Jan. 22, 1957 H. J. SHAFER 2,778,338

INTERNAL FLUID SHUT OFF FOR HYDRAULIC MOTOR

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FIG. 2

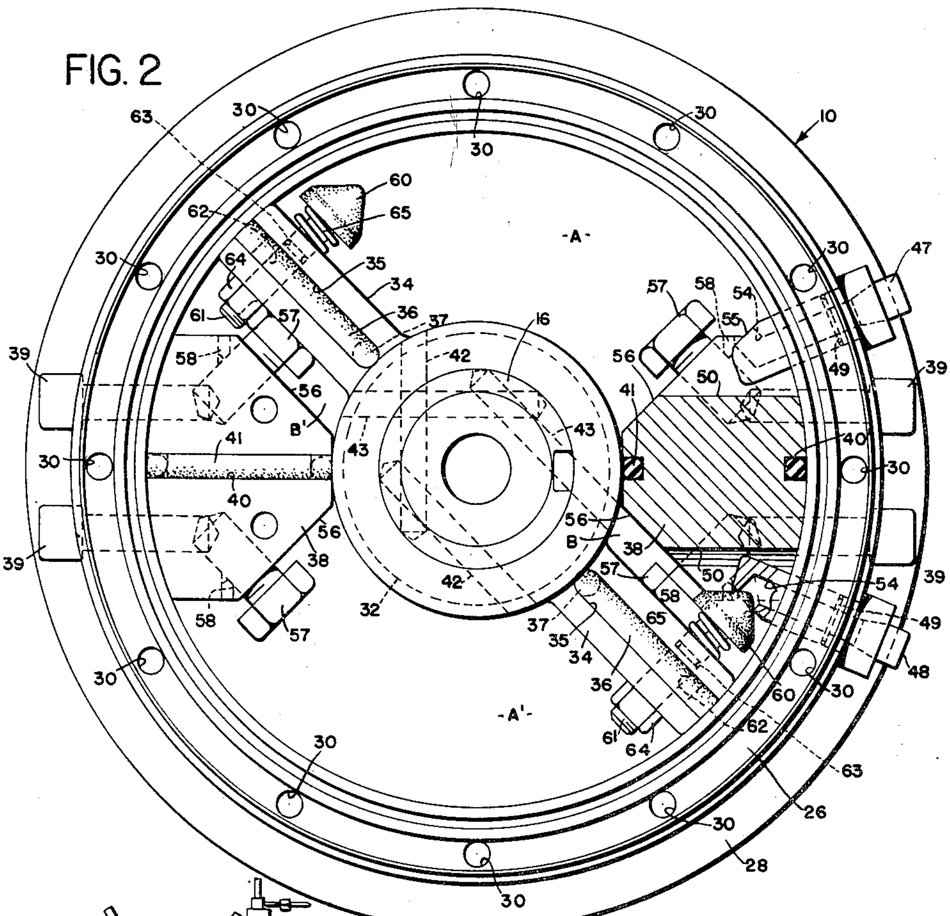


FIG. 1

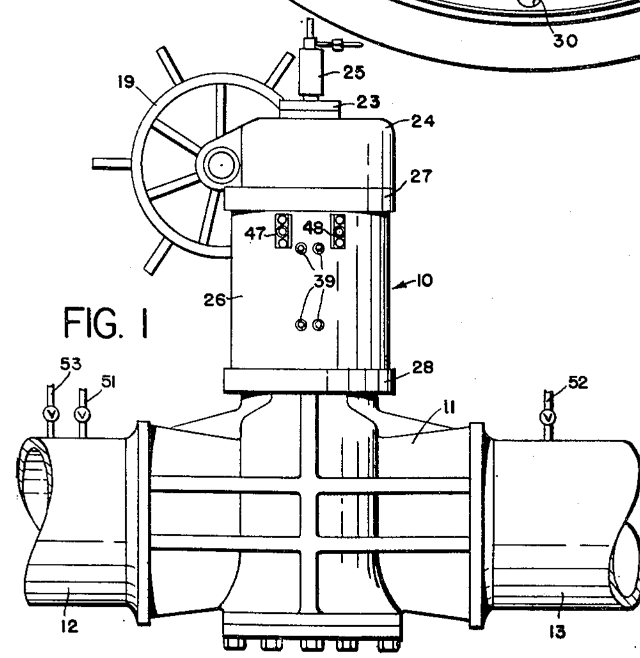
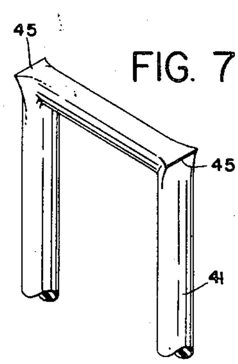


FIG. 7



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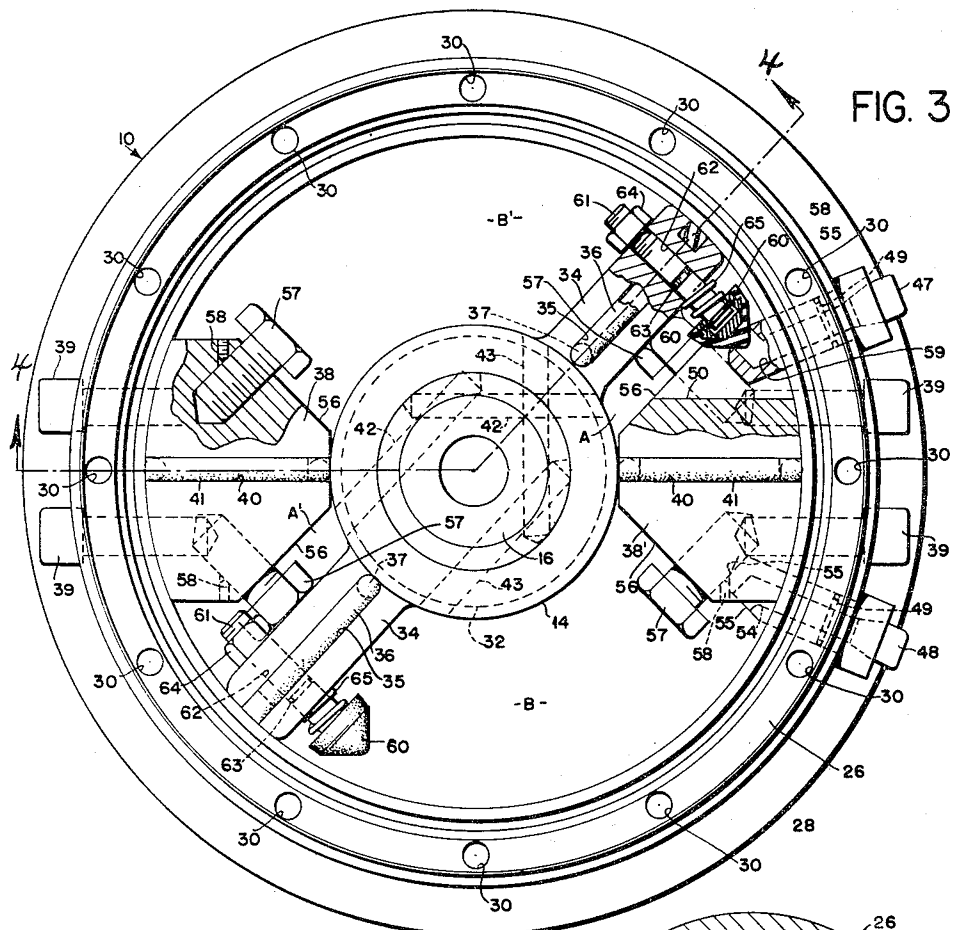
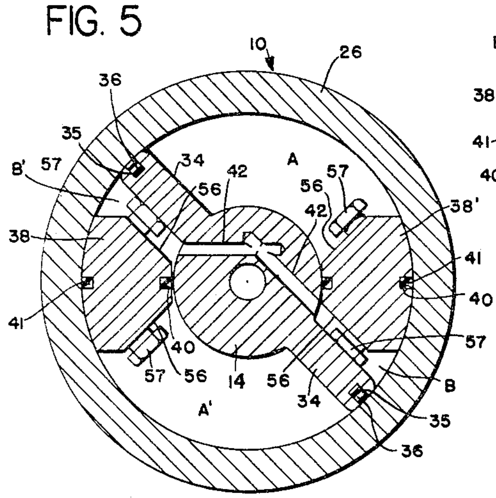


FIG. 3

FIG. 5



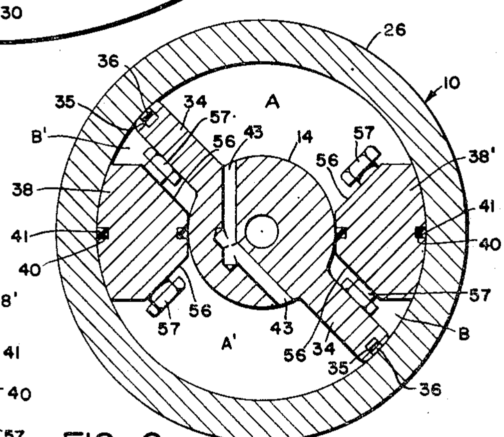


FIG. 6

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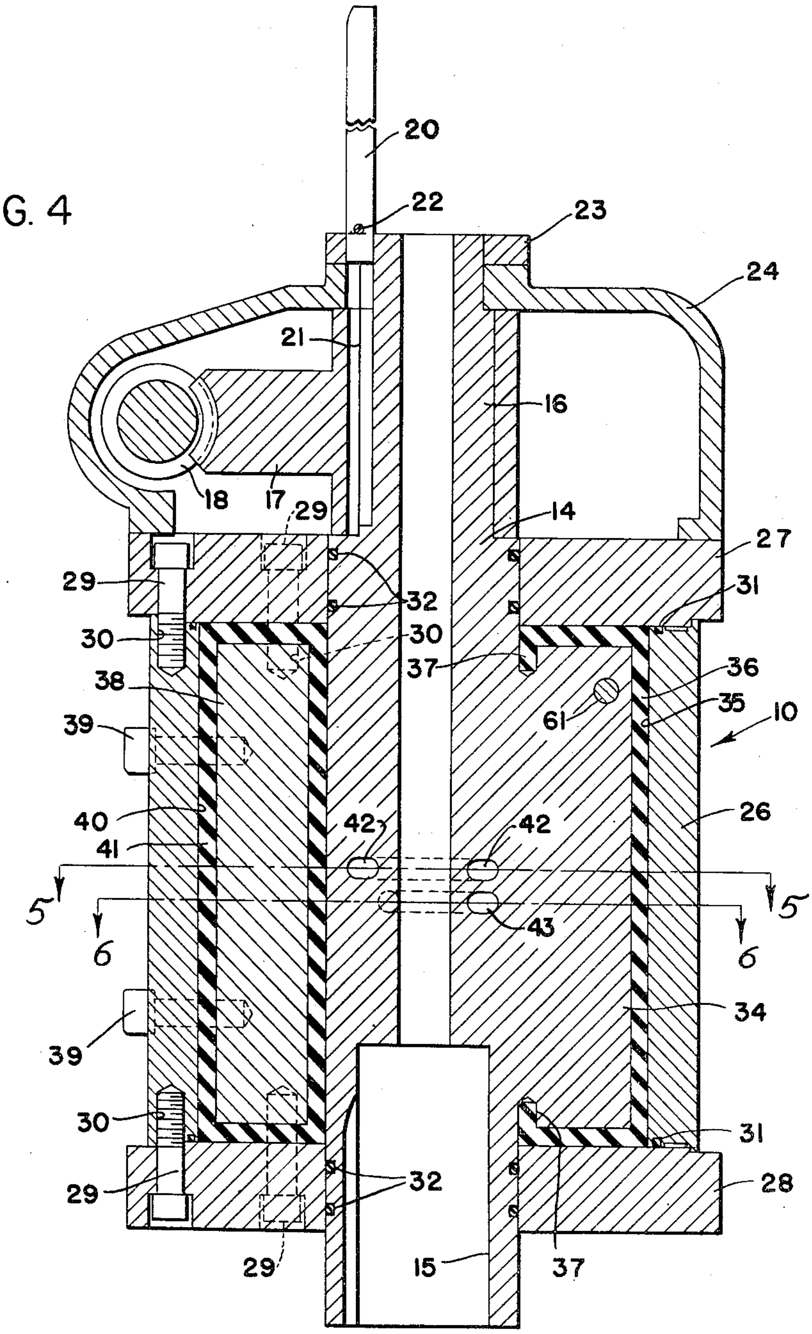
FIG. 4



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INTERNAL FLUID SHUT OFF FOR HYDRAULIC MOTOR

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Application January 27, 1953, Serial No. 333,496

2 Claims. (Cl. 121—38)

The invention relates generally to hydraulic motors having a rotary impeller vane, and more particularly to novel means for preventing leakage of pressure fluid from the motor during operation.

Hydraulic motors of the character referred to have many applications. By way of example, such a motor is shown and described as adapted for operating valves in high pressure pipe lines transporting oil, gas, gasoline, or other fluids. Such motors may operate rotary plug valves in the pipe line and the motor may be actuated automatically by a change in line pressure caused, for example, by a break in the line, or may be actuated by remote control manually or automatically. In either case the power for actuating the motor may be applied for a substantial period of time after the valve is operated.

A substantially fluid tight seal is provided between the impeller vane and cylinder wall of the motor to separate the pressure chamber from the exhaust chamber, but when power is applied to the pressure chamber to rotate the vane, the pressure fluid tends gradually to flow or seep past the seal and leak out through the exhaust chamber port, particularly when high pressure continues to be applied after the vane has been rotated to its limit in one direction, as in the case of the motor closing a pipe line valve. The pressure fluid in the motor may be oil, gas, air, or other suitable fluid, and cumulative leakage resulting from continued operation may be expensive and may interfere with the balance of fluid in the pressure and exhaust chambers of the motor where the fluid operates in a closed system.

It is an object of the present invention to provide a novel shut-off device for preventing leakage of pressure fluid in a rotary oscillatory hydraulic motor after the motor is operated in one direction or the other.

Another object is to provide an improved hydraulic motor having a rotary impeller vane with novel internal shut-off means closing off the pressure fluid on the exhaust side of the vane when the vane reaches its limit in either direction.

A further object is to provide novel shut-off means mounted on the impeller vane of a rotary hydraulic motor for closing the pressure fluid exhaust port at the limit of movement of the vane in either direction.

These and other objects are accomplished by the improvements comprising the present invention, a preferred embodiment of which is shown and described herein by way of example. It is to be understood that various changes and modifications in details may be made without departing from the scope of the invention as defined in the appended claims.

Referring to the drawings:

Fig. 1 is a side elevational view of the hydraulic motor of the present invention applied to a high pressure pipe line valve;

Fig. 2 is an enlarged top view of the motor with the

top plate removed and showing the vane at the limit of its movement in one direction;

Fig. 3 is a similar view showing the vane at the limit of its movement in the opposite direction;

Fig. 4 is a vertical sectional view through the motor removed from the valve, taken on line 4—4 of Fig. 3;

Fig. 5 is a reduced plan sectional view on line 5—5, Fig. 4;

Fig. 6 is a similar view on line 6—6, Fig. 4; and

Fig. 7 is a fragmentary perspective view of one of the specially designed rings for fitting in the shoes or abutments in the pressure chamber.

The hydraulic motor of the present invention, indicated generally at **10**, is shown in Fig. 1 mounted on the valve stem of a high pressure valve **11** of the rotary plug type mounted in a pipe line of which **12** and **13** are sections. Referring to Fig. 4, the rotor **14** of the motor is provided with an axial socket **15** at its lower end into which the valve stem is keyed in a usual manner, and the motor operates the valve. This application of the motor is shown by way of example, and it is to be understood that the invention embraces all other uses of the motor which are within the scope of the appended claims.

As shown in Figs. 1 and 4, the rotor **14** is provided with an axial shaft **16** at its upper end, on which is mounted a worm sector **17** and a worm **18** is operable by a hand wheel **19** for manually operating the valve. A key **20** is provided for connecting the worm sector to the motor when manual operation is desired, in which case the key is inverted from the position shown and inserted in the keyway **21**. In the position shown a cross pin **22** holds the key disengaged from the sector to allow operation of the valve by the motor, but connects the motor shaft to an indicator ring **23** rotatable on top of the gear case **24** for indicating the position of the valve. A lubricating device **25** is mounted on top of the motor for forcing lubricant through the bore of the rotor to the plug in valve **11**. This device may be similar in construction to that shown in my copending application Serial No. 189,810, filed October 12, 1950. The bearing construction of the rotor shaft in the plates **27** and **28** is per se not part of this invention but is the subject of the copending application of James F. Horst, Serial No. 359,138, filed June 2, 1953.

The motor **10** includes a cylindrical casing **26** having top and bottom plates **27** and **28** secured thereto by annular series of studs **29** screwed into tapped holes **30** in the ends of the casing. O-rings **31** of usual construction provide fluid tight seals between the casing and the plates **27** and **28** respectively, and pairs of O-rings **32** provide fluid tight seals around the rotor shaft where it passes through the plates **27** and **28**.

The rotor is provided with diametrically opposite, preferably integral vanes **34** dividing the annular chamber of the motor into two chambers. Each vane is provided along its top, side and bottom edges with a continuous groove **35** of rectangular cross section, in which is located a substantially U-shaped seal **36** having a rounded or circular cross section except at the corners and forming a pressure seal between the vanes and the walls of the chamber to prevent the escape of pressure fluid from one chamber to another. The ends **37** of the seals **36** may be turned at right angles to the upper and lower legs thereof and anchored in holes in the rotor communicating with the grooves 35, as shown in Fig. 4.

A pair of diametrically opposite abutments or shoes **38** and **38'** is mounted in the casing by means of screw studs **39**, and each shoe is provided along its top, bottom and inner and outer edges with a continuous groove **40** of rectangular cross section, in which is located a rectangular sealing ring **41**. The rings **41** having a rounded or circular cross section except at the corners provide a pressure seal between the shoes and the walls of the chamber, and also between the inner edges of the shoes and the rotor 14. Thus the vanes 34 and shoes 38 and 38′ divide the annular space between the casing and the rotor into four chambers indicated at A, A′, B and B′. As shown in Figs. 5 and 6, chambers A and A′ are interconnected through the hub of rotor 14 by angular communicating ports 42, and chambers B and B′ are interconnected by angular communicating ports 43.

Preferably, the seals 36 and 41, as well as rings 31 and 32, are made of synthetic rubber or plastic sealing material which is resistant to the oil or other fluid used as pressure fluid in the motor, and the seals and rings are substantially circular in cross section and distorted by pressing them in their grooves of rectangular cross section to provide a pressure seal according to well known practice. The U-shaped seals 36 and rectangular seals 41 are molded so as to have sharp, substantially rectangular squared-off projecting portions 45 at their outer corners extending transversely of the seals, as shown in Fig. 7, in order to insure a perfect seal, because if these corners are rounded transversely the distortion of the seals at the outer corners is sometimes not sufficient to fill in the right-angled corners between the top and side surfaces within the motor chamber, and slight leaks may develop. The molded corners 45 provide positive seals around the right-angled corners at all times.

The chambers A, A′, B and B′ may be filled with oil and the power to rotate the vanes 34 and rotor 14 may be gas, air or liquid under pressure supplied to oil pressure tanks for forcing oil through one of the nozzles 47 or 48 which communicates with chambers A and B respectively, for rotation in one direction and to the other nozzle for rotation in the other direction. When pressure is supplied through nozzle 47, nozzle 48 acts as an exhaust port and vice versa. Each of the nozzles is preferably provided with an O-ring packing 49 where it extends through the casing, and the inner ends of the nozzles extend into grooves 50 provided on opposite sides of the shoe 38′. At their outer ends the nozzles 47 and 48 are internally threaded for attachment with pressure lines.

When the motor is used to operate a valve 11 in a pipe line, as shown in Fig. 1, which may be carrying gas under high pressure, the line sections 12 and 13 on each side of the valve may be tapped as indicated by lines 51 and 52 which are connected through a suitable control valve to the nozzles 47 and 48 to furnish the power for operating the motor 10. The control valve may be actuated manually or automatically in various ways. If it is desired to actuate the control valve automatically by a change in the line pressure, the pipe line may be connected by a tap line 53 to suitable control valve actuating means.

At their inner ends the bores 54 of the nozzles are angled laterally to terminate in seating faces 55 parallel to the inner beveled faces 56 of the shoes which alternately parallel the vanes 34 at their limits of movement. The faces 56 of each shoe 38 and 38′ are at 90° to each other and the vanes rotate through 90° from adjacent one face to the other, as indicated in Figs. 2 and 3. Preferably, stop studs 57 are screwed in the faces 56 of both shoes against which the vanes abut in their extreme positions, so that the vanes are spaced from the shoes when they strike the studs at the end of 90° of travel in either direction. The studs 57 may be secured in adjusted position by set screws 58.

The novel internal shut-off means is arranged to close off one or the other of the nozzles 47 and 48, whichever is acting as the exhaust port, at the end of vane movement in either direction. The shut-off means comprises two spring-pressed plunger valves 60, mounted in the vanes and adapted to seat in the nozzle openings 54 in the seating faces 55 of the nozzles 47 and 48. The valves 60 are preferably conical caps of resilient oil resistant material such as neoprene for making a fluid-tight seal around the nozzle openings. Each valve cap 60 is secured on the end of a pin 61 slidably inserted in a hole 62 extending through one of the vanes 34 at right angles thereto. Preferably, the cap is secured on the pin by a split retaining ring 60a in a manner to allow slight universal movement of the cap. A small O-ring 63 surrounds the pin within the vane to prevent leakage of fluid through the hole 62. The opposite end of the pin 61 is threaded and a retaining nut 64 is screwed thereon. Between the cap 60 and the vane is a helical spring 65 urging the cap away from the vane, and the spring tension can be controlled by adjusting the nut 64. Thus when one of the valve caps 60 engages one or the other of the nozzle openings 54 in nozzles 47 and 48, it is resiliently held on its seat by the spring 65, the springs being adjusted to allow the caps to seat before the stop screws 57 abut the vanes.

In the operation of the motor 10, with the rotor in the position of Fig. 2, the lower valve 60 is shown closing off the nozzle 48 which acted as the exhaust port in the previous operation of the motor, when pressure was introduced through nozzle 47 into chamber A and through ports 42 to chamber A′, rotating the rotor counterclockwise. Now if pressure is applied through nozzle 48 into chamber B and through ports 43 to chamber B′, nozzle 47 becomes the exhaust port and the rotor is rotated clockwise to the position of Fig. 3 where the vanes abut diametrically opposite stops 57 and the upper valve closes off the exhaust port 54 in nozzle 47. Thus, the instant the rotor reaches either of its extreme positions, the exhaust port is sealed off and there can be no leakage of pressure fluid from the motor. By having the cap 60 conical and capable of slight universal movement, registry of the cap with the exhaust port, followed by a complete seal is assured.

Before pressure is introduced into the nozzle on the pressure side of the vane, the nozzle is sealed tight by one of the shut-offs as a result of the previous operation. The instant pressure strikes the shut-off, the spring 65 behind the shut off yields sufficiently to admit pressure fluid into the chamber where it acts on the vanes with the effective force of pressure times area and starts the vane to rotate. Without the yielding movement of the shut offs, excessively high pressure would be required to unseat the shut off before rotating the vane.

If it were not for the shut offs 60, leakage would occur due to the tendency of the pressure fluid to seep or flow by the sealing strips 36 from the pressure side to the exhaust side of the vanes. While the seals 36 provide a substantially fluid tight seal between the vanes and the cylinder wall as the vanes rotate, there is bound to be some seepage past the seals when the vanes are stopped with high pressure on one side and exhaust on the other side.

Accordingly, even though the pressure for operating the motor continues to be applied for a substantial period after the motor is operated, the shut offs 60 prevent leakage of fluid from the motor. For example, if the motor is used to close the pipe line valve 11, the instant the valve is closed the exhaust from motor cylinder 26 is automatically shut off, preventing leakage of the fluid therefrom no matter how long the power for operating the motor is applied thereto. This automatic shut off represents a substantial saving where the pressure fluid is expensive and is exhausted to the atmosphere or to waste. Where the power is transmitted to fluid such as oil in the motor, contained in a closed circuit, it prevents unbalance of the fluid in the pressure and exhaust chambers, such as would be caused by leakage from the exhaust chamber.

What is claimed is:

1. In a hydraulic motor including a cylindrical housing having transverse end walls, an impeller vane oscillating in said casing on a shaft axially thereof, and a stationary shoe extending radially of the cylinder and partitioning the cylinder into chambers, the side and end faces of said vane having a continuous U-shaped groove therein of rectangular cross section, a U-shaped continuous seal of

resilient material in said groove having a rounded cross section and forming a pressure seal between the vane and the end and side walls of said housing, and the seal being molded to form sharp straight line transverse outer corners equal in breadth to the cross sectional breadth of the groove and fitting tightly in the corners of the housing walls to form a pressure seal between the vane and the housing at those points.

2. In a hydraulic motor including a cylindrical housing having transverse end walls, an impeller vane oscillating in said housing on a shaft extending axially thereof, and a stationary shoe extending radially of the cylinder and partitioning the cylinder into chambers, the side and end faces of the vane having a continuous U-shaped groove of rectangular cross section, the side and end faces of said shoe having a continuous rectangular groove of rectangular cross section, resilient sealing strips of rounded cross section located in said grooves and extending continuously throughout their lengths forming pressure seals between the sides and ends of the vane and the adjacent housing walls, and between the sides and ends of the shoe and the adjacent walls of the housing and the impeller vane hub, and the corners of the sealing strips being molded to form squared-off transverse edges equal in breadth to the corners of the groove and fitting tightly into the corners of the housing to form pressure seals around the vane and shoe at those points.

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