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Bobier

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[54] **FLUID DEVICE HAVING MEANS FOR ALIGNING A CYLINDER BARREL**

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Related U.S. Application Data

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[52] **U.S. Cl.** **91/506**

[51] **Int. Cl.** **F01b 13/04,** F04b 49/00

[58] **Field of Search** 91/504–507; 417/222

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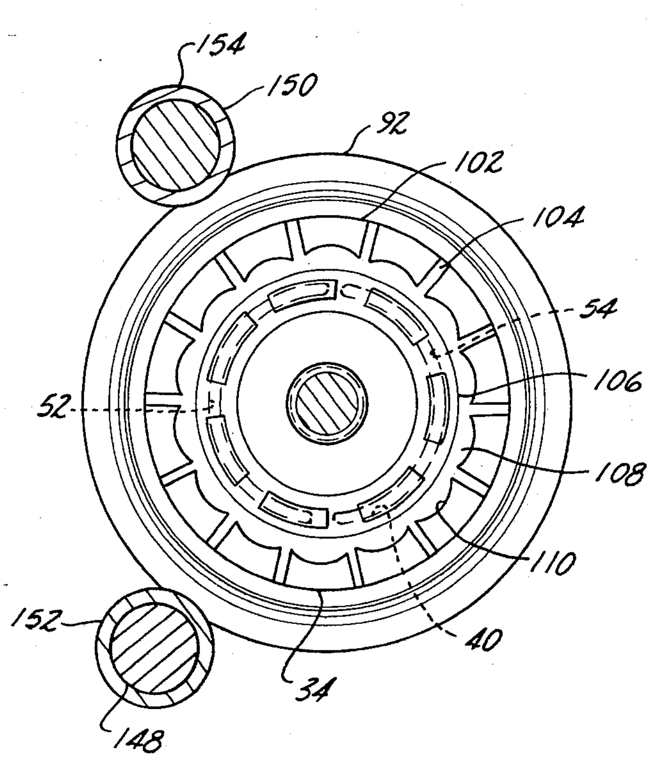
[57] **ABSTRACT**

A fluid device of the axial piston type having high and low pressure operating passages, one of which may be an inlet and the other an outlet depending upon the pumping or motoring function of the device. The fluid device which may be of the fixed or variable displacement type has a rotatable cylinder barrel with each end of a plurality of pistons disposed for reciprocation within cylinder bores in the cylinder barrel, and cylinder ports successively communicating each of the cylinder bores with arcuate inlet and outlet passages formed in a valving face disposed at one end of the cylinder barrel. The other ends of the pistons are drivingly engaged by an inclined thrust plate assembly disposed to impart a reciprocal stroking movement to the pistons within the cylinder bores as the cylinder barrel is rotated. In one example of the invention, the thrust plate assembly, the cylinder barrel and other rotating components of the fluid device are constructed of a sintered material enclosed in a plastic housing which is preloaded by a predetermined amount that is a function of the expansion forces exerted on the housing by the fluid pressure acting against the pistons within the cylinder bores.

In a second example of the invention, a variable displacement fluid device is disclosed as having several means for varying the inclination of the thrust plate assembly with respect to the longitudinal axis of the shaft on which the rotating cylinder barrel is carried.

6 Claims, 11 Drawing Figures



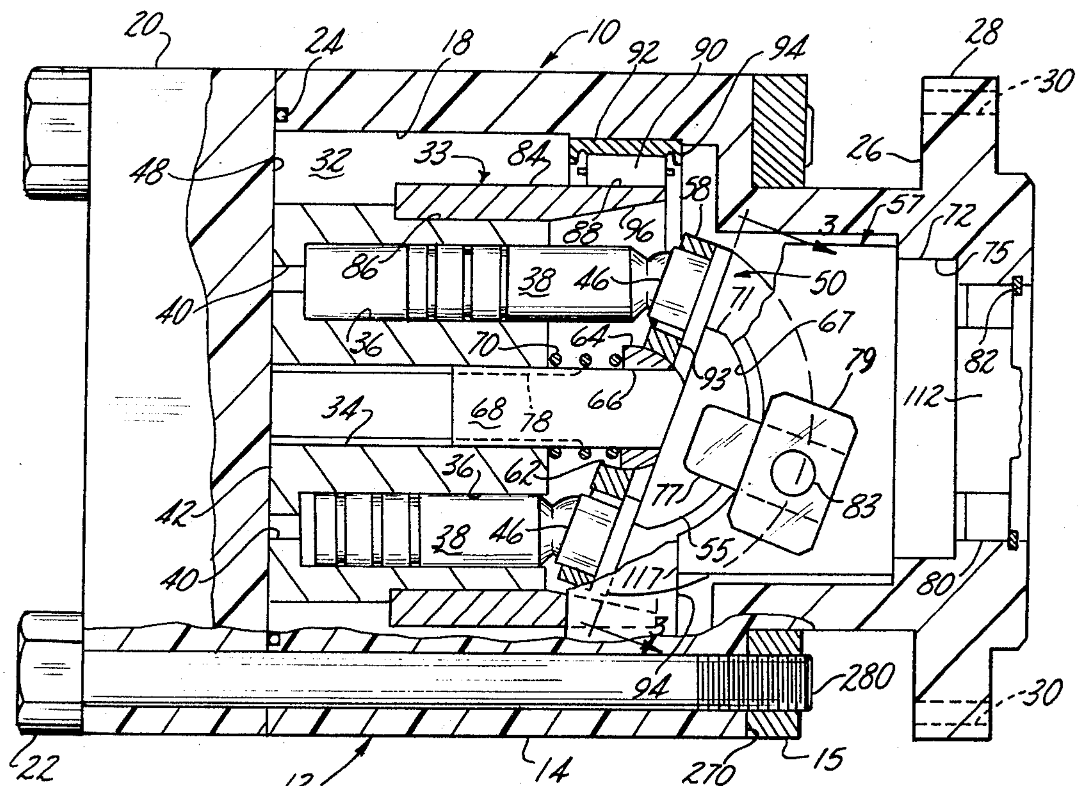


Fig - 2

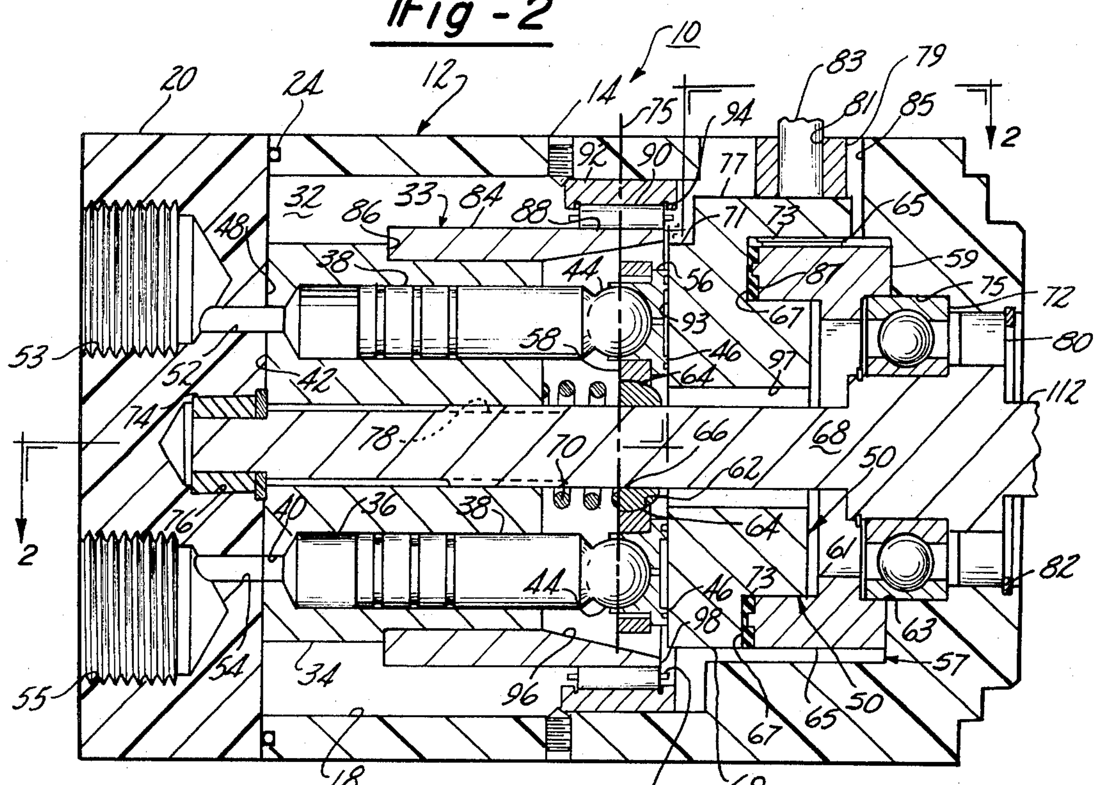


Fig - 1

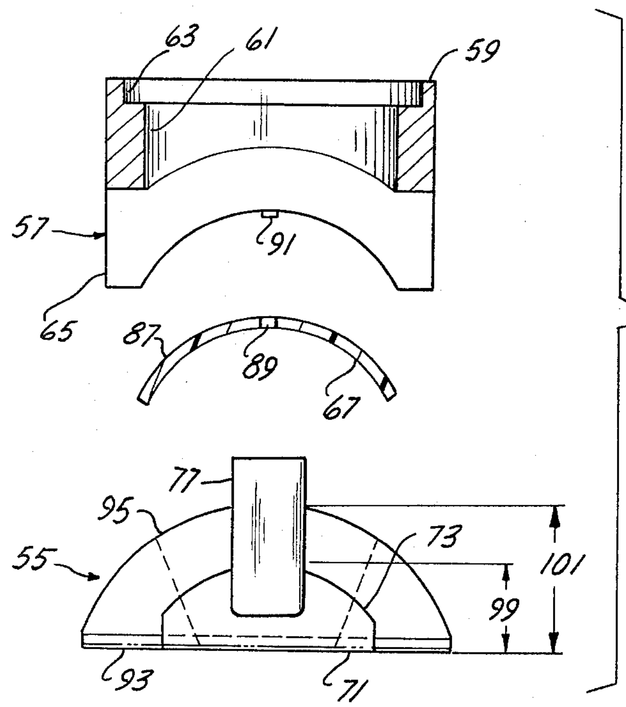


Fig-5

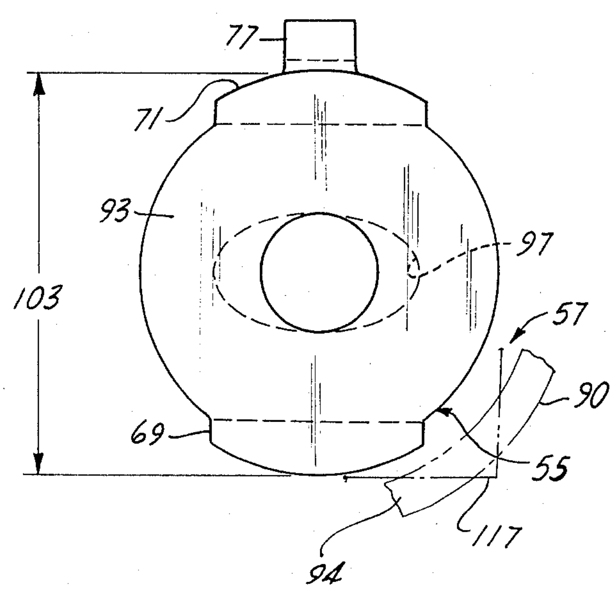


Fig-3

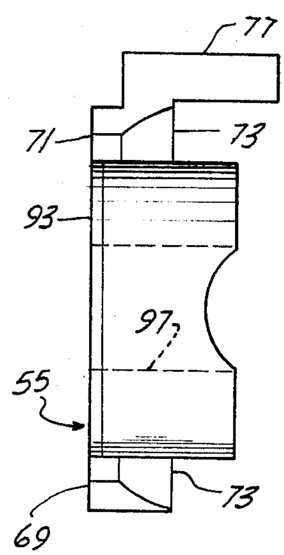


Fig-4

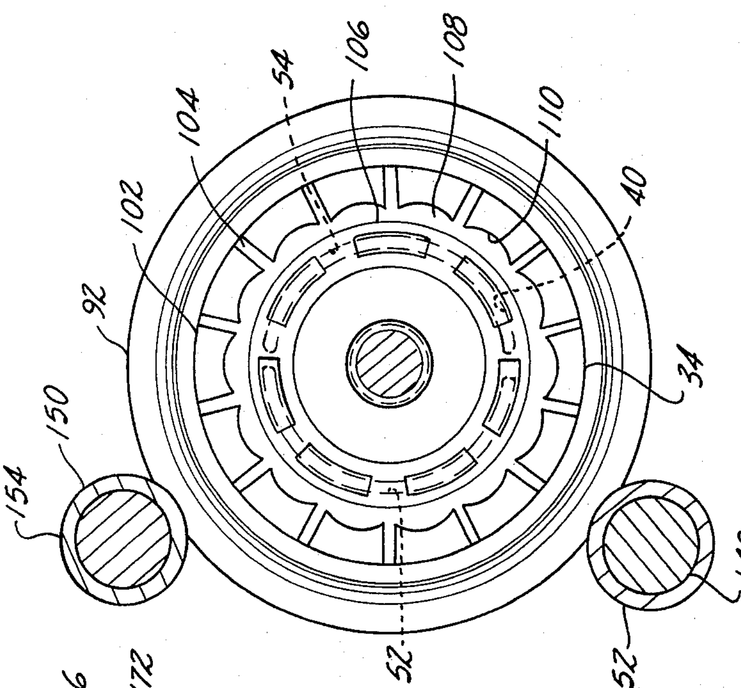

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Fig-7

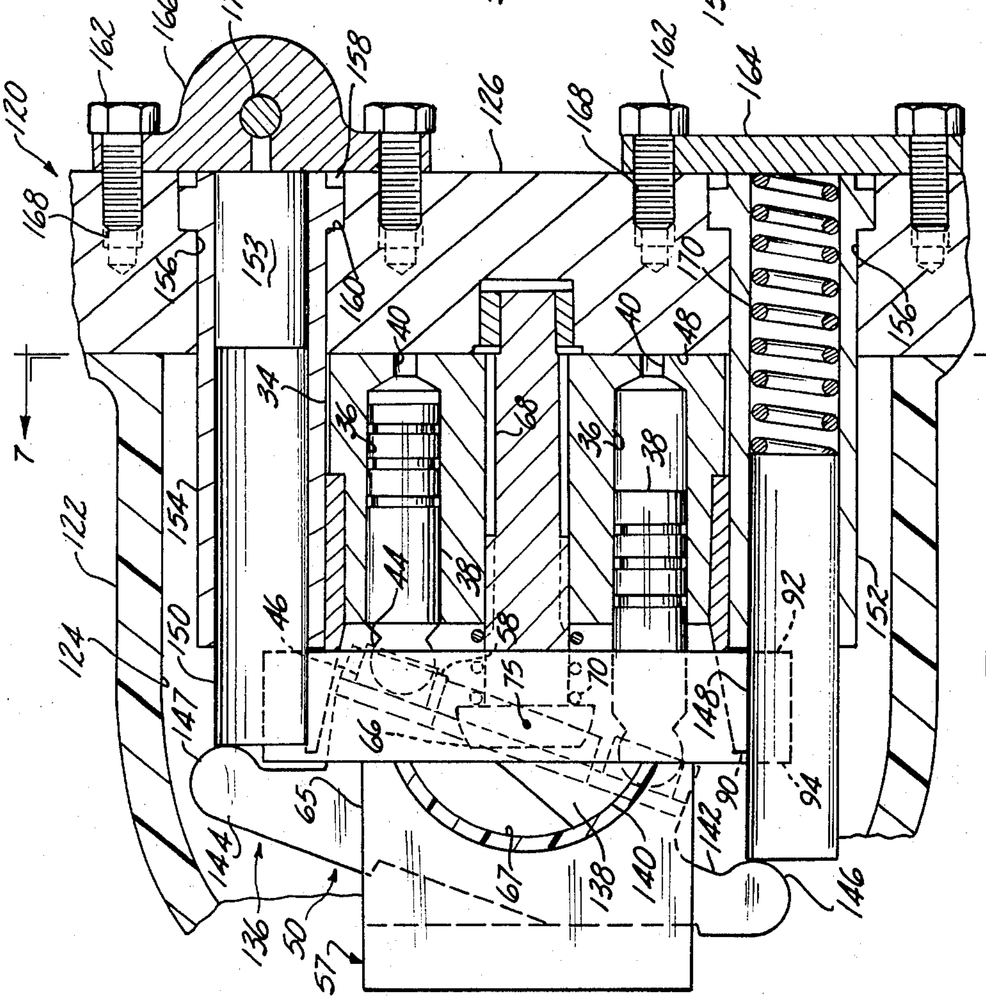
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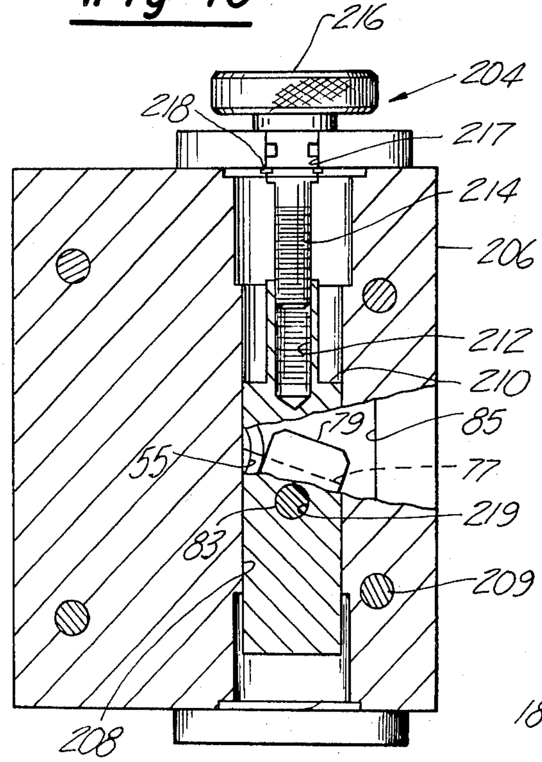
Fig-6

Fig-10



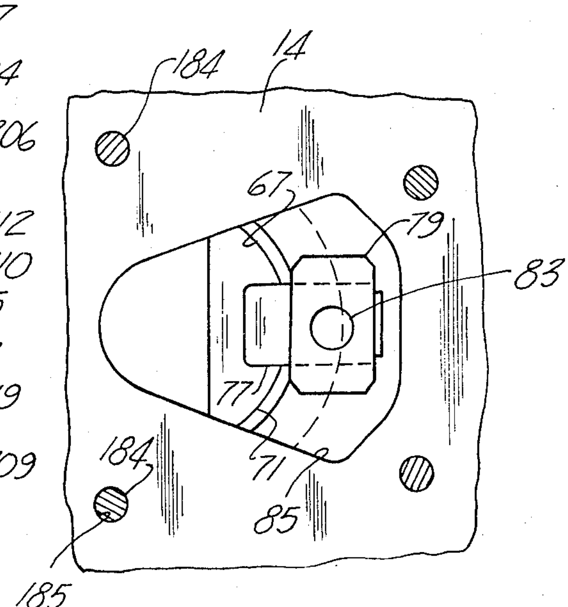


Fig-8

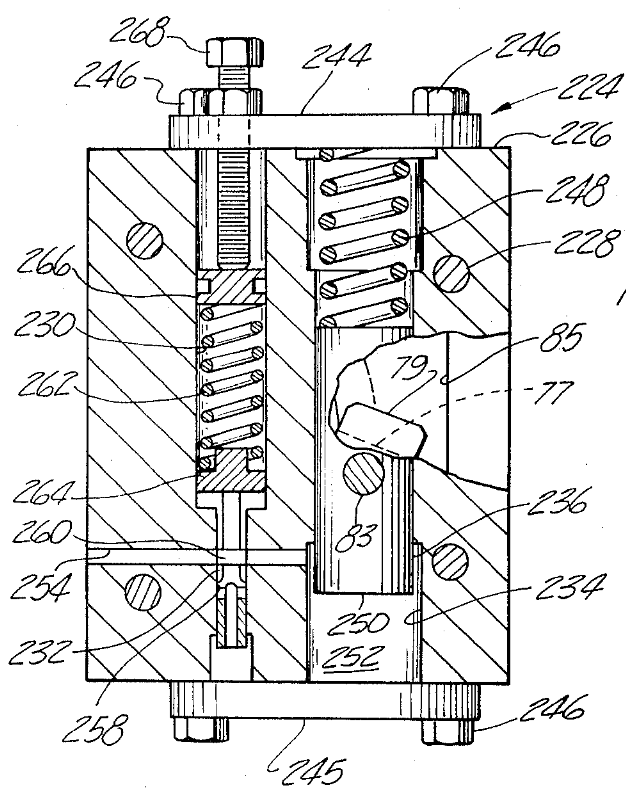


Fig-11

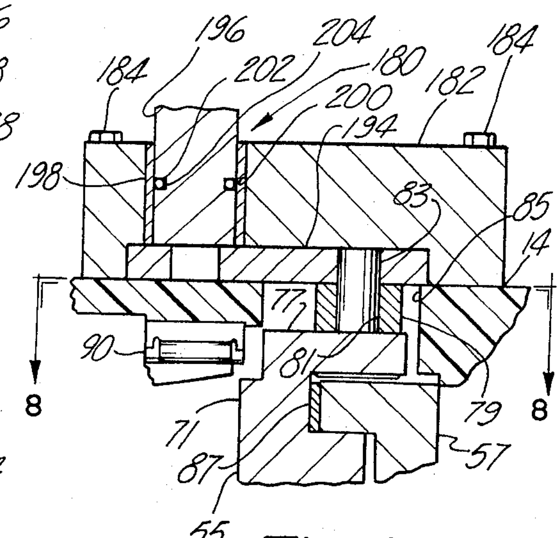


Fig-9

FLUID DEVICE HAVING MEANS FOR ALIGNING A CYLINDER BARREL

This is a division of co-pending U.S. Pat. Application Ser. No. 60,333 filed Aug. 3, 1970, now U.S. Pat. No. 3,739,691.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to fluid devices and particularly to those of the axial piston type which may function either as a fluid pump or as a fluid motor.

2. Description of the Prior Art

Heretofore, fluid pumping or motoring devices of the axial piston type have been constructed of a metallic housing having a revolving cylinder barrel with a plurality of parallel cylinder bores herein, within which pistons are reciprocated by means of a thrust plate assembly or the like. A rotary valve mechanism in the form of cylinder ports at one end of the cylinder barrel alternately connects each cylinder bore with an inlet and an outlet passage of the device as the cylinder barrel is rotated.

The thrust plate assembly in fluid devices of the variable displacement type normally takes the form of a yoke having transversely extending pintles rotatably carried in bearings suitably mounted to the wall of the housing such that the entire force exerted against the thrust plate assembly due to the fluid pressure acting against the piston within the cylinder barrel bores is taken by the housing, thus necessitating a strong metal housing. Such metal housings are expensive in that they must be cast molded and subsequently require a machining operation to provide the necessary precision that is needed in such constructions. It would be desirable to provide a housing for such axial piston fluid devices, constructed of a plastic material which would eliminate the subsequent machining operations and the resulting expenses normally incurred in using such metal housings. For example, housings constructed for fluid devices having the same displacement capacity would cost approximately $2.00 for a metal housing as compared to $.60 for a housing constructed of a plastic material. The equipment needed to manufacture a metal housing costs approximately $750,000.00 as compared to $3,500.00 for an injection mold which would be used in constructing a housing of a plastic material.

Further, heretofore fluid devices of the variable displacement type have used a thrust plate assembly which is normally of a metal construction such as cast iron or steel which, in addition to requiring substantial machining, adds to the overall weight of the device. It would be desirable to replace such cast iron and/or steel thrust plate assemblies with one constructed of a sintered material which, heretofore, has not been possible because of the high loads and complicated shape that such thrust plate assemblies require.

In addition to the high loads transmitted to the thrust plate assembly, suitable means must be provided which permit an easy movement of the thrust plate assembly with respect to the longitudinal axis of the drive shaft on which the cylinder barrel is rotated so as to vary the amount of reciprocal stroking movement imparted to the pistons within the cylinder bores to thereby permit a selected variation in the displacement of such axial piston fluid devices.

In such previously constructed axial piston fluid devices, the displacement control mechanism used to control the inclination of the thrust plate assembly with respect to the longitudinal axis of the drive shaft has necessitated a different design for both the fixed displacement device and the variable displacement pump as the displacement control mechanism is normally constructed as part of the housing in such variable displacement devices, thus requiring a larger housing for the variable displacement device. Heretofore, if the same housing were used for both variable and fixed displacement units, a larger housing would have been required since portions thereof would be used to mount the displacement control mechanism. The use of such a variable displacement housing in a fixed displacement unit results in an unduly large unit in proportion to its displacement. It would therefore be desirable to provide a housing which is constructed for both variable displacement and fixed displacement devices without requiring a larger housing for the variable displacement design.

It is also a conventional practice that such previously used devices have been normally constructed to use only one type of displacement varying control mechanism, whereas it may be desirable to have a fluid device having a housing construction which is adaptable for use with manual controls, pressure compensated controls and the like, thus eliminating the necessity of having several different housing designs for the same capacity unit so as to accommodate different displacement control applications.

Fluid devices of the axial piston type normally are characterized by having a valving face formed by a flat surface on which the cylinder barrel normally runs in abutment and in a fluid sealing relationship. The abutting face of the cylinder barrel on which the cylinder ports are disposed normally has been provided with arcuately spaced elevated pressure pads disposed radially outwardly from the cylinder ports providing a bearing surface on which the cylinder barrel rides in a manner which avoids excessive wear. Such bearing pads are more commonly referred to as "Kingsbury Pads" and have functioned in an acceptable manner in the past to compensate for wear and variations in oil viscosity due to changing temperatures and different fluids. In devices of this type operating at high speeds and high pressures, considerable difficulty may be experienced in providing a satisfactory running surface between the cylinder barrel and the valving face due to a lack of oil flow across the face of the cylinder barrel from the cylinder ports to the Kingsbury pads.

It would therefore be desirable to provide a new and improved Kingsbury pad for such axial piston fluid devices.

As speed and pressure is increased in such previously used fluid devices, there is always an accompanying increase in noise. This general increase in noise with increased speed and pressure may be attributed to a number of factors in devices of the axial piston type. First, the sound frequencies generated by the device increase with speed as the components of the device are subjected to increased alternating impact forces; second, the intensity of speed related sounds increases as the impact forces between components of the device increase; and third, the excitation spectrum of the significant piston harmonics also broadens, thus increasing the number of resonant responses.

It would therefore be desirable to provide a fluid device wherein the attendant noise and vibration levels are significantly reduced.

SUMMARY OF THE INVENTION

The present invention, which will be described subsequently in greater detail, comprises a fluid pumping or motoring device of the axial piston type having construction which permits the adaptation of an outer plastic housing with a substantially large percentage of the rotating parts thereof constructed of a sintered material, providing an axial piston fliud device adapted for use over a wide range of applications.

It is therefore an object of the present invention to provide a rotary fluid device of the axial piston type having an improved construction which is readily adapted to low cost manufacturing.

It is also an object of the present invention to provide a rotary fluid device of the axial piston type having an improved cylinder barrel construction resulting in a reduction in surface wear and galling between the cylinder barrel and the valving face.

It is also an object of the present invention to provide a rotary fluid device of the axial piston type having an improved thrust plate assembly resulting in greater reliability and long life while operating at high pressures and temperatures, proportioned and simplified so that it can be made inexpensively from sintered materials.

It is also an object of the present invention to provide a rotary fluid device of the axial piston type having a construction which contributes to the reduction in the general noise radiated by such a device.

It is also an object of the present invention to provide a rotary fluid device of the axial piston type having means for varying the displacement thereof, and a housing construction adaptable to accommodate a variety of displacement varying mechanisms.

Other objects, advantages, and applications of the present invention will become apparent to those skilled in the art of such fluid devices when the accompanying description is read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and in which:

FIG. **1** is a longitudinal cross sectional view of a fluid device incorporating a feature of the present invention;

FIG. **2** is a longitudinal cross sectional view of the fluid device illustrated in FIG. **1** and taken generally on line **2—2** thereof;

FIG. **3** is a fragmentary transverse cross sectional view of the fluid device of FIG. **1** and illustrating a component thereof and taken generally on line **3—3** of FIG. **2**;

FIG. **4** is a side view of the component illustrated in FIG. **3**;

FIG. **5** is a fragmentary, exploded view of the fluid device illustrated in FIG. **1**;

FIG. **6** is a fragmentary cross sectional view of a fluid device incorporating another feature of the present invention;

FIG. **7** is a fragmentary, transverse, cross-sectional view of the fluid device illustrated in FIG. **6** and taken on lines **7—7** thereof; and

FIGS. **8** through **11** are fragmentary views of several modifications of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, and particularly FIGS. **1** and **2**, there is illustrated a fluid device in the form of an axial piston pump **10** comprising a housing **12** having a body section **14** constructed of a plastic material and a longitudinally disposed bore **18** enclosed by a cap **20** secured to the body section **14** by bolts **22** extending axially through the cap **20** and the body section **14** and threadedly engaging clamps **15.** An O-ring **24** insures a fluid tight seal between the juncture of the body section **14** and the cap **20.** The body section **14** includes a pilot portion **26** forming a mounting flange **28** having mounting holes **30** extending therethrough to permit the mounting of the pump **10** at a desired location. The housing bore **18** provides a chamber **32** in which a rotating group **33** is positioned. The rotating group **33** includes a cylinder barrel **34** which is provided with a plurality of arcuately spaced cylinder bores **36,** each having one end of a piston **38** axially slidable therein. A plurality of cylinder ports **40** axially aligned with each cylinder bore **36** communicate each of the cylinder bores **36** with a front face **42** of the cylinder barrel **34.** Each of the pistons **38** have spherical ends **44** on which are swaged socketed shoes **46.** The cylinder barrel **34** is positioned axially between a valving face **48** formed on the inner face of the cap **20** and an inclined thrust plate assembly **50.** The valving face **48** serves in a well known manner to provide a properly phased connection between the cylinder ports **40** and a pair of arcuate ports **52** and **54** such that the cylinder ports **40** communicate successively with the arcuate ports **52** and **54** as the cylinder barrel **34** rotates. The arcuate ports **52** and **54** are, respectively, connected to the external inlet and outlet connection ports **53** and **55** of the pump **10.**

The piston shoes **46** have outwardly extending flanges **56** which are contacted by an annular cage **58** with holes corresponding to each piston **38.** The annular cage **58** has a centrally disposed conical bore **62** adapted to contact a spherical outer surface **64** of a collar **66** which is, in turn, carried on a drive shaft **68** that extends longitudinally through the housing bore **18.** A spring **70** disposed between the piston end of the cylinder barrel **34** and the collar **66** exerts a force urging the face **42** of the cylinder barrel **34** into engagement with the valving face **48,** while at the same time biases the shoes **46** by means of the collar **66** and the annular cage **58** into engagement with the thrust plate assembly **50.** The drive shaft **68** is supported between bearings **72** and **74.** The bearing **72** is carried in a bore **75** of a decreased diameter at the thrust plate assembly end of the housing **12** while the bearing **74** (shown only in FIG. **1**) is carried in a centrally disposed bore **76** within the cap **20.** The drive shaft **68** is effective to transmit torque from a prime mover (not shown) to the cylinder barrel **34** through a splined driving connection **78** in a conventional manner. A conventional shaft seal **80** is provided in the decreased diameter bore **75** and retained in position by a snap ring **82.**

The cylinder barrel **34** is provided with a skirt portion **84** snuggly fitted in a recessed portion **86** at the piston end of the cylinder barrel **34** to form an inner race **88** for roller bearings **90**; the outer race **92** of which is carried by the body section **14** in abutment with the thrust plate assembly in a manner which will be described in greater detail hereinafter. The skirted portion **84** has an annular inclined inner surface **96** extending upwardly from the cylinder barrel **34** and terminating in such a manner that the thrust plate assembly end **98** of the inner race **88** is flush with the thrust plate assembly end **100** of the roller bearings **90.** Heretofore, fluid devices have been constructed with the inner race of the bearing extending beyond the roller bearings the same distance as the outer race. By having the end **98** of the inner race **88** flush with the end **100** of the roller bearings **90,** a greater diameter of thrust plate assembly **50** with respect to the longitudinal axis is provided which may increase the displacement capacity of the pump **10** by as much as **15%** as compared to fluid devices heretofore constructed by allowing the pistons to operate on a larger piston bore circle. The piston bore circle is a circle defined by the longitudinal axes of the pistons **38** as the same rotate about the longitudinal axis of the shaft **68.** As the diameter of the piston bore circle is increased, the diameter of each piston bore **36** may likewise be increased, thus the displacement of the pump **10** may be increased without increasing the overall size thereof.

The face **42** of the cylinder barrel **34** which is substantially identical to the configuration illustrated in FIG. **7,** comprises a plurality of bearing pads **102,** separated from one another by radial grooves **104** and separated from the balancing lands **106** of the cylinder ports **40** by an annular groove **108.** The bearing pads **102** are generally referred to as "Kingsbury pads" and function in a manner well known in the art. The bearing pads **102** are further provided with a concave contour on the inner wall **110** facing the cylinder ports **40** to provide a large oil pool to aid in lubricating the bearing pads **102** as the cylinder barrel **34** rotates. The oil pools decrease excessive wear during high temperature and high speed operations, thereby increasing the life of the face **42** of the cylinder block **34.**

As can best be seen in FIG. **7,** the cylinder ports **40** are arranged in a circle, having a radius equal to the radius of the arcuate ports **52** and **54** (shown in phantom lines in FIG. 7) so that communication will be maintained throughout the full length of the arcuate ports **52** and **54.** This communication will be interrupted whenever a cylinder port **40** moves across a cut-off portion or space separating the arcuate ports **52** and **54.**

With reference to FIGS. **1** and **2,** as the cylinder barrel **34** rotates, a reciprocating stroking motion is imparted to the pistons **38** due to the inclination of the thrust plate assembly **50,** thus a relative reciprocating motion between the cylinder barrel **34** and the pistons **38** results as the cylinder barrel **34** rotates wherein the cylinder bores **36** are alternately compressed and expanded, resulting in fluid being drawn into and expelled from the cylinder bores **36** through the cylinder ports **40.**

From the foregoing it can be seen that when a rotary movement is imparted to the outer end **112** of the drive shaft **68,** the cylinder barrel **34** will be revolved to alternately register the cylinder bores **36** with the arcuate ports **52** and **54** of the valving face **48** by means of the cylinder ports **40.**

Referring to FIGS. **1–5** for an understanding of the accompanying description of the thrust plate assembly **50** which comprises a movable yoke **55** and a fixed yoke support **57.** The fixed yoke support **57** has a U-shaped configuration, the bottom wall **59** of which has an bore **61** through which the drive shaft **68** extends. The bore **61** has an end enlarged portion **63** having an inner diameter closely fitting the outer diameter of the drive shaft support bearing **72,** and thus as can best be seen in FIG. **1** the yoke support **57** is axially aligned with respect to the drive shaft **68** when positioned on the outer periphery of the bearing **72.**

The yoke support **57** includes a pair of axially projecting sidewalls **65,** each of which has arcuately shaped bearing surface **67** supporting the movable yoke **55** on which the piston shoes **46** slidably engage as the cylinder barrel **34** is rotated so as to impart a reciprocal stroking movement to the pistons **38.** The yoke **55** has a pair of transversely extending aligned support pins **69** and **71** each of which has arcuately shaped bearing surfaces **73** contoured to meet with the arcuately shaped bearing surfaces **67** of the projecting sidewalls **65** such that the yoke **55** is adapted to pivot within the side wall bearing surfaces **67** about a axis **75** defined by the radius of the transversely extending support pins **69** and **71** in a manner which will be described in greater detail hereinafter.

The yoke support pin **71** includes a L-shaped arm **77** integrally formed therewith and projecting rearwardly away from the support pin **71.** The projecting leg of the arm **77** carries a member **79** (FIGS. **1** and **2**) having a slot **81** in which a connecting pin **83** is disposed. The connecting pin **83** extends through an opening **85** formed in a sidewall of the body section **14** and is adapted to be coupled to any one of several displacement varying mechanisms such as the types disclosed in the aforementioned patent application. The opening **85** is so sized as to permit the member **79** to be positioned therethrough onto the arm **77** during assembly with the connecting pin **83** extending through the housing body section **14** and adapted to pivot about the axis **75** defined by the radius of the support pins **69** and **71** without interference with the sidewall of the housing bore **85 14.** As can best be seen in FIG. **2,** the preferred axis of rotation for the connecting pin **83** and for purposes of description the longitudinal axis of the support pins **69** and **71,** is the axis **75** passing through the center point about which each of the arcuate bearing surfaces **73** is formed. The axis **75** should intersect the plane at which the centers of the spherical piston ends **44** lie and may also intersect the longitudinal axis of the drive shaft **68.** However, the axis **75** may be vertically offset from the drive shaft axis, in a well known manner, depending upon the desired results.

The arcuately shaped bearing surfaces **67** formed on the sidewalls of the yoke support **57** are in the form of a plastic bearing **87,** such as a teflon-lead bearing or the like, which provides the necessary support to withstand the load transmitted through the pistons **38** and the movable yoke **55,** while at the same time offering the least amount of frictional resistance to the pivotal movement of the yoke **55** therewithin. The plastic bearings **87** have a central aperture **89** (FIG. **5**) adapted to receive a boss **91** formed in each sidewall **65** to securely retain the bearing **87** on its associated sidewall **65.**

The yoke **55** has a circular thrust bearing face **93** with which the shoes **46** cooperate and a hemispherical cross section **95** (FIS. **5**) with an elliptical, centrally disposed bore **97** through which the drive shaft **68** extends. The elliptical shape of the bore **97** permits the yoke **55** to rotate about the shaft **68** without interference therewith. Since the yoke **55** and the yoke support **57** are both constructed of a sintered material, the radial thickness **99** (FIG. 5) of support pins **69** and **71**, as measured from the bearing face **93** to the bottom of the support pin bearing surface **73** must be at least 40% of the total thickness or longitudinal **101** of the yoke **55** as measured from the bearing face **93** to the bottom thereof to assure that the yoke **55** will withstand the loads to which it is subjected, while the L-shaped arm **77** extending from the support pin **71** should have a length which is at least equal to the yoke thickness **101** in order to provide good fill characteristics when the same is manufactured.

The amount of friction between the bearing surfaces of the yoke **55** and the yoke support **57** will be directly proportional to the load exerted thereon, while the frictional torque is in direct proportion to the radius of the arcuate bearing surfaces or **73**. In the present design the radius of the bearing surfaces is kept to a minimum, and thus the frictional torque minimized. It should also be noted that present construction of the yoke **55** and the yoke support **57** results in the length **103** and the thickness **101** of the yoke **55** being respectively shorter and greater than comparable components of presently used devices. The shorter length and increased thickness of the yoke **55** reduces unit vibrations and results in an extremely quiet pump compared to such presently used designs.

Since the periphery of the yoke support **57** is rectangular and the periphery of the yoke **55** is circular, each corner **117** of the yoke support **57** will project radially outwardly beyond the yoke **55** as illustrated in FIG. 3 in phantom lines. As can best be seen in FIG. 2, the bearing **90** is axially positioned with respect to the center of each piston ball **44** by the abutment of the thrust plate facing side **94** of outer race **92** against the corners **117** of the yoke support **57**. This arrangement provides a simple construction which insures proper axial alignment, which is essential for a smooth, efficient and accurate operation of the pump **10**.

Referring now to FIGS. 6 and 7 wherein there is illustrated a modification of the present invention in the form of a variable displacement axial piston pump **120** comprising a housing **122** having an internal bore **124** enclosed by a cap **126** by means of screws (not shown) extending through the cap **126** and into threaded bores within the housing **122**, the pump **120** is similar to the pump **10** disclosed in FIGS. 1 and 2 in that it is provided with a drive shaft **68** on which a cylinder barrel **34** is rotatably mounted and having a plurality of parallel cylinder bores **36** and cylinder ports **40** through which fluid communication to arcuate passageways **52** and **54** (FIG. 7) in the valving face **48** formed on the inner face of the cap **126** for directing fluid from an inlet port (not shown) to an outlet port (not shown). Radial support for the cylinder barrel **34** is provided by roller bearings **90** in the same manner as described hereinbefore. Each of the cylinder bores **36** has a piston **38** reciprocably mounted therein with the pistons **38**, in turn, having rounded ends **44** on which piston shoes **46** are positioned against a thrust plate assembly **50** by means of the contact cage **58**, the collar **66** and spring **70** in a manner substantially identical as hereinbefore described.

The thrust plate assembly **50** comprises the fixed yoke support **57** carried on the inner wall of the housing **122** by bearing **75** and includes a pair of axially projecting sidewalls **65**, each of which has an arcuately shaped bearing surface **67** supporting a movable yoke **136** on which the piston shoes **46** slidably engage as the cylinder barrel **34** is rotated so as to impart a reciprocal stroking movement to the pistons **38**. The yoke **136** has a pair of transversely extending, aligned support pins **138**, each having arcuately shaped bearing surfaces **140** contoured to mate with the arcuately shaped bearing surfaces **67** of the projecting sidewalls **65**, such that the yoke **136** is adapted to pivot within the sidewall bearing surfaces **67** about the axes **75** of the transversely extending support pins **138** (only one of which is shown in FIG. 6). The yoke **136** includes a pair of transverse arms **142** and **144** which project in a plane perpendicular to the support pins **138** and have rounded bearing surfaces **146** and **147** at their projecting ends which respectively cooperate with a pair of pistons **148** and **150** to rotate the yoke **136** within the bearing surface **67** in a manner which will be described in greater detail hereinafter.

The pistons **148** and **150** are slidably mounted for reciprocal movement, respectively, within sleeve members **152** and **154** which, in turn, are carried within stepped bores **156** in the cap **126**. Each sleeve member **152** and **154** has an enlarged end portion **158** which abuts a step **160** within bores **156**, and is secured to the cap **126** by screws **162** extending through cover plates **164** and **166** into threaded bores **168** within the cap **126**. The inner ends of each sleeve member **152** and **154** abuts one side of the outer race **92** of the roller bearings **90** to maintain the opposite side **94** of the outer race **92** in abutment with the corner **117** formed on the yoke support **57** in the same manner hereinbefore described with respect to the pump **10**. As can best be seen in FIGS. 6 and 7, the sleeve members **152** and **154** have a sufficient radial thickness such that the pistons **148** and **150** will traverse the outer surface of the outer race **92** without interference therewith.

The sleeve member **152** has a spring **170** in compression between the cover plate **164** and the piston **148** biasing the piston **148** to engage the round bearing surface **146** of the arm **142** and rotate the yoke **136** so as to stroke the yoke **136** to a full displacement position, that is, the yoke is at an angle with respect to the longitudinal axis of the drive shaft **68** that permits the greatest degree of relative reciprocal stroking movement between the pistons **38** and the cylinder bores **36**.

The interior **153** of the sleeve member **154** is adapted to be communicated to a source of pressure through a pressure compensated valve **172** or the like, which selectively controls the pressure admitted to the interior of the sleeve member **154** to move the piston **150** against the bearing surface **147** of the arm **144** to selectively position the yoke for controlling the inclination of the thrust plate with respect to the longitudinal axis of the drive shaft **68**. Thus, the displacement of the pump **10** may be varied to provide any desired output from a minimum output to a maximum output.

The cylinder barrel **34**, the piston shoes **46**, the yoke **136** and the yoke support **57** are all constructed of a sintered metal which, in addition to reducing the weight of the pump **120**, increases the lubricating characteristics of the rotating components and results in a fluid device which is substantially less expensive to manufacture than fluid devices previously used.

The plastic housing illustrated in FIG. 2 has an outer annular recessed portion **270** at the drive shaft end thereof on which the elongated metal clamps **15** are carried. By tightening the bolts **22** within threaded bore **280** in the clamps **15**, the plastic body section **14** may be precompressed to a predetermined amount, which is a function of the pressure at which the pump **10** will operate. During operation of the pump **10**, the pressure within each cylinder bore **36** generates a force against each piston **38** which acts in a direction normal to the face of the cylinder barrel **34**. This force can be resolved in an axial component force and a radial component force acting at the center of the spherical piston ends **44**. These forces tend to exert a load on the plastic body section **14** of the housing **12** which tends to longitudinally expand the same. By precompressing the plastic body section **14** by a predetermined amount, the effect of the expansion loads exerted on the plastic body section **14** by internal forces of the rotating group **33** will be cancelled.

Thus, it can be seen that the present invention has provided a rugged, compact and low cost fluid device of the axial piston type that can function as a motor or a pump and which has an improved means for mounting the cylinder barrel and for varying the displacement thereof.

While the forms of the embodiments of the invention as disclosed herewithin constitute a preferred form, it is to be understood that other forms might be adopted, all coming within the spirit of the invention and the scope of the appended claims.

What is claimed is as follows:

1. A fluid pressure energy translating device of the axial piston type, comprising: a housing; a cylinder barrel rotatably mounted within said housing, said cylinder barrel having a plurality of arcuately spaced cylinder bores and cylinder ports communicating each of said cylinder bores with one end of said cylinder barrel; a plurality of pistons with inner ends disposed for reciprocal stroking movement within said cylinder bores; a valve face having arcuate passages; said valve face and said one end of said cylinder barrel being disposed for relative rotary movement with said cylinder ports communicating successively with said arcuate passages in said valve face; thrust plate means comprising a yoke support fixedly mounted in said housing and a yoke movably supported by said yoke support, said yoke being in a driving relationship with the other ends of said pistons for imparting said reciprocal stroking movement to said pistons within said cylinder barrel bores as said cylinder barrel rotates; bearing means having an outer race carried within said housing, an inner race carried around a portion of the peripheral surfaces of said cylinder barrel, said bearing means providing radial support for said cylinder barrel, said bearing means being in contact with said yoke support at a plurality of circumferentially spaced locations for properly locating said cylinder barrel with respect to said yoke; said outer race being carried by said housing concentric with said housing bore; said means for varying the inclination of said yoke comprising a pair of sleeve members each disposed along an axis paralleling the axis of said shaft and radially outwardly spaced from the peripheral surface of said cylinder barrel, each of said sleeve members having one end of a piston member reciprocably mounted therein, the other ends of said piston members adapted to abut a portion of said yoke to pivot said yoke, said sleeve members being radially spaced a distance from the centerline of said shaft axis to abut the outer race of said bearing means at locations which are between said cylinder barrel and said sleeve members to maintain said bearing races in abutment with said yoke support, said piston members carried within said sleeves being so spaced from said longitudinal axis of said shaft to freely reciprocate in a spaced relationship from the outer periphery of said outer race.

2. The fluid pressure energy translating device defined in claim **1** further comprising a plurality of roller bearings disposed between said inner and outer races, the yoke facing ends of said roller bearings and said inner race being substantially flush; a portion of said inner race extending beyond said other end of said cylinder barrel and having an annular inclined inner surface flared upwardly from said other cylinder barrel end and toward said yoke facing end of said inner race.

3. A fluid pressure energy translating device of the axial piston type, comprising: a housing having a longitudinal bore; first bearing means mounted in said bore; a shaft rotatably supported by said bearing means; a cylinder barrel drivingly connected to and rotatable with said shaft, said cylinder barrel having a plurality of arcuately spaced cylinder bores and cylinder ports communicating each of said cylinder bores with one end of said cylinder barrel; a plurality of pistons with inner ends disposed for reciprocal stroking movement within said cylinder bores; a valve face having arcuate passages; said valve face and said one end of said cylinder barrel being disposed for relative rotary movement with said cylinder ports communicating successively with said arcuate passages in said valve face, said first bearing means being spaced from said cylinder barrel a fixed distance; thrust plate means comprising a U-shaped yoke support journalled on said first bearing means and in abutment with said housing, said yoke support having longitudinally extending and laterally spaced legs defining concave bearings therein between and corners at the extended ends of said yoke support legs, a movable yoke having correspondingly shaped bearing surfaces mating with said yoke support bearing surfaces, such that said yoke is movably supported by said yoke support; said yoke being in a driving relationship with the other ends of said pistons for imparting said reciprocal stroking movement to said pistons within said cylinder barrel bores as said cylinder barrel rotates; second bearing means having an outer race carried around a portion of the peripheral surfaces of said cylinder barrel, said second bearing means providing radial support for said cylinder barrel, the four corners of the yoke support defined by said extended ends providing abutments to support said second bearing means at circumferentially spaced locations on said second bearing means for properly locating said cylinder barrel with respect to said yoke.

4. The fluid pressure energy translating device defined in claim **3** further comprising a plurality of roller bearings disposed between said inner and outer races, the yoke facing end of said roller bearings and said inner race being substantially flush, a portion of said inner race extending beyond the other end of said cylinder barrel and having an annularly inclined inner surface flared upwardly from said other cylinder barrel end and toward said yoke facing end of said inner race.

5. The fluid pressure energy translating device defined in claim 3, further comprising: means for varying the inclination of said yoke with respect to the longitudinal axis of said shaft for selectively varying the amount of reciprocal stroking movement imparted to said pistons within said cylinder barrel bores.

6. A fluid pressure energy translating device of the axial piston type comprising:

a housing;

a cylinder barrel rotatably mounted within said housing, said cylinder barrel having a plurality of arcuately spaced cylinder bores and cylinder ports communicating each of said cylinder bores with one end of said cylinder barrel;

a plurality of pistons with inner ends disposed for reciprocal stroking movement within said cylinder bores;

a valve face having arcuate passages, said valve face and said one end of said cylinder barrel being disposed for relative rotary movement, with said cylinder ports communicating successively with said arcuate passages in said valve face;

an inclined thrust plate comprising a yoke support fixedly mounted in said housing and a yoke movably supported by said yoke support, said yoke being in a driving relationship with the other end of said piston for imparting a reciprocal stroking movement to said pistons within said cylinder barrel as said cylinder barrel rotates;

means for varying the inclination of said yoke with respect to the longitudinal axis of rotation of said cylinder barrel for selectively varying the amount of reciprocal stroking movement imparted to said pistons as said cylinder barrel rotates;

bearing means having an outer race carried by said housing concentric with said housing bore;

an inner race carried around a portion of the peripheral surface of said cylinder barrel;

a plurality of roller bearings disposed between said inner and outer races;

said means for varying the inclination of said yoke comprising a pair of spaced sleeve members, each disposed along an axis parallel to the axis of rotation of said cylinder barrel and radially outwardly spaced from the peripheral surface of said cylinder barrel, each of said sleeve members having one end of a piston reciprocably mounted therein, the other end of said pistons adapted to abut a portion of said yoke to pivot said yoke about an axis transversely disposed with respect to the axis of rotation of said cylinder barrel, said sleeves being radially spaced a distance from the axis of rotation of said cylinder barrel to abut the outer race of said bearing means at locations which are between said cylinder barrel and said sleeve members to maintain said outer race in contact with said yoke support at a plurality of circumferentially spaced locations for properly locating said cylinder barrel with respect to said yoke, said piston members being carried within said sleeves and so spaced from said axis of rotation of said cylinder barrel as to freely reciprocate in a spaced relationship with respect to the outer periphery of said outer race.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,868,889

DATED : March 4, 1975

INVENTOR(S) : Wilfred S. Bobier

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, Line 8, after "longitudinal" insert --length--; and

Column 7, Line 20, after "surfaces" insert --67--.

Signed and sealed this 1st day of July 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks