BUS SERVICE, INC.

Your Brakes

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Fundamentals of Braking

There are a variety of mechanical forces and physical components that make up the braking system of your coach. The forces that effect your brake system include things like friction, speed, wear, brake imbalance and driver habits. Some of the physical components that we will discuss in this newsletter include your air compressor, brake shoes and linings, drums, brake chambers and air lines.

Welcome to winter...

Inside this issue:

Friction is the force between the brake linings and the brake drums which slows the vehicle down and eventually stops it. Through this friction the speed of the vehicle is converted to heat which is then dissipated by the brake system. The amount of friction is dependent upon the amount of force applied and the coefficient of friction. The coefficient of friction is the frictional relationship between two bodies in direct contact with each other. This coefficient is going to change dependent on the material composition. For example, the coefficient between a clean drum and shoe will be greater than the coefficient between a drum and shoe which are covered with oil. Applying the same force to both of the scenarios just listed, will produce very different results as anyone who has had a leaking wheel seal will tell you. In addition, differences in lining materials will change the coefficient.

The friction coefficient of a brake lining also changes with temperature, rubbing speed and contact force. Since all linings today are made of non-asbestos, organic based fibers, which do not have ideal frictional characteristics, materials such as alumina or silica are added to improve the frictional qualities. As the temperature of the lining increases, the coefficient of friction reduces and causes fade. As the fade increases, braking ability decreases.

Speed has a direct effect on the coefficient of friction of a lining. The effectiveness of the lining typically decreases as speed increases.

The high temperatures generated during braking is the major cause of lining wear. It has a similar effect on the drum but to a lesser degree. Extreme temperatures, which occur where the drum and lining contact each other, can actually cause changes in the composition of the brake drum material. Over time, these changes will cause the drum to show signs of stress and crack.

Special points of interest:

- How does the air system work?
- What are the air components?
- Which are the brake components?
- What is the role of air or brakes in an air brake problem?

Fundamentals of Braking (Continued)

Brake imbalance is when all of the brakes throughout the coach are not exerting the same amount of force. Since braking will not be uniform, one position will experience premature wear while another will have an extended life.

Driver habits directly effect the coefficient simply by the way the driver brakes. Is the driver someone who moves along at higher speeds only to have to slam on his brakes in order to stop? Applying the ideas illustrated above, you can see the direct effect driving habits will have on things like wear, and lining or drum temperature.

Compressed Air Fundamentals

"Moisture is not desireable in the air system because…"

Many components on your coach are operated by compressed air. In an air brake system, the compressor furnishes the compressed air for brake operation by taking free air or atmosphere and compressing it to 100-120 PSI. Maximum pressure in an air brake system is generally 150 PSI. The pressurized or compressed air leaves the compressor at 105—125 PSI and flows through a cooling tube assembly (the line from the compressor all the way to the tanks). This is an important step because the compressor causes an increase in the temperature of the air and cooling down the air condenses the water that collects in the wet tank.

One reason for cooling the air lies in the fact that the higher the temperature of the air, the more moisture it tends to hold. Moisture is not desirable in the air system because over time it causes corrosion and wear on the components, not to mention the capacity to freeze during cold ambient temperatures. The compressed air passes from the compressor through an air dryer and into a reservoir or tank where it (and its energy) are stored until it is needed. The tank usually has either an automatic or manually operated drain valve which ejects the moisture from the bottom of the tank. The compressed air is held in the tank until released by the driver operating air control valves. When the brake valve is operated, air flows to the chambers where its energy is transformed into the mechanical force needed to apply the brakes.

Air Components

The first air brake component is the air compressor. It is the source of energy for the air-brake system. It is driven by the vehicle engine and is lubricated by the engine lubrication system. The cylinder head and cylinder block are cooled by the engine cooling system. Attached to the compressor is a drive hub. The air compressor crankshaft continuously turns while the engine is running, even when the regulated air pressure has been obtained.

In order to properly maintain the air compressor, the cylinder head should periodically be removed so that carbon can be cleaned away from discharge and inlet valves. The compressor discharge line should be checked. The mounting bolts should be re-torqued. All oil and air lines going to and from the compressor should be checked and tightened if necessary. Finally, when changing the antifreeze in the engine coolant system, be sure to remove the drain plug to drain the antifreeze and then re–install the plug.

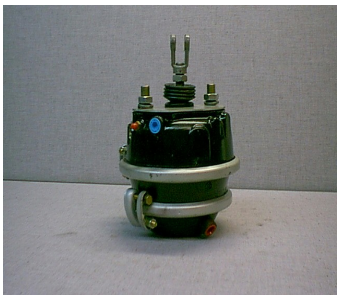
The governor is the next component. It attaches directly to the compressor and maintains the reservoir air pressure between the minimum and maximum settings. The D-2 governor is adjustable. While the compressor runs the entire time the engine is running, the governor dictates when it will begin and stop compressing air.

The DD-3 brake chamber, when equipped, is a double diaphragm chamber with three functions; (1) service braking, (2) emergency braking, and (3) parking. All the air brake chambers on your coach are used to convert the energy of compressed air into the mechanical force required to apply the brakes. The yoke of the chamber push rod is connected to the slack adjuster which in turn is mounted onto the brake camshaft. It is extremely important to have the correct size chamber installed on each position on your coach.

"The air compressor crankshaft continuously turns while the engine is running…"

There are a variety of valves in different positions on your coach. Each valve performs a different function. Unfortunately, there are far too many valves to list and describe in limited space of our newsletter. If you need specific information on any coach brake valve, we can be reached by phone, fax or e-mail.

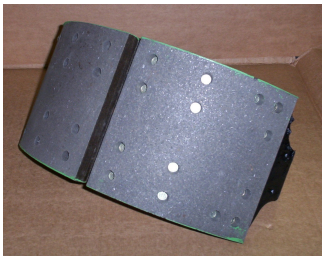
Air lines are another critical item in the air system. Your air lines should be checked regularly for cracks, leaks, kinking, chafing, fitting defects or looseness and any other type of deterioration. Losing an air line can make your air brake system inoperative. These hoses can take the form of copper line, flexible hose, or DOT approved plastic air line.



Introducing...your brake components

Your actual brake system is made up of: brake shoe and lining (except in the case of disc brakes), slack adjuster, anchor pin and/or roller, return springs, s-cam, drum and assorted hardware such as bushing, seal, washer, and snap ring. The spider is also a part of the system but we will not discuss that here.

The component that most people are familiar with is the brake shoe and lining. The first thing to remember is that all linings are not created equal. Like just about every other market these days, linings are a product whose quality can vary along a scale. And like everything else, quality comes with a price tag. Friction ratings and correct application based on things such as gross axle weight should dictate the lining that you buy.



When inspecting your brake shoe look for surface damage such as broken welds, elongated anchor pin slots, elongated bolt or rivet holes, flattened roller slots corrosion or any type of shoe deformity. When inspecting the lining, look for problems such as glazing, wear, and broken or missing lining.

Slack adjusters function as adjustable levers and provides an easy and quick way of adjusting the brakes. This is done primarily to compensate for normal wear of the lining. Some are manual, some are automatic. Make sure to have the appropriate one necessary to properly outfit your coach.

Except in the case of disc brakes, standard coach brakes consist of two shoes per wheel which pivot/move on anchor pins at one end. The shoes are expanded on the other end during brake application by the s-cam. The s-cams go through the brake spider through a bushing. The anchor pins act as a rigid pivot point for the fixed end of the shoes. In addition to the anchor pins and s-cams, there are also brake rollers and return springs. The brake rollers are positioned on the s-cam side of the shoes and form the contact between the shoe and the cam. The return springs hold the rollers firmly against the cam.

"Drums should never be machined beyond the maximum allowable diameter.."

Nearly everyone is familiar with the brake drum. We briefly explained part of its role in the fundamentals of braking section. The drum plays a very large part of the braking capacity of the coach. Drums come in standard dimensions but can be machined should they become scored. In the event the drum is machined, it is important to compensate for the larger inside diameter by replacing the standard shoe with one containing the appropriate oversized lining. Drums should never be machined beyond the maximum allowable diameter which is cast into an area of the drum. Doing so **will** make your brakes malfunction.

Continued on Pg. 5

Your brake components...continued

What we have just presented is a very basic overview of your brake components. Some newer coaches have disc and/or rotor type brakes. In addition, other units are equipped with wheel sensors or brake modulators. None of these topics will be discussed here.

Some examples……

Reviewing our discussion, both the air system and brake system work together in the air brake system. In the case of difficulties, it is important to understand which of the two systems performs which function. We have provided some examples below for illustrative purposes. We will use a format of presenting the problem followed by possible causes.

1. Problem—Slow pressure buildup
   a. Air leak
   b. Faulty compressor
   c. Open or leaking air line to reserviour
   d. Defective compressor governor

Note that each of the possible causes is within the air system.

"In the case of difficulties, it is important to understand which of the two systems performs which function."

2. Problem—Rapid loss of pressure when the engine is stopped and the brakes are fully applied.
   a. Leaking chamber hose
   b. Leaking service line
   c. Leaking application valve
   d. Leaking brake chamber
   e. Defective quick release valve

Again, each possible cause lies in the air system or one of its components.

3. Problem—Uneven braking.
   a. Defective brake chamber
   b. Uneven slack adjuster setting
   c. Unequal springs in the brake chambers or betwen brake shoes
   d. Uneven lining wear
   e. Brake shoe return spring is weak or broken
   f. Bad or defective brake drum

In this case, the cause can be in the air system—a defective brake chamber, or in the brake system if, for instance, the cause was uneven lining wear.

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In summary, your air brake system is made up of two systems which are independent and yet must be used together for a properly operating system—your air system and your brake system. If either one or both are not working properly, your brakes will be inadequate and may completely malfunction.

With winter approaching there are concerns including rain or snow, humidity and freezing temperatures that should be addressed. Daily maintenance such as draining your air tanks now becomes critical. Automatic drains are most desirable since manual drain valves depend on the driver remembering to purge them. Manual valves frequently do not remove all contaminants and are often hard to reach. In addition, alcohol in the air system as a preventative measure against freezing will prove extremely valuable.

We hope that you have a safe winter as you travel our great country and that the information we have provided will prove helpful. Additional brake information will be provided on our website's frequently asked questions page over the coming weeks. Happy Traveling!!!

Newsletter sources include: Bendix, Rockwell/Meritor, GM

Happy traveling!