Sept. 14, 1965 R. DAUB 3,205,832

HYDRAULIC PUMP

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Fig. 3

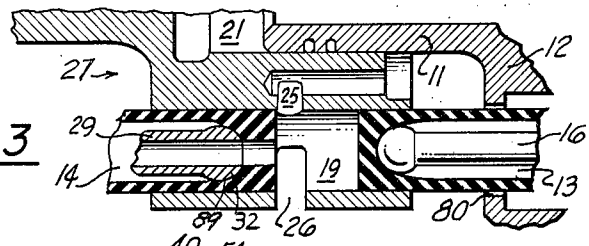
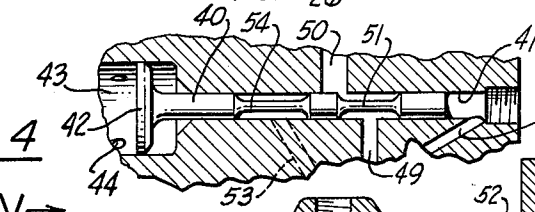


Fig. 4



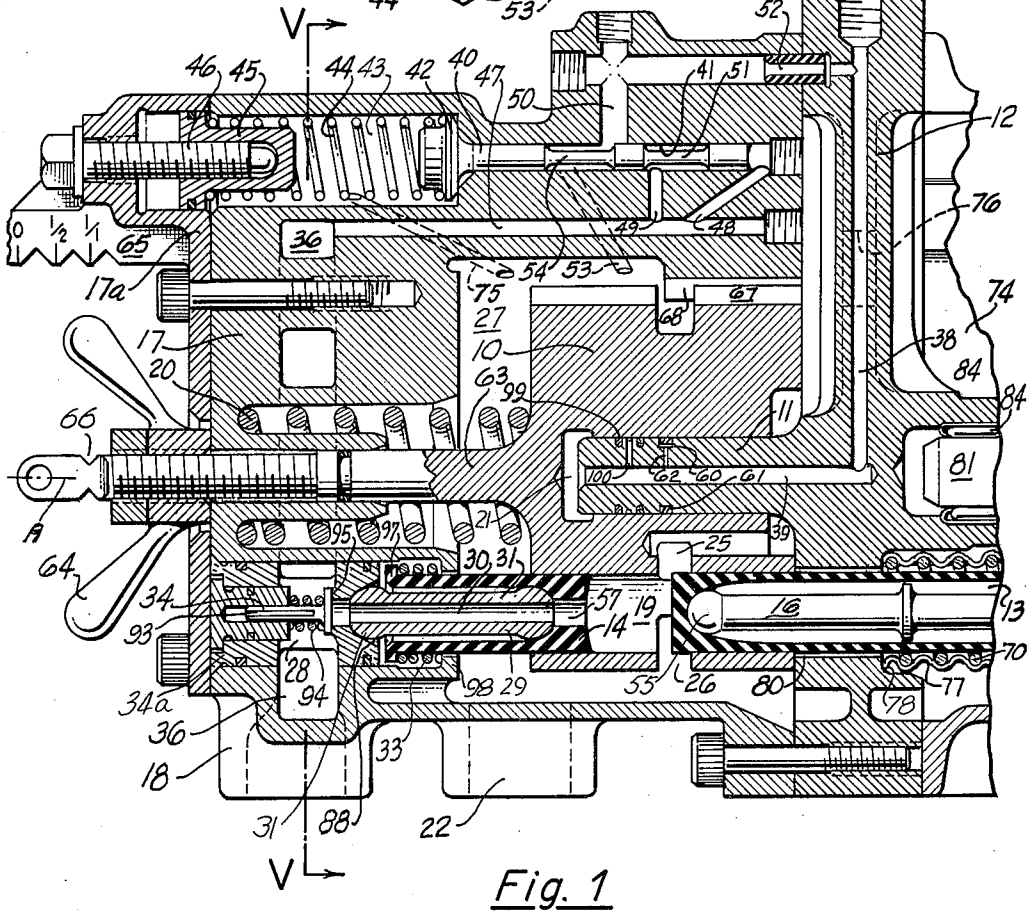


Fig. 1

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HYDRAULIC PUMP

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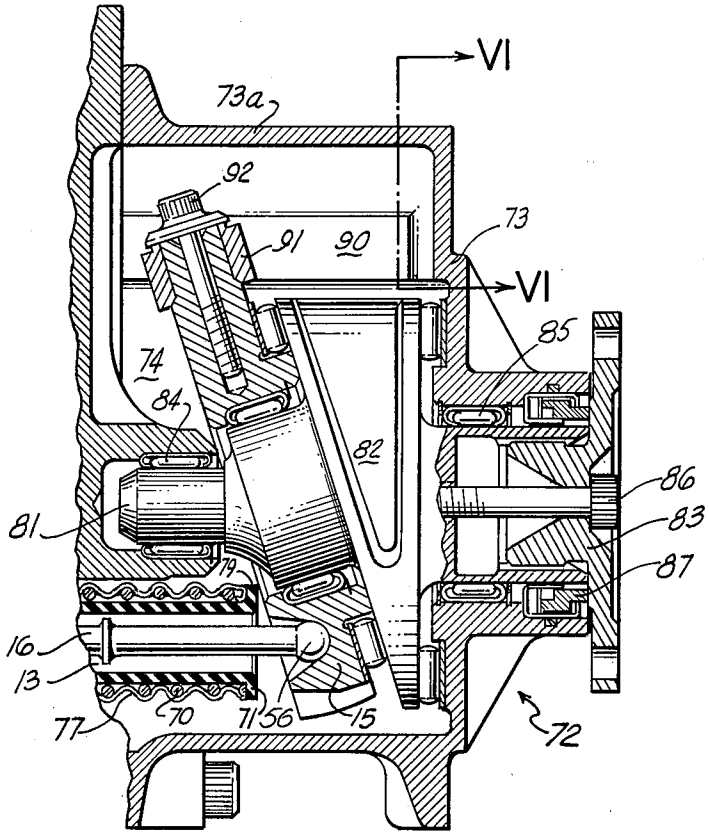


Fig. 2

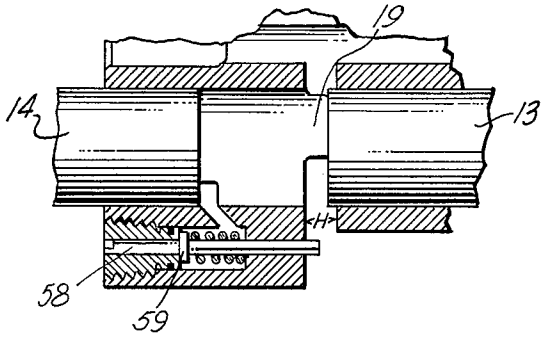


Fig. 7

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HYDRAULIC PUMP

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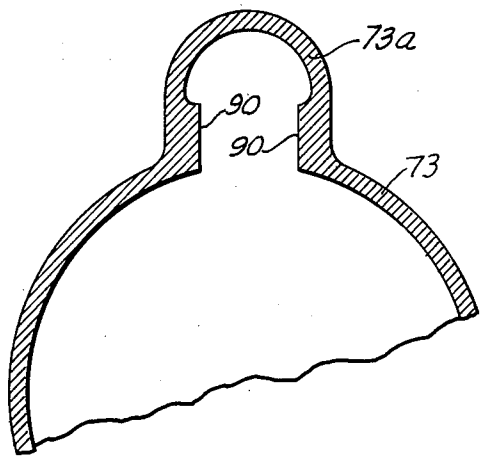


Fig. 6

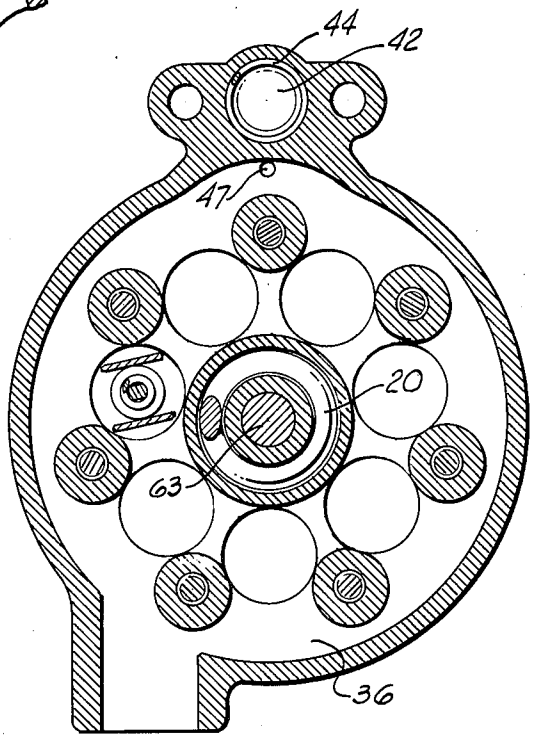


Fig. 5

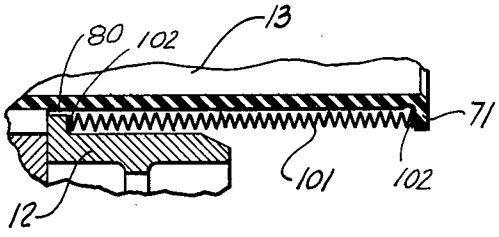


Fig. 8

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United States Patent Office 3,205,832 Patented Sept. 14, 1965

3,205,832

HYDRAULIC PUMP

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Filed Aug. 28, 1962, Ser. No. 219,987
6 Claims. (Cl. 103—173)

This invention relates to axial type pumps having a cylinder block axially movable to vary the fluid displacement.

In pumps of this type the pump pistons have a constant stroke. The capacity or fluid displacement of the pump is varied by axially moving the cylinder block to vary the effective stroke of the pistons. The cylinder block is usually held in the maximum displacement position by a helical spring and is moved to a lesser displacement by hydraulic pressure applied against the cylinder block in opposition to the spring pressure. The displaced fluid is discharged from the pump through a stationary valve housing coupled to the cylinder block by fluid transfer means.

An object of this invention is to provide an axial type of hydraulic pump that has a cylinder block sensitively adjustable for varying the capacity of the pump by having fluid transfer means between the cylinder block and valve housing without imposing side loads on the bores of the cylinder block.

Another object of this invention is to provide an axial type hydraulic pump that has fewer parts and is less expensive than present comparable pumps and has a greater versatility in adjustment.

Another object of this invention is to provide an axial type hydraulic pump with a movable cylinder block that has damping means impeding the movement of the cylinder block.

A further object of this invention is to provide sealing means between the cylinder block compartment and the wobble plate compartment of an axial type hydraulic pump.

Other and further objects and advantages will be apparent from the following description, taken in connection with the drawings, in which

FIGS. 1 and 2 are separate fragmentary sectional views of the pump taken through the main axis;

FIG. 3 is a fragmentary sectional view of the bore of the cylinder to illustrate a reduced effective stroke;

FIG. 4 is a fragmentary view of the valve housing illustrating the pressure adjusting valve in a position to provide pressure to alter the position of the cylinder block;

FIG. 5 is a sectional view of the valve housing taken along lines V—V of FIG. 1;

FIG. 6 is a fragmentary view of the wobble plate housing illustrating the yoke holding the wobble plate from rotation taken along lines VI—VI of FIG. 2;

FIG. 7 illustrates a modification of the cylinder block with means for supplying fluid to the bore on the retraction of the pump piston; and

FIG. 8 is another embodiment of the resilient sleeve sealing the valve housing compartment from the wobble plate housing compartments.

Referring to the drawings, the cylinder block **10** is slidably mounted on a center positioned projection **11** formed as part of a partition member **12** extending transverse to the main axis A of the pump and has longitudinally extending bores **19** with pump pistons **13** at one end and valve pistons **14** at the other end. The valve pistons are actuated by a wobble plate **15** by means of push rods **16**. The valve pistons **14** are part of the fluid transfer means coupling the cylinder block **10** and the valve housing **17** for delivery of fluid under pressure to the valve housing and discharge at the outlet **18**.

The cylinder block **10** is forced by the spring **20** to a

full effective stroke position. This force is countered by fluid pressure applied to the chamber **21** between the projection **11** and the cylinder block **10**. On increase in pressure in the chamber, the spring is compressed and the cylinder block moved toward the valve housing and the effective stroke reduced. The cylinder block has a plurality of longitudinally extending bores **19** with the pump pistons **13** and the valve pistons **14** fitting snugly therein to prevent oil leakage therearound and to support the pistons in the block. The pump pistons **13** reciprocate in relation to the axially ported valve pistons **14**. Ports **25** and **26** are intermediately positioned to supply fluid to the bores from the fluid supply compartment **27** formed by the valve housing **17** and the partition member **12**. A fluid supply connection **22** is provided through the housing **17**.

In FIG. 1 the cylinder block is at the full effective stroke position, so that the pistons **13** cover the ports **25** and **26** in the initial portion of the stroke to provide the maximum amount of fluid between the pump piston and the valve piston. As the cylinder block **10** is moved towards the valve housing, the ports **25** and **26** are moved closer to the valve pistons delaying the cutoff of the ports, thereby reducing the effective stroke of the piston.

In the modification of FIG. 7 the cylinder block **10** has ducts **58** adjacent to the faces of the valve pistons for supplying fluid to the bore **19** through check valves **59** on the return stroke of the respective pump piston. This supply of fluid permits the ports to have a lesser port height H than the ports of the embodiment of FIG. 1. This provides a longer effective stroke and increases the volumetric efficiency.

The valve pistons **14** are coupled to the check valve block **28** by the hollow swivel joints **29** having passages **30** receiving fluid from the orifice **57** in the valve piston. The swivel joints have rounded ends **31**, **32** fitting in the sloped seating surfaces or seats **88**, **89** of the check valve block and valve piston, respectively, to form fluidtight seals. The curvature on the swivel joint can vary from the respective curvatures on the piston or check valve to form thin circular high pressure seals. An initial pressure is provided by the helical springs **33** bearing against the valve housing and valve pistons. The swivel joints **29** permit the valve pistons to accommodate to lateral movement of the cylinder block and also to compensate for tolerances between the bores and the valve seat. Side loads against the bores are eliminated while providing high pressure seals. The fluid is delivered past the check valves **34** to the valve discharge chamber **36** extending circumferentially within the valve housing and thence to the discharge outlet **18**.

Fluid pressure is supplied to the chamber **21** through passages **38** and **39** in the partition member and projection **11**, respectively. The fluid pressure may be supplied to passage **38** either from the valve discharge chamber **36**, through sleeve **52** or from a remote pressure control means (not shown) through the socket **37**.

The fluid pressure from the chamber **36** is controlled by the valve **40** which has a stem slideably fitting in the bore **41** and a lateral head **42** in the chamber recess **43**. A helical spring **44** bears against the lateral head **42** at one end and against the spring retainer **45** at the other. The spring retainer is adjustably held by the pressure adjustment screw **46** threaded in the end cover **17***a* and rotatably bearing against the retainer. Thus the pressure applied by the spring to the valve may be adjusted. Fluid pressure is applied to the opposite end of the valve by the passages **47** and **48** connecting the chamber **36** to the bore **41**. As the pressure increases in the chamber **36** the valve is forced to the left to connect the pressure passage **49** to the passage **50** around the reduced portion **51** overlapping with the passage **50**. The

fluid pressure is applied through the passage **50** and the sleeve **52** connecting the valve housing and the partition member and thence to the passages **38** and **39**. The adjustment of the spring length relates the movement of the cylinder block **10** to the fluid pressure developed. Vent passage **53** connects the passage **50** around the reduced section to discharge fluid to the inlet pressure side of the pump and relieve the pressure in chamber **21** on the cylinder block assuming the full effective stroke position. Passage **75** connects the recess **43** with the supply compartment **27**.

The remote pressure control means (not shown) is connected to the partition member **12** by means of the socket **37**. The passage in sleeve **52** is blocked to prevent the application of fluid pressure from the chamber **36**. The fluid pressure is then applied by the remote control means through the passages **38, 39** to the chamber **21** for positioning the cylinder block.

In order to stabilize and dampen the cylinder block **10** an annular groove **60** is provided in the projection **11** to receive the steel ring **61** bearing against the cylinder block **10**. Fluid pressure is supplied to the groove **60** by the duct **62** to force the ring against the cylinder block **10**, thereby increasing the frictional relationship between the cylinder block and the projection **11**.

Instead of the ring **61** two O-rings **99** may be provided around the projection **11** and axially spaced with a duct **100** extending from the passage **39** to apply pressure on the O-rings to dampen the movement of the cylinder block.

The cylinder block may be mechanicaliy positioned by the rod **63** formed as part of the cylinder block and extending axially through the valve housing. A winged nut **64** is threaded on the rod and bears against the valve housing to compress the spring **20**. A scale **65** is indexed by notch **66** to indicate the position of the cylinder block.

The pump pistons **13** extend through openings **80** in the partition member **12** and are driven by the wobble plate **15** by means of the push rods **16**. An initial and return force to hold the push rods against the wobble plate and the piston is provided by the helical springs **70** bearing against the partition member **12** and the end flange **71** of the pistons. The push rods have round ends **55, 56** to rotatably fit in the seats in the pistons and wobble plate. The wobble plate **15** is eccentrically mounted to provide axial movement to each piston on a single rotation of the wobble plate. The cylinder block **10** is held against rotation by the interfit of the key **67** and groove **68** in the valve housing.

The wobble plate is driven by and mounted on the wobble plate drive means **72** and is held against rotation by block **91** sliding in guides **90** in a conventional manner.

The wobble plate housing forms a chamber or compartment **74** for holding lubricating fluid and may be connected to the fluid supply chamber **27** by passages **76** if the hydraulic fluid can also serve as a lubricant. If the chambers are to contain different fluids, flexible sleeves **77** are positioned around the springs **70** and the pump pistons **13** and have flanges **78** seating against the partition member **12** and flanges **79** seating against the flanges **71** on the pistons. The sleeves **77** seal the openings **80** through which the pistons **13** pass from the chamber **27** to the chamber **74**.

The wobble plate drive means **72** comprises a stub shaft **81**, eccentric member **82** and a driving flange member **83** mounted in the partition member **12** by needle bearing **84** and needle bearing **85** in housing **73**. The flange member **83** is splined to the eccentric member **82** and secured thereto by bolt **86**. A shaft seal **87** seals the compartment **74**.

The check valves **34** slideably fit in inserts **34***a* of the blocks **28** and have flats **93** in the stem to provide equalizing fluid pressure at the back of the stems. Springs **94** press the valves against seats **95** to seal the block on the return stroke. The check valve blocks are held in the valve housing by the cover **17***a*. The springs **33** bear against piston flanges **97** and the valve housing flanges **98**. The valve pistons are clear of the valve housing and form with the bores axially extending seals while the swivel joint ends provide spaced seals adjustable to the tilt of the joint. Thus the joints form sealed linkages between the valve pistons and the valve housing ports.

In FIG. 8 a modification of the means for sealing the openings **80** is illustrated. The springs **70** and sleeves **77** are replaced by spring bellows **101** seating on the partition member **12** and the flanges **71** of the pistons. Seals or gaskets **102** are placed at the ends of the bellows.

I claim:

1. An axial type hydraulic pump comprising an intermediate partition member extending normal to the axis of the pump and having a central axial projection, a cylinder block slideably supported by said projection, a valve housing mounted on said partition member on the same side as said projection and forming a fluid supply compartment containing said cylinder block, said cylinder block having longitudinally extending bores with reciprocating pump pistons and valve pistons, swivel joint means adjustably coupling said valve pistons and said valve housing for transference of fluid from said bores to said valve housings, said valve pistons and said valve housing having seats for receiving axial forces and said swivel joint means having rounded ends fitting in said seats to seal the transferred fluid by axial pressures of said valve pistons with minimal side loads on said cylinder block, said cylinder block and said projection forming a chamber to adjust the position of said cylinder block under hydraulic pressure supplied to said chamber, and said partition member having passages for supplying fluid to said chamber to vary the position of said cylinder block with minimal frictional resistance with said valve pistons.

2. In an axial type hydraulic pump having an axially slideable cylinder block with bores having pistons driven by a drive means for supplying fluid under pressure to a stationary valve housing and with a spring forcing said block to a full effective stroke position, a supporting center projection axially coincident with the pump axis and a cylindrical bore in said block having its axis coincident with the axis of the pump and in sliding fitting relation with said projection to support said block with a sliding fit, said projection forming a chamber with said block and having means for supplying fluid under pressure to position said cylinder axially to vary the effective stroke of said pistons and having a resilient ring extending around said projection bearing against said bore and having passage means connected to said supply means for providing fluid pressure against said ring to vary the friction between said slideable cylinder block and said stationary projection with the pressure.

3. In an axial type hydraulic pump having an axially movable cylinder block with axially extending bores having pistons driven by a drive means for supplying fluid under pressure to a stationary valve housing having fluid passing ports with seats therearound, a hydraulic fluid transmitting means between said stationary valve housing and said cylinder block for conveying hydraulic fluid from said bores to said valve housing, comprising valve pistons in said bores with fluid passing end ports having seats around said ports facing said housing seats and hollow fluid transmitting swivel joints having round surfaces at each end movably fitting in said seats in said pistons and valve housings to form axial pressure tight seals with said pistons and housing for adjusting to lateral forces with minimal side loads between said pistons and said bores.

4. In an axial type hydraulic pump having an axially slideable cylinder block with bores having pistons driven by a drive means for supplying fluid under pressure to a stationary valve housing and with a spring forcing said block to a full effective stroke position, a supporting center projection axially coincident with the pump axis

and a cylindrical bore in said block having its axis coincident with the axis of the pump and in sliding fitting relation with said projection to support said block with a sliding fit, said projection forming a chamber with said block and having means for supplying fluid under pressure to position said cylinder axially to vary the effective stroke of said pistons, resilient means bearing against said cylinder block and passage means connected to said supply means for providing fluid pressure against said resilient means to vary the friction between said slideable cylinder block and said stationary projection with the pressure.

5. An axial type hydraulic pump comprising an intermediate partition member extending normal to the axis of the pump and having a central axial projection, a cylinder block slideably supported by said projection, a valve housing mounted on said partition member on the same side as said projection and forming a fluid supply compartment containing said cylinder block, said cylinder block having longitudinally extending bores with reciprocating pump pistons and valve pistons, swivel joint means adjustably coupling said valve pistons and said valve housing for transference of fluid from said bores to said valve housing, said cylinder block and said projection forming a chamber, said partition and said projection having passages for supplying fluid under pressure to said chamber for adjusting the position of said cylinder block, and said projection having resilient means bearing against said cylinder block and means for supplying fluid pressure to said resilient means to vary the frictional relationship between said slideable cylinder block and said projection.

6. An axial hydraulic pump comprising a partition member, a stationary housing forming a fluid supply compartment with said partition member, said housing having valve blocks with ports for passing fluid and with sloped seating surfaces around each port facing said fluid supply compartment, a cylinder block in said compartment having longitudinally extending bores each with an intermediate intake port for supplying fluid from said compartment to said bores and with reciprocable pump

pistons and substantially stationary valve pistons containing passages for passing fluid, said partition member having a central axial projection extending into said compartment, said cylinder block slideably mounted on said projection and forming a closed chamber therewith and having resilient means urging said cylinder block toward said partition for full capacity operation, said projection having fluid supply passages for supplying fluid under pressure to said chamber to gradually position said cylinder block for less than full capacity operation, said valve pistons having sloped seating surfaces facing the sloped seating surfaces of said valve blocks, joint means having passages for passing fluids from said pistons to said blocks and rounded ends fitting in said sloped seating surfaces of said valve blocks and valve pistons forming fluid-tight seals under the axial pressure of said valve pistons to relieve the cylinder block of side loads, thereby permitting the cylinder block to respond to fluid pressures with minimal resistance from said valve pistons.

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