March 6, 1951 F. E. STAATS 2,544,055

VARIABLE THROW CRANKSHAFT PISTON TYPE RADIAL PUMP

Filed Dec. 11, 1946 6 Sheets-Sheet 1

Fig. 1

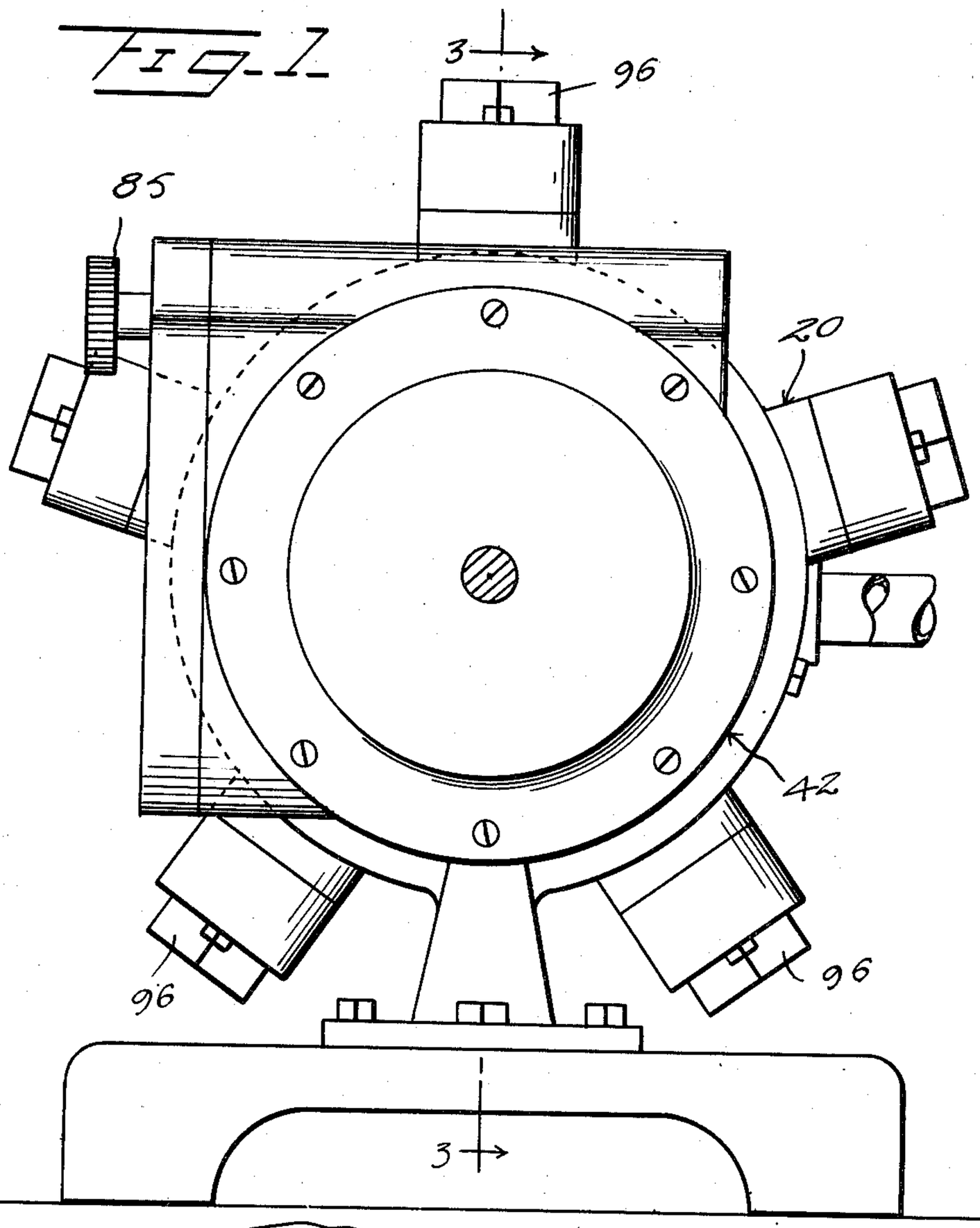
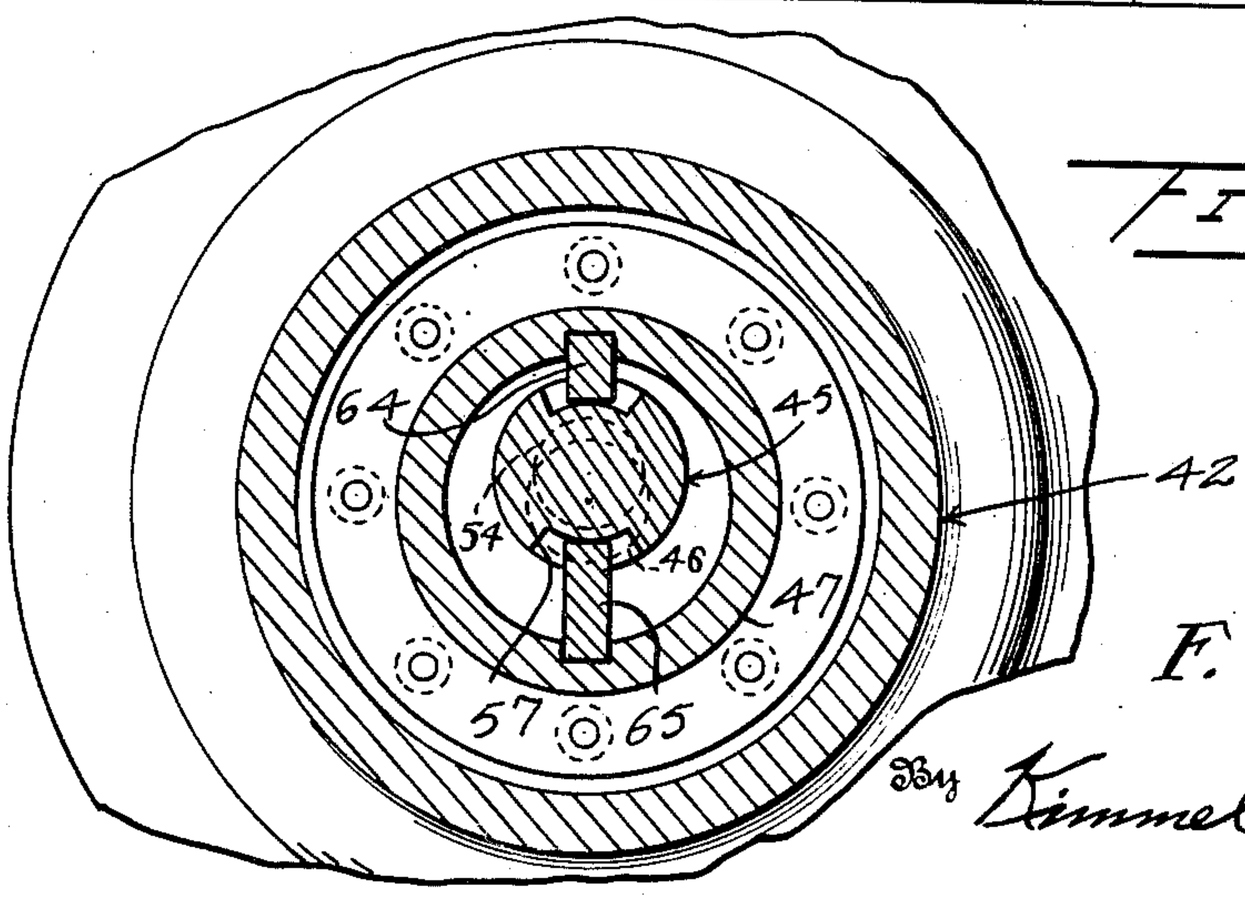


Fig. 6



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VARIABLE THROW CRANKSHAFT PISTON TYPE RADIAL PUMP

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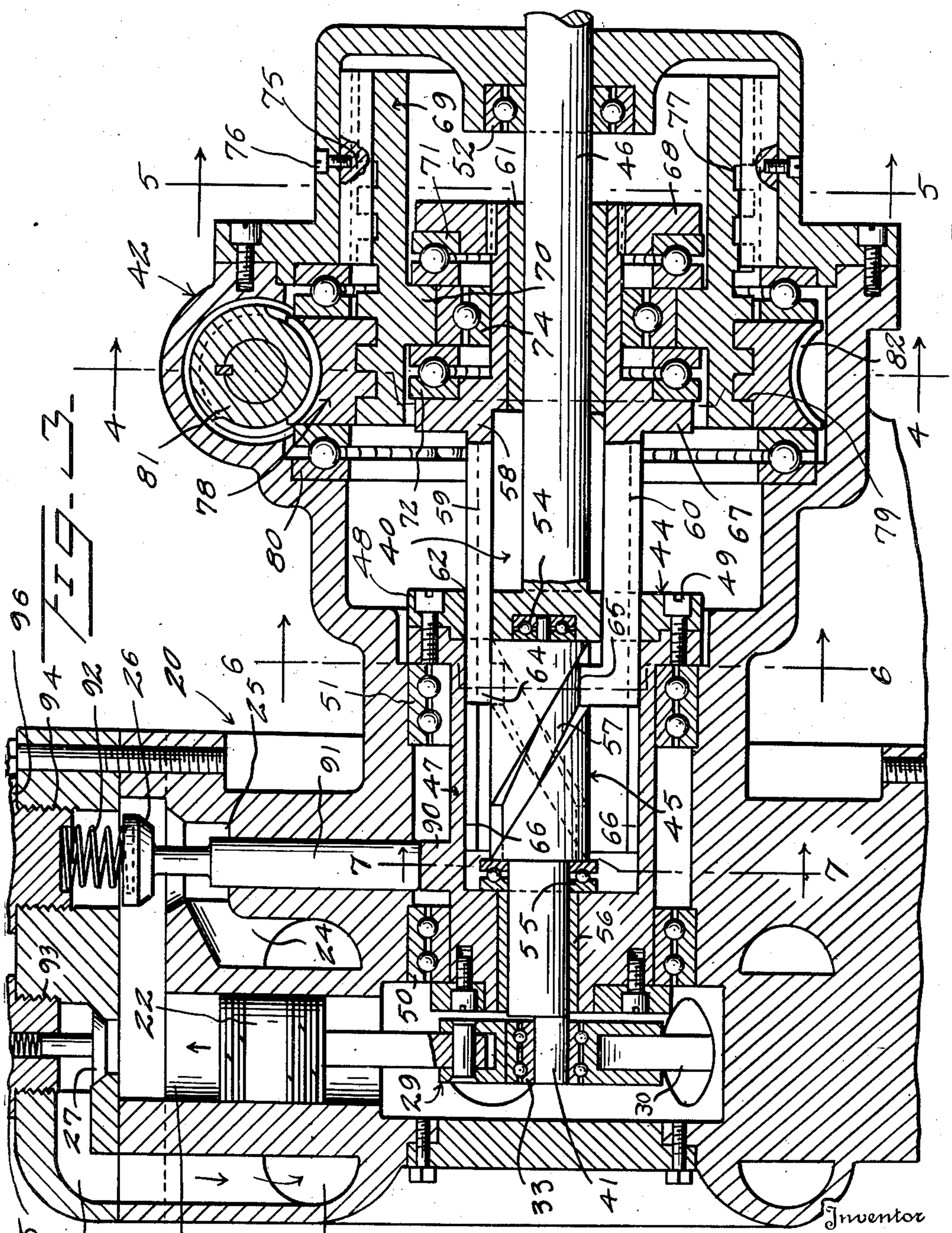

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VARIABLE THROW CRANKSHAFT PISTON TYPE RADIAL PUMP

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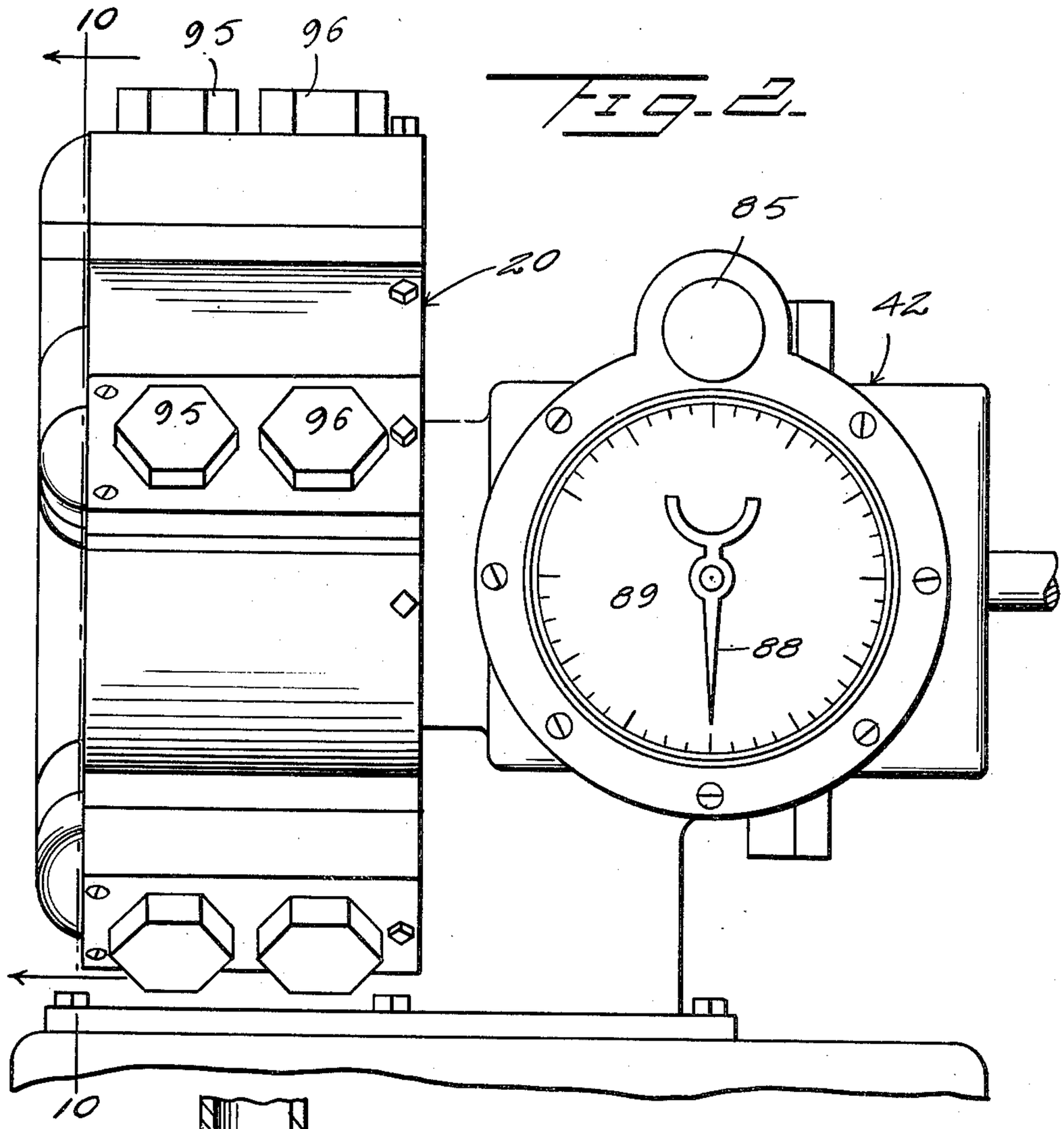

Fig. 2.

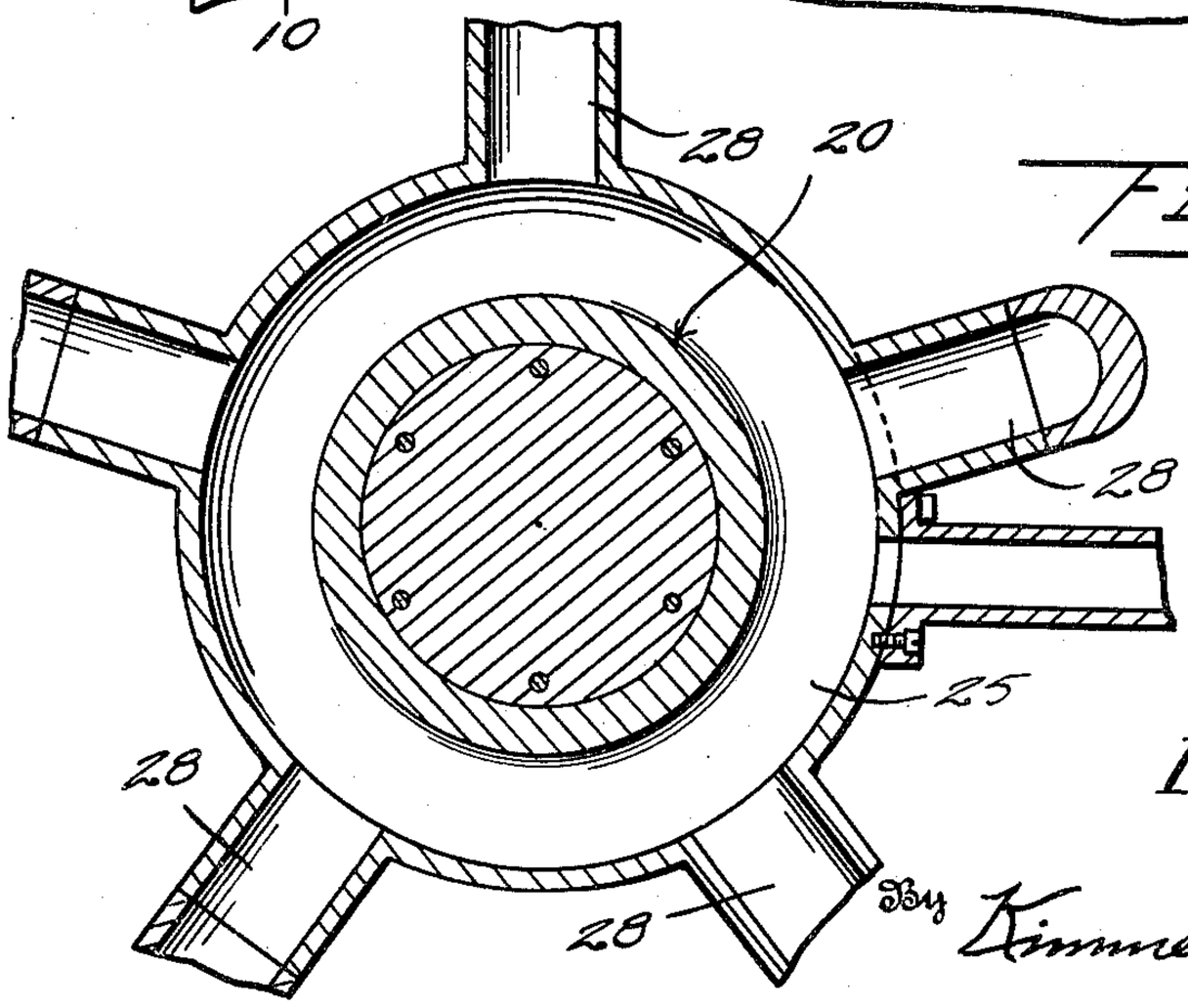

Fig. 10.

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VARIABLE THROW CRANKSHAFT PISTON TYPE RADIAL PUMP

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Fig. 4.

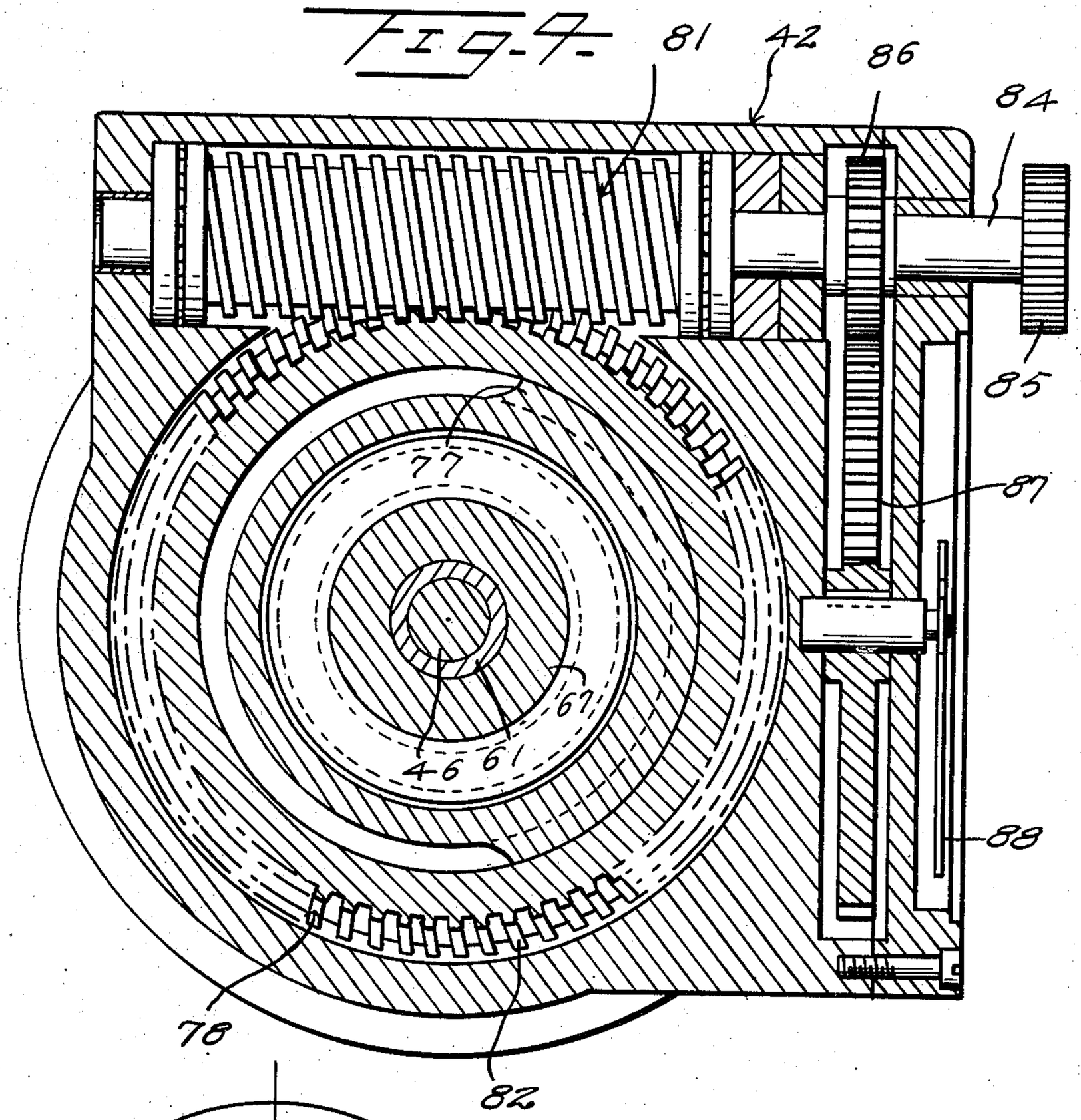
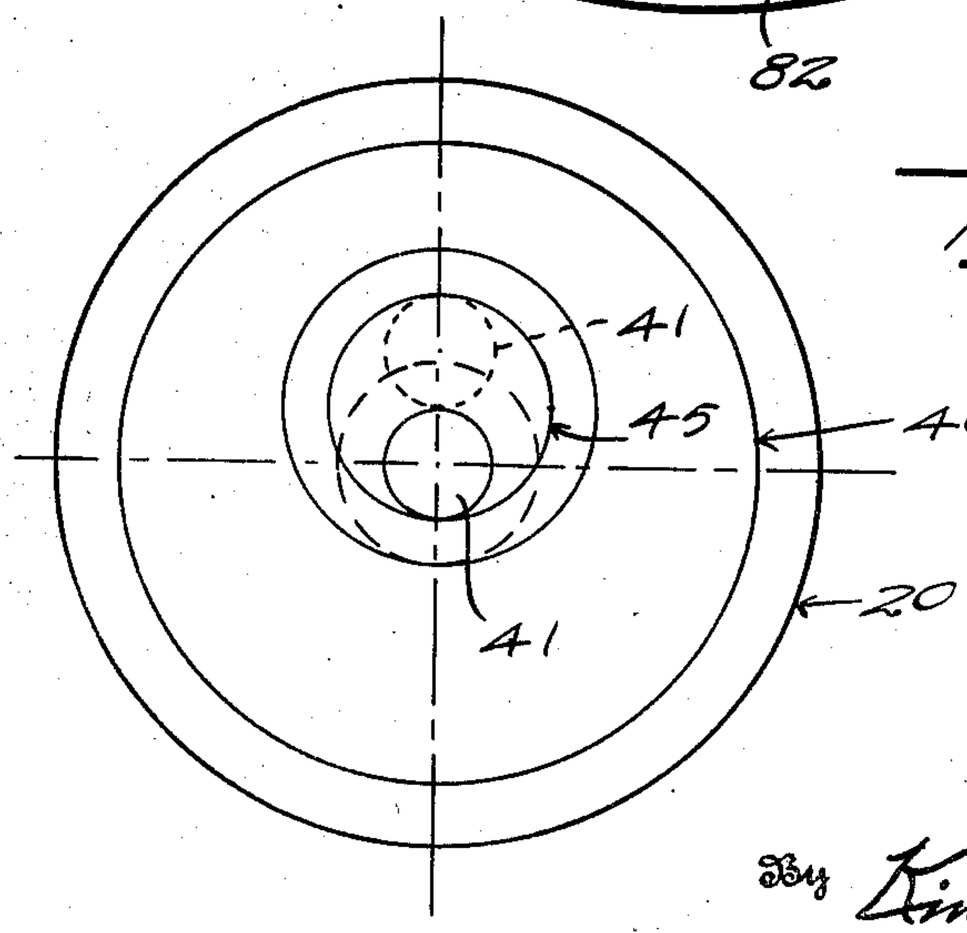


Fig. 9.



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VARIABLE THROW CRANKSHAFT PISTON TYPE RADIAL PUMP

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Fig. 5.

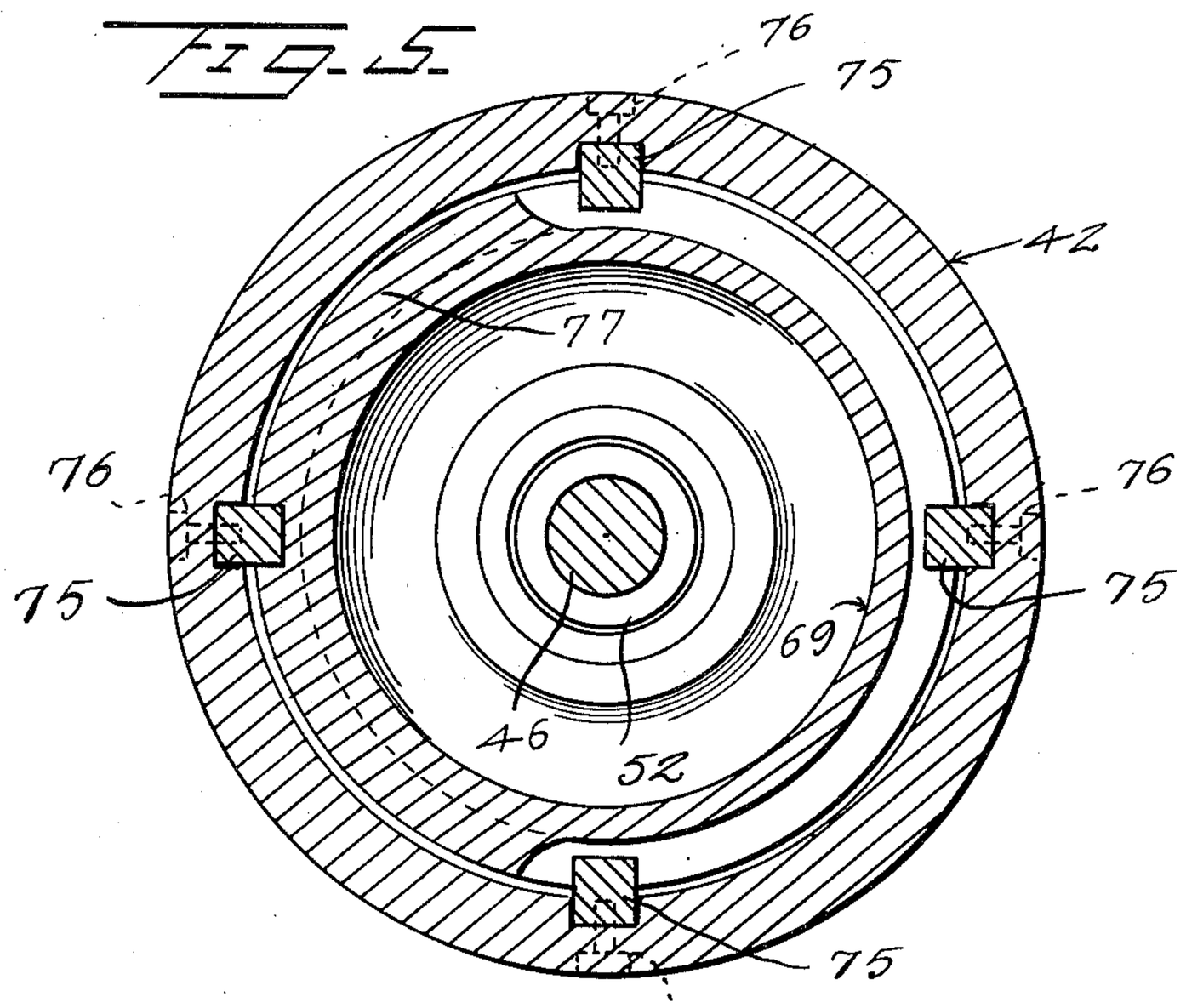

Fig. 7.

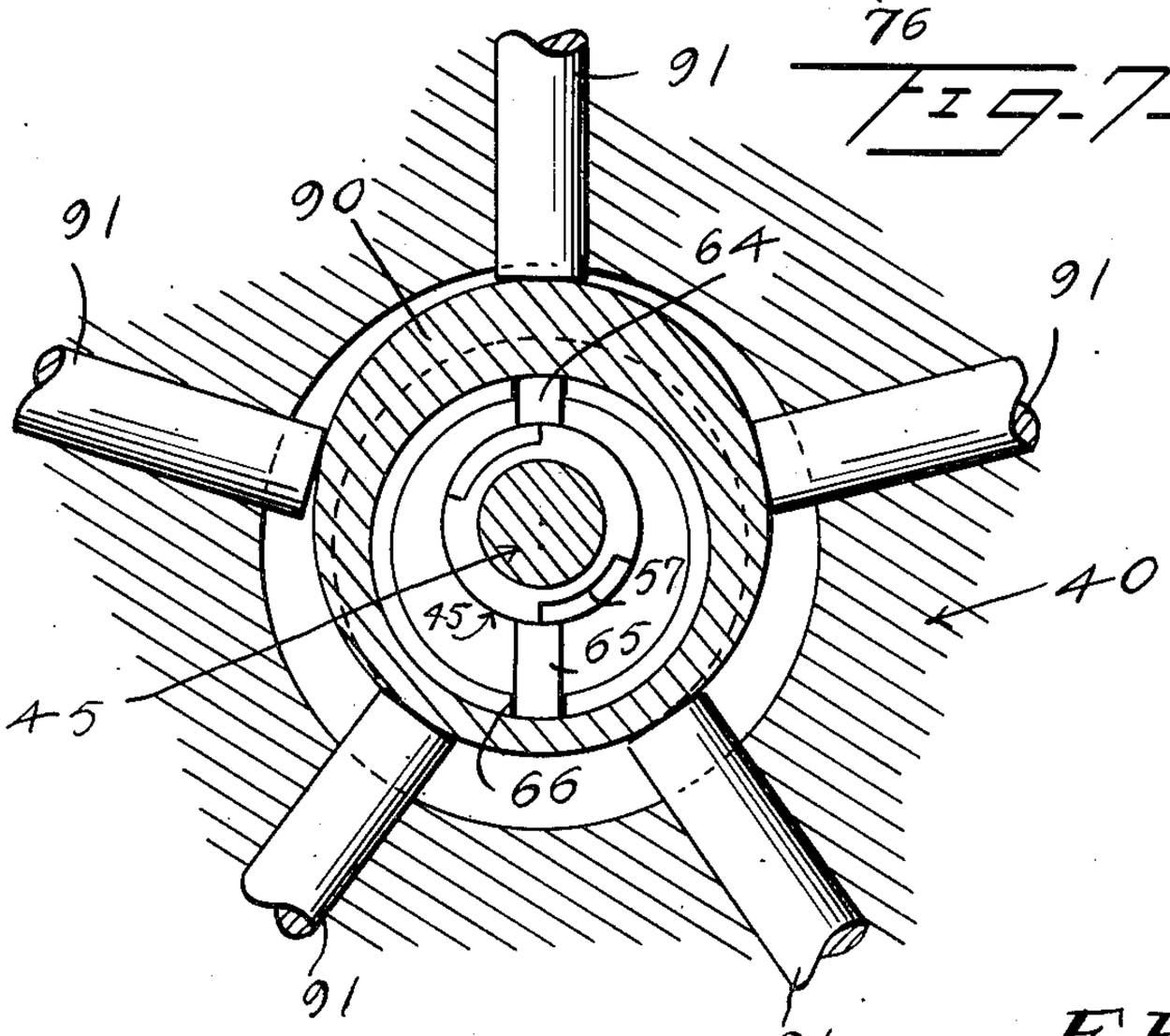

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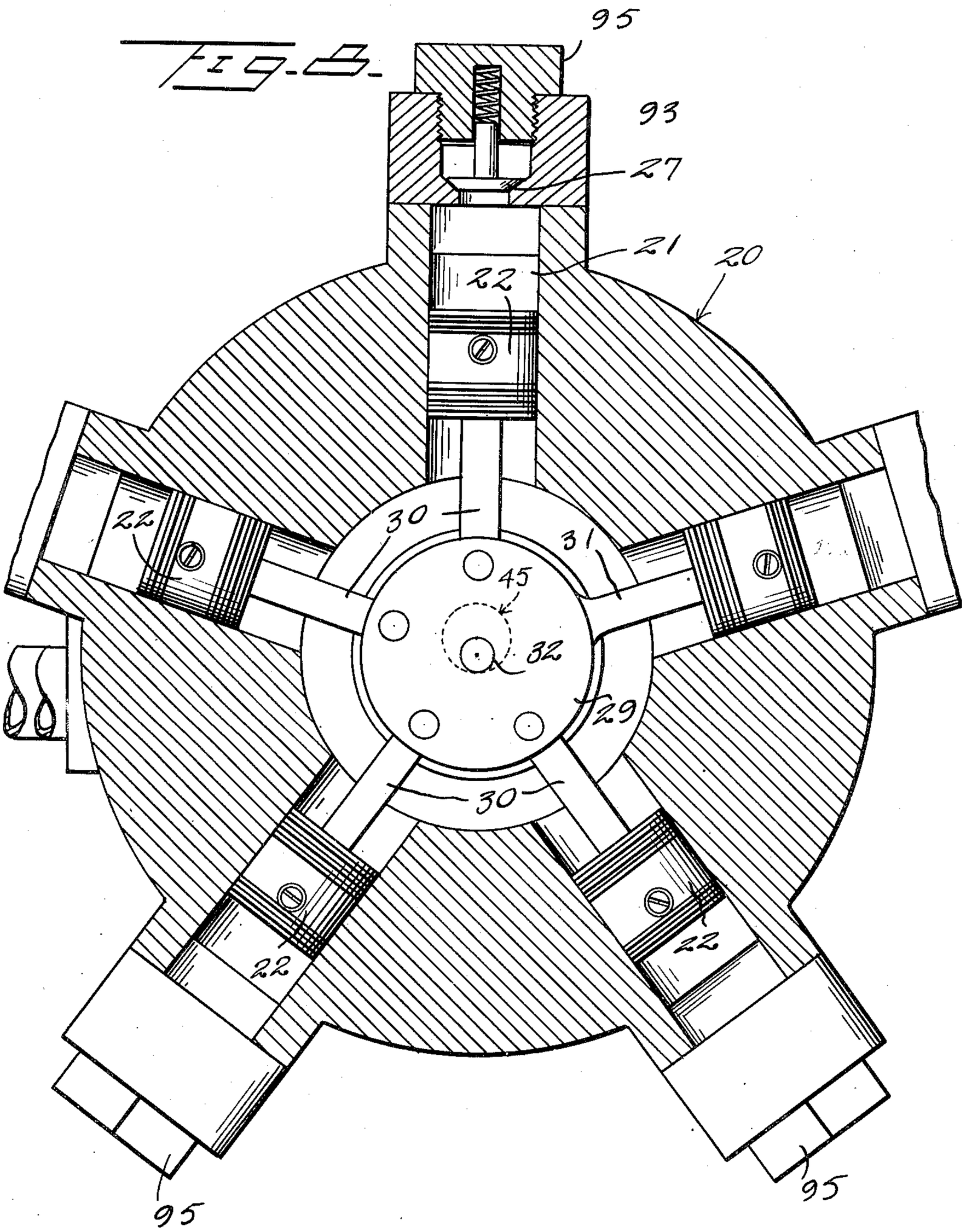
Fig. 8.



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UNITED STATES PATENT OFFICE

2,544,055

VARIABLE THROW CRANKSHAFT PISTON TYPE RADIAL PUMP

Franklin E. Staats, Keithsburg, Ill.

Application December 11, 1946, Serial No. 715,415

2 Claims. (Cl. 74—600)

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This invention relates to crankshafts with variable strokes more particularly in radial type pumps having reciprocating pistons, being a means for varying the length of the stroke of the pistons during the operation of the pump.

Heretofore pumps of this general type have been produced having means for varying the throw of the pistons by movement of the crank pin relative to the crankshaft, wherein the means for varying the position of the crank pin have been fixed relative to the pump housing, or wherein the position of the crank pin could be changed only by stopping the pump while the change was being accomplished.

It is an object of this invention to provide an improved pump of the kind to be more particularly described hereinafter, wherein the crank pin may be changed in its position relative to the crankshaft at any time during the operation of the pump to provide a minimum stroke of zero displacement, to a maximum stroke to be determined by the particular construction and size of the respective parts of the pump.

Another object of this invention is to provide an improved pump of this kind having a driving shaft and a driven shaft, the driven shaft being rotatably mounted eccentrically in the driving shaft, rotatable with the driving shaft, and further rotatable by a sliding element about the driving shaft connected in spiral grooves in the driven shaft, the driven shaft having a crank pin eccentrically mounted on one end for reciprocating pistons connected thereto, the position of the crank pin being controlled by the position of the sliding element relative to the driven shaft.

Still another object of this invention is to provide an improved pump of this kind having a driving crankshaft and a driven crankshaft, the driven shaft being rotatable with the driving shaft for rotating an eccentric crank pin on the driven shaft, and the driven shaft being eccentric to the driving shaft and rotatable independently of the driving shaft for varying the position of the crank pin relative to the axis of rotation of the driving shaft, whereby the stroke of pistons connected to the crank pin may be varied during the rotation of the shafts, thus varying the output of the pump.

A further object of this invention is to provide an improved pump of this kind having a crank pin, the position of which may be varied at the will of an operator during the operation of the pump, for varying the output of the pump, the control means for the crank pin being fixed relative to the pump housing and having an indicator dial for indicating the output of the pump, the dial reading in fluid pressure units or fluid volume units as desired, the movement of the indicator being correlated with the movement of the crank pin.

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With the above and other objects in view, my invention consists in the arrangement, combination and details of construction disclosed in the drawings and specification, and then more particularly pointed out in the appended claims.

In the drawings,

Figure 1 is a rear end elevation of a pump constructed according to an embodiment of this invention,

Figure 2 is a side elevation,

Figure 3 is a vertical section, partly broken away, taken on the line 3—3 of Figure 1,

Figure 4 is a transverse section taken on the line 4—4 of Figure 3,

Figure 5 is a transverse section taken on the line 5—5 of Figure 3,

Figure 6 is a transverse section, partly broken away, taken on the line 6—6 of Figure 3,

Figure 7 is a transverse section, partly broken away, taken on the line 7—7 of Figure 3,

Figure 8 is a transverse section taken through the cylinder body of the pump,

Figure 9 is a diagrammatic view showing the relative positions of the crank pin relative to the crankhaft,

Figure 10 is a transverse section taken on the line 10—10 of Figure 2.

Referring to the drawings, the numeral 20 designates generally the housing of a radial type pump which is provided with a crankshaft to be driven at a constant speed, and so constructed and arranged that the stroke of the pistons may be varied during the rotation of the crankshaft, for varying the output of the pump selectively, by an operator at any time.

The housing 20 encloses therein radially arranged cylinders 21, having pistons 22 slidable therein, and houses the intake and exhaust valves and the intake and exhaust passages for the fluid of the pump. The intake passage 24 and the exhaust passage 25 are annular within the housing 20, for communicating with each of the cylinders 21. The intake passage 24 is communicated with the cylinder 21 through the passage 25, having an intake valve 26 therein. The intake valve 26 is spring-pressed closed and in this instance is adapted to be opened by a cam driven by or fixed on the crankshaft to be described hereinafter.

The exhaust or outlet valve 27 is spring-pressed closed between the cylinder 21 and the passage 28 which communicates the cylinder with the exhaust or outlet passage 25. The outlet valve 27 is of the check valve type so that it will be open as the piston 22 moves upwardly in the cylinder 21, for forcing the fluid from the cylinders of the pump.

As the pump is formed with a plurality of radially disposed pistons 22, a main bearing 29 is provided to which the pistons 22 may be attached by articulated connecting rods 30, one piston as 22*a*, being connected to the bearing 29 by a main rod 31 fixed relative to the bearing 29. The bearing 29 is provided with a central opening or bearing 32 in which a crank pin is adapted to be engaged for oscillating the bearing 29, causing successive reciprocation of the pistons 22.

The bearing 29 is journaled on the crank pin by an anti-friction bearing 33. The anti-friction bearing 33 may be of the ball bearing or roller bearing type. For oscillating the main bearing 29 and actuating the pump, I have provided a crankshaft 40 having a crank pin 41 on one end thereof, engageable in the bearing 33 of the main bearing 29.

There are many types of pumps in which the crankshaft is driven at a constant speed with the result that the output of fluid from the pump is constant at all times. Many efforts have been made to provide means for varying the output of a pump having a constant speed crankshaft. It is most desirable to effect this result without restricting the flow of the output of the pump which builds up a resultant pressure rearwardly of the restriction. To accomplish this result then, it is found necessary to vary the position of the crank pin radially relative to the axis of the crankshaft. This I have accomplished by forming the crankshaft in several parts, certain parts being eccentric to others and having the crank pin eccentric on the eccentric parts so that the crank pin in certain positions of the eccentric part of the crankshaft will be in axial alignment with the axis of the crankshaft.

For varying this crank pin 41 relative to the crankshaft 40, there is provided a housing 42 formed on the rear end of the housing 20, for enclosing the crankshaft 40, and the means for varying the position of the pin 41. The crankshaft 40 is formed with a driving shaft 44 and a driven shaft 45. The driving shaft 44 is formed with a drive shaft 46 having a hollow front end or coupling member 47 fixed on the front end thereof for connecting the driven shaft 45 to the drive shaft 44.

An annular flange as 48 is fixed to or formed on the front end of the rear or drive shaft 46 and the annular hollow coupling member 47 is secured to the flange 48 by bolts 49 or other suitable fastening devices.

The crankshaft 40 is journaled in the housing 20 by anti-friction bearings 50 and 51 and journaled in the housing 42 at the rear end thereof by anti-friction bearings 52. The drive shaft 46 and crankshaft 40 are located concentric to the housings 20 and 42. The driven shaft 45 is mounted in the coupling member 47 and to the front end of the drive shaft 46 eccentric thereto. The driven shaft 45 is supported in the driving shaft 44 by thrust bearing 54 between the rear end of the driven shaft 45 and the front end of the driving shaft 46, and by a thrust bearing 55 between the coupling member 47 and the driven

shaft 45. The forward end of the driven shaft 45 is supported in a bushing or bearing 56 fixed in the front end of the coupling member 47 or drive shaft 44, eccentric to the axis of the drive shaft 44, and driving shaft 46.

The crank pin 41 is fixed on the front end of the driven shaft 45 and extends forwardly from the coupling member 47 or driving shaft 44, eccentric to the axis of the driven shaft 45. The driven shaft 45 is therefore, rotatable both with the driving shaft 46 and relative to the driving shaft, in such a manner that the crank pin 41 may be disposed in axial alignment with the entire crankshaft 40 in a rotated position of the driven shaft 45, and at other times will be eccentric to the axis of the crankshaft 40.

In the eccentric position of the crank pin 41, oscillation of the main bearing 29 is effected upon rotation of the crankshaft 40 and when the crank pin 41 is in axial alignment with the crankshaft 40 and driving shaft 46, no oscillating motion of the main bearing 29 or reciprocating motion of the pistons 22 will be effected.

The output of the pump is, therefore, relative to the radial position of the crank pin 41 relative to the axis of the crankshaft 40 and drive shaft 46.

For rotating the driven shaft 45 relative to the driving shaft 46, the driven shaft 45 is formed with a spiral groove 57 about the outer edge thereof. The groove 57 need only make half a a revolution along the length of the shaft 45 for effecting a complete cycle of adjustment of the crank pin 41 from the maximum to the minimum output of the pump.

A sliding nut member 58 which is formed of an annular body having forwardly extending arms 59 and 60 thereon is disposed about the driving shaft 46 and journaled thereon by a bushing 61. The forward end of the arms 59 and 60 extend through slots or openings 62 in the flange 48 and are formed at their extreme forward end with lugs 64 and 65 which engage in the helical groove 57 on the driven shaft 45. The nut member 58 is concentric to the drive shaft 46 and due to the fact that the driven shaft 45 is eccentric to the drive shaft 46, one lug as 65 will be longer than the other lug 64 for engagement in the groove 57.

As the arms 59 of the nut 58 engage the side edges of the slots 62, the nut 58 is slidable along the length of the driving shaft 46 while being rotated by and with the shaft 46. Keyways as 66 may be provided on the inside of the coupling member 47 in which the arms 59 and 60 may slidably engage to provide a greater bearing surface for rotation of the nut member 58 with the driving shaft 46. In this manner the driven shaft 45 is coupled to the driving shaft 46 for rotation with the driving shaft and upon sliding movement of the nut 58, shaft 45 is rotated relative to the shaft 46.

For sliding the nut 58 on the drive shaft 46, longitudinally spaced apart flanges 67 and 68 are fixed to or formed on the nut 58 annularly thereof. An annular sliding member 69 is provided in the housing 42 about the nut 58 and is formed with an inwardly extending flange 70 engageable between the flanges 67 and 68 of the nut 58 for sliding the nut 58 upon sliding movement of the member 69 in the housing 42. The flanges 67 and 68 are separated from the flange 70 by thrust bearings 71 and 72 and the flange 70 is positioned about the driving shaft 46 by anti-friction bearing 74. The sliding member 69 is fixed in the housing 42 against rotation, but is permitted to

slide to effect sliding of the nut 58 while it is being rotated with the shaft 46.

The sliding member 69 is held against rotation by a key 75 which engages in a keyway 76 in the sliding member 69, the key being fixed in the housing by bolts or other suitable fastening devices. The outer surface of the sliding member 69 is formed with a spiral groove or thread 77 and a gear 78, having a thread 79 on the inner periphery thereof, engages the thread 77 for moving or sliding the member 69 in the housing 42. The gear 78 is rotatable in the housing 42, being disposed concentric to the housing 42 and to the driving shaft 46 and held against movement longitudially by thrust bearings 80.

For rotating the gear 78, a screw 81 tangentially engages the teeth 82 about the outer periphery of the gear 78. The screw 80 is rotatable in the housing 42 and is formed with a shank 84 which extends outwardly of the housing 42, having a knurled knob or handle 85 thereon for rotation by an operator.

A small gear as 86 is fixed on the shank 84 of the screw 81 within the housing 42, near one side thereof, and engages a larger gear 87 rotatably fixed in the housing 42. An indicating arm as 88 is fixed on the shaft of the large gear 87 for registering on a dial 89 the relative position of the crank pin 41, as the position of the crank pin 41 is effected directly by rotation of the screw 81. The dial 89 may be calibrated in gallons per minute or any other suitable unit which indicates volume relative to time.

The coupling member 47 is formed within the housing 20 with a cam 90 thereabout for raising the inlet valves 26 to provide for the direct operation of these valves rather than to permit the fluid to enter the pump through a check valve. The valve stem 91 of the inlet valves 26 engages the cam 90, being urged against the cam by spring 92 above the valve in the housing 20. The springs for the valves 26 and 27 are located above the valves in the housing 20 and in order that the valves 26 and 27 may be inserted into the housing 20, the housing is formed with openings 93 and 94 opening radially therefrom, and nuts 95 and 96 engage in the openings 93 and 94 respectively for securing the valves therein.

In the use and operation of this pump, the driving shaft 46 is adapted to be driven at a constant speed by any suitable power. As the drive shaft 46 is rotated, the driven shaft 45 is also rotated, being fixed in the coupling member 47 for rotation with the drive shaft 46. When the crank pin 41 is in axial alignment or concentric with the drive shaft 46, as shown in Figure 3 of the drawings, the crankshaft 40 will rotate at a constant speed and no movement of the pistons 22 will be effected. This then is the minimum output of the pump. For raising the output of the pump to any suitable quantity within the limits of the size of the pump, the crankshaft 41 may be displaced radially relative to the crankshaft 40 and to the axis of the drive shaft 46 by an operator by rotation of the screw 81 by means of the knurled knob or handle 85. Rotation of the screw 81 will effect the rotation of the gear 78 at right angles to the rotation of the screw 81.

The gear 78, threadably engaging the sliding member 69, will upon rotation cause the sliding member 69 to move forwardly in the housing 42. The sliding member 69, being in engagement with the nut 58, will slide the nut 58 forwardly on the driving shaft 46 and the sliding of the nut 58

will cause rotation of the driven shaft 45 relative to the crankshaft 40 and driving shaft 46. As the crank pin 41 is eccentric to the axis of the driven shaft 45, the crank pin 41 upon rotation of the driven shaft 45 will be displaced radially relative to the crankshaft 40. While this crankshaft and the means for varying the position of the crank pin 41 relative to the axis thereof is shown here as applied on a pump, it is understood that this type of crankshaft and the means for varying the crank pin may be applied to other devices which are actuated by oscillating members or reciprocating devices actuated by a crankshaft.

I do not mean to confine myself to the exact details of construction herein disclosed, but claim all variations falling within the purview of the appended claims.

What I claim is:

1. A variable throw crankshaft construction comprising a housing, a driving shaft rotatably mounted in said housing, a radially extending flange formed on one end of said driving shaft, a hollow tubular coupling member carried by said flange, a driven shaft rotatably mounted in said coupling member and eccentric relative to the axis of rotation of said driving shaft, a crank pin fixed on said driven shaft eccentric to the axis of rotation of the latter, a pair of longitudinally extending helical grooves formed in said driven shaft, a tubular sliding member slidably mounted in said housing, means on said housing engaging said sliding member for preventing rotation thereof, a sleeve about said driving shaft and longitudinally slidable relative thereto, anti-friction bearing means interposed between said sliding member and said sleeve, cooperating means on said sleeve and said sliding member adapted to effect sliding of said sleeve upon sliding of said sliding member, a pair of diametrically opposed parallel arms extending from one end of said sleeve through said flange, inwardly directed end portions on said arms engaging in said grooves, an external thread formed on said sliding member, an annular worm wheel rotatable in said housing and disposed about said sliding member, internal threads formed on said worm wheel meshing with said first mentioned thread, and a worm gear extending transversely of said housing and meshing with said worm wheel whereby rotation of said worm gear will effect displacement of said crank pin relative to the axis of rotation of said driving shaft.

2. A variable throw crankshaft construction comprising a housing, a drive shaft rotatable in said housing, a radially extending flange formed on one end of said drive shaft, a hollow tubular coupling member secured to said flange, a driven shaft rotatably mounted in said coupling member eccentric to said drive shaft, a crankpin fixed on the outer end of said driven shaft eccentric to the axis of rotation of the latter, a pair of longitudinally extending helical grooves formed in said driven shaft, a tubular sliding member slidably carried by said housing, interengaging means on said housing and said sliding member adapted to prevent rotation of the latter, a sleeve member slidable on said drive shaft, a pair of radially extending longitudinally spaced apart flanges formed on said sleeve member, an inwardly extending flange formed on said sliding member and adapted to be received between said pair of sleeve member flanges, anti-friction means interposed between said pair of flanges and said inwardly extending flange whereby said sleeve member is slidable with said sliding member and

rotatable relative thereto, a pair of diametrically opposed parallel arms extending from one end of said sleeve member and through said drive shaft flange, inwardly directed end portions on said arms engaging in said helical grooves, an external thread formed on said sliding member, an annular member having internal threads engaging said sliding member threads and rotatably mounted in said housing, gear teeth formed on the outer surface of said annular member, a worm screw rotatable in said housing at right angles to the axis of rotation of said drive shaft and meshing with said gear teeth whereby rotation of said worm screw will effect displacement of said crankpin relative to said drive shaft axis of rotation.

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