

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN
HYDRAULIC AND AIR/HYDRAULIC BRAKES PREVENTIVE
MAINTENANCE

HEADQUARTERS, DEPARTMENT OF THE ARMY
23 NOVEMBER 1989

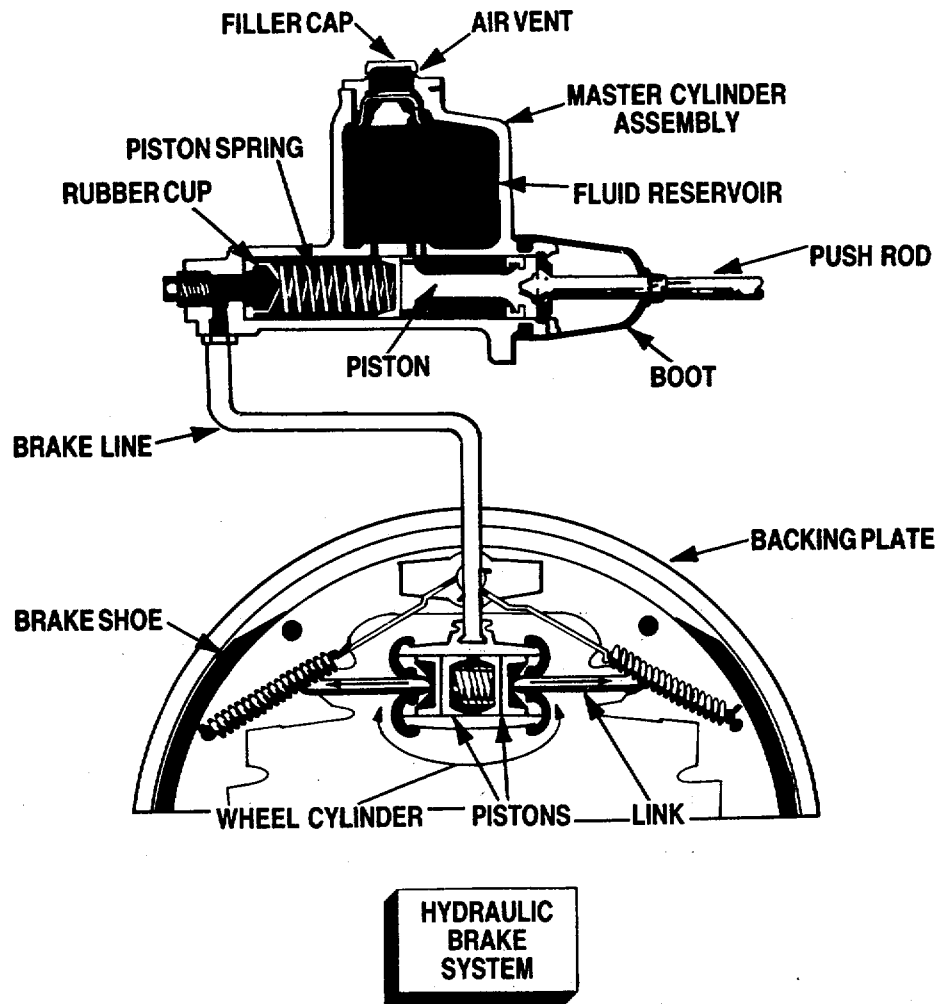
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SECTION I. INTRODUCTION

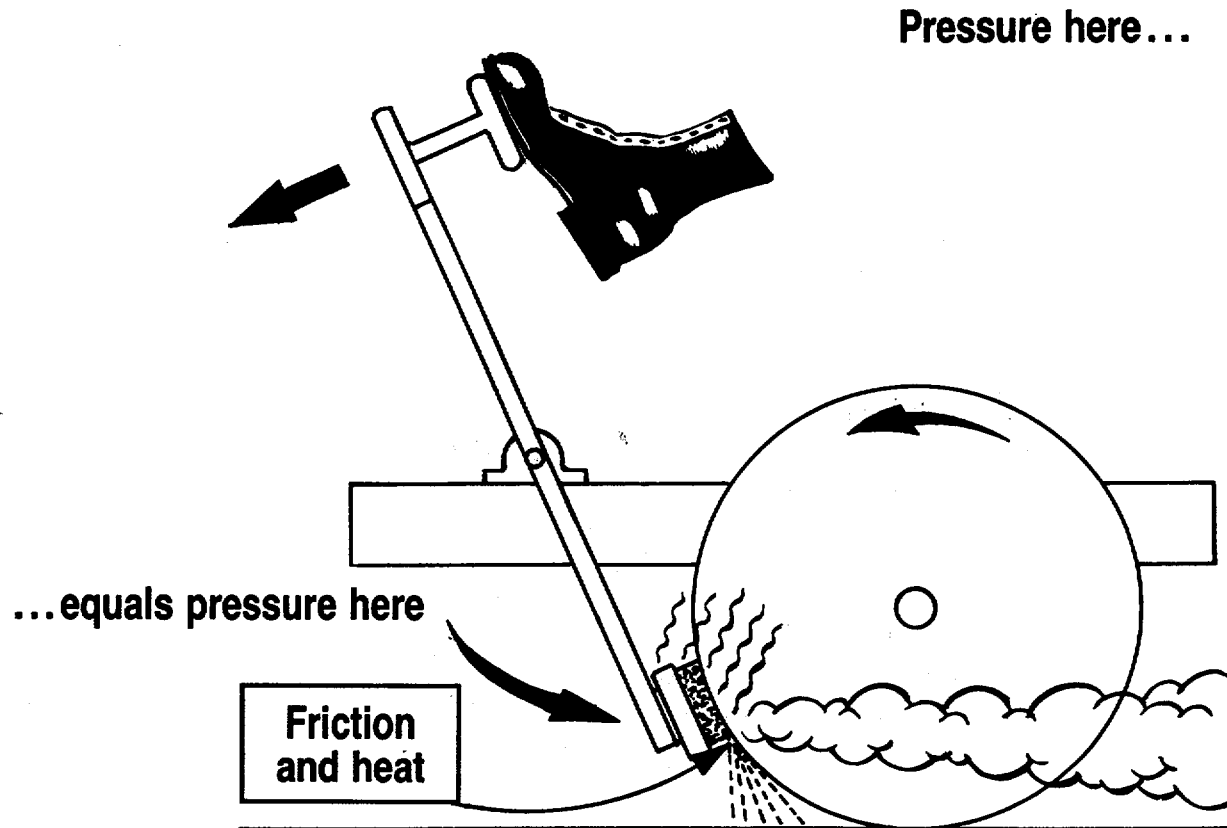
1. Purpose. This bulletin provides the field methods of troubleshooting hydraulic and air/hydraulic brakes on Department of Army tactical wheeled vehicles.
2. Scope. This bulletin contains preventive maintenance procedures for hydraulic and air/hydraulic brake systems on Department of the Army tactical wheeled vehicles. It covers how the systems operate, trouble signs, safety procedures and expedient repairs.
3. Suggested Improvements. You can help improve this bulletin. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA form 2028 to; Commander, US Army Tank-Automotive Command, ATTN. AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished to you.

4. General

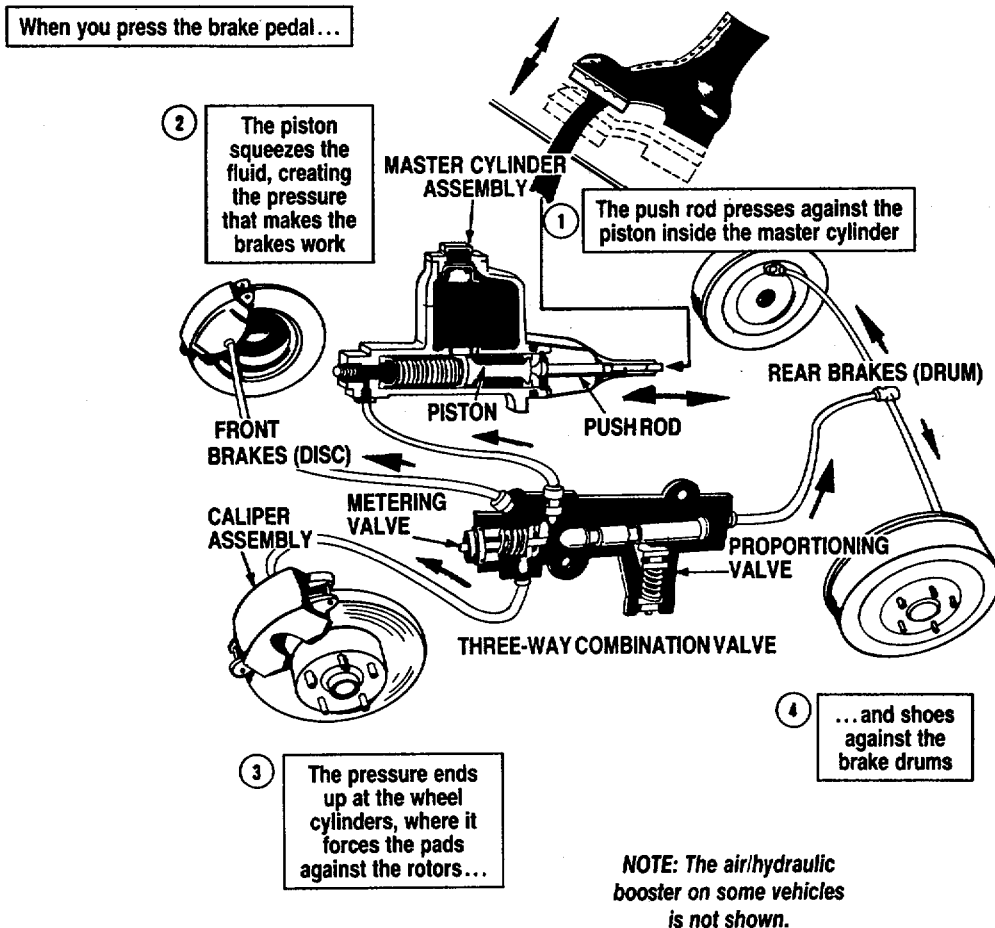
a. A truck's hydraulic system is basically an airtight group of cylinders, valves and lines filled with fluid. Pressure is created in the system when you step on the pedal. That pressure ends up at the wheel cylinders, where it forces the shoes against the brake drums. On disk brakes, the fluid goes to the caliper pistons, which push the brake pads against the rotors.



b. When brake shoes press hard against a drum or rotor, they develop friction. This friction does the braking. The truck stops as long as you have good brake linings and an airtight hydraulic system filled with fluid.



- c. Hydraulic and air/hydraulic brakes work because of a simple law of hydraulics; pressure cannot compress fluid, but fluid will transfer pressure.
- d. The master cylinder is the heart of the hydraulic brake system. When you press the brake pedal, the push rod presses against the piston inside the master cylinder. This creates the pressure that makes the brakes work.
- e. That's why a leak in the brake system cuts down on the stopping power. When you lose fluid, the space is filled up with air. Air compresses under pressure, leaving the truck with a sinking or spongy brake pedal. If you lose enough fluid, and trap enough air, you won't have any brakes.
- f. If the fluid level in the master cylinder is low, it usually means there is a leak in the system. The brake system does not consume fluid.
- g. Some mechanics start troubleshooting a leak at the master cylinder. They replace the master cylinder, but the truck still has trouble. Nothing has been solved and the cost of a new master cylinder has to be absorbed.



SECTION II. BRAKE PEDAL SYMPTOMS

1. If you recognize the symptoms of brake trouble, it's easy to pinpoint the problem. For example, the brake pedal can tell you a lot about the condition of the brakes.

2. Put your foot on the pedal. It should drop about 1/4-inch or so under the weight of your foot. That's called free travel. While you're doing this, also check the action of the pedal return spring. If you push the pedal down and it doesn't snap back when you release it, there's a problem with the spring or linkage. It must be checked out.

NOTE

HMMWV's and CUCV' have a hydro-booster that lets the pedal sink if you apply steady, hard pressure while stopped. This can be misleading, so check out the brakes if the driver reports it.

3. The pedal should be firm once you pass the free travel on most trucks. A sinking brake pedal is the sign of a leak. If you can't find a leak, and the fluid in the master cylinder stays up, the master cylinder may be defective.

4. A spongy or soft pedal means there is air in the lines. Air gets trapped when the fluid level drops too low in the master cylinder, or the brakes were not bled properly the last time they were serviced, or there is a leak.

5. Bleed all the lines and pump the brakes several times. If the pedal starts to soften again, there is a leak.

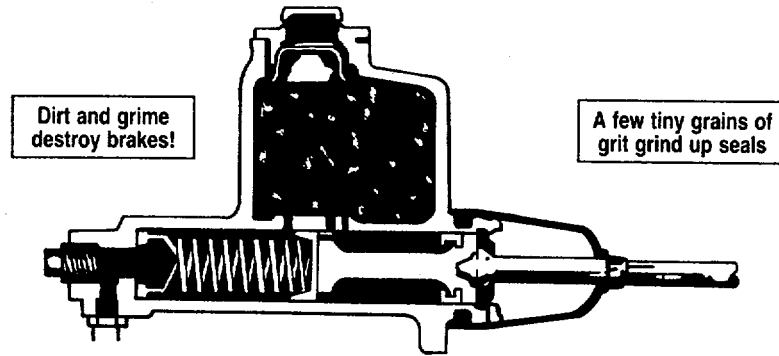
6. A spongy pedal can also mean a hose has become weak and is ready to burst. Brake hose inspection is required at each semiannual service, but don't wait if you have a spongy pedal.

7. Replace any hose with a bulge. Look close at the hoses that run near the frame. Check each hose for wear or pinching. If a hose is worn or cracked through the outer cover down to the first layer of fabric, or if it's crimped, replace the hose.

8. Additional information on mandatory brake hose inspection can be found in TB 9-2300-405-14, Mandatory Brake Hose Inspection and Replacement-Tactical Vehicles.

SECTION III. CLEANING

1. Before you get a wrench and go to work on the brakes, there is one thing to remember, keep it clean.
2. A few tiny grains of grit inside the brake system rubs like sandpaper, grinding up master cylinders and destroying seals. The only cure for this problem is prevention.



3. Grit and dirt usually sneak into the brake system when you check or add fluid. This is true for all vehicles, but the problem is worse on 2 1/2- and 5-ton trucks. Dirt has more chances to get into the brake system because the master cylinder is located underneath the trap door in the floorboard..

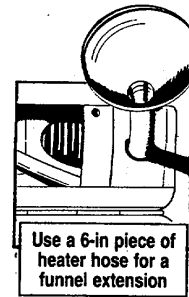
WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/ shield, gloves, etc.).

4. There is usually dirt, water and other debris you don't want in the master cylinder on the floorboard. Give the floorboard a good sweeping before you open the trap door. Then use an air hose to clean the area around the filler cap. Make sure you wear goggles when you clean with compressed air.
5. Also on 2 1/2-ton trucks, you have to remove the vent line to get to the filler cap. Blow the area clean with compressed air and then wipe it off with a rag.
6. The best place for the filler cap is on the master cylinder. If you check the fluid level and its low, replace the cap while you get the fluid and funnel. This is the only sure way to keep airborne grit and dirt out of the brake lines.

7 Use the funnel in the No. 1 Common shop set to add fluid. This works fine on the 5-ton trucks but the 2 1/2-ton trucks have a crossmember that is in the way. Use a 6-inch piece of heater hose on the funnel's spout as an extension to reach the master cylinder.

8 Clean the funnel and extension before you use them again. Oily funnels attract dust and dirt that will contaminate the brake fluid. It doesn't take much dirt to damage brake systems.



9. Wipe off the fluid bottle cap before you screw it back on. Also, be careful where you lay the master cylinder cap. Always wipe it off.

10. A few minutes of prevention can save hundreds of dollars and several manhours of repair time.

SECTION IV. BLEEDING BRAKE SYSTEMS

1. The easiest way to bleed brake systems is with a filler/ bleeder, NSN 4910-00-273-3658. It's in the No. 1 and No. 2 Common shop sets, and the instructions on how to use it are in the vehicle's -20 technical manual.

2. If you don't have a filler/bleeder, you can still bleed the hydraulic lines with the help of an assistant, a long piece of clear plastic tubing, NSN 4720-00-964-1433, and a clear glass or plastic container. The procedure is as follows:

NOTE

Use only clean silicone brake fluid, NSN 9150-01-102-9455.

- a. Put about an inch of clean brake fluid in the container.
- b. Fit the tubing over the bleeder valve on the wheel farthest from the master cylinder, usually the right rear wheel. Run the loose end of the tubing down inside the jar into the fluid.
- c. Make sure the master cylinder is full of fresh, clean fluid and the cap is on tight before you bleed each line. Refill the master cylinder after you bleed each line. Check the reservoir periodically while bleeding. If it runs low, air can get sucked into the line and then it has to be bled again.
- d. Have the assistant pump the brake pedal three times and then hold the pedal down. This will keep the fluid coming while you bleed.

- e. Open the bleeder valve. Watch and listen as the fluid flows through the tube. When you no longer hear a sputtering sound, or see air bubbles, or the flow stops, tighten the valve and tell the assistant to release the brake pedal.
- f. If the fluid stopped flowing before all the bubbles were out, have the assistant pump up the pressure and bleed the line again until you see a steady flow of fluid.
- g. Move to the next longest line and bleed that wheel cylinder. Work your way down to the shortest line, usually the left front wheel.
- h. When you're finished, get rid of the old fluid according to your SOP.

SECTION V. TESTING THE BRAKES

1. Test brakes in the motor pool, not on the road. If anything feels wrong or looks out-of-place, take time to investigate using the brake troubleshooting section in the vehicle's -20 technical manual.
2. If you have to take anything apart, make sure it goes back right and always bleed the entire brake system. The schematic you need to trace the lines and pinpoint the connections are also in the -20 technical manuals.
3. Any time air gets into the system, bleeding is the only way to get rid of it.

SECTION VI. DRAGGING BRAKE SHOES/PADS

1. After testing the brakes in the motor pool, drive the truck out on the road. Hold the steering wheel loosely in your hands and apply the brakes. Feel the steering wheel to see if the truck pulls to one side. If it does, the brake shoes/pads are probably dragging on one of the brake drums/rotors.
2. Adjust the brakes and try the road test again. If the truck still pulls one way or the other when you apply the brakes, it could be either a rusted or sticking wheel cylinder/caliper, or glazed or oily brake shoes/pads.
3. Brake shoes/pads are cheap and trucks are expensive and you can't put a price on a life. When in doubt, replace the brake shoes/pads.

4. Do not take shortcuts like sanding a glazed brake lining, or cleaning them with drycleaning solvent. If a lining is glazed, worn, or has grease or brake fluid on it, replace it along with all other brake shoes/pads on that axle. Replacing all the linings on an axle keeps brakes working evenly.
5. When brake linings become covered with dirt or mud, clean them with water and a brush. Never use drycleaning solvent. It breaks down the material in the lining. Replace the linings if there is anything on them that the brush and water won't take off.
6. You should always play it safe. Take a look at the brake lining any time you have a wheel off. Replace all the linings on that axle if the lining is worn to within 1/8-inch of the rivet heads. On bonded linings, follow the wear limit specifications in the -20 technical manual.

SECTION VII. REPAIRS

1. Do not repair master cylinders, wheel or air/hydraulic cylinders. When you find a bad master or wheel cylinder, order a new one. Parts from a disposal point may look all right, but they can fail as soon as the truck gets on the road.
2. Never cut corners on brake repair. That can be fatal to the driver and anyone who gets in the driver's way.
3. Before you put any new brake part on a truck, carefully compare it with the old one. Mistakes are made in the supply system. If it doesn't look or fit right, don't use it.
4. Never substitute parts from another vehicle or brake system, even though they may look alike. Parts may look very similar, but they don't always work the same.
5. It takes time to do any brake job right. Don't put on a set of brake pads/shoes in a hurry. Take the time to look at the wheel bearings and other components in the brake system.
6. Copper tubing won't hold up to the high pressure in hydraulic brakes. It's not for hydraulic brakes because it can rupture at a crucial moment, leaving the truck without any way to stop. Always use steel.

7. Some copper lines look like steel. When you're not sure if a line is steel plated copper, use a magnet. If you don't have a magnet, use a pocket knife and try to nick the tubing. Steel is tough to cut, so if it nicks easily, it's copper.
8. While you're at it, check all lines to make sure they are double flared before you put them on.

SECTION VIII. PAINTING

1. Never paint a flexible hydraulic brake hose, but if paint is already there, leave it alone. The harsh solvents needed to remove the paint will harm the hose more than the paint.
2. Paint hides cracks and cracks in a brake hose lead to brake failure. Replace a painted hose at the next scheduled service or anytime you spot a crack that goes all the way down through the cover to the fabric.
3. For additional information on brake hose inspection, see TB 9-2300-405-14, Mandatory Brake Hose Inspection and Replacement-Tactical Vehicles.

SECTION IX. TAGGING

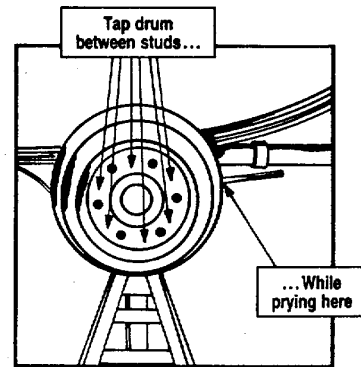
1. Place a red tag on the steering wheel while a truck is NMC for brake work. It might save a life. A red tag tells you and anyone else that the truck is NMC for brakes.
2. You can order 50 of the red tags, DD Form 1577, with NSN 9905-00-537-8954.

SECTION X. BRAKE PROBLEMS-CUCV

1. The rear brake drum on an M1009 CUCV is hard to get off when rust freezes it to the flange.
2. The following is the easiest way to get the drum off.
 - a. Clean rust and dirt off the drum and flange with a wire brush.
 - b. File off any burrs on the flange.
 - c. Squirt penetrating oil, NSN 6850-00-973-9091, where the drum slides over the flange. Give it a few minutes to soak in.
 - d. Put a bar between the drum and backing plate and carefully pry out while you gently pull off the opposite side of the drum. Be careful not to bend the backing plate.

e. At the same time you are prying on the brake drum, have an assistant use a 1/4-inch punch and a 1-pound ballpeen hammer to tap on the drum between the studs.

f. If the drum doesn't come off after a few taps, squirt on more penetrating oil, let stand a few minutes, and try again.



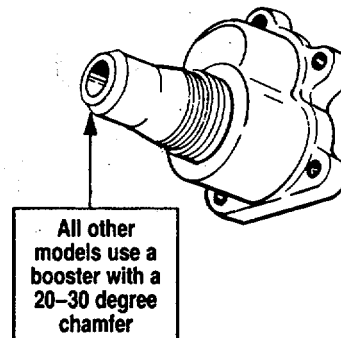
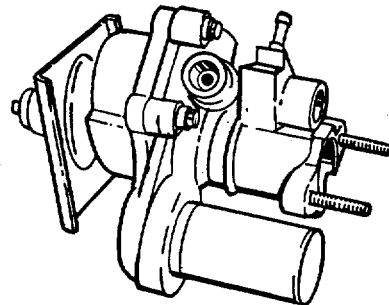
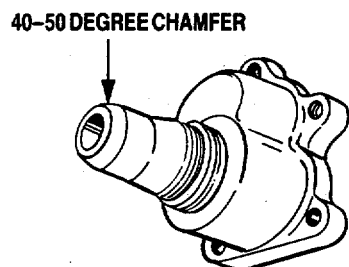
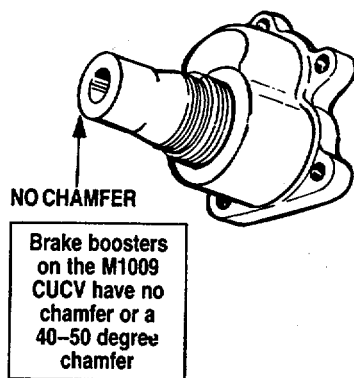
3. The hydraulic brake boosters on the M1009 CUCV are different from all other models of CUCV's. If you put an M1009 booster on another model CUCV, the brakes will not work right.

4. The boosters look alike except for the pushrod end, where it attaches to the brake pedal. The housing on the M1009 booster is machined flat, or has a 40- to 50-degree bevel. It is assigned NSN 2530-01-154-1294.

5. All other models use NSN 2530-01-157-3005 or 2530-01-151-5967. The pushrod end has a shallower, 20- to 30-degree bevel.

6. If you are not sure which booster is on a CUCV, get a flashlight and look under the dash. Follow the brake pedal up to where it connects to the booster pushrod on the firewall. Look close at the bevel on the pushrod housing.

7. If the CUCV has the wrong booster, don't wait, change it.



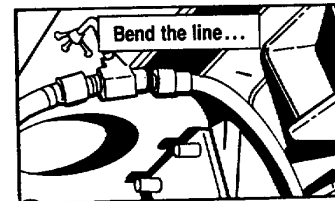
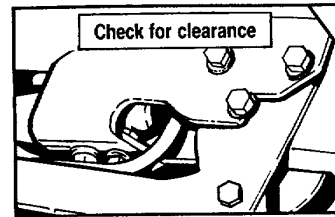
SECTION XI. BRAKE PROBLEMS-M151 SERIES

1. The improved rear differential mounting bracket on 1/4-ton trucks can rub a hole in the brake line, leaving you without brakes.

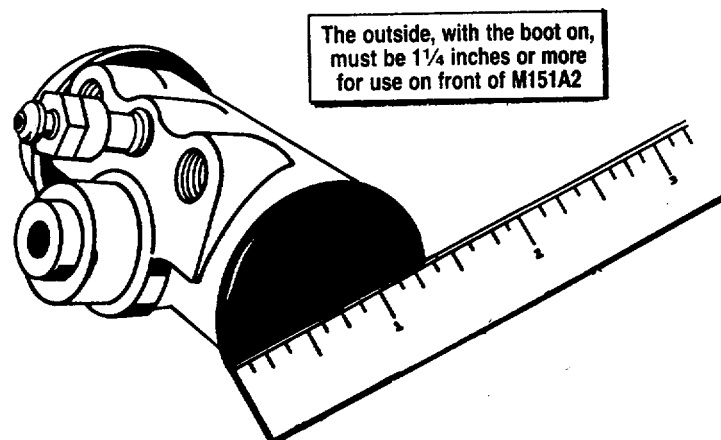
2. Take a look at the hose. There should be at least 1/8-in clearance between the line and the top of the bracket, and 1/2-in of space at the bottom.

3. If there's not enough clearance, move the hose gently. Bend the brake line at the "T" and turn the hose clamp on top of the rear suspension arm. You must be careful not to move them more than they need.

4. Once the line is in the clear, have an assistant apply the brakes while you check the line for leaks.

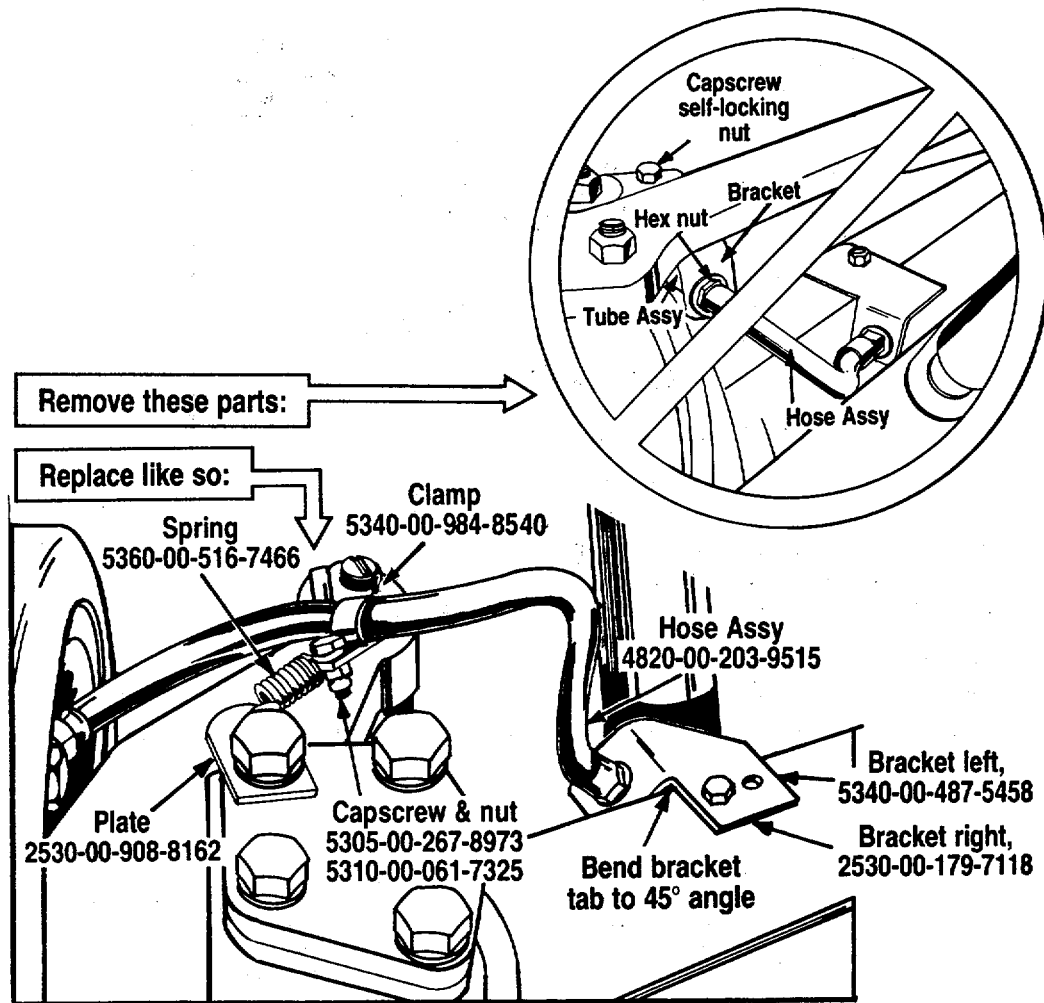


5. M151 Brake Cylinder Matchup - Wheel brake cylinders come in two sizes for the 1/4-ton trucks. Mixing them makes the brakes unsafe. M151 and M151A1's use 3/4-in brake cylinders, assigned NSN 2530-01-071-9851, on the front and rear brakes. M151A2's use 3/4-in cylinders on the rear, but on the front they need 1-in cylinders, assigned NSN 2530-01-071-9850. The size is stamped on the cylinders.



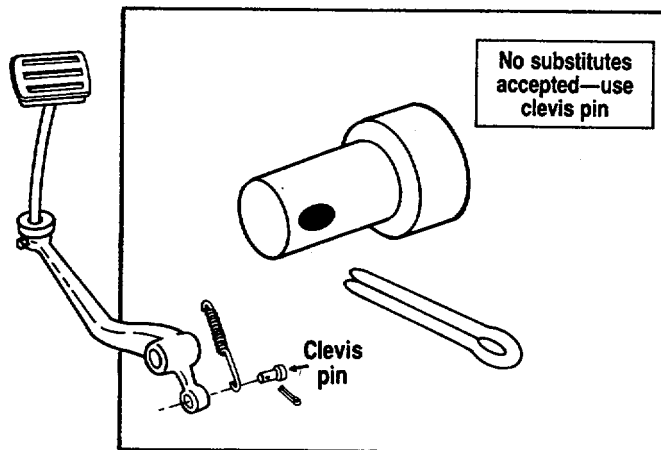
SECTION XII. BRAKE PROBLEMS-2 1/2-TON TRUCKS

1 The original front hydraulic brake hose on the M44-series trucks is too short. It breaks. Before it does, replace it with NSN 4720-00-203-9515. The new hose is longer and doesn't fit the setup on the truck. The replacement procedure is in Paragraph 4-10a of TM 43-0143, but basically is performed as follows.

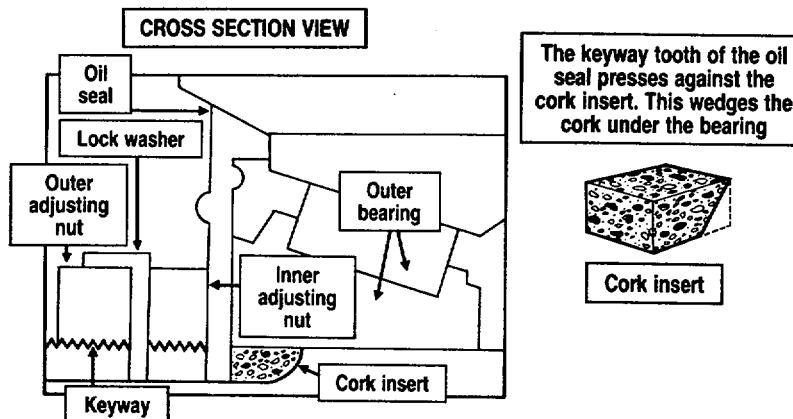


SECTION XIII. BRAKE PROBLEMS-2 1/2-TON and 5-Ton Trucks

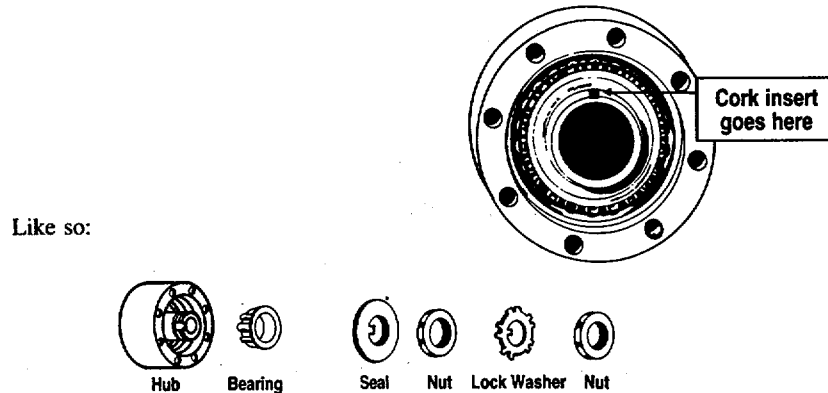
1. You can get somebody killed if you use a nut and bolt instead of a clevis pin at the truck's master cylinder. The nut vibrates off a standard bolt and then you have no brakes.
2. All M44-, M39-, and M809-series trucks have the right pin listed in their -20P TM's. It's easier to find and use the clevis pin than to explain after an accident why you used a substitute.



3. That little piece of cork that goes on the rear wheel drums of these trucks may not look important, but it is. If the inner oil seal leaks, it keeps oil from washing grease out of the wheel bearings. Without grease, the bearings burn up. The oil will get on the brake drum, the lining and the brake shoes.
4. Oil and brakes don't mix. The brakes will go out and the driver could get a fatal surprise if he has to stop in a hurry. All because of a small piece of very important cork.

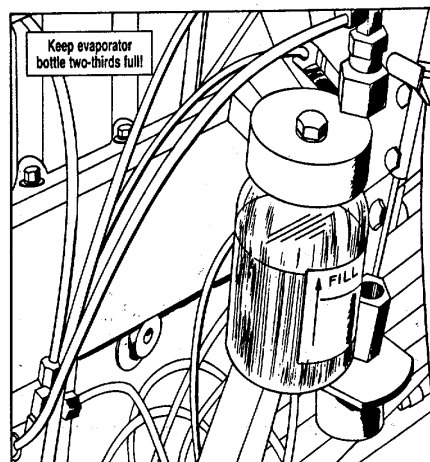


5. Oil in the axle housing travels out to the end of the axle housing spindle. The outer seal blocks this oil from getting into the hub, except where the spindle keyway provides a handy channel under the outer bearing.
6. That's where the cork insert does its job. It plugs the keyway under the bearing and stops oil from getting into the hub.
7. Cork insert, NSN 5330-00-348-8365, is used on 2 1/2-ton trucks, while insert NSN 5330-01-133-7262, is used on the 5-ton trucks. Here is where it goes.



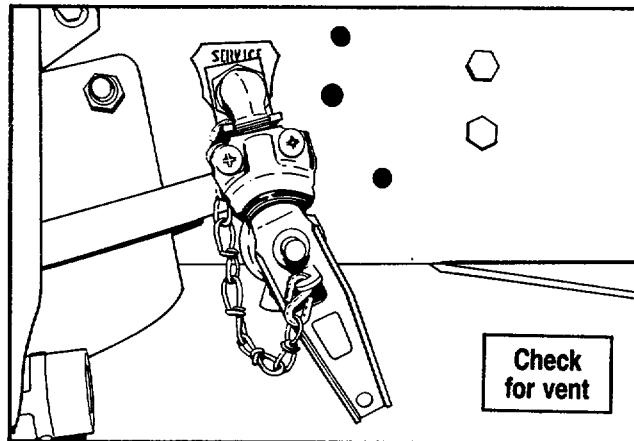
The cork insert is jammed under the bearing by the seal keyway tang when pressure is applied to the nut.

8. An alcohol evaporator bottle is added to the brake system on some 2 1/2- and 5-ton trucks as part of the winterization kit. Keep alcohol in the bottle or it will melt. Big diesel engines get hot enough to soften, bend or crack an empty plastic bottle, even in cold weather. Eyeball the bottle each time you open the hood to make sure it's two-thirds full. When you add alcohol, always use the filler plug. Unscrewing the jar ruins the gasket.

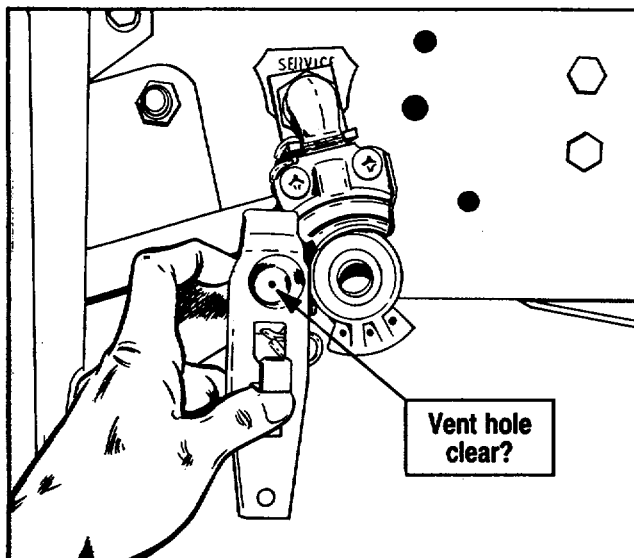


SECTION XIV. BRAKE PROBLEMS - 5-TON TRUCKS

1. You will waste money if you trash can the worn out brake shoes on your M39- or M809-series 5-ton trucks. The SMR code shows the shoes as non-repairable, but that is not true. Direct Support can replace the linings and make them good to go for a lot less than the cost of new brake shoes.
2. Always replace the front SERVICE glad hand on a 5-ton truck with vented coupling, NSN 2530-00-740-9445. If you use a regular dummy coupling, the brakes won't release after the driver applies them.



3. That's because the service dummy coupling needs a breather vent to release air pressure. If you have the right coupling and the brakes lock up, the vent hole may be plugged with dirt or paint.



By Order of the Secretary of the Army

CARL E. VUONO
General, United States Army
Chief of Staff

Official: :

WILLIAM J. MEEHAN II
Brigadier General United States Army
The Adjutant General

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*U.S. GOVERNMENT PRINTING OFFICE 1993: 342 421/80784

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THE METRIC SYSTEM AND EQUIVALENTS

NEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
 1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
 1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
 1 Kilogram = 1000 Grams = 2.2 lb.
 1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
 1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
 1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
 1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
 1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

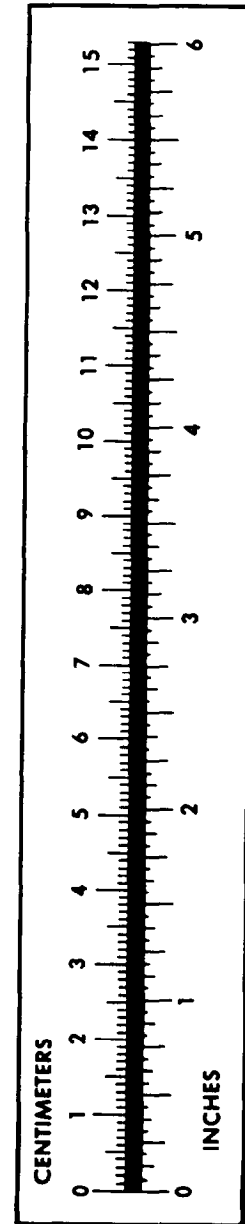
TEMPERATURE

$5/9(^{\circ}\text{F} - 32) = ^{\circ}\text{C}$
 212° Fahrenheit is equivalent to 100° Celsius
 90° Fahrenheit is equivalent to 32.2° Celsius
 32° Fahrenheit is equivalent to 0° Celsius
 $9/5^{\circ}\text{C} + 32 = ^{\circ}\text{F}$

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
arts	Liters	0.473
gallons	Liters	0.946
Ounces	Liters	3.785
Pounds	Grams	28.349
Short Tons	Kilograms	0.454
Pound-Feet	Metric Tons	0.907
Pounds per Square Inch	Newton-Meters	1.356
Miles per Gallon	Kilopascals	6.895
Miles per Hour	Kilometers per Liter	0.425
	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
gallons	Gallons	0.264
ounces	Ounces	0.035
pounds	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



PIN: 067030-000