TECHNI/TIPS

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HYDRAULIC EQUIPMENT

The use of hydraulic equipment is steadily increasing. Hydraulics offer a fairly simple method of applying great force with an amazing flexibility of control. The versatility of hydraulic equipment is such that it can easily provide a number of coordinated and interlocked motions and forces which would be almost impossible to obtain any other way.

Hydraulics offer unlimited flexibility in power transmission. Some of the features of hydraulic power, in addition to its general flexibility, include: (1) simplicity of design; (2) simplicity of operation; (3) lends itself to automation; (4) variety of force availability; (5) durability of system due to (a) automatic lubrication, (b) release under overload condition, (c) minimal vibration, (d) infinte variability of acceleration and deceleration; (6) ease of modernizing equipment as design progresses and (7) efficient and economical operation.

The variety of fluid power and transmission applications will continue to increase. Hydraulic power is used in essentially every industry and for all types of manufacturing and distribution operation; on both stationary and mobile equipment. The use is limited only by the imagination of the designer.

Let's review the fundamentals of hydraulic systems. In 1650, Blaise Pascal discovered the fundamental law upon which all hydraulic systems are based. Briefly, it *is - Pressure exerted on a confined liquid is transmitted undiminished in all directions and acts with equal force on all equal areas.*

Figure 1 illustrates that law. Here a force of 10 pounds is applied to piston A, which has an area of one square inch. Obviously, the pressure on piston B will 10 psi. Since piston B has 10 square inches area, the total force against it is 100 pounds. A small force applied to a small piston is transformed into a larger force acting on a larger piston. If piston A were moved 10 inches, the volume of oil displaced would be 10 cubic inches. When the displaced fluid in cylinder A goes into cylinder B, it is moved only one inch. In this case, a small force exerted through a long distance results in a large force exerted through a short distance.

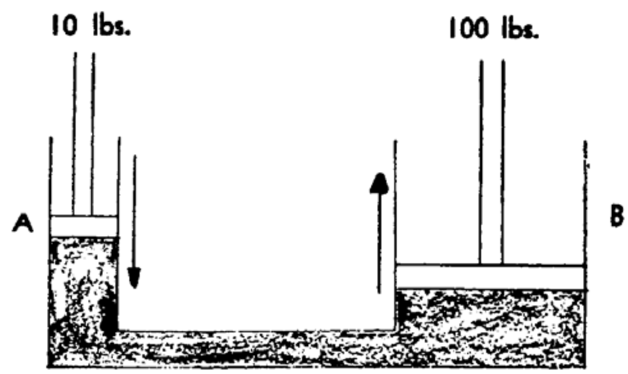

Figure 1

To convert this rough example into an hydraulic system to perform work, we must replace piston A with a pump to put pressure constantly against cylinder B. To have a continuous operating pump, there must be an oil reservoir, and a vent are needed so that when cylinder B is pushed all the way out, excess oil can be returned to the reservoir. Piston B could operate against a spring to return it to its original position.

We could apply power in the opposite direction on the cylinder by setting up a pressure system to both sides of the cylinder. Now we can power it in either direction. We should include a four-way selector valve so that the fluid under pressure can be sup-plied to either side of the piston while fluid on the opposite side is free to return to the reservoir.

A simple hydraulic circuit is shown in Figure 2. Most systems are considerably more complicated. For rotary power, a fluid motor is used in place of the cylinder. To move several parts of the machine - some at varying speed, force and time interval - several cylinders or fluid motors are installed in this system. Each can be moved at will through valves designed to accomplish whatever movement is desired.

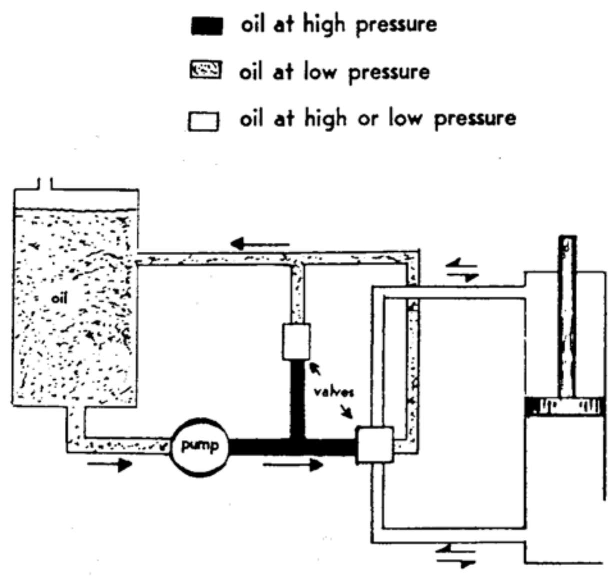

Figure 2

PUMPS

The heart of any hydraulic system is the pump, for it generates the force required by the fluid to activate the working parts. Pumps may be classified into two groups, based upon performance: (1) Fixed delivery when running at a given speed, and (2) variable delivery when running at a given speed.

Fixed delivery pumps discharge relatively constant volume of fluid per cycle. Such pumps are often used on machine tools such as saws, surface grinders and shapers and on mobile equipment such as construction machinery, farm machinery, truck mounted snowplows, forklifts, etc.

Variable delivery pumps usually run at constant speed, and are designed so that volume can be varied from zero to maximum. These pumps are more complex, and their use is limited to applications which require this special feature such as hydraulic transmission, rewind spools and constant tension devices.

Hydraulic pumps may be classified according to the design used to create the force: (1) gear, (2) vane and (3) piston types. All three types may be used in constant volume systems. Only vane and piston pumps are normally used in variable volume systems.

Gear Type Pumps

Gear type pumps trap oil between the gear teeth and the housing, to carry it from suction side to the discharge side of the pump. Oil from the discharge side cannot return to the intake side because of the close meshing of the two gears and the small clearances between the gears and housing. The gears may be of spur, herringbone or helical type.

Figure 3 shows a common internal gear pump. When driven at constant speed, gear pumps can discharge only a constant volume of oil.

Vane Type Pumps

Vane type pumps are popular, particularly on machine tools, and may be either constant or variable delivery type. Basically, a vane pump consists of a cylindrical case and a small eccentric rotor with radial slots containing close fitting vanes which are free to slide in and out, as in Figure 4. As the rotor revolves, a centrifugal force slides the vanes against the outer ring and forms a seal. Side plates confine the oil to the width of the rotor and vanes.

The vane pump can be made to discharge a variable volume of oil while running at constant speed, by moving the rotor off center with the case. When the vanes remain in contact with the case, and there is no change in volume between any two vanes as the rotor turns, the rotor is on dead center with the ring, and there is no pumping. When the rotor is moved from dead center, the vanes continue to follow the case around and there is a change in volume, and oil is pumped. When the rotor is moved to maximum from dead center, the greater change in volume between two adjacent vanes allows the maximum amount of oil to be pumped. Movement of the rotor is handled by suitable controls outside the housing.

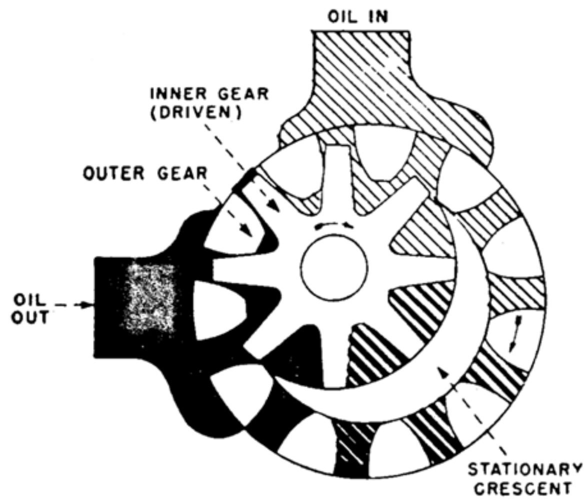

Figure 3

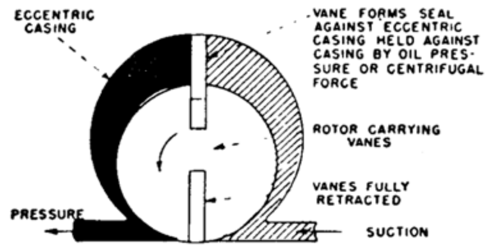

Figure 4

Piston Type Pumps

Variable volume reciprocating piston pumps are commonly used where high pressure and accurate control of the volume are required. They are based on either radial piston or axial piston design and generally for variable output at a given speed. Fixed delivery designs are possible.

Axial piston pumps contain a cylinder block assembly which rotates with the shaft. The piston connecting rods are fastened to a wobble plate. block assembly may be moved in relation to the drive shaft **(Figure 5)**, or the wobble plate may be angled in relation to the drive shaft. Either way, as the whole unit rotates inside the case, the wobble plate pushes the pistons in and out. By varying the angle of the block assembly with the drive shaft (or angle of the wobble plate), the flow will vary from maximum through zero (at no angle) to maximum in the other direction. The cylinder

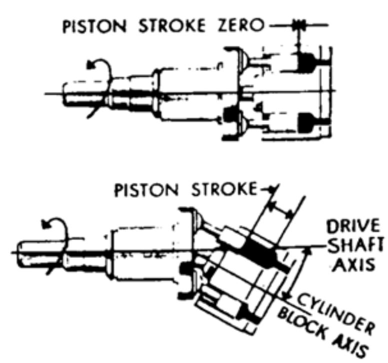

Figure 5

Radial piston pumps have a rotating cylinder block with cylinders radial to the shaft, like a radial aircraft engine **(Figure 6).** The volume of oil delivered is controlled by moving the shaft off center. Delivery volume ranges from maximum with the shaft all the way on one side, through zero when the shaft is centered.

Figure 6

Space doesn't allow us to describe all methods used in the manufacture of all types of pumps. Each manufacturer has his own design for improving efficiency, reducing wear, etc. This is just basic information of various types involved.

Liquid under pressure, controlled by valving and tubing, can be converted into most any kind of mechanical motion. Rotor, linear or even reciprocating angular motion is obtained by using activating cylinders or fluid motors.

A cylinder, simply a suitably enclosed round unit with a piston, is used where comparatively short linear motion is required. Oil under pressure is admitted to one end of the cylinder to move the piston to the opposite end. The piston return may be by gravity, by spring or by admitting oil under pressure to the opposite end of the cylinder.

Fluid motors may be thought of as hydraulic pumps working in reverse. Oil under pressure enters the motor and causes the shaft to rotate as a rotary drive. It may be connected directly or through gears to the machine to be actuated. Again, fluid motors are of the gear, vane or piston type.

Fluid motors in fluid drive transmissions are becoming more popular. Using the proper fluid motors and hydraulic pumps, with either constant or variable discharge, almost limitless control of any possible movement or sequence of movements is possible; constant speed, torque or power, fast reverse, control acceleration or deceleration.

Valves are very necessary in hydraulic systems. They are used to control the direction of oil flow, volume of oil to different parts of the system and the oil pressure at different locations. Manufacturers have many types of valves on the market today.

Finally, a Hydraulic System is composed of: a **Reservoir** for the oil supply; a **Pump** to move the oil under pressure; Valves to control pressure and flow; **Hydraulic Motors** to provide mechanical motion; all connected by tubing of seamless steel, flexible hose or occasionally copper tubing. These are joined by flared or flareless fittings and welded or screwed connections. Packing and seals are used throughout. Accumulators, which function to smooth out pulsations in the system and to hold pressure for a longer period of time, may be used to store up energy for subsequent conversion into work.

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