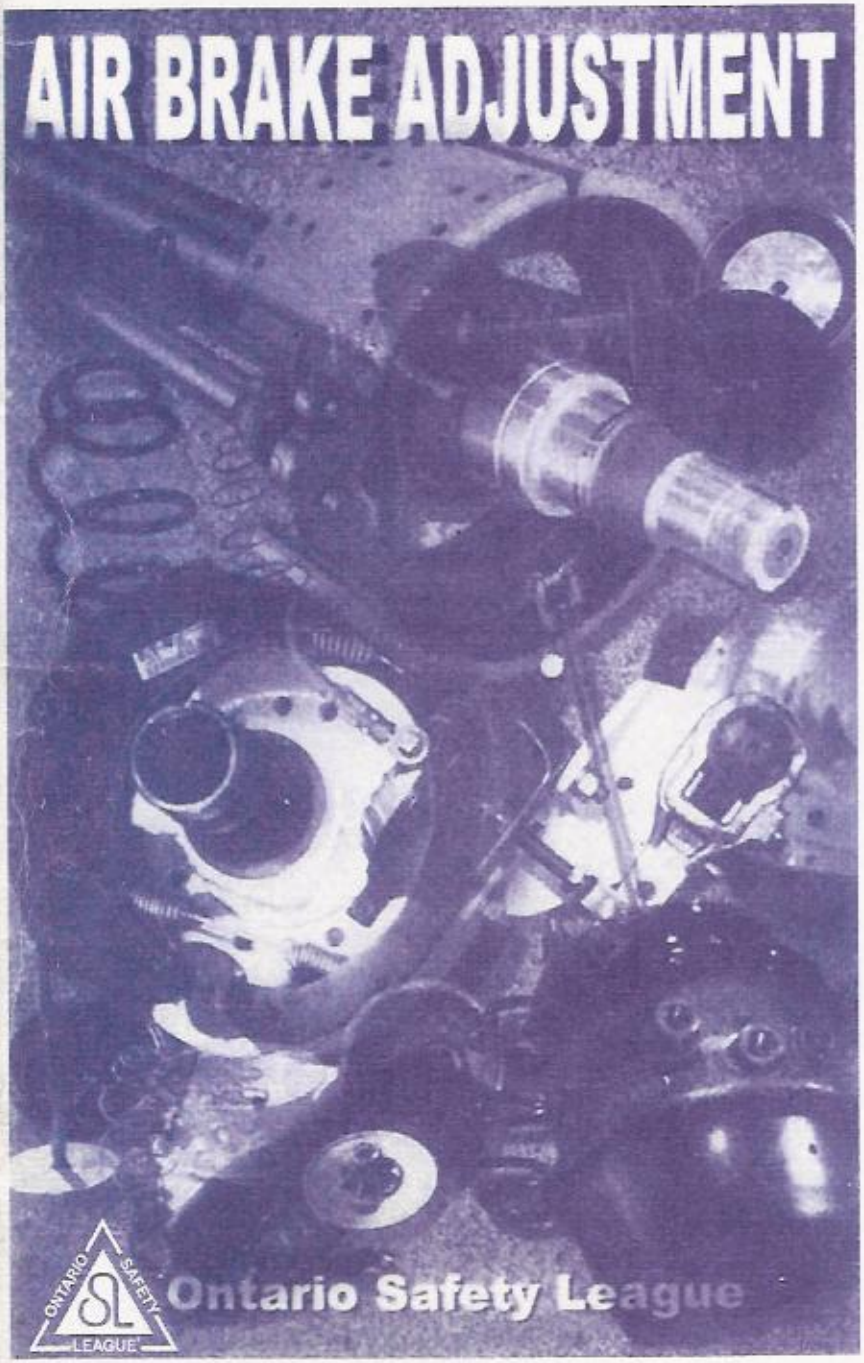
AIR BRAKE ADJUSTMENT



Ontario Safety League

BRAKE CHAMBER DATA CHART

CLAMP RING BRAKE CHAMBERS

CHAMBER TYPE	OVERALL DIAMETER	MAX. PUSHROD TRAVEL
6	4 1/2"	1 1/4"
9	5 1/4"	1 3/8"
12	5 11/16"	1 3/8"
16	6 3/8"	1 3/4"
16L	6 3/8"	2"
20	6 25/32"	1 3/4"
20L	6 25/32"	2"
24	7 7/32"	1 3/4"
24L	7 7/32"	2"
24L*	7 7/32"	2 1/2"
30	8 3/32"	2"
30L	8 3/32"	2 1/2"
36	9"	2 1/4"

The

AIR BRAKE ADJUSTMENT

Manual

Student Edition

Contents

ADMINISTRATION

This course is presented by the Ontario Safety League on behalf of the Ministry of Education and Training, Ontario.

The Instructor has been trained by the Ontario Safety League to present this training and must adhere to all prescribed training and evaluation procedures.

This program is intended to provide information on the laws, regulations and correct procedures for checking and performing air brake adjustments. The degree of proficiency achieved will depend upon the student's effort, comprehension and practice of the material contained herein.

While every effort has been made to ensure that this information is correct and up to date, responsibility remains with the student to remain current on changes to laws, regulations, procedures, technology and any other relevant factors. The program presumes that both students and instructors will pursue further education and retraining as necessary.

Due to the nature of the components and vehicles dealt with in the air brake adjustment process, students must be aware of the potential for serious hazard. For this reason, students must exercise every safety precaution, beginning with common sense. If any vehicle or component is unfamiliar, or if any aspect of the adjustment process is unclear, the student must not attempt to perform the adjustment.

Any comments concerning this program should be forwarded in writing to:

ONTARIO SAFETY LEAGUE
5045 Orbitor Drive
Building 11, Suite 100
Mississauga, Ontario
L4W 4Y4

INTRODUCTION

STUDENT OBJECTIVES

- To gain a thorough knowledge of the laws and regulations that apply to performing air brake adjustments.

- To be proficient in checking the proper condition and functioning of an air brake system.

- To be able to check and adjust pushrod travel, as well as identify defects in the brake components.

PURPOSE

To ensure those persons performing air brake adjustments have sufficient knowledge of the following:

Trade Qualification &Apprenticeship Act - amended by Reg. 269/96
This 1996 amendment allowed drivers to adjust air brake chamber push rod stroke on trucks and trailers so equipped, provided that they had successfully completed an approved course of study.

Highway Traffic Act — Regulation 575
This requires all drivers of commercial motor vehicles to perform a pre-trip inspection on their vehicle at the start of each shift. One component of the pre-trip inspection is a complete and thorough check of the braking system. Should it be determined that the brakes are out of adjustment, the driver must record and rectify the defect before taking the vehicle on the road.

Prior to the introduction of TQAA Regulation 269/96, air brake adjustments were required to be performed by a mechanic. Substantial supplementary expenses often resulted, in the form of down time, labour and travel. However, a more efficient solution came about through enabling drivers certified under the new MET program to perform the necessary adjustment themselves.

Regulation 575 further mandates that all vehicles manufactured after 30 April 1995 are equipped with automatic slack adjusters and brake wear indicators. However due to the possibility of component malfunction or failure, a driver must still perform a manual check of the vehicle's air brake adjustment.

SAFETY PROCEDURES

Never climb under a vehicle unless it has been properly chocked and secured to prevent movement.

The following items should be used in order to minimize the risk of hazard or injury:

- Safety glasses
- Gloves
- Bump cap or hard hat
- Coveralls
- Safety boots

Always exercise extreme caution around moving parts.

Ensure that any person giving assistance has a full and clear understanding of both the equipment and signals to be used.

Special attention must be given to the spring brake portion of a brake chamber (if so equipped). If there is any evidence of damage due to corrosion or impact, do not go near it! Refer the defect to a qualified mechanic.

WHAT HAPPENS DURING BRAKING

When a vehicle is brought to a stop, much more is happening than meets the eye. Physics provides a good explanation of how a vehicle's brakes cause it to come to a stop.

When an object with a mass is in motion, it has what is called *kinetic energy*; an object with a mass at rest has none. For example, a moving vehicle will have a great deal of kinetic energy, while a stopped vehicle will have none.

In order to come to a stop, a moving object must get rid of all of its kinetic energy. However, this energy must be changed into another form, since the laws of physics do not allow energy to simply disappear. For a moving vehicle, this is exactly what the braking process does. When the brake pedal is applied, brake linings come into contact with the brake drums and cause friction, which produces heat. Kinetic energy is changed into heat energy and the vehicle will come to a stop.

Under normal braking conditions, the heat produced by friction is radiated into the atmosphere. However, in more severe braking circumstances, heat in the brake drum cannot dissipate quickly enough and the drum will continue to get hotter. The drum expands as it heats, causing its contact area to move away from the brake shoes, resulting in decreased braking effectiveness. If the brake drums generate too much heat, they can expand to the point where there is no longer any braking action at all. This condition is referred to as brake fade.

Braking is a necessary part of driving a vehicle, whether in normal or exceptional driving conditions. Each time the brakes are applied, the resulting friction causes a small amount of wear to both the linings and drums. Eventually the wear will be sufficient to necessi late readjustment for the brake system.

EFFECTS OF MALADJUSTED BRAKES

A vehicle with improperly adjusted brakes is both unsafe & expensive to operate. The previous section describes how poorly adjusted brakes will reduce the friction that occurs between the linings and drums during braking. Because of this, a vehicle with brakes in such condition would require greater stopping distances.

In cases where one or more brakes are out of adjustment, the remaining better-adjusted brakes will be required to perform all the work. The good brakes will wear much more rapidly, causing them also to go out of adjustment. Unless the defect is corrected, this cycle will continue until absolutely no braking power is available.

Another result of having brakes that are out of adjustment is an increased demand on the air supply system. As the pushrod stroke increases, more air is required to fill the brake chamber for each brake application. The air pressure available for the next brake application decreases if the compressor has not had sufficient time to regenerate the air supply.

BRAKE BALANCE

Modern air brake systems are engineered so that all brakes apply at the same time and evenly. This characteristic, referred to as *brake balance*, is dependent on proper brake adjustment. If the brakes are allowed to go out of adjustment, this balance would be upset, possibly resulting in jackknifing, steering pull, or loss of vehicle stability.

GOOD DRIVING HABITS

There are a number of good driving habits that all drivers, especially professionals, should adopt. These will help reduce wear on the vehicle, save fuel and decrease the chances of being involved in a collision.

Keep the Eyes Up

Aim up and well in front to see what is happening ahead. A driver can do very little about what happens immediately in front of his or her vehicle, so it is essential to look ahead as far as possible and have sufficient time to react to potential hazards.

Plan Ahead

Don't race to come to a stop. Plan ahead when approaching stop signs, traffic lights or other situations where slowing or stopping may be necessary.

Maintain Safe Following Distance

A vital element in safe braking and stopping is a driver maintaining proper following distances. A good general rule is to allow one second of following distance for every ten feet (three metres) of vehicle length when driving in ideal conditions.

Be Aware of What's Around

A driver must always know what is ahead, behind and to the side, being fully aware of potential dangers.

Prepare

Constantly leave an avenue of escape in order to be able to avoid any hazards, or to minimize any harm should a collision become unavoidable.

Do It!

When confronted with a potential hazard, act decisively and without hesitation. Large commercial vehicles do not react quickly and every second will be critical.

COMPONENTS OF THE FOUNDATION BRAKE (S-CAM BRAKES)

A vehicle equipped with air brakes has a supply system that compresses a controlled amount of air, eventually storing it in two service reservoirs. Through the use of valves, the brakes are applied by regulating the amount of air delivered to the service brakes.

The foundation brake consists of the following components:

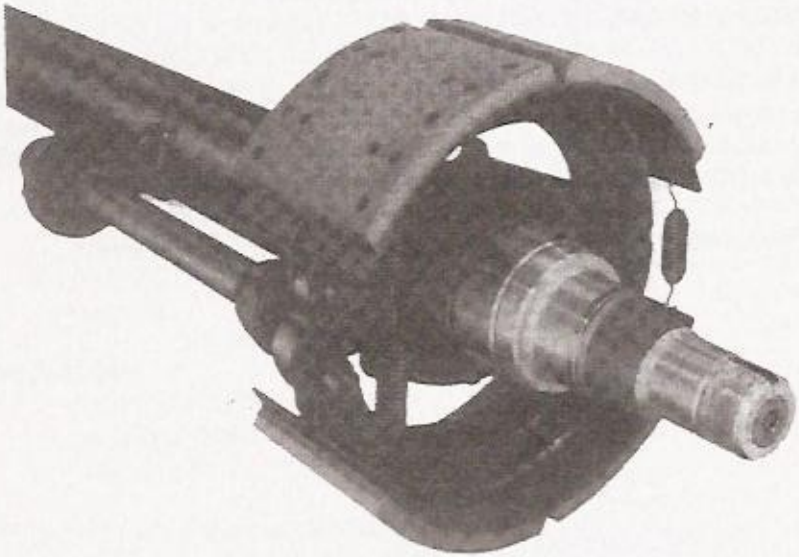
- Brake Chamber
  - Service Brake
  - Spring Brake
- Slack Adjuster
- S-Cam
- Cam Roller
- Brake Spider
- Dust Shield
- Brake Shoes & Linings
- Brake Drum

These will be discussed in more detail in the following section.

Note

This course focuses on describing an S-cam brake system that uses a clamp ring brake chamber; other types of braking systems and brake chambers will be covered later in the manual.

Foundation Brake



SERVICE BRAKE

The *service brake* is a brake chamber in which the potential energy in compressed air is changed into a mechanical force.

Air entering through an inlet port causes the diaphragm to expand like a balloon. The diaphragm in turn pushes against a plate at the end of the pushrod, forcing it to extend. When air is released from the brake chamber, a return spring causes the components to return to their original position.

When the brakes are out of adjustment, the plate or piston at the end of the pushrod will eventually bottom out against the brake chamber housing. At this point, the brake will become totally ineffective.

FOUNDATION BRAKE COMPONENTS

Brake chambers come in a variety of sizes and types in order to meet

When the parking brakes are *released*, air is sent into the spring brake chamber, causing the spring to compress, or cage. When the parking brakes are *applied*, air releases from the spring brake chamber, the power spring uncages, and the pushrod is forced to extend and apply the brakes. If an air loss occurs in the system, air caging the spring brakes is also lost, causing the brakes to apply.

The other half of the brake chamber is a normal service brake, which operates in a similar way.

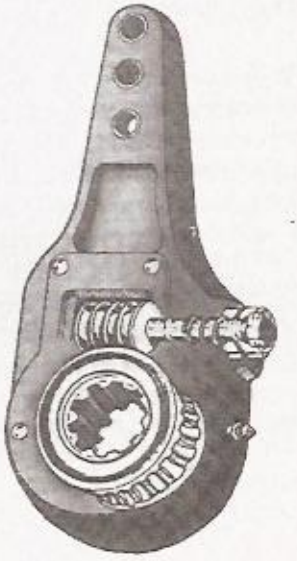
SLACK ADJUSTER

Note

The contents of this course are based on an air brake system that is equipped with manual slack adjusters. While some automatic slack adjusters have provision for manual adjustments, they are considered to be defective if out of adjustment and must not be adjusted manually.

The *slack adjuster* is a device that compensates for wear to brake linings, brake drums and other components. It is connected to the pushrod by means of a clevis yoke, clevis pin and a cotter pin. When the pushrod extends, it forces the slack adjuster to rotate.

The slack adjuster has an adjusting bolt that is held in place by a locking collar. With the locking collar retreated, the adjusting bolt can be turned, causing the worm gear set inside the slack adjuster to rotate.



Slack Adjuster

S-CAM

While one end of the slack adjuster is connected to the pushrod, the other end is fitted to the splined end of an *S-cam*. The S-cam itself extends into the foundation brake, and has spiral ramps on the other end. These spiral ramps can rotate left or right, depending on the application. When the slack adjuster rotates, it causes the spiral ramps to rotate.

CAM ROLLER

As the S-cam rotates, its outer surface (or cam) pushes against the *cam rollers*. Cam rollers sit in notches in one end of the brake shoes and are usually held in place by a retaining clip.

BRAKE SPIDER

The *brake spider* is a heavy stamped steel or cast metal part that is secured to an axle by either bolts or welds. It attaches the foundation brake's components together.

DUST SHIELD

Dust shields are attached to the back of the brake spider to keep debris out from between the linings and drums. Although slots are built in to allow for internal inspection of the linings and drums, visibility of these components is limited.

BRAKE SHOES AND LININGS

Brake linings are fastened to the *brake shoes* by either rivets or bolts. When cam rollers are pushed outward by the S-cam, the brake shoes pivot on the brake shoe anchor pin(s), forcing the brake linings to come into contact with the drum. This is how friction is created in a braking system. The amount of friction generated is directly proportional to the pressure applied.

Another factor affecting friction is the type of materials used in each component. As the friction coefficient can vary in different applications, it is important to ensure that the materials used for re-lining brakes are appropriate to the vehicle. Mismatched linings decrease brake effectiveness and reduce brake balance.

BRAKE DRUMS

Brake drums can weigh in excess of 100 lbs. This heavy construction enables the drums to withstand tremendous forces, and to absorb and dissipate the heat generated during braking. Care is taken during manufacturing to ensure that they are round and balanced. Brake drums are fastened directly to the hub; their placement will vary according to the application.

THE IMPORTANCE OF IDENTIFYING DEFECTS

Any braking system component that is broken, missing or not functioning properly will affect the operation of a foundation brake assembly. It is also grounds for putting a vehicle out of service. Operating a vehicle in unsafe condition is a regulatory violation and can result in severe penalties for both drivers and operators.

More importantly, professional drivers do not compromise the safety of themselves or other road users by operating a vehicle in unsafe condition. Safety defects of any type must be corrected prior to taking a vehicle out on the road.

Although this course focuses specifically on brake adjustment, drivers must remember that there are many other steps in ensuring that a vehicle is fit for the road. A *full* pre-trip inspection, including a complete air brake check, must *always* be performed.

BRAKE CHAMBERS

The rubber air lines attached to the brake chambers are reinforced with a built-in woven cord. If a line is rubbed to a point where the cord is visible, it is considered to be out of service.

The fittings where the air lines enter into the brake chamber should be secure and free from leaks.

An audible leak at the service brakes when brakes are applied is usually a sign of a ruptured diaphragm. If a leak is audible at the brake chamber with the parking brake released, it will likely indicate that the spring brake's diaphragm is ruptured, often resulting from the power spring itself breaking.

Note

Another reminder: if any damage is apparent to the spring brake due to corrosion or impact, do not go near it!! Refer the problem to a qualified mechanic for an assessment and any necessary repairs.

SLACK ADJUSTER

With time, it is common for clevis pins to seize, either in the clevis yoke or in the slack adjuster. Should the clevis pin seize in both, brake operation may be affected during application; the return spring inside the service brake may be prevented from returning the pushrod to its original position. As a result, the brake linings will stay in contact with the drum, causing excessive heat build up in the drum.

Although slack adjusters can wear or corrode to a point where they are no longer serviceable, the most common problem is for the locking sleeve to stick in the retracted position. This quite often results from dirt, paint or rust coming between the adjuster locking sleeve and the slack adjuster body. If a tap side to side with a hammer does not dislodge it, a cold chisel and hammer can be used to tap it back out. In either case, extreme caution should be exercised so as not to damage any of the components.

S-CAM

Although not visible to the driver, the S-cam's the spiral ramps can wear. The bushings can, however, be checked for free play by trying to push the S-cam from side to side. The slack adjuster should also be checked to ensure that it fits properly onto the splined end.

CAM ROLLERS

The cam rollers will not be visible to the driver during a routine brake inspection.

BRAKE SHOES AND LININGS

Normally, any wear to the brake shoes themselves is negligible. However, the large return spring between the two brake shoes can break and result in overheated brakes.

Brake linings themselves wear a small amount with each brake application, eventually causing them to become unserviceable and in need of replacement. The linings can be viewed through an inspection slot in the dust shield. They must not be worn beyond the manufacturer specifications. No contamination can be present that is due to oil or grease coming into contact with the linings. Where there is evidence of severe overheating, pieces of the lining may crack or break away from the brake shoe. In any of these cases, the vehicle would be considered out of service.

BRAKE DRUM

The brake drum, as with the linings, will wear slightly each time the brakes are applied, eventually causing the drums to be unserviceable. While a dust shield makes seeing inside the drum very difficult, its exterior will be visible inside the wheel and should be checked for cracks or loose fasteners.

Excessive heat will damage the brake drums, possibly in the form of heat cracks that can eventually join and form a visible crack. Since regular wear makes the brake drum thinner, expansion from applying the brakes may make the drum crack or shatter at some point.

CAMMING OVER

As the foundation brake's parts--in particular, the drums and linings--begin to wear, the slack adjuster must itself be adjusted. This will maintain correct lining-to-drum clearance.

When enough component wear has occurred, the tips of the S-cam's spiral ramps can rotate past the cam rollers. This is referred to as *"camming over"*.

If the brake cams over while being adjusted, the return spring will pull the cam rollers back against the S-cam's central portion and cause a loud noise. A brake that cams over during operation will result in an inability to feel contact with the brake drum in a reasonable period of time when turning the adjusting nut. Any brake in this condition would be considered out of service.

METHODS OF CHECKING

Not only is it important to know how to check air brake adjustment, but also why it is important. When the brakes are applied, a diaphragm at the end of the pushrod pushes against a piston, causing the pushrod to extend. If the brakes are not adjusted properly, the piston will simply bottom out in the chamber.

There are two methods recommended by manufacturers to determine whether or not an air brake system requires adjustment. These are *measuring pushrod travel* and *free stroke*.

MEASURING PUSHROD TRAVEL

This method, used by enforcement officers during roadside inspections, is the preferred and most accurate method of checking if brakes require adjustment.

The pushrod travel is measured by the following procedure:

1. Chock the vehicle.
2. Release the brakes.
3. Build the system's air pressure up to 90-100 psi.
4. Ensure that the brakes are fully retracted.
5. Place a chalk mark on the pushrod where it enters the brake chamber.
6. Fully apply and hold the brake.
7. Measure the distance that the chalk mark has moved; this is the actual pushrod travel distance measurement.
8. Compare this measurement with the brake's chamber data chart.

CHECKING BRAKE ADJUSTMENT

FREE STROKE

While the free stroke method is considered to be an acceptable alternative to measuring pushrod travel, it is less reliable and more difficult to perform.

To check a brake's adjustment by the *free stroke* method:

1. Chock the vehicle.
2. Release the brakes.
3. Build air pressure up to 90-100 psi.
4. Ensure that the pushrod is fully retracted.
5. Place a chalk mark where the pushrod enters the brake chamber.
6. Pull the slack adjuster as far as possible away from the brake chamber.
7. Measure the distance from the chalk mark to where the pushrod now enters the brake chamber.

One obvious problem with this method is that in some locations, pulling the slack adjuster can be very difficult. In some instances, using a pry bar or large screwdriver will help. The major drawback to this method, however, is that the test will only cause lining-to-drum contact (referred to as slack), and not simulate a full brake application. It does not take into account additional movement—such as flexing of the components—that will take place under normal operating conditions.

While there is no direct relationship between free stroke and pushrod travel, a free stroke movement of 1/2 to 1 inch usually indicates that the brake is within adjustment. As this may vary, it is important to measure pushrod stroke and compare it to the free stroke for each specific vehicle. Checking pushrod travel on a regular basis will help to ensure reliable results.

WEAR INDICATORS

Any air brake-equipped vehicle manufactured after 30 April 1995 must have stroke indicators to show when a brake is nearing its readjustment limit. In most cases, these take the form of a series of grooves or ridges on a section of the pushrod that is sometimes painted orange. As the pushrod meets its readjustment limit, the indicators will become visible. With time, corrosion and wear will make them increasingly difficult to see.

Aftermarket stroke indicators are readily available and work well when properly installed. A full brake application is necessary for them to function as intended. Use of the parking brake only will give inaccurate results.

PERFORMING BRAKE ADJUSTMENT

METHODS OF ADJUSTING

Before adjusting an air brake system, a simple check on the brakes should be performed to determine if the adjustment is necessary. This can be checked using either the measuring pushrod travel or free stroke method. If the travel is beyond acceptable limits, one of two methods may then be used to perform an adjustment. These are referred to as *wheels up* and *wheels down*. 'Wheels up' is the more accurate, and therefore better method. However, the specialized equipment required means that it used less often.

Note

In order to be accurate, air brake adjustments must only be performed when the drums are cool. If carried out while the drums are still hot, the brakes can in fact be out of adjustment. When the drums cool off, this might cause the brakes to drag.

TOOLS

The following tools will be required for adjusting air brakes:

- wheels chocks
- 9/16 inch wrench

However, it is a very good idea to also have the following on hand, in case they are needed:

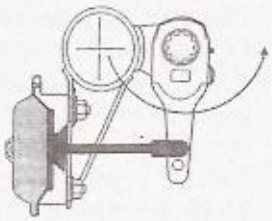
- small hammer
- small cold chisel or screwdriver
- pry bar or large screwdriver
- wire brush
- penetrating oil
- cloths or rags
- flashlight

WHEELS UP

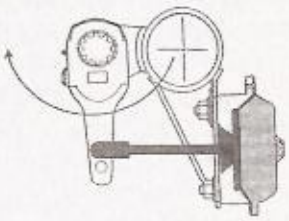
When adjusting brakes, ensure that the pushrod is fully retracted into the brake chamber. If it is not, it can indicate a broken return spring, a seized clevis pin, or a brake that has cammed over.

With the pushrod retracted, push the slack adjuster's locking collar in, rotating the adjusting bolt so the linings come into contact with the brake drum. This is possible only if the cam is rotating in the direction of the applied stroke.

Proper Cam Rotation



Next, reverse the direction of the adjusting bolt's rotation so the linings are no longer in contact with the drum. They should be as close as possible to the drum without actually touching it. If the brakes do touch or drag, heat will be generated, causing wear and damage.



The *wheels up* method, where the wheel to be adjusted is raised off of the ground, uses the following procedure:

1. Chock the vehicle.
2. Release the parking brake.
3. Check the air brake adjustment.
4. Build air pressure up to over 100 psi.
5. Use a jack or lift to raise the wheel requiring adjustment off the ground.
6. Ensure the pushrod is in the retracted position.
7. Tighten brakes with the slack adjuster - *check cam rotation.*
8. Check lining-to-drum contact.
9. Loosen brakes until the wheels can be rotated - *make sure the brakes are not dragging.*
10. Re-check the pushrod stroke.
11. Repeat for each wheel that requires adjustment.

WHEELS DOWN

The *wheels down* method, as the name implies, is performed with the vehicle's wheels on the ground. In order to use this method of brake adjustment:

1. Chock the vehicle.
2. Release the parking brake.
3. Check the air brake adjustment.
4. Build air pressure up to over 100 psi.
5. Ensure the pushrod is in its retracted position.
6. Tighten brakes with the slack adjuster - *check cam rotation.*
7. Check lining-to-drum contact.
8. Back the adjuster bolt off by a half turn (For a type 30 brake chamber).
9. Re-check the pushrod travel.
10. Repeat for each wheel that requires adjustment.

The drawback to using this method is that the brakes cannot be checked for dragging. While backing the brake off by a quarter turn will usually provide enough clearance, an extra quarter turn must be used as a safety margin This means that the brake should be backed off by one half turn.

Immediately after a vehicle's brakes have been adjusted, it is extremely advisable that it be driven for 15-20 minutes, stopped and the brakes checked for excessive heat.

DISC BRAKES

Light vehicles have been equipped with *disc brakes* for many years now, almost universally in front wheel applications and often in rear wheel applications for higher performance vehicles. They are also found on some commercial vehicles, in particular highway coaches.

Although more efficient than S-cam brakes, disc brakes have not been widely accepted in the past for most heavy commercial vehicle applications. However new technology has produced an actuating system that is totally enclosed and needs no external adjustments. This new generation of disc brakes may generate much more interest from the heavy vehicle markets.

The older generation disc brake systems were equipped with slack adjusters, either manual or automatic. If equipped with the manual type, the vehicle's brakes would be adjusted using the same procedures as for an S-cam brake, however the free stroke must be at least 3/4 inch. After a brake relining the initial adjustment would need to be slightly longer. The pushrod stroke with brakes fully applied must also comply with the brake chamber data chart.

WEDGE BRAKES

While *wedge brakes* are more efficient than the S-cam system, they have much higher maintenance requirements. As a result, they have not been widely used and are rarely found on vehicles today.

A wedge brake system has one or two brake chambers that fasten directly to the brake spider. These force a wedge between the brake shoes, forcing them against the drum, and causing the friction that acts as a braking force.

Any adjustment to a wedge brake system must be performed by a qualified mechanic.

ROTOCHAMBERS & BOLTED FLANGE BRAKE CHAMBERS

Both of these brake chamber types are virtually extinct. Unfamiliar chamber types should first be identified by a qualified person and then adjusted based on the appropriate maximum pushrod stroke from the brake chamber data chart.

LONG STROKE BRAKE CHAMBERS

For several years, some drive and trailer axles have been equipped with a type 24L brake chamber. The "L" indicates that it is a long stroke chamber with a readjustment limit of two inches. This compares to a limit of 1-3/4 inches for a standard type 24.

A Type 30L and a Type 3030L chamber, both with readjustment limits of 2-1/2 inches, have recently become available. As long stroke chambers have many advantages over the regular ones, their usage may become more widespread in the near future.

AUTOMATIC SLACK ADJUSTERS

An *automatic slack adjuster* is a device that senses excessive pushrod travel and compensates automatically. The way that the device functions will vary, depending on the manufacturer.

Automatic slack adjusters have been available for many years now and have been improved for both durability and reliability. However, regular brake maintenance procedures, including a pre-trip inspection check, are still required to verify that the devices have not failed. Other components must also be checked for serviceability during the pre-trip, as they too will affect proper functioning of the automatic slack adjuster.

Most failures of this component result from moisture entering into the mechanism, oxidizing the internal components, and causing the automatic slack adjuster to seize. Although some can be adjusted manually, any improper functioning should be considered to be a defect and referred to a qualified mechanic for repair or replacement.