

CHAPTER 9
ELECTRIC BRAKES
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CHAPTER 9

ELECTRIC BRAKES

9.1 SCOPE. This Chapter applies to the operation and inspection of electric brake systems.

9.2 INTRODUCTION. The information in this Chapter is intended to provide general information describing the operation of electric brake systems and their major component parts in addition to providing a suggested inspection procedure to determine whether such systems and their component parts are functioning properly.

9.3 DEFINITIONS. Definitions appropriate to this Chapter are contained in Annex A of this Guide (Glossary of Terminology).

9.4 SYSTEM DESCRIPTION AND OPERATION.

9.4.1 Service Brake System. The electric trailer brake is an electrically operated mechanical friction device which employs expandable shoes to apply braking force.

- a. Electromagnets located on the axle inside the brake drums force the brake shoes against the drums when electrical current is applied,.
- b. Current to operate the system is supplied by the electrical system of the motor vehicle.
- c. The amount of force applied to the brake shoes depends on the amount of current delivered to the electromagnets. The current applied is controlled by a rheostat located in the motor vehicle in a position to be operable by the driver.

9.4.2 Breakaway Brake System. Breakaway brakes to control the trailing in the event of breakaway from a towing vehicle are normally included in a electrical brake system as follows:

- a. A battery is installed on the towed vehicle to supply electrical energy.
- b. A battery, is connected into the brake system wires through a switch, usually of the plunger type.
- c. The plunger of the switch is connected by cable or other suitable means to the towing unit.

* d. Upon breakaway, the plunger is pulled from the switch causing the contact points to close. This permits current from the battery to flow to the brake system and apply the brakes.

9.4.3 Service Brake System Operation. The service brake system operates as follows:

- a. When the brake control is moved, the magnets become energized attracting the armature with increasing force as the control is moved towards the full on position.
- b. The magnets lock up with the armature . and are forced to revolve with it. As the magnet begins to turn, a lug attached to it forces the brake bands against the drum. When the bands begin to press against the drums, the, magnet stops turning and remains in this position applying braking force as long as current is reaching the magnet.

9.5 COMPONENT PARTS.

9.5.1 Wheel Brake Assembly. The component parts of one type electric brake are illustrated below in Figure 9-1.

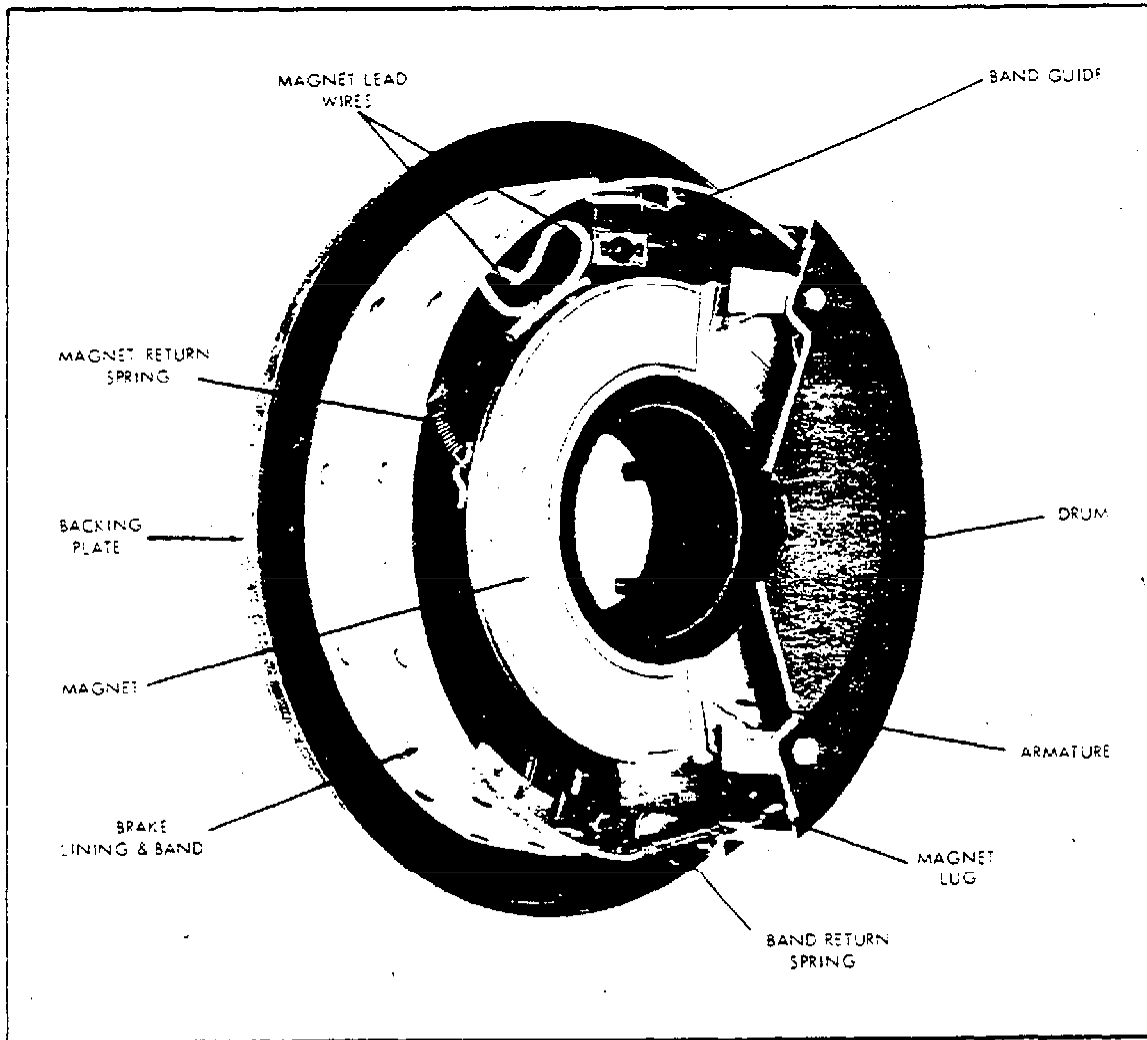


Fig. 9-1. Components of a 12-inch Brake

9.5.2 Electric Brake Assembly. Component parts of an electric brake system are illustrated below in Figure 9-2.

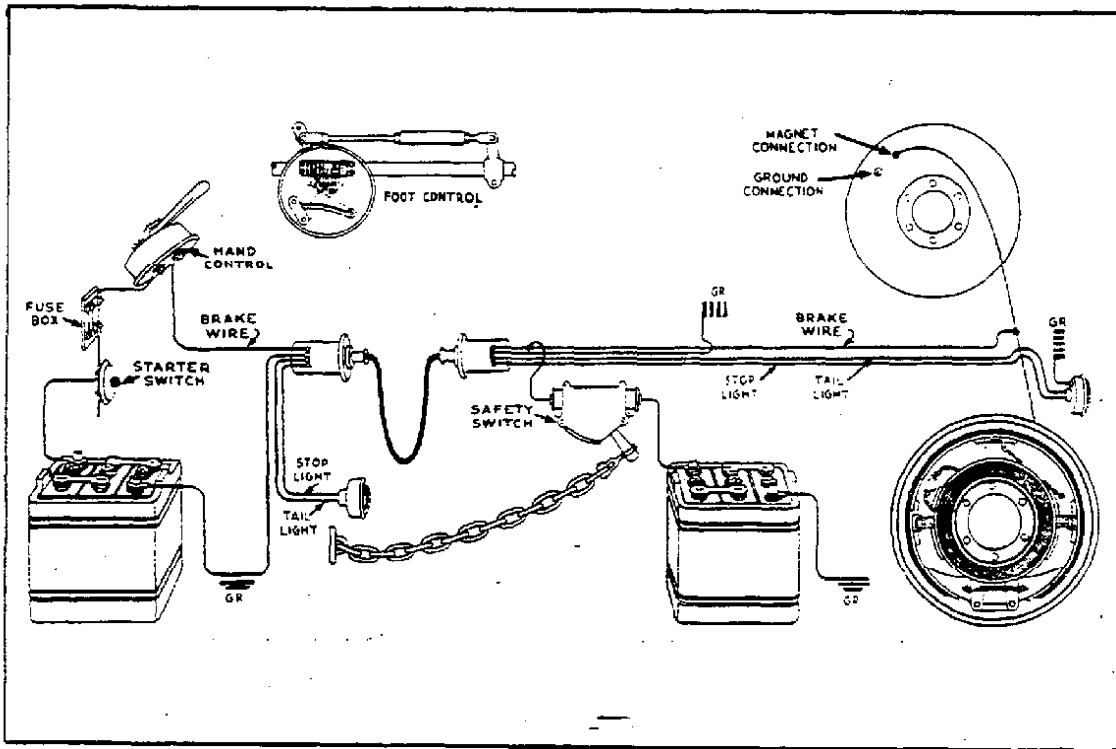


Fig. 9-2. Component Parts of an Electric Brake System

9.5.3 Hand Control Unit. The hand control device as shown in Figure 9-2' is mounted in the motor vehicle in such a manner that the driver can control the application of brakes to the towed vehicle. It may be installed so as to allow the brakes to be applied to the towing vehicle upon application of the foot brake or it may be installed as a single control device to be operated manually independent of the foot brake. In most instances a single control must operate all brakes on the combination of vehicles (Section 26458 VC).

9.6 INSPECTION AND TEST PROCEDURES.

9.6.1 Inspection Procedure Guide. The following procedures are offered as a guide to assist in making a complete inspection of an electric braking system.

9.6.2 Current, Polarity, and Amperage Check. In diagnosing brake trouble, the following checks should be made of the electric braking system on a trailer and towing vehicle.

a. Check controller current available at controller. Ascertain that the electrical circuit of the towing vehicle is fully connected to the electrical circuit of the trailer as shown in Figure 9-3.

(1) Check the socket and plug contacts to ensure a clean, tight connection.

(2) Disconnect either of the brake circuit wires from the controller and connect a low-reading DC ammeter (0-25 capacity) as shown in Figure 9-4 between the controller terminal or wire and the wire just removed.

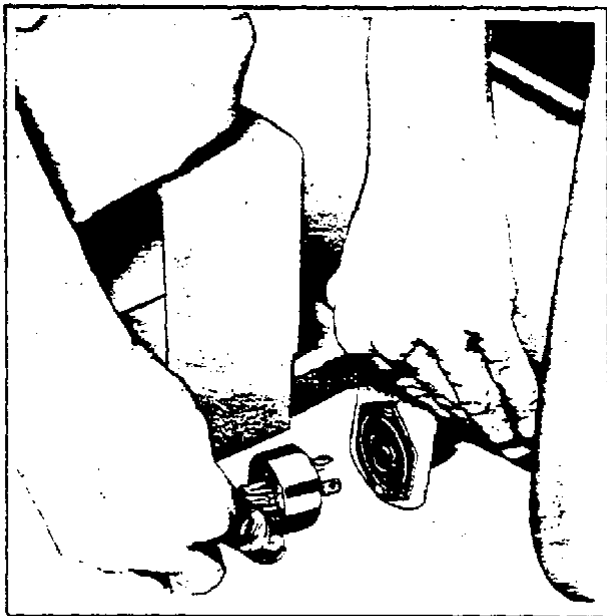


Fig. 9-3. Electrical Connection -
Towing to Towed Vehicle

b. Make a light, fast application and observe the direction of movement of the ammeter needle as shown below in Figure 9-5. If the needle moves in the wrong direction, reverse ammeter leads. This check prevents current of the wrong polarity from damaging the ammeter. When the ammeter is correctly connected in the brake circuit, make a full application of the controller noting the total current in the circuit as shown by the ammeter. To determine whether proper amount of current is available for braking, refer to Magnet Current Rating Table as shown in Figure 9-6.

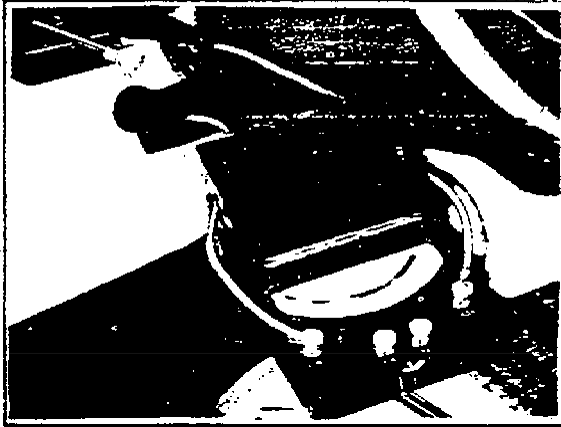


Fig. 9-4. Ammeter Connection

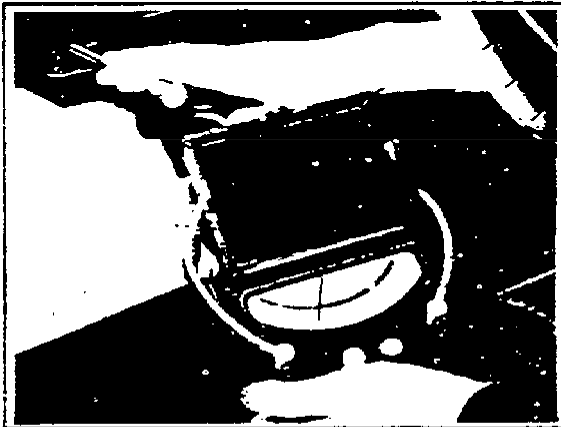


Fig. 9-5. Ammeter Reading

c. The total current in the brake system should be equal to the number of brakes times the values given in the Magnetic Current Rating Table as shown below in Figure 9-6.

MAGNET CURRENT RATING TABLE		
Brake Size	Amps	
	6 V	12 V
10"	4.0 - 4.4	2.0 - 2.2
12"	4.0 - 4.4	2.0 - 3.3

Fig. 9-6. Magnetic Current Rating Table

(1) If the reading at the controller is higher than the maximum, based on the Table, check for a short in the wiring, cable, controller, brake magnets, or for lights wired in the circuit.

(2) If the reading at the controller is less than the minimum, based on the Table, check the complete electrical circuit for loose or dirty connections, broken wires, improper wire size, and conformity of wiring arrangement with the wiring diagram that is available from the company who designed the system.

(3) If towing vehicle has a 12-volt electrical system and trailer brakes are 6-volt, check to make certain proper step-down resistor is being used. All splices must assure a good connection and the ground connection should be made at the battery ground.

d. After checking controller amperage, an individual amperage check at each brake magnet should be made.

(1) Connect the ammeter between either of the brake wires or terminals and the wire disconnected from the brake. Make light, fast controller application to ensure that meter is properly connected to brake circuit with respect to polarity. The reading at each brake should be the same and approximate the value given in the Magnet Current Rating Table as shown in Figure 9-6.

(2) if the current reading for any one brake is incorrect, inspect for broken wires, dirty or loose connections, and short circuits.

(3) When no external fault is found and brake amperage is still incorrect, remove wheel for further inspection. (This step is not appropriate for on-highway inspections.)

9.6.3 Wheel Bearing Check. During brake inspection, all wheels on the trailer should be checked for loose bearings. This condition causes undue heat and rapid lining wear, grabby or noisy brakes, and could even result in a wheel freezing on the axle. When wheels must be removed for maintenance or repair, always check for worn or defective bearings and cups. Defective parts should be replaced. Also, check the hub for cracks and for proper fit of the bearing cups in the hub,.

9.6.4 Brake Drum Checks. During regular maintenance periods the drum should be checked for an out-of-round condition. This may be accomplished with an inside micrometer, caliper, or dial indicator. Drums should not be out of round more than .010", since such a condition can cause erratic, grabby braking action and difficulty in mounting the wheel on the axle.

- a. Whenever a wheel is removed, check proper installation of drum to hub, since a loose drum has the same effect as loose wheel bearings. A loose drum may also cause the drum mounting bolts to shear during a hard brake application.
- b. Check drums for excessive heat checking and scoring. Heat checking may be a sign of an undersized brake, a dragging brake, or an un-balanced brake condition. Heat checking will also be accompanied by excessive brake lining wear.
- c. If the brake drum is scored, check for loose lining rivets or foreign metal particles imbedded in the lining. Drums which show excessive heat checking or scoring should be turned or replaced.

9.6.5 Drum and Lining Clearance. Since the electric brake is self-adjusting to compensate for drum lining wear, clearance between drum and lining is one of the most important factors governing electric brake operation. Brake band and lining assemblies as received from the factory are ground to give a drum-to-lining clearance of approximately .020" Max. (.040" on the diameter) with respect to the nominal brake -- diameter. This clearance is best controlled during initial installation or during relining or drum replacement.

- a. If proper clearance between drum and lining is maintained at these times, the electric brake is so designed that the lining will be worn out by the time the maximum magnet travel is reached. However, if too much clearance is present initially, maximum magnet travel will be reached before the lining is completely worn out and a gradual loss of brake power will result.
- b. Too little clearance initially may cause a brake to drag with a possible wheel lockup or make it difficult to mount the wheel on the axle. Considerable variation in the drum-to-lining clearance between brakes on a given unit can cause unbalanced braking.

9.6.6 Magnet and Armature Relationship Check. If magnet and armature are in proper relationship, magnet poles should always be in metal-to-metal contact with the armature as shown below in Figure 9-7. The magnet friction facing is undercut from .005" to .007" to insure that the magnet poles will be fully seated in their armature tracks before normal wear brings magnet friction material into contact with the armature.

- a. During operation, the face of the armature and magnet will become scored or grooved to some extent as shown below in Figure 9-8. This condition is normal and does not indicate excessive wear or defective parts. The magnet pole tracks in the armature should be only slightly wider than the magnet poles. Excessively wide tracks on the armature indicate a loose drum or loose or worn wheel bearing.
- b. Often when there is a complaint of weak brakes and all other things appear normal, a glazed magnet facing may be preventing the magnet poles from coming into direct contact with the armature. This condition may be remedied by placing the magnet in a lathe, and undercutting the magnet facing (do not machine the magnet poles) with a carbide-tipped tool. A small piece of sandpaper (do not use emery cloth) on the fingertips or on a small block of wood may also be used. Whenever possible, use only sandpaper because undercutting the magnet facing in a lathe reduces magnet wear life.

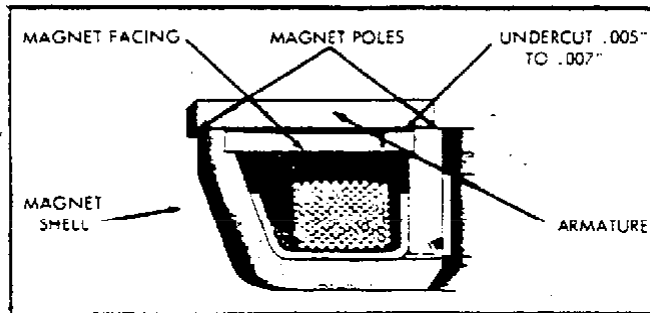


Fig. 9-7. Magnet and Armature Relationship

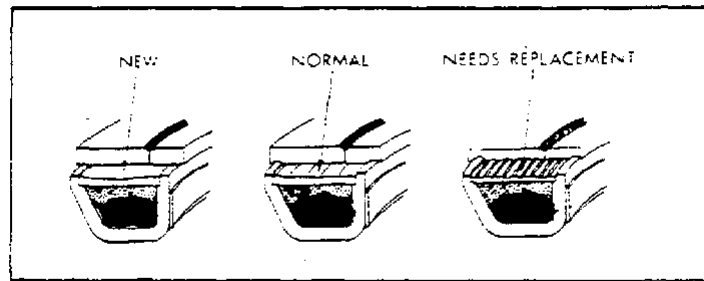


Fig. 9-8. Armature Wear

9.6.7 Operational Check. With the trailer brake control applied, move the towing vehicle ahead slowly. If the trailer brakes do not hold, the system is defective (Section 26453 VC),

9.6.8 Breakaway Brake System Check. Simulate a breakaway by pulling the safety pin- and attempt to tow the trailer (Sections 26304(a) and 26453 VC).

- a. If the brakes apply as determined by increased drag on the towing vehicle or sliding of the trailer wheels, the safety switch and battery are functioning properly.
- b. If brakes do not apply, check safety switch following instructions given in the trouble shooting charts (Paragraph 9.7) and check the battery.

9.6.9 Single Brake Control Test. Make a service brake application. Ascertain if one control operates all brakes on the combination of vehicles as required (Section 26458 VC).

9.6.10 Visual Inspection. Inspect the component parts of the system to determine if the system is properly maintained and in good working order (Section 26453 VC).

9.7 TROUBLE SHOOTING CHARTS. Trouble shooting charts for electric brake systems are contained in Figures 9-9 through 9-13.

POSSIBLE CAUSE	HOW TO ELIMINATE TROUBLE
Broken wire in circuit Poor connections Broken wire on magnet Poor ground connection in circuit Defective connector plug or socket (between trailer and towing vehicle) Burned-out resistor	Check entire wiring system for broken wires. Install new wires where necessary. All splices must assure a good connection. Check, clean, and tighten all connections at brake, controller, resistor, and socket. Replace magnet contact wires. Clean and tighten connections. All ground connections on frame MUST be welded. Check plug and socket for loose connections, dirty or corroded blades, or broken Bakelite insert in socket. Inspect resistor and replace if broken or burned out.

Fig. 9-9. Trouble Shooting - No Brakes or Intermittent Braking Action.

POSSIBLE CAUSE	HOW TO ELIMINATE TROUBLE
Loose or worn wheel bearings Out-of-round drum Distorted band Score Drum Lining loose on rivets Improper lining	Tighten or replace bearings. Check drum for concentricity Correct distortion using band gauge supplied with installation and service kit. Bore out the drum to remove as much scoring as possible without weakening the drum. Replace with new lining and rivets Replace with lining recommend by factory

Fig. 9-10. Trouble Shooting - Noisy Brakes

POSSIBLE CAUSE	HOW TO ELIMINATE TROUBLE
Improper lining	Replace with factory-recommended lining.
Worn-out lining	Reline brake bands with factory-approved lining.
Worn brake drums	Reline brake bands so there will be approximately .020" CLEARANCE between lining and drum. Shim stock should be used between band and lining where grinder as little as .015 clearance is allowable between lining and drum.) NOTE: Above clearances apply to drums that are concentric.If condition of drum is questionable, it should be checked on a drum lathe. Replace drums that are oversize.
Out-of –round brake band	Check and adjust band using band gauge supplied with installation and service kit.
Greasy magnet facing	Remove grease with solvent. If this is not effective, replace magnet with a new one.
Greasy brake lining	Replace. with factory-recommended lining. Cleaning will give only temporary relief.
Stop lights connected in brake circuit	Stop lights must not be connected in the brake circuit. This changes the graduation of the current as it passes through the controller resulting in weak or grabbing brakes. Wire a separate circuit for stop lights.
Broken wire	Check entire wiring system for broken wire. Replace wire that is found defective. All splices must assure a good connection.
Incorrect armature-magnet relationship	Check to ensure proper armature-magnet relationship (armature depression).
Insufficient current	Insufficient current may be due to poor connections at the brake, sockets , plugs, controller, resistor, controller, resistor, starter, ground connections, battery connections, or too small a wire. Check, clean, and tighten all connections.
Poor wiring	Rewire.

Fig. 9-11. Trouble Shooting - Weak Brakes

POSSIBLE CAUSE	HOW TO ELIMINATE TROUBLE
Loose wheel bearing	A loose wheel bearing is the most common cause of "grabby" brakes. It is very important that bearings be tightened properly. Common practice is to draw the axle nut tight enough to make the bearings bind slightly when wheel is rotated. The axle nut is then backed off from one-sixth to one-quarter turn and locked in place. NOTE: Under normal operation, the magnet poles will wear a groove in the armature face slightly wider than the magnet poles. A still wider groove indicates that wheel bearings are loose or badly worn.
Worn or damaged wheel bearings	Examine the bearings. If they are worn or damaged replace the bearings and bearing cup. Check the hub for cracks and for snug bearing cup fit.
Sticky or grease-coated lining	Replace with factory-recommended lining.
Out-of-round drums	Bore out drum concentric with axle . NOTE: It is necessary to use shim stock under lining when drums are rebored.
Axle flange improperly mounted	Remove and reweld flange in proper position.
Axle loose on springs or frame	Make necessary repairs.
Lining loose on rivets	Replace with new lining and rivets.
Distorted bands	Round out bands using band gauge supplied with installation and service kit.
Bent or distorted contactor blades in controller or Blades in contact when controller is off	Realign contact blades so they are equally spaced and none are in contact when controller is off.
Only one brake working	Check the amperage at each brake. Where no amperage is indicated, check the wires leading to brake. If no defect is found in these wires, remove the magnet from backing plate assembly and check it for amperage capacity, ground, or short. If brake is OK electrically, check for mechanical defects.

Fig. 9-12. Trouble Shooting - Brakes Grabbing or Locking

POSSIBLE CAUSE	HOW TO ELIMINATE TROUBLE
Brake wired in stop-light circuit	Brakes should not be wired to stop-light switch. This results in "on" and "off" operation with no graduation of power, which will give grabbing brakes. Wire separate circuit for stop lights.
Poor electrical connections	Check wiring for loose connections and broken wires or insulation.
Burned-out controller	Replace with new controller.
Drums loose on hub	Tighten drum bolts. Check drum for concentricity.
Broken or weak band return springs	Replace springs using band spring pliers supplied with installation and service kit. Be sure all broken spring parts are removed from brake assembly. Always replace springs in pairs. Care should be taken that open end of the loop is toward the inside of the brake.
Damaged or bent backing plate	If plate is bent beyond repair, replace with new plate.
Broken or loose parts	Remove broken parts. Replace with new parts. Check for other damage.

Fig. 9-12a. Trouble Shooting - Brakes Grabbing or Locking (continued)

POSSIBLE CAUSE	HOW TO ELIMINATE TROUBLE
Weak or dead hot shot battery	Replace with 6-volt multiple ignition (hot shot battery (NOTE: 12-volt braking systems require 2 6-volt hot batteries. Replace both.) If brakes still fail to function after new battery is installed, check breakaway safety switch and replace if necessary.
Faulty breakaway safety switch wiring	Check breakaway safety switch circuit for broken or frayed wires. Replace wire where necessary with no smaller than No. 12 gauge. All splices must assure a good connection.
Faulty breakaway safety switch	Check breakaway safety switch by pulling plunger and attempting to tow the trailer. If switch is working properly brakes will engage.

Fig. 9-13. Trouble Shooting - Breakaway Switch Fails to Function