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AUTOMOTIVE DIESEL MAINTENANCE 2 UNIT IV, AUTOMATIC TRANSMISSIONS--HYDRAULICS (PART II).
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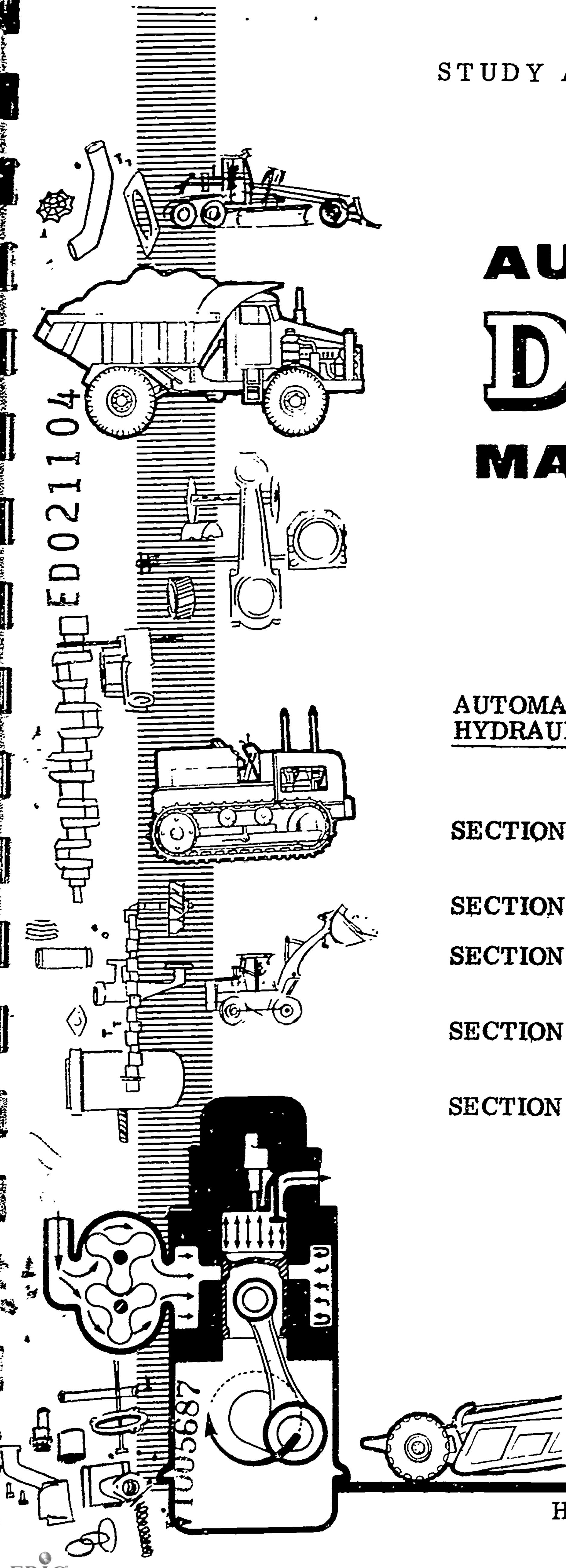
THIS MODULE OF A 25-MODULE COURSE IS DESIGNED TO DEVELOP AN UNDERSTANDING OF THE OPERATION AND MAINTENANCE OF VALVES UTILIZED IN HYDRAULIC TRANSMISSIONS USED ON DIESEL POWERED VEHICLES. TOPICS ARE (1) REVIEWING FACTS ABOUT PUMPS, (2) USING VALVES FOR CONTROL, (3) TROUBLESHOOTING PROCEDURES ON RELIEF VALVES, (4) USING DIRECTIONAL CONTROL VALVES, AND (5) FLOW CONTROL VALVES. THE MODULE CONSISTS OF A SELF-INSTRUCTIONAL PROGRAMED TRAINING FILM "UNDERSTANDING DIRECTIONAL CONTROL VALVES" AND OTHER MATERIALS. SEE VT 005 685 FOR FURTHER INFORMATION. MODULES IN THIS SERIES ARE AVAILABLE AS VT 005 685 - VT 005 709. MODULES FOR "AUTOMOTIVE DIESEL MAINTENANCE 1" ARE AVAILABLE AS VT 005 655 - VT 005 684. THE 2-YEAR PROGRAM OUTLINE FOR "AUTOMOTIVE DIESEL MAINTENANCE 1 AND 2" IS AVAILABLE AS VT 006 006. THE TEXT MATERIAL, TRANSPARENCIES, PROGRAMED TRAINING FILM, AND THE ELECTRONIC TUTOR MAY BE RENTED (FOR $1.75 PER WEEK) OR PURCHASED FROM THE HUMAN ENGINEERING INSTITUTE, HEADQUARTERS AND DEVELOPMENT CENTER, 2341 CARNEGIE AVENUE, CLEVELAND, OHIO 44115. (HC)

STUDY AND READING MATERIALS



AUTOMOTIVE DIESEL MAINTENANCE

AUTOMATIC TRANSMISSIONS --
HYDRAULICS (PART II) UNIT IV

SECTION A	REVIEWING FACTS ABOUT PUMPS
SECTION B	USING VALVES FOR CONTROL
SECTION C	TROUBLESHOOTING PROCEDURES ON RELIEF VALVES
SECTION D	USING DIRECTIONAL CONTROL VALVES
SECTION E	FLOW CONTROL VALVES

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OFFICE OF EDUCATION

HUMAN ENGINEERING INSTITUTE

This unit is the second of two units discussing basic hydraulics designed to cover information necessary to understand the Allison transmission. Coverage includes a review of hydraulic pumps and various types of valves, with emphasis on the directional flow valve.

SECTION A -- REVIEWING FACTS ABOUT PUMPS

In previous units we learned there are two classifications of pumps. One is the non-positive displacement type, the other is the positive displacement type. Since only the positive displacement pump is used in automatic transmissions, only this type will be reviewed.

A positive displacement pump produces a pulsating flow, but -- since it provides a positive internal seal against slippage -- its output is relatively unaffected by system pressure variations.

If the outlet port of a positive displacement pump were blocked to prevent release of the developed flow, the pressure would immediately build to a dangerous point at which the pump housing might rupture. Various safety devices are installed to prevent this from happening in most cases. Safety devices (valves) will be covered later in the unit.

The rotary gear pump, the spur type pump shown in Figure 1, is the type used in the Allison transmissions. This pump may have two or more rotating gears (for two different functions) within the pump housing, but the operating principle is the same for all. These pumps start displacing fluid as soon as the gears start rotating. Oil trapped in between the gear teeth and the housing is carried from the suction side of the pump to the discharge side of the pump. Oil from the discharge side is prevented from returning to the intake side by the close meshing of the two gears, and by the small clearances present between the gears and housing.

The maximum pressure that can be developed with a gear pump depends upon the design and closeness of the fit between the gears and the housing.

Gear pumps have a tendency to churn the oil. This action may raise the oil temperature and produce oil "foaming" within the transmission. More will be said about oil foaming, and how it is prevented, in later units.

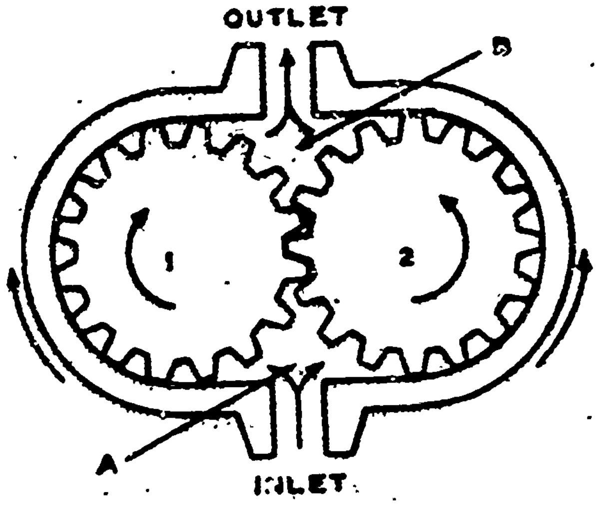


Fig. 1 Rotary spur type pump

OPERATION -- In Figure 1, the pump consists of a drive gear (1) and a driven gear (2) enclosed in a closely fitted housing. The gears rotate in opposite directions and mesh at a point in the housing between the inlet and outlet ports. As the teeth of the two gears separate, a partial vacuum is formed which draws liquid through the inlet port into chamber (A). Liquid in chamber (A) is then trapped between the teeth of the two gears and the housing so that it is carried through two separate paths around to chamber (B). As the teeth again mesh they produce a force which drives the liquid through the outlet port. The close mesh of the gear teeth serves to provide a seal between the inlet and outlet sides and to minimize slippage.

The operation, maintenance and overhaul of the Allison transmission pump will be covered in greater detail in units to follow.

SECTION B -- USING VALVES FOR CONTROL

NEED FOR VALVES -- It is virtually impossible to have a hydraulic system operate without valves to control it, and a transmission of the Allison type is no exception.

Control equipment includes a variety of valves that regulate, direct, stop, and start the flow of oil, relieve and regulate pressure and provide proper transmission operation. The function of valves in a transmission can be broken down into four areas:

1. To control the volume of flow
2. To control the direction of flow
3. To control the pressure at which the transmission operates
4. To stop and start the flow of oil

TYPES OF VALVES -- All valves can be classed as simple, compound or directional valves, according to their method of operation. In the Allison transmission there are several types of valves which fall under these classifications.

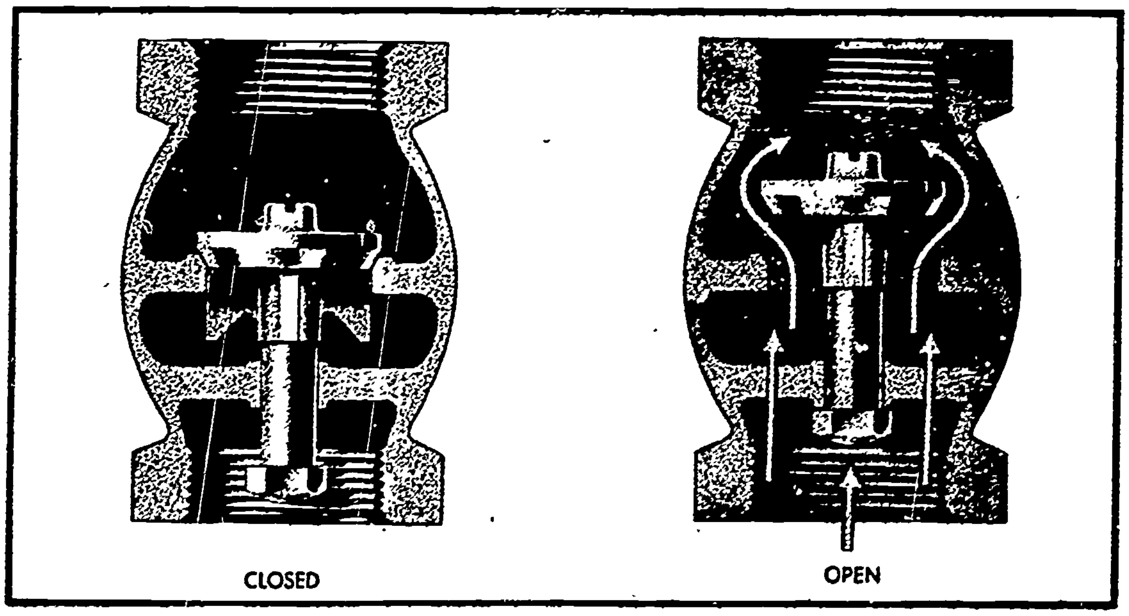


Fig. 2 Simple check valve

CHECK VALVE -- A check valve (simple) permits flow of fluid in only one direction, and is opened and closed by the flow of fluid in a system. The force of the liquid in motion opens the check valve, while it is closed by back flow, by the action of a spring, or by gravity. Figure 2 shows a simple check valve in the open and closed position.

SIMPLE RELIEF AND SAFETY VALVES -- It often is necessary to make sure that system pressure does not rise above a certain level. RELIEF valves are used for this purpose. Figure 3 shows two relief valves in the open and closed positions. These can be used for relieving system pressure IF they are equipped with a spring adjusted to compress when the pressure reaches a definite level. Liquid is then bypassed out of the system or back into a reserve supply. This valve, Figure 4, is controlled by means of an adjustment screw against which the top of the spring is seated. An inward adjustment of this screw increases the compression of the spring, allowing it to resist a higher pressure. Relief valves usually are installed near the source of pressure, to protect as large a part of the system as possible.

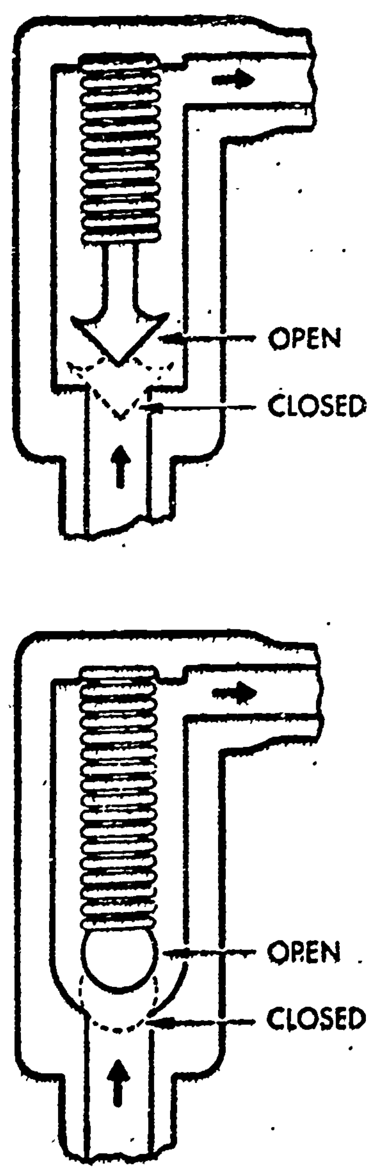


Fig. 3 Relief valves

RELIEF valves can be considered true safety valves only if they are large enough to handle the entire discharge of the mechanism in case of breakdown. SAFETY valves are designed to open only when the system is endangered, as for example if the operating mechanism stalls. They can take care of the entire load of the system. Relief valves are intended to relieve occasional excess pressures arising during the course of normal operations.

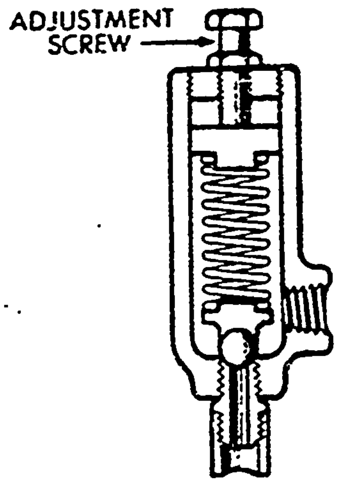


Fig. 4 Controllable relief valve

PILOT TYPE RELIEF VALVE -- Pilot pistons often are used to reduce the area exposed to pressure. The settable relief pressure range for a particular valve usually is narrow, because of the limited range of spring force. Small pilot pistons adapt a valve to higher pressures without going beyond practical designs. Figure 5 shows a pilot type relief valve in open and closed positions.

OPERATION -- The operation of this valve is such that flow at the primary port is blocked from the secondary port until the pressure present in the

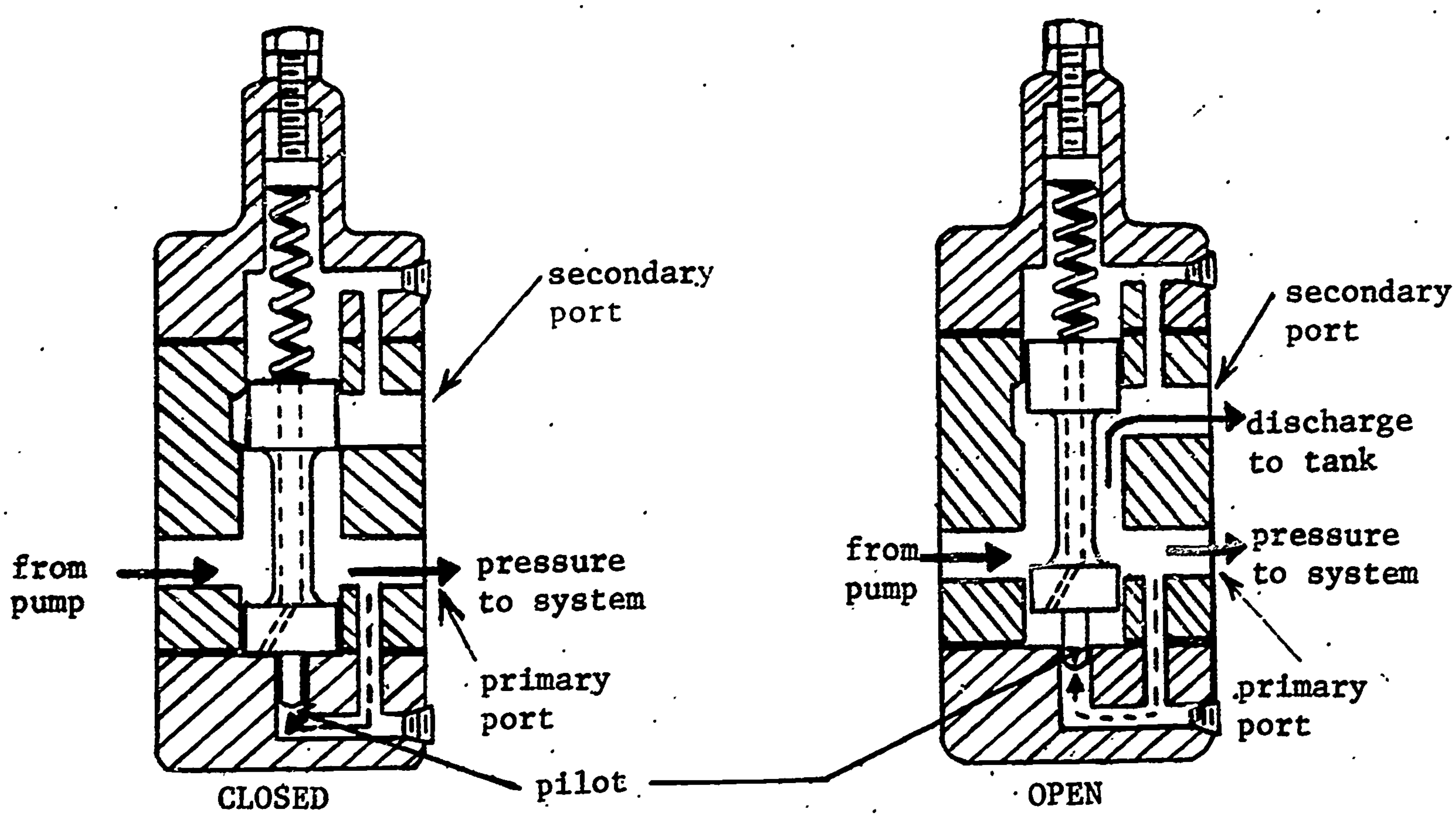


Fig. 5 Pilot type relief valve

pilot passage, and effective beneath the pilot piston, overcomes the valve spring force of the valve setting. The spool is then raised, allowing the flow to pass through the secondary port freely to the tank until the pressure at the primary port again drops below the valve setting.

The relief valve automatically creates a passageway between the pressure line and the reservoir that is large enough to divert all of the excess fluid supplied by a pump back to the reservoir when the pressure exceeds a chosen value.

Manufacturers usually are able to make pilot valves leakproof insofar as internal leakage is concerned, at about 85 to 90 percent of relief pressure. Naturally, this percentage is lowered as damage or scoring occurs on the seating surface. To prevent this damage and the resultant leakage, we must make sure the oil and filters are kept clean.

Some valves of this type have been known to last longer than the pump itself. But an inherent weakness is found in its failure to close immediately. The main valve spring is the weak "link" in this valve. It sometimes takes tenths of a second, instead of the usual hundredths, for this valve to readjust to a sudden fluctuation in the pressure line. Availability of space in which to install the valve limits the size of the valve. This, in turn, limits the size and therefore the strength of the main spring that can be used.

To function best, particularly in lifting circuits, the valve should be inserted between the pump and control valve, and not between the control valve and the cylinder.

BALANCED PISTON TYPE RELIEF VALVE -- To better show the operation and construction of this valve, look at Figure 6.

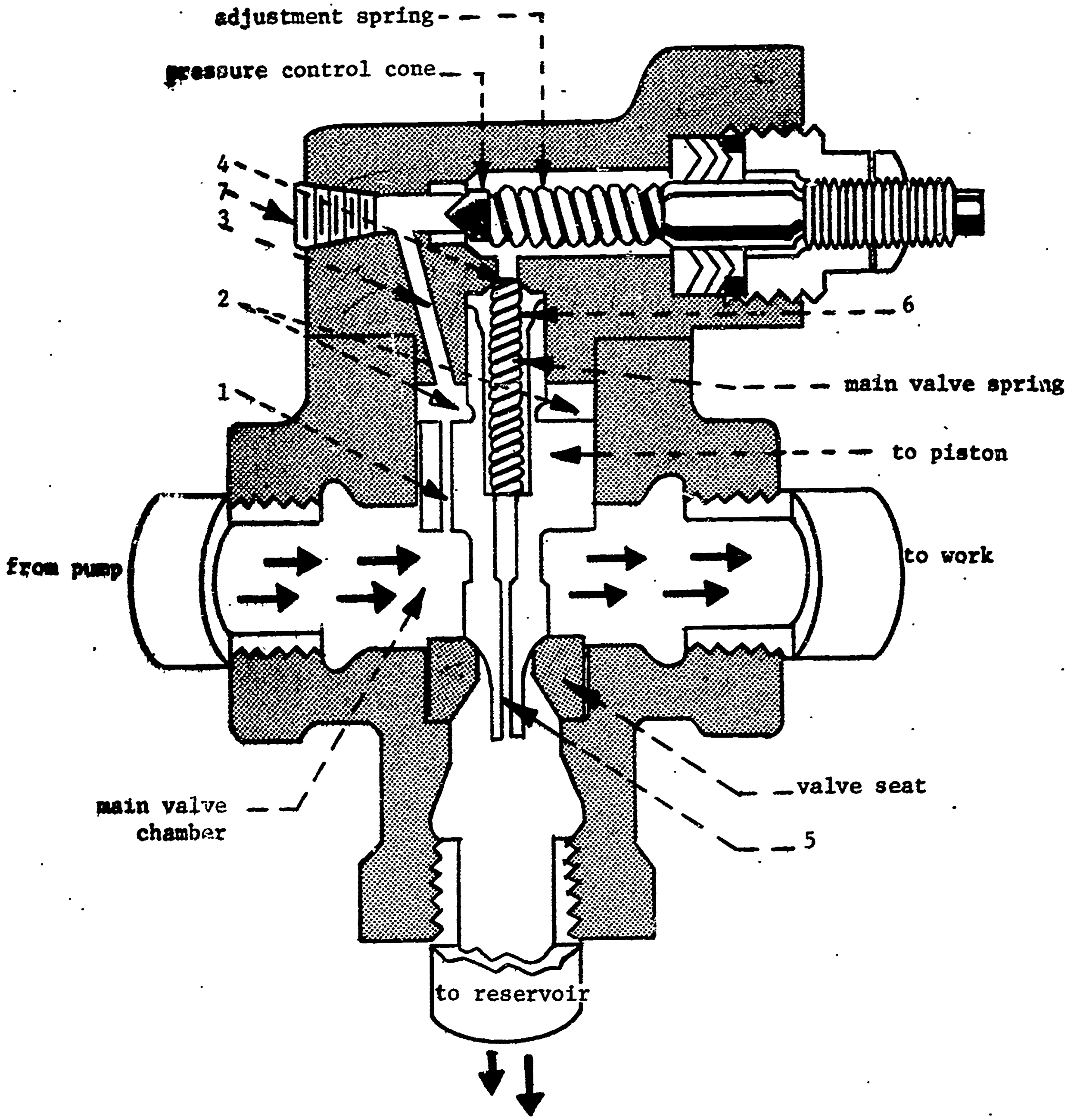


Fig. 6 Balanced piston type relief valve

Valve Construction -- The valve consists of a main valve and a pilot va
These two valves are connected with each other, with the main pipe lin
and with a drain line to the reservoir by a number of passages and chambers.

The main valve extends down through the main line of flow of the high pressure liquid. Flow past this port of the valve is always possible, s it fills only a portion of the pipe. The lower end of the main valve terminates in a cone, the upper part of which locates itself in a conica shaped seat to prohibit flow to the reservoir when the main valve is closed. Above the line of flow the main valve expands to form a pistoı Above this piston is a chamber, which is connected by a small passag to the main line and by a larger passage to the pilot valve. The areas on the upper and lower surfaces of the piston are approximately equal The main valve is equipped with a light spring.

With both valves closed, the entire assembly is divided into two press systems. Pressure on one side of the pilot valve is normally high, si it is determined by pressure in the main line. Pressure on the other of the pilot valve is normally low, since it is determined by pressure reservoir line.

Valve Operation -- Refer to Figure 6 to follow the operation descripti

(a) The main valve will remain closed so long as a greater force acts downward than acts upward.

(b) Oil passes through passages 1 and 2 and fills chamber 3, which forces the main valve down.

(c) The oil can be carried off through passages 4 and 5 to the reservoir if the pressure becomes too great on the pressure control cone in the pilot valve.

(d) If the pressure becomes too great in the main line, it will force the main valve piston up and the liquid will return to the reservoir.

(e) When the pilot valve and the main valve have the proper pressure and they remain closed they are said to be in balance.

These valves may be made to operate in the conventional manner by providing a plug at port (7). Or, by connecting a line to this port and leading it to an additional control valve, the relief valve may be controlled remotely. This additional valve may be a simple shut off valve which, when opened, will allow oil in chamber (2) to drain to tank, thus unbalancing pressures above and below the main piston, and causing the main piston to be forced off its seat. Or, it may be a remote control valve as shown in Figure 7, the operation of which is similar to that for the pilot valve arrangement contained in the cover of the relief valve. Regardless of what type of external valve is used, the required operation involves development of unbalanced chamber pressures, which will result in the opening of the main piston and the release of excessive fluid through the return port.

In general, a compound type relief valve offers less pressure override than is present with simple type relief valves of similar capacity. This means that it can be operated in a narrower pressure setting range to give more accurate operation.

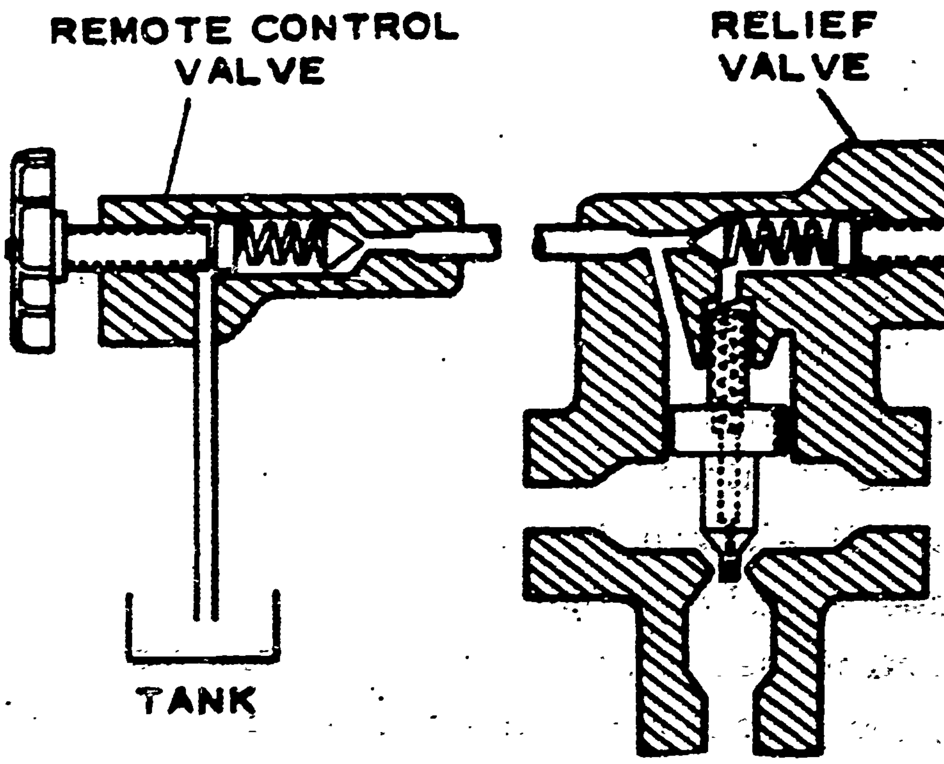


Fig. 7 Remote control valve used to control operation of relief valve

SECTION C -- TROUBLESHOOTING PROCEDURES ON RELIEF VALVES

If a relief valve fails to function properly, the failure may be caused by one or more of the following conditions:

1. Dirt or air in the oil will cause a pressure fluctuation. Air in the oil may be due to a leak in the inlet line caused by improper piping, an insufficient amount of oil in the reservoir, or a foaming action of the oil. This latter will cause quite a pressure fluctuation. Lint, pipe compound, scale or other foreign matter in the oil can foul the relief valve and not allow the piston to properly seat itself, thus causing leakage and fluctuation of pressure. While there is usually a strainer on the intake line to the pump for removing impurities, there may still be some within the piping or within the valve itself.

2. A noisy or chattering relief may be caused by too much oil passing through the valve at high velocity. A larger valve should be used. Other causes of noise may be high temperature, scored valve piston or valve seat, excessive tank back pressure, high frequency shock loadings, control chamber orifice too large for viscosity of fluid, worn pump with erratic pulsating delivery too high for relief valve to level out, or relief valve setting too close to the setting of another valve in the system.

3. If pressure fails to register on the pressure gage after tension is placed on the valve spring, the valve spring may be broken or the piston may be stuck due to some foreign substance lodging between the body and the piston. It is also possible that the valve and piston may be worn to such a point that the amount of leakage will make the valve inactive.

If we disassemble the relief valve for any reason, we should exercise caution when reassembling, to make sure that all of the parts are replaced correctly. A mistake which can be made easily is to replace the cover gasket so that a port hole will be cut off, preventing the valve from functioning.

When installing piping from the exhaust port of the relief valve to the reservoir, make certain that no restrictions are present. Back pressure can be troublesome in any hydraulic system.

SECTION D -- USING DIRECTIONAL CONTROL VALVES

One of the most important types of valves in the Allison transmission is the directional control valve. This valve allows the transmission to be shifted from one range to another.

Directional valves are designed for the specific purpose of directing the flow of liquids in hydraulic systems. It may be desired, for example, to perform a work operation by driving a piston back and forth in its cylinder. A directional valve whose movable parts change position so as to alternately introduce and drain off liquid from each end of the piston cylinder would make this possible.

Directional valves may operate hydraulically by differences of force set up on opposite sides of their movable parts, or they may be positioned by hand, by mechanical means, or by electric power. Practically all of the Allison transmissions are manually operated. However, there has been some work done on shifting these transmissions electrically and pneumatically. More information on this subject will be covered in later units.

Four-way valves are directional valves with four line connections: one from the pressure source, a second from, or to, the reservoir, and the other two connected to the work cylinder. This is the type of valve most commonly used.

Directional valves are of two designs -- spool and rotary. The spool type is the one used in Allison transmissions and the one that will be discussed in this unit.

In the spool design, a specially shaped sliding piston opens and closes passages through the valve as it is moved back and forth in its cylinder.

TWO-WAY SPOOL VALVES -- A two-way sliding valve is shown in the open and closed positions in Figure 8. As the piston is moved back and forth, it either allows liquid to pass through the valve or prevents flow. The piston cannot move back and forth by differences in hydraulic pressure set up within its cylinder, since the forces there are in balance. As indicated by the arrows against the piston heads, the same pressure acts on equal areas on their inside faces; and when the input passage is blocked the piston blocking it is acted on all around its circumference by the same pressure.

A number of features common to most spool valves are shown in Figure 8. The drain openings at either end of the cylinder are needed so that back pressure will not be built up in the cylinder to hinder movement of the piston. When spool valves become worn they may lose balance because of greater leakage on one side of a spool than the other. In that case the piston would tend to stick and wouldn't move back and forth. Small grooves are therefore machined around the sliding surfaces of the spools, so that leaking liquid will encircle the spools and keep them lubricated and centered.

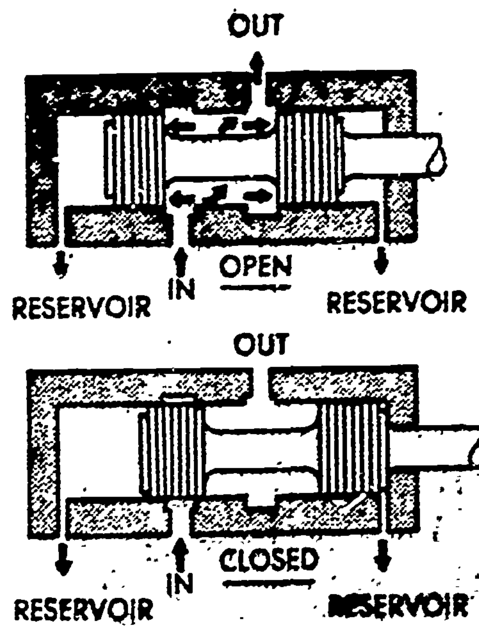


Fig. 8 Two-way spool valve

FOUR-WAY SPOOL VALVES -- Valves of this type connect with four separate lines. Let's look at a typical installation of this valve that would be comparable to one-half of the system on a front end loader, see Figure 9.

In Figure 9, one line connects the valve to the pump. Another connects it with the reservoir, by means of two exits from the inside of the valve. The other two lines run to either end of the work cylinder.

As the piston of the four-way valve is moved back and forth, each end of the work cylinder is connected in turn with the pressure line from the pump, while the other end of the work cylinder is connected to the reservoir, or sump. This enables the work piston to be driven back and forth without meeting hydraulic resistance.

Keep Figure 9 in mind as you view Figure 10, which is a closer look at the four-way valve operation.

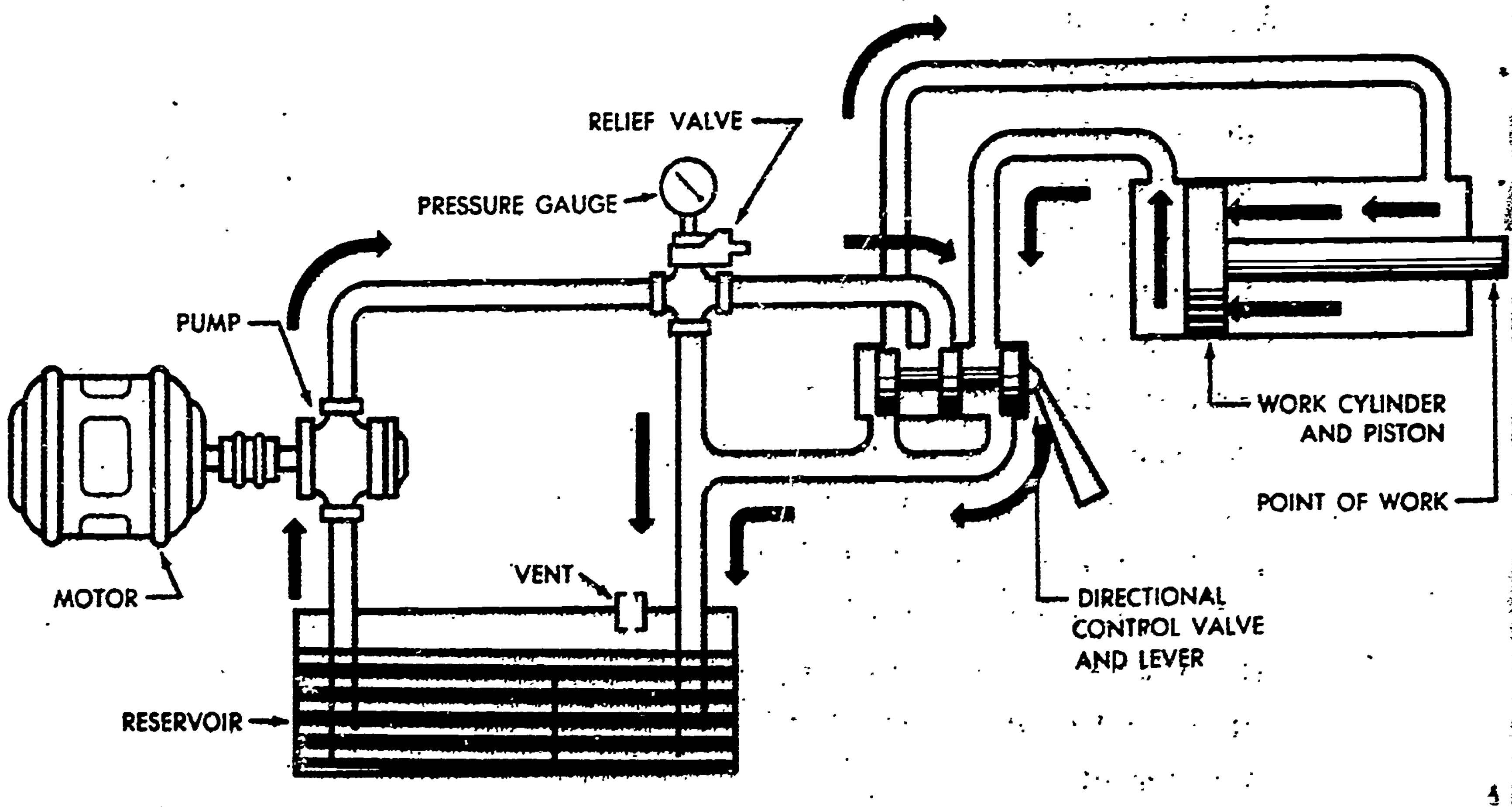


Fig. 9 Typical four-way spool valve installation.

The position of the piston in Figure 10 (A) corresponds to the situation shown in Figure 9. With the piston of the valve to the far right in its cylinder, liquid from the pump flows to the right end (R) of a work cylinder, while liquid from the left end (L) of the work cylinder is being returned to the reservoir. In Figure 10 (B), with the piston to the far left in its cylinder, relations are reversed, since liquid from the pump flows to the left end of the work cylinder, while liquid from the right end is being returned to the reservoir. In Figure 10 (C), with the piston in the intermediate position, flow through the valve from the pump is shut off and both ends of the work cylinder can drain to the reservoir, unless other valves are called on to control flow from them.

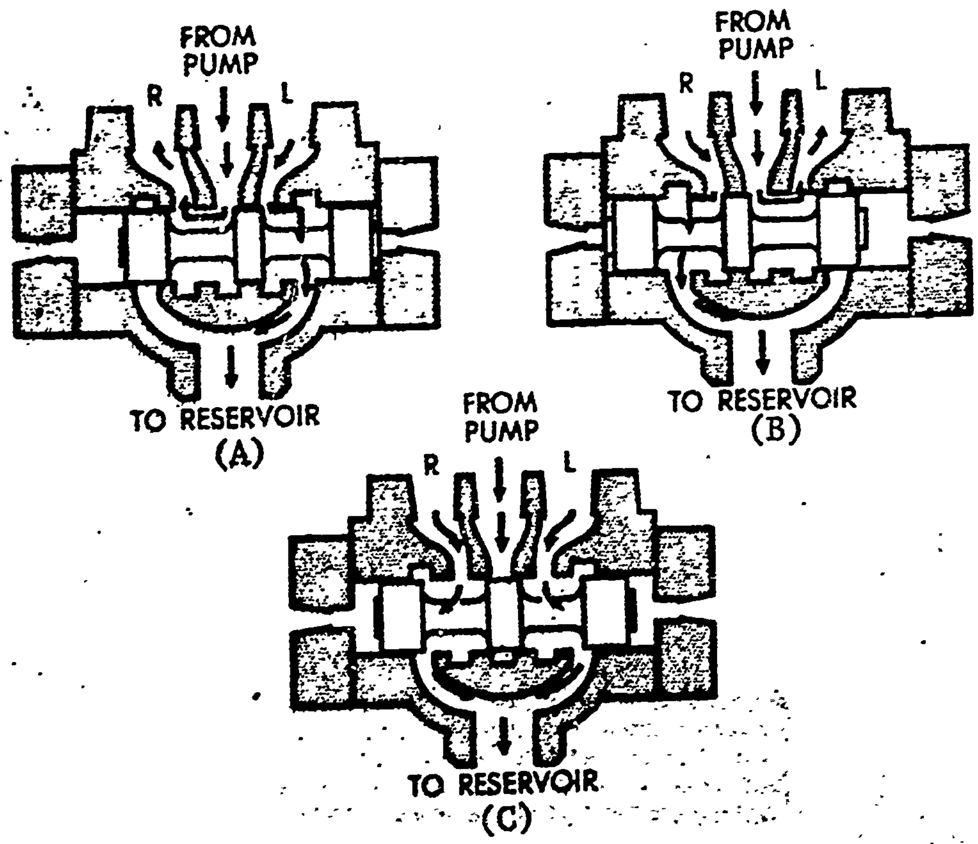


Fig. 10 Four-way valve operation

The piston of the directional valve itself can be positioned in a number of ways: manually, as for example by lever; mechanically, through the action of a cam brought into position at the proper moment by the work operation; mechanically by means of gears and shafting; electrically, in a number of ways; or hydraulically through the action of a pilot valve.

The valve in Figure 9 is operated by moving a lever.

The valves in Figure 10 are designed to be operated by a pilot valve. The pilot valve alternately delivers pressure to one end and then to the other of the cylinder of the four-way valve, in exactly the same manner as the reversing valve might be used to drive a work piston; see Figure 11. In Figure 10 (A), for example, the pilot valve would stop delivering pressure to the left-hand end of the piston, and would begin delivering pressure to the right-hand end, thus reversing the position of the valve piston.

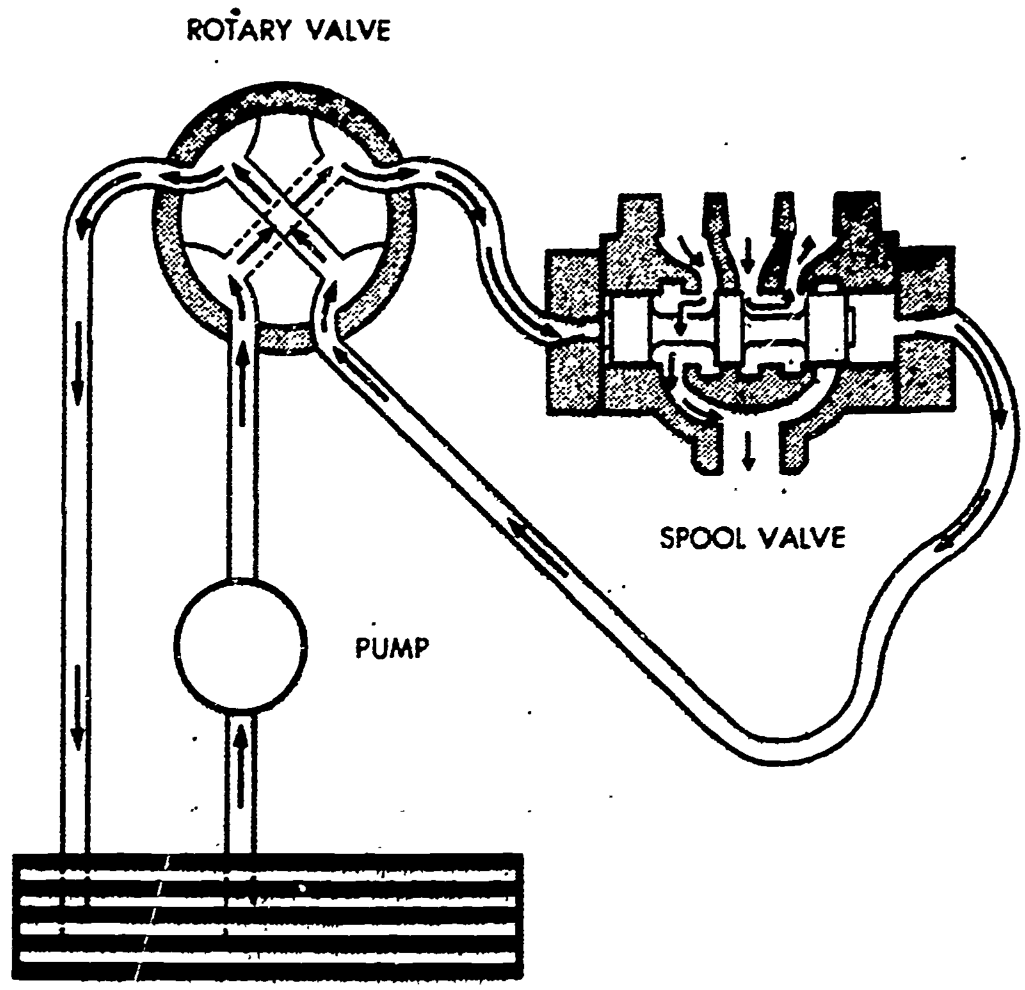


Fig. 11 Controlling a four-way valve by means of another type valve

CLOSED AND OPEN CENTER SPOOL VALVES -- In closed center valves the piston is solid, and all passages through the valve are blocked when the piston is centered in its cylinder; see Figure 12. In open center valves, the spools on the piston are slotted or channeled so that all passages are open to each other when the piston is centered; see Figure 13.

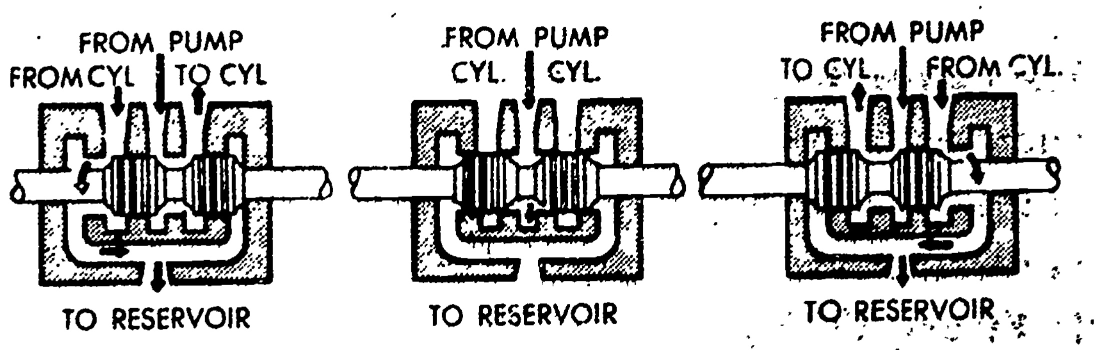


Fig. 12 Closed center valve

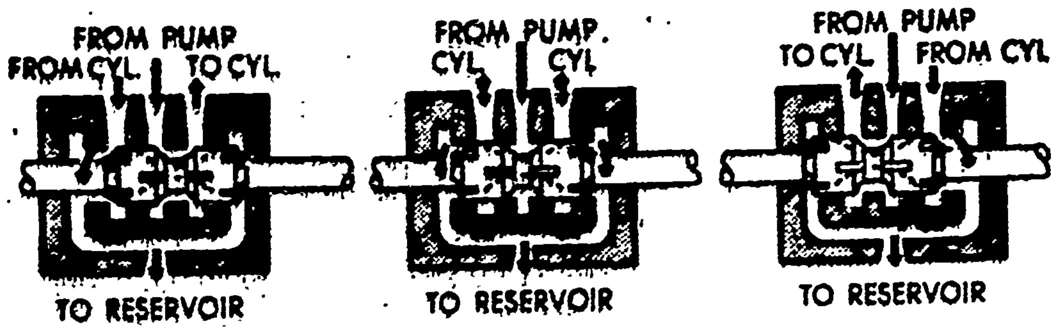


Fig. 13 Open center valve

In some open center valves, passages to the work cylinder are blocked when the valve is centered, while liquid from the pump is carried in bored passages through the piston and out the other side of the valve to the reservoir; see Figure 14. In valves of this kind liquid must be carried to both ends of the piston of the directional valve to keep it balanced, that is, to A and B in Figure 14. Instead of discharging into the reservoir when the valve is centered, liquid may be directed to other valves so that a set of operations is performed in sequence.

Open center valves are used when the work cylinder does not have to be held in position by pressure, and where the power is used to perform a single operation. They also avoid shock to the system when the valve spool is moved from one position to another, since in the intermediate position pressure is temporarily relieved by the passage of liquid from the pump directly to the reservoir. Reversal action is therefore smooth.

Closed center valves are used when a single pump or accumulator performs more than one operation, and where there must be no pressure loss in shifting the direction of stroke at the point of work.

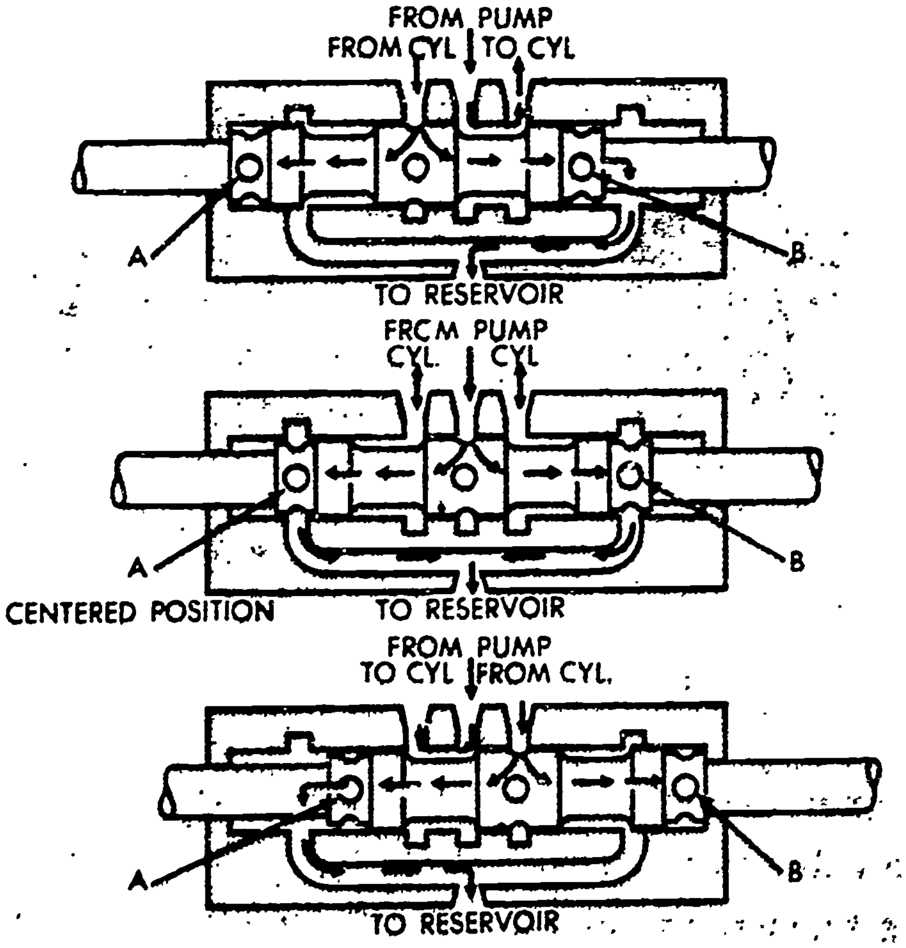


Fig. 14 Different type of open center valve.

SECTION E -- FLOW CONTROL VALVES

METERING VALVE -- A partially cutaway rotating core can be used to meter the flow of a liquid; see Figure 15. As the position of the core is changed, a greater or smaller quantity of liquid is allowed to pass through the valve. In this way, the speed with which an operating part moves can be controlled, the action of a valve delayed, or pistons cushioned at the end of a work. In later units describing the Allison transmission, we will see where a valve similar to this is used to prevent jerking of the vehicle as the gears of the transmission are shifted.

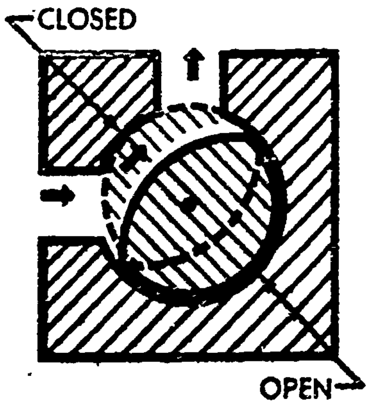


Fig. 15 Metering valve

TIME DELAY VALVE -- The action of a time delay valve is shown in Figure 16. Liquid moving from the pump through a control valve (not shown) at different times takes three paths: (1) around the time delay valve, past check valve (A) and on to the point where work is to be done; (2) through the time delay valve; and (3) through check valve (B) to produce a force on the bottom of a piston in the time delay valve, which is held in place by a spring. As an increase in hydraulic pressure compresses the spring of the piston, it rises to shut off flow through the time delay valve. Figure 16 shows the valve in this position.

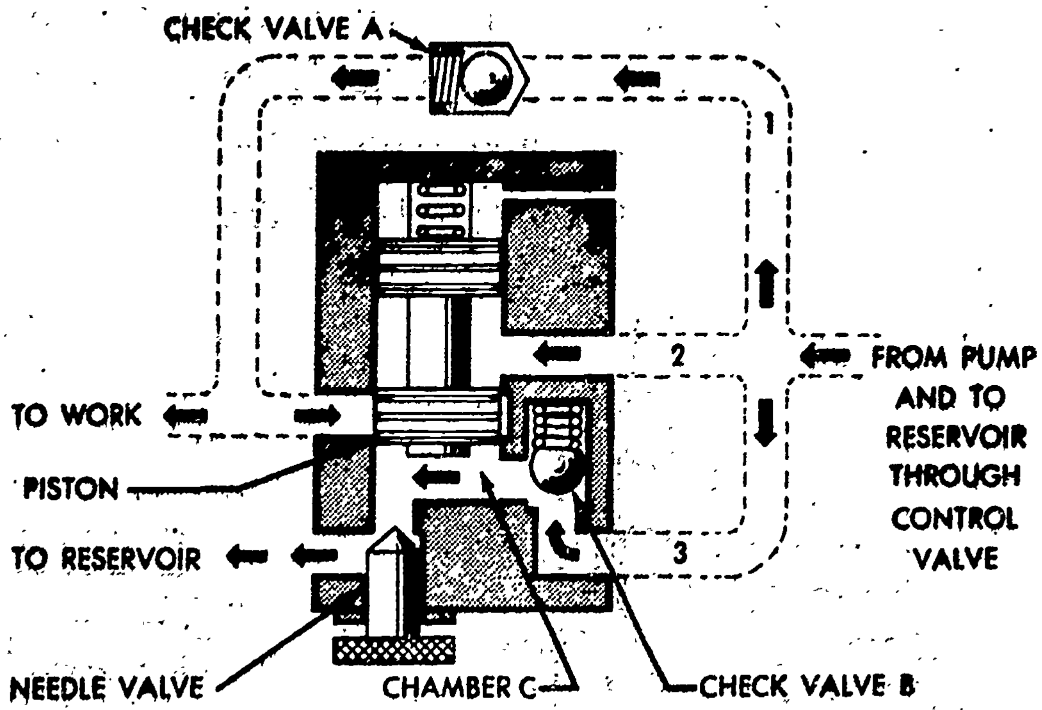


Fig. 16 Action of a time delay valve

When the position of the valve controlling flow from the pump is changed, liquid returns from the point of work, but is blocked from passage (1) around the time delay valve by the upper check valve, and from passage (2) through the time delay valve by the lower piston head of the valve. B a needle valve under the piston slowly drains liquid from chamber (C), so that the piston can slowly descend, allowing liquid to pass over it and on to the reservoir by the same path that liquid from the pump originally entered the valve. This is made possible by a different positioning of a control valve.

BYPASS VALVE -- In this type of valve flow runs in one passage until a certain pressure is reached. It is then also carried along a second pass to another work operation; see Figures 17 and 18. Liquid flows around (P_1) to one point of work, until a pressure is reached which raises (P_1) against the resistance of its spring. Then liquid will also flow through the second passage of the valve to do other work; see Figure 17. Valve (P_1) is held open by a smaller pressure than is needed to open it, becau of the greater area against which this pressure can then act. When the position of the control valve governing the bypass valve is changed, liqu returns through the bypass valve from work area (A) past the base of (P and from work area (B) past (P_2); see Figure 18.

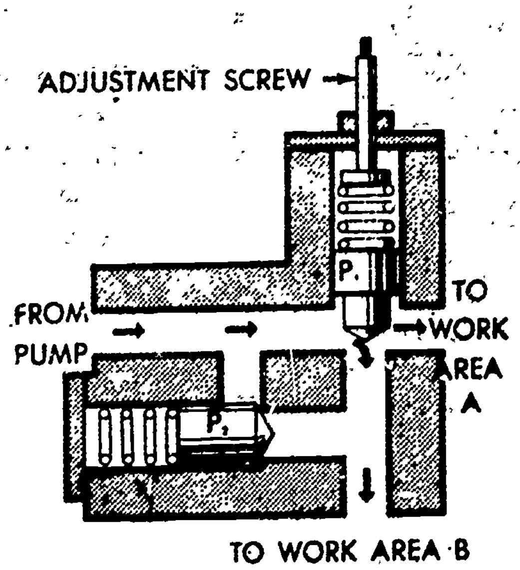


Figure 17

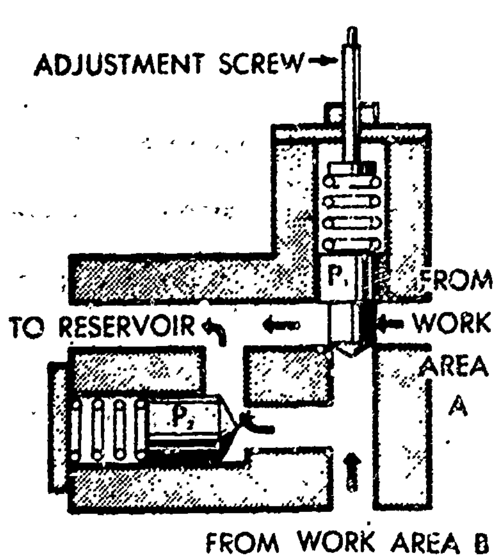


Figure 18

This unit has outlined some of the basic facts concerning hydraulics that we need to know in order to understand the Allison transmission. More about hydraulics will be covered in later units.

DIDACTOR PLATES FOR AM 2-4D AND MM 2-18D

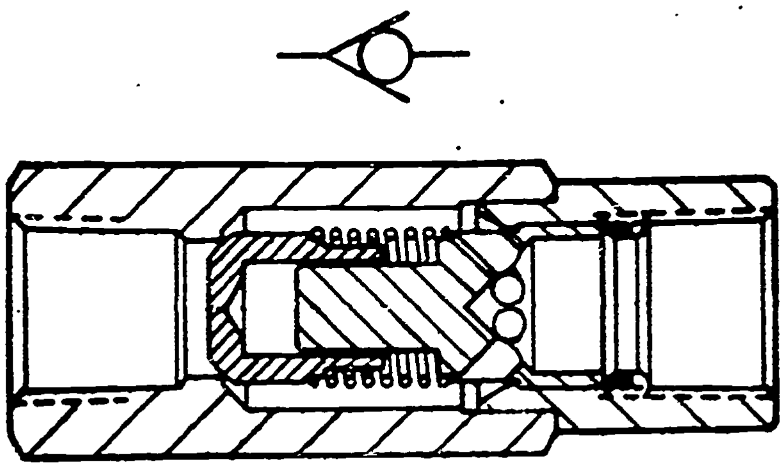


Plate I Simple check valve with ASA symbol

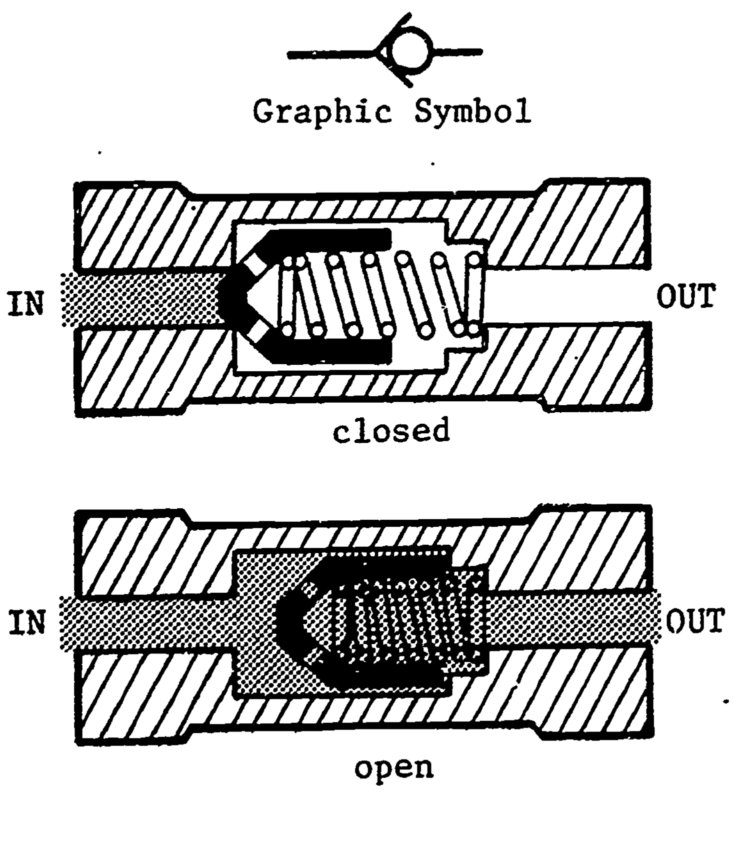


Plate II Check valve operation

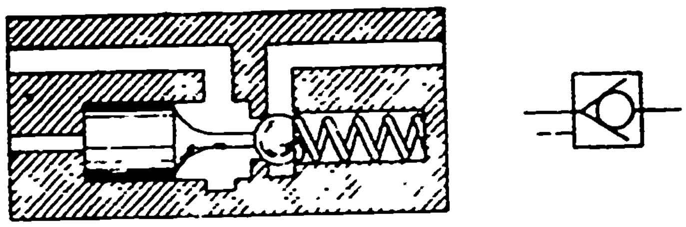


Plate III Pilot check valve with ASA symbol

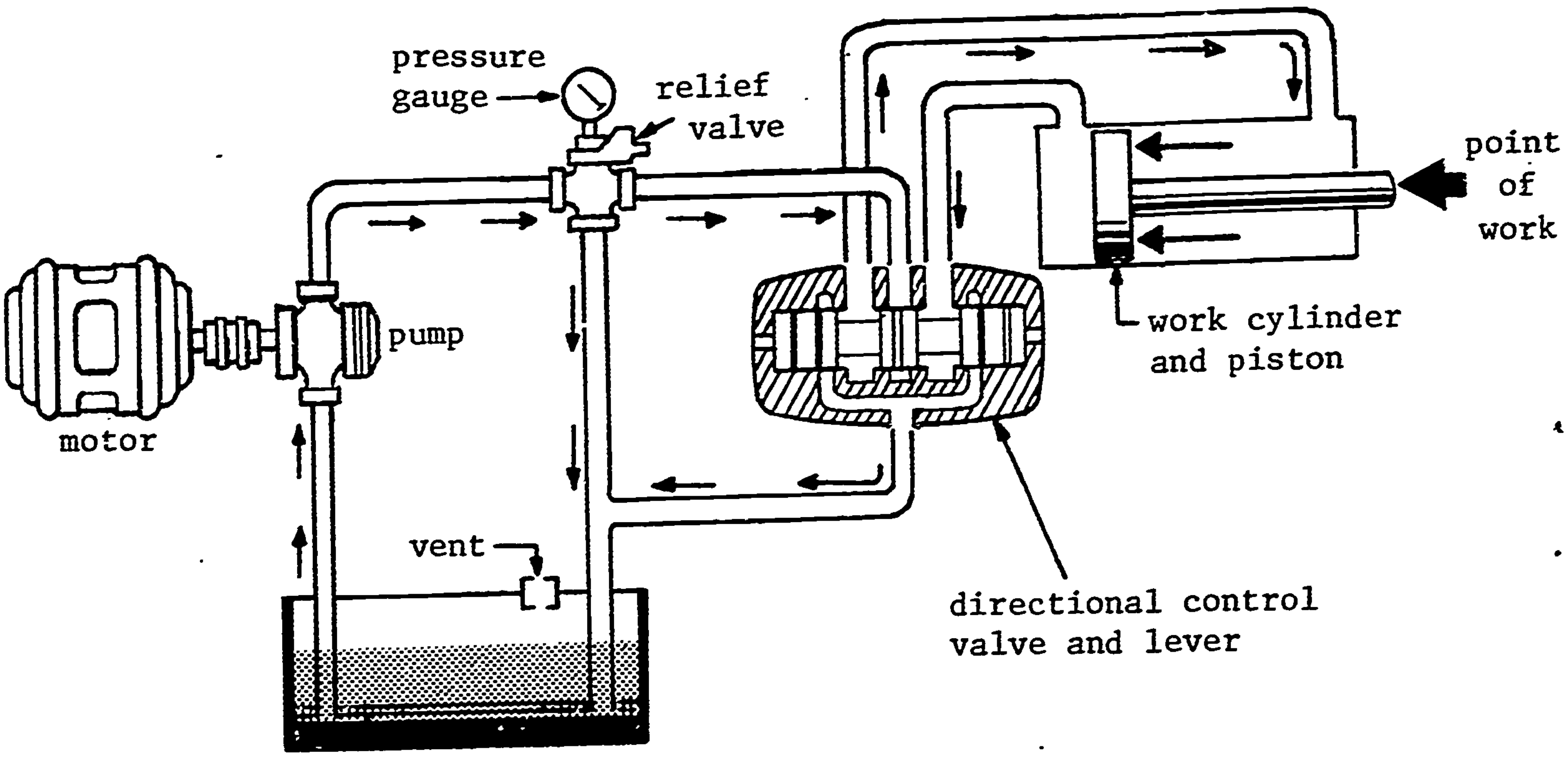


Plate IV Four-way valve

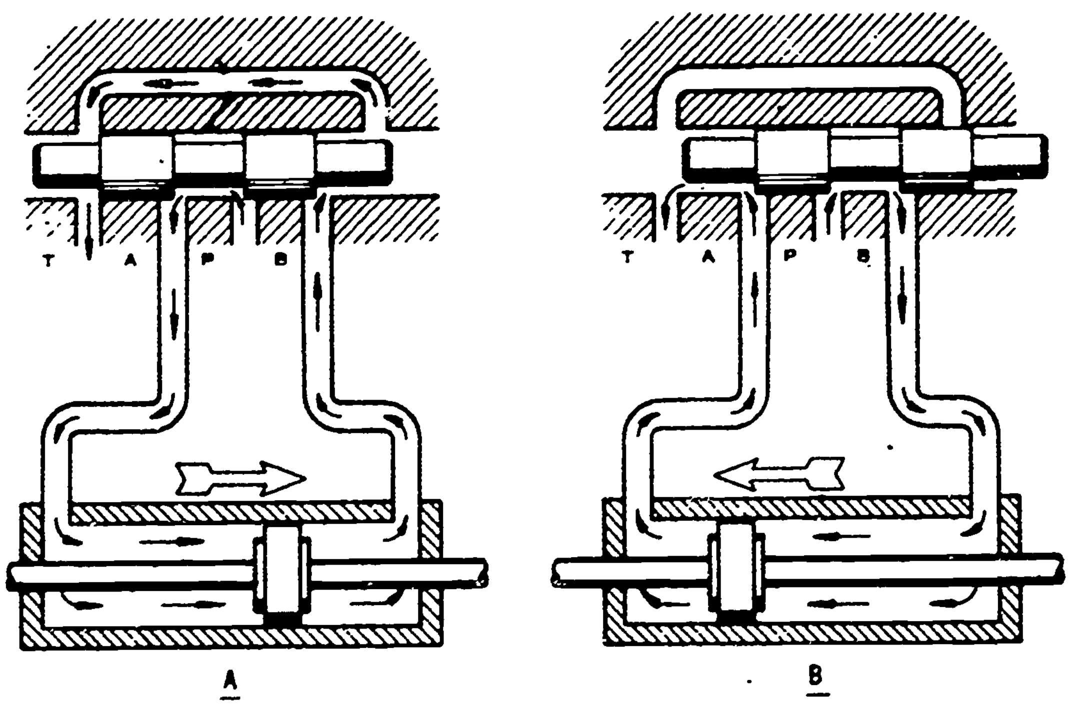


Plate V Four position valve operation

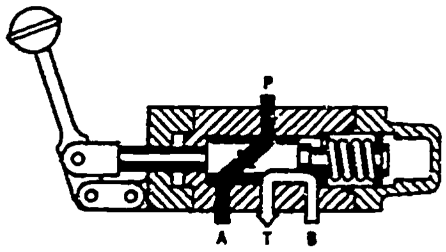
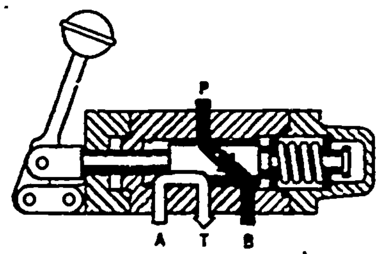
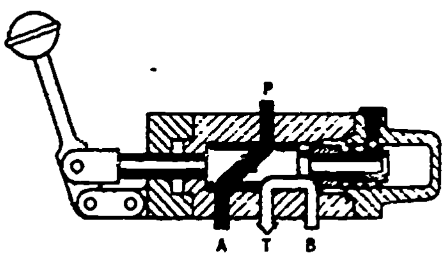
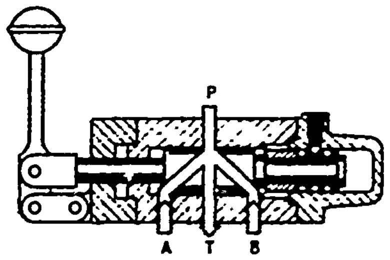
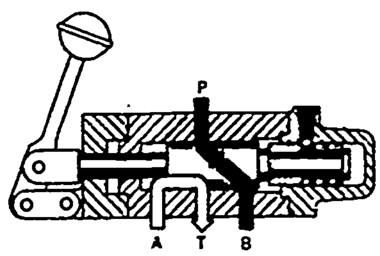
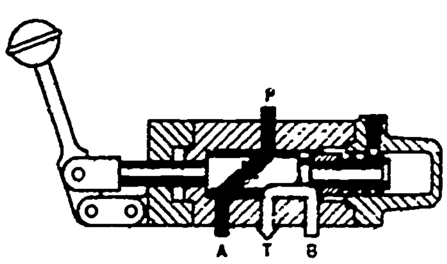
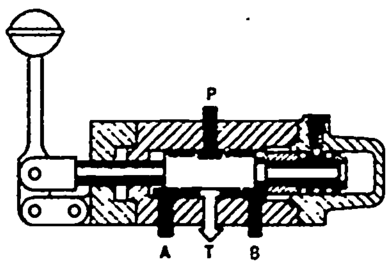
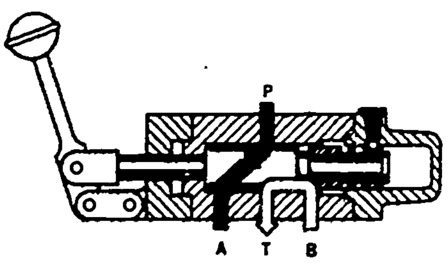
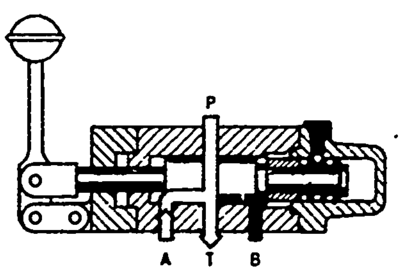
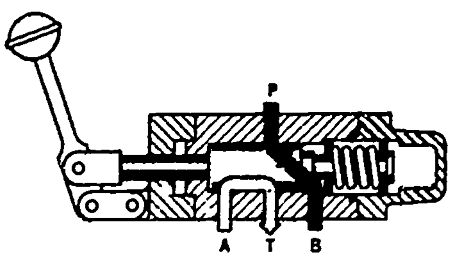
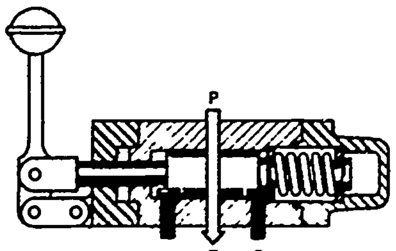
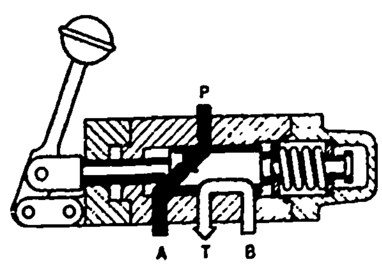
TYPE	EXTREME "OUT" POSITION	CENTER POSITION	EXTREME "IN" POSITION
SPRING OFFSET	PRESSURE (P)—CYL. "A" CYL. "B"—TANK (T)  OPEN CENTER AND CLOSED CENTER TYPES	THERE IS NO CENTER POSITION IN SPRING OFFSET MODELS.	PRESSURE (P)—CYL. "B" CYL. "A"—TANK (T)  OPEN CENTER AND CLOSED CENTER TYPES
SPRING CENTERED AND NO SPRING	PRESSURE (P)—CYL. "A" CYL. "B"—TANK (T)  OPEN CENTER TYPE	PRESSURE (P), CYL. "A", AND CYL. "B"—TANK (T)  OPEN CENTER TYPE	PRESSURE (P)—CYL. "B" CYL. "A"—TANK (T)  OPEN CENTER, CLOSED CENTER AND "SI" CENTER TYPES
	PRESSURE (P)—CYL. "A" CYL. "B"—TANK (T)  CLOSED CENTER TYPE	PRESSURE (P), CYL. "A", AND CYL. "B" BLOCKED  CLOSED CENTER TYPE	
	PRESSURE (P)—CYL. "A" CYL. "B"—TANK (T)  "SI" CENTER TYPE	PRESSURE (P) AND CYL. "A"—TANK (T) CYL. "B" BLOCKED  "SI" CENTER TYPE	
	PRESSURE (P)—CYL. "B" CYL. "A"—TANK (T)  TANDEM CENTER TYPE	PRESSURE (P)—TANK (T) CYL. "A" AND CYL. "B" BLOCKED  TANDEM CENTER TYPE	PRESSURE (P)—CYL. "A" CYL. "B"—TANK (T)  TANDEM CENTER TYPE

Plate VI Hand operated valve table

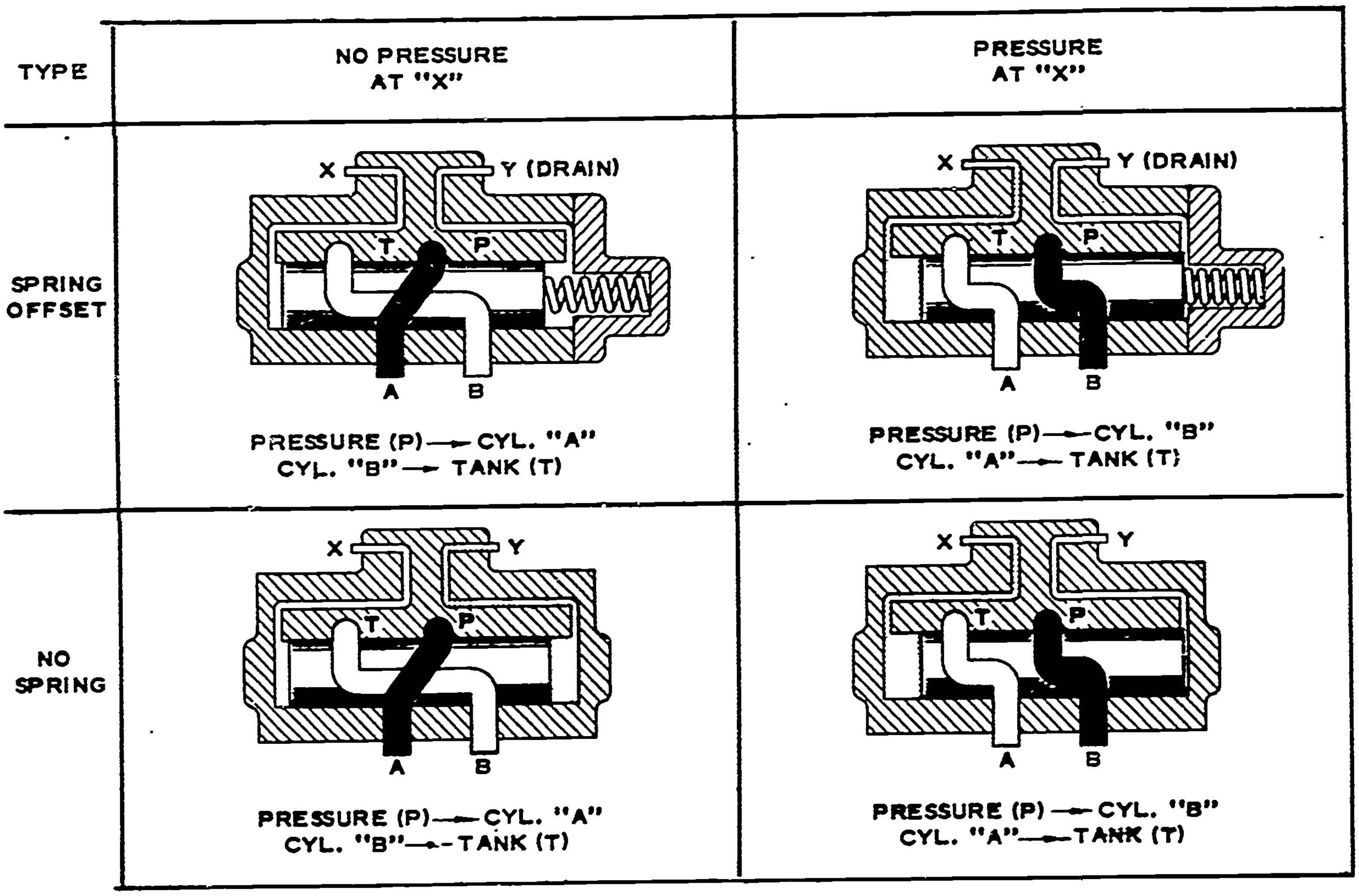


Plate VII Pilot operated four way valves

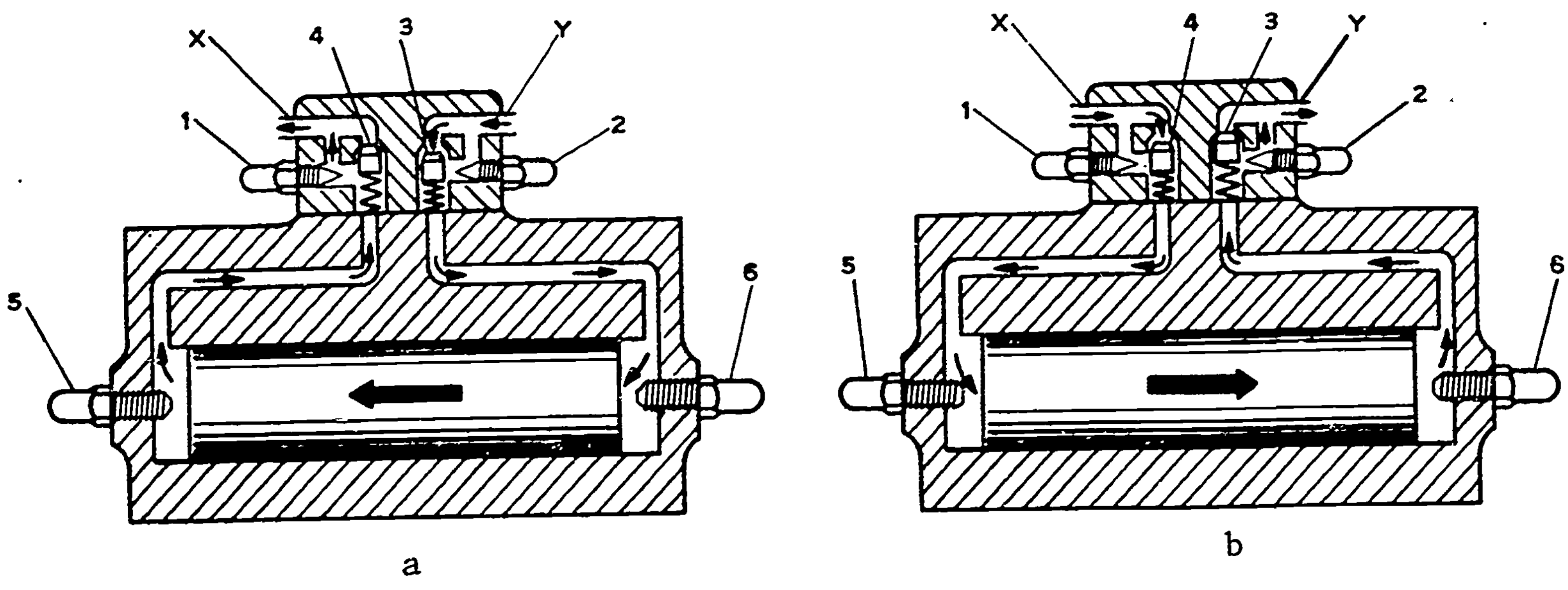


Plate VIII Pilot choke assembly with stroke adjusting device

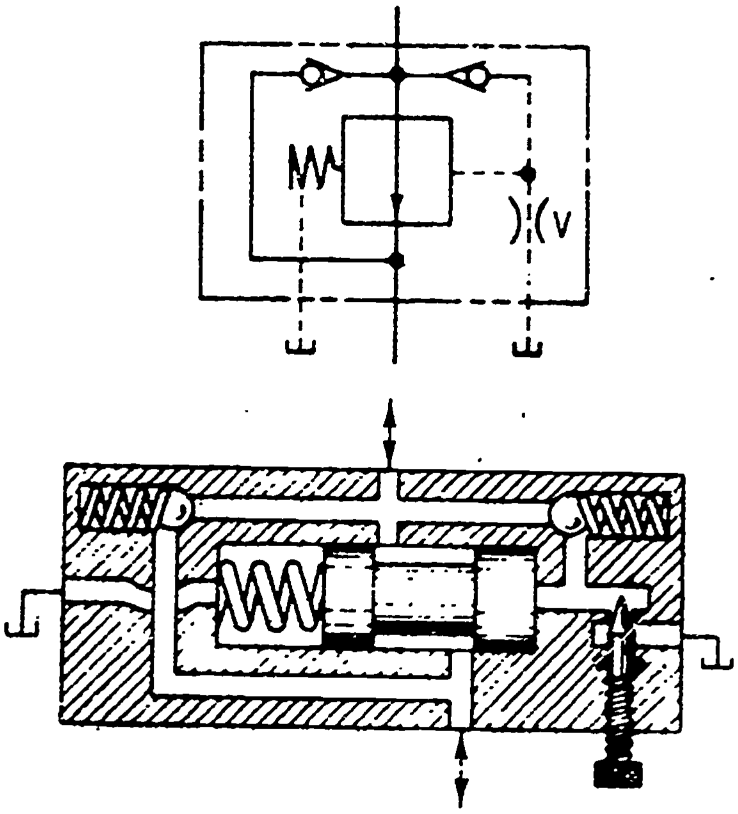


Plate IX Time-delay valve, with JIC symbol

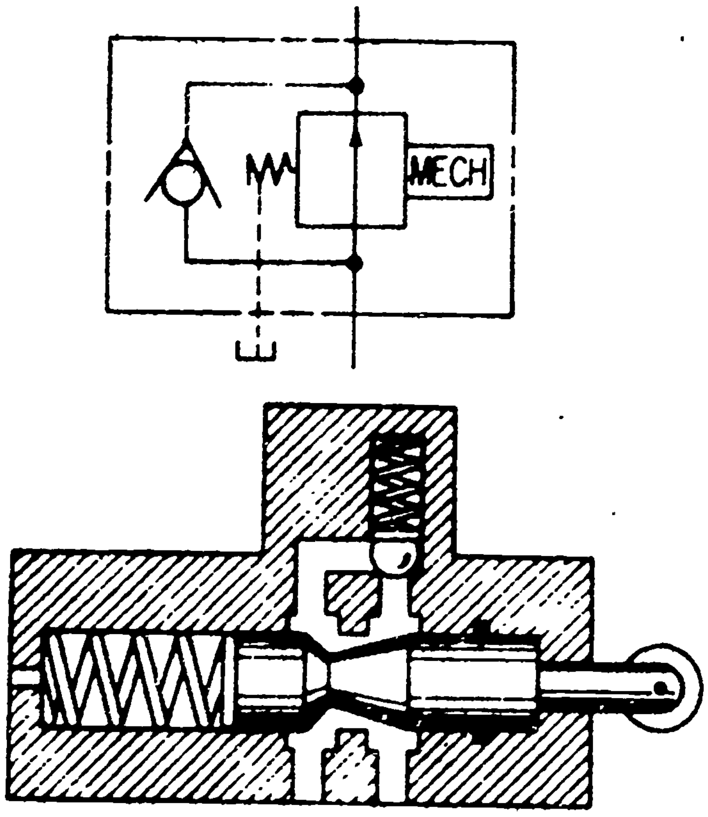
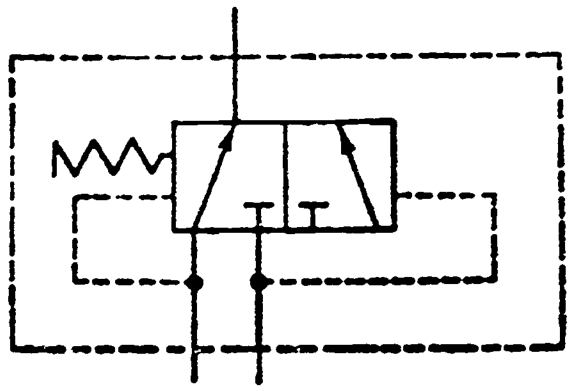


Plate X A normally open deceleration valve, with integral check



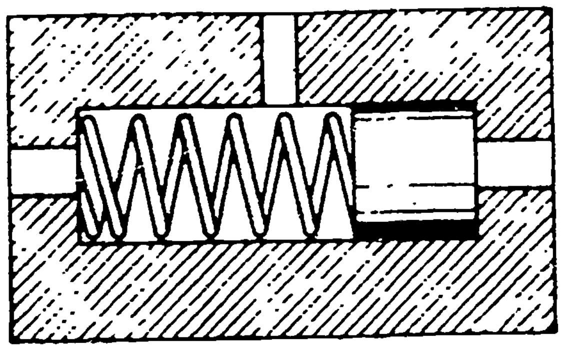


Plate XI A single shuttle valve, with symbol

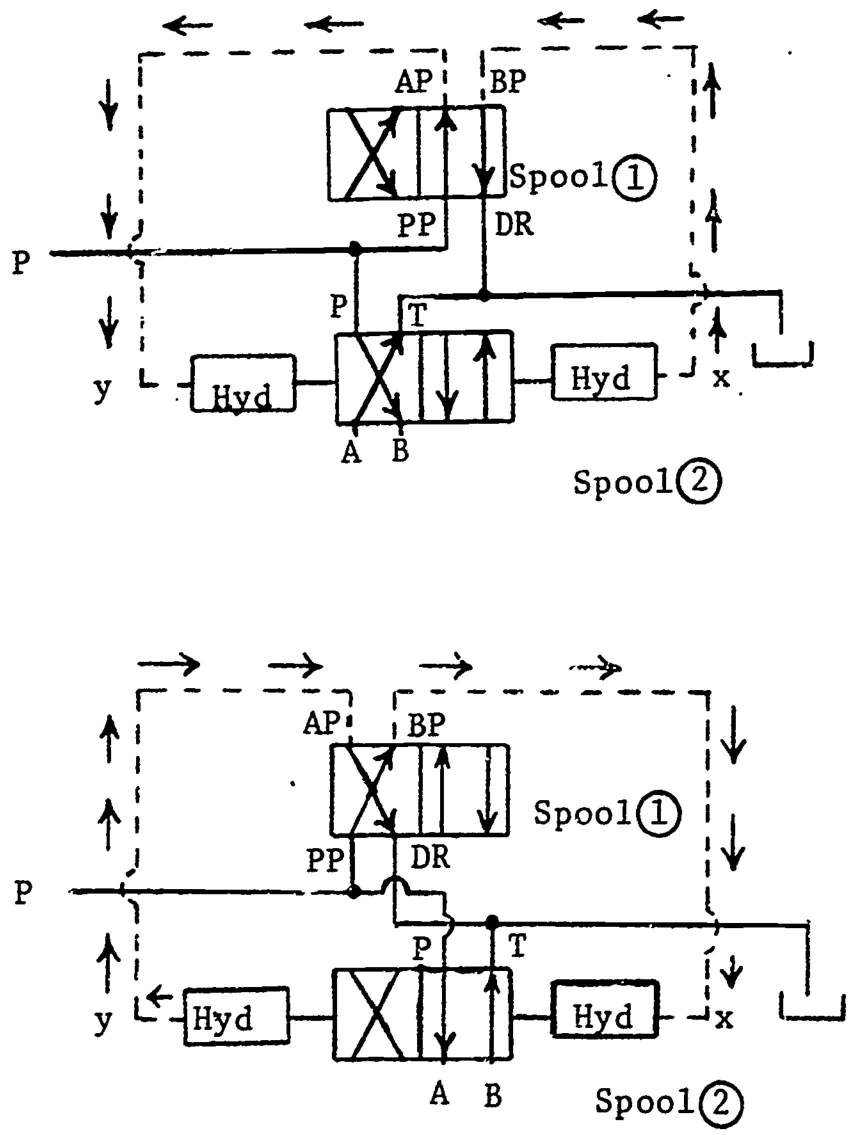


Plate XII Operation of a solenoid controlled, pilot operated four way valve

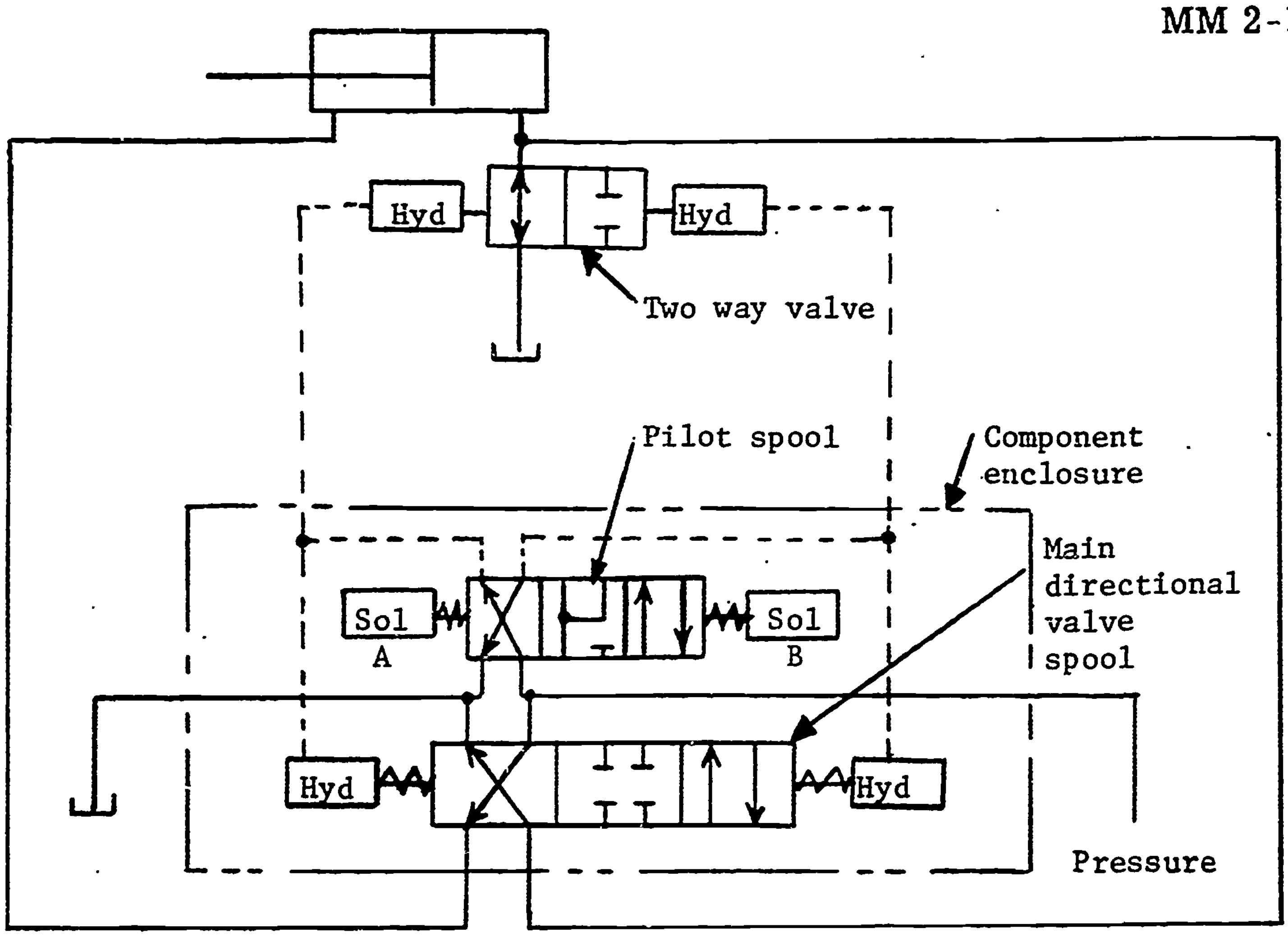


Plate XIII Pilot operation of two way valve

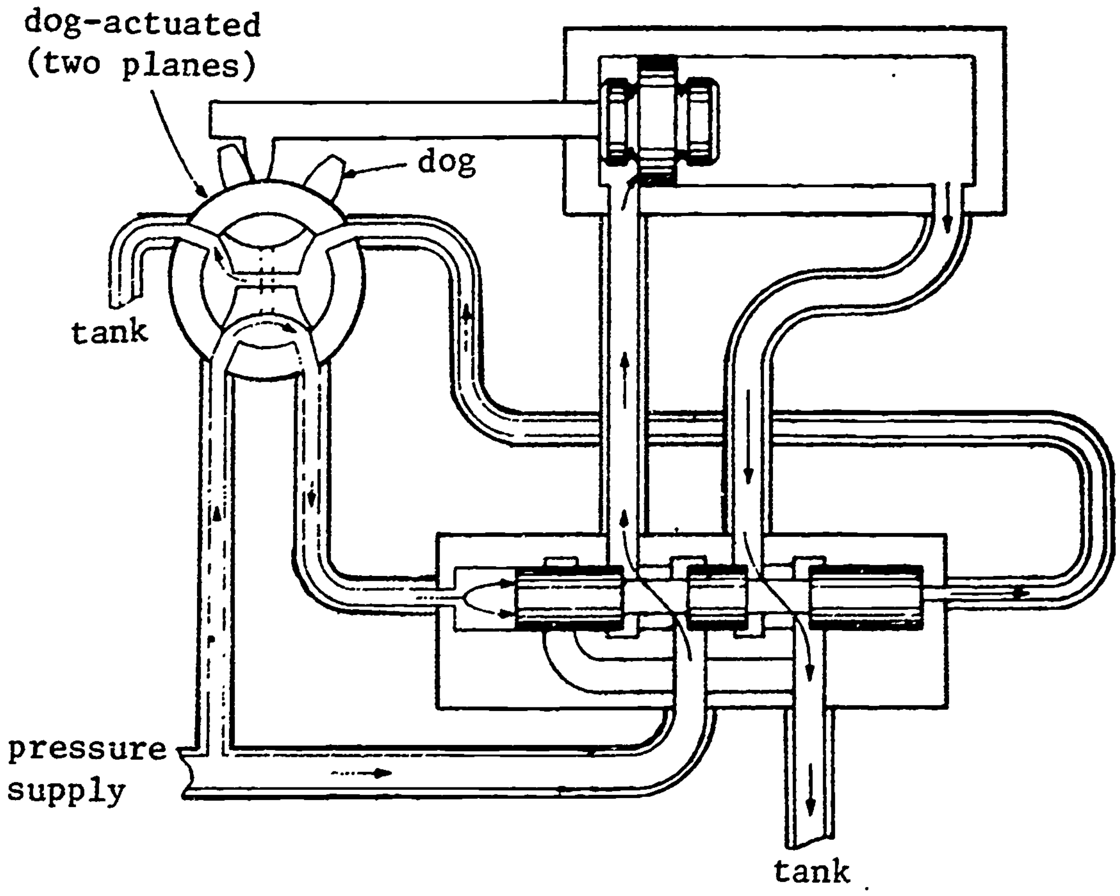


Plate XIV Simple hydraulic reversal system, showing use of rotary four way directional valve

0

AM 2-4D and MM 2-18D 3/7/67

UNDERSTANDING DIRECTIONAL CONTROL VALVES

Human Engineering Institute

Press A — 1 Check to see that timer is OFF

1-1

1

This film lesson is designed to assist you to better understand the basic technology behind directional control valves. We will look at the various types of valves, how they are constructed, their operation, purpose, and the role each valve plays in typical hydraulic circuits. Be sure you understand each frame before going to the next frame.

Press A — 2

1-2

2

Directional control valves are used to direct the flow of fluid generated by the pump to the various fluid-actuating units. These valves, in themselves, are not intended to meter the flow; they either block the flow completely or channel the flow to various lines where fluid power is needed to operate a fluid motor or to actuate a pilot-operated control valve.

Press A — 3

1-3

3

CHECK VALVES -- The simplest directional control valve is the check valve shown with its JIC symbol in Plate I.

This valve will permit free flow of liquid in one direction and will prevent fluid flow in the opposite direction. It can be designed using various types of closing devices including a swinging disk, a spring-seating disk or ball, and a gravity or self-seating ball.

Press A — 4

1-4

4

Of the various types of check valves, the ones most common are the ball type (with or without a spring), and the poppet type. Plate II shows how fluid can be bypassed in one direction and restricted in the other direction.

Check valves are usually held closed by a spring so that the valve requires pressure to unseat the blocking component in the valve. Some valves require as little as 5 psi, whereas others may require 65 psi. The high pressure valves usually are used to maintain pilot pressure for operation of piloted directional valves.

Press A — 5

1-5

5

Directional control check valves are used in hydraulic circuits to ______________ the fluid flow.

A. restrict — 7
B. meter — 6
C. circulate — 6

1-6

6

No. If you said check valves are used to meter or circulate the flow, you are incorrect. We said a few moments ago that the check valve is used to restrict the flow of fluid in one direction.

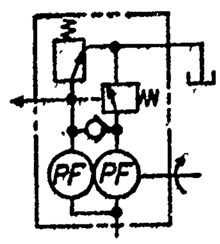
Press A — 7

1-7

7

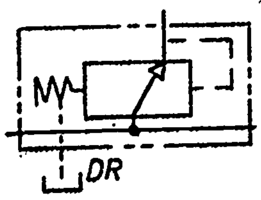
Correct. Of the three diagrams pictured below, which one contains a directional control check valve?

A. — 9



B. — 8

C. — 8



1-8

8

No. Remember, we said the symbol for a directional control check valve is: (—○—). Try this question again.
Press A – 7

1-9

9

Correct. The symbol for a directional control check valve is: (—○—).

Another valve very similar to the simple check valve is the pilot-operated check valve shown in Plate III. The pilot-operated type will always permit free flow in one direction and will allow flow in the normally blocked or opposite direction if pilot pressure is applied at the pilot pressure port of the valve. Pilot check valves are often used for locking cylinders in position.

Press A – 10

1-10

10

POSITION VALVES -- These valves are used to direct fluid to one or more different flow lines. They do this by being shifted into two or more different positions. In each position of the valve, the interconnection of the external ports produces various combinations of flow direction. In referring to piston (spool) valves, the number of main ports on the valve is designated by the terms two way, three way, four way, etc. The number of positions defines the valves, as being two position, three position, etc.

1-11

Press A – 11

11

In general, two way valves are strictly shut off valves, three way valves are used for controlling a single-acting cylinder where only one motor port is required, and four way valves are used for controlling double-acting cylinder movement.

Plate IV shows a four way valve being used to extend and retract a cylinder. As the piston of the four way valve is moved back and forth, each end of the work cylinder is connected in turn with the pressure line from the pump, while the other end of the work cylinder is connected to the reservoir. This arrangement allows ________.

A. free flow of fluid through valve – 12
B. automatic control of the valve – 13
C. no resistance from hydraulic pressure – 14

1-12

12

No. Free flow of oil through the valve takes place whenever the spool bands are not covering the ports. Try this question again. Press A – 11

1-13

13

No. Position valves such as the one in Plate IV are either shifted manually or are controlled by using springs, cams, solenoids, oil or air pilot fluid pressure servos, or by mechanical linkage. The flow of oil alone cannot control the valve. Try this question again. Press A – 11

1-14

14

Correct. The fluid in the piston must have a way to escape back to the reservoir when the piston displaces it. Otherwise, pressure within the cylinder would render the system inoperative.

Let's take a closer look at how a four position valve operates in a circuit. Look at Plate V. Notice in the picture the four valve ports are marked (P), (T), (A) and (B), wherein (P) is connected to a source of flow, (T) to tank, and (A) and (B) to the respective ports of a work cylinder, hydraulic motor or some other valve in the circuit.

1-15

Press A – 15

15

When the spool is in the position shown in (A), Plate V, port (P) is open to port (A), and port (B) to port (T). Ports (A) and (B) are connected to ports of a cylinder, and flow of fluid through ports (P) and (A) causes the piston to move to the right.

In (B) of Plate V, port (P) is open to port (B), which causes the piston to move to the left. When the piston is moving to the right, return flow escapes through ports __(1)__ and __(2)__. When the piston moves to the left, the return flow escapes through ports __(3)__ and __(4)__.

A. (1) (A) (2) (T) (3) (B) (4) (T) – 16
B. (1) (B) (2) (T) (3) (A) (4) (T) – 18
C. (1) (A) (2) (P) (3) (B) (4) (A) – 17

1-16

16

No. It is just the opposite: when fluid flow is going through (T) and (B), the piston is moving to the right; see (A) in Plate V. When (A) and (T) are open to each other, the piston is moving to the left.

Try this one again. Press A – 15

1-17

17

No. Your answer could not possibly be right because (T) is not open in either instance. Look at Plate V closely. If (T) were closed, no fluid could be returned to sump. As we learned earlier, fluid has to return to sump for the unit to operate. Try this question again. Press A – 15

1-18

18

Correct. Notice in both (A) and (B) of Plate V that all ports are open except the bypass return line in (B).

Now let's talk some more about how valves are operated. MANUALLY OPERATED FOUR WAY VALVES are suited for applications in which it is desirable to control the direction of flow manually such as in a fork-lift truck, or in an automatic transmission.

Press A – 20

2-1

XC – 19

19

Correct. However, you have missed one or more of the questions in this sequence of material. Before going on, review this material. Read each frame carefully, and take your time in answering the questions.

Press A – 2

1-19

20

The spool in a manually operated four way valve is shifted by operating a hand lever as shown in Plate VI. In spring offset models, the spool is normally in the extreme "out" position and is shifted to the extreme "in" position by moving the lever toward the valve. Spring action automatically returns both spool and lever to normal "out" position when the lever is released.

In two position, no-spring models (not shown in Plate VI), the spool is shifted to one of two positions, where it remains until it is manually shifted back to its original position.

Press A – 21

2-2

21

In three position, no-spring units, detents (devices which lock or unlock a movement) retain the spool in any one of three selected positions after lever force is released. In three position, spring centered models, the lever is used to shift the spool to either extreme position away from center. Spring action automatically returns the spool to center position when the lever is released.

In spring offset valves, mentioned earlier, there is no center position. This is a __________ statement.

A. true – 23
B. false – 22

2-3

22

No. There is not a center position to these valves. Remember, we said the spring returns the lever and spool from the extreme "in" position which was reached by using the lever. The correct answer is that the statement in the previous frame is true: there is no center position on a spring offset valve.

Press A – 23

2-4

23

Correct. There is no center position in the spring offset valves.

Manually operated valves equipped with detents __________ __________.

A. stabilize the spool after lever action is released – 25
B. assist movement of the lever and spool under high pressure – 24
C. are spring loaded valves – 24

2-5

24

No. If you said detents assist movement of the lever under high pressure, or that detents meant the valve was spring loaded, you are incorrect. The correct answer is that detents help stabilize the spool in one position after lever action is released.

Press A – 25

2-6

25

Correct. A detent is sometimes referred to as a catch, pawl, dog, or a click. It stabilizes the spool after lever action is released.

PILOT OPERATED FOUR WAY VALVES are used where it is desirable to remotely control the direction of the flow through the use of pilot pressure.

These are two-position units in which the spool is shifted by application of pilot pressure at one end or either end, see Plate VII.

2-7

Press A – 26

26

In spring offset models (see Plate VII) the spool is held in its normal offset position by spring thrust and shifted to its other position by application of pilot pressure to the free end of the spool. When pilot pressure is removed, spring thrust returns the spool to its original offset position.

In no-spring models, the spool is shifted by the application of pilot pressure to either end of the spool. These valves are not detent held, so pilot pressure has to be supplied to maintain desired spool position.

2-8

Press A – 27

27

Of the two valves discussed -- the pilot operated spring offset valve, and the no-spring valve -- which one do you think could become inoperative more easily?

A. The no-spring valve – 28

B. The spring offset valve – 29

2-9

28

Of course, it is possible that both could become inoperative through excessive dirt in the line or valve freeze-up.

However, disregarding those possibilities, if the spring should become weak, or break, in the spring loaded valve it would become inoperative because the piston (spool) could move to only one position.

Press A – 29

2-10

29

Correct. Of course both types could become inoperative because of valve "freeze-up", or excessive dirt in the lines. However, if the spring in the one type should be unable to return the spool, it would be useless, whereas the "no-spring" type would not have this problem.

PILOT CHOKES -- A modification of the pilot operated unit is the pilot choke assembly shown in Plate VIII. This valve also has a stroke adjusting device.

Press A – 30

2-11

30

The pilot choke, Plate VIII consists of: two needle valves (1) and (2), two check valves (3) and (4), and pilot passages (X) and (Y). The assembly provides a means for independent regulation of the speed of the spool movement in either direction.

As the spool moves to the left, Plate VIII (a), the pilot fluid from (Y) flows through check valve (3). The discharge from the opposite end of the spool throttles past the needle valve (1) adjustment, which determines the speed at which the spool shifts when moving in this direction.

Press A – 31

2-12

31

As the spool moves to the right, (Plate VIII (b)), the pilot fluid from (X) flows through check valve (4). Here again, needle valve (2) determines the speed at which the spool can move to the right.

In this valve, the stroke of the spool also can be adjusted so that total travel is only slightly in excess of that required to cause flow reversals. The "dead period" can be minimized in this manner. The stroke adjusting devices are stop screws (5) and (6).

Press A – 32

2-13

32

The purpose of the check valves (3) and (4) in the pilot choke valve pictured in Plate VIII is to ________.

A. prevent an excessive amount of fluid from entering the valve and possibly rupturing the valve 33

B. control the amount of fluid leaving the valve housing -34

C. force the fluid leaving the housing to take another exit -35

2-14

33

No. The size of piping and the amount of pressure in the lines determine the amount of fluid flow. The check valve opens at a very low psi, allowing all the fluid available to bypass it.

Try this question again. Press A - 32

2-15

34

No. The check valves do not control the amount of fluid leaving the valve housing. They stop it completely and force the fluid to find another exit, namely past (1) and (2).

Press A - 35

2-16

35

Correct. If the check valves were not present, the purpose that (1) and (2) serve now would be lost. The fluid, when leaving the valve, must find another exit due to the check valve closing.

The purpose of (1) and (2) in the valve in Plate VIII is to ________.

A. create enough pressure through resistance flow to close the check valve -36

B. decrease or increase the spool stroke distance - 37

C. decrease or increase the spool stroke speed 38

2-17

36

No. Look at Plate VIII. Notice that each check valve is spring loaded. No pressure is required to close them; fluid pressure is required only to open them.

Try this question again. Press A - 35

2-18

37

No. You are confused with (5) and (6). The purpose of (1) and (2) is to limit the spool travel speed by allowing a little fluid to escape, rather than all at once. In Plate VIII, (5) and (6) control the stroke length of the spool.

Press A - 38

2-19

38

Correct. The needle valves limit the amount of fluid leaving the valve housing, thus decreasing or limiting spool travel.

A similar valve to the one in Plate VIII is shown in Plate IX, with its symbol. This is called a time-delay valve. Let's see how it works.

This valve always allows free flow of fluid in one direction through the valve. When flow is reversed, however, the valve is blocked for a definite time interval, until the blocking fluid can escape to the reservoir and allow the spring to open the valve.

Press A - 39

3-1

39

There are several different designs of deceleration valves. They are used to gradually accelerate or decelerate the piston rods of fluid cylinders at the end or beginning of the stroke. The type shown in Plate X, with its symbol, is a spool type having a roller follower actuated by a cam at the ends of the cylinder stroke. When the cam engages the roller, the fluid flowing through the valve is restricted, thus forcing the fluid to flow through a separate flow-control valve which decelerates the piston. Flow in the opposite direction is free to move through the valve because of the presence of a check valve in the main housing.

Press A - 41

3-2

XC - 40

40

You have missed one or more questions in the last sequence. Before going to new material review the last few frames very carefully. Be sure you understand each frame of information before going on. Take your time in answering the questions. Press A – 18

2-20

41

Another type of valve, known as the shuttle valve, permits a system to operate from either of two fluid power sources. This requirement may be necessary for safety reasons in case the main pump is unable to power emergency devices.

This valve (see Plate XI) consists of a floating piston which can be shuttled to one side or the other depending on which side of the piston has the greater pressure. Generally, a spring is added on one side of the piston to favor one of the supply sources.

Press A – 42

3-3

42

Suppose you wanted to adjust the time delay in a hydraulic circuit using the valve pictured in Plate IX. To lengthen the time delay, you would ___(1)___. To shorten the time delay, you would ___(2)___.

A. (1) rotate the screw clockwise
(2) rotate the screw counterclockwise – 44

B. (1) rotate the screw counterclockwise
(2) rotate the screw clockwise – 43

C. Neither A or B is correct to adjust the time delay. – 43

3-4

43

No. If you said to rotate the screw counterclockwise to lengthen the time, and clockwise to shorten the time, or that movement of the screw in either direction would not adjust the time, you are incorrect.

Turning the screw clockwise would decrease the opening (orifice), which would in turn allow less fluid to escape, thus increasing the time.

As the screw is backed out (counterclockwise) the orifice is increased in size, reducing the time.

Press A – 44

3-5

44

Correct. That was a "thought question" and you did well.

ELECTRICALLY OPERATED HYDRAULIC CIRCUITS

Electrical control circuits combine with hydraulic systems through solenoid (a coil that moves a push rod back and forth) operated valves. Control signals from timers, limit switches, pressure switches and other electrical control elements are switched through relays to activate valve solenoids. These, in turn, sequence the hydraulic system. In operation, the spool is shifted by energizing a solenoid located at one or both ends of the spool. Should there be only one solenoid then there would have to be a ____________ at the other end of the spool.

A. detent – 45
B. spring – 46
C. Neither A or B – 45

3-6

45

No. A detent would hold the spool in place. What is required is something to force the spool back to its position after the solenoid is retracted, hence a spring.

Press A – 46

3-7

46

Correct. Unless there is a solenoid at each end of the spool to move it first one way then the other, the spool must be spring loaded at the end without the solenoid.

SOLENOID CONTROLLED, PILOT OPERATED VALVES

Solenoids for valve operation usually provide less than 15 pounds of force and are limited to about 35 to 40 pounds of force. Spool valves in sizes to 1/4 inch usually are actuated directly, but solenoids for direct operation of larger valves would be bulky.

3-8

Press A – 47

47

For valves with spools over 1/4 inch, a directly actuated solenoid valve is combined with a pilot operated valve. The solenoid valve controls only pilot flow to the larger valve. These two valves mount together and the combination is called a solenoid controlled, pilot operated valve. A two position, solenoid controlled valve may be combined with a two position pilot operated valve; or they both may be three position valves.

Let's analyze how a solenoid controlled, pilot operated valve circuit works. Look at Plate XII.

3-9

Press A – 48

48

In Plate XII, the small solenoid controlled valve (pilot valve) directs the fluid flow to either end of the pilot operated spool (piloted valve). The pilot valve has a two land spool. The piloted valve has a four land spool.

In Plate XII (a), the pilot spool (1) is positioned to permit pilot flow to be directed from port (P_p) to (A_p) and then to the (Y) end of spool (2), shifting spool (2) to the position shown.

Return flow from the (X) end of spool (2) passes through port (B_p) of the pilot valve and returns to the tank through port (DR). With pilot spool (1) in this position, the main spool (2) is shifted to allow flow from port (P) to port (B), and from port (A) to port (T).

Press A - 49

3-10

49

When the piloted valve is mentioned in Plate XII we are referring to the valve with ____(1)____ lands in the spool. When referencing the pilot valve, we are referring to the valve with the ____(2)____ land spool. Only the ____(3)____ valve is solenoid operated.

A. (1) three (2) two (3) pilot - 50
B. (1) four (2) two (3) pilot - 51
C. (1) two (2) four (3) piloted - 50

3-11

50

No. You will recall we said the pilot valve is solenoid controlled. The pilot valve, through its action, then operates the piloted valve. We also said that the pilot valve has a two land spool and the piloted valve has a four land spool.

Press A - 51

3-12

51

Correct. Now, look at Plate XII (b). When the pilot spool (1) is shifted to this position, a reverse flow situation occurs. Pilot flow directed through port (P_p) and (B_p) to the (X) end of spool (2) shifts spool (2) to the position shown.

Return flow from (Y) end of spool (2) passes to tank through ports (A_p) and (Dr) in the pilot valve.

When the pilot spool (1) is in this position, the main spool (2) is shifted to allow flow from port (P) to port (A) and from port (B) to port (T).

3-13

Press A - 52

52

In Plate XII, the reason for the two extra lands in spool (2) is ________________.

A. these lands are moved by the solenoid, which in turn moves the large spool (2) - 53
B. to allow flow of fluid in one direction only - 54
C. to serve as a component which allows fluid to flow in both directions - 55

3-14

53

No. These two extra lands are moved into position as a result of the solenoid moving spool (1), not spool (2). However, as a result of these lands, the fluid that passes through them actuates the main spool (2). There must be two, because they alternate in serving as drains, thus allowing fluid to flow in either direction at the proper time.

Press A - 55

3-15

54

No. This does not act like a check valve, which allows fluid to flow in one direction only. These must serve as components capable of allowing fluid to flow in either direction at the proper time.

Press A - 55

3-16

55

Correct. Two of the lands in spool (2) must serve as the controlling factors for the main spool and be capable of allowing fluid to flow in either direction, for drain purposes.

Now let's analyze the circuit in Plate XIII. When solenoid (A) is energized, the pilot spool is positioned to allow fluid under pressure to ________________.

A. flow through the main spool valve immediately and fill the rod side of cylinder - 56
B. flow through the pilot spool and activate the two way valve and main directional valve simultaneously - 58
C. escape from the rod end of the cylinder and return to tank (T) - 57

3-17

56

No. Fluid cannot flow through the main spool valve until it is activated by the pilot valve. Look at Plate XIII closely and try this question again. Press A – 55

3-18

57

No. The piston is moving away from the rod end of the cylinder, not toward it. Look at Plate XIII closely and try this question again. Press A – 55

3-19

58

Correct. Once the main spool valve is open, fluid flows through it to the rod side of the piston, forcing it to move to the right. It is possible in this circuit (Plate XIII) that the fluid draining from the head end of the cylinder can drain in two different routes into the tank. This is a ______________ statement.

A. false – 59

B. true – 60

3-20

59

No. You are incorrect. It is true: there are two paths to tank in this circuit, one through the two way valve and the other through the main directional valve.

Press A – 60

3-21

60

Correct. Two paths of drain to tank are possible in this circuit in Plate XIII.

ROTARY DIRECTIONAL VALVES -- In Plate XIV there is a rotary directional valve being controlled by the cylinder movement. Let's analyze how this valve operates the spool of the four way directional control valve. When the four way control valve is in this position______________________.

A. fluid under pressure is continuously being applied to the spool – 63

B. there are two pressure inlets to the valve and one drain outlet flowing from the valve – 61

C. an equal amount of fluid travels through both inlet lines until the rotary valve changes position – 62

3-22

61

No. There are two pressure inlets to the valve and two drains involved here. Look at Plate XIV closely; then try this question again. Press A – 60

3-23

62

No. Fluid under pressure flows through the rotary valve to the spool of the four way valve only until the spool has bottomed to the other side, then it stops. However, fluid flows continuously through the valve until the piston reaches well past center and changes the rotary valve. Look at Plate XIV and try this question again. Press A – 60

3-24

63

Correct. Fluid under pressure has to be applied continuously to the end of the spool to keep it in this position.

TROUBLESHOOTING DIRECTIONAL VALVES. There are both external and internal conditions which may affect the performance of directional valves in a hydraulic circuit. Let's see what some of these conditions are.

Press A – 65

XC – 64

4-1

64

The correct answer to the last question is: fluid under pressure has to be applied continuously to the spool end to maintain its position.

You have missed one or more of the questions in this last sequence of material. Before going on, go over this material again. Read each frame carefully and take your time in answering the questions. Press A - 38

3-25

65

HEAT -- Moderate heat will often cause excessive leakage past the piston stem seal or cover gasket. Extreme heat will cause the packing seals to deteriorate. When valves are used around furnaces, or if the oil circulating temperature is 150 F or more, it is necessary to use a high temperature type packing that is made for temperatures up to 500 F.

Press A - 66

4-2

66

DIRT -- A dirty hydraulic system can cause damage not only to the valves but to other components in the system as well. This dirt condition can be harmful whether it is external or internal.

Externally, certain abrasives and other hard foreign matter can score the valve stem so that it will cut the packing and cause a leak. Internally, dirt can score the valve body or piston and can cause internal leakage, or may cause the piston to stick.

4-3

Press A - 67

67

Valves can be affected both ___(1)___ and ___(2)___ by abnormal heat and dirt conditions which can cause valve ___(3)___.

A. (1) physically (2) outwardly (3) rupture - 68
B. (1) internally (2) externally (3) leakage - 69

4-4

68

No. The answer to the last question is that through excessive heat and dirt, valves can be affected both internally and externally. Both of these conditions can cause valve leakage. Press A - 67

4-5

69

Correct.

One of the conditions that can cause early deterioration of valve seals is ________________.

A. excessive vibration - 70
B. too much pressure in the line - 70
C. using oil over 500 F - 71
D. using the wrong type packing - 72

4-6

70

No. Excessive vibration and too much pressure in the system could very well cause early deterioration of the valve seals, but the item most appropriate to what we have discussed so far is: using the wrong type packing. If the wrong type packing is used in a system which carries over 150 F oil, the packing will deteriorate rapidly.

Press A - 72

4-7

71

No. Using oil over 500 F would deteriorate more components than just the packing. The point here is that special packing must be inserted in the valves if oil is to be used in the system.

Press A - 72

4-8

72

Correct. Valve packing which should be used in temperatures under 150 F, but is used in circulating oil having a temperature of 250 F, can deteriorate very rapidly.

BACK PRESSURE -- Back pressure due to a restrictive exhaust often will cause the spool seals to freeze against the spool and make the valve inoperative. This is especially true with solenoid operated valves.

Press A – 73

4-9

73

With a manually operated valve, the operator usually has enough strength to push the piston from one extreme to the other, but with a solenoid there is only a limited amount of force available and a small amount of back pressure can quickly freeze the piston. This is especially true of spring-offset type solenoid valves. The solenoid usually is just strong enough to overcome the normal spring pressure.

Press A – 74

4-10

74

INTERNAL LEAKAGE. If a valve fails to allow the full fluid volume to go to the next component, check the valve for internal leaks. Some of the pressure may be passing from the inlet port to the tank port. A "wire drawing" action may have taken place on the piston or the valve body may be scored.

A valve body usually wears much faster than the piston, because of the softer material of the valve body. In replacing the piston, enough grinding stock should be available on the new piston so that the piston can be ground and then lapped into the body. A piston of standard size seldom fits into an old valve body with the proper clearance.

Press A – 75

4-11

75

Back pressure in a hydraulic system can be caused by ________________.

A. a spool stuck in a valve – 76
B. high operating temperature – 76
C. Neither A or B above – 77

4-12

76

No. It was mentioned earlier that back pressure usually is caused by a restrictive exhaust. A spool stuck in a valve may be the result of a high back pressure. Press A – 77.

4-13

77

Correct. A high back pressure in a system is a result of a restricted exhaust.

The type of valve that is affected most by a high back pressure in a system is a ____________________.

A. manually operated valve – 78
B. spring loaded valve – 79
C. solenoid operated valve – 80

4-14

78

No. A manually operated valve usually can be forced into position by the manual force supplied by the operator. The correct answer is that a solenoid operated valve is most likely affected by back pressure in a circuit.

Press A – 80

4-15

79

You are partially correct. The spring offset solenoid operated valve is highly affected by back pressure in a hydraulic circuit.

Press A – 80

4-16

80

Correct.

Broken springs. Broken return springs will not allow the piston to center properly when the piston is released on a spring-centered type valve. A broken spring in a two position, spring offset type valve will not allow the piston to shift to its normal position when released.

If a valve fails to allow the full fluid volume to go to the next component, the valve may be leaking internally. It is very probable that some of the pressure is passing from the inlet port to the tank port. If this is happening, ________________.

A. the valve spool probably is worn – 81
B. the valve body is worn – 82
C. Neither A or B is the cause – 81

4-17

81

No. A valve body usually wears much faster than the piston (spool) because of the softer material of the valve body.

Press A – 82.

4-18

82

Correct. The spool in a valve is of a higher grade material than the body. If either of the valve parts wear, it usually will be the valve body.

Now let's have a few review questions about directional valves, covering important points you should now know.

Directional valves are used in hydraulic circuits to ________.

A. meter the fluid flow – 83
B. direct the flow of fluid generated by the pump – 84
C. Neither A or B is correct. – 83

4-19

83

No. Directional valves do not meter the flow of fluid. You are confusing directional control valves with volume control valves, which will be covered in later units. Press A – 84

4-20

84

Correct.

A directional control check valve is used in hydraulic circuits for the purpose of __________ the fluid flow.

A. metering – 85
B. circulating – 85
C Neither A or B is correct. – 86

4-21

85

No. If you said check valves are used for metering or circulating the fluid flow, you are incorrect. Check valves are used to restrict the flow of fluid to one direction in the circuit.

Press A – 86

4-22

86

Correct. Check valves are used in a hydraulic circuit to restrict fluid flow to one direction.

A detent valve is one which ________________.

A. has one or more lands in the spool – 87
B. is spring loaded at one end – 87
C. is a solenoid operated valve – 87
D. Neither A, B, nor C is correct. – 88

4-23

87

No. A detent valve does not refer to the number of lands in the spool, nor the fact that it's spring loaded, nor whether it's solenoid operated or not. A detent valve is one which holds the spool in a certain position by using spring actuated steel balls to resist its movement.

Press A – 88

4-24

88

Correct. None of those answers apply to a detent valve. A detent simply refers to a mechanism within the valve that resists movement of the spool when the spool is in a certain position.

Congratulations, this completes the lesson on directional control valves.

Press REWIND.

XC 34

4-25

80

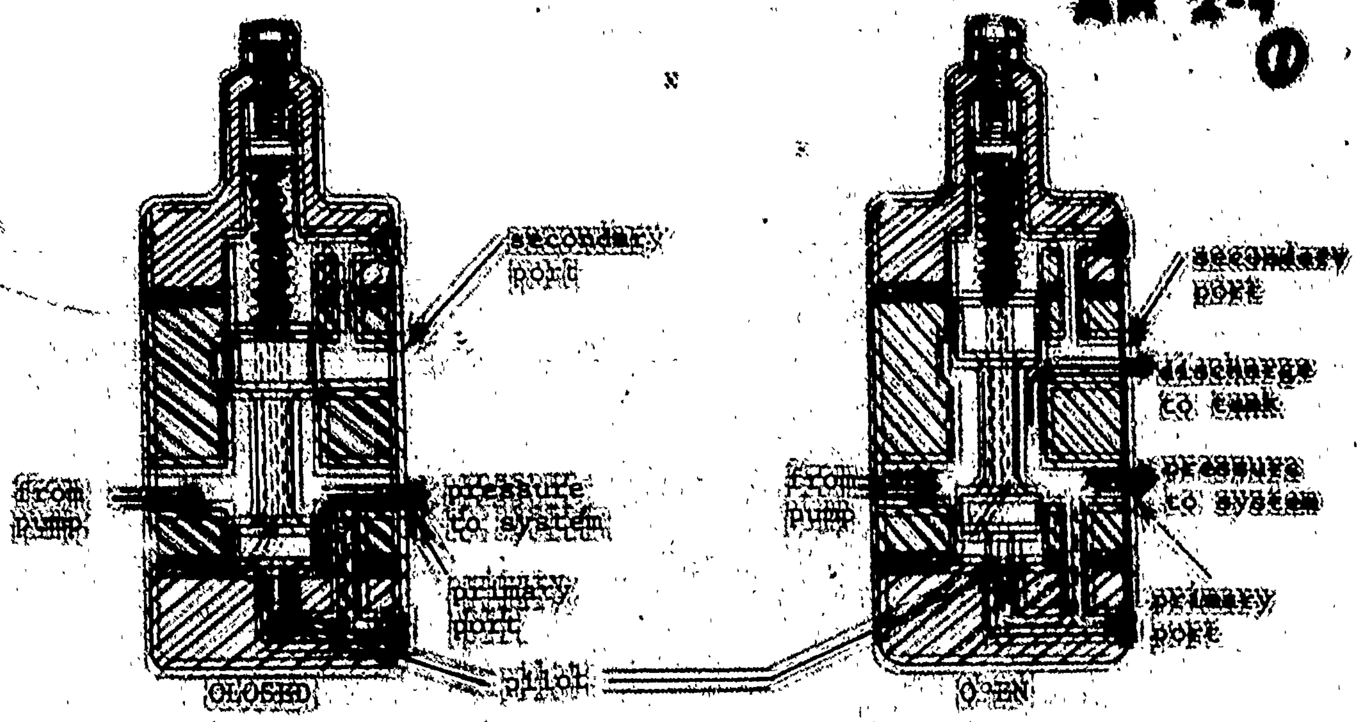
Correct. A detent valve is one that will hold the spool in certain desired positions.

You have missed one or more of the questions in the last sequence of material. Before finishing with this lesson, review the last few frames. Read each frame carefully and take your time in answering the questions. Press A

— 63

4-26

AM 2-4



Pilot type relief valve

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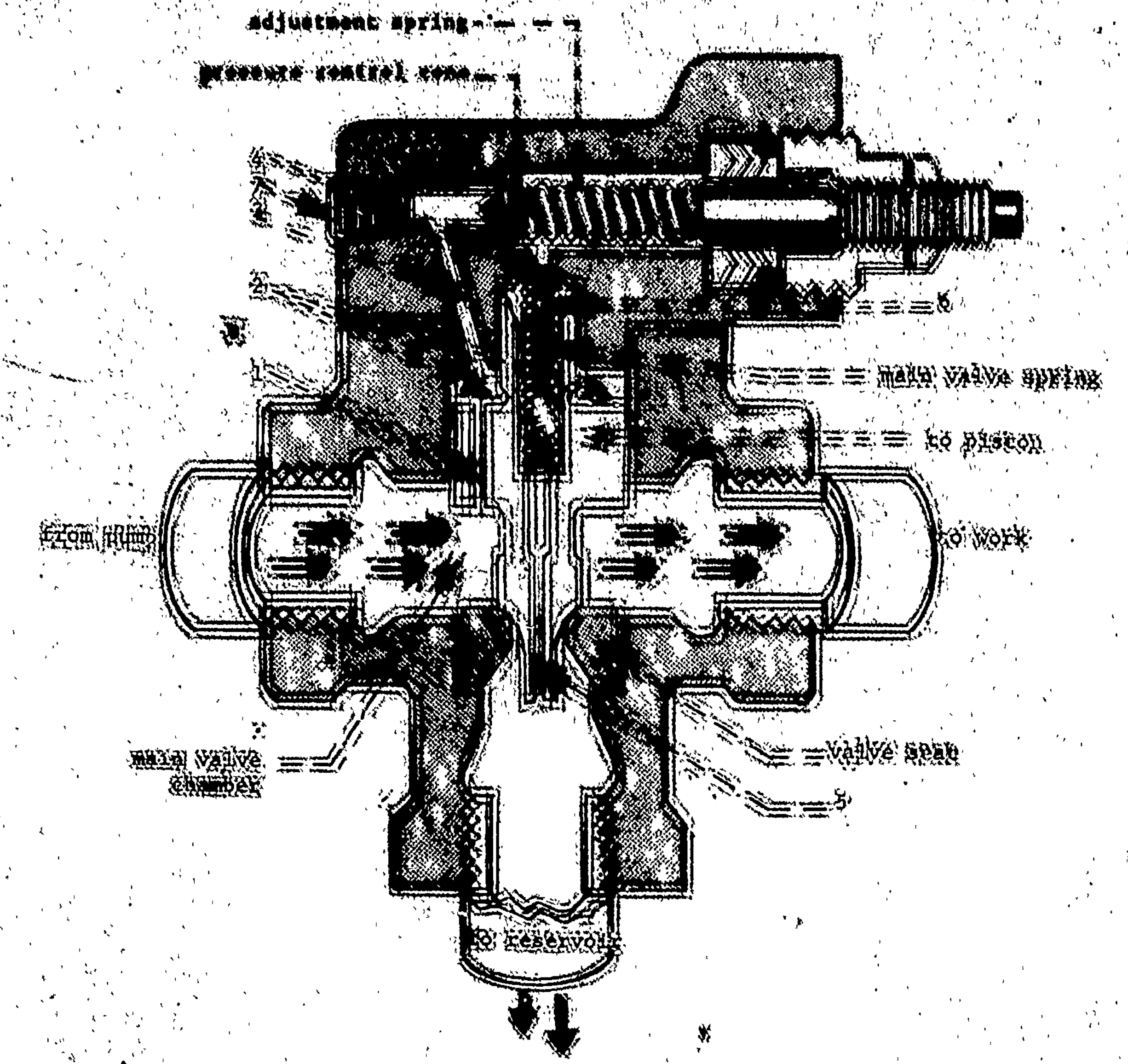
AM 2-4 ②



Balanced piston type relief valve

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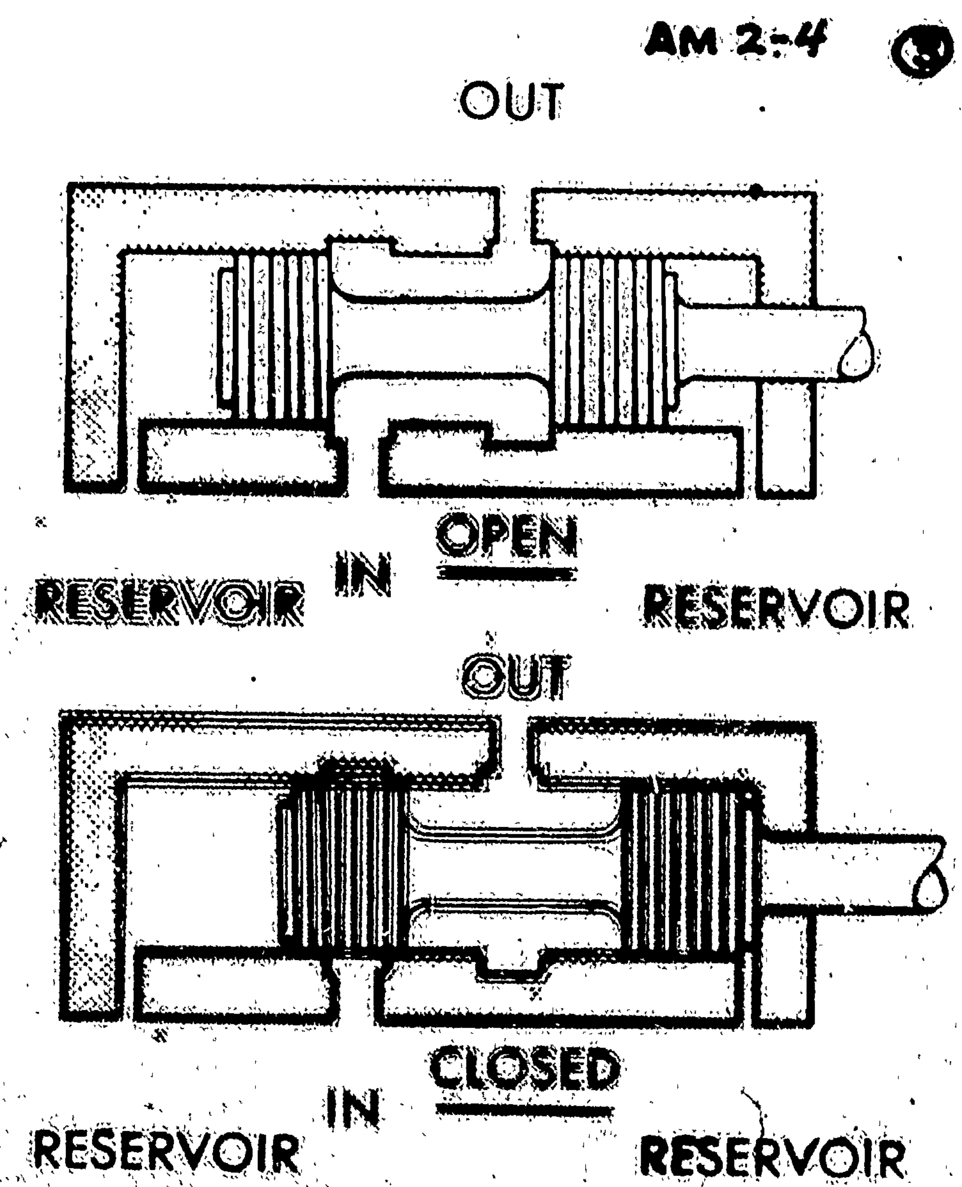

Two-way spool valve

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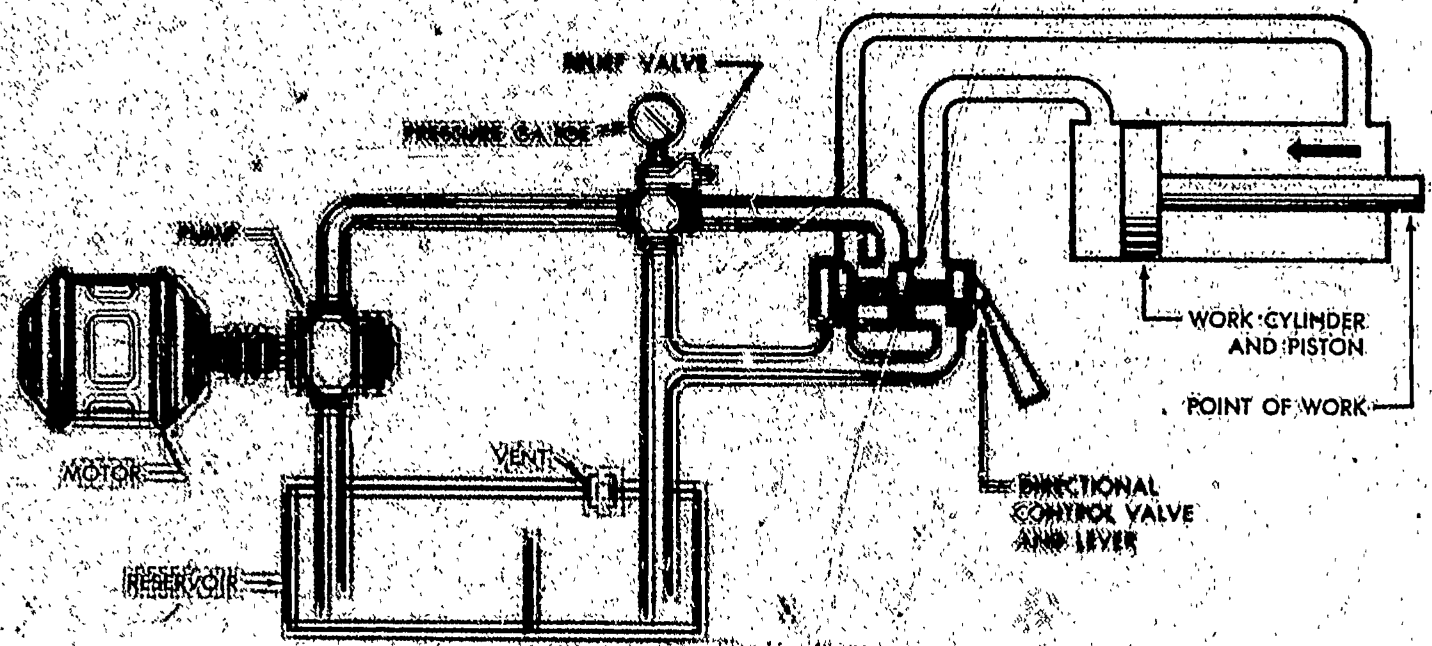
AM 2-4 (4)



Typical four-way spool valve installation

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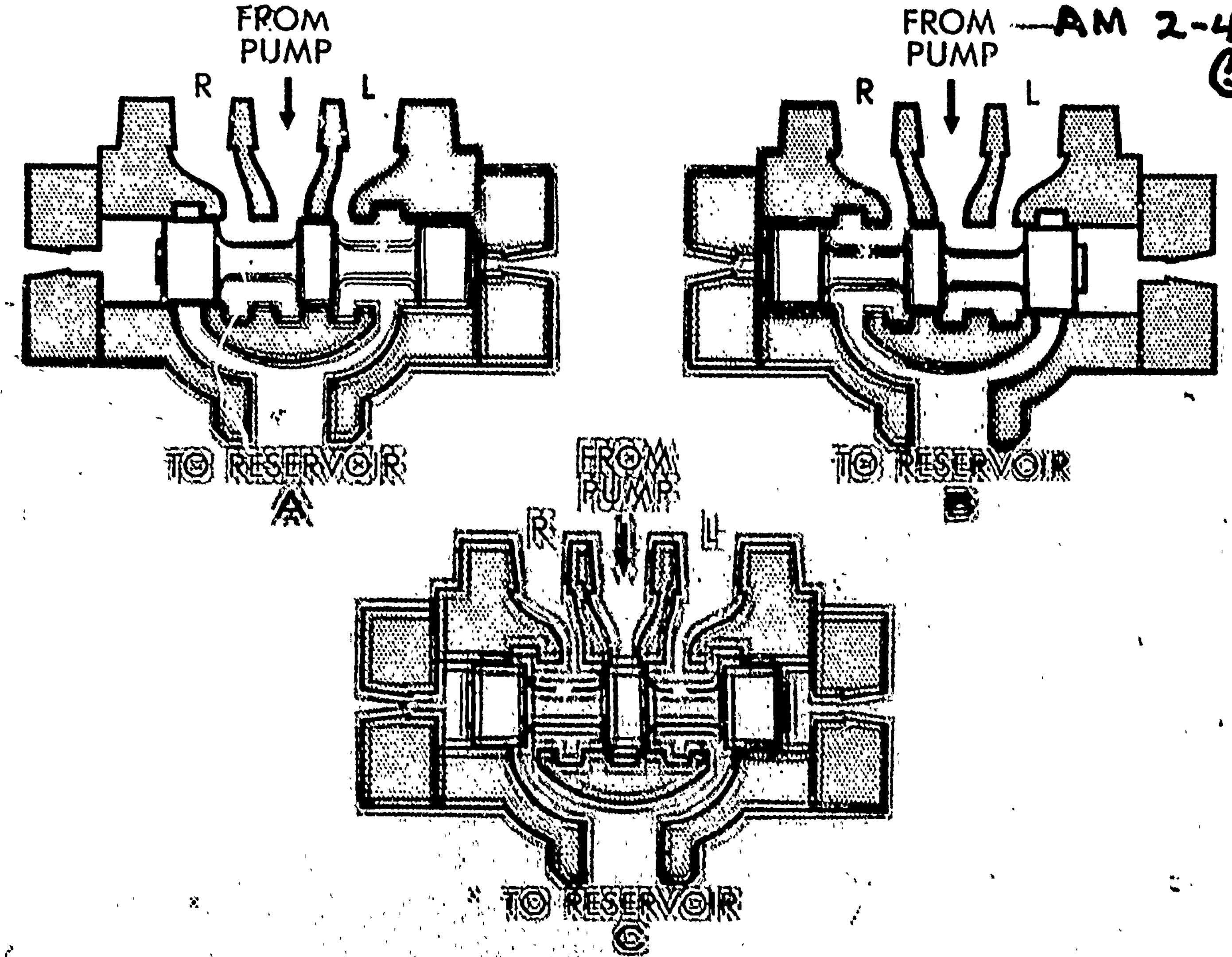
AM 2-4

(5)



Four-way valve operation

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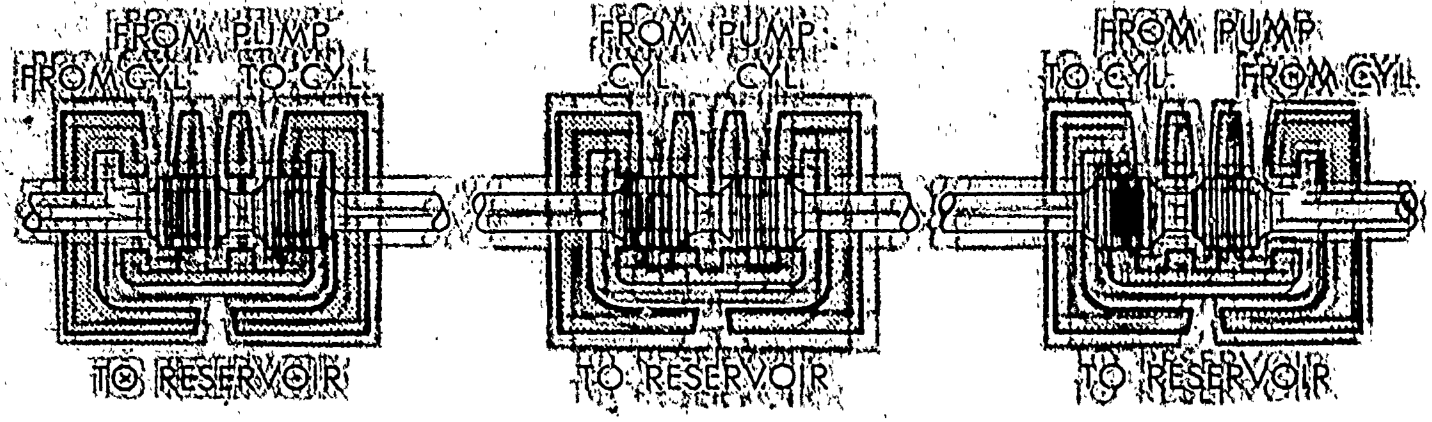
AM 3-4



Closed center valve

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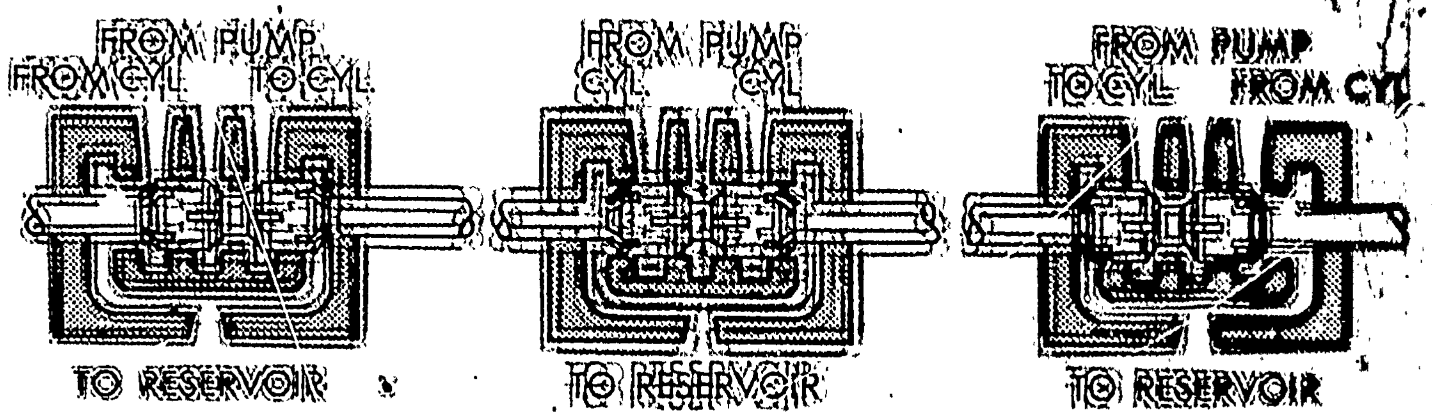
AM 2-4 (7)

DIRECTIONAL VALVES



Open center valve

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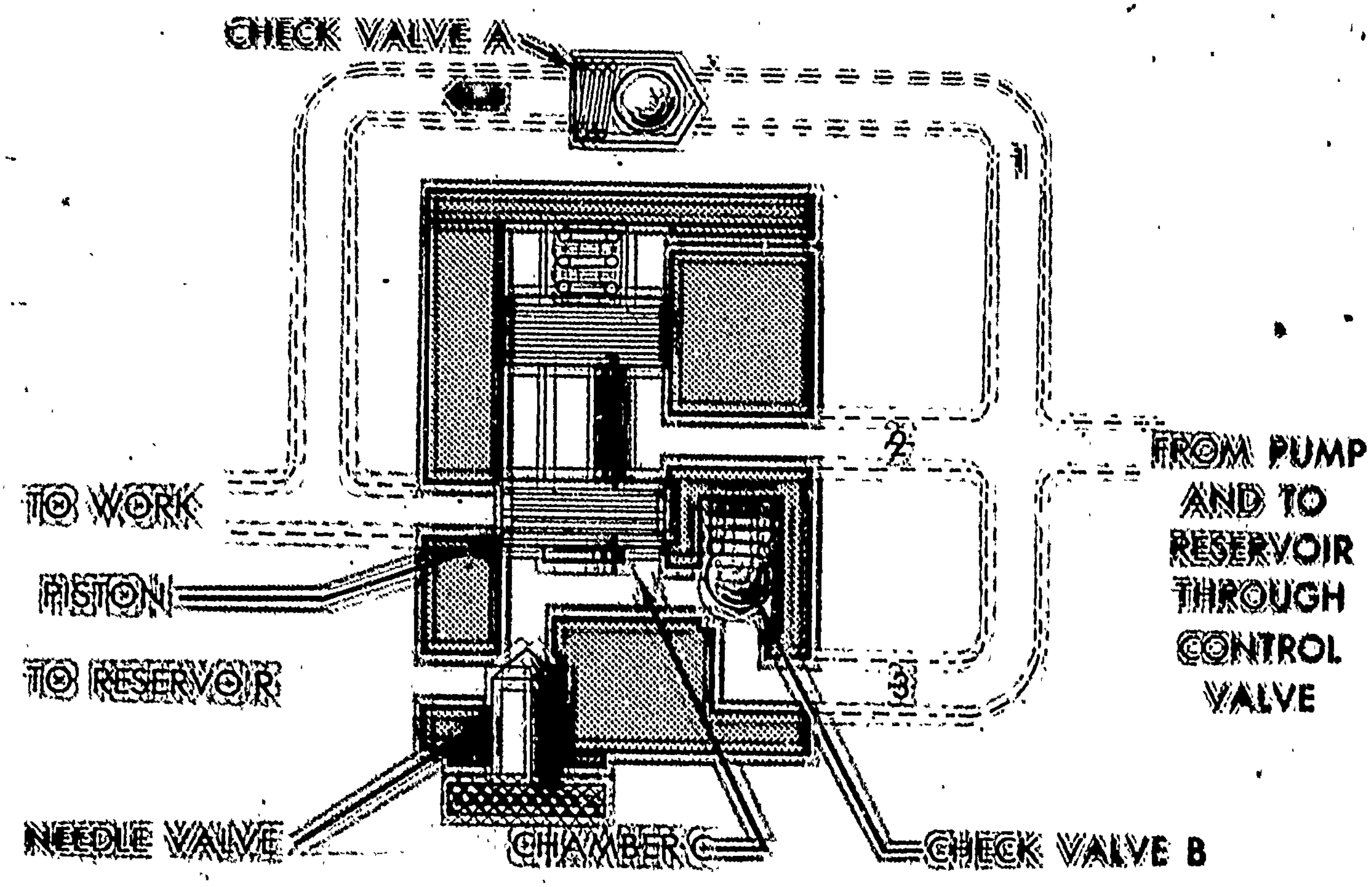
AM 2-4 (8)



Action of a time delay valve

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INSTRUCTOR'S GUIDE

Title of Unit: AUTOMATIC TRANSMISSION - HYDRAULICS (PART II) AM 2-4 3/30/67

OBJECTIVES:

1. To present Part II of a series of two hydraulic units designed to acquaint the students with transmission operation.

2. To explain the different types of valves utilized in the Allison Transmission.

LEARNING AIDS suggested:

VU CELLS:
AM 2-4 (1) (Pilot type relief valve)
AM 2-4 (2) (Balanced piston type relief valve)
AM 2-4 (3) (Two-way spool valve)
AM 2-4 (4) (Typical four-way spool valve installation)
AM 2-4 (5) (Four-way valve operation)
AM 2-4 (6) (Closed center valve)
AM 2-4 (7) (Open center valve)
AM 2-4 (8) (Action of a time delay valve)

MODELS: Any parts of valves or the valves themselves that can be brought into class for demonstration purposes would be helpful.

QUESTIONS FOR DISCUSSION AND GROUP PARTICIPATION:

1. What is the difference between positive and non-positive displacement pumps?

2. Which of the two types mentioned in (1) above are used in the Allison Transmission?

3. Is it true that oil moves through the gears in a spur gear pump?

4. Are both gears in a spur gear pump driven?

5. What opens and closes a check valve in a hydraulic system?

6. When is a relief valve a safety valve?

7. What is the purpose of a relief valve in a hydraulic system? What activates this type of valve?

8. Is it correct to insert a relief valve between the control valve and the cylinder in a hydraulic circuit?

9. What are the various methods of controlling spool valves? Explain.

10. What is meant by open and closed center spool valves?

11. When are open center valves used in a hydraulic system?

12. What would a flow control valve be used for in a hydraulic system?

13. Why would some type of time delay valve be required in the Allison Transmission?

14. Can fluid flow in only one direction through a by-pass valve? Explain.