Exercise 1-2

Introduction to Pneumatics

EXERCISE OBJECTIVE

- To learn about pneumatic power characteristics, applications, advantages and disadvantages;
- To investigate a basic pneumatic circuit.

DISCUSSION

Fluid power systems convert mechanical energy into fluid energy, and then convert this fluid energy back into mechanical energy to do useful work. The fluid power devices that convert the energy of a pressurized fluid into mechanical energy to do work, are called actuators. The two basic types of actuators are cylinders, which generate linear motion, and motors or rotary actuators, which generate rotary motion.

Most pneumatic circuits contain a source of compressed air, a pressure control device, conductors such as pipe or tubing, an actuator, and a directional control valve to control the operation of the actuator. The power source comes from a motor or engine, called a prime mover, that operates a compressor having its inlet port connected to the atmosphere. The mechanical energy is converted into fluid power when this air is compressed. In addition to a prime mover and a compressor, a pneumatic power source includes an air storage tank called a receiver. The receiver stores the compressed air until this energy is needed elsewhere in the system.

A pneumatic circuit is a fluid power circuit that uses gas to transmit power. Air is commonly used as a gas in pneumatics because it is readily available, inexpensive, and can be returned to the atmosphere after use.

Air is extremely compressible and elastic. It is capable of absorbing large amounts of potential energy. These properties of compressed air make possible smooth acceleration and deceleration and reversal of direction of mechanical motions, with relative freedom from shock.

As a power medium, compressed air has numerous distinct advantages such as:

- easy to transport and store;
- unlimited conductive geometry;
- offers little risk of explosion or fire;
- is a very fast working medium and enables high working speed to be obtained;
- provides flexibility in the control of machines;
- provides an efficient method of multiplying force;
- no return lines necessary;
- efficient and dependable.

The main disadvantages of compressed air are:

- safety precautions are necessary in handling;
- expensive compared to some mechanical, electrical or hydraulic means for a given application;
- generally suitable for relatively low power requirements;
- pressure limits;
- leakages must be controlled to maintain usable pressures;
- dirt and humidity must not be present.

Compressed air finds wide use in transportation and industry fields: air brakes, air cylinder, tools, die casting, etc. Figure 1-17 shows some typical applications.

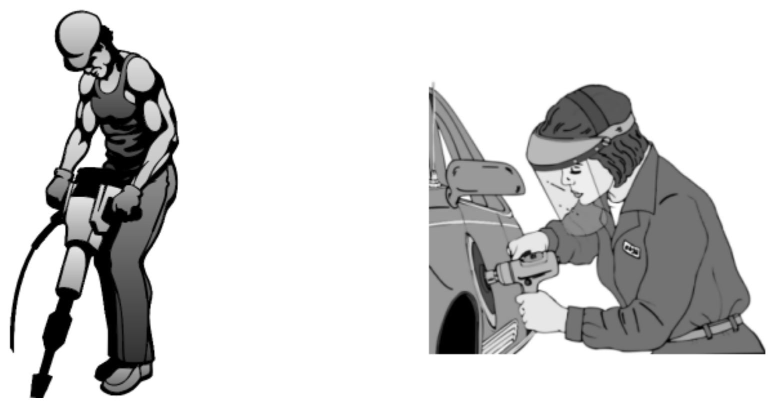

Figure 1-17. Compressed Air Applications.

Figure 1-18 illustrates the flow of air through a fundamental pneumatic circuit. Air is drawn from the atmosphere by the compressor and compressed in the receiver. When the directional control valve (DCV) is operated, air flows through the valve and to side A of the cylinder. This causes the cylinder to extend and the air from side B is exhausted and returned to atmosphere.

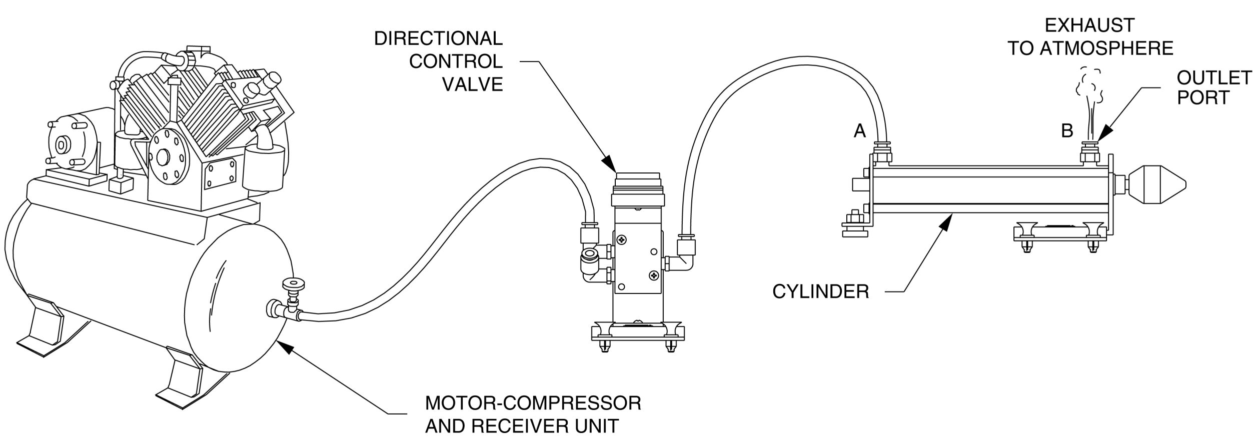

Figure 1-18. Fundamental Circuit Flow.

Become Familiar with the Operation of the Push-in Tube Fittings

Trainer components are equipped with push-in tube fittings that allow one to quickly assemble and disassemble pneumatic circuits. To connect tubing to a fitting, simply push the tubing in as far as it will go. To disconnect the tubing, grasp the tubing near the fitting and push the tubing and collar of the fitting in toward the component. Hold down the collar in one hand, and pull the tubing out with the other hand.

The ends of the tubing will wear out with repeated use. Eventually, the tubing will not seal properly in the fittings. When this happens, the worn tubing end must be trimmed. Use a tube cutter to remove about 12 mm (or 1/2 in) of the worn tubing.

Procedure summary

In the first part of the exercise, you will verify the status of the trainer by executing the "trainer status verification procedure".

In the second part of the exercise, you will set up and operate a pneumatic circuit using the Conditioning Unit, a directional control valve and a cylinder.

EQUIPMENT REQUIRED

Refer to the Equipment Utilization Chart, in Appendix A of this manual, to obtain the list of equipment required to perform this exercise.

PROCEDURE

Trainer Status Verification Procedure

☐ 1. Each procedure in this manual that requires the use of the Pneumatics Trainer includes the statement: "Verify the status or the trainer according to the procedure given in Exercise 1-2". This status verification procedure consists of the following steps:

- Install the work surface on a work table or on a support bench, if any.
- Make sure the work surface is secured to the work table or support bench to ensure that it will not move or fall down.
- If you use a support bench, make sure the four caster brakes are locked.
- On the Conditioning Unit, close the main shutoff valve by pushing down on the control button.
- Pull up the regulator adjusting knob to unlock the regulator and turn it completely counterclockwise.
- Close the four branch shutoff valves of the manifold (collar in the lower position). Figure 1-19 shows the Conditioning Unit with shutoff valves.

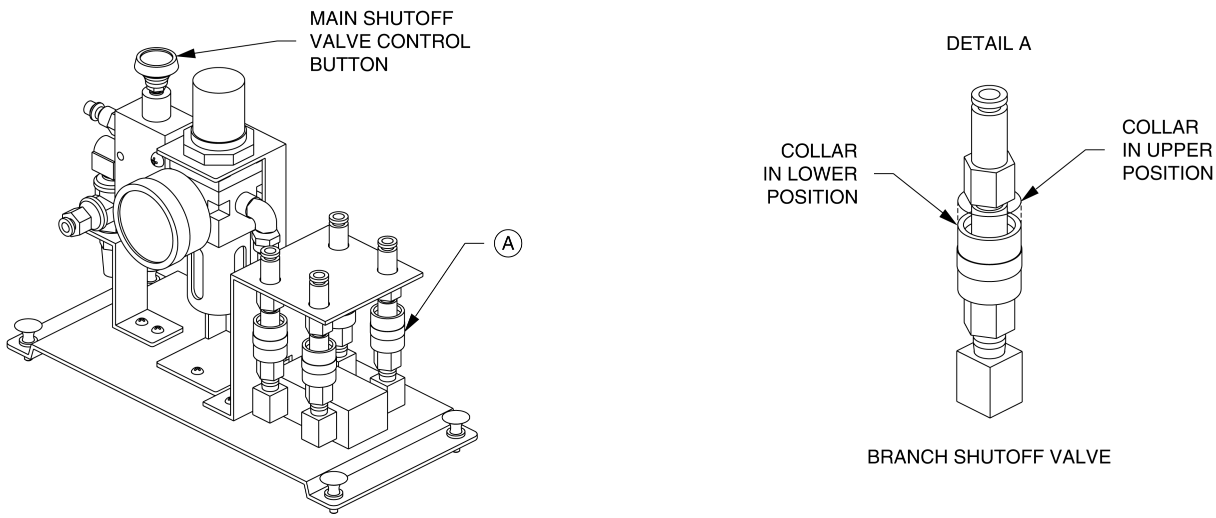

Figure 1-19. Conditioning Unit with Branch Shutoff Valves.

Fundamental Pneumatic Circuit

☐ 2. Locate the following components:

- Conditioning Unit;
- Directional control valve, 3-way, 2-position, pushbutton-operated;

> **Note:** *A directional control valve is a device used to open and close flow paths in a pneumatic circuit.*

- Cylinder, 2.7-cm (or 1 1/16-in) bore, 10-cm (or 4-in) stroke, single-acting, spring return.

> **Note:** *A cylinder is an actuator that converts fluid energy into mechanical energy. Single-acting cylinders generate force in a single direction.*

☐ 3. Mount the components on the work surface and connect the circuit shown in Figure 1-20. Refer to the connection diagram shown in Figure 1-21 to make your connections. Connect the Conditioning Unit to the NC (normally non-passing) port of the directional control valve.

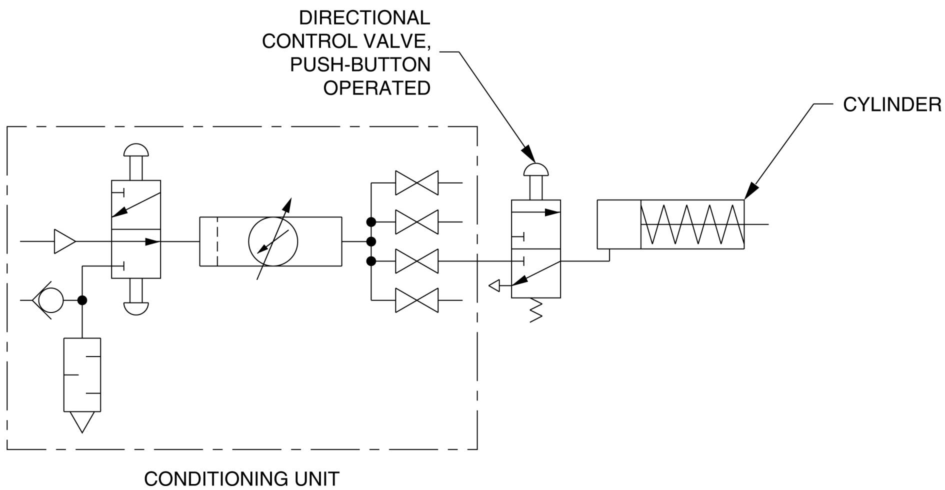

Figure 1-20. Schematic Diagram of a Pneumatic Circuit.

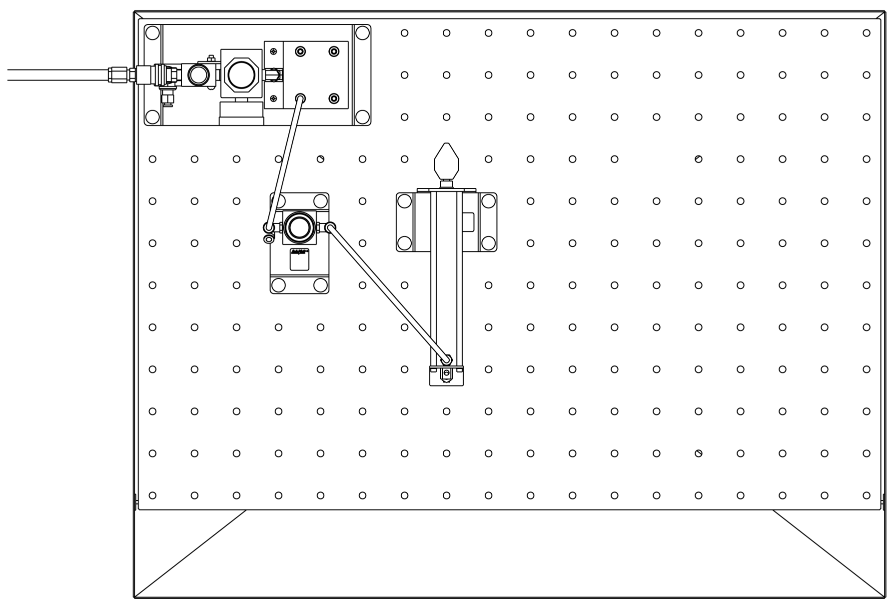

Figure 1-21. Connection Diagram of a Pneumatic Circuit.

☐ 4. On the Conditioning Unit, open the main shutoff valve and the branch shutoff valve at the manifold. Screw a tip (bullet) to the rod of the cylinder.

☐ 5. Pull up the regulator adjusting knob to unlock the regulator and turn it clockwise to set the pressure at 200 kPa (or 30 psi) on the regulated Pressure Gauge.

Note: *Each time you set the pressure, it is recommended to close and reopen the main shutoff valve to overcome friction. Readjust the pressure if necessary.*

☐ 6. Does the rod of the cylinder extend? Explain why.

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☐ 7. Push the button on the directional control valve and maintain the button pressed for approximately 5 s, and then, release the button. Does the rod of the cylinder extend when the button is pressed?

☐ Yes ☐ No

☐ 8. Explain what happens to the cylinder when the button is released?

____

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☐ 9. Does the cylinder convert fluid energy into linear mechanical motion?

☐ Yes ☐ No

☐ 10. Close the shutoff valves and turn the regulator adjusting knob completely counterclockwise. You should read 0 kPa (or 0 psi) on the regulated Pressure Gauge.

☐ 11. Disconnect and store all tubing and components.

CONCLUSION

In the first part of the exercise, you learned how to set up the trainer. You verified the trainer status verification procedure.

In the second part, you set up and operated a pneumatic circuit using a directional control valve and a cylinder. You observed that a directional control valve is used to open and close flow paths in a pneumatic circuit. You saw that a cylinder converts fluid energy into linear mechanical motion.

Introduction to Hydraulics

UNIT OBJECTIVE

When you have completed this unit, you will be able to identify the Hydraulics Trainer components and to safely operate the trainer. You will demonstrate your ability by constructing simple hydraulic circuits.

DISCUSSION OF FUNDAMENTALS

Introduction

The intensive use of hydraulics in today's industry comes from the many advantages provided by hydraulic systems. With hydraulic power, very little energy is required to control and transmit tremendous amounts of power. For example, 1.5-kW (2-hp) electric motors can be used to actuate hydraulic hoists lifting up to 4000 kg (8800 lb), as Figure 1-1 shows.

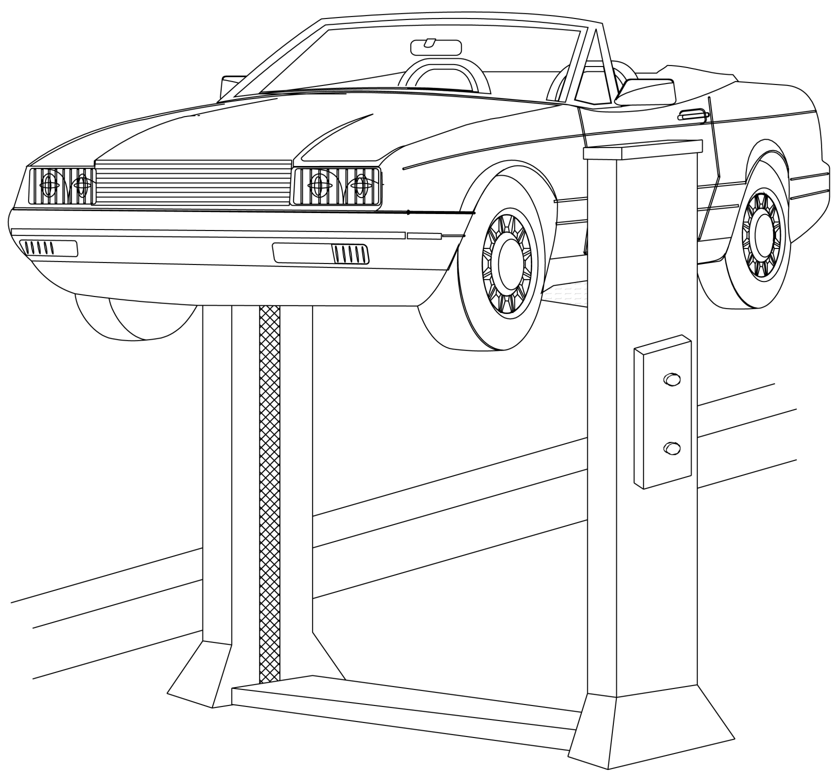


Figure 1-1. Hydraulic hoist.

Gigantic rockets that hurl satellites into orbit around the earth, and that carry men and women to the moon and other planets also depend on hydraulic power to control their flight. Only hydraulic power systems have the “muscle” and power to control with the delicacy of a feather touch, the millions of horsepower released by rocket engines and direct the payload to its destination.

Aviation is another industry that presently places a heavy demand on hydraulics. The hydraulic power used in aircraft travels anywhere a pipe or tube can be run. Aircraft hydraulic systems are lightweight and compact, yet powerful enough to move the control surfaces of the largest planes.

Another industry that relies heavily on hydraulics is robotics. The hydraulic systems of robots, like those used by automobile manufacturers, are simpler than comparable electrical systems. In general, the easy speed control, minimum vibration, and design versatility of hydraulics will keep hydraulic power with industry for a long time to come.

Hydraulics basic principles

Hydraulics is the technology or study of liquid pressure and flow. Liquids are materials which pour and conform to the shape of their containers. Example of liquids are oil and water.

Because liquids are not very compressible, they permit to transfer and multiply forces. Figure 1-2 illustrates this basic property of liquids. The force applied to the input piston produces a pressure on the liquid. The liquid then exerts the same amount of pressure equally in all directions. As a result, the pressure applied to the input piston transfers to the output piston.

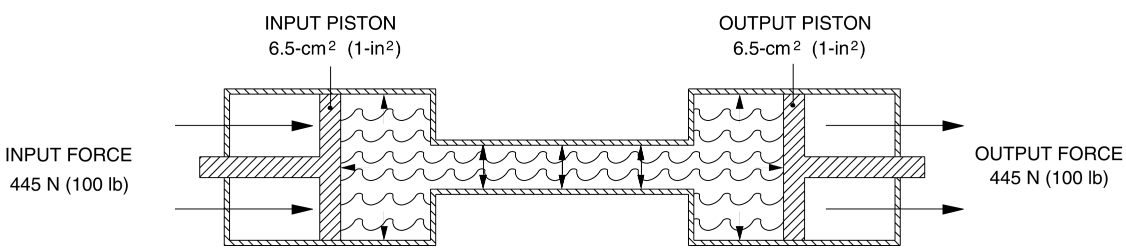


Figure 1-2. Direct transfer of force.

Now what happens if the pistons are of different sizes, as in Figure 1-3? The input piston is the same size as in the previous example (6.5 cm^2), but the output piston is now 26 cm^2. Since the liquid exerts the same amount of pressure equally in all directions, the force transferred to the output piston now equals 1780 N, which provides a mechanical advantage in force of 4:1.

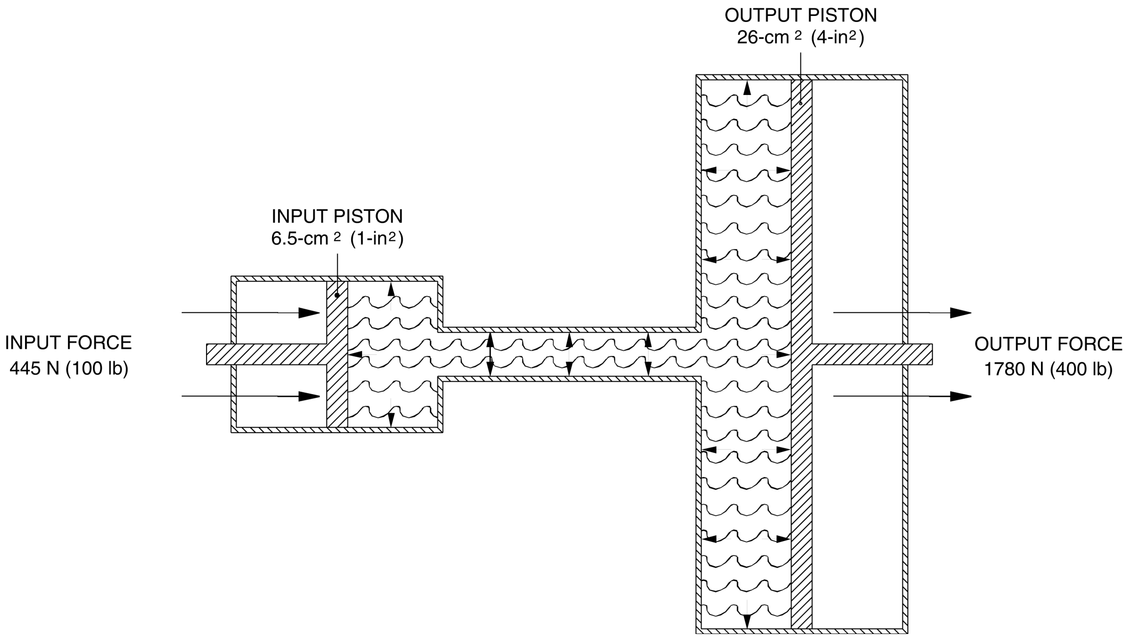


Figure 1-3. Multiplication of force.

Pressure is the amount of force exerted by a liquid on a unit of area. Pressure is measured in kilopascals (kPa) in the S.I. system, in bars (bar) in the metric system, and in pounds per square inch (psi) in the English system. 1 kPa is equal to 0.01 bar or 0.145 psi. 1 psi is equal to 6.895 kPa or 0.069 bar. The pressure of a liquid can be measured by using a pressure gauge, or manometer.

Operation of a basic hydraulic circuit

A hydraulic circuit is a path for oil to flow through hoses and components. Figure 1-4 shows a basic hydraulic circuit.

– The **reservoir** holds the oil.

– The **pump** “pushes” the oil, attempting to make it flow through the circuit.

– The **directional control valve** allows the operator to manually control the oil flow to the cylinder.

– The **cylinder** converts fluid energy into linear mechanical power.

– The **relief valve** limits system pressure to a safe level by allowing oil to flow directly from the pump back to the reservoir when the pressure at the pump output reaches a certain level.

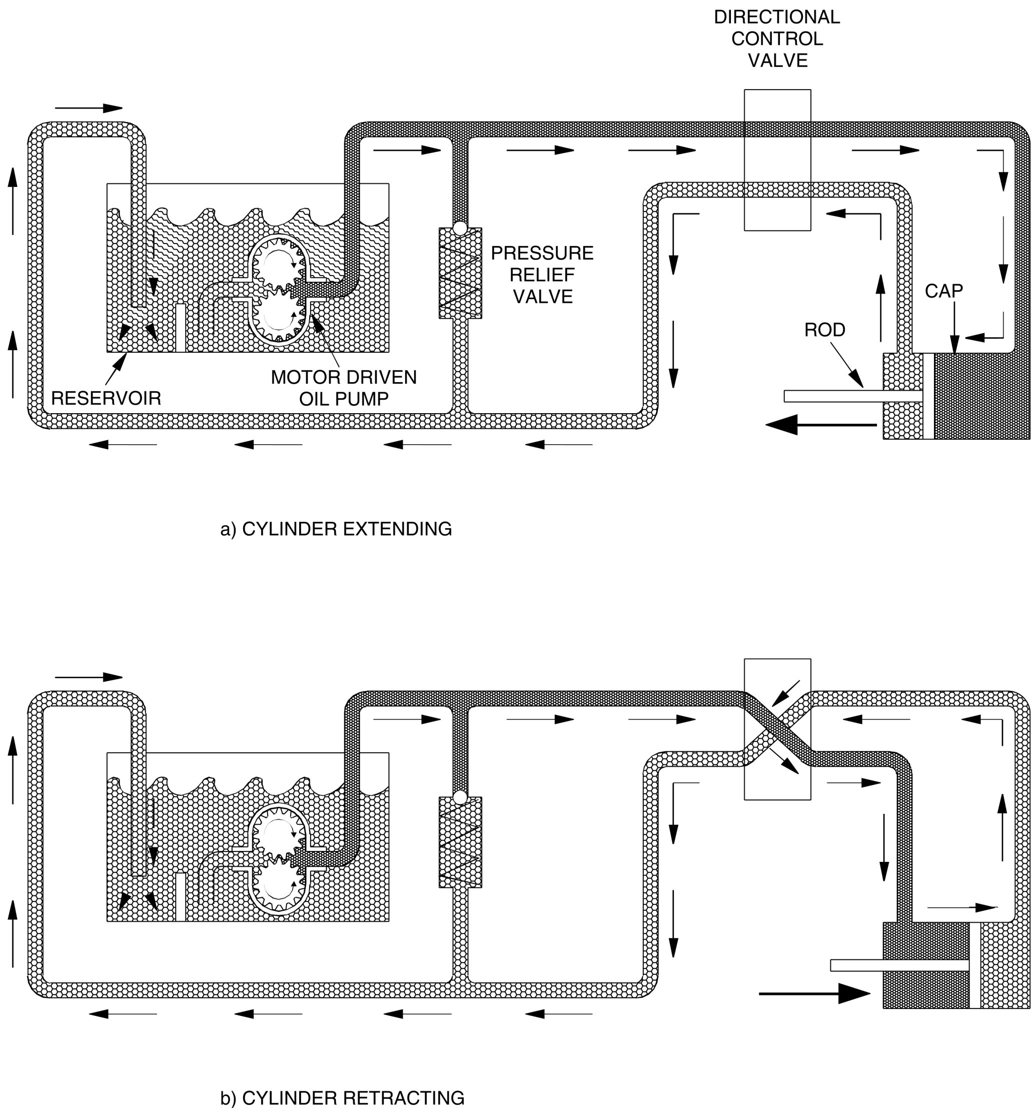


Figure 1-4. Basic hydraulic circuit.

With the directional control valve in the condition shown in Figure 1-4 (a), the pumped oil flows to the cap end of the cylinder. Since the oil is under pressure from the pump, it pushes the piston inside the cylinder, causing the piston rod to extend. The oil on the rod end of the cylinder is drained back to the reservoir through the directional control valve.

With the directional control valve in the condition shown in Figure 1-4 (b), the pumped oil flows to the rod end of the cylinder, causing the piston rod to retract. The oil on the cap end of the cylinder is drained back to the reservoir through the directional control valve.

Exercise 1-1

Familiarization with the Lab-Volt Hydraulics Trainer

EXERCISE OBJECTIVE

- To become familiar with the Lab-Volt Hydraulics Trainer;
- To identify the various system components;
- To be aware of the safety rules to follow when using the Lab-Volt Hydraulics Trainer.

DISCUSSION

The Lab-Volt Hydraulics Trainer

The Lab-Volt Hydraulics Trainer consists of a work surface, hydraulic components and instruments, hoses, and a power unit.

Work surface

The work surface consists of a main perforated panel hinged to an oil catching tray on which hydraulic components can be mounted either horizontally or vertically. The main panel can be tilted to facilitate the mounting of the components. Two additional perforated panels, respectively covering a third and two thirds of the main panel surface, can be mounted on the main panel to increase the work surface area. Any number of work surfaces can be positioned side by side and components be bridge-mounted across adjacent work surfaces.

Hydraulic components

Each hydraulic component is attached to a base plate that allows the component to be secured to the work surface using either **push-lock fasteners** or the **Quick-Lock System**. Each component has its **symbol** and part number indicated on a sticker affixed on the component body or on the component base plate.

Figure 1-5a shows how a component can be secured to the work surface when **push-lock fasteners** are used. The component base plate has four identical push-lock fasteners. To secure a component to the work surface, align the four push-lock fasteners with the work surface perforations, then firmly push on the fasteners.

Familiarization with the Lab-Volt Hydraulics Trainer

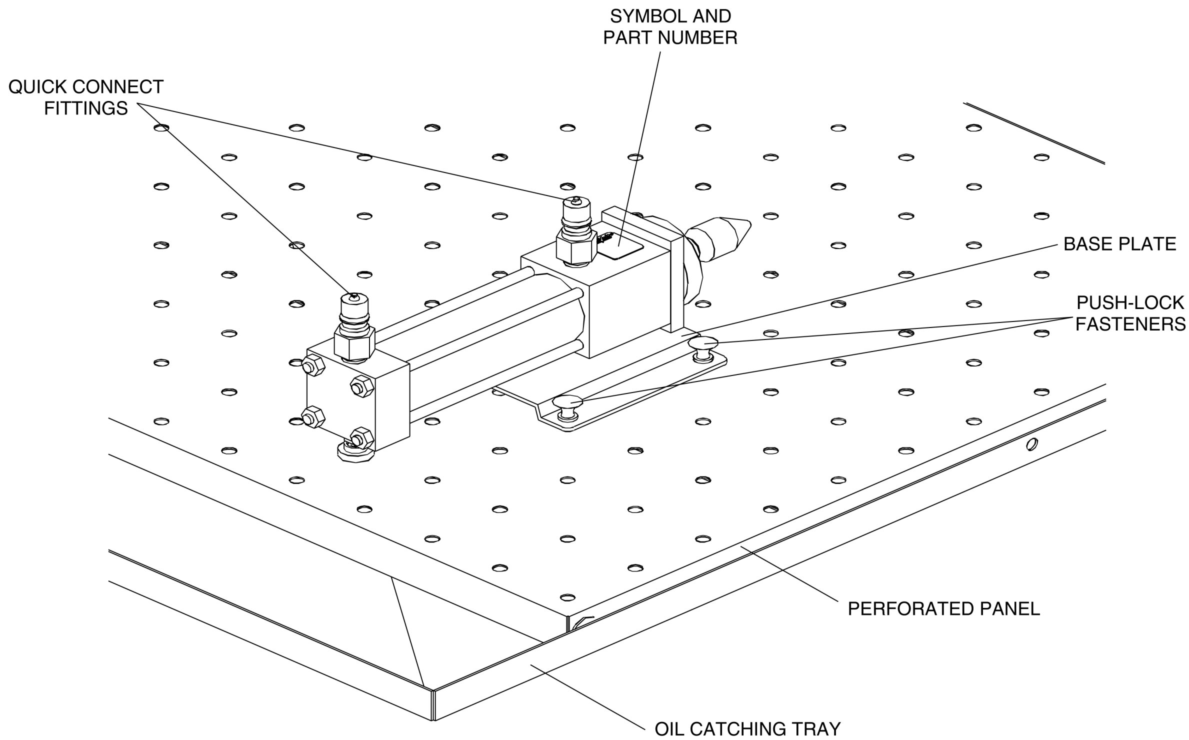


Figure 1-5a. Securing a component to the work surface with push-lock fasteners.

Figure 1-5b shows how a component can be secured to the work surface when the **Quick-Lock System** is used. With this system, each component base plate has four fasteners: three fixed (black) fasteners and one twist-lock fastener (fastener with a yellow knob and a red tab).

(1) First, ensure that the yellow rotating knob of the twist-lock fastener is turned fully, so that the red tab (pointed by the arrow) of this fastener is fully visible.

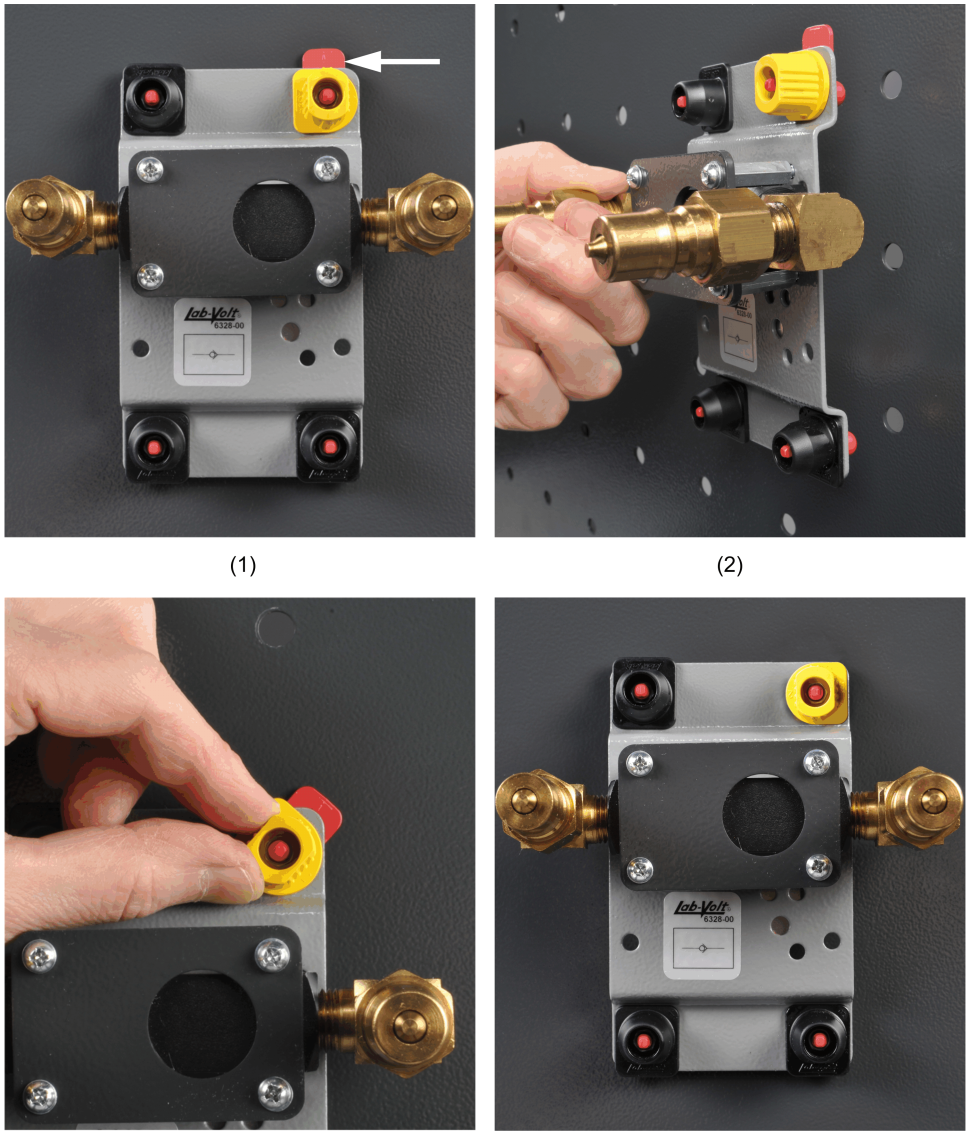
On some components, the yellow knob must be turned fully counterclockwise, while on other components, the yellow knob must be turned fully clockwise.

(2) Align the red pins of the four fasteners with the work surface perforations, then press the component base plate gently into the work surface.

(3) Lock the component into place by turning the yellow knob fully in the required direction, depending on the component.

> **Note:** *To secure components to the work surface, the yellow knob must be turned fully clockwise on some components, or fully counterclockwise on other components.*

(4) Ensure that the red tab of the twist-lock fastener **is not visible**, which indicates that the component is safely locked into place.



(1) (2) (3) (4)

Figure 1-5b. Securing a component to the work surface with the Quick-Lock System.

To remove the component from the work surface, unlock the component by turning the yellow knob fully in the required direction so that the red tab of the twist-lock fastener becomes fully visible, then withdraw the component.

> **Note:** *Throughout this manual, the components are shown with quick-lock fasteners.*

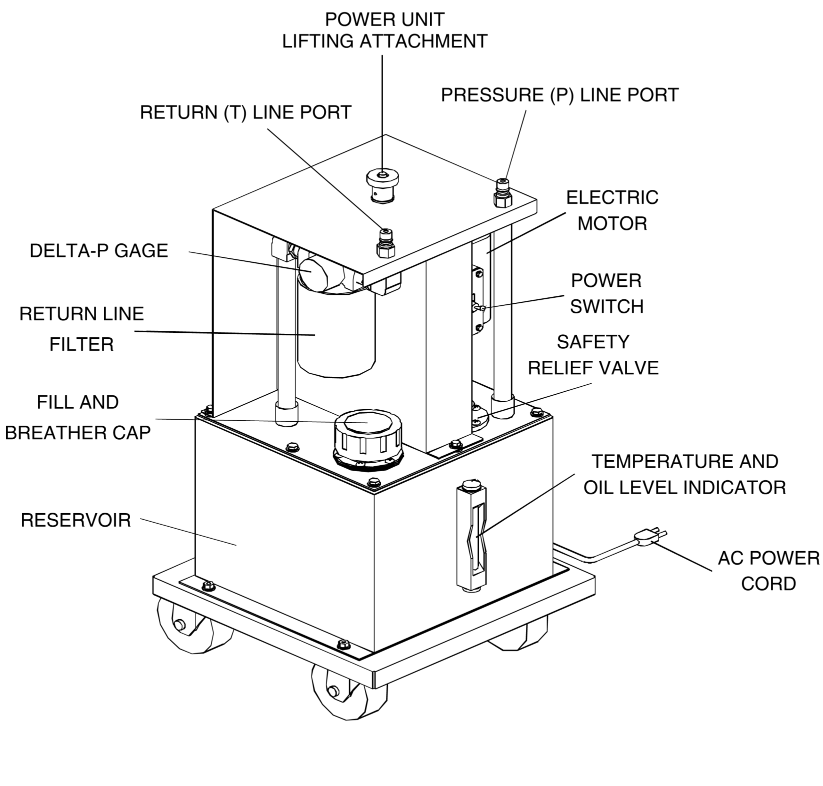
Hoses

The trainer components and hoses use quick connect fittings. This type of fitting allows you to easily and quickly connect and disconnect circuits. Quick connect fittings have **check valve** on their end to prevent oil from running out of the hose or component when the hoses are disconnected. Note, however, that these fittings should only be connected and disconnected when they are not under pressure.

A hose rack is provided to store the trainer hoses. The rack has a slotted top for hanging hoses, and a drip pan bottom to catch oil from the hose connectors.

Power Unit

The Power Unit supplies oil under pressure to the system. It mainly consists of an oil reservoir, a hydraulic pump, a pressure relief valve, and a filter. Figure 1-6 shows the Power Unit, as well as its symbol.



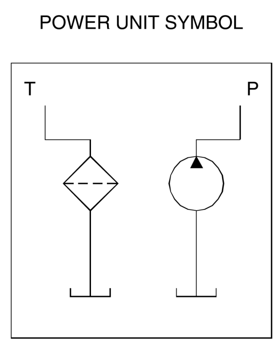


Figure 1-6. Power Unit.

The **return line filter**, connected between the return line port and the reservoir (see Figure 1-6), keeps dirt and indissoluble contaminants from entering the reservoir. This filter is equipped with a Delta-P gauge measuring the drop in pressure through the filter. When the pressure drop is too high, the filter must be replaced. The gauge has a safety valve which will allow the oil to flow unfiltered into the reservoir if the filter becomes clogged.

Familiarization with the Lab-Volt Hydraulics Trainer

Figure 1-7 shows an inside view of the Power Unit. The reservoir holds the oil. The hydraulic pump is connected directly to the electric motor shaft. It converts mechanical power from the motor into fluid power to supply oil under pressure to the circuit. A pressure relief valve limits system pressure and working forces to a safe level by allowing oil to flow directly from the pump output back to the reservoir when the pressure at the valve reaches a certain level. This level has been factory set to 6200 kPa (900 psi) @ 22°C (72°F). The maximum circuit pressure you will use throughout this manual is about 4100 kPa (600 psi).

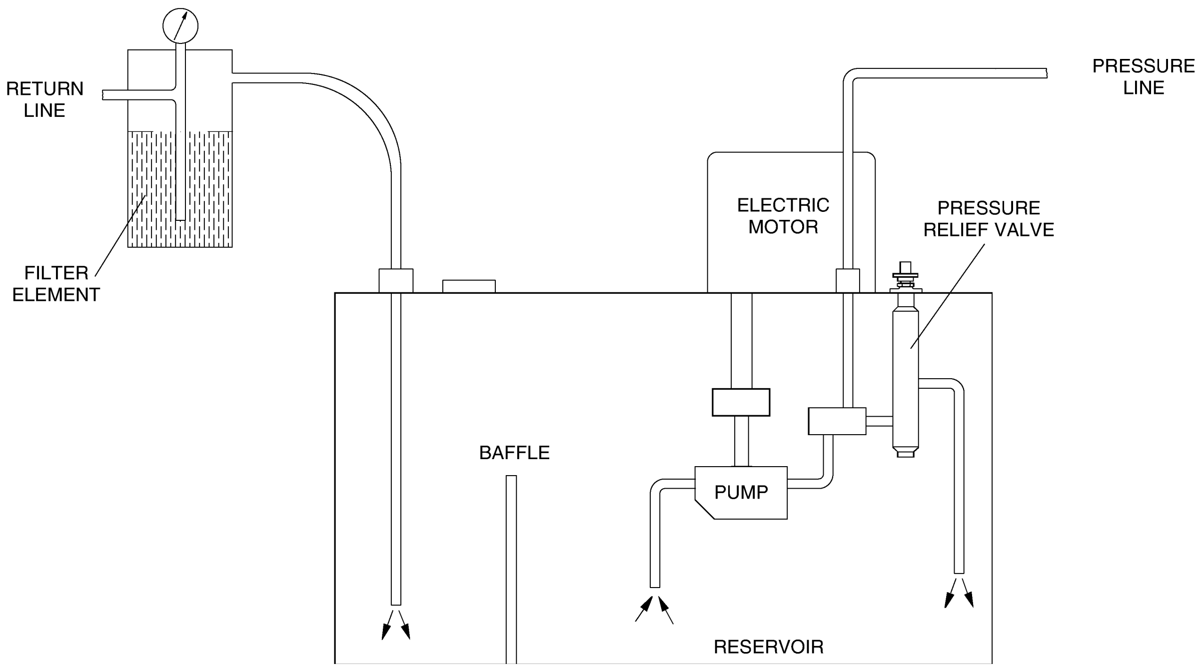


Figure 1-7. Inside view of the Power Unit.

Safety rules

The Lab-Volt Hydraulics Trainer has been designed with safety as a primary concern. However, the instructor and student must be aware of certain potential hazards that exist when using the Hydraulics Trainer.

a. The Power Unit must be connected to an appropriate ac outlet with safety ground. The ground connection must never be removed from the end of the Power Unit line cord. If the cord does not fit your receptacle, call an electrician. The electric cord should be inspected periodically to ensure that the insulation has not deteriorated.

b. The pressure relief valve on the Power Unit should NEVER be tampered with or readjusted.

c. Hoses, components, and other devices that are not part of the trainer should not be used with the trainer because they may burst and injure the operator.

d. Avoid stretching or twisting the hoses. Also, avoid sharp bends which could pinch or weaken the hose.

e. Leaks on hydraulic equipment should never be tightened while there is pressure in the system. Stop the Power Unit and release the pressure, then repair the leak.

f. Should a component or a system develop a leak that sprays or shoot a stream of fluid, do not try to cover the leak. Immediately turn off the Power Unit. The reason for this is that high pressure oil can be forced through your skin and cause serious problems. Numerous fluid power personnel have been injected with fluid. An awareness of this industrial hazard will help you protect yourself and the others from injury. Should you be injected with any fluid, get immediate medical attention.

g. Use caution whenever any part of the trainer is under pressure. It is easy to forget that immobile components may be pressurized to as much as 4100 kPa (600 psi) or more. Make sure that the Power Unit is off whenever connecting or disconnecting hoses.

h. Hydraulic cylinders produce tremendous forces. Never place the cylinders in a position where they may become wedged or confined between rigid parts of the trainer. Damage to the operator and the unit could result.

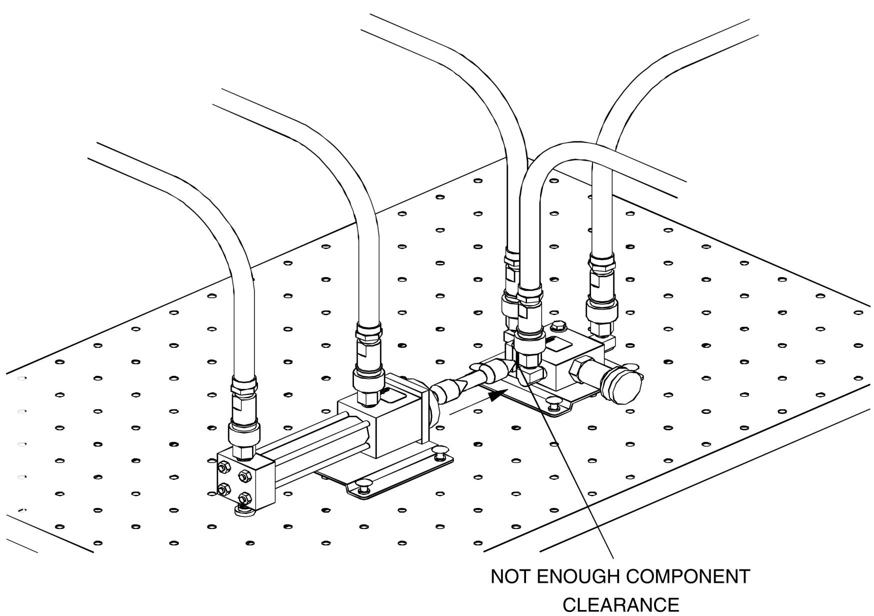


Figure 1-8. Component safety.

i. Cylinders may pinch fingers. Do not get your hands close to cylinders when operating the unit.

j. When using the flywheel with the hydraulic motor, be sure it is free of sharp edges or burrs. Do not allow the flywheel to turn in your hand. Always wear leather gloves when holding the flywheel. Be sure the flywheel is tight on the shaft.

k. Oil spilled on the trainer or on the floor should be cleaned immediately. Use rags or towels. Granular floor-dry should be avoided in the hydraulic laboratory because it powders and gets into the hydraulic equipment.

l. Always wear facility approved safety glasses whenever the Hydraulics Trainer is being used.

m. Before disassembling your circuits, move the lever of the directional control valve through all positions. This will release the pressure in the components and make hose coupling and uncoupling easier.

n. Keep the trainer and its components clean and in good working order. Clean plastic components with mild soap and water. Harsh cleanser can cause crazing. Inspect components and other equipment for damage. Any damaged equipment should not be used until further inspection indicates they are safe for operation.

Following the above safety rules allows you to use the Hydraulics Trainer without injury.

Procedure summary

In the first part of the exercise, you will identify the various components of your Hydraulics Trainer.

In the second part of the exercise, you will configure your work surface.

In the third part of the exercise, you will measure the pressure setting of the relief valve in your Power Unit.

In the fourth part of the exercise, you will verify the condition of the return line filter on your Power Unit.

EQUIPMENT REQUIRED

Refer to the Equipment Utilization Chart, in Appendix A of this manual, to obtain the list of equipment required to perform this exercise.

PROCEDURE

Identifying the trainer components

☐ 1. Inspect your hydraulic Power Unit. To do so, identify the various components of the unit by writing the appropriate names in the blank spaces of Figure 1-9. Then, physically locate each component on your Power Unit.

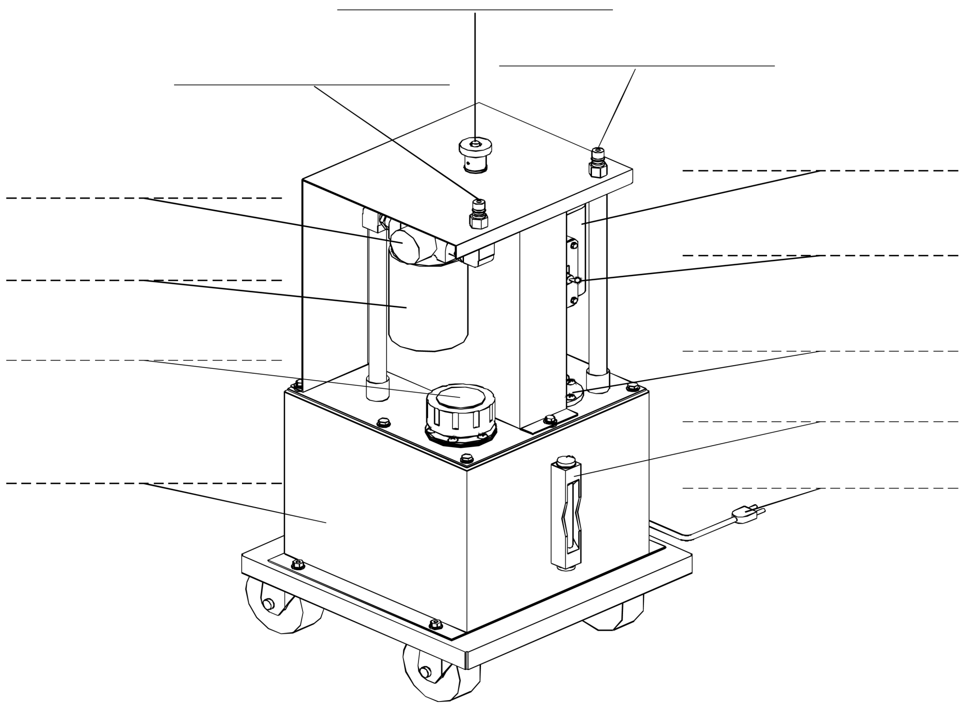


Figure 1-9. Identifying the Power Unit components.

☐ 2. The components illustrated in Figure 1-10 are supplied with your Hydraulics Trainer. Get these components from their storage location, then look at the symbol drawn on the sticker affixed on each component. Draw the symbol of each component in Figure 1-10.

☐ 3. Examine the Pressure Gauges. These instruments convert pressure into rotary motion which translates to a dial reading. Each Pressure Gauge is equipped with three quick connect fittings. These fittings are interconnected, so that the hoses connected to a gauge are also connected together.

The Pressure Gauges are calibrated in metric units of bars (bar) and in english units of pounds per square inch (psi). They measure pressures between 0 and 69 bar (0 and 6900 kPa) or 0 and 1000 psi. Based on the Pressure Gauge dials, how many bar is 300 psi?

____

☐ 4. How many psi is 3500 kPa?

Note: *1 bar equals 100 kPa.*

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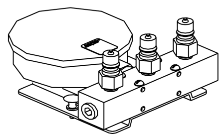
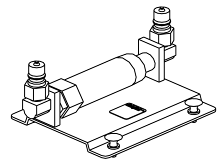


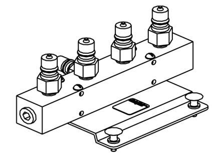
P/N:6350
PRESSURE GAUGE (2)

SYMBOL: ____________________



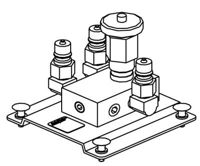
P/N:6351
FLOWMETER

SYMBOL: ____________________



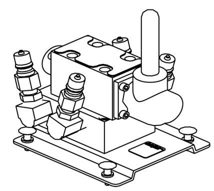
P/N:6390
MANIFOLD, 5 PORTS, FIXED (2)

SYMBOL: ____________________



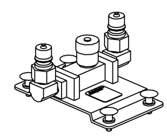
P/N:6322
RELIEF VALVE

SYMBOL: ____________________



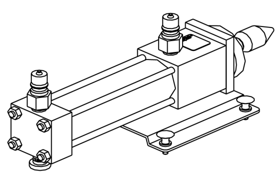
P/N:6320
DIRECTIONAL VALVE,
LEVER OPERATED

SYMBOL: ____________________



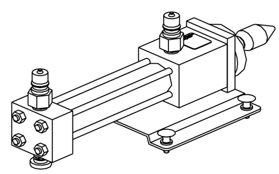
P/N:6321
FLOW CONTROL VALVE,
NON COMPENSATED

SYMBOL: ____________________



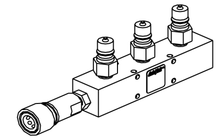
P/N:6341
DOUBLE-ACTING CYLINDER,
3.8-cm BORE

SYMBOL: ____________________



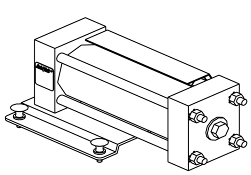
P/N:6340
DOUBLE-ACTING CYLINDER,
2.5-cm BORE

SYMBOL: ____________________



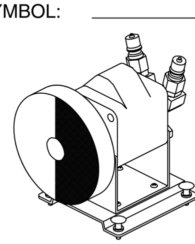
P/N:6391
MANIFOLD, 4 PORTS, MOBILE (2)

SYMBOL: ____________________



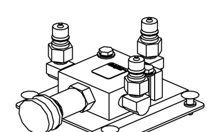
P/N:6380
LOADING DEVICE, SPRING TYPE

SYMBOL: ____________________



P/N:6342
BIDIRECTIONAL MOTOR
AND FLYWHEEL

SYMBOL: ____________________



P/N:6323
PRESSURE REDUCING VALVE

SYMBOL: ____________________

Figure 1-10. Identifying the Hydraulics Trainer components.

☐ 5. Examine the two 5-ports Manifolds. These devices are identical. Each manifold has five quick connect fittings. These fittings are interconnected, so that the hoses connected to a manifold are also connected together.

One of the two 5-ports Manifolds is used as a supply manifold. It receives the oil under pressure directly from the Power Unit and supplies it to the circuit. The other 5-ports Manifolds is used as a return manifold. It receives the oil from the circuit and returns it to the Power Unit reservoir through the filter.

To which port on the Power Unit must the supply manifold be connected?

____

To which port on the Power Unit must the return manifold be connected?

____

☐ 6. Examine the various valves of your trainer. Valves are used in hydraulics to control pressure and flow. Some valves have two ports. Other valves have more. List the number of ports on each trainer valve in Table 1-1.

TYPE OF VALVE	NUMBER OF PORTS
Flow Control Valve	
Directional Control Valve	
Relief Valve	
Pressure Reducing Valve	

Table 1-1. Identifying the trainer valves.

☐ 7. Examine the cylinders of your trainer. Cylinders are actuators that convert fluid energy into linear mechanical power. The cylinders of your trainer are of double-acting type because they work in both the extension and retraction stroke of their piston rod. List the number of ports on each cylinder in Table 1-2.

TYPE OF CYLINDER	NUMBER OF PORTS
Double-acting, 2.54-cm (1-in) bore x 1.59-cm (0.625-in) rod x 10.16-cm (4-in) stroke cylinder	
Double-acting, 3.81-cm (1.5-in) bore x 1.59-cm (0.625-in) rod x 10.16-cm (4-in) stroke cylinder	

Table 1-2. Identifying the trainer cylinders.

Configuring the work surface

☐ 8. Install your work surface on a work table or on a support bench, if any. Make sure the work surface is secured to the work table or support bench to ensure that it will not move or fall down. If you use a support bench, make sure the four caster brakes are locked.

☐ 9. Figure 1-11 shows different ways of configuring your work surface. The main panel can be tilted to facilitate component mounting. Additional panels can be mounted on the main panel to increase the work surface area. They both can be tilted and used as control panels by mounting your hydraulic instruments (Pressure Gauges and Flowmeter) on them.

Configure your work surface according to your preferences:

– To help you lift and tilt the panels, lift handles have been supplied with your trainer kit. To fasten a lift handle to a panel, align the fasteners of the handle base plate with the panel perforations, then lock the handle into place with the fasteners, as shown in Figure 1-12.

– To tilt a panel, slowly lift it until the desired inclination is obtained, then hold the panel in place using the two legs on the back of the panel. Fasteners on the legs and perforations on each side of the panel allow you to tighten down the legs, as shown in Figure 1-13. Tighten these down.

CAUTION!

When using tilted surfaces, always check their legs to make sure they are secure before turning on the Power Unit. Failure to this important step may result in panels or components coming loose from the trainer. The result can be personal injury or equipment damage.

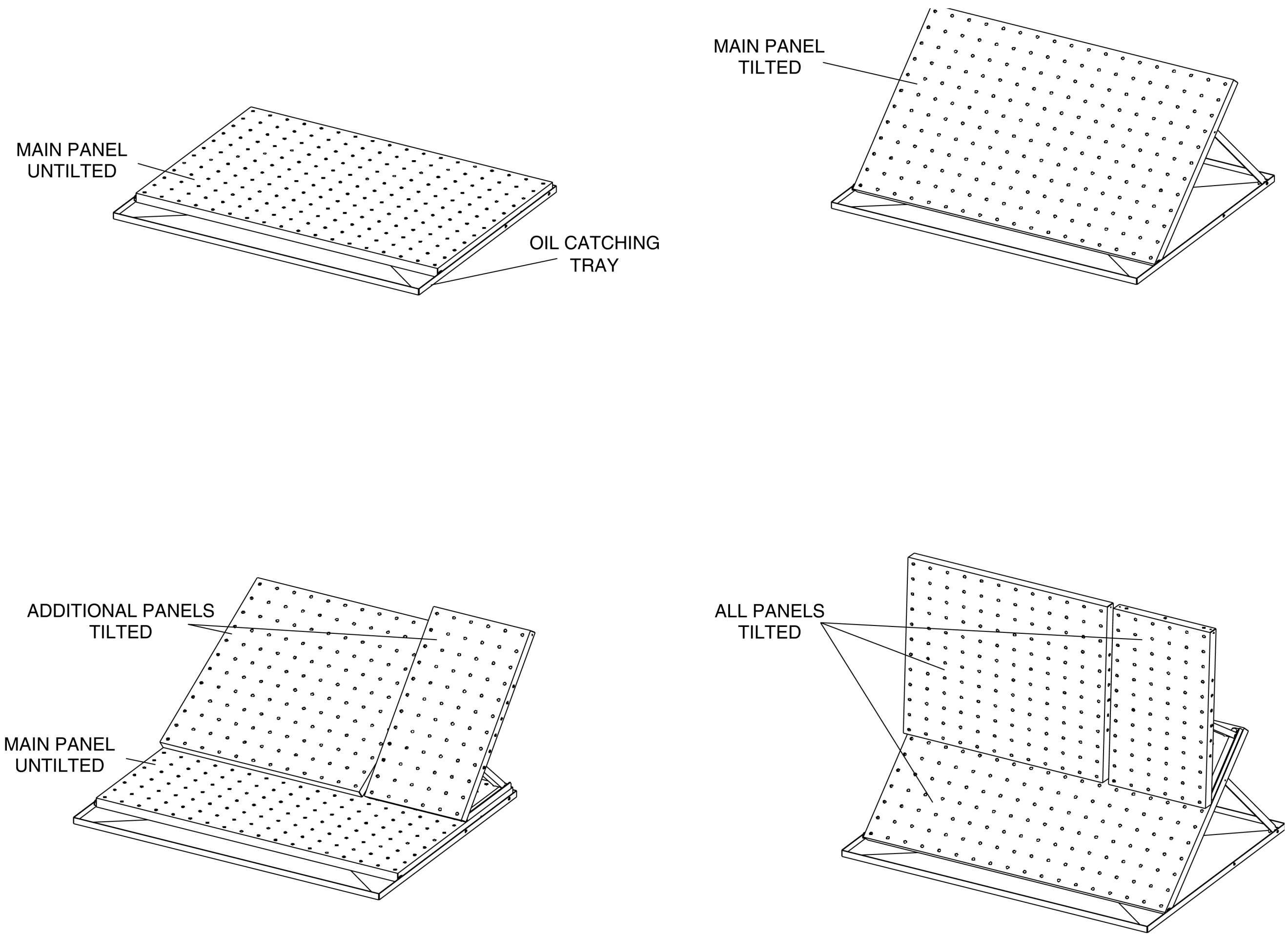


Figure 1-11. Various work surface configurations.

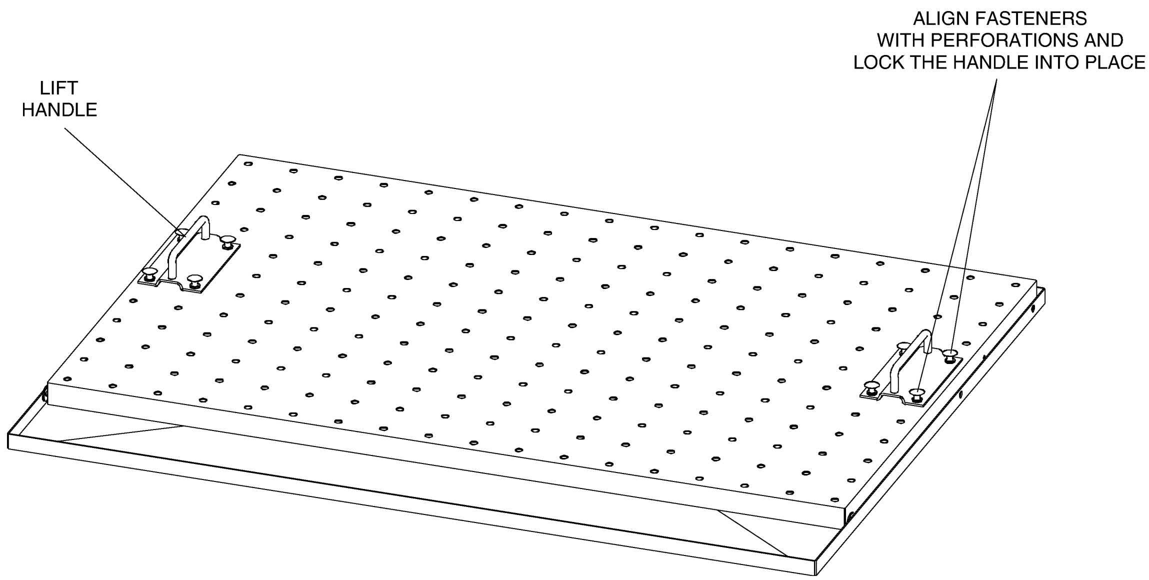


Figure 1-12. Fastening lift handles to a panel.

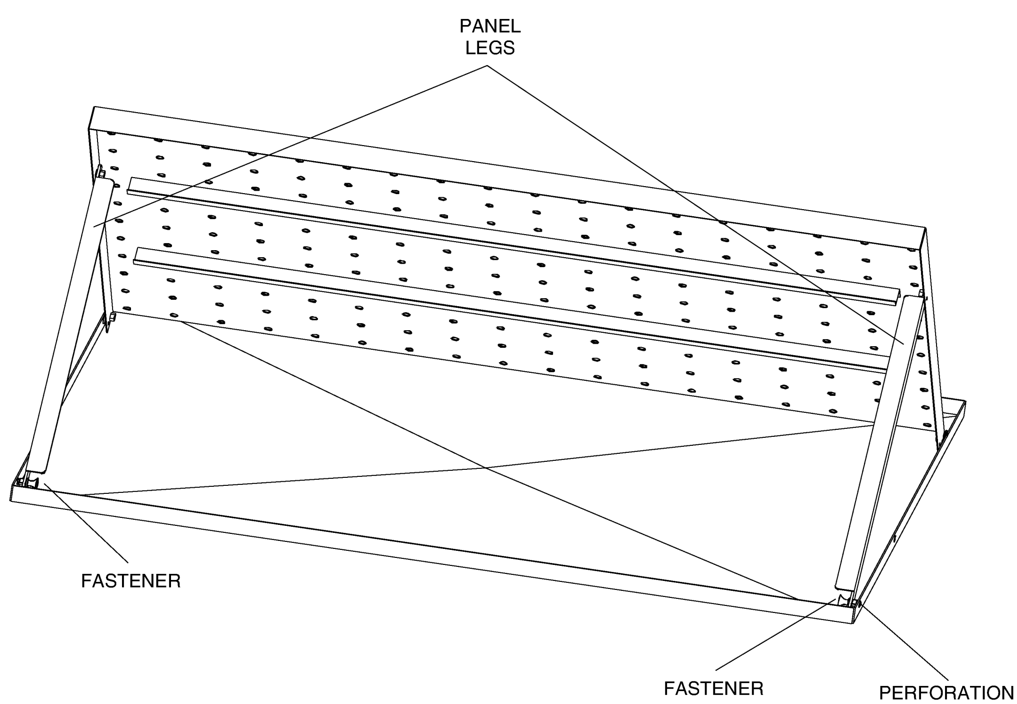


Figure 1-13. Tightening the panel legs.

Measuring the pressure setting of the Power Unit relief valve

☐ 10. Set up the basic circuit shown in Figure 1-14. To do so, perform the following steps:

a. Mount the supply manifold (5-ports Manifold) and the Pressure Gauge on the work surface. Secure these components to the work surface: align the fasteners on the component base plate with the perforations of the work surface, then lock the components into place with the fasteners.

> **Note:** *Do not mount the supply manifold too near of the edge of the work surface. This will prevent oil from dripping onto the floor when you disconnect hoses from the supply manifold.*

b. Connect a hose between the pressure line port of the Power Unit and the input port of the supply manifold, as Figure 1-14 shows. Connect a second hose between one of the four remaining ports on the supply manifold and one of the three ports on the Pressure Gauge.

To connect a hose, pull the knurled collar back over the hose end (see Figure 1-15), push the hose onto the fitting until it seats firmly, then release the collar. To make sure a hose is firmly connected, pull on the hose. If it holds, it is correctly connected. Avoid stretching or twisting the hoses. Also, avoid sharp bends which could pinch or weaken the hose.

To disconnect a hose, push the hose toward the fitting while pulling the knurled collar back over the hose, then pull the hose off the fitting.

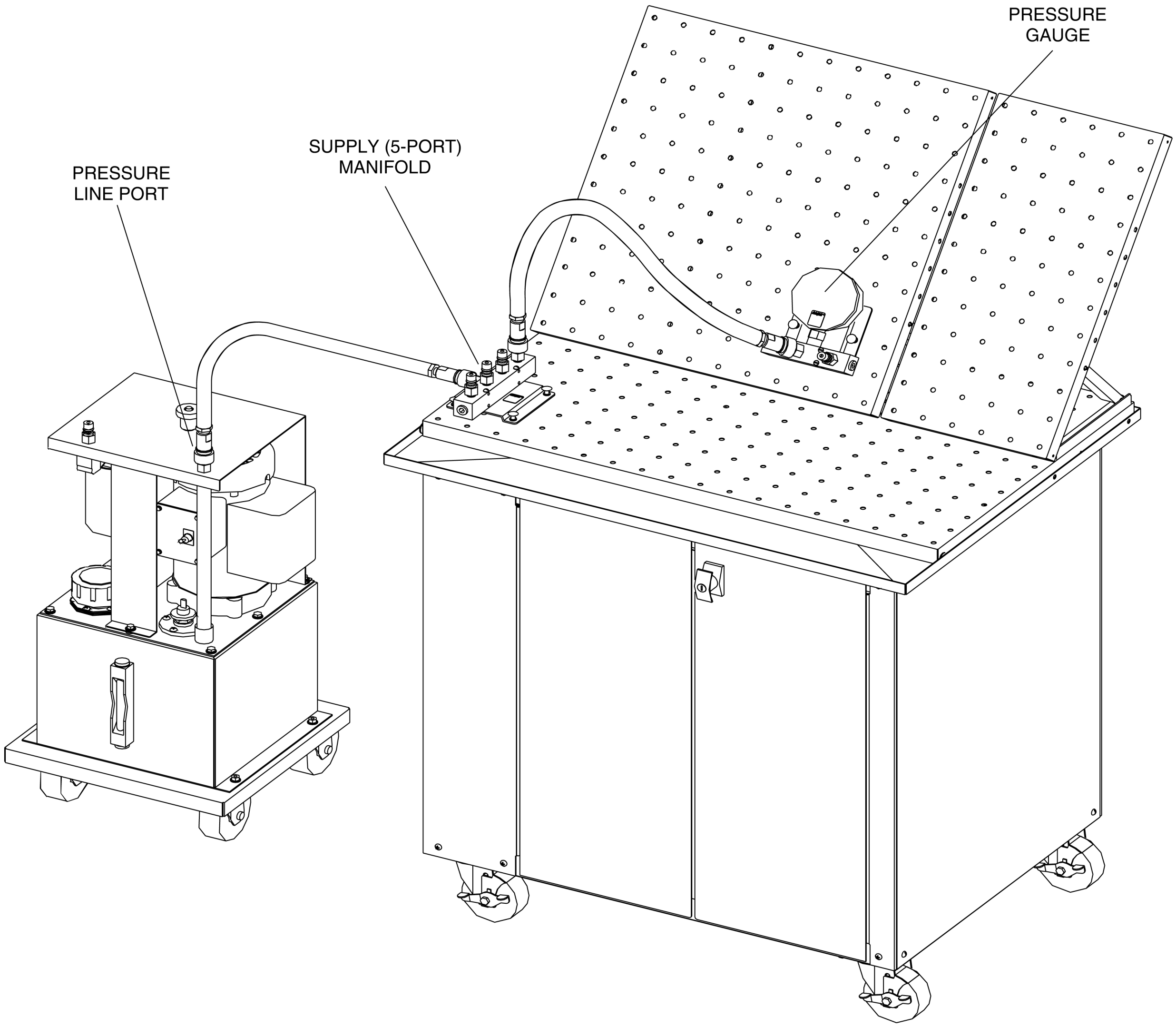


Figure 1-14. Basic circuit to mount.

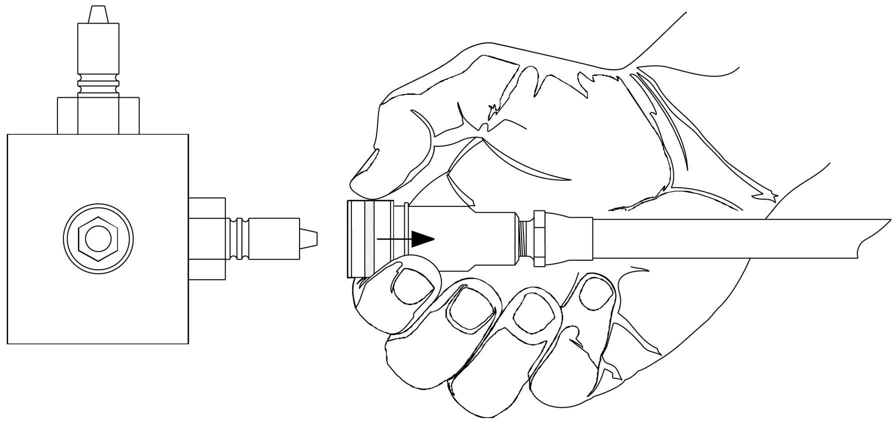


Figure 1-15. Connecting and disconnecting a hose.

☐ 11. Before starting the Power Unit, perform the following start-up procedure:

a. Make sure your hoses are firmly connected.
b. Check the level of the oil in the reservoir as indicated by the temperature/oil level indicator on the Power Unit. The red line indicates the low oil level and the black line indicates the full oil level. With the Power Unit off, oil should cover, but not be over, the black line above the indicator, as Figure 1-16 shows.

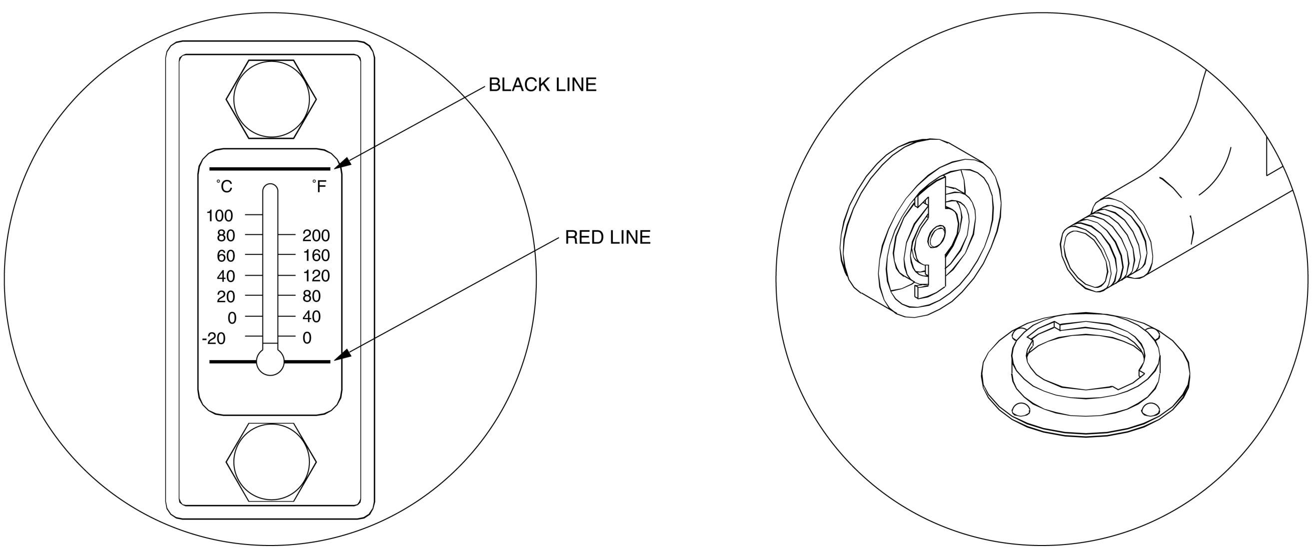


Figure 1-16. Oil should cover but not be over the black line.

Fresh oil must be added to the reservoir periodically because disconnecting quick-connect fittings spills some oil. If required, add oil by unscrewing the reservoir breather/filler cap and by filling the reservoir up to the black line. Use one of the fluids listed on the information sticker on the front of the reservoir. Spilled or drained oil should NOT be re-used. If re-use is imperative, the oil must be carefully strained or filtered as it is returned to the reservoir.

c. Put on safety glasses.
d. Make sure the power switch on the Power Unit is set to the OFF position.
e. Plug the Power Unit line cord into an appropriate ac outlet.

☐ 12. Turn on the Power Unit by setting its power switch to ON. Since the oil flow is blocked at the Pressure Gauge because there is no return path to the reservoir, all the pumped oil is now flowing through the pressure relief valve inside the Power Unit.

The Pressure Gauge reading corresponds to the pressure setting of the pressure relief valve and to the pressure at the pressure line port of the Power Unit. Record the Pressure Gauge reading below.

Gauge pressure: ______ kPa or ______ psi

Note: *If you are working with S.I. units, multiply the measured pressure in bar by 100 to obtain the equivalent pressure in kPa.*

☐ 13. Turn off the Power Unit.

Verifying the condition of the return line filter

☐ 14. Disconnect the end of the hose connected to the input port of the supply manifold, then connect it to the return line port of the Power Unit, as Figure 1-17 shows. This circuit allows all the pumped oil to return directly to the reservoir through the Power Unit return line filter.

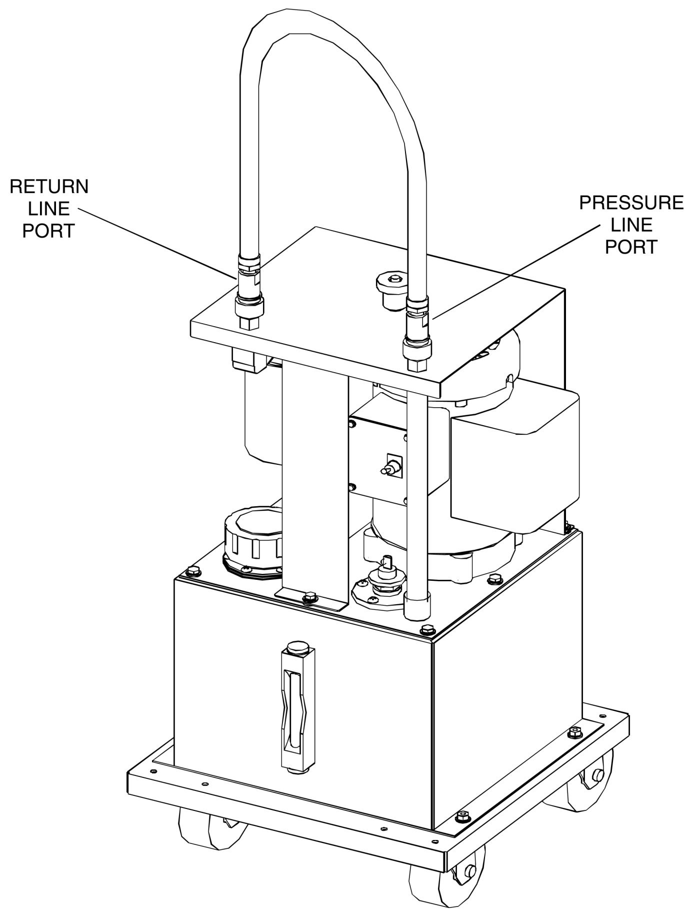


Figure 1-17. Modified circuit.

☐ 15. Turn on the Power Unit.

☐ 16. Evaluate and record the reading of the Delta-P gauge on the return line filter. This is the drop in pressure across the return line filter, in psi.

Delta-P gauge pressure: ______ kPa or ______ psi

If the pressure drop is greater than 70 kPa (10 psi), the filter needs to be replaced. Does the filter need to be replaced?

☐ Yes ☐ No

☐ 17. Turn off the Power Unit. If the filter needs to be replaced, get instructor's attention. Appendix B of this manual indicates how to replace the filter.

☐ 18. Disconnect all hoses and return them to the hose rack. The loose ends of the hoses must be kept inside the drip pan to prevent oil from dripping on the floor. Wipe off any hydraulic oil residue.

☐ 19. Remove all components from the work surface and wipe off any hydraulic oil residue. Return all components to their storage location.

☐ 20. Clean up any hydraulic oil from the floor and the trainer. Properly dispose of any paper towels and rags used to clean up oil.

CONCLUSION

In this exercise, you identified the various trainer components. You connected a basic circuit restricting the system pressure through the pressure relief valve to measure the valve pressure setting. Next, you connected the pressure line port to the return line port on the Power Unit and verified that the pressure drop across the return line filter was lower than 70 kPa (10 psi).

REVIEW QUESTIONS

1. Which port on the Power Unit provides oil under pressure to the circuit?

____

2. How many ports are there on the input manifold?

____

3. What is the purpose of the return manifold?

____

4. What does the Delta-P gauge on the return line filter measure?

____

____

5. Why is it necessary to have a pressure relief valve in a hydraulic circuit?

____

6. In the circuit shown in Figure 1-18, what should be the pressure gauge reading? Explain.

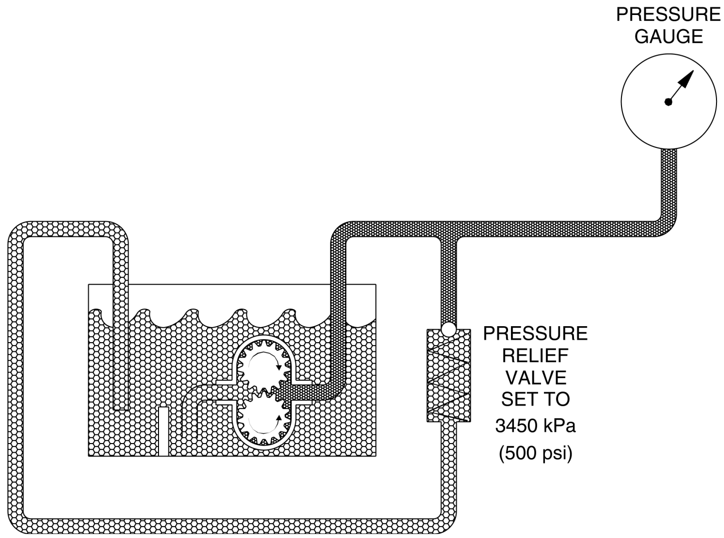


Figure 1-18. Circuit for review question 6.

7. Study the graphic diagram shown below and identify each of the lettered symbols.

A.	______________	E.	______________
B.	______________	F.	______________
C.	______________	G.	______________
D.	______________	H.	______________

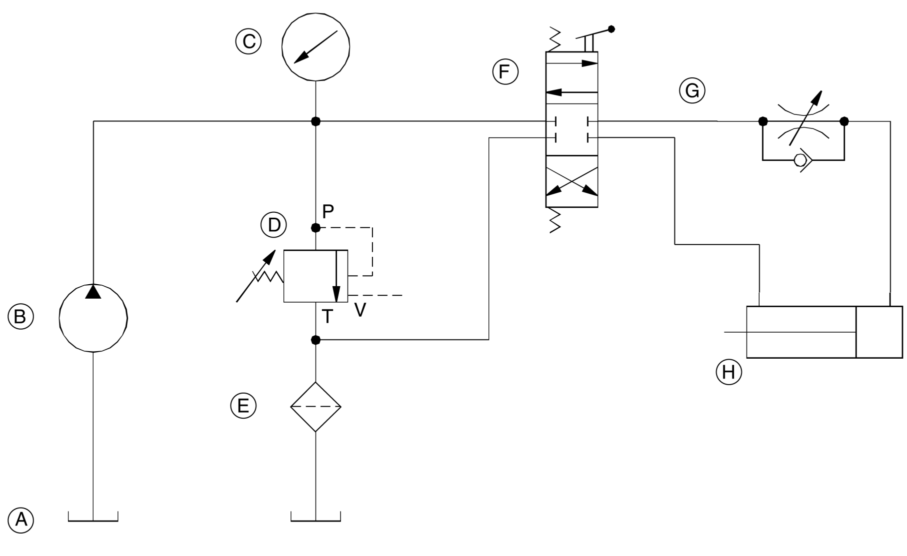


Figure 1-19. Symbol identification.