Feb. 20, 1940. H. VON TAVEL 2,190,900

MOTION TRANSMITTING MECHANISM

Filed April 4, 1938 2 Sheets-Sheet 1

Fig.1.

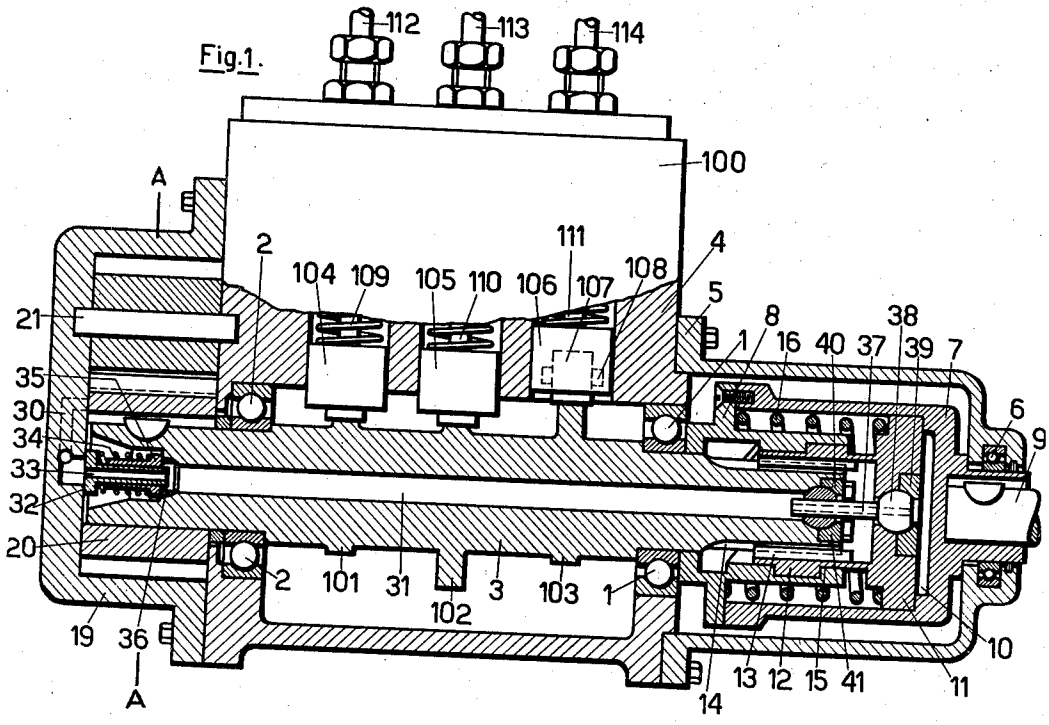


Fig.2.

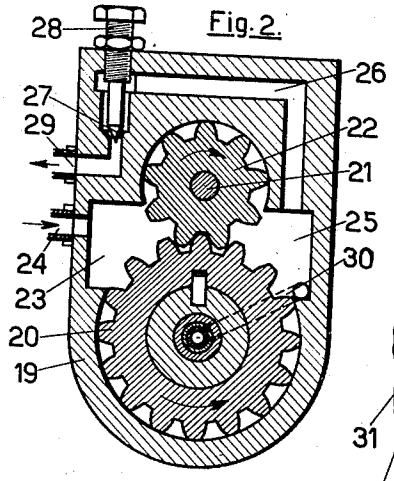
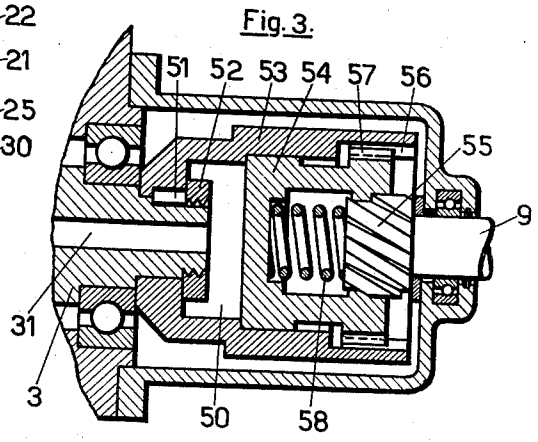


Fig.3.



Inventor:

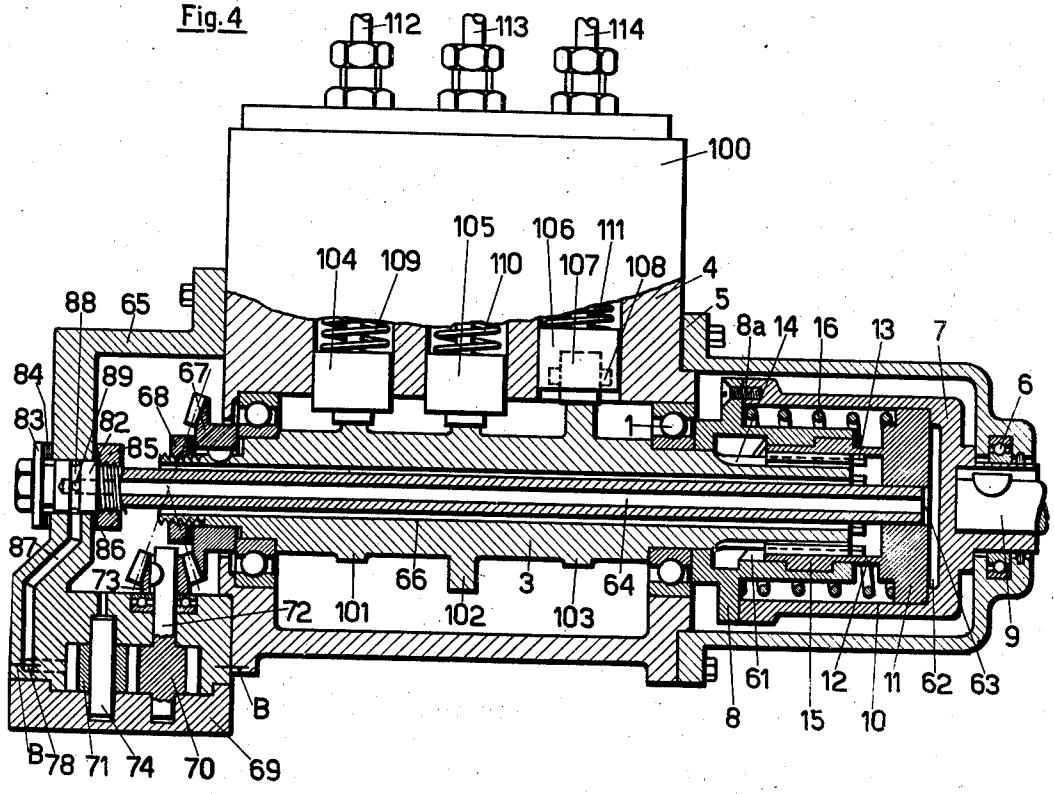
Kasper von Tavel

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Filed April 4, 1938 2 Sheets-Sheet 2

Fig.4



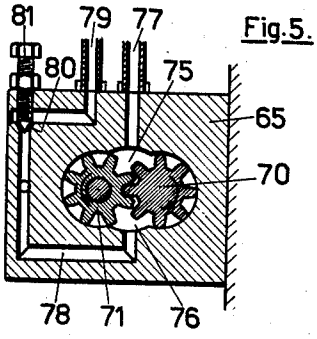


Fig.5.

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Patented Feb. 20, 1940

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UNITED STATES PATENT OFFICE

2,190,900

MOTION TRANSMITTING MECHANISM

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Application April 4, 1938, Serial No. 200,049
In Switzerland April 5, 1937

11 Claims. (Cl. 64—25)

This invention relates to a motion transmitting mechanism including a fluid-pressure responsive, angularly adjustable shaft coupling device. In particular, though not exclusively, such mechanism may be used for driving auxiliary apparatus, such as fuel injection pumps, ignition apparatus, valve gear and the like, cooperating with internal combustion engines, the fluid-pressure responsive, angularly adjustable shaft coupling device then serving for varying the timing of the operation of such auxiliary apparatus in relation to the working cycle of the internal combustion engine.

One of the objects of my invention is to provide a simple and compact arrangement of the said mechanism, in which no linkage rods or levers are required for adjusting the said shaft coupling device.

Another object of the invention is to arrange the parts so as to diminish the possibilities of leakage of the pressure-fluid supplied for adjusting the said shaft coupling device.

The invention further has for its purpose to provide a construction in which the said fluid-pressure is supplied to the angularly adjustable shaft coupling device through means well protected from accidental damage.

Further objects and advantages of my invention will appear from the following description of embodiments thereof with reference to the accompanying drawings, and it will be understood that while I have described what may be considered as preferable embodiments of my invention, I do not limit myself to the precise conditions or proportions herein set forth, as they may be varied by those skilled in the art in accordance with the particular purposes for which they are intended, and the conditions under which they are to be utilized.

In the said drawings,

Fig. 1 is a longitudinal section through a fuel injection pump for internal combustion engines, and through its injection timing device embodying the invention.

Fig. 2 is a cross-section on the line A—A of Fig. 1.

Fig. 3 shows, also in longitudinal section, an adjustable shaft coupling suitable for replacing that included in the apparatus shown in Fig. 1, without departing from the scope of the invention. The parts not shown in Fig. 3 may be exactly similar to the corresponding parts shown in Fig. 1.

Fig. 4 is a longitudinal section through a fuel injection pump and injection timing device, in which the invention is embodied still in another way.

Fig. 5 is a horizontal section on the line B—B of Fig. 4.

In the embodiment shown in Figs. 1 and 2, the reference number 100 indicates generally the fuel injection pump of a three-cylinder internal combustion engine; 4 is the housing of the said pump, and 3 is the cam shaft supported in the ball bearings 1 and 2 lodged in the housing 4. The cam shaft 3 has three cams 101, 102 and 103 formed thereon and each actuating one piston of the feul injection pump through a pusher 104, 105, 106 carrying a loose roller such as 107 on a journal 108, and guided in the housing 4. Springs 109, 110 and 111 are provided for pressing the pushers 104, 105 and 106 home onto their actuating cams 101, 102 and 103. As the fuel injection pump 100 may operate on any suitable principle and does not form a part of the present invention, its cylinders, pistons, valves and similar parts have not been shown in the drawing and need not be described; they are concealed in the upper portion of the housing 4, from which injection conduits 112, 113 and 114 lead to the cylinders of the internal combustion engine, which are not shown.

5 is a housing fixed to the pump housing 4 and enclosing the adjustable coupling device. A further ball bearing 6 lodged in the housing 5 supports the driving member 7, to which a cover piece 8 is secured by screws 8a. The cover piece 8 is rotatably supported on the cam shaft 3 next to the bearing 1. The driving member 7 is keyed to a shaft 9 driven from the internal combustion engine in a way not shown and has a cylindric recess 10 in which the axially displaceable piston 11 is a tight working fit. The piston 11 has a coaxial tubular extension 12 which on its inside is provided with parallel splines 13 engaging corresponding slots 14 in the end portion of the cam shaft 3. On its outside, the piston extension 12 has a quick pitch thread 15 engaging a corresponding female thread in a boss of the cover piece 8, thus angularly coupling the latter to the piston extension 12. A coil spring 16 interposed between the flange of the cover piece 8 and the piston 11 presses the latter into the cylindric recess 10.

At the other end of the injection pump, where its cam shaft is supported by the bearing 2, the casing 19 of a gear pump is fixed to the injection pump housing 4. Said pump comprises a gearwheel 20 which is keyed to the cam shaft 3 and which meshes with a second gearwheel 22 journalled on the pin 21. Both said gearwheels

tightly fit the gear pump casing 19 on their faces and on a considerable portion of their circumference, so that when driven as indicated by the arrow they displace liquid from the supply chamber 23 to the delivery chamber 25. The supply chamber 23 is connected to a reservoir (not shown) by a supply pipe 24. From the delivery chamber 25 a duct 26 leads to a restricted passage 27 whose cross-section may be adjusted by means of the adjusting screw 28, and a conduit 29 is connected after said passage 27 for carrying the liquid away. In the conduit 29, the liquid pressure will suitably be kept substantially constant by a pressure regulating device which may comprise a spring-loaded piston valve acted upon by the liquid pressure in the conduit 29 and controlling a release passage.

The liquid supplied to the described system from the reservoir may be lubricating oil, glycerine, fuel oil or the like. If the fuel oil used is suitable for being injected into the cylinders of the internal combustion engine, it will preferably be fed to the suction chamber of the injection pump through the conduit 29.

Through the duct 30, the delivery chamber 25 communicates with a longitudinal bore or passage 31 provided in the cam shaft 3, through which bore the pressure of the liquid is transmitted from the gear pump to the pressure-responsive adjustable coupling at the other end of the injection pump. The duct 30 issues in the plane inner face 32 of the gear pump casing 19, opposite the end face of the cam shaft 3. A short flanged tube 33 communicating with the bore 31 of the cam shaft 3 has on its flange a plane end face tightly fitting the face 32 of the casing 19 and pressed thereto by a spring 34. The latter abuts the flange of another short tube 35 in which the tube 33 is a slidable tight fit, and presses said tube 35 against a ring 36 having a spherical face fitting a corresponding recess in the end face of the cam shaft 3. The connection thus established between the duct 30 and the bore 31 allows for free movement of the cam shaft 3. On account of the spherical fitting surfaces of the ring 36 with the cam shaft 3 and because the flange of the tube 33 can slide along the casing face 32, the cam shaft may both rotate and suffer some deflection without the tightness of the connection between the duct 30 and the bore 31 being impaired.

At the opposite end of the cam shaft 3 the longitudinal bore 31 communicates with the recess 10 through a connection penetrating through the piston 11. The said connection comprises the tube 37 which is held in tight contact with the piston 11 though angularly movable with relation to the axis of the latter, as the said tube 37 has a spherical head 38 which is confined by the cup 39 forced into a recess of the piston 11. The tube 37 is guided in a bore of the ball 40, which is retained in a spherical recess of the cam shaft 3 by a cup 41 forced into said recess.

When the internal combustion engine is running, the driving shaft 9, the driving member 7, and the cover piece 8 rotate together. The tubular extension 12 being angularly coupled to the latter by the quick pitch thread, the piston 11 follows the rotating movement, and the splines 13 which engage the slots 14 of the cam shaft cause the latter to rotate and to actuate the fuel injection pump. The cam shaft 3 also drives the gear pump 20, 22, which displaces from the supply chamber 23 to the delivery chamber 25 a quantity of liquid increasing according to the number of revolutions of the cam shaft 3. From the delivery chamber 25, the liquid flows off through the duct 26 and the restricted passage 27, and thence through the conduit 29. Because of the throttling effect in the restricted passage 27 the liquid pressure in the duct 26 increases approximately according to the square of the angular speed of the cam shaft 3. This liquid pressure is transmitted to the cylindric recess 10 through the duct 30, the tube 33, the bore 31 of the cam shaft 3, and the tube 37. As the angular speed of the cam shaft 3 increases, the increasing liquid pressure in the recess 10 displaces the piston 11 against the force of the spring 16. As the said piston and its extension 12 are guided by the quick pitch thread 15 engaging the cover piece 8 carried by the driving member 7, they are angularly displaced relatively to the latter while proceeding under the effect of the liquid pressure, and as the splines 13 are in engagement with the slots 14 of the cam shaft 3, the latter must follow this angular displacement. The quick pitch thread 15 is directed in such a way that when the pressure in the recess 10 increases the angular displacement of the shaft 3 relatively to the member 7 takes place in the sense of rotation of the said cam shaft. Thus the fuel injection by the injection pump is advanced when the internal combustion engine runs faster, and delayed when it runs slower. Such a variation of the injection timing is known to have a good influence on the steady running of the internal combustion engine at all speeds.

In the embodiment shown in Fig. 3 a cylinder 53 is carried by the end of shaft 3, to which it is angularly coupled by a pin 51 and fixed by the nut 52. The piston 54 is a tight fit in the cylinder 53 and bounds therein a working chamber 50 which is in open communication with the bore 31 of the shaft 3. The piston 54 is provided with splines 57 engaging slots 56 in the cylinder body 53. The said piston 54 has also a female quick pitch thread in engagement with a corresponding male thread 55 provided on the driving shaft 9 which, in a way not shown in the drawings, is coupled to the crank-shaft of the internal combustion engine. The driving shaft 9 is supported in a ball-bearing 6 lodged in the housing 5. As already mentioned, the device shown in Fig. 3 is intended to replace the corresponding device in the apparatus shown in Fig. 1, so that the fuel injection pump 100, the gear pump fitted thereto in the housing 9, and the means connecting the delivery chamber in the latter to the bore 31 of the cam shaft 3, may be constructed exactly as shown in Fig. 1 and have therefore not been represented again in Fig. 3.

When the driving shaft 9 is rotated by the internal combustion engine, its quick-pitch screw-thread 55 causes the piston 54 to revolve also, thus driving, by means of the splines 57, the cylinder body 53 and the cam shaft 3, which actuates the injection pump and the gear pump not shown in Fig. 3. As described with reference to Fig. 1, a liquid pressure increasing with engine speed is set up in the bore 31. Because of the open communication between the said bore and the working chamber 50, this pressure is also effective in the latter. When the engine speed increases, the pressure overcomes the force of the spring 58 and displaces the piston 54 to the right. Owing to the high-pitch thread 55, the said piston is also angularly displaced relatively to the shaft 9. The cylinder body 53 and the cam shaft 3 follow this angular displacement, thus advancing

the time of injection relatively to the working cycle of the internal combustion engine.

In the embodiment shown in Figs. 4 and 5, the injection pump 100 is of similar design as shown in Fig. 1. Its cam shaft 3 is connected to the drive shaft 9 by means of an angularly adjustable coupling comprising a drive member 7 keyed to the shaft 9, a cover piece 8 rotatably mounted on shaft 3 and secured to the member 7 by screws 8a and provided with internal quick pitch thread 61. The end portion of shaft 3 has parallel slots 14. The piston 11 also is provided with a tubular extension 12 having on its outside a quick pitch thread 15 engaging thread 61 of the cover piece 8 and internal splines 13 engaging the slots 14 of shaft 3, and it is axially displaceable in a cylindric recess 10 of the drive member 7, in which it defines a working chamber 62. The parts and their features as thus far described are similar to the corresponding ones in Fig. 1. However, the piston 11 has a cylindric axial hole 63 tightly fitted by the tube 64, which latter is secured to the housing 65, at the other end of the injection pump 100, and extends through the whole length of the axial passage 66 provided in the cam shaft 3. Adjacent to its ball bearing 2, the latter carries a bevel gear wheel 67 keyed thereto and secured by a nut 68. In the bottom portion of the housing 65 and readily accessible by dismantling a cover 69, there are two spur wheels 70 and 71 in mesh with each other. The wheel 70 is made integral with a shaft 72, to which is keyed a second bevel gear wheel 73 meshing with the aforesaid wheel 67 on the shaft 3. The shaft 72 is rotatably supported both in the bottom of housing 65 and in the cover 69, and a thrust bearing is provided between wheel 73 and the housing 65. The other spur wheel 71 is journalled on the pin 74, which also is supported in the said housing 65 and cover 69.

Both wheels 70 and 71 tightly fit a recess of the housing 65, but a supply chamber 75 and a delivery chamber 76 are provided adjacent to the place where their teeth are in engagement. Lubricant or fuel oil is supplied from some source to the supply chamber 75 through the conduit 77 and carried to the delivery chamber 76 when the gear wheels 70 and 71 are revolving in their normal sense of rotation indicated by the arrows. From the delivery chamber 76, the oil is carried away through the duct 78 and the conduit 79. In the duct 78, a restricted passage 80 is provided, whose cross-section may be adjusted by the screw pin 81.

The tube 64 has a portion 82 of greater diameter which fits a corresponding opening in the wall of housing 65, and an abutment 83 between which and the housing wall a packing 84 is interposed. On the other side of the said wall, a nut 85 tightened on another packing 86 cooperates with the abutment 83 to hold the tube 64 in position and in tight fit with the housing wall. In the said wall, there is a duct 87 communicating with the aforesaid duct 78, ahead of the restricted passage 80, and with an annular groove 88 on the portion 62 of tube 64, which groove is connected, through a hole 89, to the inside of the said tube, and through the latter, to the working chamber 62 of the shaft coupling device.

After what has been explained with reference to Fig. 1, it will readily be seen that, owing to the throttling effect in the passage 80, the oil supplied to the delivery chamber 76 by the cooperating gear wheels 70 and 71 is under a pressure increasing with the speed of rotation of said wheels, i. e., with the speed of the internal combustion engine. This pressure is transmitted to the working chamber 62, through the ducts 78 and 87, the groove 88, the hole 89, and through the tube 64. In the chamber 62, the said pressure becomes effective on piston 11, displacing the latter to the left against the resistance of spring 16, as engine speed increases. The said piston simultaneously effects an angular displacement due to the quick pitch threads 15 and 61 and thus advances the time of injection with reference to the angular position of shaft 9 and the working cycle of the internal combustion engine.

What I claim is:

1. The combination of a rotatable shaft having an axial passage formed therein; a rotatable member axially aligned with said shaft; a cylinder and an axially shiftable piston enclosing together a variable working space; a spline connection between said piston and said rotatable member and a spline connection between said piston and said shaft, at least one of said spline connections being helicoidal and the spline connections so arranged that axial displacement of the piston entails relative angular displacement of said rotatable member and said shaft; a housing enclosing a fluid-containing space, means adapted for maintaining a controlled fluid-pressure in said fluid-containing space; means connecting said variable working space through said passage in said shaft to said fluid-containing space; and yielding means opposing axial displacement of said piston by the fluid pressure in said variable working space.

2. The combination of a rotatable shaft having an axial passage formed therein, a rotatable member axially aligned with said shaft and having a cylindric recess formed therein; a piston axially shiftable in said cylindric recess and bounding therein a variable working space; a spline connection between said piston and said rotatable member and a spline connection between said piston and said shaft, at least one of said spline connections being helicoidal and the spline connections so arranged that axial displacement of the piston entails relative angular displacement of said rotatable member and said shaft; a housing enclosing a fluid-containing space; means adapted for maintaining a controlled fluid-pressure in said fluid-containing space; means connecting said variable working space through said passage in said shaft to said fluid-containing space; and yielding means opposing axial displacement of said piston by the fluid pressure in said variable working space.

3. The combination of a rotatable shaft having an axial passage formed therein; a rotatable member axially aligned with said shaft; a cylinder carried by said shaft and an axially shiftable piston, which cylinder and piston enclose together a variable working space; a spline connection between said piston and said rotatable member and a spline connection between said piston and said cylinder, at least one of said spline connections being helicoidal and the spline connections so arranged that axial displacement of the piston entails relative angular displacement of said rotatable member and said shaft; a housing enclosing a fluid-containing space; means adapted for maintaining a controlled fluid-pressure in said fluid-containing space; means connecting said variable working space through said passage in said shaft to said fluid-containing space; and yielding means opposing

axial displacement of said piston by the fluid-pressure in said variable working chamber.

4. The combination of a rotatable shaft having an axial passage formed therein; a rotatable member axially aligned with said shaft; a cylinder; a piston provided with an opening and axially shiftable in said cylinder, said cylinder and piston enclosing together a variable working space; a spline connection between said piston and said rotatable member and a spline connection between said piston and said shaft, at least one of said spline connections being helicoidal and the spline connections so arranged that axial displacement of the piston entails relative angular displacement of said rotatable member and said shaft; a housing enclosing a fluid-containing space; means adapted for maintaining a controlled fluid-pressure in said fluid-containing space; means connecting said variable working space to said fluid-containing space, through said opening in said piston and through said passage in said shaft.

5. The combination of a rotatable shaft having an axial passage formed therein; a rotatable member axially aligned with said shaft; a cylinder and an axially shiftable piston enclosing together a variable working space; said piston being splined to said rotatable member and to said shaft, in such a way that axial displacement of the piston entails relative angular displacement of said rotatable member and said shaft; a housing enclosing a fluid-containing space; means adapted for maintaining a controlled fluid-pressure in said fluid-containing space; tubular means guided on said shaft and on said housing so as to allow for motion of the shaft relatively to the housing whilst forming a fluid-tight connection between said fluid-containing space and said passage in the shaft; means forming a fluid-tight connection between said passage in the shaft and said variable working space; and yielding means opposing axial displacement of said piston by the fluid pressure in said variable working space.

6. The combination of a rotatable shaft having an axial passage formed therein; a rotatable member axially aligned with said shaft; a cylinder; a piston provided with an opening and axially shiftable in said cylinder, said cylinder and piston enclosing together a variable working space, said piston being splined to said rotatable member and to said shaft in such a way that axial displacement of the piston entails relative angular displacement of said rotatable member and said shaft; a housing enclosing a fluid-containing space; means adapted for maintaining a controlled fluid pressure in said fluid-containing space; tubular means guided on said shaft and on said housing so as to allow for motion of said shaft relatively to said housing whilst forming a fluid-tight connection between said fluid-containing space and said passage in the shaft; tubular means guided on said shaft and in the opening of said piston so as to form a fluid-tight connection between said passage in the shaft and the said variable working chamber while allowing for relative motion of said shaft and piston; and yielding means opposing axial displacement of said piston by the fluid pressure in said variable working space.

7. The combination of a rotatable shaft having an axial passage formed therein; a rotatable member axially aligned with said shaft; a cylinder carried by said shaft and an axially shiftable piston enclosing together a variable working space in open communication with said passage in the shaft, said piston being splined to said rotatable member and to said shaft, in such a way that axial displacement of the piston entails relative angular displacement of said rotatable member on said shaft; a housing enclosing a fluid-containing space; means adapted for maintaining a controlled fluid pressure in said fluid-containing space; tubular means guided on said shaft and on said housing so as to allow for motion of said shaft relatively to said housing whilst forming a fluid-tight connection between said fluid-containing space and said passage in the shaft; and yielding means opposing axial displacement of said piston by the fluid pressure in said variable working space.

8. The combination of a rotatable shaft having an axial passage formed therein; a rotatable member axially aligned with said shaft; a cylinder; a piston provided with an opening and axially shiftable in said cylinder, said cylinder and piston enclosing together a variable working space; said piston being splined to said rotatable member and to said shaft in such a way that axial displacement of the piston entails relative angular displacement of said rotatable member and said shaft; a housing enclosing a fluid-containing space; means adapted for maintaining a controlled fluid pressure in said fluid-containing space; tubular means secured to said housing, extending through said passage in said shaft and guided in said opening of said piston so as to form a fluid-tight connection between said fluid-containing space in the housing and said variable working space while allowing for motion of said piston relatively to said housing; and yielding means opposing axial displacement of said piston by the fluid pressure in said variable working space.

9. The combination of a substantially closed housing; a driven shaft mounted to rotate in said housing and having both ends enclosed thereby; a driving shaft entering said housing and axially aligned with said driven shaft; a cylinder turning with and forming an extension of one of said shafts within said housing; a piston axially shiftable in said cylinder, interposed between the ends of said shafts and having torque transmitting spline connections with each of said shafts, at least one of said spline connections being helicoidal; a fluid transmitting connection for conducting pressure fluid to said cylinder to act against said piston, said connection leading axially through the driven shaft from the end thereof remote from said piston; means for delivering fluid under controlled pressure to said connection; and yielding means resisting movement of said piston under such fluid pressure.

10. The combination of a substantially closed housing; a driven shaft mounted to rotate in said housing and having both ends enclosed thereby; a driving shaft entering said housing and axially aligned with said driven shaft; a cylinder turning with and forming an extension of one of said shafts within said housing; a piston axially shiftable in said cylinder, interposed between the ends of said shafts and having torque transmitting spline connections with each of said shafts, at least one of said spline connections being helicoidal; a fluid transmitting connection for conducting pressure fluid to said cylinder to act against said piston, said connection leading axially through the driven shaft from the end thereof remote from said

piston; means comprising a pump driven by said driven shaft, enclosed within said housing, and arranged to deliver fluid under controlled pressure to said axial connection for developing fluid pressure in said cylinder; and yielding means resisting movement of said piston under such fluid pressure.

11. The combination of a substantially closed housing; a driven shaft mounted to rotate in said housing and having both ends enclosed thereby; a driving shaft entering said housing and axially aligned with said driven shaft; a cylinder turning with and forming an extension of said driving shaft within said housing; a piston axially shiftable in said cylinder, interposed between the ends of said shafts and having torque transmitting spline connections with each of said shafts, at least one of said spline connections being helicoidal; a fluid transmitting connection for conducting pressure fluid to said cylinder to act against said piston, said connection leading axially through the driven shaft from the end thereof remote from said piston, and including a leak-resisting slip connection with the piston, leading through the piston and adapted to permit functional movements of the piston; means for delivering fluid under controlled pressure to said connection; and yielding means resisting movement of said piston under such fluid pressure.

HESPER VON TAVEL.