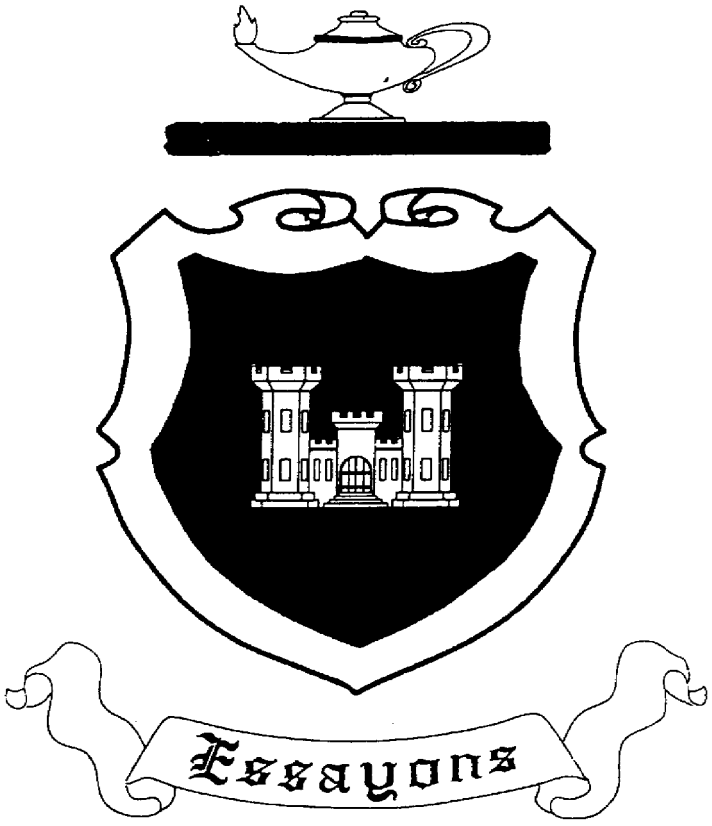
SUBCOURSE
EN5258

EDITION
A

US ARMY ENGINEER CENTER AND SCHOOL

CONSTRUCTION-EQUIPMENT BRAKE SYSTEMS



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THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

CONSTRUCTION-EQUIPMENT
BRAKE SYSTEMS

Subcourse EN5258

EDITION A

United States Army Engineer School
Fort Leonard Wood, Missouri 65473

7 Credit Hours

Edition Date: March 1999

SUBCOURSE OVERVIEW

This subcourse is part of the military occupational specialty (MOS) 62B Construction Equipment Repairer Course. It is designed to teach the knowledge and skills necessary to perform tasks related to servicing and maintaining brake systems found on items of engineer equipment. This subcourse is presented in five lessons, each corresponding to a terminal learning objective as indicated below.

There are no prerequisites for this subcourse.

This subcourse reflects the doctrine which was current at the time it was prepared. In your own work situation, always refer to the latest official publications.

Unless otherwise stated, the masculine gender of singular pronouns is used to refer to both men and women.

Appendix A contains a metric conversion chart.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn the basic principles of automotive brake systems, including their construction and operation, and how to troubleshoot the system.

CONDITION: You will be given the material in this subcourse, paper, a number (No.) 2 pencil, and an Army Correspondence Course Program (ACCP) examination response sheet.

STANDARD: To demonstrate competency of this task, you must achieve a minimum of 70 percent on this subcourse.

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TM 5-3810-293-14&P-2	*Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual (Including Repair Parts Information and Supplemental Maintenance Instructions) for Crane, Truck Mounted, Hydraulic, 25-Ton (CCE), (Harnischfeger Model MT-250, Non-Winterized)(NSN 3810-00-018-2021) and (Model MT-250, Winterized)(3810-00-018-2007). 6 June 1980.*

Use the above publication extracts to take this subcourse. At the time we wrote this subcourse, these were the current publications. In your own work situation, always refer to the latest publications.

LESSON 1

BRAKE-SYSTEM PRINCIPLES

Critical Tasks: 091-62B-1005
091-62B-3054

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn about the principles of brake systems and how to identify the major components that make up most brake systems in use today.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn the principles of automotive brake systems, including the construction and operation of mechanical, air, and hydraulic brake systems.

CONDITION: You will be given the material contained in this lesson.

STANDARD: You will correctly answer practice exercise questions at the end of this lesson.

REFERENCE: The material contained in this lesson was derived from the TM 9-8000.

INTRODUCTION

Braking action is the use of a controlled force to slow down or stop an object or to hold that object in a stationary position. Braking action is the result of friction caused by two surfaces rubbing together. An example of friction is the force that tries to stop your hand as you apply pressure and slide it across a table or a desk. This means that by forcing the surface of an object that is not moving (stationary) against a moving object's surface, the resistance to movement or the rubbing action between the two surfaces of the objects will slow down the moving surface. In a braking system, one surface is rotating and one surface is nonrotating.

1-1. Brake History. Brakes on early motor vehicles were nothing more than modified wagon brakes used on horse-drawn wagons. These were hand-operated, mechanical, lever-type brakes that forced a piece of wood against one or more wheels, causing friction or a drag on the wheel or wheels as shown in Figure 1-1, page 1-2. This action also results in friction between the wheel and the ground that tries to prevent the wheel from sliding or skidding.

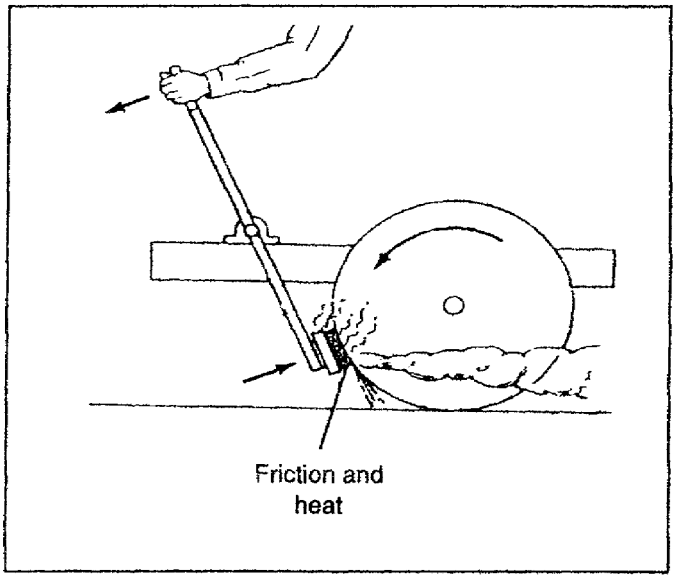


Figure 1-1. Development of friction and heat

1-2. External-Contracting and Internal-Expanding Brakes. There are many different types of brake systems. All systems require the use of a rotating and nonrotating unit. Each of these units has braking surfaces, which when forced together, produce the friction required for braking action. The rotating unit on many military vehicle brakes consists of a drum that is secured to and driven by a wheel. The nonrotating unit consists brake shoes and the linkage required to apply the brake shoes to the drum. Brakes may be external-contracting or internal-expanding (Figures 1-2 and 1-3), depending on how the stationary surface is forced against the rotating surface.

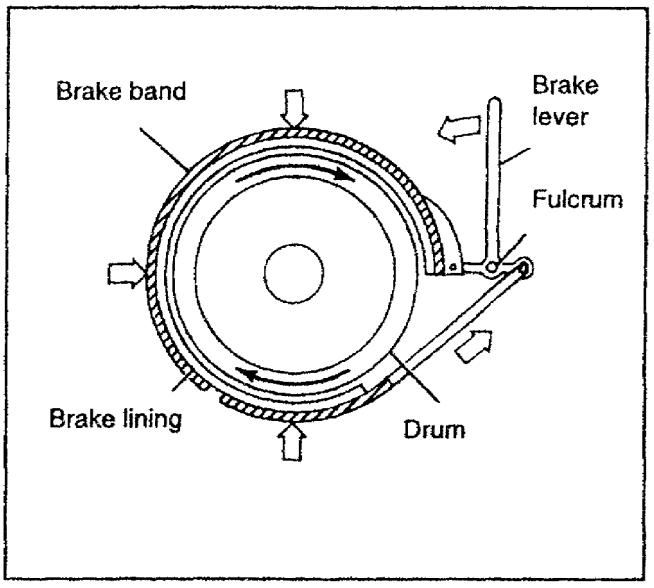


Figure 1-2. External-contracting brake

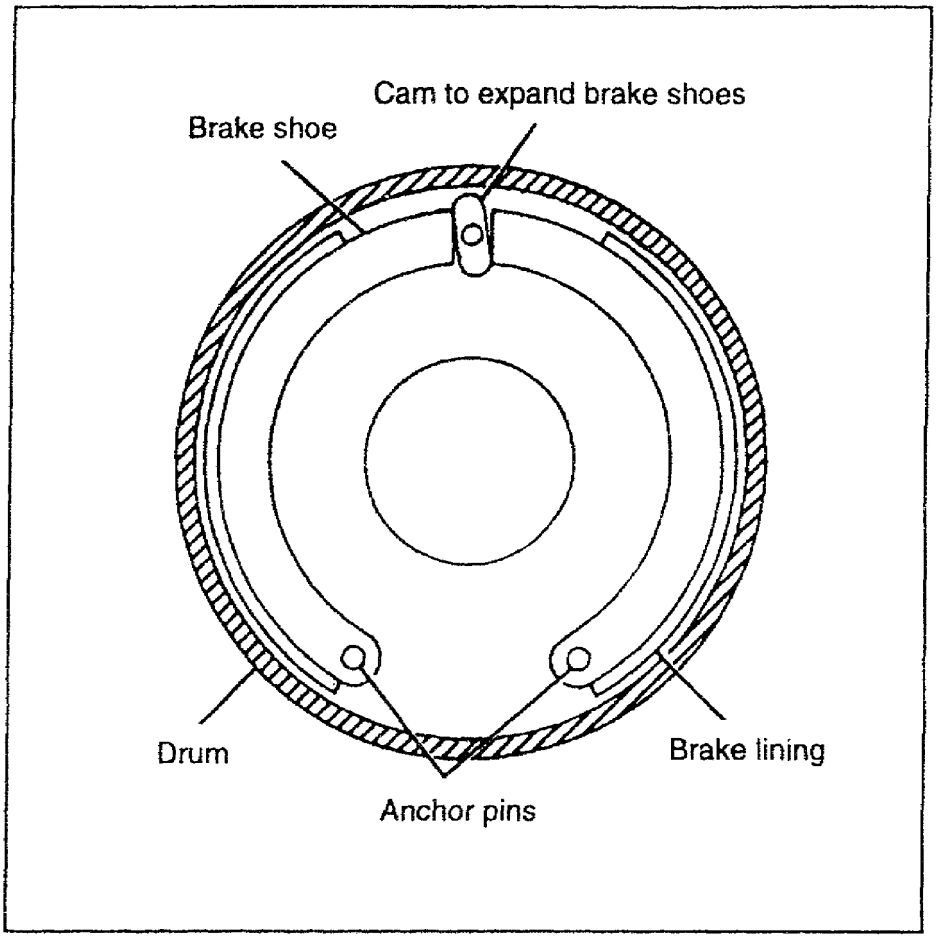


Figure 1-3. Internal-expanding type brake

1-3. Rotating and Nonrotating Brake-Drum Units. The brake drum is mounted directly on the wheel that provides the rotating surface, and the brake shoe is mounted on the nonrotating surface. The primary function of the brake-drum assembly is to force the brake shoe against the rotating drum to provide the braking action.

a. Self-energizing action. Most brake drum assemblies use what is called *self-energizing action.* This self-energizing action is produced as the brake shoe engages the rotating brake drum. As the brake-actuating mechanism forces the brake shoes outward, as shown in A, Figure 1-4, page 1-4, the top of the brake shoe tends to stick or wedge to the rotating brake drum and rotates with it. This effect on the brake shoe greatly reduces the amount of effort required to achieve a given amount of retardation. If two brake shoes were linked together, as shown in B, Figure 1-4, application of the brakes would produce self-energizing and servo effects. The servo effect is a result of the primary shoe or the brake shoe that is facing towards the front of the vehicle attempting to rotate with the brake drum. Due to both shoes being linked together, the rotating force of the primary shoe applies the secondary shoe. In the forward position, the anchor point for both brake shoes is at the heel of the secondary brake shoe. As the vehicle changes direction, the toe of the primary brake shoe becomes the anchor point, and the direction of self-energizing and servo actions change as shown in C, Figure 1-4.

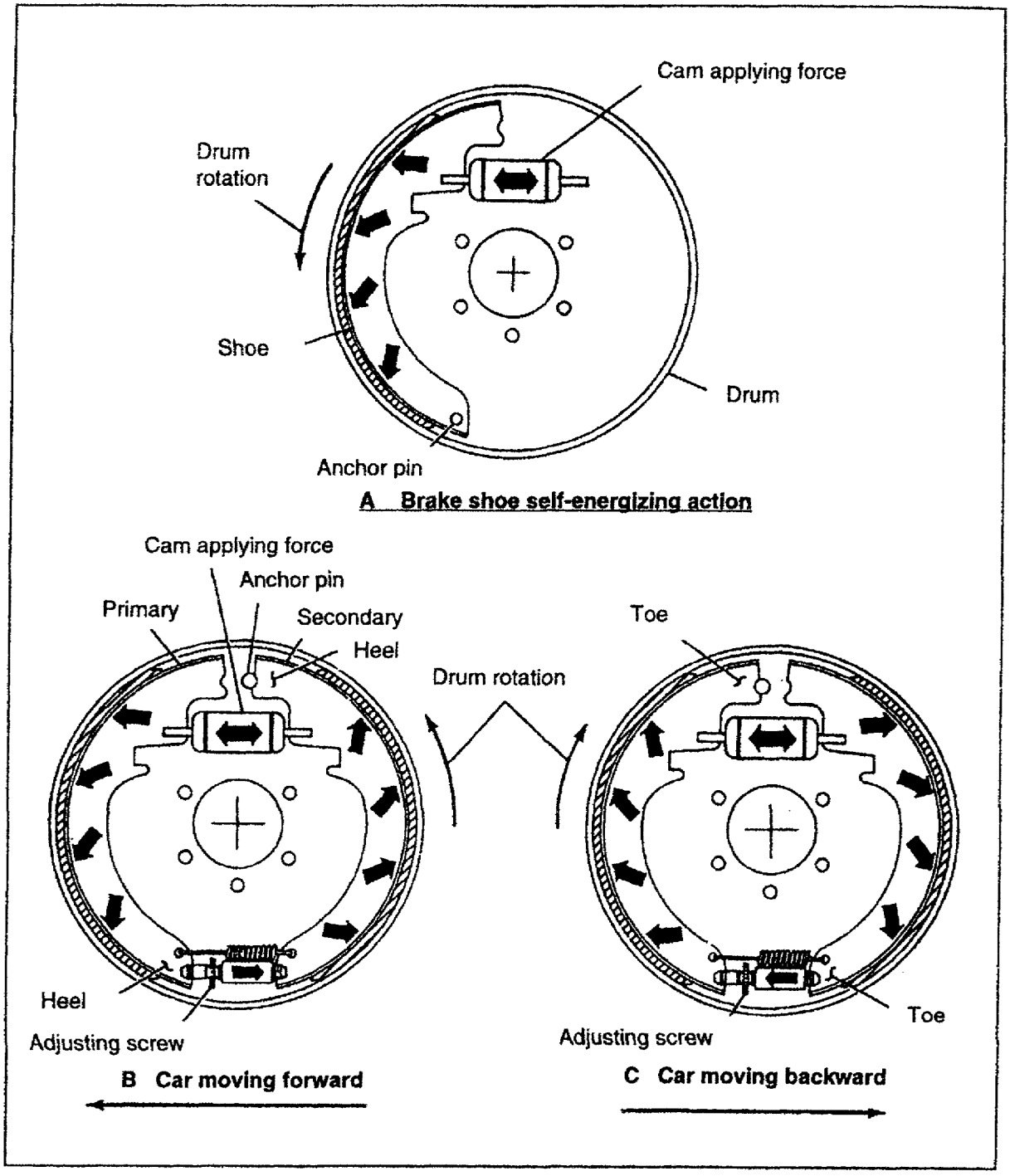


Figure 1-4. Self-energizing and servo actions

b. Brake-drum assembly configurations. The most popular configurations of brake-drum assemblies are discussed below.

(1) Single-anchor, self-energizing servo action. In this configuration (A, Figure 1-5, page 1-6), both brake shoes are self-energizing in forward and reverse directions. The brake shoes are self-centering and provide servo action during brake application. This system has one anchor pin, which is rigidly mounted to the backing plate and is nonadjustable. Both forward and reverse brake torques are transmitted to the backing plate through the anchor pin. One brake cylinder with dual pistons is used in this configuration.

(2) Single-anchor, self-centering. In this configuration (B, Figure 1-5), only the primary brake shoe is self-energizing in the forward direction and therefore provides the majority of the brake force. This system is self-centering, in that the lower shoe anchor does not fix the position of the brake shoes in relation to the brake drum. The brake shoes are allowed to move up and down as needed. This system has one brake cylinder.

(3) Double-anchor, single cylinder. In this configuration (C, Figure 1-5), each brake shoe is anchored at the bottom by rotating eccentric-shaped anchor pins. Only the primary shoe is self-energizing, and the system does not develop servo action. Spring clips are used at the middle of the shoe to hold the shoes against the backing plate. This system has one wheel-brake cylinder.

(4) Double-anchor, double cylinder. In this configuration (D, Figure 1-5), the brake shoes are provided with an anchor at each heel. The anchors are eccentric-shaped to allow for adjustment and centering. Each shoe has a single-piston cylinder mounted at the toe of the brake shoes, which allows both brake shoes to be self-energizing in the forward direction only.

1-4. Brake-Drum Construction. Brake drums are made of pressed steel, cast iron, or a combination of two metals, or aluminum.

a. Cast-iron brake drums. These brake drums dissipate the heat generated by friction faster than steel drums and have a higher coefficient friction with any particular brake lining. However, cast-iron drums of sufficient strength are heavier than steel drums. To provide lightweight brake drums with sufficient strength, centrifuge brake drums (Figure 1-6, page 1-6) made of steel with a cast-iron liner for the braking surface are used. A solid cast-iron brake drum of the same total thickness as the centrifuge drum would be too weak, while one of sufficient strength would be too heavy for the average passenger car.

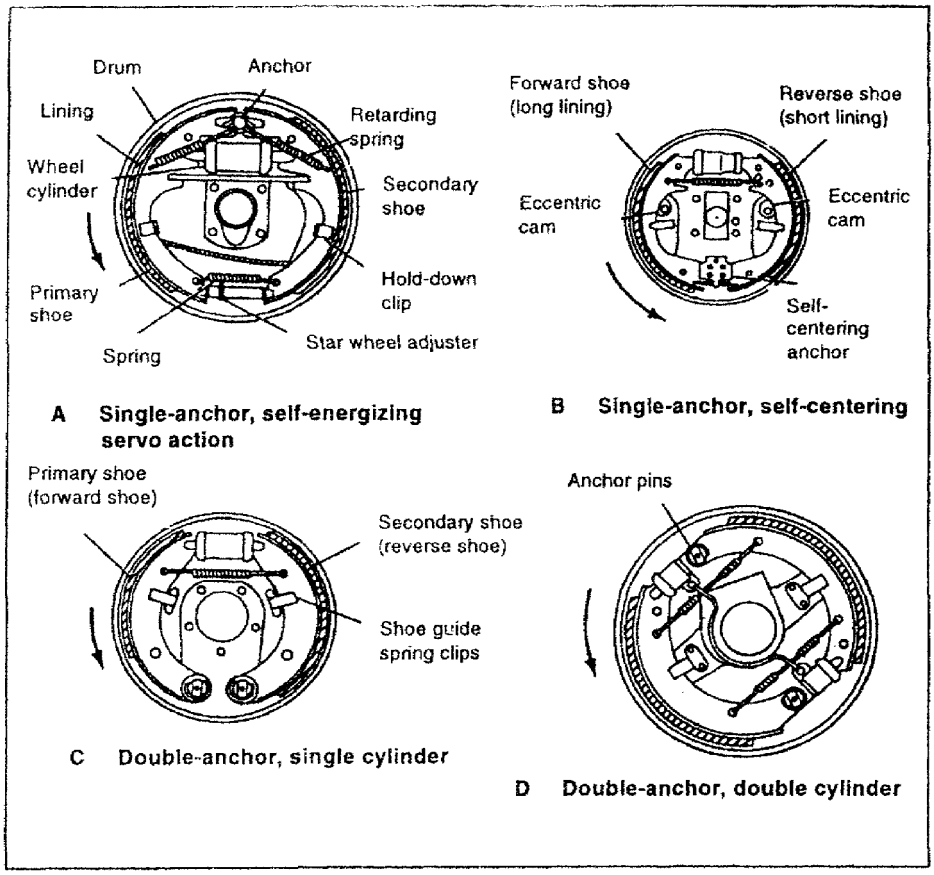


Figure 1-5. Brake-drum assembly configurations

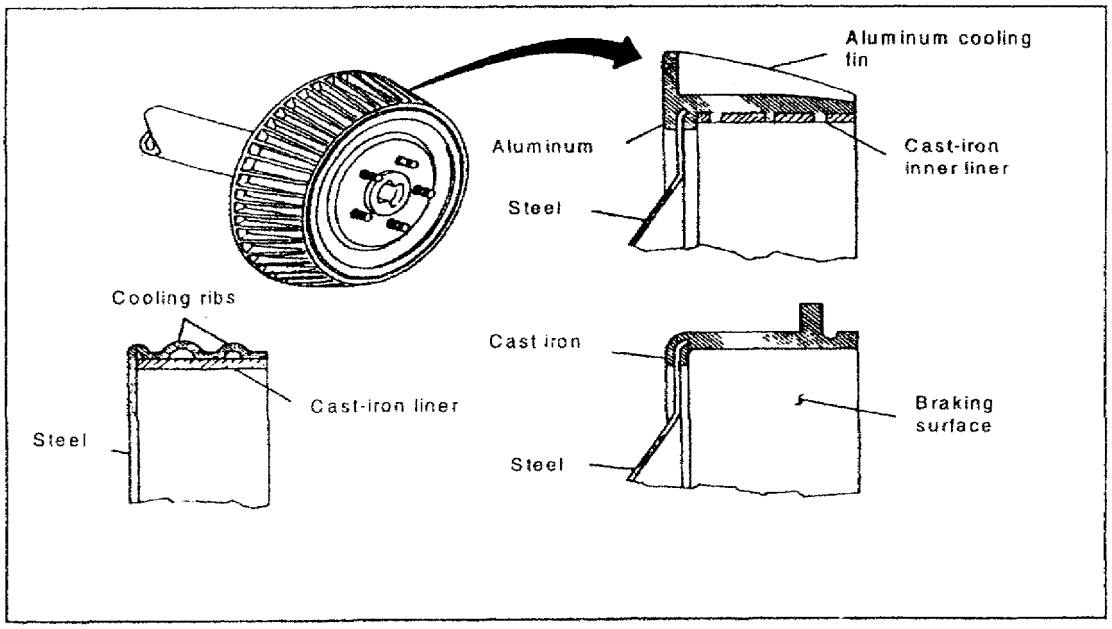


Figure 1-6. Brake-drum construction

b. Aluminum brake drums. These brake drums are constructed similar to centrifuge drums. They consist of aluminum casting with a cast-iron liner for a braking surface.

While reducing weight, this design allows heat to be transferred to the surrounding atmosphere more readily. Cooling fins or ribs are also added to most brake drums to allow heat to be transferred to the atmosphere more readily, thereby keeping the brake drum cooler and helping minimize brake fade.

c. Brake-drum surfaces. For good braking action, the brake drum should be perfectly round and have a uniform surface. Brake drums become out of round from pressure exerted by brake shoes and from heat developed by the application of the brakes. The brake-drum surface becomes scored when it is worn by the braking action. When the surface is scored or the brake drum is out of round, it may be necessary to machine the brake drum until it is smooth and true again.

1-5. Brake-Shoe and Lining Construction. The brake shoes and lining (Figure 1-7) work together. The brake shoes are used to support, strengthen, and move the brake lining.

a. Brake shoe. The brake shoe is made of malleable iron, cast steel, drop-forged steel, pressed steel, or cast aluminum. Pressed steel is commonly used because it is cheaper to produce in large quantities. A steel brake shoe expands at about the same rate as the brake drum when heat is generated by brake application, thereby maintaining the clearance between the brake drum and brake shoe under most conditions.

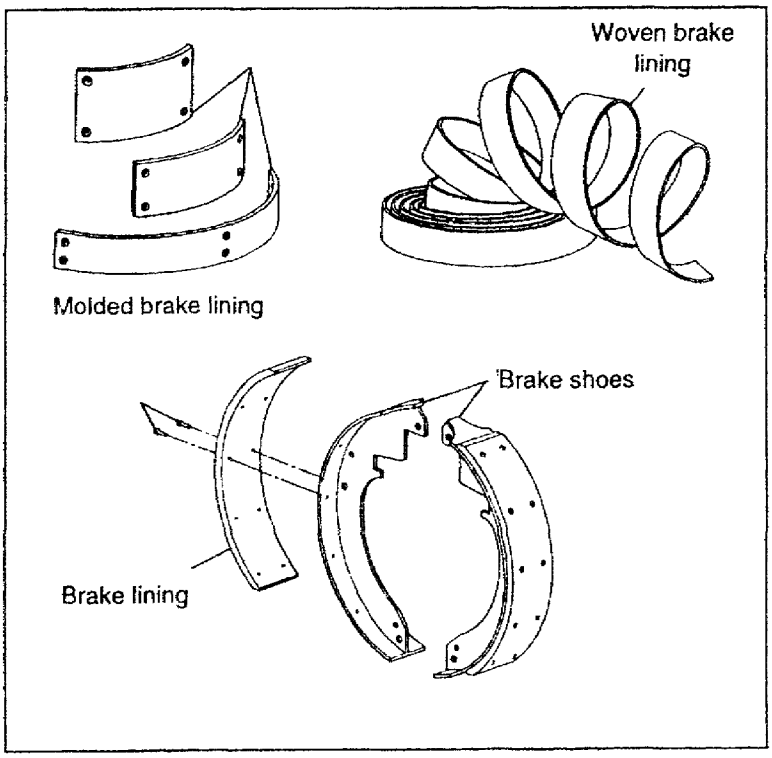


Figure 1-7. Brake shoes and brake lining

b. Brake lining. The brake lining is riveted or bonded to the face of the brake shoe, and it makes contact with the inner surface of the brake drum. Brass rivets are chosen over other types, because brass does not score the brake drum excessively if the lining is worn past the point of replacement. Aluminum rivets are not used because they may corrode due to moisture. The brake lining may be bonded to the brake shoe with special cement. It is not always necessary to fasten the lining to the shoe. In some brake assemblies, the lining is not fastened to the brake shoe or the brake drum but floats between them and is held by a lining retainer on one side and the brake shield on the other side.

c. Brake-lining types.. Variations in brake design and operation make it necessary to have different types of brake linings as shown in Figure 1-7, page 1-7. Brake linings come in molded and woven types.

(1) Molded. This lining is made of dense, compact asbestos fibers. The lining is sometimes impregnated with fine copper wire and may be cut into blocks to fit different sizes so that they will match the corresponding brake shoes. Its frictional qualities are low because it has a smooth surface, but it dissipates heat rapidly and wears longer than woven brake lining.

(2) Woven. This lining is made of asbestos or cotton fibers and copper or bronze wire. After being woven, the lining is treated with compounds intended to lessen the effects of water and oil. The lining is also compressed and heat-treated before being installed. The main advantage of the woven lining is its high-frictional qualities. Woven lining does not dissipate heat as rapidly as molded brake lining.

1-6. Disk-Brake System. This system consists of a disk-brake assembly, floating or fixed calipers, and multipiston designs.

a. Disk-brake operation. The disk-brake assembly (Figure 1-8), like the brake-drum assembly, is operated by pressurized hydraulic fluid. The fluid, which is routed to the calipers through steel lines and flexible high-pressure hoses, develops its pressure in the master cylinder. Once the brake pedal is depressed, fluid enters the caliper and begins to force the piston(s) outward. This outward movement forces the brake pads against the moving rotor. Once this point is reached, the braking action begins. The greater the fluid pressure exerted on the piston (s) from the master cylinder, the tighter the brake pads will be forced against the rotor. This increase in pressure will cause an increase in braking effect. As the pedal is released, pressure diminishes and the force on the brake pads is reduced. This allows the rotor to turn more easily. Some calipers allow the brake pads to rub lightly against the rotor at all times in the released position. Another design uses the rolling action on the piston seal to maintain a clearance of approximately 0.005 inch (Figure 1-8) when the brakes are released.

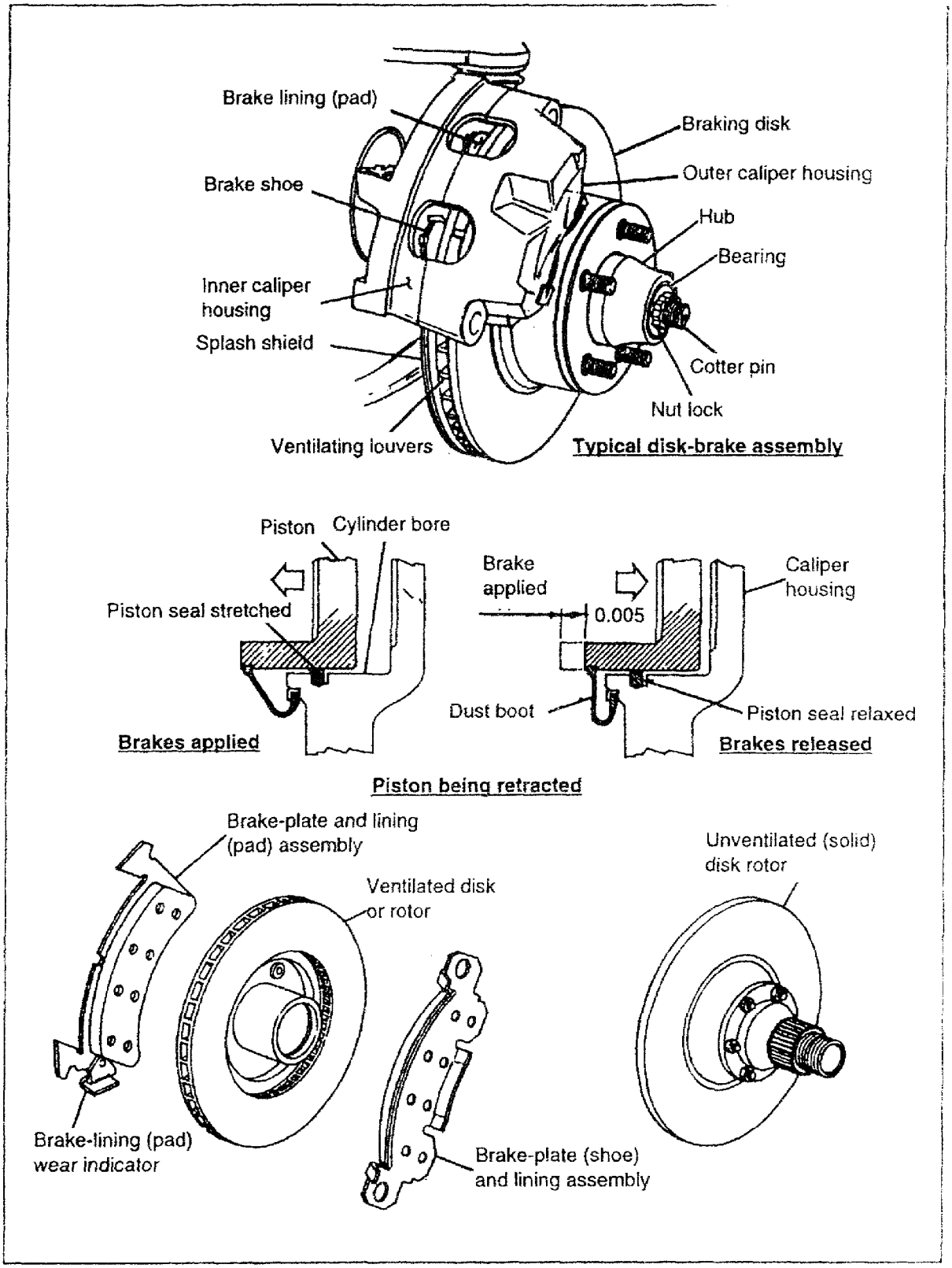


Figure 1-8. Disk-brake assembly

b. Disk-brake versus brake drum assemblies. Both the disk-brake and the brake-drum assemblies are used on modern vehicles and are well-designed systems. Each system exhibits certain inherent advantages and disadvantages. The most important point of interest are discussed below. One major factor that must be discussed in automotive brakes, as well as all other brake systems, is the system's ability to dissipate heat. As discussed previously, the by-product of friction is heat. Because most brake systems use this concept to develop braking force, it is highly desirable for brake systems to dissipate heat as rapidly and efficiently as possible. The disk-brake assembly, because of its open design, has the ability to dissipate heat; faster than the brake-drum assembly. This feature makes the disk-brake assembly less prone to brake fade due to a buildup of excess heat. The disk-brake assembly may have additional heat-transfer qualities due to the use of a ventilated rotor. This type of rotor (Figure 1-8, page 1-9) has built-in air passages between friction surfaces to aid in cooling.

(1) While the brake-drum assembly requires an initial shoe to-drum clearance adjustment and periodic checks, the disk-brake assembly is self-adjusting and maintains proper adjustment at all times. The disk-brake assembly automatically compensates for lining wear by allowing the piston in the caliper to move outward, thereby taking up excess clearance between the pads and the rotor. The disk system is simple in comparison to the drum system. Due to its design and lack of moving parts and springs, the disk-brake assembly is less likely to malfunction than the brake-drum assembly.

(2) Overhauling the disk-brake assembly is faster because of its simple design. It is also safer due to the fact that the disk-brake assembly is open and asbestos dust from the linings is less apt to be caught in the brake assembly. Like brake drums, rotors may be machined if excessive scoring is present. Rotors are also stamped with a minimum. thickness dimension, which should not be exceeded. The brake-drum assembly requires the drum to be removed for lining inspection. Some disk pads have a built-in lining wear indicator that produces an audible high-pitch squeal when the linings are worn excessively. This harsh squeal is a result of the lining wearing to a point that allows a metal indicator to rub against the rotor as the wheel turns. Because of its small frictional area, and lack of self-energizing and servo effect, the disk-brake assembly requires the use of an auxiliary power booster to develop enough hydraulic pressure for good braking.

c. Floating calipers. Floating calipers (Figure 1-9) are designed to move laterally on their mounts. This movement allows a caliper to maintain a centered position with respect to the rotor. This design also permits the braking force to be applied equally to both sides of the rotor. A floating caliper usually is of one-piece, solid construction and uses a single piston to develop the braking force. This type of caliper operates by pressurized hydraulic fluid like all other hydraulic calipers. The fluid enters the piston cavity and begins to force the piston outward. As this happens, the brake pad meets the rotor. Additional pressure then forces the caliper assembly to move in the opposite direction of the piston, thereby forcing the brake pad on the opposite side of the piston to engage the rotor. As pressure is built up behind the piston, it forces the brake pads tighter against the rotor to develop additional braking force.

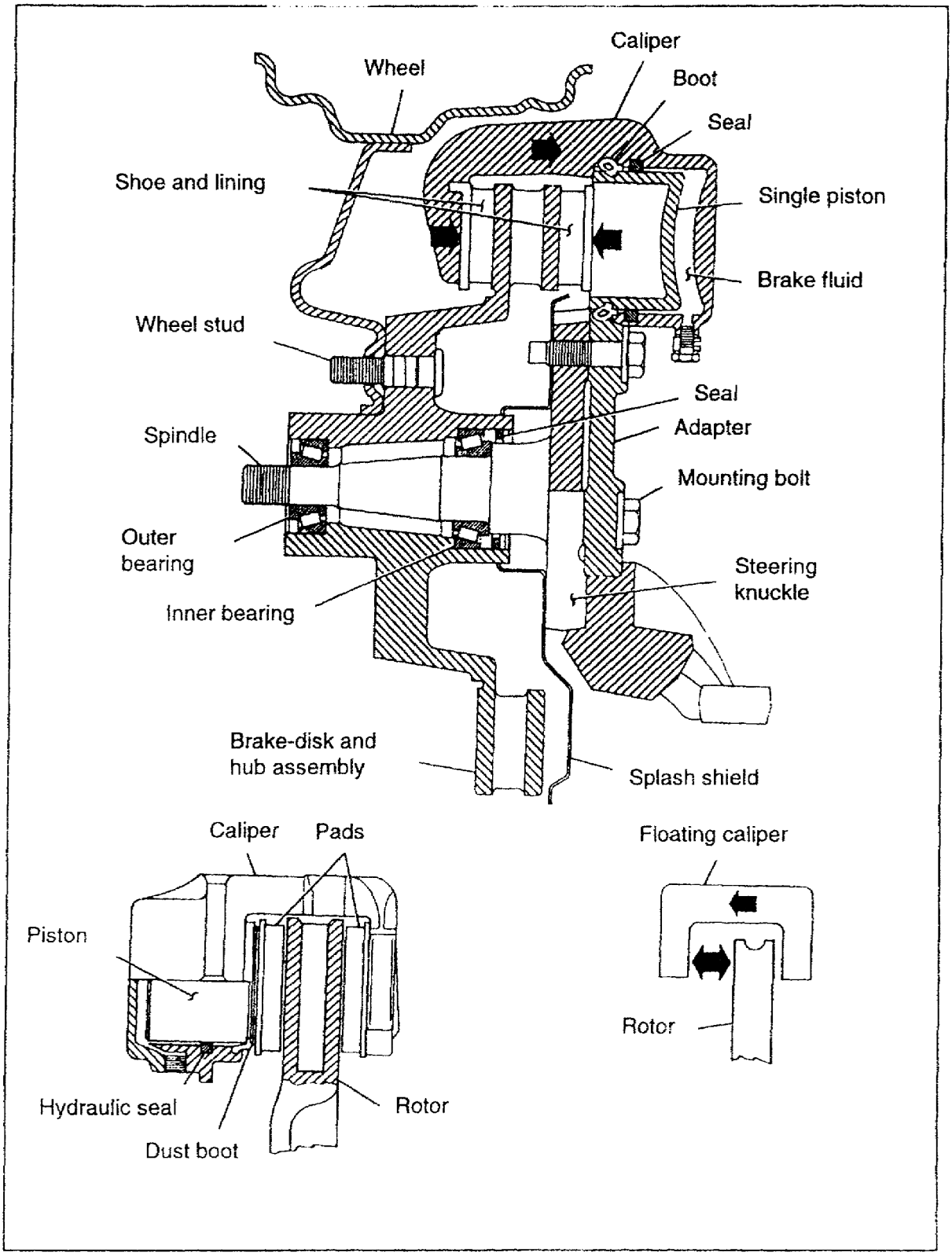


Figure 1-9. Floating caliper

d. Fixed calipers. Fixed calipers (Figure 1-10) are mounted firmly to the spindle or splash shield. In this design, the caliper is usually made in two pieces and has two, three, or four pistons in use. The pistons, which may be made of cast iron, aluminum, or plastic, are provided with seals and dust boots and fit snugly in bores machined in the caliper. The pistons accomplish the centering action of the fixed caliper as they move in their bores. If the lining wears unevenly on one side of the caliper, the piston would take up the excess clearance by simply moving farther out in its bore. As the brakes are applied, the fluid pressure enters the caliper on one side and is routed to the other side through an internal passageway or an external tube connected to the opposite half of the caliper. As pressure is increased, the piston forces the brake pads against the rotor evenly and the pistons maintain an equal amount of pressure on both sides of the rotor.

e. Multipiston designs. Fixed calipers use a multipiston design to provide the braking force. The fixed caliper may be designed to use two, three, or four pistons as shown in Figure 1-10. The dual-piston design provides a slight margin of safety over a single-piston floating caliper. If a piston seizes in the caliper, the single-piston caliper would be rendered useless, while the dual-piston design would still have one working piston to restore some brake ability. The three- and four-piston design provides for the use of a larger brake lining. The brake force developed may be spread over a larger area of the brake pad.

1-7. Mechanical Brakes. On wheeled vehicles, the energy supplied by the operator's foot while pushing down on the brake pedal is transferred to the brake mechanism on the wheels by various means. A mechanical hookup has been used since the earliest motor vehicles, but mechanical-operated brake systems are practically obsolete now. However, mechanical hookups are still used for a portion of the braking system.

1-8. Parking Brakes. The parking brake is designed to keep a vehicle stationary when it is parked. The parking brake can be used to stop a vehicle in an emergency if the service brakes fail. For this reason, the parking brake is sometimes referred to as the emergency brake. The brake in vehicles with a hydraulic system operates mechanically on the transmission, the transfer case, or the brake shoes of the rear wheels. When the hand brake operates on the rear wheels, it is usually linked to the same shoes that are operated by the hydraulic pistons. Toggle leverage is used to apply the shoes. With this arrangement, the hand lever applies the shoes either hydraulically by the brake pedal or mechanically. In normal operation, the braking action is entirely one of hydraulic force with the mechanical hookup working in connection with the hydraulic system. With the correct amount of fluid in the lines and the brakes properly set, the mechanical hookup is inactive. If the hydraulic system fails, the mechanical linkage acts as a safeguard.

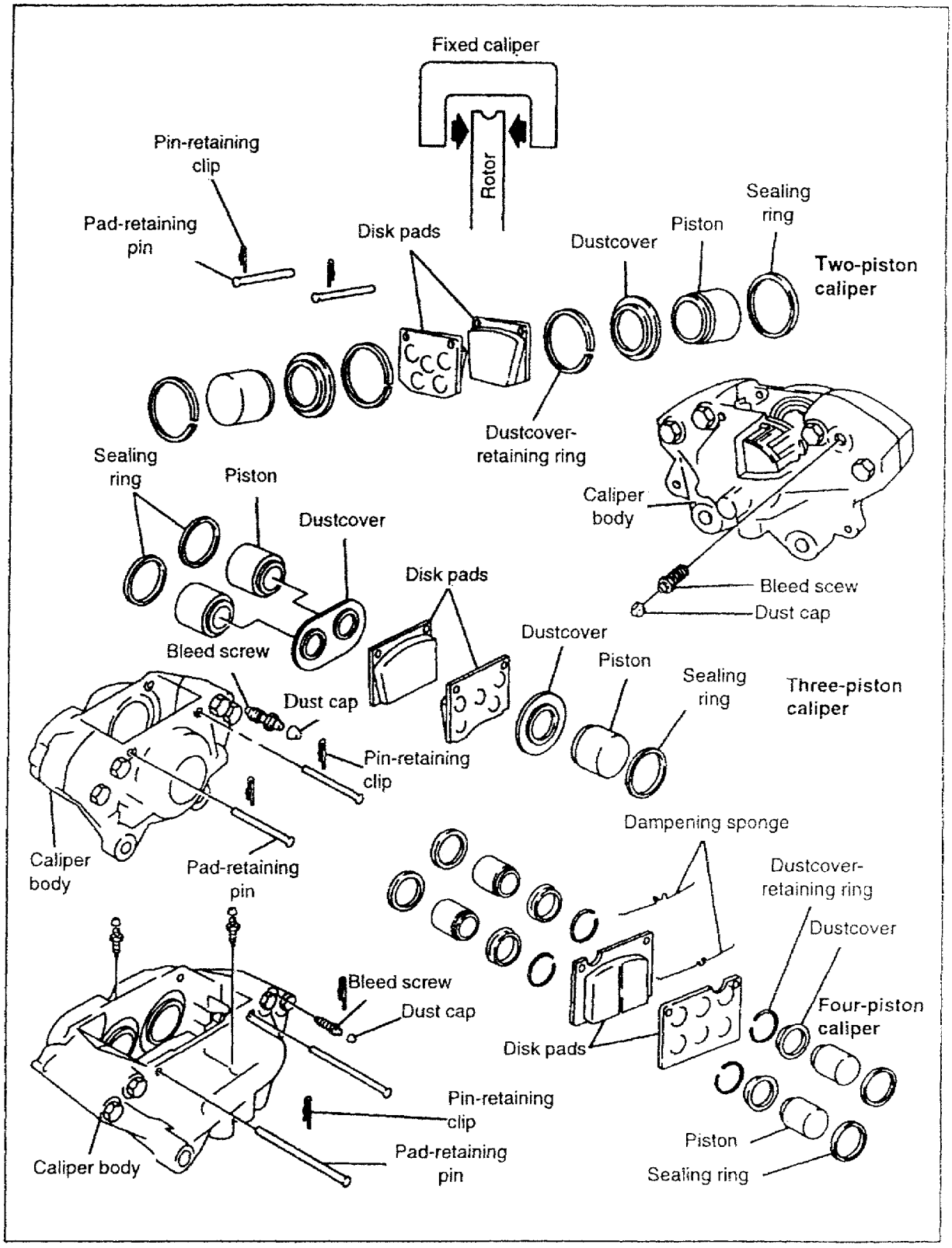


Figure 1-10. Fixed and multipiston calipers

LESSON 1

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. Which of the following is used to slow or stop a vehicle?

   A. Friction
   B. Momentum
   C. Inertia
   D. Heat

2. Which of the following metals are used to make brake drums?

   A. Pressed steel, cast iron, or a combination of two metals, or aluminum
   B. Cast iron and cast aluminum
   C. Cast aluminum and pressed steel
   D. Rolled steel and cooper

3. What action is taken when a brake drum is badly scored or the drum is out of round?

   A. Replace the brake shoes
   B. Replace the drum
   C. Machine the brake drum
   D. Reverse the brake shoes

4. Which of the following metals are cheaper to use when making brake shoes?

   A. Malleable iron
   B. Cast iron
   C. Pressed steel
   D. Cast aluminum

5. What type of rivets are used to attach the brake linings to the brake shoes?

   A. Brass
   B. Iron
   C. Steel
   D. Aluminum

6. What are the two types of brake linings?

   A. Copper and fiber
   B. Molded and woven
   C. Asbestos and cotton
   D. Asbestos and fiber

7. What is the primary function of a brake-drum assembly?

   A. To force the brake drum outward
   B. To decrease the amount of braking effort on the brake drum
   C. To dissipate the heat generated by friction on the brake drum
   D. To force the brake shoe against the rotating brake drum

8. Which of the following is an advantage of self-energizing brakes?

   A. Smoother brake action
   B. Reduced amount of effort required to achieve a given amount of retardation
   C. Decreased tendency to skid on sudden stops
   D. Decreased brake fade

9. Which of the following is an advantage of disk brakes?

   A. Less prone to brake fade
   B. Self-energizing
   C. Less expensive
   D. Easy to adjust

10. What are the two types of brake calipers?

   A. Floating and fixed
   B. Free and stationary
   C. Rotating and wedge
   D. Floating and attached

LESSON I

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item	Correct Answer
1. A.	Friction Each of these units has braking . .. (page 1-2, para 1-2)
2. A.	Pressed steel, cast iron, or a combination of two metals, or aluminum Brake drums are made of... (page 1-5, para. 1-4)
3. C.	Machine the brake drum When the surface is scored ... (page 1-7, para 1-4c)
4. C.	Pressed steel Pressed steel is commonly used .. (page 1-7, para 1-5a)
5. A.	Brass Brass rivets are chosen ... (page 1-8, para 1-5b)
6. B.	Molded and woven Brake linings come in molded and woven types. (page 1-8, para 1-5c)
7. D.	To force the brake shoe against the rotating brake drum The primary function of the brake ... (page 1-3, para 1-3)
8. B.	Reduced amount of effort required to achieve a given amount of retardation This effect on the brake . . (page 1-3, para 1-3a)
9. A.	Less prone to brake fade This feature makes the ... (pages 1-10, para 1-6b)
10. A.	Floating and fixed Floating caliper and fixed caliper. (page 1-10 through 1-12, para 1-6c and 1-6d)

LESSON 2

HYDRAULIC BRAKE SYSTEMS

Critical Tasks: 091-62B-1005
091-62B-3054

OVERVIEW

LESSON DESCRIPTION:

After completing this lesson, you will understand the principles of hydraulic brake systems and how to troubleshoot, adjust, and repair a hydraulic brake system on a SEE.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn the principles of hydraulic brake systems.

CONDITION: You will be given the material contained in this lesson.

STANDARD: You will correctly answer practice exercise questions at the end of this lesson.

REFERENCES: The material contained in this lesson was derived from TMs 5-2420-224-20-1, 5-2420-224-20-2, and 9-8000.

INTRODUCTION

Hydraulics is the study of liquids in motion or the pressure exerted by liquids that are conveyed in pipes or conduits. In a hydraulic brake system, pressure applied at the brake pedal is transmitted to the brake mechanism by a liquid. To better understand how pressure is transmitted by a hydraulic brake system, it is necessary to understand the principles of hydraulics. Two well-known hydraulic principles are liquid compression and liquid distribution.

PART A - PRINCIPLES

2-1. Compression. Liquids cannot be compressed under ordinary pressures, and this may be demonstrated by placing a weight on top of a piston fitted to a jar (Figure 2-1, page 2-2). The

force of the weight does not change the level of the liquid; therefore, it does not diminish the volume or compress the liquid.

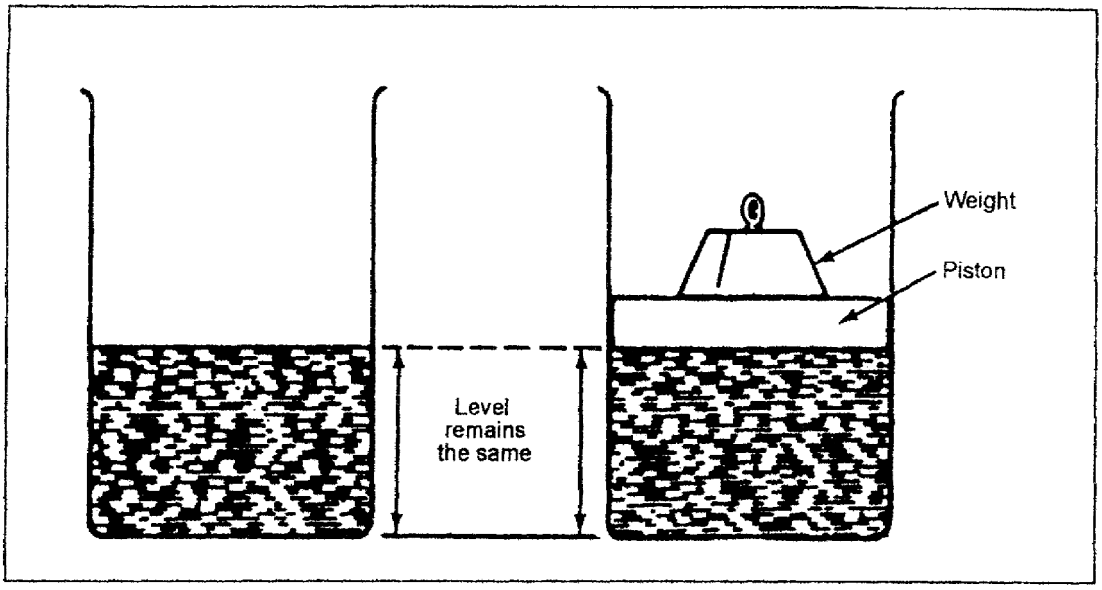


Figure 2-1. Noncompressibility of liquids

2-2. Distribution. Force that is exerted at any point upon a confined liquid is distributed equally through the liquid in all directions. That is, if a total force of 20 pounds, including the piston and the weight, is placed upon liquid in a jar and the piston in the jar has an area of 5 square inches, the unit hydraulic pressure is increased by 20 to 5, or 4 pounds per square inch (psi). This is shown in Figure 2-2. A gauge inserted at any point in the jar will indicate a pressure of 4 psi, since the liquid transmits the pressure equally throughout the jar.

2-3. Illustration. The use of hydraulic principles may be illustrated by interconnecting two jars of the same diameter that contain liquid (Figure 2-3). If force is exerted on the piston in one jar (the left jar in Figure 2-3), the piston in the other jar will receive the same amount of force due to the transmission of pressure by liquid. When the areas of the two pistons are equal, moving one piston produces an identical movement of the other piston because the liquid is not compressible and therefore maintains the same volume. The following paragraphs contain more illustrations of hydraulic principles.

a. Two jar illustration. By connecting two jars together, the second jar having twice the diameter of the first and therefore four times the area. The results are somewhat different, although the same facts apply (Figure 2-4, page 2-4). When force is exerted on the piston in the small jar, the piston in the large jar will receive four times as much force because the hydraulic pressure acts on four times the area. Since liquid will always occupy the same volume, the large piston will move one-fourth as far as the small piston.

b. Four jar illustration. With four jars of the same diameter connected to a central jar (Figure 2-5, page 2-4), an approximation of the action in four wheel brakes is obtained. Force that is exerted on the piston in the central jar will be transmitted to each of the other jars so that the piston in each jar will receive an identical force but will move only one-fourth as far as the central piston. If the four jars have a larger diameter than the central jar, the total pressure on each of the four pistons is greater than that applied to the central one, and each of the four pistons moves less than one-fourth as far as the central piston. Hydraulic brake systems operate in such a manner.

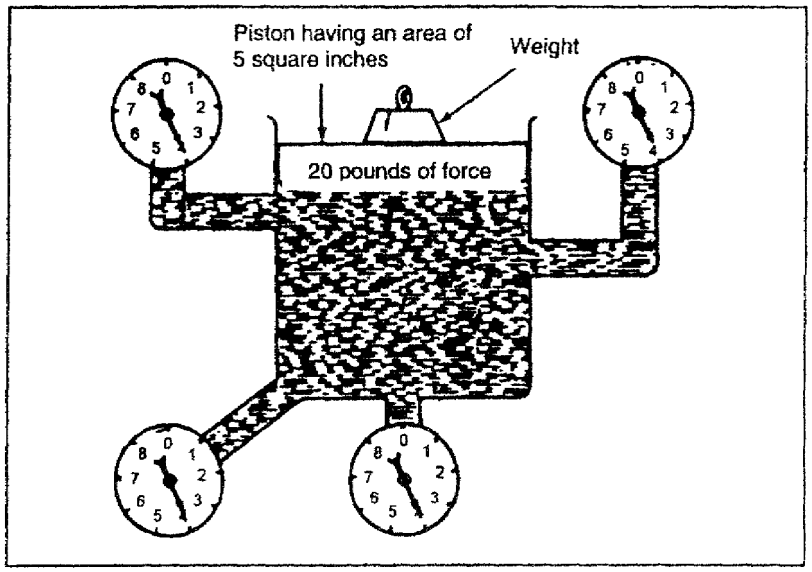


Figure 2-2. Equal distribution of force on confined liquid

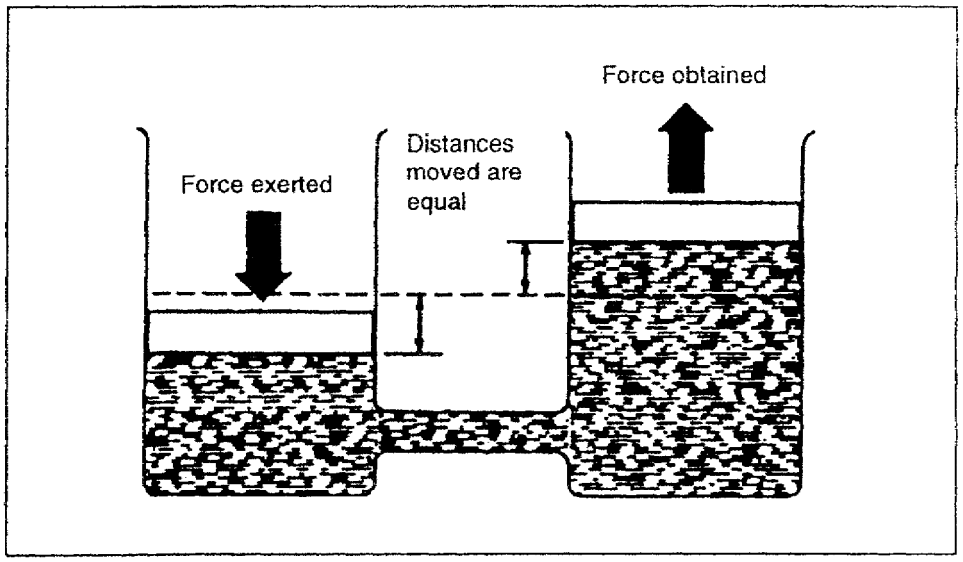


Figure 2-3. Distribution of force in a hydraulic system using the same-size pistons

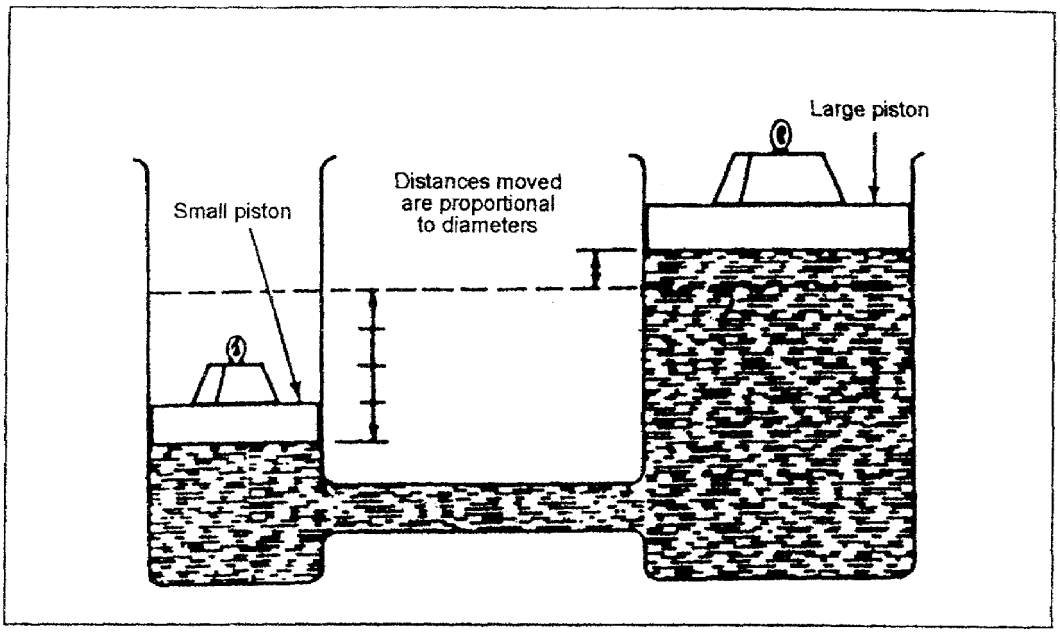


Figure 2-4. Distribution of force in a hydraulic system using different-size pistons

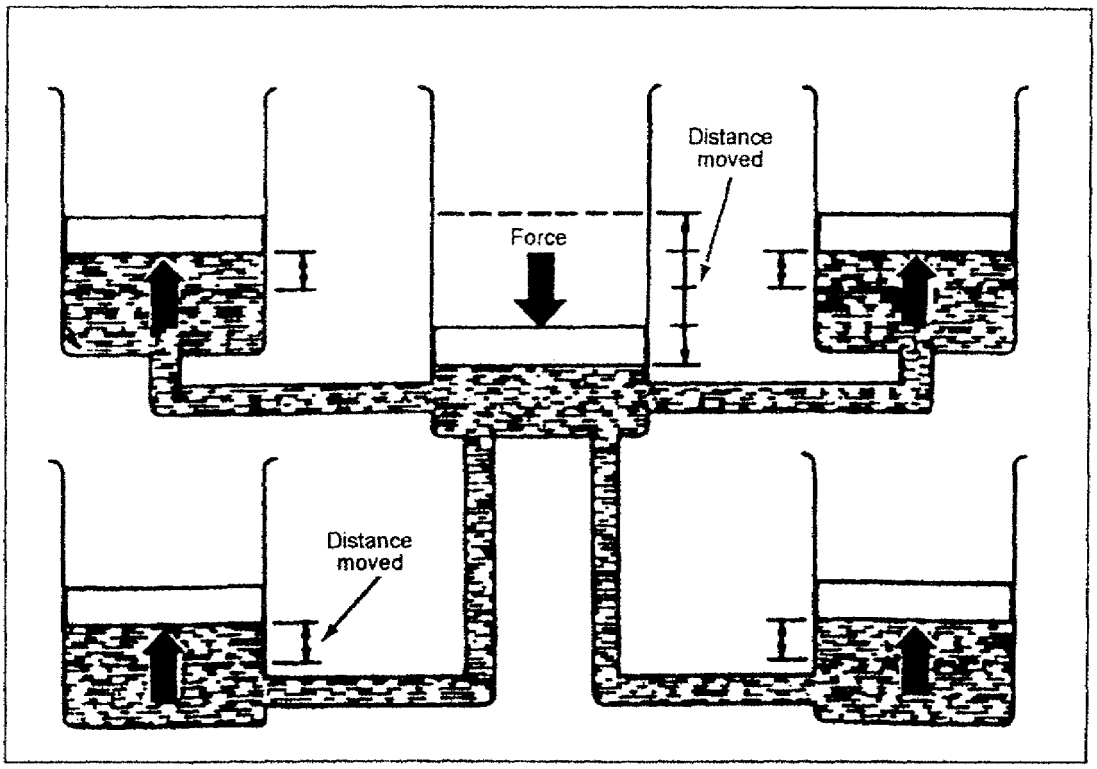


Figure 2-5. Four jars connected to a central jar

2-4. Operation. In a hydraulic brake system, force is applied to the piston in a master cylinder. The brake pedal operates the piston by linkage and each wheel brake has a cylinder (Figure 2-6). Inside the cylinder are opposed pistons that are connected to the brake shoes. When the brake pedal is depressed, it moves the piston within the master cylinder, forcing the brake fluid from the master cylinder through the tubing and flexible hose into the four wheel cylinders.

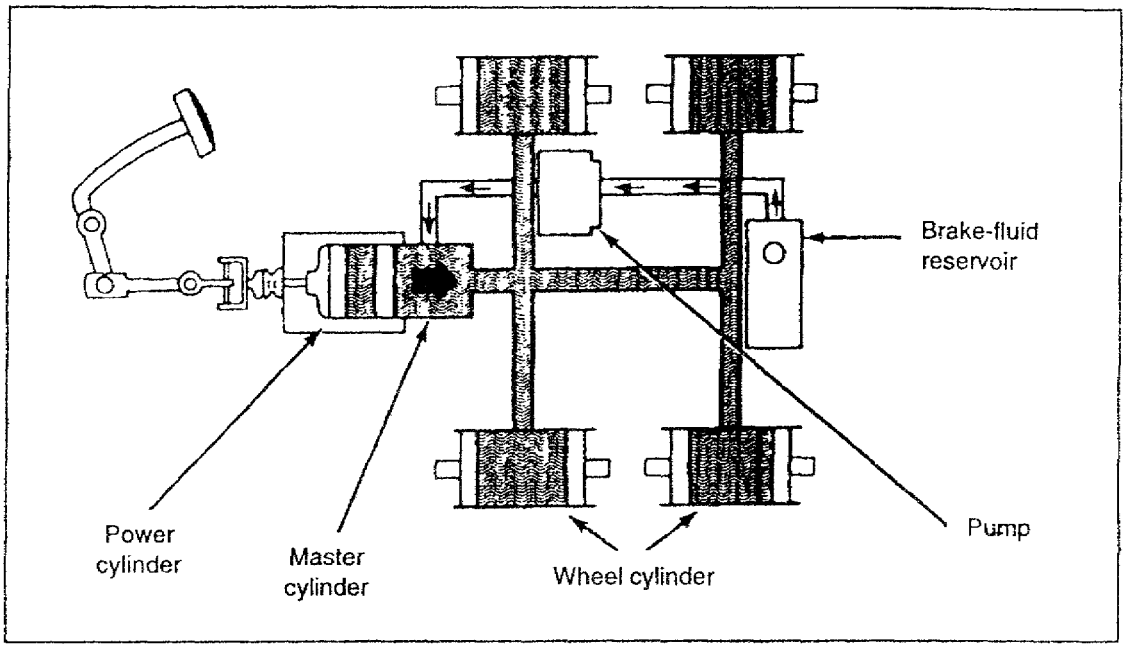


Figure 2-6. Hydraulic brake system

a. Fluid type. All hydraulic brake systems use silicone brake fluid. Silicone brake fluid does not freeze or boil at temperatures encountered in year-round operation of the construction equipment.

b. Fluid flow. Brake fluid enters each of the wheel cylinders between the opposed pistons, making the pistons move the brake shoes outward against the brake drum. As pressure on the pedal is increased, more hydraulic pressure is built up in the wheel cylinders and more force is exerted against the ends of the brake shoes.

c. Brake release. When the pressure on the pedal is released, retracting springs on the brake shoes pull the shoes away from the drum. This forces the wheel-cylinder pistons to release their positions and forces the brake fluid back through the flexible hose or tubing to the master cylinder.

2-5. Master Cylinder (Power Conversion). The master cylinder (Figure 2-7, page 2-6) is the primary unit in the brake system that converts the force of the driver's foot into fluid pressure to operate the wheel brake cylinders. The master-cylinder housing is an aluminum or iron casting that may have an integral reservoir, which is usually a detachable nylon or steel reservoir. The reservoir carries sufficient reserve fluids to allow for expansion and contraction of brake fluid and allow for brake-lining wear. The reservoir is filled to the top and is well sealed by a

removable filler cap containing a vent. The master cylinder usually is mounted to the fire wall, which allows for easy inspection and service and is less prone to dirt and water.

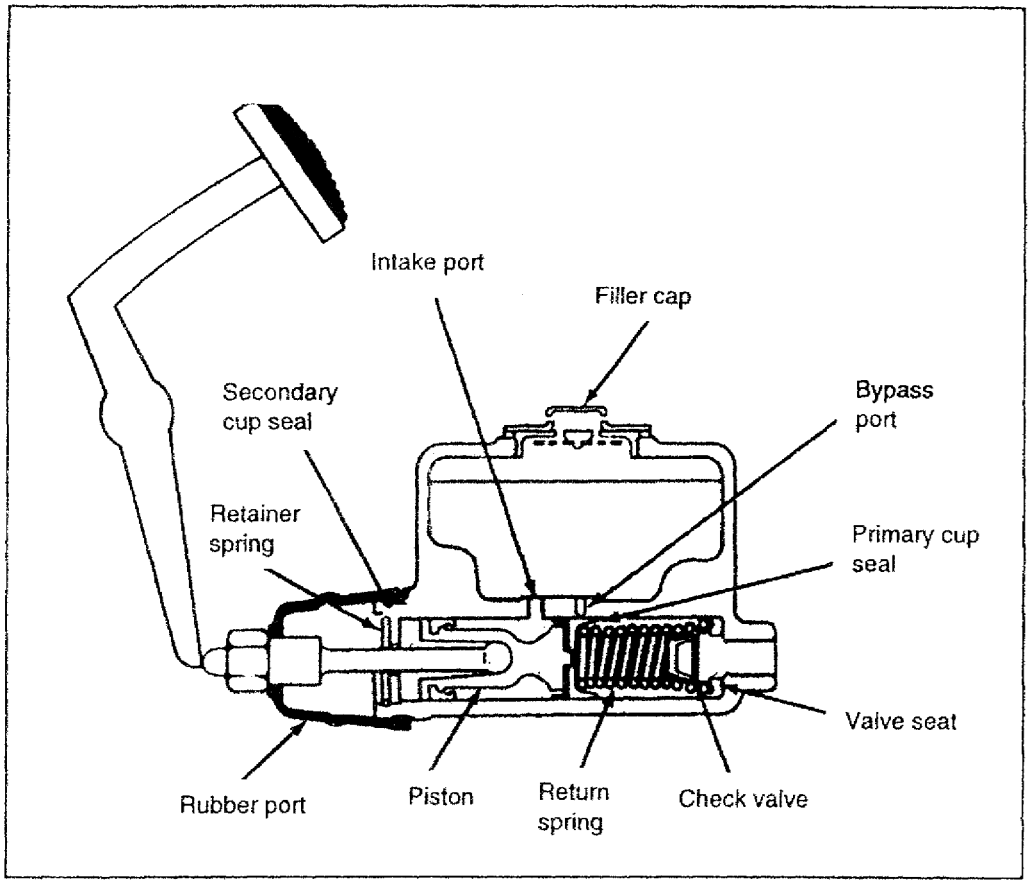


Figure 2-7. Master cylinder

a. Construction. The master-cylinder piston is a long, spool-like member with a rubber secondary cup seal at the outer end. It has a rubber primary cup, which acts against the brake liquid just ahead of the inner end. The primary cup is kept against the end of the piston by a return spring. The inner-piston head has several small bleeder ports that pass through the head to the base of the rubber primary cup. A steel, stop disk, held in the outer end of the cylinder by a retaining spring (snap ring), acts as a piston stop. A rubber boot covers the piston end of the master cylinder. This boot is vented to prevent air from being compressed within it.

b. Operation. In the outlet end of the cylinder, there is a combination inlet and outlet check valve that is held in place by the piston return spring. This check valve is a little different from most check valves that let fluid pass through them in one direction only. If enough pressure is applied to this valve, fluid can go in or around it in either direction. This means it will keep some pressure in the brake lines. The check valve consists of a rubber valve cup in a steel valve case. This assembly rests on a rubber valve seat that fits in the end of the cylinder. In some designs, the check valve consists of a spring-operated outlet valve that is seated on a valve cage rather than a rubber cup outlet valve; but the principle of operation is the same. The piston

return spring normally holds the valve cage against the rubber valve seat to seal the brake fluid in the brake line.

2-6. Wheel Cylinder. The wheel cylinder (Figure 2-8) changes hydraulic pressure into mechanical force. This pushes the brake shoes against the drum.

a. Operation. The wheel-cylinder housing is mounted on the brake's backing plate. Inside the cylinder are two pistons that are moved in opposite directions by hydraulic pressure and, at the same time, push the shoes against the drum.

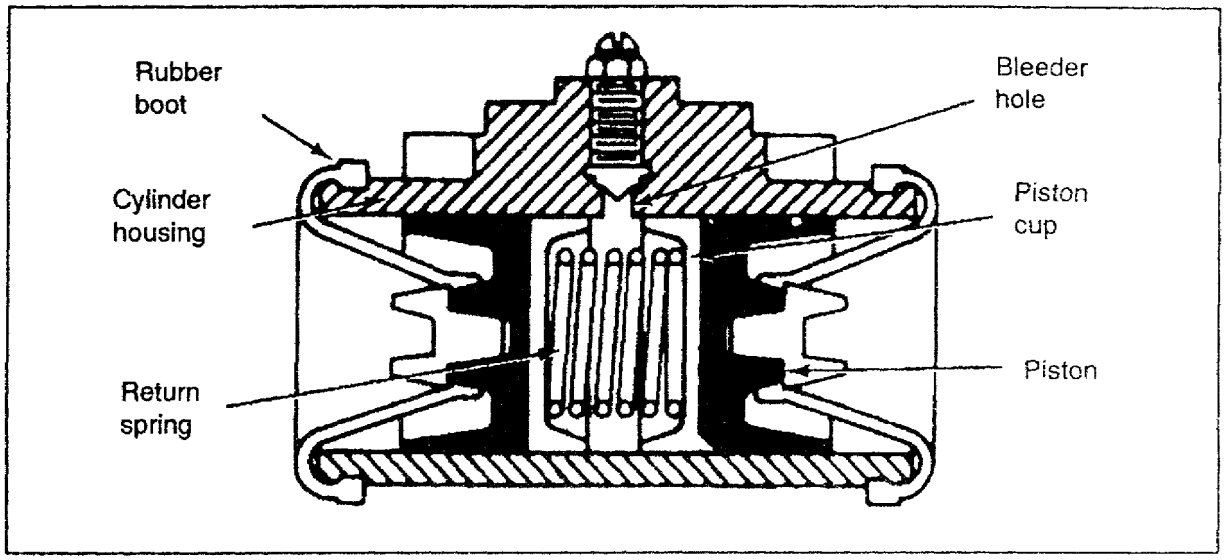


Figure 2-8. Wheel cylinder

b. Description. The pistons or piston stems are connected directly to the shoes. Rubber piston cups fit in the cylinder bore against each piston to prevent the escape of brake fluid. Light springs between the cups keep the cups in position against the pistons. To keep out foreign matter, the open ends of the cylinder are fitted with rubber boots. Brake fluid enters the cylinder from a brake-line connection between the pistons. At the top of the cylinder, between the pistons, there is a bleeder hole and a screw through which air is released when the system is being filled with brake fluid.

c. Cause and effect. Due to the self-energizing action on some vehicles, a stepped wheel cylinder (Figure 2-9, page 2-8) is used to compensate for the faster rate of wear on the front shoe than on the rear shoe. By using a larger piston for the rear shoe, the shoe receives more pressure to offset the self-energizing action of the front shoe. If it is desired that both shoes be independently self-energizing, it is necessary to have two wheel cylinders, one for each shoe. Each cylinder has a single piston and is mounted on the opposite side of the brake-backing plate from the other cylinder.

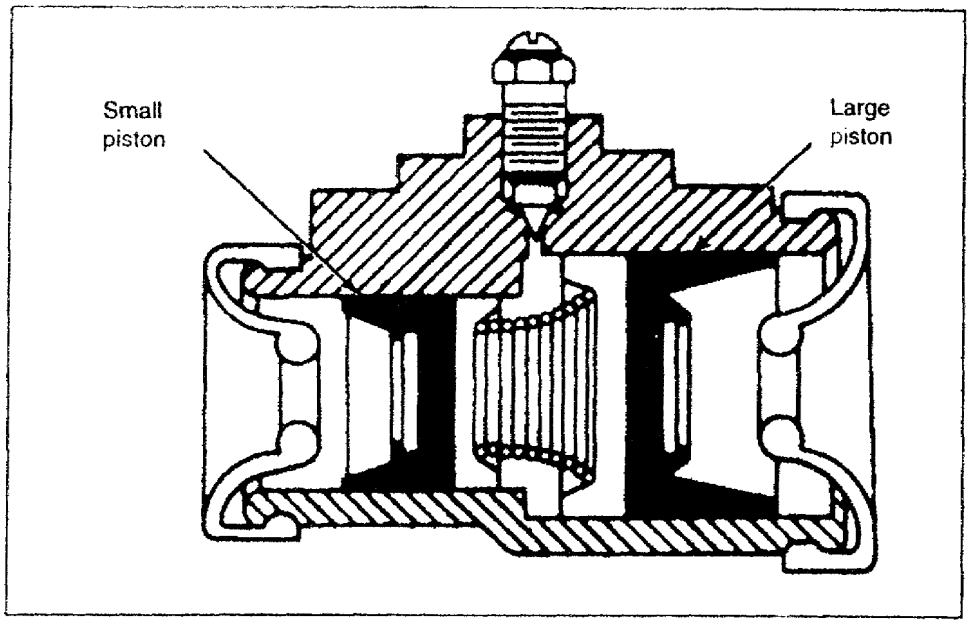


Figure 2-9. Stepped wheel cylinder

2-7. Brake Operation. Previous paragraphs have discussed the parts that make up a hydraulic brake system. To illustrate what happens to these parts when the brakes are applied and released, assume that the master cylinder is installed on a vehicle and the hydraulic system is filled with fluid. As the operator pushes down on the brake pedal, the linkage moves the piston in the master .cylinder. As the piston moves inward, the primary cup seals off the bypass port (sometimes known as the compensating port).

a. Bypass port closed. With the bypass port closed, the piston t-raps the fluid that is ahead of it and creates pressure in the cylinder. This pressure forces the check valve ,o open, and fluid passes into the brake line. The piston continues to move and forces fluid through the line into the wheel cylinders. Hydraulic pressure causes the wheel-cylinder pistons to move outward and forces the brake shoe against the brake drum. As long as pressure is kept on the brake pedal, the brake shoes will remain pressed against the brake drum.

b. Brake pedal released. When the brake pedal is released, the pressure of the linkage or pushrod is removed from the master-cylinder piston. The return spring pushes the piston back to the released position and reduces the pressure in front of the piston. The check valve slows the sudden return of fluid from the wheel cylinders. As the piston moves toward the released position in the cylinder, fluid from the master-cylinder supply tank flows through the in port and then through the bleeder holes in the head of the piston. This fluid will bend the primary cup's lips away from the cylinder wall, and the fluid will flow into the cylinder ahead of the piston. When the pressure drops in the master cylinder, the brake-shoe return springs will pull the shoes away from the drum. As the shoes are pulled away from the drum, the shoes squeeze the wheel-cylinder pistons together, thus forcing the brake fluid to flow back into the master cylinder. The returning fluid forces the check valve to close. The entire check valve is then forced off its seat. The fluid then flows into the master cylinder around the outer edges of the valve. When the

piston in the master cylinder has returned to its released position against the stop plate, the primary cup uncovers the bypass port and any excess fluid flows through the bypass port to the reservoir. This prevents the brakes from "locking up" when the heat of the brakes causes the brake fluid to expand.

c. Cycle repeated. The check valve seats when the pressure of the piston return springs is more than the pressure of the return fluid. The valve will keep a slight pressure in the brake line and wheel cylinders. The brake system is now in position for the next brake application.

PART B - TROUBLESHOOTING

2-8. Introduction. This part provides information required for diagnosing and correcting the unsatisfactory operation or the failure of a hydraulic brake system on an item of engineer construction equipment. A job situation has been created that requires the use of Department of Army (DA) Form 5988-E (Figure 2-10, page 2-10), a troubleshooting guide (Appendix D, pages D-3 through D-13), and a maintenance allocation chart (Appendix D pages D-14 through D-15). The SEE tractor will be used for the job situations.

2-9. Requirement. The requirement for each situation is to diagnose the problem, take appropriate corrective action, and complete the DA Form 5988-E. For all situations you will be a sergeant (E-5), heavy construction repairman (62B20), assigned to B Company, 88th Engineer Battalion (Combat Heavy), Fort Chaos, Kansas. You are the senior construction-equipment repairer in the maintenance section, and you will have an operator available for assistance. Safety is a prime consideration. Ensure that the engine is shut off, all control and transmission levers are in the neutral position, the parking brake is set, and the wheels are chocked.

2-10. Initial Situation. You have received a DA Form 5988-E (Figure 2-10) with instructions to troubleshoot the hydraulic brake system. After obtaining your assigned toolbox and a copy of TM 5-2420-224-20-1, proceed to where the operator is standing by with the SEE. The most logical place to begin the troubleshooting process is to talk to the SEE operator. The operator relates that he was in the process of moving the SEE from its assigned parking position to the equipment washrack. When he reached the washrack, he attempted to stop the SEE with the service brakes. After repeatedly pushing the brake pedal without results, he had to use the parking brake to make an emergency stop. Ensuring that you observe all safety restrictions, your next step is to personally check the SEE's operation. Since there is no traffic in the general area, operate the SEE in both forward and reverse gears and verify that the wheel brakes will not stop the SEE. Using the parking brake, ease the SEE to a hardstand. Since there is no other indication of why the brakes failed, you should perform a visual inspection. Use the following paragraphs to determine what actions should be taken:

Date: 19 August 96 | Equipment Maintenance and Inspection Worksheet | DA Form 5988-E

B Company, 88th Engineer Battalion (Combat Heavy)

Equipment Data

Administrative Number: A222
Equipment Model: SEE
Equipment NOUN: TRACTOR, Wheeled 4 by 4
Equipment NSN: 2420011602754
Equipment Serial Number: 1237865743
Registration Number: 22D78621
Type inspection: Daily

	Number	Date	Change Number
Publication:	TM 5-2420-224-20-1	July 93	
Publication:	TM 5-2420-224-10	July 93	

Signature: _____ Time: _____ Signature: _____ Time: _____

Parts Requested

Fault	DOC Number	NIIN	Quantity Due/Received	Status Date	Date Completed	Priority	Deadline Code

SAMPLE

Maintenance Faults

Item Operation Number	Fault Date	Fault Status	Fault Description	Corrective Action	Hours	License Number
	20 Aug 96	X	Service brakes will not stop when applied.			

Figure 2-10. Sample DA Form 5988-E

a. Interpret inspection data. Refer to Appendix D, page D-3, paragraphs 83 and 84. Follow steps 1 through 5 below to perform this task:

Step 1. Interpret the fault-status symbol indicated on DA Form 5988-E (see Figure 2-10). Four symbols may appear in this column. Each one indicates a different fault status. Use Table 2-1 to define the symbols.

Table 2-1, Fault-status symbols

Symbol	Definition
/	This symbol indicates that there is a deficiency and the vehicle may be operated.
⊗	This symbol indicates that the vehicle may be used for limited operations.
X	This symbol indicates that the vehicle is in an inoperative status.
—	This symbol indicates that there is an inspection component replacement, or an overdue maintenance work order has not been applied.

Based on the fault-status symbol shown in Figure 2-10, page 2-10, and Table 2-1, the X indicates that the brakes are in an inoperative status.

Step 2. Use a troubleshooting guide when inspecting an unserviceable piece of equipment. The guide helps narrow down the possible causes for each discrepancy, instruct on any other checks that must be made, and determine where to go next to correct the problem.

Problem: Refer to Appendix D, page D-3, paragraphs 83 and 84. Following the inspection, determine which paragraph (83 or 84) best describes the fault status stated on DA Form 5988-E.

Solution: Determine the correct answer. Paragraph 83 (step 1) is the correct answer.

Step 3. Continue with a visual inspection of the SEE and make the following notes. This paragraph presents the most possible causes for wheel-brake failure in this situation.

- The brake-fluid level in the reservoir is full.
- There are no leaking lines.
- There are no damaged fittings.
- There is no air when bleeding the brake system.

Step 4. Refer to Appendix D, page D-3, paragraphs 83 and 84. Determine the most probable cause and solution for the brake failure by comparing your notes with the steps in paragraph 83.

Problem: Which is the correct solution for the brake-failure problem?

A. Add silicone brake fluid.
B. Tighten or replace the brake lines and fittings.
C. Bleed the brake system.
D. Replace the brake master cylinder.

Solution: Based on the findings, D is the correct answer. When reporting these findings to the maintenance supervisor, you are instructed to determine the level of maintenance needed for the replacement or repair of the master cylinder.

Step 5. Refer to Appendix D, pages D-14 and D-15, to determine the appropriate level of maintenance by locating the appropriate level in column 4.

Problem: Which maintenance level authorizes the replacement of the master cylinder?

A. C (crew)
B. O (organization)
C. F (direct support)
D. H (general support)
E. D (depot)

Solution: The correct answer is B. Based on this answer, the maintenance supervisor assigns you the task of replacing the master cylinder.

b. Remove and reinstall the master cylinder. In preparation for this task, the outside engine hood was removed, the wheels were chocked, and the parking brake was set. Suitable containers are available to catch the brake fluid. Use the following steps to remove and reinstall the master cylinder (refer to Figure 2-11):

Step 1. Tag the lines before disconnecting them to aid in reconnecting them.

Step 2. Disconnect the brake-fluid reservoir hose (1) and the clutch hydraulic reservoir hose (2). Drain each hose in a suitable container.

Step 3. Use a wrench to disconnect the two brake-line fittings (3 and 4).

Step 4. Remove the three screws (5), the three spring-tension washers (6), and the brake master cylinder (7). Discard the three spring-tension washers.

Step 5. Remove the two bleeder valves (8 and 9).

Step 6. Reinstall the two bleeder valves (8 and 9).

Step 7. Reinstall the brake master cylinder by installing the two bleeder valves (8 and 9).

Step 8. Install the brake master cylinder (7), the three screws (5), and the three new spring-tension washers (6).

Step 9. Use a wrench to connect the two brake-line fittings (3 and 4).

Step 10. Connect the two hoses (1 and 2).

Step 11. Fill the clutch hydraulic reservoir according to lubrication order (LO) 5-2420-224-12.

Step 12. Fill the brake-fluid reservoir according to LO 5-2420-224-12.

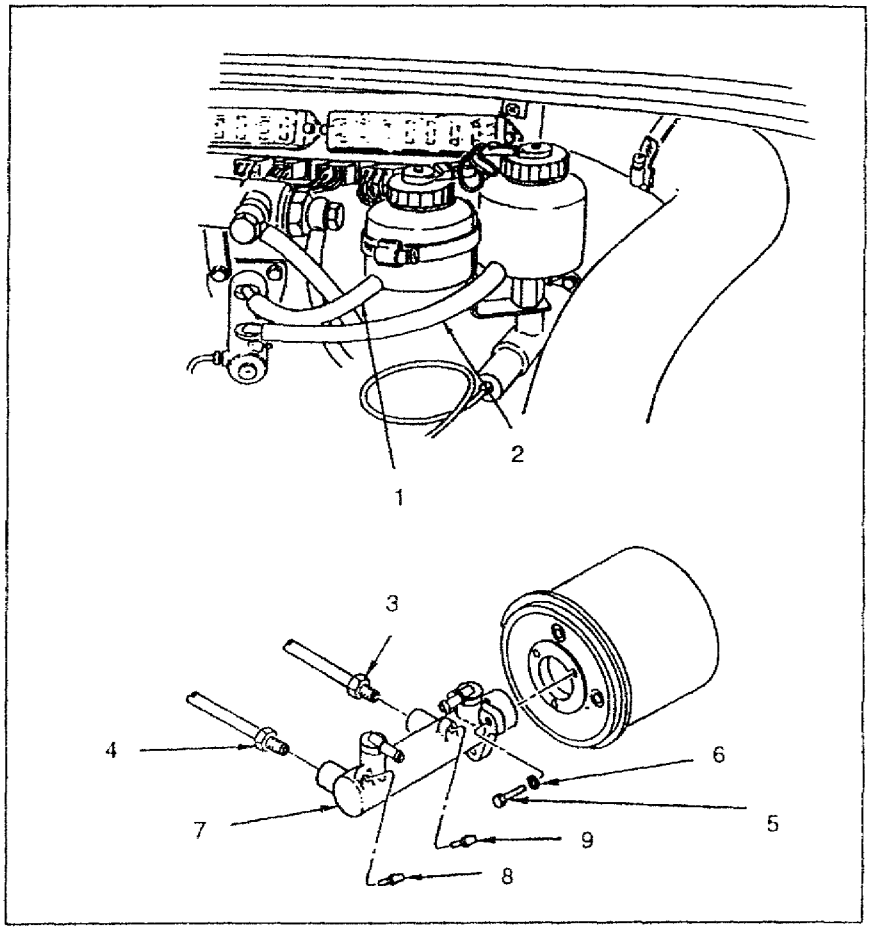


Figure 2-11. Removing and reinstalling the master cylinder

c. Bleed the brake system. Following the installation of the master cylinder, the next task is to bleed the brake system. Bleeding the brake system by pumping the brake pedal is not sufficient. Compressed air (regulated to 14.5 to 29 psi [1-2 bar]) must be used to bleed the brake system to prevent damage to the equipment. Do not reuse the brake fluid as it is considered contaminated and could damage the equipment. Follow steps 1 through 13 below (Figure 2-12, page 2-14) to bleed the brake system:

Step 1. Remove the two brake-fluid reservoir caps (1 and 2) from the two brake-fluid reservoirs (3 and 4).

Step 2. Install the two elbows (6) on the hose (5).

Step 3. Install the adapter assembly (9) to the two brake fluid reservoirs (7 and 8).

Step 4. Connect the adapter assembly (9) to the air supply hose (10). Remember to—

- Use a suitable container to catch the brake fluid.

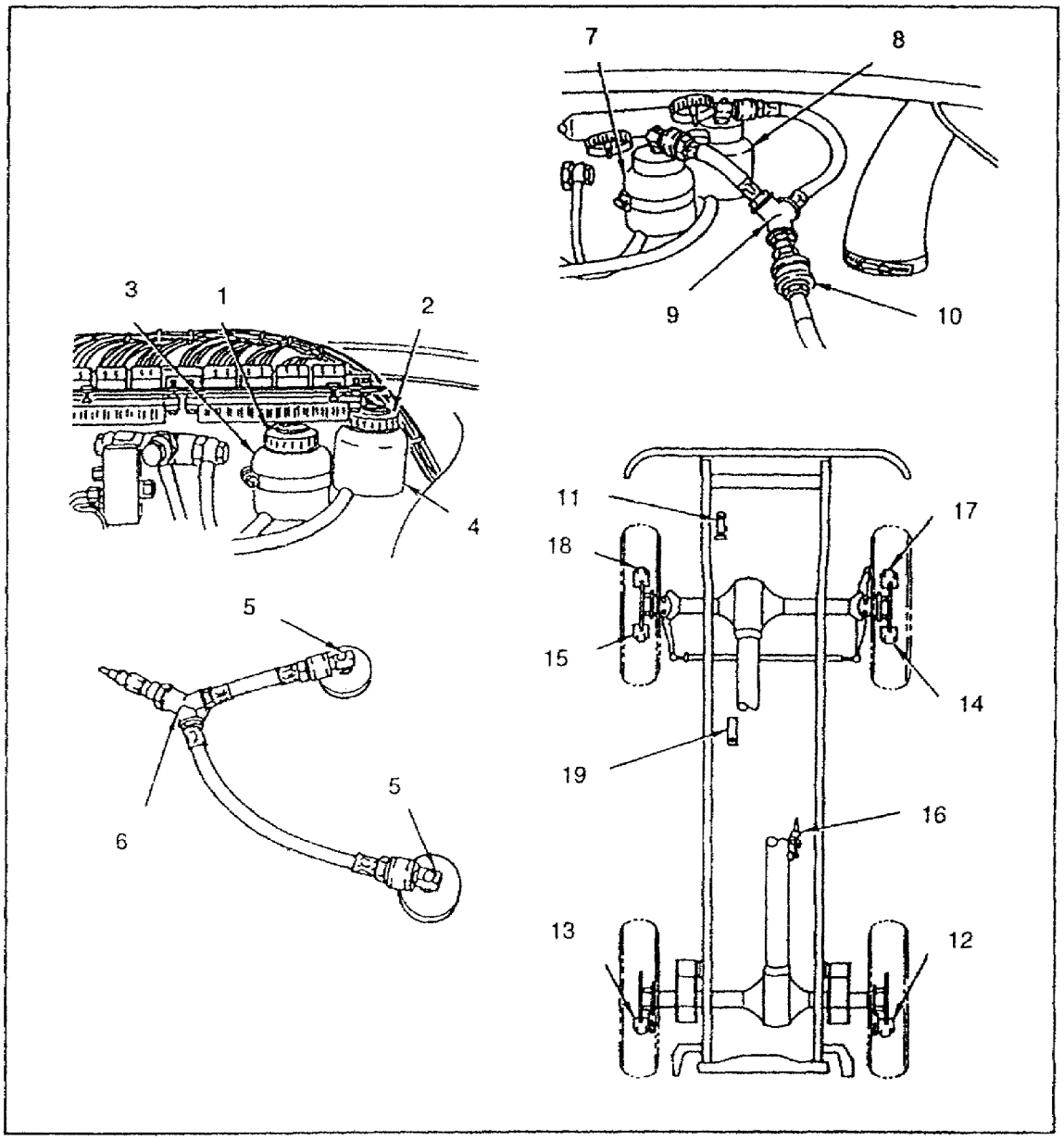


Figure 2-12. Brake system bleeding

- Open only one bleeder valve at a time.
- Observe the fluid level in the brake-fluid reservoirs and do not allow the brake fluid to go below the MIN indicator before adding more fluid to the reservoir.

Step 5. Bleed the brake system in the following order:

- Master cylinder (11) in two places,
- Right-rear caliper (12).
- Left-rear caliper (13).
- Right-front caliper (14).
- Left-front caliper (15).
- Antilock brake modulator (16).
- Right-front caliper (17).
- Left-front caliper (18).
- Clutch-slave cylinder (19).

NOTE: The brake system is considered to be properly bled when a steady stream of brake fluid, with no air bubbles, comes out of the bleeder valve.

Step 6. Disconnect the air-supply hose (10) from the adapter assembly (9).

Step 7. Remove the adapter assembly (9) from the two brake-fluid reservoirs (7 and 8).

Step 8. Remove the two elbows (6) from the hose (5).

Step 9. Fill the two brake-fluid reservoirs (7 and 8) to the MAXX indicator with brake fluid.

Step 10. Install the two brake-fluid reservoir caps (1 and 2) on the two brake-fluid reservoirs (3 and 4).

Step 11. Fill the clutch hydraulic reservoir according to LO 5-2420-224-12.

Step 12. Fill the brake-fluid reservoir according to LO 5-2420-224-12.

Step 13. Install the outside engine hood.

d. Adjust the brake pedal. The brake pedal requires adjustment at this stage of the task. Refer to Figure 2-13 while using the following steps to adjust the brakes:

Step 1. With the brake pedal (1) at neutral, the piston-rod clearance must be 0.04 inch (1 millimeter).

Step 2. If the measurement is not within tolerance, adjust the clearance by turning the eccentric screw (2).

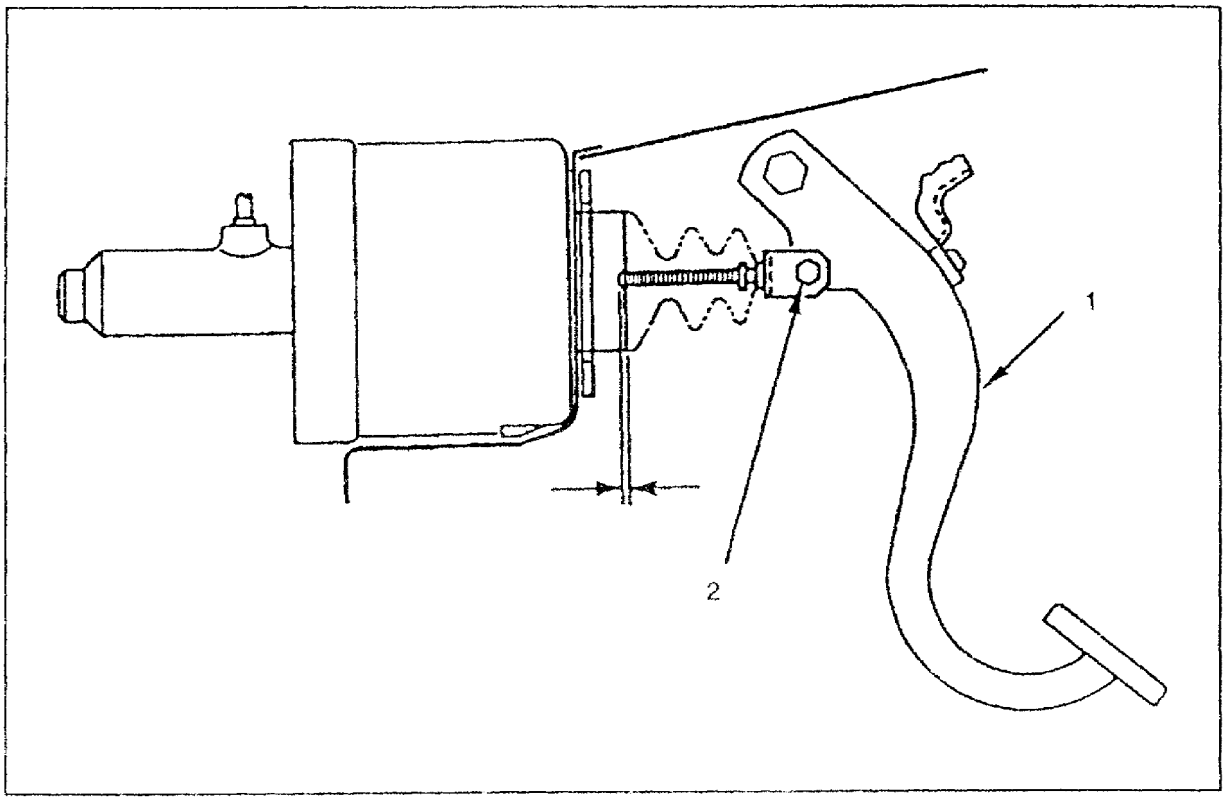


Figure 2-13. Brake-pedal adjustment

LESSON 2

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer to each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. The wheel cylinder changes hydraulic pressure into what type of force?

   A. Hydraulic
   B. Mechanical
   C. Electrical
   D. Centrifugal

2. A stepped wheel cylinder is used on the front and rear shoes to compensate for what rate of wear?

   A. Faster
   B. Slower
   C. Equal
   D. Unequal

3. The liquid used in a hydraulic brake system is known as_____.

   A. Hydraulic fluid
   B. Brake fluid
   C. OE-10
   D. GO-90

4. What status symbol would be shown on DA Form 5988-E if the brakes were inoperative?

   A. /
   B.
   C. X
   D. –

5. Which is the primary unit in the brake system that converts the force of the driver's foot into fluid pressure for operating the wheel cylinders?

   A. Linkage
   B. Brake line
   C. Brake fluid
   D. Master cylinder

6. After verifying a status fault, which of the following sources is used to determine the maintenance level?

   A. Maintenance supervisor
   B. Troubleshooting guide
   C. Maintenance allocation chart
   D. DA Form 5988-E

7. The most logical place to begin the troubleshooting process is with the

   A. DA Form 5988-E
   B. Troubleshooting guide
   C. Maintenance supervisor
   D. Operator

8. When replacing a master cylinder, what additional item must be replaced as well?

   A. Brake hoses
   B. Bleeder valves
   C. Spring-tension washers
   D. Reservoir caps

9. Pumping the pedal is not sufficient when bleeding the brake system. To prevent damage to the equipment, compressed air is used to bleed the brake system. How much air should be used?

   A. 18 to 20 psi
   B. 15 to 25 psi
   C. 14.5 to 45 psi
   D. 14.5 to 29 psi

10. Which substance should be missing from a steady stream of brake fluid that is coming out of a properly bled brake system?

   A. Oil
   B. Silicone
   C. Bubbles
   D. Hydraulic fluid

LESSON 2

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item		Correct Answer
1.	B.	Mechanical The wheel cylinder changes...(page 2-7, para 2-6)
2.	A.	Faster Due to the self-energizing action…(page 2-7, para 2-6c)
3.	B.	Brake fluid All hydraulic brake systems…(page 2-5, para 2-4a)
4.	C.	X Table 2-1 (page 2-11, para 2-10a, step 1)
5.	D.	Master cylinder The master cylinder is the …(page 2-5, para 2-5)
6.	C.	Maintenance allocation chart Refer to Appendix D…(page 2-12, para 2-10a, step 5)
7.	D.	Operator The most logical place to begin …(page 2-9, para 2-10)
8.	C.	Spring-tension washers Install the brake…(page 2-13, para 2-10b, step 8)
9.	D.	14.5 to 29 psi Compressed air (regulated to…(page 2-13, para 2-10c)
10.	C.	Bubbles **NOTE: The brake system is considered** …(page 2-15, para 2-10c, step 5)

LESSON 3

COMPRESSED-AIR BRAKE SYSTEMS

Critical Tasks: 091-62B-1005
091-62B-3054

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will understand the principles of the compressed-air brake system and how to troubleshoot, adjust, and repair this system on a Harnischfeger Model MT 250 crane.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn the principles of compressed-air brake systems.

CONDITION: You will be given the material contained in this lesson.

STANDARD: You will correctly answer practice exercise questions at the end of the lesson.

REFERENCES: The material contained in this lesson was derived from TMs 5-3810-293-14&P1 and 9-8000.

INTRODUCTION

The pressure applied at the brake pedal is transmitted to the brake mechanism by air. To better understand how pressure is transmitted by an air brake system, it is necessary to understand the principles of compressed gasses.

PART A - PRINCIPLES AND BASIC COMPONENTS

3-1. Principles. The principle characteristic of an air brake system is that the brakes, although controlled by the operator, are applied by compressed air. Compressed air provides enough braking force to control even the heaviest vehicle. Unlike liquids, gasses are compressed easily. If a gas, such as air, is confined and a force is applied to it, the gas is compressed and has less

volume (Figure 3-1). Placing a weight on a piston that fits into a container may exert such a force. The air that originally filled the entire container is pressed into only a portion of the container due to the force of the weight upon it. The pressure of the compressed air, resulting from the force exerted on it by weight, will be equally distributed in all directions just as it is in a liquid. Compressed air under pressure may be stored conveniently and made available for the power application of brakes. An air line connects the compressed air in the air reservoirs to the brake valve. The brake pedal operates the lever on the brake valve. When the brake pedal is depressed, it opens a valve in the brake valve and measures a certain amount of compressed air from the air reservoirs to go to the front and rear axles.

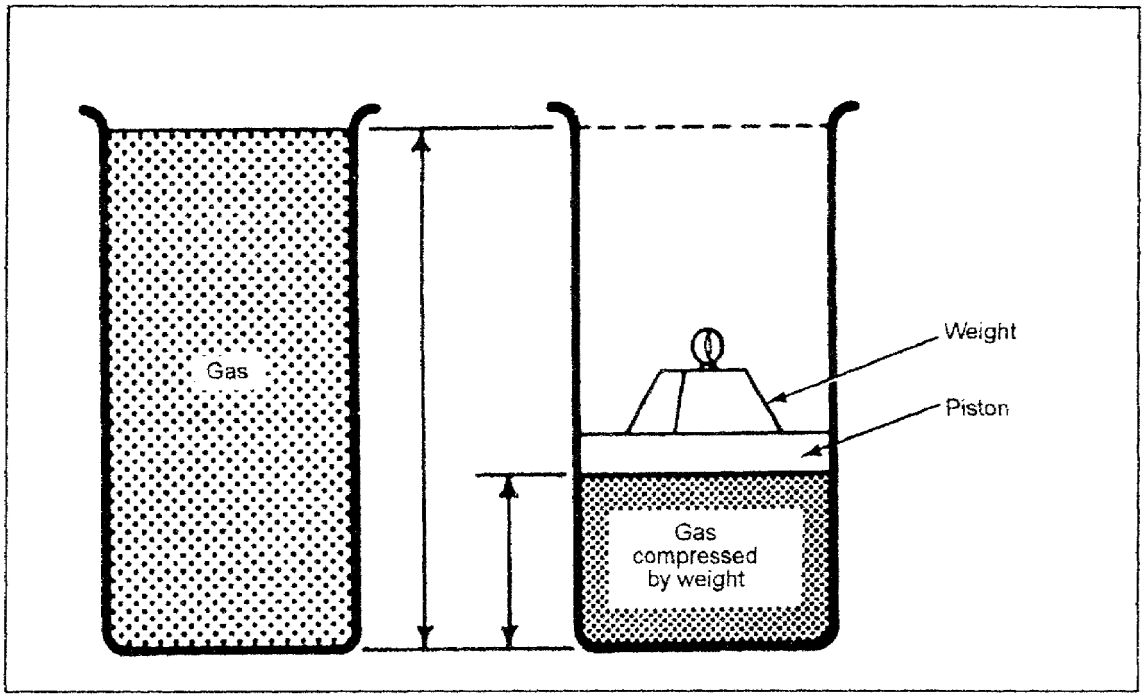


Figure 3-1. Gas compressibility

3-2. Basic Components. The compressed air brake system consists of eight components (Figure 3-2). They are the—

- Compressor.
- Reservoirs.
- Governor.
- Brake valve.
- Brake chambers.
- Quick-release valve.

- Relay valve.
- Slack adjusters.

This system is similar to the hydraulic brake systems in Lesson 2. There may be some minor differences in the compressor and the governor, but they will not affect the maintenance practices on the components. A pump or compressor driven by the engine is used to compress air and force it into a reservoir, where it is forced under pressure and made available for operating the brakes. Air under pressure in the reservoir is released to the brake lines by a valve operated by the brake pedal. This released air goes to the brake chambers (near the wheel brakes), which contain a flexible diaphragm. A plate against the diaphragm is connected directly to the mechanism on the wheel brakes by linkage. The force of the compressed air admitted to the chamber causes the diaphragm to move the plate and operate the brake shoes through the linkage. Special regulating valves operate brakes on all vehicles and trailers.

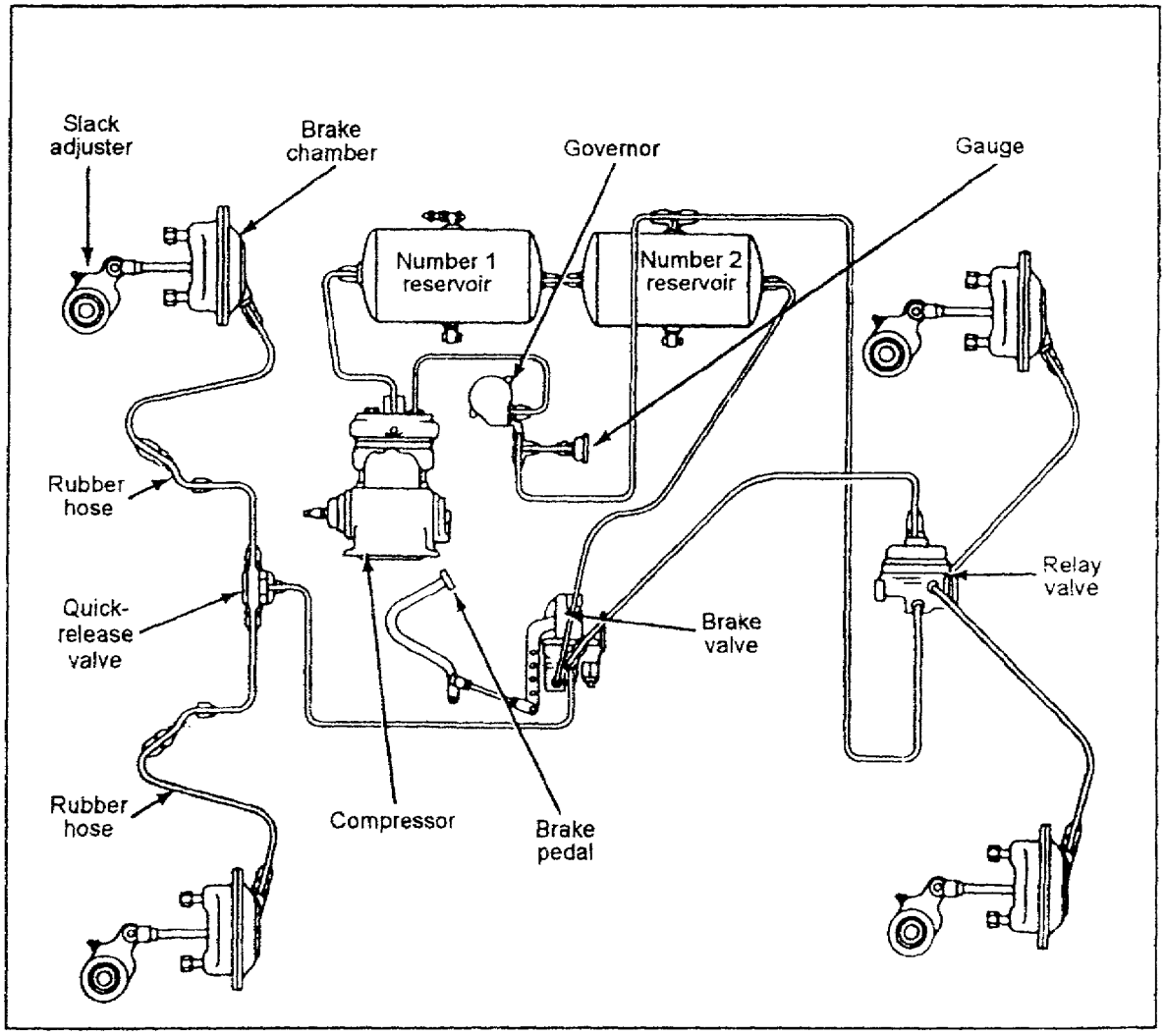


Figure 3-2. Compressed-air brake system and components

a. Air compressor and air reservoir. The air compressor furnishes compressed air for brake operations. It is driven directly from the engine crankshaft or from one of the auxiliary shafts. The air reservoir receives air from the compressor and stores it for use in the brake system.

(1) Description. Air compressors are usually single-acting reciprocating units, either self-lubricated or lubricated from the vehicle engine's lubricating system. Both water-cooled and air-cooled cylinder heads are used. Air compressors with a displacement of approximately 7 cubic feet per minute (cfm) have two cylinders, while those with a displacement of 12 cfm have three cylinders. A typical air compressor is shown in Figure 3-3.

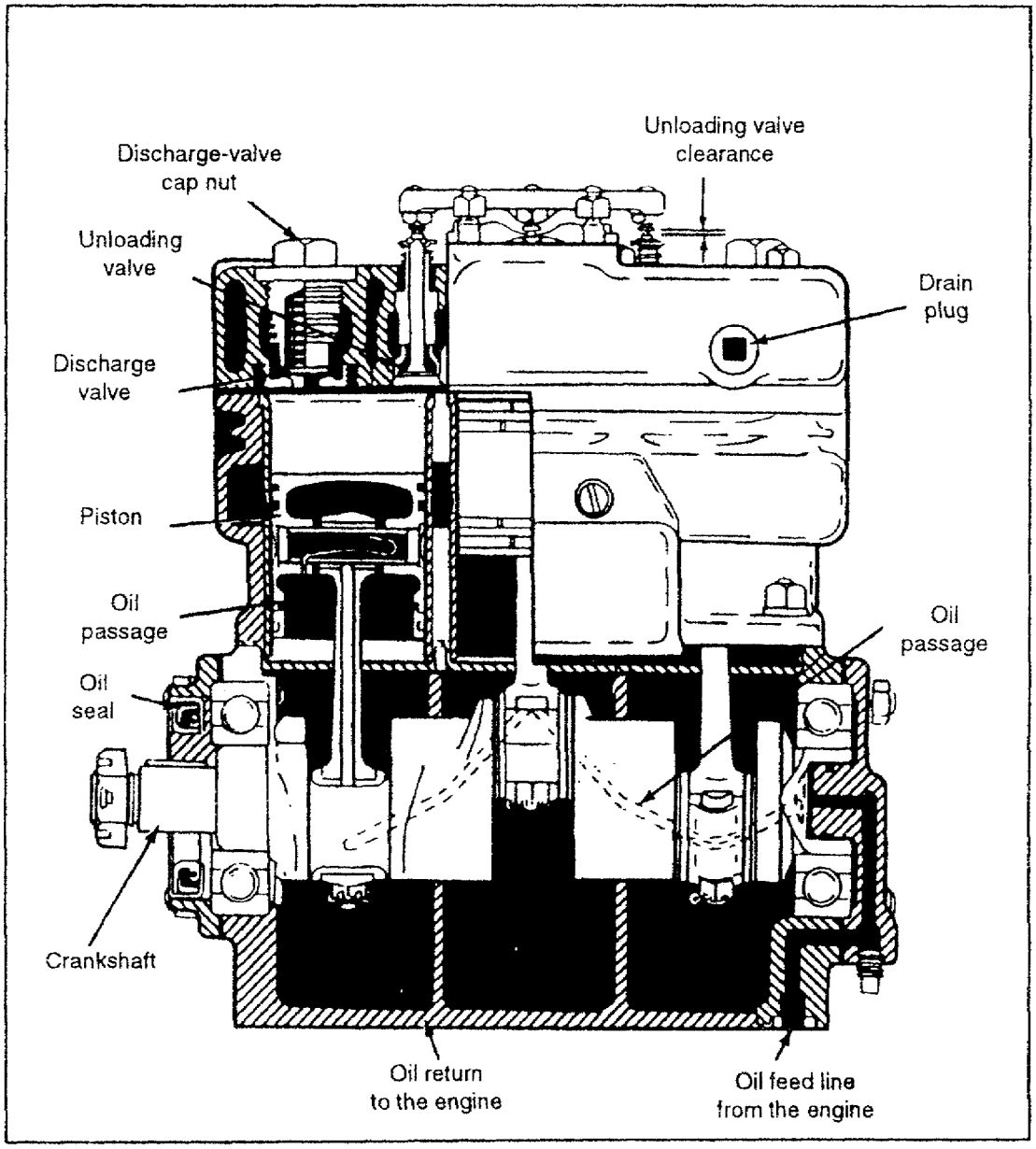


Figure 3-3. Typical air compressor

(2) Operation. Air compressors operate continuously while the engine is running, but the governor controls the actual compression of air. With a partial vacuum created on the piston downstroke, intake ports are uncovered near the bottom of the stroke. Intake ports are covered as the piston starts its upstroke, and air in the cylinder is compressed. The pressure lifts the discharge valve, and the compressed air is discharged to the reservoirs. When the piston starts its downstroke, the discharge valve closes as soon as the pressure is relieved. When the reservoir air pressure reaches the maximum setting of the governor, air under pressure is allowed to pass into a cavity below an unloading diaphragm in the cylinder head. This air pressure lifts one end of the unloading lever, which pivots on its pin and forces the unloading valves off their seats. With the unloading valves off their seats, an unloading cavity forms a passage between the cylinders and the compression is stopped. A drop in air pressure below the minimum setting of the governor causes the unloading valves to release the air pressure from beneath the unloading diaphragm. The unloading valves return to their seats, and compression is resumed.

b. Air governor. This component limits the pressure produced by the compressor.

(1) Description. The air governor (Figure 3-4) maintains the air pressure in the reservoir by controlling the compressor-unloading mechanism.

(2) Operation. A gear-driven air compressor mounted on an engine supplies air pressure for the brake system. Compressed air is stored in interconnected metal tanks. Pressure produced by the compressor is controlled by the air governor, which controls the operation of the compressor. The air governor is set to regulate the pressure in the air system at 100 psi. When air use drops the pressure, the air governor is actuated to cause the air compressor to build up the set pressure.

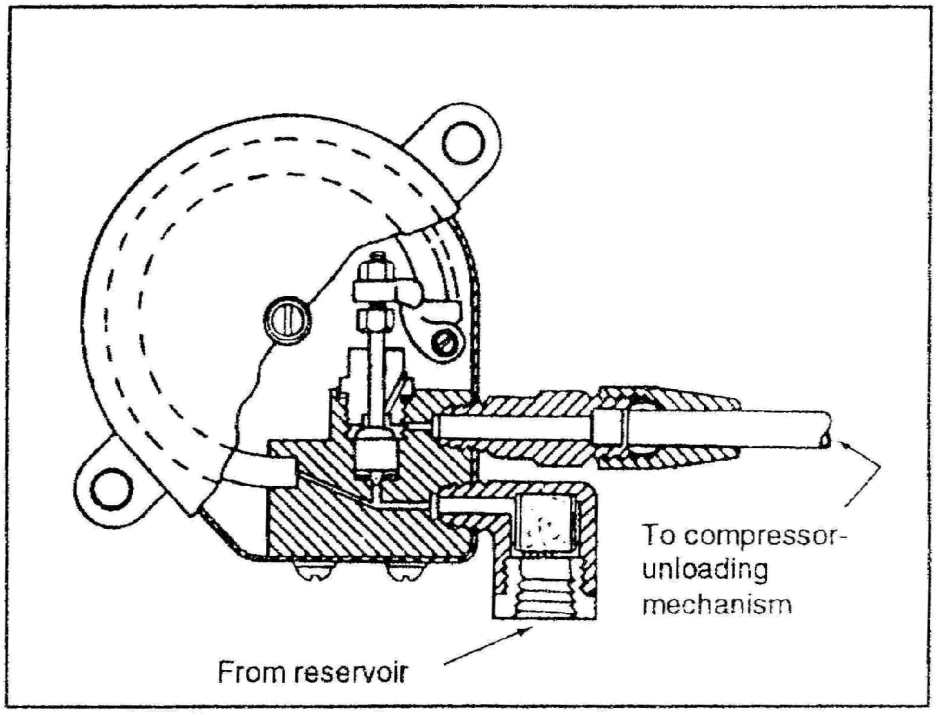


Figure 3-4. Air governor

c. Air brake valve. This component controls the brake operation. It directs the flow of air from the reservoir to the air brake chambers when the brakes are applied and from the air brake chambers to the atmosphere when the brakes are released.

(1) Description. The air brake-valve lever is connected to the brake pedal. The lever controls the operation of the inlet and exhaust valves (Figure 3-5). These valves control the air that is delivered to or released from the brake chamber.

(2) Operation. When the brake pedal is depressed, the air brake-valve lever moves toward its applied position. The plunger and the regulating spring are forced down, applying mechanical force on the diaphragm. The exhaust-valve spring is weaker than the intake-valve spring, so the exhaust valve is forced downward onto its seat before the intake valve is opened. When the intake valve opens, air from the reservoir is allowed to flow through the air brake valve to the air brake chambers to apply the brakes. When the air pressure below the diaphragm overcomes the mechanical force exerted on top of the diaphragm, the diaphragm lifts enough to close the intake valve and maintain a constant air pressure in the system. Further depression of the pedal puts additional mechanical force on the diaphragm, thereby allowing further brake application. If the operator releases the brake pedal, reducing the mechanical force on the diaphragm, the inlet valve remains closed while the exhaust valve opens to allow the air to be exhausted from the air brake chambers to release the brakes.

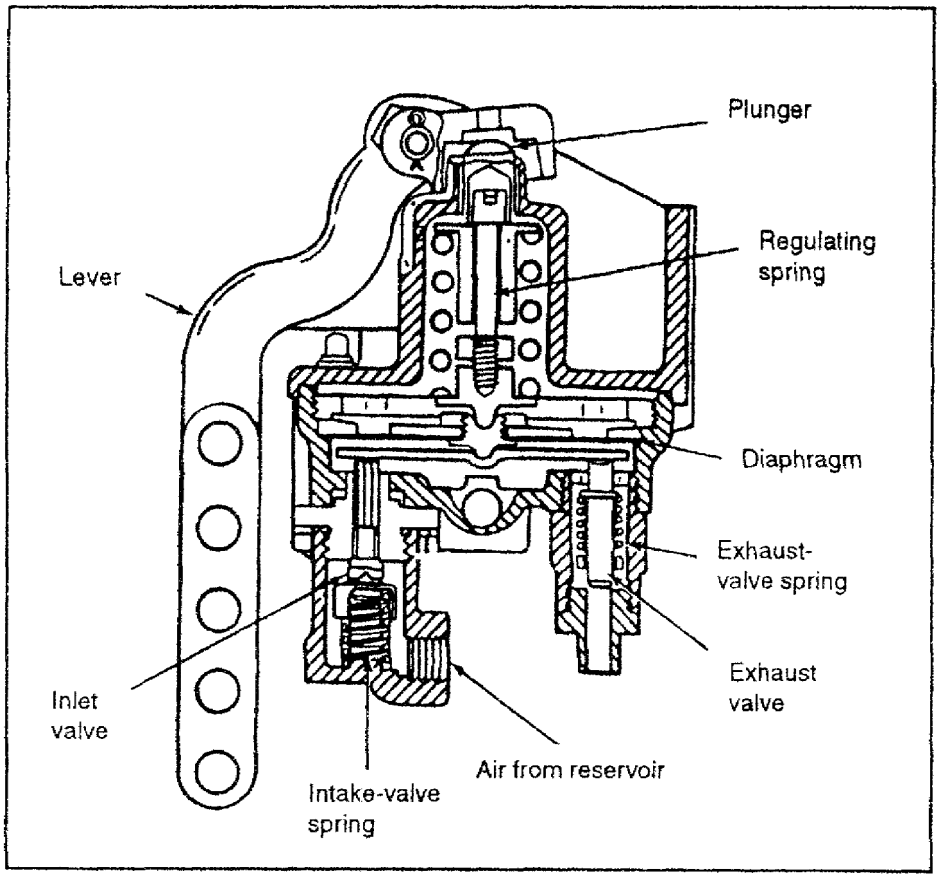


Figure 3-5. Air brake valve

d. Air brake chambers. These components (one for each wheel) are used to convert the pressure of the compressed air into mechanical force for applying the brakes.

(1) Description. An air brake chamber (Figure 3-6) at each wheel converts air pressure to mechanical motion.

(2) Operation. Air under pressure enters an air brake chamber behind the diaphragm. The diaphragm compresses the return spring, causing the pushrod to travel. The slack adjuster rotates and turns the camshaft. An S-cam connected to the end of the camshaft turns and pushes the brake shoe assemblies apart, causing the brakes to apply.

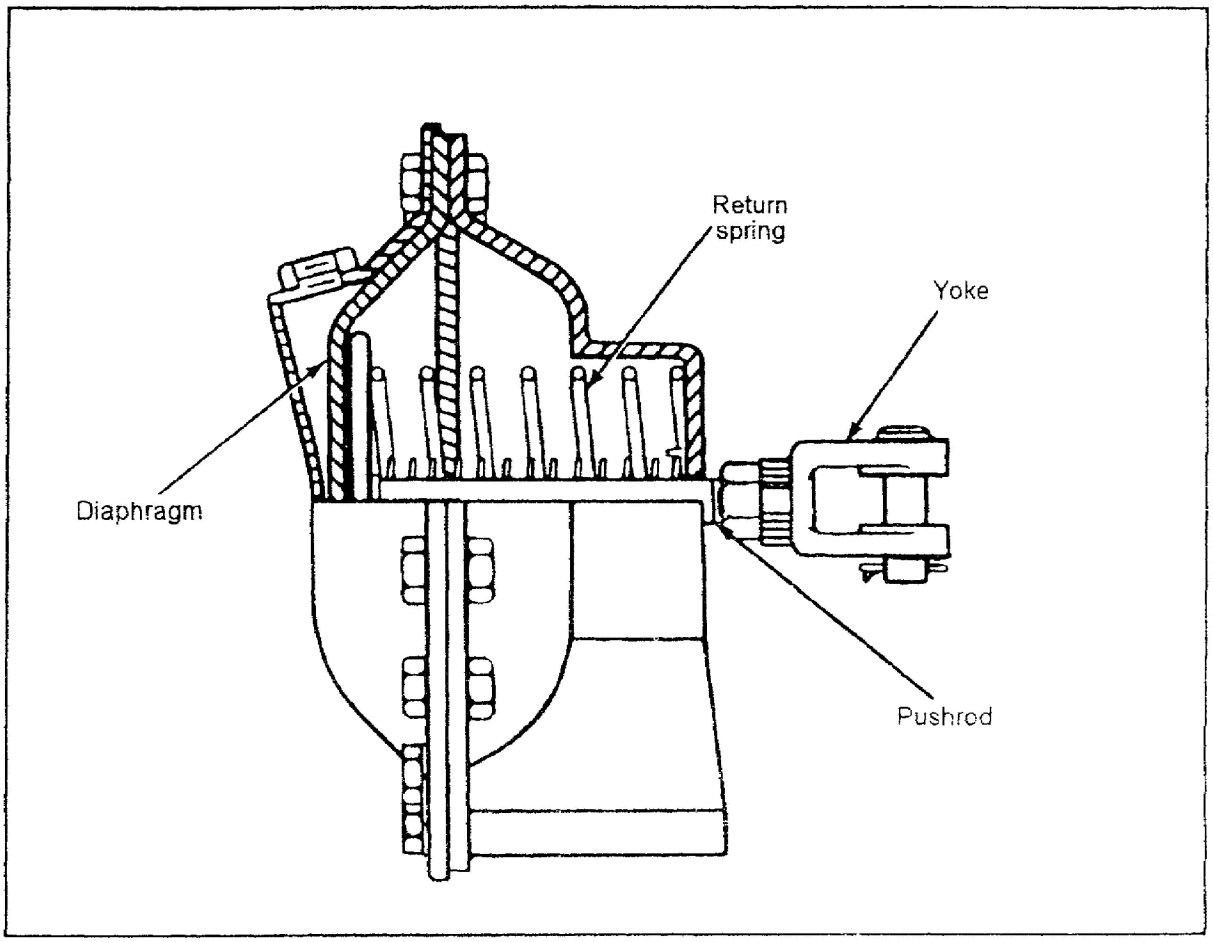


Figure 3-6. Air brake chamber

e. Air quick-release valve. This component is used to speed up the exhaust of the ,air brake chambers, so that all the brakes may be quickly released. The.;: e chambers : -re not close to the brake valve.

(1) Description. The valve (Figure 3-7, page 3-8) is an air line that goes from the brake valve to the front axle. The air quick-release valve is provided to reduce the time required to release the brakes by slowing the exhaust of air under pressure from the air brake chambers.

(2) Operation. The valve contains a spring-loaded diaphragm that allows airflow through the valve in only one direction. In the brake-application piston, air that is under pressure from the brake valve enters the inlet port. The diaphragm is forced downward and closes the exhaust port. The air that is under pressure then deflects the outer edges of the diaphragm downward and enters the brake chambers to apply the brakes. When the air pressure in the chambers and below the diaphragm equals the air pressure above the diaphragm, the diaphragm spring forces the outer edge of the diaphragm up against the valve body, closing the brake chambers for the inlet port. In this holding position, the diaphragm continues to keep the exhaust valve closed. If the pressure above the diaphragm is reduced or is completely released by the operator releasing the brake pedal (partially or completely), the air pressure below the diaphragm causes the diaphragm to raise opens the exhaust port, and releases the brake chamber's air pressure.

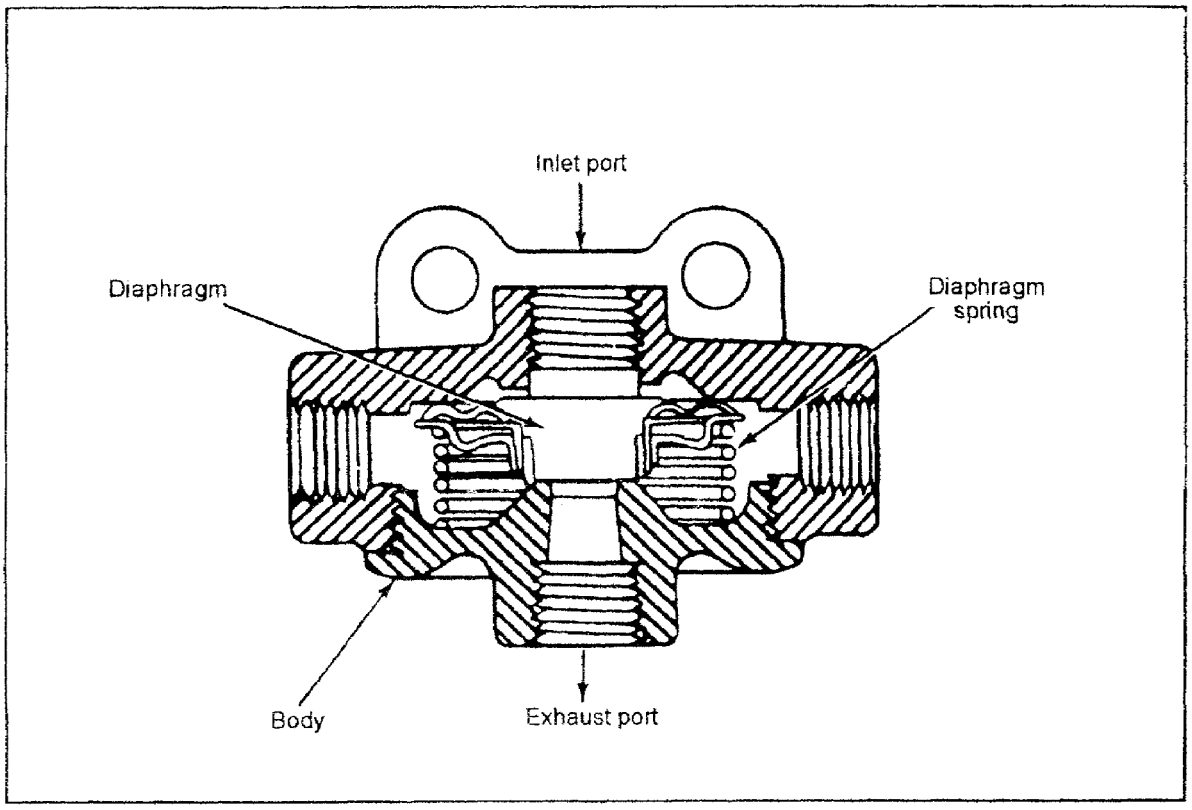


Figure 3-7. Air quick-release valve

f. Air relay valve. This component is used to speed the operation of the rear wheel brakes on trailers and trucks with long wheelbases. Shorter brake lines permit rapid brake action without the aid of a relay valve on trucks with short wheelbases.

(1) Description. An air line connects the brake valve to the air relay valve (Figure 3-8) located at the rear of the vehicle. Normally, this line also contains the stoplight switch. A second air line supplies reservoir air pressure to the air relay valve. The air relay valve is controlled by the brake valve and speeds up application and release of the rear wheel brakes

for long wheelbase vehicles. It reacts quickly to slight changes in air pressure from the air brake valve.

(2) Operation. When the brake pedal is depressed, the brake valve meters a certain amount of air to the relay valve. This air opens a valve in the air relay valve and allows a small amount of air from the air reservoir to go to each of the air brake chambers for the rear wheels. When the brake pedal is released, air pressure in the line between the brake valve and the relay valve is released. This closes the valve in the air relay valve, shutting off the air supply from the air reservoir. At the same time, an air quick-release valve in the relay valve opens and allows the air pressure in the air brake chambers to escape. This, in turn, releases the rear brakes. The air in the line from the brake valve escapes from the brake valve's exhaust valve. The amount of braking action applied to the truck wheels depends on how far down the brake pedal is depressed. When the pedal is pressed down, a greater amount of air pressure is applied to the air brake chambers. This causes the brake shoes and linings to press harder against the brake drums and provides a greater braking action.

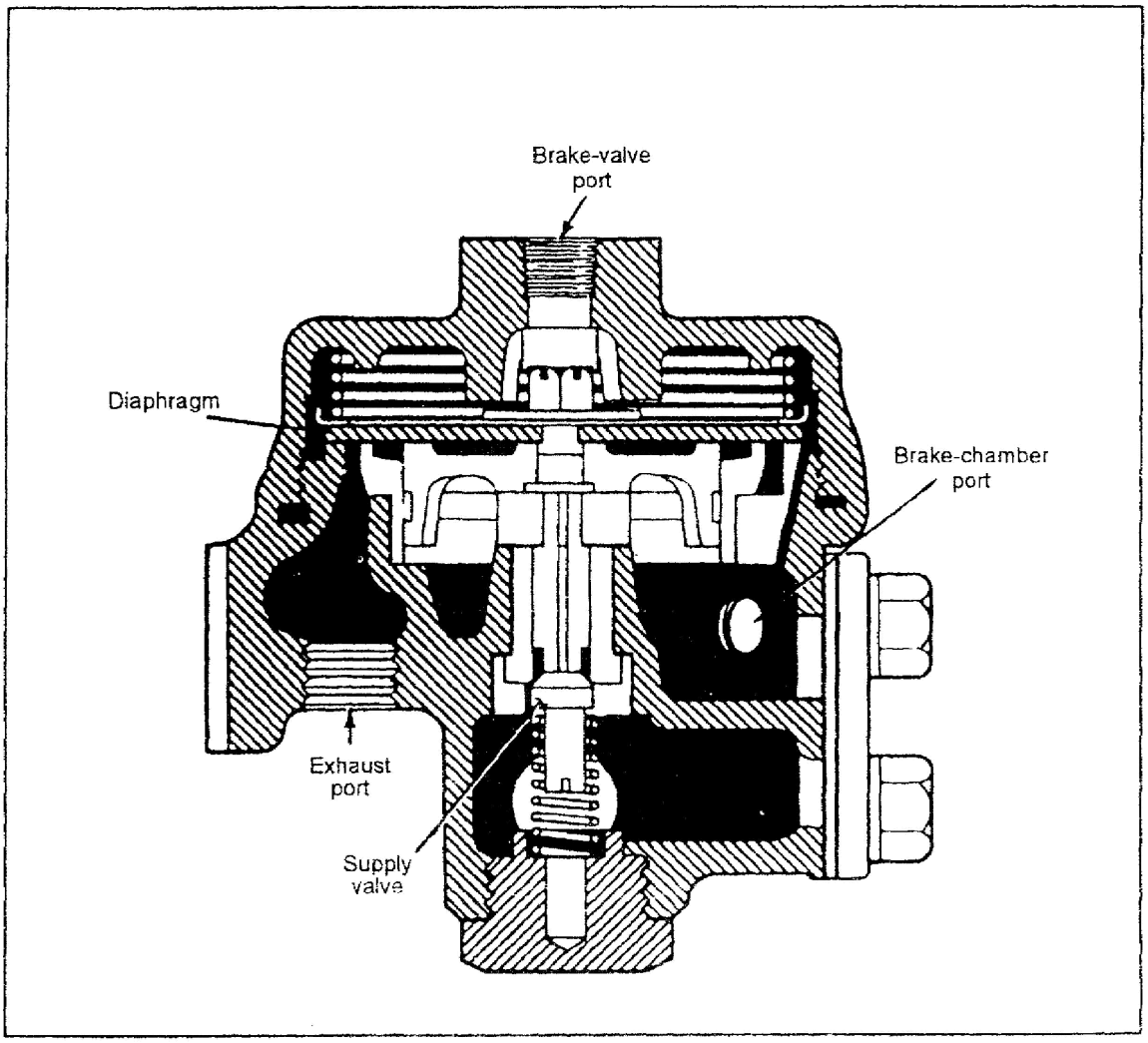


Figure 3-8. Air relay valve

g. Slack adjuster. This component is used to adjust the brakes to compensate for lining wear.

(1) Description. The slack adjuster functions as an adjustable lever and provides a means of adjusting the brakes. The pushrod of the air brake chamber is connected to a slack adjuster. The slack adjuster (Figure 3-9) serves two purposes–it changes the back- and-forth motion of the pushrod to rotary motion and makes minor adjustments to the brake shoes and linings.

(2) Operation. The slack adjuster is splined to one end of a shaft that goes through the backing plate of the wheel brake. The other end of the shaft contains a cam. When the air brake chamber pushrod moves the toe end of the slack adjuster, it causes the shaft to rotate. As the cam on the brake end of the shaft rotates, it causes the brake shoes and linings to move against the drum. Rotating the worn shaft on the slack adjuster makes a minor adjustment to the brakes. The wheel brake assemblies are much the same as those for hydraulic or air-over-hydraulic systems. The main difference is that the wheel cylinder is replaced with an operating cam.

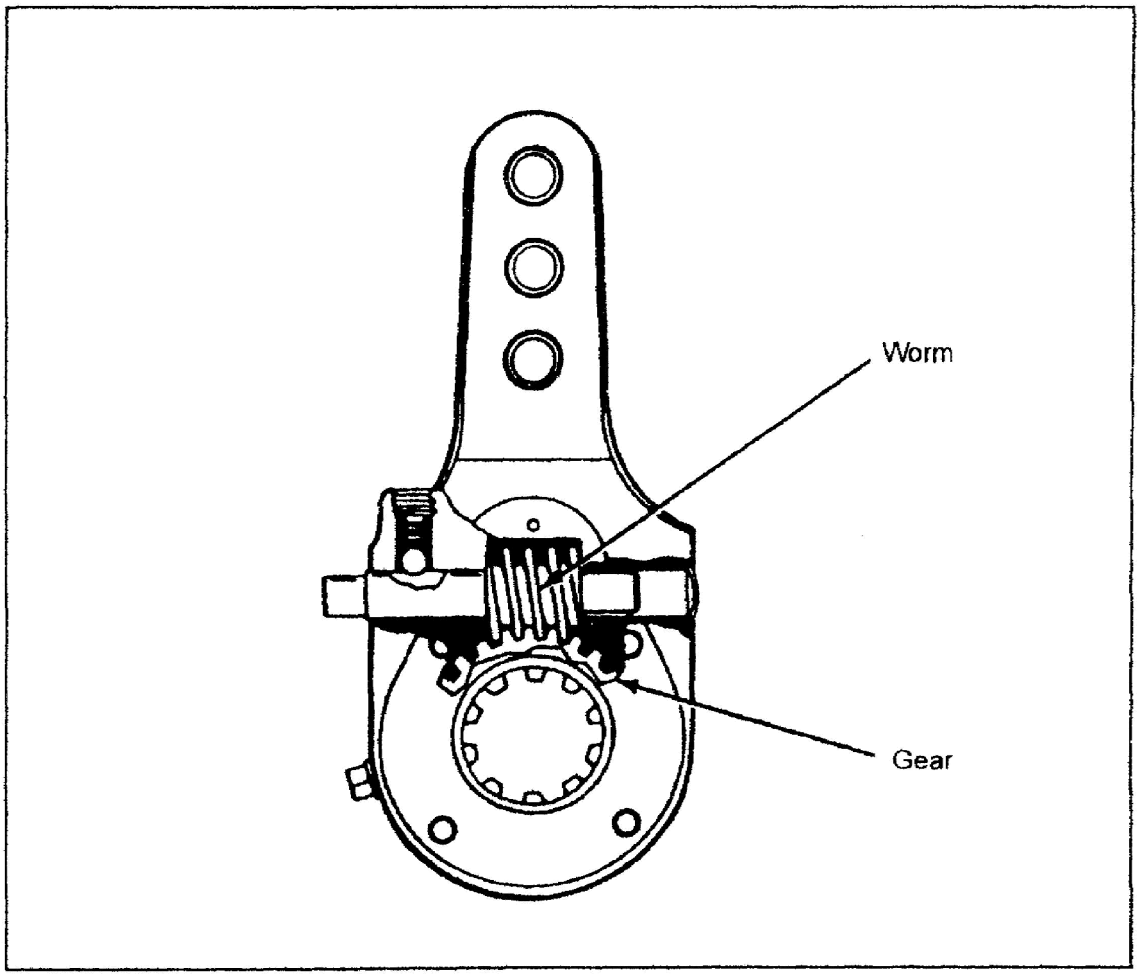


Figure 3-9. Slack adjuster

PART B - TROUBLESHOOTING

3-3. Introduction. This lesson provides information required for diagnosing and correcting the unsatisfactory operation or the failure of an item of engineer construction equipment and its components is provided in this lesson. A job situation has been created that requires the use of a maintenance allocation chart (Appendix D, pages D-16) and a troubleshooting guide (Appendix D, pages D-17 and D-18).

3-4. Requirement. The equipment used throughout the job situation is a Harnischfeger Model MT-250 25-ton crane. Your requirement is to troubleshoot the problem and take the appropriate corrective action. Your duty assignment will be the same as in Lesson 2 (page 2-9), and an operator will assist you. Safety is a prime consideration. Ensure that the engine is shut off, all control and transmission levers are in the neutral position, the parking brake is set, and the wheels are chocked.

3-5. Initial Situation. You have been assigned to troubleshoot the brake system on a Harnischfeger Model MT-250 25-ton crane. The fault description on DA Form 5988-E (Figure 3-10, page 3-12) states that air pressure will not build to the normal pressure and air can be heard escaping around the air tank. A visual inspection reveals a ruptured air tank. The following paragraphs show what actions need to be taken:

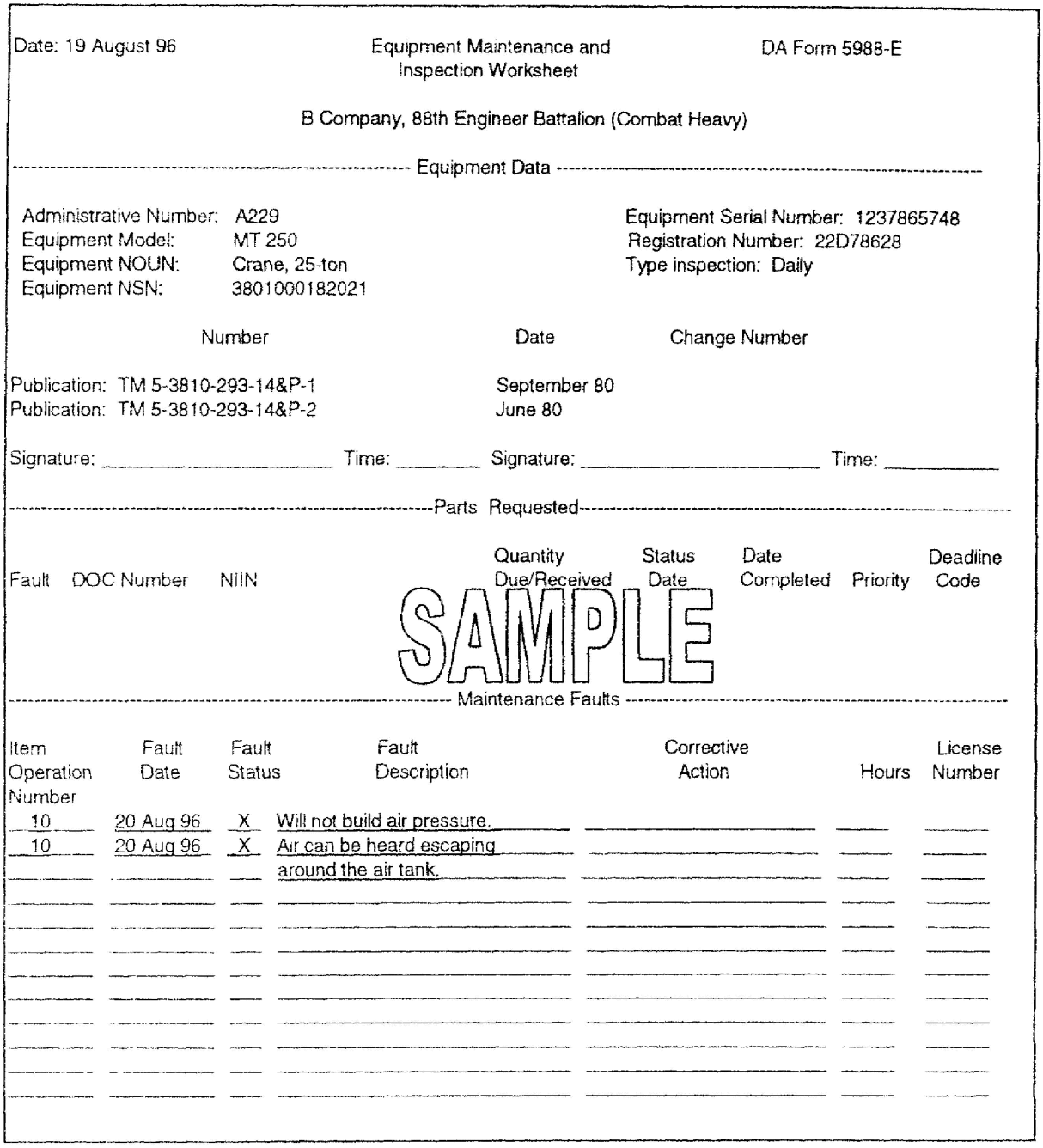
a. Interpret the inspection data. Use steps 1 through 3 below to perform this task:

Step 1. Based on the fault description information from DA Form 5988-E, use the maintenance allocation chart (Appendix D, page D-16) to determine what maintenance level has the responsibility for replacing the air tank.

Step 2. If the operation is at the organizational level, use Appendix D, pages D-19 and D-20, to determine the figure and item numbers, the correct equipment nomenclature (NOUN), and the part or national stock number (NSN).

Step 3. A quick look at Appendix D, page D-16, shows that replacement of an air-tank is an organizational maintenance responsibility. You should have located the air' tank under its correct equipment NOUN of "reservoir, air." The air reservoir in Appendix D, pages D-19 and D-20, refers to reference number 52 and part number 27Z5. The maintenance supervisor has instructed you to remove and install the air reservoir; however, this lesson will not go into the steps required but will move to the next situation.

b. Determine what caused the air reservoir to erupt. When checking the troubleshooting guide (Appendix D, pages D-17 and D-18), you noted statements, concerning broken, leaking, or restricted tubing or hose lines. These were listed under all of the following malfunctions: brakes apply too slowly, brakes release too slowly, brakes do not apply, brakes do not release, air pressure drops quickly with engine stopped and brakes released, and air pressure drops quickly with engine stopped and brakes fully applied. Broken, leaking, or restricted tubing or hose lines are the cause of many malfunctions. You have been instructed by the maintenance supervisor to replace the hose assembly. Use the following steps to perform this task:



Date: 19 August 96 Equipment Maintenance and Inspection Worksheet DA Form 5988-E

B Company, 88th Engineer Battalion (Combat Heavy)

Equipment Data

Administrative Number: A229
Equipment Model: MT 250
Equipment NOUN: Crane, 25-ton
Equipment NSN: 3801000182021

Equipment Serial Number: 1237865748
Registration Number: 22D78628
Type inspection: Daily

	Number	Date	Change Number
Publication:	TM 5-3810-293-14&P-1	September 80	
Publication:	TM 5-3810-293-14&P-2	June 80	

Signature: _____ Time: _____ Signature: _____ Time: _____

Parts Requested

Fault	DOC Number	NIIN	Quantity Due/Received	Status Date	Date Completed	Priority	Deadline Code

SAMPLE

Maintenance Faults

Item Operation Number	Fault Date	Fault Status	Fault Description	Corrective Action	Hours	License Number
10	20 Aug 96	X	Will not build air pressure.			
10	20 Aug 96	X	Air can be heard escaping around the air tank.			

Figure 3-10. Sample DA Form 5988-E

Step 1. Check Appendix D, page D-16, to confirm that replacing the hose assembly is an organizational-level task.

Step 2. Determine the materials required to replace the hose assembly by using Appendix D, pages D-19 and D-20. Reference number 20 is the material needed to replace the hose assembly (part number 820P292D2, hose assembly, treadle service and supply, and two each). Steps for replacing the hose assembly will not be covered in this lesson.

c. Repair service brakes. Use the following steps to perform this task:

Step 1. Use Appendix D, page D-16, to determine the maintenance functions you are authorized to perform on the service brakes.

Step 2. As indicated in Appendix D, page D-16, service brake adjustment is authorized for organizational maintenance. Figure 3-11, page 3-14, shows the slack adjuster with its locking sleeve and (Figure 3-12, page 3-14) shows the adjusting screw installed on the front wheel brake chamber. Repair the service brakes as follows:

- Use the outriggers to raise the wheels off the ground.

- Push in the locking sleeve on the slack adjuster and turn the adjusting screw until the stroke required to apply the brakes is reduced to 1 inch.

NOTE: Use either an open-end or socket wrench to turn the adjusting screw. Ensure that the locking sleeve is held in, thereby disengaging the locking mechanism. Never use a wrench on the locking sleeve.

- Check the brake adjustment by making several brake applications. The air-chamber pushrod should move a total of 1 inch from the released position to the applied position.

- Ensure that the brake shoes are not dragging by releasing the brakes and spinning the wheel by hand.

NOTE: Use a feeler gauge to check the lining-to-drum clearance of the front brakes. If the clearance is more than 0.06 inch (1.5 mm), adjust the brakes manually as described below and schedule the vehicle for brake service.

- Jack or hoist the front wheels off the ground.

- Remove the dustcover from the adjusting slots above and below the brake chambers.

- The adjusting bolts have right-handed threads. Use an adjusting spoon to turn the steering wheel until a heavy drag develops, then back off the star wheel to a light drag on the drum. Reinstall the dustcovers in the adjusting slots.

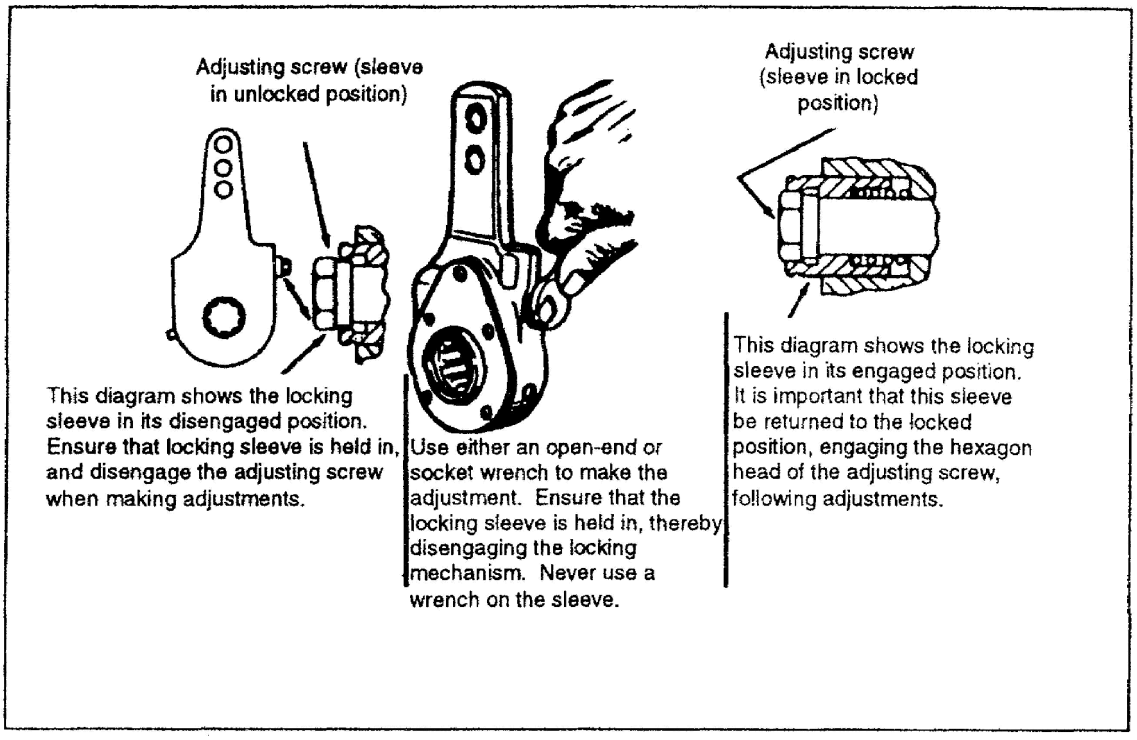


Figure 3-11. Slack adjusters

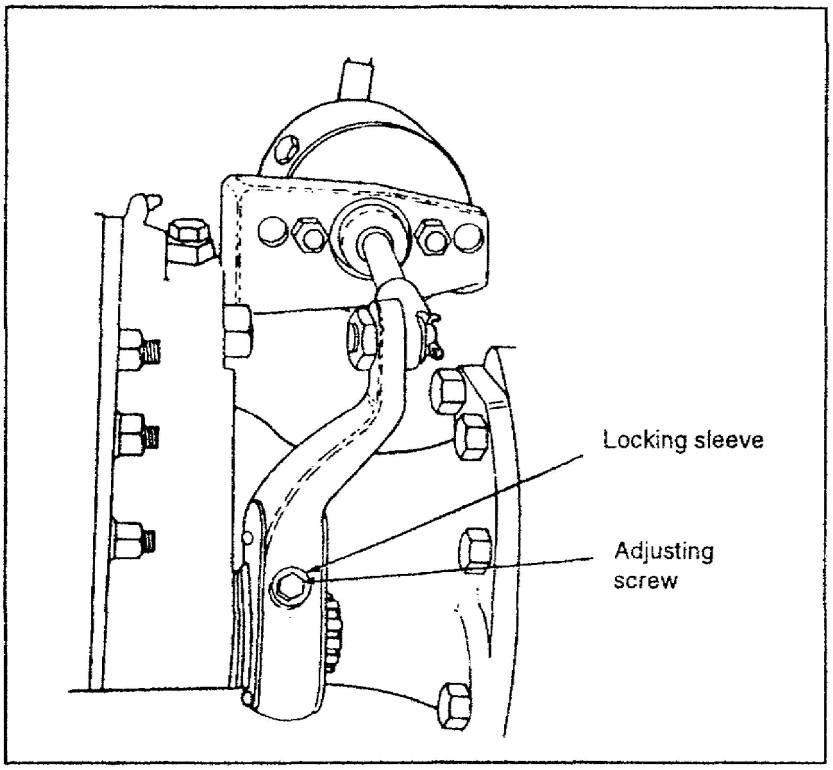


Figure 3-12. Front wheel brake chamber

d. Perform a leakage test. Periodically, a leakage test is performed to determine whether a brake chamber is suitable for continued service. You have been assigned this task. Use the following steps to test for leakage (Figure 3-13):

Step 1. Have the operator make and hold a full brake application.

Step 2. Coat the nonpressure housing, the clamping ring, and the inlet ports and fittings with a soap solution. Ensure that there is no leakage at these points.

Step 3. Tighten the clamp bolt only enough to stop the leakage if leakage is detected around the clamping ring. Tightening the clamp bolt excessively could distort the diaphragm sealing flange.

Step 4. Disassemble and repair the brake chamber if leakage occurs at the nonpressure housing or if leakage cannot be stopped by tightening the clamp bolt.

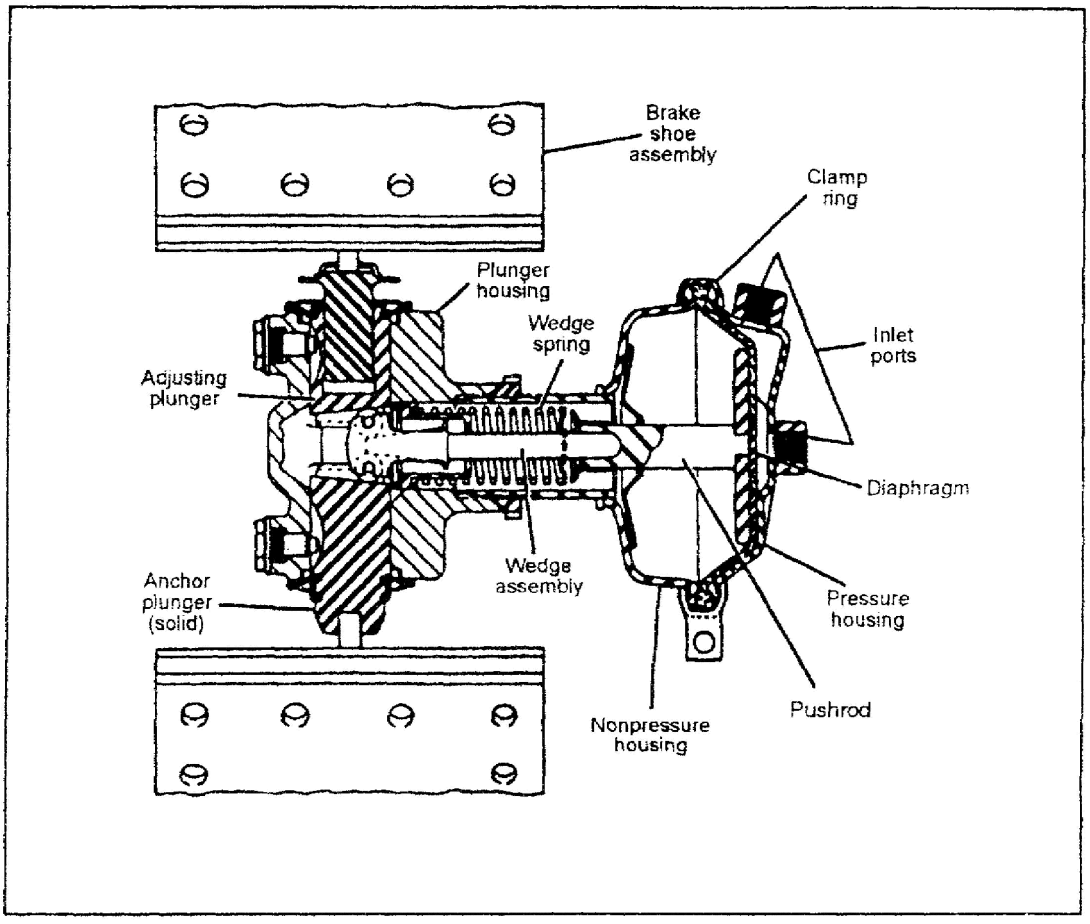


Figure 3-13. Brake chamber

e. Replace the brake chamber. According to the maintenance allocation chart (Appendix D, page D-16), replacement of the brake chambers is a function of organizational-level maintenance.

(1) To replace the front brake chamber, it must be removed before it can be disassembled and reassembled. Use steps 1 through 5 below to remove the brake chamber (Figure 3-14):

Step 1. Release all the air pressure.

Step 2. Remove the slack-adjuster cotter pin.

Step 3. Unscrew the air-line connector at the rear of the brake.

Step 4. Remove the mounting nuts and washers.

Step 5. Remove the front brake chamber.

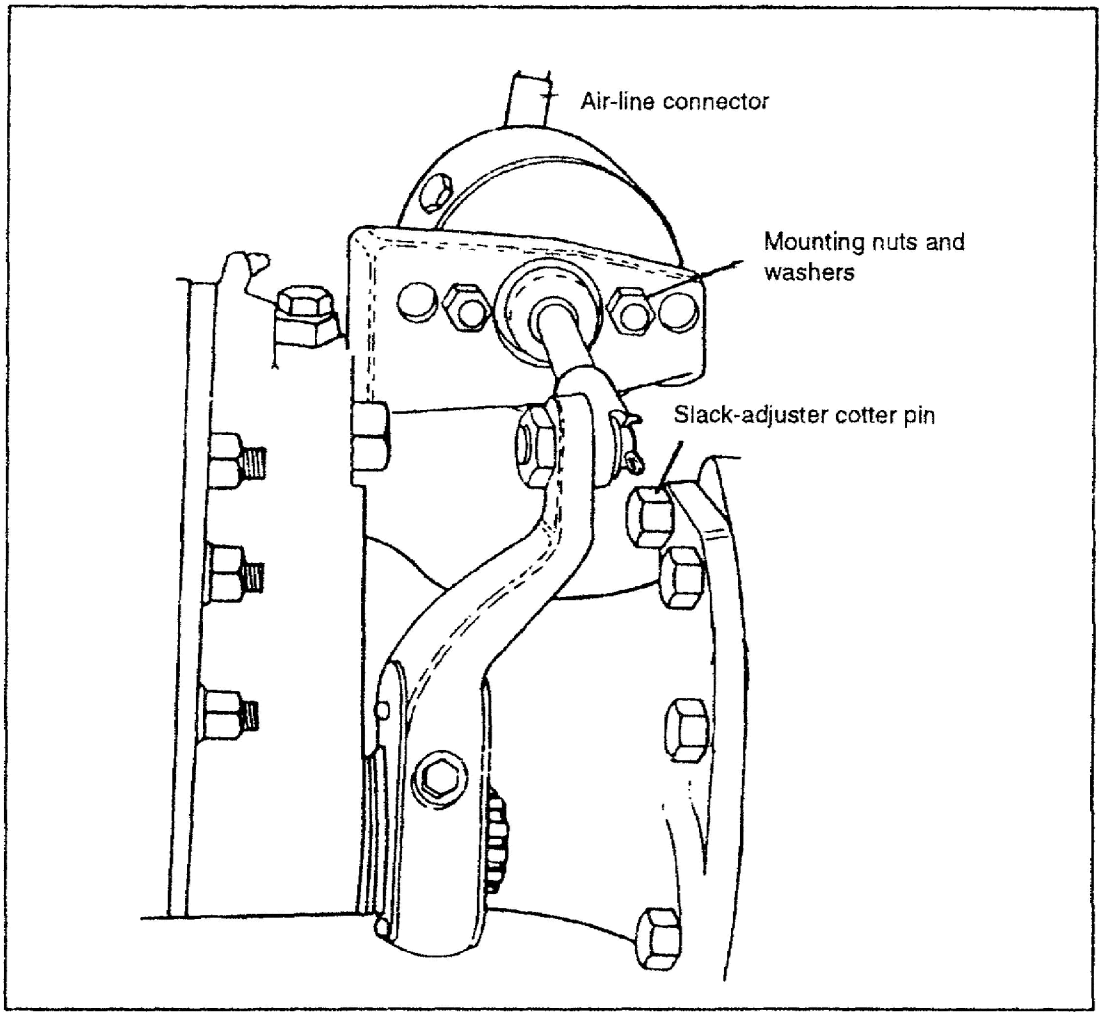


Figure 3-14. Front brake chamber

(2) To disassemble and reassemble the front brake chamber, refer to Figure 3-15 and use the following steps listed for each procedure:

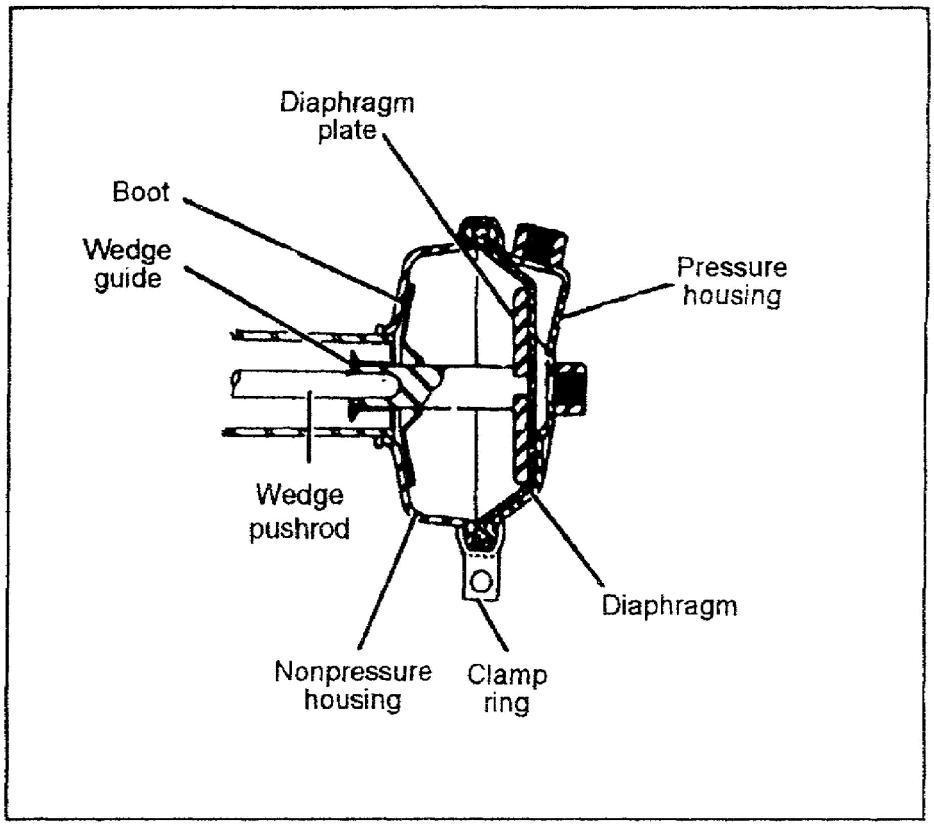


Figure 3-15. Brake chamber

(a) Disassemble. The following steps describe the method for removing the diaphragm and the boot. These items are the ones that cause leakage when the brake chamber is on the machine.

Step 1. Disconnect the air line or lines at the brake chamber.

Step 2. Remove the clamp ring and the nut bolt. While holding the pressure housing in place, spread the clamp ring and remove it.

Step 3. Hold the diaphragm against the nonpressure housing and remove the pressure housing.

Step 4. Remove the diaphragm carefully while holding the diaphragm plate against the wedge rod. This prevents the wedge assembly from coming out of engagement with the plungers.

NOTE: If the wedge assembly backs out of the plungers at anytime during the procedure, it will be necessary to remove the brake shoes to replace the wedge assembly.

Step 5. Continue to hold the diaphragm plate and inspect the boot. If the boot is torn or not attached to the nonpressure housing, strip the old boot from the housing.

Step 6. Extract the diaphragm plate carefully from the wedge assembly. The boot and the wedge guide will remain on the diaphragm-plate pushrod.

(b) Reassemble. The following steps describe the method for installing a new diaphragm and boot.

Step 1. Install a new boot on the diaphragm-plate pushrod and press the wedge guide all the way to the end of the pushrod.

Step 2. Clean the nonpressure housing with cement thinner or a similar solvent in the area where the boot is to be cemented.

Step 3. Apply cement around the tube end of the nonpressure housing. Position the diaphragm-plate pushrod in the tube. Carefully engage the wedge rod so that it does not pull out of the plungers.

Step 4. Press the boot into position for cementing while holding the diaphragm against the wedge assembly.

Step 5. Install a new diaphragm over the diaphragm plate and onto the nonpressure housing while pushing the diaphragm plate against the wedge assembly.

Step 6. Install the pressure housing over the diaphragm. Install the clamps ring over the nonpressure and pressure housing flanges. Secure the clamp ring with the clamp-ring bolt and nut.

Step 7. Reconnect the air line or lines to the brake chamber. Have the operator make and hold a full brake application and check the brake chamber for leakage. Check the brake performance by road testing the machine.

LESSON 3

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. Gasses, unlike liquids, are easily_____.

   A. Compressed
   B. Transferred
   C. Exerted
   D. Transmitted

2. Driven by an engine, compressed air is forced into a reservoir by a/an_____.

   A. Diaphragm or air pump
   B. Air pump or governor
   C. Compressor or diaphragm
   D. Air pump or compressor

3. How many major components make up a typical air brake system?

   A. Five
   B. Six
   C. Seven
   D. Eight

4. Which component receives air and stores it for use in a braking system?

   A. Governor
   B. Reservoir
   C. Relay valve
   D. Brake chamber

5. Which valve controls brake operation by directing the flow of air from the reservoir to the brake chambers when the brakes are applied?

   A. Air brake
   B. Quick release
   C. Relay
   D. Compressor

6. Which test should be performed periodically to determine whether a brake chamber is suitable for continued service?

   A. Road
   B. Operational
   C. Leakage
   D. Pressure

7. Which tool should be used to check the lining-to-drum clearance of the front brakes on a Harnischfeger Model MT 250 crane?

   A. Ruler
   B. Micrometer
   C. Feeler gauge
   D. Tape measure

8. Which component limits the pressure produced by the compressor to a predetermined range?

   A. Governor
   B. Brake chamber
   C. Slack adjuster
   D. Quick-release valve

9. If the brake chamber is defective, there are only two components that could cause the brake chamber to leak. One of these is the boot, the other is the

   A. Diaphragm plate
   B. Diaphragm
   C. Pressure housing
   D. Clamp ring

10. If leaking occurs at the nonpressure housing or if leakage cannot be stopped by tightening the clamp bolt, the brake chamber should be

    A. Replaced
    B. Welded
    C. Disassembled and repaired
    D. Disassembled and fabricated

LESSON 3

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item		Correct Answer
1.	A.	Compressed Unlike liquids, gasses are compressed easily. (page 3-1, para 3-1)
2.	D.	Air pump or compressor A pump or compressor driven ... (page 3-3, para 3-2)
3.	D.	Eight The compressed air brake system ... (page 3-2, para 3-2)
4.	B.	Reservoir The air reservoir ... (page 3-4, para 3-2a)
5.	A.	Air brake This component controls... (page 3-6, para 3-2c)
6.	C.	Leakage Periodically, a leakage test is ... (page 3-15, para 3-5d)
7.	C.	Feeler gauge **NOTE: Use a feeler gauge** ... (page 3-13, para 3-5c, step 2)
8.	A.	Governor This component limits ... (page 3-5, para 3-2b)
9.	B.	Diaphragm Disassemble. The following steps describe . . (page 3-17, para 3-5e [2] [a])
10.	C.	Disassembled and repaired Disassemble and repair ... (page 3-15, para 3-5d, step 4)

LESSON 4

AIR-OVER-HYDRAULIC BRAKE SYSTEMS

Critical Tasks: 091-62B-1005
091-62B-3054

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn about the principles of an air-over-hydraulic brake system and its major components. You will also learn how to troubleshoot, adjust, and repair this system on an MW24C scoop-type loader.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn the principles of air-over-hydraulic brake systems.

CONDITION: You will be given the material contained in this lesson.

STANDARD: You will correctly answer practice exercise questions at the end of this lesson.

REFERENCES: The material contained in this lesson was derived from TMs 5-3805-262-10, 5-3805-262-20, 5-3805-262-24P, and 5-3805-262-34, 9-8000.

INTRODUCTION

Most passenger cars and light-duty trucks have a straight hydraulic brake system that uses only the energy that is applied to the brake's foot pedal. This type of brake does a good job on light-duty vehicles, but medium- and heavy-duty vehicles require a better braking system. The Army's 2 1/2-ton and some 5-ton tactical-design trucks have air-over-hydraulic brakes. Air-over-hydraulic brakes have hydraulics and compressed-air systems. The hydraulic systems of straight hydraulic brakes and air-over-hydraulic brakes are about the same. The compressed-air system supplies air pressure to boost the hydraulic pressure to the wheel cylinders above the amount supplied from the master cylinder.

PART A - CONSTRUCTION AND OPERATION

4-1. Components. The air-over-hydraulic brake system (Figure 4-1) has all the components of a straight hydraulic system, plus those of the compressed-air brake system. Therefore, this lesson will review those components and will show how the two systems work together to form one system. The major difference in this system and an air brake system is the brake actuator (or power cluster). The actuator converts air pressure to hydraulic pressure for applying the brakes. In contrast, the brake actuators in the total air system convert air pressure to mechanical force for applying the brakes. Besides boosting the hydraulic pressure of the brakes on the truck or piece of engineer equipment, the compressed-air system can also be used to apply the brakes of a trailer and operate accessories such as the wiper motor and horn. The major components of this system and their functions within the system are discussed below:

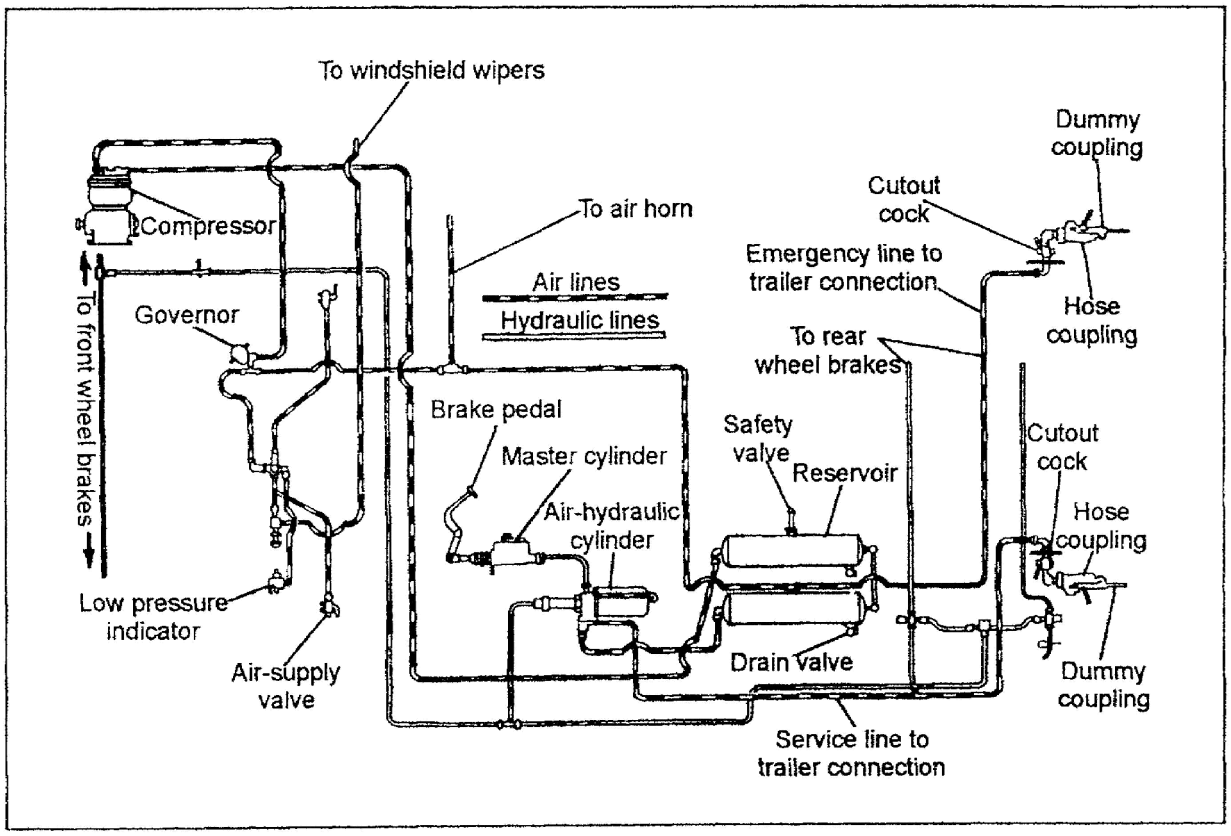


Figure 4-1. Air-over-hydraulic brake system

a. Air compressor. The air compressor is mounted on the top or side of the engine and compresses the air that is used to actuate the hydraulic master cylinders for the brakes. The compressor is driven by a belt connected to the engine and runs only when the engine runs. Air compressed by the compressor passes through the governor that is connected between the air reservoir and the compressor. The governor controls the pressure level in the system by

starting or stopping compression of air at specified pressures. If the governor does not work correctly, a relief valve connected to the air reservoir opens at 150 psi to prevent damage to the air system.

b. Air reservoir. Compressed air from the compressor flows to the air reservoir for storage until the compressed air is needed by components in the air system. There is a check valve at the air-reservoir inlet so that the compressed air cannot flow back to the compressor.

c. Brake valves. Brake valves, sometimes called treadle valves, control the flow of air to the brake actuators. Each brake valve has a rubber spring. By pushing the brake pedal, pressure is put on the rubber spring. The rubber spring pushes back against your foot so that more pressure is necessary to push the brake pedal further. The system lets you control the pressure in the brake system with more accuracy. Figure 4-2, page 4-4, shows the components of the brake pedal and the rubber spring. When the pedal is pushed, force is applied through the rubber spring to the piston and the piston moves down. The stem of the piston makes contact with the valve for inlet and exhaust. When the stem, which is the exhaust seat, makes contact with the valve, the exhaust port from the upper chamber is closed. As the piston continues to move down, the stem pushes the valve off the inlet seat, opening the inlet port to the upper chamber. Air supply from the air reservoir flows through the inlet seat and into the upper chamber. From the upper chamber, the air supply flows to the brake actuators and to the other components connected to the upper chamber.

d. Brake actuators. The brake system on an MW24C scoop-type loader has two brake actuators, one each for the front and rear wheels. Figure 4-3, page 4-5, shows a disassembled brake actuator. The brake valve controls operation of the brake actuator. Either of the two brake valves control the flow of air to both brake actuators. Each brake actuator has an air chamber and a hydraulic master cylinder. Air pressure from the brake valves flows to the air chamber of each brake actuator. The air pressure pushes the diaphragm and the pushrod into the air chamber. The pushrod pushes the piston in the master cylinder, which increases the hydraulic pressure in the brake lines and applies the brakes.

e. Master cylinder. The master cylinder used with air-over-hydraulic brakes is like the one described in Lesson 2. In straight hydraulic brake systems, the master cylinder receives the initial mechanical force from the pedal linkage, changes it to hydraulic pressure, and sends the brake fluid under pressure directly to the wheel cylinders. In air-over-hydraulic brakes, the master cylinder sends brake fluid under pressure to an air-over-hydraulic cylinder before it goes to the wheel cylinders. On all military-designed vehicles, the master cylinder has a vent fitting at the top of the reservoir for connecting a vent line to the vent system of the vehicle. This prevents water from entering the master cylinder through the vent during fording operations. The special drilled bolt and fitting installed in the filler cap of the master cylinder serves this purpose.

f. Air-over-hydraulic cylinder. This cylinder is put into operation by the hydraulic pressure from the master cylinder. It uses compressed air to boost the hydraulic pressure from the master cylinder. The Army uses more than one model of air-over-hydraulic cylinders; all models contain the same major units and operate on the same principles. The units are

made up of three major units in one assembly–the control unit, the power cylinder, and the slave cylinder. The units of the M809-series vehicles consist of an air valve, air cylinder, a hydraulic cylinder, and a piston.

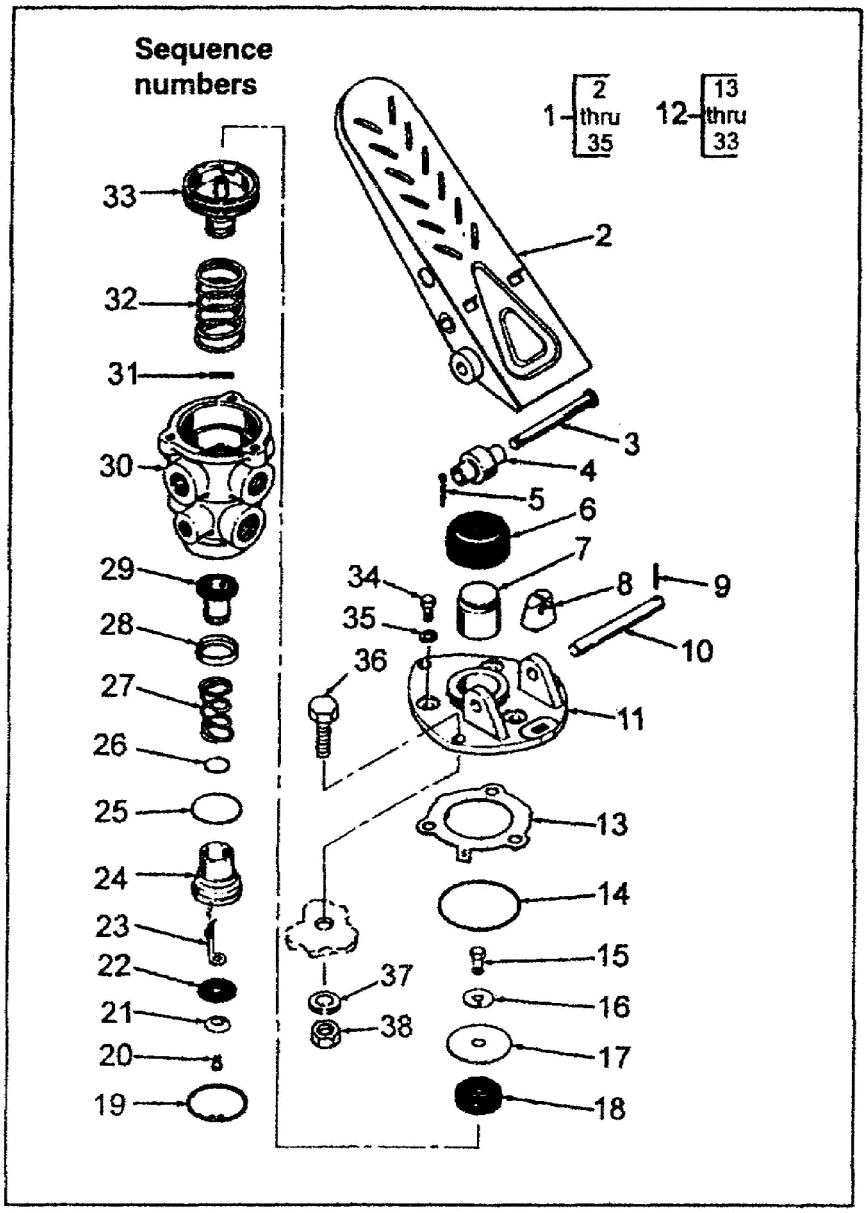


Figure 4-2. Brake valve/treadle valve

g. Control unit. The control unit contains a control-valve (relay) piston, which is hydraulically operated by brake fluid from the master cylinder, and a diaphragm or compressor assembly, which is operated by pressure differences between brake fluid and air and spring pressure. A return spring holds the hydraulic-relay piston and the diaphragm assembly in the released positions when there is no hydraulic pressure. Two air poppets, assembled on one stem control the air pressure flowing in and out of the power cylinder. The poppets are normally held in the released position by the poppet return spring.

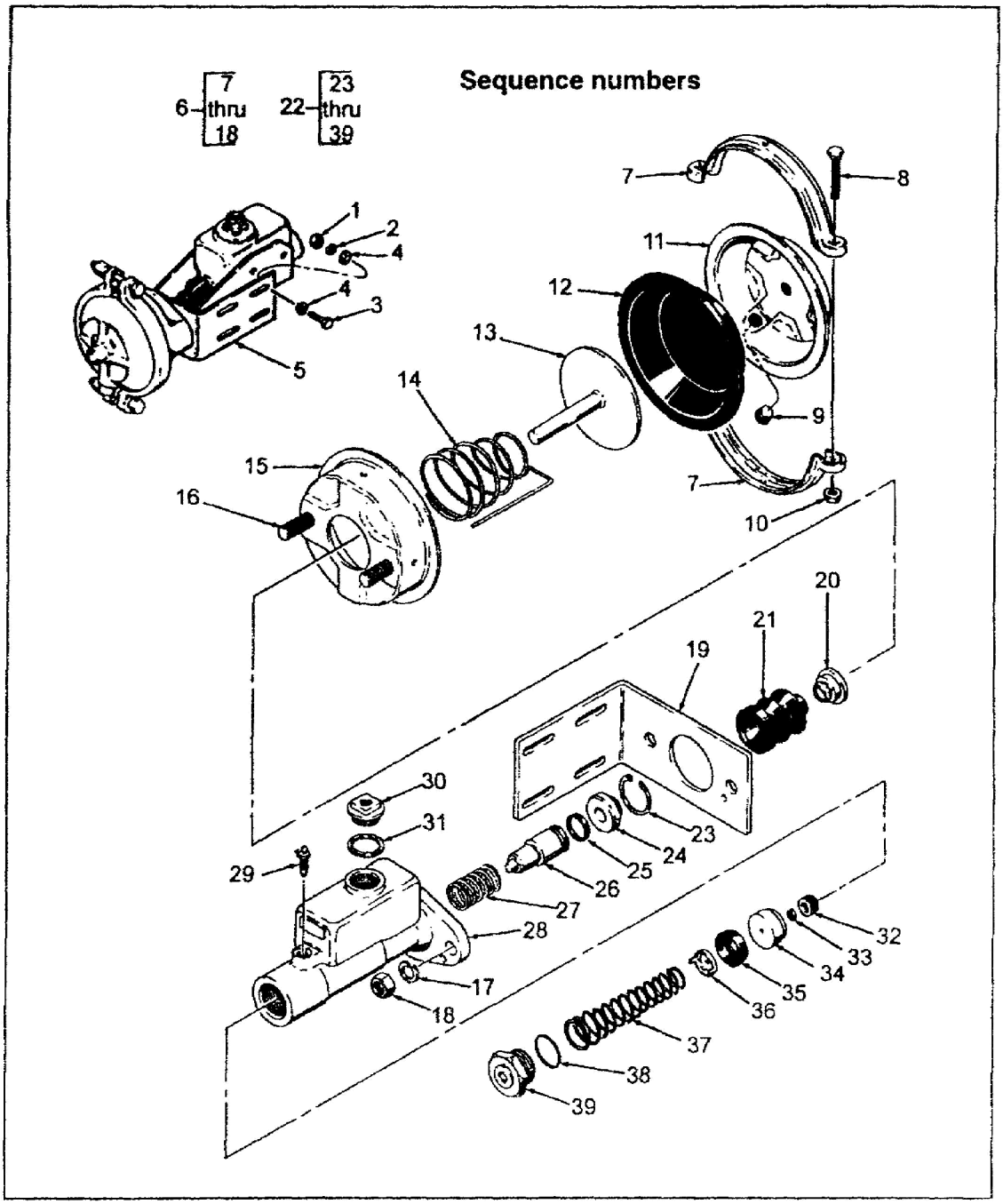


Figure 4-3. Disassembled brake actuator

PART B - TROUBLESHOOTING

4-2. Introduction. This learning event provides information useful in diagnosing and correcting unsatisfactory operation or failure of an item of engineer construction equipment and its components. Job situations have been created requiring the use of DA Form 5988-E (Figure 4-4, page 4-6), the troubleshooting guide (Appendix D, pages D-21 through D-25), and the appropriate maintenance allocation chart (Appendix D, pages D-26 and D-27).

Date: 13 August 97 | Equipment Maintenance and Inspection Worksheet | DA Form 5988-E

B Company, 88th Engineer Battalion (Combat Heavy)

Equipment Data

Administrative Number: A223
Equipment Model: MW24C
Equipment NOUN: LOADER, Scoop
Equipment NSN: 3805011504814

Equipment Serial Number: 1237865744
Registration Number: 22D78622
Type inspection: Daily

	Number	Date	Change Number
Publication:	TM 5-3805-262-10	1 Sep 87	
Publication:	TM 5-3805-262-20	1 Sep 87	

Signature: _____ Time: _____ Signature: _____ Time: _____

Parts Requested

Fault	DOC Number	NIIN	Quantity Due/Received	Status Date	Date Completed	Priority	Deadline Code

SAMPLE

Maintenance Faults

Item Operation Number	Fault Date	Fault Status	Fault Description	Corrective Action	Hours	License Number
	13 Aug 97	X	Wheel brakes do not work.			
	13 Aug 97	X	The parking brake will not hold the loader while parked.			

Figure 4-4. Sample DA Form 5988-E

4-3. Requirement. The piece of equipment used throughout the following situations will be a loader, scoop-type, diesel engine driven (DED), 4 by 4, articulated frame steer, 2 1/2 cubic yard, (J. I. Case Model MW24C). Your duty position and unit of assignment will be the same as in Lessons 2 and 3. An operator will be present to assist you. Safety will always be a prime

consideration. Ensure that the engine is shut off, the control and transmission levers are in the neutral position, the parking brake is set, and the wheels are chocked.

a. In this situation, use the maintenance allocation chart (Appendix D, pages D-26 and D-27) to identify the brake group numbers in column one. Determine who is authorized to replace the hydraulic brake lines and the brake-treadle valve.

Problem: Who can adjust the wheel disk brakes?

Solution: After examining the maintenance allocation chart, you should have determined that organizational maintenance has the responsibility to replace the brake lines and the brake-treadle valve.

b. In this situation, you have been assigned to troubleshoot a an MW24C scoop-type loader. DA Form 5988-E (Figure 4-4) states that the "wheel brakes do not work." During your personal inspection you determine that—

- There is sufficient air pressure present.
- There is no indication of a break in the air lines.
- The hydraulic fluid is low in the power cluster.
- The compressor belt is tight.

Problem: Based on this information, determine the probable cause of the malfunction and the appropriate corrective action. Use the troubleshooting guide shown in Appendix D, pages D-21 through D-25.

Solution: The probable cause is insufficient hydraulic fluid in the actuator; and the corrective action is to add fluid, bleed the brake system, and road test the loader.

NOTE: To bleed air from the brake system and fill it with hydraulic fluid, refer to Appendix D, pages D-21 through D-25, D-28, and D-29.

c. This situation involves filling the actuator and road testing the scoop-type loader. While road testing the scoop loader, you find the service brakes will not stop the machine.

Problem: Based on the information above, determine the probable cause of the malfunction and the appropriate corrective action. Use the troubleshooting guide in Appendix D, pages D-21 through D-25.

Solution: Since there are no indications of air or fluid leaks, the logical assumption is that the disk brakes need to be inspected. After looking at the maintenance allocation chart, you determined that the inspection is done by organizational maintenance. (Refer to Appendix D, page D-32, for inspection steps.) You have determined through the inspection of the disk brakes that the lining measurements were less than 2.54 millimeters.

A quick look at the maintenance allocation chart (Appendix D, pages D-26 and D-27) shows that replacement of the brake linings n organizational maintenance responsibility. You should have located the linings under the correct nomenclature of linings, friction by using the parts manual extract (Appendix D, pages D-37 through D-42). The linings are item number 3 and its part number is 9640184, which is part of a kit 9680436. Looking at the extract of the cross-reference indexes (Appendix D, pages D-37 through D-42), the NSN for the kit is 2530-01-180-0799. (For information on removing, cleaning, inspecting, and installing the brake linings, refer to Appendix D, pages D-33 through D-36.)

d. This situation involves the use of the parking brake. The parking brake holds the loader in position while it is parked and also acts as an emergency brake. The loader cannot be moved until at least 65 psi of pressure has been built up in the air system. The air pressure acting on the brake actuator overcomes the spring pressure and releases the parking brake. The brake is mounted on the transmission, and a valve mounted on the instrument panel operates the brake actuation. When the valve lever is pulled out, the air is exhausted, allowing the springs to set the brake. You have been given a DA Form 5988-E (Figure 4-4, page 4-6) stating that "the parking brake will not hold the loader while parked."

Problem: Determine which level of maintenance has the responsibility for adjustment, replacement, and repair of the parking brake.

Solution: By looking at the maintenance allocation chart (Appendix D, pages D-26 and D-27), you find that organizational maintenance has the responsibility for adjusting, replacing, and repairing the parking brake. (Use the steps provided in Appendix D, page D-31, to adjust the parking brake.)

e. While adjusting the scoop loader's parking brake, you find that the nut on the actuator rod is stripped.

Problem: Use the maintenance allocation chart (Appendix D, pages D-26 and D-27) to determine who is responsible for the repair.

Solution: If you looked at the maintenance allocation chart for the one responsible for the repair, situation d clearly stated that organizational maintenance is responsible for adjusting, replacing, and repairing the parking brake linkage.

NOTE: Use the steps in Appendix D, page D-31, to replace the nut.

f. In this situation, you will be working with the brake treadle valve.

Problem: What level of maintenance is authorized to replace the brake treadle valve?

Solution: Removal. Refer to Appendix D, pages D-43 and D-44, for the removal and installation of a brake treadle valve.

LESSON 4

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer to each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. What is the essential difference between the hydraulic brake system and the air-over-hydraulic brake system?

   A. Master cylinder
   B. Power cluster
   C. Air supply
   D. Safety valve

2. What is the probable cause for inoperative wheel brakes?

   A. Insufficient air pressure
   B. Loose compressor belt
   C. Insufficient hydraulic fluid in the power-cluster reservoir
   D. All the above

3. What controls the flow of air to the brake actuators?

   A. Governor
   B. Air compressor
   C. Treadle valve
   D. All the above

4. The thickness for each lining must be more than _____ millimeter s).

   A. 12.7
   B. 0.1
   C. 2.54
   D. None of the above

5. Use a _____ to push the brake-caliper pistons into the brake-caliper body.

   A. Screwdriver
   B. Pry bar
   C. Brake adjusting tool
   D. Box-end wrench

6. Whenever a component or line in the brake system is disconnected for servicing, what must be done?

   A. Chock the vehicle
   B. Bleed air from the system
   C. Run the engine at 500 revolutions per minute (rpm)
   D. None of the above

7. The loader cannot be operated until there is an air pressure reading of approximately psi.

   A. 65
   B. 75
   C. 85
   D. 95

8. The parking brake holds the loader in position while it is parked. It also acts as a/an

   A. Pressure-release valve
   B. Brake chamber
   C. Emergency brake
   D. Brake treadle

LESSON 4

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item		Correct Answer and Feedback
1.	B.	Power cluster The major difference ... (page 4-2, para 4-1)
2.	D.	All the above During your personal inspection ... (page 4-7, para 4-3b)
3.	C.	Treadle valve Brake valves, sometimes called ... (page 4-3, para 4-1c)
4.	B.	0.1 Thickness of each lining ... (page D-32, para 7-2a[1] [b])
5.	B.	Pry bar Using pry bar ... (page D-34, para 7-2a[21[dl)
6.	B.	Bleed air from the system Whenever a component line ... (page D-28, para 7-2c, Warning)
7.	A.	65 The loader cannot be moved ... (page 4-8, para 4-3d)
8.	C.	Emergency brake The parking brake holds ... (page 4-8, para 4-3d)

LESSON 5

D7G BRAKE SYSTEM

Critical Tasks: 091-62B-1005
091-62B-3054

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn about the principles of the brake system on a D7G tractor. You will learn how to troubleshoot, adjust, and repair the winch brake system.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will identify the steps used to troubleshoot, repair, and adjust the brake system on a D7G tractor.

CONDITION: You will be given the material contained in this lesson.

STANDARD: You will correctly answer practice exercise questions at the end of the lesson.

REFERENCES: The material contained in this lesson was derived from TMs 5-2410-237-10 and 5-2410-237-20.

INTRODUCTION

Most brake systems have internal nonrotating brake bands. They expand to a rotating brake drum that is used to slow down or stop the moving vehicle. The slow-down or stopping power in most brake systems is assisted by air- or hydraulic-type systems. The external-contracting brake for the D7G tractor has the same objective− to slow or stop the tractor. In addition, it must steer the equipment because of its independent brake system.

PART A - OPERATION

5-1. General. The tractor has two, band-type brakes (one on each steering-clutch drum) which are used to slow or stop the tractor and assist with steering the tractor. When the steering levers are pulled completely out, or the brake pedals are depressed, the bands tighten around the steering-clutch drum.

a. Steering-clutch drum. There is one clutch which controls the steering of the tractor for each track. The steering-clutch lever in the operator's station controls the hydraulically

operated clutch. When turning left, the left clutch is released. This causes the left track to stop moving, and the track functions as a pivot for the tractor to turn on. The same thing happens when turning right.

b. Control valve. The control valve is connected mechanically to the steering control levers. The valve directs the flow of oil pressure in response to the movement of the control levers.

5-2. Brake Mechanisms. Brake mechanisms may be of different designs, but they all require a rotating unit and a nonrotating unit. The rotating unit consists of a drum connected to a shaft. The nonrotating unit consists of brake shoes and the linkage -necessary to apply the shoes to the drum. Depending on how the nonrotating braking surface is forced against the rotating braking surface, the brakes are either an external-contracting or internal-expanding type.

5-3. External-Contracting Brake. When the brake shoes of the brake bands are applied against the outside of the rotating brake drum, the brake is known as an external-contracting brake. The nonrotating braking surface must be forced inward around the drum to produce the friction necessary for braking. This type of external-contracting band is found on the D7G brake system (Figure 5-1). The brake band is tightened around the drum by moving a lever. If a proper cover is not provided, the external-contracting brake is exposed to dirt, water, and other foreign matter. This exposure rapidly wears the lining and drum, destroying their frictional properties.

PART B -TROUBLESHOOTING

5-4. Introduction. Information required for diagnosing and correcting the unsatisfactory operation or failure of an item of engineer construction equipment and its components is provided in this lesson. Job situations have been created requiring the use of a DA. Form 5988-E (Figure 5-2, page 5-4), a maintenance allocation chart (Appendix D, page D-47), and a troubleshooting guide (Appendix D, pages D-45 and D-46). Equipment used throughout these situations will be a tractor, full-track, model D7G.

5-5. Requirement. Your requirement for each situation is to troubleshoot the problem and take the appropriate corrective action. Your duty assignment will be the same as in the previous lessons. An operator will be available to assist you. Safety is a prime consideration. Ensure that the engine is shut off and the control and transmission levers are in the neutral position.

5-6. Initial Situation. You have been assigned to troubleshoot the steering system on the D7G tractor.

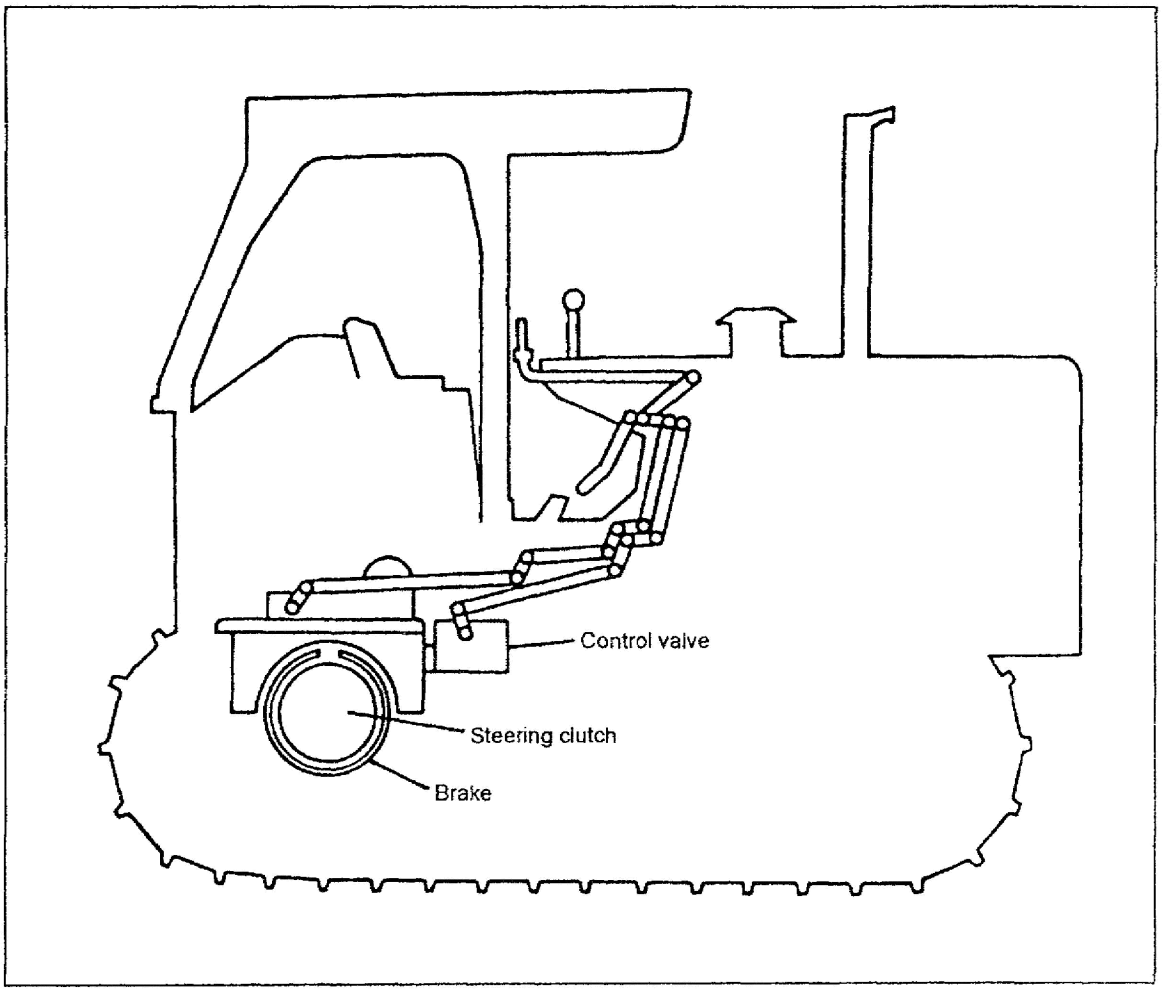


Figure 5-1. D7G braking and steering

a. Review DA Form 5988-E (Figure 5-2, page 5-4). Figure 5-2 indicates that the brakes failed to stop the tractor with either brake pedal and the brakes failed to turn in either direction.

Problem: After road testing the tractor for the discrepancies noted, which of the following sources should you use to narrow down the possible causes and their remedies?

a. Maintenance supervisor

b. Parts manual

c. Troubleshooting guide

d. Maintenance allocation chart

Solution: The correct choice is c. The troubleshooting guide (Appendix D, pages D-45 and D-46) indicates that the steering or the brake linkage may be out of adjustment.

Review of the maintenance allocation chart (Appendix D, page D-47) indicates that organizational maintenance is the authorized level to adjust the steering and brake linkages.

Date: 13 August 96 — Equipment Maintenance and Inspection Worksheet — DA Form 5988-E

B Company, 88th Engineer Battalion (Combat Heavy)

Equipment Data

Administrative Number: A225
Equipment Model: D7G
Equipment NOUN: TRACTOR, Crawler, Full-Track
Equipment NSN: 2420011602761
Equipment Serial Number: 1237865745
Registration Number: 22D78625
Type inspection: Daily

	Number	Date	Change Number
Publication:	TM 5-2420-224-10	28 Feb 93	
Publication:	TM 5-2420-224-20-1	28 Jul 93	

Signature: _____ Time: _____ Signature: _____ Time: _____

Parts Requested

Fault	DOC Number	NIIN	Quantity Due/Received	Status Date	Date Completed	Priority	Deadline Code

SAMPLE

Maintenance Faults

Item Operation Number	Fault Date	Fault Status	Fault Description	Corrective Action	Hours	License Number
	13 Aug 96	X	Brakes will not stop or turn.			

Figure 5-2. Sample DA Form 5988-E

b. Inspect linkages and make corrections. Inspection of the steering and brake linkage indicates that the steering-linkage measurement is correct; however, the brake-linkage measurement is not. Use the following steps to make adjustments on the brake

linkage (Figure 5-3). You have a new gasket and cotter pins on hand, and the floor plates have been removed. The steps listed below are for the right side of the tractor; repeat them for the left side. Refer to Figure 5-3 while making the adjustments.

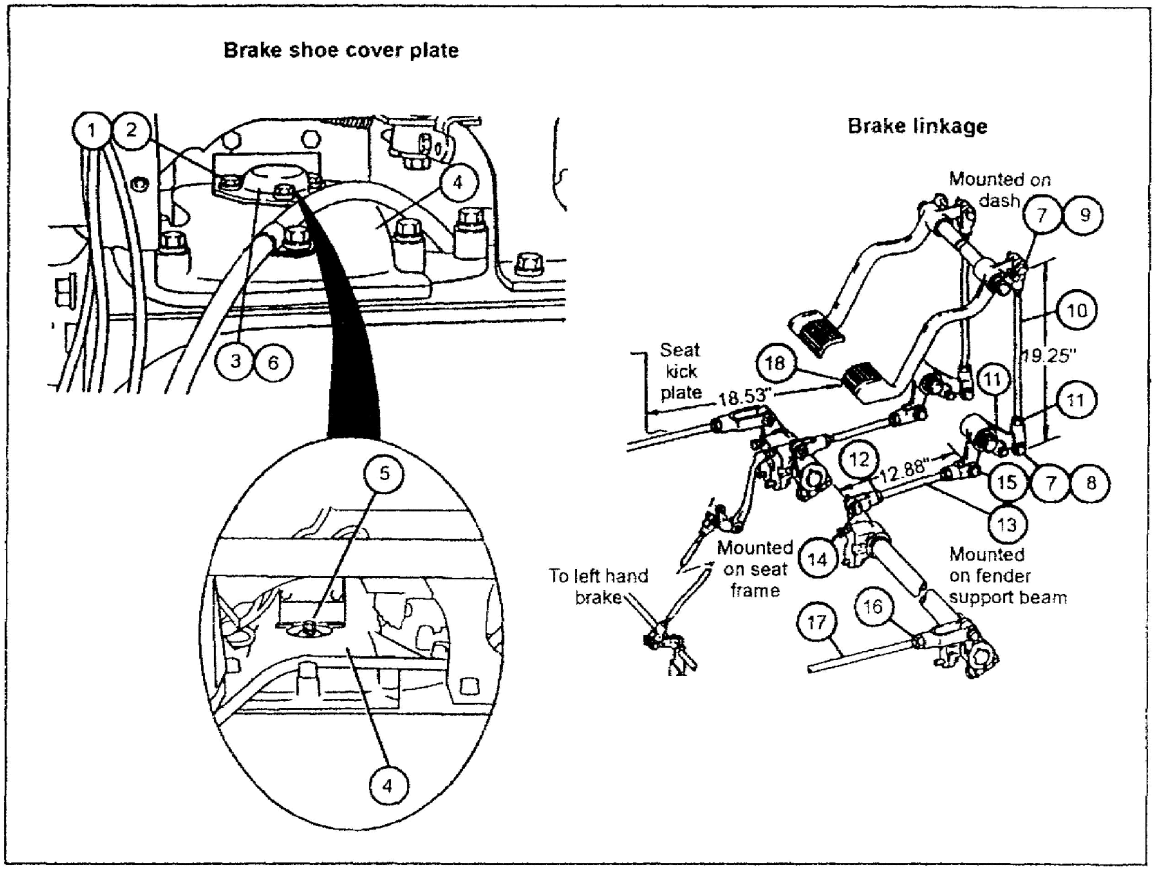


Figure 5-3. Brake-shoe cover plate and brake linkage

Step 1. Use a wrench to remove the three cap screws (1) and the washers (2) from the cover plate (3).

Step 2. Remove the cover plate (3) with gasket (6) from the top of the final drive case (4) to gain access to the brake-band adjusting nut (5). Discard the old gasket.

Step 3. Use a wrench to turn the brake band adjusting nut (5) clockwise until the band is tight, and then loosen the nut 1 1/2 turns (9 clicks) counterclockwise.

Step 4. Remove the rod (10) by removing the cotter pins (7) and the pins (8 and 9). Discard the cotter pins.

Step 5. Use two wrenches to loosen the nut (11) at both ends of the rod (10).

Step 6. Turn the rod (10) until the distance between the center line of the pins (8 and 9) is 19.25 inches, plus or minus 0.02 inch.

Step 7. Use a wrench and a torque wrench to tighten the nut (11) to a torque of 75 foot-pounds.

Step 8. Install the rod (10) and secure it with pins (8 and 9) and new cotter pins (7).

Step 9. Use two wrenches to loosen the nut (12) on the rod (13).

Step 10. Turn the rod (13) until the distance between the centerlines of the pins (14 and 15) is 12.88 inches.

Step 11. Use a wrench and a torque wrench to tighten the nut (12) to a torque of 75 foot-pounds.

Step 12. Use two wrenches to loosen the nut (16) on the rod (17).

Step 13. Turn the rod end to adjust the length of the rod (17) so that the distance between the front of the right brake pedal (18) and the seat kick plate is 18.53 plus or minus 0.12 inch.

Step 14. Use a wrench and a torque wrench to tighten the nut (16) to a torque of 75 foot-pounds.

Step 15. Install the gasket (6) and the cover plate (3). Use a wrench to install three washers (2) and cap screws (1).

Step 16. Repeat steps 1 through 13 for the left side.

Step 17. Reinstall floor plates.

Step 18. Test drive the equipment for proper operation and return to service.

LESSON 5

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you have completed the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. Which of the following units are required by brake mechanisms?

   A. Expanding and nonrotating
   B. Rotating and nonrotating
   C. Centrifugal and mechanical
   D. Hydraulic and centrifugal

2. Which of the following type brake is used by a D7G tractor?

   A. External-contracting
   B. Internal-expanding
   C. Internal-contracting
   D. External-expanding

3. What assists the brakes on a D7G?

   A. Air
   B. Hydraulics
   C. Both A and B
   D. None of the above

4. Which of the following is the correct distance between the front of the right brake pedal and the kick plate?

   A. 12.88 inches, plus or minus 0.12 inch
   B. 18.53 inches, plus or minus 0.12 inch
   C. 19.25 inches plus or minus 0.02 inch
   D. 75 inches, plus or minus 0.1 inch

5. Refer to Appendix D, page D-47. What maintenance level is authorized to replace the steering brakes on the D7G tractor?

   A. Operator
   B. Maintenance supervisor
   C. Direct support
   D. Organizational support

LESSON 5

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item	Correct Answer
1. B.	Rotating and nonrotating Brake mechanisms may be of different . ..(page 5-2, para 5-2)
2. A.	External-contracting When the brake shoes of the ... (page 5-2, para 5-3)
3. C.	Both A and B The slow down or stopping power ... (page 5-1, Introduction)
4. B.	18.53 inches, plus or minus 0.12 inch Turn the rod end to adjust ... (page 5-6, para 5-5b, step 13)
5. C.	Direct support Appendix D (page D-47)

APPENDIX A

METRIC CONVERSION CHART

This appendix complies with current Army directives which state that the metric system will be incorporated into all new publications. Table A-1 is a conversion chart.

Table A-1. Metric conversion chart

US Units	Multiplied By	Equals Metric Units
Length		
Feet	0.30480	Meters
Inches	2.54000	Centimeters
Inches	0.02540	Meters
Inches	25.40010	Millimeters
Miles (statute)	1.60930	Kilometers
Miles (nautical)	1.85320	Kilometers
Yards	0.91400	Meters
Area		
Square inches	6.45160	Square centimeters
Square feet	0.09290	Square meters
Square yards	0.83610	Square meters
Volume		
Cubic inches	16.38720	Cubic centimeters
Cubic feet	0.02830	Cubic meters
Cubic yards	0.76460	Cubic meters
Gallons	3.78540	Liters
Fluid ounces	29.57300	Milliliters
Quarts	0.94600	Liters
Weight		
Ounces	28.34900	Grams
Pounds	453.59000	Grams
Pounds	0.45359	Kilograms
Short tons	0.90700	Metric tons
Long tons	1.01600	Metric tons

Table A-1. Metric conversion chart (continued)

Metric Units	Multiplied By	Equals US Units
Length		
Centimeters	0.39370	Inches
Meters per second	2.23700	Miles per hour
Millimeters	0.03937	Inches
Kilometers	0.62137	Miles (statute)
Kilometers	0.53960	Miles (nautical)
Meters	3.28080	Feet
Meters	39.37000	Inches
Meters	1.09360	Yards
Area		
Square centimeters	0.15500	Square inches
Square meters	10.76400	Square feet
Square meters	1.19600	Square yards
Volume		
Cubic centimeters	0.06100	Cubic inches
Cubic meters	35.31440	Cubic feet
Cubic meters	1.30790	Cubic yards
Milliliters	0.03380	Fluid ounces
Liters	1.05700	Quarts
Liters	0.26420	Gallons
Weight		
Grams	0.03527	Ounces
Kilograms	2.20460	Pounds
Metric tons	1.10200	Short tons
Metric tons	0.98400	Long tons

APPENDIX B

LIST OF COMMON ACRONYMS

/	This fault status symbol indicates that the vehicle is still operative.
⊗	This fault status symbol indicates that the vehicle may be used for limited operations.
X	This fault status symbol indicates that the vehicle is in an inoperative status.
—	This fault status symbol indicates that there is an inspection component replacement or that an overdue maintenance work order has not been applied.
ACCP	Army Correspondence Course Program
AIPD	Army Institute for Professional Development
AMEDD	Army Medical Department
APO	Army Post Office
attn	attention
AUTOVON	automatic voice network
aux	auxiliary
AV	Automatic voice network
AWR	answer weight reference
C	operator/crew (maintenance level)
CCE	commercial construction equipment
cfm	cubic feet per minute
co	company
cont	continued
D	depot (maintenance level)
DA	Department of Army

DED	diesel-engine driven
DETC	Distance Education and Training Council
DINFOS	Defense Information School
DOC	document
DOD	Department of Defense
DS	direct support
DSN	Defense Switched Network
E-5	sergeant
EDL	emergency depot level
EIC	equipment identification code
EN	engineer
equip	equipment
F	intermediate director support (maintenance level)
fig	figure
FM	field manual
FSCM	federal stock classification for manufacturers
ft	foot/feet
GS	general support
H	general intermediate general support (maintenance level)
HMMH	high mobility material handler
ICE	Interservice Correspondence Exchange
ID	identification
in	inch(es)
INTMED	intermediate level

IPD	Institute for Professional Development
JFK	John Fitzgerald Kennedy
lb	pound(s)
LO	lubrication order
maint	maintenance
max	maximum
MI	middle initial
min	minimum
mm	millimeter(s)
MO	Missouri
MOS	military occupational specialty
MT	military trainer
NIIN	national item identification number
No.	number
NOUN	nomenclature
NSN	national stock number
NSS	national support system
O	organizational (maintenance level)
para	paragraph
PN	part number
psi	pounds per square inch
qty	quantity
UOC	usable on codes
RCOAC	Reserved Component Officer's Advanced Course

reg	regulation
rpm	revolutions per minute
RS	response sheet
RYE	retirement year ending
SEE	small emplacement excavator
SM	soldier's manual
SMR	source maintenance and recoverability
SSN	social security number
SSN	standard supply numbering
TM	technical manual
TRADOC	United States Army Training and Doctrine Command
US	United States (of America)
VA	Virginia

APPENDIX C

RECOMMENDED READING LIST

These publications provide additional information about the material in this subcourse. You do not need these materials to complete this subcourse.

DA Form 5988-E. *Equipment Inspection Maintenance Worksheet (EGA).* March 1991.

LO 5-2420-224-2. *Tractor, Wheeled, 4x4 DED Small Emplacement Exavator (NSN 2420-01-160-2754) (EIC: EDL) and Tractor, Wheeled, 4x4 DED High Mobility Material Handler (HMMH) (NSN 2420-01-205-8636).* 28 July 1993.

LO 5-2420-224-12. *Tractor, Wheeled, 4x4 DED Small Emplacement Exavator (SEE) (NSN 2420-01-160-2754) (EIC: EDL) and Tractor, Wheeled, 4x4 DED High Mobility Material Handler (HMMH) (NSN 2420-01-205-8636) (This Item is Included on EM 0100).* 28 July 1993.

TM 5-2410-237-10. *Operator's Manual for Tractor, Full Tracked, Low Speed: DED, Medium Drawbar Pull, SSN M061 Tractor With Ripper, (NSN 2410-01-223-0350) Tractor With Winch, (2410-01-223-7261) Tractor With Ripper and Winterized Cab, (2410-01-253-2118) Tractor With Winch and Winterized Cab, (2410-01-253-2117).* 26 January 1993.

TM 5-2410-237-20. *Unit Maintenance Manual for Tractor, Full Tracked, Low Speed: DED, Medium Drawbar Pull, SSN M061, Tractor With Ripper, (NSN 2410-01-223-0350) Tractor With Winch, (2410-01-223-7261) Tractor With Ripper and Winterized Cab, (2410-01-253-2118) Tractor With Winch and Winterized Cab, (2410-01-253-2117).* 30 March 1993.

TM 5-2420-224-20-1. *Unit Maintenance Manual for Tractor, Wheeled, 4x4 DED Small Emplacement Excavator (SEE) (NSN: 2420-01-160-2754) (EIC: EDL) and Tractor, Wheeled, 4x4 DED High Mobility Material Handler (HMMH) (2420-01-205-8636).* 28 July 1993.

TM 5-2420-224-20-2. *Unit Maintenance Manual for Tractor, Wheeled, 4x4 DED Small Emplacement Excavator (SEE) (NSN 2420-01-160-2754) (EIC: EDL) and Tractor, Wheeled, 4x4 DED High Mobility Material Handler (HMMH) (2420-01-205-8636).* 28 July 1993.

TM 5-2420-224-10. *Operator's Manual for Tractor, Wheeled, 4x4 DED Small Emplacement Excavtor (SEE) (NSN 2420-01-160-2754) (EIC: EDL) and Tractor, Wheeled, 4x4 DED High Mobility Material Handler (HMMH) (2420-01-205-8636).* 28 July 1993.

TM 5-3805-262-10. *Operator's Manual for Loader, Scoop Type, DED 4x4, Articulated Frame Steer, 2 1/2 Cubic Yard (J.I. Case Model MW24C) (NSN 3805-01-150-4814).* 1 September 1987.

TM 5-3805-262-20. *Organizational Maintenance, Loader, Scoop Type, DED 4x4, Articulated Frame Steer, 2 1/2 Cubic Yard, (J.I. Case Model MW24C) (NSN 3805-01-150-4814).* 1 September 1987.

TM 5-3805-262-24P. *Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Loader, Scoop Type, DED, 4x4, Articulated Frame Steer, 2 1/2 Cubic Yard (J.I. Case Model MW24C) (NSN 3805-01-150-4814).* 30 July 1992.

TM 5-3805-262-34. *Direct Support and General Support Maintenance Manual for Loader, Scoop Type, DED 4x4, Articulated Frame Steer, 2 1/2 Cubic Yard, (J.I. Case Model MW24C) (NSN 3805-01-150-4814).* 1 September 1987.

TM 5-3810-293-14&P-1. *Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual Including Repair Parts Information and Supplemental Maintenance Instructions for Crane, Truck Mounted, Hydraulic, 25-Ton (CCE), Harnischfeger Model MT-250 Non-Winterized (NSN 3810-00-018-2021) and Harnischfeger Model MT-250 Winterized (3810-00-018-2007).* 15 September 1980.

TM 5-3810-293-14&P-2. *Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual (Including Repair Parts Information and Supplemental Maintenance Instructions) for Crane, Truck Mounted, Hydraulic, 25-Ton (CCE), (Harnischfeger Model MT-250, Non-Winterized) (NSN 3810-00-018-2021) and (Model MT-250, Winterized) (3810-00-018-2007).* 6 June 1980.

TM 9-8000. *Principles of Automotive Vehicles.* 25 October 1985.

APPENDIX D - PUBLICATION EXTRACTS

TM 5-2420-224-20-1, 28 July 1993.
TM 5-2420-224-20-2, 28 July 1993.
TM 5-3805-262-20, 1 September 1987.
TM 5-3805-262-24P, 30 July 1992.
TM 5-3810-293-14&P-1, 15 September 1980.
TM 5-3810-293-14&P-2, 6 June 1980.

Use the above publication extracts to take this subcourse. At the time we wrote this subcourse, these were the current publications. In your own work situation, always refer to the latest official publications.

Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

BRAKES AND AIR SYSTEM

CAUTION

When repairing disc brakes, make sure stretch bolts for fastening brake caliper to wheel hub drive housing are always fitted at side where disc emerges from pads. Failure to do so could cause damage to equipment.

NOTE

Replace disc brake pads in sets for entire axle.

83. BRAKES FAIL OR BRAKE PEDAL SPONGY.

Step 1. Check for low brake fluid level in brake fluid reservoir.

- If brake fluid level is low, add silicone brake fluid (LO 5-2420-224-12).
- If brake fluid level is not low, go to step 2.

Step 2. Check for leaking and damaged hydraulic brake lines and fittings.

- If hydraulic brake lines and fittings are leaking or damaged, tighten or replace brake lines and fittings (pages 4-278, 4-280, 4-282, 4-284).
- If hydraulic brake lines and fittings are not leaking or damaged, go to step 3.

Step 3. Check for air in hydraulic brake system.

- If there is air in hydraulic brake system, bleed brake system (page 4-262).
- If there is no air in hydraulic brake system, replace brake master cylinder (page 4-276).

84. BRAKING UNEVEN.

Step 1. Check hydraulic brake lines for kinks and restrictions.

- If there are kinks or restrictions in hydraulic brake lines, replace brake lines (pages 4-278, 4-280, 4-282, 4-284).
- If there are no kinks or restrictions in hydraulic brake lines, go to step 2.

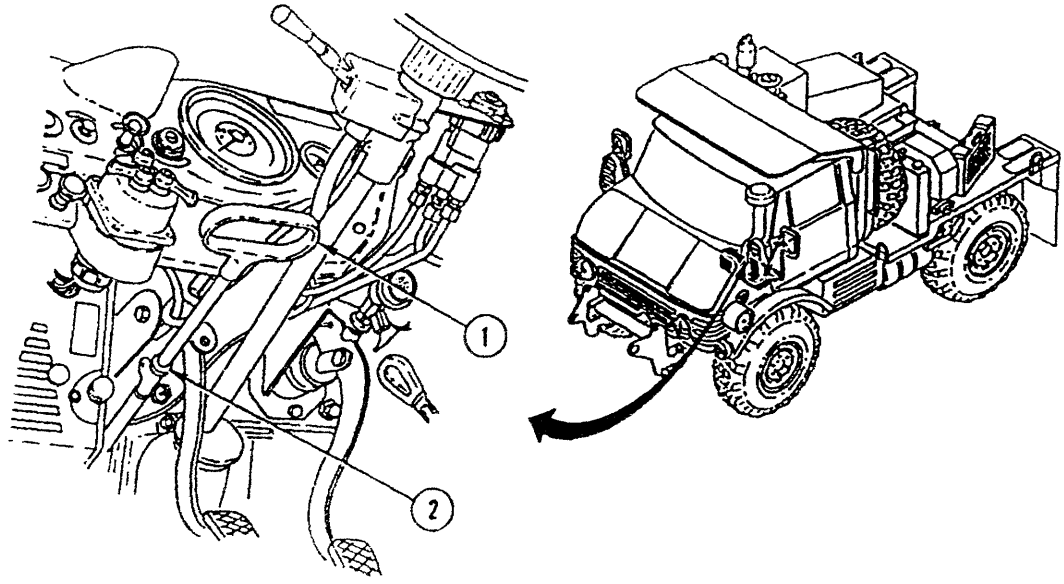
Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action
BRAKES AND AIR SYSTEM (CONT)
NOTE Step 2 is for front brakes only.
Step 2. Check dust cover for damage. • If dust cover is damaged, replace dust cover (page 4-271). • If dust cover is not damaged, go to step 3.
Step 3. Check for damaged spring clip and retaining pins. • If spring clip or retaining pins are damaged, replace spring clip (page 4-268) or retaining pins (page 4-271). • If spring clip or retaining pins are not damaged, go to step 4.
Step 4. Check for disc brake pads worn to 0.08 in. (2 mm) or less. • If disc brake pads are worn, replace pads in sets (pages 4-268, 4-271). • If disc brake pads are not worn, go to step 5.
Step 5. Check for oily disc brake pads. • If disc brake pads are oily, replace pads in sets (pages 4-268, 4-271) and replace axle final drive outer seal (pages 4-247, 4-248). • If disc brake pads are not oily, go to step 6.
Step 6. Check for scored disc surface. • If disc surface is scored, replace disc (page 4-265). • If disc surface is not scored, notify direct support maintenance.
85. BRAKES OVERHEAT.
Step 1. Check for sticking disc brake pads. • If disc brake pads are sticking, replace pads in sets (pages 4-268, 4-271). • If disc brake pads are not sticking, go to step 2.
Step 2. Check for damaged spring clip, retaining pins, and wheel hub mounting. • If spring clip, retaining pins, or wheel hub mounting are damaged, replace parts as required (pages 4-268, 4-271). • If spring clip, retaining pins, or wheel hub mounting are not damaged, go to step 3.

Table 3-5. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

BRAKES AND AIR SYSTEM (CONT)



NOTE

Step 3 is for rear axle only.

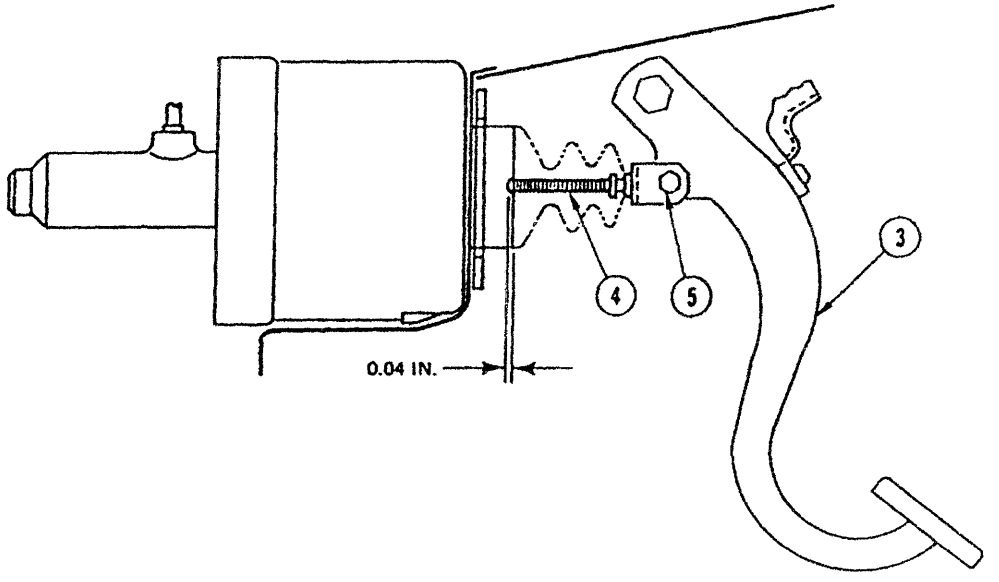
Step 3. Check parking brake adjustment by pulling parking brake handle (1) and measuring distance from parking brake handle to stop (2). Distance should be 7-9 in. (180-220 mm).

- If parking brake is not properly adjusted, adjust parking brake (page 4-254).
- If parking brake is properly adjusted, go to step 4.

Table 3-5. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

BRAKES AND AIR SYSTEM (CONT)



Step 4. Check brake pedal (3) adjustment with brake pedal at neutral (brakes not applied). Piston rod (4) clearance must be 0.04 in. (1 mm).

- If piston rod clearance is not 0.04 in. (1 mm), adjust clearance by turning eccentric screw (5).
- If piston rod clearance is 0.04 in. (1 mm), go to step 5.

Step 5. Check for proper operation of air brake booster by depressing brake pedal and observing gage needle on dashboard for deflection.

- If air brake booster is not operating properly, replace air brake booster (page 4-295).
- If air brake booster is operating properly, notify direct support maintenance.

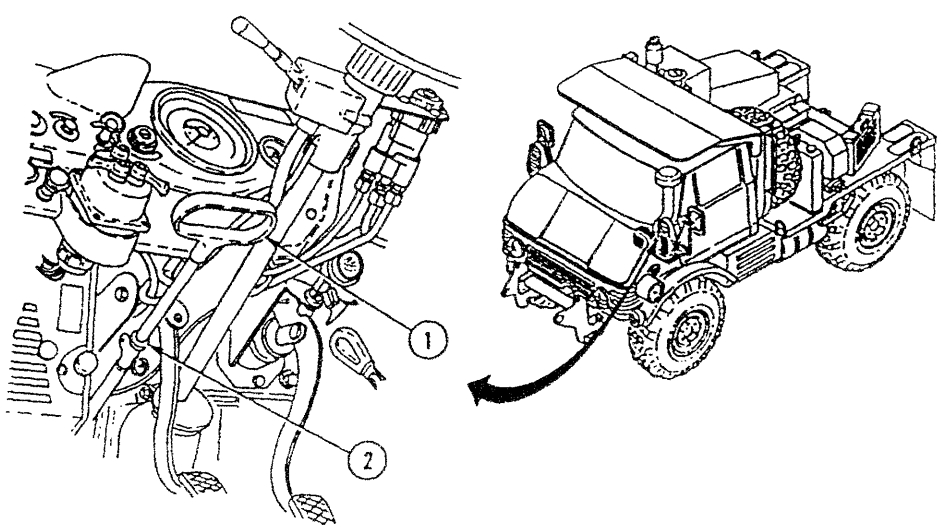
86. BRAKES SQUEAL.

Check for dirty, glazed, and worn disc brake pads.

- If disc brake pads are glazed or worn, replace pads in sets (pages 4-268, 4-271).
- If disc brake pads are dirty, clean pads.

Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action
BRAKES AND AIR SYSTEM (CONT)
87. BRAKE INDICATOR LIGHT LIGHTS.
Step 1. Check for low brake fluid level in brake fluid reservoir. • If brake fluid level is low, add silicone brake fluid (LO 5-2420-224-12). • If brake fluid level is not low, go to step 2. NOTE Step 2 is for rear axle only.



Step 2. Check parking brake adjustment by pulling parking brake handle (1) and measuring distance from parking brake handle to stop (2). Distance should be 7-9 in. (180-220 mm).

- If parking brake is not properly adjusted, adjust parking brake (page 4-254).
- If parking brake is properly adjusted, go to step 3.

3-271

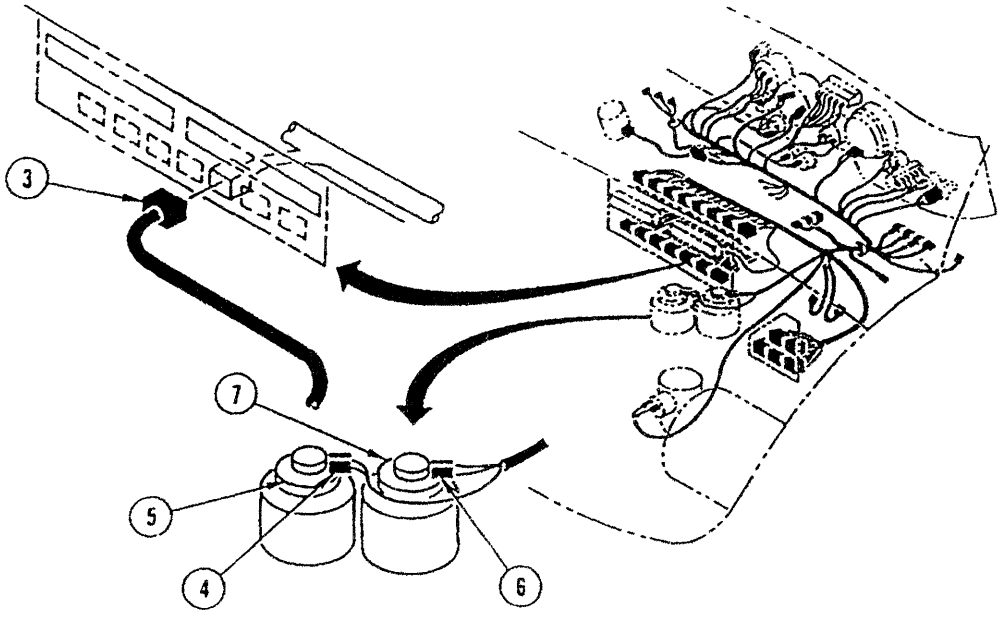
Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

BRAKES AND AIR SYSTEM (CONT)

Step 3. Check for disc brake pads worn to 0.08 in. (2 mm) or less.

- If disc brake pads are worn, replace pads in sets (pages 4-268, 4-271).
- If disc brake pads are not worn, go to step 4.



Step 4. Disconnect connector C (3) and check if brake indicator light is lit.

- If brake indicator light is not lit, reconnect connector C and go to step 7.
- If brake indicator light is lit, reconnect connector C and go to step 5.

Step 5. Disconnect wire 224 (4) from filler opening cap (5) and check if brake indicator light is lit.

- If brake indicator light is not lit, replace filler opening cap.
- If brake indicator light is lit, reconnect wire 224 and go to step 6.

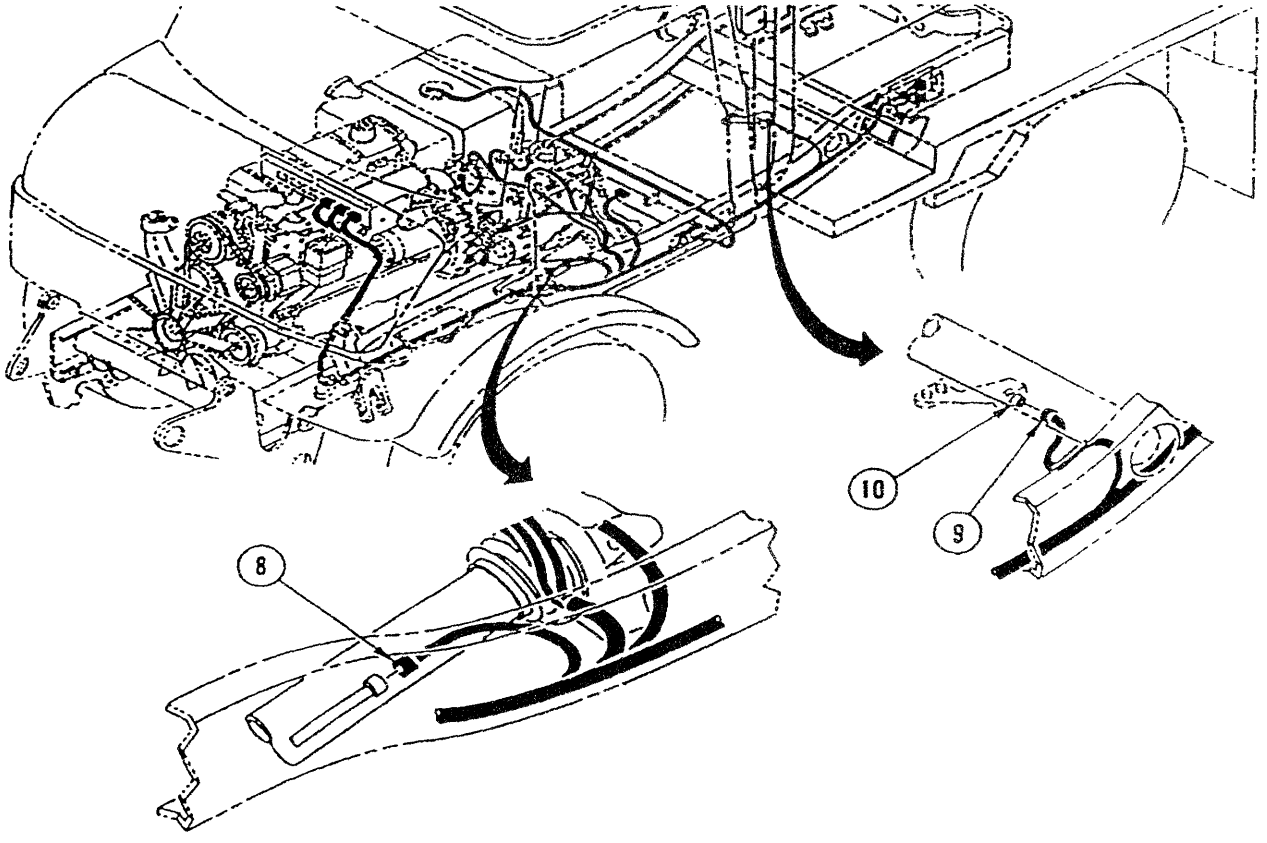
Table 3-5. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

BRAKES AND AIR SYSTEM (CONT)

Step 6. Disconnect wire 223 (6) from filler opening cap (7) and check if brake indicator light is lit.

- If brake indicator light is not lit, replace filler opening cap.
- If brake indicator light is lit, repair wiring 223 between filler opening cap and brake indicator light.



Step 7. Disconnect connector AF (8) and check if brake indicator light is lit.

- If brake indicator light is not lit, reconnect connector AF and go to step 9.
- If brake indicator light is lit, reconnect connector AF and go to step 8.

3-273

Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

BRAKES AND AIR SYSTEM (CONT)

Step 8. Disconnect parking brake switch connector (9) from parking brake switch (10) and check if brake indicator light is lit.

- If brake indicator light is not lit, replace parking brake switch (page 4-210).
- If brake indicator light is lit, repair wiring 332 and wiring 333 between connector C, connector AF, and parking brake switch connector.

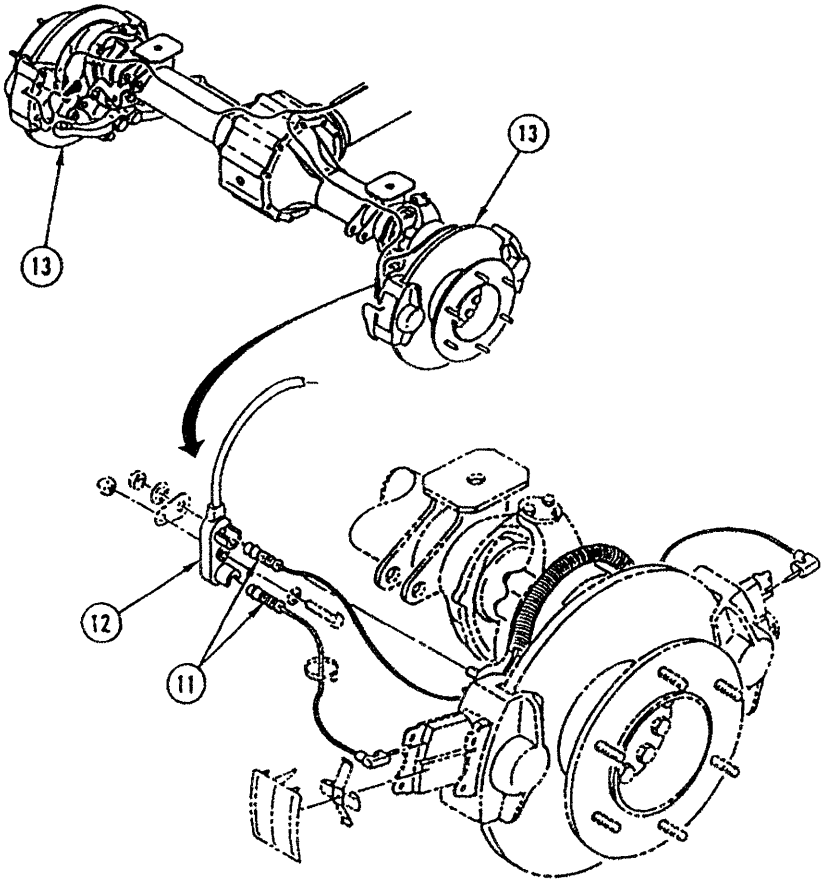


Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action
BRAKES AND AIR SYSTEM (CONT)
Step 9. Disconnect hook switch leads (11) from front disc brake pad indicator wiring harness (12) at both front brake assemblies (13) and check if brake indicator light is lit. • If brake indicator light is lit, replace front disc brake pad indicator wiring harness (page 4-231). • If brake indicator light is not lit, go to step 10.
Step 10. With hook switch leads (11) disconnected, check continuity between hook switch leads and ground. • Replace hook switch that shows short to ground.
88. TRAILER BRAKE SYSTEM FAILS OR BRAKING WEAK.
NOTE Brake lever must be fully actuated and dual brake gage indicating normal pressure.
Step 1. Check for leaking and damaged brake hose couplings. • If brake hose couplings are leaking or damaged, tighten or replace couplings (page 4-324). • If brake hose couplings are not leaking or damaged, go to step 2.
Step 2. Check for air leaks around trailer air supply valve. • If there are air leaks around trailer air supply valve, replace trailer air supply valve (page 4-331). • If there are no air leaks around trailer air supply valve, go to step 3.
Step 3. Check for air leaks around trailer hand brake valve. • If there are air leaks around trailer hand brake valve, replace trailer hand brake valve (page 4-326). • If there are no air leaks around trailer hand brake valve, notify direct support maintenance.

Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

BRAKES AND AIR SYSTEM (CONT)

89. AIR SYSTEM HAS NO EFFECT ON BRAKING (HARD BRAKING).

Step 1. Start engine. Check for low pressure in air tanks by waiting until red warning light goes out or until dual brake gage indicates pressure of 75-106 psi.

- If dual brake gage indicates 75-106 psi, replace air brake booster (page 4-295).
- If dual brake gage indicates less than 75-106 psi, go to step 2.

Step 2. Stop engine. Check for leaks in air system by observing brake fluid reservoir air pressure indicator. If reservoir pressure drops suddenly, there are leaks in air system.

- If there are leaks in air system, tighten or replace loose lines or connectors (pages 4-302, 4-303, 4-304, 4-307, 4-310, 4-313, 4-315, 4-318, 4-320, 4-324, 4-327, 4-329, 4-333). If problem continues, notify direct support maintenance.
- If there are no leaks in air system, go to step 3.

Step 3. Check fluid regulating valve adjustment as follows:

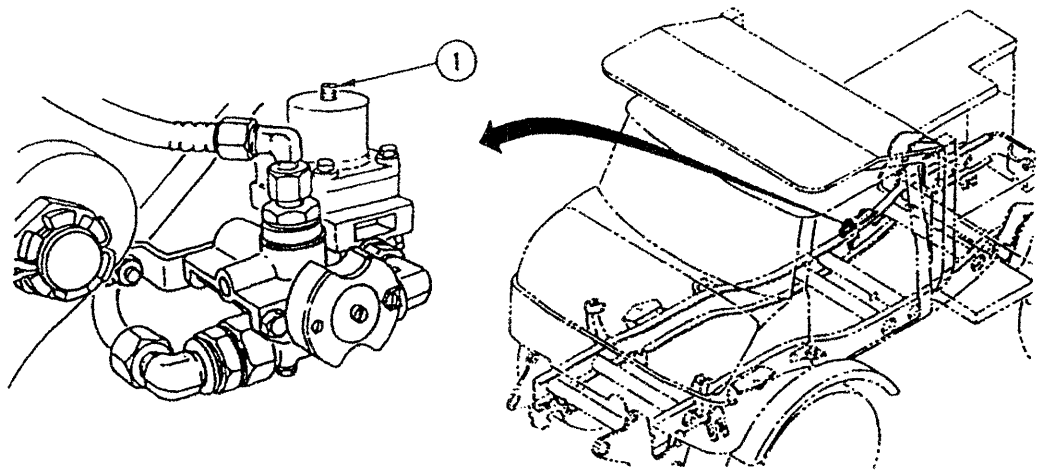


Table 3-5. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

BRAKES AND AIR SYSTEM (CONT)

NOTE

When fluid regulating valve reaches cut-out pressure, there will be an audible "pop."

a. Start and run engine at idle until fluid regulating valve reaches cut-out pressure.

b. Read pressure on dual brake gage. Reading must be approximately 106 psi.

- If reading is not approximately 106 psi, turn fluid regulating valve adjusting screw (1) 1/4-turn to right to increase pressure, or 1/4-turn to left to decrease presssure. Relieve air pressure (page 2-23) from air tanks to approximately 80 psi and repeat steps a and b until cut-out pressure is approximately 106 psi. If correct cut-out pressure cannot be attained, replace fluid regulating valve (page 4-306).
- If problem continues, notify direct support maintenance.

STEERING

90. STEERING WHEEL HARD TO MOVE FULL RIGHT AND FULL LEFT.

Step 1. Check for low oil level in power steering tank.

- If oil level is low, add oil (LO 5-2420-224-12).
- If oil level is not low, go to step 2.

Step 2. Check for loose and damaged V-belt on power steering pump.

- If V-belt is loose or damaged, tighten or replace V-belt (page 4-356).
- If V-belt is not loose or damaged, go to step 3.

Step 3. Check for damaged power steering lines.

- If power steering lines are damaged, replace power steering lines (page 4-357).
- If power steering lines are not damaged, go to step 4.

Step 4. Check for clogged power steering filter element.

- If filter element is clogged, replace filter element (page 4-359).
- If filter element is not clogged, notify direct support maintenance.

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
12	BRAKES								
1201	Parking Brake Controls	Inspect	0.1	0.1					
		Service		0.1					
		Adjust		1.2				11	
		Replace		2.0				5,11	E
1202	Brake Disc and Hub	Inspect		0.2					
		Replace		6.0				5,11,15,18	
		Repair			1.5			3	
	Disc Brake Pads	Inspect		0.5					
		Replace		1.0				5,11,15,18	
	Brake Caliper	Replace		1.0				5,11,15,18	
		Repair			1.8			3,11,16,17,20,23	
1204	Master Cylinder	Replace		1.2				5,11,15,18	
		Repair			1.3			3,11	
	Hydraulic Lines and Fittings	Inspect	0.1	0.1					
		Replace		1.7				5,11,15,18	
	Brake Pressure Regulator (ALB Valve)	Adjust			1.0			3,11,23	
		Replace			2.5			3,11	
		Repair			2.5			3,11	
	Brake Fluid Reservoir	Inspect	0.1						
		Service	0.1						
		Replace		2.0				5,11	
1206	Brake Pedal	Adjust		0.5				11	
		Replace		1.0				11	
1208	Air Pressure Tanks	Inspect	0.1						
		Service	0.1						
		Replace		2.0				5,11	
	Overflow Valves and Fittings	Replace		1.5				5,11	
	Brake Booster	Replace		1.2				11	
		Repair			1.0			11	
	Air Lines and Fitings	Inspect		0.5					
		Replace		2.0				11	
	Antifreeze Reservoir	Replace		0.5				5,11,15,18	

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL C	O	F	H	D	(5) TOOLS AND EQUIPMENT	(6) REMARKS
	Fluid Regulating Valve	Replace Repair		0.5	1.0			5,11 3,11	
	Antifreeze Device	Inspect Replace Repair	0.2	1.2	1.0			5,11,15,18 3,11	
	Tandem Valve	Inspect Replace Repair	0.1	1.0	0.8			11 3,11	
1211	Trailer Hand Brake Valve	Replace		0.5				11	
	Front Trailer Coupling	Replace		0.5				11	
	Trailer Air Supply Valve	Replace		1.5				11	E
	Tractor Protection Valve	Replace		1.0				5,11	
	Protection/Relay Valve	Replace		1.0				11	
	Lines and Fittings	Inspect Replace	0.1	2.0				11	
13	WHEELS								
1311	Wheel Assembly	Inspect Replace	0.2	0.2 0.5				5	
1313	Tires	Inspect Service Replace Repair	0.5 0.2	0.5 1.0	0.8	1.0		5 3,10	M
14	STEERING								
1401	Tie Rod	Inspect Adjust Replace Repair	0.2	0.2 1.0 1.3 0.5				11 5,11,15,18 5,11	
	Steering Wheel	Replace		0.4				5,11	
	Drag Links	Inspect Adjust Replace	0.2	0.2 0.7 0.8				5,11 5,11,15,18	

MAINTENANCE ALLOCATION CHART – CONTINUED

(1) Group number	(2) Component/Assembly	(3) Maintenance function	(4) Maintenance category C	O	F	H	D	(5) Tools and eqpt	(6) Remarks
09	PROPELLER, PROPELLER SHAFTS, UNIVERSAL JOINTS, COUPLER AND CLAMP ASSEMBLY								
0900	Propeller Shafts	Inspect		0.2					
		Replace			1.5				
	Universal Joints	Inspect		0.2					
		Service	0.2						
		Replace		1.6					
10	FRONT AXLE								
1000	Front Axle Assembly	Inspect		0.2					
		Service		0.2					
		Replace			5.0				
11	REAR AXLE								
1100	Rear Axle Assembly	Inspect		0.2					
		Service		0.2					
		Replace			5.0				
1102	Differential	Inspect				0.5			
		Replace				2.0			
		Repair				4.0			
		Overhaul				6.0			
	Shaft Assemblies	Replace				1.0			
		Repair				1.0			
12	BRAKES								
1202	Service Brakes								
	Brake Shoe Assemblies	Inspect		1.0					
		Adjust		1.0					
		Replace			12.0				
		Repair			2.0				
1208	Air Brake System								
	Hoses, Lines, Fittings	Inspect		0.1					
		Replace		0.5					
	Chamber, Brakes	Inspect		0.1					
		Adjust		4.0					
		Replace		0.5					
		Repair			0.6				
	Valves, Brake	Inspect		0.1					
		Replace		0.8					
		Repair			0.8				
	Reservoir, Air	Inspect	0.1						
		Service	0.1						
		Replace		2.0					

Depress the brake pedal fully. Test gauge pressure should approximately equal dash gauge pressure. Hold the pedal in several different positions; delivery should vary rapidly in accordance with changes in pedal position. Check for quick application and release of all brakes.

With the engine stopped, reduce air pressure to approximately 30 pounds (2.06 BARS) by making a series of brake applications. The Maxibrake control knob should move inward to the applied position automatically when the pressure drops below 30 pounds (2.06 BARS). Check the rear brakes to be sure they are in the applied position when the Maxibrake control valve is in the applied position.

Push in the Emergency Release Valve knob and pull out the Maxibrake control valve knob. Pressure from the emergency air tank should be transferred to the Maxibrake control valve and the Maxibrakes should release.

TROUBLESHOOTING

1. INSUFFICIENT BRAKES
   - Brakes need adjusting, lubricating or relining
   - Low air pressure in the brake system (below 80 pounds)
   - Brake valve delivery pressure below normal

2. BRAKES APPLY TOO SLOWLY
   - Brakes need adjusting or lubricating
   - Low air pressure in the brake system (below 80 pounds)
   - Brake valve delivery pressure below normal
   - Excessive leakage with brakes applied
   - Restricted tubing or hose line

3. BRAKES RELEASE TOO SLOWLY
   - Brakes need adjusting or lubricating
   - Brake valve not returning to fully released position
   - Restricted tubing or hose line
   - Exhaust port of brake valve or quick release valve restricted or plugged
   - Defective brake valve or quick release valve

4. BRAKES DO NOT APPLY
   - No air pressure in brake system
   - Restricted or broken tubing or hose line
   - Defective brake valve

5. BRAKES DO NOT RELEASE
   - Brake rigging binding
   - Brake valve not in fully released position
   - Defective brake valve
   - Restriction in tubing or hose line

6. BRAKES GRAB
   - Grease on brake lining – reline brakes
   - Brake drum out of round
   - Defective brake valve
   - Brake rigging binding

7. UNEVEN BRAKES
   - Brakes need adjusting, lubricating or relining
   - Grease on brake lining – reline brakes
   - Brake shoe release spring or brake chamber release spring broken
   - Brake drum out of round
   - Brake chamber diaphragm leaking

8. AIR PRESSURE WILL NOT RISE TO NORMAL
   - Defective air gauge (registering incorrectly)
   - Excessive leakage
   - Reservoir drain cock open
   - Cut-out cock improperly left open
   - Governor out of adjustment
   - No clearance at compressor unloading valves
   - Slipping compressor drive belt
   - Defective compressor

9. AIR PRESSURE RISES TO NORMAL TOO SLOWLY
   - Excessive leakage
   - Clogged compressor air strainer
   - No clearance at compressor unloading valves
   - Engine speed too slow
   - Compressor discharge valves leaking
   - Compressor drive belt slipping
   - Worn compressor
   - Excessive carbon in compressor cylinder head or discharge line

10. AIR PRESSURE RISES ABOVE NORMAL
    - Defective air gauge (registering incorrectly)
    - Compressor governor out of adjustment
    - Defective compressor governor
    - Restriction in line between governor and compressor unloading mechanism
    - Too much clearance at compressor unloader valves
    - Unloading valve cavities or unloading passage in compressor cylinder head blocked with carbon
    - Compressor unloading valves stuck closed

TOUBLESHOOTING (Cont'd)

11. AIR PRESSURE DROPS QUICKLY WITH ENGINE STOPPED AND BRAKES RELEASED
   - Leaking brake valve
   - Leaking tubing or hose line
   - Compressor discharge valve leaking
   - Compressor governor leaking
   - Excessive leakage elsewhere in the Air Brake System

12. AIR PRESSURE DROPS QUICKLY WITH ENGINE STOPPED AND BRAKES FULLY APPLIED
   - Leaking brake chamber,
   - Cut-out cock improperly left open
   - Leaking brake valve
   - Leaking tubing or hose line

13. COMPRESSOR KNOCKS CONTINUOUSLY OR INTERMITTENTLY
   - Loose drive pulley
   - Back lash in drive gears or drive coupling
   - Worn or burnt out bearings
   - Excessive carbon deposits in compressor cylinder head

14. SAFETY VALVE "BLOWS OFF"
   - Safety valve out of adjustment
   - Air pressure in the Air Brake System above normal

15. EXCESSIVE OIL OR WATER IN THE BRAKE SYSTEM
   - Reservoirs not being drained often enough
   - Compressor passing excessive oil
   - Compressor air strainer dirty

CARRIER AIR BRAKE ASSEMBLY (Continued)

QTY	STOCK	Ref.	Part Number	Description	Quantity Figure Number 1	3	4
		–	8100J1260-1	CARRIER AIR ASSEMBLY – SUPPLY CIRCUIT →	↓		
		–	8100J1260-3	CARRIER AIR ASSEMBLY – SUPPLY CIRCUIT →		↓	
		–	8100J1260-4	CARRIER AIR ASSEMBLY – SUPPLY CIRCUIT →			↓
		01	44Z214D2	. CONNECTOR, Female	1	1	1
		02	44Q3D1	. FITTING, Female swivel	1	1	1
		03	44Q14D2	. FITTING	7	7	7
		04		. HOSE, 1/4 in. ID x 1/2 in. OD x 7 in.	1	1	1
		05	44Q14D1	. FITTING	1	1	1
		06		. HOSE, 1/4 in. ID x 1/2 in. OD x 11 in.	3	3	3
		07	44Z112	. MANIFOLD	1	1	1
		08		. SCREW, Rd. hd. mach. 1/4-20UNC x 3/4 in.	6	6	6
		09		. WASHER, Lock 1/4 in.	6	6	6
		10		. NUT, Hex 1/4-20UNC	6	6	6
		11	44Z226D2	. PLUG, Pipe 1/4 in.	3	3	3
		12	44Z206D3	. ELBOW, 90° street	5	5	5
		13	44Z210D3	. BUSHING, Reducer 3/8 x 1/4 in.	1	1	1
		14	20F57D29	. GROMMET	4	4	4
		15	820P267D3	. HOSE ASSY., Treadle valve to manifold	1	1	1
		16	36Z225	. VALVE, Brake treadle	1	1	1
		17		. SCREW, Hex hd. 5/16-18UNC x 1 in.	3	3	3
		18		. WASHER, Lock 5/16 in.	5	5	5
		19		. NUT, Hex 5/16-18UNC	5	5	5
		20	820P292D2	. HOSE ASSY., Treadle service and supply	2	2	2
		21	14Z9D5	. FITTING, Through frame	4	4	4
		22	44Z259D17	. ELBOW, 90°	1	1	1
		23	14Z9D3	. FITTING, Through frame	18	18	18
		24	44Z259D10	. ELBOW, 90°	11	11	11
		25		. TUBE, 3/8 in. OD x 0.032 wall x 21 ft. 6 in.	1	1	1
		26		. TUBE, 1/2 in. OD x 0.049 wall x 21 ft. 6 in.	1	1	1
		27	44Z259D20	. ELBOW, 90°	2	2	2
		28	44Z758D16	. HOSE, Compressor discharge	1	1	1
		29	44Z371D6	. UNION, Tube	1	1	1
		30		. TUBE, 5/8 in. OD x 0.049 wall x 16 ft.	1	1	1
		31	44Z206D1	. ELBOW, 90° street	1	1	1
		32	44Z773D7	. CONNECTOR, Male	1	1	1
		33		. TUBE, 3/8 in. OD x 0.032 wall x 15 ft.	1	1	1
		34	44Z187D8	. CONNECTOR	18	18	18
		35	44Z187D14	. CONNECTOR	1	1	1
		36	44Z124D9	. TEE, Male	1	1	1
		37		. TUBE, 3/8 in. OD x 0.032 wall x 3 ft. 6 in.	1	1	1
		38		. TUBE, 1/2 in. OD x 0.049 wall x 1 ft. 6 in.	1	1	1
		39	44Z187D15	. CONNECTOR	1	2	2
		40	44Z187D18	. CONNECTOR	1	1	1
		41		. TUBE, 5/8 in. OD x 0.049 wall x 1 ft. 6 in.	1	1	1
		42	44Z187D19	. CONNECTOR	1	1	1
		43		. TUBE, 3/8 in. OD x 0.032 wall x 2 ft.	1	1	1
		44	44Z42D3	. TEE, Union	1	1	1
		45		. TUBE, 3/8 in. OD x 0.032 wall, 1 ft. 3 in.	2	2	2
		46	816T23	. BRACKET, Supply valve	1	1	1
		47	36Z7	. VALVE, Air supply	1	1	1

CARRIER AIR BRAKE ASSEMBLY (Continued)

QTY	STOCK	Ref.	Part Number	Description	Quantity Figure Number 1	3	4
		48	44Z226D2	. PLUG, Pipe	1	1	1
		49	44Z210D7	. BUSHING, Reducing 3/4 x 1/4 in.	1	1	1
		50	36Z8	. COCK, Drain	3	4	4
		51	818T949	. BRACKET, Air reservoir mounting	2	2	2
		52	27Z5	. RESERVOIR, Air	3	3	3
		53	16Z34	. BRACKET, Reservoir	6	6	6
		54	44Z226D3	. PLUG, Pipe	4	6	6
		55		. SCREW, Hex hd. 3/8-16UNC x 1 in.	2	6	6
		56		. SCREW, Hex hd. 3/8-16UNC x 1-1/4 in.	14	14	14
		57		. WASHER, Lock 3/8 in.	16	20	20
		58		. NUT, Hex 3/8-16UNC	16	20	20
		59		. WASHER, Plain 3/8 in.	12	12	12
		60	44Z816	. VALVE, Check	2	3	3
		61	44Z259D18	. ELBOW, 90°	3	4	4
		62	44Z694D7	. NIPPLE, Hex pipe	–	3	3
		63		. NIPPLE, 3/4 in. close galvanized pipe	2	–	–
		64		. TUBE, 1/2 in. OD x 0.049 wall x 3 ft. 6 in.	1	1	1
		65		. TUBE, 1/2 in. OD x 0.049 wall x 1 ft. 2 in.	1	–	–
		66	36Z6	. VALVE, Safety	1	1	1
		67	44Z210D3	. BUSHING, Reducer 3/8 x 1/4 in.	2	2	2
		68	44Z41D1	. TEE, Adapter	1	1	1
		69	44Z259D16	. ELBOW, 90°	2	2	2
		70		. TUBE, 1/2 in. OD x 0.049 wall x 10 ft. 10 in.	–	1	1
		71		. TUBE, 1/2 in. OD x 0.049 wall x 9 ft. 1 in.	–	1	1
		72	27Z709	. RESERVOIR, Air	–	1	1
		73	16Z180	. BRACKET, Reservoir	–	2	2

Ref. Dwg. 8100J1260 (G) 100J4268-1
100J4268 (F) 100J4268-2
8100J1260-1
8100J1260-4

3-18. SERVICE BRAKE SYSTEM TROUBLESHOOTING (CONT)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. SERVICE BRAKES SQUEAK OR GROAN AT END OF STOP (Cont).

Step 1. (Cont).
Remove tire and wheel from axle end (page 8-4).
Check brake calipers for brake fluid leakage or sticking piston.
Repeat for other wheel and axle.

a. If brake caliper is leaking or piston sticking, replace brake caliper (page 7-28).

b. If brake caliper is okay, go to step 2 below.

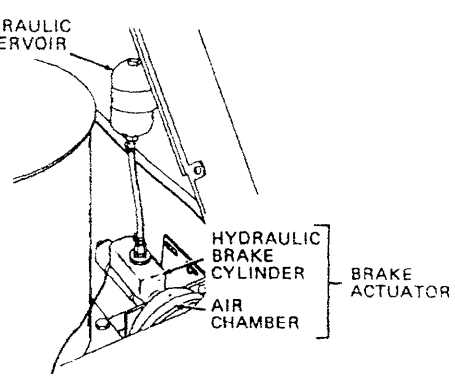
Step 2. Check brake pads for wear (page 7-18), uneven glaze, and brake fluid or lubricant contamination.

a. Replace brake pads if worn, glazed, or contaminated (page 7-19).

b. If brake pads are okay, check each disk for scored or grooved condition (page 7-18). Notify next higher maintenance level to replace disk if these conditions are seen.

5. SERVICE BRAKES DO NOT STOP LOADER (AIR SYSTEM OPERATING OKAY).

Step 1. Remove engine left side panels (page 9-14) and open front access door.
Bleed air from front and rear brakes systems (page 7-30).
Open air reservoir drain valve and drain air.
At front brake actuator, disconnect air hose connected to elbow installed in brake actuator air chamber.
Connect a 9/16-18 street tee to elbow.
Connect air hose disconnected from elbow above to street tee.



Connect zero to 150 psi pressure gage to street tee.
Close air reservoir drain valve.
Tell assistant to start and operate engine at 1000 rpm until AIR PRESS gage needle indicates in green area.

3-18. SERVICE BRAKE SYSTEM TROUBLESHOOTING (CONT)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. SERVICE BRAKES DO NOT STOP LOADER (AIR SYSTEM OPERATING OKAY) (Cont).

Step 1. (Cont).
Tell assistant to press brake treadle and valve.
Pressure gage should indicate 90 psi minimum.
Tell assistant to shut off engine.

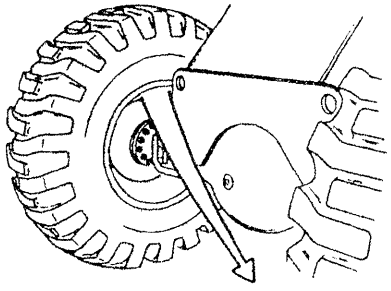
a. If pressure gage did not indicate 90 psi minimum, open air reservoir drain valve and drain air.
Disconnect pressure gage, air hose connected to street tee, and street tee.
Connect air hose disconnected from street tee to elbow.
Go to step 3 below.

b. If pressure gage indicated 90 psi minimum, go to step 2 below.

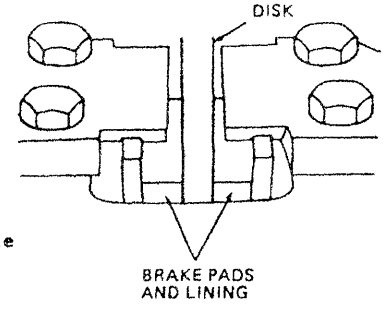
Step 2. Place blocks at each wheel to prevent loader from moving.
Engage transport/service link (page 9-8).
Ensure that parking brake is applied.

WARNING

Before raising loader from ground, be sure that transport/service link is engaged. Failure to do so may cause loader to turn and slip off jacks or jack stands causing serious injury or death.



Raise front axle and wheel off ground.
Remove tire and wheel from axle end.
Tell assistant to start and operate engine at 1000 rpm until AIR PRESS gage needle indicates in green area.
Tell assistant to press brake treadle and valve while you check if brake pads move inward.
Tell assistant to shut off engine.



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3-18. SERVICE BRAKE SYSTEM TROUBLESHOOTING (CONT)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

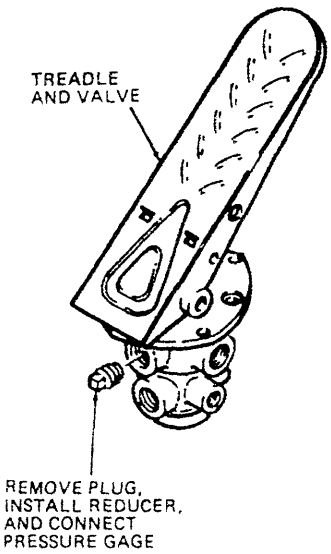
5. SERVICE BRAKES DO NOT STOP LOADER (AIR SYSTEM OPERATING OKAY) (Cont).

Step 2. (Cont).

a. If brake pads did not move, replace front brake actuator (page 7-51).

b. If brake pads did move, replace rear brake actuator (page 7-51).

Step 3. Open air reservoir drain valve and drain air. Remove one plug from brake treadle and valve upper chamber and install 1/2 to 1/8 NPT reducer. Connect zero to 150 psi pressure gage to reducer. Pressure gage hose should be long enough so that you can read pressure gage in cab. Close air reservoir drain valve. Start engine and operate at 1000 rpm until low air pressure buzzer stops sounding. Slowly press brake treadle and valve while watching pressure gage. Pressure gage shall indicate increasing air pressure as brake treadle and valve is pressed.



a. If pressure gage does not indicate increasing air pressure, replace brake treadle and valve (page 7-53).

b. If pressure gage indicates increasing air pressure, go to step 4 below.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. SERVICE BRAKES DO NOT STOP LOADER (AIR SYSTEM OPERATING OKAY) (Cont).

Step 4. Operate engine at 1000 rpm until air pressure gage indication on left instrument cluster no longer increases.
Press brake treadle and valve down completely.
Pressure gage connected to brake treadle and valve port shall indicate approximate pressure in air reservoir.
Correct pressure is approximately 110 psi when brake treadle and valve is fully pressed.

a. If pressure gage does not indicate approximately 110 psi, replace brake treadle and valve (page 7-53).

b. If pressure gage indicates approximately 110 psi, go to step 5 below.

Step 5. Release brake treadle and valve.
Pressure gage connected to brake treadle and valve port shall indicate zero psi.

If pressure gage does not indicate zero psi, replace brake treadle and valve (page 7-53).

3-19. AIR BRAKE SYSTEM TROUBLESHOOTING

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. LOW AIR PRESSURE WARNING BUZZER SOUNDS.

WARNING

Do not operate loader if low air pressure warning buzzer is sounding and if AIR PRESS gage indication is not in green zone. Failure to do so could cause death or serious injury and extensive property damage due to loss of braking power.

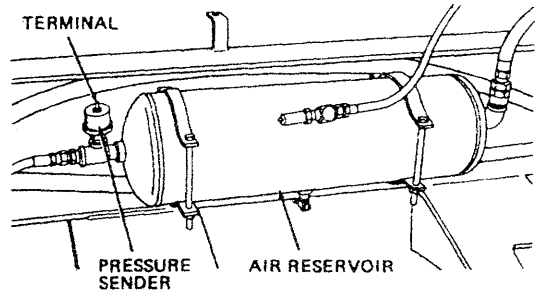
Start engine and operate for several minutes to build up air pressure. At left instrument panel, check AIR PRESS gage indication.

a. If AIR PRESS gage indicates in green zone, replace air pressure warning switch (page 5-48).

b. If AIR PRESS gage does not indicate in green zone, go to MALFUNCTION 3 below (page 3-121).

2. AIR PRESSURE GAGE INDICATES LOW AIR PRESSURE (LOW AIR PRESSURE BUZZER NOT SOUNDING).

Step 1. Remove engine right side panels (page 9-14).
At air reservoir port, disconnect wire lead from pressure sender terminal.
AIR PRESS gage should indicate in green zone.



a. If AIR PRESS gage indicates in green zone, go to step 2 below.

b. If AIR PRESS gage does not indicate in green zone, check for short circuit to ground in wire lead between gage and pressure sender.
If wire lead checks okay, remove instrument cluster (page 5-34) and replace AIR PRESS gage (page 5-39).

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL UNIT C	MAINT LEVEL UNIT O	MAINT LEVEL INTMED F	MAINT LEVEL INTMED H	MAINT LEVEL D	TOOLS & EQUIP. (5)	REMARKS (6)
12	Brakes								
1201	Parking Brake (Transmission)								
	Parking Brake	Replace		1.0				1,2,3,4	
		Repair		1.0				1,2,3,4	
	Parking Brake Chamber	Replace		0.5				1,2,3,4	
		Repair			1.5			1,5	
	Parking Brake Linkage	Inspect		0.2				1,2,3,4	
		Replace		1.0				1,2,3,4	
1202	Service Brakes								
	Brake (Disc)	Inspect		0.2				1,2,3,13	
		Replace			1.5			1,2,3,4,5	
1204	Hydraulic Brake System								
	Hydraulic Reservoir	Service		0.2				1,2,3,4	
		Replace		0.8				1,2,3,4	
		Repair			1.0			1,5	
	Calipers	Replace		1.2				1,2,3,4	
		Repair			1.5			1,5	
	Hoses, Lines & Fittings	Inspect		0.2				1,2,3,4	
		Replace		2.0				1,2,3,4	
1208	Air Brake System								
	Brake Actuator	Replace		1.0				1,2,3,4	
		Repair			1.5			1,5	
	Brake Treadle Valve	Replace		1.0				1,2,3,4	
		Repair			1.5			1,5	
		Test			0.5			1,5,9	
	Air Brake Valve	Replace		0.5				1,2,3,4	
		Repair			1.0			1,5	
	Air Brake Reservoir	Inspect		0.2				1,9	
		Service	0.1						
		Replace		0.8				1,2,3,4	

* MAINTENANCE LEVELS:
C - OPERATOR/CREW, O - ORGANIZATIONAL = UNIT
F - INTERMEDIATE DIRECT SUPPORT, H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

SECTION II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	MAINT LEVEL UNIT C	MAINT LEVEL UNIT O	MAINT LEVEL INTMED F	MAINT LEVEL INTMED H	MAINT LEVEL D	TOOLS & EQUIP. (5)	REMARKS (6)
	Pressure Reducing Valve	Replace		0.5				1,2,3,4	
	Pressure Protection Valve	Replace		0.8				1,2,3,4	
		Repair			0.5			1,5	
	Double Check Valve and Stop Light Switch	Replace		0.8				1,2,3,4	
		Repair			0.5			1,5	
	Hoses, Lines & Fittings	Inspect		0.2				1,2,3,4	
		Replace		2.0				1,2,3,4	
1209	Air Compressor Assembly	Replace		1.0				1,2,3,4	
		Repair			1.0			1,5,9	
	Governor	Adjust		0.8				1,2,3,4	
		Replace		0.8				1,2,3,4	
		Repair			1.0			1,5,9	
	Air Compressor Lines	Inspect		0.1				9	
		Replace		1.0				1,5	
	Alcohol Evaporator	Service	0.1						
		Replace		1.0					
13	Wheels								
1311	Wheel Assembly	Replace		1.0				1,2,3,4,7	
		Repair		1.5				1,2,3,4,7	
1313	Tires	Inspect	0.1						
		Service		0.3				1,2,3,4,7	
		Replace		2.0				1,2,3,4,7	
		Repair		1.0				1,2,3,4,7	
14	Steering								
1401	Steering Wheel	Replace		1.0				1,2,3,4	
1407	Power Steering Gear (& Steering Column)	Replace			2.0			1,5	
		Repair			3.0			1,5	
1410	Aux/Emergency Steering Motor and Pump	Replace			0.8			1,5	
		Repair			2.0			1,5	
1411	Steering Hoses, Lines & Fittings (articulation)	Inspect		0.2				1,2,3,4	
		Replace		2.5				1,2,3,4	

* MAINTENANCE LEVELS:
C - OPERATOR/CREW, O - ORGANIZATIONAL = UNIT
F - INTERMEDIATE DIRECT SUPPORT
H - INTERMEDIATE GENERAL SUPPORT
D - DEPOT

7-2. SERVICE BRAKE SYSTEM MAINTENANCE (CONT)

c. Calipers (cont).

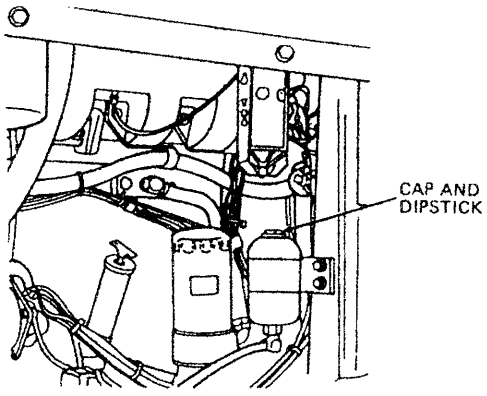
BLEEDING AIR FROM BRAKE SYSTEM (SHEET 1 OF 2)

WARNING

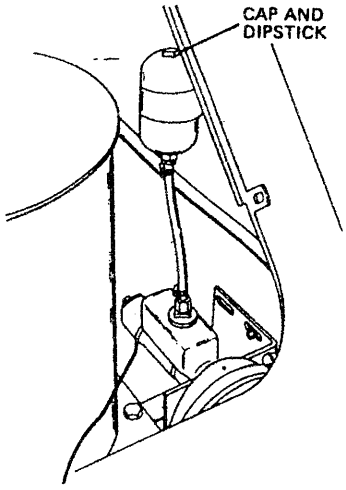
Whenever a component or line in the brake system is disconnected for servicing, the air must be bled from the brake system. Failure to do so could cause serious injury or death due to loss of braking control.

(1) Remove engine left side panels (page 9-14) and open front access door.

(2) Set-up pressure fluid tank according to instructions included with tank and fill tank with brake fluid.



REAR BRAKES HYDRAULIC RESERVOIR



FRONT BRAKES HYDRAULIC RESERVOIR

(3) Using open end wrench, loosen and remove cap and dipstick from brake hydraulic reservoir.

(4) Connect line from pressure fluid tank to filler opening on brake hydraulic reservoir.

(5) Open pressure fluid tank valve.

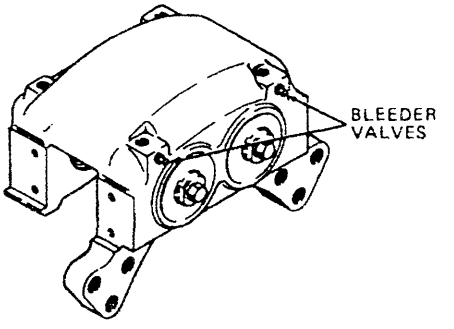
BLEEDING AIR FROM BRAKE SYSTEM (SHEET 2 OF 2)

(6) Loosen two bleeder valves at one brake caliper.

(7) Watch brake fluid flowing from bleeder valves. When brake fluid is clear and free of air bubbles, tighten bleeder valves.

(8) Loosen two bleeder valves at brake caliper on opposite axle end.

(9) Watch brake fluid flowing from bleeder valves. When brake fluid is clear and free of air bubbles, tighten bleeder valves.



(10) Close pressure fluid tank valve.

(11) Disconnect pressure fluid tank line from brake hydraulic reservoir.

(12) Repeat steps (3) through (11) above to bleed air from brake system at other axle, if necessary.

(13) Install engine left side panel (page 9-17) and close and lock front access door.

7-1. PARKING BRAKE MAINTENANCE (CONT)

d. Parking Brake Linkage. This task covers inspection and adjustment of parking brake linkage.

TOOLS: No. 1 Common Organizational Maintenance Tool Kit
Fixed open end wrench set
Slip joint pliers

NOTE

PRELIMINARY PROCEDURE: Loader turned completely to right.

INSPECTION

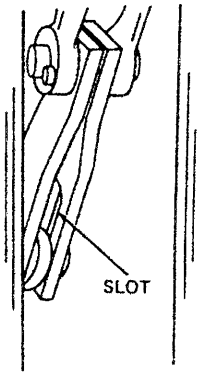
(1) Stop engine and pull out knob of parking brake valve to apply parking brake.

(2) Push in knob of parking brake valve to release parking brake. If necessary, start and operate engine at idle speed until there is enough air pressure to release parking brake.

(3) At left front of rear chassis, lift up brake lever of parking brake mounted on transmission until lever stops moving.

(4) Check position of clevis pin in slot in parking brake linkage.

(5) If clevis pin is not at bottom of slot in parking brake lever linkage, adjust parking brake lever linkage (page 7-17).



ADJUSTMENT

(1) Park loader on level surface and turn it completely to the right.

(2) Stop engine and pull out knob of parking brake valve to apply parking brake.

(3) Push in knob of parking brake valve to release parking brake. If necessary, start and operate engine at idle speed until there is enough air pressure to release parking brake.

(4) At left front of rear chassis, remove cotter pin securing clevis pin to parking brake chamber yoke.

(5) Remove clevis pin.

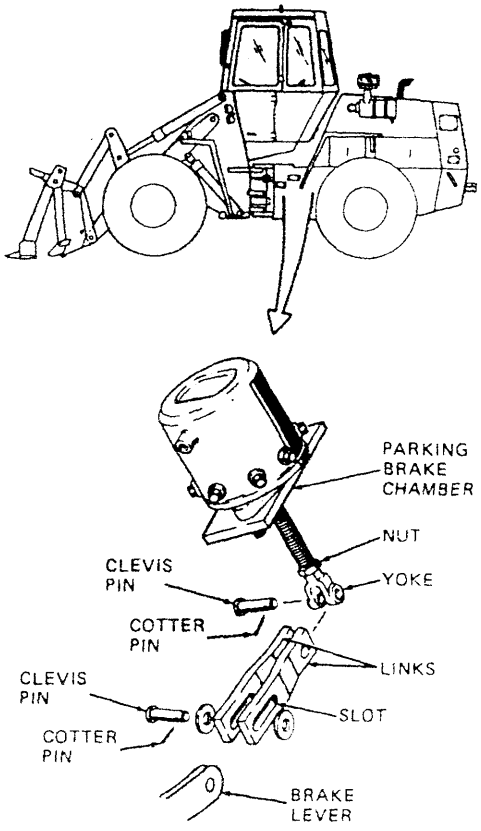
(6) Loosen nut securing yoke.

(7) Hold up brake lever and turn yoke up or down until holes in yoke and links are alined; install clevis pin.

(8) Check position of clevis pin in slot of parking brake links; clevis pin shall be at bottom of slot. If not, repeat step (7) above.

(9) Reinstall cotter pin to secure clevis pin, yoke, and links.

(10) Tighten nut against yoke.



7-2. SERVICE BRAKE SYSTEM MAINTENANCE

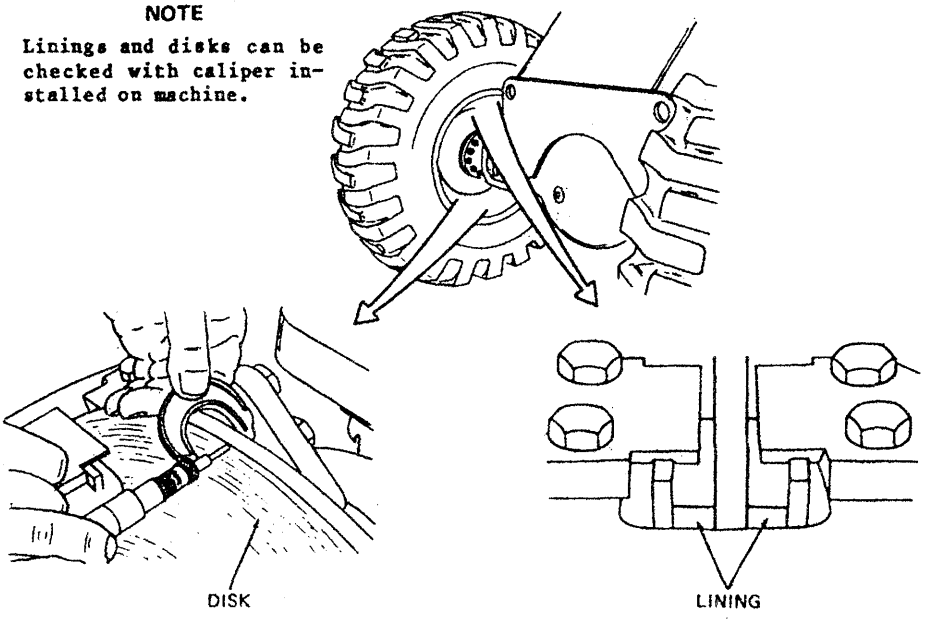
a. Disk Brakes.

(1) Inspection. This task covers inspection of disk brakes. Inspect disk brakes after every 250 hours of operation or every month, whichever occurs first.

TOOLS: Automotive Mechanic's Tool Kit
Machinist's steel rule
Outside micrometer, one inch capacity

NOTE

Linings and disks can be checked with caliper installed on machine.



(a) At each wheel end, measure thickness of lining on each brake pad using machinist's steel rule.

(b) Thickness of each lining must be more than 0.100 inch. If lining thickness is not 0.100 inch, replace linings (page 7-19).

(c) Thickness of lining in each caliper must be approximately equal. If lining thickness is not equal, caliper is leaking at one side and must be replaced (page 7-28).

(d) Measure thickness of each disk.

(e) Each disk must be at least 0.500 inch thick. If disk is not at least 0.500 inch thick, notify direct support maintenance (disk must be replaced).

(f) Check disks for deep grooves and warpage. If disk has deep grooves or warpage, notify direct support maintenance (disk must be replaced).

7-2. SERVICE BRAKE SYSTEM MAINTENANCE (CONT)

a. Disk Brakes (cont).

(2) Replacement. This task covers removal, cleaning, inspection, and installation of disk brakes brake shoes and brake linings.

TOOLS: No. 1 Common Organizational Maintenance Tool Kit
Fixed open end wrench set
Torque wrench, 1/2 inch drive
Automotive Mechanic's Tool Kit
Socket wrench set, 1/2 inch drive
Machinist's steel rule
Micrometer
Prybar

MATERIALS/PARTS: Clean cloths (Appendix C, item 1)
Cleaning solvent P-D-680 (Appendix C, item 2)
Thread sealant (Appendix C, item 24)
Shoe and lining kit (FSCM 52256 PN 9680436)

NOTE

PRELIMINARY PROCEDURE: Wheel and tire removed from axle end where brake shoes and linings are to be removed (page 8-4).

REMOVAL (SHEET 1 OF 2)

WARNING

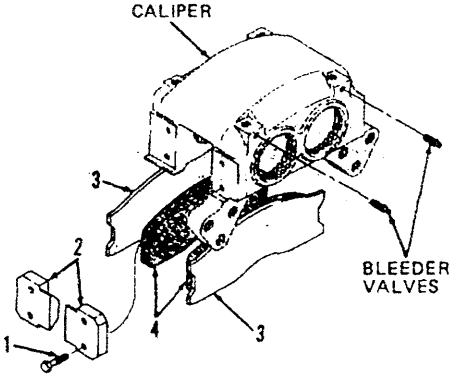
Brake linings contain asbestos fibers. Do not create dust when working on brake system. Do not remove dust or dirt using compressed air. Serious bodily harm may result from breathing asbestos dust.

Before performing following step, be sure that chassis is securely supported by jack stands. Failure to do so could cause chassis to fall on you causing serious injury or death.

(a) Remove eight capscrews (1) and four plates (2).

(b) Remove brake shoes (3) with brake linings (4).

(c) Loosen two bleeder valves on brake caliper.



7-19

7-2. SERVICE BRAKE SYSTEM MAINTENANCE (CONT)

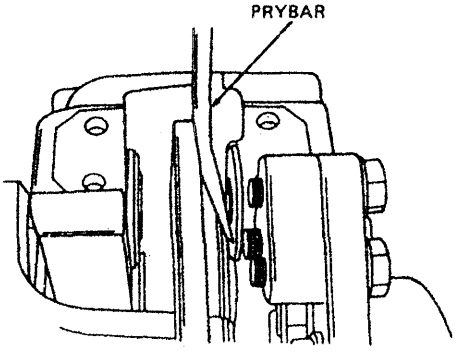
a. Disk Brakes (cont).

(2) Replacement (cont).

REMOVAL (SHEET 2 OF 2)

(d) Using pry bar, push brake caliper pistons into brake caliper body.

(e) Tighten bleeder valves.



CLEANING

WARNING

Dry cleaning solvent P-D-680 used to clean parts is toxic and flammable. Wear protective goggles and gloves and use only in a well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat and don't smoke when using it. Failure to do so could cause serious injury. If you become dizzy while using cleaning solvent, get fresh air and medical attention immediately. If contact with skin or clothes is made, flush with large amounts of water. If contact with eyes is made, wash eyes with water and get medical aid immediately.

(a) Clean all metal parts using cleaning solvent P-D-680. Dry using clean cloths.

(b) Wipe brake linings with clean, dry cloth.

INSPECTION

NOTE

Replace item if inspection indicates need for replacement.

(a) Check thickness of brake linings (4) using machinist's steel rule. Replace brake shoes with brake linings if thickness of either lining is 0.100 inch or less, or if thickness of linings in each caliper are not approximately equal.

(b) Inspect brake linings (4) for contamination.

(c) Inspect all other parts for cracks, distortion, or thread damage. Replace brake linings and shoes as an assembly if brake shoes require replacement.

(d) Inspect brake caliper for fluid leakage. If leakage is found, replace brake caliper (page 7-28) and forward to direct support maintenance for repair.

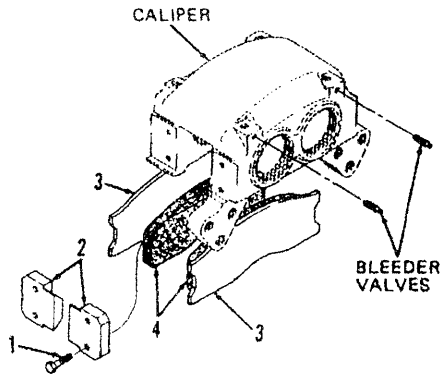
(e) Inspect disk for grooves and warpage. Check thickness of disk using micrometer. Thickness of disk must be at least 0.500 inch. If disk thickness is not at least 0.500 inch or if it is grooved or warped, notify direct support maintenance to replace it.

7-2. SERVICE BRAKE SYSTEM MAINTENANCE (CONT)

a. Disk Brakes (cont).

(2) Replacement (cont).

INSTALLATION



(a) Install brake shoe (3) with brake lining (4) as an assembly; brake linings (4) toward brake disk.

(b) Apply thread sealant to capscrew (1) threads in brake caliper.

(c) Position four plates (2) and install eight capscrews (1). Tighten capscrews (1) to 170 lb-ft.

WARNING

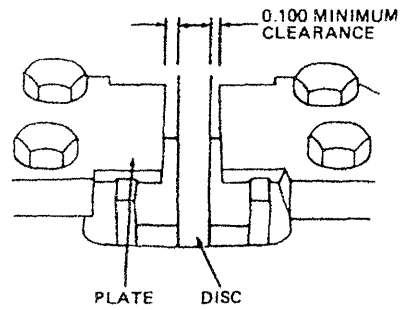
Whenever a component or line in the brake system is disconnected for servicing, air must be bled from brake system. Failure to do so could cause serious injury or death due to loss of braking control. Refer to page 7-30 for bleeding air from brake system.

(d) Bleed air from brake system (page 7-30).

(e) Apply and release brakes several times.

(f) Check clearance between plates (2) and disk. If clearance is less than 0.100 inch, remove brake shoes (3) with linings (4) and find and correct cause.

(g) Install tire and wheel on axle end (page 8-9).



(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES(UOC)	(6) QTY
				GROUP 1201 HAND BRAKE FIG.78 PARKING BRAKE	
1	PFOZZ	24617	9409042	BOLT,SELF-LOCKING.....	4
2	PFOZZ	10988	121-422	BOLT,SPECIAL.....	4
3	PFOZZ	10988	L72813	FLANGE,COMPANION.....	1
4	PFOZZ	78500	DLM10-39	BRAKE,SHOE TYPE.....	1
5	PAOZZ	78500	A3736M455	.PLATE,BACKING,BRAKE.....	1
6	PAOZZ	97286	372G85	.LEVER,CAM OPERATING.....	1
7	PFOZZ	78500	1779J88	.SPACER,SLEEVE.....	1
8	PAOZZ	78500	2758W23	.SPRING,HELICAL,EXTE.....	2
9	PAOZZ	78500	A2-3722L194	.BRAKE SHOE.....	2
10	KFOZZ	78500	2740Y623	..LINING, BRAKE, NSS PART OF KIT P/N 2000L246.....	2
11	PFOZZ	78500	RV354	..RIVET,TUBULAR PART OF KIT P/N 2000L246.....	24
12	PFOZZ	78500	3719V178	.BRAKE DRUM.....	1

END OF FIGURE

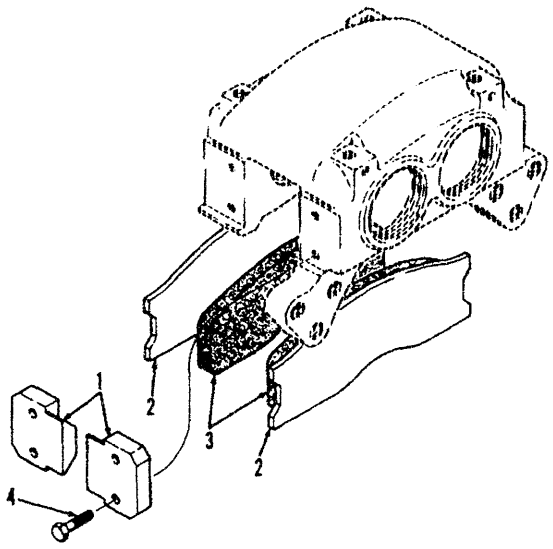


Figure 79. Service brakes.

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODES(UOC)	(6) QTY
				GROUP 1202 SERVICE BRAKES FIG.79 SERVICE BRAKES	
1	PFOZZ	52256	9630134	PLATE,BACKING,BRAKE.....	4
2	KFOZZ	52256	9640079	SHOE, BRAKE PART OF KIT P/N 9680436.	2
3	KFOZZ	52256	9640184	LINING, BRAKE PART OF KIT P/N 9680436.....	2
4	PFOZZ	96906	MS90725-162	SCREW,CAP,HEXAGON H.....	8

END OF FIGURE

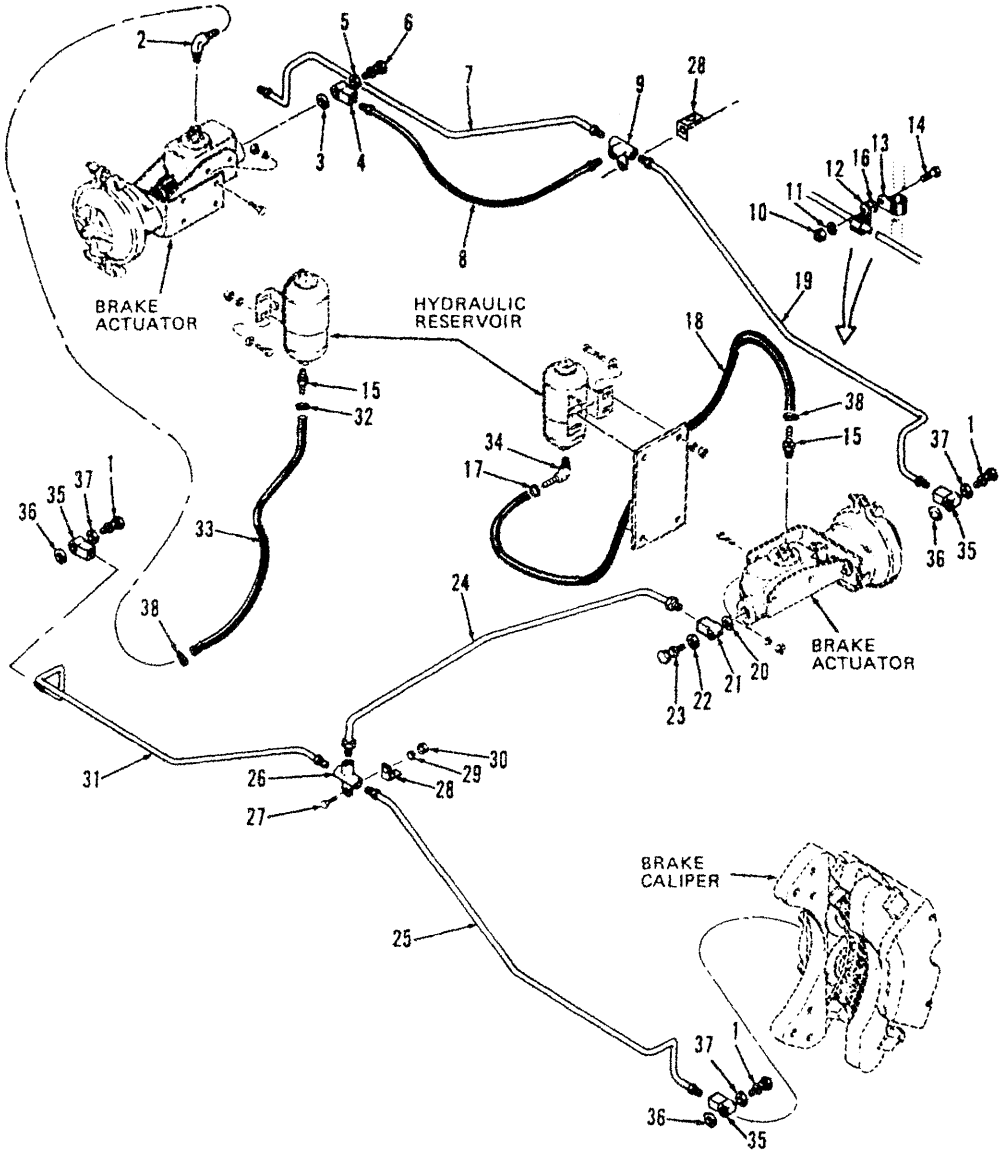


Figure 80. Hydraulic brake system hoses, lines, and fittings.

CROSS-REFERENCE INDEXES

PART NUMBER INDEX

FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
13445	88564	5310-01-129-9829	37	33
60703	88752-2	5355-01-176-7864	77	3
			121	5
75175	89-2308	2540-01-018-9075	114	7
01364	8942	5340-01-194-9344	40	16
60703	89515-6	2540-01-182-6887	121	7
70040	8985372	2510-01-165-8137	36	12
70040	8985384	9905-01-197-3008	36	27
70040	8985496	5340-01-199-2003	36	21
70040	8985658	7690-01-182-3476	36	29
70040	8985670	2540-01-184-0474	36	13
53867	9-400-230-043	2910-01-195-3716	17	
			17	3
53867	9-420-234-068	2910-01-191-6641	17	1
10988	9-71525		125	21
10988	9-95721		125	12
77052	90-2724	5940-01-221-5886	97	16
08752	90-454		97	8
13445	90000-01	5930-01-085-2206	37	39
77977	902Y108-24V	6220-01-184-2758	150	12
24617	905599	3110-00-850-0443	56	17
73342	907427	3110-00-045-7322	57	4
24617	907428	3110-00-592-9967	56	12
73342	907429	3110-00-869-9585	51	1
24617	907431	3110-00-913-6086	55	28
73342	907808	3110-00-155-6152	57	1
			57	16
			61	27
16764	907940	3110-00-107-7564	33	5
96151	9086-2	5330-01-106-1159	95	21
62491	909122	2540-01-184-5549	112	16
77977	912		150	14
53591	917529	2930-01-221-7334	31	3
01364	920-2538	5365-01-185-4742	38	5
24234	936043	2540-01-082-2214	124	1
24617	9409018	5306-00-940-9018	61	13
73342	9409027		58	21
24617	9409042	5306-00-292-4590	78	1
73342	9409052	5305-00-006-0669	55	1
73342	9409239	5306-01-085-3876	59	17
89345	9409949	4730-00-010-3875	71	8
			71	10
			72	36
			74	8
			75	43
16764	9412305	5310-00-955-6000	35	7
73342	9414207	3110-00-913-6116	56	27
16764	9415235	5365-00-715-1152	35	9
			35	26
97907	9416389		62	1
		2520-00-081-5114	62	14

CROSS-REFERENCE INDEXES

PART NUMBER INDEX

FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
16764	9418881	5310-00-944-5896	33	13
11862	9418968	5305-00-725-2317	22	7
			40	41
			66	6
			82	20
			84	3
			104	4
			104	19
			107	13
			110	9
24617	9422846	5310-01-084-1197	61	12
73342	9433260	3110-00-085-2998	62	6
16764	9437171	3110-01-079-7024	33	43
73342	954528	3110-00-198-2848	55	15
			56	24
78500	959-55-41392	2520-01-059-1444	69	5
78500	959-64-41393	2520-01-192-4688	68	1
78500	959-65-41393	2520-01-057-0259	68	2
78500	959-92-41392	2520-01-191-6515	69	1
78500	959-92-41845	2520-01-060-7087	70	1
78500	9595441845	3010-00-388-9744	70	2
52256	9630134	2530-01-180-0974	79	1
52256	9630159		81	3
52256	9630173		81	4
52256	9640079		79	2
52256	9640105	3040-01-179-5669	81	8
52256	9640137		81	6
52256	9640138	2530-01-179-8866	81	5
52256	9640184		79	3
52256	9650253		81	11
52256	9650303	2530-01-176-4090	81	1
52256	9680381		81	7
52256	9680382	2530-01-180-0976	KITS	
52256	9680401	2530-01-180-0975	81	2
52256	9680436	2530-01-180-0799	KITS	
13548	99011R	6220-01-198-4210	44	6

7-3. AIR BRAKE SYSTEM MAINTENANCE (CONT)

b. Service Brake Treadle and Valve and Declutch Treadle and Valve. This task covers removal, installation, and testing of service brake treadle and valve and declutch treadle and valve.

TOOLS: No. 1 Common Organizational Maintenance Tool Kit
Fixed open end wrench set
Socket wrench set, 3/8 inch drive
Air pressure gage, zero to 150 psi
Reducer, 1/2 to 1/8 NPT (FSCM 10988 PN 221-54)

MATERIALS/PARTS: Clean cloths (Appendix C, item 1)
Detergent (Appendix C, item 3)

PERSONNEL REQUIRED: Two Construction Equipment Mechanics MOS 62B

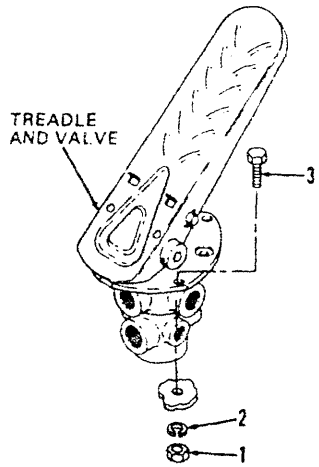
NOTE

PRELIMINARY PROCEDURE: All air lines, adapters, tees, and fittings disconnected and removed from treadle and valve being removed (page 7-74) and cab floor mat pulled back just enough to gain access to treadle and valve mounting hardware.

REMOVAL

(1) While assistant in cab holds capscrews (3) using socket wrench, remove three nuts (1) and lock washers (2) from beneath cab deck.

(2) Remove three capscrews (3) and treadle and valve from loader cab.



b. Service Brake Treadle and Valve and Declutch Treadle and Valve (cont).

INSTALLATION

(1) Position treadle and valve on cab deck.

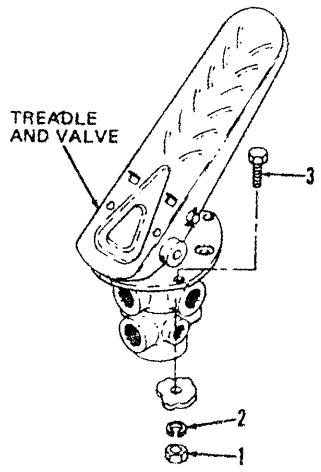
(2) Install three capscrews (3). Tell assistant to install and tighten three lock washers (2), and nuts (1).

(3) Connect air lines and fittings to treadle and valve (page 7-82).

(4) If necessary, install double check valve and stop light switch (page 7-68).

(5) Close air reservoir drain valve.

(6) Reposition cab floor mat.



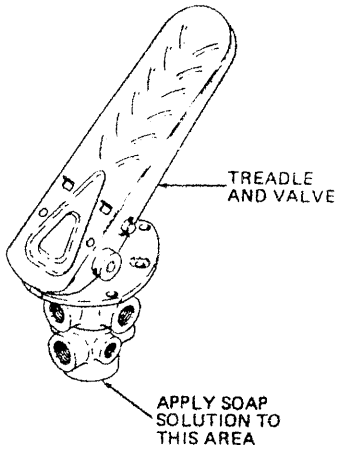
LEAKAGE TEST

(1) Start engine and operate at idle speed. Continue to operate engine until air pressure gage indication on left instrument cluster no longer increases.

(2) Apply parking brake.

(3) Turn off engine. Be sure treadle and valve is fully released.

(4) Apply soap solution on and around bottom bore of valve body. Watch for bubbles. If bubbles are seen, this indicates air leakage. If there is any air leakage, replace treadle and valve. Forward defective treadle and valve to direct support maintenance for repair.



(5) Tell assistant to press treadle completely while you apply soap solution on and around bottom bore of valve body. Watch for bubbles. If bubbles are seen, this indicates air leakage. If there is any air leakage, replace treadle and valve. Forward defective treadle and valve to direct support maintenance for repair.

Table 2-3. Mechanical Troubleshooting (Cont'd)

MALFUNCTION TEST OR INSPECTION	CORRECTIVE ACTION
Step 4. Check oil line connections for leaks.	Tighten connections (page 5-27).
Step 5. Check for damaged oil lines.	Replace damaged oil line(s) (page 5-27).
Step 6. Check for obstruction at the system vents.	Clean or replace breathers (page 5-16).
Step 7. Check for loose oil filter cover.	Tighten cover capscrews and/or replace seal (page 5-29).
Step 8. Check converter oil temperature gage for proper operation using a gage known to be good.	Replace oil temperature gage if test gage does not indicate overheating (page 4-24).
Step 9. Check oil cooler.	Clean or replace oil cooler (page 5-22).
Step 10. Check water pump.	Replace water pump (page 3-112).
END OF TESTING!	
STEERING	
32. TRACTOR WILL NOT TURN IN ONE DIRECTION	
Step 1. Inspect steering clutches control linkage for damage.	If linkage is damaged, notify intermediate maintenance.
Step 2. Check steering clutches control linkage travel.	Adjust steering control linkage (page 9-5).
END OF TESTING!	

Table 2-3. Mechanical Troubleshooting (Cont'd)

MALFUNCTION TEST OR INSPECTION	CORRECTIVE ACTION

33. TRACTOR WILL NOT TURN IN EITHER DIRECTION

Step 1. Check steering clutches control linkage travel.

Adjust steering control linkage (page 9-5).

Step 2. Check steering brakes control linkage travel.

Adjust brakes control linkage (page 9-2).

END OF TESTING!

34. TRACTOR TURNS IN EITHER DIRECTION WHEN BOTH STEERING CONTROL LEVERS ARE PULLED AT THE SAME TIME

Check steering clutches control linkage travel.

Adjust steering control linkage (page 9-5).

END OF TESTING!

35. SLOW RESPONSE TO STEERING CONTROL LEVER MOVEMENT

Step 1. Check fluid level of bevel gear and steering clutch compartment.

Add oil if necessary (page 5-16).

Step 2. Check control linkages travel for steering clutches and brakes.

Adjust steering and brakes control linkages as necessary (pages 9-5 and 9-2).

END OF TESTING!

HYDRAULIC SYSTEM (BULLDOZER AND RIPPER)

36. IRREGULAR CYLINDER MOVEMENT (NOT SMOOTH)

Step 1. Check all hydraulic lines and connections for leaks, kinks, or other damage.

Replace damaged lines and/or fittings (pages 13-12 through 13-26).

Section II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER (1)	COMPONENT/ASSEMBLY (2)	MAINTENANCE FUNCTION (3)	(4) MAINTENANCE LEVEL					TOOLS & EQUIP (5)	REMARKS (6)
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
1305	Track Assembly:	Inspect		0.2					
		Adjust		0.5				3	
		Replace		4		4		3,6	EE
		Repair			26.0			6	
		Overhaul					40	6	
14	STEERING								
1403	Steering Brakes:								
	Actuating Mechanisms, Steering Brakes	Replace			6			6	
		Repair			6			6	
	Hydraulic Controls, Steering Brakes	Replace			1			6	
		Repair			1.5			6	
	Pedals and Linkage, Steering Brakes	Adjust		0.5				3	
		Replace			3.6			6	
		Repair			2			6	
	Brake Lock Lever, Steering	Replace		1				2	
	Steering Brake Lining	Replace			0.5			6	
	Steering Clutch	Replace			4			6	
		Repair			10			6	
	Steering Clutch Hubs	Replace			1			6	
	Steering Clutch Levers and Linkage	Adjust		0.5				3	
		Replace			1.6			6	
		Repair			3			6	
1414	Steering System Valves:								
	Relief Valve, Steering Brake	Replace			0.5			6	
	Steering Clutch Control Valve	Replace			4.2			6	
		Repair			3			6	
15	FRAME, TOWING ATTACHMENTS AND DRAWBARS								
1501	Frame Assembly:								
	Frame and Case Assembly	Repair				12		6	

B 13