitudinally shifting said first named pinion for changing the phase relation of said crank shafts.

10. In a variable capacity constant speed reciprocating pump, a plurality of pistons and cylinders arranged in sets, a crank shaft for all of the pistons in each set, the pistons in one set being arranged to form cooperating pairs with the corresponding piston in the other set, the cylinders in each pair being provided with a common surge chamber forming a common intake and discharge passage for the pairs of cylinders, a prime mover for driving said crank shafts, a gear on each of said crank shafts, a shiftable pinion meshing with said gears, means connecting said prime mover to said shiftable pinion for driving the crank shafts from the prime mover, and pressure actuated means connected to said shiftable pinion for longitudinally shifting the pinion for changing the phase relation of the crank shafts.

11. In a variable capacity constant speed reciprocating pump, a plurality of pistons and cylinders arranged in sets, a crank shaft for all of the pistons in each set, the pistons in one set being arranged to form cooperating pairs with the corresponding piston in the other set, the cylinders in each pair being provided with a common surge chamber forming a common intake and discharge passage for the pairs of cylinders, a prime mover for driving said crank shafts, a gear on each of said crank shafts, a shiftable pinion meshing with said gears, an elongated pinion connected to said prime mover, a gear meshing with said elongated pinion and connected in driving connection with said shiftable pinion and movable therewith for driving the crank shafts from the prime mover, pressure actuated means connected to said shiftable pinion for longitudinally shifting the pinion for changing the phase relation of said crank shafts, and selective means to provide manual or automatic control of the delivery of pressure fluid to said pressure actuated means.

NELSON E. BRIGHAM.