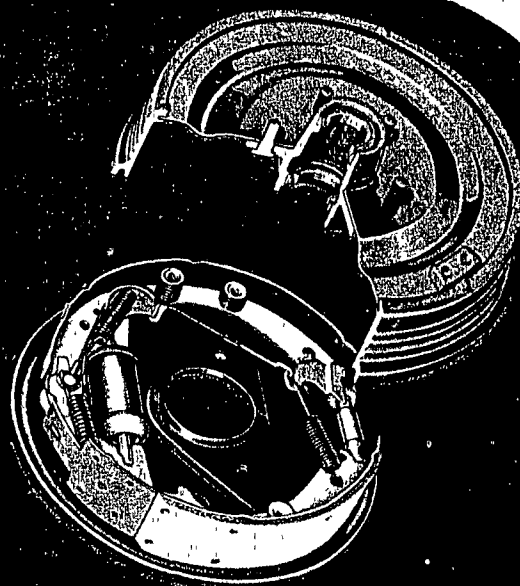


THE FORD SERVICE TECHNICIAN



1961 FORD SERVICE FORUM • NO. 9

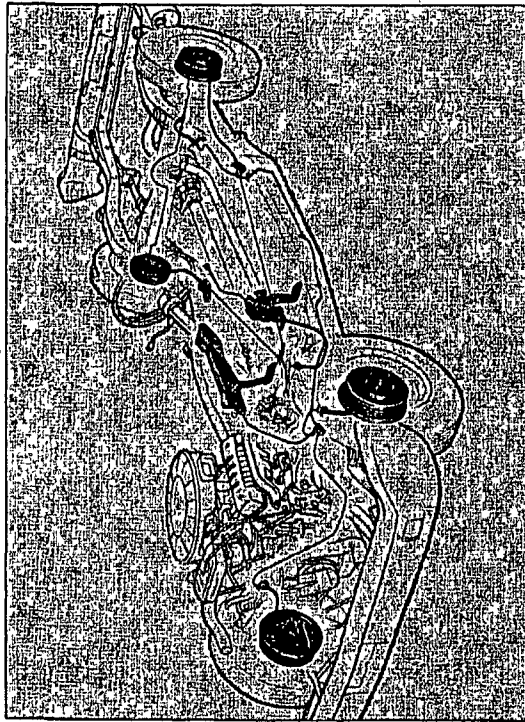


BASIC AUTOMOTIVE BRAKES

TABLE OF CONTENTS

INTRODUCTION.....	3
BRAKING PRINCIPLES.....	4
Kinetic Energy.....	4
Coefficient of Friction.....	5
Brake Linings and Drums.....	7
HYDRAULIC SYSTEM.....	10
VACUUM SYSTEM.....	14
TROUBLE SHOOTING.....	16
Trouble Shooting Chart.....	16
Diagnosis Tips.....	18
DUO-SERVO BRAKES.....	19
Operation.....	19
Automatic Brake Adjustment.....	21
TERMS AND DEFINITIONS.....	24

The descriptions and specifications contained in this booklet were in effect at the time the publication was approved for printing. The Ford Division of Ford Motor Company, whose policy is one of continuous improvement, reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring obligation. COPYRIGHT, 1961, FORD MOTOR COMPANY, DEARBORN, MICHIGAN. ALL RIGHTS RESERVED.



This Ford Service Forum Booklet is published to assist the Service Technician to more fully understand the braking system of present-day cars. The average person may think of automotive brakes as a simple, basic, well-understood component of the car; however, each model year increases the need for better comprehension of the operational and design features in order to perform *Quality Service*.

The Braking Principles section of this booklet explains the fundamentals involving kinetic energy and heat transfer as related to the braking system.

Other sections cover the hydraulic and vacuum systems and the design and operation of the Ford Duo-Servo brakes.

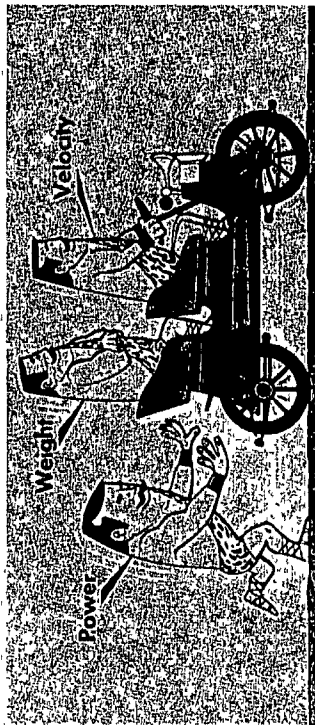
Diagnosis tips and a brake system trouble shooting chart are also included to aid the Technician in locating possible trouble areas in the braking system.

The use of the correct terminology is as important in the brake repair field as in any other. This booklet fully explains the meaning of all brake terms in common use today to assist in conveying reports and diagnosing trouble

KINETIC ENERGY

Among the principles of braking it is known that a moving vehicle is kept in motion not only by the

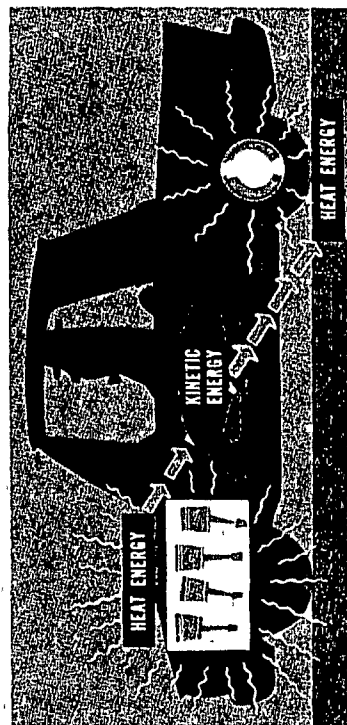
power which started it moving, but also by the power of its own weight and velocity. This is called *kinetic energy*, or the energy of motion.



The heavier an object and the faster it is traveling, the more kinetic energy it possesses.

Once energy is released, it cannot be destroyed; it can only be changed into some other kind of energy. The heat energy pro-

duced by the engine in a car is changed into *kinetic energy* through the drive train. The braking system provides the means of converting the kinetic energy back into heat energy through the use of friction to slow or stop the car.

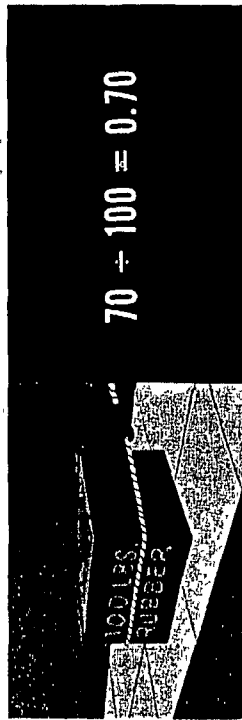


The friction created by the opposing force of the brake lining against the revolving brake drum causes heat. As the heat increases, it absorbs the kinetic energy and the heat passes from the brake assemblies to the atmosphere.

COEFFICIENT OF FRICTION

Friction is basically the resistance to motion. The coefficient of

friction is the effectiveness of one material to resist sliding over another. For example, it takes about 70 pounds of pulling effort to slide a 100-pound block of rubber over a concrete surface; but it takes only about two pounds of pulling effort to slide a 100-pound block of ice over the same surface. Thus, the pulling effort divided by the weight of the load equals the coefficient of friction.



The friction of an object at rest is known as static coefficient of friction and is greater than the friction of motion, or kinetic coefficient of friction.

If the pulling effort required to

keep a block of rubber moving is 70 pounds, the kinetic coefficient of friction is 0.70. However, the pulling effort required to start the block of rubber in motion would be considerably more and, therefore, the static coefficient of friction would be greater.

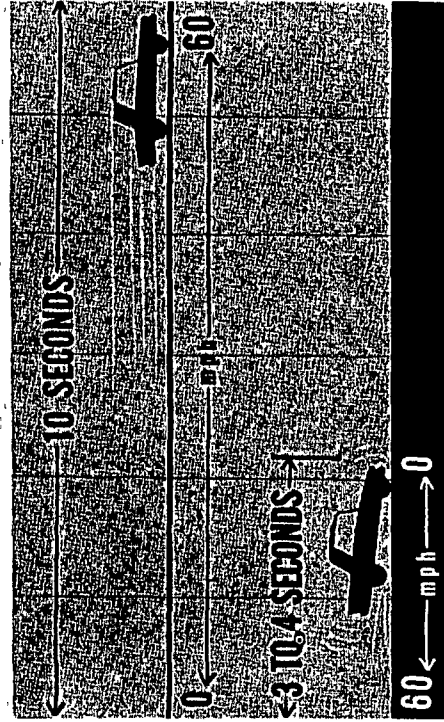


Coefficient of Friction (Cont.)

traveling at 60 mph represents a great amount of kinetic energy. Considering that it takes approximately ten seconds to accelerate from 0 to 60 mph, and only three or four seconds for the modern braking system to stop the car; the brakes must develop several times more horsepower than the engine. All of the kinetic energy built up in ten seconds must be cancelled-out in three or four seconds.

In automobiles, static coefficient of friction exists between the brake linings and drums when the car is stopped and the brakes are applied. Kinetic coefficient of friction exists when the car is in motion and the linings contact the drum.

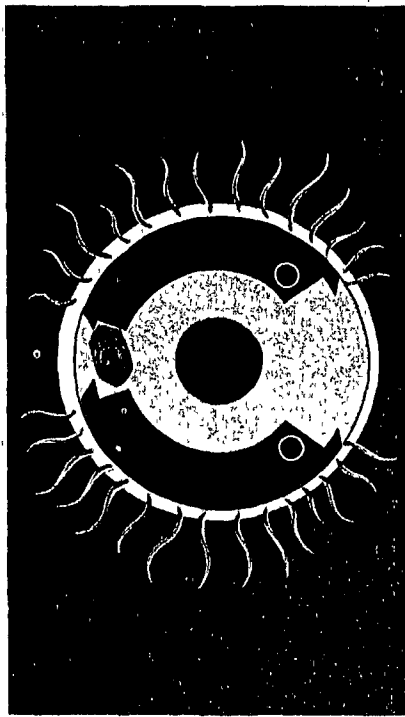
The average 4,000-pound car



BRAKE LININGS AND DRUMS

In arresting the kinetic energy of a moving car to effect a stop, considerable heat must be generated by the brakes and then dis-

ipated into the atmosphere. The brake linings must be able to provide enough friction to produce enough heat to stop the rotation of the drums without heat damage and with minimum wear on the linings and drums.



Brake linings are made of a great variety of materials; for the most part asbestos, because of its heat resisting qualities combined with a relatively high and stable coefficient of friction range. A variety of thermo-setting type binders are used, and often rubber and small metallic particles are included in the formula to provide the desired lining life and fade-resisting characteristics.

During a "panic" stop, the temperature of the brakes in an average car may rise by about 450 degrees. On large trucks the

temperature rise is often over 1000 degrees. As the temperature rises, the coefficient of friction of some lining material is lowered. Therefore, it is important that the brakes be cooled as rapidly as possible so they will be ready for the next application.

The thermal conductivity or the ability of a substance to conduct heat, and adequate ventilation are the most important factors in the dissipation of heat in order to maintain a narrow range of friction coefficient.

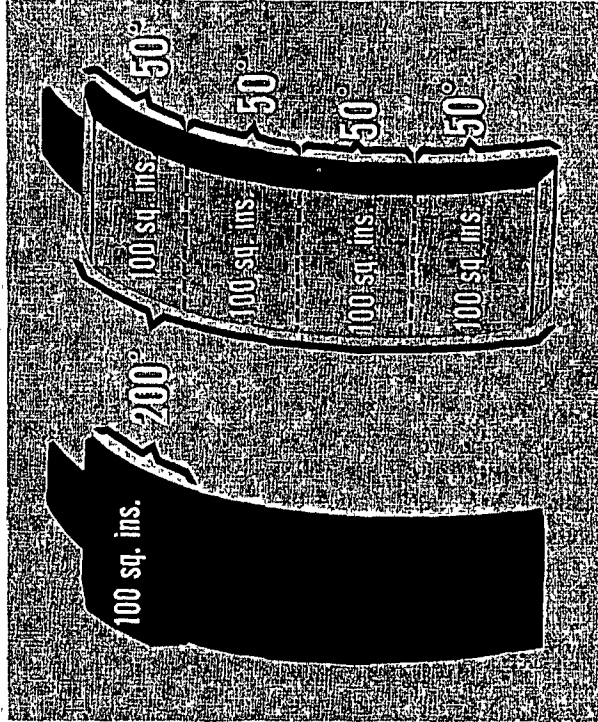
Brake Linings and Drums (Cont.)

If the brake linings and drums get too hot, some of the binding agents in the lining may tend to soften or start to melt, thereby changing the coefficient of friction between the lining and drum, resulting in brake "fade."

The area of contact between the lining and the drum is the greatest determining factor in the amount of heat transferred and dissipated to the atmosphere. Therefore, heavier vehicles re-

quire increased braking area because more heat must be generated and dissipated.

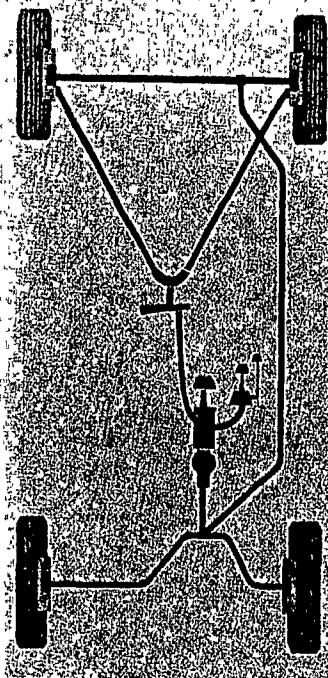
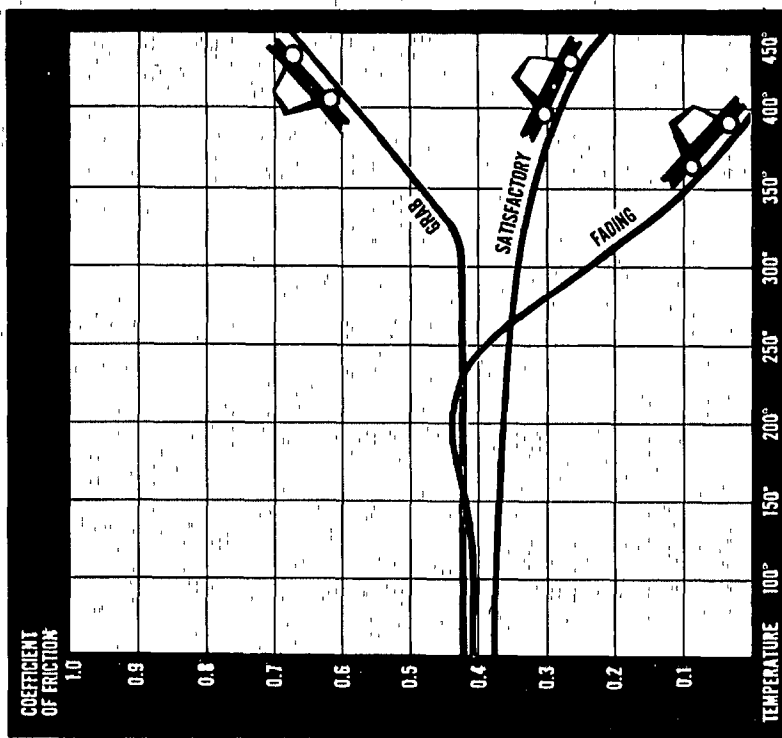
Assuming that 100 square inches of brake lining can absorb about 200 degrees of heat during a brake application, the same amount of heat distributed over 400 square inches, or four times the area, would amount to only 50 degrees of heat absorption per 100 square inches. This would result in greater heat dissipation for cooler-running brakes and longer lining life with a more stable coefficient of friction range.



In an effort to keep brake temperatures as low as possible, the material used in the linings and drums and the lining area of Ford brakes are carefully engineered and machined to provide the most desirable frictional and heat conduction characteristics. In effect, the linings are "tailored" for each type of vehicle service.

Non-standard brake linings may change the coefficient of friction in various undesirable ways and result in brake grabbing, fading, or short lining life.

Always install genuine FoMoCo brake lining of the correct part number.

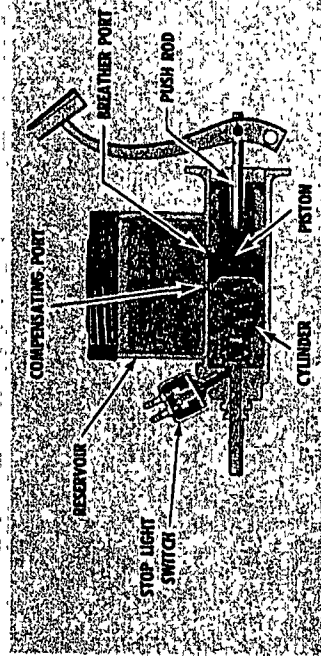


The hydraulic portion of the braking system consists of a master cylinder that is controlled by brake pedal action, a hydraulic cylinder at each wheel, and the necessary connecting lines and fittings.

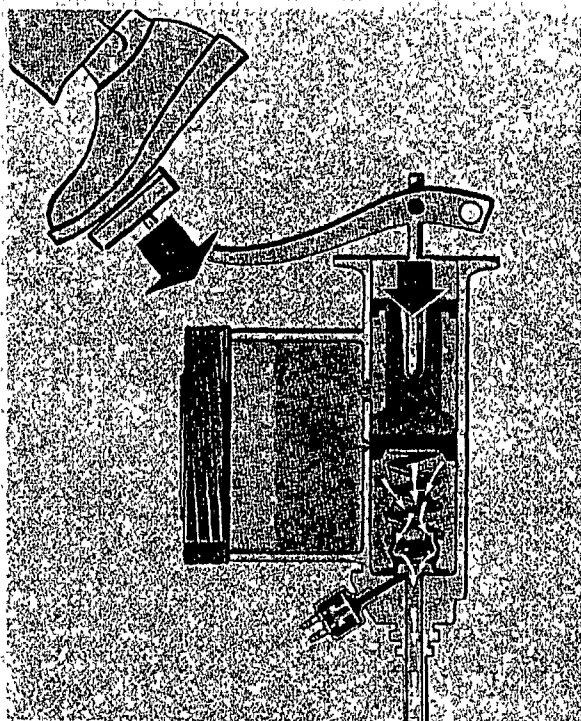
to the fluid reservoir through the compensating and breather ports of the cylinder.

A stop light switch is installed in the pressure side of the master cylinder. The diaphragm of the switch is exposed to the hydraulic fluid; and when the brakes are applied, the diaphragm forces the movable contact of the switch toward the stationary contacts to turn on the stop lights.

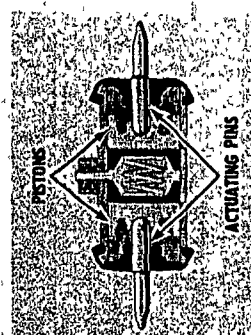
The master cylinder assembly is a self-contained unit which has a fluid reservoir, a cylinder, a push rod, a piston, and a piston stop or snap ring. In the released position, both sides of the piston are open



As the brake pedal is depressed, the piston moves forward and the primary cup closes the compensating port. As the piston continues to move forward, pressure is applied to the fluid in the cylinder and the fluid is forced out through the residual check valve into the brake lines and wheel cylinders.

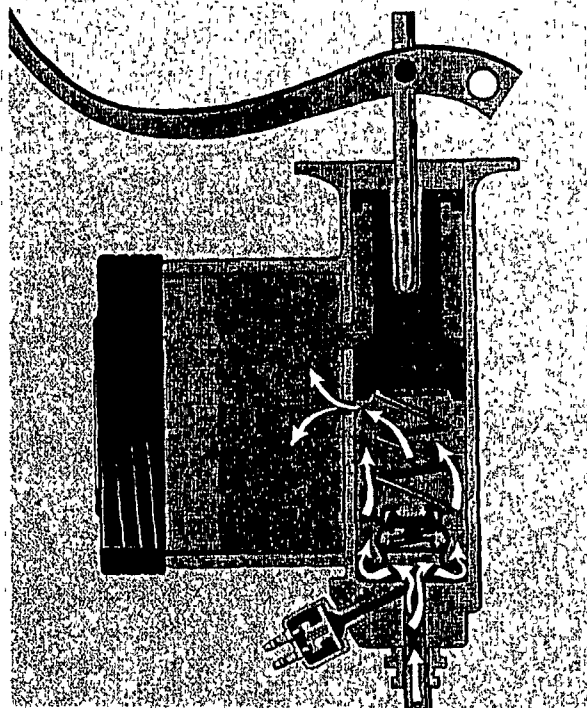


As the wheel cylinder pistons are pushed outward by the hydraulic pressure being applied from the master cylinder, the actuating pins move the brake shoes into contact with the drums. After the brake shoes have made contact with the drums, force on the master cylinder piston builds up pressure in the hydraulic system to apply increased force on the brake shoes. A boot at the ends of



When the brake pedal is released, the piston in the master cylinder moves rearward, and the fluid behind the primary cup, which has entered the master cylinder through the breather port, flows through the valve in the end of the piston and around the primary cup to reduce the pressure in the system.

With reduced pressure in the system, the brake shoe retracting springs push the wheel cylinder pistons INWARD to force fluid out of the cylinders. This overcomes the residual pressure and the spring pressure in the master cylinder to allow the excess fluid to flow into the master cylinder reservoir.

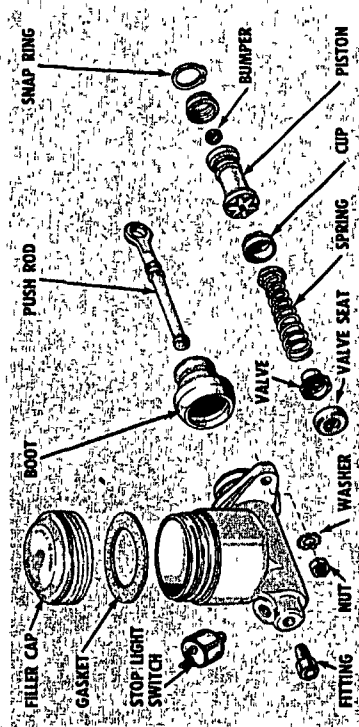


As the pistons in the wheel cylinders move inward, the brake shoes move away from the drums.

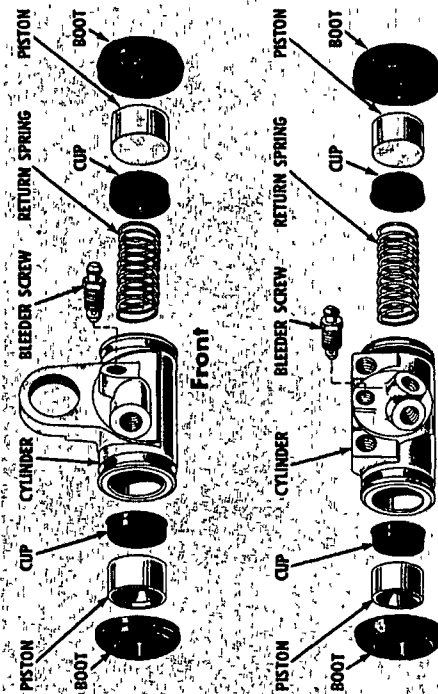
8-15 pounds of residual pressure in the system at all times. This pressure keeps the wheel cylinder cup lips securely against the sides of the wheel cylinder and prevents air from entering the system.

The residual check valve operates against a spring which offers enough resistance to maintain

All hydraulic system components and coated with brake fluid during installation. Do not use petroleum-type solvents in the hydraulic system.



Disassembled View of Master Cylinder



Front

Rear

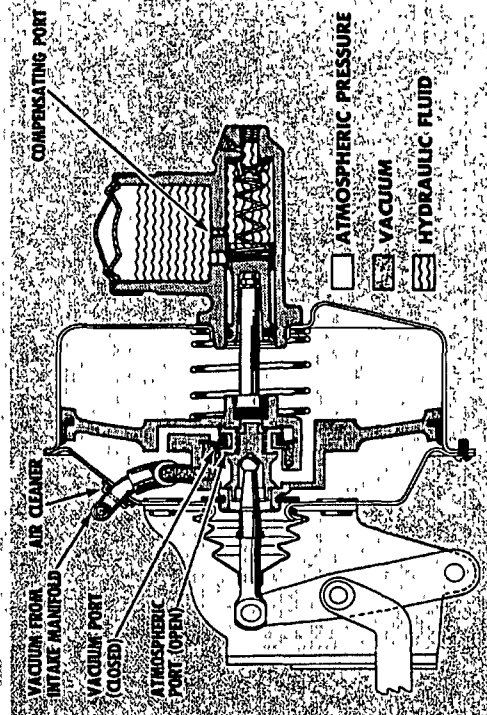
Disassembled View of Wheel Cylinders

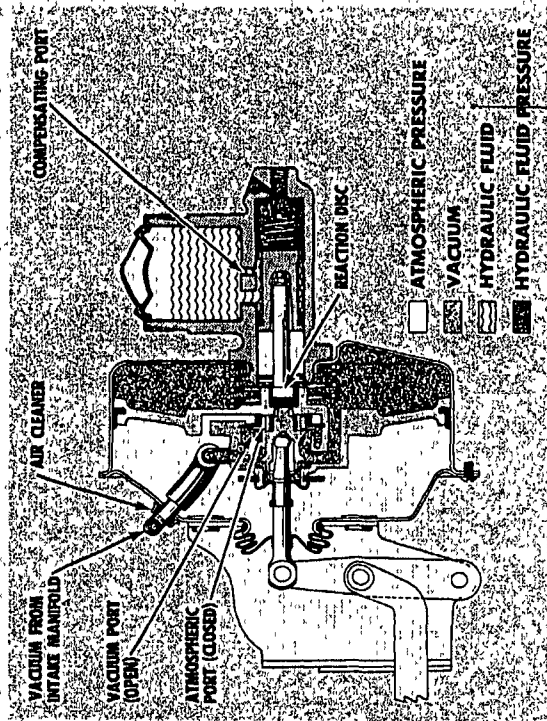
The brake vacuum booster power unit is optional equipment on Ford cars and standard equipment on Thunderbirds.

The power unit consists of the vacuum reservoir and the booster. The reservoir receives vacuum from the engine intake manifold. When the engine is stopped, a check valve in the reservoir retains the vacuum and prevents the accumulation of raw fuel vapor in the reservoir and in other parts of the vacuum system. The reservoir retains enough vacuum for several power-assisted brake applications after the engine has been stopped. In the event of vacuum power failure, the brakes will remain effective, although

greater pedal effort will be required.

Filtered air at atmospheric pressure is admitted to the rear chamber of the vacuum booster at all times through an air cleaner. When the brake pedal is in the released position, the valve return spring holds the valve opening rod and valve plunger against the piston rear plate, leaving the valve atmospheric port open and the vacuum port closed. Atmospheric pressure passes through the port in the valve and through porting in the booster piston to the front chamber of the booster. The piston is then balanced by the atmospheric pressure on both sides and will remain in the released position.





As the brake pedal is depressed, the valve operating rod and plunger move forward against the poppet valve to close the atmospheric port. Further travel of the rod and plunger moves the poppet valve and reaction disc to open the vacuum port and admit vacuum through the porting in the valve and piston to the forward chamber of the booster. As the vacuum removes air from the forward chamber, atmospheric pressure behind the booster piston exerts force against the master cylinder push rod and piston to provide the power assist.

The amount of assist supplied by the power unit is a direct multiple of the amount of pressure being applied to the brake pedal; thus, gradual application of the brakes is possible.

As pressure is developed within

SYMPTOMS		POSSIBLE CAUSES									
		Brakes do not apply	Pedal gradually goes to floor	Excessive pedal travel	Low pedal reserve	Spongy pedal	Hard pedal	Pinch-out squeal	Bonded brake squeal	Wire brush noise	
Incorrect tire pressures		●	●	●		●					
Low fluid level											
Parking brake applied				●			●				
Damaged linkage				●			●				
Bent or improperly adjusted brake shoes				●	●		●				
Faulty or incorrect retracting springs											
Glazed linings							●				
Dirt on drum-to-lining surface											
Worn lining				●							
Faulty brake cylinder					●						
Air in hydraulic system						●					
Hydraulic lines restricted							●				
Improperly adjusted or worn wheel bearings											
Drum out of round											
Oil or grease on lining											
Loose carrier plate											
Self-adjusters not operating				●	●						
Threaded drum											
Incorrect undergrind											
Faulty holddown springs								●			
Loose linings								●			
Incorrect chamfer								●			
Drum finish too smooth								●			
Carrier plate ledges not lubricated											
Damp brakes											
High-speed stops with non-burnished linings											
Dirty brake fluid						●					
Faulty master cylinder		●					●				
Incorrect lining material							●			●	

A high-contrast, black and white illustration of a person sitting at a desk, writing on a piece of paper. The person is wearing a hat and a jacket. On the desk, there is a lamp, a pen, and a small object. The background is dark and textured.

If the pedal feels "spongy" as a steady pressure is applied, it is an indication of air in the hydraulic system.

The use of inferior brands of hydraulic brake fluid can cause air in the system; as the alcohol in the fluid will boil and evaporate to create air pockets in an otherwise tightly sealed and filled system. Use only FoMoCo Super Heavy Duty brake fluid B7A-19542-A.

If it is necessary to add brake fluid to the system, inspect the master cylinder, brake lines, and wheel cylinders for leaks.

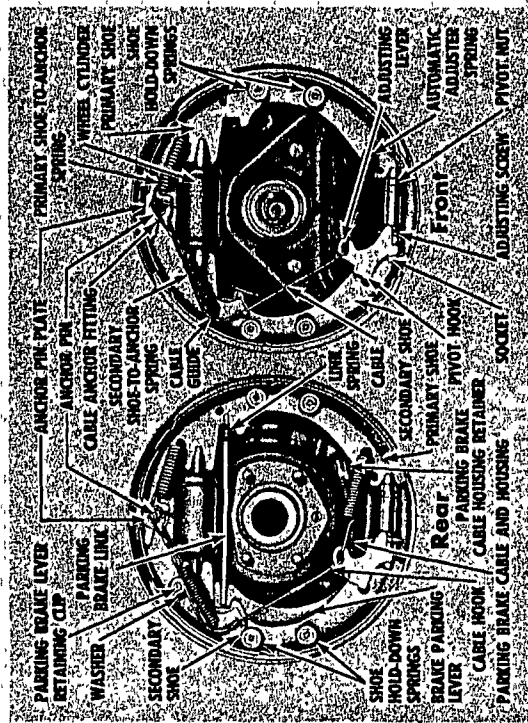
If there is evidence of dirt in the brake fluid, flush the system with clean denatured alcohol, then install new fluid and bleed the system.

If one or more of the brakes are locked, open the wheel cylinder bleeder screw to release a few drops of fluid. This will free the brake to allow the car to be moved to a service area for repair.

Push the brake pedal down as far as it will go while the car is standing still. If the pedal can be pushed down more than halfway between the released position and the floor, the brake fluid, brake adjustment, or the automatic brake adjusters may require attention.

[illegible]

OPERATION

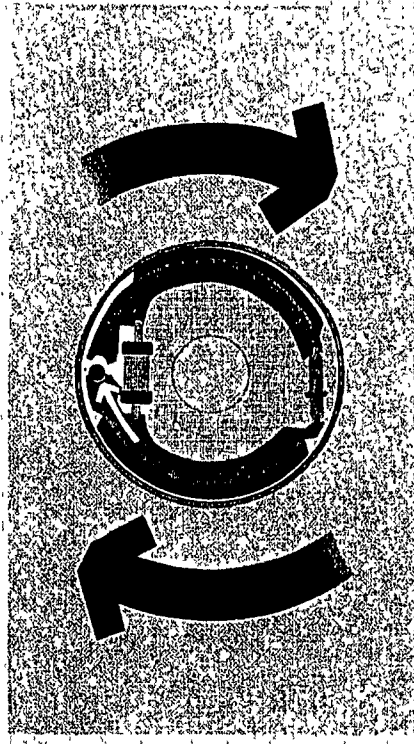
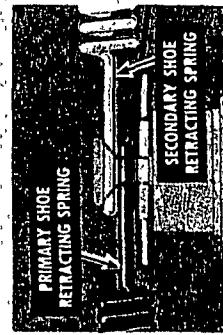


Ford car and Thunderbird brakes of the Duo-Servo design are self-energizing, single-anchor, internal expanding, self-adjusting type brakes.

The parking brake is part of the rear wheel brake assemblies and is operated by mechanical linkage and cables.

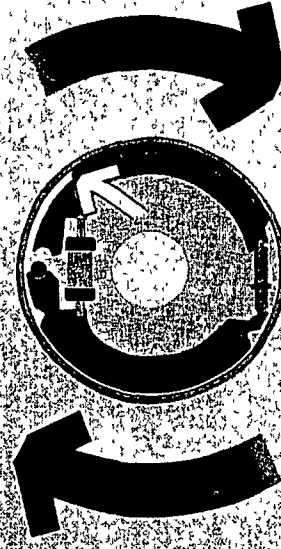
The duo-type wheel cylinders are double-acting to apply both the primary and secondary brake shoes. The initial hydraulic pressure generated at the master cylinder expands both pistons of each wheel cylinder equally, how-

ever the design of the brake shoe anchor pin incorporates a chamfer on the pin so that the primary brake shoe has less retracting spring resistance to overcome than the secondary shoe. This allows the primary shoe to move toward the brake drum an instant before the secondary shoe moves.



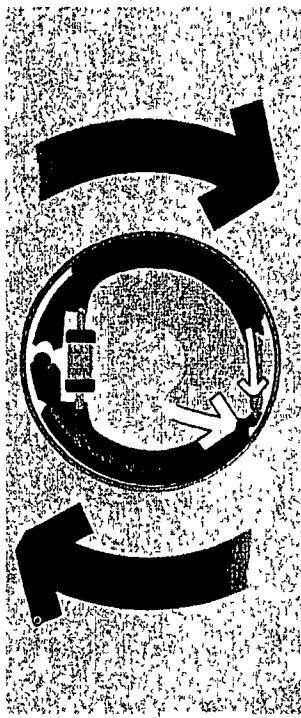
As the toe, or top, of the primary lining contacts the brake drum, the frictional force between the brake drum and lining attempts to turn the primary shoe into the secondary shoe. This forces the secondary shoe into the drum and onto the anchor pin due to

the connection between the two shoes at the adjuster. The rotation of the drum continues this wrap-around, or self-energizing of the brake shoes, to utilize the frictional force to help the applying force on both shoes.



The primary shoe is energized only by its own friction, and the secondary shoe is energized by its own friction and by the primary shoe. As a result, the sec-

ondary shoe exerts about twice as much braking effort as the primary. Thus the secondary shoe has a longer and thicker lining than the primary.



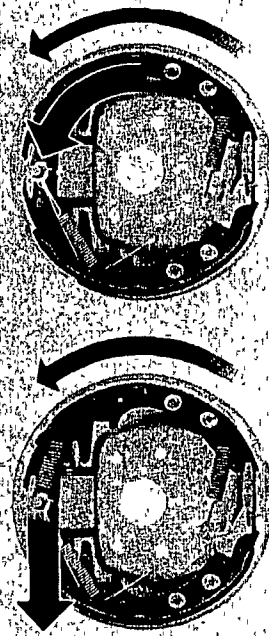
AUTOMATIC BRAKE ADJUSTMENT

Automatic brake adjusters are standard equipment on Ford cars and Thunderbirds.

Brakes will remain in adjustment for the service life of the linings. The design of the Duo-Servo

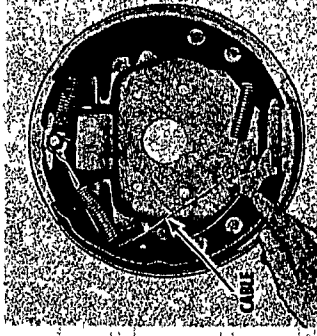
brakes is such that proper lining-to-drum clearance will be maintained without over-adjustment.

When the car is moving in reverse, and the brakes are applied, the wrap-around action of the brake shoes following the drum forces the toe of the primary shoe against the anchor pin.



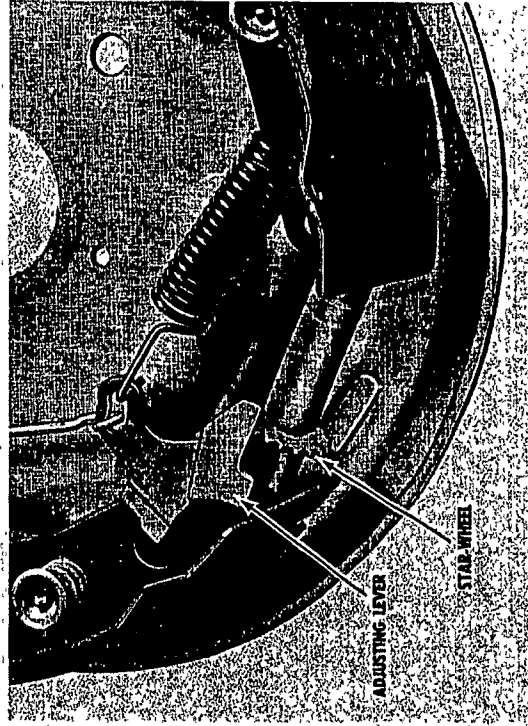
Automatic Brake Adjustment (Cont.)

As the primary shoe moves against the anchor pin, the action of the wheel cylinder moves the toe of the secondary shoe away from the anchor pin. Movement of the secondary shoe causes the cable to pull the adjusting lever upward and against the end of a tooth on the adjusting screw star-wheel.



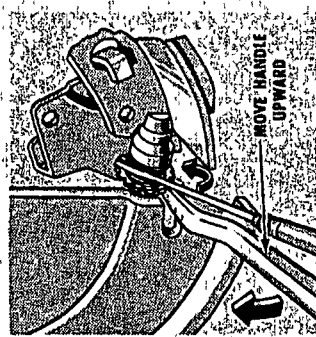
As lining wear increases, upward travel of the adjusting lever increases. This is because the secondary shoe travels further to reach the drum. When the lever can move upward far enough, it passes over the end of the tooth

and engages it. When the brake is released, the adjuster spring pulls the lever downward, causing the star wheel to turn and expand the brake shoes. The star wheel is turned one tooth at a time as the linings wear.



Satisfactory operation of the self-adjusting mechanism depends upon the adjusting lever engaging the star-wheel notch when adjustment is required. If proper engagement is not made, the self-adjusters will not function.

If it is necessary to back-off the adjustment to facilitate the removal of a brake drum, hold the adjusting lever away from the star-wheel while using the adjusting tool.

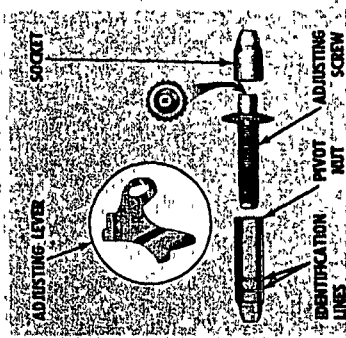


Use care not to burr, chip, or otherwise damage the notches in the adjusting screw star-wheel.

The adjusting screw must be free to turn with finger pressure, or the retracting spring will not be able to force the adjusting lever to turn the star-wheel. The use of high-temperature Lubriplate COAZ 19548-A is recommended during brake repair.

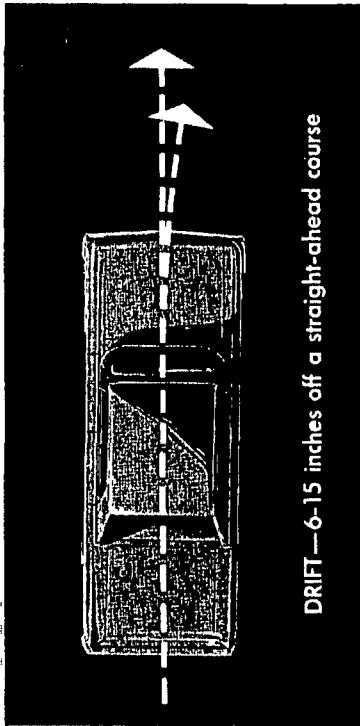
Different brake adjusting screw assemblies and adjusting levers are designed and manufactured for installation in the right and left side brakes. The adjusting screws and levers must not be interchanged. Interchanging the adjusting screw and levers from one side of the car to the other would cause the brake shoes to retract rather than expand each time the self-adjusters operated.

The adjusting screw and lever are identified by an "R" or "L" stamped on the face of the lever and in the socket end of the screw. The adjusting pivot nuts can be identified by the number of lines machined around the body of the nut. Two lines indicate a right-hand nut for the right side of the car, one line indicates a left-hand nut for the left side of the car.



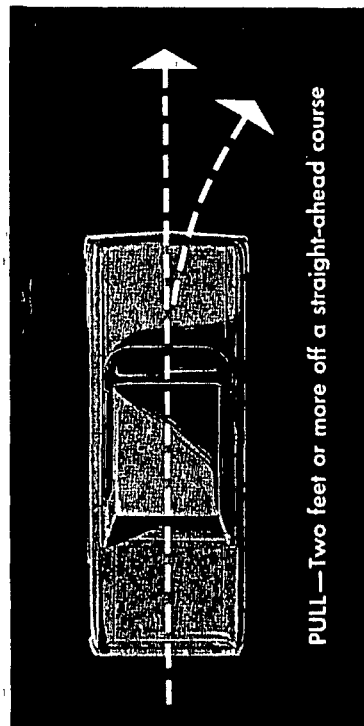
The correct interpretation of brake terminology is necessary when diagnosing brake troubles.

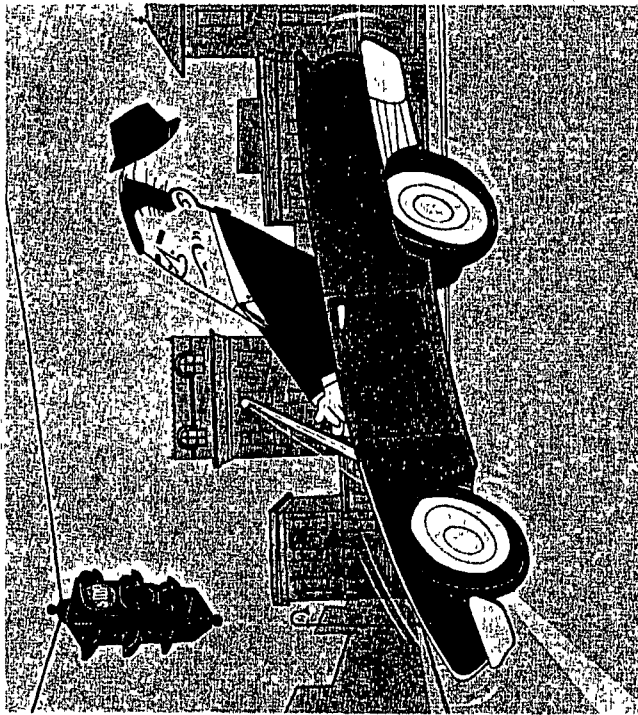
This section explains the major terms in common use and gives the basic causes of the complaint.



• **Drift**—Usually caused by a rear brake malfunction or by non-burnished linings. Drift may occur on level pavement during a light to moderate stop as the car slows from 45 to 25 mph. The car may drift off a straight-ahead course from 6 to 15 inches.

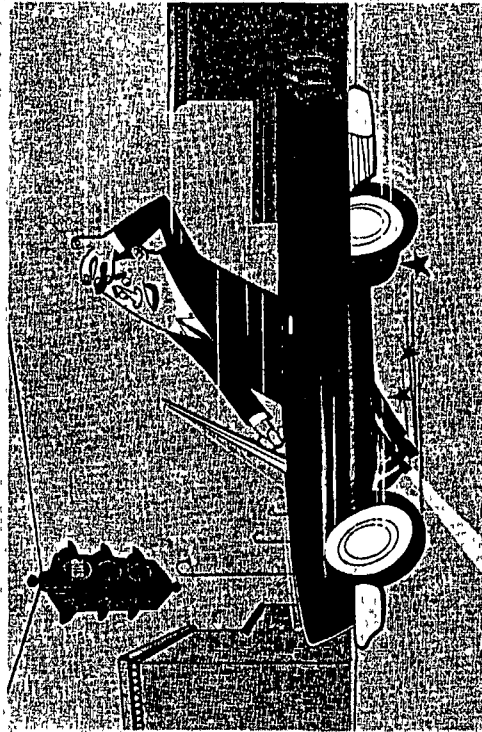
• **Pull**—Front brakes that have been overheated or improperly installed or adjusted will cause the car to "pull" under the same road conditions as "drift." However, the car may pull off a straight-ahead course in excess of two feet.





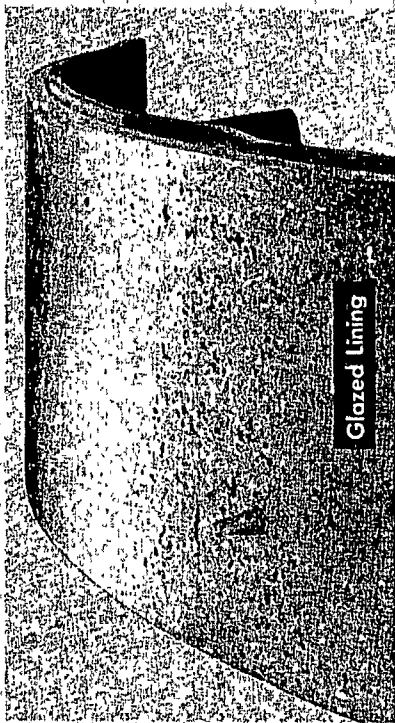
- **Dive**—Usually caused by a malfunction of one of the front brakes. Dive is a severe pull to one side which is not controllable with the steering wheel. Often the brakes must be released before the car can be brought to a straight-ahead course.
- **Over-Sensitive**—A severe pull or dive usually occurring on the first several stops in the morning. Over-sensitivity may be caused by the absorption of moisture from the atmosphere by the brake lining or by dust in the brake assembly. Occasionally, if there is a trace of a petroleum product on the lining, it will cause a pull or dive until the brakes reach operating temperature.
- **Lock-Up**—A locking or skidding of only one wheel during a brake application. Lock-up is usually caused by overheating from a "dragging" brake, or from the parking brake being partially applied while the car is in motion.

- **Fade**—High pedal effort—hard pedal—without apparent wheel brake action is the result of brake "fade." Fading is usually caused by making several high-speed stops during a short period of time, or after many brake applications in heavy traffic. Severe



- **Drag**—If the brake linings continuously contact the brake drums, the brakes will "drag." Dragging brakes may be caused by "riding" the brake pedal, partial application of the parking brake, improper installation or the use of incorrect parts, incorrect lining-to-drum clearance, or the lack of lubrication on the carrier plate ledges.
- **Brake drag** will result in complaints of fade, pull, dive, and lock-up; and the braking system may be impaired by glazed or burnt linings, burnt drums, overheated brake fluid, or burnt wheel cylinder seals.

On cars equipped with a vacuum

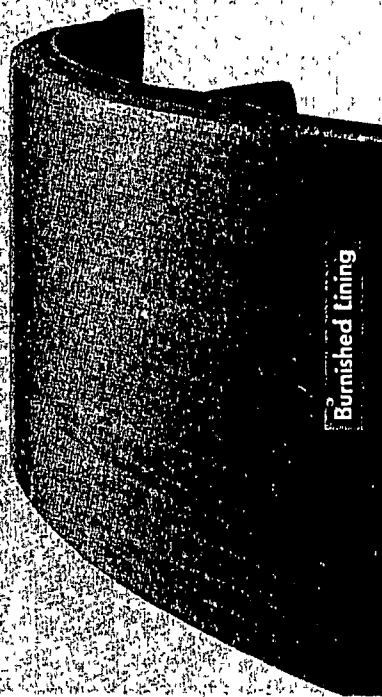


Glazed Lining

the edges of the lining will usually lift away from the shoe.

• **Glazed Linings**—Usually the result of overheating of the lining induced by brake drag. This changes the coefficient of friction of the lining due to the "boiling out" of the resins. Glazing can be identified by small bubbles on the lining surface or small holes, or "pock" marks, into the lining. Also,

A shiny lining surface does not indicate a glazed lining. A completely shiny lining surface is an indication of successful burnishing, or seating-in of the lining to the drum.



Burnished Lining

• **Undergrind and Fall-Off**—An undergrind is usually used on service linings to produce proper clearance between the lining and the drum. A clearance of 0.005-0.015-inch is required to eliminate the possibility of heel and toe contact which would cause pull and dive.

Production linings are cam ground so that initially only the center of the lining contacts the drum to produce a fall-off, or sufficient clearance, at the heel and toe when the center of the lining is in contact with the drum.

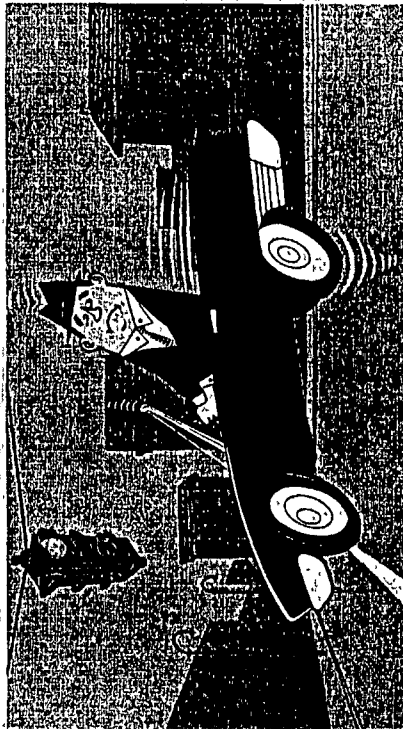
• **Out of Round Drums**—Erratic braking action may result if the brake drum runout is in excess of 0.008-inch. Out of roundness within 0.008-inch is satisfactory unless the entire specification

tolerance is within a 30-degree radius. This is described as a bump or a hole in the drum.

Front brake drums that are out of round can be detected by a pulsation felt through the brake pedal during a moderate-to-hard stop from approximately 50 mph.

Out of round rear drums may produce a grab or slip feeling known as rear wheel hop, and may also cause a severe body vibration during brake application.

• **Pedal Vibration or Light Pulsation**—Usually occurs on very light brake applications or when "riding" the brake pedal. This possible malfunction may be mistaken for out of round drums. However, it is often caused by an unequal lining-to-drum clearance adjustment.

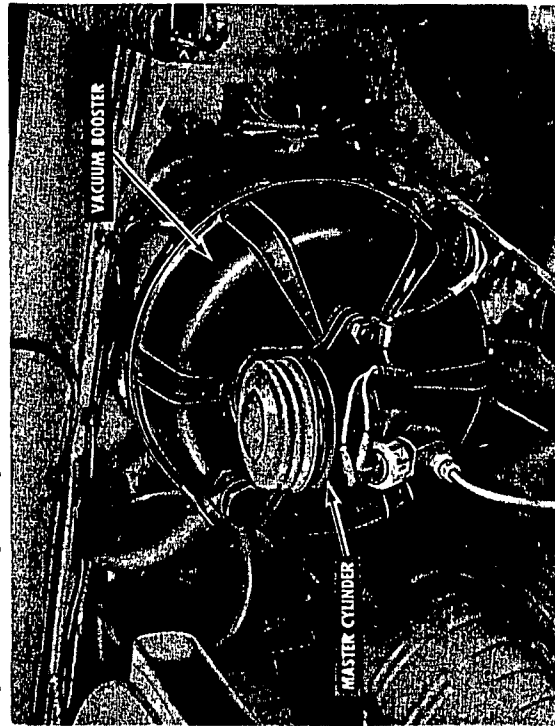


• **Threaded Drums**—An imperfectly-turned brake drum with heavy tool marks resembling a screw thread pattern will cause shoe slap, which is a "pop" or a "bang" in the brake assemblies during a slow-speed stop. This condition is usually found in left-side brake assemblies as the lining "screws" into the drum, breaks free, and hits the carrier plate. Refacing the brake drum will usually correct the trouble.

• **Hard or Hot Spots on Drum**—Fast, hard stops with incompletely burnished linings will create excessive heat and cause a series

of small blue spots running the full diameter of the drum and on the center of the lining. This condition requires the replacement of the damaged parts.

• **Hard Brake Pedal**—If high pedal effort is required under normal operating and temperature conditions, inspect the brake drums for a smooth finish which would allow the lining to slip due to low frictional resistance. Be sure the lining is of the correct material, and not glazed or burnt. A restriction in the master cylinder check valve, or vacuum power booster failure will also cause hard brake pedal complaints.



• **Spongy Pedal**—Air or dirt in the hydraulic system is indicated if the pedal feels *spongy* but can be "pumped-up" to apply the brakes. Flushing the system with denatured alcohol and bleeding the system should correct the trouble.

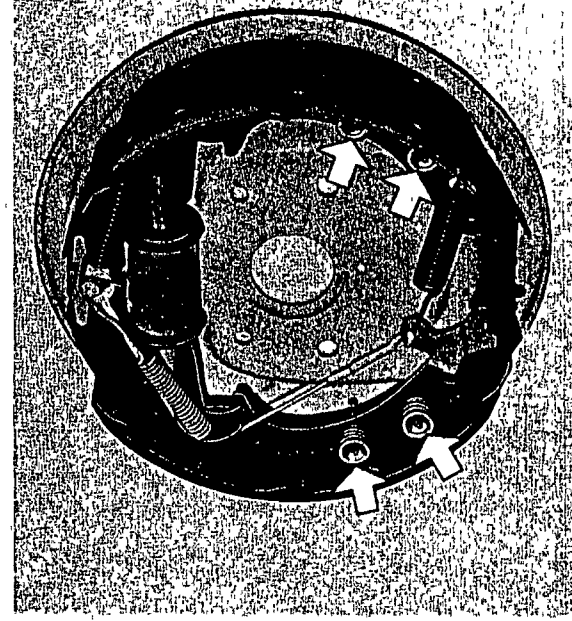
• **Pinch-Out Squeal**—If a high-pitched noise is produced during the last three wheel revolutions before the car stops, inspect the brake lining to be sure it is of the correct material, and is tight on the shoes.

• **Wire Brush Noise**—A noise that sounds like a wire brush being

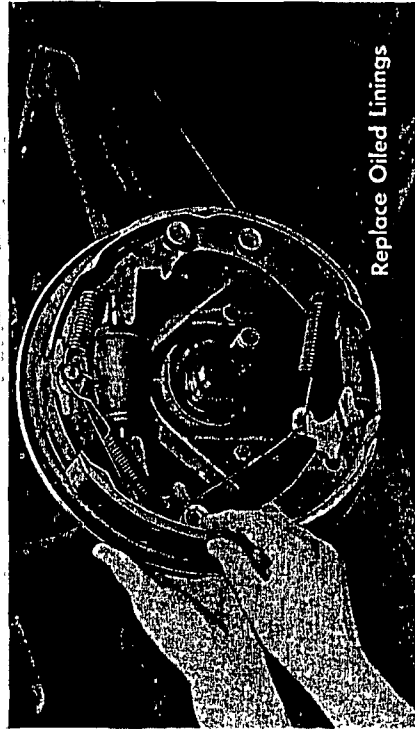
rubbed against the drum, and is most audible during the last ten wheel revolutions of a normal stop. Wire brush noise is caused by the installation of non-specified brake lining material.

Use only genuine **FoMoCo** brake lining of the correct part number.

• **Brake Honk**—A honk or a groan occurring the last few wheel revolutions of a normal stop and is usually caused by the brake shoe assemblies vibrating against the carrier plate. Be sure the correct brake shoe hold-down springs are used.



- **Wrap-Up Clunk**—The first reverse stop after forward stops, or the first forward stop after a reverse application, will produce a clunk noise. Some clunk noise is normal and is due to wrap-around effect of the brake shoe assemblies. If the noise is excessive, check the brake lining-to-drum clearance and tighten the carrier plate bolts.
- **Grating Brakes**—A grating or grinding noise present during any stop is an indication of foreign objects in the brake assembly or lining rivets rubbing the drum because of excessive wear.
- **Oiled Linings**—Oil on the brake linings will cause drift, pull, dive, and over-sensitiveness. *Do not attempt to clean oiled linings; they must be replaced.*



Replace Oiled Linings

- Be sure to repair any leaking wheel cylinders and replace damaged oil seals before installing new brake lining.
- **Burnish**—New brake linings must go through a break-in period known as burnishing. The micro finish of the brake drums is intended to burnish-in new linings more rapidly, however, it is often 1000 miles before the linings are completely burnished, or seated to the drum. A fully-burnished lining has a uniformly shiny surface which indicates that it has been making full contact with the drum. Non-burnished linings may have a tendency to cause drift or pull, therefore, attempts at repairs or adjustments should not be made before the car has been driven 1000 miles unless obvious mechanical trouble occurs.

FORD DIVISION FORD MOTOR COMPANY

