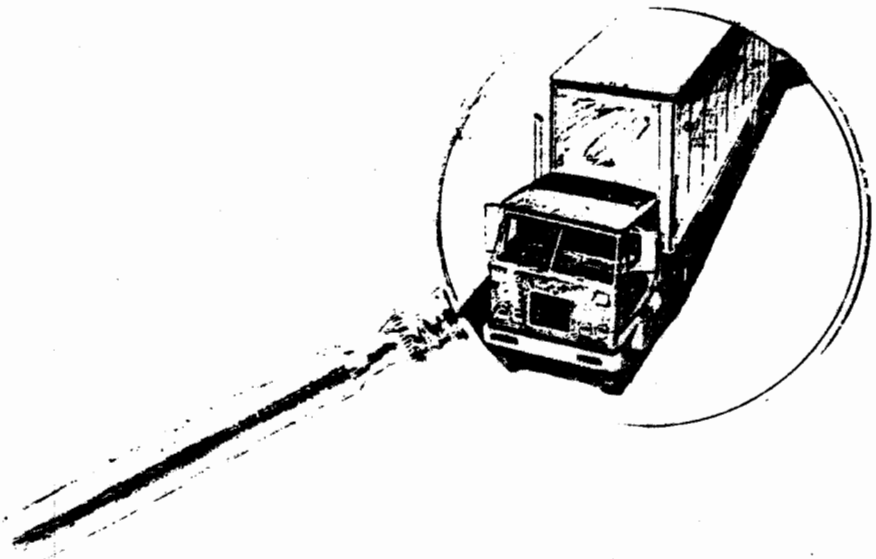
California
Highway
Patrol

VEHICLE EQUIPMENT INSPECTION GUIDE



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DEPARTMENT OF CALIFORNIA HIGHWAY PATROL

VEHICLE EQUIPMENT INSPECTION GUIDE

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JANUARY 1973

FOREWORD

The purpose of this Guide is to provide training material for vehicle inspection personnel and to establish standard inspection procedures to determine whether vehicles are equipped as required, brake systems are adequate, equipment is maintained in good condition and functions properly, and vehicles are safe for operation on the highway.

The objective is to obtain compliance with laws relating to vehicle equipment requirements and to achieve uniformity in vehicle inspection activities of the California Highway Patrol.

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This Guide replaces the Vehicle Inspection Procedures Manual formerly published by this Department. Any inquiries or comments relating to this Guide should be directed to Safety Services Division.

OFFICE OF THE DEPUTY COMMISSIONER

DISTRIBUTION: A E S(BIS, CVIS, MCOS, and all officers assigned to commercial enforcement)

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CHAPTER 1

REVISED AUGUST 1980

WHEELS, RIMS, AND TIRES

1. INTRODUCTION. This chapter describes tires, wheels, and rims and their major parts; provides an inspection procedure for these items; and lists the load ratings of foreign and domestic tires.

2. DEFINITIONS.

a. Bandura Tire. A treadless new tire that receives its first application of the tread at the distributor or dealer to complete the manufacturing process. This type of new tire has not been manufactured since 1974, so any applications of Bandag tread rubber since then are retreads.

b. Breaker or Belt. One or more plies under the tread area and approximately as wide as the tread.

c. City-Suburban Tire. A tire designed for use on buses operating only in city and suburban service at speeds limited to 55 mph for continuous operation not to exceed one hour.

d. City Tire. A tire for use on buses operating only in slow speed, start-and-stop intracity service, at speeds not to exceed 35 mph.

e. Cord. Strands forming the plies in a tire.

f. Cord Separation. Parting of the cords from adjacent rubber compounds.

g. Groove. Space between adjacent tread ribs, lugs, or other tread configurations. A space less than 5/64 inch in width is not a groove.

h. Load Rating. Maximum load the tire is designed by the manufacturer to carry safely at a given inflation pressure.

i. Lock Ring. Steel ring designed to hold the side ring to the rim base of multipiece rims or wheels.

j. Major Groove. Any one of the tread's two or more circumferential depressions that had the greatest equal depth when the tire was new.

k. Maximum Load Rating. Load rating at the maximum permissible inflation pressure for that tire.

l. Ply. Layer of rubber-coated parallel cords.

m. Ply Separation. Parting of the rubber compound between adjacent plies.

n. Pneumatic Tire. Tire designed to be inflated or capable of inflation with compressed air.

o. Regroovable Tire. Tire manufactured with sufficient material for renewal of the original tread pattern or generation of a new tread pattern without exposing the cord.

p. Rim. Metal support for a tire or a tire and tube assembly upon which the tire beads are seated.

q. Side Ring. Separate flange that retains the tire on multipiece rims.

r. Spacer. Device used with dual tires on cast spoke wheels to hold the two rims apart and provide proper spacing between the tires.

s. Tread Separation. Pulling away of the tread rubber from the tire body plies, belts, or breakers.

3. WHEEL CONSTRUCTION.

a. Disc Wheels. Disc wheels are secured to the axle hub by means of studs and cap nuts (or cone nuts for discs specially designed for them). Three different methods of securing a dual disc wheel assembly are shown in Figures 1-1, 1-2, and 1-3. Each wheel manufacturer recommends a tightening sequence for his wheels, with the most common sequence shown in Figure 1-4.

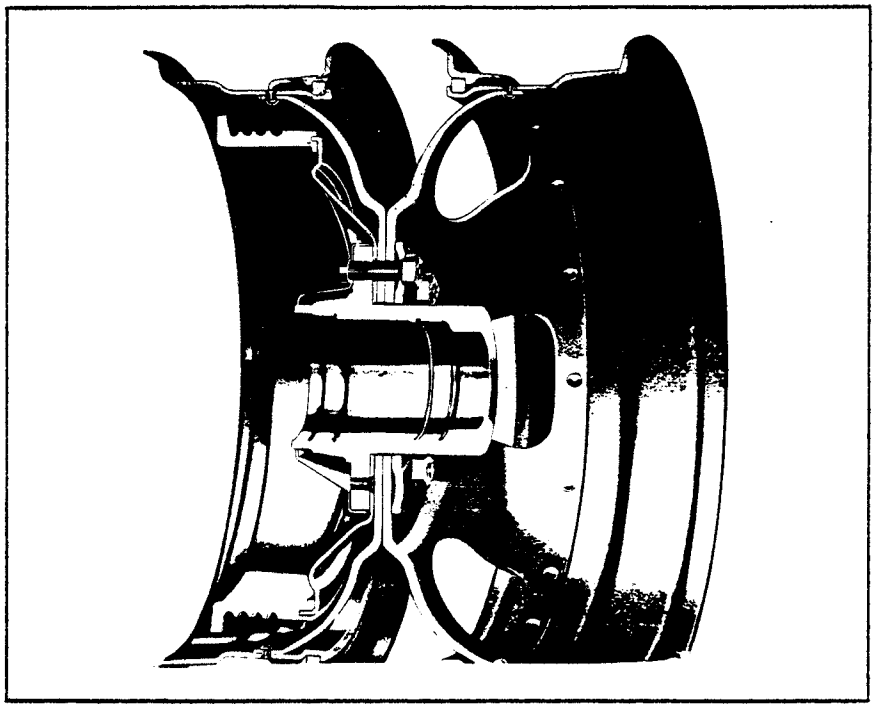


Fig. 1-1. Dual Disc Wheels, Three-Piece Lock Ring, with Nut and Plate Securement

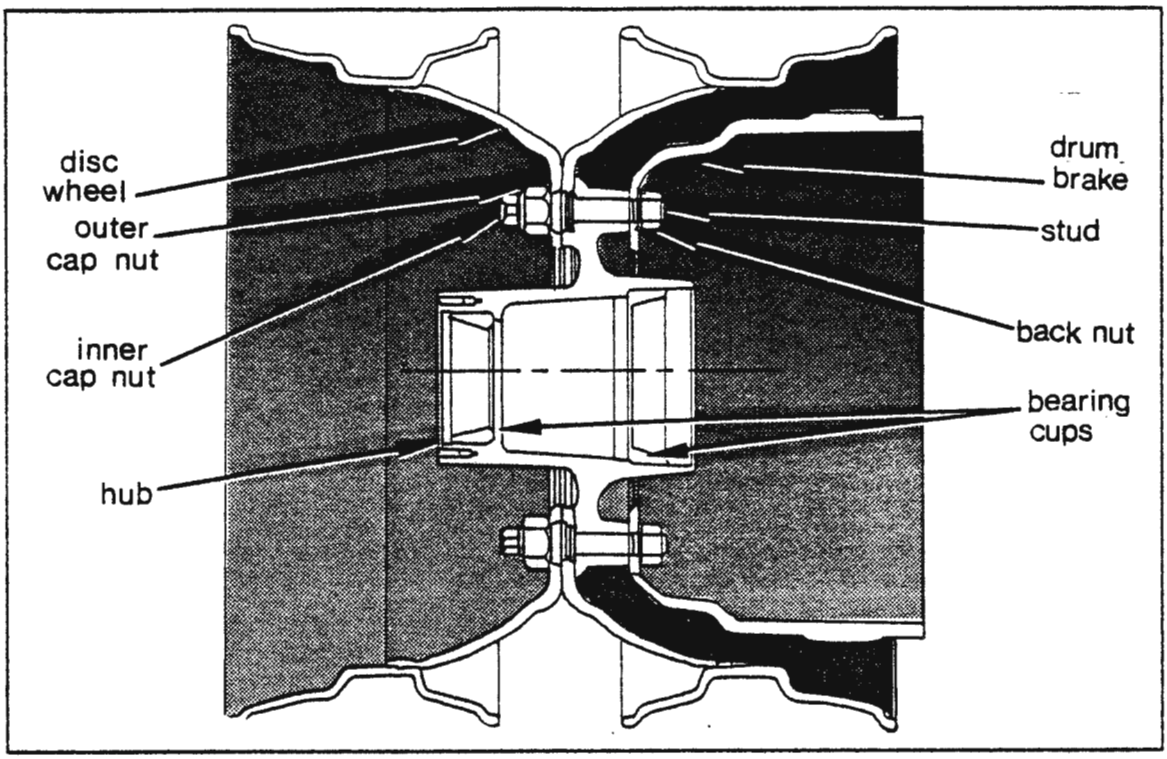


Fig. 1-2. Dual Disc Wheels, Drop Center Rims
with Inner and Outer Cap Nut Securement

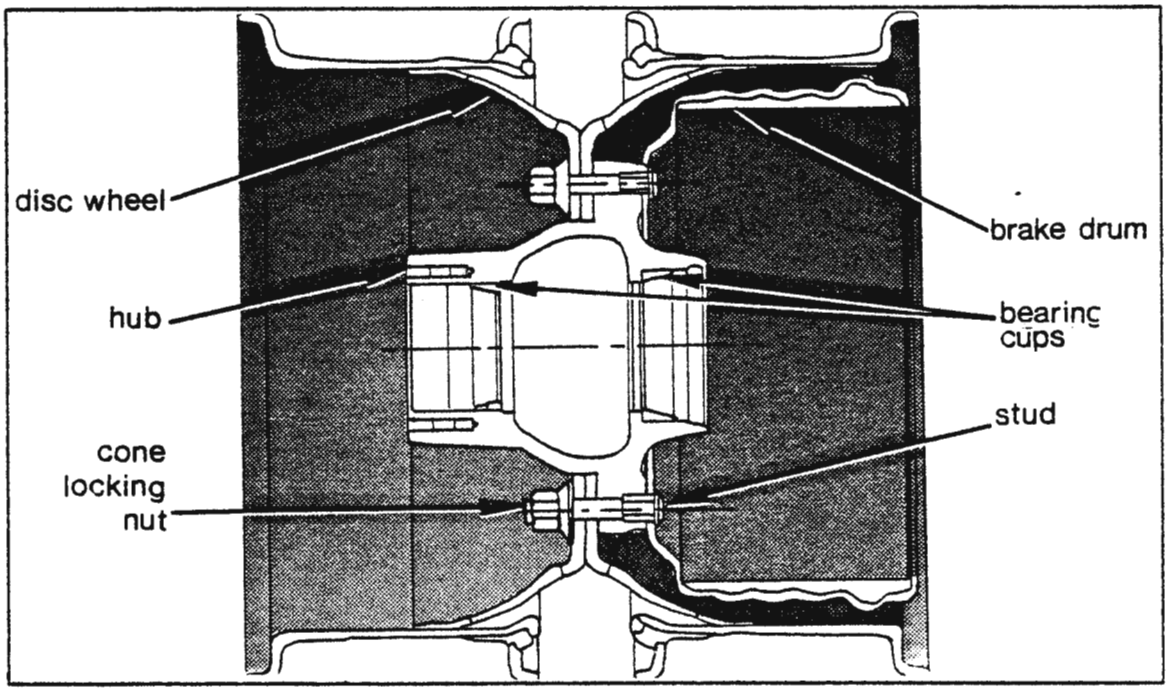


Fig. 1-3. Dual Disc Wheels, Three-Piece
Lock Rim with Cone Nut Securement

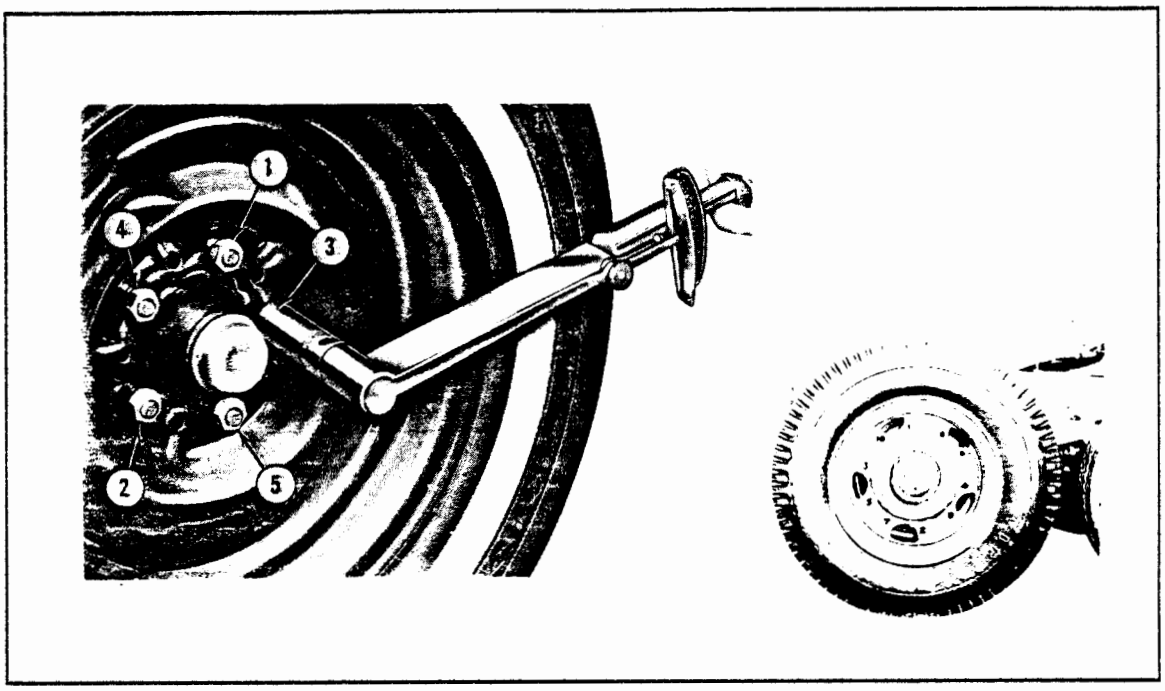


Fig. 1-4. Disc Wheel Nut Tightening Sequence

b. Cast Spoke Wheels. Rims on cast spoke spiders are secured by clamps that are held by studs or bolts and nuts. An exploded view of a cast spoke wheel assembly with dual rims and the nomenclature of each part is shown in Figure 1-5. Clamps and nuts are designed for specific wheels and are not generally interchangeable between wheels of different manufacturers. The most common types and their tightening sequence are shown in Figures 1-6 and 1-7.

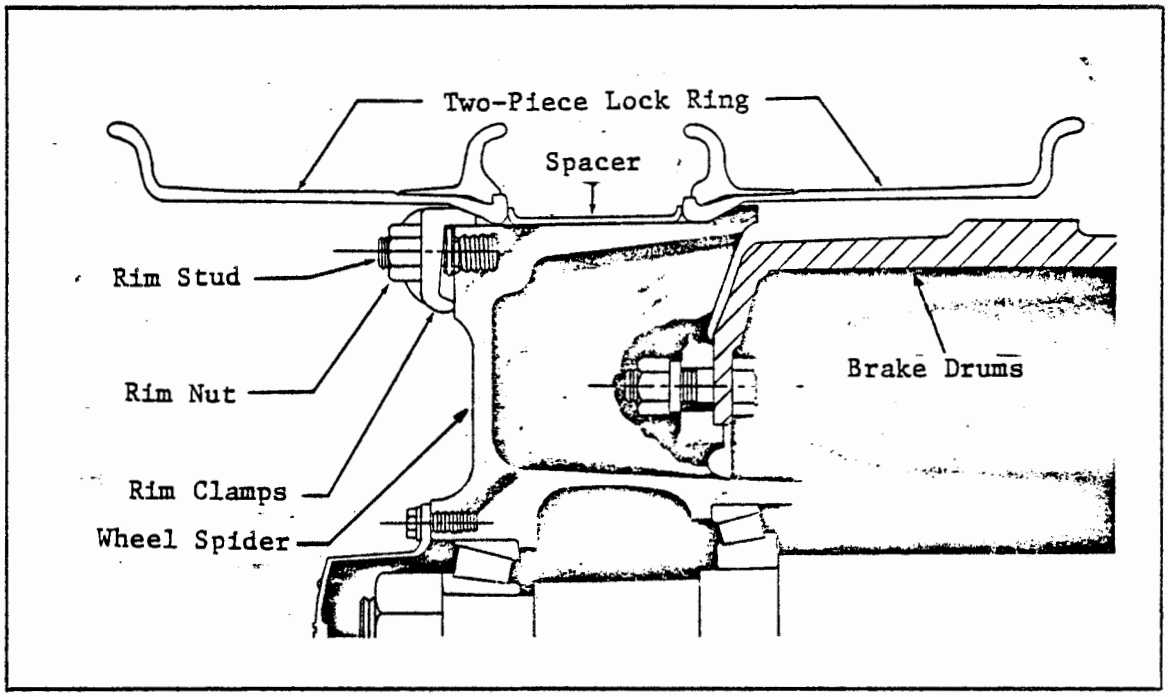
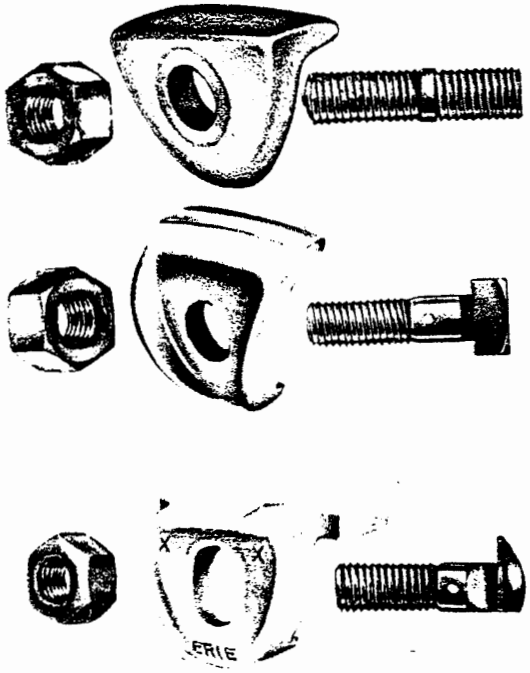


Fig. 1-5. Two-Piece Lock Rim and Securement to Cast Spoke Wheel



DAYTON-WEBB-GUNITE: Wheel has solid spoke. Stud is threaded on both ends, and may be 5/8" - 11 thread, or 3/4" - 10 thread. Nut has a flat face and is threaded to fit either 5/8 or 3/4 stud. Clamp usually has Dayton or Gunite name and part number.

GUNITE–3 spoke, 5 spoke tubular, 6 spoke: Wheel has hollow spoke. Bolt protrudes through end of spoke, has a 5/8 - 11 thread, has a square head, and is held in with a cotter pin. Nut is the same as for Dayton wheel with a flat face.

ERIE: Wheel also has a hollow spoke, but has a square hole in the end of the spoke through which the bolt with the square shank protrudes. This bolt is also held in with a cotter pin. Head has one flat side. The nut used with this wheel has a ball face. Bolt and nut are 5/8 - 11 thread. Clamp has Erie name and is usually identified by an X or a K. Clamp has recessed surface for ball surface of nut to fit.

Fig. 1-6. Cast Spoke Wheel Clamps, Studs, Bolts, and Nuts

Place rims and spacer band on wheel. Secure clamps evenly in position and draw up nuts alternately in the sequence shown at right. Do not tighten them fully, however. This procedure will permit the inside rim to properly align itself on the 28° mounting bevel on the back of the cast wheel, thus avoiding damaging wheel wobble.

Then, tighten nuts fully, using same alternate sequence. Be sure to tighten these nuts only to the torque level recommended.

Fig. 1-7. Cast Spoke Wheel
Nut Tightening Sequence

c. Rim Construction. Rims are constructed as either drop center or lock ring types. Lock rings are used on flat rim bases or semi-drop center rims. A rim may be either a permanent part of a disc wheel or a separate component clamped to a cast spoke wheel.

(1) Drop Center Rim. Drop center rims are formed in one piece with the rim base made in a shallow "U" shape to permit tire installation, as the flanges are not removable. Tubeless tires can be used only on drop center rims. See Fig. 1-8.

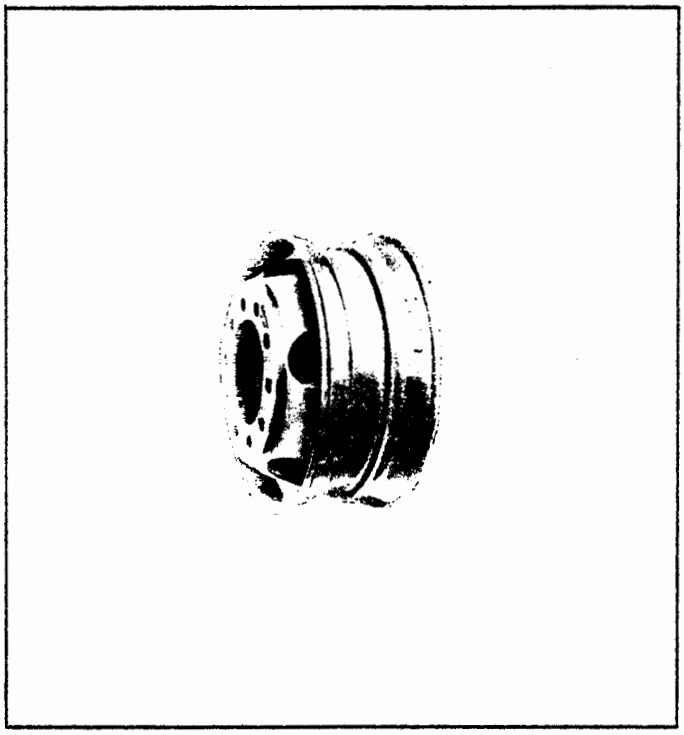


Fig. 1-8. Drop Center Disc Wheel

(2) Lock Ring Rim. The rim base assembly has one removable ring, known as a combination side and lock ring, or two rings, known as the side ring and the lock ring. Tires with tubes can be used only on these rims.

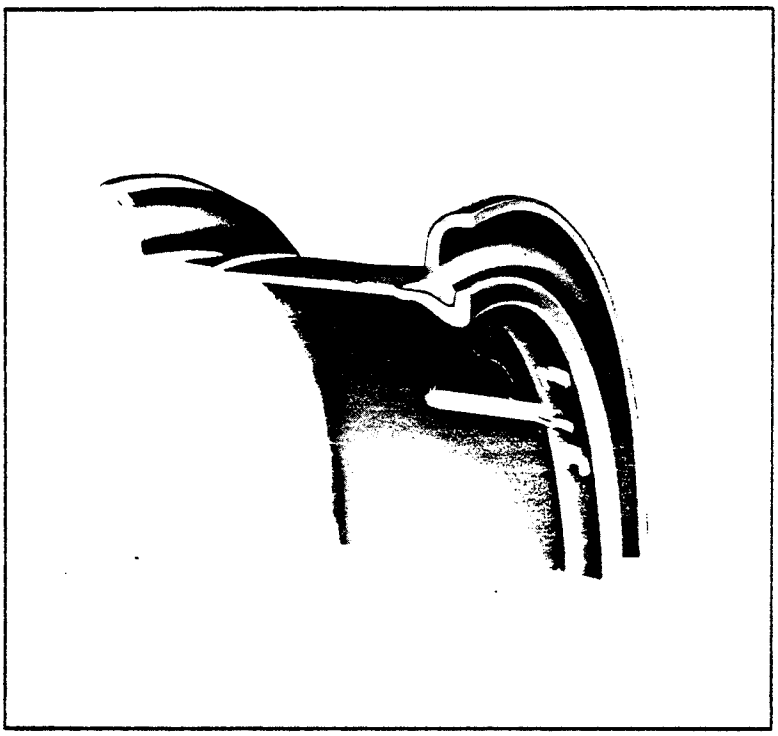


Fig. 1-9. Two-Piece Lock Ring Rim

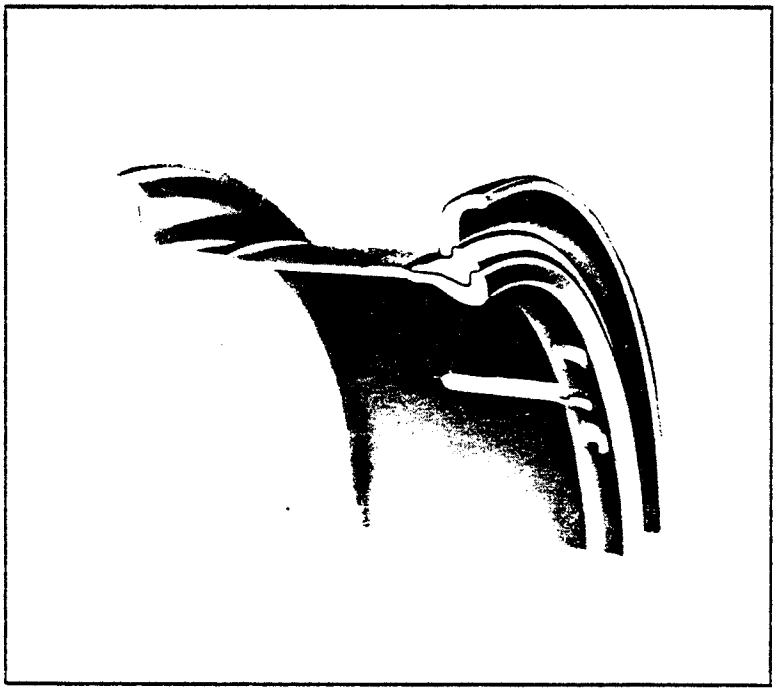


Fig. 1-10. Three-Piece Lock Ring Rim

4. TIRE CONSTRUCTION.

a. Type of Ply. Typical tire construction and nomenclature are shown in Figure 1-11. The three principal types of passenger car and light truck tires (bias ply, belted bias ply, and radial ply) are shown in Figure 1-12. These designs may be in either tube or tubeless type.

(1) Bias Ply. Bias ply tires may have two, four, or more body plies made from rayon, nylon, polyester, or other material. These plies cross the centerline of the tire at an approximate angle of 35 degrees and provide strength to contain the inflation pressure. Bias tires may have breaker strips in the tread area.

(2) Bias Belted Ply. Bias belted ply tires are similar to bias ply tires but have two or more additional cord layers or "belts" under the tread. This construction reduces tread movement ("scrub" or "squirm") during contact with the road.

(3) Radial Ply. Radial ply tires have body cords that extend from one bead to the other crossing the centerline of the tire at an approximate angle of 90 degrees. These tires have two or more belts extending around the tire under the tread, thereby reducing tread movement ("scrub" and "squirm") during contact with the road. This construction gives greater strength to the tread area and more flexibility to the sidewall.

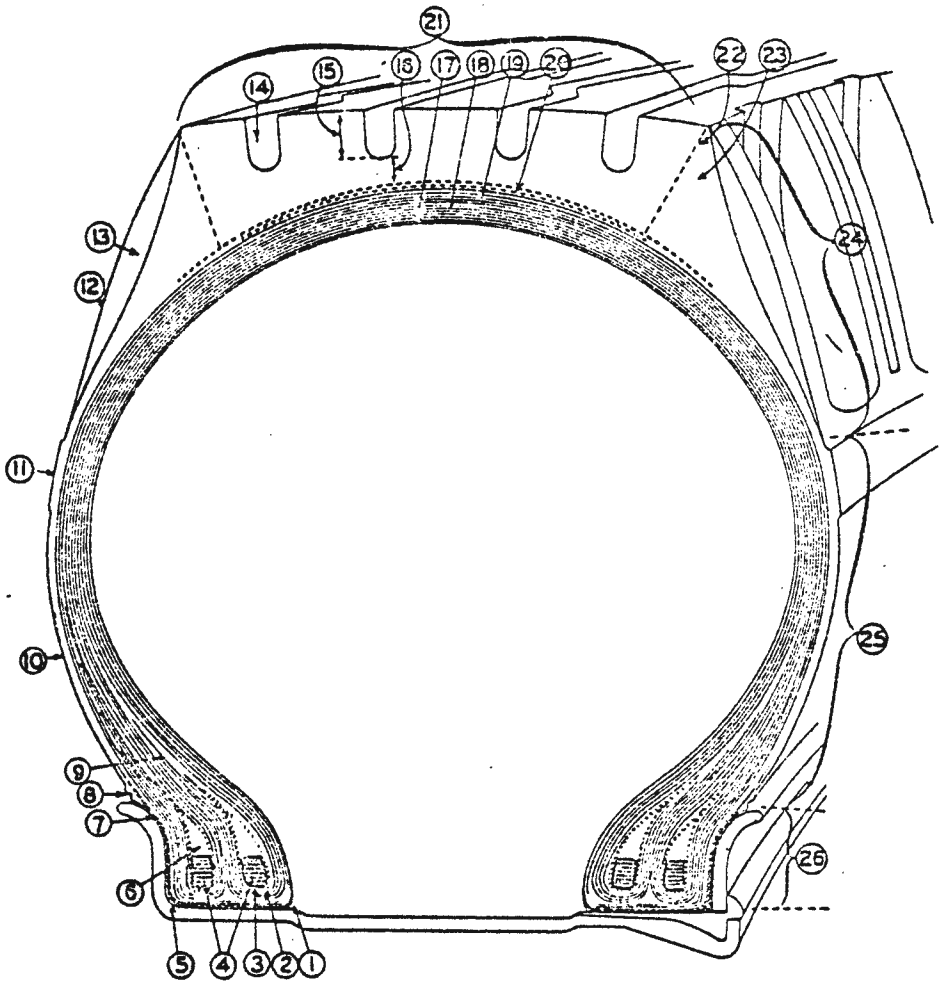
b. Snow Tread Tire. Snow tread tires have the following characteristics:

(1) Passenger car tires that are permanently marked on one sidewall with the words "MUD AND SNOW" or any contraction using the letters "M" and "S" (such as MS, M/S, M-S, M&S, etc.) in accordance with the Rubber Manufacturers Association standards are snow tread tires.

(2) Passenger car tires without the M&S markings are snow-tread tires if they have a deep aggressive tread pattern and are of a type and design manufactured for use on snow as a replacement for tire chains. (Generally tires manufactured before January 1, 1976, when the RMA standard became effective.)

(3) Light truck tires (to which the RMA marking standard does not apply) are snow-tread tires if they have a deep and aggressive tread pattern and are of a type and design manufactured for use on snow as a replacement for tire chains.

(4) Snow tires with the tread worn to a depth of less than 6/32 inch are no longer effective as snow treads and should not be used in lieu of chains.



1.	Bead Toe	10.	Sidewall	19.	Top or Cap Ply
2.	Flipper	11.	Buffing Rib	20.	Breaker Plies
3.	Wrap	12.	Buttress	21.	Tread Area
4.	Insulated Bead Wire	13.	Shoulder	22.	Center-Wing Junction
5.	Bead Heel	14.	Groove	23.	Tread Wings
6.	Gum Neck	15.	Non-Skid Depth	24.	Shoulder Area
7.	Chafer	16.	Under Tread or Base	25.	Sidewall Area
8.	Vent Rib	17.	First or Drum Ply	26.	Bead Area
9.	Ply Turn Up	18.	Carcass Plies		

Fig. 1-11. Tire Nomenclature

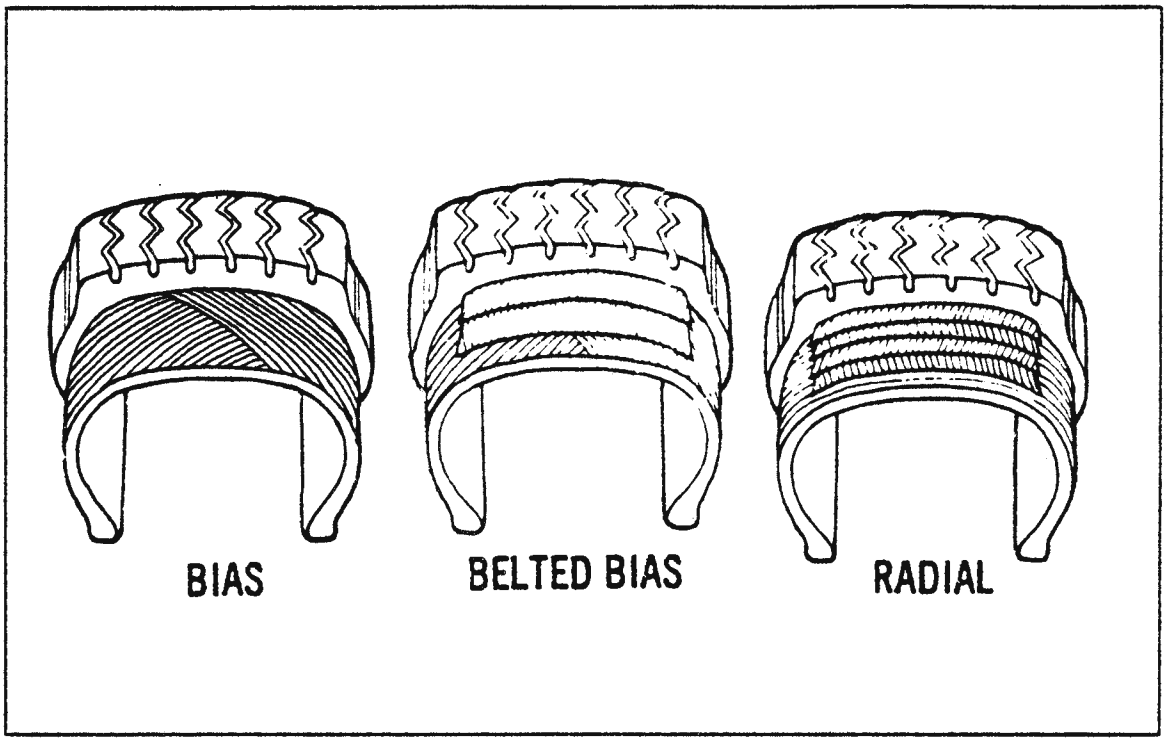


Fig. 1-12. Typical Passenger Car and Light Truck Tires

c. Tire Profile. Tire "profile ratio" represents the tire cross-section height as a percentage of the cross-section width as shown in Figure 1-13. Tire profiles have changed over the years, going from an almost round tube-type profile number of 83 for older conventional tires down to as low as 35 for modern wide tires. Large truck tires generally have a ratio of 90 except for wide base types, which have a ratio of approximately 65.

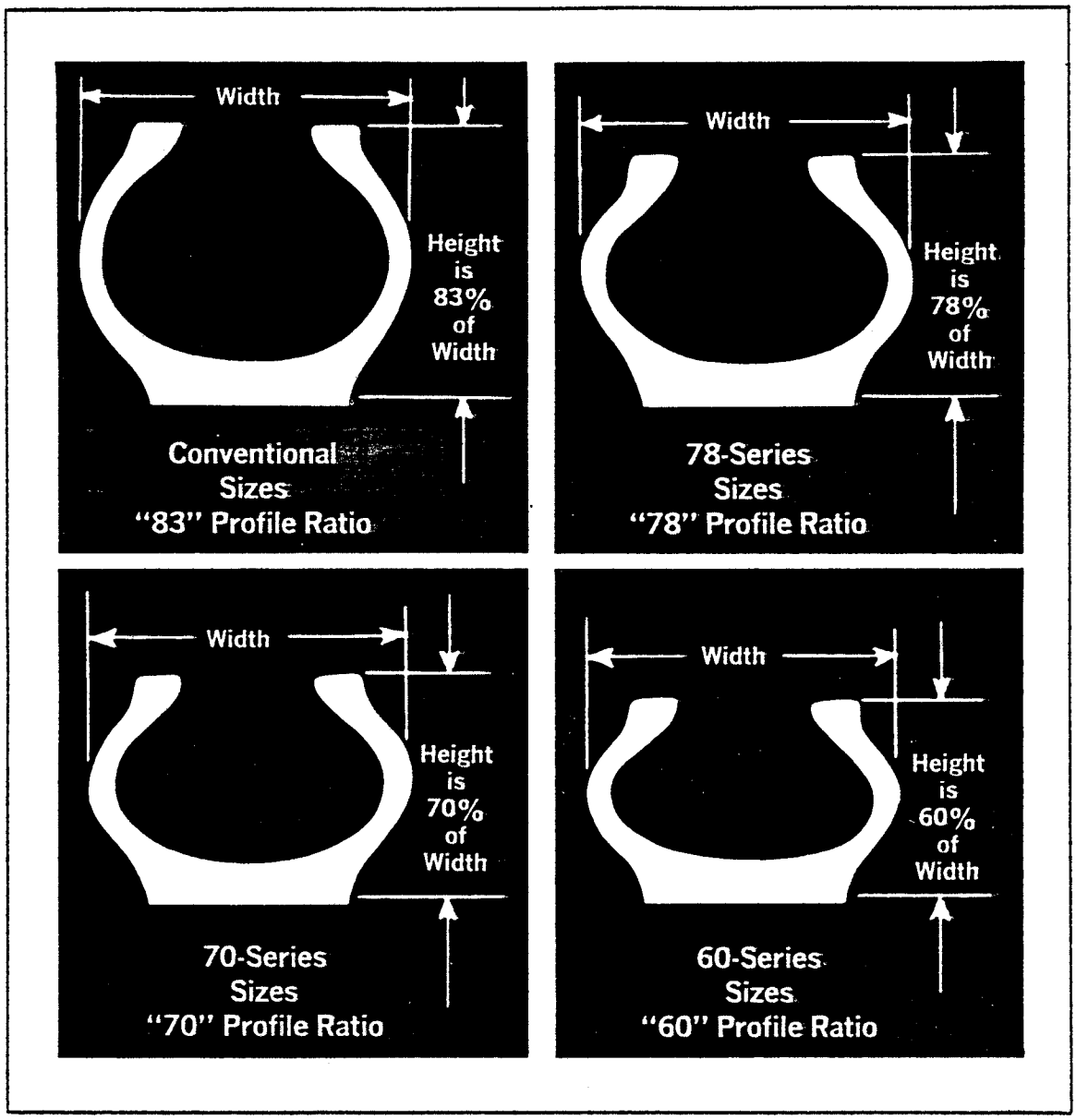


Fig. 1-13. Tire Profile

d. Tire Wear Causes. The most common tire wear problems and cures are shown in Figure 1-14.

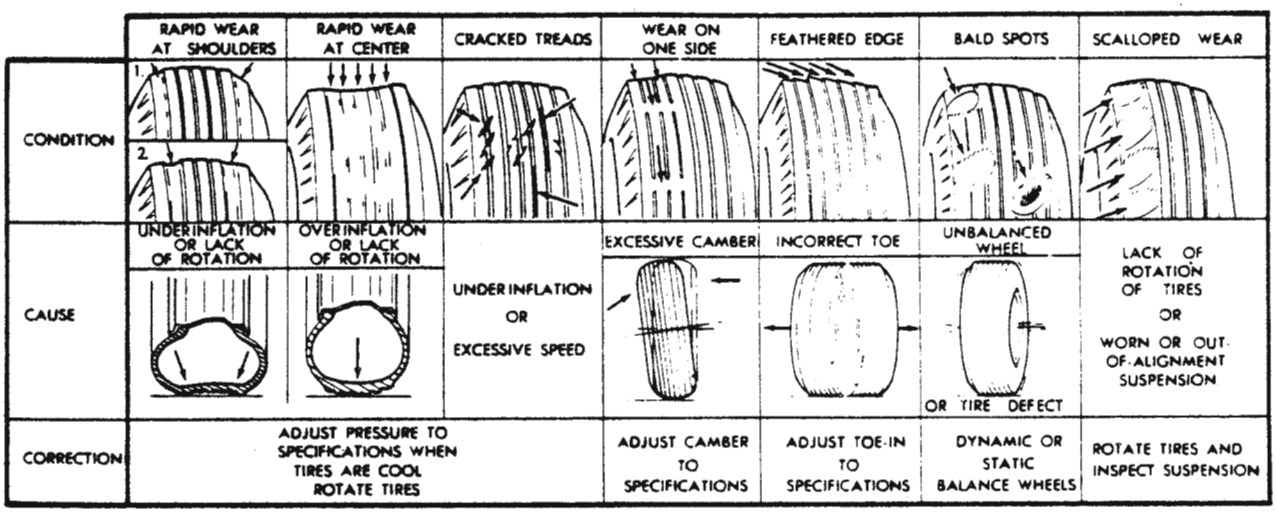


Fig. 1-14. Tire Wear Problems and Cures

e. Tire Markings. Tires are required to be marked as follows:

(1) New Tires. Passenger car tires manufactured after January 1, 1968, are required to have the following markings illustrated in Figure 1-15 (FMVSS 109, FMVSS 119, 49 CFR Part 574, and Title 13, California Administrative Code, Section 1084):

(a) The "DOT" symbol followed by identification number shown in Figure 1-16.

(b) Identification of manufacturer by name or brand name.

(c) Size designation.

(d) Maximum load rating.

(e) Maximum permissible inflation pressure.

(f) Actual number of plies in the sidewall and the actual number of plies in the tread area, if different.

(g) Composition of cord material in sidewalls and, if different, in tread.

(h) The word "tube type" or "tubeless" as applicable.

(i) The letter denoting the tire load range.

(j) Speed restriction, if 55 mph or lower.

(k) The word "regrooveable" if the tire is designed for regrooving.

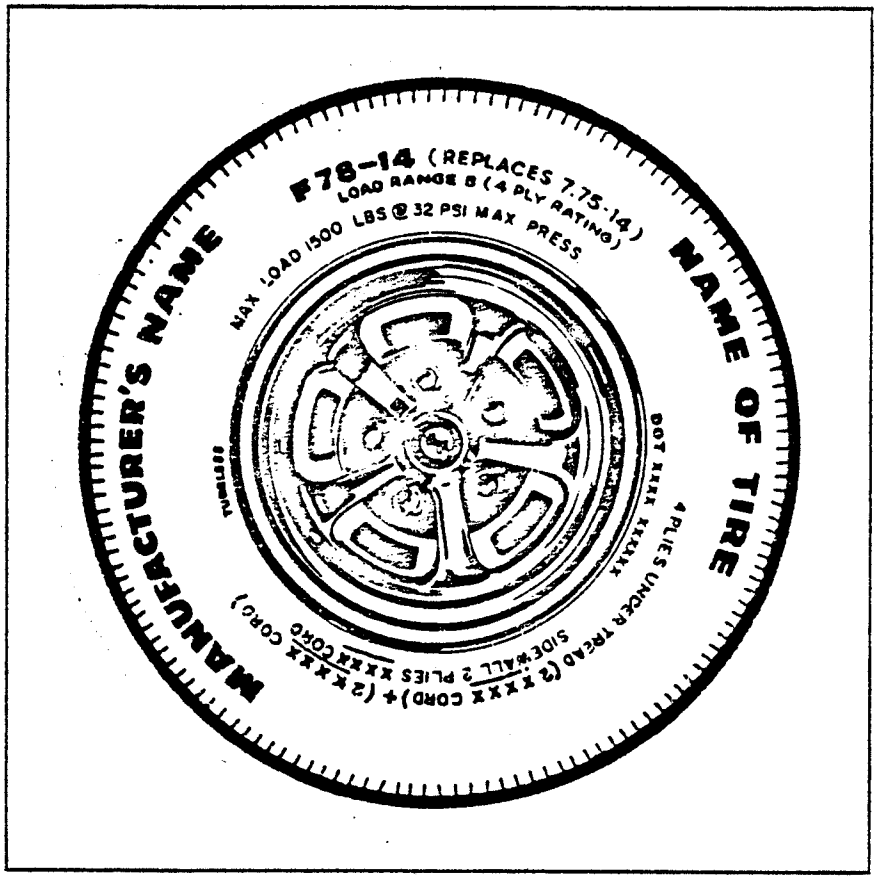


Fig. 1-15. New Passenger Car Tire Marking

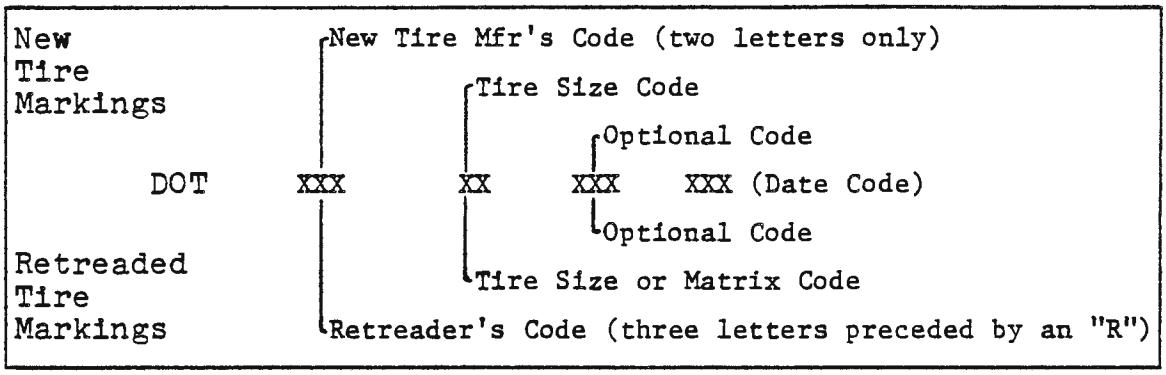


Fig. 1-16. New and Retreaded Tire Identification Marking

(2) Retreaded Tires. Retreaded tires used on the front wheels of vehicles subject to Motor Carrier Regulations (except buses, school buses, and farm labor vehicles) are required to be marked with the California Retreading Standards Committee symbol or the Tire Manufacturers Retreading symbol shown in Figure 1-17 (Title 13, California Administrative Code, Section 1088(d)).

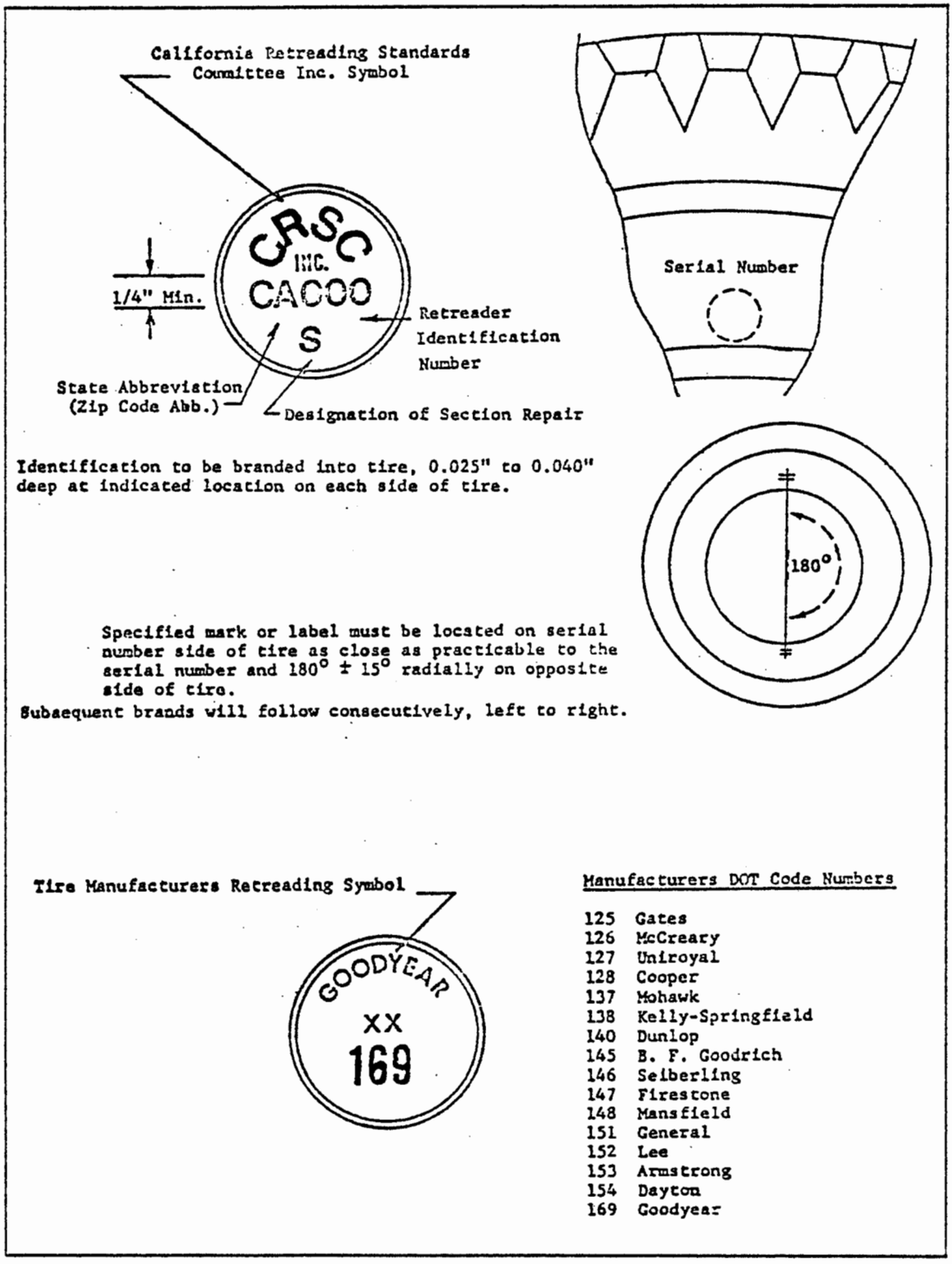


Fig. 1-17. Retread Tire Marking

5. INSPECTION PROCEDURE.

a. Wheel Defects. Wheels and rims shall be inspected for the following defects, which are conditions of improper maintenance and which would constitute a violation of Section 24002 VC:

(1) Cracks at any location on the rim or wheel web.

(2) Rim and lock ring or side ring that are not matched as shown in Figure 1-18.

(3) Aluminum wheels with evidence of welding or other heat having been applied.

(4) Aluminum wheels with evidence of corrosion or flaking as shown in Figure 1-19.

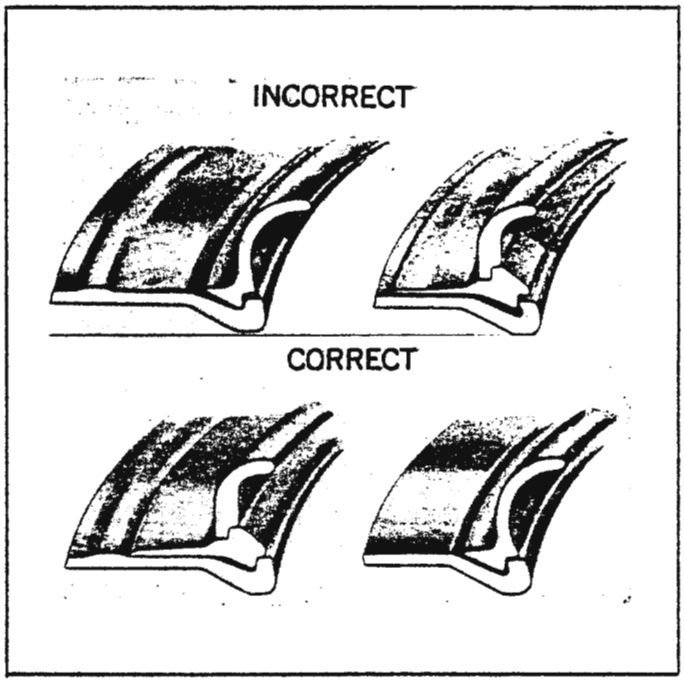


Fig. 1-18. Rim and Lock Ring Matching

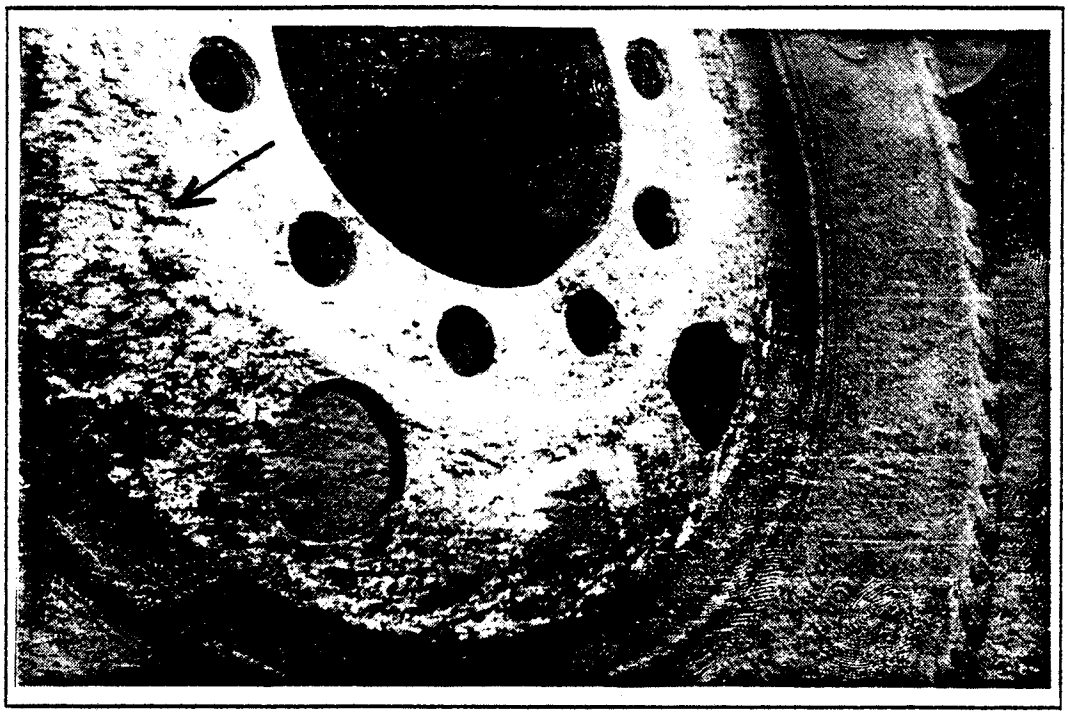


Fig. 1-19. Aluminum Wheel Corrosion or Flaking

b. Wheel Securement Deficiencies. Studs, nuts, or clamps shall be inspected for the following defects, which are conditions of improper maintenance and may constitute a violation of Section 24002 VC:

(1) Studs, nuts or clamps that are missing, broken, or fit improperly (Figure 1-20) on any wheel in excess of the following numbers:

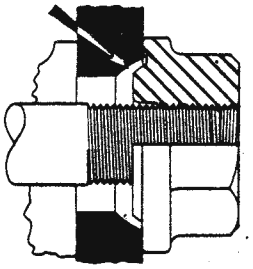
(a) Two or more on wheels with ten stud holes.

(b) One or more on all other types of wheels.

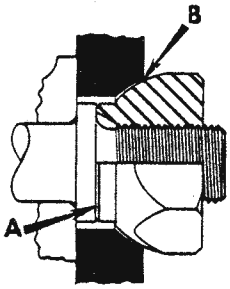
(c) Studs or nuts that are too small or do not fit the wheel seat properly.

NOTE: Nuts used on aluminum wheels may appear to be too small. Thicker aluminum wheels may have around the stud opening a countersunk area 1/16 inch deep by 1/8 inch wide. This area prevents the nut shoulder from contacting the ball seat of the wheel and permits the use of the inner and outer cap nuts originally supplied with the steel wheels. This is a permissible condition.

NOT RECOMMENDED



Flanged cap nuts B-71736,7 and B69912,3 or their equivalent, **must not** be used with Firestone Duplex wheels having 5/8" or thicker discs, since ball seating will not occur (arrow



Alcoa nuts 5554R-L or B-70613,4 should not be used to mount Duplex wheels on hubs equipped with shoulder studs since bottoming may occur (arrow A) before the nuts are seated (arrow B). Use of these nuts is permissible if the shoulder is recessed in the hub.

Fig. 1-20. Improperly Fitting Nuts

(2) Nuts on steel wheel studs with a thread engagement of less than 0.6 of the stud diameter.

NOTE: Because the mounting flange thickness of aluminum wheels is greater than that of most steel wheels, the last threads in the nut may not be completely engaged with the stud. The actual length of thread engagement with the assembled wheel cannot be determined by simple visual inspection, since the distance from the ball seat of the wheel mounting flange to the first thread of the nut may vary. To determine the number of engaged threads, tighten all nuts in the regular manner then loosen one to a hand-tight position. Remove the nut from the stud, counting the number of turns required to disengage the units. For disengagement it should require at least seven full turns for a 3/4-inch nut and five full turns for a 1-1/8-inch nut.

c. Tire Tread Depth. Tread depth shall be measured, avoiding locations with tiebars, fillets or humps. Since 1968, passenger car tires have wear bars molded into the tread. Since March 1975, truck and bus tires also have these wear bars. When these smooth bands appear in two or more adjacent grooves, the tires have been worn to 2/32 inch or less. (FMVSS 119 requires motorcycle tires to have wear bars at 1/32 inch.)

(1) Passenger Cars and Light Trucks. All tires (except those on vehicles subject to California motor carrier safety regulations, including school buses) with a tread depth of less than 1/32 inch in two adjacent grooves at any location, as shown in Figure 1-21, are in violation of Title 13, California Administrative Code, Section 1088(a) (2).

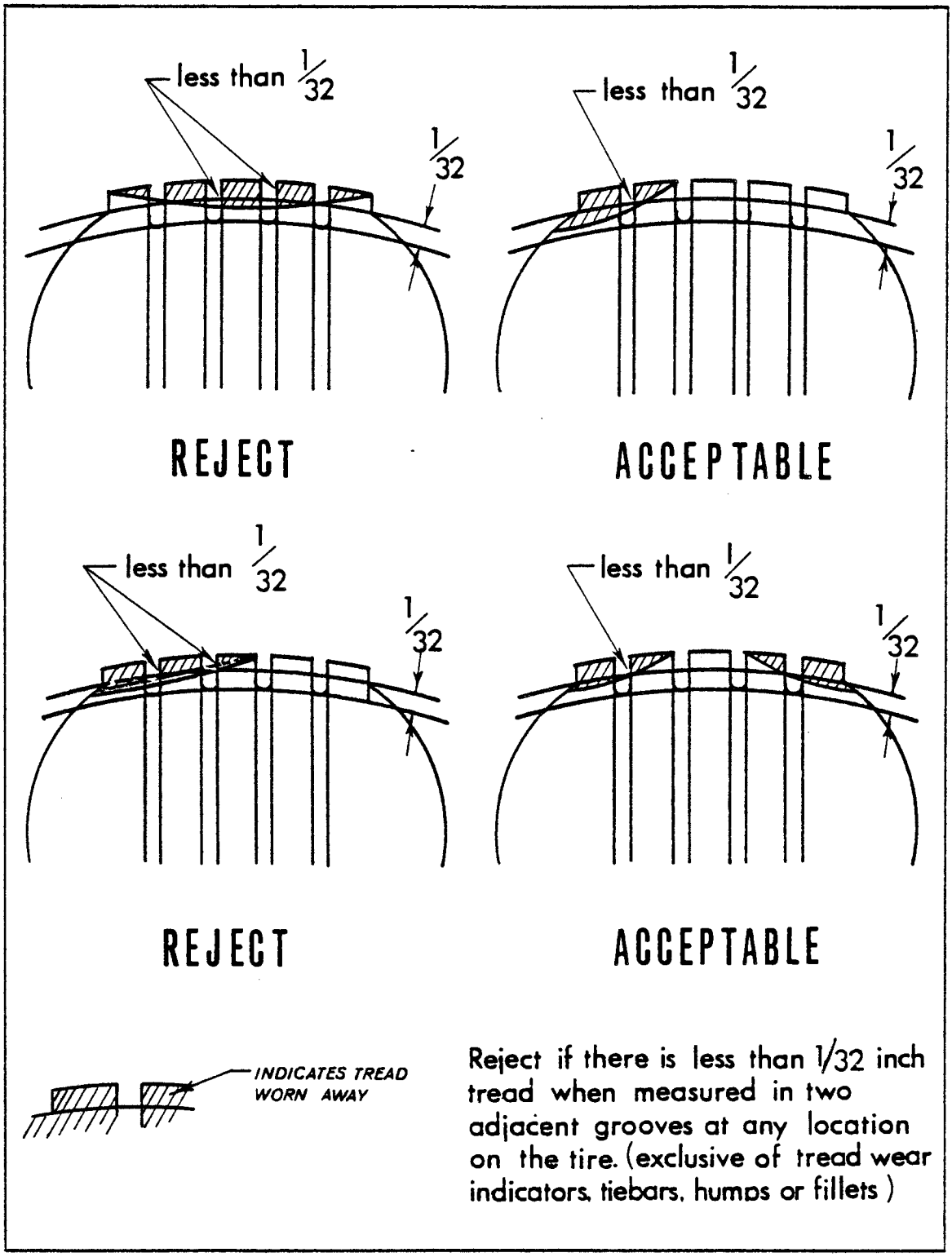


Fig. 1-21. Tread Depth Measurement for Vehicles Not Subject to Motor Carrier Regulations

(2) Motor Carrier Trucks. A tire mounted on the steering axle of a vehicle subject to motor carrier regulations is in violation under the following conditions:

(a) Tire is so worn that the tread depth is less than 2/32 inch in a major tread groove at any location on the tire (13 CAC 1088(a) (1)).

(b) Tire has been regrooved (13 CAC 1088(c)).

(c) Retreaded tire does not display the CRSC marking or major tire manufacturer retread marking as shown in Figure 1-5 (13 CAC 1088(d)).

(3) Buses, School Buses and Farm Labor Vehicles. Any tire mounted on buses, school buses and farm labor vehicles is in violation under the following conditions:

(a) Tire is so worn that the tread depth is less than 2/32 inch in a major tread groove at any location on the tire (13 CAC 1088(a)(1)).

(b) Retreaded tire is on the front axle (13 CAC 1088(d)).

d. Tire Condition. Tires should be inspected for the following defects and conditions of improper maintenance that may be violations of Title 13, California Administrative Code, Section 1088(b):

(1) Use of boot or blowout patch.

(2) Unrepaired fabric break.

(3) Exposed or damaged cords.

(4) Bumps, bulges, or knots.

(5) Cuts that measure more than one inch and expose the body cord.

(6) Cracks in valve stem rubber.

(7) Treads regrooved or recut below the original tread groove depth, except on commercial vehicle tires which have extra undertread rubber for that purpose (13 CAC 1087(a)).

e. Tire Misuse. Tires should be inspected for the following conditions of misuse in violation of 13 CAC 1086:

(1) Load per tire exceeding the maximum load rating except provided for increased tire loads at reduced speeds as provided in paragraph 6 d of this chapter.

(2) Nonradial tube in radial tire.

(3) Tires with following markings not used as specified:

(a) LT Tires. Tires identified with the letters "LT" after the size (such as 7.00-15LT) are designed for light trucks and may be used on any vehicle.

(b) MH Tires. Tires identified with the letters "MH" after the size (such as 8-14.5MH) shall be used only on mobile homes and other trailers.

(c) ML Tires. Tires identified with the letters "ML" after the size (such as 10.00-22ML) shall not be used on vehicles traveling more than 50 miles (80 km) in any 1-hr period, and at no time shall they be used on vehicles that exceed a speed of 80 km/h (50 mph).

(d) NHS Tires. Tires identified with the letters "NHS" after the size (such as 7.00-15 NHS) shall not be used except on implements of husbandry. Tires identified as "NHS" may be used on cotton trailers (defined as implements of husbandry in the Vehicle Code) only when such trailers are operated at not more than 64 km/h (40 mph).

(e) SL Tires. Tires identified with the letters "SL" after the size (such as 9.00-16SL) shall be used only on agricultural and industrial equipment operated at not more than 32 km/h (20 mph).

(f) ST and Other Trailer Tires. Tires identified with the letters "ST" (such as 7.00-13ST) or with the words "TRAILER" or "TRAILER SERVICE" after the size shall not be used on motor vehicles.

(g) T Tires. Tires identified with the letter "T" after the size (such as 3.75-19T) shall be used only on motorcycles or sidecars with tapered bead rims.

(4) Tires with markings such as follows indicating they are not designed for use on the highway:

(a) "Off-Highway"

(b) "Racing Purposes Only"

(c) "Not for Highway Use"

(d) "Farm Use Only"

(e) "Aircraft"

6. TIRE LOAD LIMITS.

a. Tire Table Basis. Tables in this chapter give load limits required by Federal Motor Vehicle Safety Standards 109 for passenger car tires and 119 for truck, bus, and trailer tires of various constructions, sizes, uses, and load ranges. The maximum load limit for the tire (not adjusted for reduced speed) is the load in pounds molded on at least one sidewall of the tire.

b. Load Range. A tire's "load range" is identified on truck, bus, and trailer tires by a capital letter (A, B, C, etc.) indicating the range of loads a tire may carry at various cold inflation pressures. For example, a size 10.00-20 truck tire with load range designation H may carry not more than 4,290 pounds at 60 psi to 6,610 pounds at 115 psi on a single wheel. Tables in this guide show only the maximum allowable load at maximum cold inflation pressure taken from the standards of the Tire and Rim Association, the European Tire and Rim Technical Organization, and the Japanese Standards Association. The letter after the words "load range" on a tire corresponds as follows to the tire strength ply rating, which it replaces (although the actual number of plies may be fewer than shown):

Load Range	Former Ply Rating	Load Range	Former Ply Rating
A	2	G	14
B	4	H	16
C	6	J	18
D	8	L	20
E	10	M	22
F	12	N	24

c. Maximum Load Limit. The tables in Annexes B, C, and D list the maximum weight the tire may carry at its maximum cold inflation pressure, limited in some instances to certain types of service. The weights in these tables are the same as the maximum load rating required to be molded on at least one sidewall of new tires as required in the federal standards. If a tire in question is not listed in these tables, the amount shown on the sidewall is the maximum load that can legally be carried by the tire, except as provided in the following subsection d. (13 CAC 1080-1087) Information on tires not listed may be obtained from Commercial and Technical Services Section.

d. Load Limit at Reduced Speeds. Certain types of tires are allowed to carry increased loads at higher inflation pressures when operated at reduced speeds. The footnotes in the particular tables show the percentage

increases in allowable load at the reduced speeds. These loads are not allowed unless the vehicle has a mechanically-restricted top speed appropriate for the load or unless it has a maximum speed sign on the rear as specified in 13 CAC 1080-1087 and is operated at a speed not exceeding that limit.

e. Wheel Load Limit. Where a vehicle manufacturer or operator uses a wheel of a lower rating than shown for the particular tire size, the load on the highway shall not exceed the wheel rating. Some wheels are labeled in accordance with SAE J179 and are marked on the outside of the rim base or the wheel disc with the maximum load at maximum inflation pressure.

Example: SAE J179
MAX LOAD 5430 LB
MAX PSI 85

7. TIRE LOAD LIMIT TABLES. Tire load limits are shown in tables in Annexes B, C, and D. If a tire manufacturer designs tires (such as steel belted radials) for load ratings that are higher than those in these tables, the loads shown in the manufacturer's tire data book are acceptable.

CHAPTER 2

STEERING AND SUSPENSION

2.1 SCOPE. This Chapter contains a description of steering systems and component parts and provides a suggested procedure for the inspection of steering and suspension systems.

2.2 INTRODUCTION.

2.2.1 Source. Standards and definitions contained in this Chapter are consistent with "USA Standard Inspection Procedures for Motor Vehicles, Trailers, and Semitrailers Operated on Public Highways" published by the American Standards Association July 26, 1963, and sponsored by the American Association of Motor Vehicle Administration and Insurance Institute for Highway Safety.

2.2.2 American Standard. An American Standard implies a consensus of those substantially concerned with its scope and provisions. An American Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American Standards are subject to periodic review and users are cautioned to obtain the latest editions.

2.2.3 Application. Appropriate corrective action should be taken when conditions are at variance with the standards contained herein to such a degree that a violation of the law or an unsafe condition exists or the operation of the vehicle may be adversely affected (Section 24002 VC).

2.3 DEFINITIONS.

2.3.1 Sideslip (or Scuff). The amount of sidewise tire slippage occurring on the road surface while the vehicle is traveling straight ahead.

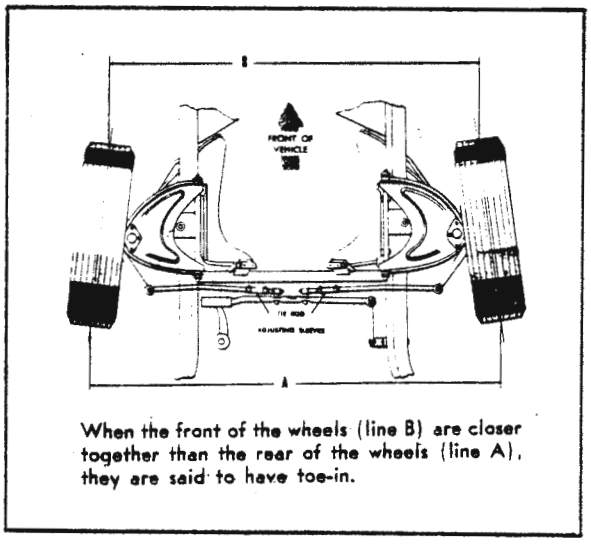
2.3.2 Wheel Plane. The central plane of the tire, perpendicular to the axis of rotation.

2.3.3 Camber. The inclination of the wheel plane to the vertical. It is measured in degrees and considered positive when the wheel leans outward at the top and negative when the wheel leans inward.

2.3.4 Caster. Caster is the tilt of the kingpin either toward the front or rear of the vehicle. Tilting the top of the kingpin to the rear is positive caster. Tilting the top of the kingpin to the front is negative caster.

2.3.5 Kingpin or Steering Axis Inclination. The outward tilt of the bottom of the kingpin toward the wheel. When the ball joint system is used, the tilt is called steering axis inclination.

2.3.6 Toe-In/Toe-Out. When the distance between the tires at the front is less than the distance between the front tires at the rear, measured at spindle height, the condition is called toe-in. When the distance is greater in front the condition is called toe-out.



When the front of the wheels (line B) are closer together than the rear of the wheels (line A), they are said to have toe-in.

Fig. 2-1. Toe-In

2.4 SYSTEM OPERATION.

2.4.1 Design Criteria. A properly designed, adjusted, and maintained steering system will:

a. Provide precise directional control of a vehicle without excessive steering effort.

b. Operate without excessive vibration or shimmy.

c. Through steering geometry design, reduce tire wear caused by turning to a minimum.

d. Ensure that front wheels will return to the straight ahead position when the steering wheel is released.

2.4.2 Caster. A wheel aligns itself to follow the point of load. Caster, or forward inclination of the kingpin at the bottom, moves the point of load forward in relation to the wheel as shown in Figure 2-2.

a. Proper caster will cause the wheels to align themselves in the direction in which the vehicle is traveling which increases directional control.

b. Too much caster causes hard steering, excessive road shock, and shimmy.

c. Too little caster provides easy low speed steering, high speed instability, and wander.

d. The amount of caster required, and whether it is positive or negative, can be influenced by another angle - steering axis inclination.

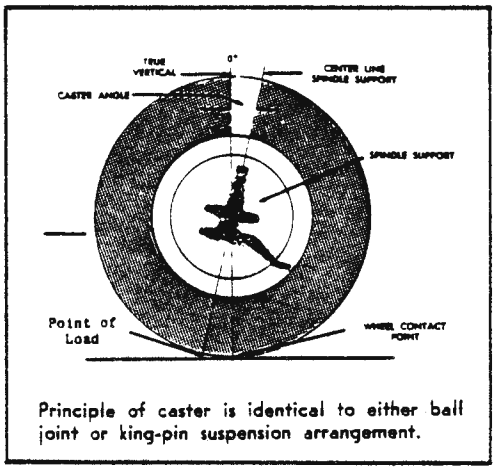


Fig. 2-2. Caster Angle

2.4.3 Steering Axis Inclination. Steering axis inclination helps position the load point under the tire as shown in Figure 2-3.

a. The camber angle required is reduced by steering axis inclination.

b. The load point is brought under the tire reducing steering effort.

c. This angle causes the spindle to rise when the wheel is turned. Vehicle weight causes the wheels to return to a straight ahead position, contributing to directional stability.

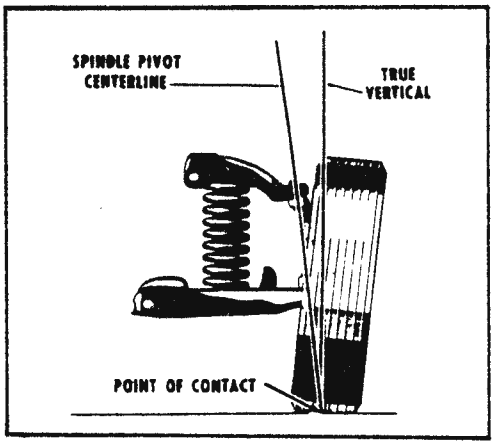


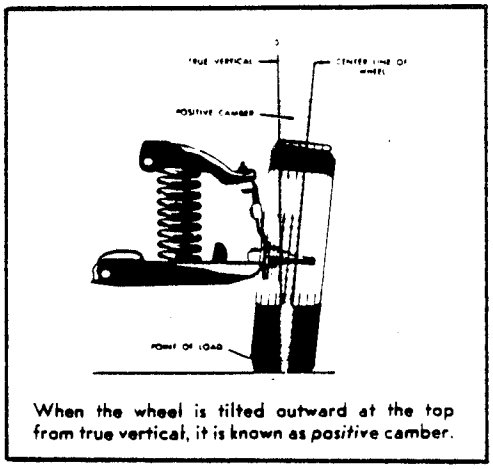
Fig. 2-3. Steering Axis Inclination

2.4.4 Camber. Camber brings the tire under the load point as shown in Figure 2-4.

a. Camber, in conjunction with the steering axis inclination, provides ease of steering and increased directional control.

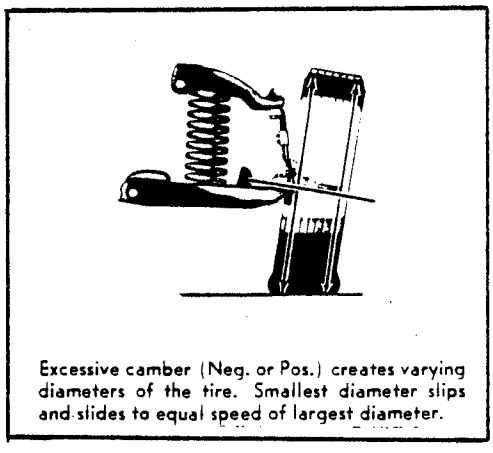
b. Camber, when proper, reduces tire wear by properly positioning the load point under the tire.

c. Excessive camber increases tire wear by causing varying diameters between the two sides of the tires as shown in Figure 2-5. Tire wear increases as tire width increases.



When the wheel is tilted outward at the top from true vertical, it is known as *positive* camber.

Fig. 2-4. Camber Angle



Excessive camber (Neg. or Pos.) creates varying diameters of the tire. Smallest diameter slips and slides to equal speed of largest diameter.

Fig. 2-5. Tire Diameter Change from Camber Angle

2.4.5 Wheel Turning Radius (Steering Geometry). Each front wheel negotiates a different arc when the vehicle is turned.

a. To avoid excessive tire wear, the wheel spindles must turn different degrees when the steering wheel is turned.

b. This is accomplished by designing the system so that the spindle arms are closer at the tie rod end as shown in Figure 2-6.

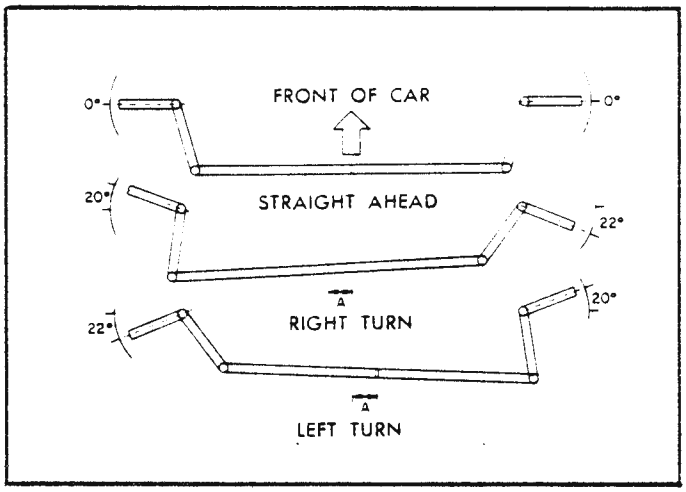


Fig. 2-6. Steering Geometry

2.4.6 Toe-In. As a vehicle moves forward, the forces against the wheels tend to compress the steering mechanism. "Toe-In" of the wheels compensates for this and in operation the wheels run straight.

2.5 COMPONENT PARTS. The component parts of steering and suspension systems are illustrated in Figures 2-7 through 2-13.

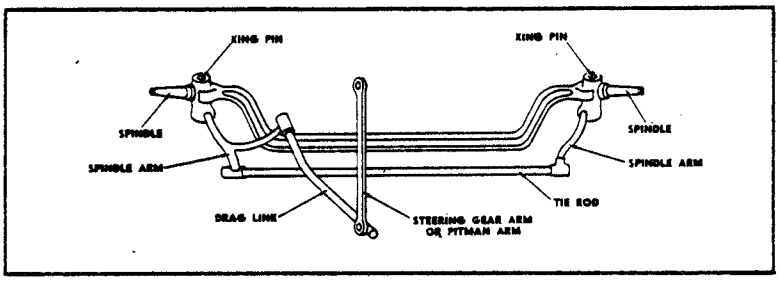


Fig. 2-7. Conventional Axle Front Suspension

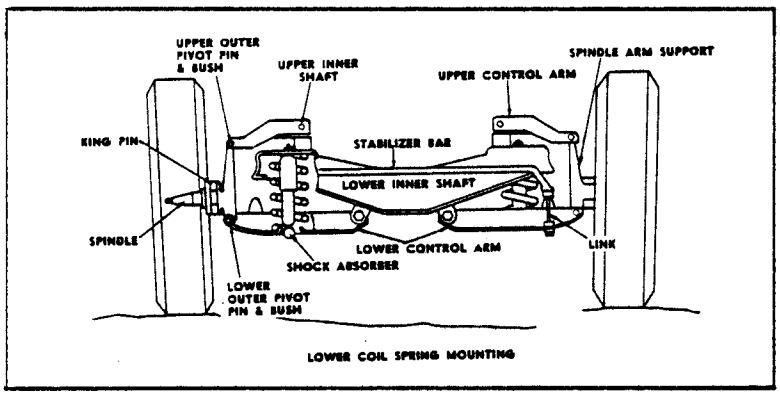


Fig. 2-8. Independent Front Suspension

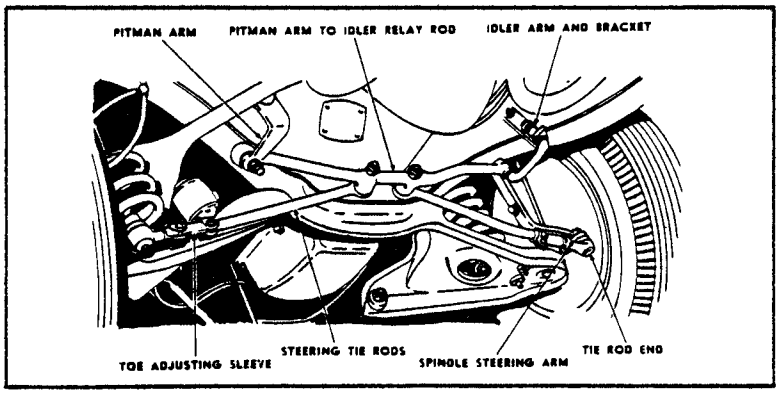


Fig. 2-9. Steering Linkage Component Parts

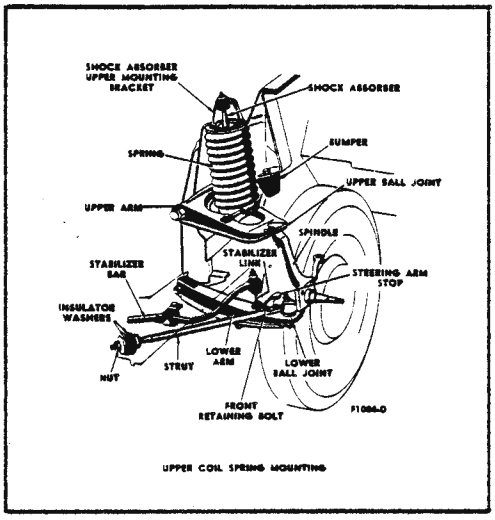


Fig. 2-10. Independent Front Suspension

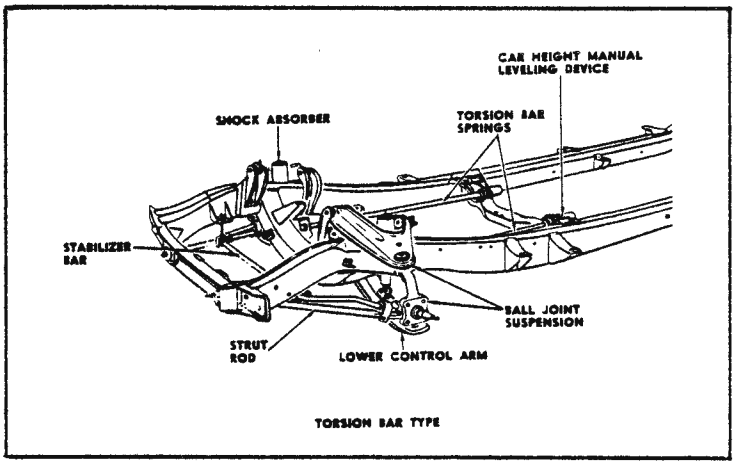


Fig. 2-11. Independent Front Suspension

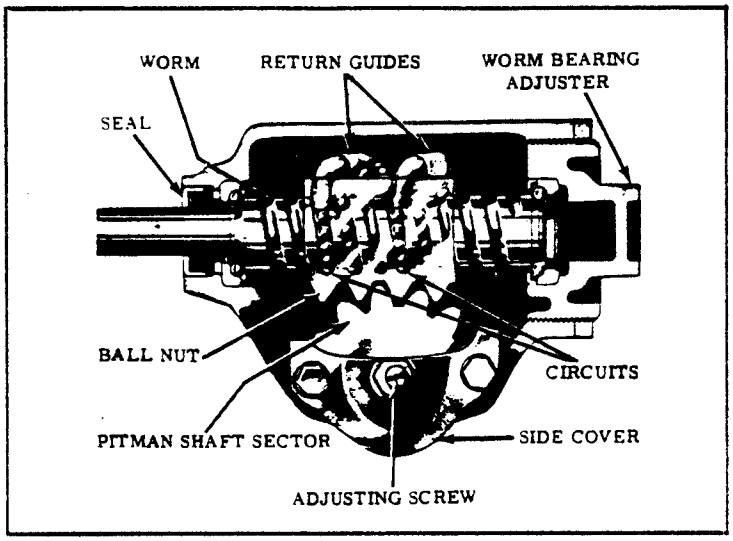


Fig. 2-12. Manual Steering Gear

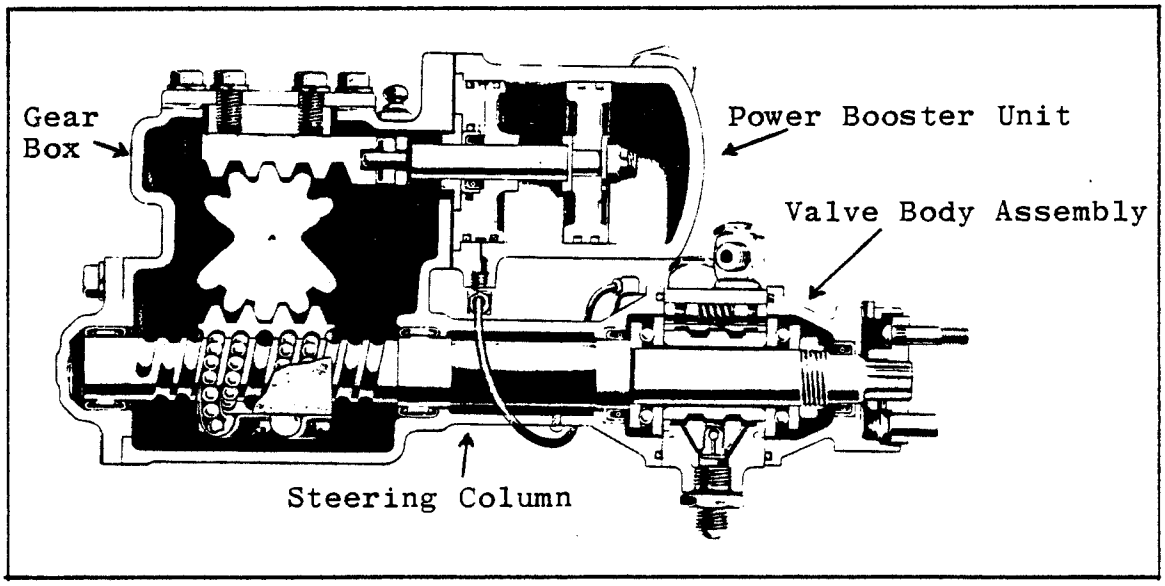


Fig. 2-13. Power Steering Gear (Cross Section)

2.6 INSPECTION PROCEDURE.

2.6.1 Preliminary Requirements. Inspection of steering systems should be conducted on a clean, relatively level surface.

a. Caster, camber, toe-in, and steering axis alignment can be inspected only with the use of wheel aligning equipment.

b. Ball joints, kingpins, and kingpin bushings can be inspected only when the joint is unloaded. (Front end raised off the ground.)

2.6.2 Steering Column. Inspect the steering column and steering gear box for proper mounting, securement, and operation (Section 24002 VC).

a. Turn steering wheel through a full right and left turn and feel for binding or jamming conditions.

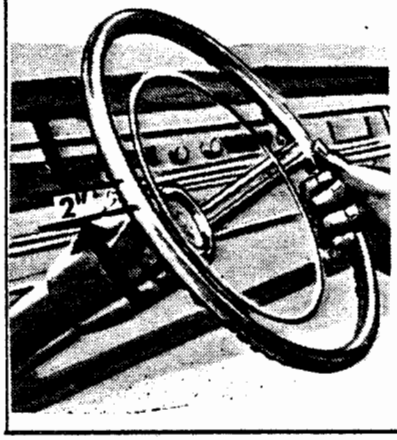
b. Care should be taken at the extreme ends of the turn to avoid deflecting the mechanism against stops.

c. Steering shaft should turn through full range in both directions without binding or hard pull and be free of any rough spots.

(1) Binding indicates misaligned steering gear on mountings or coupling.

(2) Rough spots indicate damaged bearings or parts. Hard pull indicates excessive preload adjustment.

d. With road wheels in straight ahead position, turn steering wheel until motion of the wheels can be observed. Measure lash. Total movement of the steering wheel before the wheels begin to move should not be greater than shown in Figure 2-14.



Steering Wheel Diameter	Lash
16"	2"
18"	2-1/4"
20"	2-1/2"
22"	2-3/4"

Fig. 2-14. Lash

e. Inspect flexible coupling in steering column (if the vehicle is so equipped) for excessive misalignment; tightness of adjusting screw or nut; flexible disc worn, torn or frayed; elongated bolt or rivet holes; and missing bolts, nuts, or rivets.

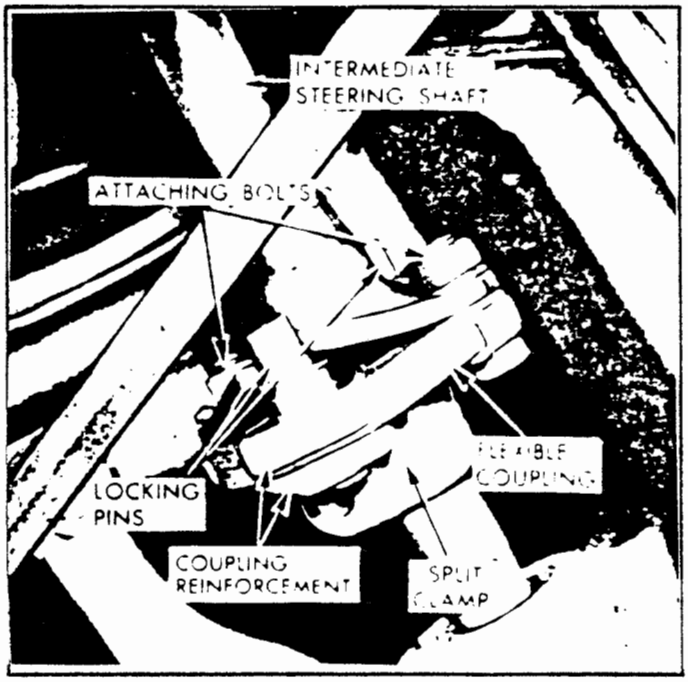


Fig. 2-15. Flexible Steering Coupling

f. Check the securement of the steering gear box to the frame. Determine that there are no loose or missing mounting bolts.

g. Examine the power steering valve body and hose connections for leaks.

* h. Check steering column shaft upper bearing for excessive wear and on a remote type check lower bearing for defects as shown in Figure 2-16.

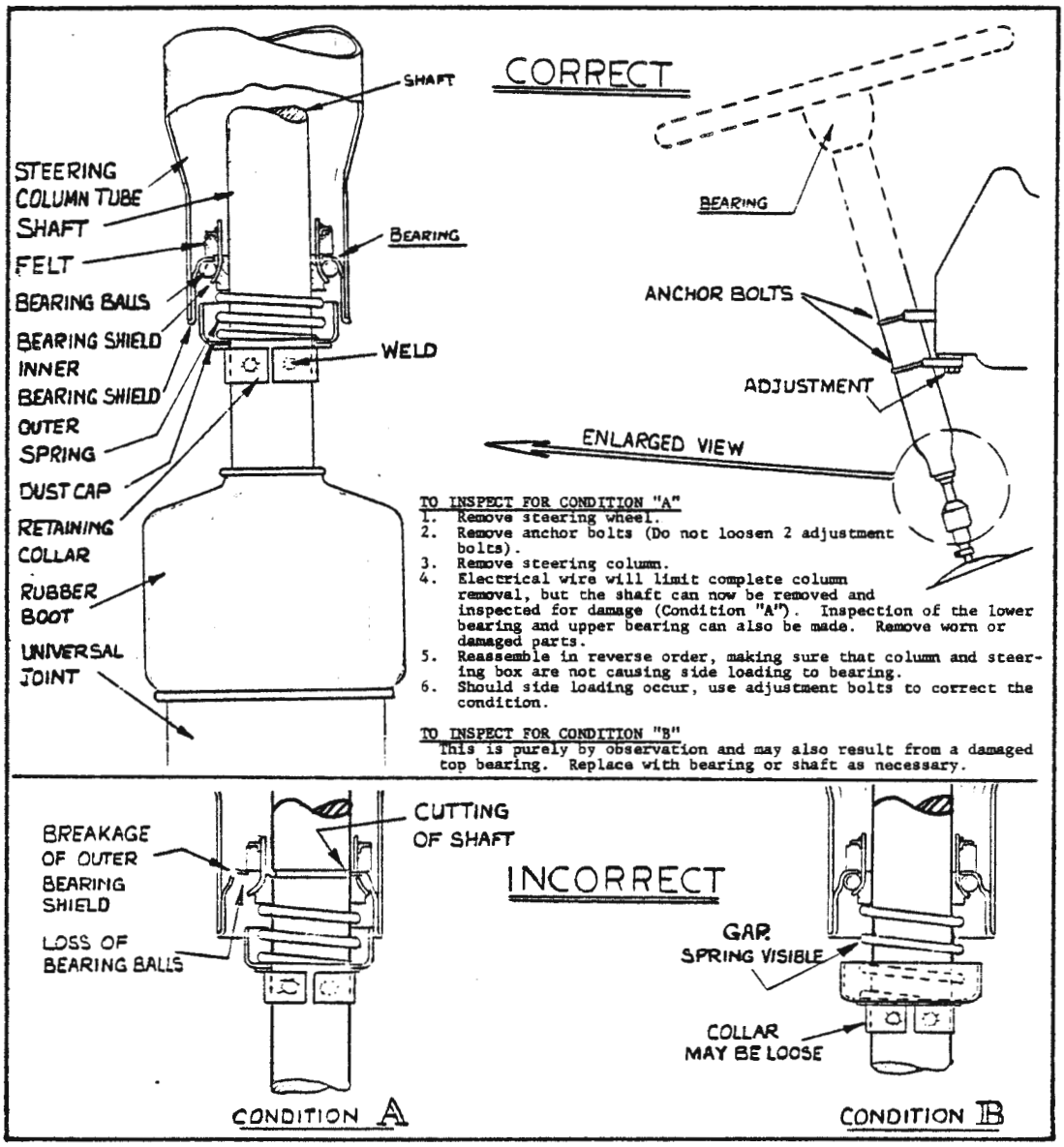


Fig. 2-16. Steering Column Inspection

i. Check the top mounting bracket for looseness.

2.6.3 Springs. Inspect coil springs and spring leaf suspension components that are weakened, displaced, or broken.

2.6.4 Steering Linkage Play. The combined wear of the steering linkage components as shown in Figures 2-7 and 2-9 is determined as follows (Section 24002 VC).

a. Raise one wheel off the ground.

b. Grasp front and rear of tire and attempt to turn assembly right and left.

c. Grasp top and bottom of the tire and attempt to rock in and out.

d. Record movement at extreme front and rear - top and bottom of tire.

e. A bar for leverage may be required for heavy wheels.

f. Movement shold not exceed that specified in the following table.

Movement	Wheel Diameter
1/4-inch	16" or less
3/8-inch	17" and 18"
1/2-inch	over 18"

2.6.5 Tie Rod Ends. Inspect all spherical joints on tie rod ends and steering linkage for excessive wear and looseness (Section 24002 VC).

a. Joints should twist freely but should have no end play except as allowed by compression of the tie rod end spring.

b. Note condition of sealing boots, particularly on sealed joints without plugs or fittings.

2.6.6 Idler Arm. Inspect idler arm for worn bushing as may be indicated by up-and-down play (Section 24002 VC).

2.6.7 Pitman Arm. Check pitman arm on steering gear box for looseness. There should be no up-and-down movement of idler or pitman arm (Section 24002 VC).

2.6.8 Ball Joints and Kingpins. Raise the front end of the vehicle so that the ball joint will not be loaded and check the ball joints and kingpins for excessive looseness (Section 24002 VC).

a. Grasp the tire and wheel assembly at the 11 and 5 o'clock positions on the tire. Work the wheel in and out to detect any looseness. Move hands to the 1 and 7 o'clock positions and repeat.

b. Position a pry bar under the front tire and wheel and with a lifting motion move the wheel up and down and observe movement shown on dial indicator.

c. There should be no perceptible movement of the unloaded ball joint. (The upper ball joint on vehicles where the spring is supported by the lower control arm and the lower joint when the spring is supported by the upper control arm.)

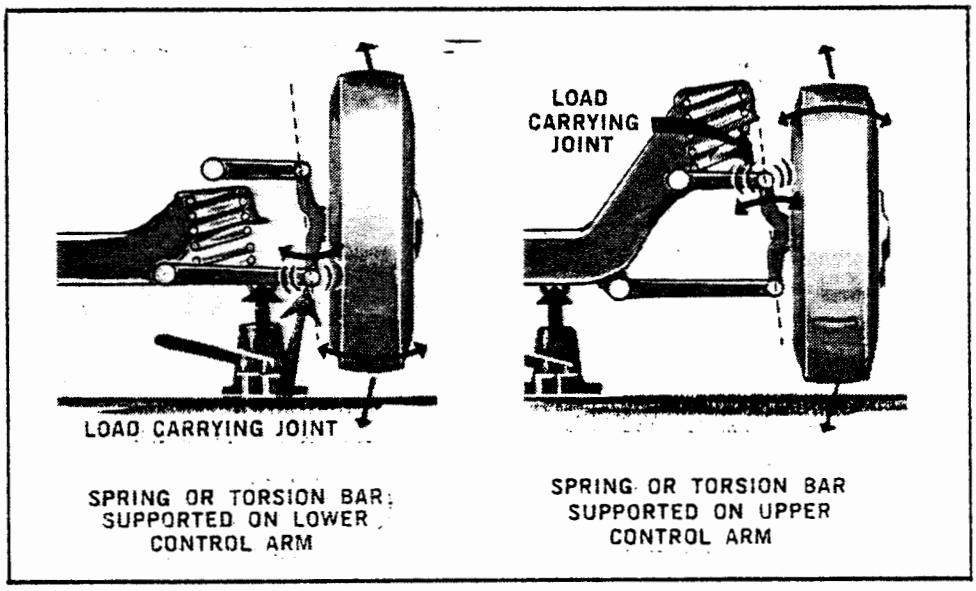


Fig. 2-17. Proper Jacking to Unload Ball Joints

2.6.9 Front Wheel Bearings. Attempt to move wheel relative to the spindle either by grasping front tire top and bottom or by using a bar for leverage.

a. Bearing maladjustment or wear is determined by the relative movement between the brake drum (or disc) and the backing plate (or splash shield).

b. Movement between the drum and backing plate should not exceed 1/4-inch measured at the tire tread (Section 24002 VC).

c. Check for overly tightened and defective wheel bearings by rotating the wheel on the spindle.

2.6.10 Toe-In. A measuring device specifically designed for the purpose is normally required for measuring toe-in.

a. Measure the distance between tire tread centers at the front and rear of the front tires.

b. The front measurement should be less than the rear measurement and within manufacturers' recommended tolerances.

2.6.11 Camber and Caster. Camber and caster can be measured only with gauges specifically designed for the purpose. Camber and caster should be adjusted to manufacturers' specifications.

CHAPTER 3

REVISED AUGUST 1980

AIR BRAKES

1. INTRODUCTION. This chapter explains the operation of air brake systems and the functions of the major components. It provides procedures for inspecting air brake systems to determine whether they meet legal requirements, function properly, and are maintained in good working order. The procedures also apply to the air portion of air-over-hydraulic brakes. This chapter is not intended to serve as a technical manual for repairing and servicing air brake systems.

2. INSPECTIONS. The order in which the inspections are made and the tests are conducted may be varied to suit the need of the person doing the inspecting, the availability of test equipment, and the physical layout of the brake system. In order to inspect as many vehicles as possible, inspections should concentrate on critical items. Additional components may be tested when vehicle defects indicate to the inspector that further testing is necessary.

3. DEFINITIONS. Definitions appropriate to this chapter are in the Glossary of Brake Terminology (Annex A). The reference to the California Administrative Code Sections (13 CAC) in the inspection procedures apply to vehicles listed in Vehicle Code Section 34500 quoted below:

"34500. The Department of the California Highway Patrol shall regulate the safe operation of the following vehicles:

(a) Motortrucks of three or more axles.

(b) Truck tractors.

(c) Buses and schoolbuses.

(d) Trailers, semitrailers, pole or pipe dollies, auxiliary dollies, and logging dollies used in combination with motortrucks of three or more axles, truck tractors, buses or schoolbuses.

(e) Any combination of a two-axle truck and any vehicle or vehicles set forth in subdivision (d) that exceeds 40 feet in length when coupled together.

(f) Any truck, or any combination of a truck and any other vehicle, transporting hazardous materials.

(g) Trailer coaches which, when moved upon the highway are required to be moved under a permit as specified in Section 35780 or 35790."

4. SYSTEM DESCRIPTIONS.

a. The Air Brake System. In an air brake system, the force of compressed air is applied to a device that through the use of levers, cams, or wedges forces the brake shoes against the brake drums or brake pads against the rotors.

(1) The basic air brake system is very simple requiring only a source of compressed air, a valve to control the amount of air applied, and a means of converting the force of compressed air into mechanical force to apply the brakes.

(a) Compressed air is generated by a compressor driven by the engine. The air is stored in reservoirs.

(b) The application or control valve is a foot- or hand-operated valve that applies the appropriate amount of air pressure required to slow or stop the vehicle.

(c) The air brake chambers convert the force of compressed air pressing against the brake chamber diaphragm into mechanical force to apply the brake shoes to the brake drums or the brake pads to the rotors.

(2) Other valves, and devices such as air driers, may be added to make the brake system operate more efficiently and safely.

b. Air Brake System Diagrams. Diagrams of air brake systems with their most common components are shown in Figures 3-1, 3-2, and 3-3. Amendments to FMVSS 121 have eliminated the requirement for antilock devices on vehicles other than buses, but they are still in use on some vehicles.

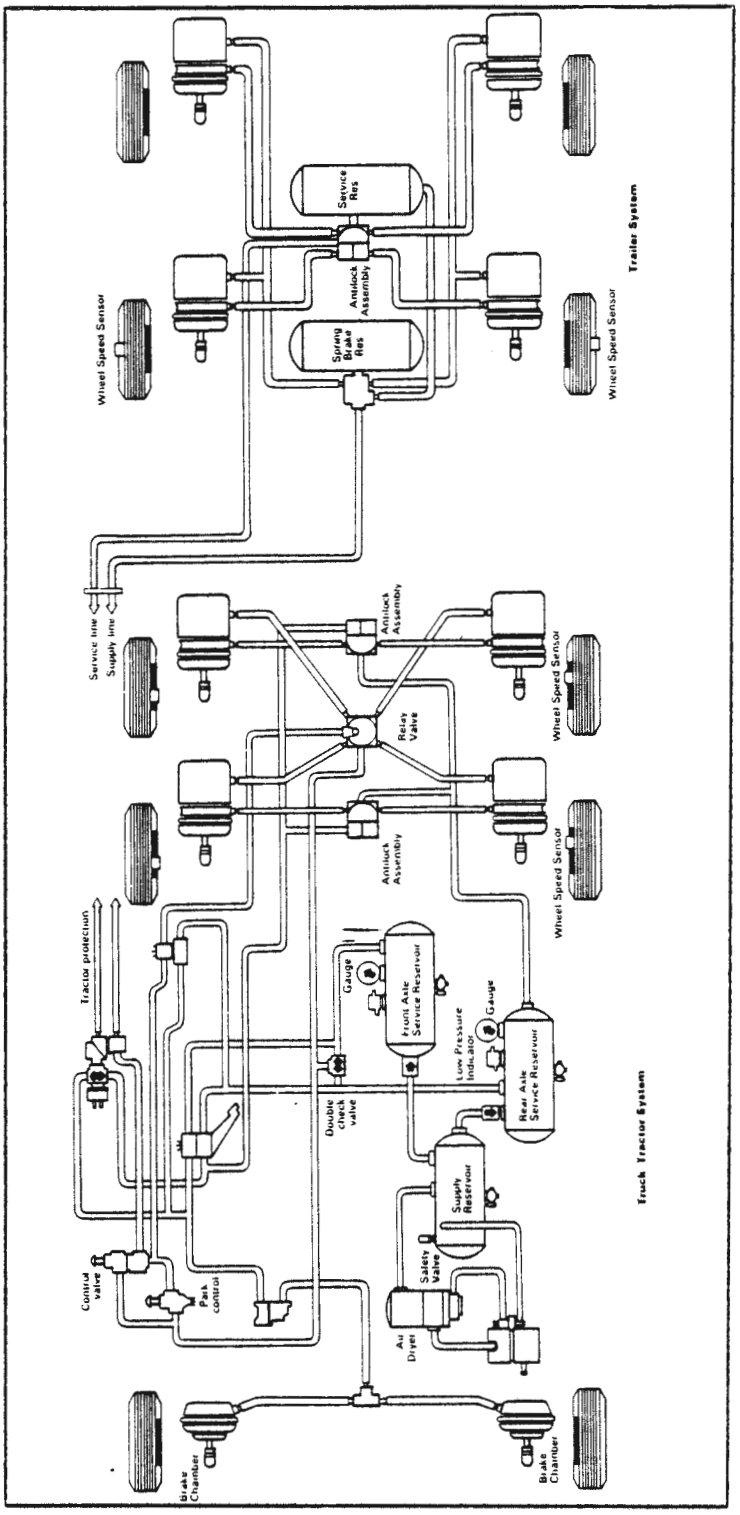
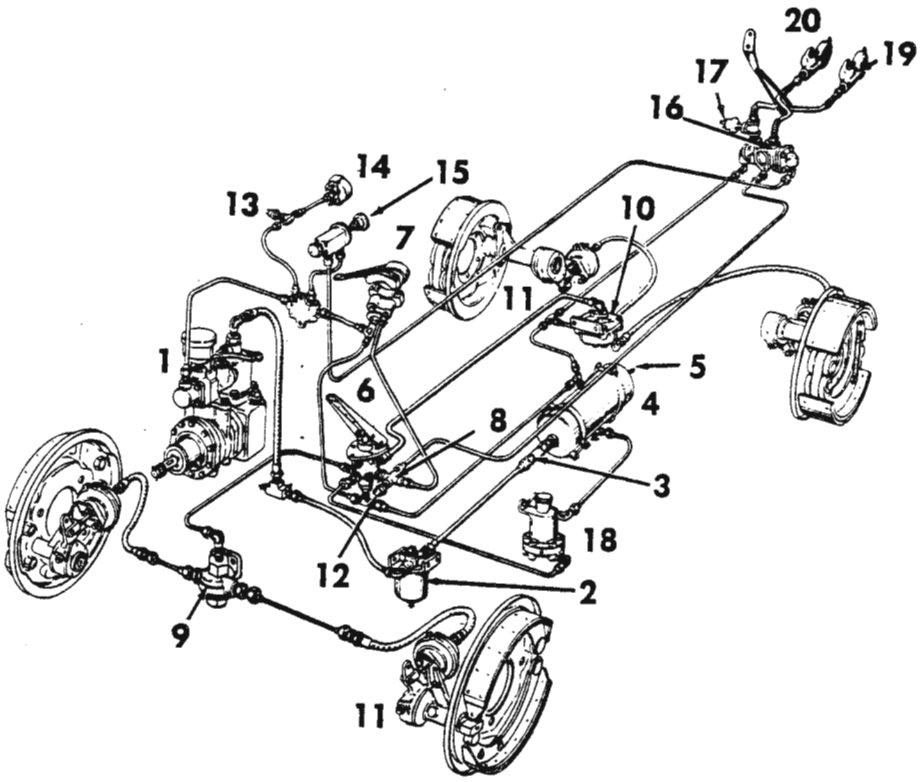
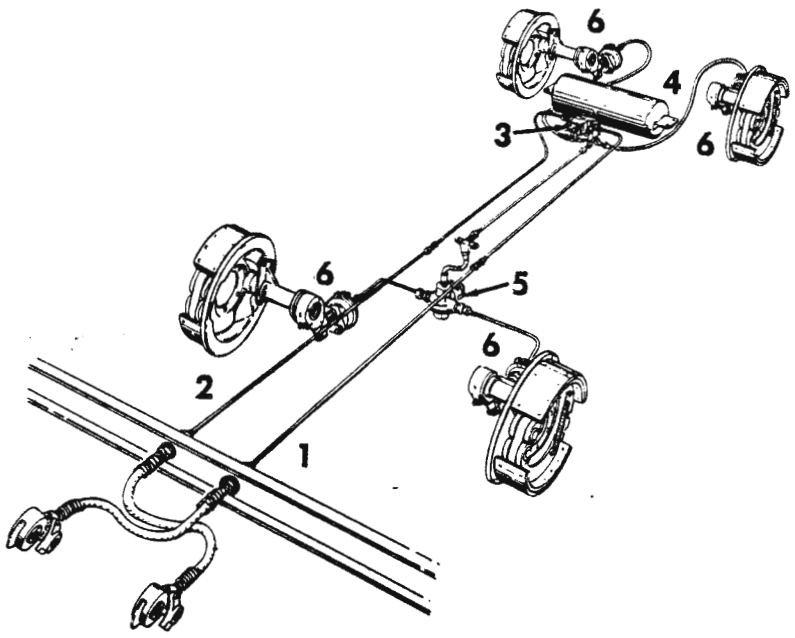


Fig. 3-1. Tractor-Trailer Air Brake System Meeting FMVSS 121



1. Compressor (includes Control Valve)
2. Alcohol Injector-Accessory
3. Single Check Valve
4. Air Tank
5. Safety Valve
6. Foot Valve
7. Hand Valve
8. Double Check Valve
9. Quick-Release Valve
10. Relay Valve or Quick-Release Valve
11. Brake Chamber
12. Tractor Stop Lamp Switch
13. Low Pressure Indicator Switch
14. Air Gauge
15. Tractor Protection Dash Control Valve
16. Tractor Air Line Protection Valve
17. Trailer Stop Lamp Switch
18. Moisture Ejection Valve
19. Emergency Line and Hose Coupler
20. Service Line and Hose Coupler

Fig. 3-2. Tractor Air Brake System--Before FMVSS 121



1. Emergency Line
2. Service Line
3. Relay Emergency (Breakaway) Valve
4. Trailer Air Tank
5. Quick-Release Valve
6. Brake Chamber and Slack Adjuster

Fig. 3-3. Trailer Air Brake System--Before FMVSS 121

5. AIR BRAKE COMPONENTS.

a. Reciprocating Air Compressor. Figure 3-4 illustrates a reciprocating type air compressor that operates as follows:

(1) Rotation of the compressor crankshaft causes the pistons to move up and down in the cylinder.

(2) On the down stroke the inlet valves open permitting air to enter the cylinder. The discharge valves are closed.

(3) On the up stroke the inlet valves close. As the piston moves up, the air is compressed in the cylinder. The discharge valves open at the top of the stroke to allow the compressed air to enter the reservoirs through the compressor discharge line.

(4) The compression cycle of the compressor is controlled by an air governor.

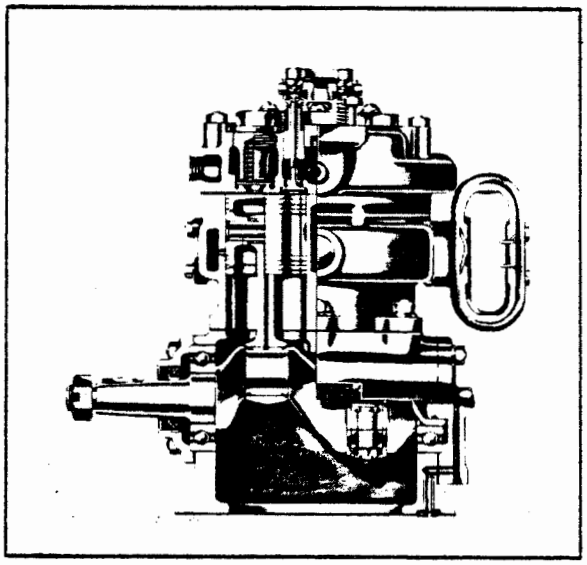


Fig. 3-4. Air Compressor

b. Air Governor for Reciprocating Air Compressor. There are several types of air governors for reciprocating compressors, two of which are described below:

(1) Bourdon Tube Governor. Figure 3-5 illustrates an air governor which uses air pressure applied to a Bourdon tube and operates as follows:

(a) When the reservoir pressure reaches the cut-out setting of the governor, the pressure slightly straightens the Bourdon tube sufficiently to allow the valve mechanism to move up, permitting the upper valve to close the exhaust port in the governor. Reservoir pressure then passes through the governor to operate the compressor unloading mechanism, stopping further compression of air by the compressor.

(b) When reservoir pressure is reduced to the cut-in setting, the tube relaxes sufficiently to close the lower valve and open the upper valve, shutting off and exhausting the air from the compressor unloading mechanism, and resuming compression.

(c) The governor can be adjusted for proper cut-in and cut-out pressure.

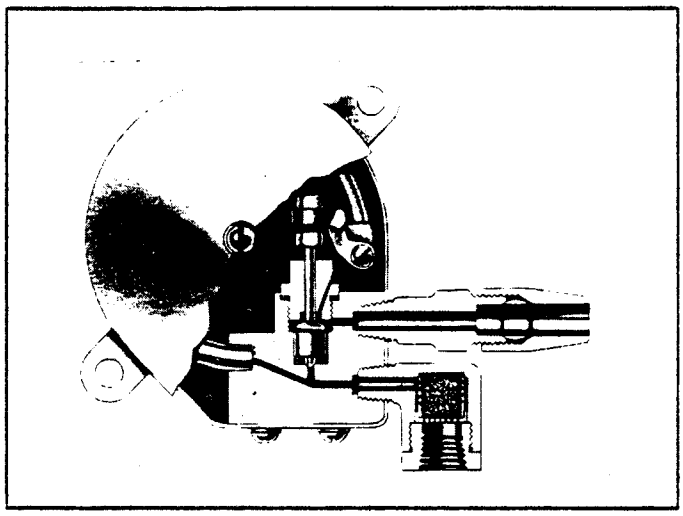


Fig. 3-5. Air Governor--Bourdon Tube Type

(2) Diaphragm Governor. Figure 3-6 illustrates an air governor which uses air pressure against a diaphragm for operation.

(a) When the reservoir pressure reaches the cut-out setting of the governor, the diaphragm or piston is subjected to sufficient force to overcome the spring loading, allowing the valve mechanism to move up, permitting the exhaust stem to close the exhaust valve and to open the inlet valve. Reservoir pressure then passes through the governor to operate the compressor unloading mechanism, stopping further compression of air by the compressor.

(b) When the reservoir pressure is reduced to the cut-in setting, the spring loading within the governor overcomes the force of the air pressure under the diaphragm or piston. The valve mechanism is actuated, closing the inlet valve and opening the exhaust valve, thereby shutting off and exhausting the air from the compressor unloading mechanism and resuming compression.

(c) The cut-in and cut-out pressures can be set at the desired level by adjusting the spring tension in the governor.

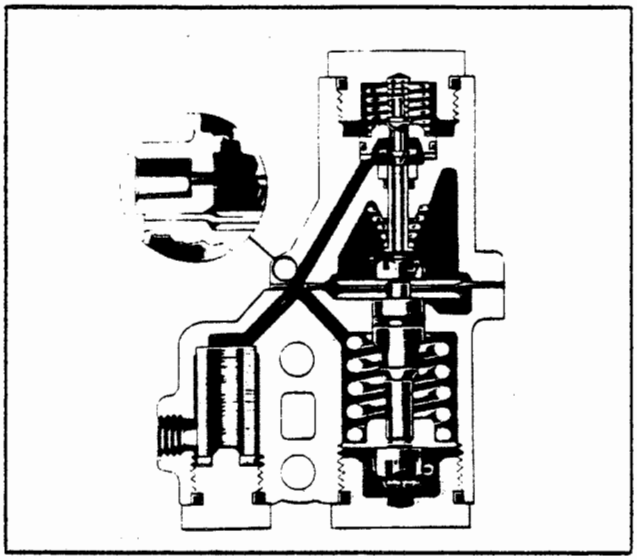


Fig. 3-6. Air Governor--Diaphragm Type

c. Rotary Air Compressor. Figures 3-7 and 3-8 are illustrations of a rotary air compressor which operates as follows:

(1) The rotor and shaft is off center in relation to the stator. Four equally spaced blades carried by the rotor are held in wiping contact with the stator by centrifugal force. Four compression chambers are formed by the blades.

(2) Due to the off center location of the stator and the action of the rotor blades, each chamber increases in size as it passes the intake port and decreases in size as it passes the discharge port. The air is compressed as the size of the chamber decreases. Lubricating oil seals the clearance between the blades and the stator.

(3) The compressed air, mixed with oil, is discharged into the air dome where the oil is separated from the air and returned to the compressor for reuse.

(4) Compressed air from the air dome is discharged into the air reservoirs through the compressor discharge line.

(5) The compression cycle is regulated by a built-in control valve on the top of the compressor, which can be adjusted for proper cut-in and cut-out pressures.

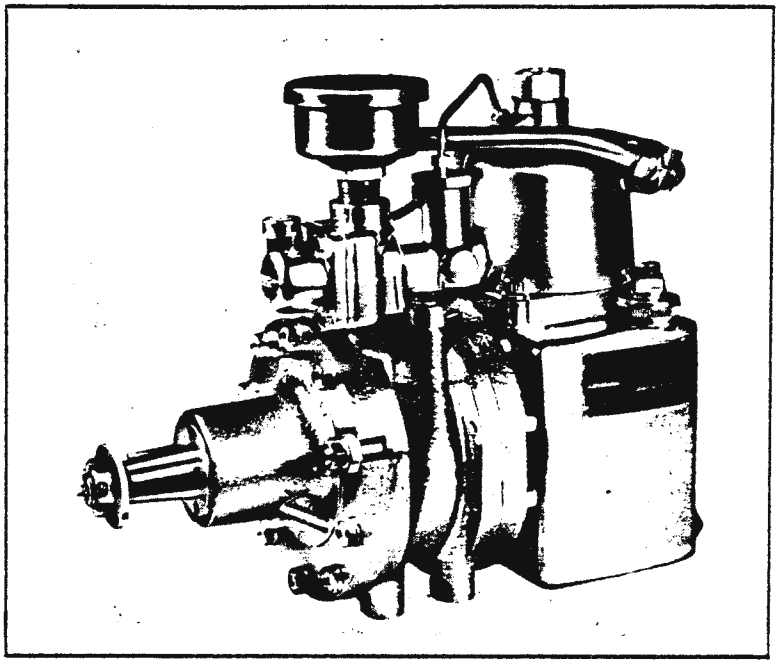


Fig. 3-7. Rotary Air Compressor

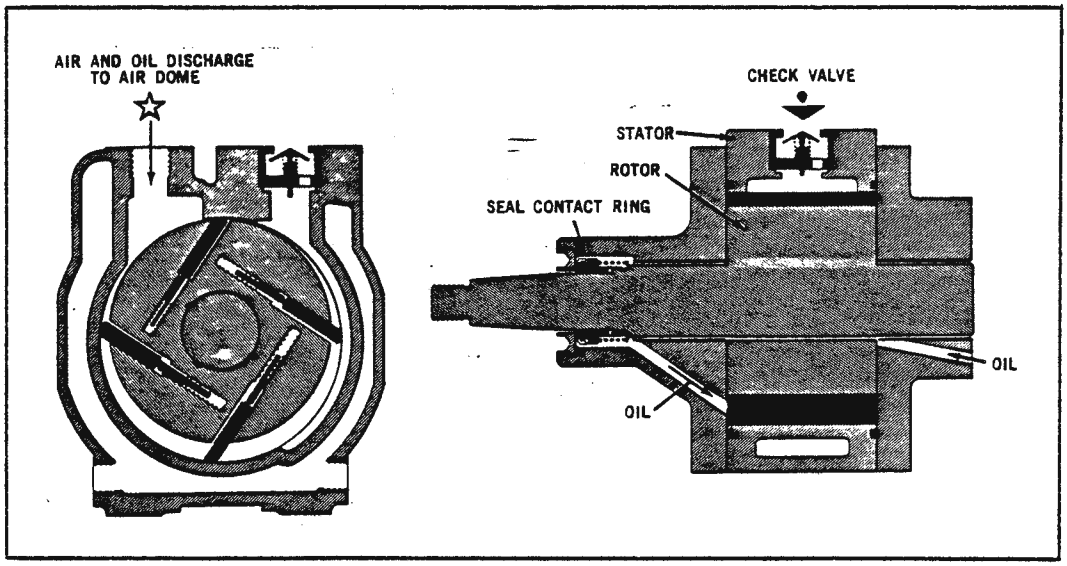


Fig. 3-8. Cutaway View of Rotary Air Compressor

d. Treadle Valve. The treadle or foot valve is a floor-mounted, foot-operated, air pressure regulating valve designed to permit the driver to apply the amount of air pressure to the brake system necessary to slow or stop the vehicle.

(1) The valve provides accurate control of the air pressure delivered to the brake chambers throughout the pressure range available from the air reservoirs.

(2) Several types of foot valves are designed for different uses, the three most common being:

(a) A single-chamber valve designed to apply all brakes from one air chamber.

(b) A dual-chamber valve designed to apply front and rear wheel brakes from separate chambers and reservoirs. This is a split system where failure of one-half of the system will not render the other half inoperative.

(c) A dual-chamber valve with an emergency stopping system application feature at full open position. This valve provides the safety features of a split system and, in addition, provides for application of the emergency stopping system under panic stop conditions.

(3) Illustrations of foot valves are shown in Figures 3-9, 3-10, and 3-11.

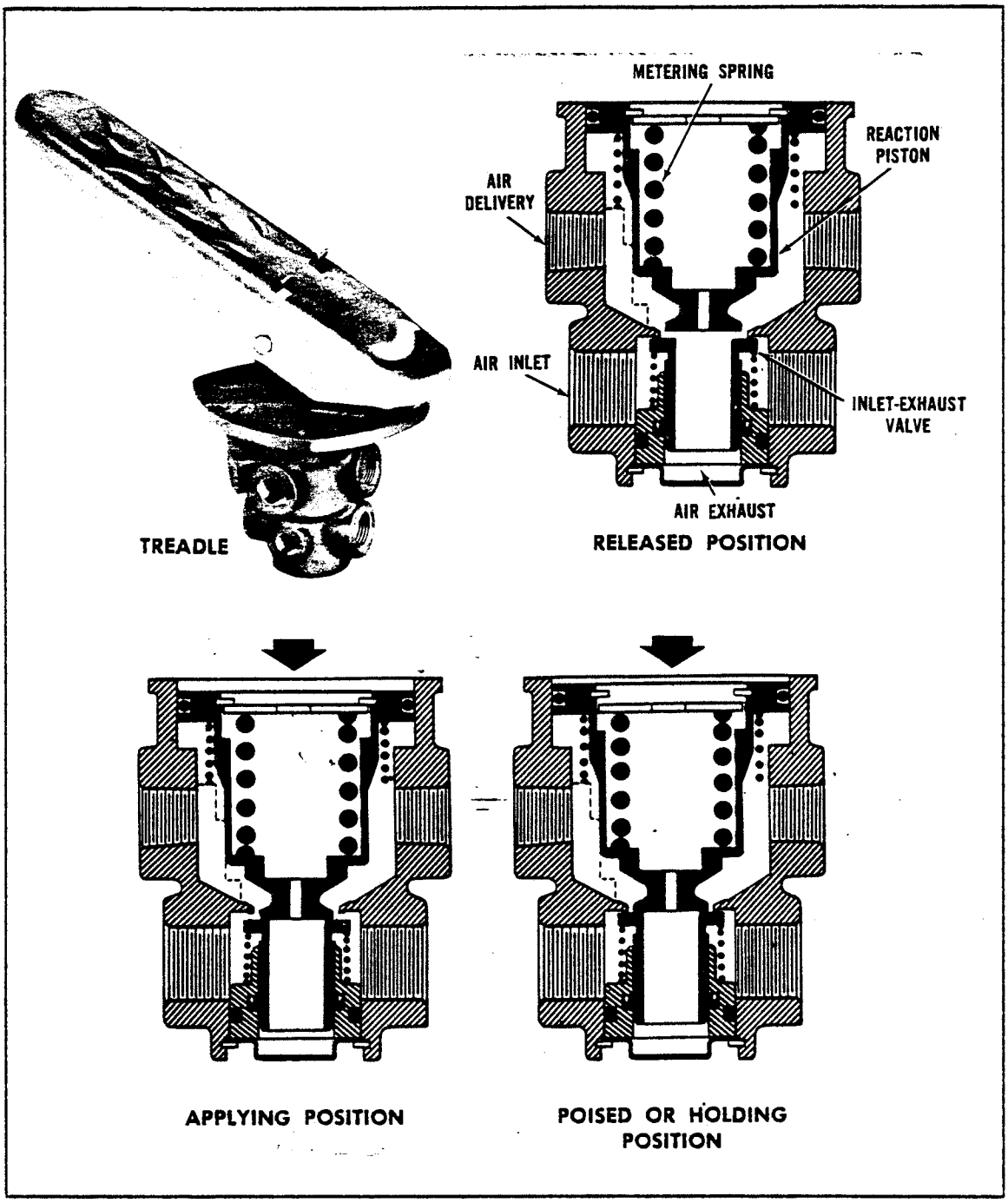


Fig. 3-9. Single-Chamber Foot Valve

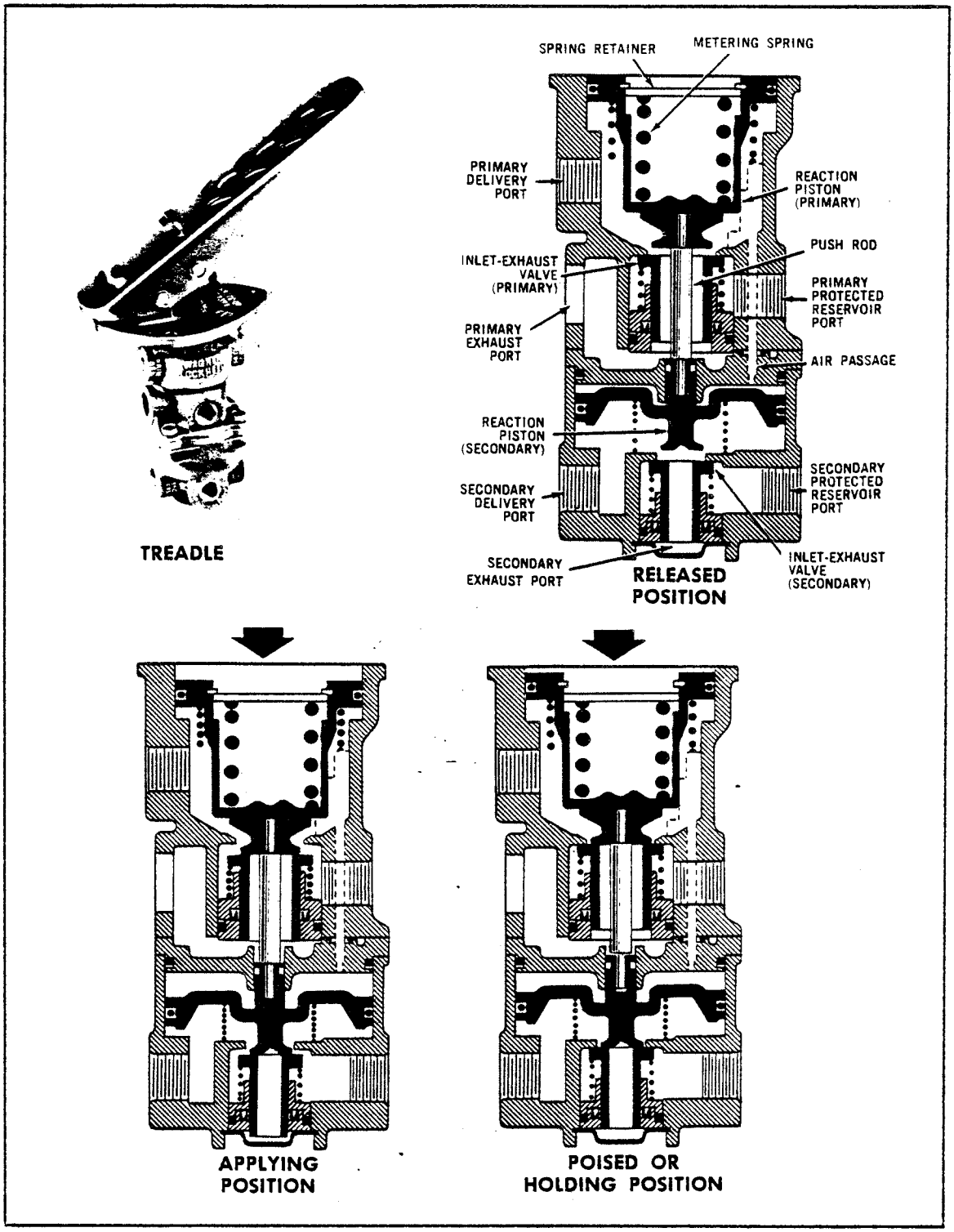


Fig. 3-10. Dual-Chamber Foot Valve

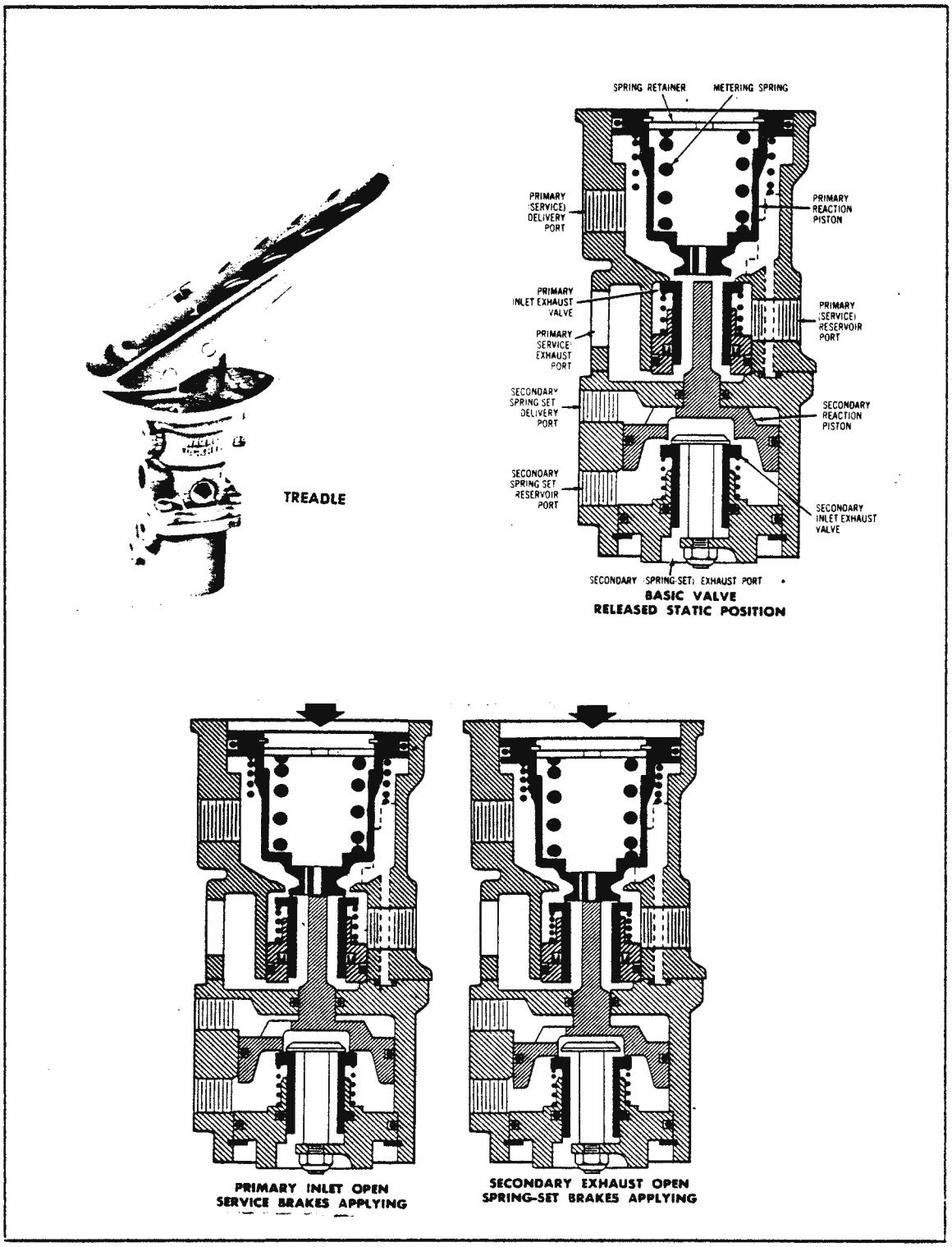


Fig. 3-11. Dual-Chamber Foot Valve with Spring Brake Application

e. Hand Valve. A hand-operated control valve is normally used to apply the trailer brakes alone in a combination of vehicles.

(1) The principle of operation of the hand valve is similar to the operation of the foot valve.

(2) An illustration of a hand valve is shown in Figure 3-12.

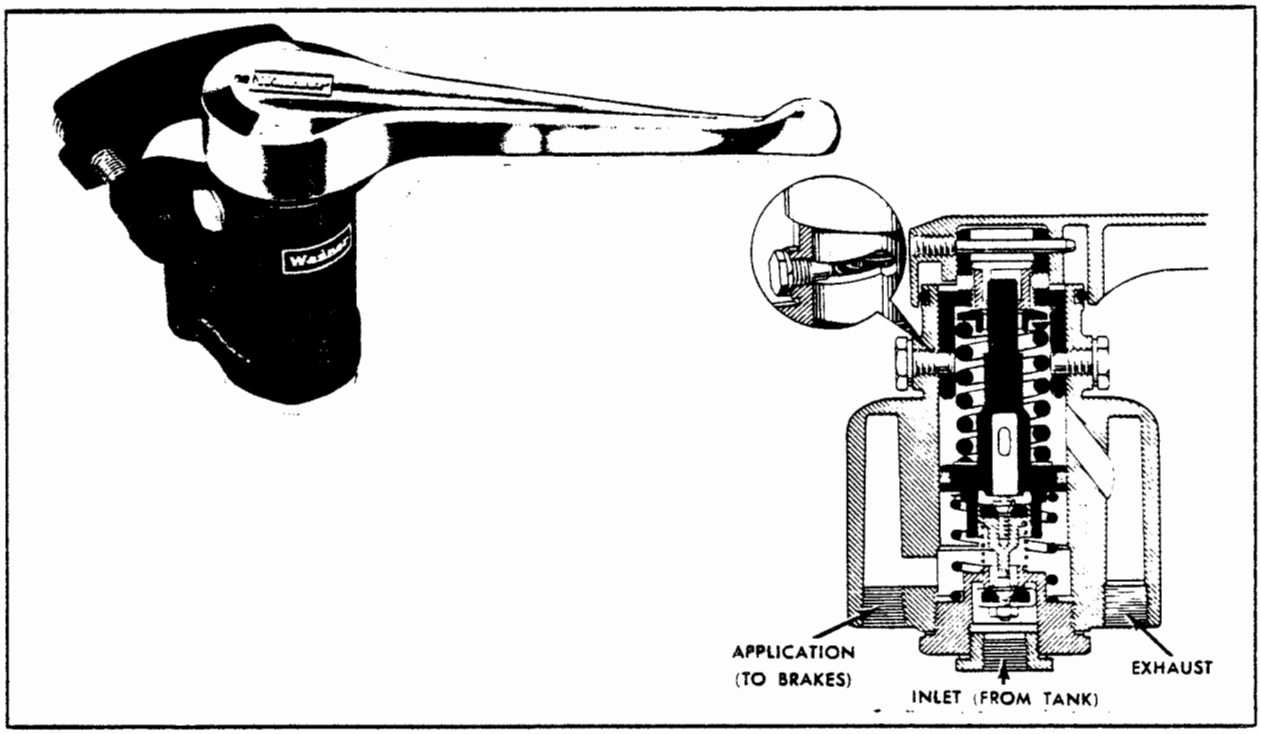


Fig. 3-12. Hand-operated Air Brake Application Valve

f. Check Valve. Two types of check valves are in common use, single and two-way illustrated in Figure 3-13.

(1) A single check valve permits air to pass in one direction only. The valve is installed between the air compressor and the supply reservoir or at the inlets to the service reservoirs.

(2) The two-way check valve connects an air line with two application sources and automatically seals off the source not being used. A common application is between the hand valve and foot valve to prevent air from exhausting through the unapplied valve. Another application is from the supply reservoir to each of two service reservoirs in a split emergency air brake system.

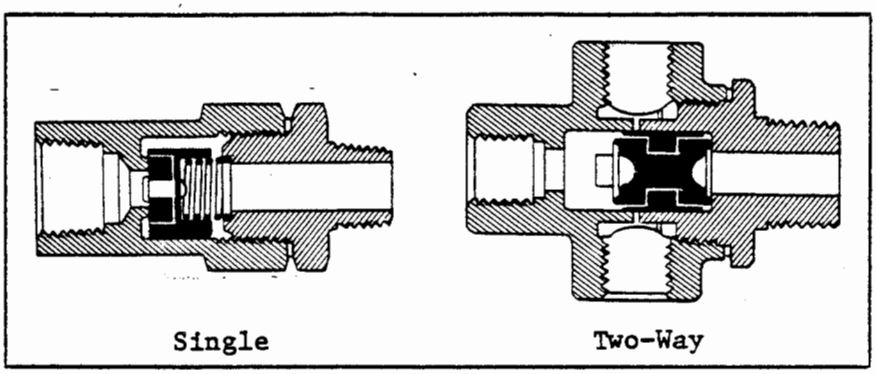


Fig. 3-13. Air Line Check Valves

g. Tractor Protection Valve. The tractor protection valve is installed in the service and emergency air lines leading to the trailer. It seals these air lines in an emergency and also in normal bob-tailed operation of the tractor. One type of valve shown in Figure 3-14 operates as follows:

(1) In normal operation with trailer connected, the dash control valve is opened permitting air from the air reservoirs to pass into the control line to the tractor protection valve.

(2) Reservoir pressure in the control line forces the valve diaphragm and plunger into position to permit air to flow into the trailer emergency line and, when the foot or hand valve is applied, into the service line.

(3) Loss of pressure in the control line causes the plunger to return to closed position and seal the trailer emergency and service lines, thus preventing air from flowing into the trailing unit.

(4) Pressure loss in the control line can be produced either by activating the dash control or by breaking the emergency line between the towed and towing unit.

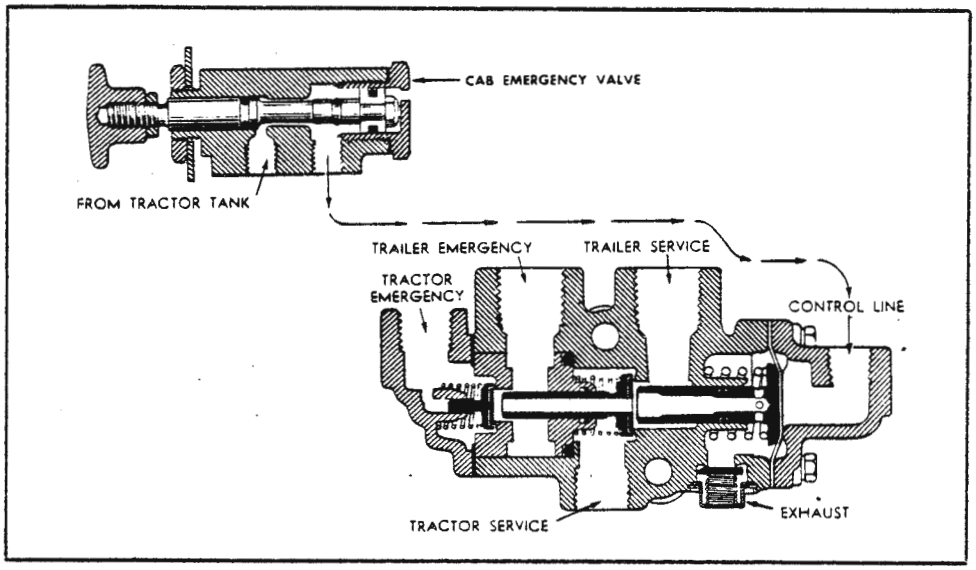


Fig. 3-14. Tractor Protection Valve

h. Relay Emergency Valve. A relay emergency valve is normally installed on trailers but may be installed on or near any braked axle.

(1) The relay emergency valve is used in conjunction with an air reservoir and serves the following purposes:

(a) Passes air from the emergency line into the trailer reservoir and serves as a check valve to retain air in the trailer reservoir.

(b) Relays air from the reservoir to the brake chambers. Since the air from the reservoir thereby travels a very short distance to the brake chambers, brake response time is considerably reduced compared to the time that would be necessary if all the air traveled from the motor vehicle reservoirs through the foot valve.

(c) Provides full application of the trailer brakes in the event of a breakaway between the towed and towing vehicle which causes the emergency line to be severed.

(d) Satisfies California requirements for an emergency stopping system on trailers and semitrailers but does not meet FMVSS 121 requirements for parking and emergency brakes on trailers manufactured after January 1, 1975.

(2) The relay emergency valve illustrated in Figures 3-15 and 3-16 works as follows:

(a) Air from the emergency line passes through the valve into the air reservoir and is then held in the reservoir by the valve in the event the trailer emergency line is broken. This is commonly called a "no bleed back" valve.

(b) Application of the foot or hand valve sends a signal of air from the service line into the valve, causing it to relay air from the air reservoir to the brake chambers. When the brake chamber pressure equals the application pressure, the port to the reservoir is closed. This results in brake chamber pressure equal to application pressure.

(c) Pressure from the charged emergency line holds the valve in normal operating position. When this pressure is released, the port from the reservoir to the brake chamber is opened, causing full emergency application of the service brakes.

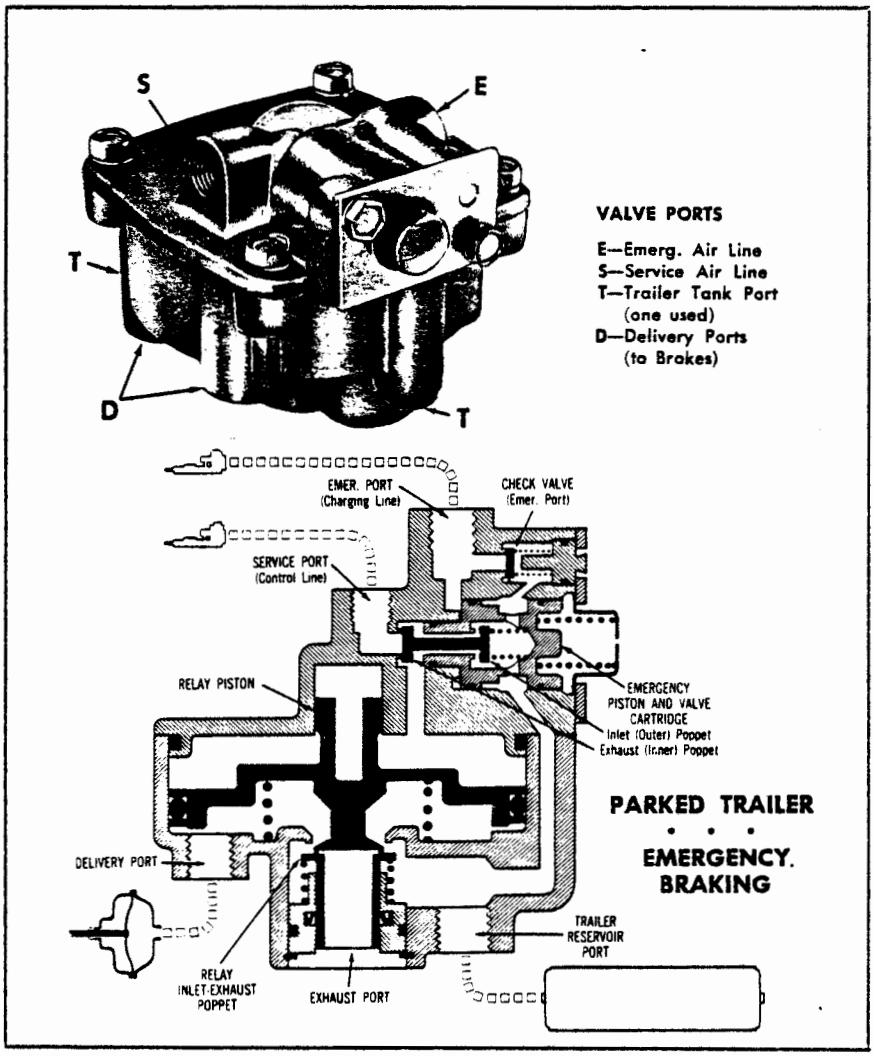


Fig. 3-15. Relay Emergency Valve

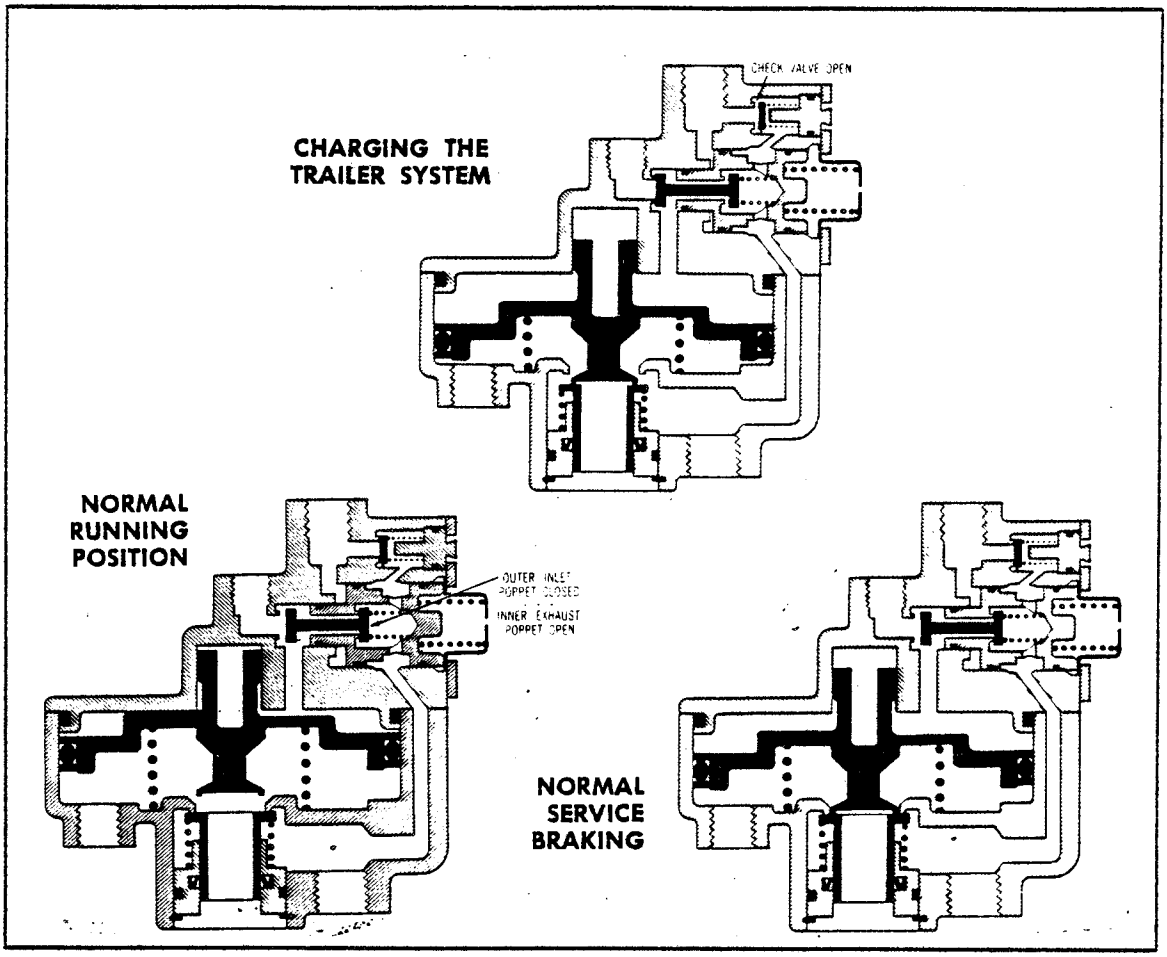


Fig. 3-16. Relay Emergency Valve Operation

i. Quick Release Valve. The air brake system is often equipped with one or more quick release valves to effect faster brake release. The valve directly exhausts braking air pressure. The unit is usually installed in place of a brake pipe tee to handle the exhaust from one axle. One type of quick release valve is illustrated in Figure 3-17 and operates as follows:

(1) Air pressure from the brake application valve enters the quick release valve through the port above the diaphragm and forces the center of the diaphragm to seat tightly against the exhaust port. Air pressure also overcomes diaphragm cup tension to deflect the outer edge of the diaphragm down, which permits air to flow around the diaphragm and out of side ports to the brakes.

(2) When the brake application valve is released, the small volume of air above the diaphragm quickly exhausts from the brake application valve. The pressure drop above the quick release valve diaphragm permits braking pressure to raise the center of the diaphragm from the exhaust port and escape directly to atmosphere. This eliminates the need for the air in the brake chambers to travel back to the application valve exhaust port, thereby speeding the release of the brake shoes from the brake drum.

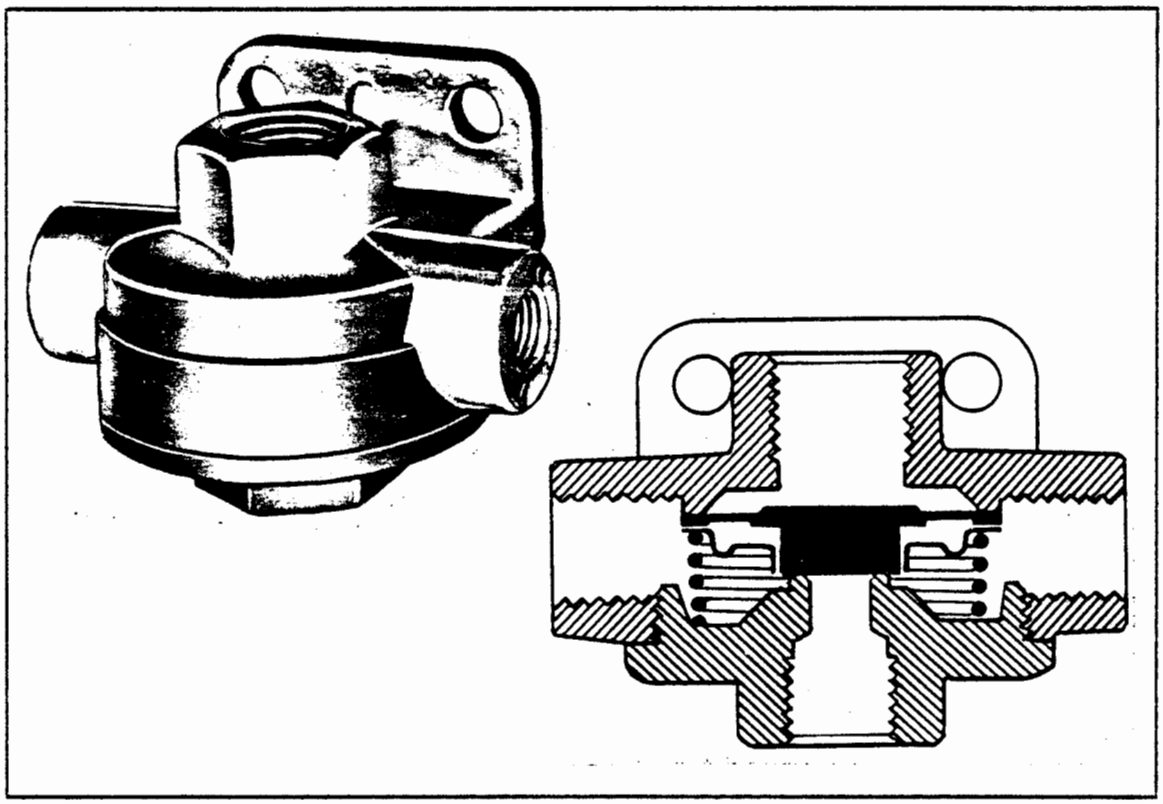


Fig. 3-17. Quick-Release-Valve

j. Relay-Quick-Release Valve. A combination relay-quick-release valve is used to reduce brake application and release time. The valve, one of which is illustrated in Figure 3-18, is used in conjunction with an air reservoir and functions as follows:

(1) A signal of air from the brake application valve opens the valve to permit air from the reservoir to flow directly to the brake chambers.

(2) When the air pressure in the brake chambers equals the pressure in the service line, the valve closes the port to the air reservoir resulting in brake chamber pressures equal to the service line pressure.

(3) Upon release of application pressure, the exhaust port opens permitting brake chamber air to exhaust to atmosphere. The air reservoir port closes preventing air in the reservoir from entering the valve.

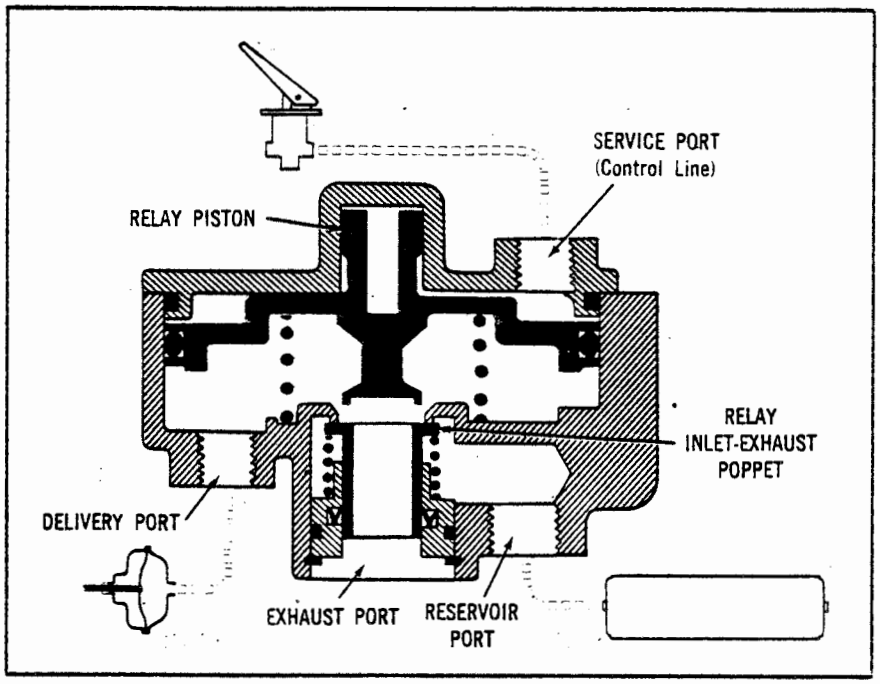


Fig. 3-18. Relay-Quick-Release Valve

k. Brake Chamber. Brake chambers convert the pressure of compressed air into mechanical force to apply the brake shoes to the brake drums or brake pads to the rotors. Brake chambers are illustrated in Figure 3-19 and operate as follows:

(1) Air pressure entering the unit presses against the brake chamber diaphragm forcing the brake chamber push rod out.

(2) The force applied to the push rod is equal to the number of square inches of the diaphragm times the air pressure applied to the diaphragm.

(3) When the air pressure is released, the return spring returns the push rod to the released position.

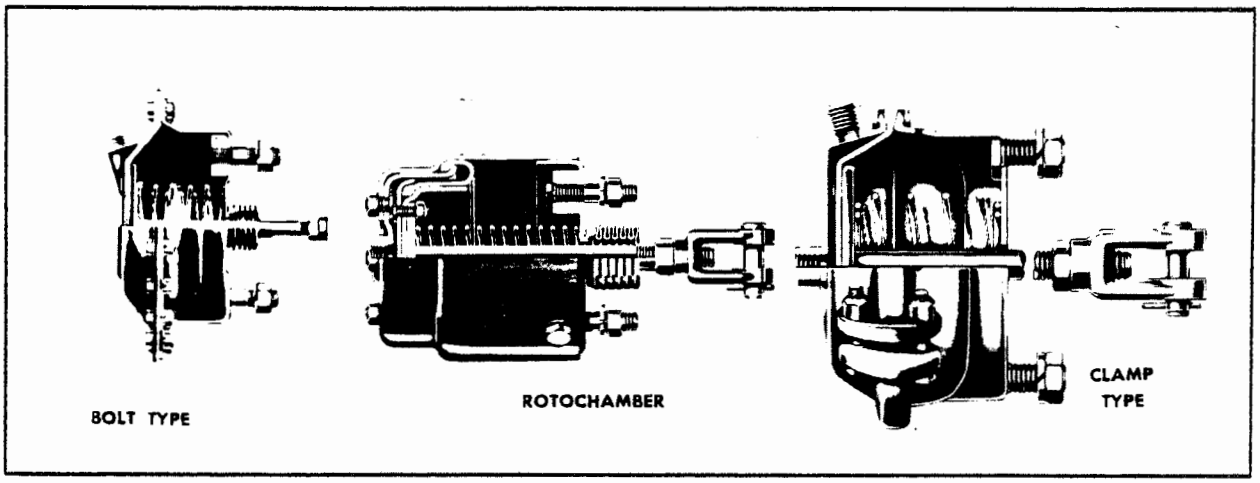


Fig. 3-19. Types of Brake Chambers

1. Moisture Ejection Valve. Moisture ejection valves are attached to air reservoir tanks to provide automatic ejection of contaminants from the brake system. One type of valve illustrated in Figure 3-20 operates as follows:

(1) Applied air pressure forces the lower diaphragm upward to seat on and close the exhaust valve. Further upward movement then raises the exhaust valve and stem, opening the inlet valve.

(2) Reservoir pressure forces fluid and air mixture from the bottom of reservoir to pass the inlet valve and into the fluid chamber where it is momentarily trapped.

(3) Release of application pressure permits pressure of the trapped mixture to force the exhaust valve diaphragm downward, permitting the inlet valve to close.

(4) Continued releasing action moves the lower diaphragm away from the exhaust valve seat permitting the contaminants to escape through the exhaust port.

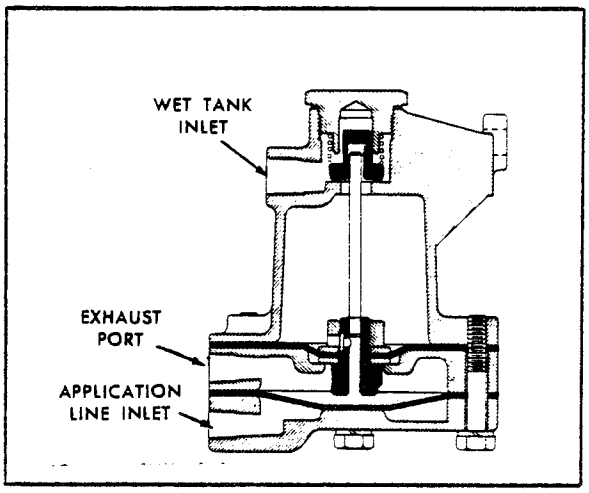


Fig. 3-20. Moisture Ejection Valve

m. Slack Adjuster. The slack adjuster acts as a lever to convert the force exerted by the brake chamber push rod into torque which rotates the brake cam shaft. The slack adjuster, one of which is illustrated in Figure 3-21, also provides a means for adjusting the brakes as follows:

(1) Brake lining wear requires more push rod travel in order to press the shoes against the drums.

(2) When maximum travel as limited by the brake chamber body is reached, the brakes no longer apply.

(3) When the adjusting screw in the slack adjuster is turned, the worm gear on the inside of the slack adjuster rotates the brake cam shaft, positioning the shoes closer to the drum.

(4) With the shoes closer to the drum, the push rod travel is decreased between the fully applied position and the released position.

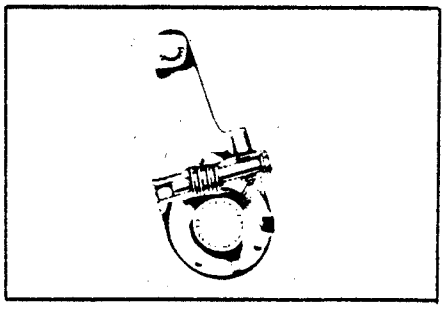


Fig. 3-21. Slack Adjuster

6. AIR SYSTEM INSPECTION.

a. Safety Precautions. Block the wheels, leave the engine running, release the parking brakes, and instruct the driver to release or apply the brakes only as directed.

b. Control Valve Positions. Place all control valves for the brake system in the normal (released) position at the start of the inspection.

c. Instrument Hookup. An air test kit, illustrated in Figure 3-22, is recommended for use in testing air brake systems when hooked up as follows:

(1) When a motor vehicle is towing a trailer, place the tractor protection dash control valve in the emergency position and attach the test kits between the gladhands in the trailer emergency and service lines.

(2) After the test kits are connected, place the tractor protection dash control valve in the "normal" or "trailer charged" position. Additional gauges may be connected to an appropriate air fitting in any brake chamber in the combination of vehicles to check the pressure delivered to the chamber (usually on a rear axle with the highest number of valves between it and the air supply).

(3) The air test kit cannot be used on single motor vehicles unless the vehicle is equipped with air hoses and gladhands for trailer towing. When the vehicle is so equipped, the air test kits may be connected to the air hoses. Blanks must be used in the open gladhand of the test kit to prevent air escape.

(4) When trailer connections are not available, separate air gauges may be used. Hoses of sufficient length to permit the gauges to be read in the cab may be attached. Hook up the gauges as follows:

(a) Connect one test gauge into a fitting in the service (No. 2 or dry) reservoir.

(b) Connect a second test gauge into a brake chamber fitting or an air hose that supplies a brake chamber on the rear axle.

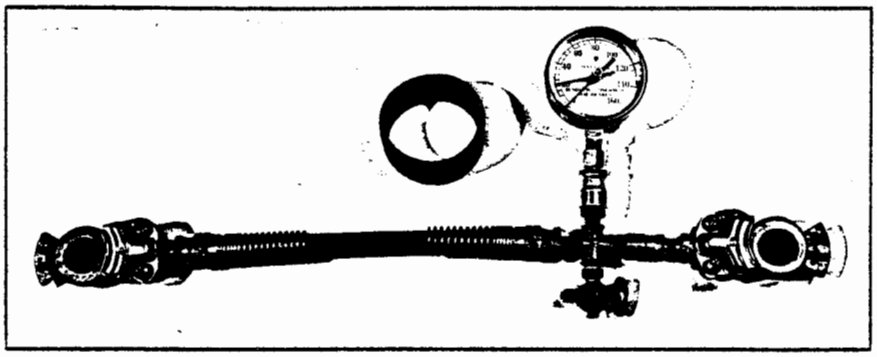


Fig. 3-22. Air Test Kit

d. Governor Setting. With the engine operating at 1000 to 1200 rpm, slowly reduce the air pressure from the system until the air governor cuts in and the air compressor begins to operate.

(1) The air pressure may be reduced by a slow repeated application and release of the foot valve or hand valve, by draining the air tank slowly, or by the use of the petcock on the air test kit in the emergency line. The cut-in pressure shown by the emergency line air test kit gauge shall not be less than 85 psi (26504 VC and 13 CAC, 1061).

NOTE: The cut-in pressure may be as low as 65 psi for air-assisted hydraulic brakes on motor vehicles of not more than 25,000 pounds GVWR. The cut-in pressure for vehicles towing trailers manufactured after January 1, 1975, to FMVSS 121 requirements must be at least 100 psi to assure that spring brakes on any such trailer will not drag after a full service brake application and release. (See paragraph r. in conjunction with pressure drop allowed in paragraph h.)

(2) Build up the air pressure to the governor cut-out point by operating the engine at a speed of 1200 to 1500 rpm. The cut-out pressure, as shown by the emergency line air test kit gauge, shall not exceed 130 psi (26504 VC and 13 CAC 1061).

NOTE: Special systems permitted by regulation allow the governor cut-out pressure to be 150 psi when the maximum air delivered to the brake system reservoir is regulated to between 100 and 130 psi. This 150-psi cut-out pressure will not normally be indicated on the emergency line test gauge and truck dash gauge which show only the air brake system reservoir pressure.

e. Tractor Protection Valve. Check the tractor protection valve for proper operation and installation as follows on vehicles designed to tow trailers:

(1) Deplete the air in the system either by opening the test kit petcocks or by slow repeated application of the foot valve.

(a) The tractor protection valve should vent the emergency line, causing the relay emergency valve to apply the trailer brakes when the line pressure is between 20 and 45 psi.

(b) A tractor protection valve that fails to vent the emergency line is a condition of improper maintenance and a violation of 26453 VC.

(2) After the tractor protection valve has operated, disconnect the emergency and service lines and apply the foot valve.

(a) Check for air leakage out of the service and emergency lines on the truck or tractor.

(b) A properly functioning tractor protection valve will retain sufficient air (20 psi or more) in the tractor to permit at least one service brake application (26304(b) VC).

(c) The escape of all service air may be caused by a defective tractor protection valve or lack of such a valve.

(3) The air supply line for the tractor protection valve or dash control valve is considered part of the brake system. The air supply must be drawn from the reservoir protected by the check valve required by 26507 VC to preclude accidental operation that may be caused by a failure of the compressor line.

(4) When the tractor protection valve is used as a manual and automatic means to apply the emergency stopping system on the trailer, the manual control must be identified and its emergency position or method of operation clearly marked. The automatic portion is required to operate when the pressure is reduced to not less than 20 psi nor more than 45 psi on a slow bleed down (26508(b)(1) VC).

NOTE: The low air warning device may begin operation during this test. If this occurs, note the presure at which operation begins.

f. Low Air Pressure Warning Device. Reduce the air pressure in the brake system to the activating pressure of the low air pressure warning device by venting the air through the emergency line test kit petcock, air tank drain cock, or by slow repeated application of the foot valve. Observe the pressure at which the device begins to operate.

(1) The warning may be either visible or audible.

(2) Operation at a pressure between 55 and 75 psi is required, and the device must continue to operate at all pressures below the pressure at which it begins operation (26506 VC).

(3) If the low air warning device fails to operate, repeat the test with the engine running. On some vehicles the device will not operate with the engine stopped.

g. Air Pressure Buildup Time. Place the tractor protection control valve in the normal position or open the air line cut-off cocks to the towed vehicle.

(1) Start the engine and operate between 600 and 900 rpm. Check the time required to build air pressure from 50 to 90 psi.

(2) Time required in excess of five minutes is generally an indication of improper maintenance and may be caused by loose or slipping belts, worn compressor rings, inadequate compressor size, or possibly an unusually large or extra reservoir. A violation of 26453 VC exists only when the slow buildup can be attributed to a defect in the compressor or compressor drive belts.

(3) This check is time-consuming and should only be done when previously observed slow buildup indicates the buildup time will be in excess of these minimum standards.

h. Air Reservoir Capacity. With the supply system at governor cut-out pressure, make and hold a full service brake application with the foot valve. Observe the pressure drop as shown by the air test kit gauge. (This check may be made in conjunction with the air buildup test in paragraph g.) On vehicles listed in 34500 VC and manufactured after January 1, 1967, a drop in pressure in excess of 30% is a violation of 13 CAC 1245(h).

i. Air Reservoir Contaminants. Open the reservoir drain cocks or automatic drain valves and check for contaminants. (This step may be conducted in conjunction with the check valve test in paragraph j.)

(1) Oil in the air hoses or brake chambers or one quart or more of contaminants in a reservoir are conditions of improper maintenance and a violation of 26453 VC.

(2) Vehicles listed in 34500 VC are required to have all air brake reservoirs, including axles or frame members used as air reservoirs, marked to show the manufacturer, the SAE number, the rated working

pressure, and the date of manufacture, in accordance with SAE Standard J10 (13 CAC 1245(h)(i)). Vehicles manufactured after January 1, 1975, to comply with FMVSS 121 requirements are not required to be marked.

(3) Check operation of automatic drain valve if installed. The type pictured in Figure 3-23 may be checked by making service brake applications. It may be manually checked by depressing the wire stem in the exhaust port on the bottom of the valve. A faulty valve allowing excessive water and oil to accumulate in the reservoir is a condition of improper maintenance and a violation of 26453 VC.

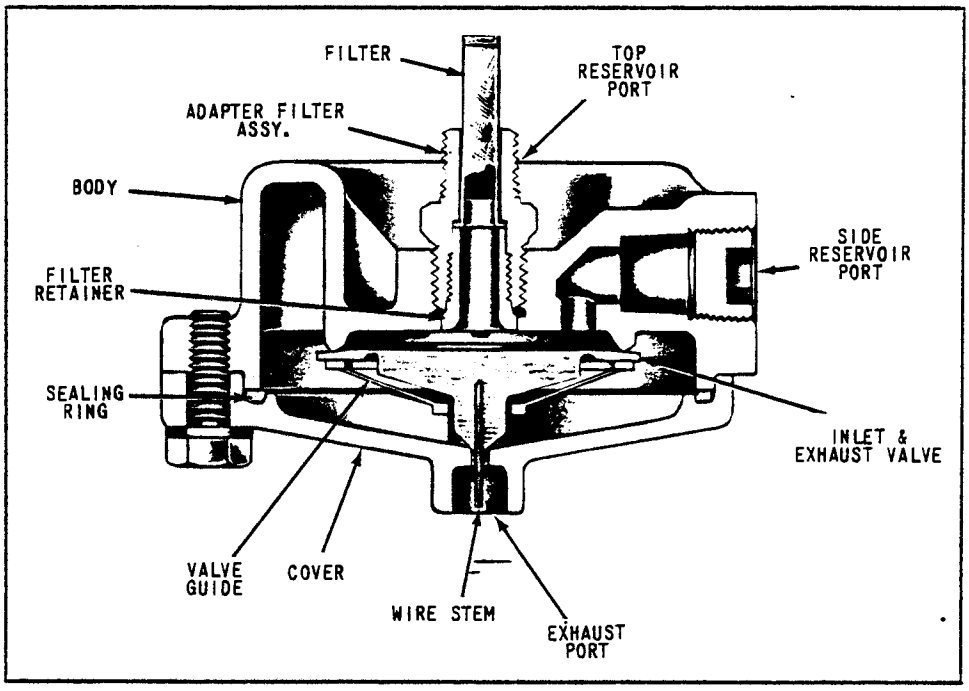


Fig. 3-23. Automatic Drain Valve

j. Check Valve. Check for proper installation and functioning of the check valve as follows:

(1) A check valve is required to be installed in one of the following two locations (26507 VC):

(a) Between the compressor and the supply (No. 1 or wet) reservoir adjacent to the inlet of the reservoir, or

(b) Between the supply reservoir and the service (No. 2 or dry) reservoir adjacent to the inlet of the service reservoir, provided the

air for the brakes is not drawn from the supply (No. 1) reservoir. (Some supply and service reservoirs are combined in a single divided tank with the check valve connected between the two sides.)

(2) If the check valve is installed at the inlet of the service (No. 2) reservoir, drain the supply (No. 1) reservoir. If the check valve is installed on the compressor side of the supply (No. 1) reservoir, check its function by venting the air from the compressor discharge line. Motor vehicles listed in 34500 VC are required to have a readily accessible means of testing the operation of the check valve, usually a petcock on the check valve itself. (13 CAC 1245(e))

NOTE: In this test a loss of air from the open compressor line, or a truck air gauge reading of "0", is not a reliable indication that no check valve is present or that it is defective. For instance, if the check valve is installed at the inlet of the No. 2 reservoir and the gauge is connected to the No. 1 reservoir, air will escape from the No. 1 reservoir and the gauge will read "0", even though the No. 2 reservoir is properly protected.

(3) When the air is completely discharged, make a foot brake application. If there is insufficient air in the system to apply the brakes, the brake system is incorrectly plumbed to the reservoir ahead of the check valve, the vehicle is not equipped with a check valve, the check valve is defective, or the air was exhausted during a preceding test (26507 VC).

(4) The check valve required by 26507 VC is required to be connected adjacent to the air inlet of the protected reservoir, either directly or with a necessary close nipple, reducer, elbow, or tee. In some installations, lack of space makes it necessary to use a short piece of tubing between the check valve and its protected reservoir.

k. Safety Valve. Check for installation of an air reservoir safety valve.

(1) The physical test of the safety valve is not to be conducted unless tools and proper test equipment are available.

(2) When bench test equipment is available and the valve is to be tested, remove valve from truck system and install on the test bench. Apply pressure to determine at what pressure the device pops off and reduce pressure to determine at what pressure the device reseats.

(3) The valve is required to be adjusted and maintained to open and discharge the air system under any condition at a pressure not to exceed

150 psi. It is required to close and reseat itself at a point above the maximum air governor setting (26503 VC).

NOTE: Safety valves are often difficult to locate and in some cases may be combined with a check valve.

(4) Two types of safety valves are illustrated in Figure 3-24.

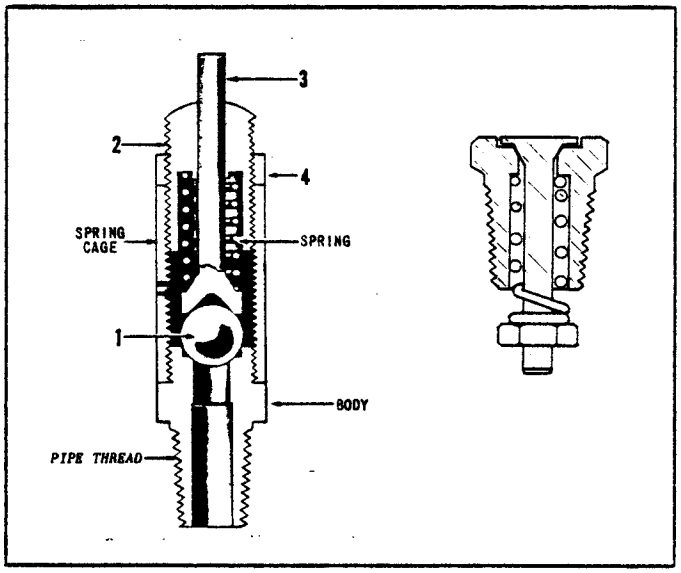


Fig. 3-24. Safety Valves

1. Air Gauge Accuracy Test. Compare the pressure reading of the test air gauge installed in the emergency line with the truck air gauge.

(1) The truck gauge is required to be accurate to within 10% of the actual air reservoir pressure, and visible and legible to the driver at all times (26505 VC).

(2) Gauges on 1975 and later model vehicles which comply with FMVSS 121 are required to be accurate within 7% of the governor cut-out pressure. If, for example, the cut-out is at 115 psi, the gauge may legally be $\pm$ 8 psi in error at any lower pressure, such as 20 psi. On these vehicles, 26505 VC applies only at cut-out pressure.

(3) The requirement for legibility and visibility requires the gauge to be located in the driver's compartment so a person seated in the driver's seat can read it. For night operation sufficient illumination, either internal or external, to permit reading the gauge is required.

m. Air Loss--Brakes Released. With the engine stopped and the air at governor cut-out pressure, check the air pressure drop with the brakes released after allowing time for the pressure to stabilize.

(1) Loss in air pressure exceeding the following rates is a violation of 26453 VC and 13 CAC 1245(f):

(a) Single vehicle - 2 psi/min.

(b) Two vehicle combination - 3 psi/min.

(c) Three or more vehicle combination - 5 psi/min.

(2) Air loss caused by a properly operating air pressure lubricating system is not considered a violation.

n. Air Loss--Brakes Applied. With the brakes fully applied, and after the air pressure has stabilized, check the pressure drop.

(1) Loss in air pressure exceeding the following rates is a violation of 26453 VC and 13 CAC 1245(f):

(a) Single vehicle - 3 psi/min.

(b) Two vehicle combination - 4 psi/min.

(c) Three or more vehicle combination - 6 psi/min.

(2) Air loss will be detected on vehicles equipped with Rockwell-Standard Super Fail-Safe Stopmaster spring brakes if the service brake application is made and held while the spring brakes are applied. This is not a condition of improper maintenance. There is no violation unless the air leak continues under a service brake application when the spring brake is released.

o. Air Loss--Trailer Brakes Applied. Instruct the driver to apply the hand valve before releasing the foot valve in the preceding test, and check the pressure drop.

(1) Loss in air pressure exceeding the following rates is a condition of improper maintenance and a violation of 26453 VC:

(a) Single towed vehicle - 2 psi/min.

(b) Two or more towed vehicles - 4 psi/min.

(2) Instruct the driver to release the hand valve.

p. Air Pressure at Brake Chambers. With all brakes fully applied, compare the pressure indicated on the air test kit gauge in the service line with the pressure indicated on the air test kit gauge installed in the emergency line.

(1) Air pressure in the service line and any brake chamber is required to be at least 90% of the pressure in the service air supply reservoir as indicated by the emergency line air test kit gauge.

(2) Insufficient delivery may be caused by the treadle stop, floor mat under treadle, improper linkage adjustment of remote mounted valves, improper installation of floor mounted valves, or failure of the driver to depress the brake pedal fully.

NOTE: Some intercity buses with tandem axles have an air suspension system that limits the weight carried by the nondrive axle and a valve that limits the maximum air pressure to 60 psi to the brake chambers on that axle. Some 1979 and later model truck tractors have a valve to improve brake balance that limits the air pressure at the front axle when towing a semitrailer and a second valve that limits the pressure to the rear axles when operated without a trailer.

q. Trailer Relay Emergency Valve. Check as follows for proper operation and installation of the relay emergency (or breakaway) valve on trailers manufactured before January 1, 1975:

(1) With the emergency and service lines disconnected, check to see that all the trailer brakes are applied.

(2) Failure of the brakes to apply and remain applied may be due to an air leak, lack of a relay emergency valve, a defective relay emergency valve, or absence of air in the trailer reservoir tank, and is a violation of 26453 VC or 26304 VC as appropriate.

(3) Bleed back of air can be detected by placing a finger over the emergency and service line gladhand openings. Air bleed back through either line caused by a defective relay emergency valve is a condition of improper maintenance and a violation of 26453 VC.

r. Trailer Emergency, Breakaway, and Parking Brakes. Check as follows for proper operation of the combined emergency, breakaway, and parking brakes on trailers manufactured after January 1, 1975, in compliance with FMVSS 121:

(1) With the service line to the trailer vented and 90 psi in the emergency line, check that the trailer brakes are released. Failure of the trailer brakes to release may be due to too strong a spring brake or insufficient air pressure relayed to the spring brake chambers and is a condition of improper maintenance and a violation of 26453 VC.

(2) With both the emergency and service lines disconnected, check that the nonsteering trailer brakes are applied. Failure of the brakes to apply may be due to caged spring brakes, a broken spring, or a defective relay valve in the spring brake air system and is a condition of improper maintenance and a violation of 26453 VC.

NOTE: FMVSS 121 permits the trailer portion of an auto transporter manufactured before January 1, 1980, a bulk agricultural commodity trailer not longer than 28 feet, a heavy hauler trailer, a pulpwood (logging) trailer, and a converter dolly to use a relay emergency valve (as checked in paragraph a.) in lieu of the spring brakes otherwise required.

s. Parking Brake Controls. Check that the parking brakes on a towed vehicle manufactured on and after January 1, 1975, and equipped with parking brakes required by FMVSS 121 can be applied and released by a control in the driver's cab of the towing vehicle.

(1) FMVSS 121 contains the following parking brake requirements for vehicles meeting that standard:

(a) Trucks, truck tractors, and buses shall have a parking brake control separate from the service brake control, operable by a person seated in the normal driving position, and identified to show the method of operation.

(b) The parking brake control shall operate the parking brakes of the motor vehicle and any airbraked vehicle it is designed to tow.

(c) The parking brake system shall be capable of being applied and of holding with any single leakage-type failure in any other brake system.

(d) The parking brakes may be applied by air but shall be held in the applied position solely by mechanical means.

(2) Failure of parking brakes on FMVSS 121 equipped vehicle to function as specified is a condition of improper maintenance and a violation of 26453 VC.

t. Emergency Stopping Systems--Pre-FMVSS 121. Check the operation of the emergency stopping system on motor vehicles manufactured before March 1, 1975, as follows:

(1) Determine that the driver is able to demonstrate the application and release of the emergency stopping system on each vehicle in the combination (26508(o) VC).

(2) Check in the motor vehicle cab that the control used to operate the emergency stopping system on the towed vehicle (usually the tractor protection valve control) is clearly marked to indicate its emergency position (26508(b)(2) VC).

(3) Check spring brake systems as follows:

(a) Drain the air from all the service brake reservoirs on the motor vehicle, but do not drain any reservoir that is used solely for releasing the spring brakes and is protected from the rest of the brake system by a check valve.

(b) Apply and release the emergency stopping system until all air is exhausted. The spring brakes shall be capable of being manually applied, released and reapplied at least once by a person seated in the driver's seat. They shall not be capable of any further release unless immediate reapplication can be made. (26508(f) VC)

(4) Check non-spring brake systems and more complicated spring brake systems in accordance with Chapter 4.

u. Emergency Stopping System—FMVSS 121. Check the operation of split emergency stopping systems on motor vehicles manufactured on and after March 1, 1979 in accordance with FMVSS 121 requirements as follows:

(1) With the air supply system above governor cut-in pressure, drain the service reservoir for one-half of the split system. (Do not deplete the air by repeated application of the foot pedal, as this will exhaust both reservoirs.)

(2) Fully apply and release the service brake foot pedal.

(3) Repeat preceding procedures (1) and (2) for the other half of the dual system.

(4) Failure of the brakes supplied by the nondrained half of the system to apply and release is a violation of 26508(f) VC.

v. Final Check of Air System. Before returning the vehicle to service, remove the air test kits, reconnect the trailer hoses, and install any plugs removed for test gauges. Check that the reservoir air pressure is built up to the proper level, the tractor protection valve is in the proper ("normal") position, drain cocks and safety valve test cocks are closed, and all brakes operate.

7. MECHANICAL COMPONENT INSPECTION.

a. Safety Precautions. Instruct the driver to release the parking brakes with the wheels still blocked and to apply or release the service brakes only as directed. This inspection may be made in conjunction with the air system inspection in paragraph 6.

b. Air Compressor. Check the air compressor for loose or worn belts, loose mounting, oil leaks, and general mechanical condition. Check the type of material used on compressor discharge line. The discharge line should be of material capable of withstanding high heat.

(1) On motor vehicles listed in 34500 VC the first 24 inches of the air discharge line extending from the discharge port of a reciprocating air compressor shall be capable of withstanding a temperature of 450°F. When a flexible hose is used, it is additionally required to have an outer layer of wire metal braid (13 CAC 1245(j)). Vehicles built to and complying with FMVSS 121 are exempt from this requirement.

(2) Flexible hose which will not withstand 450°F may be used in the discharge line farther than 24 inches from the compressor.

(3) Hoses that are worn through the metal braid, hoses or tubing that are kinked, or hoses or fittings that leak are conditions of improper maintenance and a violation of 26453 VC.

c. Wheel Brake Assembly. Wheel brake assembly parts are illustrated in Figures 3-25 and 3-26.

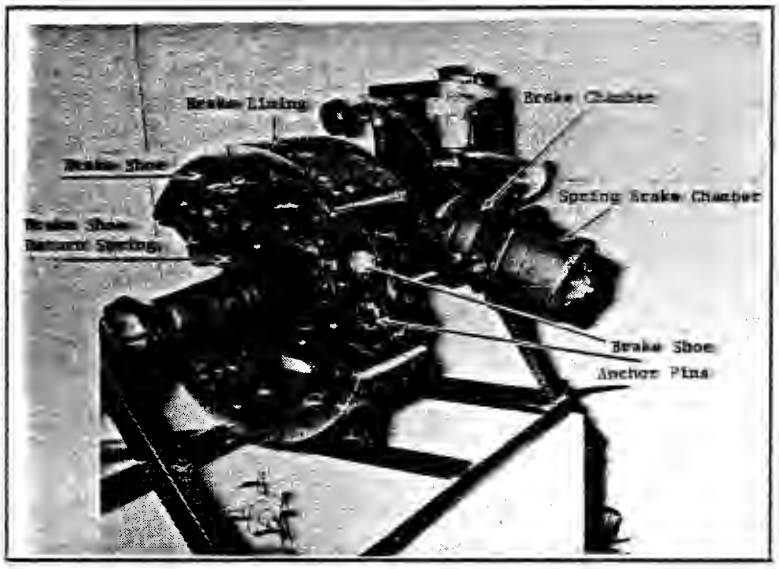


Fig. 3-25. Wheel Brake Assembly Parts

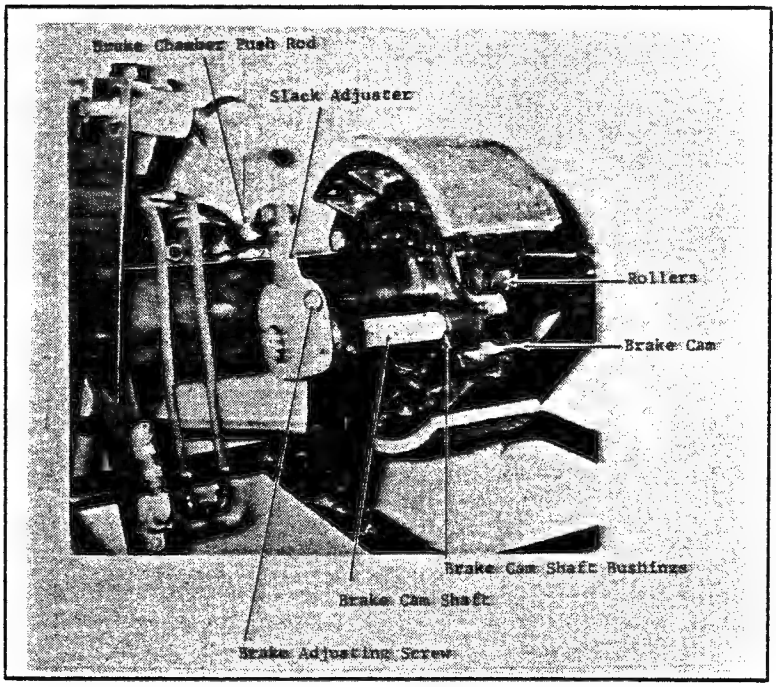


Fig. 3-26. Wheel Brake Adjustment Parts

d. Brake Chambers. Check condition and mounting of air brake and spring brake chambers.

(1) Air brake and spring brake chambers with loose or missing mounting bolts, broken housings or mounting brackets, or spring brakes mechanically backed off, are conditions of improper maintenance and a violation of 26453 VC.

(2) Mark the brake chamber push rods at the face of the brake chamber. The mark will be used later to measure brake chamber push rod travel.

e. Camshafts and Bushings. With all brakes released, check the brake camshaft and camshaft bushings for excessive wear. Camshaft bushings that are missing or are worn so the brake shoes drag when unapplied, slack adjusters that have been backed off because of excessive wear, and broken cams or camshafts are conditions of improper maintenance and a violation of 26453 VC.

f. Anchor Pins and Brake Shoes. Check brake shoe anchor pins and bushings, brake shoes, brake shoe rollers, and return springs for excessive wear. The following conditions are conditions of improper maintenance and a violation of 26453 VC.

(1) Brake shoe anchor pins worn so as to permit the brake shoes to drag when brakes are released.

(2) Brake shoe rollers that are flattened so as to interfere with brake operation.

(3) Absence of or excessively weak brake shoe return springs.

(4) Broken or cracked brake shoes.

g. Brake Lining. Check the condition of the brake lining. The lining is improperly maintained and a violation of 26453 VC when it is:

(1) Worn to within 1/64-inch of the bolts, rivets, or other fastening means that secure the lining to the shoe.

(2) Worn so bolts, rivets, or other fastening means contact the drum.

(3) Worn to such an extent that the brake cam is on end or the cam has turned over.

(4) Broken, has a section missing, or only partially contacts the drum when the brakes are applied.

(5) Contaminated with lubricant.

h. Brake Drums. Check brake drums for cracks that open when the brakes are applied.

(1) Brake drums which are broken or cracked through the outside of the drum surface, or cracked brake drums which have been repaired by banding or any other method after the drums have been cracked, are conditions of improper maintenance and a violation of 26453 VC.

(2) Heat checks are not cracks, and banding a drum that is not cracked is not a violation.

i. Air Hoses and Brake Lines. Check the condition of air brake hoses and air brake lines as defined in the Glossary of Brake Terminology (Annex A).

(1) Air hoses and lines cut or worn through any steel or fabric braid, or which have become hardened or swollen, are conditions of improper maintenance and a violation of 26453 VC.

(2) Air hoses or lines worn through all fabric layers, or cracked or broken at a connection or other place so that a possibility of a failure of the line or hose exists, is a hazard and must be repaired or replaced at the place of inspection.

(3) Where flexing is necessary, air brake hoses must be sufficiently long and flexible to accommodate all normal motion without damage.

(4) Splices in air brake hoses are permitted only when a union specifically manufactured for that purpose is used and is properly installed. Splices made with any other device or connection, such as tubing or pipe inserted into the hose or push-on type splices are not permitted and are violations of 26453 VC.

(5) Splices in nonflexing air brake lines other than hoses may be of any type that is mechanically sound, structurally adequate, and airtight.

(6) Any hose installed in or connected to draw air from the air brake system must meet the standards specified for hoses in 13 CAC 1245.

(7) Reusable and permanent type fittings permitted for use on air brake hoses are illustrated in Figure 3-27.

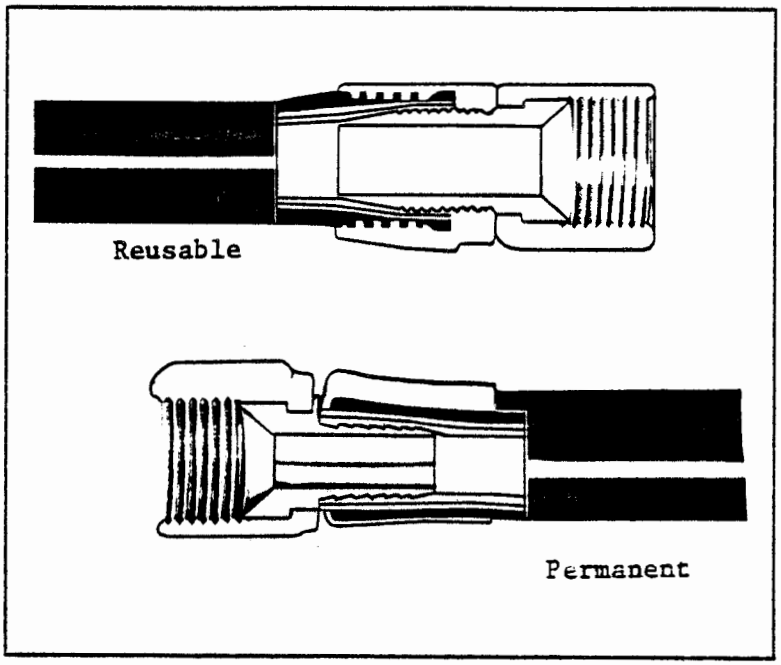


Fig. 3-27. Air Brake Hose Fittings

j. Brake Operation. Instruct the driver to apply and release the foot valve slowly on command. Observe movement of brake chamber push rod, brake shoe, or brake pad at each wheel.

(1) Lack of movement can be caused by a plugged air line, a brake cam rolled over, hand control valve in the applied position, tractor protection control valve in the emergency position, or closed cut-off cocks to the trailer.

(2) Movement of brake shoes in wedge type brakes can be detected by inserting a stiff thin probe, such as a brake adjustment gauge, into the inspection hole and between the brake shoe and drum. Lack of movement of the instrument indicates that the brake is inoperative.

(3) When all other controls are in the normal position and cut-off cocks to trailers are open, failure of a brake to apply and release when the hand or foot valve is operated is a condition of improper maintenance and a violation of 26453 VC.

8. BRAKE ADJUSTMENT.

a. Critical Item. Brake adjustment is one of the most critical items of inspection since it is impossible for the brake lining to touch the drums if the maximum push rod travel does not cause brake application. The efficiency of the brake chamber decreases appreciably as maximum stroke is approached and too long a stroke can result in the brake chamber bottoming out when the drums expand under extensive heat.

b. Cam Brakes. With the brakes applied by a *80-90 psi* pressure application, measure from the face of the brake chamber to a mark made on the brake chamber push rod when the brakes were released.

(1) Brake chamber push rod travel *equal to* the limits shown in the column headed "Maximum Stroke at Which Brakes Should be Readjusted" shown in Figure 3-28 is a condition of improper maintenance and a violation of 26453 VC.

Type	Effective Area (Sq. In.)	* Outside Diameter	Maximum Stroke	Maximum Stroke With Brakes Adjusted	Maximum Stroke at Which Brakes Should Be Readjusted
BOLT TYPE BRAKE CHAMBER DATA (Dimensions in inches)					
A	12	6 15/16	1 3/4	Should be	1 3/8
B	24	9 3/16	2 1/4	as short as	1 3/4
C	16	8 1/16	2 1/4	possible	1 3/4
D	6	5 1/4	1 5/8	without	1 1/4
E	9	6 3/16	1 3/4	brakes	1 3/8
F	36	11	3	dragging	2 1/4
G	30	9 7/8	2 1/4		2
ROTOCHAMBER DATA					
9	9	4 9/32	2	Should be	1 1/2
12	12	4 13/16	2	as short as	1 1/2
16	16	5 13/32	2 1/2	possible	1 7/8
20	20	5 15/16	2 1/2	without	1 7/8
24	24	6 13/32	2 1/2	brakes	1 7/8
30	30	7 1/16	3	dragging	2 1/4
36	36	7 5/8	3 1/2		2 5/8
50	50	8 7/8	4		3
CLAMP TYPE BRAKE CHAMBER DATA (Dimensions in inches)					
6	6	4 1/2	1 5/8	Should be	1 1/4
9	9	5 1/4	1 3/4	as short as	1 3/8
12	12	5 11/16	1 3/4	possible	1 3/8
16	16	6 3/8	2 1/4	without	1 3/4
20	20	6 23/32	2 1/4	brakes	1 3/4
24	24	7 7/32	2 1/4	dragging	1 3/4
30	30	8 3/32	2 1/2		2
36	36	9	3		2 1/4

*Dimensions listed do not include capscrew head projections for rotochambers and bolt clamp projections for clamp type brake chambers.

Fig. 3-28. Brake Chamber and Rotochamber Specifications

(2) Sintered metallic brake linings such as "Velvetouch" are sometimes adjusted with more initial push rod stroke than other types of linings. However, the push rod travel must not exceed the maximum readjustment stroke specified in the appropriate brake adjustment charts.

(3) Bendix-Westinghouse DD2 and DD3 brake actuators have a maximum stroke of 3 inches. Push rod travel exceeding 2-1/4 inches is a condition of improper maintenance and a violation of 26453 VC.

(4) Some models of urban transit buses are originally equipped with clamp type 30 brake chambers, 14.5 x 10-inch brake drums, and 7-inch automatic slack adjusters. The automatic adjusters on these vehicles can have a push rod travel up to 2-1/4 inches. Travel beyond 2-1/4 inches is a condition of improper maintenance and a violation of 26453 VC.

c. Wedge Brakes. With the inspection hole cover removed from the brake dust shield, check the adjustment at each wheel using the gauge illustrated in Figure 3-29.

(1) Insert the flat end of the gauge into the inspection hole in the dust shield, or, if there is no dust shield, midway between the ends of the shoe. Place one edge of the gauge against dust shield inspection hole or the brake drum lip with the square end against the brake lining or shoe.

(2) With the brakes released, make a scribe mark on the brake lining or shoe opposite one of the scribe lines on the gauge as illustrated in Figure 3-29.

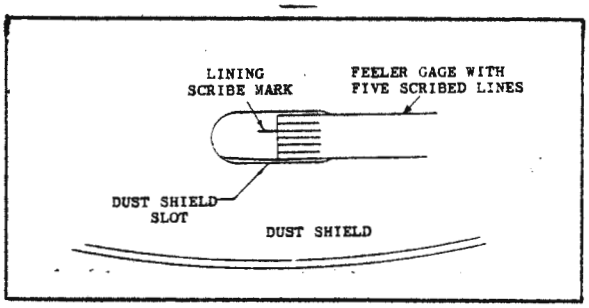


Fig. 3-29. Measurement Gauge and Lining Scribe Mark

(3) Movement of the scribe mark on the lining of more than 1/16 inch with respect to the marks on the gauge when the brakes are applied, as illustrated in Figure 3-30, is a condition of improper maintenance and a violation of 26453 VC.

(4) Failure of the brake shoes to move is a condition of improper maintenance and a violation of 26453 VC and may be due to rusting of the brakes.

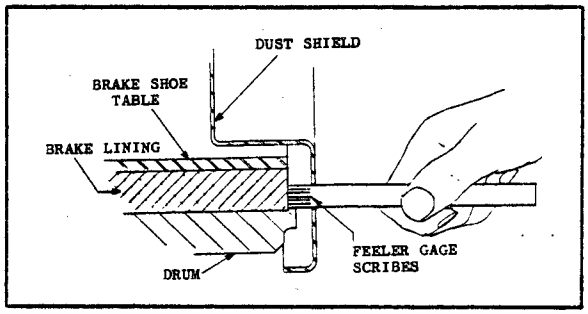


Fig. 3-30. Measurement of Wedge Brake Adjustment

NOTE: The gauge may be made of feeler gauge stock 0.025-inch x 3/8-inch x 8-inch. Scribe five 1/2-inch lines spaced 1/16-inch apart.

d. Disc Brakes. After the brakes have been applied by a full pressure application, measure the push rod travel from the released position as described for cam brakes in paragraph 8b.

(1) Except as noted in the following paragraphs, disc brake chamber push rod travel exceeding the maximum stroke at which brakes should be readjusted as shown in Figure 3-28 is a condition of improper maintenance and a violation of 26453 VC.

(2) For B. F. Goodrich disc brakes with manual or automatic slack adjusters, push rod travel exceeding the maximum stroke at which brakes should be readjusted, as shown in Figure 3-31, is a condition of improper maintenance and a violation of 26453 VC.

Brake Chamber Type Used With Disc Brakes	Maximum Stroke at Which Brakes Should be Readjusted, inches
12	1-5/8
16	1-7/8
20	2
24	2-1/8
30	2-1/4

Fig. 3-31. Push Rod Travel for Manual Slack Adjusters Used With Disc Brakes

e. Slack Adjuster, Push Rod, and Brake Chamber Relationships. Check slack adjuster, push rod, and brake chamber for proper angular and dimensional relationships.

(1) In order to maximize the braking effort at long push rod travel, the inner angle between the push rod and the axis of the slack adjuster arm should be 90° at the maximum stroke at which brakes should be re-adjusted, as shown in Figure 3-32. An angle of less than 80° or more than 105° when the brakes are fully applied is a condition of improper maintenance and a violation of 26453 VC.

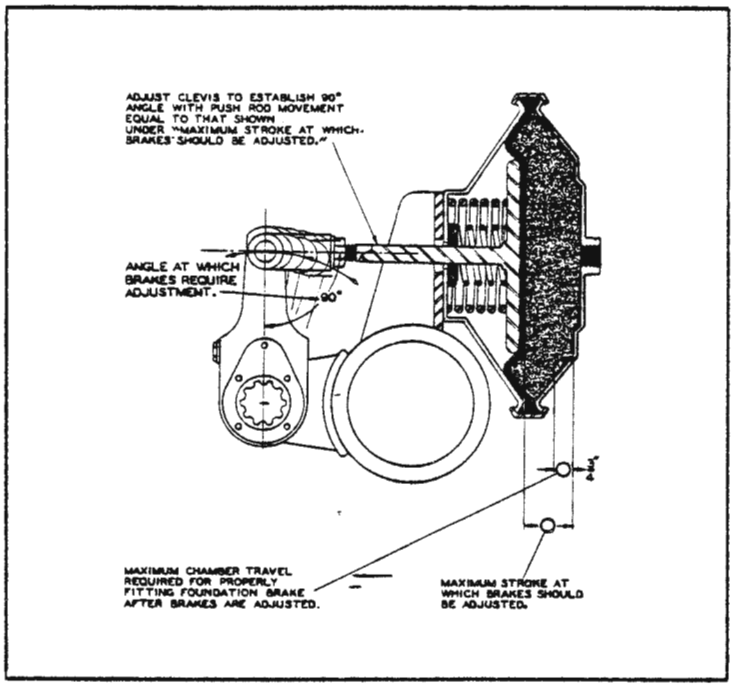


Fig. 3-32. Adjustment of Angle Between Push Rod and Slack Adjuster Arm

(2) Figure 3-33 illustrates the need for keeping push rod travel adjusted to as short a stroke as practical without the brakes dragging. For a clamp type 30 chamber, the braking effort at the 2-1/2-inch maximum possible stroke before the push plate bottoms out is only 60 to 70% as great as at a 1-inch stroke.

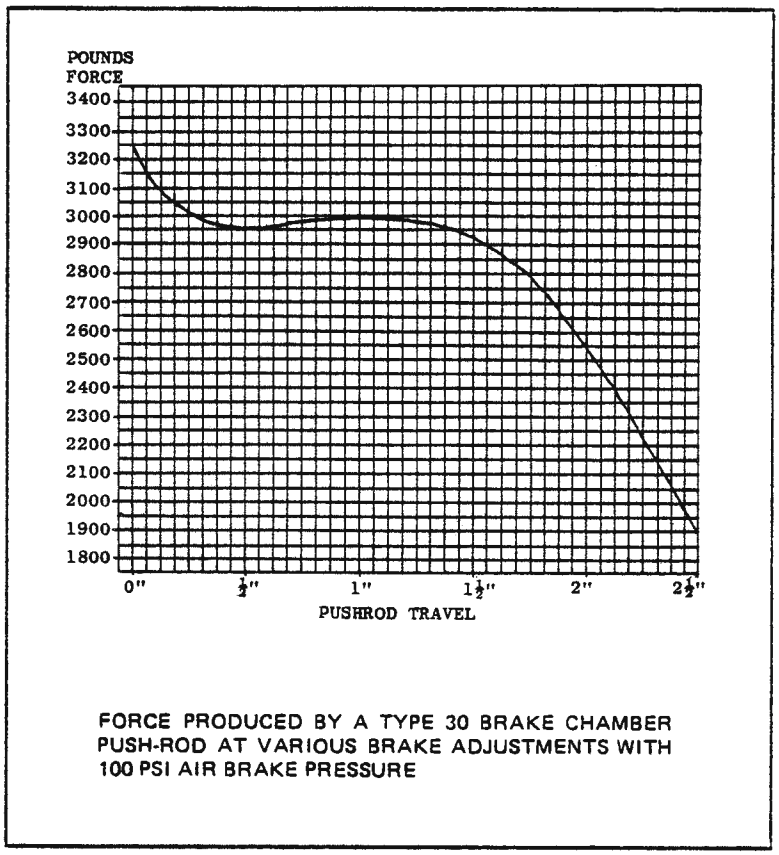


Fig. 3-33. Actuator Force vs. Push Rod Travel

f. Parking Brakes. Check parking brakes for proper functioning and adjustment as described in Chapter 8. In addition, the performance of parking brakes on vehicles built to FMVSS 121 requirements (trucks, tractors and buses manufactured on and after March 1, 1975, and trailers manufactured on and after January 1, 1975) are in compliance if they meet the following requirements:

(1) Vehicles shall be equipped with parking brakes on all axles, except steerable front axles on motor vehicles and trailers.

NOTE: FMVSS 121 does not require mechanical parking brakes on the trailer portion of an auto transporter manufactured before January 1, 1980, a bulk agricultural trailer not longer than 28 feet, a heavy hauler trailer, a pulpwood (logging) trailer, and a converter dolly. Such trailers may instead have the relay emergency valve type breakaway brakes described in Section 6.

(2) After application, the parking brakes shall be mechanically held in the applied position upon exhaustion of all air from the entire brake system.

(3) The parking brakes on each vehicle shall hold the vehicle stationary uphill or downhill on a 20% grade, empty or loaded.

(4) Parking and emergency brakes on individual axles shall, in addition to holding on a 20% grade, perform as follows:

(a) Trucks, buses, trailers, and two-axle tractors shall have parking and emergency brakes on each rear axle that exert a braking force equal to at least 0.28 times the gross weight of the axle. The holding ability can be checked by placing 20-inch ramps that have a rise of 5-1/2 inches in front of each wheel of the rear axles (single or tandem) and driving the wheels up the ramps in either a forward or rearward direction.

(b) Tractors with three or more axles shall have parking and emergency brakes on each rear axle that exert a braking force equal to at least 0.14 times the gross weight rating of the axle. The holding ability can be checked by placing 20-inch ramps that have a rise of 2-3/4 inches in front of each rear wheel and driving the wheels up the ramps in either a forward or rearward direction.

(5) Failure of the parking and emergency brakes to hold the vehicle (or combination of FMVSS 121 vehicles) stationary on a 20% grade or to hold the wheels stationary on the specified ramps is a condition of improper maintenance and a violation of 26453 VC.

CHAPTER 4

EMERGENCY STOPPING SYSTEMS

4.1 SCOPE. This Chapter applies only to those vehicles which use compressed air for applying the service brakes at the wheels. Exceptions in the requirements are listed in subsections (m) and (n) of Vehicle Code Section 26508.

4.2 INTRODUCTION. The inspection procedures and information contained in this Chapter are intended to establish a uniform procedure for the inspection of emergency stopping systems to determine compliance with the Vehicle Code and clarify the requirements of Section 26508.

4.3 GENERAL.

4.3.1 Types of Emergency Stopping Systems.

a. There are three basic types of emergency stopping systems in present use. They are listed below.

(1) Spring Applied Systems.

(a) Commonly known as spring brakes.

(b) Used primarily on motor vehicles.

(2) Air Applied Systems.

(a) No bleed back relay emergency valve.

1 Used primarily on trailers.

2 May be encountered on some pre-1964 motor vehicles.

(b) Axle-by-Axle protected air brakes.

1 Will have a separate air tank for each axle except vehicles manufactured prior to 1964 may or may not be so equipped. (Section 26508(c), (j) VC).

2 Is used only on motor vehicles.

(c) Dual treadle valve systems (a form of axle-by-axle protected air brakes).

1 Sometimes referred to as split systems or dual circuit systems.

2 Primarily used on late model Fords, Chevrolets, and some school buses.

3 Is used only on motor vehicles.

(3) Mechanical Systems.

(a) Usually consists of a conventional lever operated parking brake.

(b) May be connected to a drive shaft or wheel brake assembly.

b. The most common type of emergency stopping system in present use on motor vehicles is the spring brake system.

c. The most common type of emergency stopping system in present use on towed vehicles is the no bleed back relay emergency valve system.

d. The mechanical system normally installed on the drive shaft or connected to the rear axle brakes on motor vehicles will meet the design and operational requirements of Section 26508 VC for motor vehicles operated singly but will not meet the stopping distance requirements of subsection (k) of Section 26508 VC under most conditions.

e. Occasionally special systems, which are in most cases variations of a spring applied or air applied system, will be encountered. The difference usually is in the method of manual or automatic application of the system. However, some motor vehicles which were manufactured

prior to 1964 are equipped with relay emergency valves with separate air tanks for each axle and some have axle-by-axle protected air brakes with a separate air tank for each of at least two axles. When these systems are encountered, care must be exercised to determine if the system is properly installed and if it meets the requirements of the Vehicle Code.

4.3.2 Depth of Inspections.

a. Each inspection must be in sufficient detail to determine as a minimum the following:

(1) If the controls are marked as required on motor vehicles used to tow other vehicles.

(2) If the system functions as required.

(3) If the system is properly installed and maintained.

(4) If the driver is knowledgeable in its operation.

b. Inspections should not proceed into a diagnostic process for the purpose of maintenance inspections.

4.3.3 Adequacy of Emergency Stopping Systems. The only positive method of determining the adequacy of an emergency stopping system is by performance tests under actual operating conditions or by dynamometer testing. Therefore, if there is any question as to whether a particular system will meet the stopping distance requirements of Section 26508(k) VC, it may be necessary to conduct an actual stopping test to make the proper determination.

4.3.4 Performance Requirements. Performance requirements for emergency stopping systems are contained in Vehicle Code Section 26508(k). References are included herein where appropriate for clarification of requirements or understanding of inspection procedures.

4.3.5 Service Brake Inspection.

a. An inspection of the service brake system should be conducted prior to, or along with, the inspection of the emergency stopping system dependent on the type of emergency stopping system installed on the vehicle and the purpose of the inspection.

b. A complete inspection of the service brake system is not necessary to determine if the emergency stopping system meets the requirements of the Vehicle Code. However, if the inspection is to serve as a basis for the issuance of a commercial vehicle inspection sticker, a complete inspection of the service brake system is required and the inspection of the emergency stopping system should be conducted along with that inspection.

4.4 SYSTEM DESCRIPTIONS. The emergency stopping systems depicted in the following illustrations are representative of those in current use. A brief explanation of how the systems function has been included below each illustration.

4.4.1 Spring Applied Emergency Stopping Systems on a Motor Vehicle. Figure 4-1 shows a spring applied emergency stopping system on a two-axle motor vehicle with spring brake actuators on the rear axle.

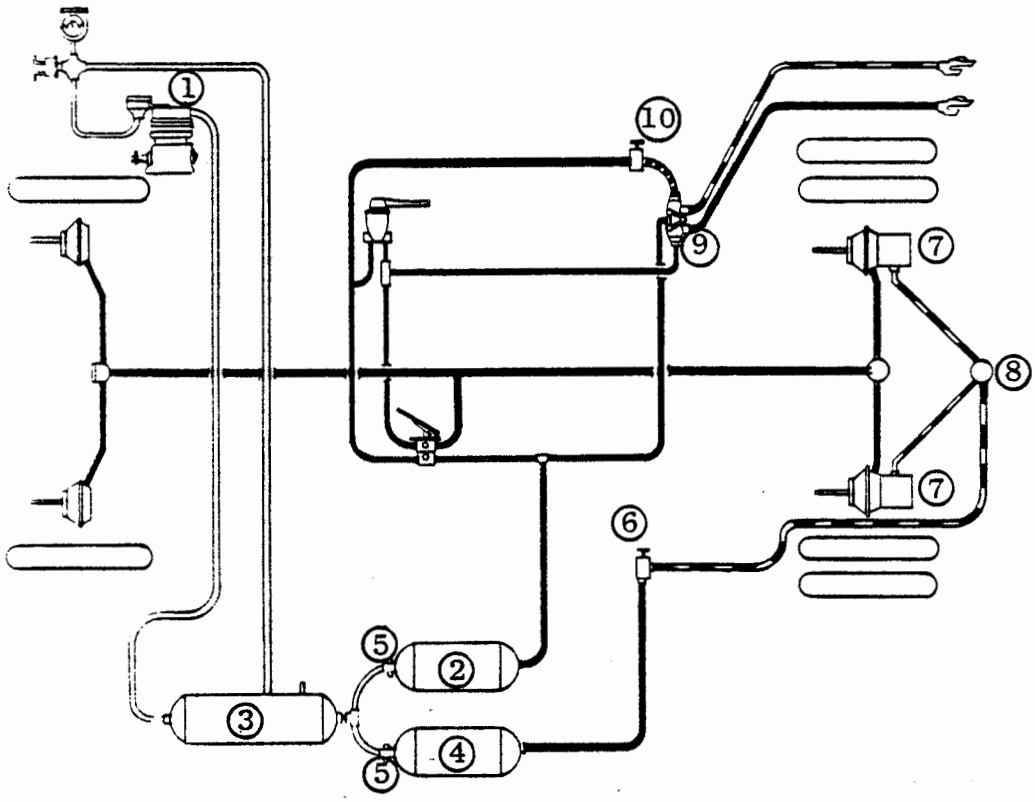


Fig. 4-1. Spring Applied Emergency Stopping System

a. Description. The emergency system consists of the spring brake actuators, a spring brake dash control valve, a protected air reservoir tank, a check valve for the protected air tank, and the attendant piping.

b. Operation. The protected reservoir draws its air from between the wet and dry reservoirs and is protected against backflow through the service brake system by a check valve at the inlet of the reservoir. Air pressure from the protected reservoir feeds through the dash control valve and holds the springs in the brake actuators compressed. Application and release of the spring brakes are controlled by the dash control valve. This system will not operate automatically if the air in the service brake system is exhausted.

4.4.2 Air Applied Emergency Stopping System with DD3 Brake Actuators. Figure 4-2 shows an air applied emergency stopping system on a two-axle motor vehicle using DD3 type brake actuators on the rear axle.

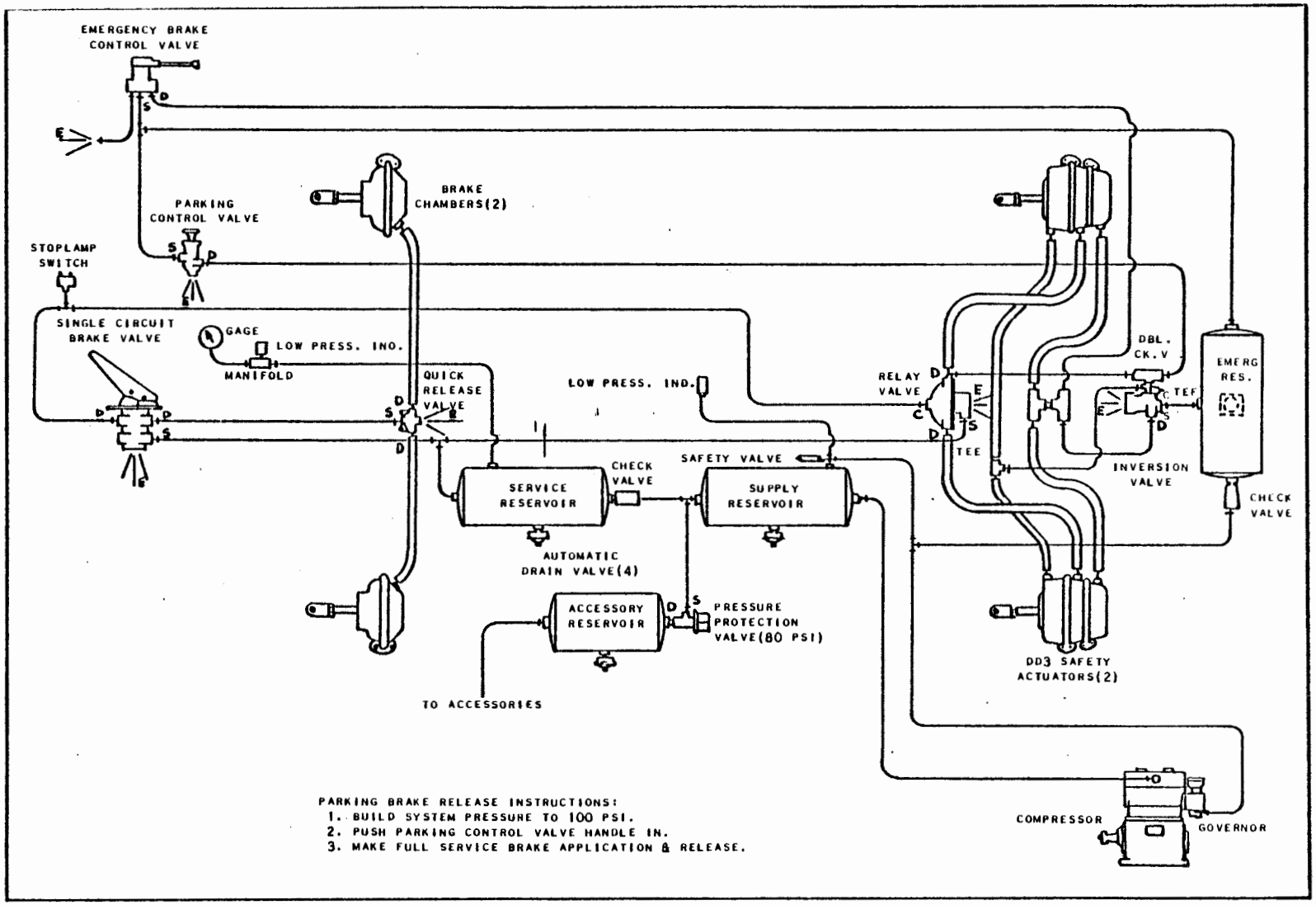


Fig. 4-2. DD3 Air Applied System

a. Description. The air port nearest the slack adjustors on the DD3 actuators feed air to an internal mechanical locking device to hold it in the released position during normal operation. The center port functions with service brake operation, and the rear port functions in conjunction with the front port to meet the emergency stopping system and parking brake requirements. This system was designed for motor vehicles operated singly and, without modification, will not meet the requirements for motor vehicles used to tow other vehicles.

b. Operation. Operation of the DD3 actuator is explained in paragraph 4.5.3.

4.4.3 Air Applied Emergency Stopping System with DD2 Brake Actuators. Figure 4-3 shows an air applied emergency stopping system on a three-axle motor vehicle with DD2 brake actuators on the rear axle.

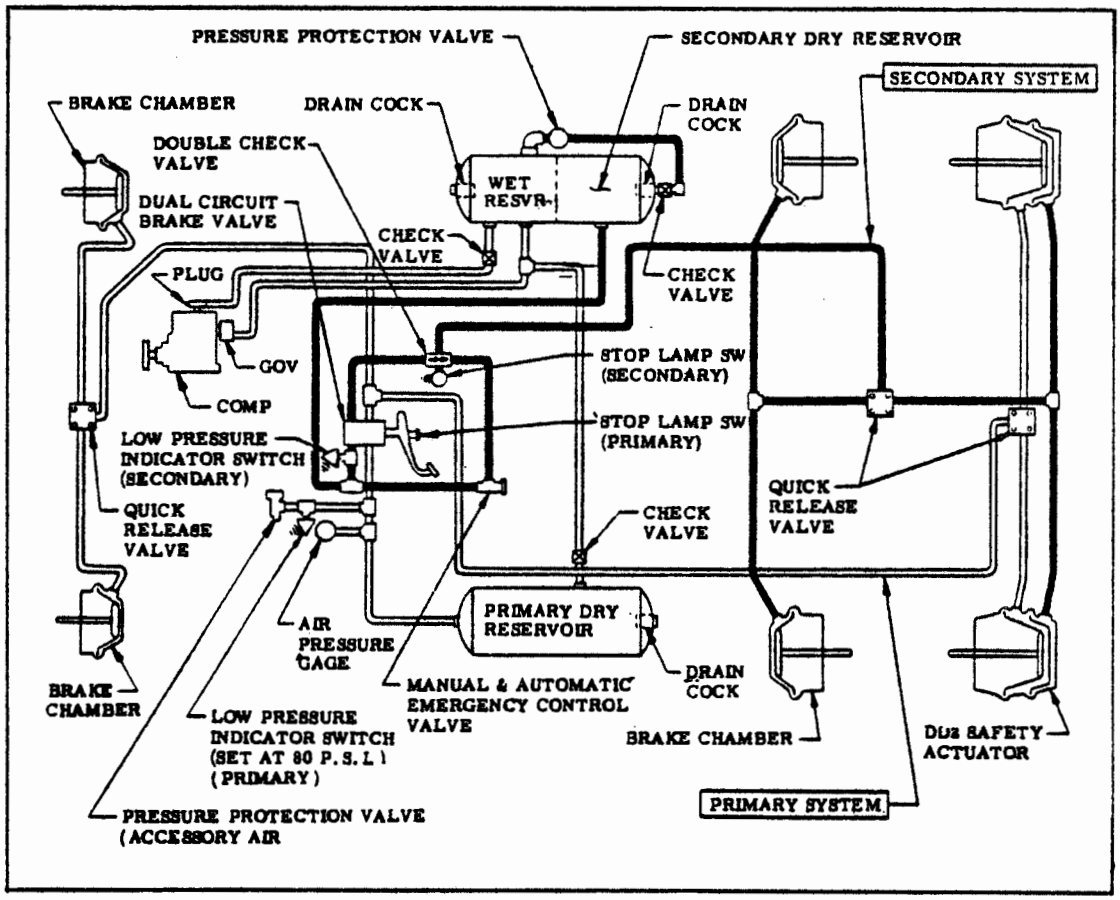


Fig. 4-3. DD2 Air Applied System

a. Description. The above illustration shows a dual circuit service and emergency braking system. The system is designed so that failure in either system will not leave the vehicle without brakes on at least one axle. This is accomplished through the use of a dual treadle valve and double diaphragm (DD2) brake actuators with a protected air supply. The system may be installed to be manually or automatically applied. In this particular design, the system is installed to serve as a service and emergency braking system and may be manually or automatically applied. It will not meet the parking brake requirements.

b. Operation. Both circuits of this system operate with each application of the treadle valve. In addition, the DD2 actuators are installed to operate with the dash or manual control valve application. Operation of the DD2 actuator is explained in Section 4.5.4 of this publication.

4.4.4 Dual Circuit System with Spring and Air Applied Brake Actuators. Figure 4-4 shows a dual circuit service and emergency braking system with spring and air applied brake actuators on a two-axle motor vehicle. The dotted lines indicate additional equipment for motor vehicles which are used to tow other vehicles.

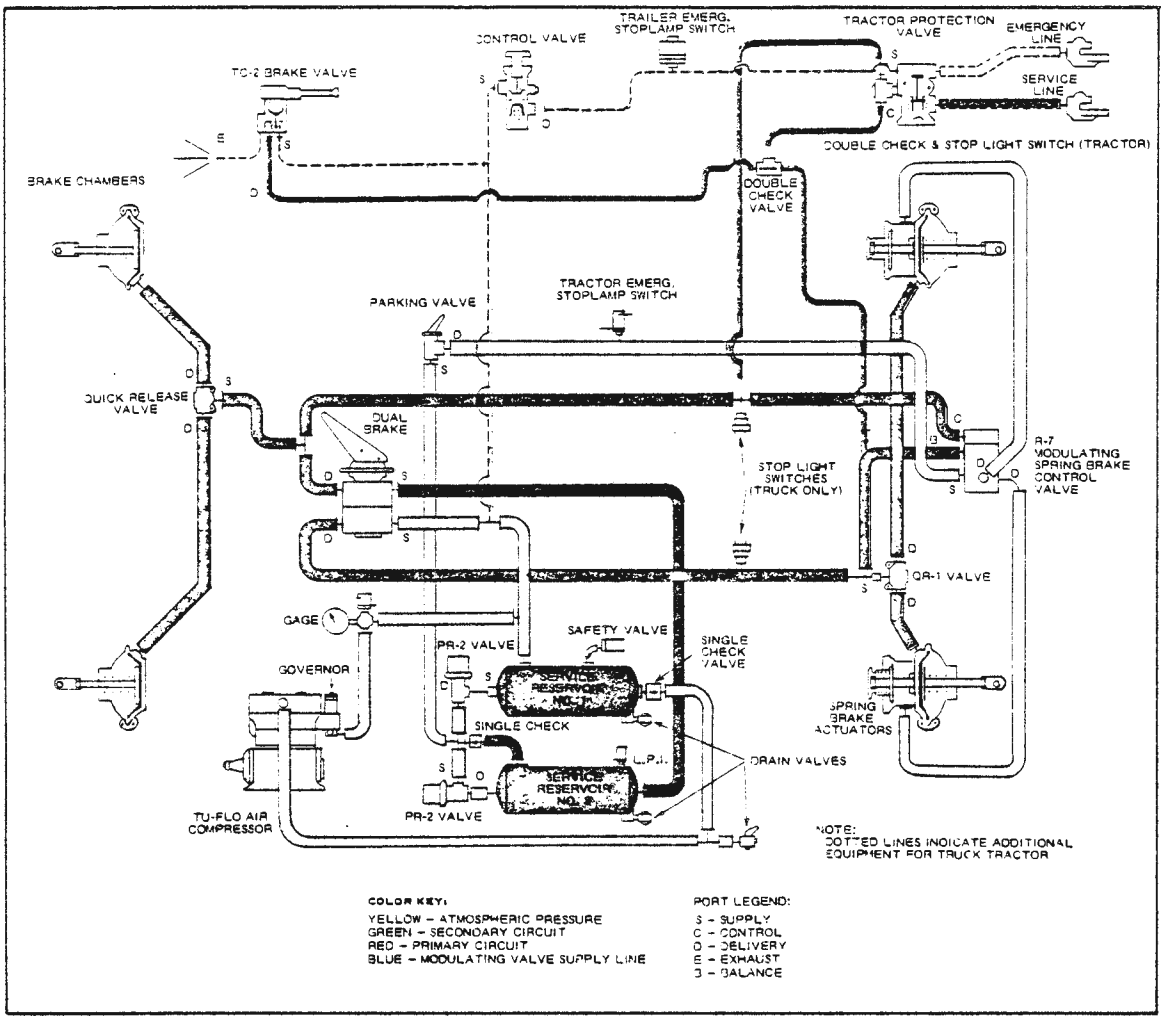


Fig. 4-4. Dual Circuit Spring and Air Applied System

a. Description.

(1) Service Brakes. The service brakes in this system are split across the dual treadle valve to supply the rear axle from the primary circuit and the front axle from the secondary circuit. The trailer service brakes are supplied by both circuits via a double check valve.

(2) Emergency Brakes. The emergency brakes are considered to be the remaining intact circuit of the dual circuit system. Both reservoirs are protected by pressure protection valves (PR2) so that a single failure anywhere will not exhaust both reservoir tanks.

(a) If the secondary brake air supply is lost, only the front axle brakes are lost; the tractor rear and trailer service brakes are applied as the emergency brakes.

(b) If the primary brake air supply pressure is lost, the front axle and trailer brakes can be applied, but the rear axle service brakes cannot be applied; however, rear axle braking is accomplished by the function of the R-7 modulating valve which exhausts the spring hold-off cavity pressure, thereby allowing the spring brake actuators to apply.

(3) Parking Brakes.

(a) A full parking application can be made by moving the parking valve control handle to the "park" position which exhausts the R-7 modulating valve supply and the spring hold-off cavities of the spring brake actuators.

(b) If a service application is made when the spring brake actuators are in the applied position (spring hold-off cavities vented), the double check valve in the R-7 modulating valve allows recharging the spring hold-off cavities, thereby preventing compounding of push rod forces.

(c) The compressor discharge is piped to the No. 1 reservoir and protected by a single check valve. The No. 2 reservoir is supplied by the No. 1 reservoir. A complete loss of air in either No. 1 or No. 2 reservoir is prevented by the PR2 pressure protection valves which are set to close automatically at a predetermined pressure level.

(d) The parking control valve is supplied from a point between the No. 1 and No. 2 reservoirs to minimize automatic application of the spring brake actuators. If loss of air in No. 1 reservoir occurs, the parking brake control valve is supplied from No. 2 reservoir through the single check valve (both PR2 valves close upon loss of air in either reservoir); if loss of air in No. 2 reservoir occurs, the governor allows the compressor to resupply No. 1 reservoir to the PR2 pressure protection valve opening pressure. Therefore, the PR2 valve protecting No. 1 reservoir provides a supply for the parking brake control valve. The delivery of the parking brake control valve is piped to the supply port of the R-7 modulating valve. Thus, with the parking brake control valve in the "release" position, the spring brake actuators are released. As stated before, the purpose of this piping arrangement is to minimize automatic application of the spring brake actuators.

(e) The primary circuit of the dual brake valve is supplied by No. 1 reservoir, and the secondary circuit is supplied by No. 2 reservoir. The primary circuit actuates the rear axle service brakes and supplies the balance port of the R-7 modulating valve. The secondary circuit actuates front axle brake chambers and supplies the control port of the R-7 modulating valve. Either primary or secondary circuits will actuate the stoplight switch.

b. Operation.

(1) During normal operation, the spring brake actuators are held in the released position by air pressure supplied to the parking brake control valve and the R-7 modulating valve. The parking brake control valve is supplied from either or both service reservoirs; the two sources of supply air minimize automatic applications.

(2) To park the vehicle, the parking control valve is placed in the "park" position, which exhausts the air from the spring brake actuators.

(3) During normal service braking, air from the two circuits of the dual brake valve is delivered to the R-7 modulating valve and there will be no effect upon the spring brake actuators. Braking will be through the normal action of air pressure on the diaphragms of the front, rear, and trailer axle brake chambers.

(4) Should the primary circuit of the dual brake valve fail, there would be no air pressure to actuate the service brakes on the rear axle; however, the air pressure delivered by the secondary circuit of the dual brake valve to the R-7 modulating valve would cause the R-7 modulating valve to exhaust air from the spring brake actuators and provide rear axle braking as well

as normal service braking to the front axle and the trailer.

(5) Should the secondary circuit of the dual brake valve fail, the primary circuit will provide normal service brakes to the rear axle and trailer. The spring brake actuators and front axle brake chambers will not be actuated.

(6) Regardless of which circuit of the dual brake valve might fail or malfunction for any reason, a signal will be sent back to the trailer because both circuits of the dual brake valve supply the trailer service line through double check valves.

(7) The parking control valve and the tractor protection control valve serves as a secondary emergency brake control and can be actuated in the event of treadle failure.

4.4.5 Relay Emergency System for Trailers. Figure 4-5 shows a typical relay emergency valve type emergency stopping system for trailers and semitrailers.

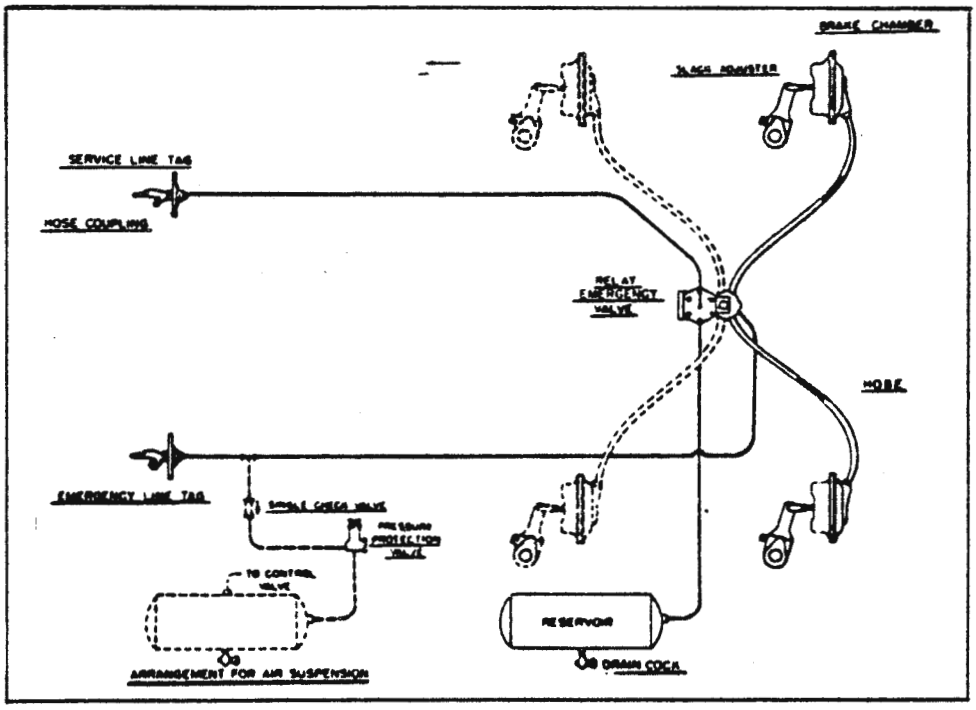


Fig. 4-5. Relay Emergency Valve System for Trailers

a. Description. The relay emergency (RE) valve combines the functions of a relay valve and an emergency valve. It automatically applies the trailer brakes when the emergency line to the trailer is broken, disconnected, or otherwise vented to atmosphere and the trailer air brake system is charged. It is used on trailers which require an emergency brake application upon breakaway from the truck or tractor. Some RE valves are mounted directly on the trailer reservoir while others are mounted away from, but connected to, the trailer reservoir by tubing. Both valves operate in a similar manner.

b. Operation. The relay emergency valve serves several important operating functions in the air brake system.

(1) When a tractor is connected to a trailer and the service and emergency lines are opened, the relay emergency valve permits charging the trailer air brake reservoir to approximately the same air pressure that is present in the tractor reservoirs.

(2) During normal operation of a tractor-trailer unit, the relay emergency valve serves as a relay valve and synchronizes trailer service brake air pressure and tractor service brake air pressure as the service foot brake valve on the tractor is operated. The trailer brakes can also be applied independently of the tractor brakes on some combinations by use of the hand control brake valve on the tractor and the relay emergency valve on the trailer.

(3) If a trailer is disconnected from a tractor for loading or unloading, or if the trailer is separated from the tractor under emergency breakaway conditions, or if its emergency line is vented to atmosphere by other means, the relay emergency valve applies the trailer brakes automatically at existing trailer reservoir pressure. If a trailer is to remain

parked under these conditions, the wheels should be blocked to avoid the possibility of a runaway.

(4) If it is desired to release the emergency brake application on the trailer under these conditions, the trailer reservoir drain cock can be opened, or the trailer air brake system can be recharged through the trailer emergency line.

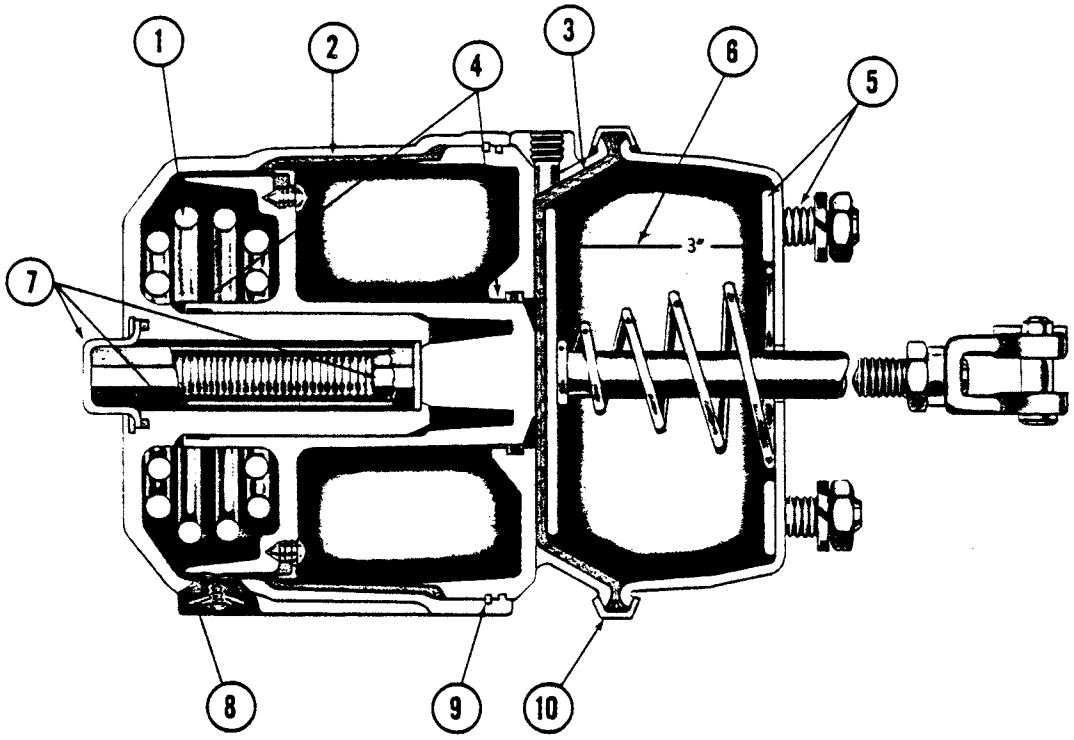
4.5 COMPONENT PARTS.

4.5.1 Illustrations.

a. The parts depicted in the following illustrations are used primarily in emergency stopping systems.

b. Parts which serve a dual function in the service and emergency brake systems are illustrated in Chapter 3 of this publication

4.5.2 Spring Brake Actuator. Figure 4-6 shows a spring and service brake actuator combined.



1. Emergency Spring
2. Emergency Diaphragm
3. Service Diaphragm
4. Bearing Seals
5. Mounting Studs
6. Stroke
7. Mechanical Release
8. Exhaust Check
9. Lock Wire
10. Clamp Ring

Fig. 4-6. Spring and Service Brake Actuator

a. Description. This brake actuator will meet the requirement for service, emergency, and parking brakes when properly installed. It consists of a spring applied emergency and/or parking brake and an air applied service brake.

b. Operation. Under normal operating conditions, the emergency spring is held in a compressed condition by air pressure applied against the emergency diaphragm. When the air is exhausted

from the emergency sections of the actuator, the spring will automatically apply the brake. The actuator may be installed to be manually and/or automatically applied under emergency conditions or as a parking brake.

4.5.3 DD3 Brake Actuator. Figure 4-7 shows a DD3 brake actuator.

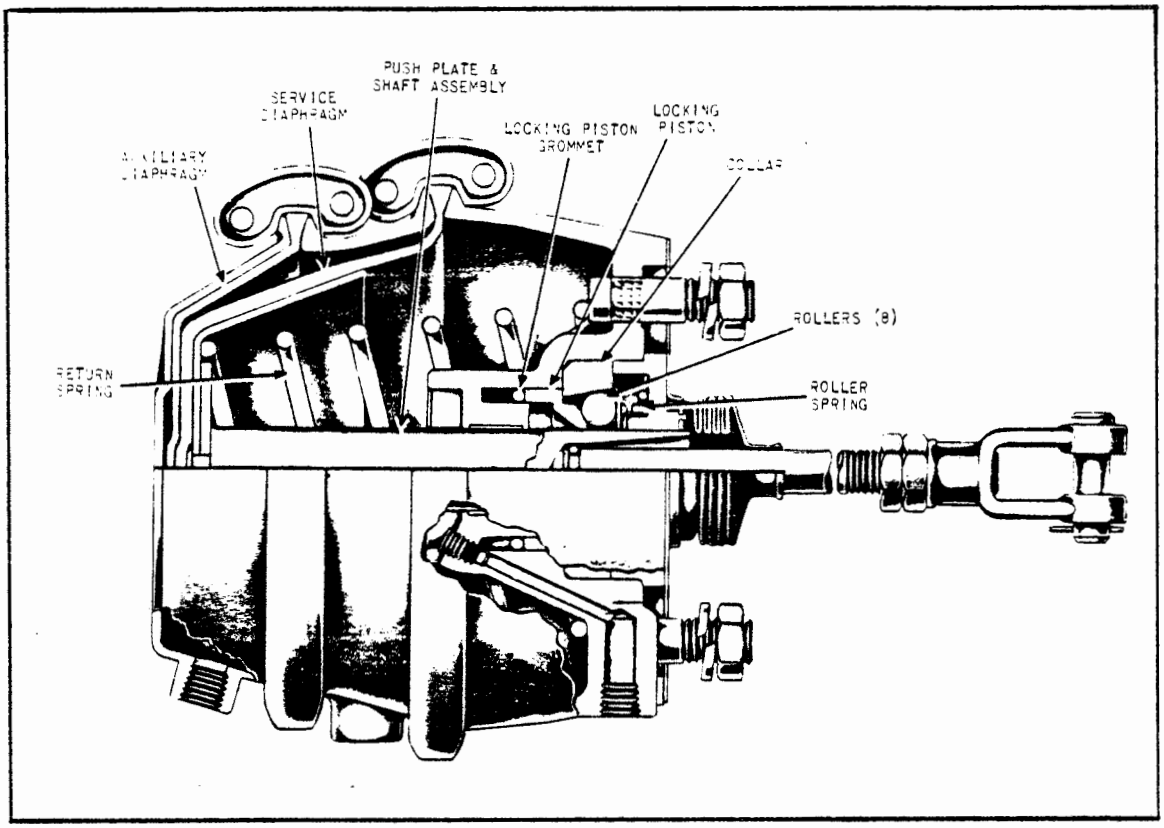


Fig. 4-7. DD3 Brake Actuator

a. Description. The prefix DD describes the double diaphragm and the suffix 3 denotes the triple action for service, parking, and emergency braking. The actuator functions normally as a service brake chamber but in addition has a means of mechanically locking a brake application so it can be used for parking. With

various system arrangements, the actuator may be installed to be automatically or manually applied under emergency braking conditions.

b. Operation. Through the operation of a control valve, air enters the actuator locking port and exerts pressure on the locking piston grommet. The resultant force moves the locking piston forward against the rollers and roller spring. The beveled or ramp end of the piston will pick up and hold the rollers away from the shaft.

c. Normal Running. As long as air pressure remains against the locking piston and the rollers are not in contact with the shaft, normal service brake applications will permit the shaft to move freely, back and forth, past the locking mechanism. When a normal service brake application is made, air enters the actuator service port and pushes against the service diaphragm. The diaphragm moves the push plate and shaft out, applying the brakes. Upon release of the service application, the brakes are released.

d. Parking. To park, air is exhausted from the locking port and air is applied against the auxiliary diaphragm through the auxiliary diaphragm port. When air is exhausted from the lock piston, the roller spring forces the rollers against the collar and shaft. Air entering the parking port exerts force on the auxiliary diaphragm. The diaphragm moves the push plate and shaft out, applying the brakes. With no air on the lock piston, if the shaft partially retracts, it becomes mechanically locked in the applied position when the rollers wedge between the shaft and collar.

NOTE: While in a parked position, when there is a loss of air pressure on the auxiliary diaphragm, the output force on the shaft is reduced. However, the shaft will not retract since its output force is transferred to the mechanical lock mechanism.

e. Release of Parking Application.

(1) To release a parking application of the DD3 actuator, it is necessary to reapply air pressure to equal a shaft force approximately the same as was used in making the parking application. This is necessary to release the locking rollers so they can be moved away from the shaft when air is reapplied to the locking piston. This can be accomplished by making a heavy service application after the control valve is operated to release the parking application.

NOTE: A heavy service application should never be made on a DD3 actuator when the control valve is in the "applied" or "park" position as this will compound the force on the shaft locking it in the farthest extended position. When locked in this position, it is almost impossible to get the movement necessary to release the locking rollers.

(2) To release a parking application, air enters the locking piston and the air on the auxiliary diaphragm is exhausted. A heavy service brake application will be necessary to force the shaft forward sufficiently to allow the locking rollers to disengage and unlock the shaft. Upon release of the service application, the return spring will return the shaft to the release position, releasing the parking application.

f. Emergency Operation. Through different system arrangements, the DD3 actuator, in conjunction with other automatic or manual air applied valves, will operate for emergency situations in the same sequence as described under "Parking".

4.5.4 DD2 Brake Actuator. Figure 4-8 shows a DD2 brake actuator.

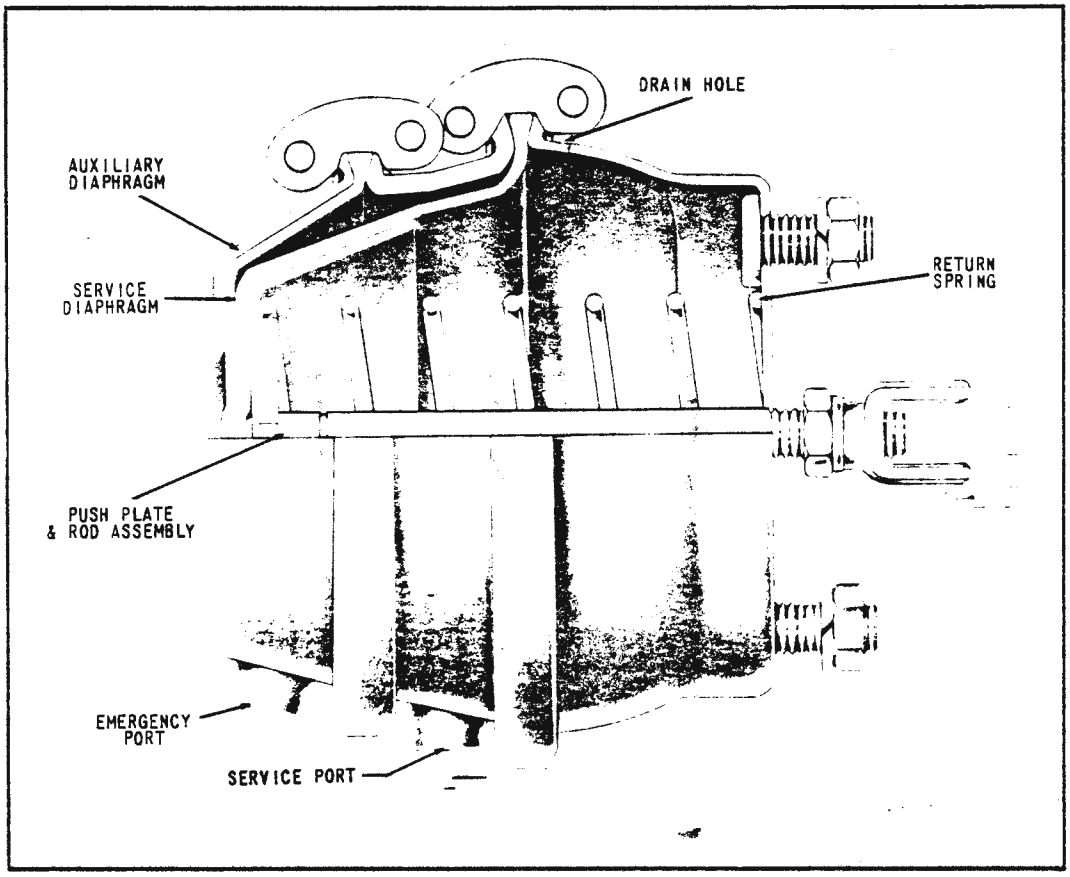


Fig. 4-8. DD2 Brake Actuator

a. Description. The DD2 actuator is a double diaphragm actuator that functions normally as a service brake chamber, but in addition has an auxiliary diaphragm which is used for emergency braking. The actuator may be installed to be automatically or manually applied in various systems. Two (2) connecting lines are used for the actuator installations to the service and emergency ports.

b. Normal Service Operation Application. On a normal service brake application, air enters through the service port on the pressure side of the actuator, forcing the diaphragm to move the push rod assembly forward. The push rod is connected to a slack adjuster which is attached to the cam shaft that rotates the brake cam and applies the brake shoes against the brake drums.

c. Emergency Application. Through different system arrangements, the DD2 actuator in conjunction with other automatic or manual applied air valves, will operate in emergency braking situations. During an emergency brake application, air enters the emergency diaphragm port on the pressure side of the actuator, forcing the emergency diaphragm and the service diaphragm forward to apply the vehicle brakes.

d. Releasing. When air pressure is released from the actuator, the push rod return spring in combination with the brake shoe return spring returns the diaphragms, push rod, slack adjuster, and brake cam to their release positions, releasing the brakes.

4.6 PRELIMINARY INSPECTION-PROCEDURES.

4.6.1 Safety Precautions. Block the wheels, leave engine running, release all brakes, and instruct driver to release or apply brakes only as directed by brake inspector.

4.6.2 Valve Position. On motor vehicles towing trailers, the tractor protection control valve should be in the normal position, the hand control valve should be off, and the cutoff cocks, if the vehicle is so equipped, should be open.

a. If the dash control valve for the tractor protection valve is in the emergency position, or the cutoff cocks are off, no air is delivered to the towed vehicle and the towed vehicle brakes will not operate.

b. If the hand valve is applied, the towed vehicle brakes will be applied and movement of the brake chamber push rods cannot be detected when the foot valve is applied.

4.7 INSPECTION PROCEDURE. This inspection procedure consists of two parts. The first part is a basic inspection which applies regardless of the type of emergency stopping system installed on the vehicle. The second part is dependent upon the particular type of system to be inspected.

4.7.1 Basic Inspection.

a. Determine the type of emergency stopping system installed on the vehicle and whether the vehicle is used to tow other vehicles.

b. Determine that the driver is familiar with the requirements of Section 26508 VC and that he is able to demonstrate the application and release of the emergency stopping system on each vehicle whether operated singly or in a combination of vehicles (Section 26508(o) VC).

c. With air brake supply system at governor cutout and the engine off, instruct the driver to apply, release, and reapply the emergency stopping system of the motor vehicle.

(1) Observe the movement of the slack adjusters to determine if the system is functioning properly.

(2) Observe whether the driver is able to apply and release the system from the driver's seat (Section 26508(b)(2), (f) VC).

d. Determine that motor vehicles used to tow other vehicles which use compressed air for applying the service brakes at the wheels are equipped with a manual and automatic means of applying the emergency stopping system on the towed vehicle(s), that the emergency position or

method of operation of the manual device is clearly indicated, and that both devices function properly (Section 26508(b)(1) and (2), (f) VC).

(1) Regardless of the position of the manual control device, the automatic device must operate automatically when the service brake air supply of the towing vehicle is reduced to a level of not lower than 20 pounds per square inch nor higher than 45 pounds per square inch (Section 26508 (b)(1) VC).

(a) The requirement is usually met by equipping the vehicle with a tractor protection valve.

(b) The emergency stopping system on motor vehicles is not required to apply automatically but may be so designed.

(2) The requirement for manual operation is usually met by installing a dash control valve to permit manual operation of the tractor protection valve.

(a) Toggle valves used for this purpose have the emergency position indicated with the word "emergency". The other position on the valve is usually labeled "normal" or "charged".

(b) Push-pull type valves used for this purpose have such markings as "pull to apply" and "push to release".

(c) No specific wording is required on valves used for this purpose but the emergency position or method of operation must be clearly indicated (Section 26508(b)(2) VC).

(3) The manual device must be operable by a person seated in the driver's seat.

(4) Vehicles which are not used to tow other vehicles are not required to be equipped with devices described in this paragraph.

e. Determine whether the trailer brakes apply automatically when the service air is reduced to between 20 and 45 pounds per square inch when inspecting combinations of vehicles (Section 26508(b)(1) VC).

f. Visually examine the system during the inspection process to determine if it is in good repair (Section 26453 VC).

g. Observe the movement of the push rods, slack adjustors, and cam shafts during application and release and determine if the brakes operate properly (Section 26453 VC).

(1) The application and release should be free of any binding or jerking movement.

(2) The shoes should set firmly against the drum when in the applied position.

(3) The shoes should not be in contact with the drum when in the released position.

h. Determine that the emergency stopping systems on towed vehicles meet the following requirements:

(1) The air supply reservoir is protected against backflow through the supply line (Section 26508(d)(1) VC).

(2) The system applies automatically upon breakaway from the towing vehicle (Section 26508(d)(2) VC).

(3) The brakes remain applied for 15 minutes after breakaway (Section 26508(d)(2) VC).

4.7.2 Spring Applied Systems on Motor Vehicles.

a. Drain all air reservoirs used in the service brake system on the motor vehicle. This may

be done by opening the pet-cock on the air tank or the air test kit when the kit is used. The treadle valve should not normally be used for this purpose.

b. Instruct the driver to apply and release the spring brakes (Section 26508(o) VC).

(1) If the vehicle is equipped with an air starter, instruct the driver to start the engine before applying the brakes.

(2) The brakes must be capable of being applied and released by a person seated in the driver's seat, and

(3) The brakes must be capable of being released without any air remaining in the service brake system (Section 26508(f) VC).

(a) Failure of the brakes to operate properly may be caused by any of the following conditions:

1 No protected air reservoir.

2 A defective check valve on the protected air reservoir.

3 Improper operation of the cab controls.

4 Improper plumbing.

(b) There is no requirement for the spring to be completely compressed when the brakes are released.

c. Instruct the driver to continue to apply and release the emergency system until the air pressure in the protected reservoir is too low to further apply the brakes.

(1) The brakes must remain in the applied position (Section 26508(f) VC).

(2) The brakes on motor vehicles which meet the requirements of Section 26508(c) VC (air applied systems) are not required to remain in the applied position provided:

(a) All other requirements of Section 26508 VC are met, and

(b) There is available a means which can be applied from the driver's seat to stop and hold the vehicle or combinations of vehicles. A legal parking brake will usually meet this requirement.

d. Ensure that all valves are returned to their proper position, that all air lines are reconnected properly, that all test equipment is removed, and that the driver builds up the air pressure in the brake system before departing.

4.7.3 Axle-by-Axle Protected Air Brakes on Motor Vehicles.

a. Check the system to determine that a separate air tank is provided for each axle (Section 26508(j) VC).

(1) Motor vehicles manufactured prior to 1964 are not required to have a separate air tank for each axle if a separate reservoir is provided for each of at least two axles and the system meets all other requirements of Section 26508 VC (Section 26508 (c) VC).

(2) Motor vehicles manufactured after 1963, which are equipped with a dual treadle valve system, need have no more than two protected air tanks in such system, one for each section of the dual treadle valve (Section 26508(j) VC).

b. Open the drain cock(s) on the air reservoir(s) which supplies air to the service brake control valve. Do not drain the protected air reservoir(s).

(1) Do not use the treadle valve to deplete the air in the service brake system.

(2) On most of these systems, the treadle valve will exhaust the air from the service and emergency reservoirs simultaneously and cause the emergency system to apply automatically.

c. Instruct the driver to apply and release the emergency stopping system (the brakes on at least one axle must apply). Determine that this can be done by a person seated in the driver's seat (Section 26508(f) VC).

d. Have the driver continue to apply and release the emergency system until the air in the protected reservoir is too low to permit further operation of the system.

(1) Check to see that the brakes are applied.

(2) The emergency system shall not be capable of being released after a reapplication when the air pressure in the protected reservoir is reduced to a point where the emergency system could not be reapplied to stop and hold the vehicle unless the motor vehicle is manufactured prior to January 1, 1964, and the vehicle is equipped with a means to stop and hold the vehicle (Section 26508(c)(f) VC).

e. Close the drain cock on the service air reservoir(s) and have the driver build the air pressure up to governor cut-out.

f. With the engine stopped, drain the air from the protected reservoir(s).

(1) Now instruct the driver to apply the service brakes.

(2) There must be sufficient air remaining in the service system to stop the vehicle within the limits specified in subsection (k) of Section 26508 VC. (See Section 26508(c) VC for exception for motor vehicles manufactured prior to 1964.) (Section 26508(e) VC)

g. Close the drain cock on the protected air reservoir, remove all test equipment, and instruct the driver to build up the air pressure to governor cut-out before departing.

4.7.4 Dual Circuit Systems on Motor Vehicles.

a. Determine the particular type of system installed on the vehicle, how it should function, how it is plumbed, and which air reservoir tank(s) is used for the emergency stopping system.

b. Most dual circuit systems use a dual treadle valve, two air reservoir tanks, and are usually plumbed as described in (1) or (2) below.

(1) Each air tank is piped to a separate stage of the treadle valve; one tank is used to supply the service brake system and the other tank is used to supply the emergency stopping system. The emergency air reservoir is protected against backflow by a check valve and is plumbed to the lower stage of the treadle valve and to a dash control valve. Full application of the treadle valve or operation of the dash control valve will activate the emergency stopping system. An illustration of a system of this type is provided in Fig. 4-3, except in the illustration a dual compartment air tank is used as a wet tank for the service brake system and a protected tank for the emergency stopping system. This system is used primarily on Chevrolet trucks.

(2) Each air tank is piped to a separate stage of the dual treadle valve and the secondary circuit is also piped to a dash control valve. Air to operate the service brakes (primary circuit) is drawn from both air tanks simultaneously under normal operating conditions. Both air tanks are protected against backflow by check valves and both are equipped with a pressure protection valve to prevent either tank from

exhausting through the other as a result of a failure in the system. This system is used primarily on Ford trucks and is illustrated in Fig. 4-4.

c. If the system is plumbed as described in paragraph b(1) above, drain the air reservoir used to supply the service brakes and proceed as prescribed in paragraphs e, f, g, and h.

d. If the system is plumbed as described in paragraph b(2), drain the air reservoir used to supply the primary circuit and proceed with the check as prescribed in paragraphs f and g.

(1) Follow the procedure specified in paragraphs g and h to complete the inspection.

(2) The primary circuit is considered to be the service brake system and the secondary circuit is considered to be the emergency stopping system for inspection purposes.

(3) Do not deplete the reservoir air pressure by repeated application of the treadle valve as this will exhaust both reservoir tanks simultaneously.

e. Instruct the driver to apply the emergency system.

(1) The emergency system must operate without any air remaining in the service system (Section 26508(f) VC).

(2) The treadle valve may not be used to apply the emergency system (Section 26508(e) VC).

(3) The emergency system must be operable by a person seated in the driver's seat.

f. Instruct the driver to continue to apply and release the emergency system until the air pressure in the protected reservoir is too low to further apply the brakes. The brakes must remain in the applied position (Section 26508(f) VC).

g. Close the drain on the service air reservoir and instruct the driver to build the air up to governor cut-out. Then stop the engine and drain the air from the reservoir for the emergency system.

(1) Instruct the driver to apply the service brakes.

(2) There must be sufficient air remaining in the service system to stop the vehicle within the limits specified in subsection (k) of Section 26508 VC. (See Section 26508(c) VC for exception for motor vehicles manufactured prior to 1964.) (Section 26508(e) VC)

h. Close the drain cock on the protected reservoir, remove all test equipment, and instruct the driver to build up the air.

4.7.5 Mechanical Systems.

a. Instruct the driver to apply and release the brake.

(1) The mechanical brake must be operable without assistance from the service brake system (Section 26508(f) VC).

(2) It must be applied and released by a person seated in the driver's seat (Section 26508(f) VC).

(3) It must be adequate to enable the vehicle or combination of vehicles to meet the requirements of subsection (k) of Section 26508 VC.

b. If the vehicle is used to tow other vehicles which use compressed air for applying the service brakes at the wheels, it must also be equipped with a manual or automatic means of applying the emergency stopping system on the towed vehicle, usually a tractor protection valve with a dash control.

c. The emergency system shall not be capable of being released after any reapplication when the handbrake is air assisted from a protected reservoir, and the air pressure is reduced to the point where the emergency system cannot be reapplied to stop and hold the vehicle (Section 26508(f) VC).

4.7.6 Relay Emergency Valve Air Applied System on Trailers.

a. Reduce the air in the service brake system on the motor vehicle until the trailer brakes apply automatically.

(1) Trailer brakes must apply automatically when the air pressure in the service brake system on the motor vehicle is reduced to a pressure not lower than 20 pounds nor higher than 45 pounds per square inch (Section 26508(b)(1) VC).

(2) A tractor protection valve that fails to vent the emergency line will prevent automatic application of the trailer brakes.

b. Disconnect both air lines between the vehicles at the gladhands, and check the air reservoir on the trailer for protection against backflow by placing a thumb over the ends of the open air lines on the trailer (Section 26508(d)(1) and (2) VC).

(1) The brakes must apply automatically upon breakaway, and

(2) They must remain applied for at least 15 minutes (Section 26508(d)(2) VC).

c. A simple check of the RE valve can be made by disconnecting the trailer supply line (hot line) at the gladhands.

(1) The trailer brakes should apply automatically.

(2) There should be no backflow of air from the trailer through the open line.

d. Observe the position of the slack adjusters and brake shoes to ensure that the brakes are fully applied.

e. There is no specific requirement that the emergency stopping system on towed vehicles can be capable of being released after being applied. However, subsection (h) of Section 26508 VC does prohibit any system that creates a hazard on the highway.

   (1) Relay emergency valve systems can be released by draining the air tank on the trailer. The wheels of the trailer should be blocked before the tank is drained to avoid a runaway vehicle.

   (2) Some spring brake actuators are designed with an internal manual release feature which makes it possible to manually release the brakes after the air pressure is exhausted from the device.

f. Under most conditions it is expected that the inspection of emergency stopping systems on towed vehicles will be conducted in conjunction with an inspection of the service brake system and an inspection of the emergency stopping system on the motor vehicle.

CHAPTER 5

HYDRAULIC BRAKES

5.1 SCOPE. This Chapter applies to the operation and inspection of hydraulic brake systems.

5.2 INTRODUCTION. The information in this Chapter is intended to provide general information describing the operation of hydraulic 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.

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

5.4 SYSTEM DESCRIPTION AND OPERATION.

5.4.1 System Description. Modern passenger cars and light trucks are universally equipped with a hydraulic system for operation of the service brakes. The major components of the hydraulic system include application pedal, master cylinder assembly with brake fluid reservoir, fluid distribution lines (tubing or hoses), and individual wheel cylinder assemblies. The system may also include a power assist feature to supplement pressure applied manually to the system.

5.4.2 System Operation. A hydraulic brake system is shown in Figure 5-1 below and operates as follows:

a. In the hydraulic system, pressure applied to the brake application pedal forces fluid from the master cylinder reservoir through distribution lines to the individual wheel cylinders. Pistons in the wheel cylinders apply mechanical leverage to force the brake shoes against the brake drum to provide braking action.

b. The force applied by the hydraulic system is self-equalizing upon brake pedal application. Since the pressure is normally equal in all parts of the hydraulic system, braking pressure cannot be applied to any one brake drum until each shoe is in contact with its respective drum or each wheel cylinder piston has moved to the limit of its travel.

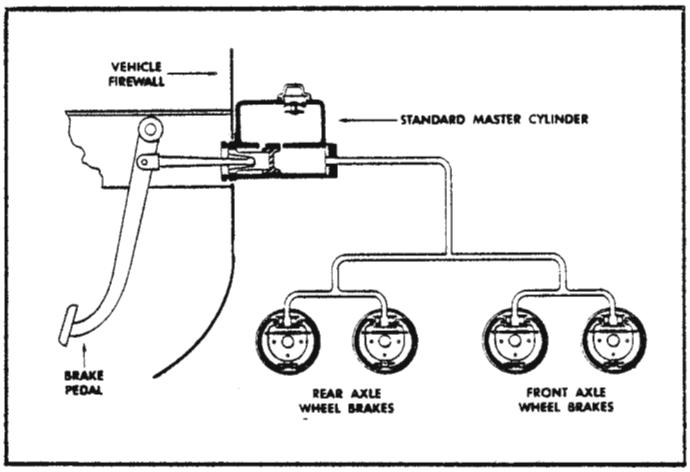


Fig. 5-1. Hydraulic Brake System

5.4.3 Split Systems. The majority of late model American passenger cars and light trucks, starting with the 1967 model year, are now equipped with split hydraulic systems, as shown in Figure 5-2. The split system is installed with or without a power assist unit and with either disc or drum brakes.

a. The split system is designed to protect against a complete loss of braking action in the event of a failure of the hydraulic system.

b. One part of the system actuates the front brakes and the other part actuates the rear brakes - two independent hydraulic systems separated by means of a split master cylinder.

c. Hydraulic leakage or complete failure in one portion of the system cannot affect the other portion.

d. Brake pedal travel increases when only one side of the system is operating and should alert the driver to a malfunction in the hydraulic system. A warning light on the instrument panel of most 1967 and later model American cars will also alert the driver.

e. Stopping distance may be increased with the defective condition inasmuch as braking action is being applied to two wheels only.

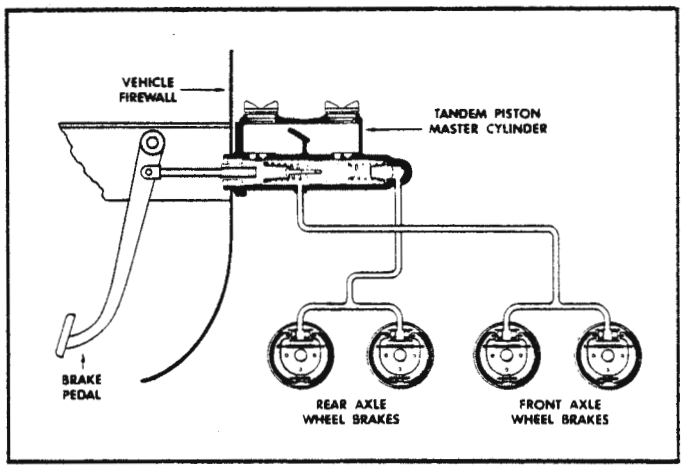


Fig. 5-2. Split Hydraulic Brake System

5.4.4 Drum-Type Brake Systems. Drum-type brakes have been classified into numerous types, each given a name descriptive of its particular manufacturer. Drum-type brakes are generally classified as "servo" or "non-servo" types. The servo type is also known as the "compound shoe" type. Systems with drum-type brakes operate as follows:

a. The brake shoes are anchored to a backing plate rigidly attached to the axle housing or wheel suspension unit and the drum rotates with the wheel. Fluid pressure forces the wheel cylinder pistons to move the brake shoes toward the rotating drum. As the brake shoe linings contact the drum, braking action is applied. Upon release of the hydraulic pressure, coiled springs return the brake shoes to the unapplied position.

b. All the brakes on a vehicle are designed to be applied equally since they normally receive the same hydraulic pressure. However, the amount of braking force upon a wheel is determined by the size of the wheel cylinders and/or the size of the brake drum and shoes.

c. Some drum-type brakes are designed to utilize the rotating force of the drum to assist in applying the service brakes. The brake shoes, anchor, and connecting linkage are so arranged that, when the shoes contact the drum, the rotating forces cause the front shoe to rotate slightly with the drum until it contacts the rear shoe and forces it against the anchor pin. Utilization of the frictional force to increase the pressure of the shoes against the drum is called self-energizing and utilization of the force in one shoe to apply the other shoe is called servo action.

d. Most modern drum-type brakes are designed with a self-adjusting mechanism. When sufficient lining has been worn from the shoes, a self-adjusting lever picks up a tooth on the star wheel of the adjusting screw. When the brakes are operated while the vehicle is moving in

reverse, the adjusting lever turns the star wheel slightly to reduce the shoe-to-drum clearance. The mechanism is designed to prevent over-adjustment.

5.4.5 Disc-Type Brake Systems. An increasing number of passenger cars with power-assisted systems utilize disc brakes either on the front wheels or on both front and rear wheels. The disc rotates and the caliper is stationary except for some lateral motion in the case of the floating caliper assembly. The caliper contains wheel cylinders and brake lining pads. A fixed caliper and a floating caliper disc brake assembly are shown in Figure 5-3. The component parts and their functions are contained in Paragraph 5.5.5 of this Chapter. Systems with disc-type brakes operate as follows:

a. During a brake application, hydraulic pressure from the master cylinder forces the pistons against the brake shoes, causing the brake linings to contact the rotor surfaces which induces braking action. As the hydraulic system is pressurized, the square section rubber sealing ring in each cylinder bore tends to distort in the applied direction as the pistons move the brake shoes toward the rotor. When hydraulic pressure is released, the distorted seals return to their normal position causing the pistons to retract in the cylinder bores.

b. Automatic adjustment of the brake shoes is obtained by the piston movement past the seals as brake lining wear takes place. Clearance is continually controlled between the friction material and rotor assembly as the piston changes its position with respect to the seal. Parallelism and lateral run-out of the rotor must be within manufacturers' specifications to maintain the proper pedal reserve and prevent brake pedal pulsation.

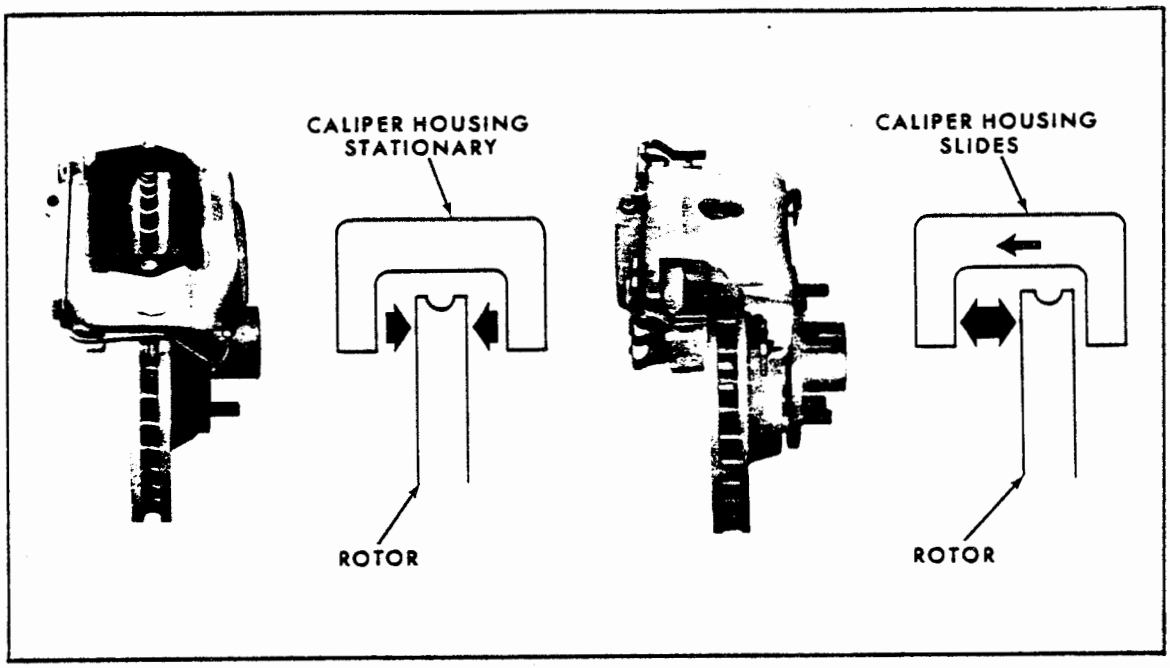


Fig. 5-3. Disc Brake Assemblies

5.5 COMPONENT PARTS.

5.5.1 Hydraulic Brake System Components. The components of a hydraulic system include application pedal, master cylinder assembly, brake fluid, fluid distribution lines (tubing or hoses), and individual wheel cylinder assemblies. The system may also include a power-assist feature to supplement pressure applied manually to the system.

5.5.2 Master Cylinder. The master cylinder is a form of hydraulic pump operated by the brake pedal through a link or push rod. A typical master cylinder consists of a cylinder, a piston with a primary and secondary cup, a residual pressure check valve, a return spring and a fluid reservoir. When force is applied to the brake pedal, the force is multiplied by the pedal lever and transmitted through the push rod or link to the master cylinder piston. The piston converts the force into hydraulic fluid pressure. Hydraulic fluid under pressure is forced through the check valve and hydraulic lines

into the wheel cylinders to expand the shoes against the drums. When the brake pedal is released, the brake shoe return springs force the fluid through the hydraulic lines and residual check valve back into the master cylinder. The compensating port is reopened when the master cylinder piston reaches the full release position. When the brake pedal is released quickly, the master cylinder piston may return faster than the fluid from the wheel cylinders. If this happens, fluid from the reservoir enters the cylinder through the inlet port to keep the chamber ahead of the piston full of fluid. As the wheel cylinder pistons return to the fully released position, the excess fluid in the system is returned to the fluid reservoir through the compensating port. A single system master cylinder is shown in Figure 5-4 and a dual system master cylinder is shown in Figures 5-5 and 5-6.

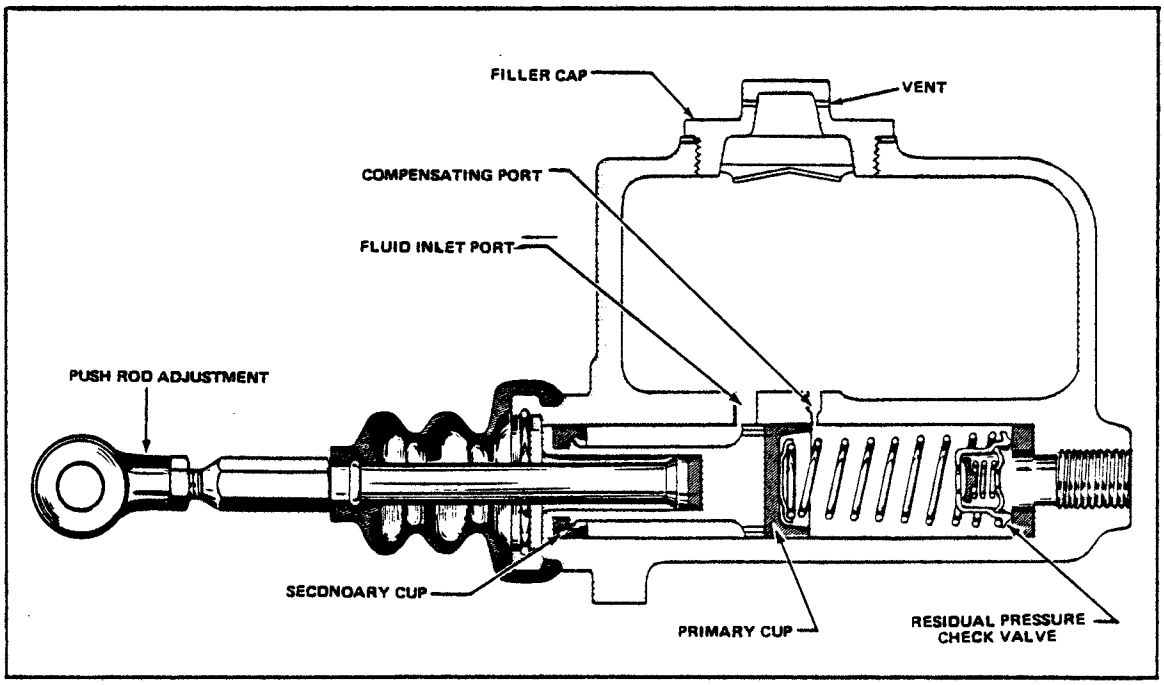


Fig. 5-4. Single System Master Cylinder

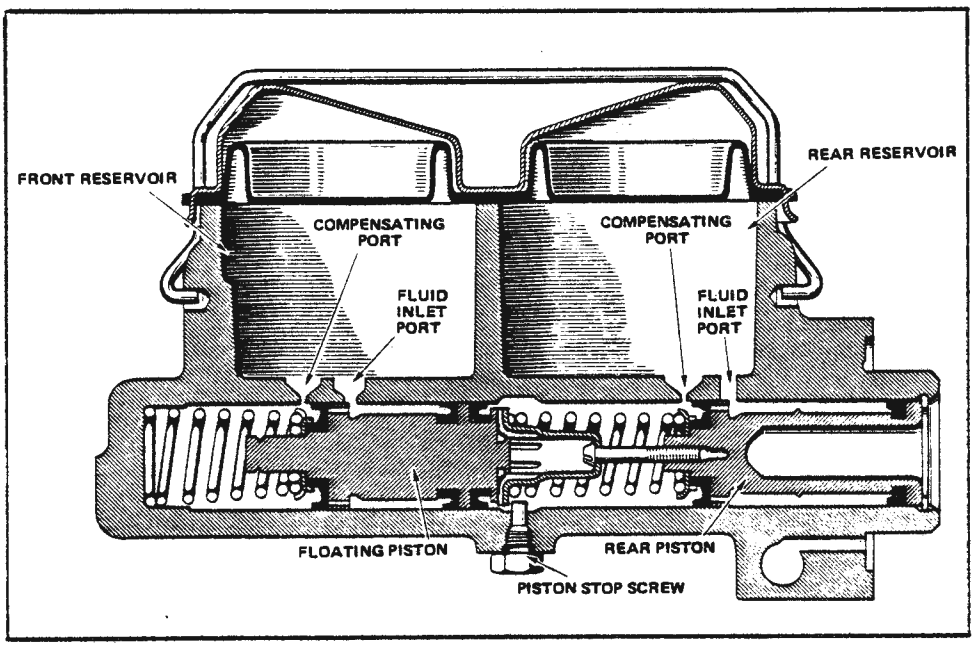


Fig. 5-5. Dual System Master Cylinder; Front-Rear Design

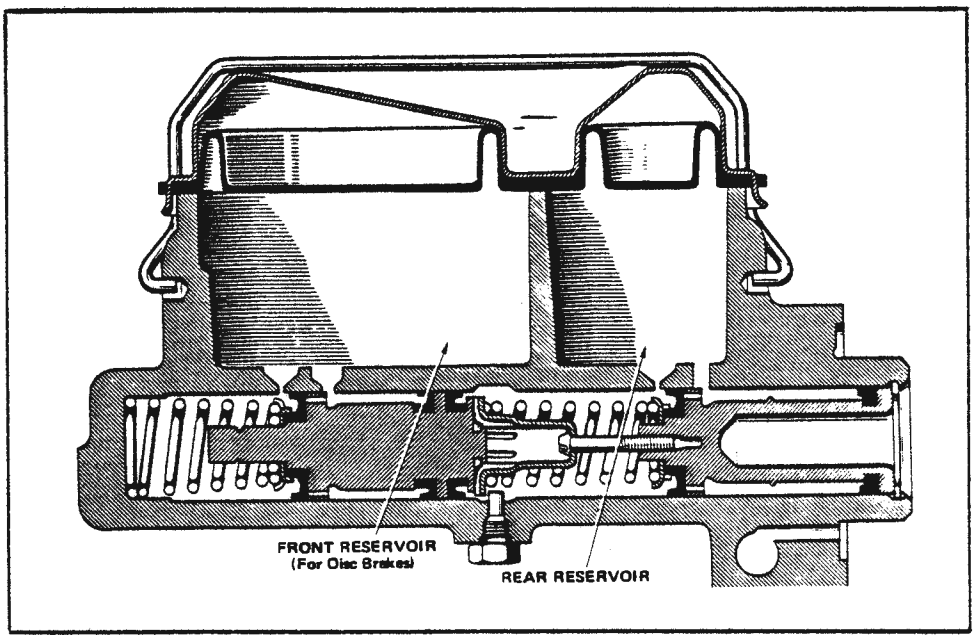


Fig. 5-6. Front-Rear Dual System Master Cylinder-Disc Brakes

5.5.3 Hydraulic Brake Fluid. Brake fluid is a specially blended liquid which provides a means of transmitting hydraulic pressure between the master cylinder and the brake wheel cylinders.

a. Brake fluid is one of the most important parts of the hydraulic brake system since it ties all of the hydraulic system components of the modern brake system together into an integral operating unit. Federal laws require that brake fluid must meet SAE (Society of Automotive Engineers) specifications. Do not use brake fluid that does not meet SAE specifications. The State of California, through regulations of the Department of Agriculture contained in Title 4 of the California Administrative Code, also requires that brake fluid be of an approved type.

b. As a result of use, brake fluid becomes contaminated and loses some of its original qualities. It is good practice to bleed the brake system until all old fluid is removed when performing major brake work. Old fluid also should be bled from the system and replaced with clean brake fluid if any of the hydraulic system parts are corroded or the fluid is discolored or dirty. If any of the rubber parts of the hydraulic system are soft or swollen, old fluid should be removed, and the hydraulic system should be flushed with alcohol and refilled with clean brake fluid. (All cups and seals also should be replaced.) Do NOT reuse old brake fluid.

c. Brake fluid must have the following characteristics:

(1) Viscosity (free flowing at all temperatures).

(2) High boiling point (remain liquid at highest operating temperatures).

(3) Noncorrosive (must not attack metal or rubber parts).

(4) Water tolerance (must be able to absorb and retain moisture that collects in the system).

(5) Lubricating ability (must lubricate piston and cups to reduce wear and internal friction).

(6) Low freezing point (must not freeze even at lowest operating temperatures).

5.5.4 Drum-Type Brakes. Drum-type brakes have been classified into numerous types, each given a name descriptive of its particular type of manufacturer. Drum-type brakes are generally classified as "servo" or "non-servo" types. The servo type is also known as the "compound shoe" type. Typical components of a single drum brake assembly are shown in Figure 5-7.

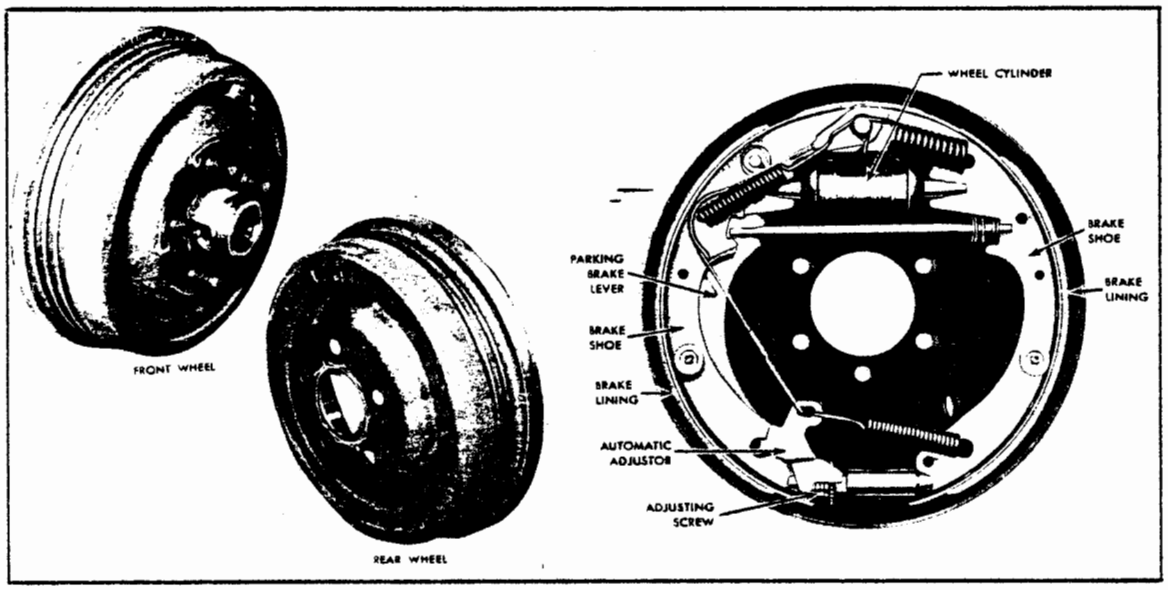


Fig. 5-7. Typical Components Single Drum Brake Assembly

5.5.5 Disc-Type Brakes. The typical components of a disc-type brake and their functions are listed below.

a. The caliper, as its name implies, provides a gripping action on the rotor of a disc brake. The caliper may be compared to a vise, the movement of the pads representing the jaws of the vise while the caliper housing represents the base. As the jaws close on a rotating plate, the clamping action retards and finally stops the rotation as pressure is exerted by the jaws. This is a very basic description of an automotive disc brake.

b. The rotor is ventilated to increase surface area and to act as an air pump. Most of the heat is carried away through the rotor which creates its own air flow. These factors aid in rapidly dissipating heat to the air stream.

c. For strength, the caliper housing is a rather heavy iron casting. Its size and location enables the caliper to absorb some of the heat generated by the friction material and rotor.

d. Brake shoe assemblies fit into the caliper housing and rest on the metal tabs that are located at each end of the steel portion of the brake shoes. Hydraulic force applied against the cylinder pistons moves the shoes in the caliper housing toward the rotor surfaces. A brake shoe assembly consists of friction material and a steel plate.

e. To protect the inner surface of the rotor against foreign matter, a metal splash shield is fastened to the spindle with a cap screw.

f. The disc brake assembly is further protected from water and contamination by a splash plate located at the inboard side. This may be compared to the backing plate of the shoe and drum brake. The wheel assembly protects the outboard side. Any liquid or foreign matter hitting the rotor surfaces would tend to be discarded by centrifugal force as the rotors revolve.

g. Since disc brakes are designed to provide a smaller mean operational area, correspondingly higher line pressures are required on full application. On vehicles equipped with front disc brakes and rear drum brakes, a proportioning valve is an important part of the system. It is installed in the hydraulic line to the rear (drum) brakes. Its function is to maintain the correct proportion between line pressure to the front and rear brakes and therefore provide a balanced vehicle braking system.

h. On vehicles equipped with front disc brakes and rear drum brakes, there are always separate fluid lines to the front and rear brakes. A residual check valve is installed in the hydraulic line between the master cylinder and the rear brakes. The valve maintains the necessary residual pressure to the rear drum brakes without affecting the front disc brakes.

5.6 INSPECTION PROCEDURES. The following procedures are offered as a guide to assist in ensuring a complete inspection of a braking system.

5.6.1 Functional Inspection. Check the brake system as follows to determine if the brakes function properly and are maintained in good condition and good working order (Section 26453 VC).

a. Firmly depress brake pedal several times to ascertain if it operates freely without locking or binding.

b. Depress the brake pedal and check the brake system warning light. (Dual or split systems only.)

c. Inspect hydraulic brake pedal free play. A minimum amount of free play should exist, enough to make sure the piston is fully returned and does not block the master cylinder compensating port (except on certain vehicles without a separate pedal return spring).

(1) Depress brake pedal slowly until it can be depressed no further.

(2) If pedal pressure builds up, drops off sharply, and builds up sharply as it is being depressed, it indicates that a piston is sticking in one or more wheel cylinders or that one of the hydraulic lines is partially blocked. Such blocking would be more likely to occur in a flexible hose due to flaking or separation of inner layers.

d. Inspect the pedal reserve. Pedal movement downward past the point of reserve (4/5 of full span), indicates that a brake adjustment or brake relining is needed. A "spongy" pedal indicates air in the lines.

e. Inspect for external leakage. If a pedal reserve is present, hold the pedal down hard for a period of one minute. If, instead of remaining stable, the pedal moves down, lessening the reserve, it is an indication that the hydraulic system is leaking fluid.

f. Inspect for internal leakage. After holding the brake pedal down hard, lessen foot pressure without completely releasing the pedal. Then depress the pedal again gradually with light foot pressure. If the reserve gradually fades under light foot pressure, hydraulic fluid may be leaking past the master cylinder primary cup lip causing pressure to be dissipated within the cylinder. If this should be the case, no external leak would be noticed, since the fluid would remain in the master cylinder.

g. Inspect for dragging brakes. If after repeated brake applications (not pumped) the pedal reserve increases and brakes at all wheels begin to drag, it indicates a blocked master cylinder compensating port, due to a swollen primary cup, lack of necessary pedal lash, or dirt in the system.

h. Inspect vacuum braking. If the vehicle is equipped with a vacuum-powered brake, stop the engine and depress the brake pedal several times to eliminate the vacuum reserve. Depress pedal hard, and while holding it, start the engine. If the power unit is working, the pedal should tend to drop appreciably under

foot pressure. (See Chapter 6 for additional information on vacuum-assisted systems.)

5.6.2 Visual Inspections. Conduct a visual inspection of the brake system as follows to determine if the brakes are maintained in good condition and good working order (Section 26453 VC).

a. Remove master cylinder cap(s) and check the fluid level. The fluid should be within 1/4-inch to 1/2-inch from the top of the reservoir (both reservoirs of a dual system master cylinder). The vent hole(s) in the caps should be clear and unrestricted.

(1) In brake systems which use drum- and shoe-type brakes, master cylinder reservoir fluid level drop is not directly related to brake wear. Periodic level check is necessary since slight reservoir loss may be expected.

(2) In disc brake systems fluid level drop is directly related to brake pad wear. Since disc brake pads or shoes have no retracting springs, master cylinder fluid level will drop as pads wear.

b. Inspect the master cylinder for leaks at the hydraulic line connections and at the push rod end.

c. Check pedal linkage for excessive wear or looseness and signs of interference at frame members or with other parts. Also check for loose locknuts and condition of pedal return spring (if used).

d. Inspect outside of backing plates, brake drums, and inner wall of tire for stains and dampness which would indicate leakage of hydraulic brake fluid.

e. Inspect tube and hose connections for stains around fittings or wet spots around hoses which indicate fluid leakage.

f. Inspect all brake hoses for cracks, weathering, and leaks.

g. Inspect brake hoses at front wheels for worn spots indicating contact with front wheels.

h. Turn steering wheel to maximum left and right turn and inspect to ensure that hoses do not contact wheels.

i. Inspect all brake lines between the master cylinder and wheels for leaks, kinks, dents, damaged fittings and/or hold-down clips.

j. Inspect the wheel brake assembly. (This check can be conducted by removing a wheel or wheel and brake drum. Wheels and drums should be removed only when proper tools are available and the condition of the brake system indicates a need for such inspection. This check is not appropriate for on-highway inspections.)

   (1) Measure the brake lining thickness. There must be at least 1/32-inch of lining above the rivets on riveted shoes, and above the shoes on bonded linings.

   (2) Inspect the brake lining for grease soaking, faulty riveting, imbedded foreign particles, cracking, and missing pieces.

   (3) Inspect brake drums for cracks and excessive wear.

   (4) Inspect hydraulic wheel cylinder for fluid leaks. The rubber boots should be pulled back to determine if brake fluid has collected between the boot and piston. The actual presence of fluid, other than mere dampness, indicates a fluid leak.

   (5) Inspect condition of brake shoe return and hold-down springs. All damaged parts should be replaced.

   (6) Inspect the automatic adjuster for free movement and proper alignment of the star wheel and pawl. Misalignment of the pawl and star wheel, and rust or other conditions which interfere with free turning of the adjuster may render the automatic adjustment feature inoperative.

(7) Inspect the caliper of disc brakes for damage, leakage, loose or damaged mounting bolts, and for loose or missing shoe retaining pins or clips.

(8) Inspect shoe or pad linings of disc brakes for proper thickness (must be more than 1/32-inch thick for bonded or more than 3/64-inch above rivets on riveted linings). Inspect for contamination with grease, brake fluid, or other material. Check lining for security on shoe or pad.

(9) Inspect the rotor disc for thickness variations (parallelism), side-to-side wobble (lateral run-out), excessive ridges, grooves, or cracks.

CHAPTER 6

VACUUM OVER HYDRAULIC BRAKES

6.1 SCOPE. This Chapter applies to the operation and inspection of vacuum over hydraulic brake systems.

6.2 INTRODUCTION. The information in this Chapter is intended to provide general information describing the operation of vacuum over hydraulic brake systems and their major component parts in addition to providing a suggested inspection procedure to determine whether the vacuum portion of such systems are functioning properly and component parts are adequately maintained.

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

6.4 SYSTEM DESCRIPTION AND OPERATION.

6.4.1 Power Brake. A hydraulic brake system which uses the force of engine vacuum to assist in brake application is a "power brake" as defined in the California Vehicle Code.

6.4.2 Systems Operation. A vacuum over hydraulic brake system uses the force created by engine vacuum to provide force supplementing manual pressure on the hydraulic system. Two of the three types of power units supplement manual pressure applied to the master cylinder and one type of unit boosts hydraulic pressure applied by the master cylinder to the wheel cylinders.

6.4.3 Types of Power Assisted Units. There are three basic types of vacuum power brake units. The integral type as shown in Figure 6-1, the pedal assist type as shown in Figure 6-2, and the pressure multiplier type as shown in Figure 6-3. They operate as follows:

a. The integral type supplements manual pressure to the master cylinder and is any type power brake unit having the master cylinder assembly mounted directly on the vacuum chamber.

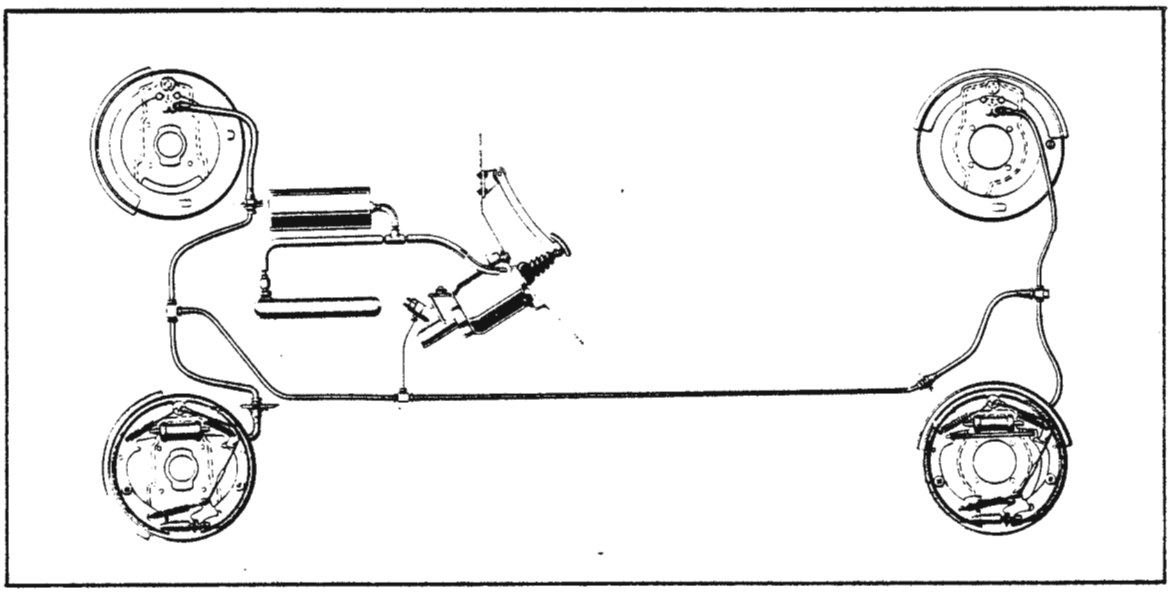


Fig. 6-1. Typical Integral Type Power Brake Installation

b. The pedal assist type power brake unit applies force to the brake pedal linkage to supplement pressure applied manually to the master cylinder. The hydraulic master cylinder is independent of this type of power brake unit.

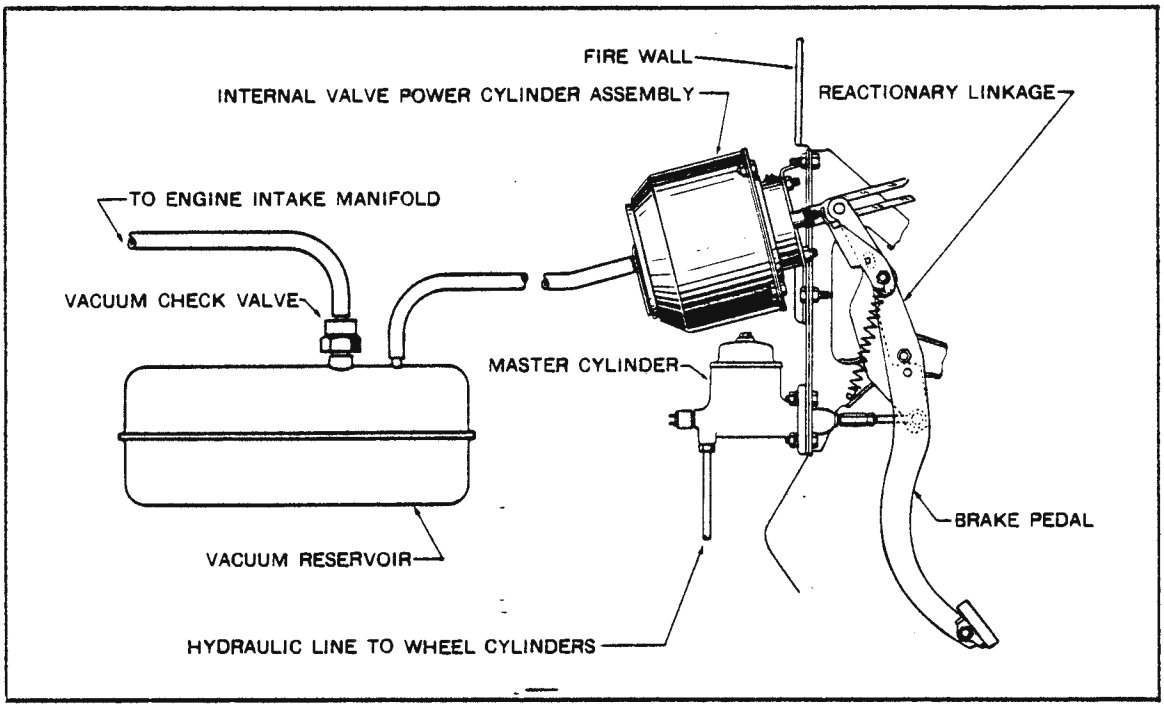


Fig. 6-2. Typical Pedal Assist Type Installation

c. The pressure multiplier type of power brake unit, sometimes referred to as a low input-high output hydraulic power brake system, has a self-contained hydraulic cylinder known as a "slave" that works in conjunction with and is actuated by the master cylinder on the vehicle to boost hydraulic pressure to the wheel cylinders.

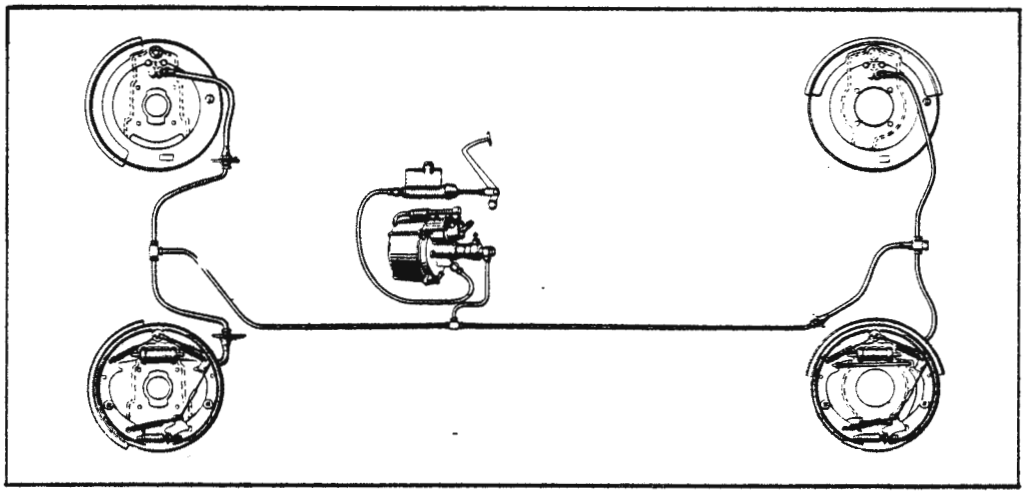


Fig. 6-3. Typical Pressure Multiplier Type Installation

6.5 COMPONENT PARTS.

6.5.1 Hydraulic Portion of a Vacuum Over Hydraulic System. The component parts of the hydraulic portion of a vacuum over hydraulic brake system are essentially the same as those contained in a straight hydraulic system. They are listed in Chapter 5 of this manual.

6.5.2 Vacuum Portion of a Vacuum Over Hydraulic System. The major components of a vacuum over hydraulic brake system are shown in Figures 6-1 through 6-3. Additional components sometimes used are vacuum gauge, warning device, check valve, and vacuum reservoir.

6.6 INSPECTION PROCEDURES.

6.6.1 Preliminary Requirements. Inspect the hydraulic portion of a vacuum over hydraulic system as outlined in Chapter 5.

6.6.2 Vacuum System Check. Stop the engine. Deplete the vacuum reserve by several applications of the brake pedal. With no vacuum in the system, depress pedal with moderate force. When the pedal reaches a steady position, hold it there, start the engine, and observe pedal action.

a. If the vacuum system is operating properly, the pedal will tend to fall away under foot pressure and less pressure will be required to hold the pedal in an applied position.

b. If unable to feel any action of the brake pedal, it is an indication that the vacuum system is not functioning.

6.6.3 Check Valve and Vacuum Reserve Check. Check the vacuum reserve and check valve by starting the engine. With the brakes unapplied, run engine at a medium speed for at least 20 seconds, then stop the engine. Wait for 90 seconds, then apply the brakes.

a. If there is no vacuum assist for one or more applications, or if the vacuum gauge drops, the check valve is defective, or there is a defect in the system which causes a vacuum loss (Section 26452 and 26522 VC).

b. If the vacuum system is not functioning, continue with the visual inspection of component parts described in Paragraph 6.6.7. If this inspection does not reveal a condition that would interfere with operation of the vacuum system, an internal malfunction is indicated. Removal and/or disassembly of the unit may be required to determine the malfunction. This step is not appropriate for an on-the-road inspection.

6.6.4 Vacuum Piping and Air Cleaner. Check conditions of the vacuum piping and air cleaner. Leaks and restrictions, collapsed hose and tubing, hose worn down to any fabric, loose hose clamps, and clogged air cleaner are conditions of inadequate maintenance (Section 26453 VC).

6.6.5 Vacuum Leakage and Low Vacuum Warning Device Test. This test can be conducted only on vehicles equipped with vacuum gauges or to which a vacuum gauge can be installed.

a. Stop the engine and observe any loss of vacuum reserve as indicated by the vacuum gauge. Any drop in vacuum should not exceed 3 inches in one minute. The absence of a check valve or the malfunction of the check valve is indicated by rapid falloff of vacuum after the engine stops (Sections 26453 and 26522 VC).

b. Apply the brakes and observe any loss of vacuum as indicated by the vacuum gauge. Leakage of vacuum greater than 3 inches in one minute is inadequate maintenance (Section 26453 VC).

c. Deplete the vacuum reserve in the system by slow repeated application of the brake pedal. Observe the vacuum gauge reading when the low vacuum warning device operates.

(1) When a vehicle is required to be equipped with a low vacuum warning device, the device shall begin operation when the vacuum drops to 8 inches of mercury or less (Section 26521 VC).

(2) A 2-inch range above and below the 8 inches of mercury required by law should be allowed because of the manufacturing tolerance in low vacuum indicators.

d. To check the vacuum measurement, start the engine and observe the vacuum test gauge. Failure of the vacuum to reach at least 15 inches indicates a defective system and is a violation of Section 26453 VC.

6.6.6 Vacuum Gauge Test. The test for vacuum gauge accuracy can be conducted only on vehicles to which test gauges can be installed.

a. Install the test gauge. Start engine and build up maximum vacuum reserve. Compare the test gauge and vehicle gauge readings.

b. A vacuum gauge which has an error of 10% or more or is not legible (at night, check for illumination) is in violation of Section 26520 VC.

6.6.7 Breakaway Brakes. Disconnect the vacuum jump lines between the motor vehicle and the towed vehicle.

a. Check the motor vehicle to determine that it will have sufficient service brakes to stop after breakaway of the towed vehicle (Section 26304(b) VC).

b. Check to see that trailer brakes are applied and determine if they will hold the vehicle stationary for at least 15 minutes (Section 26304 VC).

6.6.8 Vacuum Trailer Brake Adjustment (Actuator Reserve). Measure the rod stroke of brake chambers mounted at wheel as follows:

a. Apply service brakes and mark a reference brake chamber rod.

b. Using a rule, measure from a fixed point on the face of the chamber to the reference mark.

c. Release brakes and measure from the same fixed point on the actuator to the reference mark on the rod.

d. If the pull rod travel is more than 3 inches, the brake is out of adjustment (Section 26453 VC).

CHAPTER 7

AIR OVER HYDRAULIC BRAKE SYSTEMS

7.1 SAFETY DEVICES. Air over hydraulic brake systems are required to be equipped with all safety devices required on vehicles equipped with straight airbrakes, except the emergency stopping system otherwise required under Section 26508 VC. Refer to Chapter 3 for the complete inspection procedure of the air system on these vehicles. An air over hydraulic brake system is shown in Figure 7-1.

7.2 INSPECTION PROCEDURE.

7.2.1 Hydraulic System. Inspect the hydraulic portion of the air over hydraulic system as outlined in Chapter 5.

7.2.2 Brake Adjustment. Hold the foot brake down hard and check the brake adjustment by measuring travel in power cylinder cluster. Travel of the push rod or of the rod-type gauge on the power cylinder cluster from the fully released to the fully applied position which exceeds 75% of the manufacturer's specified maximum stroke is an indication of improper maintenance (Section 26453 VC).

7.2.3 Inspection and Check Points. Inspection and check points of the air over hydraulic brake systems are shown in Figure 7-2.

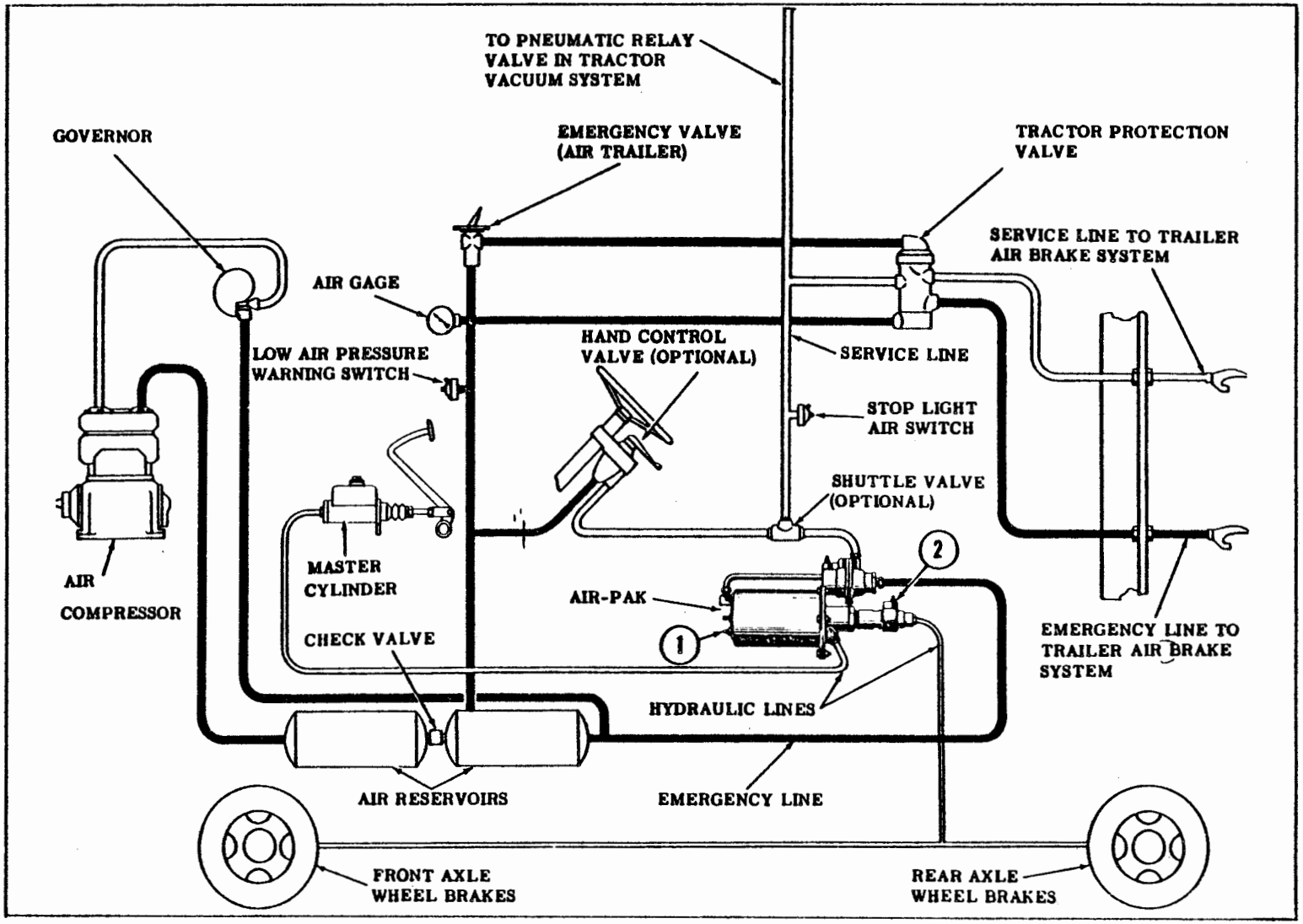
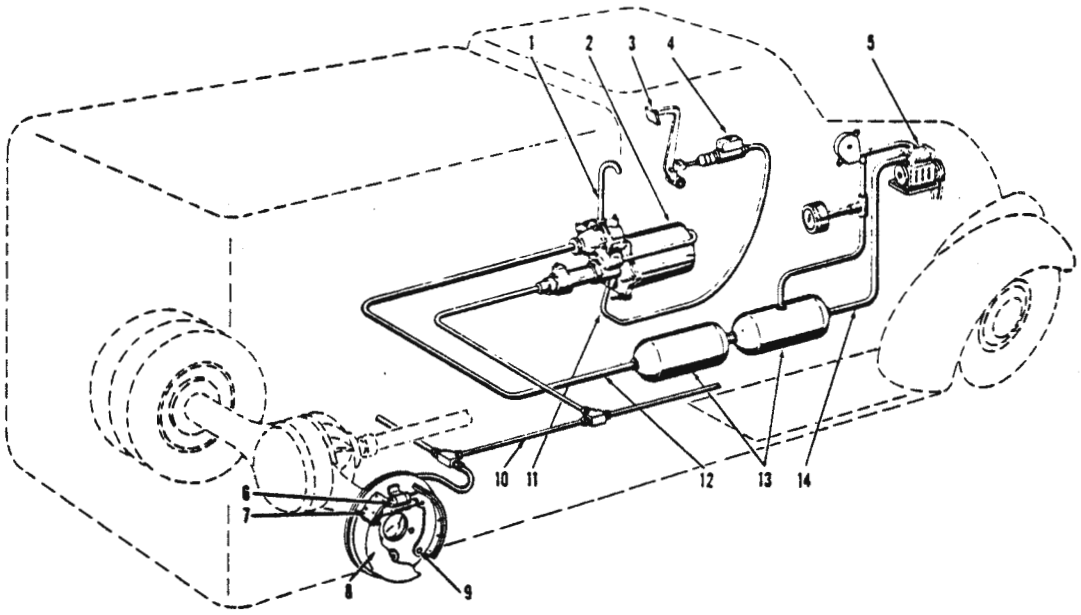


Fig. 7-1. Air Over Hydraulic Power Brake System Equipped for Towing



KEY NUMBER	DESCRIPTION
1	Air-Pak Exhaust Tube
2	Air-Pak
3	Brake Pedal
4	Master Cylinder
5	Air Compressor
6	Wheel Cylinders - (All Wheel Brakes)
7	Brake Shoes - (All Wheel Brakes)
8	Brake Drums - (All Wheel Brakes)
9	Anchor Pins - (All Wheel Brakes)
10	Hydraulic Line - Air-Pak to Wheel Brakes
11	Hydraulic Line - Master Cylinder to Air-Pak
12	Compressed Air Line - Reservoirs to Air-Pak
13	Compressed Air Reservoirs
14	Compressed Air Line - Compressor to Reservoirs

Note:

Low air pressure indicator and check valve required but not shown

Fig. 7-2. Air Over Hydraulic Power Brake System Showing Inspection and Check Points

CHAPTER 8

PARKING BRAKES

8.1 SCOPE. This Chapter applies to the operation and inspection of parking brake systems.

8.2 INTRODUCTION. This Chapter describes the function and operation of parking brake systems and provides a suggested procedure for inspection of parking brake systems. It is not intended to serve as a technical manual for the repair and servicing of parking brakes.

8.3 GENERAL.

8.3.1 Operational Requirements. The parking brake shall be adequate to hold the vehicle or combination of vehicles stationary on any grade on which it is operated under all conditions of loading on a surface free from snow, ice, or loose material. In any event, the parking brake shall be capable of locking the braked wheels to the limit of traction (Section 26451(a) VC).

8.3.2 Design Requirements. The parking brake shall be applied either by the driver's muscular efforts, by spring action, or by other energy which is isolated and used exclusively for the operation of the parking brake or the combination parking brake and emergency stopping system, and shall be held in the applied position by mechanical means, spring devices, or captive air pressure in self-contained cells (Section 26451(b), (c) VC).

8.3.3 Supplemental Parking Brake Systems. Some parking brake systems fail to meet the requirements for parking brakes specified in the Vehicle Code due to design characteristics. Such systems may be used to supplement parking brakes but may not be used in lieu of parking brakes. The system types are described in the paragraphs following.

a. Hydraulically Applied and Held Systems. Devices such as "brake locks" or "lever locks" which retain the hydraulic fluid in the service brake system may be installed on vehicles. The devices alone do not meet the requirements for a parking brake as specified in the Vehicle Code because leakage of the fluid from the system will release the brakes.

b. Air Applied and Held Systems. Devices which when applied retain air in the service brake system do not meet the requirements for a parking brake as specified in the Vehicle Code because leakage of the air from the system will release the brakes. The use of a hand control valve to apply trailer or front axle brakes and use of the "emergency" position on a tractor protection control valve to apply trailer brakes are two examples of brake applications that do not meet parking brake requirements.

c. "Park" Position - Automatic Transmissions. The "park" position in an automatic transmission is not a legal parking brake and does not meet all requirements of Section 26451 VC.

8.3.4 Removal of One Parking Brake. When the vehicle is equipped with two parking brake systems (spring brakes and a drive shaft brake for example), both systems must be properly maintained. If one of the systems is removed from the vehicle, the device is no longer a brake and need not be maintained when the following parts are removed.

a. All controls in the driver's compartment.

b. Control cables and rods.

c. Brakeshoes and bands, when they are not part of or used for the service brakes or other parking brake system.

8.4 SYSTEM DESCRIPTION AND OPERATION.

8.4.1 Types of Parking Brakes. The parking brake is a hand or foot operated mechanical brake for holding the vehicle stationary while parked. The four basic types are:

a. Integral type

b. Drive shaft type

c. Spring applied

d. Air applied mechanically locked.

8.4.2 Integral Type. The integral type parking brake as shown in Figure 8-1 is the most common parking brake in use today.

a. The integral type parking brake consists of the following major components:

(1) The parking brake operating lever in the driver's compartment.

(2) Cable and conduit system which connects from the parking brake operating lever in the driver's compartment to the parking brake levers in the rear wheels.

(3) Cable slack equalizing device.

(4) Adjusting mechanism.

(5) Levers and cams in the rear wheel brake assembly.

b. When the brake control lever is applied, the cables apply a balanced and equalized pull on both wheel parking brake levers. The levers then move linkage to force the brakeshoes against the brake drums which prevent wheel rotation.

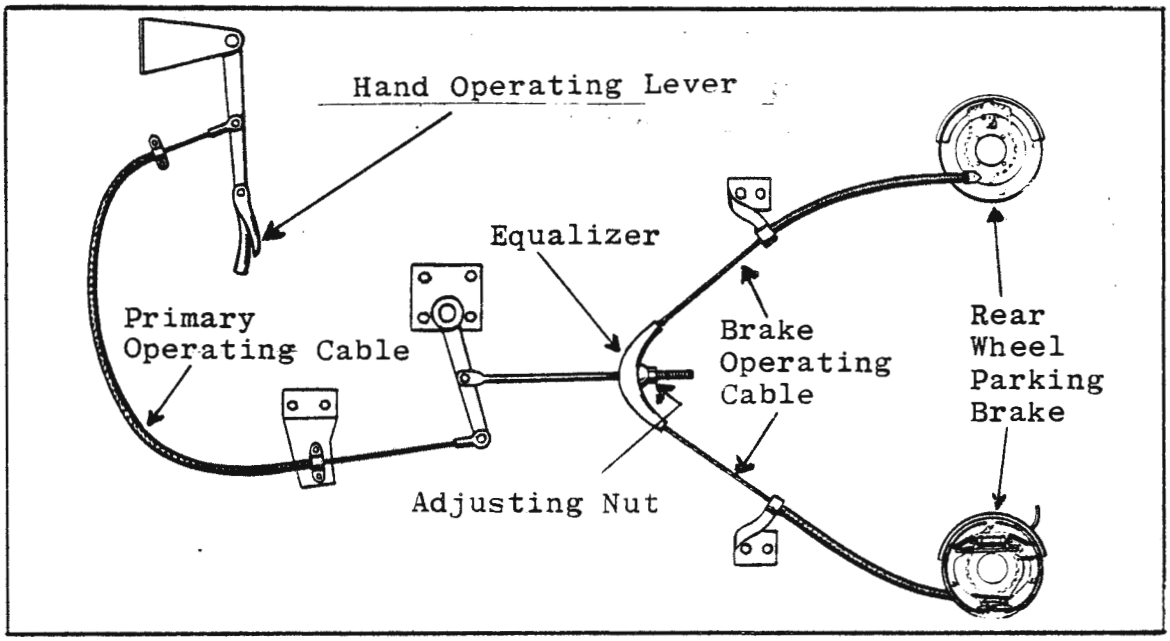


Fig. 8-1. Integral Type Rear Wheel Parking Brake

8.4.3 Drive Shaft Type. The drive shaft type parking brake as shown in Figure 8-2 is the least common type of parking brake now in use.

a. The transmission or drive shaft type parking brake consists of the following major components:

(1) The parking brake lever mechanism in the driver's compartment.

(2) A cable or rod control system which connects to the lever mechanism of the brake and brake drum.

(3) Brake drum and brakeshoes or brake disc and calipers attached to the drive shaft near the transmission. This type of parking brake may be the external band (contracting) type or the internal shoe (expanding) type.

b. When the parking brake is applied, force is transmitted through the cable or rod control

to either contract the external band or expand the internal shoes against the drum. This system prevents wheel rotation by locking the drive shaft.

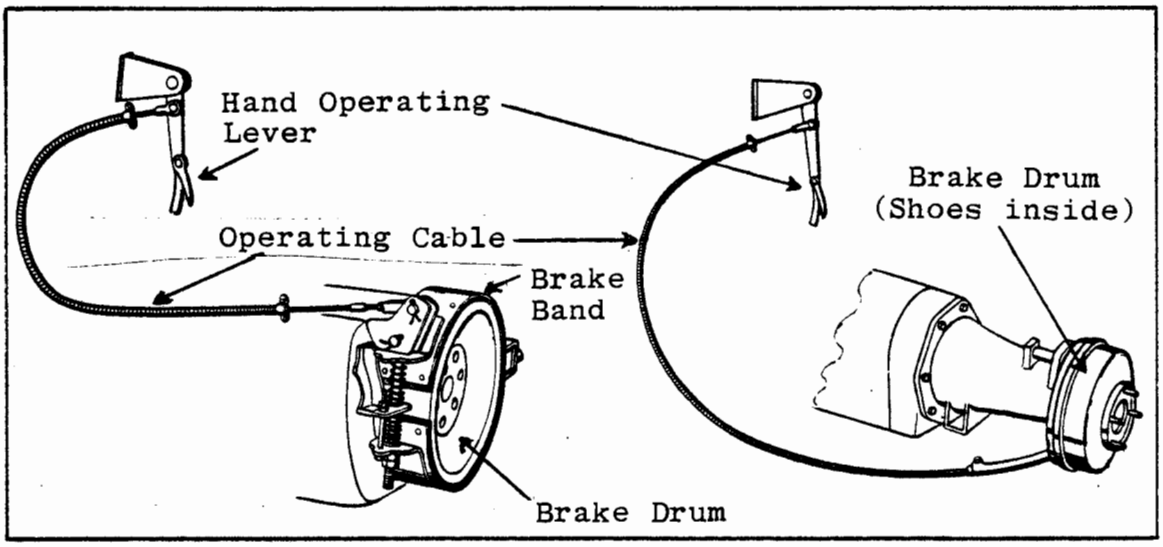


Fig. 8-2. Drive Shaft Parking Brake

8.4.4 Spring Type Brake. The spring type parking brake as shown in Figure 8-3 is used on vehicles with air brake systems.—

a. The spring type parking brake system consists of the following major components.

(1) Cab mounted operating controls.

(2) Spring chamber. (Two types: Piggyback mounted on service brake chamber. Remotely mounted on truck frame or other suitable location.)

(3) Piping, fittings, and valves necessary for operation of the system.

(4) Mechanical devices necessary to convert spring force into brakeshoe application force.

b. In the released position, air pressure in the brake chamber compresses the spring holding the brake in the unapplied position. The brake is applied by operating the cab controls to release air from the brake chamber. Release of air permits the spring to expand. The spring operates the slack adjuster either through a cable connection or through the brake chamber push rod which applies the brake.

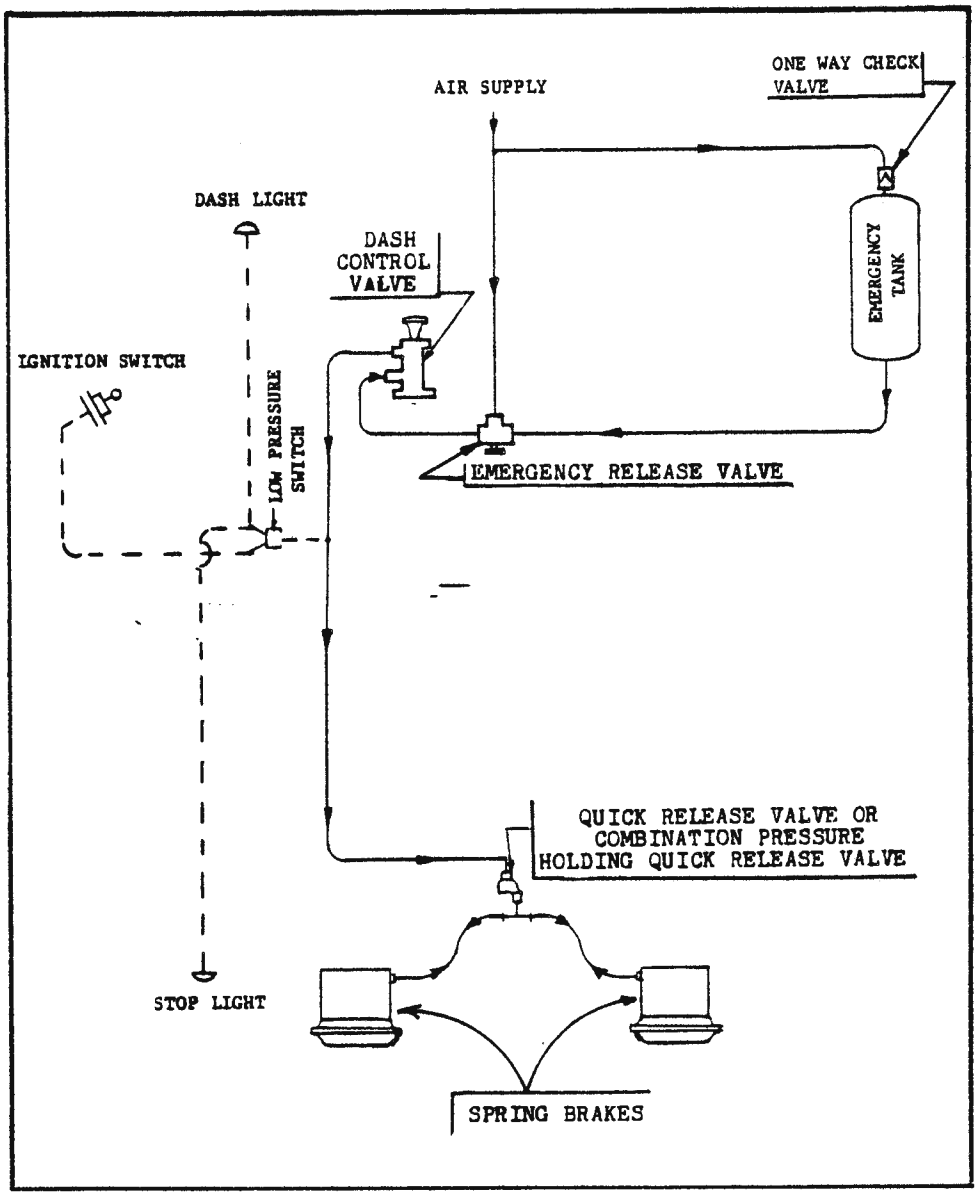
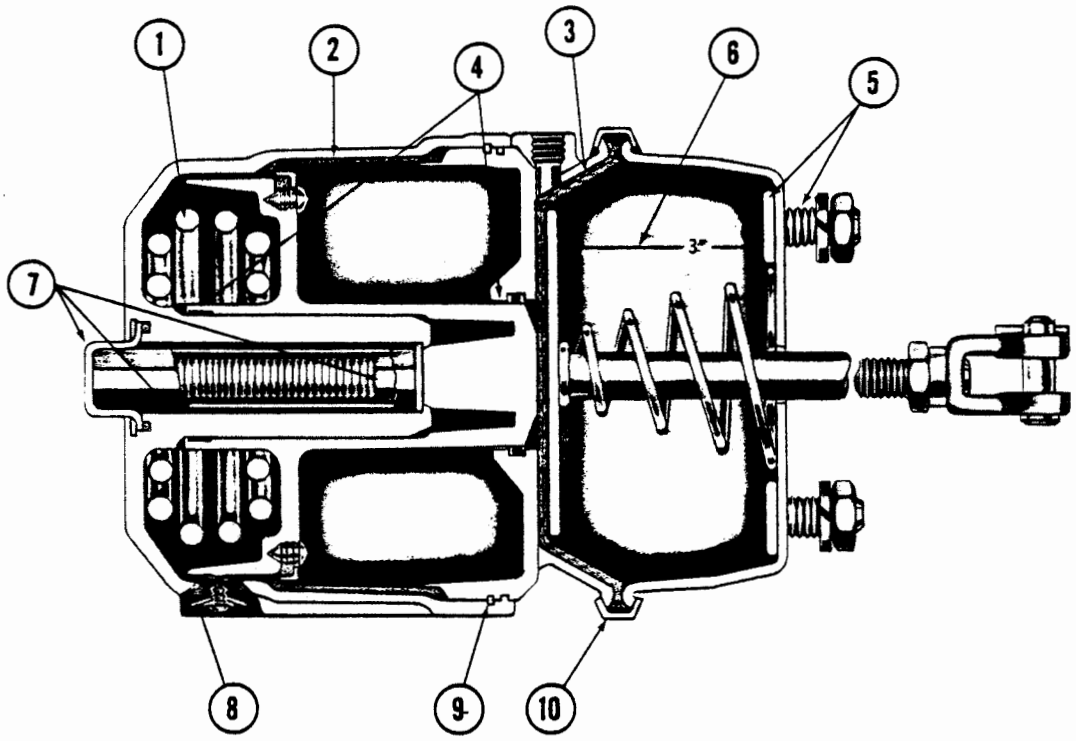


Fig. 8-3. Spring Type Parking Brake System



1. Emergency Spring
2. Emergency Diaphragm
3. Service Diaphragm
4. Bearing Seals
5. Mounting Studs
6. Stroke
7. Mechanical Release
8. Exhaust Check
9. Lock Wire
10. Clamp Ring

Fig. 8-4. Spring and Service Brake Actuator

8.4.5 Air Applied Mechanically Locked Parking Brake. The air applied mechanically locked parking brake system as shown in Figure 8-5 is used on vehicles equipped with air brake systems.

a. The system is composed of the following major components.

(1) Cab mounted operating controls.

(2) Double diaphragm brake chamber. (One diaphragm for service brake; one diaphragm to apply parking brake.)

(3) Mechanical locking device on the brake chamber push rod.

(4) Piping, fittings, and valves necessary for operation of the system.

(5) Mechanical devices and linkage necessary to convert the applied force to brakeshoe application force.

b. In this system, operation of the cab controls applies air pressure to the parking brake diaphragm which applies the brake. The chamber is designed with a mechanical lock on the brake chamber push rod. The mechanical lock is held in the released position by compressed air. When the air is released, the lock tightens around the push rod holding it in the applied position. The brake is released by applying a full application of service air to the service system and operating the cab control to release the lock mechanism.

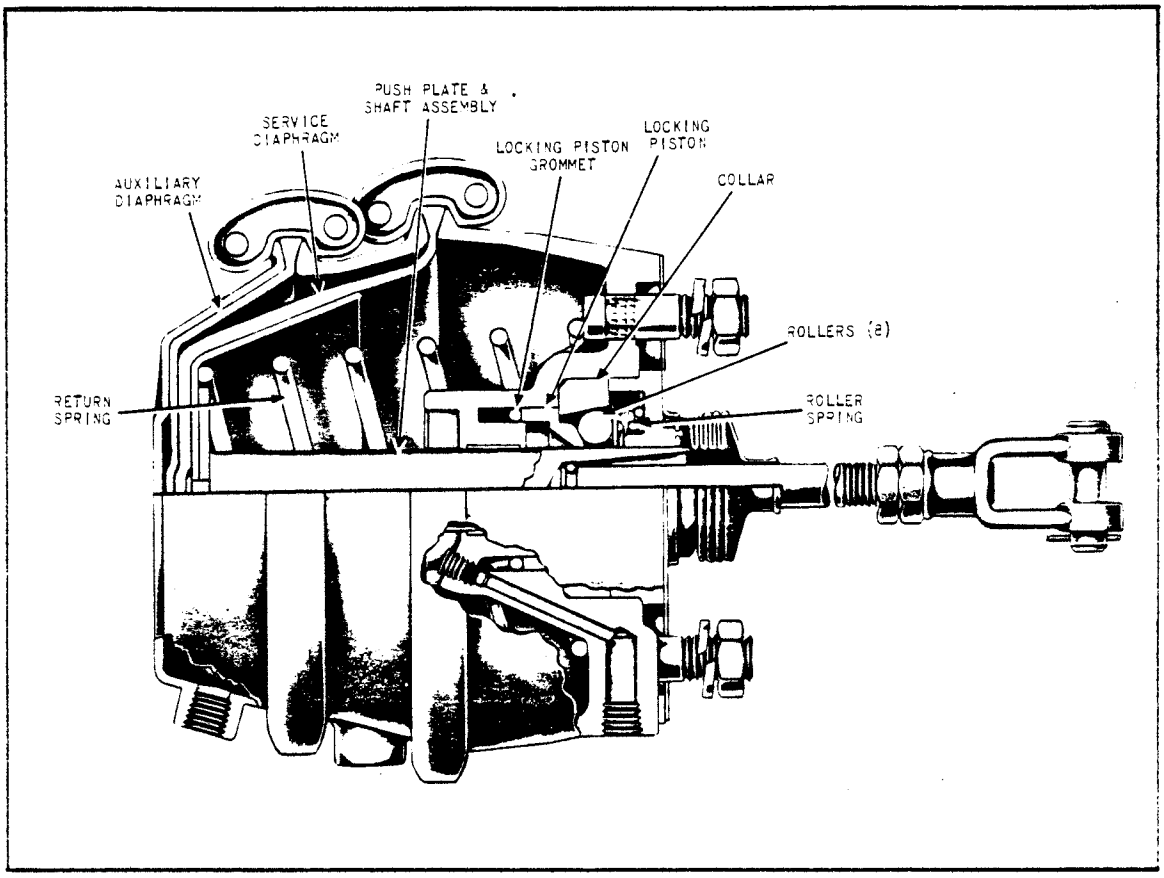


Fig. 8-5. DD3 Brake Actuator
(Air Applied-Mechanically Held)

8.5 INSPECTION AND TEST PROCEDURES.

8.5.1 Inspection Location. Sites selected for parking brake testing should meet the following requirements:

a. The site must be free of loose material.

b. The site must be on an incline which is adequate to determine the holding capability of the parking brake, or ramps must be provided to be used as an inclined surface for testing the holding capacity of the parking brake.

c. Tests should be conducted only at locations which do not interfere with traffic or cause a traffic hazard.

8.5.2 Safety Precautions. The following safety precautions must be taken prior to inspecting a parking brake system.

a. Ascertain that the service brakes are operative.

b. The wheels must be blocked, the engine must be stopped, and the transmission engaged while conducting a visual inspection.

c. In view of the possibility of structural or mechanical failure of the spring unit on spring brake assemblies, any position near a spring brake assembly during its operation must be considered dangerous; therefore, inspection personnel will not place themselves in a position where it is possible to be struck by parts of the spring brake assembly.

8.5.3 Visual Inspection. Determine the type system installed on the vehicle. Inspect the component parts as follows:

a. Apply cab mounted operating levers or controls and determine that the parking brake has applied, remains applied, and that operating controls operate freely.

b. Inspect integral and drive shaft brakes for worn clevis pins, loose parts, broken or missing springs, broken or missing brake linings, worn rods, yokes, or couplings, worn anchor pins, and worn or slack pull cables. Determine that brake shoes contact brake drums.

c. Inspect each air applied or spring applied brake chamber for lack of brake application, missing mounting bolts, missing parts, loose pipe fittings, air leaks, and cracked or broken pipes. Check push rod travel for proper brake adjustment.

8.5.4 Operational Test. An operational test for parking brakes should be conducted on an incline equivalent to a grade of not less than 6%. This is a 6 foot rise in 100 feet, or .6 feet ($7\frac{1}{4}$ inches) in 10 feet.

a. The test should be conducted as follows:

(1) Determine that service brakes operate.

(2) Have the driver apply the parking brake.

(3) Remove chock blocks.

(4) Have the driver release the service brakes.

b. Failure of the parking brake to hold the vehicle on any incline on which it is being tested is a violation of Section 26451(a) VC.

c. The holding capability of the parking brake should not be determined by pushing the vehicle or by an engine stall test.

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 unit 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.

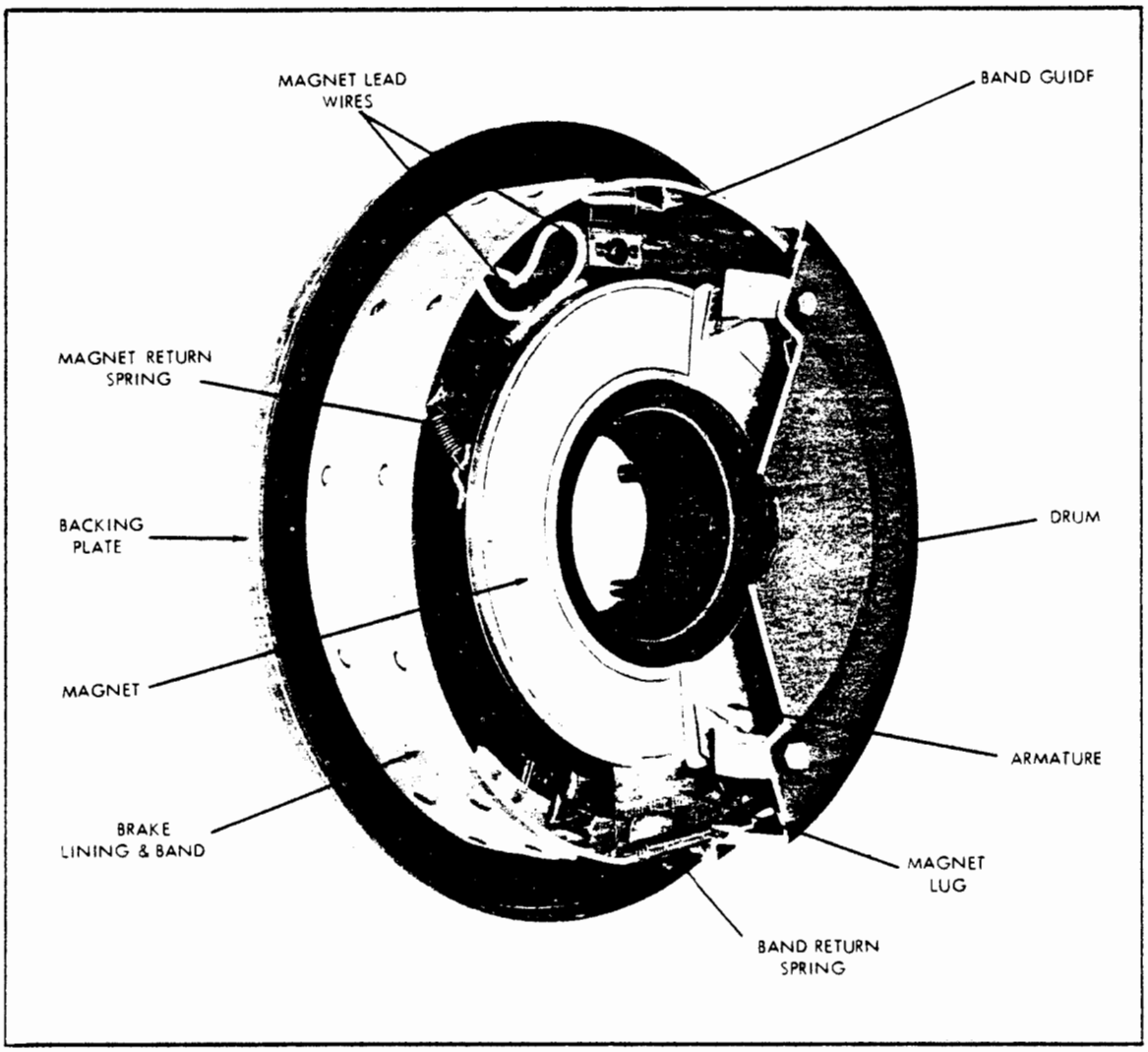


Fig. 9-1. Components of a 12-inch Brake

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

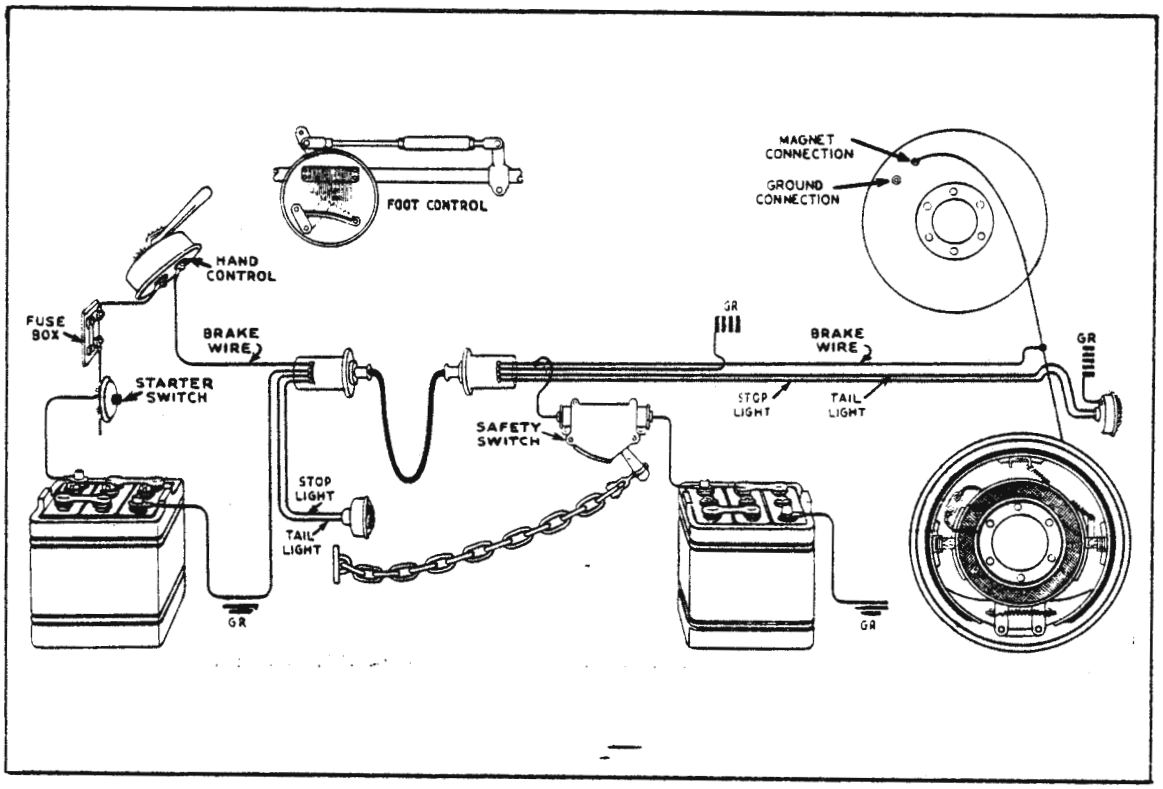


Fig. 9-2. Component Parts of an Electric Brake System

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.

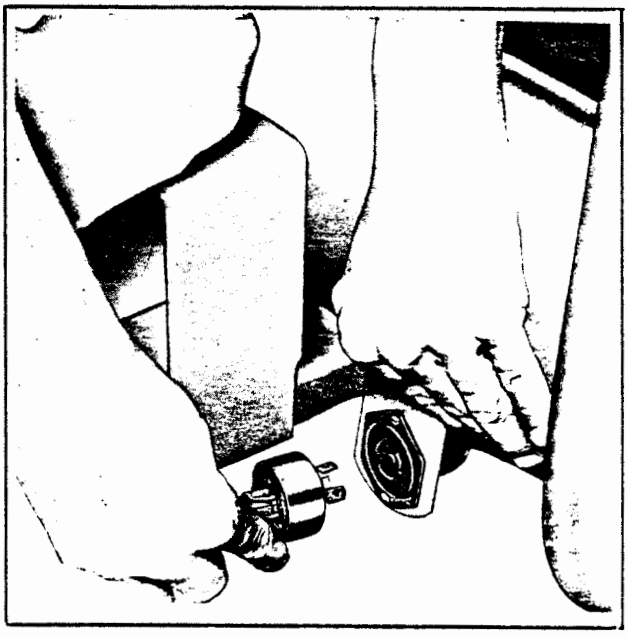


Fig. 9-3. Electrical Connection - Towing to Towed Vehicle

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.

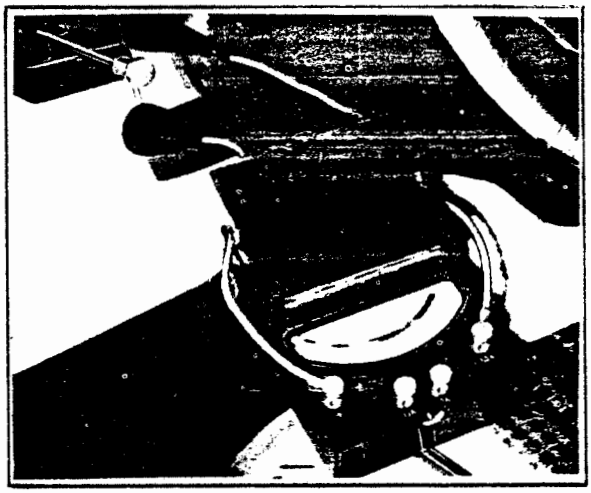


Fig. 9-4. Ammeter Connection

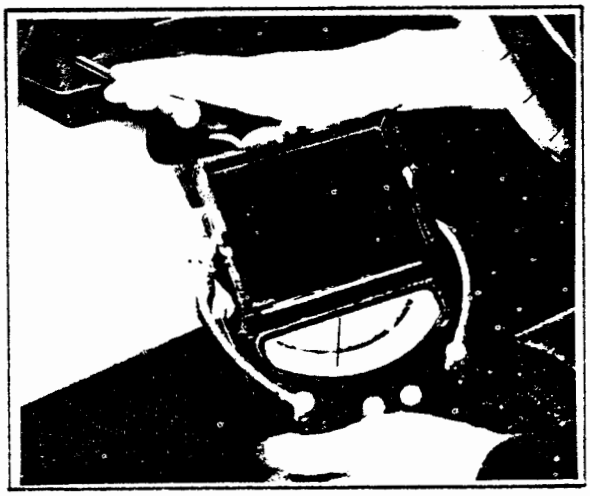


Fig. 9-5. Ammeter Reading

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 unbalanced 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 and 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.

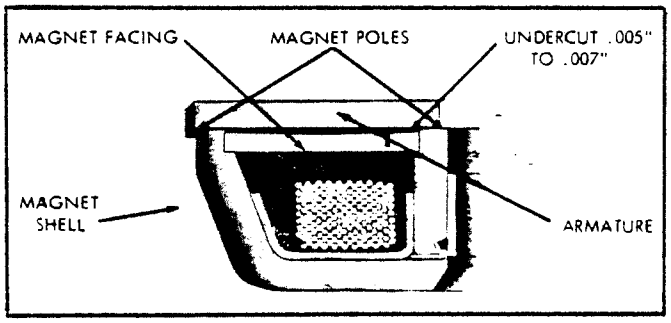


Fig. 9-7. Magnet and Armature Relationship

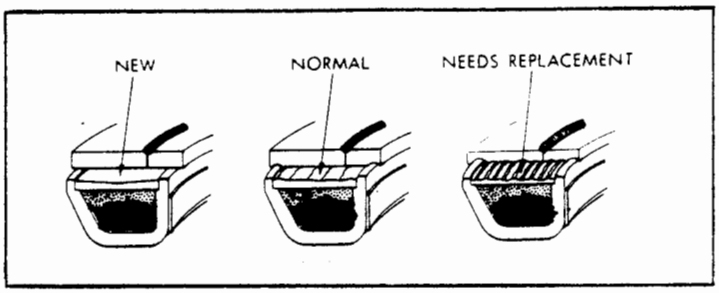


Fig. 9-8. Armature Wear

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	Check entire wiring system for broken wires. Install new wires where necessary. All splices must assure a good connection.
Poor connections	Check, clean, and tighten all connections at brake, controller, resistor, and socket.
Broken wire on magnet	Replace magnet contact wires.
Poor ground connection in circuit	Clean and tighten connections. All ground connections on frame MUST be welded.
Defective connector plug or socket (between trailer and towing vehicle)	Check plug and socket for loose connections, dirty or corroded blades, or broken Bakelite insert in socket.
Burned-out resistor	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	Tighten or replace bearings.
Out-of-round drum	Check drum for concentricity.
Distorted band	Correct distortion using band gauge supplied with installation and service kit.
Scored drum	Bore out the drum to remove as much scoring as possible without weakening the drum.
Lining loose on rivets	Replace with new lining and rivets.
Improper lining	Replace with lining recommended 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 needed. (If the band is made round with a special lining 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, 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 shot 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

CHAPTER 10

TRAILER COUPLING DEVICES (FIFTH WHEELS)

10.1 SCOPE. This Chapter applies to the operation and inspection of standard and automatic fifth wheels as defined in Paragraphs 10.3.1 and 10.3.2.

10.2 INTRODUCTION. The information in this Chapter is intended to provide general information describing the operation of fifth wheels and their component parts, in addition to providing a suggested inspection procedure.

10.3 DEFINITIONS.

10.3.1 Fifth Wheel. For the purpose of this Chapter, a fifth wheel is a coupling device used to connect two vehicles together which consists of an upper and lower skid plate, a kingpin, coupler jaws, or similar parts designed and arranged in such a way as to be readily separable, permit free rotation between the upper and lower halves, and provide lateral stability to the towed vehicle. (See Figure 10-7.)

10.3.2 Automatic Fifth Wheel. An automatic fifth wheel is a device which performs the function of a standard fifth wheel and the additional function of raising or lowering the semitrailer landing gear automatically when the vehicles are coupled or uncoupled.

a. The design of automatic fifth wheels is essentially the same regardless of the manufacturer.

b. The coupler jaws, locking mechanism, and operating handle are on the towed vehicle, and the kingpin is located on the lower half of the fifth wheel on the towing vehicle.

c. The coupler jaws and locking cam can be seen by sighting down the throat at the entry point of the mounting plate on the towed vehicle, and the operating handle is usually located in the right front rubrail of the semitrailer.

10.3.3 Kingpin. The kingpin is the pin that holds the upper and lower halves of the fifth wheel together. The pin is attached to the upper half of the standard fifth wheel and is secured by the coupler jaws to the lower half of the fifth wheel.

10.4 OPERATION - STANDARD FIFTH WHEEL.

10.4.1 Coupling. The upper and lower halves of a fifth wheel are coupled together by the use of coupler jaws in the lower half of the fifth wheel. The coupler jaws lock into a groove cut into the kingpin which is secured to the upper half.

10.4.2 Automatic Coupling. When the kingpin of the upper half of the fifth wheel is forced into the lower half of the fifth wheel, as the vehicles are coupled together, the kingpin contacts the open coupler jaws. Additional movement of the kingpin causes the coupler jaws to close around the kingpin.

10.4.3 Locking Device. The coupler jaws are held in the closed position by a mechanical locking device which is forced into position and held by spring force.

10.4.4 Manual Release. The coupler jaw locking device is released by manual operation of a releasing lever. Forward movement of the towing vehicle will then cause the coupler jaws to open and release the kingpin, permitting separation of the upper and lower halves.

10.4.5 Accidental Disconnect Prevention. The fifth wheel must be designed and maintained in such a manner that the manual release cannot be accidentally operated, or a device must be installed on the fifth wheel which will prevent accidental operation of the release lever.

10.5 DESIGN AND CONSTRUCTION.

10.5.1 Basic Design. All fifth wheels have basic design similarities in that they all have upper and lower skid plates, a king pin, and a locking mechanism to hold the kingpin in place.

a. Variations in design and construction occur with each manufacturer.

b. Design variations occur most frequently in the coupler jaw and release mechanisms.

10.5.2 No Slack Fifth Wheels. One design variation is the "no slack" fifth wheel.

a. Fifth wheels of this type are designed in such a manner that there is no slack between the kingpin and coupler jaws.

b. Wear in the kingpin or coupler jaws can be compensated for in this type of fifth wheel by coupler jaw adjustment or design.

c. Illustrations of "no slack" fifth wheel coupler jaws are below in Figures 10-1, 10-2, and 10-3.

(1) Slack is eliminated in the design illustrated in Figure 10-1 by the use of wedges behind the kingpin.

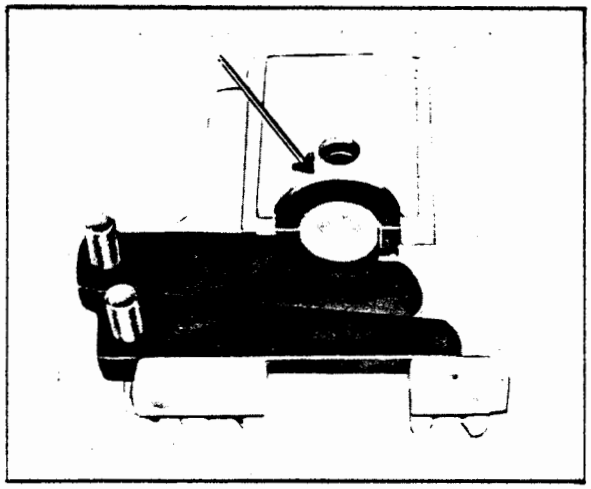


Fig. 10-1. "No Slack" Fifth Wheel Coupler

(2) Slack is eliminated in the design illustrated in Figure 10-2 by use of an offset cam in the coupler jaw pivot pin which, when rotated, varies the coupler jaw location.

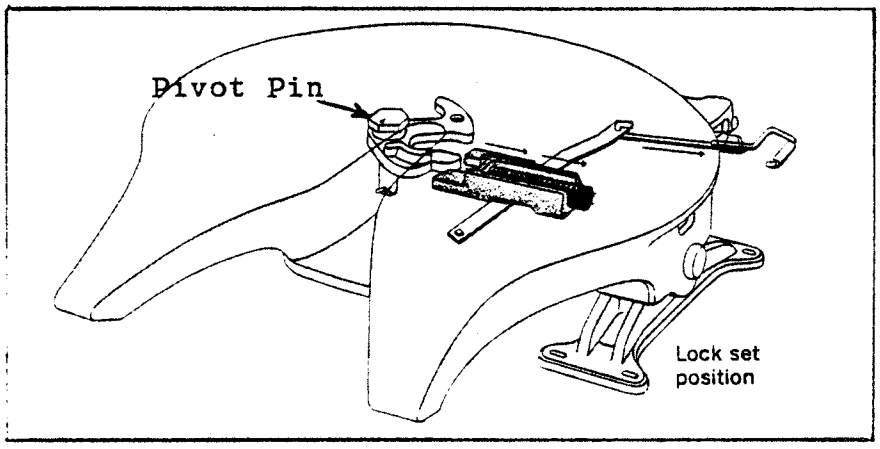


Fig. 10-2. "No Slack" Fifth Wheel Coupler

(3) Slack is eliminated in the design illustrated in Figure 10-3 by the use of a rubber buffer placed forward of and compressed by the kingpin when in the coupled position.

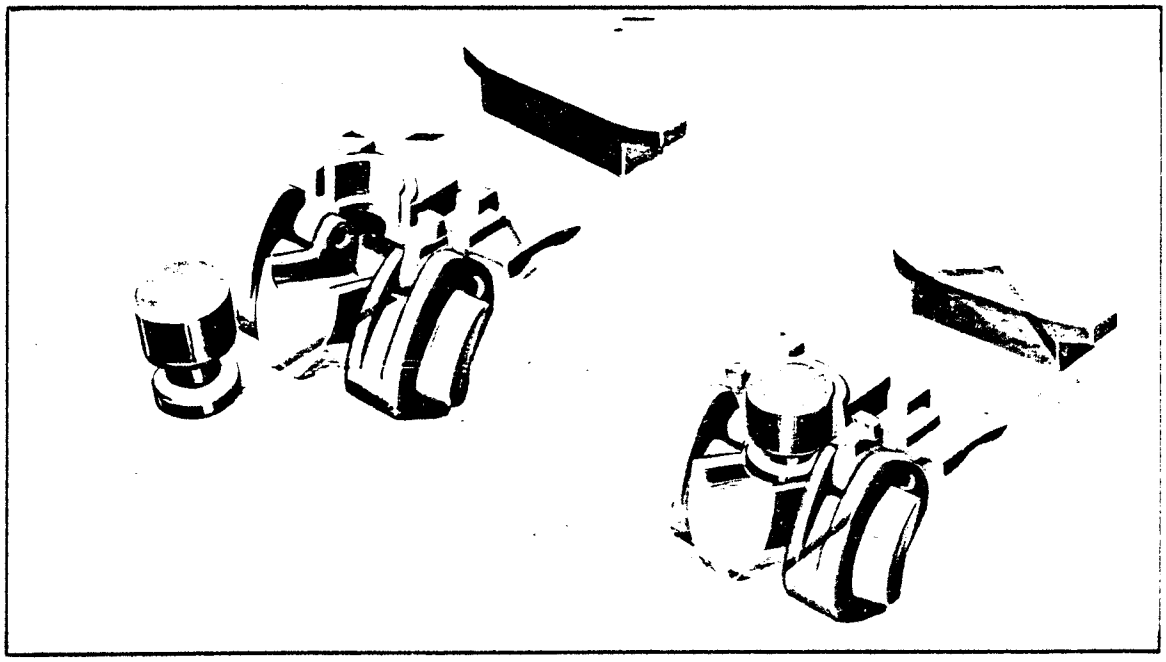


Fig. 10-3. "No Slack" Fifth Wheel Coupler

10.5.3 Mounting Brackets. The design and construction of fifth wheel mounting brackets varies considerably.

a. In some designs a pin is used to secure the fifth wheel to the mounting bracket and sustains the pulling force exerted by the tractor.

b. In other designs the mounting bracket and fifth wheel are machined with matching trunnion surfaces. The mounting bracket and fifth wheel are held in place by a pivot pin; however, pulling force is exerted against the trunnion not the pin. Rubber shoes or other types of shims are often used to absorb shock and compensate for wear.

c. Mounting brackets are illustrated in Figures 10-4 and 10-5.

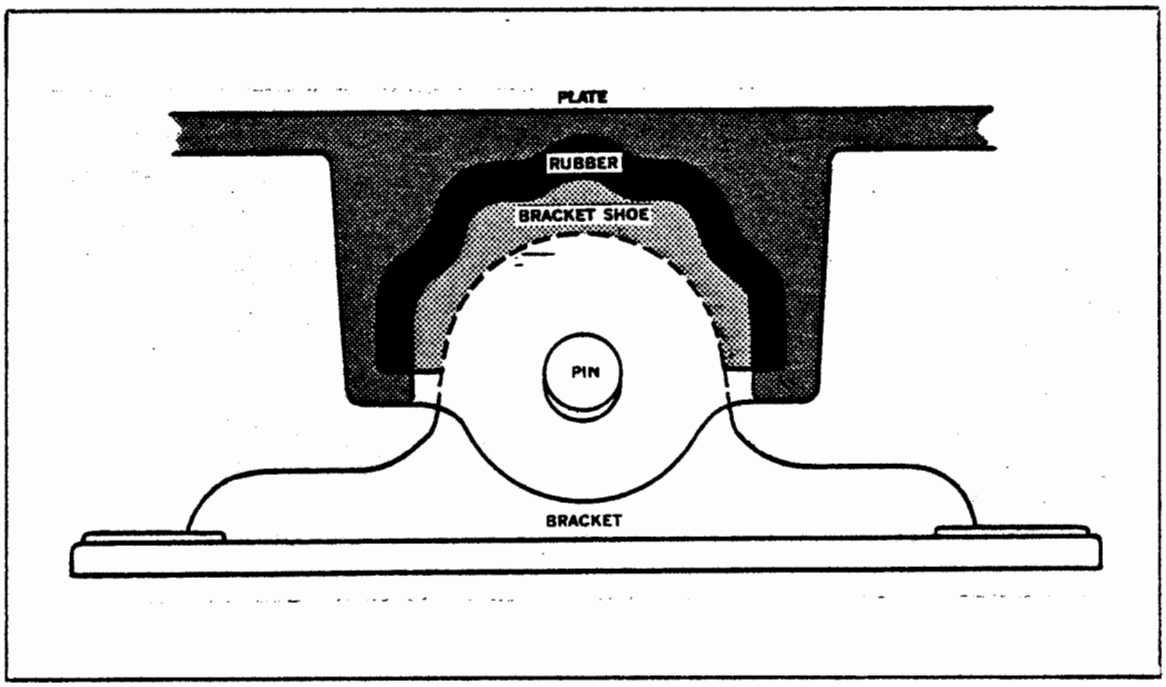


Fig. 10-4. Mounting Bracket

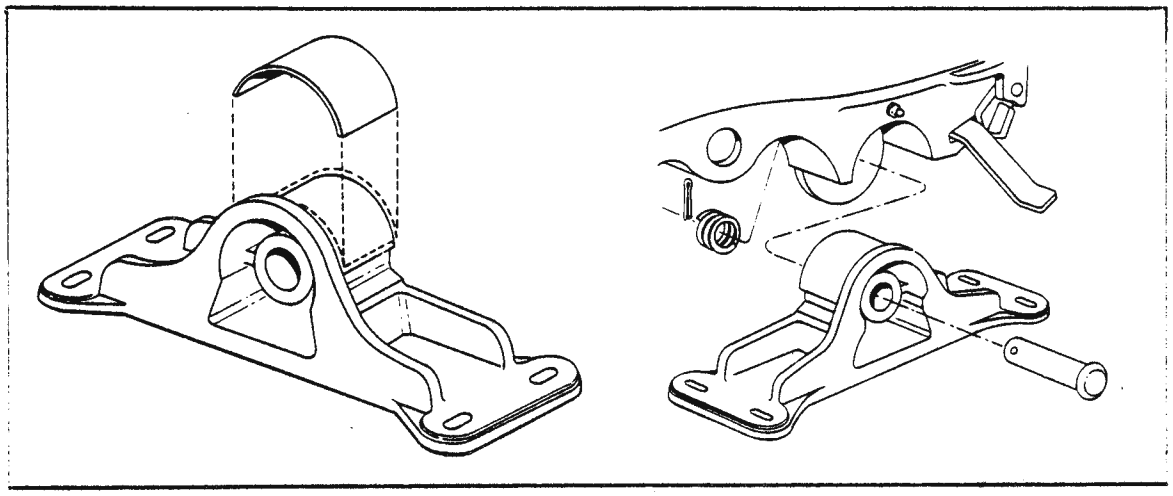


Fig. 10-5. Mounting Bracket

10.5.4 Upper Half. The upper half of the fifth wheel consists of a skid plate and kingpin. The upper half of the fifth wheel is normally attached to the towed vehicle; however, when automatic fifth wheels are used the upper half is attached to the towing vehicle. Figure 10-6 illustrates a standard kingpin.

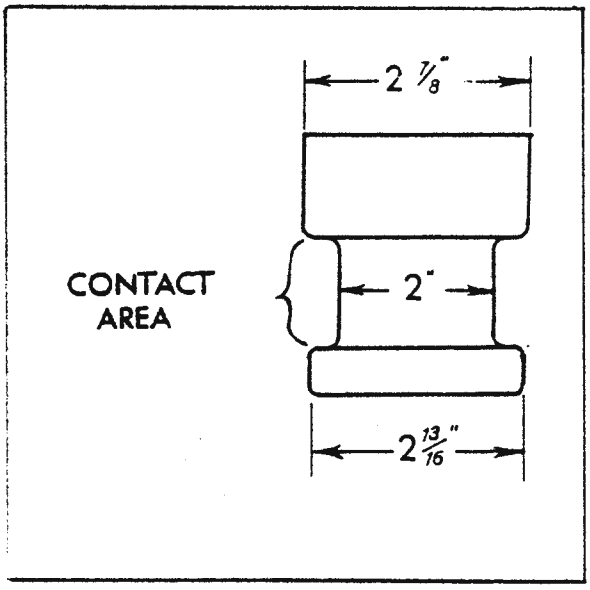


Fig. 10-6. Standard Kingpin

10.6 COMPONENT PARTS.

10.6.1 Lower Half. The component parts of the lower half of a fifth wheel are labeled in Figure 10-7 below.

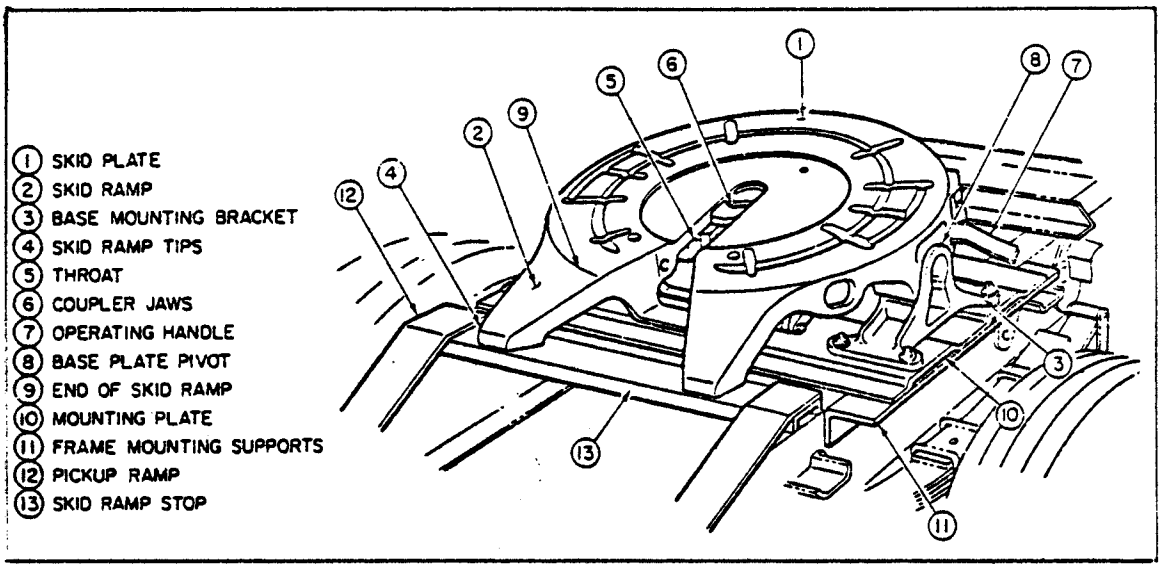


Fig. 10-7. Component Parts of a Fifth Wheel

10.6.2 Use of Nomenclature. The terms used to identify the component parts have been adopted by the SAE Fifth Wheel Committee and should be used in any written reports describing fifth wheel parts.

10.7 INSPECTION PROCEDURE.

10.7.1 Depth of Inspections. Inspections of fifth wheels are to be conducted to the depth necessary to determine whether the device complies with statutory requirements and is maintained in a safe operating condition.

a. The inspection procedure is designed to be conducted visually without the use of tools and is neither restrictive nor all inclusive.

b. Separation of vehicles for this inspection is not recommended or necessary unless some condition is observed which requires separation of the vehicles to determine if further operation would be unsafe.

10.7.2 Preliminary Procedure. It is essential for inspecting personnel to ensure that no accidental disconnection can occur which may result in dropping the semitrailer. If the vehicles are to be separated, semitrailer landing gear must be properly positioned and of adequate strength to support the vehicle.

10.7.3 Lower Half Mounting. Check the mounting and securement of the lower half to the vehicle frame to ensure that it is securely mounted to the vehicle and that proper methods and materials have been used in its installation.

a. Fifth wheels mounted on vehicles subject to the Motor Carrier regulations contained in Title 13, CAC, must comply with (1) and (2) below.

(1) If "U" bolts are used to attach the fifth wheel to the frame, they must be of one piece construction (not welded), of adequate size, and securely tightened (Title 13, CAC, Section 1213(e)).

(2) If capscrews and bolts are used to secure the fifth wheel to the frame, they must meet SAE Standard J429 for grade 5 threaded fasteners in the 1965 or later edition of the SAE Handbook and must be installed so that the frame will not crack, warp, or become deformed (Section 34506 VC and Title 13, CAC, Section 1213(e)). A table of SAE grades and head marking for threaded fasteners is shown in Figure 10-8 below.

Grade Designation	Products	Nominal Size Dia, in	Full Size Bolts, Screws, Studs, Sems: Proof Load, psi	Full Size Bolts, Screws, Studs, Sems: Tensile Strength Min, psi	Machine Test Specimens of Bolts, Screws, and Studs: Yield Strength Min, psi	Machine Test Specimens of Bolts, Screws, and Studs: Tensile Strength Min, psi	Machine Test Specimens of Bolts, Screws, and Studs: Elongation f Min, %	Machine Test Specimens of Bolts, Screws, and Studs: Reduction of Area Min, %	Surface Hardness Rockwell 30N Max	Core Hardness Rockwell Min	Core Hardness Rockwell Max	Grade Identification Marking
1	Bolts, Screws, Studs	1/4 thru 1-1/2	33,000	60,000	36,000[b]	60,000	18	35	—	B70	B100	None
2	Bolts, Screws, Studs	1/4 thru 3/4[c]	55,000	74,000	57,000	74,000	18	35	—	B80	B100	
		Over 3/4 to 1-1/2	33,000	60,000	36,000[b]	60,000	18	35	—	B70	B100	None
4	Studs	1/4 thru 1-1/2	—	115,000	100,000	115,000	10	35	—	C22	C32	None
5	Bolts, Screws, Studs	1/4 thru 1	85,000	120,000	92,000	120,000	14	35	54	C25	C34	Bolts and Screws only
		Over 1 to 1-1/2	74,000	105,000	81,000	105,000	14	35	50	C19	C30	
Ø 5.1[d]	Bolts, Screws, Sems[h]	No. 6 thru 3/8	85,000	120,000	—	—	—	—	59.5[g]	C23	C40[g]	Hex head sems only
5.2	Bolts Screws	1/4 thru 1	85,000	120,000	92,000	120,000	14	35	56	C26	C36	Bolts and Screws Only
7[e]	Bolts Screws	1/4 thru 1-1/2	105,000	133,000	115,000	133,000	12	35	54	C28	C34	Bolts and screws only
8	Bolts, Screws, Studs	1/4 thru 1-1/2	120,000	150,000	130,000	150,000	12	35	57.5	C32	C38	Bolts and screws only
8.1	Studs	1/4 thru 1-1/2	120,000	150,000	130,000	150,000	10	35	—	C32	C38	None
Ø 8.2	Bolts Screws	1/4 thru 1-1/2	See Appendix									

[a] Yield strength is stress at which a permanent set of 0.2% of gage length occurs.
[b] Yield point shall apply instead of yield strength at 0.2% offset.
[c] Grade 2 requirements for sizes 1/4 through 3/4 in apply only to bolts and screws 6 in and shorter in length, and to studs of all lengths. For bolts and screws longer than 6 in, Grade 1 requirements shall apply.
[d] Grade 5 material heat treated before assembly with a hardened washer is an acceptable substitute.
[e] Grade 7 bolts and screws are roll threaded after heat treatment.
[f] See Table 6 for gage length.
[g] Hex washer head and hex flange products without assembled washers shall have a core hardness not exceeding Rockwell C38 and a surface hardness not exceeding Rockwell 30N 57.5.
[h] Sems-screw and washer assemblies.

Fig. 10-8. Fastener Grades and Identification

b. A positive means must be provided to prevent fifth wheels, including sliding fifth wheels, from shifting on the frame of the vehicle (Section 29001 VC).

(1) A securely mounted fifth wheel with no evidence of shifting shall be deemed to meet requirements for a "positive means to prevent shifting."

(2) The number and type of locking devices in good mechanical condition, normally supplied by a manufacturer of a sliding fifth wheel, shall be deemed to provide the ultimate strength sufficient to control the gross weight of the towed vehicle or combinations of vehicles.

10.7.4 Upper Half Mounting. Check the mounting and securement of the upper half of the fifth wheel. The upper half of the fifth wheel must be securely affixed to the vehicle, structurally adequate, and installed so that the frame will not crack, warp, or become deformed (Sections 29001 VC and 29003 VC).

10.7.5 Structural Failures. Inspect for cracked welds or breaks in the vehicle frame at the mounting area, the mounting plate, or fifth wheel components. Cracks indicating impending structural failure are considered an unsafe condition (Sections 29003 VC and 24002 VC).

10.7.6 Accidental Disconnect Protection. Check the operating handle to ensure that it is designed, installed, and maintained so that it cannot be accidentally operated (Section 29002 VC).

a. The handle is not required to have a separate safety latch to prevent its accidental operation, unless by reason of its design or location it is susceptible to accidental operation. The examples illustrated in Figures 10-9 through 10-18 will assist in appropriate application of this requirement.

(1) The design illustrated in Figure 10-9 complies. The handle design and springload feature of this operating handle protects it against accidental operation and the springload holds the handle in the closed position.

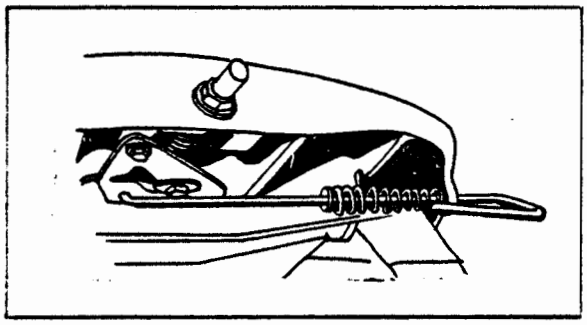


Fig. 10-9. Safety Latch Which Complies

(2) The design illustrated in Figure 10-10 complies. This operating handle must be pulled out to unlock the coupler jaws. It is shielded by the skid plate and is springloaded to hold it in the closed position.

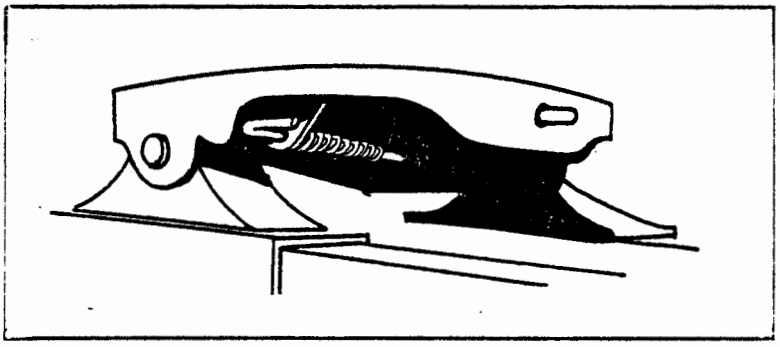


Fig. 10-10. Safety Latch Which Complies

(3) The design illustrated in Figure 10-11 complies. This operating handle is protected against accidental operation by its design and a manually operated safety latch that permits automatic closure of the coupler jaws and holds the handle in the closed position.

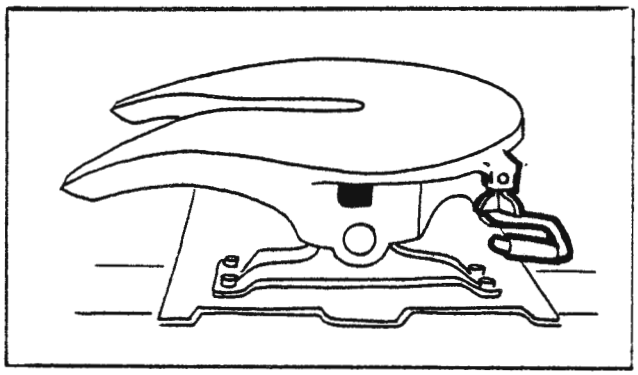


Fig. 10-11. Safety Latch Which Complies

(4) The design illustrated in Figure 10-12 complies. This operating handle is protected against accidental operation by a manually operated safety latch that permits automatic closure of the coupler jaws and holds the handle in the closed position.

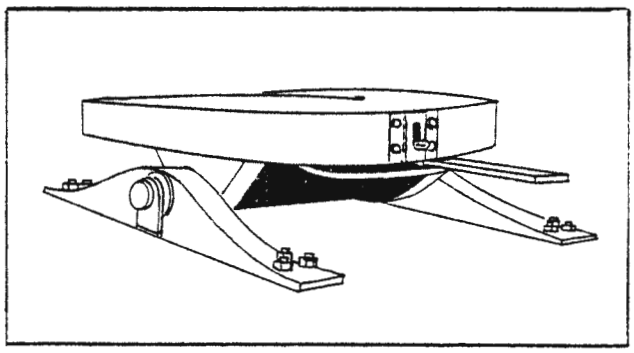


Fig. 10-12. Safety Latch Which Complies

(5) The design illustrated in Figure 10-13 complies. This operating handle is protected against accidental operation by a manually operated safety latch that permits automatic closure of the coupler jaws and holds the handle in the closed position.

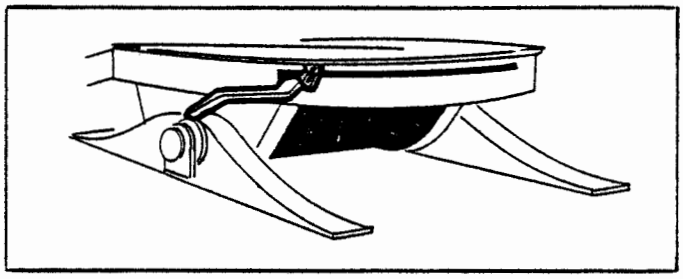


Fig. 10-13. Safety Latch Which Complies

(6) The modification kit installation illustrated in Figure 10-14 complies. This modification has been performed on several fifth wheels presently in use to bring them into compliance, including the types illustrated in Figures 10-17 and 10-18. The safety latch provides protection against accidental operation, holds the handle in the closed position, and permits automatic operation of the locking device.

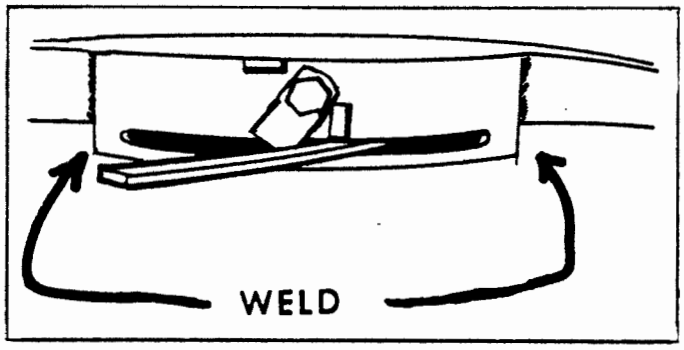


Fig. 10-14. Safety Latch Which Complies

(7) The design illustrated in Figure 10-15, "automatic" fifth wheel operating handle, complies. This operating handle is protected against accidental operation by a gravity latch that must be manually raised to move the operating handle to the open position.

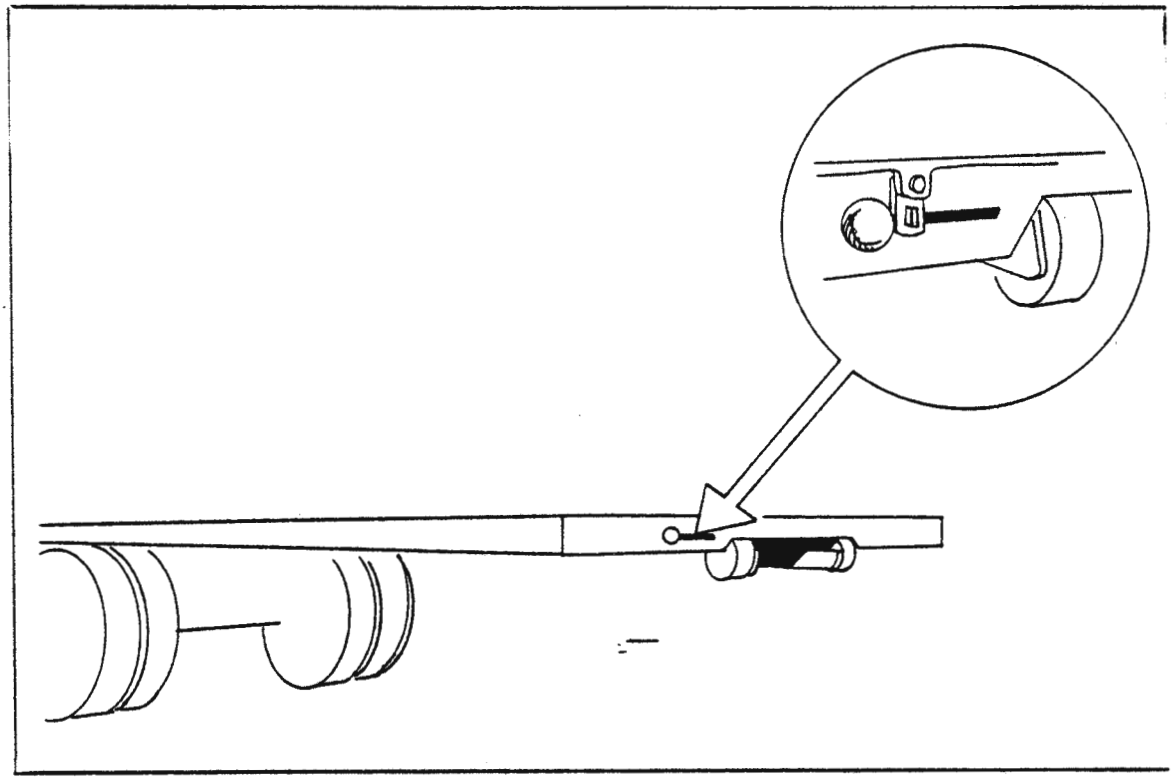


Fig. 10-15. Safety Latch Which Complies

(8) The design illustrated in Figure 10-16 does not comply. This operating handle must be lifted upward and pulled outward to release the coupler jaw locking device. It is not adequately protected against accidental operation. The location and design of the handle leaves it vulnerable to release by loose tire treads and objects set in motion by the wheel rotation. No means is provided to hold it in the closed position.

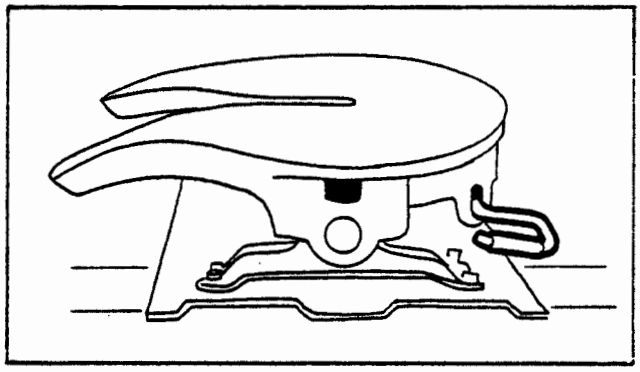


Fig. 10-16. Operating Handle Not in Compliance

(9) The design illustrated in Figure 10-17 does not comply. This operating handle is not adequately protected against accidental operation. It is dependent solely upon a notch in the lever slot to hold it in the closed position.

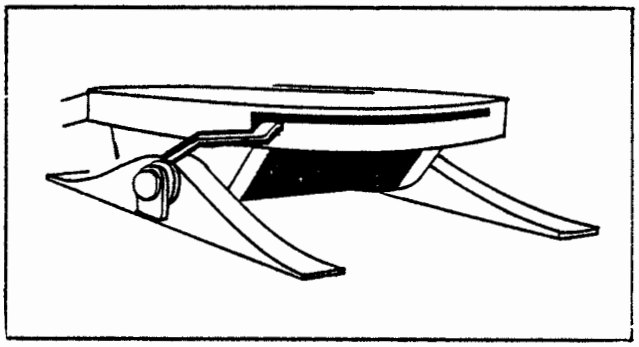


Fig. 10-17. Operating Handle Not in Compliance

(10) The design illustrated in Figure 10-18 does not comply. This operating handle is protected against accidental operation by the pin device but the pin will prevent automatic closure of the coupler jaws if returned to its keeper when the operating handle is moved to the open position.

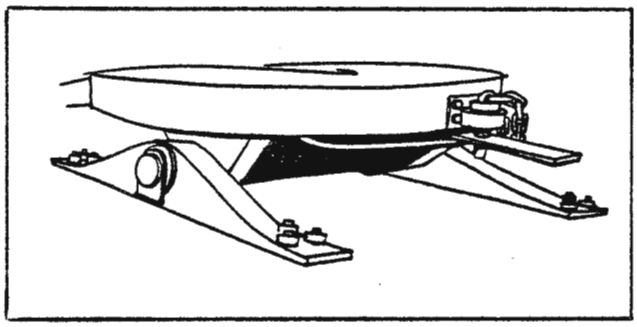


Fig. 10-18. Operating Handle Not in Compliance

b. The foregoing examples of acceptable means of compliance are not exclusive of alternate methods offering equal protection. The examples are provided as a guide to aid in evaluating compliance with the requirements.

10.7.7 Coupler Jaw Engagement. Check the coupler jaws to ensure full closure around the kingpin in the following manner (Section 24002 VC).

a. Ensure that the operating handle is secured in the locked position.

b. Sight down the throat of the skid plate and determine that the coupler jaw(s) is fully engaged. The kingpin will not be visible if the coupler jaws are fully engaged.

c. Examine operating handle for damage, deformation, or excessive wear which will prevent its returning to fully closed position automatically.

10.7.8 Coupler Jaw Locking Mechanism. Check the coupler jaw locking mechanism to ensure it is in position to prevent opening of the coupler jaws (Section 24002 VC).

a. Inspect the operating handle and spring to ensure that there are no broken or missing parts and that the operating handle does not bind.

b. Check the lubricants to ensure that through aging or absorption of dirt and residue, the lubricant has not become so thickened it interferes with free operation.

10.7.9 Kingpin. (This inspection can be made only when the vehicles are separated (Section 24002 VC).)

a. Check the kingpin mounting in the upper skid plate to ensure that it is properly secured and free of cracks, sharp edges, or grooves and is not unduly worn.

b. Check for cracks in any welds securing the kingpin to the skid plate.

c. Measure the diameter of the kingpin at the groove for out-of-round and excessive wear. Kingpins should be replaced when the wear exceeds 3/16-inch.

10.7.10 Skid Plate. Inspect the skid plates as follows (Section 24002 VC).

a. Check bearing surfaces to ensure that the upper half rests evenly and smoothly on the lower half.

b. Check contact surfaces to ensure that there is lubrication present to minimize frictional resistance. Fifth wheels equipped with plastic low coefficient friction liners need not be lubricated.

c. Check bearing surfaces for cracks or warps and heavy galling.

d. Check underplate for cracked webs, deformation, and condition of fulcrum mounting.

10.7.11 Excessive Slack. Check for excessive slack in the coupler jaws and kingpin as follows (Section 24002 VC).

a. With the towed vehicle brakes locked or with its wheels blocked fore and aft, request the driver to slowly move the towing vehicle forward and reversed enough to take up any fifth wheel coupling slack.

b. Observe any movement between the upper and lower halves.

c. If appreciable slack is noted, apply match (index) marks to the upper and lower halves and repeat the towing vehicle movements.

d. Change in alignment of the marks exceeding 3/4-inch is excessive, except that not more than 1 inch of slack is permitted for automatic fifth wheels.

CHAPTER 11

AIR POLLUTION CONTROL

11.1 SCOPE. The information included in this chapter is an overview of the entire vehicle emission control program. To obtain specific information about devices, exemptions, modifications, etc., contact the Air Resources Board, toll free telephone information 800-242-4450.

11.2 SYSTEM DESCRIPTION AND INSPECTION.

11.2.1 Typical Types. Typical vehicle emission control types are illustrated in this chapter. These are not all-inclusive and may vary by make, model, or year of vehicle. Major component parts of each type system are depicted. Disconnection, modification, or alteration of these systems are violations of Vehicle Code Section 27156.

11.2.2 PCV System. The ventilation system of the crankcase is commonly known as the positive crankcase ventilation (PCV) system. Beginning with 1963 models, most U.S. vehicles have been equipped with PCV systems except those made for California, which began with the 1961 models. A typical PCV system is depicted in Figure 11-1.

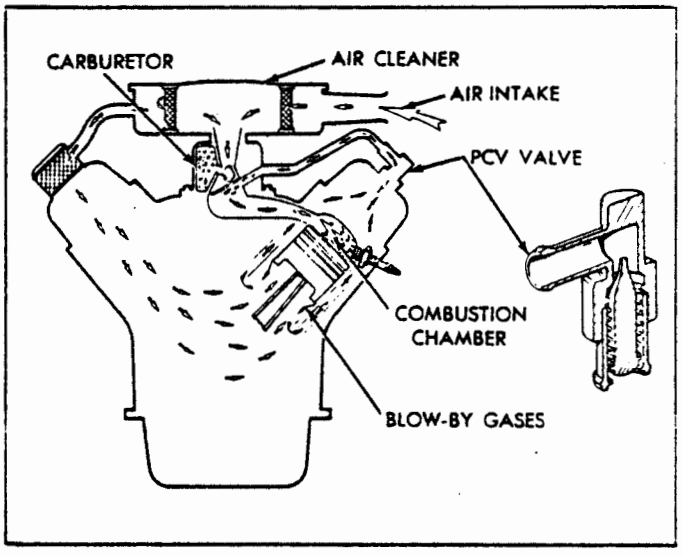


Fig. 11-1. Typical PCV System

a. Inspection Procedure. The PCV system should be inspected as follows:

(1) PCV Valve. Locate the PCV valve, usually found at or near the rocker cover.

(2) Plumbing. Inspect plumbing connections for tightness and proper routing.

b. Violation. A violation exists if plumbing is loose, broken, leaking, or improperly routed.

11.2.3 Air Injection System. Engine emission control systems consist of many different components. Some of the items that may readily be inspected are: air pump, vacuum hoses, and spark plug wires. A typical air injection system is depicted in Figure 11-2.

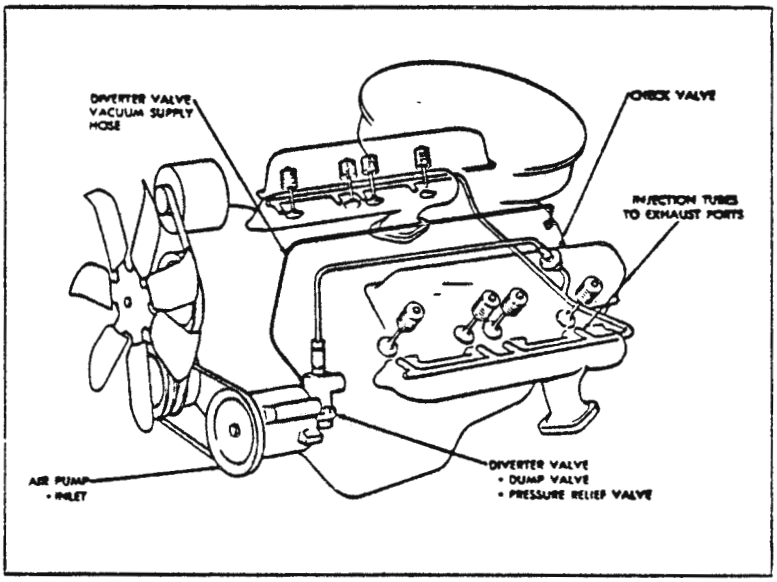


Fig. 11-2. Typical Air Injection System

a. Inspection Procedure. Not all vehicles are equipped with all items; but when they are so equipped, they should be inspected as follows:

(1) Air Pump. Locate the air pump near the front of the engine. Inspect for placement and tensioning of drive belt. Check for obstructions in the air pump.

(2) Vacuum Hoses. Inspect all vacuum hoses for tightness, leakage, pinching, and breakage.

(3) Ignition - Spark Plug Wires. Inspect wires to all spark plugs and to distributor for connections.

b. Violation. A violation exists if:

(1) Air pump drive belt is loose, frayed, cut, or missing or if there are obstructions at the air pump.

(2) Any vacuum hoses are broken, cracked, pinched, disconnected, or missing.

(3) Any spark plug wires are disconnected at either end or are broken or missing.

11.2.4 EGR System. Beginning with 1973 models, most vehicles are equipped with an exhaust gas recirculation (EGR) system which reduces levels of oxides of nitrogen (NO_x) emissions. The only parts of the EGR system readily visible to the inspector are a metering valve and a vacuum hose connecting the metering valve to the carburetor. Both are usually located near or under the air cleaner. A schematic drawing of a typical EGR system is shown in Figure 11-3.

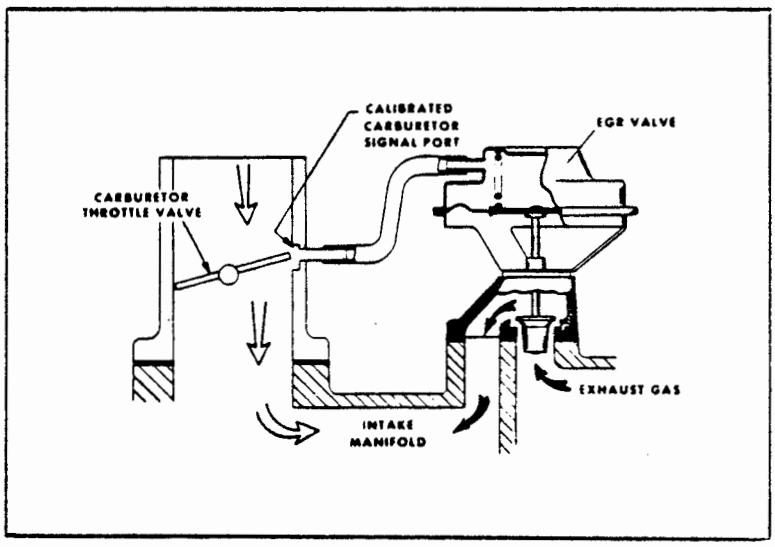


Fig. 11-3. Schematic of Typical EGR System

a. Inspection Procedure. Inspect vacuum hose from metering valve to carburetor body for breaks, pinching, and tight connections.

b. Violation. A violation exists if:

(1) Vacuum hose is disconnected at either end.

(2) Hose is cracked, broken, or pinched.

11.2.5 Evaporative Emission Control System. Most 1970 and later model vehicles are equipped with the evaporative emission control system. With the engine shut off, this system collects fuel vapors from the tank and carburetor into a cannister filled with activated charcoal. During operation of the vehicle, these vapors are purged back into the intake system and burned in the engine. It is a closed system. Therefore, it is necessary that the fuel tank filler cap be tightly in place and that all connections and tubing be securely fastened. A typical system is depicted in Figure 11-4.

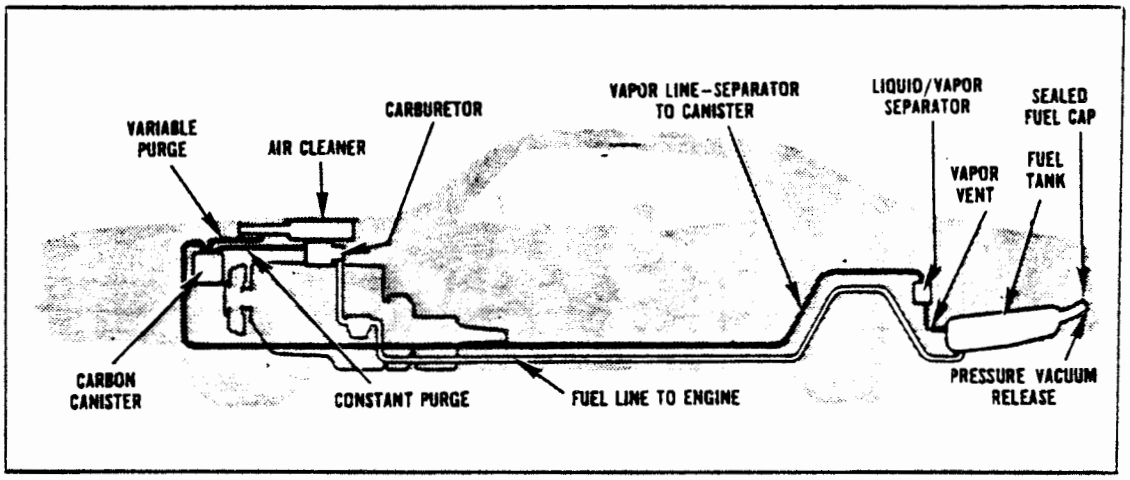


Fig. 11-4. Typical Evaporative Emission Control System

a. Inspection Procedure. The evaporative emission control system should be inspected as follows:

(1) Fuel Tank Filler Cap. Inspect fuel tank filler cap for tight fit.

(2) Cannister. Locate cannister and check hoses and lines for tight connections, cracks, or leaks.

b. Violation. A violation exists if:

(1) Filler cap is missing or fits loosely.

(2) Tubing is pinched, cracked, broken, or not connected to cannister and lines from fuel tank.

11.2.6 Engine Modification System. Engine modification systems vary and the majority of the systems function primarily through internal engine design. The Chrysler "cleaner air package" usually incorporates a deceleration spark control valve similar to that depicted in Figure 11-5. Other vehicles may have similar spark control valves.

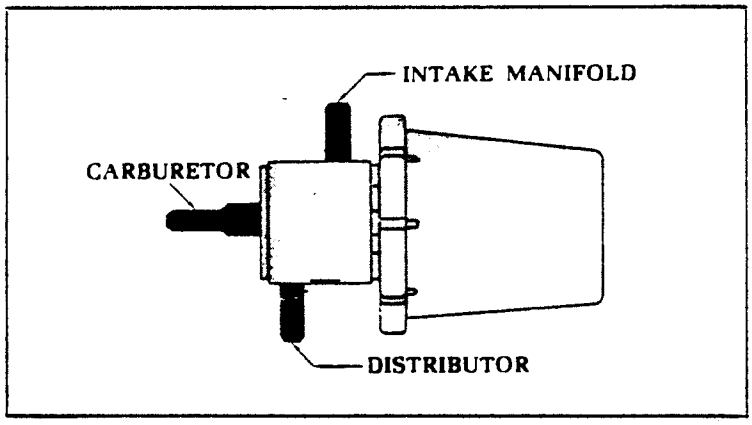


Fig. 11-5. Typical Spark Control Valve

a. Inspection Procedure. Engine modification systems should be inspected as follows:

(1) Spark Control Valve. Locate the valve, normally between the carburetor.

(2) Vacuum Hoses. Inspect all vacuum hoses for tightness, leakage, pinching, and breakage.

b. Violation. A violation exists if:

(1) Valve is disconnected or removed.

(2) Any vacuum hoses are broken, cracked, pinched, disconnected, or missing.

11.2.7 Catalytic Converter. Beginning with 1975 models, most vehicles produced for sale in California, whether of American or foreign manufacture, are equipped with catalytic converters used to oxidize hydrocarbons and carbon monoxide in the engine exhaust system. The catalytic converter is constructed of a stainless steel shell containing two ceramic elements coated with a catalytic agent, usually consisting of a mixture of palladium and platinum. The catalyst facilitates a combustion-type reaction which changes unburned hydrocarbons and carbon monoxide to harmless carbon dioxide and water. The catalytic converter requires no maintenance. However, poor engine operating condition or operation under severe load may result in excessively high temperatures within the converter which can reduce the converter life or destroy the core. Vehicles manufactured for sale in California may have a guard device attached to the converter with "U" bolts to prevent objects from coming in direct contact with the hot converter shell. This protective guard is illustrated in Figure 11-6. Figures 11-7 and 11-8 illustrate the placement of the converter in the exhaust system ahead of the muffler.

Fig. 11-6. Converter Protective Guard

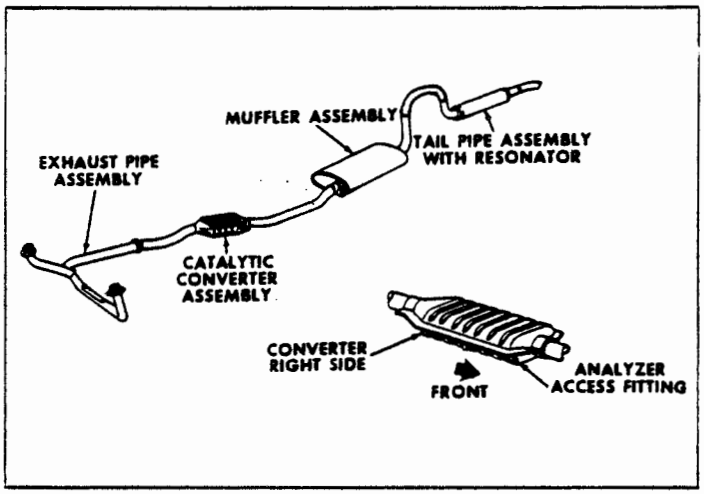


Fig. 11-7. Single Exhaust System with Catalytic Converter

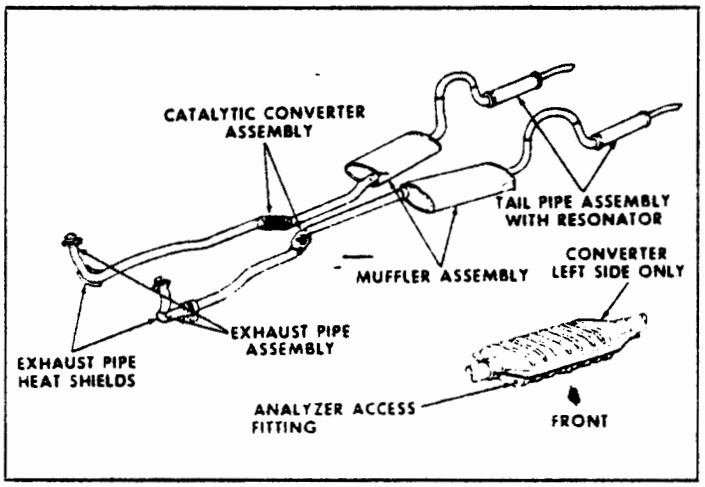


Fig. 11-8. Dual Exhaust System with Catalytic Converter

a. Inspection Procedure. Inspect the exhaust system to determine whether the vehicle is or was ever equipped with a converter.

b. Violation. A violation exists if the converter has been removed, disconnected, or bypassed.

11.3 GENERAL REQUIREMENTS.

11.3.1 Disconnection, Modification, or Alteration. It is unlawful to disconnect, modify, or alter any required motor vehicle pollution control device except for those modifications found acceptable by the Air Resources Board to use a fuel other than gasoline or diesel. It is unlawful to install any device for the purpose of improving engine performance unless such device has been found by the Air Resources Board as not interfering with the operation of any pollution control device and not resulting in vehicle emissions above State or federal standards.

11.3.2 Engine Change. Engines may be changed in vehicles providing the emission control systems required for the model year engine are retained. Engines in new or used vehicles, specially constructed vehicles (e.g., dune buggies), remanufactured vehicles, revived junk or salvage vehicles must be equipped with the pollution controls required for the year model of the engine. Documents or other evidence establishing the year model of the engine will be requested of the applicant for registration of any such vehicle.

11.3.3 Type 1 Devices. Type 1 (open) crankcase control devices on 1965 and newer vehicles do not comply with California requirements and such devices must be converted to a closed-type device upon transfer of vehicle ownership and registration in California.

11.3.4 Legal Removal. Section 27156 VC does not apply where the MVPC device disconnected, altered or modified is not a required device, such as a 1956 model vehicle equipped with a crankcase control device in a noncontrol county. The device may be legally removed.

11.3.5 Information on Conversions and Exemptions. Information regarding conversions to use a fuel other than gasoline or diesel and exemptions for limited production vehicles (less than 210 units per model year) may be obtained from the Air

Resources Board, Vehicle Emissions Control, 9528 Telstar Avenue, El Monte, CA 91731.

11.3.6 Vehicle First Sold or Registered Elsewhere. New model vehicles first sold and registered or operated outside California are normally registered in California as used vehicles, and as such, need not comply with more stringent pollution control requirements for California; however, such vehicles must comply with federal requirements.

11.3.7 Requirements by Model Year. General requirements for air pollution control devices on vehicles are shown by model year in the chart following. Unless otherwise indicated, the requirements apply to gasoline-powered vehicles. Additional exhaust control device requirements for 1955-1965 model year vehicles are contained in paragraph 11.3.8. Additional nitrogen oxides (NO_x) control devices for 1966-1970 modeo year vehicles are contained in paragraph 11.3.9. There are no air pollution control device requirements for 1954 and earlier model year vehicles.

GENERAL POLLUTION CONTROL REQUIREMENTS

Model Year	Passenger Cars and Light Trucks Under 6001 Lbs GVW		Vehicles Over 6001 Lbs GVW
	American Manufacture	Foreign Manufacture	American or Foreign Manufacture
1955-1962	Approved crankcase device required upon transfer of ownership or initial registration to person residing in Alameda, Contra Costa, Los Angeles, Marin, Napa, Orange, Riverside, San Bernardino, San Diego, San Francisco, San Mateo, Santa Clara, and Sonoma Counties and Bay Area portion of Solano County.	No requirement.	Approved crankcase device required upon transfer of ownership or initial registration to person residing in Alameda, Contra Costa, Los Angeles, Marin, Napa, Orange, Riverside, San Bernardino, San Diego, San Francisco, San Mateo, Santa Clara, and Sonoma Counties and Bay Area portion of Solano County. No requirement for vehicles of foreign manufacture.
1963-1964	Approved crankcase device required statewide.	No requirement.	Approved crankcase device required statewide. No requirement for vehicles of foreign manufacture.
1965	Approved crankcase device required statewide.	Approved crankcase device required statewide.	Approved crankcase device required upon transfer of ownership or initial registration.
1966-1967	Approved crankcase and exhaust devices required. (Exhaust device not required if first registered outside California.)	Approved crankcase device required.	Approved crankcase device required upon transfer of ownership or initial registration.
1968	Approved crankcase and exhaust devices required.	Approved crankcase and exhaust devices required.	Approved crankcase device required upon transfer of ownership or initial registration.
1969	Approved crankcase and exhaust devices required.	Approved crankcase and exhaust devices required.	Approved crankcase and exhaust devices required.
1970	Approved crankcase, exhaust, and evaporative loss control devices required. (Evaporative loss control device not required if first registered outside California.)	Approved crankcase, exhaust, and evaporative loss control devices required. (Evaporative loss control device not required if first registered outside California.)	Approved crankcase and exhaust devices required.
1971-1972	Approved crankcase, exhaust (including oxides of nitrogen (NO_x) control), and evaporative loss control devices required. (NO_x control device not required if first registered outside California.)	Approved crankcase, exhaust (including oxides of nitrogen (NO_x) control), and evaporative loss control devices required. (NO_x control device not required if first registered outside California.)	Approved crankcase and exhaust devices required.
1973 and Later	Approved crankcase, exhaust (including oxides of nitrogen (NO_x) control), and evaporative loss control devices required.	Approved crankcase, exhaust (including oxides of nitrogen (NO_x) control), and evaporative loss control devices required.	Approved crankcase, exhaust (including oxides of nitrogen (NO_x) control), and evaporative loss control devices required. (NO_x control device not required on 1973 models if first registered outside California.) Exhaust (including oxides of nitrogen (NO_x) control) devices are required on diesel-powered vehicles commencing with the 1973 model.

11.3.8 Exhaust Control Requirements and Exemptions for 1955-1965 Vehicles. Unless exempted by the Air Resources Board, exhaust control devices are required on 1955-1965 model year passenger cars and light duty trucks under 6,001 pounds gross vehicle weight upon transfer of ownership or initial registration to persons residing in certain air basins.

a. Requirements. The requirements became effective in three air basins as follows:

Date Effective	Air Basin	Counties Included
9-1-72	South Coast	Los Angeles, Orange, Riverside, San Bernardino, Santa Barbara, Ventura
12-1-72	San Diego	San Diego
3-1-73	San Francisco Bay Area	Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Sonoma and Bay Area portion of Solano

b. Exemptions. Exemptions granted by the Air Resources Board are summarized as follows:

(1) 1955-1965 year model vehicles of foreign manufacture.

(2) Vehicles with engines of 140 or less cubic inch displacement.

(3) Vehicles with engines having fuel injection.

(4) Vehicles with engines having no vacuum spark advance type distributor.

(5) Vehicles with engines having no centrifugal spark advance mechanism.

(6) All vehicles which operate on natural or liquefied petroleum gas (LPG). (Includes dual fuel systems.)

11.3.9 Oxides of Nitrogen Control Requirements and Exemptions for 1966-1970 Vehicles. Unless exempted by the Air Resources Board, oxides of nitrogen (NO_x) control devices are required on 1966-1970 model year passenger cars and light trucks under 6,001 pounds gross vehicle weight as follows:

a. Requirement. Effective April 1, 1974, installation of NO_x devices is required upon transfer of ownership or initial registration. Vehicles equipped with NO_x devices upon transfer of ownership or initial registration from out of state must remain so equipped. NO_x devices may legally be removed from any vehicles that were equipped pursuant to a statewide mandatory installation phase based on license plate numbers because that installation phase was cancelled by law.

b. Exemptions. The Air Resources Board has exempted certain 1966 through 1970 model vehicles from the requirement for installation of the NO_x exhaust emission control device. A listing of such exempt vehicles includes, but is not limited to, the following:

(1) All vehicles with engines having less than 50 cubic inch displacement.

(2) All vehicles which operate on natural gas or liquefied petroleum gas (LPG). (Includes dual-fuel systems.)

(3) All vehicles originally equipped with engines having special intake or exhaust manifolds, ram air induction, multiple carburetors, turbochargers, or fuel injection.

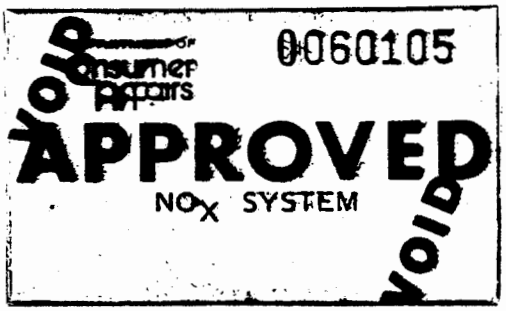
(4) Vehicles with engines equipped with originally designed and approved devices that meet the oxides of nitrogen standard.

c. Certificates of Compliance/Responsibility for Installation. Certificates of Compliance are required to be issued upon the completion of the installation of a NO_x system and upon reinspection of vehicles previously equipped with NO_x systems. Responsibility for installation of oxides of nitrogen control

devices on 1966-1970 year model vehicles upon change of ownership rests with the seller. An individual may install the device himself provided a Certificate of Compliance is obtained from an Official Motor Vehicle Pollution Control Device Installation and Inspection Station.

d. Compliance/Exemption Stickers. To assist in the enforcement of the NO_x device installation program, the following windshield stickers showing compliance or exemption have been developed by the Bureau of Automotive Repair:

Blue



Red

Fig. 11-6. Examples of "Approved" and "Exempt" Windshield Stickers

(1) The stickers are used in conjunction with the Certificates of Compliance. A compliance sticker is placed on the inside lower right corner of the windshield when a NO_x system is installed or an exempt sticker is placed in that location if the vehicle is exempt from the NO_x program.

(2) The Air Resources Board has adopted regulations pursuant to provisions of Section 40001(b)(5) of the Vehicle Code, making it unlawful for the operator or owner of any motor vehicle to remove or deface the windshield sticker which indicates the vehicle is equipped with an approved NO_x device or that the vehicle is exempt from the NO_x device installation

program. It is also unlawful for the operator or owner to request, cause, or permit removal or defacement of the windshield sticker.

(3) During the initial phase of the NO_x installation schedule (2-1-73 to 6-1-73), vehicles under 140 CID were issued exemption stickers because no device was available. Subsequently, a device became available and these vehicles are no longer exempt; but they are not required to be equipped until the next transfer of ownership occurs.

(4) If a window sticker has been removed, defaced or lost, the owner or operator of the vehicle must immediately obtain a replacement sticker from an MVPC station.

11.4 GENERAL EXEMPTIONS.

11.4.1 Totally Exempt Vehicles. The following vehicles are not required by law to be equipped or have been exempted by Air Resources Board from all requirements:

a. Diesel-powered vehicles under 6,001 pounds GVW.

b. Diesel-powered vehicles over 6,001 pounds GVW manufactured prior to the 1973 model year.

c. Motorcycles and motor-driven cycles.

d. Racing vehicles defined as competition vehicles not used on public roads or highways.

e. Vehicles equipped with rotary, two-cycle, or 12-cylinder engines.

f. Vehicles currently registered outside California.

g. Vehicles which qualify for special license plates under Section 5004 of the Vehicle Code.

h. Vehicles of 1963 and prior year models originally equipped with fuel injection, supercharger and/or multiple carburetors.

11.4.2 Vehicles Exempt from Crankcase Device Requirements. The following vehicles are exempt from the crankcase device requirements:

a. Used vehicles for which crankcase devices are not available.

b. Vehicles of 1966-1971 model years with emissions found by appropriate tests by ARB to meet state standards without additional equipment.

11.4.3 Vehicles Exempt from Original Equipment Exhaust Device Requirements. The following vehicles have been exempted from installation of exhaust control devices as original equipment:

a. Vehicles manufactured as 1965 but first sold and registered as 1966 models.

b. Commercial vehicles of 1966-1968 model years designated as being over one-half ton load carrying capacity.

c. Commercial vehicles and housecars of 1967-1969 model years in excess of 6,000 pounds GVW powered by engines manufactured before January 1, 1969, or first sold and registered outside the State of California.

d. Vehicles of 1966-1967 model years first sold and registered outside of California.

e. Vehicles for which no device is available.

11.4.4 Vehicles Exempt from Evaporative Loss Control Requirements. Off-road utility vehicles (defined as light-duty vehicles with special features for off-road operations such as four-wheel drive) manufactured between January 1 and April 30, 1971, have been exempted from evaporative loss control device requirements.

11.4.5 Specific Vehicles. From 1968 through 1973, specific vehicles were granted exemptions from certain MVPC requirements by the Air Resources Board. No exemptions have been granted to 1974 and later vehicles.

11.5 MODIFICATION AND REPAIR.

11.5.1 Approved Fuel System Conversions. Acceptable fuel conversion systems will display on the carburetor or fuel mixer a decal indicating acceptance by the Air Resources Board and providing tune-up information for the engine equipped with such system. Converted engines are not exempt from crankcase device requirements and must comply with gaseous fuel regulations.

a. Crankcase Device Requirements. A modification or conversion to use an alternate fuel does not involve the crankcase emission control device. Any such required device shall be installed and maintained in proper operating condition.

b. Dual Fuel Conversion. A vehicle modified to use dual fuels shall remain equipped with all MVPC devices required by law for the year model of the vehicle and such devices shall be maintained in proper operating condition except as provided below:

(1) Vehicles modified to utilize the standard gasoline carburetors and which have a combination gas mixer and air cleaner on the carburetor.

(2) Vehicles equipped with a modified carburetor and which have a combination gas mixer and air cleaner on the modified carburetor.

c. Carburetor Hot Air System. It is not practical to retain the carburetor hot air system on the above dual fuel system conversions. Therefore, the Air Resources Board has accepted modifications to exhaust emission systems on dual-fueled engines as follows:

(1) Removal of the original hot air system air cleaner and ducting including the heat transfer hose.

(2) Disconnecting the ignition distributor vacuum advance when Dual Systems, Inc., Model 125 (Pacific Lighting Service Co.) equipment is installed.

d. Complete Fuel Conversion. A vehicle converted to use LPG or natural gas exclusively is not subject to exhaust emission and fuel evaporative loss control requirements, otherwise applicable to the year model of the vehicle.

11.5.2 Unlawful Engine Modifications. The following are examples of modifications of approved devices which are unlawful:

a. Installed turbochargers.

b. Addition of one or more carburetors beyond number approved. (Note: Certain engine families are approved for either two or four barrel carburetors.)

c. Add-on devices not exempted by the Air Resources Board.

d. Complete removal of carburetor chokes or replacement of automatic chokes with manual chokes.

e. Replacement of distributors not equipped with vacuum advance, if vacuum advance was originally installed.

f. Replacement exhaust manifolds without air injection ports, if originally required.

11.5.3 Replacement Parts. The use of other than original manufacturer's equipment as aftermarket replacement parts solely for the purpose of maintenance or repair according to manufacturer's instructions, or for the replacement of a defective or worn part is permitted if the replacement part performs essentially the same operation as the original part. The dealer or installer of other than original replacement parts should have a reasonable basis for knowing that such parts will not adversely affect the performance of required emission control equipment. Such replacement parts may include but are not limited to:

a. Replacement or rebuilt carburetors.

b. Replacement or rebuilt ignition distributors.

c. Ignition coils.

d. Ignition wires.

e. Intake manifolds.

f. Exhaust manifolds.

g. Rocker arm covers.

h. Carburetor air cleaners.

11.5.4 Idle Limiter Caps. The removal of plastic idle limiter caps from carburetor fuel-air adjustment screws does not constitute a violation of Section 27156 VC.

11.5.5 Aftermarket Auxiliary Fuel Tank Installations. Auxiliary fuel tanks without evaporative loss emission control systems had been installed on many 1970 through 1972 model light-duty vehicles before it was determined that such installations were unlawful modifications to vehicles required to be equipped with evaporative loss controls. Legislation now provides that installations, before January 1, 1974, of aftermarket auxiliary fuel tanks on 1973 and earlier model vehicles required to be equipped with evaporative loss emission controls shall not be deemed to be a violation of Section 27156 VC. Such installations, on or after January 1, 1974, to 1970 and later model vehicles must comply with Air Resources Board standards or criteria for auxiliary gasoline fuel tank evaporative loss control devices or systems.

CHAPTER 12

PASSENGER AND LIGHT DUTY VEHICLES

12.1 SCOPE. This chapter applies to the inspection of passenger vehicles as conducted by road patrol officers.

12.2 INTRODUCTION. The information in this chapter is intended to provide guidance to personnel engaged in the inspection of passenger vehicles. It does not include detailed inspection procedures, but it provides a listing of equipment items required on a vehicle and identifies causes which constitute noncompliance.

12.3 PASSENGER VEHICLE INSPECTION.

12.3.1 Passenger Vehicle Defined. For the purpose of inspection, a passenger vehicle is one of the following classes of passenger and light duty vehicles:

a. Passenger cars, including station wagons and taxis.

b. Housecars.

c. Jeeps.

d. Pickups and panels.

e. Combinations towed by the foregoing.

f. Motorcycles and motor-driven cycles.

12.3.2 Inspection. Passenger vehicle inspection is on-highway inspection designed to reduce accident frequency by identifying and effecting correction of vehicle equipment deficiencies. Inspections are performed upon passenger vehicles when the vehicles are stopped for either observed equipment violations or other enforcement action.

12.3.3 Inspection Guide. Items to be inspected listed in the inspection guide following are not necessarily in order of importance or sequence of inspection.

For sake of brevity, those items common to all vehicles are not repeated under headings of vehicle types other than automobiles and light trucks.

Automobiles and Light Trucks

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
Driver License	Check possession and validity.	Non-possession. Expired. Improper class. Non-current address. Disobeying restrictions. Unlawful use of license. Mutilated.	12951(a) 12951(a) 12500(b) 14600(a) 14603 14610 12815
Registration	Compare vehicle against registration card.	Non-possession. Incorrect address. Vehicle and registration do not match. Card or plates lost. Plate(s) mutilated/missing, plates covered, not properly mounted. License plate altered. Tab missing. Fees or transfer due.	4454 4160 4462(b) 4457 5201 4464 5204 4000(a)
Lighting Equipment	Check condition and operation of:		
	Stoplamps	Stoplamps inoperative. Less than 2 after 1-1-58. Improper height. Not at same level on both sides. Not red or amber visible 300 ft.	24603(a) 24603(b) 24603(c) 24603(d) 24603(e)
	Red Rear Reflectors	Not equipped. Less than 2 after 1-1-65. Improper height.	24607(a) 24607(b) 24607(d)
	Backup Lamps	Later than 1-1-69, not equipped. Not white, projects more than 75 ft. Lit when not backing.	24606(a) 24606(b) 24606(c)
	Taillamps	Taillamps inoperative. Less than 2 after 1-1-58. Not at same level on both sides. Improper height. Not red visible 500 ft. on vehicles manufactured before 1-1-69 (1000 ft. on vehicles manufactured after 1-1-69).	24252(a) 24600(b) 24600(d) 24600(f) 24600(e)

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
Lighting Equipment (Continued)	License Plate Lamp	Not white, does not illuminate plate to render clearly legible from 50 ft.	24601
	Turn Signal System*	Sold 1957 or earlier equipped. Sold after 1957 not equipped. Not visible for 300 ft. Inoperative or wrong color. Inoperative pilot indicator.	24252(a) 24951(b) 24952 24953(a) 24012 (13 CAC 793(d))
	Headlamps	Inoperative. Improperly aimed. (Improper aim requires a lamp certificate.)	24252(a) 24012 (13 CAC 728)
	Beam Selector	Unable to select beam.	24406
	Beam Indicator (High Beam)	Inoperative.	24408
Suspension	During the under car portion of the brake, steering and muffler inspections, close attention should be given the following components: (1) Frame and frame members (2) Control arms (3) Stabilizer bars and connecting links (4) Ball joint seats, retainer plates and studs (5) Springs, spring shackles, "U" bolts and torsion bars (6) Shock absorbers	Malfunctions or defects which are immediate safety hazards such as cracked, broken, mechanically deformed or missing parts.	24002
Parking Brakes	Apply and release parking brake.	Not installed, inoperative, or inadequate.	26451

*Certain Ford models were produced with four parking lamps on the front as standard or optional equipment. Production of models so equipped has been stopped. Therefore, no enforcement action shall be taken when four parking lamps are noted on 1970/71 Fords and 1972 models of Maverick Grabber and Mustang Boss.

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
Service Brakes	Depress the brake pedal with engine running. Observe pedal travel.	Travel exceeds 4/5 of full travel. (Indicates adjustment or relining may be needed.)	
		Pedal depresses to floor pan and satisfactory pedal level obtained only by pumping. (Brakes out of adjustment.)	26453
		Pedal depresses slowly when applied pressure is maintained. (Leak in wheel cylinder and/or lines or internal leak in master cylinder.)	26453
Power Brakes	Check power brake booster by stopping engine, pumping brake pedal to exhaust vacuum reserve from system, and holding brake pedal in applied position while restarting engine.	Brake pedal fails to move downward slightly when engine is restarted. (Power brake vacuum booster unit is defective. Brake certificate is required.)	26453
Brake Warning Light	Release parking brake. Apply service brake.	Light remains on when parking brake is released or comes on when service brake is applied. (Brake warning light indicates half of dual brake system defective. Brake certificate required.)	26453
Hydraulic Brake Lines	Check routing and condition of flexible brake hoses to front wheels. Make cursory check of visible areas of hydraulic system for fluid leaks.	Hoses kinked, cut, cracked, or abraded into cord layer.	26453
		Fresh, wet leakage. (Hydraulic system defective. Brake certificate required.)	26453
Steering	Check: Lash. If vehicle is equipped with power steering, engine must be running.	Lash exceeds 2 inches at steering wheel rim. (Indicates adjustment may be needed.)	
	Check: Steering gear box mounting to frame.	Loose mounting; bolts missing.	24002
	Check: Power steering pump and hoses for leaks, cracks, cuts, or abrasions through cord layer.	Hoses cut, cracked, or abraded into cord layer; fresh, wet leakage.	24002
	Check: Power steering pump drive belt.	Belt cracked, loose, broken, or frayed. (Power steering pump belt should be replaced.)	24002

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
Lowered Vehicle	Determine whether vehicle has been intentionally lowered.	Any portion of vehicle is below rim height.	24008
Wheels and Tires	Observe for bent wheels, exposed cord, sidewall bumps, bulges, blisters, or knots, and cuts or snags in tread. Check tread depth.	Tires worn below minimum tread depth. Cut or snag exceeds one inch in tread area. Cord exposed or damaged. Bump, bulge, knot, or separation of tread.	27465(b) 24002 24002 24002
Emission Control Devices	Ascertain whether all component parts of systems are installed, connected, and apparently functioning.	Component parts missing, disconnected, or obviously not functioning. (Certificate of Compliance required.) Intentional removal or disconnect of system or components. (Certificate of Compliance required.)	27156 27156
Windshield Wipers	Determine condition of windshield wiper blades. NOTE: Do not operate wipers.	Blade cracked or torn. Less than 2 after 1-1-50.	26707 26706(b)
Horn	Have motorist sound horn.	Not equipped. Inoperative horn. Not audible for 200 ft. Unreasonably harsh or loud sound.	27000 27000 27000 27000
Mirrors	Determine if vehicle has two mirrors, one of which is mounted on left side.	Less than 2 mirrors. Defective mirror. No mirrors on right side when towing and/or load obstructs driver's view to rear.	26709(a) 26709(a) 26709(b)
Fenders	Determine if vehicle is equipped with adequate fenders or other devices to minimize spray or splash of mud or water to rear. (Does not apply to vehicles not subject to registration, trailers weighing less than 1500 lbs. manufactured and first registered prior to 1-1-71.)	Not equipped. Fenders are not wide enough to cover tread portion of tire.	27600 27600

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
Auxiliary Fuel Tanks	Determine if auxiliary fuel tanks installed on a 1974 or later model vehicle, after 1-1-74 are approved by the State Air Resources Board.	Unapproved auxiliary fuel tanks installed on a 1974 or later model vehicle.	27156
Fuel Cap	Determine if vehicle is equipped with proper fuel cap.	Not equipped with noncombustible cap or cover (vehicles not required to be equipped with fuel evaporative loss control systems). Not equipped with appropriate cap for type of fuel evaporative system installed. (No Certificate of Compliance necessary if this is only emission system violation.)	27155 27156
Exhaust System	Listen for exhaust leaks or excessive noise.	System not reasonably gas tight. Inadequate or defective muffler. Modified to emit excessive noise. Equipped with cutout or bypass.	27154 27150 27151 27150
Glass	Check windshield and all windows for unauthorized material or conditions that obscure driver's view.*	Unmarked or improper type materials for specific location. Object or material on windshield, side or rear windows which obscures driver's view to front, rear, or immediate left or right. *Transparent material on or affixed to windshield, side windows to the immediate left or right of the driver, or rear windows that alters color or reduces light transmittance of window. Windshield or rear window is such a defective condition as to impair driver's vision. (This violation must be corrected within 48 hours.)	26701(a) 26708(a) 26708.5 26710

*AS-1 is permitted anywhere on the vehicle; AS-2 and AS-2-26 are permitted anywhere on the vehicle, except the windshield; AS-3 and AS-3-26 are limited to rear windows not required for driver's vision, side windows directly to the rear of the driver, roof opening, and camper windows.

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
Bumpers*	Determine that bumpers are adequate if required. Vehicles not originally equipped with bumpers front or rear upon initial sale or registration, or the following vehicles are not required to be equipped with bumpers: (1) Motorcycles (2) Housecars (3) Specially constructed vehicles (4) Motor vehicles equipped with four wheel drive (5) Motor vehicles constructed on a truck chassis (6) Motor vehicles operated for hire, compensation, or profit (7) Limited production motor vehicles (8) Off-highway vehicles (9) Vehicles manufactured prior to 1933 not originally equipped with bumpers. (10) Motortrucks, including pickups (11) Truck tractors	Not equipped if required, or inadequate.	28071

*A bumper, as defined in Section 28071 VC, means a device to prevent the front or rear body portions of the vehicle from making contact with the front or rear body of another vehicle. Manufacturer, as used in Section 28071 VC, refers to the bumper manufacturer. The wording of Sections 28070 and 28071 VC places the responsibility on enforcement personnel to exercise sound professional judgment in determining whether a violation exists or that the vehicle has an adequate bumper. An adequate bumper should be regarded as a device constructed of metal, solid wood, pipe, metal bar or rod stock, heavy rubber blocks, or a combination of these materials that are securely affixed to the vehicle.

Motorcycles

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
	NOTE: Inspect automobile inspection items which also apply to motorcycles with the following additions:		
Seat Height	Determine if driver can reach ground with both feet while sitting astride the seat.	Driver unable to reach ground with both feet.	27801(a)
Handlebars	Determine if rider's hands on handgrips are at or above his shoulder height when sitting astride the seat.	Rider's hands on grips at or above his shoulder height.	27801(b)
Brakes	Determine if motorcycle is equipped with brakes on all wheels. Inspect brake system for obvious defects.	1966 or later motorcycles without brakes on all wheels. Brake cables with broken or frayed strands, mechanical parts missing, broken, or badly worn, and excessive travel of brake pedals or levers.	26311(a) 26453
Turn Signals	Determine that motorcycles manufactured and first registered on or after January 1, 1973 are equipped with lamp-type turn signal systems.	Not equipped with turn signals as required. (Not required on motorcycles unable to attain 30 mph.)	24951 (b)(4)
Passenger Equipment	Determine if seat and foot rests are provided for passenger (applies only when passengers are being carried).	Missing seat or foot rests when passenger is being carried.	27800

Campers and Housecars

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
	NOTE: Inspect automobile inspection items which also apply to campers and housecars with the following additions:		
Clearance and Sidemarker Lamps	Determine if vehicle is equipped with required clearance and sidemarker lamps if 80 or more inches in width (applies only during darkness).	Clearance or sidemarker lamps inoperable. Improper color. No midpoint sidemarker lamp on housecar more than 30 feet in length and manufactured after 1-1-69.	24252 25100(a) 25100(a)
Emergency Warning Devices	If vehicle is 80 or more inches in width, determine whether 3 emergency warning devices of approved type are carried.	Less than 3 emergency warning devices of approved type carried by vehicle 80 or more inches in width.	25300(a)
Safety Glazing Material (Campers)	Determine if safety glazing material is used in all outside doors and windows.	Other than approved safety glazing material in outside doors or windows.	26701(b)
Camper Securement	Determine if securement of camper to vehicle is adequate for structure and weight carried.	Securement inadequate.	24002
Fire Extinguisher	Determine if vehicle is required to be equipped w/fire extinguisher per 28060 VC. (Applies to vehicles sold after March 7, 1973, only.)	Not equipped as required.	28060(b)
Camper Exit	Determine if passenger in camper has at least one unobstructed exit available. (Capable of being opened from both the interior and exterior of camper.)	No exit available. Exit only capable of being opened from exterior or interior.	23129
Camper Alarm	Determine that camper, which does not have an opening between camper and vehicle, is equipped with an alarm system enabling person in camper to gain attention of driver.	No alarm system. Alarm connected to vehicle horn.	28080(a) 28080(b)

Trailers and Trailer Coaches

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
	NOTE: Inspect automobile inspection items which also apply to trailers and trailer coaches with the following additions. Turn signals are required on all trailer coaches.		
Trailer Hitch and Safety Chain	Determine if trailer hitch is properly and securely mounted and structurally adequate for weight drawn.	Trailer hitch or frame shows evidence of distortion. (Frame includes bumper (Douglass v. Webb (1962) 26 Cal. Rptr. 60))	29003
Safety Chain	Determine if safety chain is present and adequate for weight drawn.	Chain not present or not connected. Chain inadequate for weight drawn. (Chain breaking strength should be at least equal to weight of towed vehicle.)	29004 29004
Breakaway Brakes	Determine if vehicle is equipped with breakaway brake switch and power source to automatically apply brakes. (Applies to trailer coaches over 1500 lbs. equipped with power brakes registered after 12-31-55 and all trailers required to have brakes and equipped with power brakes.)	Not equipped.	26304(a)
Fire Extinguisher	Determine if vehicle is required to be equipped with a fire extinguisher per 28060 VC. (Applies to vehicles sold after March 7, 1973, only.)	Not equipped as required.	28060(b)
Power Brake Single Control	Determine if single control actuates brakes on both towing and towed vehicle. (Applies to vehicles required to be equipped with brakes and which are equipped with power brakes.)	Brakes not capable of being actuated by single control. (Dual controls permitted, but combination must have single control capability.)	26458
Clearance and Sidemarker Lamps	Determine if vehicle is equipped with required clearance and sidemarker lamps if 80 or more inches in width (applies only during darkness).	Clearance or sidemarker lamps inoperable. Improper color. No midpoint sidemarker lamp on trailer or trailer coach more than 30 feet in length and manufactured after 1-1-62.	24252 25100(a) 25100(a)

INSPECTION ITEM	INSPECTION PROCEDURE	VIOLATION	ENF. SEC (VC)
Emergency Warning Devices	If vehicle is 80 or more inches in width, determine whether 3 emergency warning devices of an approved type are carried.	Less than 3 emergency warning devices of an approved type carried by vehicle 80 or more inches in width.	25300(a)

GLOSSARY OF BRAKE TERMINOLOGY

Air Assisted Hydraulic Brake System. A hydraulic type brake system which utilizes air to assist the driver's effort to apply the brakes.

Air Brake Hose. *A flexible hose used in or connected directly into the service or emergency stopping air supply system. All hoses must conform with SAE J40 (in 1952 through 1968 editions of the SAE handbook), with J1402 (in later editions), or with requirements for type 3B coiled nylon tubing in SAE J844 (in 1970 or later editions).*

Air Brake Line. *Tubing or pipe used in a section of air system where flexing action is not necessary.*

Air Brake Reservoir. A storage container for compressed air.

Air Brakes. A brake system using compressed air either for actuating brakes at the wheels of a vehicle or as a source of power for controlling or applying brakes which are actuated through hydraulic or other intermediate means.

Air Compressor. A device which compresses air used for actuation of the brakes and/or other components of the vehicle.

Air Compressor Governor. A device which controls the compression of air within a preselected range of pressures.

Air Guage. A gauge usually mounted on the instrument panel which indicates the air pressure in the air reservoir tanks, brake application pressure, or other air system pressures.

Air Governor. A regulator which controls the supply of air pressure for the brake system, generally by controlling the air compressor cut-in and cut-out pressure within a preset range.

Air Hydraulic Power Unit. A unit consisting of an air brake cylinder or chamber, hydraulic cylinder(s) and control valve, in which driver effort is combined with force from the cylinder piston or chamber diaphragm to displace fluid under pressure for actuation of the brake(s).

Air Over Hydraulic Brake System. A hydraulic type brake system actuated by an air-powered master cylinder.

Air-Powered Master Cylinder. A brake master cylinder actuated by an air brake cylinder or chamber.

Air Pressure Protection Valve. A unit through which air flow is prevented except when a preselected input pressure is exceeded.

Air Pressure Reducing Valve. A unit which delivers a preselected output pressure.

Air-to-Vacuum Conversion Relay Valve. A relay valve which converts air brake signals to equivalent vacuum brake signals.

Antiskid Brake System. A misnomer. See Wheel Slip Brake Control System.

Armature. The rotating part of the brake actuating mechanism which is attracted by the magnet.

Automatic Moisture Ejection Valve. A unit which operates to expel a fixed volume of fluid when air under pressure is delivered to its control port. (Spitier Valve)

Auxiliary Control Valve. A unit which controls pressure in various portions of the brake system.

Auxiliary Vacuum Pump. A device which creates vacuum to augment the primary source of vacuum.

Brake. An energy conversion mechanism used to (1) retard, (2) stop, or (3) hold a vehicle.

Brake Assembly. An assembly of brake parts, the components of which are determined according to the type or design of the brake system.

Brake Cam. A cam mounted on the camshaft and located between the ends of the brakeshoes. When rotated by the brake camshaft, the cam expands the brakeshoes against the brakedrum.

Brake Camshaft. The brake camshaft is held to the vehicle axle housing or backing plate by bosses containing bronze or nylon bushings. Air pressure is converted into mechanical force by the brake chamber which is attached by a push rod to the slack adjuster. The slack adjuster multiplies this force and converts it into torque which is transmitted by the camshaft to the brake cam. The brake cam once more multiplies the force by the lever principle and applies the force to the brakeshoes.

Brake Chamber or Actuator. A unit in which a diaphragm converts pressure to mechanical force for actuation of the brake(s).

Brake Cylinder. A unit in which a piston converts pressure to mechanical force for actuation of the brake(s).

Brake Failure Warning Switch-Hydraulic. A device used to complete an electrical circuit to indicate a pressure loss in one portion of a dual hydraulic circuit brake system.

Brake Hose. A flexible conductor for the transmission of fluid pressure in the brake system.

Brake Lever or Handle. A hand-operated lever or handle which, when actuated, causes the brake(s) to be applied.

Brake Master Cylinder. The primary unit for displacing hydraulic fluid under pressure in the brake system.

Brake Pedal. A foot-operated lever which, when actuated, causes the brake(s) to be applied.

Brakeshoe. A rigid, half-moon shaped metal device with friction material affixed to the outer surface. The brakeshoes are generally mounted on a backing plate and are located inside the brake drum. When expanded by the brake mechanism, the brakeshoes press the brake lining against the brake drum, which creates friction to stop the rotation of the wheels, which in turn stops the vehicle.

Brakeshoe Anchor Pin. A pin which holds the brakeshoe in its proper place within the brake drum and serves as a pivot for the brakeshoes. One end of each brakeshoe is generally connected to the backing plate or spider by anchor pins.

Brake System. A combination of one or more brakes and the related means of operation and control.

Brake Wheel Cylinder. A unit for converting hydraulic fluid pressure to mechanical force for actuation of a brake.

Check Valve. A unit which is used to isolate automatically one part of the brake fluid system from another part.

a. Closed Type. A check valve which allows fluid flow in one direction only.

b. Open Type. A check valve, normally open to fluid flow in both directions, which closes when fluid flow in one direction exceeds a predetermined value.

c. Residual (and Compensating) Type. A two-function unit in which one function either restricts fluid from the brake wheel cylinder(s) or retains a pressure in the brake wheel cylinder(s) at the time of brake release, and the other function permits fluid compensation for fluid volume changes.

d. Two-Way Type. A shuttle type valve usually placed in the tractor service lines between the lines from the hand valve and foot valve. The two-way check valve provides for activation of the brake system by either of the two controls. The valve prevents air from exhausting from the foot valve when the hand valve is applied and vice versa.

Constant Line (Supply). A flexible conductor terminated by a hose coupler for transmitting supply vacuum from the towing vehicle to the towed vehicle.

Controller. A variable resistance for graduated control of the brake(s).

Control Line. A flexible conductor terminated by a hose coupler for transmitting control vacuum from the towing vehicle to the towed vehicle.

Cutoff Cock. A shutoff valve generally located behind the cab on tractors, or at the rear of the truck bed in the service and emergency lines of the air brake system. The valves are used to manually shut off the air to the trailer lines while the motor vehicle is running bobtail. (These valves occasionally are not installed when a tractor protection valve is used.)

Dash Control Valve. A manually operated valve that actuates the tractor protection valve or other devices.

Deceleration. The rate of reduction of the speed of the vehicle expressed in feet per second.

Diaphragm. A rubber partition placed between the two halves of the brake chamber. When air pressure is introduced into the chamber on one side of the diaphragm, the pressure flexes the diaphragm and exerts force on the pushplate attached to the push rod. The pushplate is held up against the diaphragm by a light duty return spring.

Disc Brake. A brake in which the friction forces act on the faces of a disc(s).

Disc Brake Caliper Assembly. The nonrotational components of a disc brake, including its actuating mechanism for development of friction forces at the disc.

Disc (Rotor). The parallel-faced circular rotational member of a disc brake assembly acted upon by the friction material.

Drain Cocks. Small valves located in the bottom of the air reservoir tanks to permit draining of accumulated condensed water and oil from the tanks.

Driver Perception Reaction Time or Distance. The time elapsed or distance traveled between the instant or point at which the driver has an opportunity to perceive a demand for braking and the instant or point at which the driver starts to move the braking controls.

Drum. The cylindrical rotational member of a drum brake assembly acted upon by the friction material.

Drum Brake. A brake in which the friction forces act on the cylindrical surface(s) of a drum.

Dual Brake Master Cylinder. The primary unit, consisting of two hydraulic sections for displacing fluid under pressure in a dual hydraulic circuit brake system.

Dual Hydraulic Circuit (Split Hydraulic) Brake System. A service brake system consisting of two separate hydraulic circuits which, upon failure in either circuit, retains partial brake actuating capability.

Electric Breakaway Switch. A control unit used on a towed vehicle to provide for automatic application of the electric brake(s) in case of a breakaway from the towing vehicle.

Emergency Brake System. A brake system used for stopping a vehicle in the event of a malfunction in the means of operation and control of the service brake system.

Emergency Brake Valve. A unit under the control of the driver which, when actuated, will activate the emergency brake system.

Emergency Line (Supply). A flexible air brake hose terminated by a hose coupler for transmitting supply air from the towing vehicle to the towed vehicle.

Fade.

a. Heat Fade. A temporary reduction of brake effectiveness due to a loss of friction between braking surfaces, resulting from heat.

b. Water Fade. A temporary reduction of brake effectiveness due to a loss of friction between braking surfaces resulting from water.

Follow-Up Type Valve. A unit which responds to fluid displacement or mechanical linkage movement, to modulate pressure in a cylinder or chamber.

Foot Valve. A brake application and release valve located on the floor or firewall of the motor vehicle between the throttle and the clutch. It may be either a treadle or a pedal and is operated by foot pressure applied by the driver to apply air pressure to the service brake system. The valve may be either attached to the treadle or may be remotely mounted under the floor and connected to the pedal by means of a rod. This valve generally applies air pressure to all braking axles on all vehicles in the combination.

Gladhand. See Hose Coupler.

Gladhand Rubber. A rubber gasket used in the hose couplers to provide a seal between two gladhands and to prevent the escape of air when the gladhands are connected.

Hand Control Valve (also called Graduating Hand Control Valve). A lever-operated valve located in the cab of the motor vehicle, normally mounted on the dash or steering column. This valve permits the driver to make controlled application and release of only the trailer brakes.

Hold-Off Valve. A unit which permits free fluid flow in either direction when the brakes are not applied, but prevents pressure build-up in one part of the brake system until pressure in the other part reaches a predetermined value.

Hose Coupler. A separable mechanical connector for the brake hose between the truck or tractor and the trailer, or between two trailers.

Hydraulic Brake System. A brake system in which brake operation and control utilizes hydraulic brake fluid.

Lining Glaze. Surface hardening accompanied by reduction in friction value.

Load Compensating Resistor. An adjustable resistance for limiting current in a brake control circuit to achieve brake balance.

Load Proportional Brake Control. A system or device which regulates the input force to the brakes on an axle in proportion to the load on that axle.

Logic Controller. A part of the wheel slip brake control system which interprets input signals from the sensor(s) and transmits the controlling output signals to the modulator(s).

Low Pressure Indicator. A unit or combination of units which provides a visible and/or audible warning signal whenever the stored pressure in the brake system is below a predetermined value.

Magnet. The part of the brake activating mechanism which, when energized, attracts the armature, creating a force to apply the brake(s).

Manual Hydraulic Brake System. A hydraulic type brake system which utilizes unassisted driver effort.

Manual Hydraulic Brake System. A hydraulic type brake system which utilizes unassisted driver effort.

Modulator. A part of the wheel slip brake control system which receives signals from the logic controller and adjusts brake actuation force.

Parking Brake System. A brake system independent in operation from the service brake system used for holding a vehicle in a parked position. A locking mechanism is employed to hold the brakes in the applied position when the vehicle is unattended or when the energy used to apply the brakes is no longer present.

Pedal Reserve. The pedal reserve is the amount of total pedal travel left in reserve when the brake pedal is depressed to the "brake applied" position.

Power Brakes. Any braking gear or mechanism that aids in applying the brakes of a vehicle and which utilizes vacuum, compressed air, or electricity for that purpose.

Pressure Proportioning Valve. A unit which changes the ratio of its output pressure to its input pressure.

Protected Air. Protected air is that air pressure which is retained in a reservoir system by a check valve when both the wet and dry air reservoirs in the air supply system are drained.

Push Rod. The sliding rod projecting from a brake chamber and connected to the slack adjuster by which the force of compressed air in the brake chamber is transmitted to the brakeshoes through connecting linkage during a brake application.

Quick Release Valve. A control unit which accelerates the release of air pressure from various portions of brake systems.

Reactionary Type Valve. A unit which responds to fluid displacement and pressure, or mechanical linkage movement and force to modulate pressure in a brake cylinder or chamber.

Relay Emergency Valve. A relay valve which also provides for automatic application of the trailer brakes in case of a breakaway or loss of pressure in the trailer supply (emergency) line.

Relay Valve. A secondary control unit used to accelerate the application and release of air pressure or vacuum in those types of brake systems.

Retarder. A supplemental brake system.

Safety Valve. A pressure release unit used to protect the air system against excessive pressure.

Service Brake System. The primary brake system used for retarding and stopping a vehicle.

Service Brake Valve. A foot-operated unit which is used for graduated control of all the brakes in the service brake system.

Service Line (Control). A flexible air brake hose terminated by a hose coupler for transmitting control air pressure from the towing vehicle to the towed vehicle.

Slack. The sum of all clearances in the braking system.

Slack Adjuster. A lever attached to the brake camshaft and connected to the brake chamber push rod. The slack adjuster provides a means of adjusting the brakes to compensate for brake lining wear.

Snub. The act of retarding a motor vehicle between two speed values by use of the brake system.

Snubbing Time. The time elapsed between the instant of first retardation by the brakes during a snub and the instant at which the lower velocity of the vehicle is reached.

Spring Brake Actuator. A unit which utilizes the stored energy in a spring(s) to actuate the brake(s).

Stop Light Switch. A switch which completes the electrical circuit to the stop lamp(s) when the brake(s) is (are) applied.

Straight Air Brake System. A mechanical type brake system actuated by air pressure in brake cylinder(s) or brake chamber(s).

Supplemental Brake System. An additional brake system used to assist the service brake system in retarding a vehicle.

Supply Air. Supply air is air that is under pressure in the air supply system of a vehicle. It consists of those lines or tanks except protected air tanks which are under pressure when the system is fully charged and when all valves are in the normal position with the brakes unapplied.

Trailer Control Valve. See Hand Control Valve.

Tractor Protection Valve. A unit which is a part of a towing vehicle air brake system and which:

a. Permits driver control of the opening and closing of the air brake lines to the towed vehicle whenever air pressure in the towing vehicle exceeds a predetermined value.

b. Closes the air brake lines automatically when the tractor brake system pressure is less than the predetermined value.

c. Vents the trailer supply (emergency) line when closed either manually or automatically.

Vacuum Assisted Hydraulic Brake System. A hydraulic type brake system which utilizes vacuum to assist the driver's effort to apply the brakes.

Vacuum Brake Reservoir. A storage container for vacuum.

Vacuum Hydraulic Power Unit. A unit consisting of a vacuum brake cylinder or chamber, hydraulic cylinder(s), and control valve, in which driver effort is combined with force from the cylinder piston or chamber diaphragm to displace fluid under pressure for actuation of the brake(s).

Vacuum Over Hydraulic Brake System. A hydraulic type brake system actuated by a vacuum powered master cylinder.

Vacuum Powered Master Cylinder. A brake master cylinder actuated by a vacuum brake cylinder or chamber.

Vacuum Pump. A device which creates vacuum to actuate the brakes.

Wedge Brake. A wheel brake which uses air or hydraulic pressure to force wedges instead of cams between the brake-shoes to apply the shoes against the brake drums. In air applied wedge brake systems, the brake actuator axis is parallel to the axle and pushes directly on the wedge in this direction instead of being mounted at right angles to push a slack adjuster and rotate a cam as in the conventional type of air brake system.

Wheel Slip Brake Control System. A system which automatically controls the degree of rotational wheel slip during braking.

Wheel Speed Sensor. A part of the wheel slip brake control system which senses angular rotation of the wheel(s) and transmits signals to the logic controller.

AMERICAN TIRE AND RIM ASSOCIATION LOAD LIMIT TABLES

NOTE: Load limits in this annex are shown at the maximum cold inflation pressure.

1. Passenger Car Tires. When passenger car tires are used on light trucks and trailers, the load limits are 9% lower than shown in the tables in this section.

Table B-1. "Alpha" Designated Bias and Radial Ply Tires for Passenger Cars and Station Wagons

Tire Size Designation*	Load Range B	C	D
A	1,060	1,130	1,200
B	1,150	1,230	1,300
C	1,230	1,320	1,400
D	1,320	1,410	1,490
E	1,400	1,490	1,580
F	1,500	1,610	1,700
G	1,620	1,730	1,830
H	1,770	1,890	2,010
J	1,860	1,980	2,100
K	1,900	2,030	2,150
L	1,970	2,100	2,230
M	2,090	2,230	2,370
N	2,210	2,360	2,500

NOTE: These load limits apply to all 50, 60, 70, and 78 series tires of all sizes, except those designated LT (such as E78-14LT) for "light truck."

*The letter R following the alpha designation marked on the tire (as in AR70-13) denotes a radial tire of the same load capacity as the corresponding bias ply tire (A70-13).

Table B-2. Bias Ply Tires for Passenger Cars, Station Wagons, and Multipurpose Passenger Vehicles

Tire Size Designation	Load Range B	C	D
6.00-13	1,010	--	1,140
6.50-13	1,150	1,230	1,300
7.00-13	1,270	--	1,440
5.60-14	920	--	1,050
6.00-14	1,100	--	1,240
6.45-14	1,120	--	1,270
6.50-14	1,210	--	1,370
6.95-14	1,230	--	1,390
7.00-14	1,340	--	1,520
7.35-14	1,360	1,450	1,540
7.50-14	1,500	--	1,700
7.75-14	1,500	1,600	1,690
8.00-14	1,620	--	1,830
8.25-14	1,620	--	1,830
8.50-14	1,740	--	1,960
8.55-14	1,770	--	2,000
8.85-14	1,860	--	2,100
9.00-14	1,860	--	2,100
9.50-14	2,000	--	2,260
6.00-15	1,150	--	1,300
6.50-15	1,270	--	1,440
6.70-15	1,450	--	1,640
6.85-15	1,230	--	1,390
7.00-15	1,700	1,820	1,930
7.10-15	1,550	--	1,760
7.35-15	1,390	1,480	1,570
7.60-15	1,710	1,820	1,930
7.75-15	1,490	1,590	1,690
8.00-15	1,800	--	2,040
8.15-15	1,610	1,720	1,820
8.20-15	1,920	--	2,170
8.25-15	1,620	--	1,830
8.45-15	1,740	1,860	1,970
8.55-15	1,770	1,890	2,000
8.85-15	1,860	1,980	2,100
8.90-15	2,210	--	2,500
9.00-15	1,900	--	2,150
9.15-15	1,970	--	2,230
6.00-16	1,400	1,500	--
6.50-16	1,580	1,690	--
7.00-16	1,780	1,900	--

Table B-3. Radial Ply Tires for Passenger Cars, Station Wagons, and Multipurpose Passenger Vehicles

Tire Size Designation	Load Range B	Load Range D
155R13	950	1,075
165R13	1,010	1,140
175R13	1,150	1,300
185R13	1,270	1,440
195R13	1,370	1,560
155R14	1,010	1,140
165R14	1,120	1,280
175R14	1,230	1,400
185R14	1,360	1,540
195R14	1,500	1,690
205R14	1,620	1,830
215R14	1,770	2,010
225R14	1,860	2,100
155R15	1,015	1,150
165R15	1,130	1,280
175R15	1,230	1,400
185R15	1,390	1,570
195R15	1,490	1,690
205R15	1,610	1,820
215R15	1,740	1,970
225R15	1,860	2,100
235R15	1,970	2,230

Table B-4. Radial, Bias Belted, and Diagonal Bias Ply, P-Type Tires for Passenger Cars and Station Wagons

Tire Size Designation	Load Range Standard Load	Load Range Extra Load
P165/75*13	1,003	1,080
P155/80*13	905	1,005
P205/70*14	1,356	1,466
P185/75*14	1,290	1,389
P195/75*14	1,440	1,521
P205/75*14	1,532	1,653
P255/60*15	1,786	1,929
P225/70*15	1,664	1,808

*Tire size designation will include either R (radial ply), B (bias belted) or D (diagonal or bias ply), as in P165/75R13.

2. Light Truck, Bus, and Trailer Tires.

a. The letter R marked on the tire in place of the dash shown in the tire size column (as in C78R15LT) denotes a radial tire of the same capacity.

b. The letter D in the wheel column denotes dual wheel; S denotes single wheel.

c. Percentage tire load increases as shown in the tables are permissible when:

(1) The speed of the vehicle is mechanically restricted to no more than that listed for the increased load, or

(2) The vehicle, or combination of vehicles, carries on the rear of the last vehicle a sign showing the maximum speed for the tire load.

Table B-5. Bias and Radial Ply Tires on 5-degree Drop Center or Semi-drop Center Rims for Light Trucks, Buses, Trailers, and Multipurpose Passenger Vehicles

Tire Size Designation	Wheel	Load Range C	Load Range D	Load Range E
C78-15LT	D	1,200	1,420	--
	S	1,370	1,620	--
D78-14LT	D	1,240	1,460	1,670
	S	1,400	1,660	1,890
E78-14LT	D	1,270	1,500	1,710
	S	1,440	1,710	1,950
F78-16LT	D	1,420	1,680	1,920
	S	1,620	1,910	2,180
G78-14LT	D	1,400	--	--
	S	1,590	--	--
G78-15LT	D	1,460	1,730	1,970
	S	1,660	1,960	2,240
H78-15LT	D	1,610	1,910	2,170
	S	1,830	2,170	2,470
H78-16LT	D	1,680	1,990	2,270
	S	1,910	2,260	2,580
L78-15LT	D	1,790	2,120	2,410
	S	2,030	2,400	2,740
L78-16LT	D	1,860	2,200	2,510
	S	2,110	2,500	2,850

Percentage increase when speed is restricted:

Maximum Speed (mph)	Increased Load (%)
45 through 54	9
35 through 44	16
25 through 34	24
15 through 24	32

Table B-6. Bias and Radial Ply Tires on 5-degree Drop Center or Semi-drop Center Rims for Light Trucks, Buses, Trailers, and Multipurpose Passenger Vehicles

Tire Size Designation	Wheel	Load Range C	D	E	F	G
6.00-16LT	D	1,255	1,480	1,690	--	--
	S	1,430	1,690	1,920	--	--
6.50-16LT	D	1,420	1,670	1,900	--	--
	S	1,610	1,900	2,160	--	--
6.70-15LT	D	1,355	1,600	1,820	--	--
	S	1,530	1,810	2,060	--	--
7.00-13LT	D	1,110	1,315	--	--	--
	S	1,260	1,490	--	--	--
7.00-14LT	D	1,155	1,365	1,555	--	--
	S	1,310	1,550	1,770	--	--
7.00-15LT	D	1,520	1,800	2,040	--	--
	S	1,720	2,040	2,320	--	--
7.00-16LT	D	1,580	1,870	2,130	2,370*	--
	S	1,800	2,130	2,430	2,700*	--
7.10-15LT	D	1,470	1,740	1,990	--	--
	S	1,670	1,970	2,250	--	--
7.50-15LT	D	--	2,060	2,350	--	--
	S	--	2,330	2,660	--	--
7.50-16LT	D	1,815	2,140	2,440	2,730	2,890*
	S	2,060	2,440	2,780	3,090	3,290*
8.25-16LT	D	--	2,340	2,600	2,970	3,300
	S	--	2,660	2,960	3,370	3,750
9.00-16LT	D	--	2,665	2,965	3,380	3,760
	S	--	3,303	3,370	3,840	4,275

Percentage increase when speed is restricted:

Maximum Speed (mph)	Increased Load (%)
45 through 54	9
35 through 44	16
25 through 34	24
15 through 24	32

*Load limit in this load range applies only to radial tires.

Table B-7. Bias and Radial Ply Tires on Wide Base Bias Ply Tires Mounted on 5-degree Drop Center Rims for Use on Trucks, Buses, and Trailers

Tire Size Designation	Load Range B	C	D
7.9-14LT	1,000	1,260	1,490
8.5R14LT	1,120	1,420	--
9-15LT	1,560	1,980	2,340
10-15LT	1,760	2,230	2,640
10-16LT	1,840	2,330	2,750
11-14LT	1,820	2,300	2,730
11-15LT	1,900	2,410	2,850
11-16LT	1,980	2,500	2,950
12-15LT	2,250	2,850	3,370

Percentage increase when speed is restricted:

Maximum Speed (mph)	Increased Load (%)
45 through 54	9
35 through 44	16
25 through 34	24
15 through 24	32

Table B-8. Bias and Radial Ply Tires on 15-degree Drop Center Rims for Light Trucks, Buses, Trailers, and Multipurpose Passenger Vehicles

Tire Size Designation	Wheel	Load Range B	C	D	E	F
7-14.5LT	D	--	--	1,650	1,840	2,020
	S	--	--	1,870	2,090	2,300
8-14.5LT	D	--	--	--	2,240	2,460
	S	--	--	--	2,540	2,790
9-14.5LT	D	--	--	2,310	2,590	2,840
	S	--	--	2,620	2,940	3,230
7-17.5LT	D	--	1,590	1,880	2,150	--
	S	--	1,815	2,145	2,445	--
8-17.5LT	D	--	1,820	2,155	2,460	--
	S	--	2,075	2,455	2,795	--
8.00-16.5LT	D	1,195	1,520	1,800	2,050	2,280
	S	1,360	1,730	2,045	2,330	2,590
8.75-16.5LT	D	1,380	1,750	2,070	2,360	--
	S	1,570	1,990	2,350	2,680	--
9.50-16.5LT	D	1,635	2,070	2,445	2,790	--
	S	1,860	2,350	2,780	3,170	--
10-16.5LT	D	1,620	2,050	2,420	2,760	--
	S	1,840	2,330	2,750	3,135	--
10-17.5LT	D	--	2,135	2,525	2,880	3,200
	S	--	2,425	2,870	3,270	3,640
12-16.5LT	D	--	2,090	2,640	3,120	3,560
	S	--	2,370	3,000	3,550	4,045

Percentage increase when speed is restricted:
*Load limit in this load range applies only to radial tires.

3. Heavy Truck, Bus, and Trailer Tires.

a. The letter R marked on the tire in place of the dash shown in the tire size column (as in C78R15LT) denotes a radial tire of the same capacity.

b. The letter D in the wheel column denotes dual wheel; S denotes single wheel.

c. Percentage tire load increases as shown in the tables, are permissible when:

(1) The speed of the vehicle is mechanically restricted to no more than that listed for the increased load, or

(2) The vehicle, or combination of vehicles, carries on the rear of the last vehicle a sign showing the maximum speed for the tire load.

Table B-9. Bias and Radial Ply Tires on 15-degree Drop Center Rims for Trucks, Buses, and Trailers

Tire Size Designation	Wheel	Load Range C	D	E	F	G	H	J
7-22.5	D	1,860	2,170	--	--	--	--	--
	S	2,120	2,470	--	--	--	--	--
8-19.5	D	2,110	2,460	2,780	3,070	--	--	--
	S	2,410	2,800	3,170	3,500	--	--	--
8-22.5	D	--	2,750	3,100	3,430	--	--	--
	S	--	3,140	3,530	3,910	--	--	--
9-22.5	D	--	--	3,550	3,950	4,320	--	--
	S	--	--	4,050	4,500	4,920	--	--
10-22.5	D	--	--	4,040	4,520	4,970	--	--
	S	--	--	4,610	5,150	5,670	--	--
11-22.5	D	--	--	--	4,760	5,300	5,800	--
	S	--	--	--	5,430	6,040	6,610	--
11-24.5	D	--	--	--	5,070	5,640	6,170	--
	S	--	--	--	5,780	6,430	7,030	--
12-22.5	D	--	--	--	5,190	5,780	6,320	--
	S	--	--	--	5,920	6,590	7,200	--
12-24.5	D	--	--	--	5,520	6,140	6,720	--
	S	--	--	--	6,290	7,000	7,660	--
12.5-22.5	D	--	--	--	5,290	5,890	6,440	--
	S	--	--	--	6,030	6,710	7,340	--
12.5-24.5	D	--	--	--	5,630	6,270	6,960	--
	S	--	--	--	6,420	7,150	7,820	--
14-17.5	D	2,820	3,570	4,220	4,810	5,360	--	--
	S	3,210	4,060	4,800	5,470	6,090	--	--

(continued)

Table B-9. (Continued)

Tire Size Designation	Wheel	Load Range C	D	E	F	G	H	J
15-19.5	D	--	--	--	--	6,150	--	--
	S	--	--	--	--	6,980	--	--
15-22.5	D	--	--	5,000	5,910	6,740	7,500	--
	S	--	--	5,680	6,720	7,660	8,520	--
16.5-19.5	D	--	--	--	--	--	7,430	--
	S	--	--	--	--	--	8,440	--
16.5-22.5	D	--	--	--	--	--	8,120	--
	S	--	--	--	--	--	9,230	--
18-19.5	D	--	--	--	--	6,980	7,960	8,850
	S	--	--	--	--	7,930	9,040	10,060
18-22.5	D	--	--	--	--	7,610	8,680	9,650
	S	--	--	--	--	8,650	9,860	10,970
19.5-19.5	D	--	--	--	--	--	--	9,370
	S	--	--	--	--	--	--	10,650

Percentage increase when speed is restricted:

Maximum Speed (mph)	Increased Load (%) Tire Sizes Below 14-17.5	Tire Sizes 14-17.5 and Above
41 through 50	9	7
31 through 40	16	9
21 through 30	24	12
11 through 20	32	17

Table B-10. Bias Ply High Load Tires on 15-degree Drop Center Rims for Trucks and Trailers

Tire Size Designation	Wheel	Load Range G	H
9.4-22.5	D	4,320	--
	S	4,920	--
10.3-22.5	D	4,970	--
	S	5,670	--
11.1-22.5	D	--	5,800
	S	--	6,610
11.9-22.5	D	--	6,320
	S	--	7,200

NOTE: Load limits may be increased 9% for restricted speed highway service not exceeding 50 mph when the speed of the vehicle is mechanically restricted or the vehicle is operated with a sign indicating the maximum speed for the increased tire load.

Table B-11. Bias and Radial Ply Tires on Type I, II, and III Rims for Trucks, Buses, and Trailers

Tire Size Designation*	Wheel	Load Range C	D	E	F	G	H	J
6.50-20	D	1,860	2,170	2,450	--	--	--	--
	S	2,120	2,470	2,790	--	--	--	--
7.00-15TR	D	--	--	2,260	2,500	--	--	--
	S	--	--	2,580	2,850	--	--	--
7.00-17	D	1,870	2,180	--	--	--	--	--
	S	2,130	2,490	--	--	--	--	--
7.00-18	D	--	2,270	2,560	--	--	--	--
	S	--	2,590	2,920	--	--	--	--
7.00-20	D	--	2,450	2,760	3,050	--	--	--
	S	--	2,790	3,150	3,480	--	--	--
7.50-15TR	D	--	--	2,550	2,820	--	--	--
	S	--	--	2,910	3,210	--	--	--
7.50-17	D	--	2,460	2,780	3,070	--	--	--
	S	--	2,800	3,170	3,500	--	--	--
7.50-18	D	--	2,550	2,890	3,190	--	--	--
	S	--	2,910	3,290	3,640	--	--	--
7.50-20	D	--	2,750	3,100	3,430	3,640	--	--
	S	--	3,140	3,530	3,910	4,150	--	--
8.25-15TR	D	--	--	--	3,260	3,570	--	--
	S	--	--	--	3,720	4,070	--	--
8.25-17	D	--	--	3,180	3,540	3,870	--	--
	S	--	--	3,630	4,040	4,410	--	--
8.25-20	D	--	--	3,550	3,950	4,320	--	--
	S	--	--	4,050	4,500	4,920	--	--
9.00-15TR	D	--	2,920	3,360	3,760	4,130	--	--
	S	--	3,330	3,830	4,290	4,710	--	--
9.00-20	D	--	--	4,040	4,520	4,970	--	--
	S	--	--	4,610	5,150	5,670	--	--
10.00-15TR	D	--	--	--	3,980	4,430	4,850	--
	S	--	--	--	4,540	5,050	5,530	--
10.00-20	D	--	--	--	4,760	5,300	5,800	--
	S	--	--	--	5,430	6,040	6,610	--
10.00-22	D	--	--	--	5,070	5,640	6,170	--
	S	--	--	--	5,780	6,430	7,030	--
11.00-15TR	D	--	--	--	--	4,840	5,300	--
	S	--	--	--	--	5,520	6,040	--
11.00-20	D	--	--	--	5,190	5,780	6,320	--
	S	--	--	--	5,920	6,590	7,200	--
11.00-22	D	--	--	--	5,520	6,140	6,720	--
	S	--	--	--	6,290	7,000	7,660	--
11.00-24	D	--	--	--	5,860	6,520	7,130	--
	S	--	--	--	6,680	7,430	8,130	--
11.50-20	D	--	--	--	5,290	5,890	6,440	--
	S	--	--	--	6,030	6,710	7,340	--

(continued)

Table B-11. (Continued)

Tire Size Designation*	Wheel	Load Range C	D	E	F	G	H	J
11.50-22	D	--	--	--	5,630	6,270	6,960	--
	S	--	--	--	6,420	7,150	7,820	--
12.00-20	D	--	--	--	--	6,140	6,790	7,200
	S	--	--	--	--	7,000	7,740	8,210
12.00-24	D	--	--	--	--	6,910	7,640	8,100
	S	--	--	--	--	7,880	8,710	9,230

Percentage increase when speed is restricted:

Maximum Speed (mph)	Increased Load (%)
41 through 50	9
31 through 40	16
21 through 30	24
11 through 20	32

*TR denotes "truck" to differentiate between passenger car, light truck and other service for tires of same size designation.

4. Truck and Trailer Tires for Restricted Service.

a. In Tables B-12 and B-13, the letter R marked on the tire in place of the dash shown in the tire size column (as in C78R15LT) denotes a radial tire of the same capacity.

b. In Tables B-12 and B-13, the letter D in the wheel column denotes dual wheel; S denotes single wheel.

c. Percentage tire load increases as shown in the tables are permissible when:

(1) The speed of the vehicle is mechanically restricted to no more than that listed for the increased load, or

(2) The vehicle, or combinations of vehicles, carries on the rear of the last vehicle a sign showing the maximum speed for the tire load.

Table B-12. Bias Ply High Load Tires on Type I, II, and III Rims for Trucks and Trailers

Tire Size Designation	Wheel	Load Range G	H	J
9.4-20	D	4,320	--	--
	S	4,920	--	--
10.3-20	D	4,970	--	--
	S	5,670	--	--
11.1-20	D	--	5,800	--
	S	--	6,610	--
11.1-22	D	--	6,170	--
	S	--	7,030	--
11.9-20	D	--	6,320	--
	S	--	7,200	--
11.9-22	D	--	6,720	--
	S	--	7,660	--
12.5-20	D	--	--	7,200
	S	--	--	8,210

Table B-13. Bias and Radial Ply Tires for Trucks and Trailers Operated at 50 MPH Maximum

Tire Size Designation	Wheel	Load Range G	H	J	L
13.00-20	D	--	7,400	8,140	--
	S	--	8,440	9,280	--
14.00-20	D	6,770	7,800	8,740	9,610
	S	7,720	8,890	9,960	10,960
14.00-24	D	--	--	9,750	10,730
	S	--	--	11,120	12,230

Percentage increase when speed is restricted:

Maximum Speed (mph)	Increased Load (%)
31 through 40	7
21 through 30	13
11 through 20	21

Table B-14. Bias Ply Mining and Logging Tires
for Intermittent Highway Service

Tire Size Designation	Load Range C	D	E	F	G	H	J	L
7.00-16ML	1,790	--	--	--	--	--	--	--
7.00-20ML	--	--	2,760	3,050	--	--	--	--
7.50-20ML	--	--	3,100	3,430	--	--	--	--
8.25-20ML	--	--	3,550	3,950	--	--	--	--
9.00-20ML	--	--	4,040	4,520	4,970	--	--	--
10.00-20ML	--	--	--	4,760	5,300	--	--	--
10.00-22ML	--	--	--	5,070	5,640	--	--	--
10.00-24ML	--	--	--	5,380	5,990	--	--	--
10.3-20ML*	--	--	--	--	--	4,970	--	--
11.00-20ML	--	3,850	4,560	5,190	5,780	--	--	--
11.00-22ML	--	--	--	5,520	6,140	--	--	--
11.00-24,25ML	--	--	--	5,860	6,520	--	--	--
11.1-20ML*	--	--	--	--	--	5,630	--	--
12.00-20,21ML*	--	--	--	--	6,140	6,790	--	--
12.00-24,25ML*	--	--	--	--	6,910	7,640	7,870	7,870
12.5-20ML*	--	--	--	--	--	6,790	7,000	--
13.00-20ML*	--	--	--	--	--	7,400	8,140	--
13.00-24,25ML*	--	--	--	--	--	8,290	9,120	--
14.00-20,21ML*	--	--	--	--	6,770	7,800	8,740	9,610
14.00-24,25ML*	--	--	--	--	--	8,710	9,750	10,730†
9-22.5ML	--	--	3,550	--	--	--	--	--
9.4-22.5ML*	--	--	--	--	4,200	--	--	--
10-22.5ML	--	--	4,040	4,520	--	--	--	--
10.3-22.5ML	--	--	--	--	4,970	--	--	--
11-22.5ML	--	--	--	4,760	--	5,630	--	--
11-24.5ML	--	--	--	5,070	5,640	--	--	--
12-22.5ML	--	--	--	5,190	5,780	--	--	--

NOTE: These load limits apply for a maximum speed of 55 mph and a maximum distance of 55 miles in any 1 1/2-hr period.

Maximum Speed (mph)	Increased Load (%)
31 through 40	9
21 through 30	18
11 through 20	32
6 through 10	60

*Maximum of 50 mph and 50 miles in 1 1/2 hr.
†Same load limit applies to this tire in load range N.

Table B-15. Wide Base Bias Ply Mining and Logging Tires for Intermittent Highway Service

Tire Size Designation	Load Range C	D	E	F	G	H	J
14-17.5ML	2,820	3,570	4,220	4,810	5,360	--	--
15-19.5ML	--	3,930	4,360	5,390	6,150	--	--
15-22.5ML	--	--	5,000	5,910	6,740	7,500	--
16.5-19.5ML	--	--	--	--	6,580	7,430	--
16.5-22.5ML	--	--	--	--	--	8,120	--
18-19.5ML	--	--	--	--	--	7,960	--
18-21ML*	--	--	--	--	--	8,680	--
18-22.5ML	--	--	--	--	--	8,680	9,650
19.5-19.5ML	--	--	--	--	--	--	9,370
19.5-21ML	--	--	--	--	--	--	10,190
23-21ML*	--	--	--	--	--	--	13,400
23-23.5ML*	--	--	--	--	--	--	13,400

NOTE: These load limits apply for a maximum speed of 55 mph and a maximum distance of 55 miles in any 1 1/2-hr period.

Maximum Speed (mph)	Increased Load (%)
31 through 40	7
21 through 30	9
11 through 20	17
6 through 10	40

*Maximum of 50 mph and 50 miles in 1 1/2 hr.

Table B-16. Bias Ply Special Tires for Trailers

Tire Size Designation	Load Range B	C
6.00-13ST	935	1,150
6.50-13ST	1,065	1,315
7.00-13ST	1,175	1,450
6.45-14ST	1,035	1,275
7.35-14ST	1,245	1,530
7.75-14ST	1,365	1,680
8.25-14ST	1,470	1,815
8.55-14ST	1,605	1,975
6.85-15ST	1,130	1,390
7.35-15ST	1,280	1,575
7.75-15ST	1,365	1,680
8.25-15ST	1,485	1,825
8.55-15ST*	1,620	2,000
8.85-15ST	1,695	2,090

*This tire size also available in Load Range D with a 2,330 pound load limit.

Table B-17. "78 Series" Bias Ply Tires for Special Trailer Service

Tire Size Designation	Load Range B	Load Range C
B78-13ST	1,065	1,315
C78-13ST	1,145	1,410
C78-14ST	1,145	1,410
E78-14ST	1,300	1,600
F78-14ST	1,385	1,710
G78-14ST	1,515	1,865
H78-14ST	1,650	2,035
J78-14ST	1,705	2,100
E78-15ST	1,300	1,600
F78-15ST	1,385	1,710
G78-15ST	1,515	1,865
H78-15ST*	1,650	2,035
J78-15ST	1,705	2,100
L78-15ST	1,805	2,225

*This tire size also available in Load Range D with a 2,370 pound load limit.

Table B-18. Bias Ply Tires for Trailers and Powered Vehicles Other Than Passenger Cars

Tire Size Designation	Load Range A	B	C	D	E
4.80-8	390	590	745	--	--
4.80-12	--	780	990	--	--
5.30-12	--	840	1,045	--	--
5.70-8	--	715	910	1,075	--
6.90-9	590	885	1,120	1,375	1,510
6.90-12	--	1,060	1,345	--	--
6.50-10	--	--	1,190	--	1,605
7.00-10	--	--	--	1,650	1,835
7.50-10	--	--	--	--	1,975
16.5x6.5-8	395	620	795	915	--
20.5x8.0-10	--	905	1,105	1,330	1,535
18.5x8.5-8	--	770	940	--	--
23.5x8.5-12	--	1,085	1,320	--	--

5. Bus Tires for Restricted Service. Restricted service for buses is a maximum speed of 35 mph in continuous operation or 55 mph when operation does not exceed one hour. Tires marked "inter-city" or "thru-way" are not subject to the speed restrictions.

Table B-19. Bias and Radial Ply Tires for Buses in Restricted Service

Tire Size Designation*	Wheel†	Load Range F	Load Range G
8.25-20	D	3,950	--
	S	4,500	--
9.00-20	D	4,520	--
	S	5,150	--
10.00-20	D	--	5,300
	S	--	6,040
11.00-19	D	--	5,510
	S	--	6,280
11.00-20	D	--	5,780
	S	--	6,590
11.00-22	D	--	6,140
	S	--	7,000
11.50-20	D	--	5,890
	S	--	6,710
11.50-22	D	--	6,270
	S	--	7,150
11.5-22.5	D	--	5,510
	S	--	6,280
12.00-20	D	--	6,140
	S	--	7,000
12-22.5	D	--	5,780
	S	--	6,590
12-24.5	D	--	6,140
	S	--	7,000
12.5-22.5	D	--	5,890
	S	--	6,710
12.5-24.5	D	--	6,270
	S	--	7,150
12.75-22.5	D	--	6,140
	S	--	7,000
12.75-24.5	D	--	6,530
	S	--	7,440
13.5-24.5	D	--	6,770
	S	--	7,720

*R marked on the tire in place of the dash (as in 8.25R20) denotes a radial tire of the same capacity.

†D denotes dual wheel; S denotes single wheel.

6. Mobile Home Tires. Tires used on mobile homes may exceed 100% but not more than 150% of the load limit and not more than 3,000 pounds provided the speed of the towing vehicle is mechanically restricted or the rear of the trailer has a sign indicating a 45 mph maximum speed.

Table B-20. Bias Ply Tires for Mobile Homes

Tire Size Designation	Load Range			
	C	D	E	F
7-14.5MH	--	1,870	2,090	2,300
8-14.5MH	1,970	2,270	2,540	2,790
9-14.5MH	--	2,620	2,940	3,230

EUROPEAN TIRE AND RIM TECHNICAL ORGANIZATION LOAD LIMIT TABLES

NOTE: Load limits in this annex are shown in pounds at the maximum cold inflation pressure.

1. ETRTO Speed and Load Markings. Tires manufactured under the European Tire and Rim Technical Organization Standards (ETRTO) may be marked with numbers and letters such as 98/97F following the tire size designation as in 6.00 R 16C 98/97F. The numbers are the "load index" for single-wheel/dual-wheel usage and have been taken into account in the loads shown in the following tables. The letter is a "speed symbol" representing the top speed for which the tire is designed at rated maximum load. The speeds represented by the symbols are as follows:

Speed Symbol	Maximum Designed Speed (mph)	Speed Symbol	Maximum Designed Speed (mph)
F	50	P	93
G	56	Q	99
J	62	R	106
K	68	S	112
L	75	T	118
M	81	U	124
N	87	H	130

For speeds of 25 mph and under, the carrying capacity of each tire of a dual wheel is equal to the capacity shown for a single wheel plus the additional percentage allowance for the actual speed.

2. The letter R marked on the tire in place of the dash shown in the tire size column (as in C78R15LT) denotes a radial tire of the same capacity.

3. The letter D in the wheel column denotes dual wheel; S denotes single wheel.

4. Percentage tire load increases as shown in the tables, are permissible when:

a. The speed of the vehicle is mechanically restricted to no more than that listed for the increased load, or

b. The vehicle, or combination of vehicles, carries on the rear of the last vehicle a sign showing the maximum speed for the tire load.

5. Light Commercial Vehicle Tires.

Table C-1. Bias and Radial Ply Tires for Light Commercial Vehicles

Tire Size Designation	Wheel	Load Range C	Load Range D	Load Range E
6.00 - 16C	D	1390	1610	1820
	S	1520	1650	1930
6.50 - 16C	D	1610	1870	2150
	S	1650	1980	2210
6.50 - 17LC	D	--	1610	--
	S	--	1710	--
6.50 - 20C	D	--	2210	--
	S	--	2340	--
7.00 - 16C	D	1760	2090	2470
	S	1870	2210	2540
7.00 - 20C	D	--	2400	2600
	S	--	2540	2760
7.50 - 16C	D	2090	2340	2600
	S	2210	2470	2760
8.25 - 16C	D	--	--	3000
	S	--	--	3090
9.00 - 16C	D	--	2830	3090
	S	--	3000	3310

Percentage increase when speed is restricted:

Maximum Speed (mph)	Speed Symbol Marked on Tire* F	G	J & K	L, M, & N
51 through 55	-6	0	2	8
41 through 50	0	4	4	10
31 through 40	8	9	9	14
26 through 30	12	12	12	20
21 through 26	15	15	15	25
10 through 20	25	25	25	35
below 10	65	65	65	60

*Where no speed symbol is marked on the tire, speed symbol L applies (75 mph maximum).

Table C-2. Bias and Radial Ply Super Balloon and Low Section Tires for Light Commercial Vehicles

Tire Size Designation	Wheel	Load Range C	D	E
5.20 - 12C	D	910	--	--
	S	940	--	--
5.50 - 12C	D	880	--	--
	S	940	--	--
5.60 - 12C	D	1020	--	--
	S	1070	--	--
6.00 - 12C	D	1020	--	--
	S	1070	--	--
6.00 - 14C	D	--	1320	--
	S	--	1390	--
6.40 - 13C	D	--	1480	--
	S	--	1570	--
6.40 - 14C	D	1360	--	--
	S	1430	--	--
6.50 - 14C	D	1360	--	--
	S	1430	--	--
6.70 - 13C	D	1430	1650	--
	S	1480	1710	--
6.70 - 14C	D	1480	1710	--
	S	1570	1820	--
6.70 - 15C	D	1570	1870	2150
	S	1650	1930	2210
7.00 - 14C	D	1430	1710	--
	S	1480	1760	--
7.50 - 14C	D	1570	1820	--
	S	1650	1870	--

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire* F	G	J & K	L, M, & N
51 through 55	-6	0	2	8
41 through 50	0	4	4	10
31 through 40	8	9	9	14
26 through 30	12	12	12	20
21 through 26	15	15	15	25
10 through 20	25	25	25	35
below 10	65	65	65	60

*Where no speed symbol is marked on the tire, speed symbol L applies (75 mph maximum).

Table C-3. Radial Ply Metric Tires for Light Commercial Vehicles

Tire Size Designation	Wheel	Load Range C	Load Range D
155 R 12C	D	1020	--
	S	1070	--
165 R 13C	D	1280	1390
	S	1360	1480
165 R 14C	D	1360	1520
	S	1430	1610
165 R 15C	D	1390	1520
	S	1480	1610
175 R 13C	D	1390	1520
	S	1480	1610
175 R 14C	D	1480	1650
	S	1570	1710
175 R 16C	D	1570	1710
	S	1650	1820
185 R 13C	D	1520	1650
	S	1610	1760
185 R 14C	D	1610	1760
	S	1710	1870
185 R 15C	D	1650	1870
	S	1760	1930
185 R 16C	D	1710	1870
	S	1820	1980
195 R 14C	D	1760	1980
	S	1870	2090
195 R 16C	D	1870	2040
	S	1980	2150
205 R 14C	D	1930	2150
	S	2040	2270
205 R 16C	D	2090	2210
	S	2090	2340
215 R 14C	D	2090	2340
	S	2210	2470
215 R 16C	D	2210	2400
	S	2340	2540

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire* F	G	J & K	L, M, & N
51 through 55	-6	0	2	8
41 through 50	0	4	4	10
31 through 40	8	9	9	14
26 through 30	12	12	12	20
21 through 25	15	15	15	25
10 through 20	25	25	25	35
below 10	65	65	65	60

*Where no speed is marked on the tire, speed symbol L applies (75 mph maximum).

Table C-4. Miscellaneous Diagonal and Radial Tires for Light Commercial Vehicles

Tire Size Designation	Wheel	Load
7 R 17.5C	D	2150
	S	2210
8 R 17.5C	D	2470
	S	2540
17 R 15C	D	1870
	S	1930
17 R 380C	D	1870
	S	1930
17 R 400C	D	1870
	S	1930
19 R 400C	D	2340
	S	2470
125 - 12C	D	620
	S	660
245 - 16C	D	2090
	S	2210

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire* F	G	J & K	L, M, & N
51 through 55	-6	0	2	8
41 through 50	0	4	4	10
31 through 40	8	9	9	14
26 through 30	12	12	12	20
21 through 25	15	15	15	25
below 10	65	65	65	60

*Where no speed is marked on the tire, speed symbol L applies (75 mph maximum).

6. Heavy Truck, Bus, and Trailer Tires.

Table C-5. Bias and Radial Ply Tires for Trucks, Buses, and Trailers

Tire Size Designation	Wheel	Load Range E	F	G	H	J
6.50 R 20	D	2540	--	--	--	--
	S	2680	--	--	--	--
7.00-16	D	--	2760	--	--	--
	S	--	2830	--	--	--
7.00-20	D	--	2910	--	--	--
	S	--	3090	--	--	--
7.50-16	D	--	3090	--	--	--
	S	--	3200	--	--	--
7.50-20	D	3310	3860	--	--	--
	S	3420	4000	--	--	--
8.25-16	D	--	3530	3750	--	--
	S	--	3640	4000	--	--
8.25-17	D	--	3420	3970	--	--
	S	--	3750	4190	--	--
8.25-20	D	3530	3970	4300	--	--
	S	3750	4190	4540	--	--
9.00-16	D	--	3970	4300	--	--
	S	--	4410	4670	--	--
9.00-20	D	4080	4540	5070	--	--
	S	4540	4940	5510	--	--
10.00-20	D	--	4680	5360	6010	--
	S	--	5070	5840	6620	--
10.00-22	D	--	--	--	6170	--
	S	--	--	--	6950	--
11.00-20	D	--	--	6010	6400	--
	S	--	--	6620	7170	--
11.00 R 22	D	--	--	--	6620	--
	S	--	--	--	7390	--
11.00 R 24	D	--	--	--	6780	--
	S	--	--	--	7610	--
12.00-20	D	--	--	--	6620	7170
	S	--	--	--	7390	8270
12.00-24	D	--	--	--	7170	8050
	S	--	--	--	8050	8820

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire* F	G	J & K	L & M†	N
51 through 55	-6	0	2	2	8
41 through 50	0	4	4	4	10
31 through 40	8	9	9	9	14
26 through 30	12	12	12	12	20
21 through 25	15	15	15	15	25
10 through 24	25	25	25	25	35
below 10	65	65	65	65	60

*When no speed symbol is marked on the tire, speed symbol J applies (62 mph maximum).
†For tire sizes 6.50-20, 7.00-16, 7.00-20, and 7.50-16 with L or M speed symbol, use percent increases for speed symbol N.

Table C-6. Bias and Radial Ply Tires for Trucks, Buses, and Trailers

Tire Size Designation	Wheel	Load
7 R 19.5	D	2470
	S	2540
8 R 17.5	D	2760
	S	2830
8 R 19.5	D	3310
	S	3420
8 R 22.5	D	3860
	S	3970
8.5 R 17.5	D	3090
	S	3200
9 R 17.5	D	3200
	S	3420
9 R 19.5	D	3970
	S	4190
9 R 22.5	D	4300
	S	4540
9.5 R 17.5	D	3530
	S	3750
9.5 R 19.5	D	4300
	S	4670
10 R 17.5 (130/128)	D	3970
	S	4190
10 R 17.5 (134/132)	D	4410
	S	4670
10 R 19.5	D	4680
	S	5070
10 R 22.5	D	5070
	S	5510
11 R 22.5	D	6010
	S	6620
12 R 22.5	D	6400
	S	7170
13 R 22.5	D	7170
	S	8270
15 - 19.5	S	7390
15 - 22.5	S	8540
15 R 22.5	S	9100
16.5 - 19.5 (156)	S	8820
16.5 - 19.5 (159)	S	9650
16.5 R 19.5	S	10200
16.5 - 22.5 (160)	S	9920
16.5 - 22.5 (162)	S	10470
16.5 R 22.5	S	11360
18 - 19.5 (163)	S	10750
18 - 19.5 (165)	S	11360
18 R 19.5	S	11360
18 - 22.5	S	11690
18 R 22.5	S	12350

(continued)

Table C-6. (Continued)

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire*				
	F	G	J & K	L & M†	N
51 through 55	-6	0	2	2	8
41 through 50	0	4	4	4	10
31 through 40	8	9	9	9	14
26 through 30	12	12	12	12	20
21 through 25	15	15	15	15	25
10 through 24	25	25	25	25	35
below 10	65	65	65	65	60

*When no speed symbol is marked on the tire, speed symbol J applies (62 mph maximum).
†For tire sizes 7 R 19.5 and 8 R 17.5 with L or M speed symbols use percent increases for N speed symbol.

Table C-7. Radial Ply, 70, 75 and 80 Series Tires for Trucks, Buses, and Trailers

Tire Size Designation	Wheel	Load
9/70 R 22.5	D	4300
	S	4540
10/70 R 22.5	D	5070
	S	5510
11/70 R 22.5 (142/139)	D	5110
	S	5840
11/70 R 22.5 (144/141)	D	5680
	S	6170
11/70 R 22.5 (146/143)	D	6010
	S	6615
12/70 R 22.5	D	6400
	S	7170
12/80 R 20	D	6400
	S	7170
12/80 R 22.5	D	6010
	S	6620
13/70 R 22.5	D	7170
	S	8270
13/80 R 20	D	7170
	S	8050
14/80 R 20	D	--
	S	9100
14/80 R 24	D	--
	S	10200
14.75/80 R 20	D	--
	S	10750
15.5/80 R 20	D	--
	S	11030
315/70 R 22.5	D	6400
	S	7170
315/75 R 22.5	D	7170
	S	8270

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire* F	G	J, K, L, & M
51 through 55	-6	0	2
41 through 50	0	4	4
31 through 40	8	9	9
26 through 30	12	12	12
21 through 25	15	15	15
10 through 20	25	25	25
below 10	65	65	65

*Where no speed symbol is marked on the tire, speed symbol J applies (62 mph maximum).

7. Multipurpose Truck Tires.

Table C-8. Bias and Radial Ply Wide Base Tires for On-highway and Off-highway Multipurpose Trucks

Tire size Designations	Load Range C	D	E	F	G	H	J
7.50 - 18 MPT	2340	--	--	--	--	--	--
10.5 - 18 MPT	3000	3310	--	--	--	--	--
10.5 - 20 MPT	3090	3420	3970	4300	--	--	--
12.5 - 18 MPT	--	3640	3970	4300	--	--	--
12.5 - 20 MPT	--	3750	4080	4410	4940	5360	--
14.5 - 20 MPT	--	--	4410	4940	5360	5680	6010
14.5 - 24 MPT	--	--	--	--	--	6170	--
385/55 R 18 MPT	5200	--	--	--	--	--	--

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire* F	G	J, K, L, & M
51 through 55	-6	0	2
41 through 50	0	4	4
31 through 40	8	9	9
26 through 30	12	12	12
21 through 25	15	15	15
10 through 20	25	25	25
below 10	65	65	65

*When no speed symbol is marked on the tire, speed symbol G applies (56 mph maximum).

8. Heavy Commercial Vehicle Tires for Special Applications.

Table C-9. Bias and Radial Ply Tires for Special Applications

Tire Size Designation	Wheel	All Ranges	Load Range F	G	H	J	L	M	N
5.00 R 8	D	1650	--	--	--	--	--	--	--
	S	1764	--	--	--	--	--	--	--
6.00 - 9	D	--	2210	--	--	--	--	--	--
	S	2271	--	--	--	--	--	--	--
7.00 - 12	D	--	3420	--	--	--	--	--	--
	S	--		--	--	--	--	--	--
7.00 - 15	D	--	3640	--	--	--	--	--	--
	S	--	3749	--	--	--	--	--	--
7.50 - 15	D	--	--	--	4540	--	--	--	--
	S	--	--	--	4807	--	--	--	--
8.25 - 15	D	--	--	3970	--	5680	--	--	--
	S	--	--	4190	--	5843	--	--	--
10.00 - 15	D	--	--	4410	--	6400	--	--	--
	S	--	--	4807	--	6946	--	--	--
12.00 - 20	D	--	--	--	--	--	8050	--	--
	S	--	--	--	--	--	9096	--	--
12.00 - 24	D	--	--	--	--	--	8820	--	--
	S	--	--	--	--	--	9923	--	--
13.00 - 20	S	--	--	--	--	9370	--	10200	--
14.00 - 20	S	--	--	--	--	9920	10470	11030	--
14.00 - 24	S	--	--	--	--	11030	--	12350	--
15.00 - 20	S	--	--	--	--	--	11690	12790	13890
225/90 R 20	D	5360	--	--	--	--	--	--	--
	S	5843	--	--	--	--	--	--	--

Percentage increase when speed is restricted:

Maximum Speed, (mph)	Speed Symbol Marked on Tire* F	G	J, K, L, & M
51 through 55	-6	0	2
41 through 50	0	4	4
31 through 40	8	9	9
26 through 30	12	12	12
21 through 25	15	15	15
10 through 20	25	25	25
below 10	65	65	65

*Where no speed symbol is marked on the tire, speed symbol F applies (50 mph maximum).

JAPANESE STANDARDS ASSOCIATION LOAD LIMIT TABLES.

NOTE: Load limits in this annex are shown in pounds at the maximum cold inflation pressure.

1. The letter R marked on the tire in place of the dash shown in the tire size column (as in C78R15LT) denotes a radial tire of the same capacity.

2. The letter D in the wheel column denotes dual wheel; S denotes single wheel.

3. Percentage tire load increases as shown in the tables are permissible when:

a. The speed of the vehicle is mechanically restricted to no more than that listed for the increased load, or

b. The vehicle, or combination of vehicles, carries on the rear of the last vehicle a sign showing the maximum speed for the tire load.

4. Light Truck Tires.

Table D-1. Bias Ply Tires for Light Trucks

Tire Size Designation	Wheel	Load Range B	C	D	E	F	G
5.00-13 LT	D	800	960	--	--	--	--
	S	840	1010	--	--	--	--
5.50-13 LT	D	--	1090	1280	--	--	--
	S	--	1150	1350	--	--	--
5.50-14 LT	D	--	1150	1350	--	--	--
	S	--	1200	1420	--	--	--
6.00-13 LT	D	--	1280	1490	--	--	--
	S	--	1350	1570	--	--	--
6.00-14 LT	D	--	1350	1570	--	--	--
	S	--	1410	1650	--	--	--
6.00-15 LT	D	--	1410	1640	--	--	--
	S	--	1480	1720	--	--	--
6.00-16 LT	D	--	1480	1720	--	--	--
	S	--	1550	1810	--	--	--
6.50-13 LT	D	--	1430	1680	--	--	--
	S	--	1500	1760	--	--	--
6.50-14 LT	D	--	1500	1750	--	--	--
	S	--	1580	1850	--	--	--
6.50-15 LT	D	--	1580	1840	2030	--	--
	S	--	1650	1930	2140	--	--
6.50-16 LT	D	--	1640	1920	2120	--	--
	S	--	1730	2030	2230	--	--
7.00-15 LT	D	--	1760	2060	2270	2470	--
	S	--	1850	2160	2380	2600	--
7.00-16 LT	D	--	1850	2160	2370	2580	--
	S	--	1940	2260	2490	2710	--
7.50-15 LT	D	--	--	2370	2680	2900	3030
	S	--	--	2480	2820	3050	3200
7.50-16 LT	D	--	2120	2470	2790	3020	3180
	S	--	~~2230~~	2590	2930	3180	3330
8.25-16 LT	D	--	--	--	--	--	3590
	S	--	--	--	--	--	3770
9.00-16 LT	D	--	--	3050	3420	--	--
	S	--	--	3210	3590	--	--

Percentage increase when speed is restricted:

Maximum Speed (mph)	Percent Increase
38 through 43	1
32 through 37	4
26 through 31	7
25 and under	10

Table D-2. Radial Ply Tires for Light Trucks

Tire Size Designation	Wheel	Load Range E	F	G
7.00 R 15 LT	D	--	2470	--
	S	--	2600	--
7.50 R 15 LT	D	--	2900	--
	S	--	3050	--
6.50 R 16 LT	D	2120	--	--
	S	2230	--	--
7.00 R 16 LT	D	--	2580	--
	S	--	2710	--
7.50 R 16 LT	D	--	--	3180
	S	--	--	3330
8.25 R 16 LT	D	--	--	3590
	S	--	--	3770

Percentage increase when speed is restricted:

Maximum Speed (mph)	Percent Increase
38 through 43	1
32 through 37	4
26 through 31	7
25 and under	10

Table D-3. Series 78 and 82 Tires for Light Trucks

Tire Size Designation	Wheel	Load Range B	C	D
A78-13 LT	D	--	--	1330
	S	--	--	1400
Y78-13 LT	D	830	980	1150
	S	860	1030	1200
6.95-14	S	--	1310	1530

Percentage increase when speed is restricted:

Maximum Speed (mph)	Percent Increase
38 through 43	1
32 through 37	4
26 through 31	7
25 and under	10

5. Heavy Truck and Bus Tires.

Table D-4. Bias Ply Tires for Heavy Trucks and Buses

Tire Size Designation	Wheel	Load Range E	F	G	H
7.50-18	D	3080	3370	--	--
	S	3230	3550	--	--
7.00-20	D	2830	--	--	--
	S	2980	--	--	--
7.50-20	D	3310	3640	--	--
	S	3470	3830	--	--
8.25-20	D	--	4070	4260	--
	S	--	4280	4480	--
9.00-20	D	--	4730	5070	--
	S	--	4970	5330	--
10.00-20	D	--	4870	5350	--
	S	--	5400	5950	--
11.00-20	D	--	5370	5890	--
	S	--	5700	6260	--
11.1-20	D	--	--	--	5530
	S	--	--	--	6060
12.00-20	D	--	--	6090	6540
	S	--	--	6390	6870
12.00-24	D	--	--	--	7360
	S	--	--	--	7730
12-22.5	D	--	--	5890	--
	S	--	--	6260	--

Percentage increase when speed is restricted:

Maximum Speed (mph)	Percent Increase
38 through 43	6
32 through 37	9
26 through 31	12
25 and under	15

Table D-5. Radial Ply Tires for Heavy Trucks and Buses

Tire Size Designation	Wheel	Load Range F	G	H
7.50 R 20	D	3640	--	--
	S	3830	--	--
8.25 R 20	D	--	4260	--
	S	--	4480	--
9.00 R 20	D	--	5070	--
	S	--	5330	--
10.00 R 20	D	--	5350	--
	S	--	5950	--
11.00 R 20	D	--	5890	--
	S	--	6260	--
11.1 R 20	D	--	--	5530
	S	--	--	6060
12.00 R 20	D	--	--	6540
	S	--	--	6870

Percentage increase when speed is restricted:

Maximum Speed (mph)	Percent Increase
38 through 43	6
32 through 37	9
26 through 31	12
25 and under	15

Table D-6. Large Size Bias Ply Tires for Heavy Trucks and Buses

Tire Size Designation	Wheel	Load Range H	J	L	N
12.00-20	D	--	6820	--	--
	S	--	7170	--	--
12.00-24	D	--	7680	--	--
	S	--	8070	--	--
13.00-20	D	7430	7960	8140	--
	S	7810	8360	8540	--
14.00-20	D	--	8760	9390	--
	S	--	9210	9870	--
14.00-24	D	--	--	10480	10710
	S	--	--	11000	11250

Percentage increase when speed is restricted:

Maximum Speed (mph)	Percent Increase
38 through 43	6
32 through 37	9
26 through 31	12
25 and under	15

6. Low Platform Trailer Tires.

Table D-7. Bias Ply Tires for Low Platform Trailers

Tire Size Designation	Load Range G
8.25-15	3450
9.00-15	4130
10.00-15	4480

Percentage increase when speed is restricted:

Maximum Speed (mph)	Percent Increase
38 through 43	6
32 through 37	9
26 through 31	12
25 and under	15