includes:

four-spring suspensions
neway air suspensions
mack camel back
spring suspension
u-bolts
uni-rods/maxi-rods
air springs
shock absorbers

module four
FUNCTION

As with all suspension designs, a Four-Spring Suspension’s major function is to attach the axles to the frame of the vehicle. Four-spring and other multi-axle suspensions equalize or distribute vehicle weight, in specific ratios between available axles. Vehicle weight distribution becomes extremely important upon brake application, on negotiating unlevel surfaces and in cornering.

Vehicle application and desired suspension component life are key factors to be considered when choosing a suspension model. Four-Spring Suspensions are available with heavyweight cast steel components (such as Reyco Model 21B) or lighter-weight fabricated steel components (such as Hutchens Model H-9700). Other configurations will be discussed as we examine each major component of a standard Four-Spring Suspension.

As the vehicle brakes are applied, the axles begin to rotate or “Wrap-up” (See Figure 1 - "A"). Torque arms/torque arm bushings limit this wrap-up and force the vehicle load to the rear of each spring. The leading axle leaf springs deliver this load to the equalizer (See Figure 1 - "B"). The equalizer now delivers this load to the leading end of the following leaf spring by pivoting on properly torqued bushings (See Figure 1 - "C"). This load distribution can be 50/50, 60/40 or any ratio the OE manufacturer has designed. Correct load distribution will allow each axle to brake properly. As torque arm bushings, equalizer bushings and hangers wear, this wrap-up is not accomplished smoothly. This result affects suspension loading and brake application times and can cause axle tilt (U-joint failure or tire wear), spring slap (spring failure or vibration) and unbalanced wheel loads (inferior braking). For these reasons, suspension components must be inspected and replaced if any looseness is observed at each vehicle service interval.

FIGURE 1
FOUR-SPRING SUSPENSION COMPONENTS

Four-Spring Suspensions consist of the following key components:

SPRING HANGER

• **Front** Bracket for mounting suspension to vehicle frame which accommodates the front end of the leaf spring.
• **Center** Bracket for mounting the equalizer of a Four-Spring Suspension to the vehicle frame, which allows the equalizer to pivot. This hanger is also called an equalizer bracket.
• **Rear** Bracket for mounting suspension to vehicle frame which accommodates the rear end of the leaf spring.

Basically there are four (4) types of hangers:
1. Flange Mount - Bolt on or weld on
2. Straddle Mount - Weld on
3. Under Mount - Weld on
4. Side Mount - Weld on

EQUALIZER

Equalizes, also called rockers or rocker beams, are used to transfer and maintain equal or specific load distribution between two or more axles. Equalizers pivot on single piece, two-piece, or factory assembled (Hendrickson Style) bushings. Many of these designs require regular bushing lubrication. While all designs may provide adequate service when torqued and serviced correctly, certain designs provide better service life when used in specific applications.

It is important to torque bushing fasteners only when the suspension is in its normal running position. Torquing fasteners prior to this will cause preloading of the bushings and premature failure. See page 8, figure 1.

REBOUND BOLT

Prevents leaf spring ends from exiting their positions in hangers and equalizers. Rebound bolts may be equipped with rollers or spacers. With proper torque on installation of rebound bolts, spacers are fixed in place and rollers are free to turn.

TORQUE ARM

Torque arms may also be called torque rods or radius rods.

• **Adjustable** (shown) Suspension device used to retain axle alignment and control axle torque (Wrap-up). The torque arm is adjustable so that it can be extended or retracted to obtain proper axle alignment.

• **Rigid** Suspension device used to retain axle adjustment and control axle torque (Wrap-up). In some installations rigid arms are found on opposite sides of an axle from adjustable arms. Some also incorporate alignment features using eccentric bushings, sleeves, or shims at the mounting surfaces.
TORQUE ARM (continued)

Torque arm bushings are supplied in single piece, two-piece or factory assembled versions. Proper torque is the main factor in torque arm bushing life. It is important to torque bushing fasteners only when the suspension components are in normal operating position. Torquing fasteners prior to this will cause bushing preload and premature failure.

Most commonly, one adjustable and one rigid torque arm are used per axle for alignment. The adjustable arm is normally positioned on the driver’s side and the rigid arm on the curbside. If four rigid arms are used, eccentric bushings, sleeves, or alignment shims must be used to obtain proper axle alignment.

When the torque arm is attached to a lower point on the axle, the axle vertical movement is better controlled, therefore denoting these models as “no-hop”. (See Figure 2)

![Standard Connection](image)

!["No Hop" Connection at Lower Point](image)

LEAF SPRING

Used to reduce road shock and transfer vehicle loads through suspension components to the vehicle frame. Leaf springs may be Mono-leaf to Multi-leaf styles.

Two commonly used terms used to describe leaf springs are:

- "Deflection" - Is a measure of the depression of leaf spring when suspension is placed under load.
- "Rate" - Is the load required to deflect a leaf spring a given distance.

LINERS

Liners are commonly made of Delrin (plastic) or galvanized steel. They are mostly found on single and three-leaf spring suspensions to eliminate major component contact. Typically, liners are installed between the top plate, leaf spring, and axle seat. By eliminating direct contact, wear is reduced, which in turn increases the life of suspension components.

AXLE SEAT

Supports and locates the leaf spring on the axle and is also used to connect torque arms to axles in standard suspensions. Axle seats are angled on drive axle suspensions to allow for a drive line angle which varies from one manufacturer to another. Trailer axle seats are not angled. Axle seats are also called spring seats, spring perches, or spring chairs.
TECH TIPS

Four-Spring Suspensions

SPACER BLOCK

Used on top of axle seat to obtain increased mounting height. When added to an OEM suspension to increase mounting height, these spacer blocks must be welded on to eliminate additional movement between components. Spacer blocks are also called spring spacers or riser blocks.

TOP PLATE

Located on top of the leaf spring and is held in place when U-bolts are torqued to clamp the leaf spring and axle together. Available in either cast or fabricated versions.

BOTTOM PLATE

Located on the bottom of spring (underslung) or the bottom of axle (overslung with inverted U-bolts) and held in place when the U-bolts are tightened to clamp the leaf spring and axle together. Available in either cast or fabricated versions. Also called a stabilizer in suspensions that have torque arms attached to the bottom plate.

U-BOLT

Used to clamp the top plate, leaf spring, axle and bottom plate together. Standard U-bolts wrap around the axle on each side of the spring (U-bolts up). Inverted U-bolts cross leaf springs in front and behind the axle when in place (U-bolts down). (See Figure 3)

The U-bolt keeps the leaf springs clamped solidly into place. U-bolts must be torqued properly at all times to keep the leaf springs from flexing within the axle connection area.

There are a number of surfaces between the components and leaf spring leaves which “settle” during operation. Re-torquing takes up the resulting slack allowing the leaf spring to remain tight for a longer period. Experienced operators have found that suspension component failure is greatly reduced by re-torquing U-bolts following the first day of service after suspension work has been completed. Further re-torquing of new or repaired suspensions is suggested at the end of the first 500 miles, after 1,000 miles, and on appropriate intervals determined by individual preventative maintenance plans.

Stack settling and insufficient initial torque, contribute to the need for suspension re-torquing. Be sure to inspect, install or replace the liners during leaf spring repair and/or component replacement.

FIGURE 3
Leaf springs may be located over the axle or under the axle and are referred to as overslung and underslung axle connections respectively. (See Figure 4)

The axle connection incorporates several components and is an area in which many suspension problems arise. Because of the center bolt holes and/or cupped or nibbed centers, this area is the weakest spot of a leaf spring. The most common causes for axle connection component failures are listed below:

1. Improper seating
   a. Center bolt located improperly
   b. Center bolt head too long
   c. Foreign matter between leaf spring and contacting components
2. Contact component wear
   a. Top plate worn
   b. Axle seat or spacer block worn
3. Spring not fitting properly on axle seat
4. Broken welds in axle seat area
5. Leaf spring stack “settling”
6. U-bolts
   a. Misaligned
   b. Not torqued properly

**TORQUE! TORQUE! TORQUE!**

**TORQUE**

Proper torque is the key element to suspension performance, leaf spring and component life, and vehicle reliability. On suspensions with bolt-on hangers, such as Reyco’s Model 102, the vehicle manufacturer (i.e., Kenworth, Navistar, etc.) provides proper bolt torque specifications. Other torque specifications for each suspension can be supplied by the suspension manufacturer or by calling Euclid’s Technical Service Specialists. Many components such as U-bolts, equalizer bolts, and torque arm bushing fasteners are most commonly under torqued. However, components such as rebound bolts and adjustable torque arm clamp bolts are most commonly over torqued. Over torque as well as under torque may result in component failure. For a detailed explanation of torque, refer to Euclid’s Video 8, *Keep It Right, Keep It Tight.*
ALIGNMENT

Probably the most overlooked word in maintenance is alignment. If a new vehicle is kept properly torqued, alignment will be unnecessary unless a hanger or torque arm is bent, broken or replaced. If new torque arm bushings are installed, realignment is required. Often alignment is blamed for tire wear, which actually results from over and under inflation of the tire and incorrect axle camber. “Dog tracking” is also often attributed to misalignment, but it sometimes may be traced to the mispositioning of the trailer king pin. A misaligned axle will create a wear pattern on all four tires either on the inside or the outside edges of the tread. The following steps should be used to achieve correct alignment of a Four-Spring Suspension:

1. Situate the vehicle on a flat, smooth surface and disconnect vehicle brakes.
2. With the brakes disconnected, roll the vehicle forward and backward approximately 10 feet to relieve any binding which might be caused by turning or braking.
3. Block wheels on the axle not being aligned.
4. Check to make sure there is no interference between the leaf springs and hangers.
5. Tighten torque arm fasteners and U-bolts as specified by the suspension manufacturer.
6. Measure from the trailer king pin or a fixed point at the front of a truck to either end of the front axle on trailers or rear axle on trucks and make necessary adjustments.
7. With one axle properly aligned, measure between the axles on either end of each axle and make necessary adjustments.
8. Check the fasteners on all torque arms to insure that they are tightened to the manufacturer’s specifications.

EUCLID vs. COMPETITION

• Euclid offers the most complete coverage of major suspension components for all makes of suspensions:
  
  | Binkley     | Great Dane | Mack     | Ridewell |
  | Chalmers    | Hendrickson/ | Navistar (IHC) | Spicer   |
  | Dayton      | Turner      | Neway    | Trailmobile |
  | Freightliner| Hutchens   | Page     | Volvo-White |
  | Fruehauf    | Kenworth    | Peterbilt |          |
  | Granning    | Kwik-Loc   | Reyco/Transpro |          |

• All suspension components must pass Euclid's strict quality control inspection.
• Euclid has the highest order fill rate in the industry. You get the parts you need when you need them.
• Euclid has the technical staff on hand to answer questions concerning any make or model suspension, something no other company can offer.
• Many components are made from Euclid's own tooling to insure that you get the highest quality parts at the most competitive prices. Many components exceed OEM quality.
• Euclid publishes the easiest-to-use catalog in the industry.
• Many non-catalog parts can be special ordered through Euclid's Special Order Service desk (S.O.S.).
NEWAY AIR SUSPENSIONS
(Product Code 709)

AVAILABLE TYPES
Neway manufactures both leaf spring and air spring suspensions. This Tech Tip addresses Neway Air Spring Suspensions. Neway air ride suspensions are available in three (3) major configurations:

AR Series  Trailer Suspensions
ARD Series  Drive Axle Tractor Suspensions
ART Series  Non-Drive Axle Tractor Suspensions

Each configuration consists of several models with variations in ride height, bushings, and total suspension travel.

Neway also provides a newer style drive axle suspension called the “Air-Beam”. This model has been in service a short time and is not covered in this Tech Tips’ issue.

FUNCTION
Neway and other air suspension systems provide a smoother ride than leaf spring suspensions. This reduces driver fatigue, freight damage and component failure, and increases tire life (as described in the Air Spring Section).

HOW AIR SUSPENSIONS OPERATE
In addition to providing a softer ride, Air Suspensions help balance the axle load and maintain a set ride height of the unit. The most common control system to achieve balance and ride height is the use of a height control valve. Many configurations are available to suit a variety of needs including delayed and "Immediate Response” styles (E-4323 & E-4350 respectively). Balance and height are maintained under various load and road conditions by the valve which is precisely mounted to the vehicle frame/cross member and the connecting link (E-4333/E-4334 for delayed response valves) that is attached to the axle. The "Immediate Response” height control valve includes connecting linkage. Modifications to air systems are not recommended because they may result in component failure. (See Air Spring Section)

KEY MAINTENANCE AREAS
Popular Neway Air Suspensions are of the Trailing Arm Style. (Other Air Suspension manufacturers have other styles in addition to the Trailing Arm Style.) Trailing Arm Style Air Suspensions have five major areas which require frequent observation and inspection:

1) Pivot connection
2) Axle connection
3) Height control valve
4) Air spring
5) Shock absorber

These key areas together provide desired load protection and vehicle stability. Air Springs and Shock Absorbers are covered in other sections. We will now focus on pivot and axle connections.
INSPECTION RECOMMENDATIONS

PIVOT CONNECTION

The pivot connection is the point where the trailing arm is directly connected to the frame hanger. On most models, this is also the point where axle alignment is achieved. Moderate alignment corrections can be made by cutting loose the alignment washer (round, square, or tear drop) and adjusting the alignment and rewelding. Pivot connection bushings should be inspected for wear and the bolt torque checked:

1) when any suspension work is performed,
2) when abnormal tire wear or excessive vehicle sway are experienced, and
3) when axle connections are rebushed. Pivot connection bushings should most likely be replaced when axle connections are rebushed.

TRAILING ARM POSITION DURING TORQUING

Pivot Connections, like all suspension parts, must be torqued properly. Torquing of these bushings must be done with the trailing arm in the normal position. This eliminates preloading, resulting in premature failure of the pivot connection bushings. Rubber bushings are normally considered to have 15° of total flex movement (figure 1). When installed and or torqued out of ride position, a preload may reduce this flex movement. Reduction in flex movement will prematurely tear the rubber resulting in bushing failure.
AXLE CONNECTION

General Inspection
The most common axle connections associated with Neway consist of eight components:

1) U-Bolts
2) Axle Cap
3) Rubber Axle Wrapper
4) Axle
5) Axle Adapter
6) Bottom Axle Pad
7) Axle Seat
8) Trailing Arm

A visual check of the area may identify loose U-Bolts and/or worn Wrappers or Pads. Inspect the axle for movement on either side of the axle cap as shown in Figure 2. Looseness or wear is indicated by movement of the axle in excess of .375”.

U-Bolt Maintenance
When torquing U-Bolts, be sure the Axle Cap and the Axle Seat make metal-to-metal contact. Also make sure the Wrapper is not pinched between these two parts. To help insure this fit, lubricate the parts with a soap/water base lubricant. **DO NOT USE PETROLEUM BASES.** Maintaining the proper torque of the U-Bolts is a very important factor to insure a quality axle connection and achieve a long component life. U-Bolts should not be reused.

Axle Seat Repair
When new Wrappers and Pads are required, inspect all other parts for wear or cracks. Replace Trailing Arms as required. **DO NOT ATTEMPT TO REPAIR TRAILING ARMS.**

Cracked or worn Axle Seats and Adapters must be replaced. Do not undercut the Trailing Arm or axle when removing the welded parts. Reweld the new parts as shown in Figure 3. Seats must be welded to the Trailing Arm and Axle Adapters must be welded to the axle to insure component life and vehicle stability.
Welding
All parts to be welded must be at 70°F minimum and free of dirt, grease, and scale. Use only electrodes or wire that conform to Neway specifications listed below.

<table>
<thead>
<tr>
<th>ELECTRODE</th>
<th>AWS E-7108</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/32&quot; Dia.</td>
<td>120-190 amps D.C. + 135-225 amps A.C.</td>
</tr>
<tr>
<td>3/16&quot; Dia.</td>
<td>170-280 amps D.C. + 200-300 amps A.C.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIRE</th>
<th>AWS E-705-3</th>
<th>AWS E-70T-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>C-25</td>
<td>CO2</td>
</tr>
<tr>
<td>Volts</td>
<td>19-20</td>
<td>21-23</td>
</tr>
<tr>
<td>Amps</td>
<td>180-200</td>
<td>200-220</td>
</tr>
<tr>
<td>Wire Dia.</td>
<td>.045</td>
<td>.062 Flux Cored</td>
</tr>
</tbody>
</table>

 Originally, Neway tractor drive axle suspensions used an axle connection similar to Hendrickson end beam connections. Because standard alignment on these models requires cutting and welding on the critical frame hanger, Euclid’s E-4843/E-4844 Alignment Adapters can be used to correct moderate misalignment. These alignment adapters require no cutting or welding and directly replace the axle adapters used in these applications. Neway has now replaced this style bushing on current drive axle suspensions. The new style bushing is of the bar pin design and uses shims for alignment.

EUCLID VS. COMPETITION
Euclid offers the most complete line of replacement parts for Neway Suspensions in the aftermarket, including:

- Genuine Neway bushings and major components.
- Extensive coverage of all major components for the widest range of Neway suspension models.
- A complete line of Air Springs and Shock Absorbers.
- The largest selection of repair kits in the aftermarket.
- Stock of the most commonly used air valves.
- Any non-catalog parts can be special ordered through Euclid’s Special Order Service (S.O.S.).
FUNCTION & GENERAL DESCRIPTION

Mack current production suspensions are available in five basic types:

- Camel Back Spring Suspension (SS Series)
- Taper Leaf Spring Suspension (ST Series)
- Beam Over Leaf Spring Suspension (SC Series)
- Solid Walking Beam Suspension (SW Series)
- Air Ride Suspension (SA Series)

The function of the suspension is to attach the axles to the vehicle frame. With the exception of an air ride suspension, Mack axles are attached to the frame by the use of large “Y”-shaped brackets through which a trunnion shaft is installed. Rubber, polyurethane, bonded or bronzed bushed trunnion castings on the ends of the trunnion shafts provide the pivot centers for the axles which are attached to the ends of the springs or walking beams. This suspension design is also referred to as "single point" or "trunnion" type.

The most popular and commonly found Mack suspension type is the camel back spring suspension. This section of Tech Tips covers the identification and maintenance of the Mack camel back spring suspension.

COMPONENT IDENTIFICATION

Mack Camel Back Spring Suspensions (Figure 1) are available in ratings from 34,000 lbs. to 65,000 lbs. As the weight increases, design changes occur in the trunnion type, trunnion bushing type and size, trunnion shaft size, and the spring assembly. Current model designations and their identifying features are shown in the following chart.
### IDENTIFICATION CHART - CAMEL BACK SPRING SUSPENSION

<table>
<thead>
<tr>
<th>CURRENT MODEL</th>
<th>SUSPENSION RATING (LBS.)</th>
<th>TYPE</th>
<th>BUSHING TYPE</th>
<th>BUSHING I.D.</th>
<th>BEARING O.D.</th>
<th>THREAD SIZE</th>
<th>LARGE O.D.</th>
<th>WIDTH</th>
<th>NO. OF LEAVES AND THICKNESS</th>
<th>APPLICATIONS</th>
<th>REPLACES OLD MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS34</td>
<td>34,000</td>
<td>2 pcs.</td>
<td>Rubber</td>
<td>3 7/16&quot;</td>
<td>3 1/2&quot;</td>
<td>—</td>
<td>3 1/2&quot;</td>
<td>4&quot;</td>
<td>9/.625&quot; 11/.625&quot; 3/.625 + 7/.788 3/.625 + 9/.788</td>
<td>50&quot; Center Std. 55&quot; Center Std. 50&quot; Anti-Sway 55&quot; Anti-Sway</td>
<td>SWS56 (34,000 lbs.)</td>
</tr>
<tr>
<td>SS38</td>
<td>38,000</td>
<td>2 pcs.</td>
<td>Rubber</td>
<td>3 7/16&quot;</td>
<td>3 1/2&quot;</td>
<td>—</td>
<td>3 1/2&quot;</td>
<td>4&quot;</td>
<td>4/.788&quot; + 6/.625&quot; 9/.788&quot; 10/.788&quot; 3/.788&quot; + 8/.999&quot;</td>
<td>50&quot; Center Std. 50&quot; Anti-Sway 55&quot; Anti-Sway 55&quot; Anti-Sway</td>
<td>SWS57 (38,000 lbs.)</td>
</tr>
<tr>
<td>SS440</td>
<td>44,000</td>
<td>1 pc.</td>
<td>Bronze</td>
<td>3 1/2&quot;</td>
<td>3 1/2&quot;</td>
<td>3 5/16&quot;-12</td>
<td>3 1/2&quot;</td>
<td>4&quot;</td>
<td>10/.788&quot; 11/.788&quot; 3/.788&quot; + 7/.999&quot; 3/.788&quot; + 8/.999&quot;</td>
<td>50&quot; Center Std. 50&quot; Anti-Sway 55&quot; Anti-Sway 50&quot; Anti-Sway</td>
<td>SWS571 (44,000 lbs. Bronze Brushed) SWS573 (44,000 lbs. Rubber Steel Brushed)</td>
</tr>
<tr>
<td>SS441</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS50</td>
<td>50,000</td>
<td>1 pc.</td>
<td>Bronze</td>
<td>4&quot;</td>
<td>4&quot;</td>
<td>3 7/16&quot;-12</td>
<td>4 1/8&quot;</td>
<td>5&quot;</td>
<td>13/.788&quot; 10/1.00&quot;</td>
<td>54&quot; Center Std. 54&quot; Anti-Sway</td>
<td>SWS68 (55,000 lbs.)</td>
</tr>
<tr>
<td>SS58</td>
<td>58,000</td>
<td>1 pc.</td>
<td>Bronze</td>
<td>4&quot;</td>
<td>4&quot;</td>
<td>3 7/16&quot;-12</td>
<td>4 1/8&quot;</td>
<td>5&quot;</td>
<td>13/.788&quot; 10/1.00&quot;</td>
<td>54&quot; Center Std. 54&quot; Anti-Sway</td>
<td>SWS681 (55,000 lbs.)</td>
</tr>
<tr>
<td>SS65</td>
<td>65,000</td>
<td>1 pc.</td>
<td>Bronze</td>
<td>5&quot;</td>
<td>5&quot;</td>
<td>3 7/8&quot;-8</td>
<td>5 1/8&quot;</td>
<td>5&quot;</td>
<td>10/.999&quot; 8/1.25&quot;</td>
<td>58&quot; Center 58&quot; Anti-Sway</td>
<td>SWS592 (65,000 lbs.)</td>
</tr>
</tbody>
</table>

### INSPECTION

**CAMEL BACK SPRINGS**

Camel back springs vary in the number of leaves and leaf thickness according to the suspension rating (see Identification Chart). The ends of camel back springs are secured to the axle housing through rubber shock insulators mounted below the axles (Figure 2).
INSPECTION (continued)

“T”-shaped ends of the main spring leaves engage slots in the insulator boxes. These “T-ends” serve as anchors to prevent the springs from pulling out of the insulator boxes in the event of excessive axle articulation. When the “T-ends” are not centered in the slots of the insulator boxes, it is a good indicator of axle misalignment, bushing wear, or loose suspension fasteners.

Camel back springs should be checked for cracked or broken leaves, broken center bolt, and damaged or missing alignment clips. Alignment clips are an important part of the camel back spring assembly as they keep the spring pack from shifting.

In order to maintain proper alignment and ride specifications, the two camel back springs in a suspension should be compared and matched. Many spring suppliers color code the ends of the longest leaf in order to designate matched springs. In order to assure that springs are matched in a suspension, the following should be checked:

1. Measure the insulator button hole registry in the main leaves (Figure 3-"A"). The difference in this measurement, between a matched pair of springs, should not be more than 1/8”.
2. Spring arch should be measured on a line from the insulator button holes to the top of the main leaf at the center bolt (Figure 3-“B”). The difference in this measurement, between a matched pair of springs, should not be more than 1/4”.
3. On any individual spring, the center bolt should be located between insulator button holes + or - 1/16” from the spring center line (Figure 3-“C”).

Springs should be replaced in matched pairs only. If a new spring is installed opposite a used spring, even if they match dimensionally, the new spring will have less load deflection than the used spring, causing a tire scrub alignment problem in the loaded condition.

SHOCK INSULATORS AND INSULATOR BOXES

Rubber shock insulators should be inspected on this schedule:

- Every 50,000 miles, if the vehicle travels over 100,000 miles per year
- Every 180 days, if the vehicle travels 50,000 to 100,000 miles per year
- Once a year, if the vehicle is travels less than 50,000 miles per year.

Remove the insulator boxes and the lower shock insulators (Figure 2). Inspect the insulators for cracks, deterioration or abnormal wear. Check the locating pin or insulator “button” to make sure it is centered in the insulator. To find out if the button is off-center, turn the insulator 180 degrees in the box and attempt to reinstall in the spring main leaf button registry hole. A maximum shift of 1/8” off-center is permissible. The insulator should be replaced if any of these conditions exist or the button shows excessive wear.

Visually inspect the upper rubber insulator for wear and replace as necessary. When replacing the rubber insulators, coat them with liquid soap. This helps prevent the rubber from binding in the insulator box. Do not use grease or oil.

New polyurethane upper and lower shock insulators are now available to provide longer life under severe service conditions.
Metal insulator spacer blocks are used to keep the shock insulators from shifting. They must be reinstalled as part of the assembly.

When tightening the insulator box capscrews or nuts, tighten all capscrews or nuts until snug. Alternating at diagonally opposite corners, tighten each one gradually until the recommended torque is reached.

<table>
<thead>
<tr>
<th>Insulator Box Capscrew or Nut</th>
<th>Recommended Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/8&quot;-9 Capscrew</td>
<td>380 - 415 ft. lbs.</td>
</tr>
<tr>
<td>7/8&quot;-14 Nut</td>
<td>345 - 375 ft. lbs.</td>
</tr>
</tbody>
</table>

**TRUNNIONS AND TRUNNION BUSHINGS**

**Two-Piece Trunnion with Rubber Bushing** - Model SS34 and SS38 suspensions use two-piece, upper and lower trunnion halves, with rubber bushings. Proper installation of these bushings is covered in Euclid Service Bulletin S-2.

Polyurethane bushings for two-piece trunnions are available to provide longer life under severe service conditions.

**One-Piece Trunnion with Rubber/Steel Bonded Tubular Bushing** - This type of bushing is optional on SS441 suspensions. To install this bushing into the trunnion, first coat the O.D. of the bushing with molybdenum disulfide powder. Press it into the trunnion casting. To install the trunnion and bushing onto the spindle, first lightly coat the spindle with a rust proofing compound. Align the trunnion and bushing assembly and slide it onto the spindle. Align the hole in the bushing with the hole in the spindle and install the capscrew and self-locking nut. Torque the nut to 476 to 528 ft. lbs.

**One-Piece Trunnion with Bronze Bushings** - (Figure 4) One-piece trunnions with bronze bushings vary by suspension model as follows:

- SS440/SS441 Models: 3 1/2" O.D. Bronze Bushing
- SS50 and SS58 Models: 4" O.D. Bronze Bushing
- SS65 Models: 5" O.D. Bronze Bushing

To install trunnions with bronze bushings, first lightly coat the trunnion shaft spindle with a rust proofing compound. Position the inner thrust washers and oil seals on the spindle as required. Position the trunnion and bushing assembly on the spindle. Position the outer thrust washers ("D" washers if needed) and install the adjusting nut. Tighten the adjusting nut until all clearances are taken up and the trunnion assembly is tight.

**SS440/SS441, SS50 and SS58 Models:** Back off the adjusting nut, approximately one-sixth of a turn, to obtain a .010-.020" articulation clearance. Lock the adjusting nut by tightening the clamping bolt and nut 120 to 130 ft. lbs.

**SS65 Models:** Back off the adjusting nut, approximately one-sixth to one-half turn, to obtain a .010-.015" articulation clearance. Lock the adjusting nut by tightening the clamping bolt and nut 120 to 130 ft. lbs.

Trunnion looseness can occur when the adjusting nut butts against the spindle shoulder before it bears against the trunnion. If this happens, a washer should be installed between the outer thrust washer and the adjusting nut. Then, follow the adjustment procedures described above.
Apply permatex to the trunnion and trunnion cap and secure with capscrews and lockwashers. Several years ago, the lubrication specification of trunnions was changed from oil to grease. Some trunnion caps may still have the oil fill hole. This hole should be plugged.

Current model one-piece trunnions have the grease fitting installed in the casting. The trunnions should be greased according to this schedule:

- If the vehicle is traveling over 100,000 miles per year: after the first 12,500 miles and every 15,000 miles thereafter.
- If the vehicle is traveling 100,000 miles or less per year: after the first 45 days and every 90 days thereafter.

If the proper lubrication schedule is not met, the bronze bushings will wear out prematurely.

**U-BOLTS**

The proper tightening of U-bolts is critical to the life of Camel Back Spring Suspension components. Loose U-bolts are the leading cause of misalignment, spring breakage and premature bushing and rubber shock insulator wear. Mack U-bolt high nuts are torqued to a much higher value than those in any other suspension. Using an air impact wrench to torque the high nuts usually will not give the torque required. A torque wrench and multiplier must be used.

To properly install Mack U-bolts, the following procedure must be followed:

1. Lubricate the U-bolt threads with Never-Seez (or a similar compound) or a synthetic white lead and oil solution. Also lubricate U-bolt washers to reduce drag on the high nuts.
2. Tighten high nuts in the sequence shown in Figure 5 to approximately one third of the recommended torque.
3. Repeat tightening the high nuts, using the same sequence, gradually increasing the torque. The tightening sequence may need to be repeated as many as four times until the final recommended torque is reached.
   
   **IMPORTANT:** Gradually tightening the U-bolts cannot be stressed enough. If one leg of a U-bolt is fully torqued before the other leg is tightened, the U-bolt will stretch and break either upon installation or shortly after it is on the road.
4. U-bolt high nuts should be re-torqued after the first day of operation and once a week thereafter until it is determined that the recommended torque figures are being held.

**U-BOLT RECOMMENDED TORQUE - LUBRICATED**

<table>
<thead>
<tr>
<th>U-bolt Dia.</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/8”</td>
<td>1150 to 1250 ft. lbs.</td>
</tr>
<tr>
<td>1 1/4”</td>
<td>1600 to 1700 ft. lbs.</td>
</tr>
</tbody>
</table>

**FIGURE 5**
TORQUE RODS

Horizontal torque rods attached to the axle housings and the frame brace the axle housings against rotation caused by driving and braking forces. These torque rods should be inspected as part of regularly scheduled maintenance. The torque rod should be replaced if bushings are worn, rods are bent, ball studs have damaged or stripped threads or straddle mount studs have worn mounting holes.

ALIGNMENT

Axle alignment is set at the vehicle assembly plant. However, road and wear conditions can result in misalignment. A special service shock insulator (E-3919) is available to correct alignment. This service shock insulator is not available on new production vehicles. It should only be used when the alignment cannot be brought within specified variations by means of normal maintenance and repair. It should not be used as a “quick fix” for worn suspension components or poor maintenance practices.

Use of this service shock insulator and alignment procedures are detailed in Euclid Service Bulletin S-1.

NOTE: Service information in this Tech Tips is derived from Mack Service Manuals. Euclid recommends that any service facility performing repairs or maintenance on Mack trucks refer to Mack Service Manuals for details.

EUCLID VS. COMPETITOR

• Euclid provides replacement Parts for these Mack suspension models:
  • Steering Axle Suspension
  • SC Series Suspension
  • SS44 Series Suspension
  • SS34 and SS38 Tandem Suspensions
  • SS50C and SS58C Series Suspensions
  • SS65C-W Series Suspension

• Euclid’s Mack product offering includes:
  • trunnion and bushing assemblies
  • urethane and rubber trunnion bushings
  • trunnion caps, nuts and washers
  • insulator pads, boxes and spacer blocks
  • U-bolt assemblies with hardware
  • spring eye pins, shackles and bushings

• Many components are made from Euclid’s own tooling to insure the highest quality parts at competitive prices. Many components exceed OEM quality.

• All components must pass Euclid’s strict quality control inspection.

• Euclid publishes the easiest-to-use catalog in the industry.

• Euclid has the highest order fill rate in the industry. You get the parts you need when you need them.

• Euclid has the technical staff on hand to answer questions concerning any make or model suspension; something no other company can offer.
The following information and maintenance tips will help answer your U-Bolt questions.

**U-BOLTS PERFORM THREE VERY IMPORTANT FUNCTIONS:**

1) Provide a positive clamping force between top plates, springs, axle seats and axles.
2) Provide “Flex” point for springs away from center bolt area.
3) Keeps spring pack together eliminating shearing of spring center bolts.

**MAINTAIN THE PROPER TORQUE ON U-BOLTS**

From the above functions you can see that torque is the key to U-Bolt and suspension problems. OEMs recommend that U-Bolts be torqued at time of delivery, after first 1,000 miles, after 3,000 and thereafter at 5,000 mile intervals. This same procedure should be followed when springs are replaced and/or new U-Bolts have been installed. Consult your vehicle manual for required torque.

**NEVER REUSE U-BOLTS!**

Some elongation occurs when U-Bolts are installed and properly torqued. This elongation helps maintain the correct clamping force. Because of this, a used U-Bolt will be unable to produce the clamping force required.

**SPEC THE RIGHT U-BOLT**

The four specifications required to obtain the correct U-Bolt are:

A) Type of bend (Round, semi-round, square, etc.).
B) Thread size and pitch (7/8”-14, 1 1/8”-12 etc.).
C) Length of legs (from inside highest point to end of thread).
D) Width (inside legs).

**ROLLED THREADS VERSUS CUT THREADS**

Euclid uses only rolled threaded U-Bolts. A rolled thread provides better thread structure than a cut thread. Rolled threads also have a better surface quality, allowing applied torque to go directly to clamping force, not to the galling effect often encountered with cut threads.
EUCLID’S GRADES OF U-BOLTS

Euclid U-Bolts are supplied in both Grade 5 and a Grade 8 equivalent strength in the sizes required to meet all your suspension needs.

Euclid’s "Smart" U-Bolt part numbers assist in the identification of grades and other important U-bolt characteristics.

TROUBLE SHOOTING

Things to look for in suspension problem troubleshooting:

1) Are the U-Bolts properly aligned?
2) Is the top plate or axle seat bent or broken?
3) Are the U-Bolts the proper grade?
4) Are the U-bolts at the proper torque?
5) Have U-Bolts been reused?

THREADED ROD

Euclid also stocks a complete line of threaded rods for distributors and fleets who choose to bend their own U-Bolts. Euclid threaded rods have rolled threads and identical quality characteristics of Euclid U-Bolts.
TECH TIPS

UNI-RODS/MAXI-RODS
(Product Code 740)

REPLACE TORQUE RODS BECAUSE:

Worn torque rods can mean more than jerky stops and starts for your vehicle. This leads to excessive tire wear, contribute to seal leaks, axle housing fatigue, ring and pinion gear wear, and U-joint and driveline failures.

REPLACE TORQUE RODS WHEN:

a) on rubber Maxi-Rods, if any movement is detected, and
b) on Uni-Rods, if more than 1/8” movement is found.

A manual hand check can be made on either type at time of regular P. M. program. The following are symptoms of worn rods:

• Vehicle ride has deteriorated
• Rubber bushing or seals have ruptured
• Mounting pin has shifted in bushing
• Failure of related components

The following three easy steps will help you to determine the rod configuration you need.

1) Does the rod attach to the crossmember by a bar pin or taper stud?
2) Does the rod attach to the axle by a bar pin or taper stud?
3) What is the correct length needed?

Your Euclid catalog, with the answers to these questions, will show you the correct ends or kit to use.

UNI-RODS VS. MAXI-RODS

Both Uni-Rods & Maxi-Rods offer a modular design which allows a limited inventory of components to produce virtually any torque arm required.
UNI-RODS

Uni-Rod ball end construction features include:

a) high angulation with permanently lubricated full ball design,
   b) a tough plastic bearing seat,
   c) take-up bushings for automatic wear adjustment, and
   d) a permanently attached polyurethane ball joint seal.

High angulation is beneficial for use on units which see off-road service since these applications experience rougher
terrain and require more flexibility. (Hendrickson states that the Maxi-Rods are also capable of high angulation.)

INVENTORY ADVANTAGE OF UNI-RODS

Fourteen Uni-Rod Kits can be configured to replace 1200 fixed length torque rods!

Uni-Rods are available in lengths up to 40”.

Uni-Rods require two cuts and four welds, to complete the assembly process.

MAXI-RODS

Maxi-rods use rubber to secure the pins or studs into the rod end. The rubber provides limited angular movement and
requires no lubrication. When installing new Maxi-Rod type torque rods only one (1) cut on the male end is necessary
to obtain the correct torque rod length. Therefore, only two (2) welds are needed to connect the pieces (one fillet weld
and one puddle weld). This installation uses fewer steps than the Uni-Rod installation system.

INVENTORY ADVANTAGE OF MAXI-RODS

Fifteen different end styles can be configured to replace 800 fixed length torque rods!

Maxi-Rods are available in lengths up to 35”.

If only the rubber bushings are worn out in a Maxi-Rod, a replaceable bushing cartridges can be installed. Use of
bushings can be less expensive than replacing complete Maxi-Rods. Only in cases of extreme wear, bending, or
twisting must the complete Maxi-Rod be replaced.

Different configurations of bushing cartridges are available for every two-piece rod end.

Typical assembly instructions for both Maxi-Rods and Uni-Rods are shown on the following pages.
Assembly Instructions

UNI-ROD UNIVERSAL BALL

JOINT TORQUE

To fabricate Uni-rod to required length:
1. Determine finished length
2. Reading from tape supplied with Uni-Rod end to proper length
3. Slip Uni-Rod ends into uni-daptor so that the rods butt in the center
4. Puddle weld and fillet weld according to instructions

NOTE: The measuring tapes supplied with this kit have been calibrated to provide the proper finished length.

NOTE: Euclid accepts no responsibility for the welding, the welds, or methods reliability.
### Assembly Instructions

**MAXI-RODS/HENDRICKSON UNIVERSAL RUBBER BUSHED TORQUE RODS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1    | **Rod Selection**  
Match the new MAXI-ROD ends and length to the old torque rod specifications. |
| 2    | **Measure**  
Measure center-to-center distance between bushings of old rod. |
| 3    | **Remove Excess Bar Stock**  
Remove excess spacer bar (from male end). Excess = 35” or 27” minus center-to-center distance.  
Note: After cut, file end for easy assembly. |
| 4    | **Assembly**  
Butt male and female ends. Check for center-to-center length |
| 5    | **Alignment**  
Rotate male end until scribe line is positioned in center of plug hole. |
| 6    | **Plug Weld**  
Completely plug weld both holes to hold proper alignment.  
NOTE: See detailed instructions provided with the Maxi-Rods. Use MIG or shielded arc weld only. |
| 7    | **Fillet Weld**  
Complete assembly by welding a minimum 1/4" convex fillet weld. NOTE: See detailed instructions. Convex weld must be 360° MIG or shielded arc weld. |

**NOTE:** Euclid accepts no responsibility for the welding, the weld or methods reliability.
TECH TIPS

AIR SPRINGS
(Product Code 751)

AIR SPRING BASICS
Air Springs are supplied in two major styles.

EXHIBIT 1

<table>
<thead>
<tr>
<th>REVERSIBLE SLEEVE</th>
<th>CONVOLUTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Rolling Lobe)</td>
<td>(Bellows)</td>
</tr>
</tbody>
</table>

Reversible Sleeve Design
Flexible member rolls up and down a smooth piston surface to vary height and absorb road shock.

Double Convoluted Design (Shown)
These convolutes (bellows) flex in and out to vary height and absorb road shock.

STYLE 1
STYLE 2

Each replacement Air Spring must be the same style and design as original equipment. Styles and designs are engineered for each original equipment suspension and should not be substituted. Details on selection of the correct Air Springs from the Euclid Catalog are shown in Exhibit II.

FUNCTION
Air Springs deliver a cushioned ride that transfers less road vibration and shock into the vehicle’s chassis and body parts than comparable steel leaf springs. This reduction in transferred vibration provides driver comfort, cargo protection and reduced maintenance cost.

CONTROLLED RIDE HEIGHT
Air Springs provide a controlled ride height, regardless of load variations, when used with automatic height control valves. Euclid offers a complete selection of height control valves which can be found in the Suspension Catalog 700B. This valve maintains its ride height by automatically varying the air supply to the Air Spring.

Applications not using an automatic height control valve require a manual hand valve, such as Euclid E-4329, to vary air supply. When using a manual valve, the vehicle ride height and/or the output force of an Air Spring can be modified by the operator. Some original equipment manufacturers have designed suspensions that utilize both automatic and manual control valves, allowing the operator to choose the type of control. Although modification to any air system is not recommended, many vehicle owners do modify the system for various reasons. Air Spring failure which results from these system changes would not be considered for warranty.

INSPECTION PROCEDURE
Air Springs should be inspected at each vehicle preventive maintenance (P.M.) interval. This inspection should be for: cuts and abrasions due to: 1) suspension interference; 2) Air Springs too large for the application; and 3) air lines and other vehicle components rubbing on the outside of the Air Springs.

ROLLING LOBE style pistons should be inspected for corrosion and cracks. If corrosion or cracks are present, replace the piston. Slight corrosion may be cleaned up as long as a smooth rolling surface is restored. Also inspect the flexible member for damage. At any time excessive wear is found on the flexible member, the Air Spring must be replaced.

CONVOLUTED style Air Springs should be inspected for foreign material (i.e. stones, road dirt buildup, etc.) located in the girdle area or under the retainer plates. These materials will cause excessive wear on the flexible member leading to failure. If excessive wear is found, the Air Spring must be replaced.
IDENTIFYING AIRIDE® SPRINGS

1. Read the bead plate number.
The first step to identifying an Airide spring for replacement is to read the manufacturer’s number on the yellow label adhered to the bead plate. If the number is illegible, read the part number, normally molded on the bellows directly under the manufacturer’s name. The name 1T15 or 22, etc. will tell you exactly which bellows you need, and you can skip steps 2 and 3.

2. Measure the height of 1T springs.
If for some reason you can’t read the bellows number, you can still identify the bellows by measuring it. First determine whether it is a single, double, or triple convoluted style or a 1T style, by comparing it with the pictures in this guide. If it is a 1T style bellows, measure it from the bottom of the piston to the top of the bead plate while the part is unflated. Then find that same measurement for 1T style springs in this guide. When you’ve done that, skip to step 4.

3. Measure the diameter of convoluted springs.
If the spring you are replacing is a convoluted style, first determine whether it is a single, double, or triple convoluted style by comparing it to the pictures in this guide. Then measure the diameter of the bellows across its widest area, and find that same measurement in the “Cross Section View” column in the proper section of the guide for either single, double, or triple convoluted springs. When you’ve done that, go to step 4.

4. Determine whether your spring has a rubber bumper.
Many Airide springs include a rubber bumper inside the spring. To determine whether yours includes one or not, compress the spring to its minimum height and measure the height, from the bottom plate or piston to the top of the bead plate. Then compare this measurement with those listed in the cross section view column for your spring style in this guide until you find a match. Then go on to step 5 if you have a 1T style spring, or step 6 if you have a convoluted spring.

5. Identify the piston and bead plate of 1T style springs.
The same bellows is used with many different types of bead plates and pistons, so be sure to check this closely. Compare your bead plate and piston with those diagrammed in the “Bead Plate” and “Cross Section View” columns for 1T style springs in this guide, until you find the unit with the identical hardware and measurements. (All newer pistons have four threaded holes in the outer diameter, as well as the center hole. In some mounting methods, however, the outer holes may not be used. If the diameter and height of the piston matches those listed, the piston will work, regardless of mounting method.)

6. Identify the bead plates of convoluted springs.
The same bellows is used with many different types of bead plates. Compare your bead plate with those diagrammed in this guide under the “Bead Plate” column for convoluted styles. Find the unit with the identical hardware and measurements.

To order When you find the style and part number that agrees with all the determinations you’ve made, you have the assembly that will replace your spring without modification to the suspension. Use this number to order the spring. (If you notice a ten-digit number stamped on the bead plate of your spring, use it for ordering.) This is Firestone’s assembly order number (AON). When ordering, simply place an E-FS in front of the last 4 digits of the Firestone part no. (e.g.: E-FS9092)
THE COMPONENTS OF AIRIDE® SPRINGS

1. **Stud**
   A permanent part of the bead plate assembly used to attach the air spring to the suspension.

2. **Combo Stud**
   Combination mounting stud and air fitting.

3. **Blind Nut**
   A permanent part of the bead plate assembly providing an alternate mounting system to the stud.

4. **Air Fitting Hole**
   A tapped hole usually 1/4” N.P.T. providing air entrance for the part.

5. **Bead Plate**
   Permanently crimped onto the bellows at the factory allowing complete part leak testing prior to shipment.

6. **Bellows**
   The heart of an Airide spring. Includes at least four plies, or layers, of material—an inner layer, two plies of cord-reinforced fabric, and an outer layer.

7. **Bumper (Optional)**
   A solid molded rubber, fail-safe device used on many suspension applications. Prevents excessive damage to vehicle and suspension in the case of sudden air pressure loss.

8. **Piston**
   The lower section of the 1T and 1X style of air spring made from aluminum, steel or fiber reinforced plastic. Provides lower mounting arrangement for the air spring, in the form of tapped holes or studs.

9. **Piston Bolt**
   Attaches the piston to the bellows assembly. Extended, in some cases, to serve as a means of attaching the spring to the suspension.

10. **Girdle Hoop**
    A ring between the convolutions of the convoluted-type air spring.

**Service Assembly**
On Firestone Airide springs of the 1T style, the rubber bellows bead plate portion of the spring is a separate hermetically sealed unit, available for replacement use without the piston. Called a “service assembly,” it includes a bead plate, bellows, internal bumper (if any), and all attaching hardware.
PRODUCT LIMITATIONS

Air Springs are designed to work in compression only and have a limited travel capability. Typically, shock absorbers are the stroke limiting device that prevent Air Springs from overextending. Because of this, shock absorber inspection is also a key to Air Spring life. At Preventative Maintenance intervals, inspect all shock mounts. When replacing a shock absorber, insure that the correct shock has been used for the application. This may be checked by lifting the vehicle, by the frame, until the distance between top and bottom mounting surfaces of the Air Spring are at the extended height for each Air Spring as specified. NOTE: DO NOT EXCEED THE EXTENDED HEIGHT OF THE AIR SPRING OR DAMAGE WILL RESULT. Once this distance has been reached, measure the total distance between upper and lower shock mounts. This dimension should be the same as the extended length of the shock absorber. If not, replace the shock absorber with the correct one. This measuring step can also be used to identify the proper replacement shock absorber when no original equipment number can be found on the shock absorber.

Torque is an important factor in any suspension and air ride suspensions are no exception. Listed below are the torque requirements for Euclid Air Springs.

| Max Torque (ft lbs) | 3/8” - UNC BLIND TAPS | 15-25 |
| 1/2” - UNC BOLT OR STUD | 25-30 |
| 3/4” - UNC STUD | 15-25 |
| 3/4” - UNF COMBO STUD | 40-50 |

AIR FITTINGS

| AIR FITTINGS | 1/4” - NPTF | 20 |
| 1/2” - NPTF | 20 |
| 3/4” - NPTF | 20 |

Definitions:
- UNC = United National Coarse
- UNF = United National Fine
- NPTF = National Pipe Taper "F" ("F" = Dry Seal)

Air Springs failing due to over-torquing will not be considered for warranty claims.

RELY ON EUCLID

Euclid’s complete Air Spring offering with top of the line Firestone products is listed in the new Euclid Suspension Catalog 700B. For air springs not shown this catalog, including cab air springs, contact Euclid's S.O.S. Department.

With Euclid’s high order fill rates and prompt shipping, Euclid serves all your Air Spring needs!
AVAILABLE TYPES

Shock Absorbers are supplied to the medium/heavy-duty truck market in three major designs.

**NON-PRESSURIZED/OIL VALVING** - This design is used by many manufacturers. Various rebound, lengths, compression and general performances can be reached through the use of multistage valving and different bore sizes. This is the design featured in this issue of Tech Tips and includes the Monro-Magnum® 70 Series of shocks.

**GAS CHARGED/OIL VALVING** - Used in the light-duty market, this design operates on the same principals as the non-pressurized design. However, instead of operating at normal atmosphere pressure, the oil is subjected to a high pressure nitrogen gas. This high pressure reduces fade by eliminating air bubbles in the fluid. Monroe Gas-Magnum® 60 Series and Gas-Magnum® 65 Series shocks are of this design.

FUNCTION

Shock Absorbers reduce potentially damaging shock and vibration on heavy-duty trucks. Three advantages of reducing shock and vibration are to diminish or eliminate:

1) wear to high maintenance areas such as electrical systems, suspension parts and cooling systems as well as premature wear to other components on the vehicle with resultant down time;
2) driver fatigue;
3) cargo damage.

All this is accomplished by stopping the vibration at its source; Road shock transferred through the axle.

As a wheel passes over an imperfection in the road surface, the vehicle’s springs deflect and respond by over-returning. This oscillating action will continue, slightly reduced each time the spring deflects. These oscillations coupled with road induced shock can cause severe damage to truck components. The compression and rebound force resistance built into Shock Absorbers, reduces component failures caused by shock or vibration.
HOW THEY WORK

COMPRESSION OIL FLOW PATTERN

Here we see the inside workings of the Euclid Shock Absorber, and the oil flow during the compression stroke. Some oil flows through the piston, some through the compression head into the reservoir. To control this flow there are three valving elements at each location.

At the piston (1), oil flows through the “restrictions ports” (4) first. These fairly large holes provide for a free flow of oil at slow stroking speeds but become increasingly restrictive as the speed increases, thereby contributing to the total Shock Absorber control at high speeds. At low stroking speed, the oil flows next through the “carrier orifice” (5), a small passage which allows oil to flow through the piston before there is enough pressure built up to open the bypass valve.

Faster stroking speed reduces higher oil pressure below the piston and this pressure soon becomes great enough to open the valve against the “bypass spring” (6), as shown here. Note that this spring, like all control valve springs in Euclid Shocks, is a coil spring for more uniform control and higher resistance to fatigue. Note, too, that it is a substantial spring providing a substantial amount of compression control at the piston, which is effective only because of the “O-ring” piston seal used in Euclid Shocks. Meanwhile, at the bottom of the cylinder, oil is passing the compression head (2). This is the oil that is being displaced from the inner cylinder as the piston rod (7) enters it during compression motion.

Oil flows through the “compression head orifice” (8) during slow stroking motion. This orifice, as a matter of convenience, is cut through the valve seat as shown. As the speed increases, oil pressure builds up against the compression valve until it opens against the “compression valve spring” (10).

Oil then flows through the open valve after passing through the “compression valve restriction” (9) consisting of one crosshole in the valve pin. As before, the restriction is effective at high stroking speeds.
REBOUND OIL FLOW PATTERN

Here we see what happens when the Shock Absorber is extended. The oil flow through the piston and compression head is reversed and two other valves come into play. The rod displacement oil reenters the “inner cylinder” (17) through the “replenishing valve” (18) as the piston rod is withdrawn from the inner cylinder through the “inner cylinder head” (11).

At the same time, oil is passing through the piston, entering at the “restriction ports” (12). At low stroking speeds, the oil flows through the “extension orifice” (13) consisting of one or more slots cut through the valve seat. Increasing speed increases the oil pressure until the “extension valve” (14) is forced open against the “extension valve spring” (15).

Here again the restriction ports make a significant contribution to the total control at high stroking speed. Thus, in each control valve, there are three elements affecting the overall control: low-speed orifice, spring-loaded relief valve, and high-speed restriction. Each of these elements can be varied independently to tailor the Shock Absorber resistance to its vehicle applications. It is worth noting that at low stroking speeds we have seen that only the low-speed orifice is effective in developing the resisting force of the Shock Absorber. This, then, is what is felt as you stroke the unit by hand—only one of the three elements. Therefore, hand stroking is no indication of the overall effectiveness of the Shock Absorber on the truck.

The “piston rod seal” (16) is the most important single item governing the life of the Shock Absorber. The tapered, spring-loaded, multi-lip seal shown here has been developed to a high degree of efficiency in the design, and has been reproduced with various degrees of success by nearly every other manufacturer of Shock Absorbers in the country. Its long life is preserved by the fine precision finish on the piston rod.

Oil wiped from the piston rod by the seal returns to the reservoir through the drain hole in the cylinder head.
TROUBLESHOOTING

Shock Absorbers should be checked at each vehicle Preventive Maintenance. Visual checks are 1) leaks, 2) broken mounts, and 3) extruded or worn bushings. Also, Shock Absorbers, when reducing energy of transmitted road shock or suspension vibration, are converting such energy into heat. Therefore, Shock Absorbers on a vehicle just off the road should be warm or hot from doing their work. A cold Shock Absorber is not a functioning Shock Absorber.

Shock Absorbers should also be inspected when a vehicle is experiencing 1) frequent light bulb replacements, 2) excessive king pin wear, 3) premature tire wear, or 4) air spring damage.

Shock Absorbers are integral and hard working components of an Air Ride Suspension.

Air ride suspensions work Shock Absorbers hard. Shock Absorbers are the stroke limiting device for air spring suspensions. A Shock that is too long for the application or with worn or broken mounts will allow overextension of air springs. Therefore, Shock Absorbers in the air spring application should be replaced regularly. (See page 23 of this Tech Tips for more Air Spring troubleshooting.)

EUCLID VS. COMPETITION

Euclid supplies Monroe® Shock Absorbers in three series to more closely match any application.

**Gas-Magnum® 60 Series:** This 1 3/8" bore nitrogen gas-charged medium- and heavy-duty truck and tractor shock provides outstanding performance for demanding on and off-highway conditions.

**Gas-Magnum® 65 Series:** A large 1 3/4" bore nitrogen gas-charged shock designed especially for air spring and taper leaf suspensions. The extra large piston bore is specifically manufactured to handle the demands of high mileage and severe use.

**Monro-Magnum® 70 Series:** This 1 3/4" bore shock is designed to fit many heavy-duty trucks, tractors, trailers or buses on the road today.

Euclid's hard-working Monroe Shock Absorbers can help reduce excessive vibration, which can result in better tire life, less downtime and a lower cost per mile. Monroe shocks are designed to provide a maximally stable, more comfortable ride. Manufactured to meet or exceed the requirements specified by the original equipment manufacturer, Monroe Shock Absorbers are designed to last a long time, even under the demands of high mileage and severe use.

60-Day Free Ride Offer

Monroe is so confident that you will like your Gas-Magnum 60 or Gas-Magnum 65 series Shock Absorbers, they will make you an exclusive Monroe trial offer. Try a set of four or six Monroe gas-charged shock absorbers for 60 days.* If you don't feel these units give the best ride you have ever had, Monroe will replace them with any comparably priced unit of your choice. A complete set must include the steering and all drive axles.

2-Year/200,000 Mile Warranty

Monroe Auto Equipment Company warrants Gas-Magnum 60 and Gas-Magnum 65 Shock Absorbers installed on vehicles used for commercial purposes against defects and wear-out for two (2) years from date of purchase, or 200,000 miles, whichever occurs first.**

1-Year/100,000 Mile Warranty

Monroe Auto Equipment Company warrants Monroe-Magnum 70 Shock Absorbers installed on vehicles used for commercial purposes against defects and wear-out for one (1) year from date of purchase, or 100,000 miles, whichever occurs first.**

*Offer may be withdrawn at any time. Offer covers only Monroe Gas-Magnum 60 and Gas-Magnum 65 shock absorbers. Offer does not include units improperly installed or substituted. Valid only on vehicles used for commercial use.

**See Monroe Limited Commercial Warranty for more specific details of warranty coverage.
OTHER EUCLID TECHNICAL TRAINING MODULES AVAILABLE:

**MODULE ONE - FOUNDATION AIR BRAKES**
Includes:
- Foundation Air Brake Hardware Kits
- Camshafts/Camshaft Repair Kits
- Automatic Slack Adjusters
- Air Wedge Brakes

**MODULE ONE-ONE - AIR SYSTEMS**
Includes:
- Compressors
- Governors
- Air Dryers / Air Tanks
- Air Valves / Air Hoses

**MODULE TWO - HYDRAULIC BRAKES**
Includes:
- Hydraulic Wheel Cylinders
- Master Cylinder
- Hydraulic Disc Brake Rotors
- Hydraulic Disc Brake Calipers

**MODULE THREE - WHEEL ATTACHING PARTS**
Includes:
- Disc Wheel Parts
- Spoke Wheel Parts

**MODULE FIVE - FRONT END PARTS**
Includes:
- King Pin Sets
- Tie Rod Ends
- Drag Links
- Light-Duty Front End Parts

**MODULE SIX - AIR CONDITIONING AND HEATING PARTS**

**MODULE SEVEN - ELECTRICAL COMPONENTS**
Includes:
- Alternators
- Starters

**MODULE EIGHT - ENGINE COOLING SYSTEMS**
Includes:
- Water Pumps

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