Sept. 20, 1966 R. D. THURBER 3,273,464

VARIABLE VOLUME ROTARY FLUID MOTOR AND PUMP

Filed April 16, 1964 4 Sheets-Sheet 1

Fig. 1

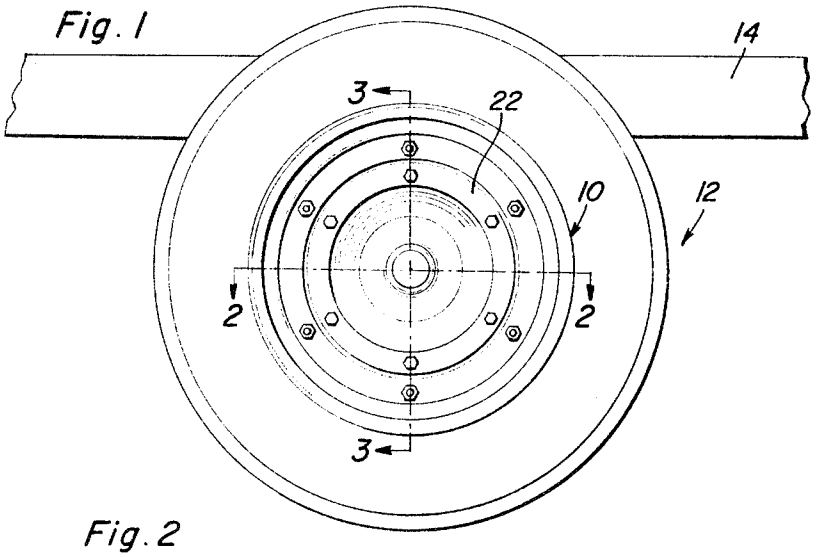
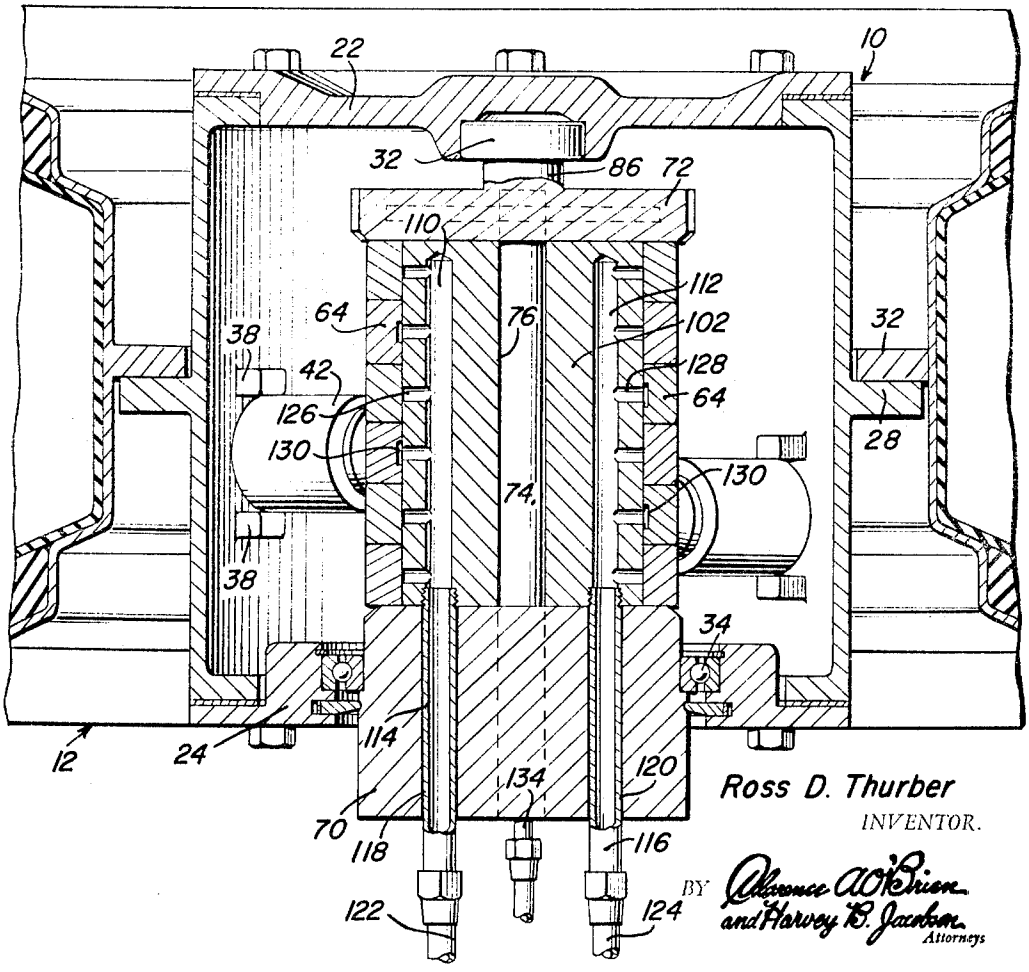


Fig. 2



Ross D. Thurber
INVENTOR.

BY Lawrence O'Brien and Harvey B. Jacobson
Attorneys

Sept. 20, 1966 R. D. THURBER 3,273,464

VARIABLE VOLUME ROTARY FLUID MOTOR AND PUMP

Filed April 16, 1964 4 Sheets-Sheet 2

Fig. 8

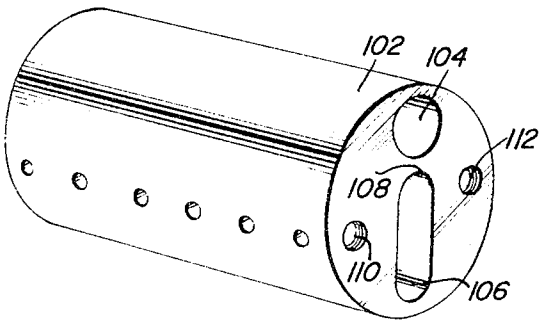


Fig. 9

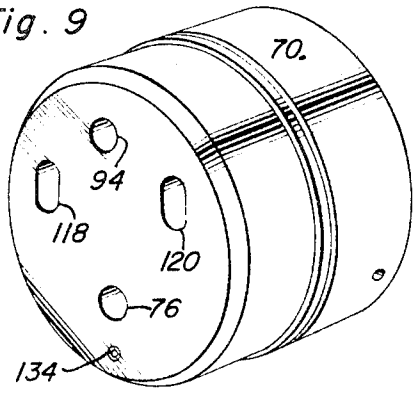
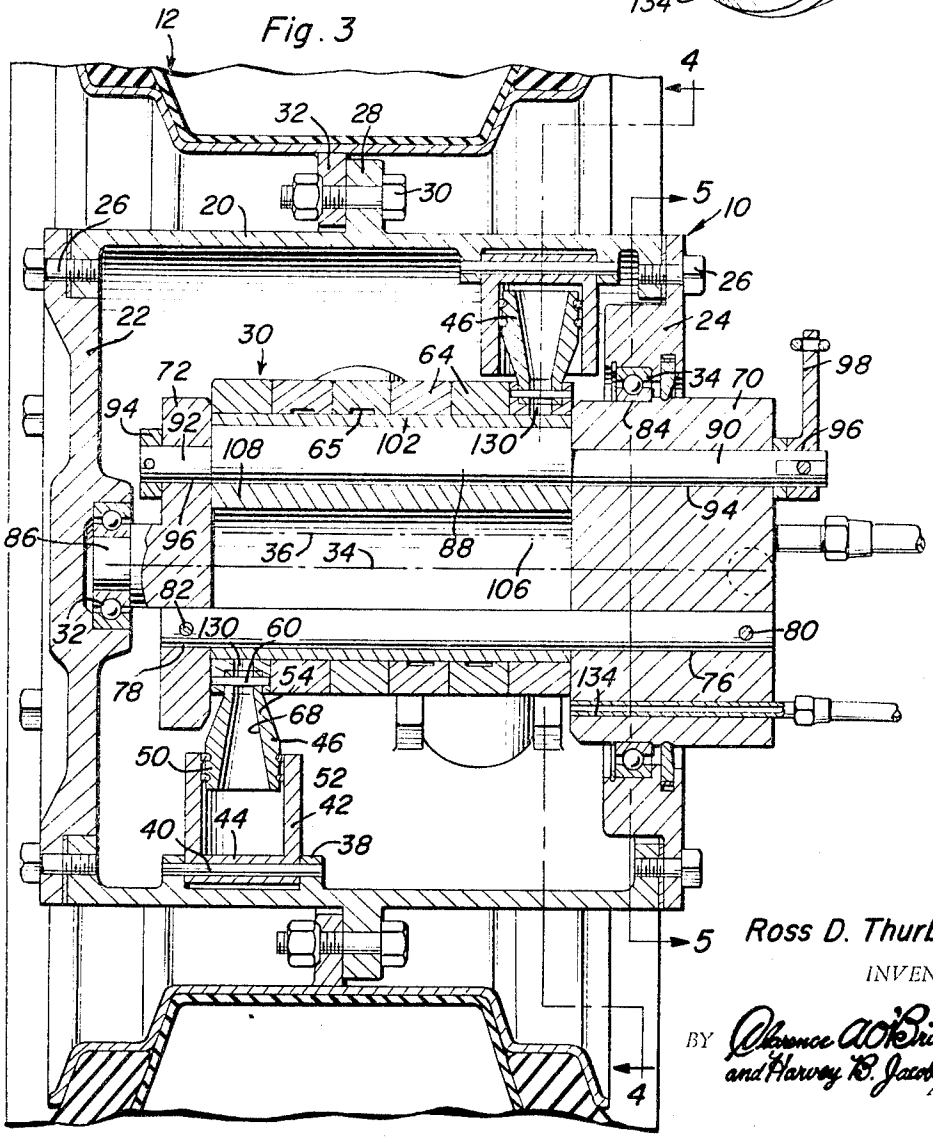


Fig. 3



Ross D. Thurber

INVENTOR.

BY Clarence A. O'Brien and Harvey B. Jacobson

Attorneys

VARIABLE VOLUME ROTARY FLUID MOTOR AND PUMP

Filed April 16, 1964 4 Sheets-Sheet 3

Fig. 4

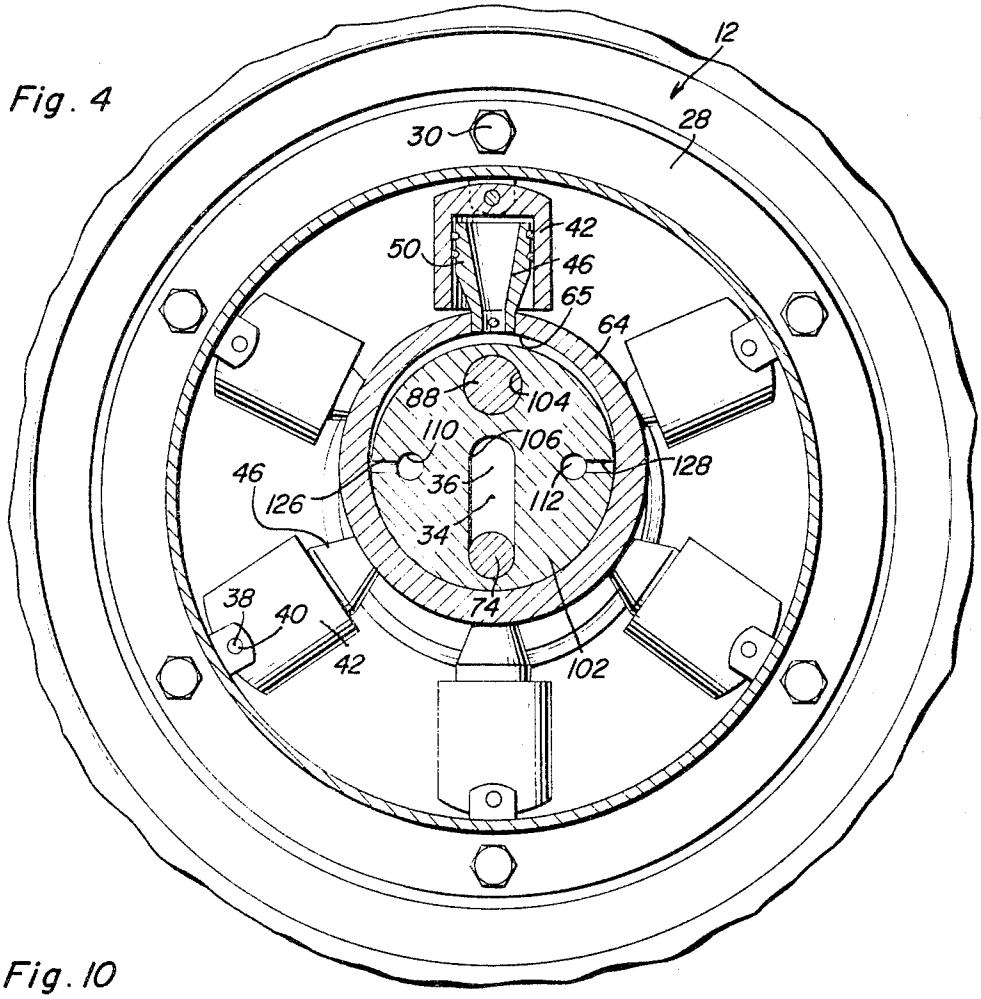
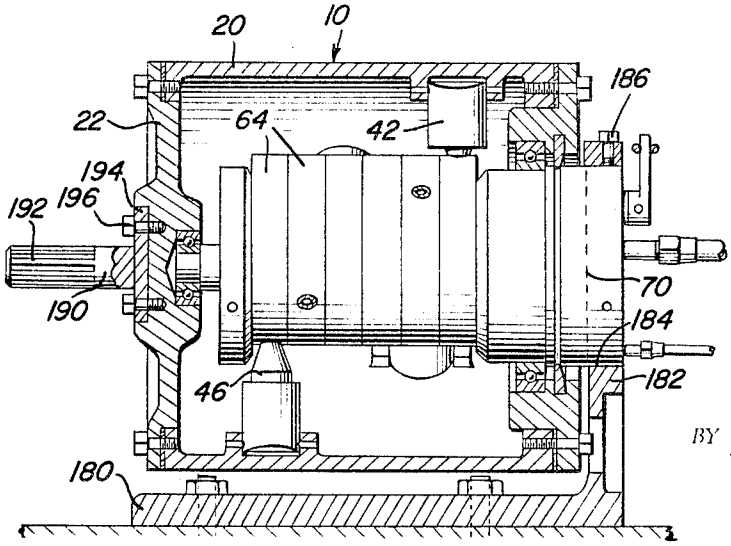


Fig. 10



Ross D. Thurber

INVENTOR.

BY Clarence A. O'Brien and Harvey B. Jacobson

Attorneys

Sept. 20, 1966 R. D. THURBER 3,273,464

VARIABLE VOLUME ROTARY FLUID MOTOR AND PUMP

Filed April 16, 1964 4 Sheets-Sheet 4

Fig. 5

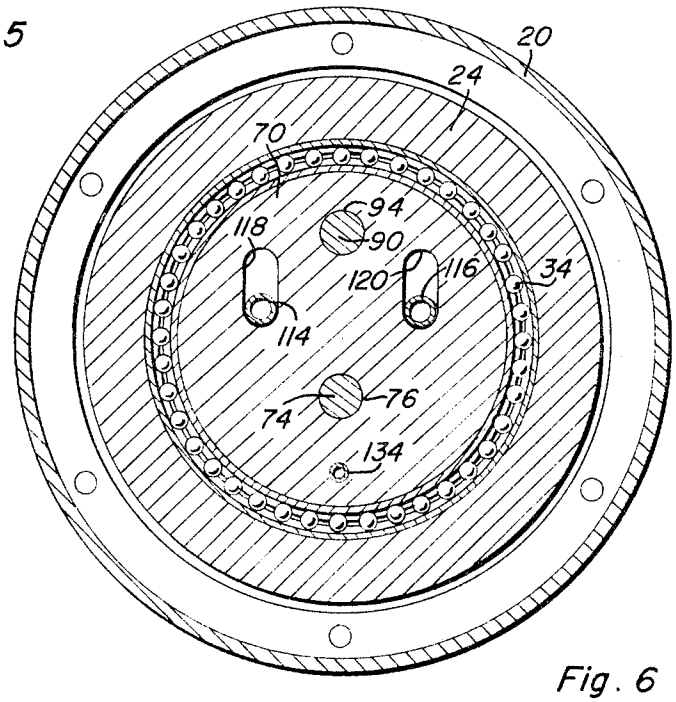


Fig. 6

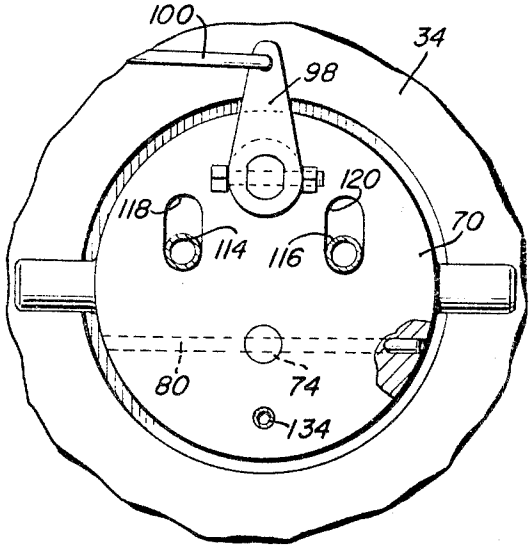
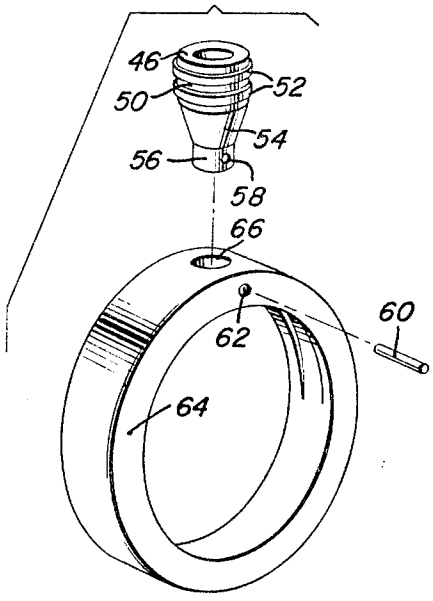


Fig. 7



Ross D. Thurber
INVENTOR.

BY Thurmon A. O'Brien and Harvey B. Jacobson
Attorneys

United States Patent Office 3,273,464 Patented Sept. 20, 1966

3,273,464
VARIABLE VOLUME ROTARY FLUID MOTOR AND PUMP

Ross D. Thurber, E. 13415 5th Ave., Spokane, Wash.

Filed Apr. 16, 1964, Ser. No. 360,191
12 Claims. (Cl. 91—204)

This invention comprises a novel and useful variable volume rotary fluid motor and pump and more particularly pertains to a rotary expansible chamber device of a compact and advantageous construction which is well adapted for a variety of uses.

The primary object of this invention is to provide a rotary fluid motor having a novel and advantageous cylinder and piston construction and mounting upon the rotary motor casing and the crankshaft.

A further object of the invention is to provide a means for adjusting the piston stroke of a rotary motor of the reciprocating piston type and which adjustment is actuatable during the operation of the motor.

Another important object of the invention in accordance with the preceding objects is to provide a very compact arrangement of the cylinder and pistons and their connections to the motor casing and crankshaft component of the device.

Still another important object of the invention in compliance with the preceding objects is to provide a rotary motor having a novel crankshaft arrangement wherein a cylindrical sleeve is adjustably mounted upon a stationary shaft to form therewith an adjustable throw crankshaft about which the pump pistons continuously revolve and through which motive fluid is supplied to and discharged from the motor cylinders.

Yet another object of the invention in accordance with the preceding objects is to provide a rotary motor having a stationary shaft assembly comprising a hub about which the motor housing and cylinders rotate and upon which the motor housing is revolvably supported.

An additional object in accordance with the preceding objects is to provide a rotary motor having a stationary shaft assembly including an adjustable crankpin sleeve and with the reciprocating motor pistons being individually journaled in side-by-side relation by connector rings upon the sleeve and with the sleeve and connector rings comprising rotary valves controlling the flow of motor fluid to and from the individual cylinders through their associated pistons.

A still further object is to provide a device in accordance with the preceding objects wherein a rotary motor assembly having a readily and controllably variable volume and which may be directly connected to or built into the hub portion of a wheel, power tool or other apparatus to establish a direct drive therewith is provided.

And a final object of the invention to be specifically enumerated herein resides in the provision of a rotary motor assembly ideally adapted for mounting within a vehicle wheel in a direct driving relation thereto.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a front elevational view of a preferred form of a fluid motor in accordance with this invention which is embodied in a wheel hub for rotation therewith, parts of a vehicle chassis upon which the wheel is mounted being broken away;

FIGURE 2 is a horizontal central longitudinal sectional view taken upon an enlarged scale substantially upon the plane indicated by the section line 2—2 of

FIGURE 1, parts of the wheel hub and of the motor fluid conduits being broken away;

FIGURE 3 is a vertical central longitudinal sectional view taken upon an enlarged scale substantially upon the plane indicated by the section line 3—3 of FIGURE 1, parts of the wheel hub and of the motor fluid conduits being broken away;

FIGURE 4 is a vertical transverse sectional view taken substantially upon the plane indicated by the broken section line 4—4 of FIGURE 3 and showing the mounting of the cylinder and piston components of the device;

FIGURE 5 is a vertical transverse sectional view taken substantially upon the plane indicated by the section line 5—5 of FIGURE 3 and showing the disposition of the various bores in the head member of the stationary shaft assembly;

FIGURE 6 is an end elevational view of the rotor hub and of the head member of the stationary shaft assembly comprising an end elevational view at the right side of FIGURE 3;

FIGURE 7 is an exploded perspective view of a piston connecting ring for securing a piston to the motor crankshaft;

FIGURE 8 is a perspective view of the eccentric adjustable crank sleeve forming the crankpin of the shaft assembly of the motor;

FIGURE 9 is a perspective view of the head member of the stationary shaft assembly which comprises the rotor hub of the motor; and,

FIGURE 10 is a vertical central longitudinal sectional view, parts being shown in elevation, of a modified construction in which the motor is mounted upon a stationary support in contrast with the wheel hub mounting of FIGURES 1–9.

Referring first to FIGURE 1, it will be observed that the numeral 10 designates generally the rotary fluid pressure motor in accordance with this invention which in the embodiment of FIGURES 1–9 is shown as being secured to and mounted within a vehicle wheel 12 of any conventional type for establishing a direct driving relation therewith. By way of example, the wheel may be one of the supporting and driving wheels of any type of vehicle, a portion of the chassis of which is indicated at 14. The chassis is supported from the wheel by an axle, not shown, which is stationary and to which the shaft assembly or crankshaft assembly of the fluid motor is rigidly mounted in any convenient manner and which in itself forms no part of the present invention and therefore is omitted from the drawings as being superfluous.

Referring now especially to FIGURES 2 and 3 it will be observed that the rotary fluid motor 10 includes a preferably cylindrical casing or housing 20 having removable end walls 22 and 24 releasably closing its opposite open ends as by means of fastening bolts 26. Preferably, the housing is provided with a medially disposed annular mounting flange 28 which by means of fastening bolts 30 may be secured to a corresponding mounting flange 32 comprising an internal mounting flange of the vehicle wheel 12 for which the fluid motor constitutes a supporting hub and driving hub assembly.

A crankshaft assembly consisting of a stationary shaft assembly indicated generally by the numeral 30 extends into the motor housing 20 and rotatably and drivingly supports the latter. For this purpose bearing assemblies 32 and 34 are formed in the end walls 22 and 24 respectively for rotatably journaling the housing 20 and thus the entire combination of the vehicle wheel and motor for rotation about a horizontal axis indicated at 34 to the stationary shaft assembly 30. The housing and the motor cylinders secured thereto rotate about this horizontal axis 34, while a piston assembly having pistons each reciprocable within

one of the cylinders is revolvably mounted for rotation about a second horizontal axis 36 which is parallel to and is adjustably displaced from the horizontal axis 34 to thereby vary the displacement of the pistons through the cylinders as set forth hereinafter.

With continuing reference to FIGURES 2, 3 and 5 it will be observed that the housing 20 upon its interior surface is provided with a plurality of pairs of apertured supporting lugs 38 and between each pair of lugs there is secured as by a pin 40 a cylinder 42 having a closed end wall 44 adjacent the housing 20 which constitutes the cylinder head and having its other end open for the reception of a hollow piston 46 slidably and sealingly engaged therein.

It is to be noted that the series of cylinders are disposed successively in a circumferentially and axially spaced relation about the interior of the housing 20 so as to effect a compact arrangement affording provision for a maximum number of the cylinder and piston units in a minimum of volume within the housing.

Referring to FIGURES 3 and 7 it will be apparent that each of the pistons 46 comprises a hollow tube consisting of a cylindrical end portion 50 provided with sealing rings 52 and which is slidably and reciprocatingly engaged in one of the cylinders 42. At its other end, the piston has a conical portion as shown at 54 which also terminates in a diametrically reduced cylindrical end portion 56 provided with a diametrically disposed aperture 58 therethrough for the reception of a fastening pin 60 adapted to be inserted in an aperture 62 in a connector ring 64 having a socket 66 therein receiving the portion 56 of the piston. It will therefore be apparent that a series of pistons are like-wise disposed in a successive axially and radially spaced disposition within the housing and about the shaft assembly 30.

As shown in FIGURE 3, the piston 46 has an axially extending conical bore 68 extending entirely therethrough and which thus is in continuous and uninterrupted communication with the interior of the cylinder 42 in which the piston reciprocates.

Referring now primarily to FIGURES 2 and 3 it will be seen that the stationary shaft assembly 30 consists of a head member 70 in the form of a drum, see FIGURE 9, together with a plate-like foot member 72. The head and foot members are rigidly connected together in fixed spaced relation by means of a rod 74 extending through bores 76 in the head member and 78 in the foot member with transversely extending pins 80 and 82 fixedly securing these elements together. It will be noted that the head member is provided with a shouldered bearing surface 84 upon its exterior surface which receives the bearing assembly 34 by which the end wall 24 of the housing 20 is rotatably journaled. The foot member 72 on the other hand has an axially projecting stub axle or pintle 86 which is received in the bearing assembly 32 whereby the other end wall 22 of the housing is rotatably journaled upon the shaft assembly.

In addition to the rod 74, there is a further member extending through the head and foot members, consisting of an eccentric shaft or drum 88 having diametrically reduced extremities at 90 and 92 which are journaled in bores 94 and 96 alined respectively in the head and foot members. A collar or other enlargement 94 is provided upon the eccentric shaft extremity 92 and the hub 96 of a manual operating handle 98 is secured upon the extremity 90 of the eccentric shaft and abuts against the head member 70 whereby the eccentric shaft is held in place in the head and foot members. It is now evident that if the handle or lever 98 is oscillated as by means of an actuating rod 100, see FIGURE 6, a corresponding oscillatory or rotational movement may be imparted to the eccentric shaft 88 for a purpose to be subsequently apparent.

Adjustably mounted upon the eccentric shaft 88 and the rod 74 is an eccentric sleeve 102, see FIGURE 8 also, which is secured between the head and foot members 70 and 72 of the shaft assembly and has a central longitudinal axis 36 adjustable toward and from the horizontal axis 34 by the eccentric shaft 88 in a manner to be now described.

Referring especially to FIGURES 3 and 8 and with additional reference being made to FIGURES 2, 4 and 5, it will be noted that the eccentric sleeve 102 is cylindrical and of uniform diameter in cross section, it being provided with an eccentrially disposed axially extending adjusting bore 104 therethrough of the same diameter as that of the eccentric shaft 88 for rotatably receiving the latter. Diametrically opposite the adjusting bore 104, sleeve 102 is provided with a diametrically elongated axially extending guide bore 106 extending from end-to-end thereof and which receives therein the guide rod 74. A relatively narrow web 108 separates the bores 104 and 106. The guide bore 106 is of sufficient extent diametrically of the eccentric sleeve to allow for the diametrical shifting of the eccentric sleeve upon rotation of the eccentric shaft 88 in the adjusting bore 104.

In addition to the bores 104 and 106, the eccentric sleeve is provided with further inlet and discharge passages 110 and 112 which form part of a means for cyclically delivering pressure motive fluid from any suitable source into the cylinders and discharging it therefrom. As shown best in FIGURE 2, the inlet and discharge passages 110 and 112 are internally threaded to receive pipes, conduits or tubular fittings 114 and 116 respectively which latter project through appropriately elongated bores 118 and 120 respectively in the head member 70. Flexible conduits or other pipes 122 and 124 respectively are connected to the members 114 and 116 to respectively supply motive fluid thereto or to discharge motive fluid therefrom.

Each of the passages 110 and 112 is provided with a series of ports 126 and 128 respectively which comprise valve ports and cooperate with corresponding ports 130 and 132, see also FIGURE 3, which are provided in the base of the sockets of the connector rings. It will thus be evident that upon rotation of the pistons and their attached connector rings about the eccentric sleeve 102 which thus constitutes a crankpin since it is offset from the axis of rotation 34 of the housing, the cooperating ports 130 in the connector rings successively register with the ports 126 and 128 for the intake of or the exhaust of pressure fluid into and from the cylinders. Thus, the crankpin itself comprises the valving means for the cyclic inlet of pressure fluid into the motor cylinders and discharge of pressure fluid therefrom upon the completion of the working stroke within the cyinders.

As will be noted from FIGURES 3 and 9 there is provided a further bore or passage 134 in the head member 70 which opens into the interior of the housing 20 and serves as a vent passage or drain passage for the discharge of any liquids accumulating in the housing 20 to any exterior destination.

From the foregoing, it is believed that the operation of the device will now be readily understood. Pressure fluid from any suitable source such as a pump, not shown, is supplied by the passage means 120, 114 and 110 and through the valve ports 126, 130 into the communicating passage 68 within the piston and thus into the interior of the associated cylinder, in proper succession as the cylinders and pistons rotate about the crankpin. This control valve action will be so timed that the fluid will be introduced at the time the combined volumes in the cylinder 42 and the hollow piston 46 is at a minimum to thus cause expansion of this volume and impart rotation to the housing. The exhaust ports 128 and 130 will register for the discharge of pressure fluid from the cylinders in succession as the cylinders reach their maximum volume at the end of their working stroke, fluid being then educted by the passage means 112, 116 and 124 back to the source of supply.

It is evident that by appropriately adjusting the eccen-

tric shaft **88** through manipulation of the lever **98** that the displacement of the axis of rotation **36** of the eccentric sleeve or crankpin of the assembly towards and from the axis of rotation **34** of the cylinder and housing unit can be readily varied from a minimum to a maximum. In some instances, these axes could be caused to coincide thus preventing any variation in volume within the cylinders and thus preventing the applying of any power to the housing to effect rotation thereof. Inasmuch as the head member **70** is stationarily secured to the stationary vehicle axle or other support structure to which the fluid motor is attached, the application of the fluid pressure in the cyclic manner above described will result in a rotation of the housing **20** about the crankpin formed by the eccentric sleeve **102**. The fluid displacement of the motor can thus be varied from a minimum to a maximum as may be desired affording a highly efficient manner for applying power from an engine driven pump to the motor units mounted in a vehicle wheel. It will be appreciated, however, that although the drawings disclose, in FIGURES 1–9, the device being mounted in the hub of a vehicle wheel, it may be applied directly to any other apparatus for the purpose of transmitting power thereto through the motive fluid supplied to the motor.

Reference is now made to FIGURE 10 which shows a modified construction in which the fluid motor is mounted upon a stationary support rather than being built into a wheel or other device. In this arrangement, the fluid motor **10** which is of an identical construction to that previously described is here shown mounted upon a stationary support base **180** having at one end thereof an upstanding mounting flange **182** provided with a mounting aperture **184** in which is received the motor head member **70**, fastening bolts as at **186** detachably retaining this head member therein. Thus, the head member is held stationary and the application of motive fluid to the fluid motor will result in rotation of the housing **20** in the manner previously described. In order to take off power from the rotating housing **20**, the end plate **22** thereof has applied thereto an axially disposed power take-off shaft **190** which is splined as at **192** for the reception of any desired element to which power is to be applied and which is provided with a mounting flange **194** secured as by bolts **196** to the end wall **22**. The operation of this form of the invention is identical to that previously described.

Referring again to FIGURE 7 in connection with FIGURES 2–4, it will be noted that the inner cylindrical or bearing surface of the connecting ring **64** has a circumferentially extending groove or channel **65** into the mid-portion of which open the ports **130**. The grooves **65** have each a cross-sectional area substantially equal to the cross-sectional area of the piston **46** communicating therewith and are of progressively greater tapering depth from their ends toward said ports **130** or their mid-portions. This construction reduces the friction and generated heat between the rings **64** and sleeve **102** to a minimum.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A rotary motor comprising a relatively stationary shaft assembly and a motor housing journaled thereon for rotation about a horizontal axis, a plurality of cylinders mounted upon the interior of said housing and rotatable therewith and directed inwardly towards said shaft assembly, a plurality of pistons each reciprocable in one of said cylinders, said shaft assembly including a crankpin comprising a cylindrical sleeve, a plurality of connecting rings rotatably journaled upon said sleeve in side-by-side relation and each fixedly connected to one of said pistons, means for cyclically delivering pressure motive fluid to and discharging it from said cylinders, means adjusting said sleeve towards and from said horizontal axis to thereby vary the stroke of said pistons in said cylinders as said cylinders and pistons revolve respectively about said horizontal axis and said crankpin.

2. The combination of claim **1** wherein said shaft assembly includes a head member and a foot member together with a rod disposed therebetween and fixedly mounted thereon, bearings on said head and foot members journaling said housing.

3. A rotary motor comprising a relatively stationary shaft assembly and a motor housing journaled thereon for rotation about a horizontal axis, a plurality of cylinders mounted upon the interior of said housing and rotatable therewith and directed inwardly towards said shaft assembly, a plurality of pistons each reciprocable in one of said cylinders, said shaft assembly including a crankpin comprising a cylindrical sleeve, a plurality of connecting rings rotatable journaled upon said sleeve in side-by-side relation and each fixedly connected to one of said pistons, means for cyclically delivering pressure motive fluid to and discharging it from said cylinders, means adjusting said sleeve towards and from said horizontal axis to thereby vary the stroke of said pistons in said cylinders as said cylinders and pistons revolve respectively about said horizontal axis and said crankpin, said shaft assembly including head and foot members with a rod disposed therebetween and fixedly mounted thereon, said adjusting means comprising an eccentric shaft rotatably journaled in both said and foot members, said sleeve having an adjusting bore extending axially therethrough and receiving said eccentric shaft and a guide bore extending axially therethrough and receiving therein said rod, said guide bore having sufficient clearance for said rod to enable shifting of said sleeve upon said rod in response to rotary adjustment of said eccentric shaft.

4. The combination of claim **3** wherein said motive fluid delivery and discharge means includes passages disposed in said sleeve together with communicating passages in said pistons opening into the associated cylinders, said sleeve and said connecting passages having registering valve ports controlling fluid flow through and registration of said piston and sleeve passages.

5. The combination of claim **1** wherein said motor fluid delivery and discharge means comprises inlet and discharge passages in said sleeve, a passage in each piston and its connecting ring continuously communicating with the associated cylinder and alternately communicating with said inlet and discharge passages.

6. The combination of claim **5** wherein said sleeve and each connecting ring having cooperating valve ports controlling fluid flow into and out of the associated cylinder.

7. The combination of claim **1** wherein each connecting ring has a socket, each piston comprising a hollow tube having one end secured in a socket and having its other end slidingly and sealingly engaged with a cylinder.

8. The combination of claim **1** wherein each piston is pinned in a connecting ring and each cylinder is pinned to said housing.

9. The combination of claim **3** wherein said adjusting bore and said eccentric shaft are of equal circular cross section, said guide body being diametrically opposite said adjusting bore and being diametrically elongated.

10. The combination of claim **3** wherein said head member includes intake and exhaust bores therethrough communicating with and forming part of said means for cyclically delivering and discharging pressure fluid.

11. The combination of claim **10** wherein said intake and exhaust bores are elongated in the direction of adjusting movement of said sleeve.

12. The combination of claim 1 wherein said cylinders and pistons are successively spaced but axially and circumferentially of said housing and shaft assembly.

References Cited by the Examiner

UNITED STATES PATENTS

1,398,788	11/1921	Mayer	91—204
1,484,960	2/1924	Peck	91—204
1,757,483	5/1930	Hele-Shaw et al.	91—204

FOREIGN PATENTS

152,695	10/1920	Great Britain.
539,399	9/1941	Great Britain.
413,377	4/1946	Italy.

MARTIN P. SCHWADRON, *Primary Examiner.*

PAUL E. MASLOUSKY, *Examiner.*