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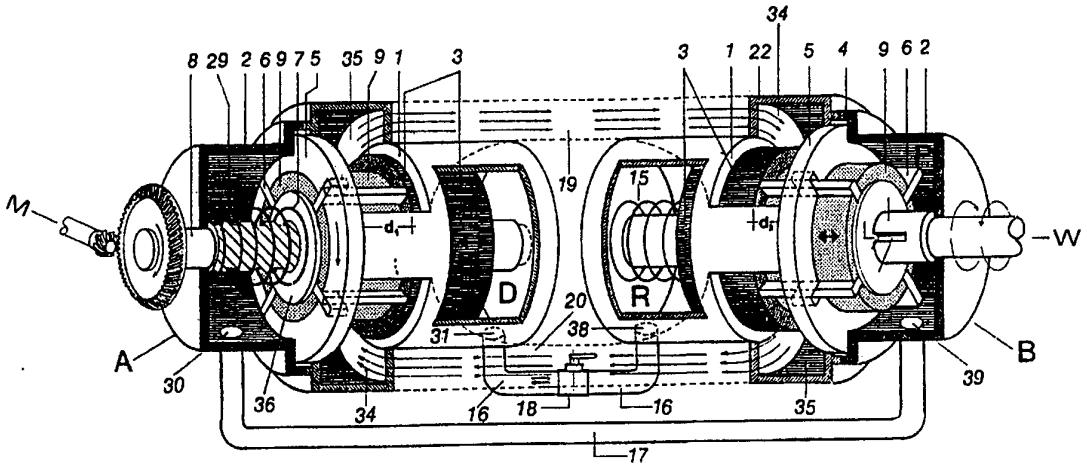
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(57) Abstract

An automatic, Inertial, Continuously Variable, Hydrostatic Transmission (C.V.T.) for motor vehicles, comprises a pair of reversible vane pump/motor (A, B) units, connected in a closed circuit. The vane pump/motor (A, B) units, are of the new "moving side" type, with fixed eccentricity. The driving pump/motor unit (A) is driven by the engine and via a torque-sensitive inertial connection, comprising a screw (29), a nut (26) and a pressure spring (7), moves through the hydrostatic fluid, the motor/pump (B) of the wheel. An alternative embodiment lacks the torque-sensitive connection (29, 26, 7), and the transmission ratio is varied continuously, but manually, without the use of a clutch.

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AUTOMATIC INERTIAL CONTINUOUSLY VARIABLE HYDROSTATIC TRANSMISSION

The present refers to a new , simple , Automatic Hydrostatic Continuous Variable Transmission (C.V.T.) of a closet circuit , which being driven by Inertia attain the motion of the vehicle with the most suitable transmission relation , so that its engine to be continuously operating at the area of the minimum consumption .

The achievement of the said goal has become possible with the design of a new vane pump-motor, of sliding vanes , of fixed eccentricity , the volume variation of which is being achieved with the continuous shift of the one side of it . This pump, in serial combination with another similar pump which , in this case , operates as an hydrostatic motor , achieve through a very simple automatic inertial mechanism the smooth,noiseless and continuous changing from a short 1st to a final speed beyond overdrive. The said Transmission is , at the same time , clutch and power brake , while at its more complex edition it also includes a self-controlled hydrostatic differential .

At the level of the previous technique there exists only one mechanical C.V.T automatic gear box , SELECTA by FIAT , which is a development of the old Variomatic of the Dutch DAF . The said box has two variable diameter pulleys which are driven by a steel belt . a planetary gear system , two hydraulic cylinders , one common differential and a complicated complex of electro-hydraulic valves which receive their instructions from a microcomputer , with sensors which provide informations for the position of the throttle , the position of the belt , the position of the selection lever and the revolutions of the engine . The said boxes have a limited ability of transferred torque due to the sliding of the belt and are being placed only to small vehicles .

The hydrostatic transmission boxes , on the other hand , which exist today use variable eccentricity vane pumps with a small area of fluctuation of their supply being achieved with the alteration of their eccentricity . This has as a result a great loss of power because at the interval positions of the rotor a part of the oil returns to the low pressure area without producing any power.

The hydrostatic systems with the axial piston pumps of variable displacement may not provide a great range of of supplies with a small size of pumps and, furthermore,they require Clutch and Differential.

All the transmissions of the previous technique wich have been mentioned, are accompanied by complicated control units, which interfere with the automation circuit, increasing the construction cost while they decrease the efficiency end the effectivnes of the system.

The invention belongs to the new technique of hydrostatic transmission of motion, yet without the disadvantages of the previous boxes of said category.

The invention is an automatic inertial continuous variable transmission , in which the transmission of motion is being carried out by a pair of reversible vane pumps of a new design, of fixed eccentricity and variable cubage, of the type "moving side" connected in series in a closed hydrostatic circuit, where the driving pump is directly connected with the engine's fly wheel,with no reverse gear box and clutch and through the hydraulic fluid, transfers its motion to the pump (B) which operates as a hydrostatic motor as well, turning the wheel. The continuous linear changing of speeds is being achived with the continuous displacement of the moving side of the pump (A) which is being accompanied by the continuous reverse displacement of the moving side of motor (B), because the circuit is closed, the quantity of whole fluid is constant and the fluids are concidered to be practicaly incompressible. When the volume of the pump is being decreased by dV the volume of the hydrostatic motor is being increased by dV, yet as the ratio of volumes is in inverse ratio with the rounds, and in direct ratio with the torques, any alteration of the ratio of volumes is being expressed with the respective alteration of the ratio of rounds and torques and since the moving side may receive infinite positions (between two limits) then and the ratios of the box will be infinit.

The said way of transmission is more advantageous of the one with pulleys and belt, as it has no losses due to the sliding of the belt, starts immediately and offers, practicaly instant torque with stable power at a wide range of speeds.

For the movements of the side of the driving pump, there operates a very simple automatic inertial mechanism which, with a wide pitch screw at the position of the axis of the pump, the formation of the rotors center hole to equivalent nut and two helical springs (7)&(15), which tends to restor the system at the position of the maximum volume of the pump (A), while it reads through the pressure being developed, continuously among the vanes (a)and(b) FIG. 6b of the two pumps, any attempted alteration of the kinetic situation of the vehicle and translates the said, to continuous rotary movements of the system "side-rotor" of the pump which, moving upon its axis (like a nut on a screw), fluctuates its volume and, inversely, the volume of the hydrostatic motor. The axis of the motor (B) does not bear a thread , but only a slot wedge , within which it may freely slide, with a wedge, the system of "side-rotor" simultaneously with the rotation of the rotor, while in the meantime there is being continually pressed by a helikoid spring (15) which tends to restore the system to the position of the minimum volume of the motor (B)
The hydrostatic motor is the one which moves the wheel and transfers through its vanes, to the vanes of the pump and through those to the rotor, all the inertial torques which the wheels meet while moving. And all these with no interference of electronic sensors and microcomputers.

Advantages :

1. With one relief valve it replaces the existence of the clutch.
2. It may have a small size and handle great pressures
3. Noiseless operation as it has no gears.
4. Minimum frictions, as it operates in lubricating fluid and minimal maintenance.
5. Great effectiveness grade.
6. Wide range of transmission ratios, from 1:3,5 to 1:0,50.
7. At its complex form FIG.7, as it needs no differential, the final reduction 1:4 is being placed at the beginning, after the engines fly wheel, so, the box is being operating at the 1/4 of the rounds of other boxes, which means less noise, heating and vibrations, litle loss of power, therefore better longevity.

FIG.1 is an axonometric perspective of the system, showing the two pumps (A)&(B) with the two main channels (19) of high pressure and (20) of low pressure, as well as the connection tubes (16) for chambers (D) and (R) and (17) for chambers (C) and (P). At the said drawing there expressively appear all the details of the two pumps in section, with the driving pump (A) on the left at the position of its maximum volume (overdrive) and the hydrostatic motor (B) on the right, at the position of its minimum volume (overdrive).

FIG.2 is a top cross-sectional view of the BASIC box, for motorcycles, drilling machines, hoisting cranes, etc. Here there appears the high pressure channel (19) with the entrances of the cross channels (24) and (25), the expansion valve (13), the drums (3) and the pumps at their positions to (overdrive) again. The final reduction ratio 1:4 (21) is being placed here on the input shaft (8), with the great advantage the transmission box to operate with 1/4 of the engine's rounds.

FIG.3 is a cross-section X-X' to which there expressively appear the three shift leve positions (10)s with the flow direction valves, the reverse channels (24) and (25), the relief valve (23), the spring (7), the main channels (19) and (20) and the two braking valves (12).

FIG.4 it is the Z-Z' section and shows the form of the two diaphragms (5). With the dotted line there is being described the position of the cylinder (1)

FIG.5 the drawing shows a cross-section of the BASIC transmission box placed on a four-wheel vehicle with a mechanical diferential, for front-wheel driven or rear-wheel driven vehicles. As it is well-known, every mechanical differential includes the final ratio 1:4 , therefor in this case the hydrostatic transmission have to be placed immediately after the engine's fly wheel and to operate with the engine's rounds.

FIG.6a shows the position of the shift lever (10) at (N) (neutral), the position of the direction valves and the return of the fluid at the channel of low pressure without producing any work.

FIG.6b shows the movement of the shift lever to the position (D) (drive), the new positions of the direction valves and the fluid flow from the pump to the motor.

FIG.6c shows the position of the shift lever to (R)(rear) and the inverse of the fluid flow through the cross channels (24) and (25).

FIG.6d shows the position of the braking valve (12) and the flow of the fluid through the relief valve (23)

FIG.7 is a top cross-sectional view of the transmission at its COMPLEX form with intependent transmission to both driving wheels. Here both driving pumps are being driven by the same axis, they have the reduction 1:4 on the input shaft and, as every wheel have its own transmission, constitute a self-controlled hydrostatic differential. The wheels are never immobilized , because the volumes of the hydrostatic pumps and motors are never nullifyed.

FIG.8 shows a top cross-sectional view of the transmission at its COMPLEX form, with one driving pump of double volume for both hydrostatic motors. This box, also, has no need of a mechanical differential.

FIG.9 is a front cross-sectional view of the semi-automatic box.

FIG.10 is a top cross-sectional view of the semi-automatic box where there is shown its amazing simplicity in comparison with the mechanical and hydraulic boxes of the previous technical level.

FIG.11 shows a mechanical differential of suffisient thicknes which achieves a better tightness by the addition into its body, springs (46) and small anti-friction metallic blócks that compress the two sides of the vanes, as they are passing through . For even better tightnes, four sliding pieces (44) with the same thickness with the vanes, extent the vanes into the diaphragms body while sliding upon the heads of them due the sliding bond (48).
This drawing also shows a new method of joining the opposite vanes of the rotor with sheet-iron springs (47) in order that they function like one piece and one push the other. This is important because on said diaphragm the helical springs (46) pressing the vanes make difficult there movement into the rotors grouves. The sheet-iron springs (two for each vane) accommodate in different levels into proper cavities (49) in the rotors body.

FIG.12 shows the external view of above diaphragm with its cover (45).

The new Inertial Automatic Continuous Variable Transmission Box, at its BASIC edition, i.e. when it drives the wheel of a motorcycle, FIG.1.FIG.2.FIG.3, or the mechanical differential (37) of a four-wheel vehicle FIG.5, consists by:

a) a pair of new-design reversible rotary vane pumps/motors of variable volum, of the type of "moving side" FIG.1 FIG.2 FIG.3 pump (B).

b) a very simple, automatic inertial mechanism FIG.2 (26) (29) (7) which is being adapted to the input shaft (8) of the driving pump (A), and:

c) by a relief valve (23), one twin , flow direction valve (10), one twin , braking valve (12), one restriction valve (18) and one expansion valve (13).

The pump of "moving side" (B) which will be described hereunder, is the basic element of the hydrostatic box, while pump (A) is similar and only defers at the point that, to this pump has been applied the automatic inertial mechanism.

The pump of "moving side" is a rotary pump with sliding vanes of fixed eccentricity,the one side of which has the ability to move,fluctuating its volume When the moving side of the pump approaches the other side, the volume of the pump is being reduced and when it moves away the volume increases. In order this to be carried out, the one side of the pump has been replaced by a drum(3) FIG.1 FIG.2 FIG.3, which it is not gripped at the axis (14) of the pump, but it may reciprocate eccentricaly sliding -but not rotating- on one hand on the axis and on the other hand inside the inner surface of the closed cylinder (1) which constitutes an extension of the internal cylinder of the pump. The drum has an absolute contact with the cylinter (1) with Orings, so that the main chamber of the pump to not communicate with the chamber (R) of the cylinder (1) and without, of course, being hindered the reciprocating movement of the drum inside it. Inside chamber (R) which is filled with the hydraulic fluid there exists a helical pressure string (15) which adverses the movement of the drum backwards, i.e. the increase of the volume of the pump and tents to keep the said at the position of its minimum volume. At the back side of the cylinder there exists a proper opening (38) for the hydraulic connection of the chamber (R) with the respective chamber (D) of the pump (A) at the connection of the two pumps at the hydrostatic box.
At the internal fase of the drum towards the pump, there is eccentricaly gripped with a ball bearing, the rotor (9) of the pump with the vanes, in a way

it may rotate with an absolute contact on the face of the drum and so eccentricaly that its perimeter will be adjacent to the internal surface of the cylinter (1) FIG.3. The drum, the rotor and the vanes, constitute in this way a unique and indivisible flexible system which we will call, furtheron, due to briefness "moving side set".

The "moving side set" is not gripped at the axis of the pump, but on the one hand it slides with a wedge (40) inside the slot wedge (28) of the axis (14) and, at the same time it rotates the axis or, is being rotated by it and, on the other hand, reciprocates inside the cylinder (1) and the cover (2) passing through the diaphragm (5).

The rotor bears at all its length 4 grooves per 90°, within which there slide the same number of metal vanes (6) with the minimum tolerances, (from 2mμ to 40mμ, depending on the size of the pump). The vanes during their rotation are pressed on the extension of the internal surface of the cylinder (1) inside the main chamber of the pump, by small springs or by the oil's pressure unterneath and from the openings (11) FIG.3 which the cylinter bears at the intake and exhaustion areas, there comes in and out the hydraulic fluid, towards or from the pump.

The other side of the pump is being replaced by a metal diaphragm (5) in a form of disk FIG.4 with a circular opening at the centre, at the same diameter as the rotor and 4 grooves at the width of the vanes. The width of the diaphragm should be adequate and the clearance among the vanes and the width of the grooves such, which woud secure the best possible tightnes, The main chamber of the pump must not communicate with chamber (P) inside which there enters the rotor with the vanes. The perimeter of the diaphragm is being tightened by a crown (4) inside which, the diaphragm is being rotating, concentricaly with the rotor, being drifted by the vanes.

When the "moving side set" moves towards the diafragm, one part of the drum enters the chamber of the pump, reducing the volume of it, while the rotor with the vanes are plunged into the diaphragm and tightly pass to the front chamber (P) which is, also, full of the same hydraulic fluid and with a proper opening (39) is being connected through the pipe (17) with the respective chamber (Z) of the pump (A) at the connection of the two pumps at the hydrostatic box. Finally, the internal diameter of the cover (2) must be concentric and equal to the one of the cylinder (1) so that the vanes, leaving the diaphragm, to be adjacent on the said. The two concentric cylinders (1) and (2) must be perfectly in a straight line between them and well smoothed.

The hydraulic fluid enters from the inlet (34) of the pump and exits from the outlet (35) and vice versa, because the vane pumps, in general, have the ability of rotating to both directions.

During the construction of the pump there shoyld be given a great attention to its static and dynamic oil-tightening of it, by a specialized constructor. One sugestion is the coating of the periphery of the drum with synthetic elastomer Perbunan (Neopren) of adequate thickness, with an additional covering of a thin Teflon layer. The thick layer of elastomer will also handle the expansions between the cylinder and the drum.

As volume (or specific supply) of the pump there is being approximately considered the difference on the cross-cuts of the drum and the rotor, by the distance (d) each time, between the drum and the diafragm.

As there is shown by the description and the drawings FIG.1 and FIG.2, the "moving side" pump consists of 3 chambers independed among them, of variable capacity :

a) The main chamber of the pump, between the drum (3) and the diaphragm (5), inside which there is being rotating, one part of the rotor with the vanes, at a time, and moves the hydraulic fluid or is being moved by it.

b) The chamber (R) which is being surrounded by the cylinter (1) inside which the drum reciprocates, and

c) The chamber (P) between the diaphragm and the cover, inside which there reciprocate the part of the rotor with the vanes which are displaced outside the pumping area, during the reduction of the volume of the pump.

All these 3 chambers must have the best possible tightness among them, because at the hydrostatic circuit of the box, each chamber of one pump communicats with a pipe (16)or(17)with the respective chamber of the other one and because each pair of chambers [(D)+(R)] and [(C)+(P)] operates with different pressurs and have a different mission, their fluids should not communicate. The same, of course, stands for the main circuit of the two pumps (A) and (B) which transmits the motion from the engine to the wheel. All the chambers and the communication pipes are full of proper hydraulic fluid.

At the hydrostatic circuit of the Automatic Inertial Continuous Variable Hydrostatic Transmission there is being used one pair of "moving side" pumps, the main chambers of which are hydraulicaly connected in series, with channels (19) and (20) and constitute the main closed hydrostatic circuit, where the driving pump (A) FIG.1, FIG.2, FIG.3 through the hydraulic fluid transfers its motion to pump (B), which here works as hydrostatic motor, rotating the wheel (T). Except the main hydraulic circuit, and secontary chambers are being connected between them in a closed hydraulic circuit, each one with the respective same one, that is to say (D) and (R) with the pipe (16) and (C) and (P) with the pipe (17). These two hydraulic systems of communicating chambers are the ones which achieve the co-operation of the two "moving side sets" of the pump and motor. Finally the two main channels (19) and (20) are being bridged over by the cross channels (24) and (25) which do not communicate between them and are used for inverting the course of the motor, without inverting the course of the driving pump FIG.6c .

The continuous changing of speeds is being achived with the continuous displacement of the "moving side set" of the driving pump (A), accompanied by the continuous inverted displacement of the "moving side set" of the motor (B), because the main circuit of the system is closed and, in that case, if the volume of pump decreases by -dV-, the volume of the motor will increase by -dV-, and because with the movement of the drum towards the diaphragm, inside the system of communicating chambers (D) and (R), there will be created an underpressure which will force the drum of motor to move to the opposite direction increasing the volume of the motor. In the meantime, the rotor with the vanes of the "moving side set", moving towards the diaphragm of the pump, passes through it and one part of it, is being plunged inside the chamber (C), dislodging an equivalent volume of fluid through the pipe (17) to the chamber (P) of the motor (B), pressing the frontage of its rotor assisting thus the "moving side set B" to withdraw increasing the volume of the motor. At any position of the "moving side set A" of the pump (A) there corresponds and one inverted position of the "moving side set B" of motor (B). Yet this corresponds to the changing of the coupling of gears at the mechanical gear boxes and because each position of the system is a different transmission ratio and these ratios are infinite, therefore the said box may offer infinite speeds.

For the movements of the "moving side set" there operates a simple, automatic, inertial mechanism. The said mechanism is being driven directly by the morphology of the ground (gradient of the road, turns, load, etc), by the resistance of the wind and, in general, by any reason which reacts to the motion of the vehicle or to the alternation of its kinetic situation, acting directly to the rotor of the "moving side set A" of the driving pump, through its vanes and the vanes of the hydrostatic motor and exploiting, each time, the differance of rounds which results between the axis and the rotor of the pump when the transmission ratio is not the proper one, moves the "moving side set A" until the pressure between the vanes (a) and (b) FIG.6b be balanced with the extent of the co-operating springs (7) and (15) FIG.1, FIG.2 at that time, when it ceases, keeping this position until a new inertial reason forces it to move again.

The automatic inertial mechanism consists of :

a) a clockwise screw, of a wide pitch (29)
b) a nut (26) of the same wide pitch as the screw, being gripped at the centre hole of the rotors cylinder,
c) two helicoid pressure strings (7) and (15) FIG.1 and FIG.2 and
d) a disk-shaped pressure ball bearing (36)

The axis of the driving pump (A) is being formed to a clockwise wide pitch screw. At the centre hole of the rotors cylinder of the "moving side set A" there is being gripped a wide pitch nut (26) of similar thread with axis screw, so that the rotor, drifting all the "moving side set A", to be able to move along the whole length of the screw, while rotating on it (like a screw with a nut). The nut also connects-with a ball bearing (33)-the rotor with the drum.

The margins of the transmission ratios which may be offered by the box are almost infinite and depent on the use for which it is intended, in any case for its placement to passenger vehicles a range of ratios from 1:3,50 (1st) to 1:0,50 (overdrive) is remarkably sufficient.

When the box passes from the movement to parking, the "moving side setA" of pump (A), due to the extention of the co-operating springs (7) and (15), rotating on its axis clockwise, is being pushed away from the diaphragm and reaches the predestined marginal position (40) of the maximum volume of

this pump, while in the meantime the "moving side set B" of the hydrostatic motor (B) is being pushed inversely, sliding in its slot wedge and occupies the predetermined position (41) which is closest to the diaphragm and is the position of the minimum volume of motor (B). FIG.1, FIG.2. Therefore when the input shaft stops to rotate the transmission returns to overdrive position.

The surfaces of the two vanes (a) and (b) (one of each pump) FIG.3, FIG.6b which are located at the positions which define the area of compression of the hydraulic fluid and are the ones which compress the hydraulic fluid, undertaking all the load of the transmission of the motion to the wheel, are in proportion with the volume of each pump and their surfaces are being altered in proportion with the alteration of the volume of the said pumps.

At the operation of the hydrostatic box, between the vanes (a) and (b) there is being developed a pressure which is in direct ratio with the torque of inertia which opposes the motion of its motor. According to Pascal's Law, this pressure has the same value at every point of the space being included between the vanes (a) and (b). The moving parts of the box situated inside the compressed space, are the two drums (3) FIG.3 and the two vanes (a) and (b), yet because the chambers (D) and (R) behind the two drums communicate between them through the pipe (16) FIG.1 FIG.2, and the diameters of the drums are equal, the pressures are counterbalanced and the drums may not withdraw both of them at the same time. Therefore the only elements which may be moved by the pressure are its vanes.

The shift lever of the automatic box, has the following selections :
(P) Parking - (R) Rear - (N) Neutral - (D) Drive - (L) Low - (Lo) Lock

At the positions (R) (N) and (D) the valve (18) of the pipe (16) is being continually open, while at the position (L) is half-closed and at the position (Lo) the valve is closed. At the position (P) the vehicle is being mechanicaly immobilised, the engine may operate yet the box does not participate.

Operation of the BASIC box, on the vehicle.

When the vehicle is parked, the box is at the ratio 1:0,50 (overdrive) on accaount of the tension of the springs, and the pump has its maximum volume while the hydrostatic motor its minimum volume.

To start the engine , we move the shift lever to (N) Neutral, where the valves of direction of flow (10) receive the intermediate positions, as shown in FIG.6a After starting the engine, the pump starts rotating with no load because the hyraulic fluid, through the cross channel (24) returns to the inlet (34) of the pump without moving the hydrostatic motor. When, following that, the selection lever is being placed to the position (D) Drive, the valves (10) close the cross channels (24) and (25) FIG.6b and the fluid, pressed by the vane (a) of the pump presses the vane (b) of the motor. The transmission ratio at resting is 1:0,50, and because the surface of the driving vane (a) is twice as much as the surface of the moving vane (b), the effort on the vane (b) at idling is very low and so the hydr. motor may not overcame the torque of inertia. Result , the pressure between the vanes highly increases and the rotor of the pump, surpassing the power of the springs (7) and (15), starts screwing on the turning axis, together with the " moving side A" towards the diaphragm, continuously decreasing the pumps volume, while in the meantime the "moving side set B" of the motor, moves inversely , increasing its volume. This has as a result the box to shift down, automaticaly, approaching the 1st speed.

At a certain point of the course of the system, the continually increasing tension of the springs and the continuous decrease of the surface of the vane (a) will balance with the continually increasing surface of vane (b) and the continually increasing of the pressure between the vanes will stop the rotor, because the ratio which has been formed is the proper one, so that the vehicle would start. If during the time that all this happen, the vehicle is immobilised with the foot brake, the "moving side set A" will continue its course, because the resistance of the vane (b) is being unrivalled, the pressure will increase more and slightly after the 1st speed there will open the pre-adjusted relief valve (23) and the hudraulic fluid will pass directly to the inlet (34) of the pump. After that, the ratio of the box it will remain slightly below the 1st speed and the valve (23), opening and closing continually like an automatic hydraulic clutch will permit to the pump to rotate without the engine to stall.FIG.6b

In case that the vehicle can not start, because it is parking at an uphill road the driver, by pushing the accelerator he offer more power and rounds to the axis of the pump and its new increased torque will cover the inertial resistance due to the gradient of the ground and the vehicle will start.

At the acceleration on an horizontal road, almost all the torque of the engine is being consumed for the increase of speed, as the inertial torques are being limited to the inertia of moving masses, the resistance of the air,and the rolling resistance of the wheels. Therefore the pressures between the vanes are drastically redused, the expansion tension of the springs supersedes and the rotor continually withdraws to overdrive, having all the time the ideal ratio of transmission.

When the vehicle, after an horizontal course, enters an uphill road the box will quickly read the inertial torque which will be developed to its vanes and will instantly adjust the "moving side set A" of it in order to handle the new situation.

In case that the load tends to drift the vehicle, such as in a downhill road, the motor becomes a pump and the pump becomes motor and the vehicle starts being drifted and accelerating. If the driver, while reaching the downhill, slow down with the brake, as the box finds resistance it will automatically down shifts, and the driver moving the lever to the position (Lo), locks the existing speed in the box and the vehicle declines slowing down by the engine. This hapen because at the position (Lo) there closes the restriction valve (18) on the pipe (16) FIG.2 which connects the chambers (D) and (R) and then the drums of the pump and of the motor can not move, anymore,and the box maintains the ratio it had, before the driver has placed the lever at the position (Lo).

Rear : When driver shifts to (R) the direction valves receive the positions shown in FIG.6c and the fluid flow, passing through the cross channels (24) and (25) which do not communicate between them, reverse the moving direction of the hydrostatic motor, with a very simple and noiseless way.

The said reverse is being possible even if the vehicle is still moving and it may be used as a panic brake. As it is shown at the drawings, the operation of the relief valve (23), is not affected by the inverse of the movement because the pump (A) is not be inverted. At the reverse motion, the box keeps changing ratios which serves to a long reverse course.

Braking : with the box, at the axis of the hydrostatic motor : FIG.6d

Pressing progressively the brake, the restriction valves (12) start closing, decelerating even more the hydrostatic motor and when the valves are completely closed the motor and the wheels stops moving.

At this procedure the hydraulic fluid with its kinetic energy and its pressure

assists the valves to close, as shown at the drawing, that means a " Power Braking " This applying of brakes would not be possible if the eccentricity of the rotor on the drum had been such that it would leave some interval between the cylinder (1) and the rotor.

For parking, of course, the shift lever have to be placed to the possition (P), where it must exists a mechanical hand brake.
During stopping with the foot brake or the hand brake, the engine does not stall, because the high pressure activates the pre-adjusted relief valve (23).

The BASIC box may be placed at large motorcycles , at four wheel vehicles with front or rear drive, in combination with a mechanical differential, to drilling machines , to trains, airplanes, copters and wherever a variable torque is required.

Operation of the COMPLEX box:
The said box is designed to be placed to every, 4wheel or 4wheel-drive vehicle and is the automatic hydrostatic box, to its most perfect form.

Every driving wheel has its own independent box, while the engine moves with a single axis, both driving pumps. Therefore each driving wheel has its own, independent, transmission. FIG.7.
When the vehicle enters a curve, the box of the internal wheel, as this wheel meets resistance, will reduce speed in proportion whith the radius of the curve and the wheel will lose rounds, increasing its toque, while the box of the external wheel, since it will face a reduced resistance, will increase the speed in proportion to the radius of its curve, which is much larger than the radius of curve of the internal wheel and, therefore, the external wheel will increase its rounds reducing its torque.
In case that one of the wheels meets a ground of reduced adherence (water, oil, pebble etc.) the other one will continue moving with the speed which it had, without the direction of the vehicle to be affected.
Kickdown: In case of a rush to lower the ratio, instantly, for a quick surpassing the driver may force a downshift by pushing the throttle to the wide-open position and the box due to the inertia of the kinetic energy of vehicle will instantly lower the speed ratio to facilitate its acceleration.
The COMPLEX box, at the front wheel drive vehicles is being placed in front or under the engine, while at the rear wheel driven vehicles, at the position

of the differential, or it is being separated to three parts where the two driving pumps is being connected to the engine's fly wheel and the two independent motors each one of them near each wheel and, of course, they are connected with the two pumps with extensions of the channels (19) and (20) and of the pipes (16) and (17).

At the COMPLEX box of FIG.8 the two driving pumps are being replaced by one driving pump of double volume (2A), the axis of which is being connected to the engine's fly wheel throuch the so called final ratio (here first ratio) The main channels (19) and (20) are being branched off and supply the two motors (B), while the secontary channels are being branched too, connecting the same chambers, The volumes of the two motors are independent to each other, yet always their sum, equals with the volume of the driving pump (2A). The hydrostatic differential of this box works as a common mechanical one, but, it has the advantage that the wheels are never immobilized because the volums of the two motors are never nullified.

Semi-automatic hydrostatic box :

If from the basic, automatic inertial, hydrostatic box, we remove the automatic inertial mechanism and we add a manual lever, which will move the drum (3) of the pump (A) FIG.9 and FIG.10 then we have e very simple Semi-automatic hydrostatic box, of scaled or infinite linear ratios, with its own clutch, its own brake and with its own rear box circuit.

Remarks:

1/ For cooling the box there are being required cooling vanes.

2/ For the expansion of the hydraulic fluid, there exists an expansion valve (13)

3/ For the possible refilling of external oil losses there will be required a small pump which will be driven by the axis of the pump (A) and an oil reservoir.

4/ At the drum of pump (A) there exists a terminal escape valve (27) which opens when the drum comes near the end of its course, because in case that fluid leaks from the pump chamber to (D) chamber, the drum will not end its course at resting position (40).

CLAIMS

1. An automatic inertial continuous variable hydrostatic transmission, which consists of a common hydrostatic transmission, belonging to the level of technique, but it is being characterized by the fact that the transmission of motion is being achieved by a pair of vane pumps, of fixed eccentricity, of variable volume and direction, of the new type of "moving side", being connected in series and constituting a closed hydrostatic circuit, where the driving pump is being connected with the engine's fly wheel through a Rack and Pinion reduction ratio 1:4, without a reverse box and clutch, and throuch the hydraulic fluid it transfers its motion to the second pump, which here operates as hydrostatic motor, turning the wheel. The continuous changing of the speeds is being achieved with the continuous movement of the moving side of the pump accompanied with the continuous inverse motion of the moving side of the hydrostatic motor, because the circuit is of a closed type and the quantity of the fluid is constant. When the volume of the pump is being redused by dV the volume of the motor will be increased by dV and because at each position of the sides of pump and motor corresponds a transmission ratio and the moving side may receive infinite positions, this hydrostatic transmission box will provide infinite ratios too.

And a simple automatic inertial mechanism which with a wide pitch screw on the pump's axis and a threaded port of the same wide pitch at the center of the rotors cylinter, a helicoid spring which tends to move the system at the position of the maximum volume of the pump, reads through the pressure being developed each time between the vanes of the pump and motor, any attempted alteration of the kinetic situation of the vehicle and translates the said to continuous motions of the "moving side setA" which with its female thread, screws or unscrews on the axis thread approaching or moving away from the diaphragm, decreasing or increasing its volume and, vice versa, the volume of the motor. The axis of the motor does not bear any screw but only a slot wedge on which it may freely slide with a wedge, the "moving side setB", in parallel with its rotation, while in the meantime is being continuously pressed by a helicoid spring, which tends to restore the system at the position of the minimum volume of the motor. The hydrostatic motor is the one which moves the wheel and transfers, through its vanes to the vanes of the pumps rotor all the torques of inertia which the wheels face at their motion.

2. A vane pump (B) FIG.1, of fixed eccentricity and variable volume, as mentioned in FIG,1, which change its volume with moving the one side of it by a manual or automatic mechanism. The one side of it has been replaced by a drum which, as a piston, may reciprocate, without rotating, inside a hydraulic cylinder. At the flat side of the drum there is being gripped, loosely and eccentrically, the rotor of the pump with the vanes, in a way that it may freely but firmly rotate, with a roll bearing, in contact with the drum. The drum, the rotor and the vanes, constitute a unique and indivisible flexible system which we will call, furtheron, due to briefness "moving side set". The vanes during their rotation are pressed on the extension of the internal surface of the cylinder, inside the main chamber of the pump, by small springs or by the oil's pressure unterneath, and from the existing openings FIG.3 the fluid enters or exits, from or towards the main channels. The other side of the pump is being replaced by a metal diaphragm, from which there tightly pass through, the vanes and the body of the rotor at the closing of the pump, with the minimum tolerances, into the chamber (P) The diaphragm is being also turning, drifted by the vanes while its perimeter moves fitted inside a crown so that there would not communicate the main chamber of the pump with the chamber (P). The axis of the pump bears a slot wedge on which there freely slides, with a wedge the "moving side set" at the same time with the rotation of its rotor.

3. An automatic inertial mechanism, as claimed in claim 1, being characterised by the fact that it uses a wide pitch screw in the position of the axis of the driving pump, a nut of the same wide pitch of the screw, being gripped at the centre hole of the rotor and one or more concentric helicoid springs for the achievement of progressive restore power. The mission of the spring is to tend to restor the "moving side set" at the position of the maximum volume of the pump, and in the meantime, with its elasticity to permit to the rotor to take for a while diferent rounds from the axis. when necessarily is moving on it. When the rotor and the axis rotate with same angular velocity, then the rotor does not change its position on the axis because the pressure which is being developed between the vanes of the pump and motor is being balanced by the extension power of the spring, whereas the transmission ratio which has been formed is the proper one, for the driving contitions at that time. If, following that, the vehicle enters an uphill road, then the rounds of the hydrostatic motor as will be going to be redused, due to the

resistance of the road, will instantly transfer the said resistance to the rotor of the pump, redusing, respectively, instantly its angular velocity as well. having as a result a differance between the axis and the rotors rounds, enforcing the "moving side set" to approach towards the side of the diaphragm, screwing on the axis screw, redusing in this way the volume of the pump until the pressures between the vanes are, once more, balanced with the new tension of the spring at this place and ceases maintaining the new transmission ratio which has been formed. At any decrease ot the volume of the pump, of course, there corresponds the supplementary increase of the volume of the hydrostatic motor, because the quantity of the fluid is constant and fluids are considered to be incompressible. As far as the volume of the pump is being decreased, the power of the spring increases, while the box downshifts continually. If in sequence the vehicle enters a flat horizontal road, then the pressures will be significantly reduced, the spring will start decompressing and the "moving side set" will commence withdrawing, moving away from the diaphragm, continuouly increasing the volume of the pump, until it stops to some point where the tension of the spring will balance the pressure which charges the vane of the pump. At the position where the rotor stops, there corresponds a transmission ratio of the box and, as the rotor may recieve infinite positions, the transmission ratios which may be provided by the new hydrostatic box are infinite.

4. An hydrostatic transmission box, as claimed at the claim 1, a characteristic of which is that with a pre-adjusted relief valve, the box instantly disengages the driving pump from the wheels, when the shift lever is placed to (D) drive, with the foot brake being pushed or when we use the brake in order to stop or in case that at starting, the inertia of the load is great enough that the engine could turn off. That is to say that, with a simple relief valve we adolish the CLUTCH.

5. An hydrostatic transmission as claimed at the claim 1 characterised by the fact, that for the reverse course it does not use a mechanical reverse gear box, but by placing the shift lever to (R) Rear FIG.6c the direction valves (10) close the main channels (19) and (20) and open the indepentent cross channels (24) an (25) whereas the flow is being inverted and the hydrostatic motor rotates at the inverse course. Because the flow of the fluid at the driving pump is not being inverted, the relief valve (23) keeps achieving its purpose and the

speeds will continue changing, even at reverse course. The moving of the shift lever from (D) to (R) may be carried out even if the vehicle is being moving, because in this case there are not being coupled any gears and for this reason it is being possible, connecting the foot brake with the direction valve, to assist the applying of brakes of the box.

6. A complex automatic, inertial hydrostatic transmission which consists of a combination of two basic hydrostatic boxes as claimed at claim 1, being characterised by the fact that each driving wheel, has its own independent box, and this complex form is at the same time an ideal shelf-controlled hydrostatic differential.

7. The complex hydrostatic box of claim 7, with the differance that it uses one single driving pump of the double volume, driving both the hydrostatic motors.

8. One semi-automatic hydrostatic box, same with the automatic one claimed in claim 1, only that it does not contain the automatic inertial mechanism, means, the axiss-screw the nut and the springs. The selection of the speeds from the driver is being carried out with the shift lever, which directly moves the drum of the pump to various positions which may have a linear form or to correspond to the gears of the common manual boxes. FIG.9 FIG.10 .

9. A mechanical diaphragm of sufficient thicknes as claimed in the claim 1 characterised by the addition into its body springs and small antifriction metallic blocks that compress the two sides of the vanes , as they are passing from the diaphragm. For a better tightness, four sliding pieces (44) with the same thickness with the vanes, extend the vanes into the diaphragm while sliding upon the heads of them due to the sliding bond (48).

CLAIMS

[received by the International Bureau on 29 November 1995 (29.11.95); original claims 1-5 amended; original claims 6-8 and 9 amended and renumbered as claims 8-10 and 7; new claim 6 added; (5 pages)]

1. An automatic inertial continuously variable hydrostatic transmission, which consists of a common hydrostatic transmission, belonging to the level of technique, but it is being characterized by the fact that the transmission of motion is being achieved by a pair of identical, reversible vane pump/motor(A,B) units of fixed eccentricity, of variable volume and direction, of the new type of "moving side", being connected in series and costituting a closed hydrostatic circuit, where, the driving pump is being connected with the engines fly wheel through a Rack and Pinion reduction ratio 1:4, without a mechanical reverse box and cluch, and through the hydraulic fluid it transfers its motion to the second pump, which here orerates as hydrostatic motor, turning the wheel. The continuous changing of the speeds is being achieved with the continuous movement of the moving side of the pump, accompanied by the continuous inverse motion of the moving side of the hydrostatic motor, because the circuit is of a closed type and the quantity of the fluid is constant. Thus, when the volume of the pump is being redused by dV the volume of the motor will be increased by dV, and because at each position of the sides of pump and motor corresponds a transmission ratio and the moving side may receive infinitte positions, this hydrostatic transmission box will provide infinite ratios too.

And a simple automatic inertial mechanism which, with a clock-wise wide pitch screw on the driving pumps axis, and a clock-wise threded port of the same wide pitch to the center of its rotor cylinter, tow helicoid springs (7,15) which tend to move the system at the position of the maximum volume of the pump, and reads through the pressure being developed, each time, between the vanes of pump and motor, any attempted alteration of the kinetic situation of the vehicle translating the said to continuous motionsof the "moving side setA" which with its female thread, screws or unscrews on the axis thread approaching or moving away from the diaphragm, decreasing or increasing its volume and, vice versa, the volume of the motor. The axis of the motor does not bear any screw but only a slot wedge on which it may freely slide with a wedge, the "moving side setB", in parallel withits rotation, while in the meantime is being continuously pressed by a helicoid spring, which tend to restore the system at the position of the minimum volume of the motor. The hydrostatic motor is the one which moves the wheel and transfers, through its vanes to the vanes of the driving pumps rotor all the torques of inertia which the wheels face at their motion.

The shift lever of the box has the following selections: (P)Parking - (R)Rear (N)Neutral - (D)Drive - (Lo)Lock - (L)Low. At the position (Lo) the restriction valve (18) FIG.1,FIG2 is closed and at the position (L) is partial closed. So, the said transmission box can offer all kinds of driving.

2. A reversible vane pump (B) FIG.1, FIG.2, of fixed eccentricity and variable volume, as claimed in claim 1, which can change its volume by moving the one side of it via a manual or automatic mechanism. The one side of it has been replaced by a drum which, like a piston, may reciprocate, without rotating, inside an hydraulic cylinder (1). At the flat side of the drum there is being connected with a rollbearing (33) FIG.2, and eccentrically, the rotor of the pump with the vanes, in a way that it may freely but firmly rotate, in contact with the drum. The drum the rotor and the vanes, constitute a unique and indivisible flexible system which we will call, furtheron, due to briefness "moving side set". The vanes during their rotation are pressed on the extension of the internal surface of the cylinter (1), inside the main chamber of the pump, by small springs or by the oil§ pressure unterneath, or by the springs (47) FIG.11, and from the existing openings (11) FIG.3, the fluid enters or exits, from or towards the main channels (19,20). The other side of the pump is being replaced by a metal diaphragm (5) FIG.1,4, or a mechanical one FIG.11,12.from which there tightly pass through, the vanes and the body of the rotor at the decreasing of the volume of the pump, with the minimum tolerances, into the chamber (P). The diaphragm is being also turning drifted by the vanes, while its perimeter moves fitted inside an oil-proof crown (4), so that there would not communicate the main chamber of the pump with the chamber (P). The axis of the pump bears a slot wedge on which there freely slides, with a wedge the "moving side setB" at the same time with the rotation of its rotor.

3. An automatic inertial mechanism, as claimed at claim 1. being characterized by the fact that it uses a clock-wise wide pitch screw in the place of the axis of the driving pump (A), a nut of the same wide pitch of the screw, being gripped at the centre hole of the rotor (A) and one or more concentric helicoid pressure springs for the achivement of progressive restore power. The The mission of the spring is to tend to restor the "moving side setA" to the position of the maximum volume of the pump (A), and in the meantime, with its elasticity to permit to the rotor to take for a while different rounds from the axis, whenever necessarily is moving on it. When the rotor and the axis

rotate with the same angular velocity, then the rotor does not change its position on the axis because the pressure which is being developed between the vanes of the pump and motor is being balanced by the extention power of the spring, whereas the transmission ratio which has been formed is the proper one, for the driving contitions at that time. If, following that, the vehicle enters an uphill road, then the rounds of the hydrostatic motor as they will be going to be redused, due to the resistance of the roadś inclination, it will instantly transfer the said resistance, from the vanes of the motor to the vanes of the pump, redusing its angular velocity as well. Result, a diferance between the axis and the rotorś rounds, enforcing the "moving side set A" to approach towards the side of the diaphragm screwing on the axis screw, and redusing in this way the volume of the pump until the pressures between the vanes are, once more, balanced with the new tension of the spring at this place and ceases holding the new transmission ratio which has been formed. At any decrease of the volume of the pump, of course, there corresponds the suplementary increase of the volume of the hydrostatic motor, because the quantity of the fluid is constant and fluids are considered to be incompressible. As far as the volume of the pump is being decreased, the power of the cooperating springs (7) and (15) increases, while the box downshifts continually. If in sequence the vehicle enters a flat level road, then the pressures will be significantly reduced, the springs will start decompressing and the "moving side setA" will commence withdrawing, moving away from the diaphragm, continuously increasing the volume of the pump, until it stops to some point where the tension of the springs will balance the pressure that charges the vane of the pump. At the posision where the "moving side setA" stops, there corresponds a transmission ratio in the box and, as the "moving side setA" may receive infinite posisions, so and the transmission ratios which may be provided by the new hydrostatic box are infinite too.

4. An hydrostatic transmission box, as claimed at claim 1, a characteristic of which is that with a preadjusted relief valve (23) the box instantly disengages the driving pump from the wheels, when the shift level is placed to (D) with the foot brake being pushed or when the driver use the brake in order to stop, or at starting, when the inertia of the load is great enough and the engine will stall. That is to say that, with a simple relief valve we adolish the CLUCH;

5. An hydrostatic transmission as claimed at claim 1, characterized by the fact that for the reverse course it does not use a mechanical reverse gear box, but by placing the shift lever to (R)Rear FIG.6c the direction valves (10) close the main channels (19) and (20) and open the indepentent cross channels (24) and (25) whereas the flow is being inverted and the hydrostatic motor rotates at the inverse course. Because the flow of the fluid at the driving pump is not being inverted, the relief valve (23) keeps achiving its purpose and the speeds will continue changing, even at reverse course. The moving of the shift lever from (D) to (R) may be carried out even if the vehicle is being moving, because in this box there are not being coupled any gears and for this reason it is being possible, in a panic braking or in a brake failur to move at the same time, the shift lever to (R).

6. A development of restriction valve (18) claimed at claim 1, to a snap action electrohydraulic one , which is characterized by its ability to take orders from the engineś throttle valve, and stays wide open when the throttle valve is in any open position, and closes, when the throttle valve is in the idling position.

Every time the driver push or release the accelerator, the throttle valveś pivot energise an electric circuit that open or close the valve (18).

With this procedure, when the driver just touch the accelerator to open the throttle valve, the transmission set free to change speeds because the valve (18) commes instantly wide open and the "moving side sets" are free to reciprocate. But if the driver pulls away his foot from the pedal, the valve closes completely, the "moving side sets" cannot reciprocate any more and the box locks the existing transmission ratio, helping the vehicle to decelerate holded by the engine.

Approaching a downhill road with a certain speed ratio in the box, the driver release the accelerator to keep this speed ratio locked in order to climb down holded by the engine. If after that the driver wish to downshift for a more tight control of the speed, he can force for a moment a Kickdown, by the accelerator, when the revolutions of the engine will increase while the turns of the rotor (A) will remain constant and so, the result will be a downshift.

7. A diaphragm as claimed in claim 1, but of sufficient thicknes characterized by the addition into its body springs and small antifriction metallic blocks that compress the two sides of the vanes, as they are passing from the diaphragm. For a better tightness,four sliding pieces (44) with the same thickness

with the vanes, extend the vanes into the diaphragms body, while sliding upon the heads of the vanes due to sliding bonds (48) FIG.11,FIG.+".

8. A complex automatic inertial hydrostatic transmission, which consists of a compination of two basic hydroststic boxes FIG.7 as claimed at claim 1, being characterized by the fact that each driving wheel, has its own independent box, and this complex edition is at the same time an ideal shelf-controlled hydrostatic differential.

9. The complex hydrostatic box of claim 8, with the differance that it uses one single driving pump of the double volume, driving both the hydrostatic motors. FIG.8.

10. A semi-automatic hydrostatic box FIG.9,FIG.10 same with the basic automatic one as claimed in claim 1. only that it does not contain the automatic inertial mechanism, means, the axis-screw the nut and the springs. The selection of the speeds from the driver is being carried out manualy with the shift lever, which directly moves the drum of the pump (A) to various positions which may have a linear form, or to correspond to the gears of the common manual boxes.

Statement under Article 19

Amended claim 1. has some insignificant amendments, refering to omissions or changes of words, but which does not have any impact on the description or the drawings. The completion added has been missed by mistake and it is mentioned in the description on page 11 line 26 to 32.

Amended claims 2 to 5 and 7 to 10, have enough insignificant amendments refering to omissions or changes of words and small phrases, but without any impact on the meaning of the descriptions text.

New claim 6. describes another use of valve (18) but as an electrohydraulic one, which improves the responce of the transmission, when in a downhill road, the wheels move the engine, and the pressures in the two main channels are inverted.

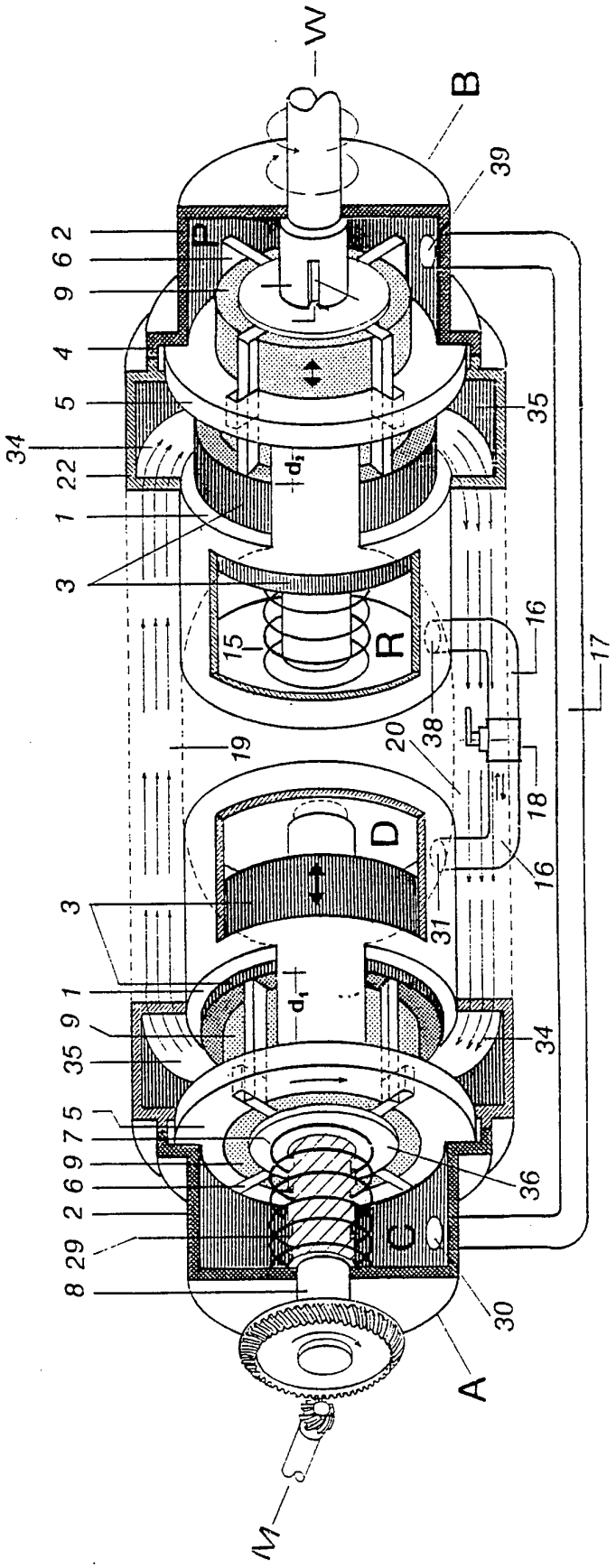

W
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P
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22
1
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35
d_2
16
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R
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38
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19
18
D
16
31
3
d_1
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9
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34
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7
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36
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8
C
30
A
M

Fig. 1

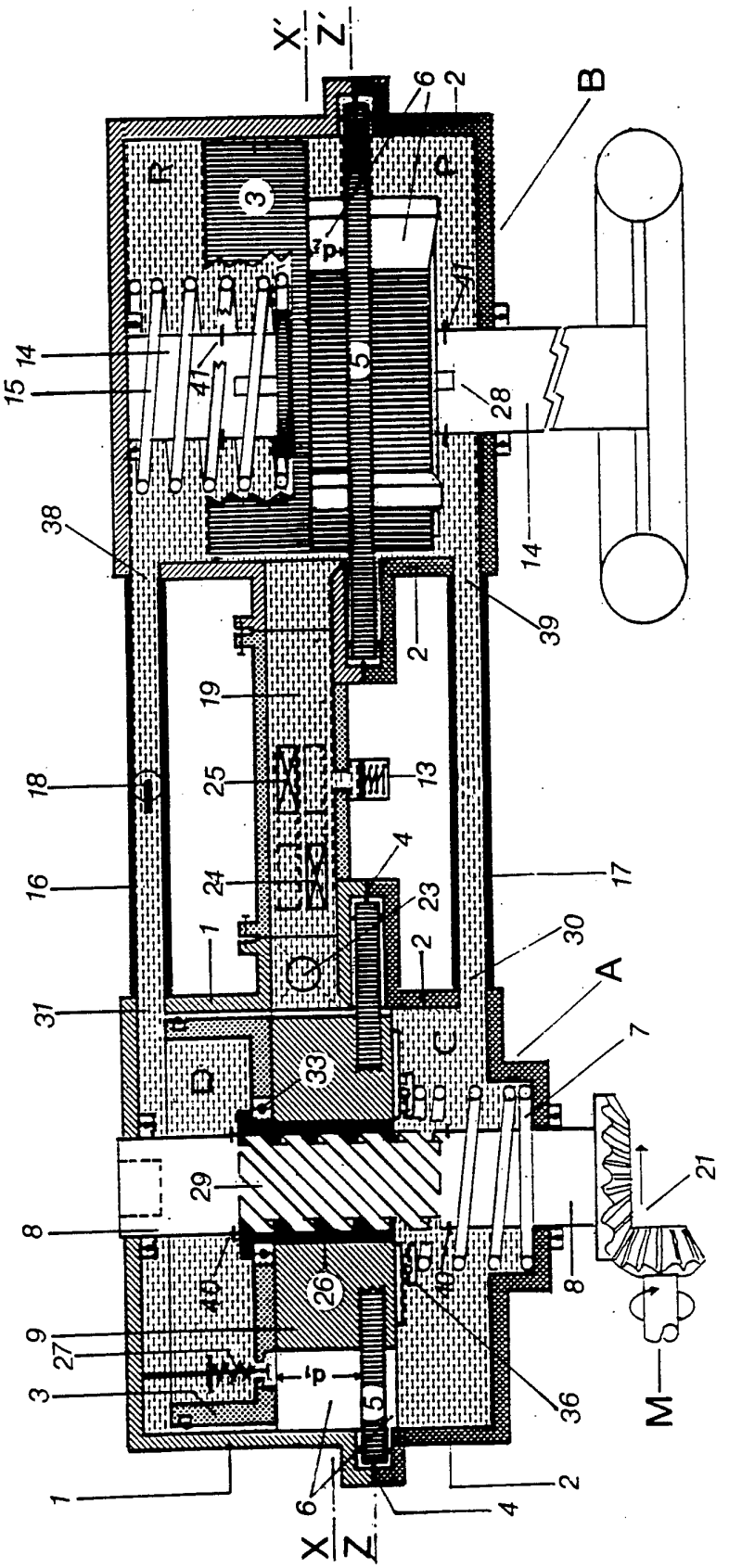

X'
Z'
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Fig. 2

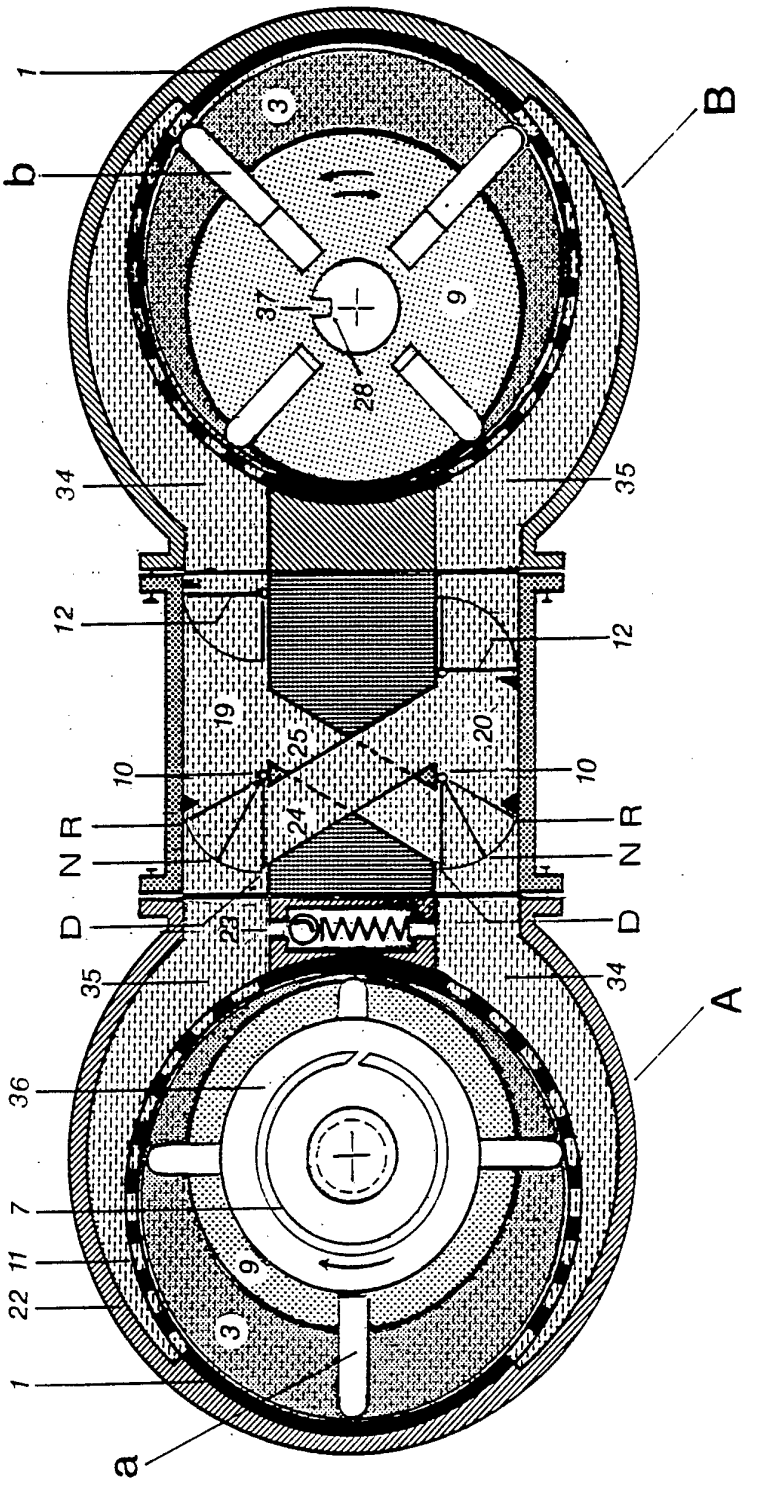

1
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B
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37
28
34
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12
19
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10
10
24
D N R
D N R
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34
A
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22
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1
a

Fig. 3

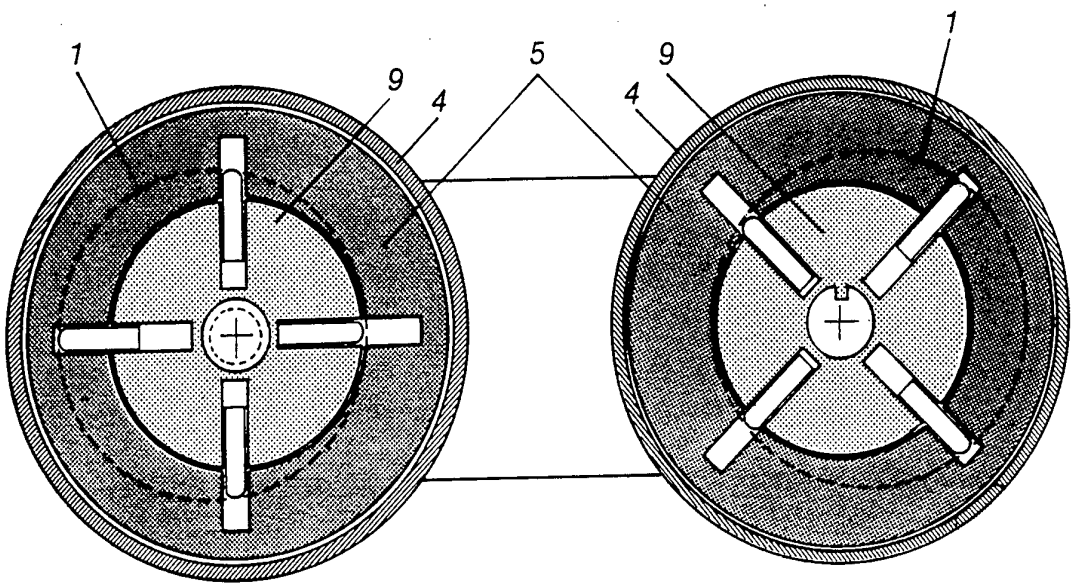


Fig. 4

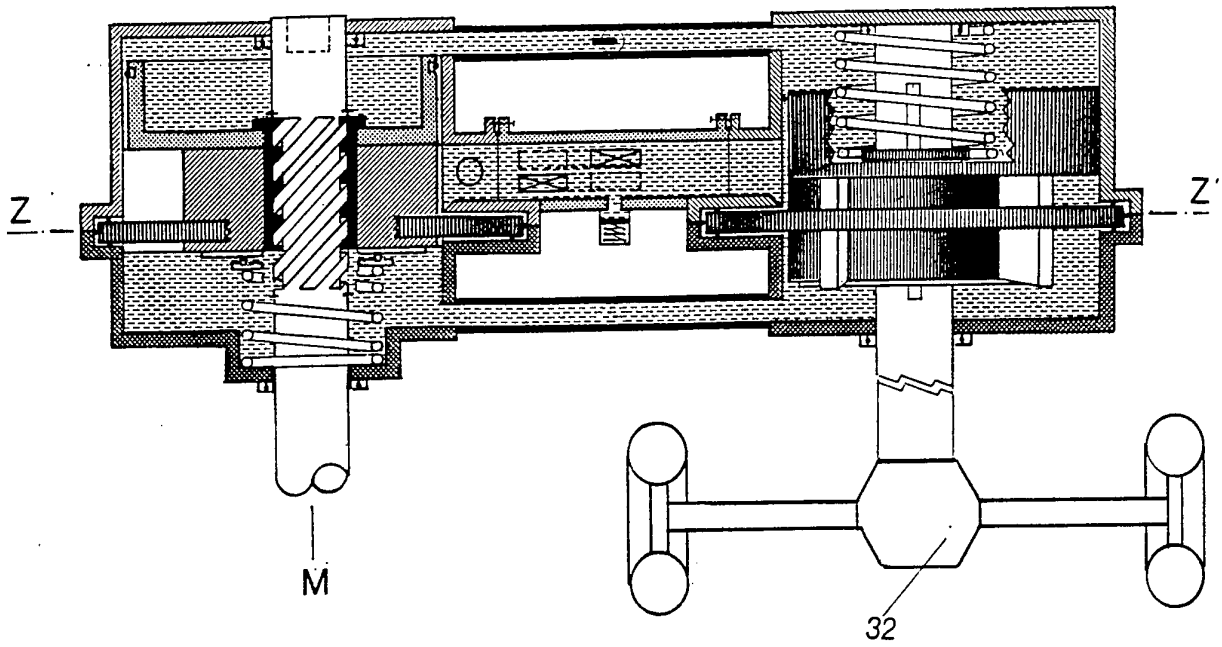


Fig. 5

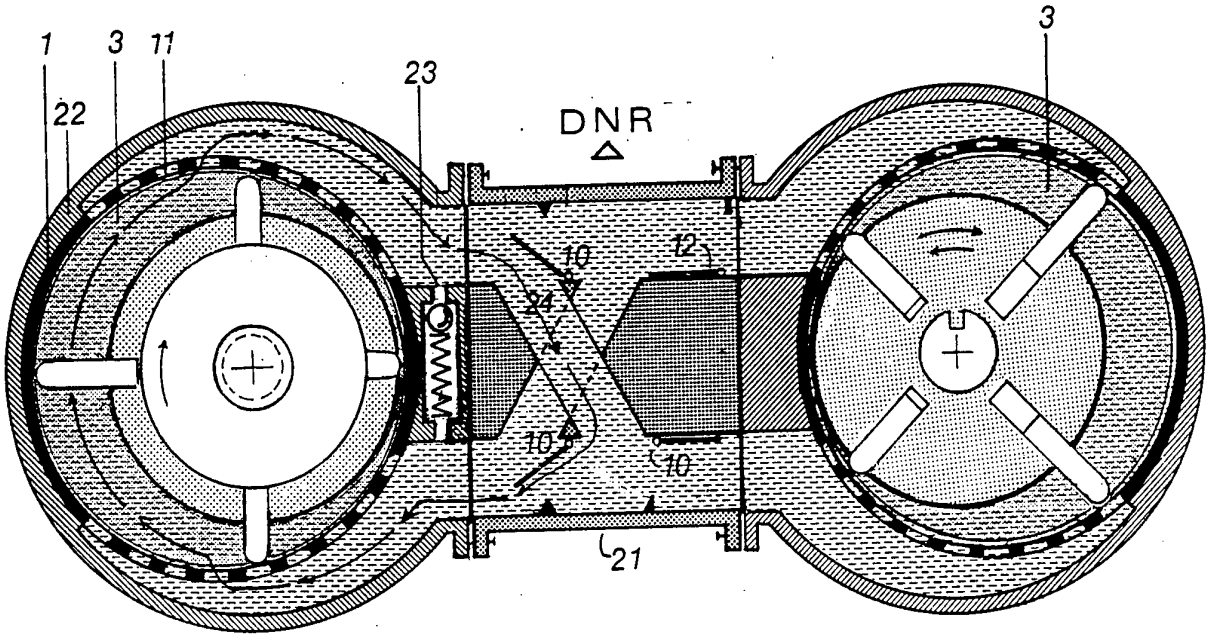


Fig. 6a

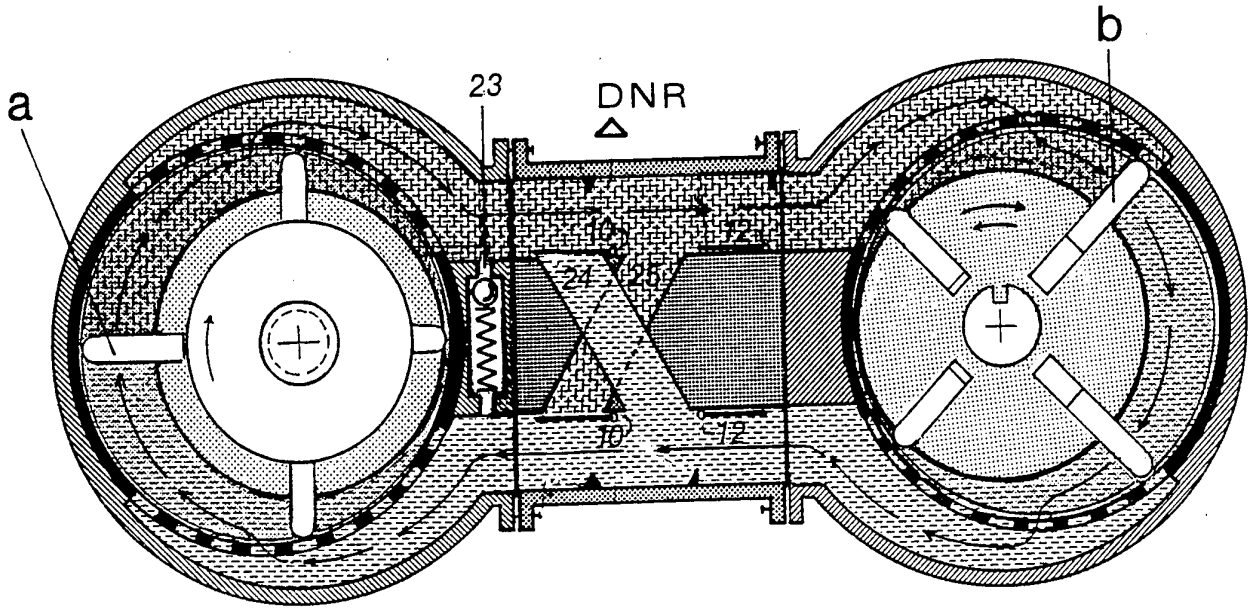


Fig. 6b

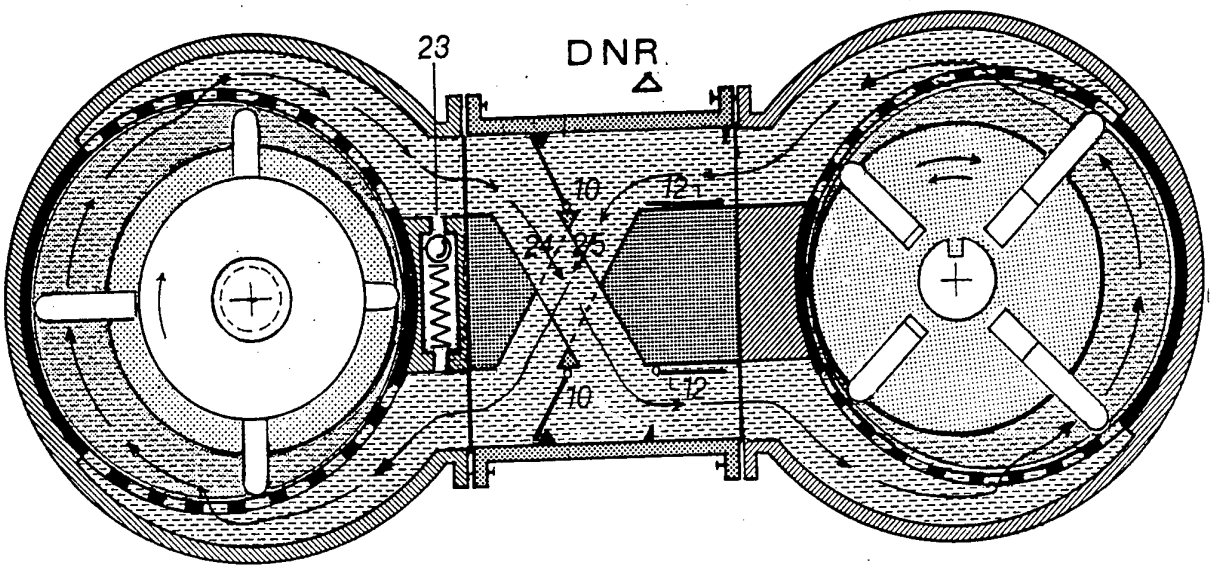


Fig. 6c

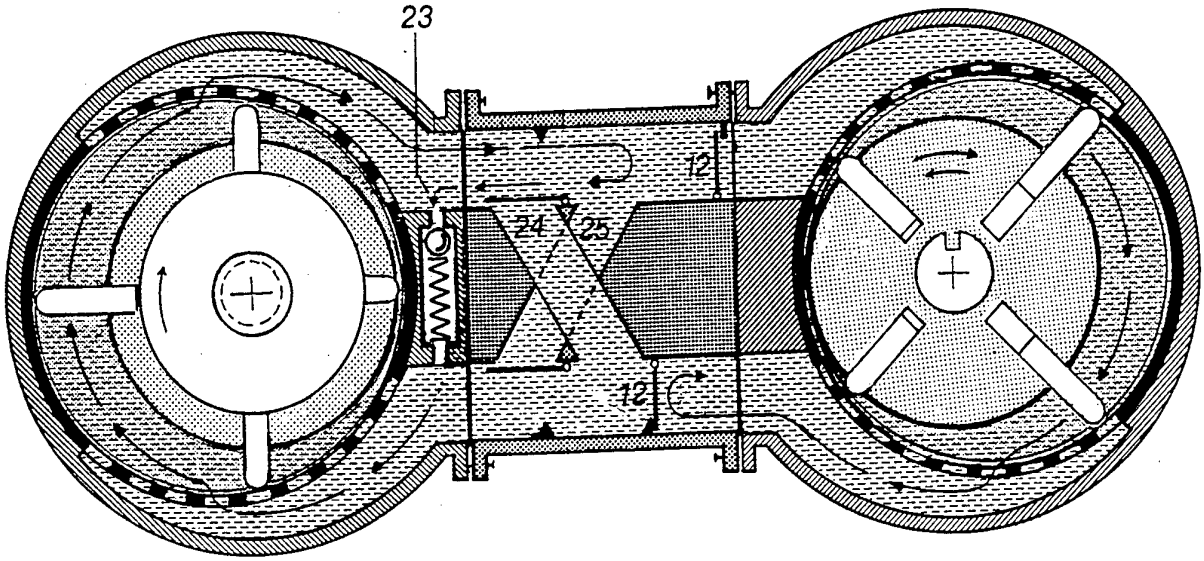


Fig. 6d

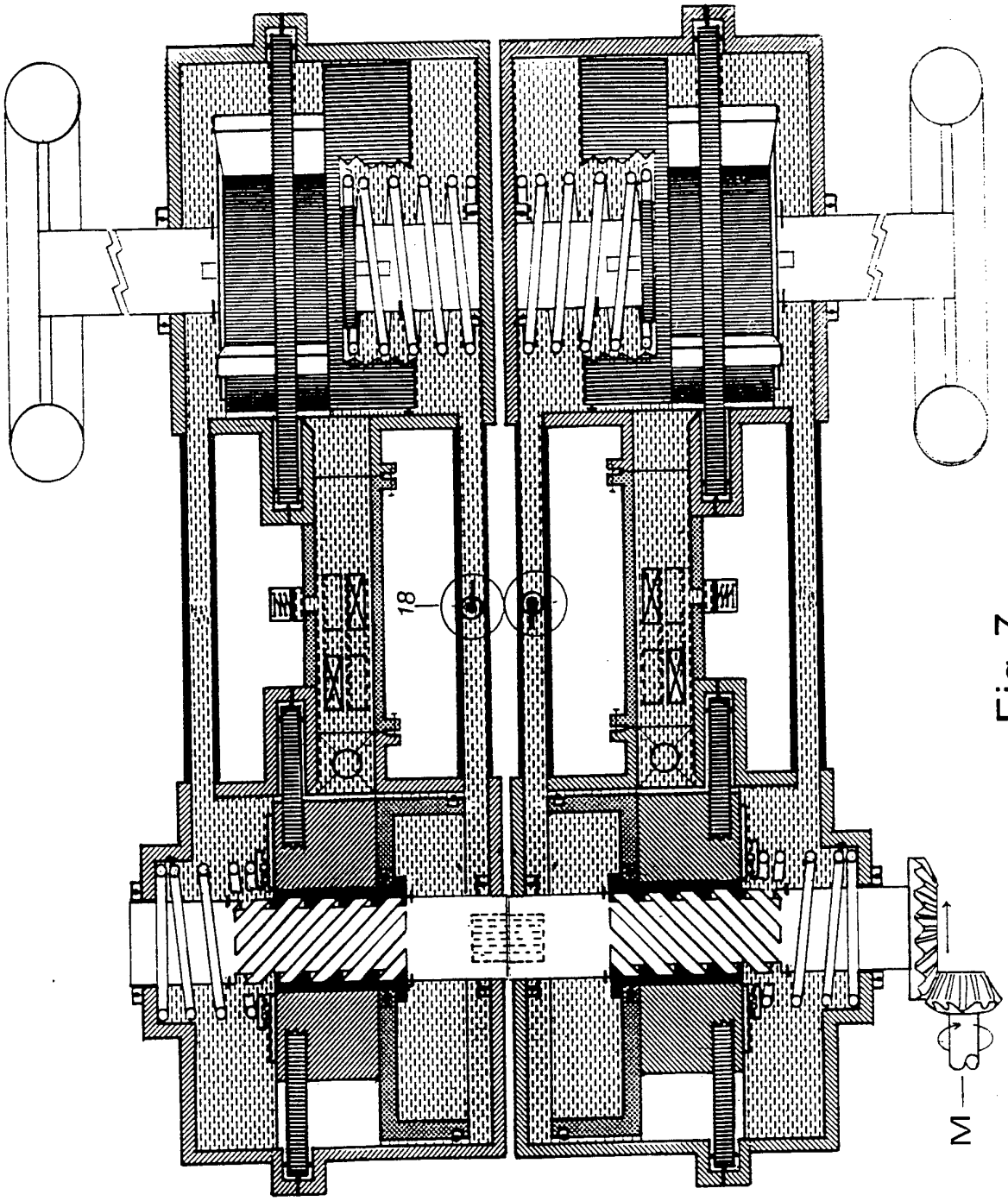


Fig. 7

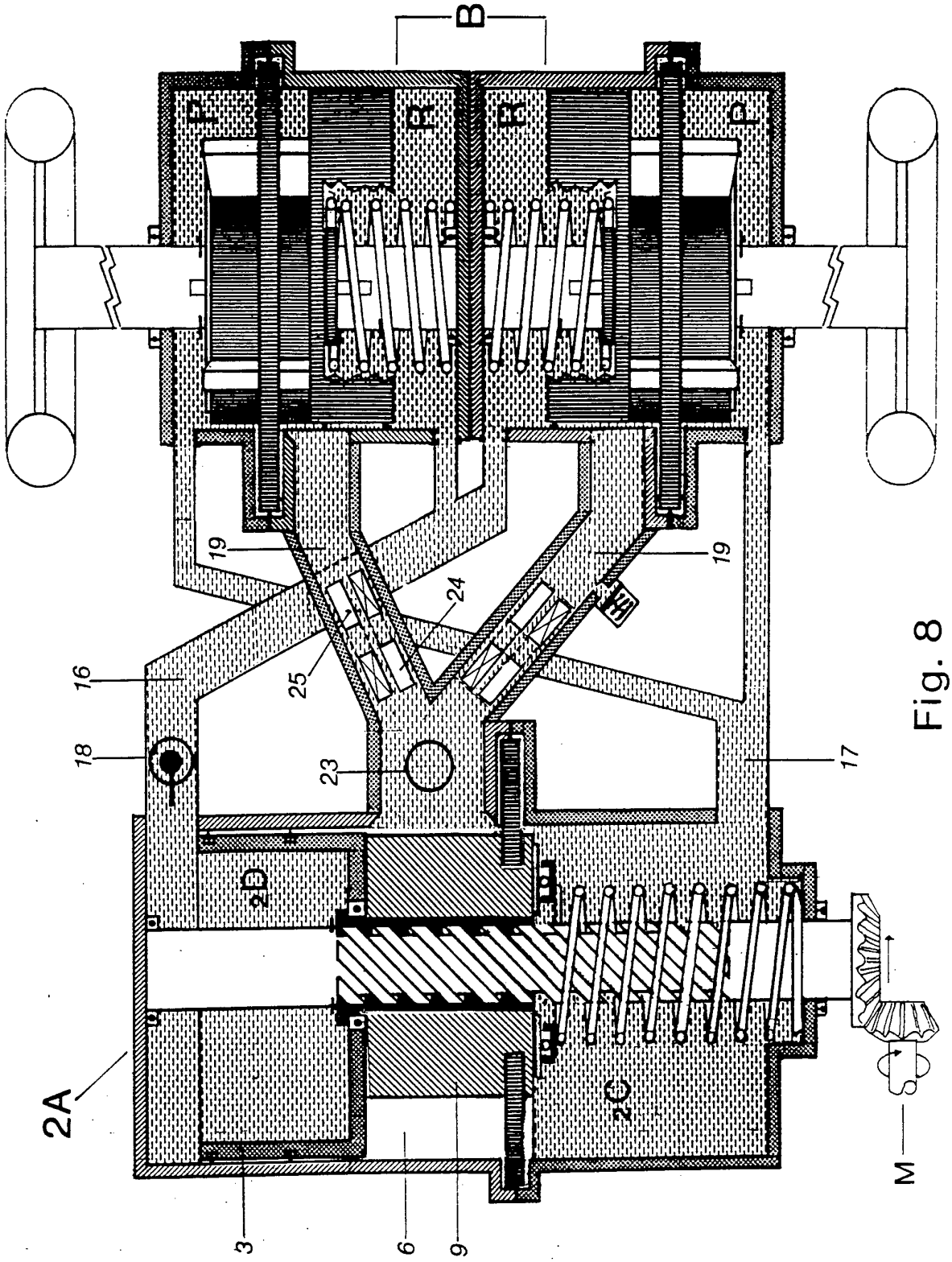


Fig. 8

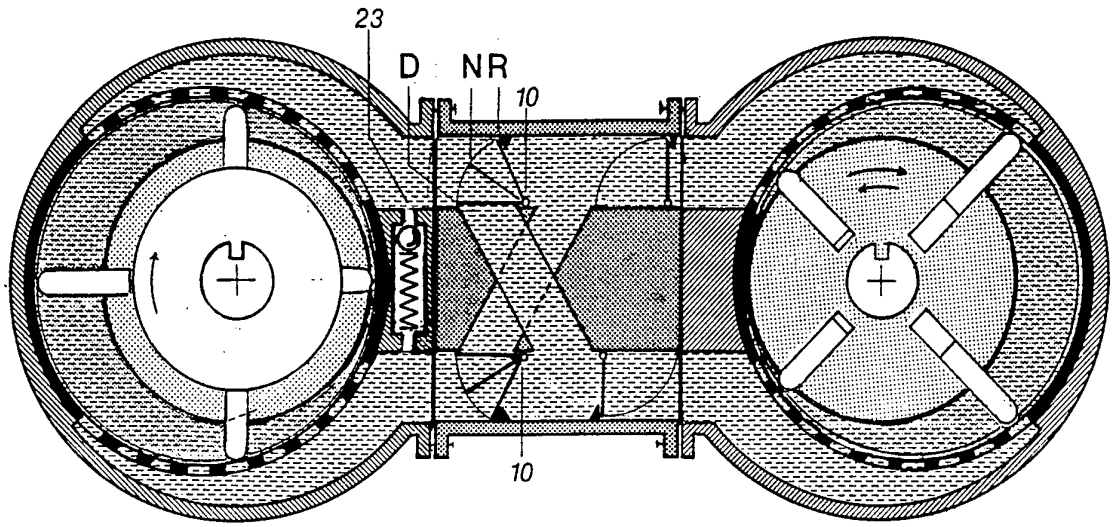


Fig. 9

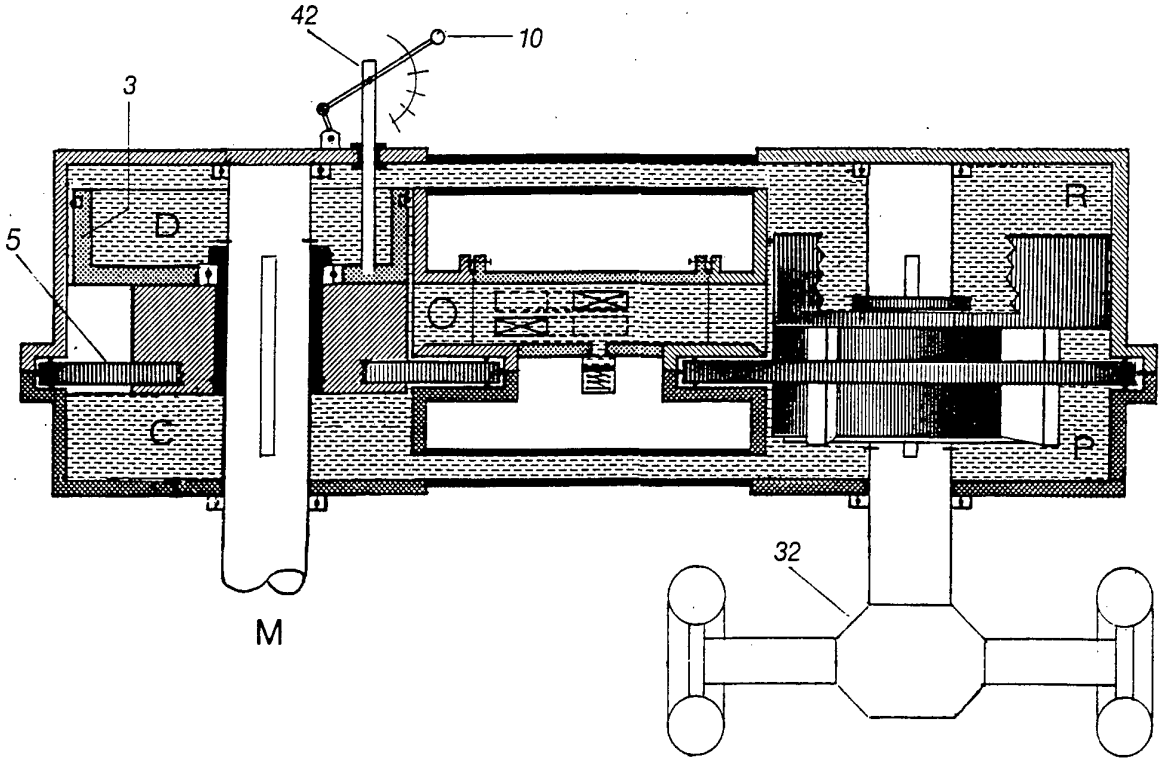


Fig. 10

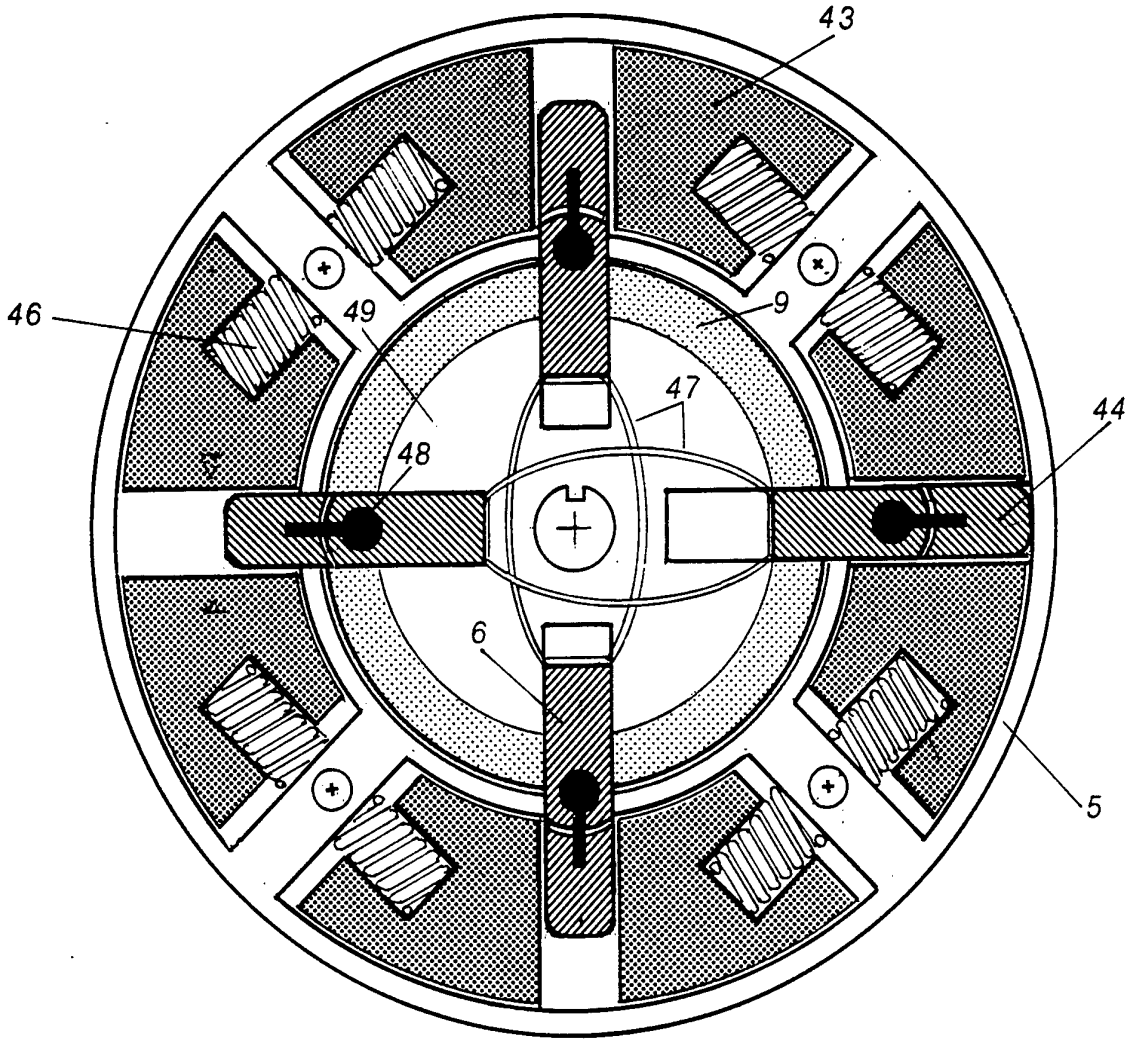


Fig.11

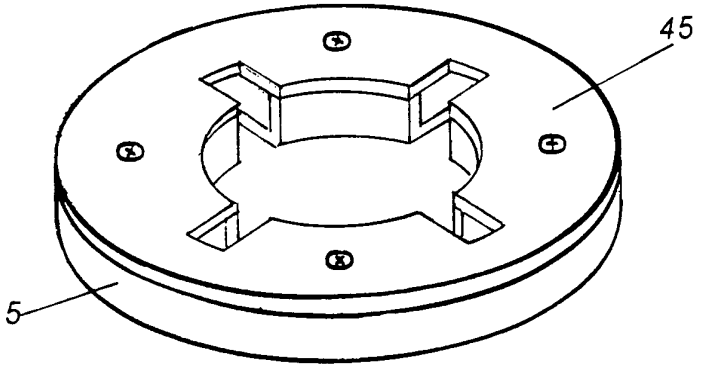


Fig.12

INTERNATIONAL SEARCH REPORT

Inten ıal Application No
PCT/GR 95/00012

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16H39/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR,A,893 799 (MICELI) 30 October 1944 see the whole document	1,4-8
A	FR,A,470 741 (GOUGE) 26 September 1914 see page 1; figure 1	1,2,8
A	FR,A,875 582 (MERCIER) 28 September 1942 see the whole document	1,3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 1995	02. 10. 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Flores, E

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INTERNATIONAL SEARCH REPORT

information on patent family members

Inter nal Application No
PCT/GR 95/00012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A-893799		NONE	
FR-A-470741		NONE	
FR-A-875582	01-10-42	NONE	