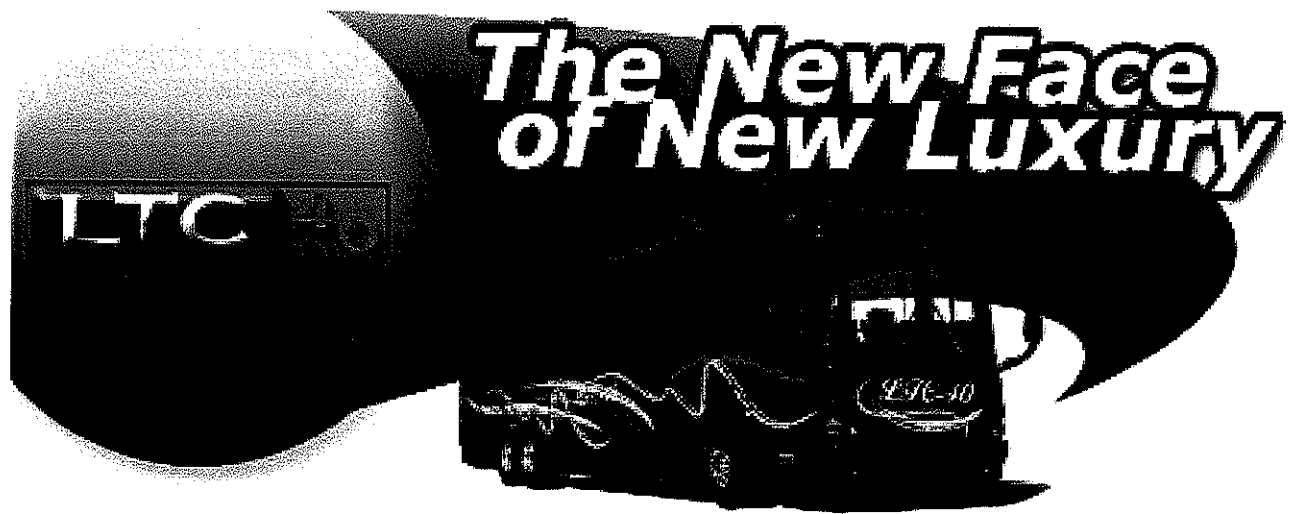




2003 LTC-40

Service Manual

P/N 0055217

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Safety

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Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

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Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

The purpose of this manual is to help you get the best value from your LTC. This manual can help you decide what work must be done and provides for routine maintenance as well as common service procedures.

This manual has diagnostic and repair procedures to use when trouble occurs. Blue Bird Corporation has tried to make this service manual as comprehensive as possible. However, in some cases only the high volume options have been included.

Additional information will be continually developed and made available in future revisions. Please contact the Blue Bird Customer Service Department if you need service information that is not in this manual.

This manual is divided into sections. Each section corresponds to a functional category of parts or assemblies. These section numbers correspond to the Blue Bird Parts Catalog group numbers that may already be familiar to you. For example, Group 030 in the Parts Catalogs and Section 030 in this Service Manual both apply to brakes.

General Dimensions of the LTC-40

Length.....40 feet
Exterior width 102 inches
Exterior height 138 inches
Wheel base..... 247 inches
Turning Radius Wall 41.5 feet; Curb 37.5 feet
Axles:..... Front 14,600 lbs., Rear 23,000 lbs.,
..... Tag 11,500 lbs.
GVWR..... 48,600 lbs. (depending on tire selection)

Engine Crankcase Oil	With Filter	Without Filter
Detroit Series 60	38 Quarts	32 Quarts
Cummins M11	9.7 Gallons	9 Gallons

Table 1—Fluid Capacities

Minus Radiator	
Detroit Series 60	24 Quarts
Cummins M11	10 Quarts

Table 2—Engine Coolant

Transmission Only	
Detroit Series 60	48 Quarts
Cummins M11	48 Quarts

Table 3—Transmission Fluid

Spicer J-230-SB, Single Speed	31.5 Pints

Table 4—Rear Axle Fluid Capacities

Jacking Instructions

Warning

Proper jacking procedures must be followed to ensure the safety of the operator. Always check to ensure the appropriate jacks and jack stands are securely in place and of sufficient strength. Make sure that the parking brake has been set before positioning yourself under the coach.

Warning

Failure to ensure that any locking device on the jack is in place and fully operational, and that the vehicle is solidly supported could result in serious injury or death.

1. Park the vehicle on flat, level concrete or on a comparable surface, capable of supporting the jacking device.
2. Apply the parking brake.
3. Install chocks at the front and rear of tires, opposite the wheel or wheels to be lifted.
4. Use jacks and jack stands of sufficient capacity to support the vehicle. Following the jack manufacturer's recommended procedure, place the jack securely under the axle at the spring or suspension beam.
5. Jack the vehicle to required height for servicing.
6. Support the vehicle under the main frame rails with jack stands or blocks before working under or around the coach.

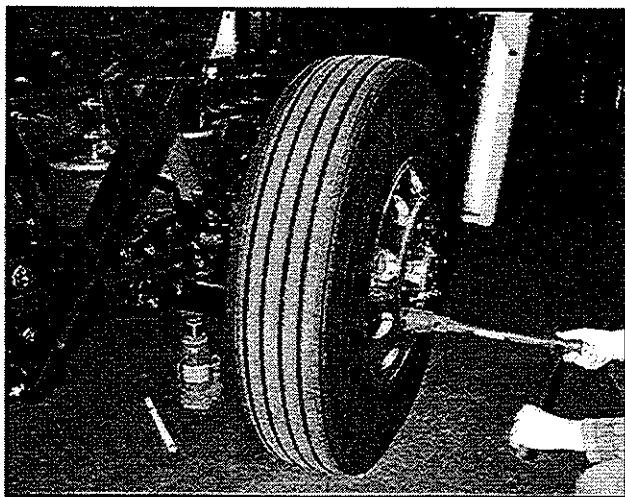


Figure 1—Jacking Procedure

Operation	Service Intervals								Months/Miles Whichever Occurs First
	1/3,000	3/5,000	3/24,000	6/6,000	6/10,000	12/12,000	12/24,000	24/24,000	*Service Intervals to be performed on a continuing basis. Example: 1/3,000 means every month or every 3,000 miles
General Instructions									
Rear Axle									
Check Lubricant				●					See Section 020 - Rear Axle. Keep oil to level of filler plug. Drain & refill at first 1,000 to 3,000 miles and then at recommended intervals. Check level testing plug on rear of axle bowl. See key No. 1
Change Lubricant							●		See key No. 1
Inspect Vent				●					See key No. 2
Front Axle									
Lubricate King Pin		●							4 Fittings. Use NLGI Grade No. 2 Grease. See key No. 3
Lubricate Tie Rod		●							2 Fittings. Use NLGI Grade No. 2 Grease. See key No. 4
Inspect Alignment and Component Wear	If Tire Wear Indicates								Caster 3° +/- 1° positive. Camber 0° +/- 7/16° RH & LH. (Toe-In 0" to 1/16") Spring and Neway Air suspensions. Axle settings are the same for both radial and bias ply tires.
Front Axle Steering									
Check Hydraulic Reservoir Fluid Level				●					Check level sight glass. Use Dexron II.
Change Reservoir Filter							●		More frequent filter changes may be necessary in a dusty environment. BB filter #2108199.
Lubricate Drag Rod				●					2 Fittings. Use NLGI Grade No. 2 Grease. See key No. 5
Inspect Power Steering Pump						●			Check for leakage around the shaft or housing. When a leak occurs (fluid oozing out), correct immediately.
Inspect Steering Gear						●			Check for leakage around the shaft or housing. When a leak occurs (fluid oozing out), correct immediately. See key No. 6
Index Pitman Arm	If Arm is Removed								See Section 120 - Steering.
Lubricate Steering Gear				●					See Section 120 - Steering. Grease fitting located on rear of gear. Use hand grease gun only. Use NLGI Grade No. 2 Grease. See key No. 6
Tires									
Check Tires	Weekly								

Chart 1 - Axle Maintenance

Operation	Service Intervals								Months/Miles Whichever Occurs First *Service Intervals to be performed on a continuing basis. Example: 1/3,000 means every month or every 3,000 miles
	1/3,000	3/5,000	3/24,000	6/6,000	6/10,000	12/12,000	12/24,000	24/24,000	
Air Brake System									General Instructions
Air Brake Operation									See Section 030 - Brakes.
Clean & Replace Air Filters				●					Bendix filter #243009. BB #1339993.
Clean Governor				●					Disassemble all valves and lubricate at 100,000 miles.
Inspect Bendix Air Dryer			●						See Bendix Service Data sheet SD-08-04.
Inspect & Clean Air Dryer								●	See Cyclo-Gard Air Dryer Form #313.
Inspect Heated Reservoir Drain Valve									See Stark Expello Valve Form S-103. Maintenance-free. No adjustment or cleaning necessary.
Drain Air Tanks	Daily-cold weather Weekly-warm weather								Drain Condensation.
Check Pop-Off Valves							●		Disassemble all valves and lubricate at 100,000 miles.
Check Single & Double Check Valves				●					Disassemble all valves and lubricate at 100,000 miles.
Clean & Lube Treadle Valve				●					Disassemble all valves and lubricate at 100,000 miles.
Clean Relay Valves								●	Disassemble all valves and lubricate at 100,000 miles.
Clean Spring Brake Valves								●	Disassemble all valves and lubricate at 100,000 miles.
Clean Parking Brake Valve								●	Disassemble all valves and lubricate at 100,000 miles.
Clean Quick Release Valves								●	Disassemble all valves and lubricate at 100,000 miles.
Inspect Brake Chambers	●								
Clean Pressure Protection Valves								●	Disassemble all valves and lubricate at 100,000 miles.
Shoe-Type Brakes (Air)									
Brake Inspect and Adjust	Weekly or as needed depending on application								See Rockwell Field Maintenance Manual No. 4, Eaton EB-31 Service Manual, or Eaton EB-32 Service Manual.
Lubricate Brake Camshaft	●								4 Fittings. Use NLGI Grade No. 2 Grease. See key No. 7.
Lube Brake Slack Adjusters	●								4 Fittings. Use NLGI Grade No. 1 Grease. (Special Stopmaster Grease). See key No. 8.

Chart 2 - Brake Maintenance

Operation	Service Intervals							Months/Miles Whichever Occurs First	
	1/3,000	3/5,000	3/24,000	6/6,000	6/10,000	12/12,000	12/24,000	24/24,000	*Service Intervals to be performed on a continuing basis. Example: 1/3,000 means every month or every 3,000 miles
									General Instructions
Electrical System									
Check Battery Water Level	●								Use distilled water to fill.
Check Battery Posts				●					Clean more often if corrosion appears. Use heavy grease to help prevent corrosion.
Inspect Alternator				●					Check belt tension.
Inspect Engine Block Heaters						●			Check wiring and hoses for proper connection, cracking, abrasion and deterioration. Replace parts as necessary.
Exhaust Systems									
Inspect Exhaust Piping and Joints				●					Inspect piping and joints for leakage and corrosion. Replace clamps if joint is leaking. Clamps are not reusable. Reseal with exhaust sealant and install new clamp.
Auto Transmission									
Check Fluid Level	Daily							Use Dexron or Dexron II fluid. See key No. 9.	
Change Fluid							●		Use Dexron or Dexron II fluid. See key No. 9
Change Internal Filter							●		Remove transmission fluid pan. Use vendor kit #23019201
Check Vent							●		Make sure vent is clean and clear of dirt.
Drivelines									
Inspect Driveshaft	●								See Section 050 - Drivelines.
Lubricate Universal Joint	●								Use NLGI Grade No. 1 or 2 Grease. See key No. 10
Lubricate Slip Joint	●								Use NLGI Grade No. 1 or 2 Grease. See key No. 11
Torque Capscrews & Bolts	If Damaged or Removed for Service								
Straighten / Balance Angles and Phasing	If Damaged or Removed for Service								
Power Take Off									
Spline	●								Use Blue Bird Part Number 0029995.
Air Intake System	●								Replace damaged pipes and tighten loose clamps, as necessary, to prevent the air system from leaking. Check for corrosion under clamps and hoses. Actual interval is 3 months or 6,000 miles.

Chart 3 - Chassis Component Maintenance

Operation	Service Intervals								Months/Miles Whichever Occurs First
	1/3,000	3/5,000	3/24,000	6/6,000	6/10,000	12/12,000	12/24,000	24/24,000	
									*Service Intervals to be performed on a continuing basis. Example: 1/3,000 means every month or every 3,000 miles.
									General Instructions
Door									
Lubricate Hinges				●					Lubricate all hinge lugs. Use lightweight lubricating oil.
Lubricate Roller Gears				●					Lubricate roller gears where required. Use lightweight grease such as White Lube.™
Adjust Door Linkage Rod	As Required								Adjust door linkage rod for proper open/closed position.
Bus Body Care									
Wash	As Required								
Emergency Exits									
Lubricate Lock Mechanisms				●					Spray lubricant into lock mechanism. Use Silicon spray.
Lubricate Roof Hatches	●								Spray silicon lubricant into lock mechanism. Work lock handle back and forth to ensure smooth operation. Use Silicon spray.
Emergency Equipment									
Inspect All Mounting Fasteners	●								Inspect all emergency equipment mounting bracket fasteners to ensure tightness.
Destination Signs									
Check & Adjust Curtain				●					
Replace Bulb	As Required								
Windows									
Lubricate Latch	●								Spray lubricant into window latch mechanism. Use Silicon spray.
Lubricate Window Slides	●								Spray lubricant into sliding frame of window. Use Silicon spray.
Heaters									
Check Heater Hoses						●			Check hoses for kinks, cracks, or other visible signs of damage.
Clean Heater Coil & RH						●			Keep airflow passage free of dust and dirt by cleaning with compressed air or vacuum, and a soft bristle brush. Straighten damaged fins with a fin comb.
Check Motor Wheels & Fans						●			Check wheels and fans for obstructions or damage by running each fan alone, then listening and feeling for irregularity. Replace damaged wheels or fans to prevent vibratory damage.
Check Heater Panels & Housing						●			Fasteners that connect and retain structural and access panels should be checked and tightened as necessary.
Tighten Heater Hose Clamps	First 1,000 Miles and Annually Thereafter								Heater hose clamps are located at the under seat heater coil, behind the access door in the heater hose covering immediately forward of the left front wheel housing, and under the floor near the right front and driver's heaters.

Chart 4 - Body Component Maintenance

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Chart 4 - Body Component Maintenance (continued)

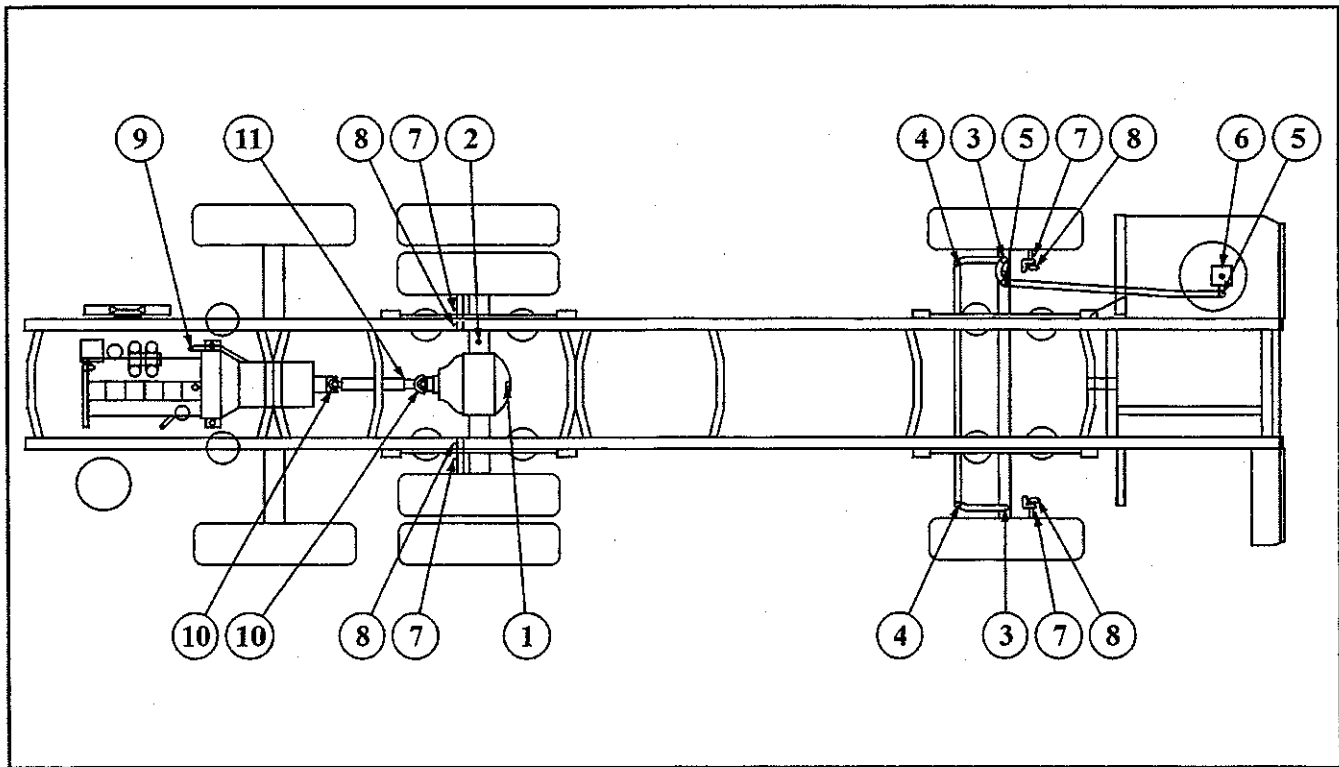


Figure 2 - LTC Maintenance Key

Key	Part or Area
1.	Rear Axle Housing
2.	Vent
3.	Front Axle (King Pin)
4.	Tie Rod
5.	Drag Rod
6.	Steering Gear
7.	Brake Camshaft
8.	Brake Slack Adjuster
9.	Automatic Transmission
10.	Universal Joint
11.	Slip Joint

Table 5 - Part or Area Location

LTC Front Axle

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Spicer® Heavy Axle and Brake Division
Spicer® Gold Series Front Axles Service Manual ©
Spicer/Dana, Form #SHABD 894-3.

Introduction

These documented procedures apply to a Blue Bird LTC with a Cummins M11 engine and an Allison B500 World Transmission.

Service Parts and Axle Identification

Genuine Spicer® Service Parts

- See Figure 1—Axle Identification
- See Figure 2—Model Identification Numbering System
- See Figure 3—View of Axle Steering Knuckle Assembly

Note

All axle models with the "SA" designation are now designated as "SG" axles. Should an axle assembly require replacement component parts, Spicer® Heavy Axle Service Parts are recommended. Spicer® Heavy Axle Service Parts are manufactured under the same rigid specifications as the original equipment axle components. This assures the customer who uses genuine Spicer® Service Parts maximum reliability for a Spicer® Heavy Axle assembly. They may be obtained through your vehicle manufacturer. The use of parts that are not Spicer® Service Parts may cause premature component failure and may void the warranty.

The items included in this manual are currently being offered as service parts at the time of printing. The part numbers and illustrations are provided specifically for reference purposes only.

Special Tools

Special service tools are available from:

OTC Division, Service Tools
655 Eisenhower Drive
Owatonna, MN 55060
Telephone: 1-800-533-0492
Fax Number: 1-800-283-8665

The following table is a list of tools needed to service the front axles in this manual. These tool numbers are from OTC Tool Division. Dana makes no warranty or representation of these tools. (See Table 1—Special Tools.)

Measurement, Torque and Lubrication

1. See Table 2—Diameter Specifications
2. See Table 3—Torque Values
3. See Table 4—Lubrication Schedule

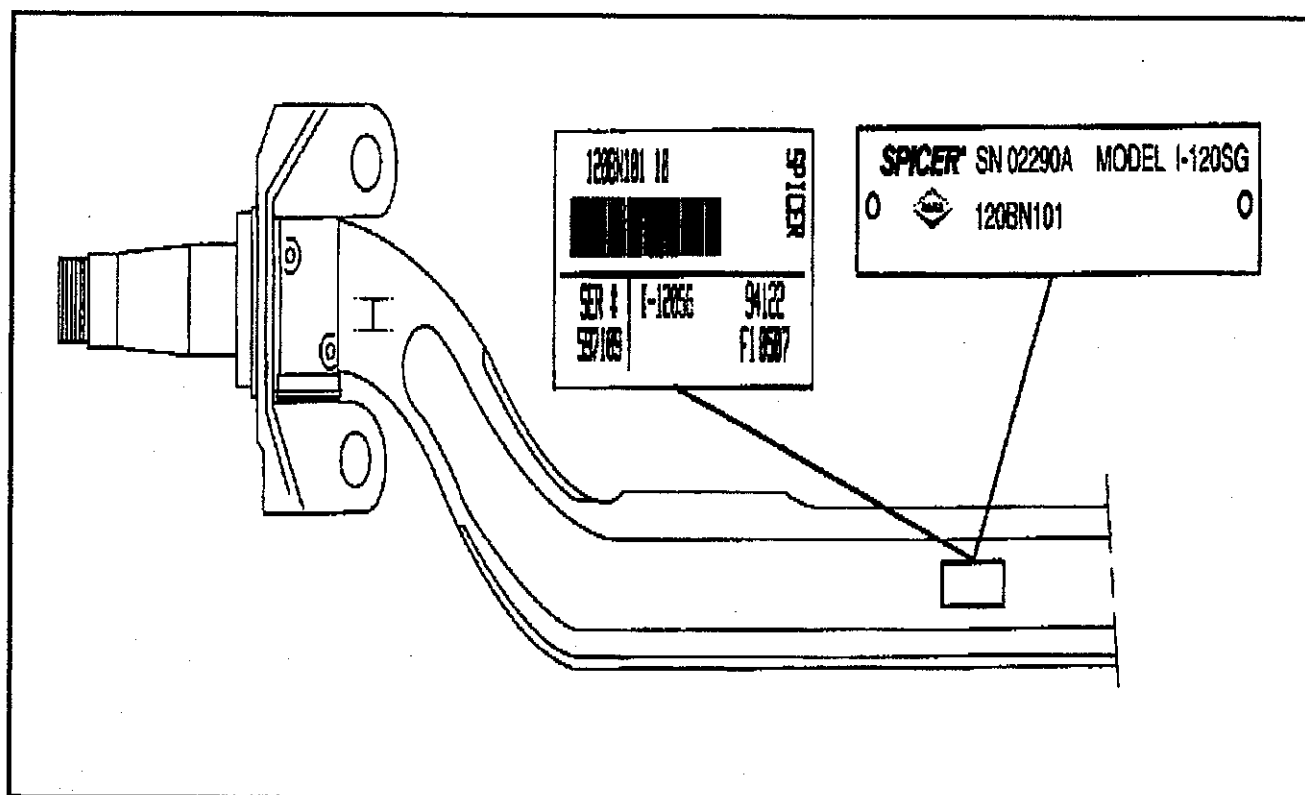


Figure 1—Axle Identification

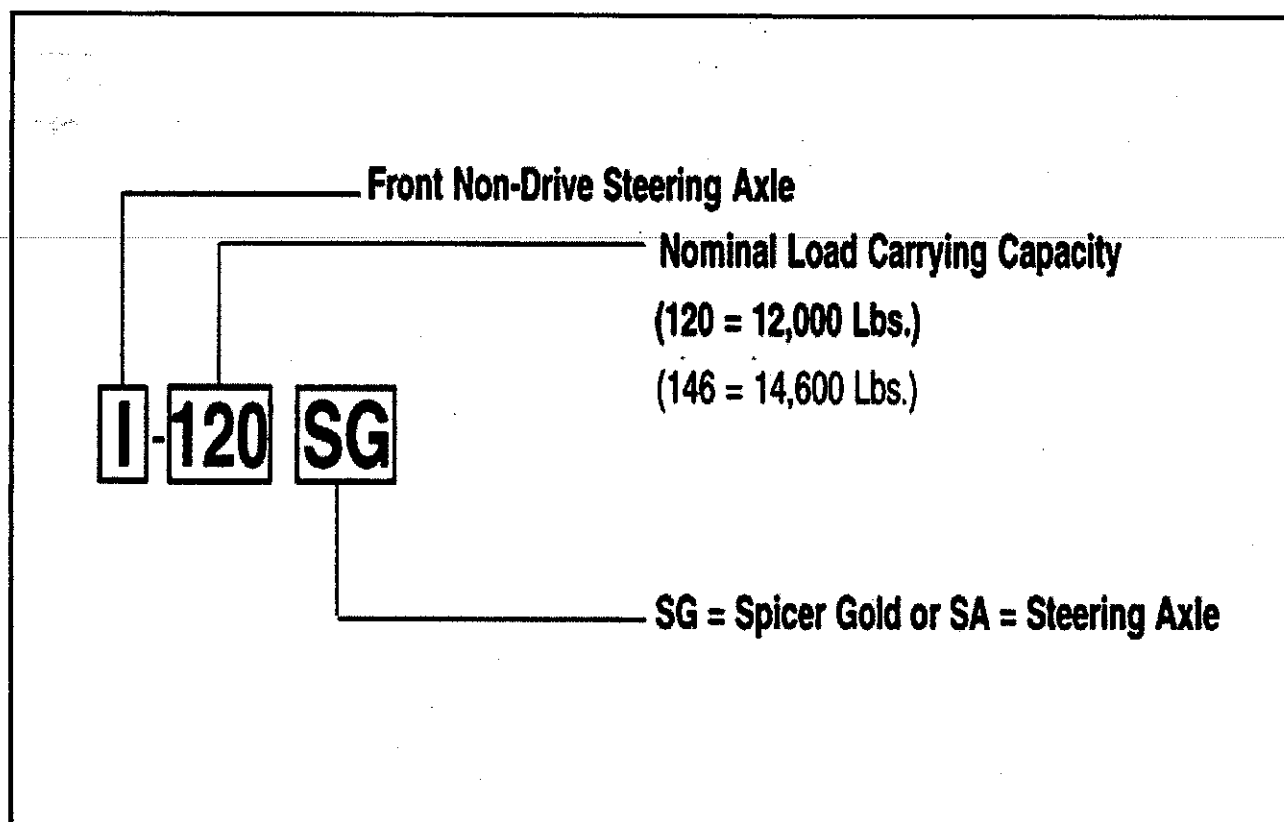


Figure 2—Model Identification Numbering System

LTC Front Axle

Models Serviced	Description	Tool Number
Tools to service all axle models	King Pin Bushing Basic Set	ZTSE 4330A
Tools to service axle models I-200SA/SG and I-146SA/SG	Bushing Installer Seal Installer	ZTSE 4330-5A ZTSE 4330-55

Table 1—Special Tools

Spicer Model	I-60SG I-80SG		I-100 SA/SG I-120SA/SG I-140 SA/SG		I-160SG I-180SG I-200SG	
	INCH	MM	INCH	MM	INCH	MM
King Pin Bushing Diameter I.D	1.3615	34.58	1.8652	47.376	2.0470	51.994
	1.3600	34.54	1.8608	47.264	2.0515	52.105
King Pin Diameter	1.3592	34.52	1.8600	47.244	2.0457	51.973
	1.3587	34.51	1.8505	47.231	2.0462	51.986
I-Beam Bore Diameter	1.3607	34.56	1.8622	47.300	2.0470	51.994
	1.3597	34.54	1.8608	47.264	2.0480	52.019

Table 2—Diameter Specifications

Note

If the cotter pin cannot be installed after minimum torque, tighten the nut more to install the cotter pin. Torque to specification. Tap the unthreaded end of the draw key sharply with a brass hammer and re-torque the draw key nut to specification.

Location	Size		Torque			
	Diameter Inches	Number Threads	Foot-Pounds Minimum Maximum		Nm Minimum Maximum	
Tie Rod End Nut	3/4	16	80	105	108	143
	7/8	14	120	160	160	218
Tie Rod Clamp Bolt	5/8	11	45	60	61	81
Steering Arm Nut & Tie Rod Arm	1-1/8	12	450	650	610	881
	1-1/4	12	775	1200	1050	1625
King Pin Draw Key Nut	3/8	16	25	31	34	42
King Pin Cap Bolts	5/16	18	17	25	23	34

Table 3—Torque Values

Note

Better distribution of grease through the kingpin bushing pockets is attained by lifting the weight off the front wheels during the lubrication process.

Recommended Maintenance Schedule for On-Highway Use.

Interval	Component	Procedure
6,000 miles/monthly	Wheel Bearings (Oil)	Check level and fill with GL-5 gear lube as required
25,000 miles/6 months	King Pins and Tie Rod Ends	Lube with NLGI-2 Lithium Grease EP-2 Moly Grease
30,000 miles/annually	Wheel Bearings (Grease)	Repack w/NGLI-2 Lithium Grease EP-2 Moly Grease
100,000 miles/annually	Wheel Bearings (Oil)	Change Lubricant GL-5

Recommended Maintenance Schedule for On/Off Highway.**Use Low Mileage/High Hour Operation**

Interval	Component	Procedure
3,000 miles/monthly	Wheel Bearings (Oil)	Check level and fill with GL-5 gear lube as required
6,000 miles/6 months/300 hours	King Pins and Tie Rod Ends	Lube with NLGI-2 Lithium Grease EP-2 Moly Grease
12,000 miles/annually/600 hours	Wheel Bearings (Grease)	Repack w/NGLI-2 Lithium Grease EP-2 Moly Grease
24,000 miles/annually/100 hours	Wheel Bearings (Oil)	Change Lubricant GL-5

Table 4—Lubrication Schedule

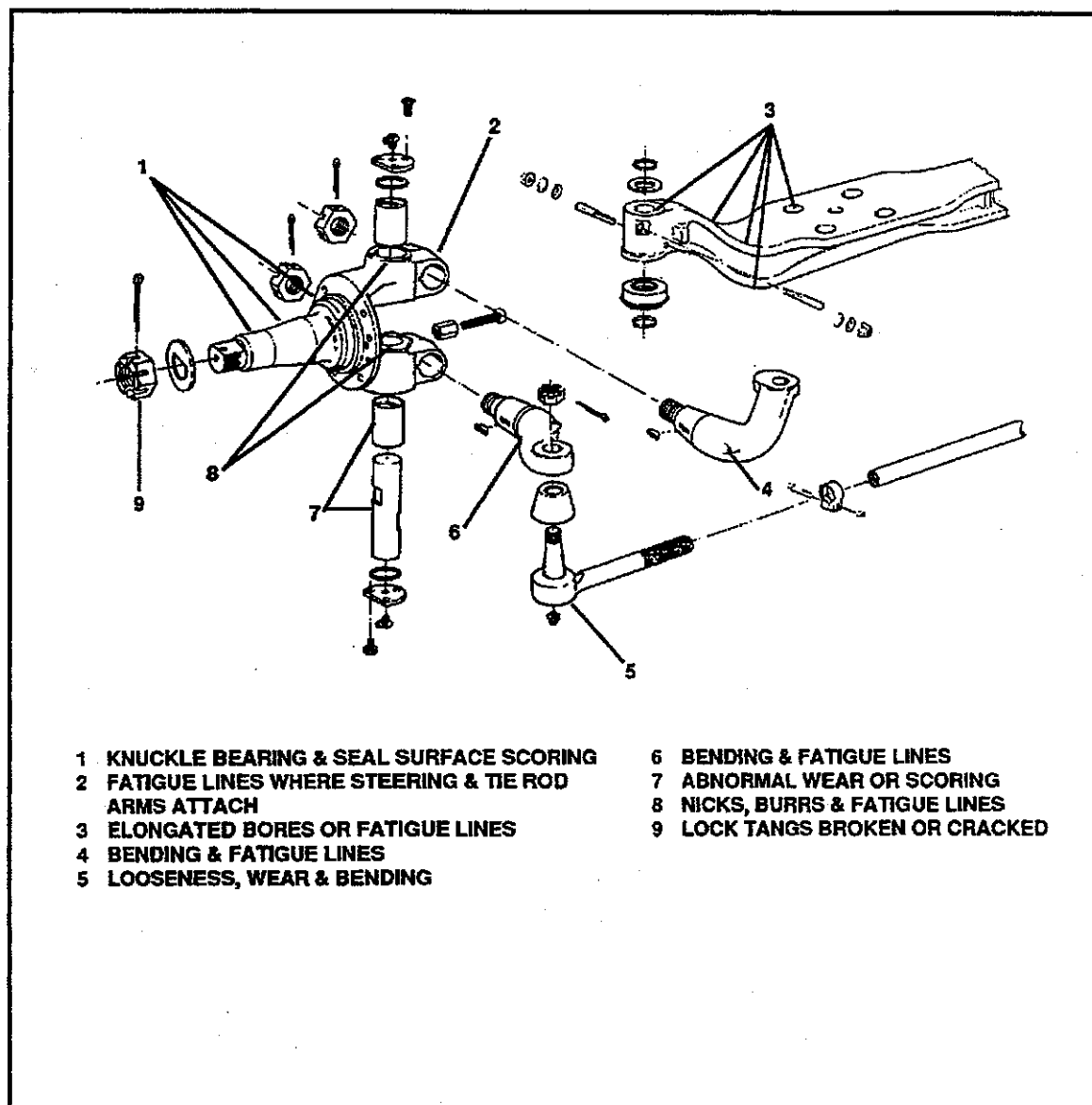


Figure 3—View of Axle Steering Knuckle Assembly

Precautions and King Pin Wear Limits

The front axles covered in this section are I-beam type, non-driving units. Front axles are machined with different kingpin angles to compensate for crowned road surfaces.

The axle must be installed with the identification tag to the front of the vehicle. Some applications may also have the word "front" cast into the lower flange of the I-beam.

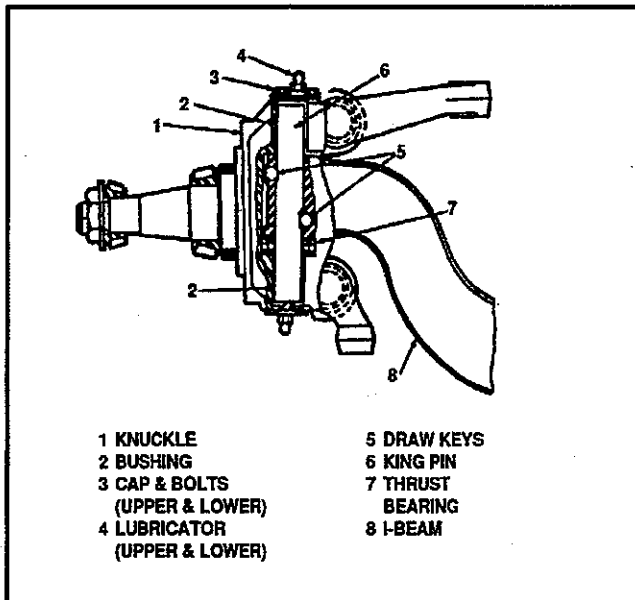


Figure 4—Typical Steering Knuckle

Precautions

Spicer strictly prohibits the modifying or re-conditioning of any front non-driving axle component for any reason. Spicer recommends replacing any component that is damaged or out of specification.

All of the major components are heat treated and therefore, cannot be bent, twisted, welded, heated or reconditioned without experiencing a strength and/or fatigue life reduction.

Example of specific prohibited operations include, but may not be limited to:

1. Hot or cold bending or twisting of I-beam, tie rod arms for any reason.
2. Welding of, or to, steering arms, tie rod arms, I-beams, steering knuckles, kingpins or tie rod assemblies.
3. Re-drilling or re-boring of I-beam king pin holes for a bushing.
4. Milling or machining of any component.
5. Spray welding of bearing diameters or other machined surfaces.
6. Re-drilling or re-boring of draw key holes.
7. Relocation or removal of tie rod clamps.

Maximum Limits for Front Axle King Pin

This procedure is for determining if front axle king pin bushing wear side play and spindle vertical end play measurements exceed the maximum wear limits for normal service, and for deciding if maintenance is necessary.

King Pin Bushing Wear Check

The simplest method for checking kingpin looseness is to use camber gauges. (See Figure 5—King Pin Bushing Wear.)

Note

King pins and bushings must not have been recently lubricated before making this check. Measurements must be made before lubrication.

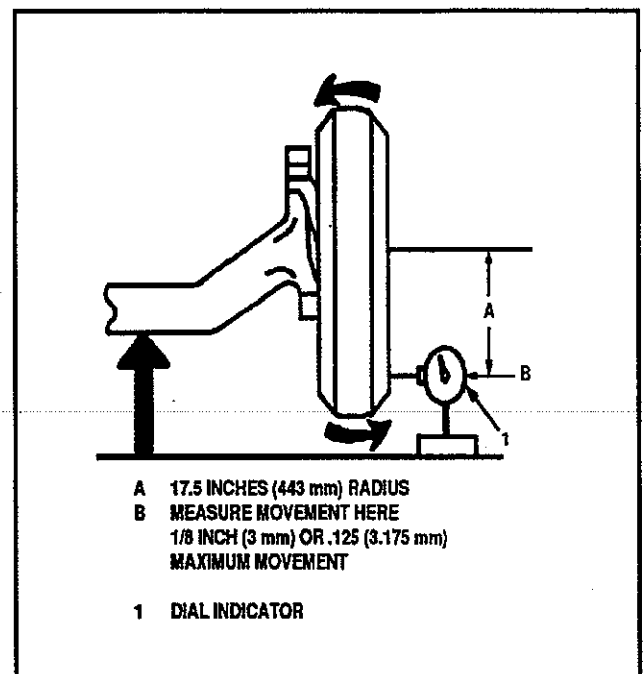


Figure 5—King Pin Bushing Wear Measurement

1. Block the rear wheels.

Note

If the axle is supported on only one jack stand, a false reading will be obtained.

2. Raise and support the axle on two jack stands.

LTC Front Axle

3. Apply the brakes to eliminate wheel bearing play and to assure a correct reading. Failure to do so will result in a false reading.
4. Mark the tire at 17.5 inches (444.5 mm) radius from the center of the spindle.
5. Position a dial indicator at 17.5 inches (444.5 mm) mark to measure tire movement. Accurate results depend upon the measurement at the specified radius.

Note

If more than 0.125 inch (3.175 mm) is obtained at the 17.5 inches (444.5 mm) mark, the king pin bushing should be replaced.

6. Push the wheel inward at the top and measure the movement obtained on the dial indicator at 17.5 inches (444.5 mm) radius mark on the tire.

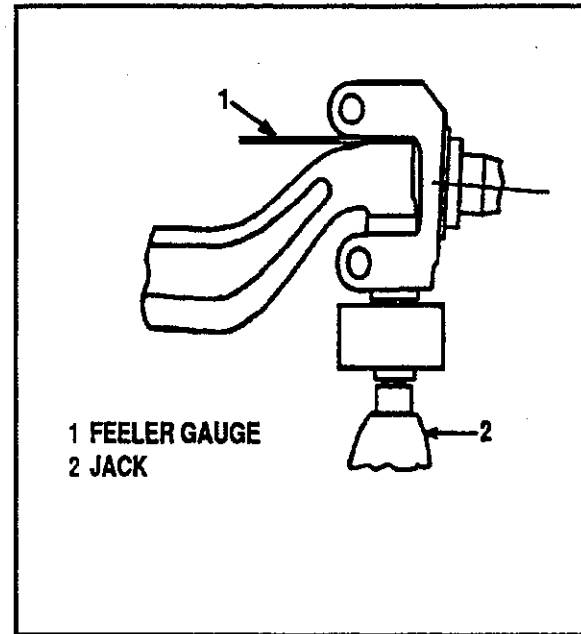


Figure 6—Feeler Gauge Measurement

Measure Spindle Vertical End Play

1. Block the rear wheels.
2. Raise and support the axle.
3. Lift the wheel and tire spindle only if the wheel is removed so that all clearance is taken up between the steering knuckle and axle pin boss.

Note

If more than 0.060 inch (1.524 mm) is measured, add shims as needed to reduce clearance to 0.005—0.015 inch (0.1270—0.3810 mm).

4. Measure with a feeler gauge clearance as shown in Figure 6—Feeler Gauge Measurement.

King Pin Bushing Replacement

Steering Knuckle Removal

The following procedure applies to one knuckle. Repeat the procedure for the remaining wheel end.

1. Block the rear wheels.
2. Raise the vehicle. Support the vehicle on stands.
3. Remove the wheels.
4. Remove the dirt shield screws and shields.
5. Remove the hubs (on vehicle with disc brakes).
6. Remove the hubs and drums (on vehicles with drum brakes).

Note

It will be necessary to support the drum brake backing plate so the weight of the backing plate is not on the air hose.

7. Remove the brake backing plate or caliper mounting bracket from the knuckle.

Note

On some axles, it may be easier to remove the steering arms from the knuckle.

8. Remove the tie rod assembly and drag link from the steering arms using a suitable tool.

9. Remove the draw key. (See Figure 7—Removing Draw Key.)
10. Drive the staked draw key out at the opposite end of the staking using a drift and brass hammer.

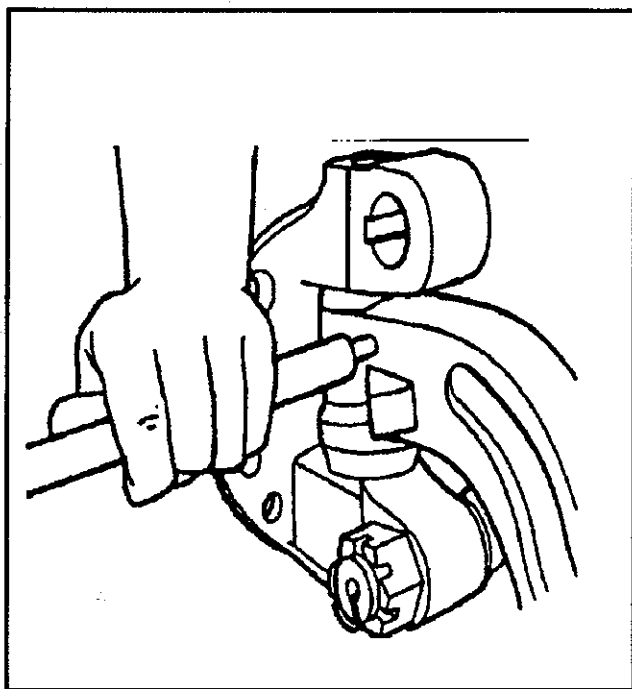


Figure 7—Removing Draw Key

Note

All front axles use dual draw keys. I-146SG and I-160SG axles use dual threaded draw keys. All axles should be serviced with the original draw key configuration.

Note

Remove, discard and replace any O-rings under caps.

11. Remove the top and bottom steering knuckle caps. (See Figure 8—Removing Steering Knuckle Cap.)

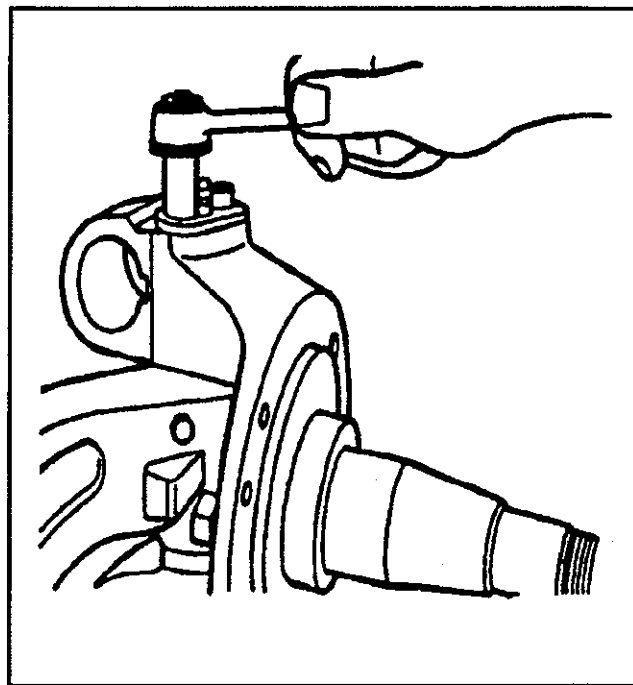


Figure 8—Removing Steering Knuckle Cap

Caution

Do not heat the axle to loosen the king pin. Heat can weaken the axle and cause excessive vehicle damage.

Note

The draw key must be removed prior to king pin removal.

12. Drive out the king pin. (See Figure 9—Removing King Pin.)
13. Remove the steering knuckles, thrust bearings and any spacer shims present.
14. Clean and inspect all parts.

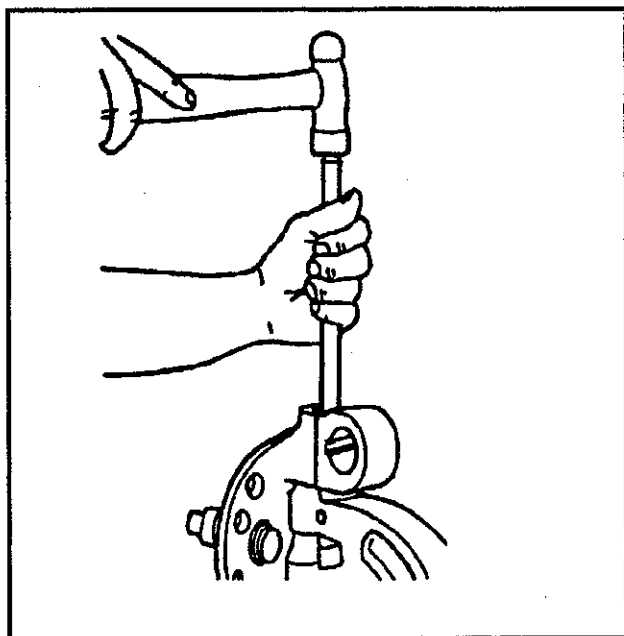


Figure 9—Removing King Pin

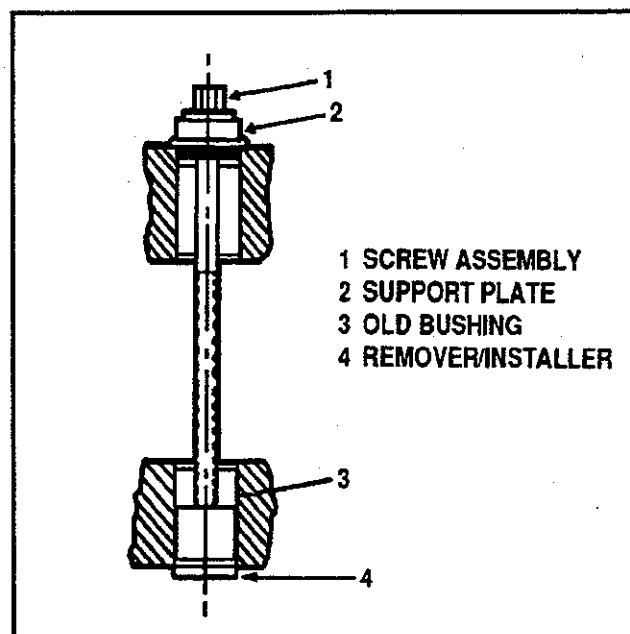


Figure 10—Bushing Removal

King Pin Bushing Removal

Note

All axles incorporate pre-sized bushings.

1. Assemble screw, support plate, and remove. (See Figure 10—Bushing Removal.)
2. Select the appropriate service tool kit (pilots, remover and installer) for the axle code number.

3. Tighten the screw with a wrench until the bushing is removed from the knuckle.
4. Assemble tool at the opposite end to remove the remaining bushing.

Note

The screw threads must be lubricated with high pressure lubricant.

5. Clean and inspect the knuckle prior to installation of new bushings. Replace if damaged.

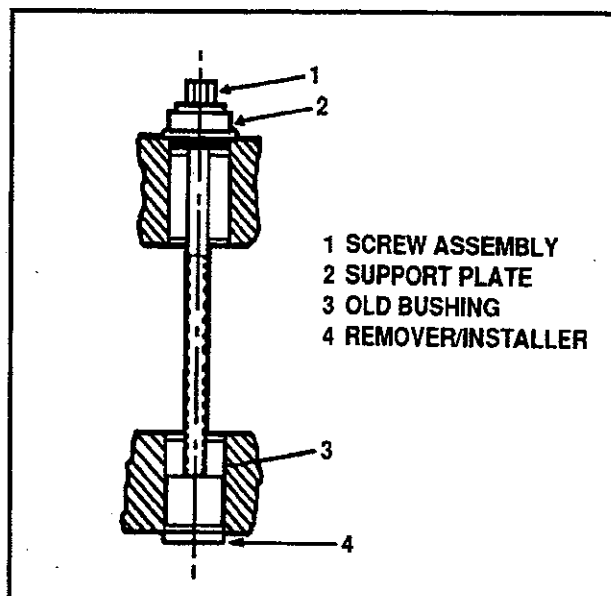


Figure 11—Installing Pre-sized Bushing

Bushing Installation (Pre-sized Type)

1. Assemble screw, support plate and installer with upper bushing. (See Figure 11—Installing Pre-sized Bushing.)
2. Tighten the screw to pull bushing into the knuckle.
3. Install the bushing to specified dimension. (See Figure 12—Bushing Seating Depth.)
4. Install the lower bushing following the same procedure used in installing the upper bushing except at the opposite end.

King Pin Seal Installation

All Model Axles

Installing Upper and Lower Seals. (See Figure 13—King Pin Bushing Seal Installation.)

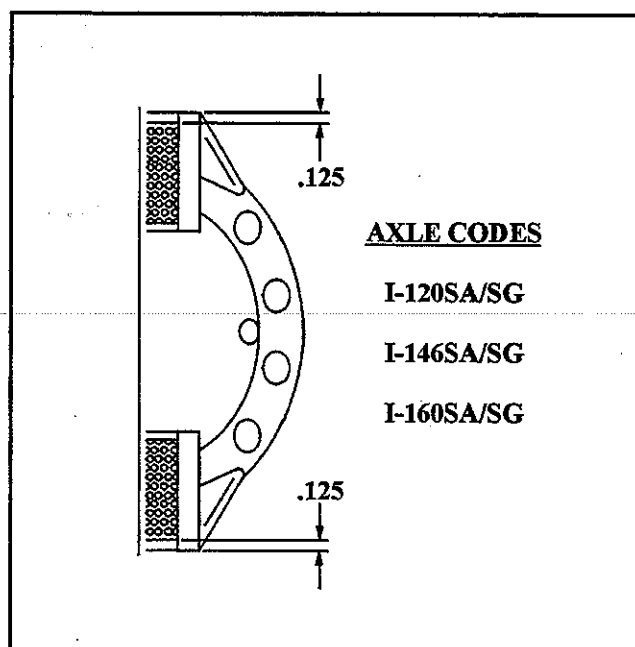


Figure 12—Bushing Seating Depth

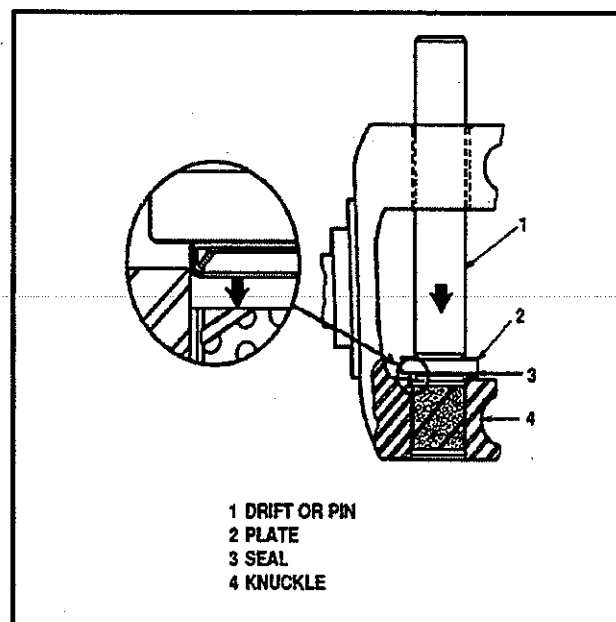


Figure 13—King Pin Bushing Seal Installation

1. Position the knuckle vertically to install the top seal into bore.
2. Start by hand with sealing the lip out or rounded edge into bore.

3. Press the seal into the knuckle bore until it is flush with the knuckle surface. Use an adapter or steel plate.
4. Install the bottom seal. (Reference Steps 2 and 3.)

Steering Knuckle Installation

Note

Make sure that the knuckle pin hole in the axle center is clean and dry. There may be two styles of thrust bearings. One type is installed on the thrust bearing with the seal on top. (See Figure 14—Thrust Bearing Seal Installation.)

1. Lubricate inside of the bushings and outside of the king pins with Fleetrite EP2 Moly Grease or equivalent NLGI No. 2 multi-purpose lithium grease, to provide initial lubrication.

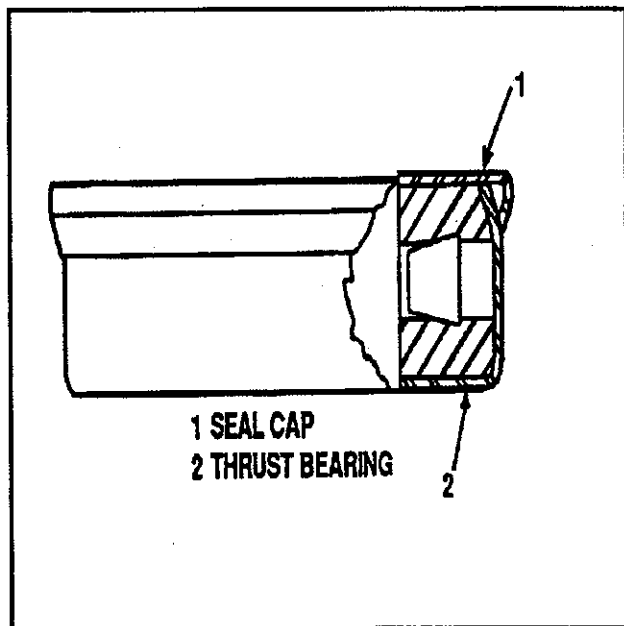


Figure 14—Thrust Bearing Seal Installation

Note

The second style thrust bearing is a one piece design with seal lip installed towards the bottom of the knuckles. (See Figure 15—Sealed Thrust Bearing.)

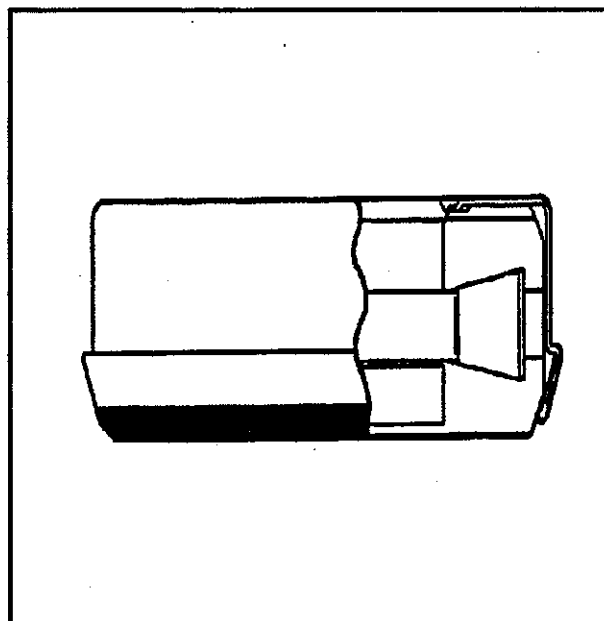


Figure 15—Sealed Thrust Bearing

2. Slide the thrust bearing between the lower face of the axle center and the lower steering knuckle yoke.
3. Align the steering knuckle yoke holes with the axle and thrust bearing holes.
4. Place a jack under the lower side of the steering knuckle yoke.
5. Raise the knuckle so that all clearance is taken up between the lower yoke, thrust bearing and lower face of the axle center end. (See Figure 16—Spindle Vertical End Play Check.)

Note

Shims are available in various thicknesses to provide a desired clearance of 0.005—0.015 inch (0.1270—0.3810 mm).

6. Check the clearance between the top face of the upper axle center end and the lower face of the upper knuckle pin boss.

7. Lubricate the king pin at the installation to ensure initial lubrication of parts.

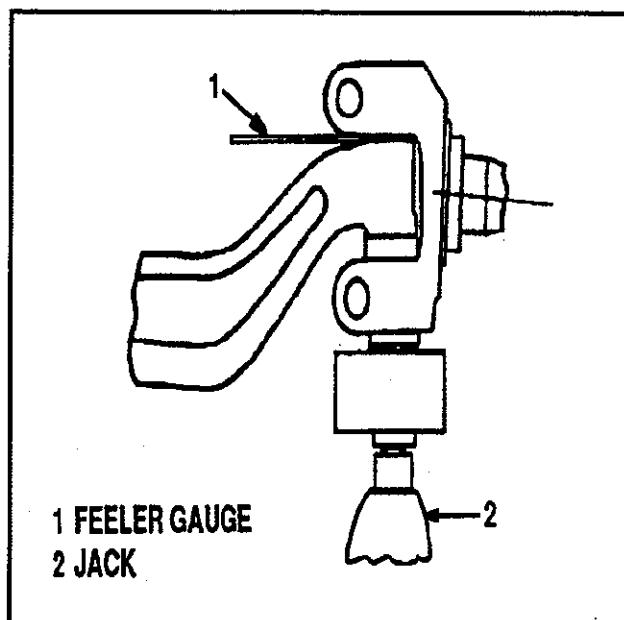


Figure 16—Spindle Vertical End Play Check

8. Install the king pin from the top. Make sure to align the notch with the draw key holes in the I-beam.

Note

The machined flats are located closer to the top of the king pin to allow installation of the thrust bearing, while maintaining correct vertical position of the king pin. The flats are also wider than the draw key, allowing slight adjustment. The king pin is vertically centered in the knuckle. This will allow both top and bottom king pin end caps to be installed without interference.

Note

The threaded draw keys will replace the staked draw keys as follows.

9. Install the draw keys. (See Figure 17—Draw Key Installation to Front of axle.)
10. Install the top draw key with the threaded end of the key to the front of the axle.

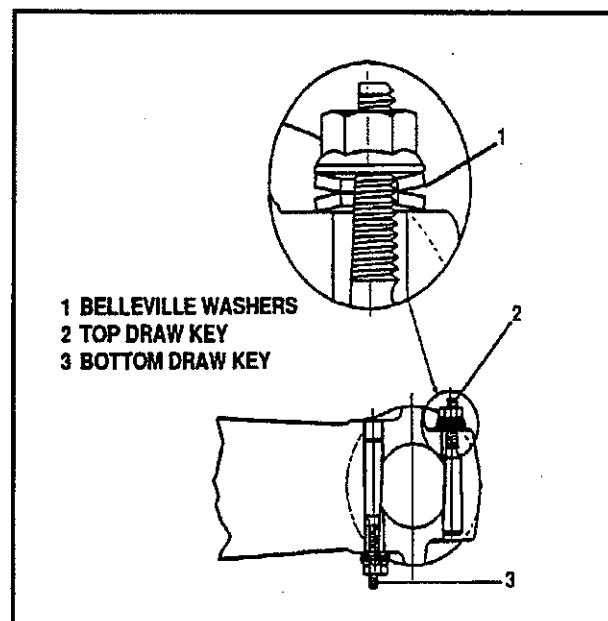


Figure 17—Draw Key Installation to Front of Axle

11. Seat the draw key, strike the unthreaded end of the key with the drift and a hammer.
12. Install Belleville washers.
13. Install the nut and tighten to specified torque. (Refer to Specifications, Torque and Special Tools.)
14. Install the bottom draw key with the threaded end to the rear of axle.
15. Repeat steps to finish the installation of the bottom draw key.

Note

Ensure the king pins will accept the lubricant. Lubricate the upper and lower king pin bushings through the cap grease fittings.

16. Install the king pin caps and O-ring.
17. Tighten the capscrews to specified torque. (Refer to Specifications, Torque and Special Tools.)
18. Reinstall the tie rod ends into the steering arms.
19. Tighten the nuts to the specified torque. (Refer to Specifications, Torque and Special Tools.)
20. Install the cotter pin.
21. Reinstall the brake components.

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22. Clean and inspect the front wheel bearings. (Refer to Group 030.2 Wheel End Components (Wheel Bearing Inspection).)
23. Install the bearings in the hub assembly using new seals. Refer to Group 030.2 (Remove and Replace Hub and Drum Assembly.).
24. Assemble the hub and bearings on the spindle. Remove and replace the hub and drum assembly. Install the wheel rims and tires.

Note

Check toe in by following original equipment manufacturer's guidelines for correct toe in adjustment.

25. Remove the vehicle from the floor stands.

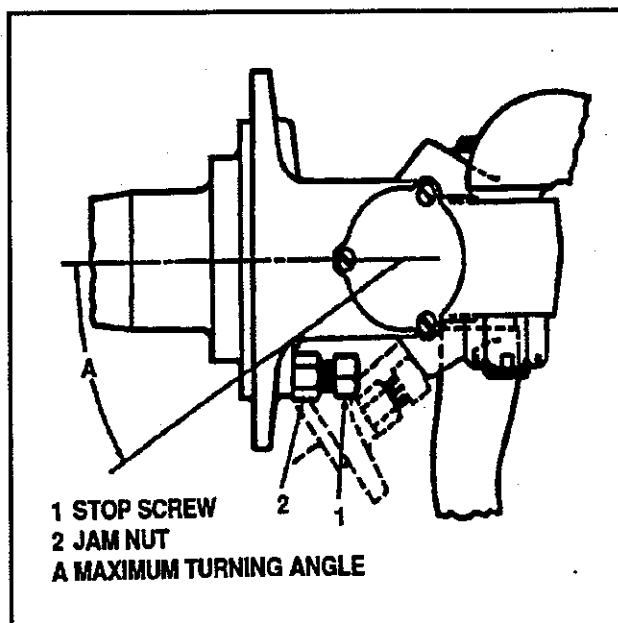


Figure 18—Steering Stop Adjustment

Steering Knuckle Stop Adjustment

Note

The steering arm stop screw should be adjusted to permit maximum turning angle. With power steering, the stop screw should be adjusted to ensure that the power steering unit would not override the axle stop.

1. Adjust the power steering systems and stop screws so that the power is cut off before contact with the axle stop screw. (See Figure 18—Steering Stop Adjustment.)
2. Adjust the axle steering stops to contact when the maximum turning angle of the specific axle is reached, and lock with jam nut.
3. Adjust the power steering unit to stop at $\frac{1}{2}$ to 1 units before the axle steering stops contact (maximum turning angle).

Note

Maximum turn angle specifications are to be checked at the inside wheel.

Periodically, check the adjustment of both the axle steering stops and the power steering unit. Correct if necessary.

For more detailed instructions to wheel stop adjustment, observe the original equipment manufacturer's guidelines for turning angles and front wheel alignment.

Tie Rod Inspection and Replacement

Note

Prior to performing a front wheel alignment, verify rear axle alignment in Group 020 (Rear Axle Alignment).

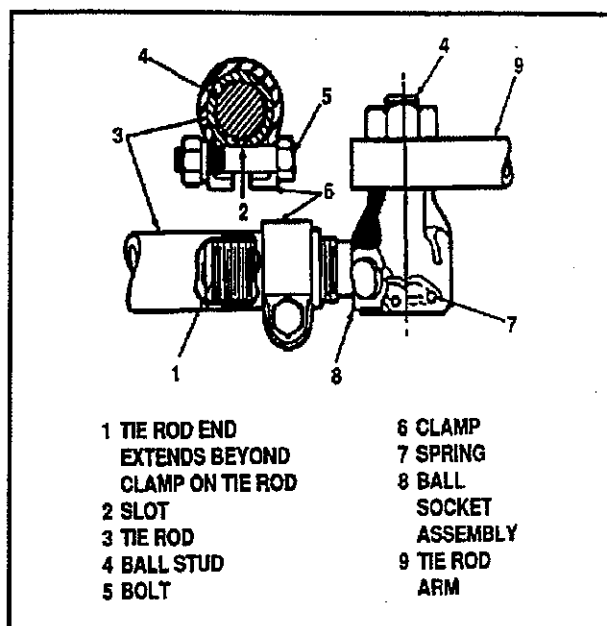


Figure 19—Typical Tie Rod

1. The tie rods are of a three piece construction, consisting of a tie rod and two rod end assemblies. (See Figure 19 - Typical Tie Rod.)
2. The ends are threaded to the rod and locked with clamp bolts.
3. Right and left threads are provided for toe in adjustment.
4. Tension on the ball stud in the rod ends is self-adjusting and requires no service other than periodic inspection.
5. Make sure that the ball studs are tight in the steering knuckle arms.
6. Fittings are provided for periodic lubrication on some types of rod ends. Where no fittings are used, the tie rods have been lubricated at assembly and no further lubrication is necessary.
7. If the tie rod taper joint is loose or the cotter pin is missing, remove and inspect.
8. Replace the tie rod arm/tie rod end if the contact surfaces are worn.

Replacement Criteria – Inspection

1. Wipe the seal clean carefully and examine for splits or tears that allow contaminants into the socket. (See Figure 20—Set Up Dial Indicator.) If the seal is acceptable, shake the tie rod assembly by hand only.

Note

If looseness is detected, set up a dial indicator. (See Figure 20—Set Up Dial Indicator.)

2. Jack up that side of the axle and measure movement at the tie rod end.
3. Move the tire in and out.

Caution

Prying on steering linkage can result in damage. A false indication of looseness can be created.

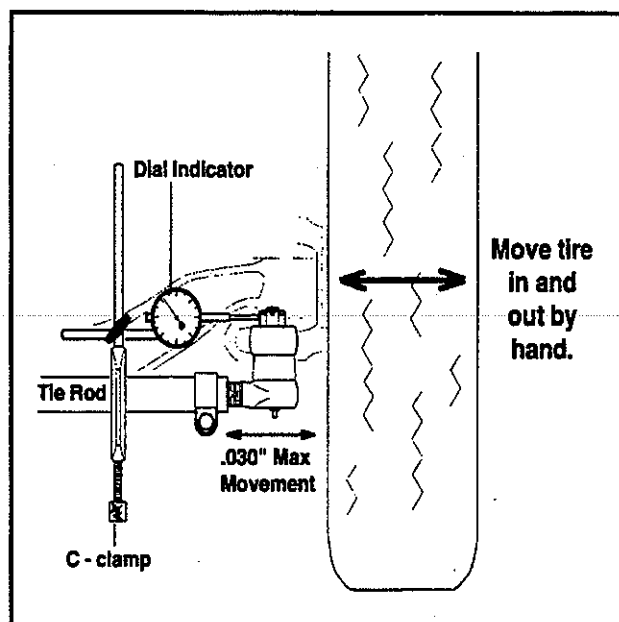


Figure 20—Set Up Dial Indicator

Note

C-clamp setup is recommended for testing the tie rod end for looseness.

4. The tie rod end should be replaced if a reading of 0.030 inch or more is taken. Replace the tie rod end at the next service interval.

Caution

Do not remove the tapered stud from the arm to check rotating torque. This may damage the seal or socket assembly. The full boot clamped seal can give a false rotational torque reading.

Note

At assembly, ensure that the slotted nut is tightened according to specification. (Refer to Specifications, Torque and Special Tools in this group).

If the cotter pin cannot be installed, tighten the nut to the next slot. Do not back off once minimum torque is reached.

When the tie rod linkage ends are replaced, they must be threaded into the tie rod or drag link sufficiently to allow positioning of the clamp over the threads if not welded on the ball joint end. Position the clamp bolt so it crosses the slot in the rod end.

Remove Tie Rod Assembly and Tie Rod Steering Arm

This procedure includes removing the tie rod ends from the tie rod. (Refer to the precautions in this section.)

1. Remove the cotter pins and the nuts that secure each tie rod to the tie rod arm.
2. Separate the tie rod assembly from the tie rod arms, using a tie rod separator tool. (See Figure 21—Separate Rod End From Rod Arm.)
3. Remove the cotter pin and the nut that fastens the tie rod arms in the knuckle.
4. Remove the tie rod arms from the knuckle.
5. Remove the key.

Note

With the stud nut assembled loosely on the stud, use a brass drift and hammer to tap on the end of the rod, avoiding damage to the threads.

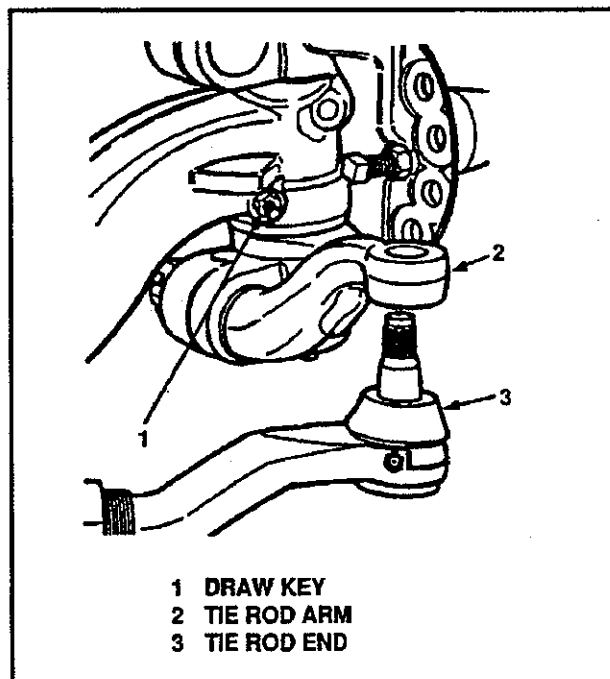


Figure 21—Separate Rod End From Rod Arm

Note

If necessary, use the following procedure to remove the tie rod ends from the rods.

6. Mark the position of each tie rod end in the tie rod tube.
7. Remove the clamp bolts and nut from the clamp on the tie rod.
8. Thread the tie rod ends out of the tube rod.

Install Tie Rod Steering Arm and Tie Rod Assembly

This procedure includes installing the tie rod ends to the tie rod. (See Figure 22—Proper Indexing of Tie Rod.)

1. Press the key in the slot in the steering arm.
2. Install the tie rod arm in the knuckle.
3. Install the nut on the tie rod arm.

4. Tighten to the specified value. (Refer to Specifications, Torque and Special Tools in this group).

Note

If necessary, tighten the nut until the holes are aligned. Do not loosen the nut to install the cotter pin. If the cotter pin can not be installed, tighten the nut to the next stop.

5. Install the cotter pins.

Note

The tie rod has right threads on one end and left threads on the other end. Make sure the ends are installed properly on the tube.

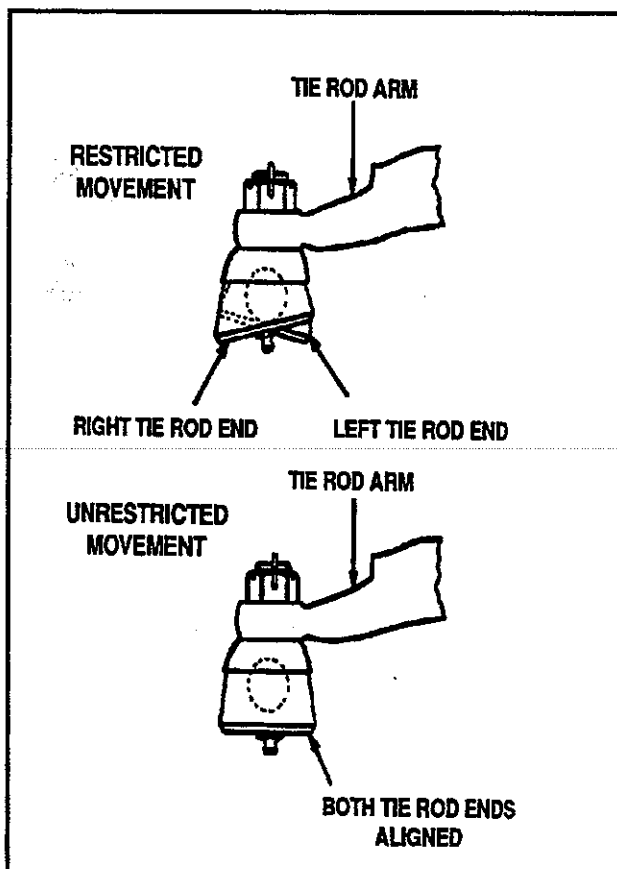


Figure 22—Proper Indexing of Tie Rods

Note

Proper indexing or alignment of the tie rod ends (the left tie rod end parallel to the right tie rod end) will eliminate restricted movement of the tie rod assembly. This restriction could cause premature failure of the tie rod end. Toe in should be checked and adjusted to vehicle specifications, if necessary.

6. When tie rod ends are replaced or toe in is adjusted, both ends must be threaded into the tie rod tube far enough to completely cover the slots in the tube. (See Figure 23—Types of Tie rod Clamps.)

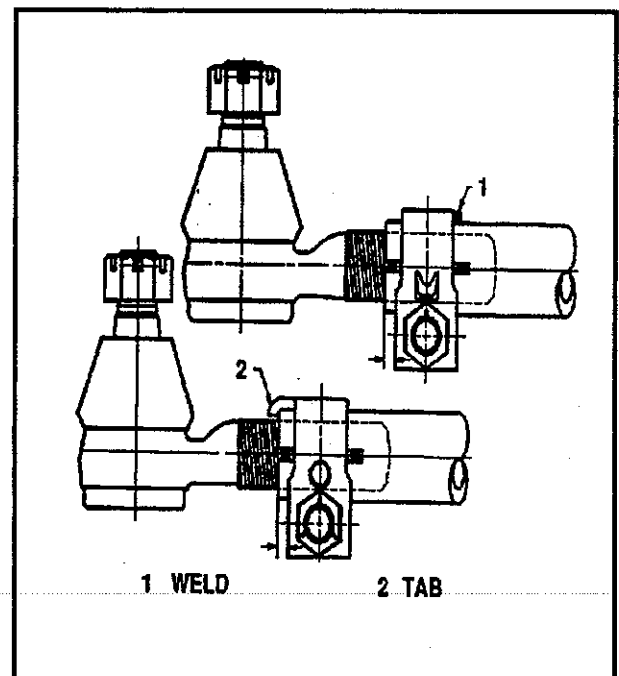


Figure 23—Types of Tie Rod Clamps

7. If removed, install the tie rod ends on the tie rod to the position marked during removal.
8. If the new tie rod ends are installed, thread the ends equally on the cross tube to the required length.
9. Install the nuts and the bolts in the clamps.
10. Tighten to the specified value. (Refer to Specifications, Torque and Special Tools in this group.)

LTC Front Axle

11. Assemble the tie rod ends into the tie rod steering arms.
12. Install the tie rod stud nuts.
13. Tighten to the specified value. (Refer to Specifications, Torque and Special Tools in this group).

Note

If necessary, tighten the nut until the holes are aligned. Do not loosen the nut to install the cotter pin.

14. Install the cotter pins.
15. Lubricate the tie rod ends.
16. Check toe in by following original equipment manufacturer's guidelines for correct toe in adjustment.
17. Some tie rod clamps will be free to rotate around the tie rod, allowing setting of toe in while avoiding contact of the axle.
18. There are two ways mechanical stops will position the clamps.
 - A spot weld on the tube limits one style of clamp.
 - A tab that will lock against the end of the tube limits the second style of clamp.

Caution

Check the bearing adjustment with a dial indicator with a magnetic base. Make sure the dial indicator is orientated parallel to the vehicle axle.

6. The bearing endplay should not exceed 0.010 inch (0.25 mm).
7. When the bearing adjustment is correct, the hub should rotate freely without excess play.
8. If the hub binds or shows excessive endplay, repeat the procedure.

Wheel Bearing Adjustment

Caution

Wheel bearings are to be adjusted. Observe original equipment manufacturer maintenance schedules or any unscheduled maintenance that requires disturbing proper adjustment of the wheel bearings.

1. After the hub and bearings are assembled in place on the spindle, install the retaining washer and adjusting nut.
2. Tighten the wheel bearing adjusting nut to 120 – 140 foot-pounds (163—190 N·m).
3. While rotating the hub to seat bearing, tighten the adjusting nut ½ turn.
4. Tighten the adjusting nut again to 50 foot-pounds (68 N·m), while rotating the hub tighten the nut ¼ turn.
5. Install the cotter pin.

LTC Rear Axle

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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions refer to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Special Safety (Non-Asbestos Fiber) Notification

Effects of some non-asbestos fibers have not been determined. Current OSHA Regulations discuss exposure levels from a few components.

Warning

Breathing brake lining dust is hazardous to your health and may cause respiratory or other bodily harm.

Note

Regulations issued by OSHA regarding testing can be found in the Federal Code 29 Regulations 1910.001. In addition to adhering to the following tips, individuals should consult and comply with appropriate OSHA standards.

1. Compressed air or dry brushing must never be used for cleaning brake assemblies.
2. People working on or around brakes must take precaution not to inhale brake lining dust.

3. Work on axles or brakes in a well-ventilated area. Respirators approved by the Mine Safety and Health Administration (MSHA) or National Institute for Occupational Safety and Health (NIOSH) should be worn at all times.
4. People working on or around brake linings should wash before eating, drinking or smoking. Be sure to shower after performing brake lining work.

Introduction

Blue Bird Corporation assumes sole responsibility to ensure that information provided here is accurate to the best of its knowledge at the time of printing. In keeping with its policy of continual product improvement, Blue Bird reserves the right to change product information without notice and without obligation.

Some information contained in this section has been re-published from the following publications:

Spicer® Heavy Axle and Brake Division
Spicer® Gold Series Rear Axles Service Manual,
©Spicer/Dana, Form #SHABD 1191-1 Rev 497.

Description of Operation

These procedures were documented using a Blue Bird LTC with a Cummins M11 ISM engine and an Allison B500 Transmission.

These maintenance and rebuild procedures are written for the Spicer J and W230 rear drive axle assemblies.

The Spicer Heavy Duty Single Reduction Rear Drive Axle is a full floating hypoid gear carrier assembly in one piece HSLA steel axle housing.

The hypoid pinion is straddle mounted, having two tapered roller bearings ahead of the pinion teeth for forward and rear thrust. A third bearing is located behind the pinion teeth for radial load.

The differential uses four precision forged pinion mate gears, a forged cross, and precision forged side gears.

A fresh supply of lube oil is delivered to the differential assembly by Spicer positive flow lube system.

Axle shafts and drive pinion splines are rolled involute type.

Service Parts and Axle Identification

Genuine Spicer® Service Parts

See Figure 1—Axle Identification

See Figure 2—Gear Set Identification

See Figure 3—Rear Axle Assembly

Note

All axle models with the "SA" designation are now designated as "SG" axles.

Should an axle assembly require replacement component parts, it is recommended that Spicer® Heavy Axle Service Parts be used. Spicer® Heavy Axle Service Parts are manufactured under the same rigid specification, as are original equipment axle components.

This assures the customer who uses genuine Spicer® Service Parts, maximum reliability for a Spicer® Heavy Axle assembly. They may be obtained through your vehicle manufacturer. The use of parts other than Spicer® Service Parts may cause premature component failure and may void the warranty.

The items included in this manual are currently being offered as service parts at the time of printing. The

part numbers and illustrations are provided specifically for reference purposes only.

Special Tools

Special service tools are available from:

OTC Division, Service Tools
655 Eisenhower Drive
Owatonna, MN 55060
Telephone: 1-800-533-0492
Fax Number: 1-800-283-8665

The following is a list of tools needed to service the front axles in this manual. These tool numbers are from OTC Tool Division. Dana makes no warranty or representation of these tools. (See Table 1—Service Tools.)

Measurement, Torque and Lubrication

See Table 2—Diameter Specifications

See Table 3—Torque Values

See Table 4—Lubrication Schedule

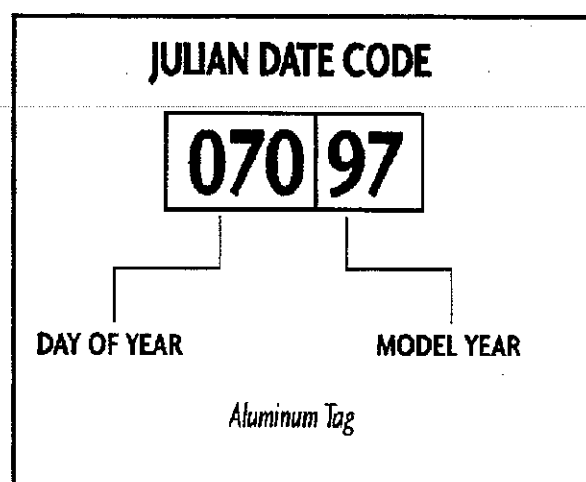
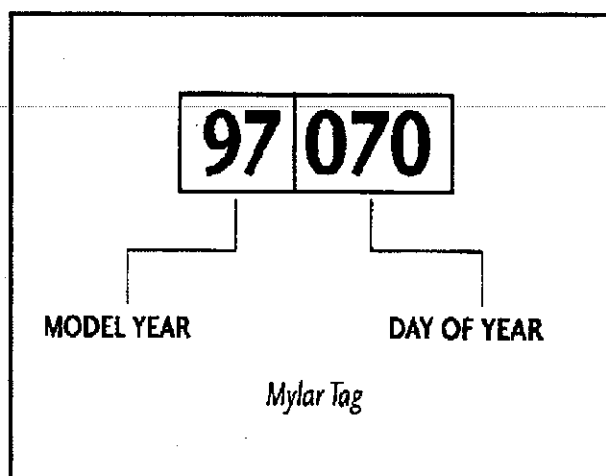


Figure 1—Axle Identification

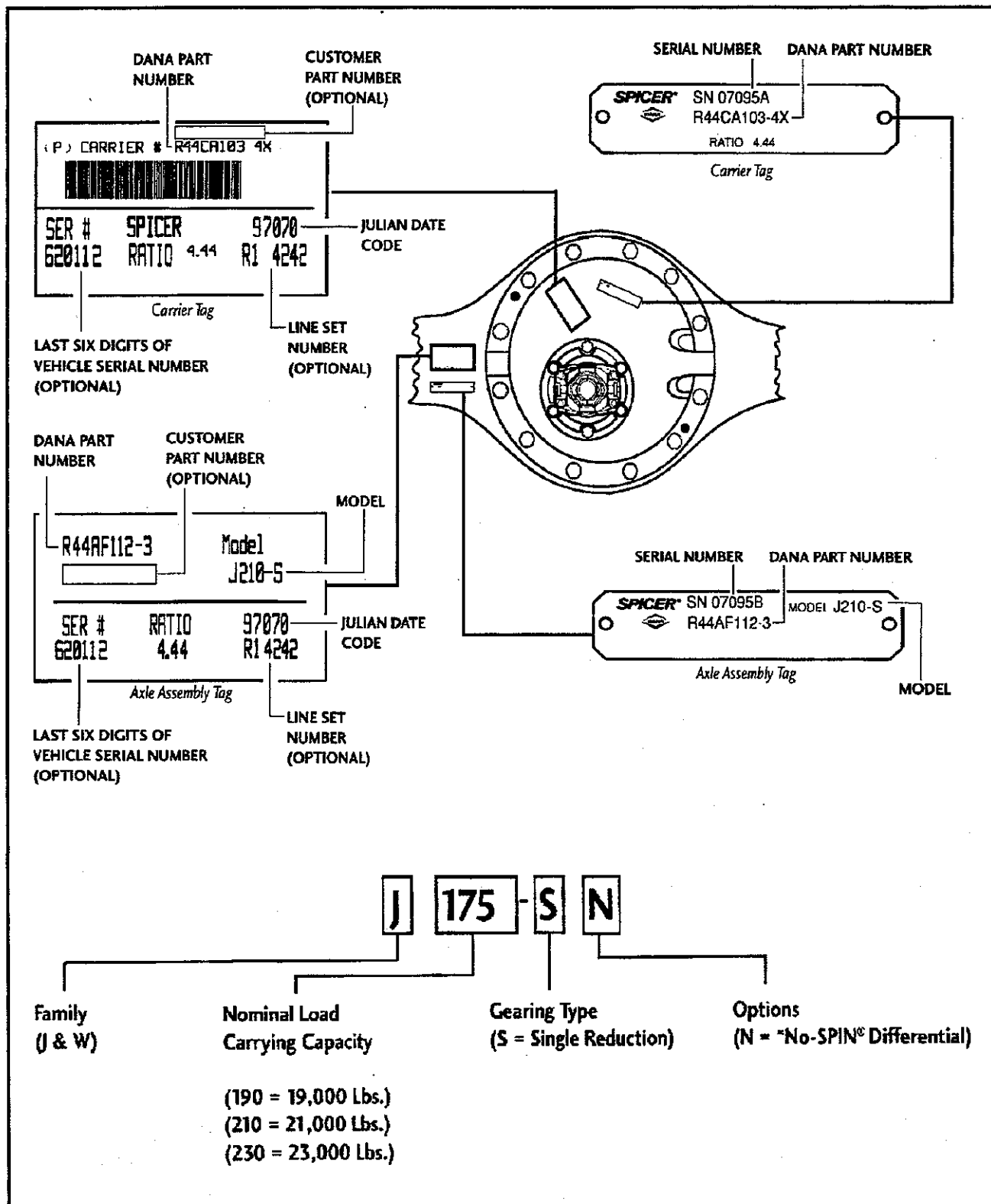


Figure 2—Gear Set Identification

Manufacturer's Date – Date gear set was made. (See Figure 3—Identification Location.)

Spicer Trademark – Company logo and location of manufacturing facility.

Part number 597000C0 of pinion, Typical.

Tooth Combination (i.e. 41-11) – Indicates the pinion has 11 teeth and the ring gear has 41 teeth that result in a 3.73:1 ratio. (See Figure 3—Identification Location.)

Match Set Number – Spicer ring gears and pinions are manufactured as matched sets. Both ring gear and pinion is marked with a corresponding number (i.e. 260) that identifies the set as a matched set.

Match Set Number – Spicer ring gears and pinions are manufactured as matched sets. Both ring gear and pinion are marked with a corresponding number (i.e. 260) that identifies the set as a matched set.

A gear set that does not have the same match set numbers should not be run together. If either ring gear or pinion requires replacement, a new matched set must be used.

Backlash Etch – Indicates backlash setting for assembly.

Pinion Etch – Indicator for proper pinion position shim stack up. (See Figure 3—Identification Location.)

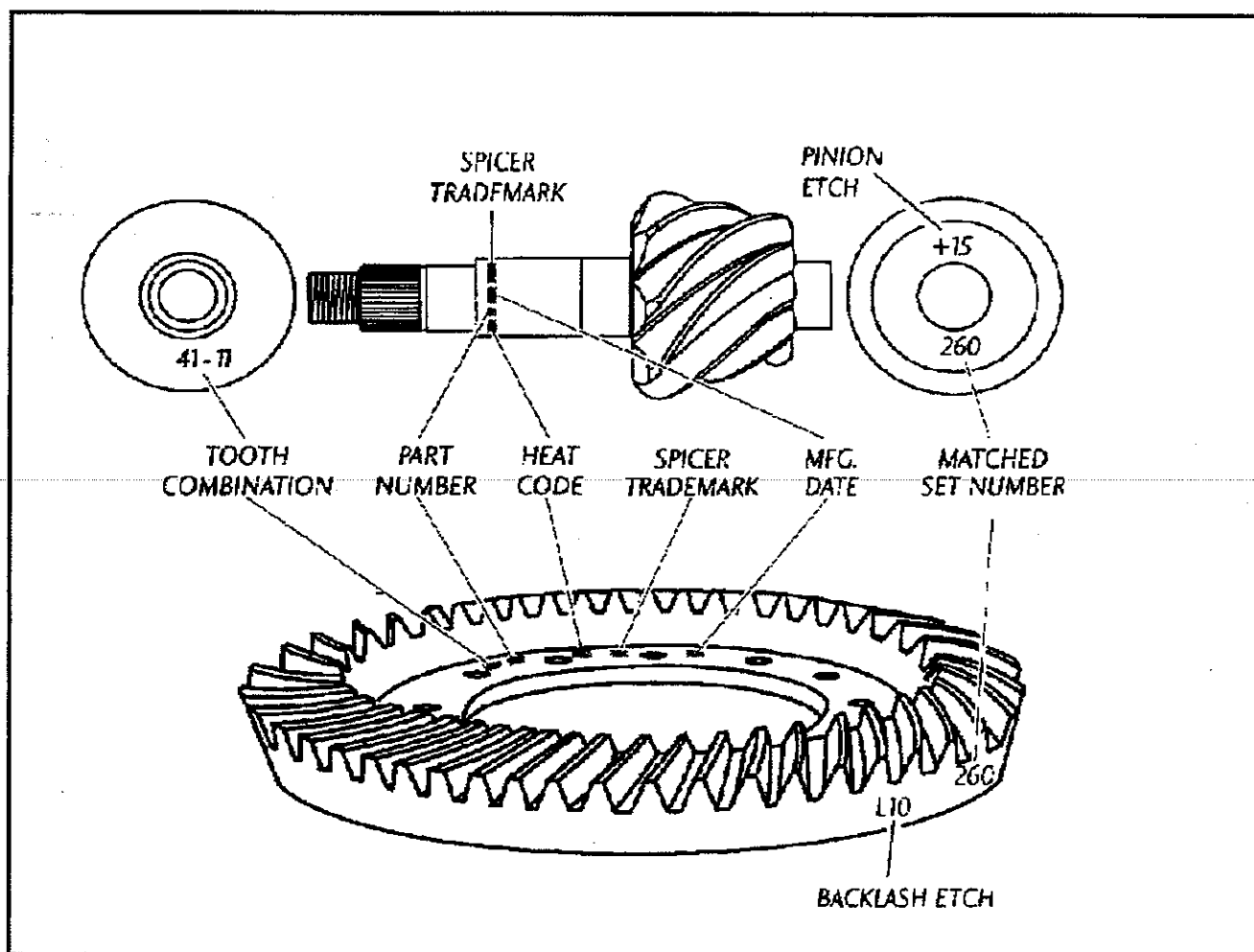


Figure 3—Identification Locations

Axle Lubricant Recommendations

To ensure proper lubrication and operating temperature, correct lubricants and lubricant levels must be obtained.

Service

Recommended lubricant change intervals are dependent upon the application and operating environment.

Submersion

If the carrier housing is submerged in water, particularly if over the vent or breather, drain lubricant and inspect internal parts for contamination. Assemble the carrier to the housing and refill with specified gear lubricant.

Recommended Gear Lubricants

Hypoid gear lubricants that meet or exceed military specification. Type MIL-L-2105D and API GL-5 are used in Spicer Medium and Heavy Duty Drive Axles. (See Figure 4—Lubricants and Temperature.)

Axle Lubricant Refill

Fill the axle assembly to the bottom of housing fill hole at each overhaul. Jack axle up six inches and hold for one minute. That procedure will allow adequate lubricate to flow into the wheel ends. Lower vehicle back to level and on the floor. Wait ten minutes to allow lube to normalize. Check and refill assembly to bottom of fill hole.

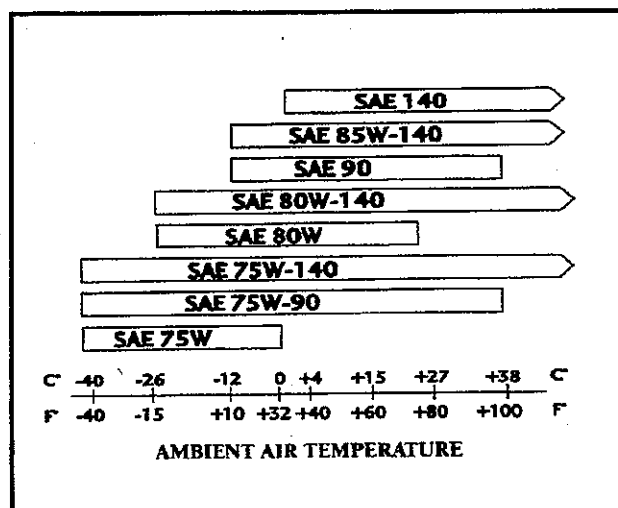


Figure 4—Lubricants and Temperature

Caution

Axle assemblies built before April 28, 1997 will require these components in Pinion-up configuration. Axle assemblies built after April 28, 1997 will use Standard Pinion Bearing Cage without Pinion-up.

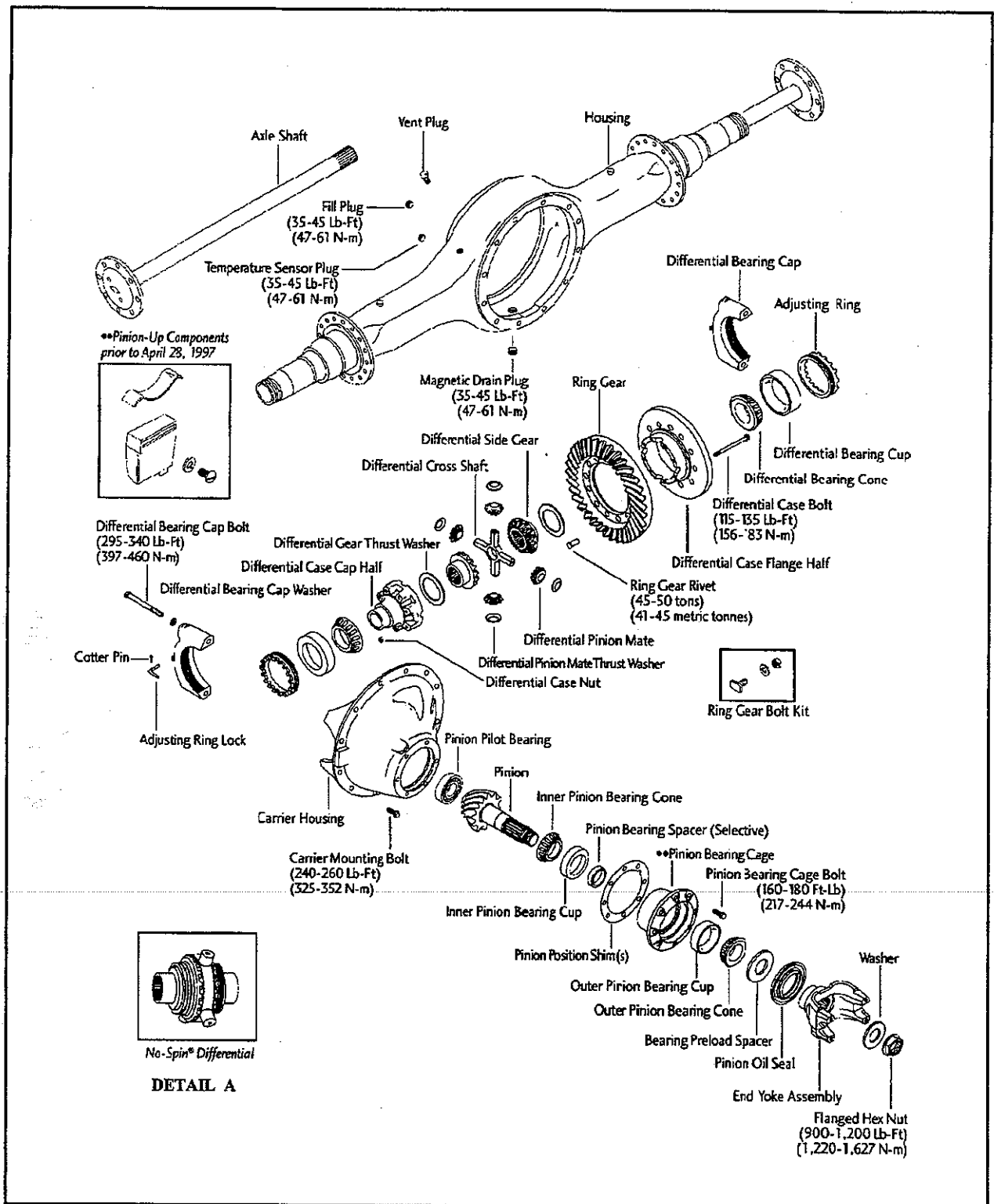


Figure 5—Rear Axle Assembly

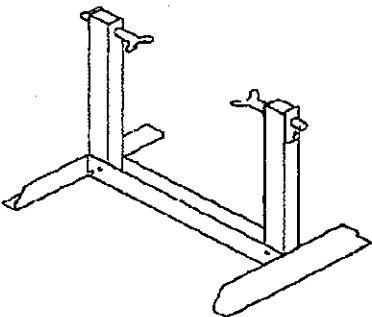
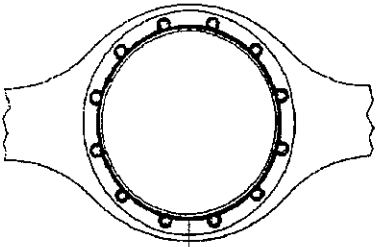
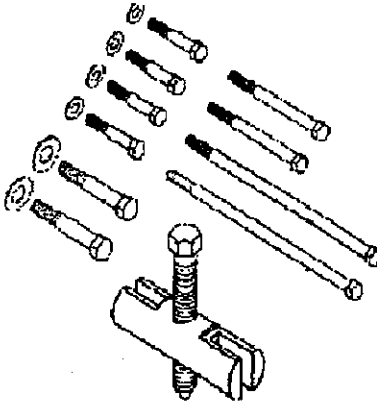
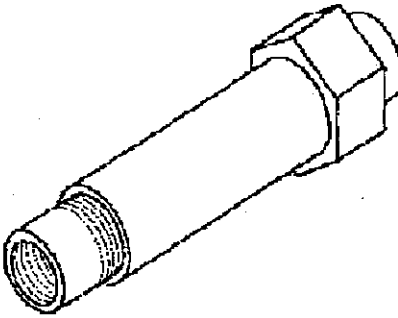
Order Number	Illustration	Description
DST 1001		Carrier Stand
DST 1002 DST 1003 DST 1004 DST 1005	 Loctite #518 Gasket Eliminator	Torque Multipliers Maximum 1,000 ft-lbs. Maximum 2,000 ft-lbs. Maximum 4,000 ft-lbs. Maximum 12,000 ft-lbs.
DST 1006		Yoke Remover, Bar Type
DST 1009		Installer, Differential 1 1/4 inches (31.75 mm)–12

Table 1—Service Tools

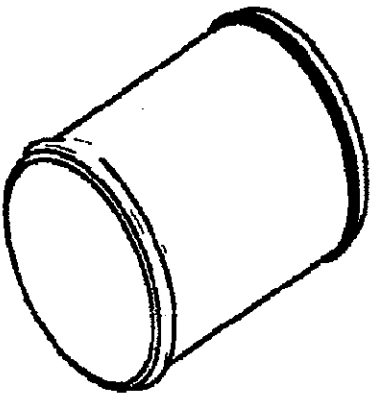
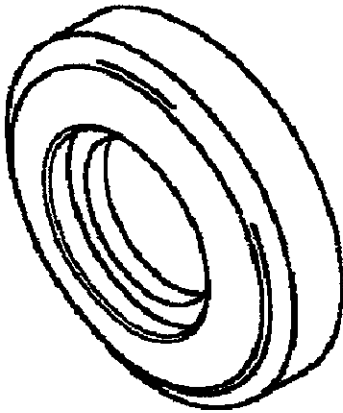
Order Number	Illustration	Description
DST 1000-1		Seal Installation Tube Handle
DST 1000-2		Pinion Seal Installer

Table 1—Service Tools (continued)

Hex Head Fasteners					
Position	Model	Thread	Grade	Foot-Pounds	Newton Meters
Flanged Hex Nut	All	1-3/4 - 12	8	900 - 1,200	1,220 - 1,627
Pinion Bearing Cage Bolts	---	9/16 - 12	8	115 - 135	155 - 183
Differential Bearing Cap Bolts	All	3/4 - 10	8	275 - 320	370 - 435
Differential Case Bolts	---	9/16 - 18	8	115 - 135	155 - 183
Carrier Mounting Bolts	All	5/8 - 11	8	160 - 185	217 - 250

Table 2—Axle Torque Specifications

Flange Head Fasteners					
Position	Model	Thread	Grade	Foot-Pounds	Newton Meters
Flanged Hex Nut	All	1-3/4 - 12	8	900 - 1,200	1,220 - 1,627
Pinion Bearing Cage Bolts	J/W	9/16 - 12	8	160 - 180	217 - 248
Differential Bearing Cap Bolts	All	3/4 - 10	8	390 - 410	536 - 563
Differential Case Bolts	J/W	9/16 - 18	8	115 - 135	155 - 183
Carrier Mounting Bolts	All	5/8 - 11	8	240 - 260	330 - 358
Fill and Magnetic Drain Plugs	All	3/4 - 14	8	35 - 45	47 - 61
Axle Flange to Wheel Hub Nuts	J190-W230	3/4 - 16	5Nylok	217 - 240	290 - 325
Axle Flange to Wheel Hub Nuts	J190-W230	3/4 - 16	Steel	275 - 320	370 - 435

Table 2—Axle Torque Specifications (continued)

Note

Pinion bearing preload is established before installation of pinion seal.

Capacity will vary depending on the housing angle in each vehicle. Fill to lower edge of fill hole in rear of axle housing.

Axle Specifications			
Item	Model	U.S.	Metrics
Pinion Bearing Preload	---	---	---
Pull Scale	J/W	3 to 9 foot-pounds	1.4 to 4.0 Kg
Torque Wrench	---	10 to 30 inch-Pounds	1.1 to 3.4 N·m
Differential	---	---	---
Ring Gear to Pinion Backlash	W	0.006 to 0.012 inch	0.23 to 0.33 mm
Ring Gear Rivet Pressure	W	50 tons	45 tonnes
Lube Capacity (Approx.)	W	34.5 pints	16.5 liters
Pinion Nominal Dimension	W	4.2845 inches	108.826 mm

Table 2—Axle Torque Specification (continued)

Differential From Axle Housing Removal

Note

Steam clean axle assembly.

1. Block wheels.
2. Remove magnetic drain plug and drain lubricant.

Note

If end yoke and/or seal are to be replaced, loosen yoke nut.

3. Disconnect drive shaft at the rear U-joint.

4. Remove axle shaft stud nuts and lock washer, or cone locks if used.
5. Remove axle shafts. Discard gasket.
6. Support the differential carrier assembly on a roller jack.
7. Secure as necessary to prevent carrier from falling off the jack.
8. Loosen carrier-to-housing mounting bolts.

Note

The two top bolts should keep the carrier from falling.

9. Remove all bolts except the top two.

10. Install two ½ (12.7 mm)-13 bolts into threaded holes in carrier housing flange. (See Figure 6—Carrier Housing Flange.)
11. Mount carrier assembly in a rebuild stand.

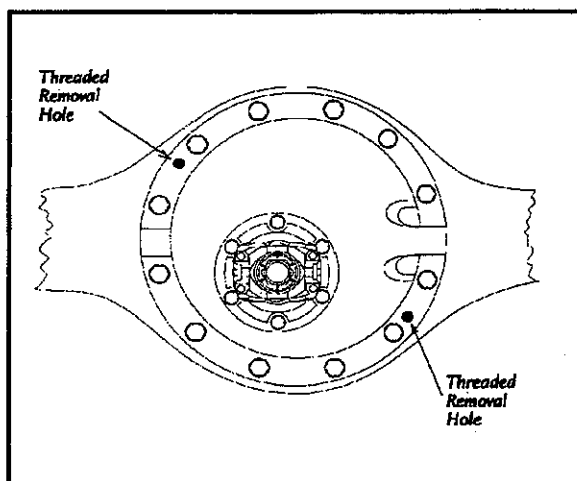


Figure 6—Carrier Housing Flange

12. Remove adjusting ring locks from bearing caps.
13. Match mark one differential bearing cap and leg with center punch. (See Figure 7—Match Mark.)

Caution

If either gear is damaged, replace as part of a matched set.

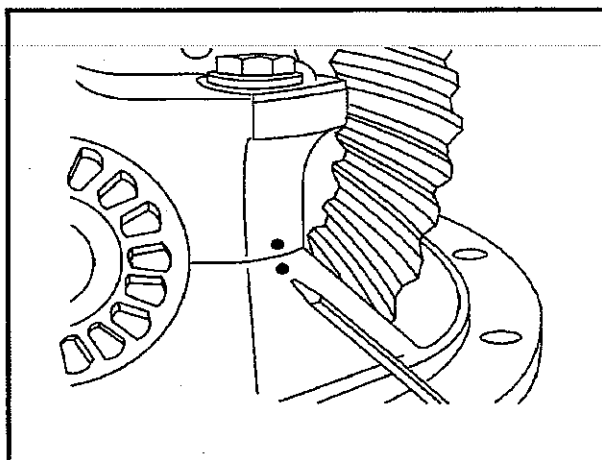


Figure 7—Match Mark

14. Loosen adjusting rings to relieve bearing preload.
15. Remove four bearing cap retainer bolts.
16. Remove bearing Caps.
17. Remove adjusting rings.
18. Lift the ring gear and differential subassembly out of the carrier carefully.
19. Match mark differential case halves with punch for correct alignment for re-assembly. (See Figure 8—Match Mark Differential Case.)

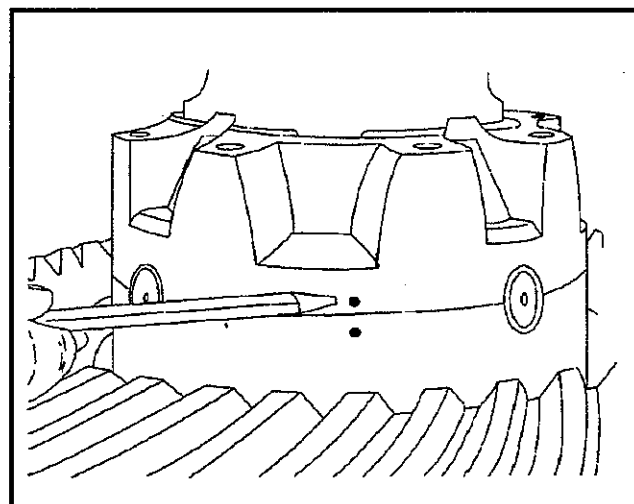


Figure 8—Match Mark Differential Case

20. Remove the differential case bolts and lift off differential case cap half. (See Figure 9—Differential Assembly.)

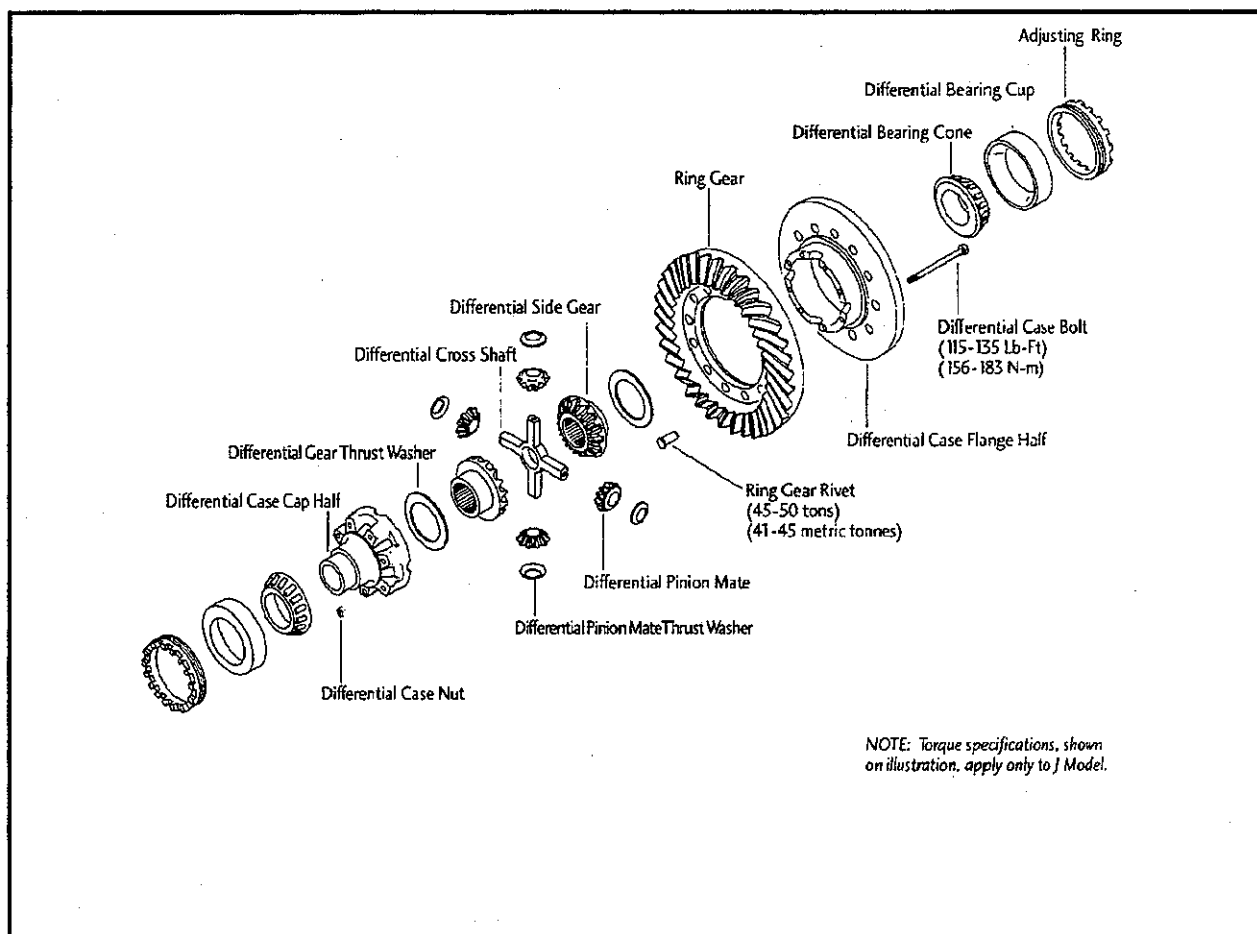


Figure 9—Differential Assembly

21. Lift out differential cross shaft, differential pinion mates, and differential pinion mate thrust washers.
22. Remove second differential side gear and differential side gear thrust washer.

Note

If differential bearing cones are to be replaced, remove old bearings using a suitable puller. All gears are to be replaced in sets.

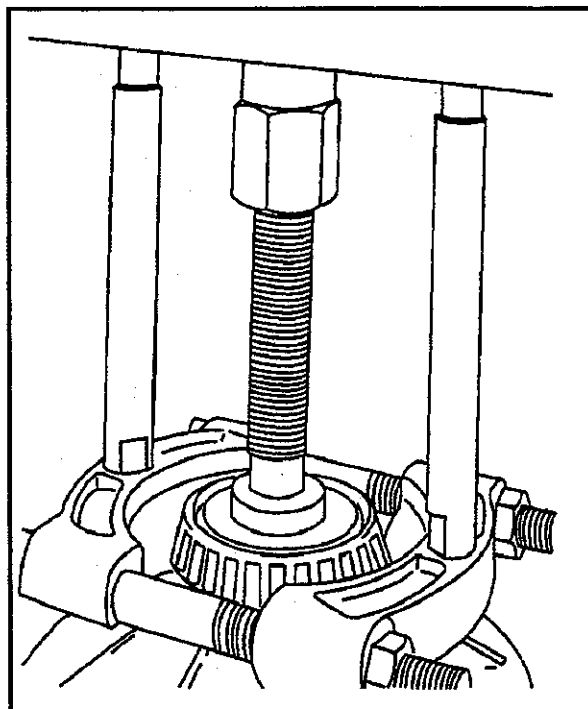


Figure 10—Removing Bearing

23. Inspect all parts including thrust washers, and the machined surfaces of the case halves.
(See Figure 10—Removing Bearing)

Caution

Always use a soft hammer or plastic head hammer to strike punch parts. Do not use a chisel to remove rivet heads, damage to differential case may result.

24. Center punch each rivet head carefully with a 9/16-inch (14.29 mm) drill bit.
25. Drill through rivet head. (See Figure 12—Incorrect Procedure for Rivet Removal.)
26. Remove pinion bearing cage mounting bolts.
(See Figure 13—Pinion Assembly.)

Note

If removing pinion assembly from carrier is difficult, place a brass drift on inner end of pinion and tap lightly.

Note

Retain shims for possible use during re-assembly.

27. Remove pinion and cage assembly from carrier housing. Keep yoke stationary, remove flanged hex nut and washer.

Note

*Torque specifications apply to the J model.
Use of torque multiplier may be necessary.*

28. Remove the end yoke use a suitable puller.
(See Figure 14—Removing End Yoke.)
29. Remove pinion from cage assembly.
30. Remove bearing preload spacer and retain for use in re-assembly.
31. Remove old pinion seal and discard.

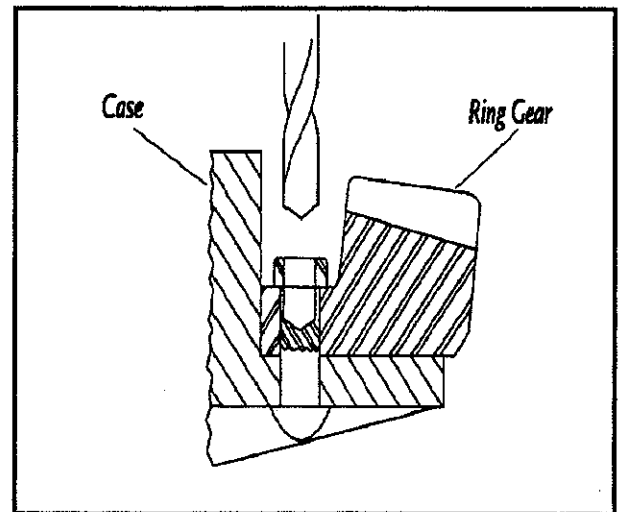


Figure 11—Procedure for Rivet Removal

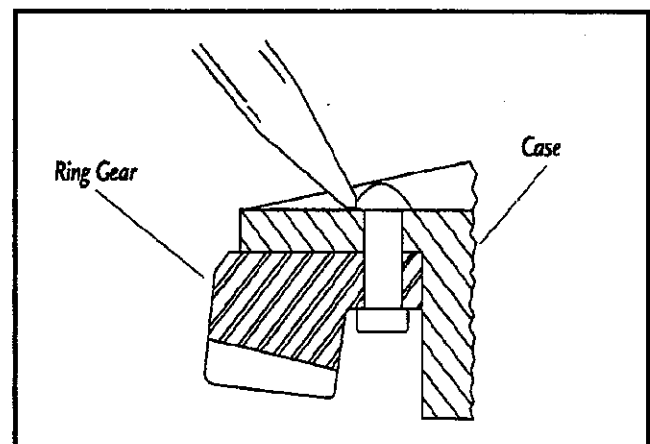


Figure 12—Incorrect Procedure for Rivet Removal

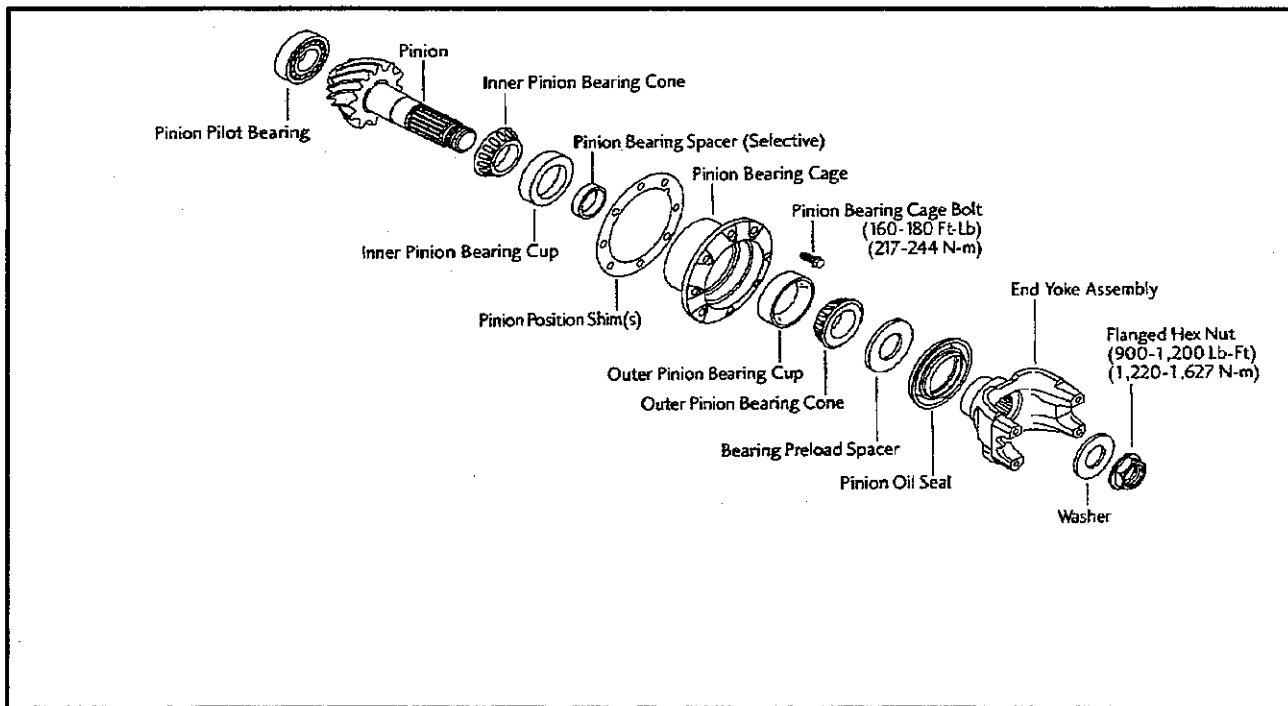


Figure 13—Pinion Assembly

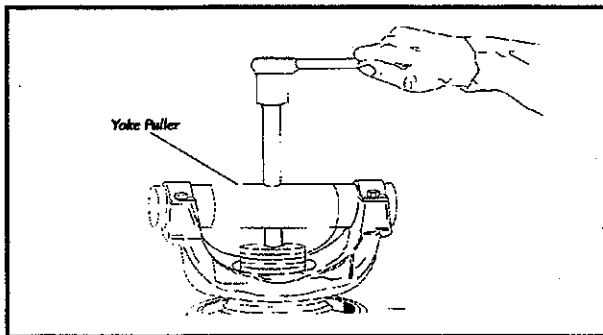


Figure 14—Removing End yoke

Caution

Do not damage bearing bore.

32. Lift out outer pinion bearing cone.
33. Remove inner pinion bearing cap. Use a suitable adapter, press, or puller.
34. Remove outer pinion bearing cap. Use a suitable adapter, press or puller.
35. Remove pinion pilot bearing from end of pinion.
36. Remove inner pinion bearing cone from pinion.

Cleaning

Warning

Solvent is toxic to the skin, eyes and respiratory tract. Skin and eye protection is required. Use in a well-ventilated area.

1. Clean parts with emulsion cleaners or petroleum base cleaning solvent.

Caution

Make sure that all inner surfaces of axle housing are cleaned before re-assembly.

1. Clean off all old gasket material from surfaces.
2. Use a clean, lint free towel to dry components after cleaning.
3. After drying, parts should be coated with a light coat of lubricant or rust inhibitor to prevent corrosion. If parts are to be stored for a long period, wrap parts in wax paper.

Inspection

Bearing surfaces should be inspected for pitting, excessive wear or overheating. (See Figure 15—Bearing Inspection Areas.)

1. Inspect thrust washers for scoring and cracking. (See Figure 16—Thruster Inspection Areas.)

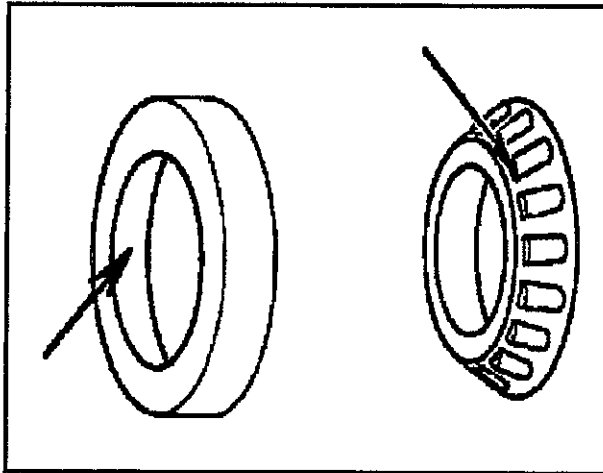


Figure 15—Bearing Inspection Areas

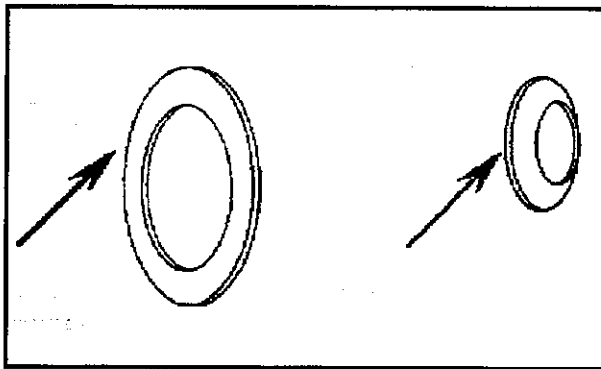


Figure 16—Thruster Inspection Areas.

2. Inspect gears for excessive wear or damage. Replace gears that are pitting, scored, broken or worn. (See Figure 17—Gear Inspection Area.)
3. Inspect shafts for nicks or scoring. (See Figure 18—Shaft Inspection Areas.)
4. Inspect all splines for excessive wear, distortion from twisting and cracking. (See Figure 19—Spline Inspection Areas.)
5. Inspect housing for stripped or damaged threads and bending fatigue. (See Figure 20—Housing Inspection Areas.)

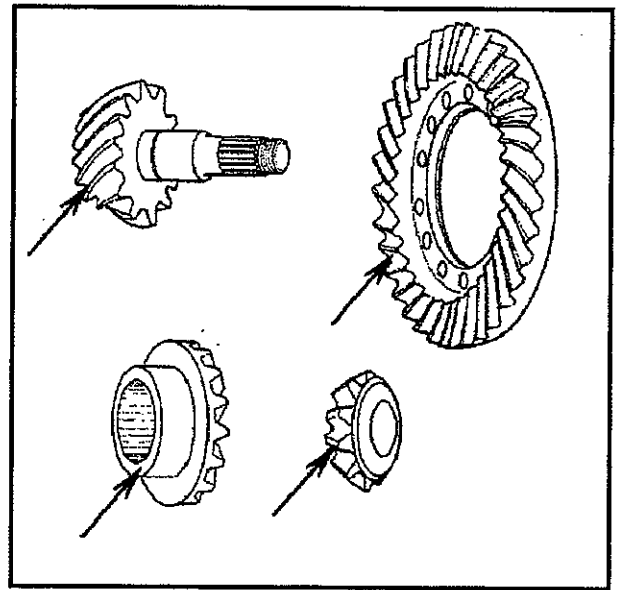


Figure 17—Gear Inspection Areas

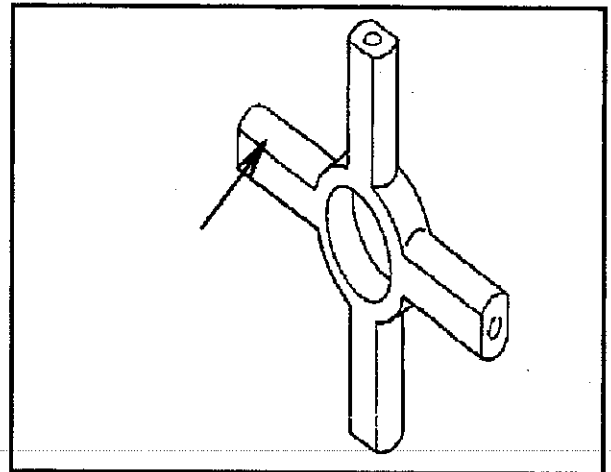


Figure 18—Shafts Inspection Areas

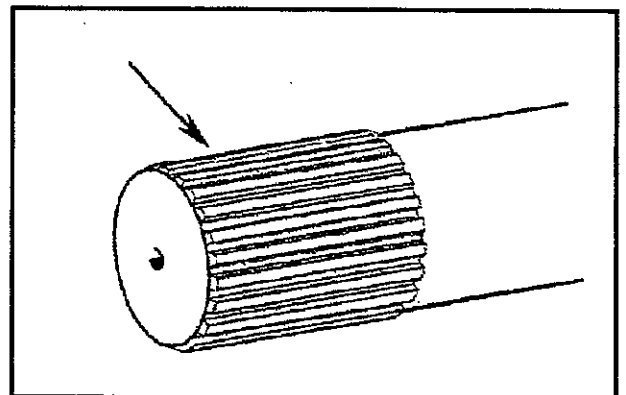


Figure 19—Spline Inspection Areas

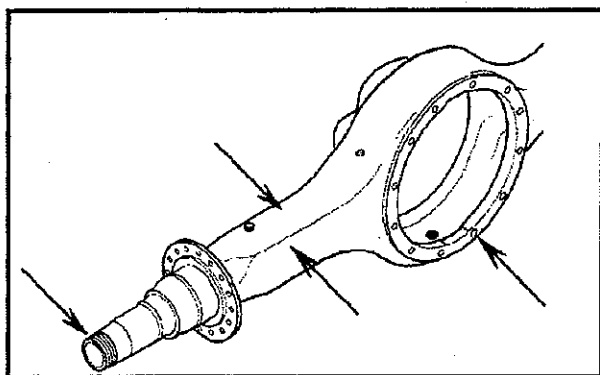


Figure 20—Housing Inspection Areas.

Pinion Assembly

1. Press inner pinion bearing cone into pinion.
(See Figure 21—Pinion Assembly.)
2. Press pinion pilot bearing onto nose of pinion.
3. Stake nose of pinion in nine places, using a center punch. (See Figure 22—Stake Nose of Pinion.)

4. Install inner pinion bearing cap into pinion bearing cage.
5. Install outer pinion bearing cap into bearing pinion cage.
6. Measure to ensure bearing caps are completely seated in bearing bores. Use feeler gage or shim stock 0.0015 inch (0.0381 mm).
7. Place pinion bearing spacer on to pinion.
8. Install outer pinion bearing cone and washer on to pinion.
9. Install inner pinion bearing cone and washer on to pinion.
10. Inspect end yoke or flange for grooves in seal surface. If grooves can be detected by fingernail, replace end yoke must be repaired with a CR approved repair sleeve.

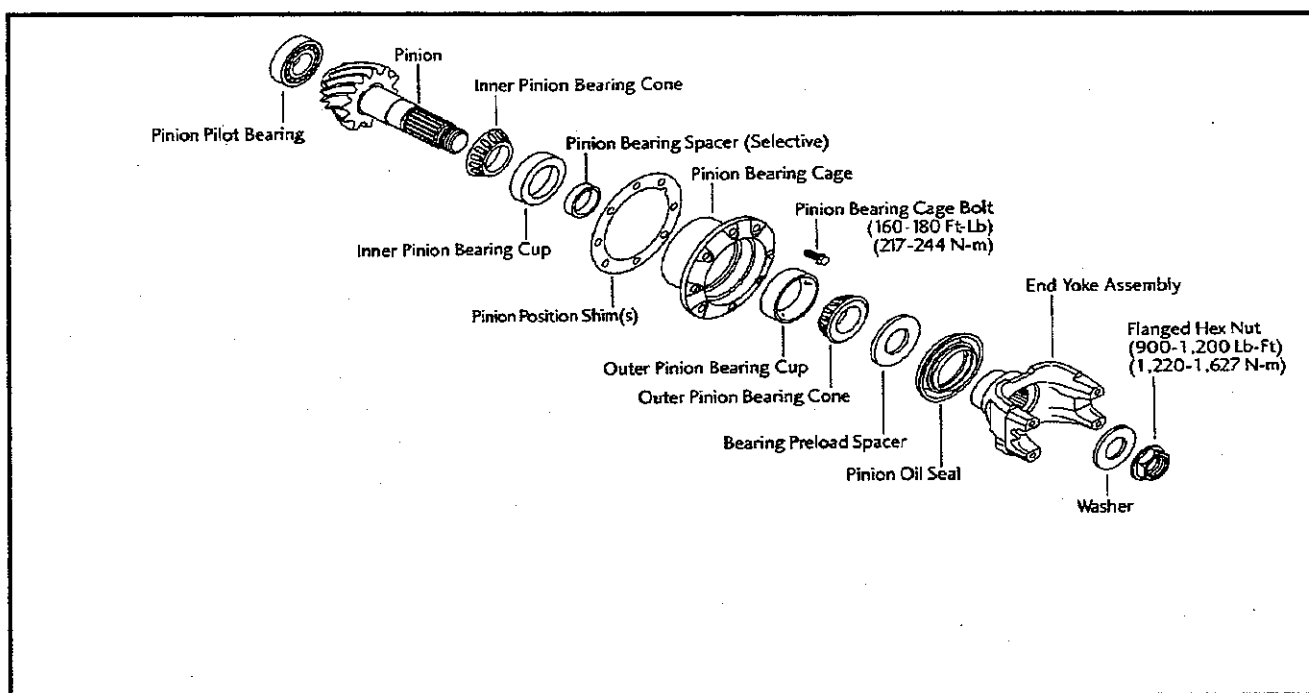


Figure 21—Pinion Assembly

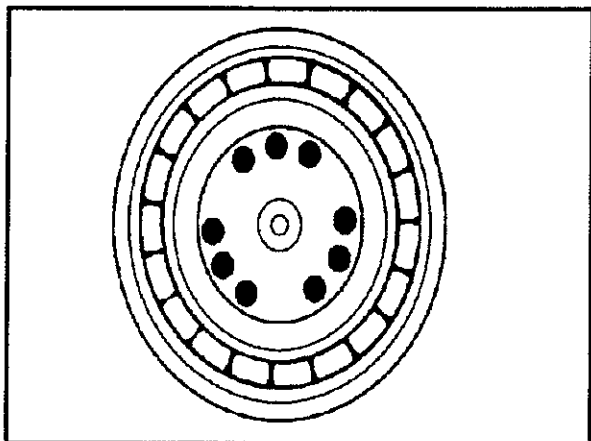


Figure 22—Stake Nose of Pinion

11. Install end yoke on to pinion without seal to allow proper setting of bearing preload. (See Figure 23—Install End Yoke.)
12. Torque pinion nut to 900 to 1,200 foot-pounds, 1,220 to 1627 N•m. (See Figure 24—Measure Preload.)
13. Attach one end of cord to a bolthole in pinion-bearing cage; attach other end of cord to the spring scale.
14. Rotate pinion bearing cage by pulling scale.
15. Read scale during fourth revolution. Scale reading must be between 3 to 9 pounds (1.4 to 4.1 kilograms). (See Figure 24—Measure preload.)
16. Measure torque to rotate with an inch-pound torque wrench.

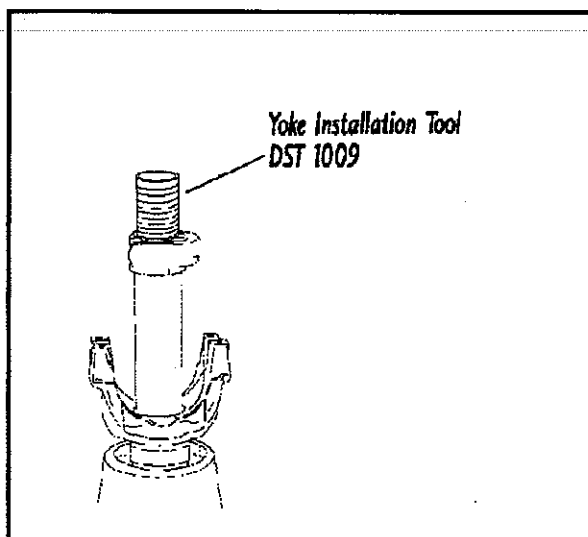


Figure 23—Install End Yoke

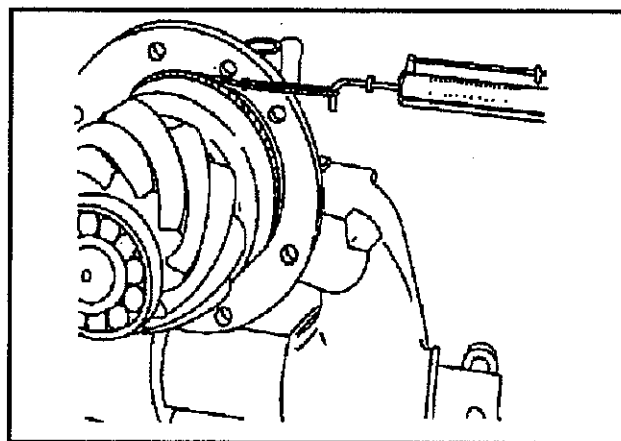


Figure 24—Measure Preload

Note

To measure preload with spring scale, clamp the end yoke horizontally in a soft-jaw vise.

Note

If bearing preload does not load within allowed limits, preload can be increased by using a thinner spacer and decrease by using a thicker spacer.

A 0.001 inch (0.0254 mm) change in preload spacer thickness will change torque to rotate approximately 30 inch-pounds (N•m).

Torque measurements should be taken every fourth revolution and should be between 10 to 30-inch-pounds (1.12 to 3.39 N•m) of bearing preload. (See Figure 25—Measure Torque.)

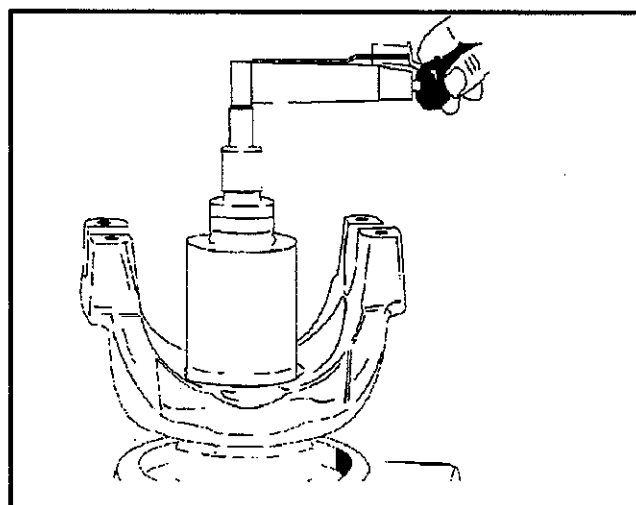


Figure 25—Measure Torque

Note

Always measure each spacer before assembly to ensure correct thickness.

Closer adjustment can be made by sanding the next thicker spacer to desired thickness using emery cloth on a flat surface.

Caution

Wash spacer thoroughly of emery cuttings before installing on pinion. Spicer® recommends that new torque prevailing nuts be used.

17. Apply Locite number 680 (green) to threads.
18. Install new pinion oil seal.
19. Apply a small amount of light grease to seal lip before installing yoke.

Differential Assembly

Caution

Ring Gear and Pinion must be replaced as a matched set only.

20. If ring gear was removed from the differential case, re-install ring gear. (See Figure 26—Differential Assembly.)
21. Bolt ring gear to differential case in two places, 180° apart, before compressing rivet.
22. Compress rivet using hydraulic or mechanical press and riveting fixture.
23. Compress to 45 to 50 tons (41 to 45 metric tons).

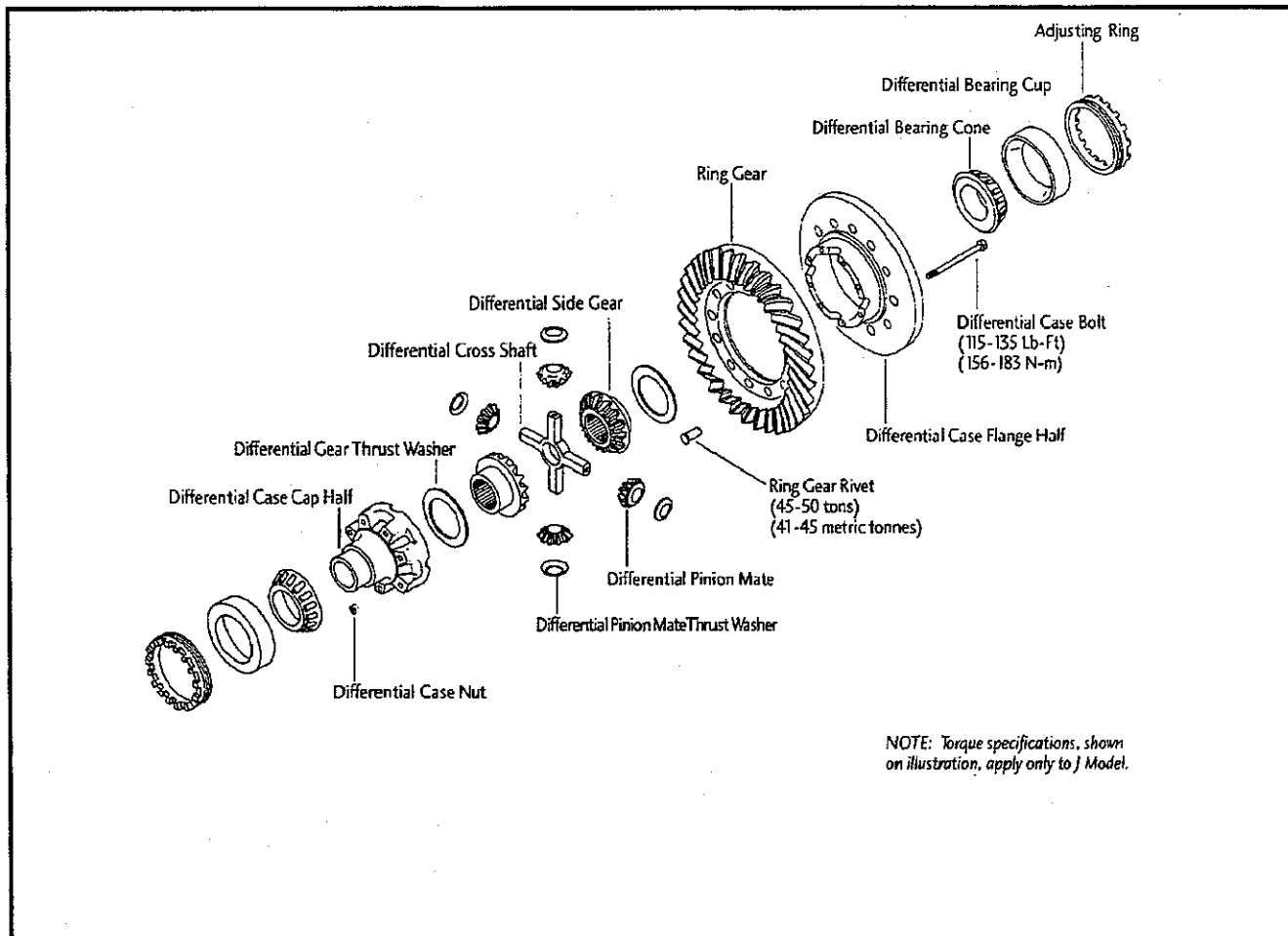


Figure 26—Differential Assembly

24. Press differential bearing cones onto differential case halves.
25. Place differential bearing caps on cones for protection during assembly.
26. Apply a small amount of gear lubricant to all mating surfaces.
27. Install differential gear thrust washer and differential side gear into differential case flange half.
28. Assemble differential pinion mates and differential pinion mate thrust washers onto differential cross shaft.
29. Place assembly into differential case flange half.
30. Place remaining differential side gear and differential side gear thrust washer in position on differential pinion mates.
31. Assemble case halves, make sure match marks are aligned.
32. Install differential case bolts.
33. Torque differential case bolts evenly to 115 to 135 foot-pounds (156 to 183 N•m).

Position Pinion

Caution

To avoid damage to the part assemblies, make sure that mounting surfaces and shims are free of burrs and dirt before assembly.

Note

Pinions and Ring gears are supplied in matched sets. Matching part numbers on both the pinion and ring gear are etched for verification. If a new set is used, verify the numbers of each pinion before proceeding with assembly.

Pinion position is a nominal mounting distance measured from the centerline of the ring gear on the nose of the pinion. The dimension is controlled by selecting the correct shim between the pinion and the cage assembly and the carrier housing. The nominal dimension is 3.976 inches (100.990 mm).

To establish the correct nominal dimension, use a pinion setting gauge and do the following:

1. Install pinion and cage assembly into carrier housing without shims. Tighten pinion cage bolts to 115 to 135 foot-pounds (115 to 183 N•m).

Caution

Make sure the lugs on the bottom of the step plate straddle the bearing staking indentation on end of pinion. Make sure differential side of bearing bores is clean and free of nicks.

2. Attach the step plate clamp assembly to the carrier mounting flange.
3. Locate step plate clamp screw over center of pinion.
4. Install step plate under clamp screw over center of pinion.
5. Install step plate under clamp screw and tighten to hold step plate securely in position.
6. Remove all burrs and wipe clean differential bearing bore.

Note

The step plate must be considered. The thickness of the step plate 0.400 inch (10.16 mm) needs to be added to the measured value for the correct micrometer distance.

On the machined end of each pinion is a plus (+), a minus (-), or a zero (0) etched. That number is the amount in thousandths of an inch (0.001 inch or 0.0254 mm) to be added or subtracted from the nominal dimension for that particular gear set.

For example, if the pinion is etched +3, the required mounting distance is more than nominal by 0.003 inch (0.076 mm). This indicates pinion requires 0.003 inch (0.076 mm) thicker shim between pinion bearing cage assembly and carrier housing than a pinion etched with zero (0).

Inches	Millimeters
0.005	0.127
0.010	0.254
0.030	0.762

Table 3—Pinion shims available

Note

Make sure mounting surfaces and shims are free of dirt and nicks before assembly.

7. Position shims on carrier housing so oil return holes align properly. Use a minimum of three shims in a pack. If the pack is made of different shim

thickness, install the thinnest shim on both sides of the pack.

Note

Studs can be used to assist with alignment.

8. Install pinion and pinion cage assembly into carrier.
9. Tighten pinion cage to carrier bolts.

Pinion Setting Description

If new gear set is being used, see the (+), (-), or (0) etching on both the old and new pinions. Adjust the thickness of the shims to compensate for the difference. (See Table 1—Pinion Setting Chart.)

For example, if the old pinion is etched +2, and the new pinion is -2, subtract 0.004 inch (0.1016 mm) from the thickness of the original shims.

If one or both the pinions are etched beyond the values on the chart, observe the same procedure to establish correct pinion position.

For example, if the old pinion is etched -12 and the new pinion is etched +9, add 0.021 inch (0.5334 mm) to the thickness of the original shims.

After determining the new total build up of pinion position shims, round the figure off to the nearest multiple of 0.005 inch (0.127 mm).

0.000 TOP(INCHES)
.000 BOTTOM(MM)

COLD PINKIN MARKING

020-21

Differential Installation

Caution

Differential assembly must be aligned within bearing bores before preload is applied. Avoid damage to the ring gear and pinion at installation to the carrier housing.

1. Install ring gear and differential assembly in to carrier housing.

Caution

Make sure side bearing caps are seated on bearing cones.

2. Assemble differential bearing caps with match marks in proper location.
3. Clean differential bearing cap bolts and washers.
4. Apply Loctite number 277 to threads of bearing caps.
5. Install bearing cap bolts. Do not torque at this time.
6. Tighten enough to eliminate visible space between differential bearing cap and carrier housing.
7. Install adjusting rings.
8. Tighten both adjusting rings until end play is eliminated and there is backlash between the ring gear and pinion. (See Figure 27—Adjusting Rings.)

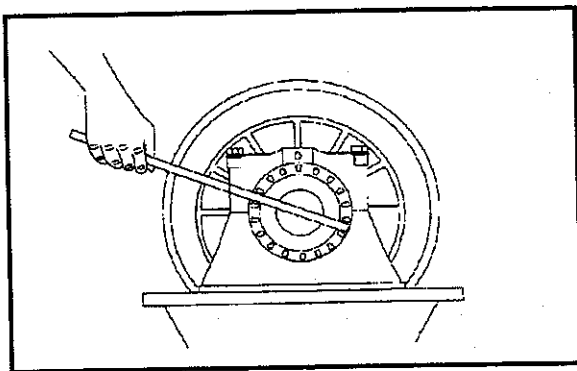


Figure 27—Adjusting Rings

9. Loosen adjusting ring on tooth side of ring gear one notch.
10. Tighten adjusting ring on flange side of ring gear one notch. Repeat adjusting until backlash is eliminated.

11. Tighten adjusting ring on tooth side of the ring gear two or three notches or until bearing preload is established.

Note

If backlash tolerances varies more than 0.003 inch (0.080 mm) between the four positions, remove the differential and determine the cause.

12. Check ring gear and pinion backlash in four equal space positions around the ring gear. Use a dial indicator. (See Figure 28—Check Backlash.)

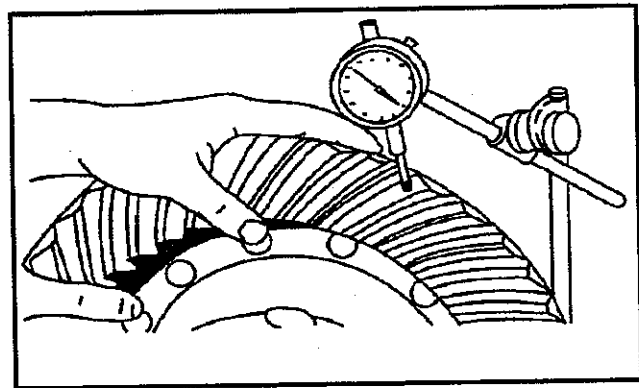


Figure 28—Check Backlash

13. Torque the differential bearing cap bolts to 295 to 340 foot-pounds (397 to 460 N•m) when backlash is set.
14. Re-check backlash after first torque of cap bolts.

Ring Gear and Pinion Tooth Contact Pattern

The procedures are to be used to establish proper gear tooth pattern after assembly of the carrier is complete.

Note

If matched sets are being reused, measure and record backlash before disassembly, and re-assembled to the same backlash. This will match ring gear and pinion to the established wear patterns. Hand rolled patterns will cover less area than the gear pattern established by previous service.

1. Paint $\frac{1}{4}$ of ring gear with marking compound on the drive side and the coast side. (See Figure 29—Gear Tooth Elements.)

2. Apply drag load. (See Figure 30—Correct Gear Patterns.)
3. Rotate pinion so that ring gear completes one revolution in each direction. (See Figure 31—Incorrect Gear Patterns.)

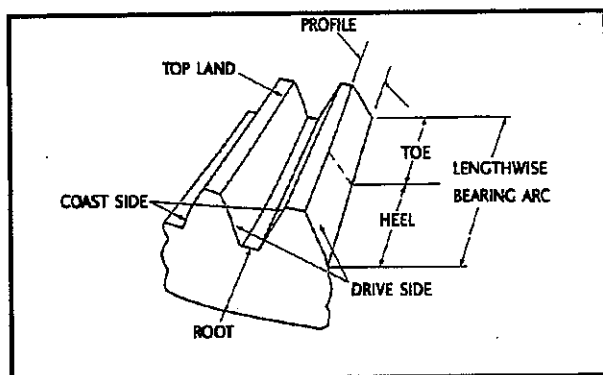


Figure 29—Gear Tooth Elements

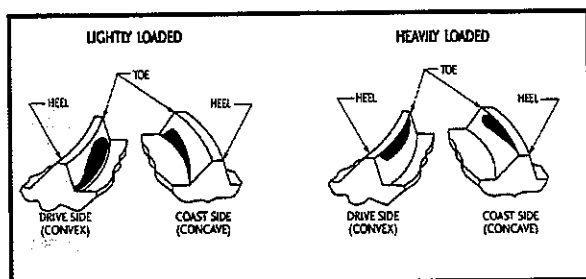


Figure 30—Correct Gear Patterns

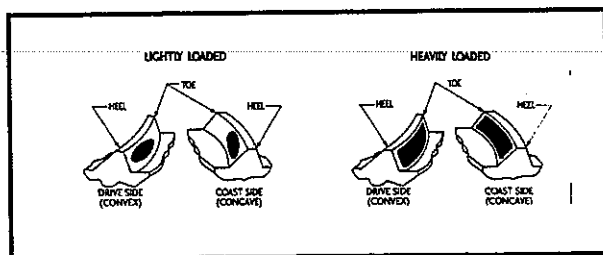


Figure 31—Incorrect Gear Patterns

Wheel Bearing Adjustments

Note

Reference *Wheel End Components Section 030.2*.

Install Differential Carrier into Axle Housing

Thoroughly clean the inside of the carrier housing and inspect for surface nicks and cleanliness.

Stone the surface required to remove burrs or nicks. Inspect boltholes for nicks and cleanliness.

1. Apply an 0.125 inch (3.175 mm) diameter bead of Loctite number 518 gasket eliminator around the axle housing and around each bolthole. (See Figure 32—Apply Loctite.)

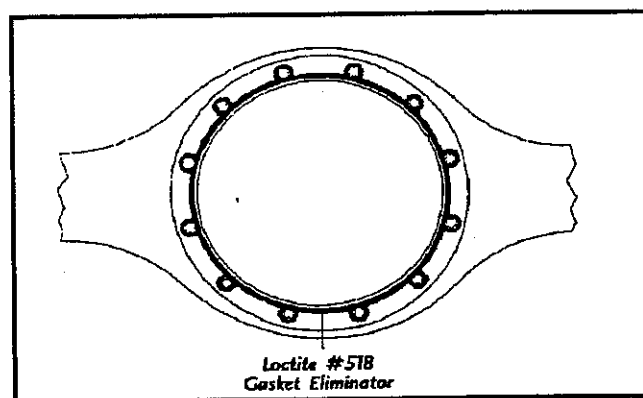


Figure 32—Apply Loctite

2. Thread two studs into the axle housing 180° apart.

Note

If re-installing used bolts, clean mounting bolts, and coat with Loctite number 277 and install bolts.

3. Install the carrier assembly to the axle housing.
4. Torque bolts evenly in cross pattern 240 to 260 foot-pounds (325 to 352 N•m).
5. Loctite cure time is one hour at room temperature.
6. Remove the old axle flange gasket and clean mating surfaces of hub and axle flange.
7. Install the new axle flange gasket.
8. Install axle shafts.
9. Torque the axle flange nuts. (Reference Table 2—Axle Torque Specification.)
10. Clean magnetic drain plug and install.
11. Torque magnetic drain plug to 35 to 45 foot-pounds (47 to 61 N•m).
12. Fill housing to proper level. (See Figure 33—Fill Axle Housing.)

Note

Fill capacity will vary depending what the housing angle is in each vehicle. Capacities for model are 31.5 pints (15 liters).

13. Install fill plug and torque to 35 to foot-pounds (47 to 61 N•m).

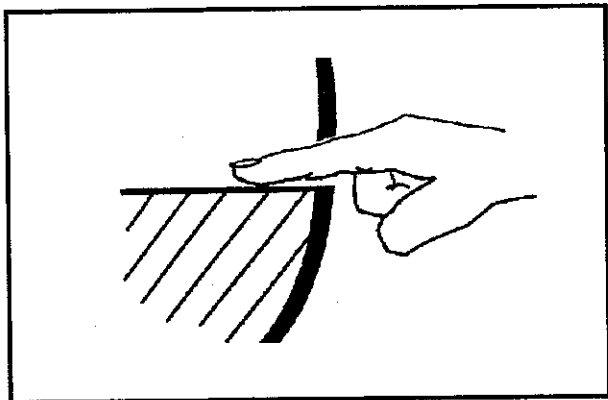


Figure 33—Fill Axle Housing

LTC Electronic ABS Brake System



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures are documented using a Blue Bird LTC with a Cummins M11 engine and an Allison B500 Transmission.

Blue Bird Corporation assumes sole responsibility for ensuring that the information provided herein is accurate to the best of its knowledge at the time of printing. In keeping with its policy of continual product improvement, Blue Bird reserves the right to change product information without notice and without incurring obligation. Some information contained in this section has been re-published from the following publications:

Allied Signal Bendix® Brakes R-12 and R-14 Relay Valves Service Data SD-13-4762.

Allied Signal Bendix® Brakes WS-20 Antilock Wheel Speed Sensor Service Data SD-13-4754.

Allied Signal Bendix® Brakes EC-15 Antilock Controller Assembly Service Data SD-13-4785.

Allied Signal Bendix® Brakes M-21 and M-22 Antilock Modulator Assembly Service Data SD-13-4793.

New Configuration for ABS

This product is a six channel, six sensor, six modulator ABS system.

If this new system is found on a Blue Bird vehicle, please call your local distributor for service relating to your vehicle.

This subsection contains information for the Bendix™ antilock braking system (ABS) MC-12.

The Bendix™ ABS is an electronic System that consists of the following:

- MC-12 Modulator/Controller
- WS-20 Wheel Speed Sensors.
- EC-15 Electronic Controller
- R-12 Relay Valve
- See Table 1—Lamp and Signal Circuits
- See Figure 1—MC-12 Modulator Controller Assembly.
- See Figure 2—MC-12 Trailer System Wiring
- See Figure 3—Speed Sensor Voltage Cycle output
- See Figure 4—Applying Normal Service Application
- See Figure 5—Balanced Position Normal Service Application
- See Figure 6—Balanced Position Normal Service Application
- See Figure 7—Exhaust Normal Service Application
- See Figure 8—Antilock Mode Solenoids Activated

- See Figure 9—Electrical Connector
- See Figure 10—Exploded View M-12
- See Figure 11—Status Light LED
- See Figure 12—Diagnostic Display Quick Reference
- See Figure 13—7-Pin Trailer Connector
- See Figure 14—Trailer Status Lamp Testing
- See Figure 15—Inspection for Illuminated LED(s)
- See Figure 16—Inspection for Illuminated LED(s)
- See Figure 17—Testing for Power to the EC-12
- See Figure 18—Testing the Modulator
- See Figure 19—Testing the Wheel Speed Sensor
- See Figure 20—7-Pin and 14-Pin Connectors

Sensors mounted at the wheel end send wheel speed data to the EC-12 through the 14-pin connector. The sensors are actually AC generators. They house magnets that create a magnetic field. When the field is interrupted by an irregular surface, such as a tone ring, AC voltage is produced. The frequency of voltage increases or decreases as wheel speed changes.

Description of Operation

Caution

Do not attempt to install, remove, disassemble or reassemble any component until you have read and understand the recommended procedure.

The MC-12 is the main component housing. The M-12 and the EC-12 contain solenoids and a standard relay valve.

The EC-12 houses the electronics that regulate the ABS. The EC-12 incorporates a diagnostic display window and a 14-pin connector.

The EC-12 mounts to the M-12 Modulator with four bolts and is internally connected to the solenoids by a four pin connector. The solenoids are the interface between the EC-12 electronic signals and the pneumatically operated modulator.

During normal, non-antilock operation, the M-12 inlet solenoid is open and the exhaust solenoid is closed.

In this application, the M-12 functions as a regular Relay Valve (R-12). The R-12 receives a control signal from the foot valve that passes through the open inlet solenoid and causes the brakes to apply in proportion to the amount of control pressure.

If wheel lock up is impending, the EC-12 commands the solenoids to modulate brake chamber pressure on the axles.

The MC-12 Modulator/Controller receives its power from the vehicle's stop light circuit (**pin 4**) on the standard seven pin connector **Red**. The power enters the EC-12 Controller at **pin A** and (optionally **pin B** from the auxiliary terminal **Blue** of the bus (**seven pin**) connector. The system ground (**pin 1**) on the **seven pin** connector **white** enters the MC-12 at **pin C**.

Each wheel speed sensor sends the MC-12 an AC signal through a pair of wires. The MC-12-pins for the sensors are **L-M** and **N-P**.

The MC-12 can send a + 12 volt failure signal to the optional bus mounted status light through **pin D**. The system light indicates the condition of the bus ABS. The MC-12 can send a grounding signal through a **pin J** to an optional bus dash mounted status lamp.

During startup, when the bus brakes are actuated the ABS immediately starts a self-check. The status lamp flashes once and then goes off. Should a problem occur, the ABS disengages and returns to normal R-12 relay valve operation.

If the status lamp comes on and remains on when the trailer brakes are actuated, a system problem has occurred. The EC-12 contains a diagnostic window, that directs the mechanic to the problem. A series of Light Emitting Diode (LED) on the EC-12 indicate the status of power, EC-12 controller, wheel speed sensors M-12 solenoids, or voltage level.

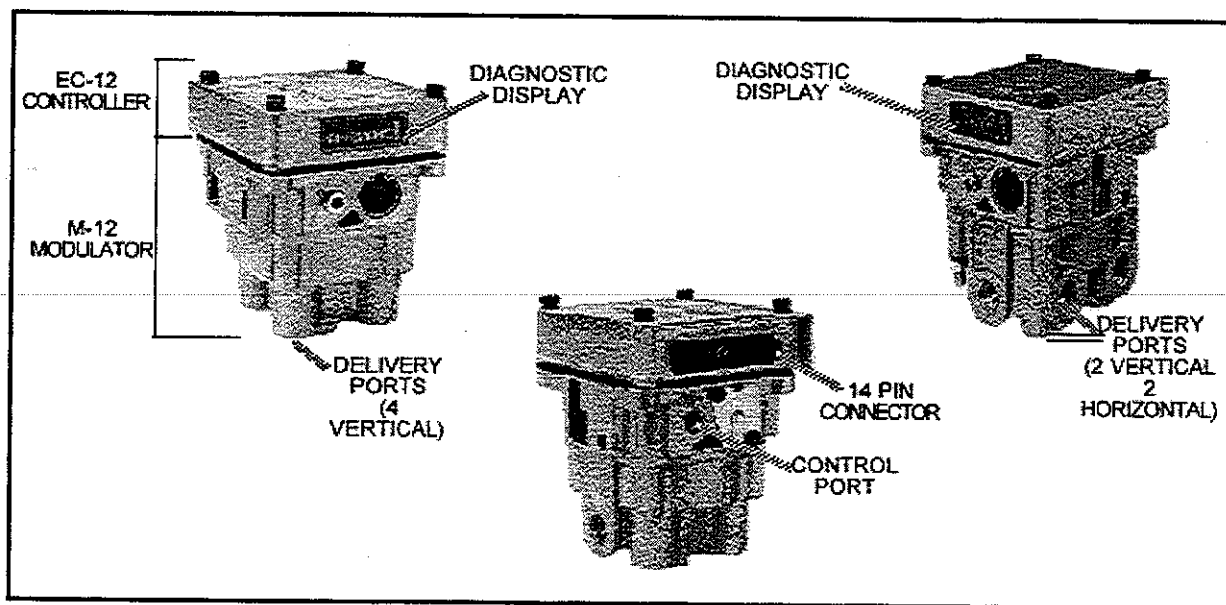


Figure 1—MC-12 Modulator Controller Assembly

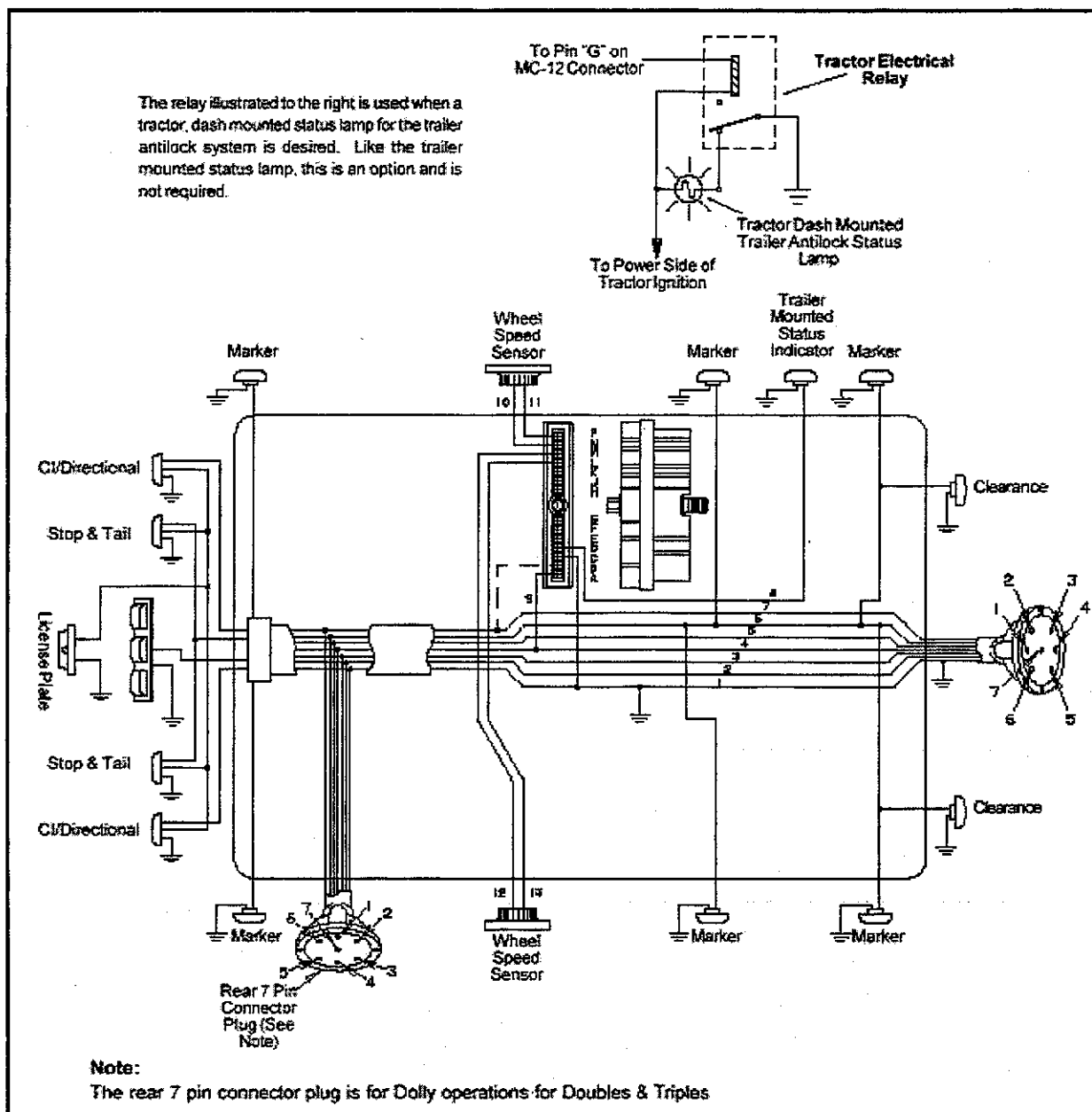


Figure 2—MC-12 System Wiring

Note

ABS connector Pin B is an option and is used to provide constant power to the MC-12 during trailer operation.

Pin Wire Connector/Lamp Signal Circuits							
Seven Pin Connector	Conductor Wire Number	ABS Connector Letter	Wire Color	Lamp/Signal Circuits	Single Dolly	Double	Triple
1	1	C	White	Ground Return to Towing Vehicle	12	12	8
2	2	---	Black	Clearance, Side Marker and Identification Lamps	12	12	12
3	3	---	Yellow	Left Turn Signal and Hazard Signal Lamps	12	12	12
4	4	---	Red	Stop Lamps	10	10	10
5	5	---	Green	Right Turn Signal and Hazard Signal Lamps	12	12	12
6	6	---	Brown	Tail, Clearance, Side Marker and License Plate Lamps	12	12	12
7	7	B	Blue	Auxiliary , Dome Etc; or Constant ABS Power	12	12	12
4	9	A	Red	ABS Power From Stop Lamp	10	10	10
---	8	D	Yellow	Trailer Mounted Status Light	14/16	14/16	14/16
---	10/11	N/P	---	Wheel Speed Sensor	16/18	16/18	16/18
---	12/13	M/L	---	Wheel Speed Sensor	16/18	16/18	16/18

Table 1—Lamp and Signal Circuits

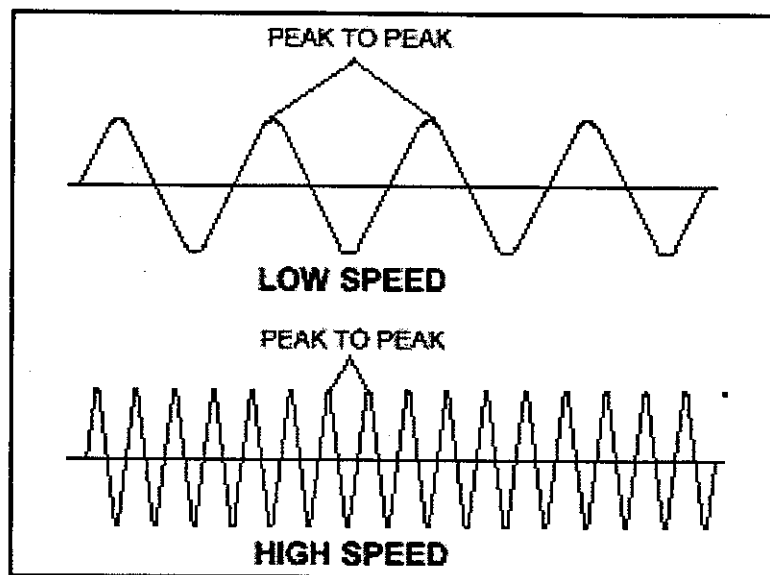


Figure 3—Speed Sensor Voltage Cycle Output

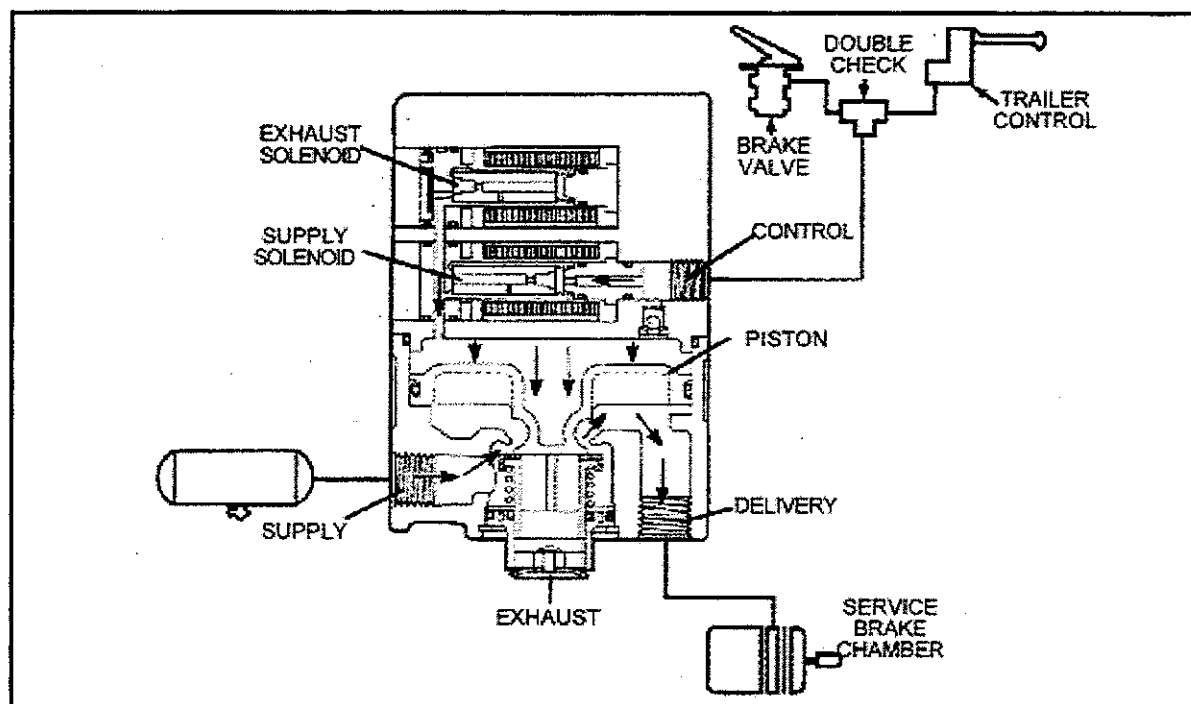


Figure 4—Applying Normal Service Application

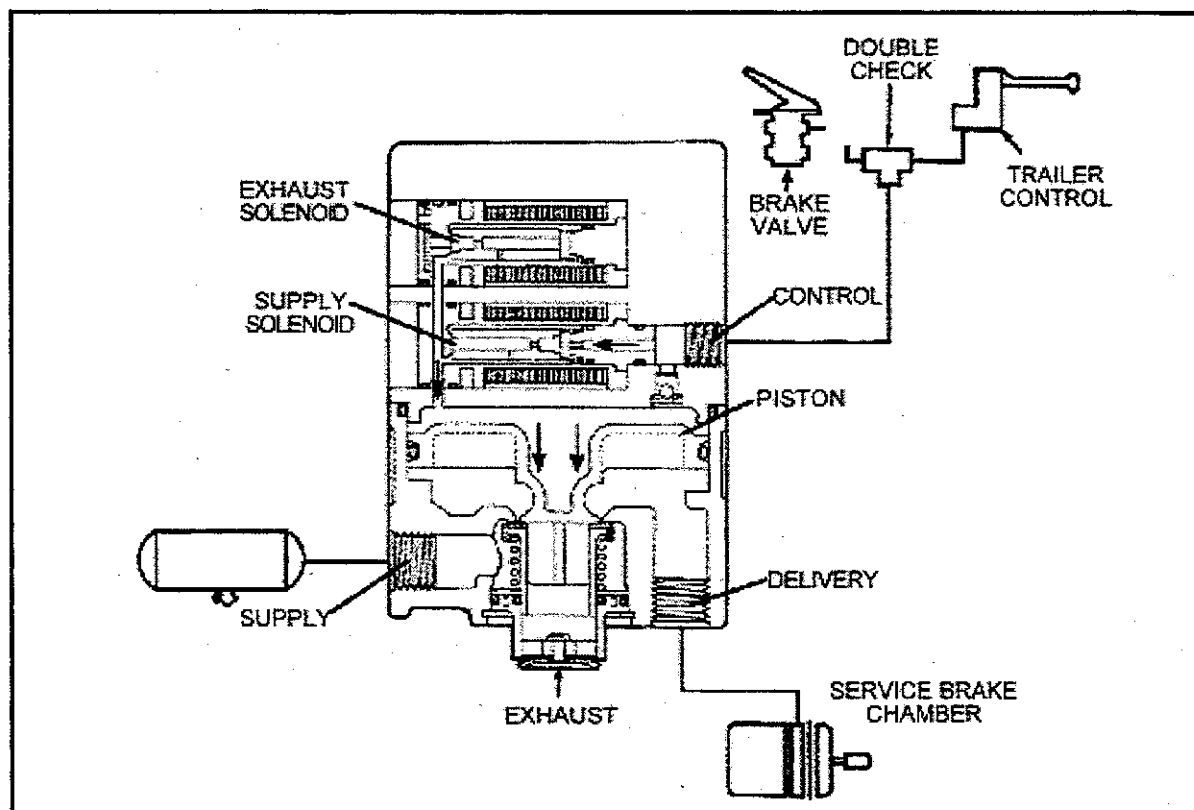


Figure 5—Balanced Position Normal Service Application

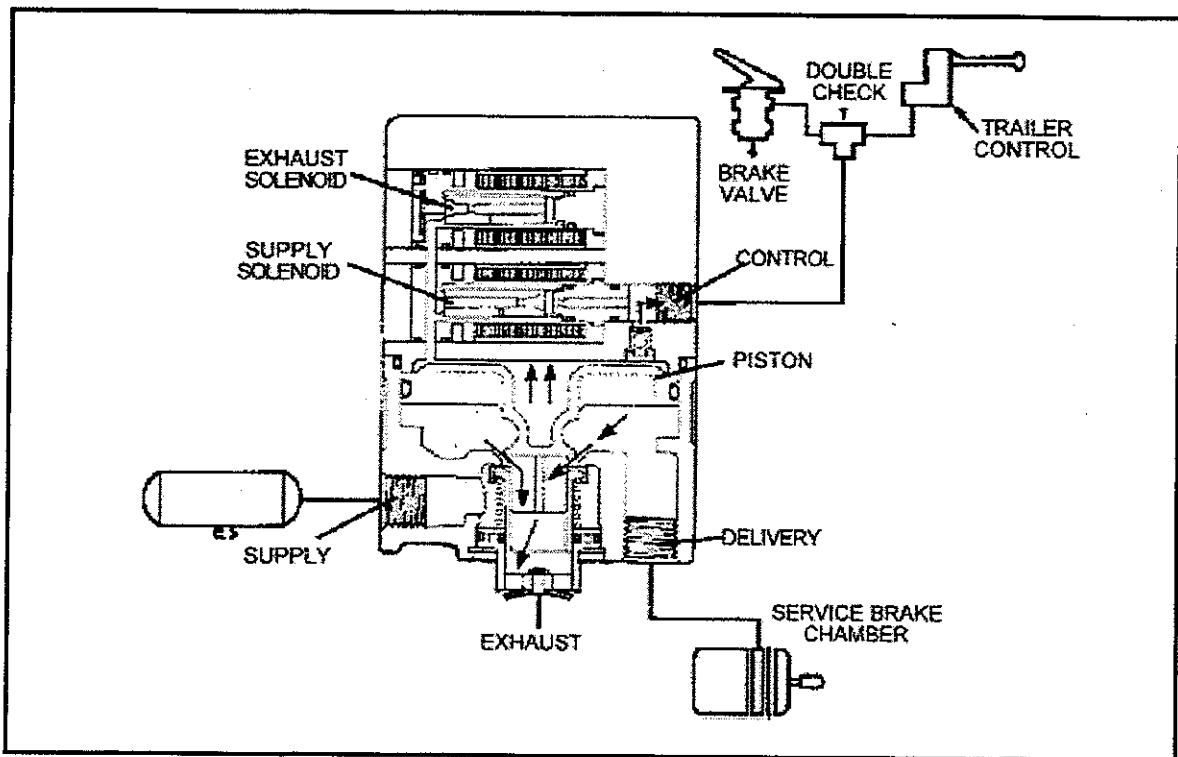


Figure 6—Exhaust Normal Service Application

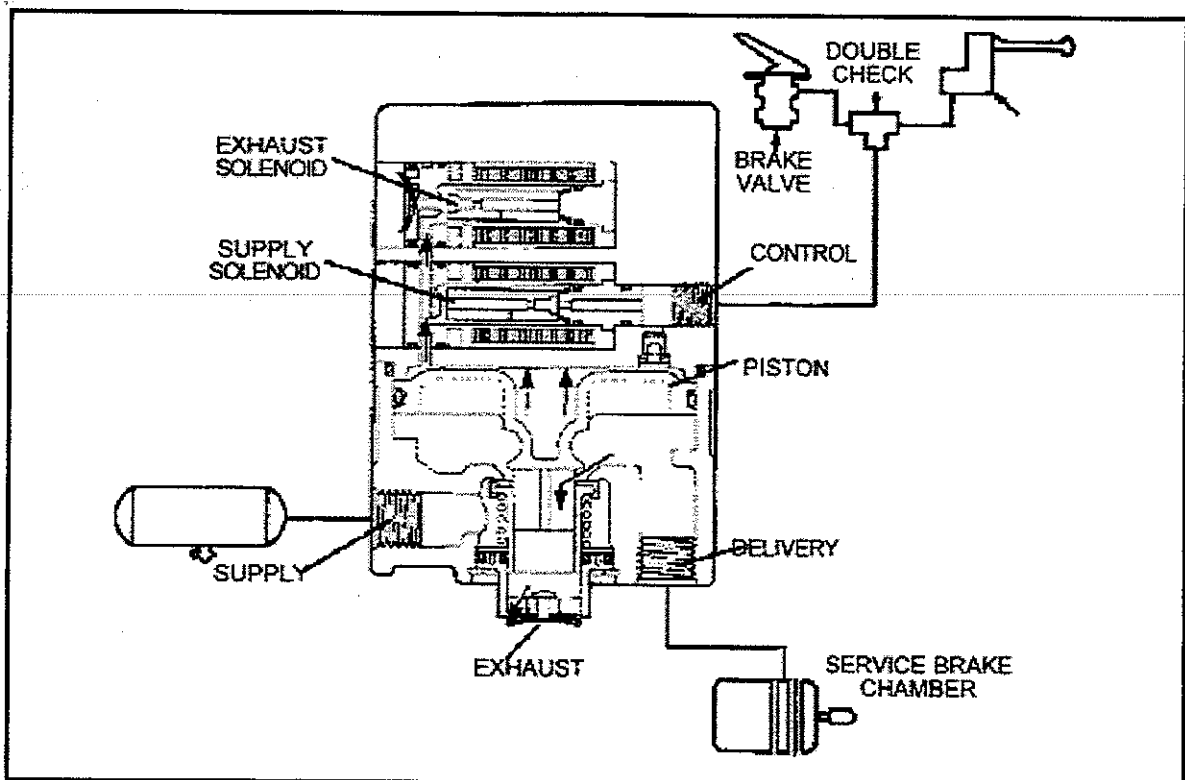


Figure 7—Antilock Mode Solenoids Activated

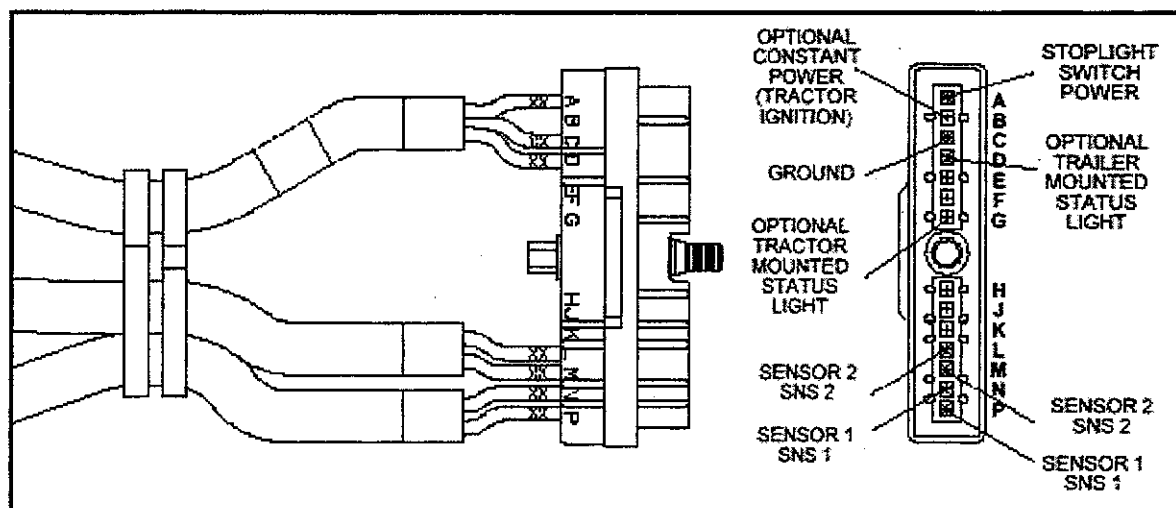


Figure 8—Electrical Connector

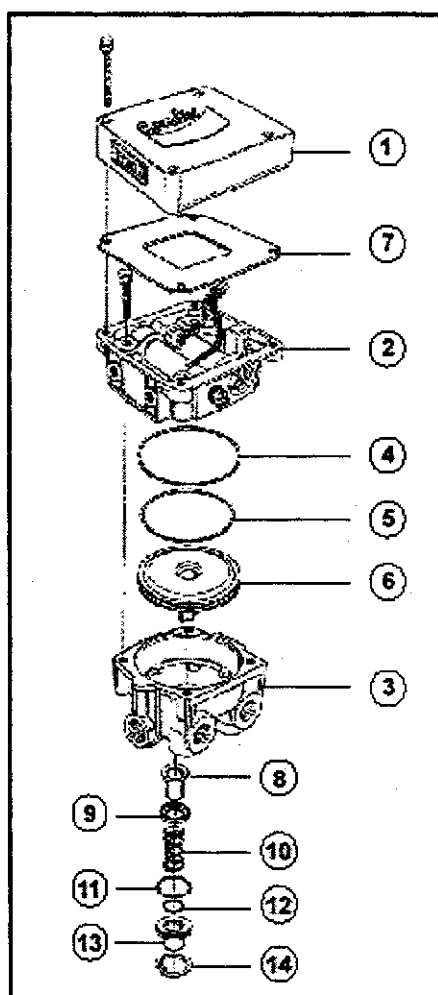


Figure 9—Exploded View

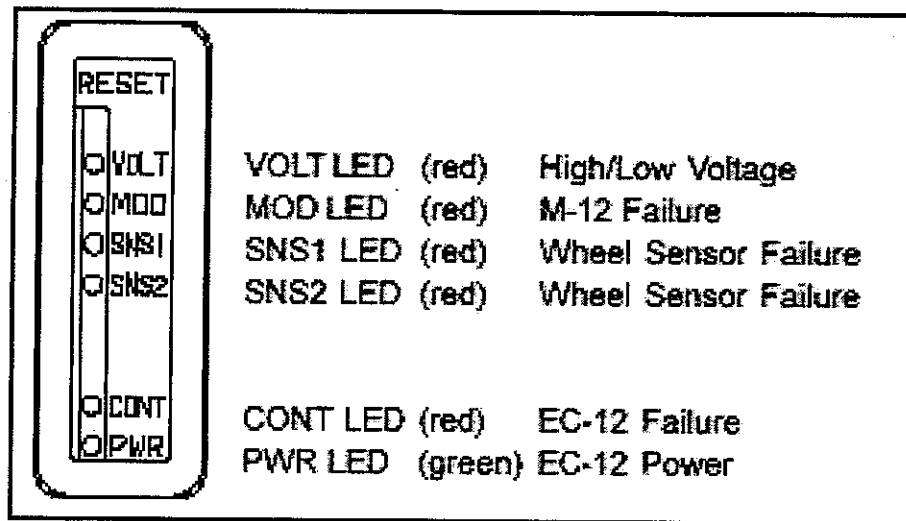


Figure 10—Status Light LED

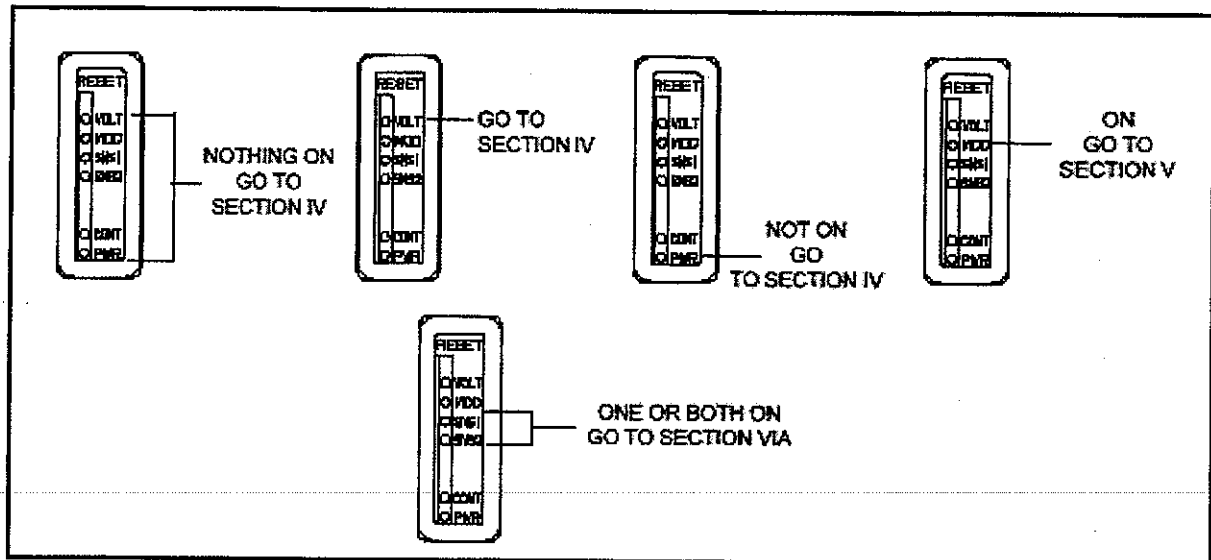
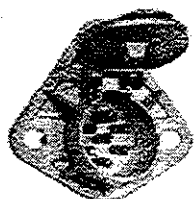
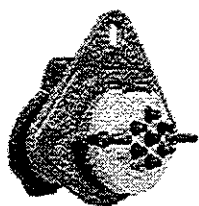


Figure 11—Diagnostic Display Quick Reference

**TYPICAL 7 PIN TRAILER
ELECTRICAL CONNECTOR**



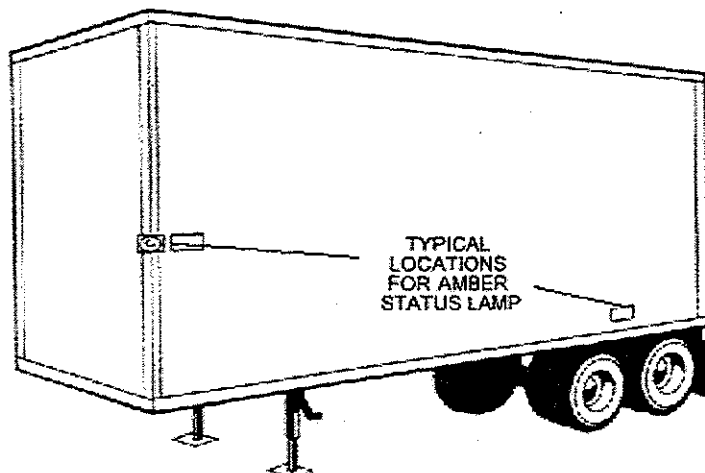
7 PIN TRAILER CONNECTOR



GROUND

CONSTANT POWER (IGNITION)

STOPLIGHT POWER



TYPICAL
LOCATIONS
FOR AMBER
STATUS LAMP

Troubleshooting

INITIAL START-UP PROCEDURE

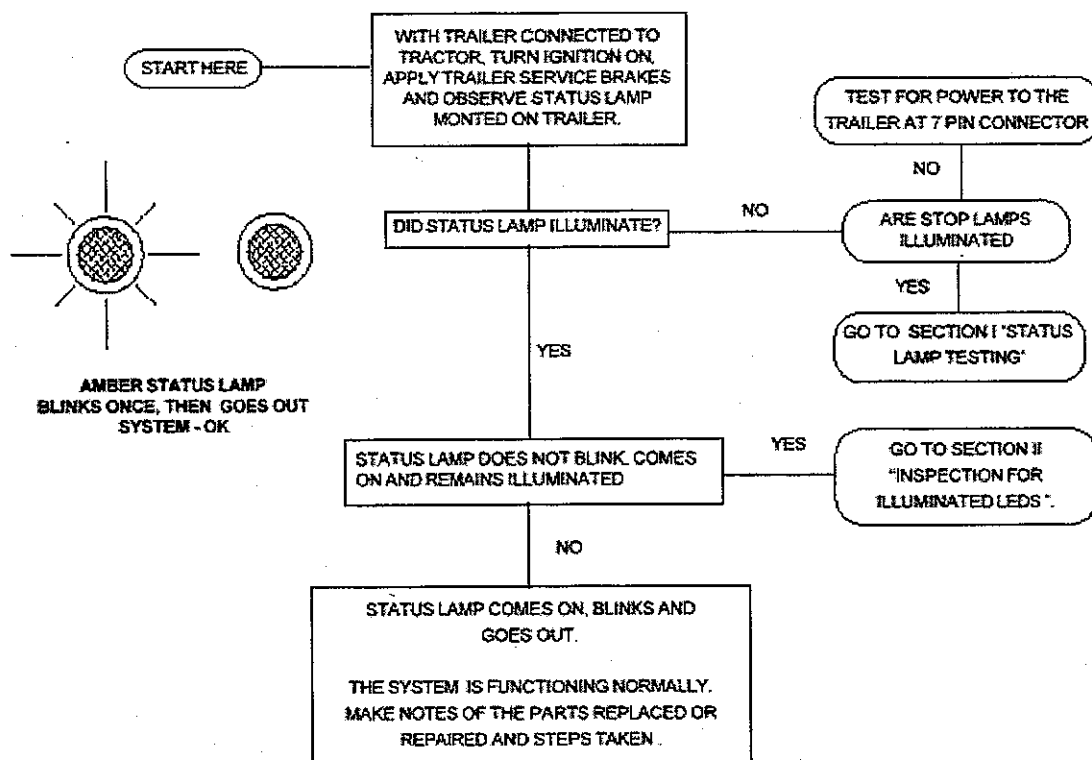


Figure 12—7-Pin Connector

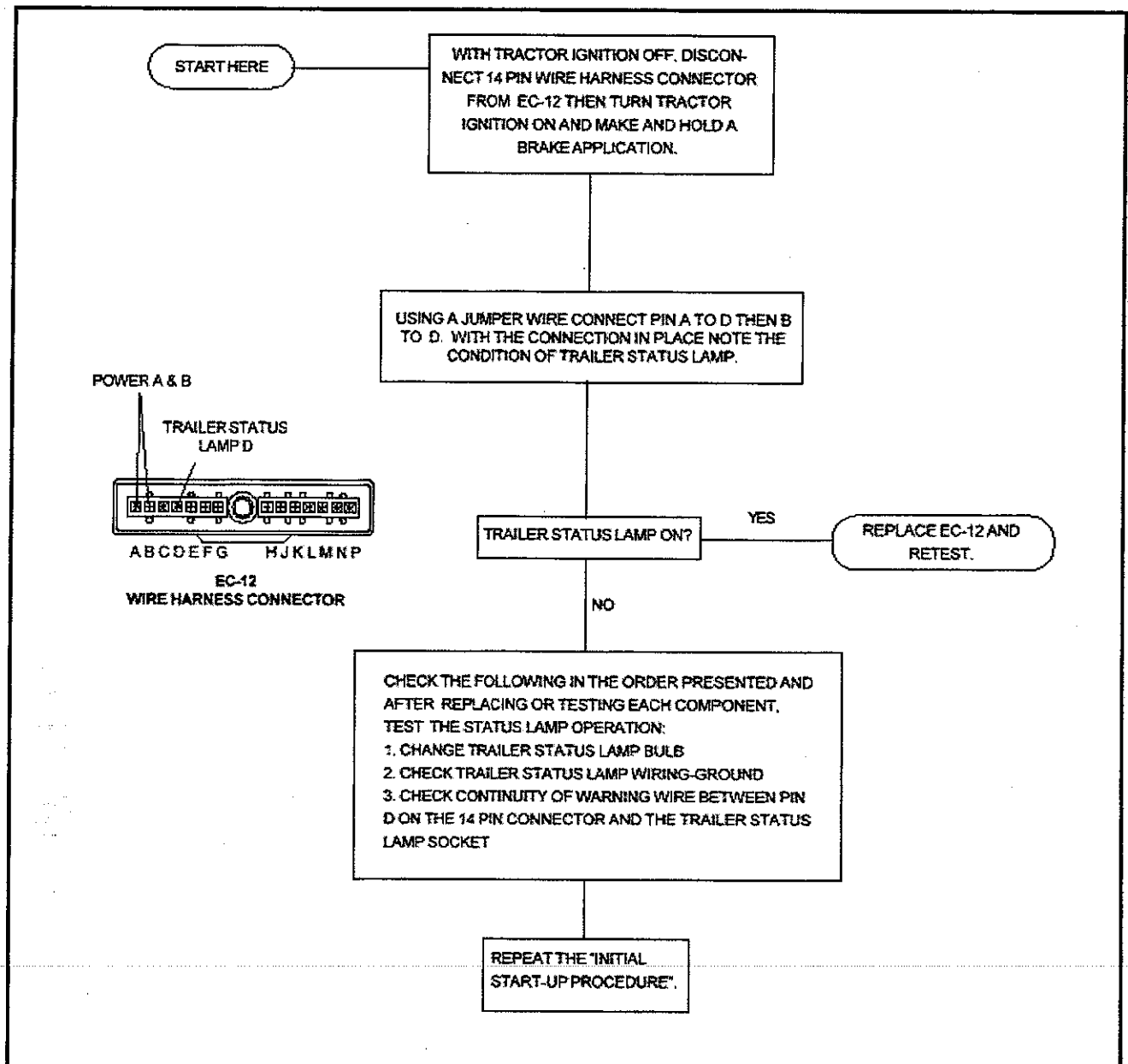


Figure 13—Status Lamp Testing

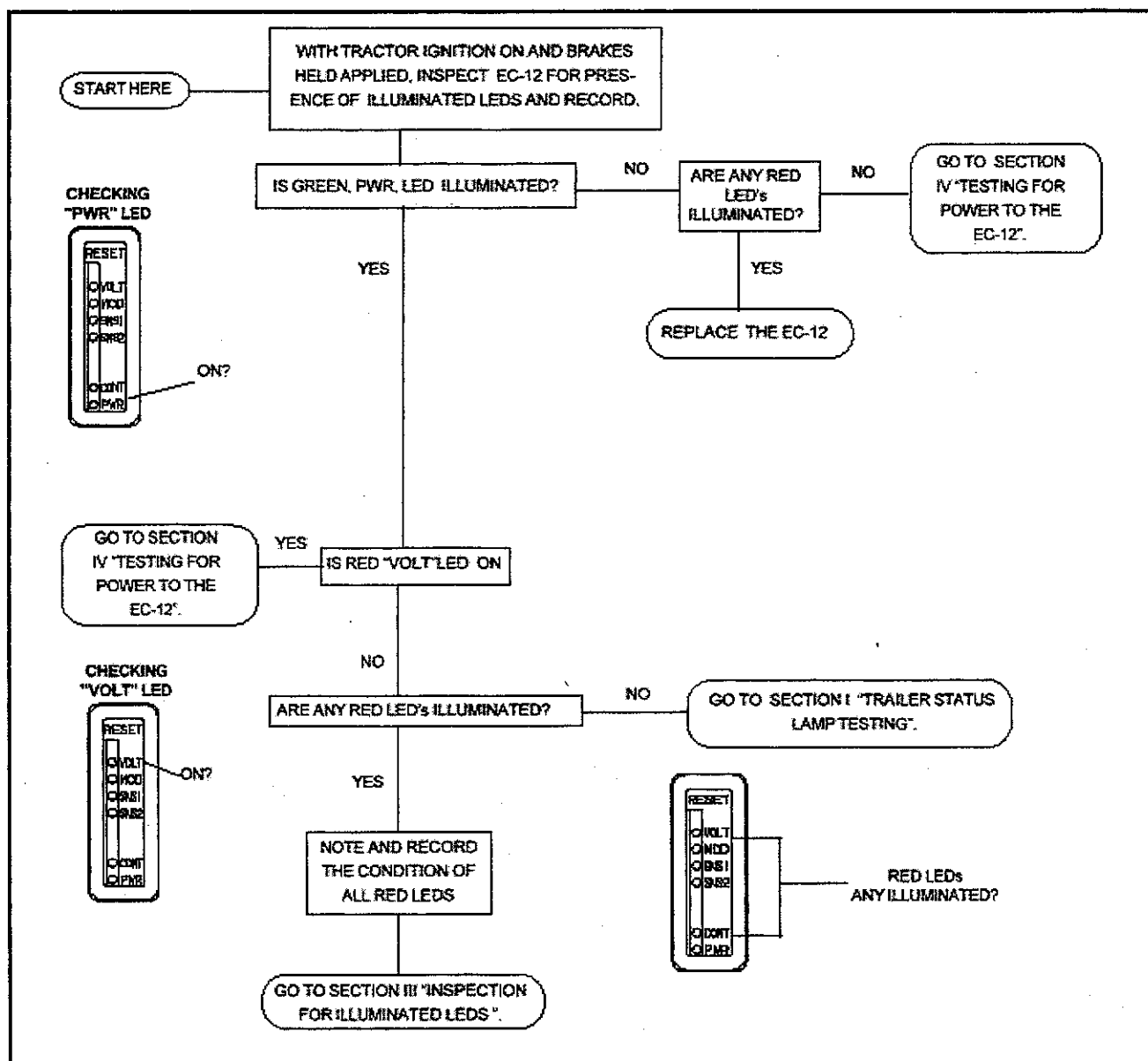


Figure 14—Inspection for Illuminated LED(s)

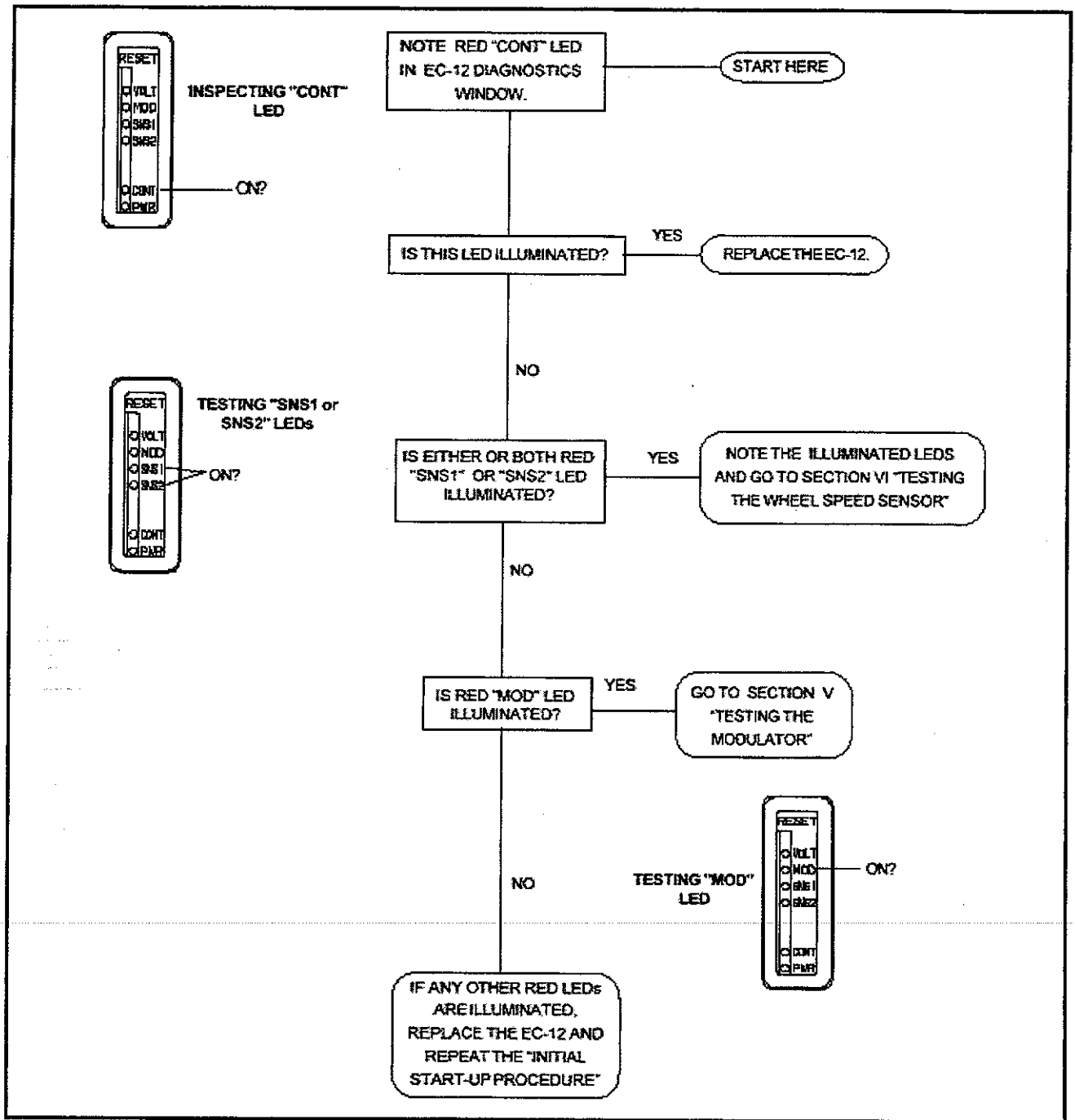


Figure 15—Inspection for Illuminated LED(s)

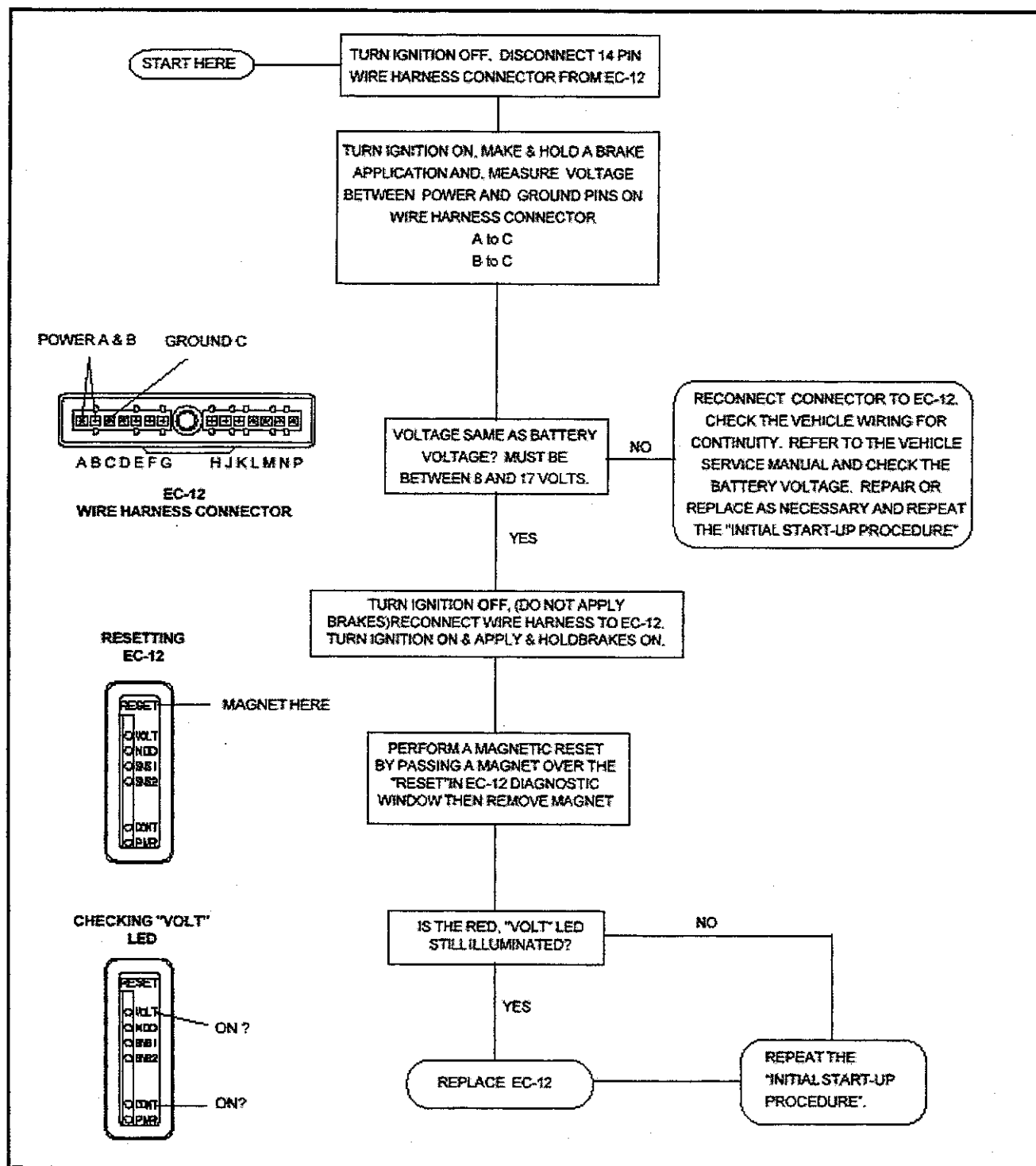


Figure 16—Testing for Power to the EC-12

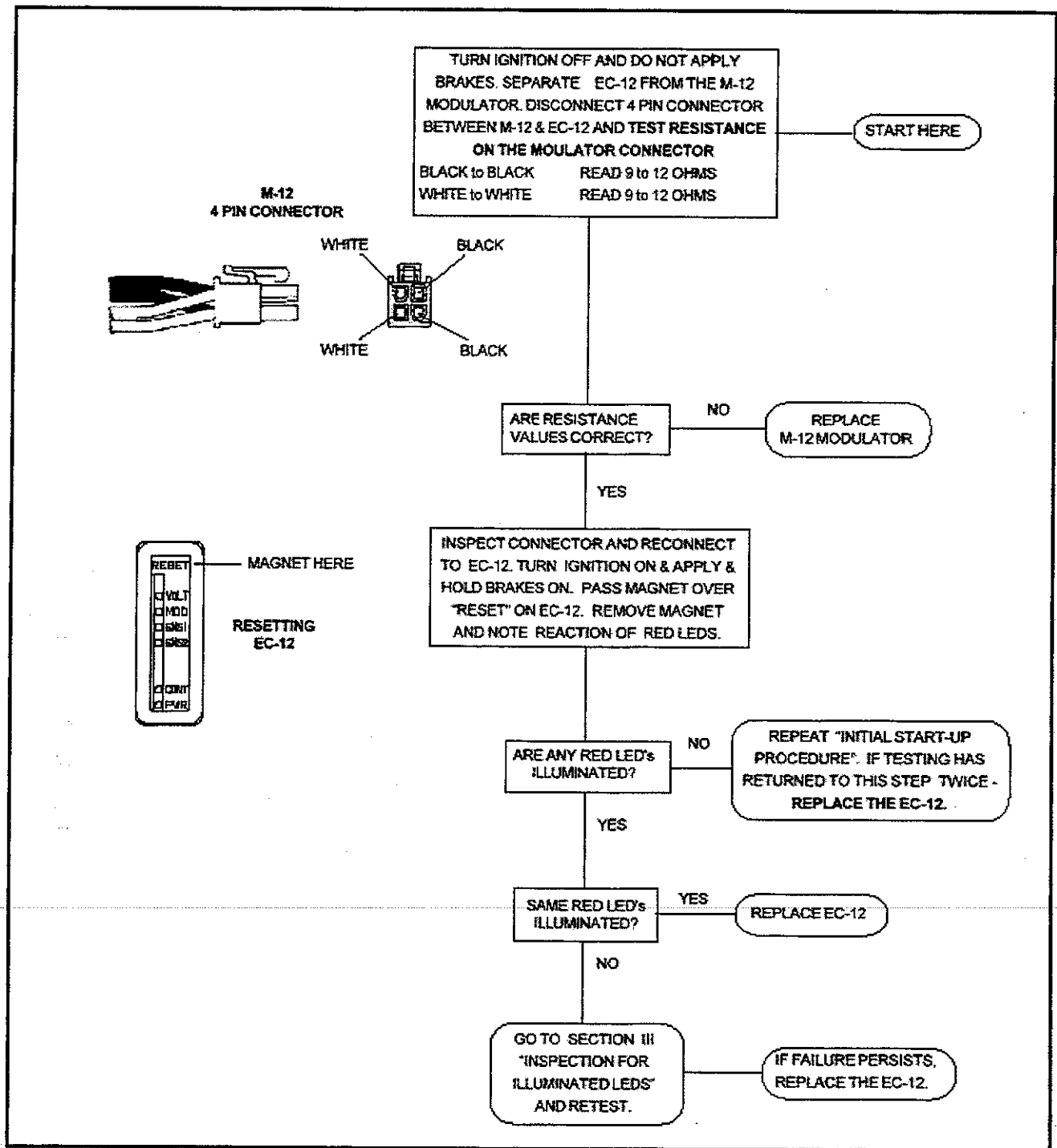


Figure 17—Testing the Modulator

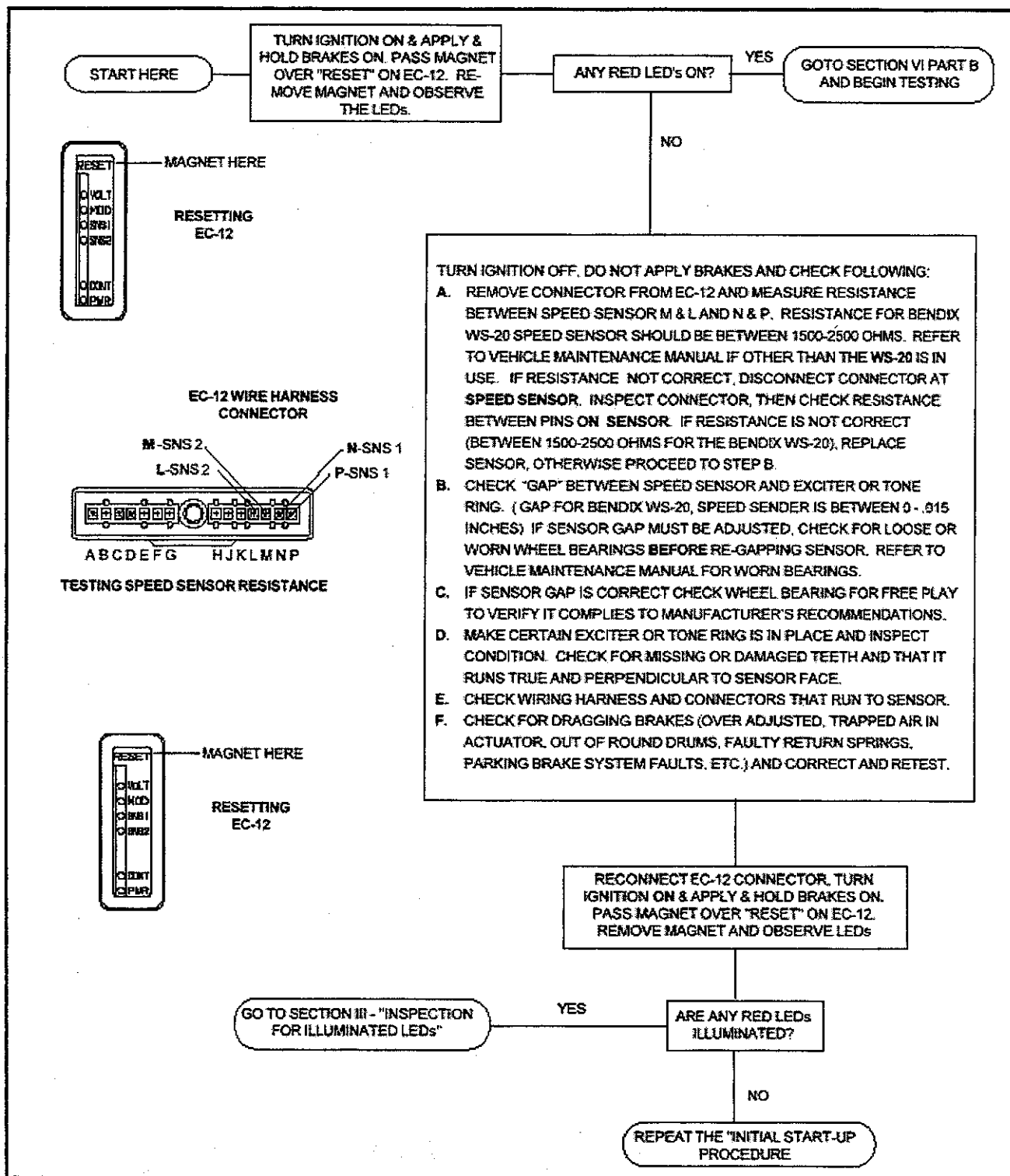


Figure 18—Testing the Wheel Speed Sensor

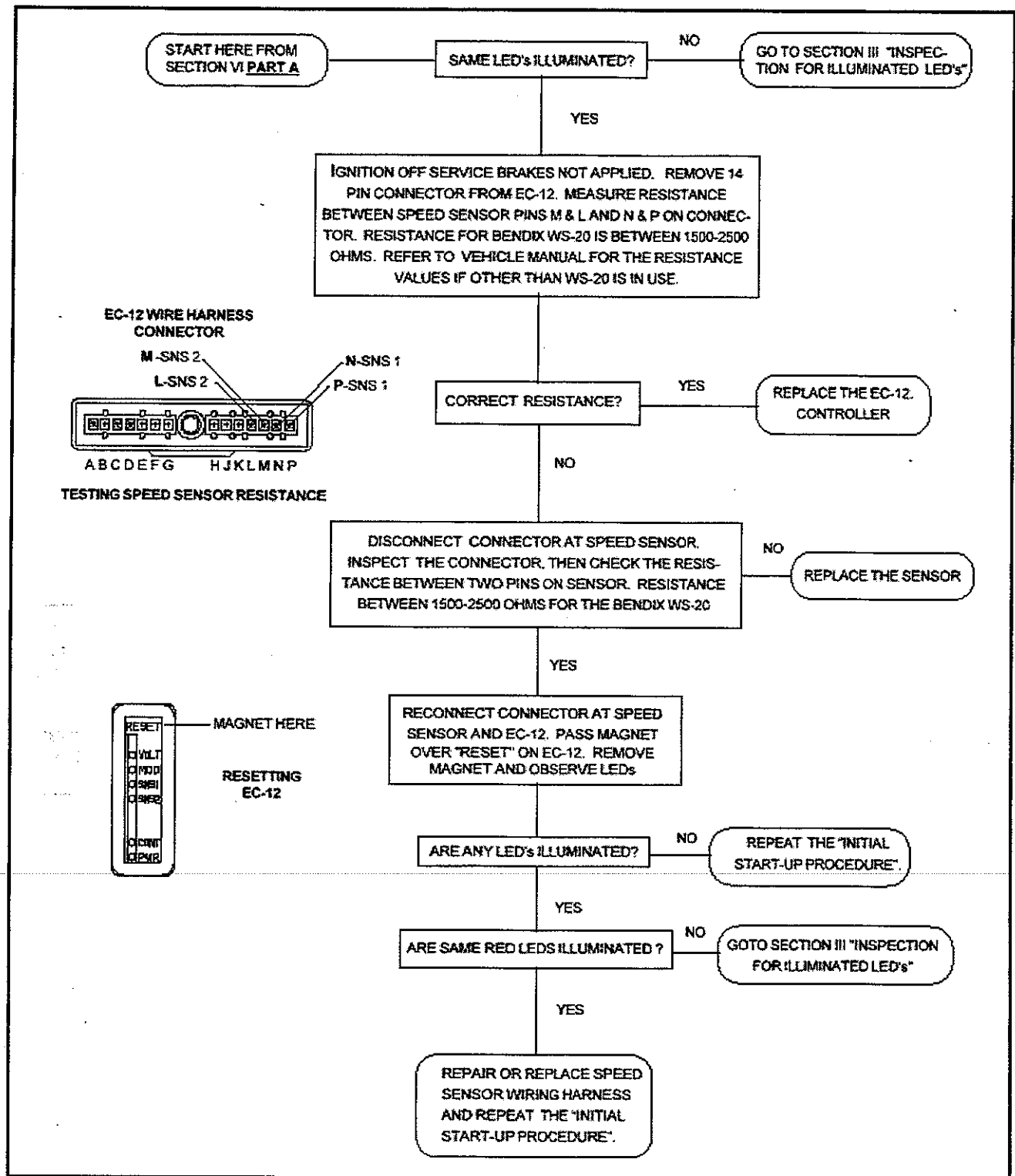


Figure 19—Testing the Wheel Speed Sensor

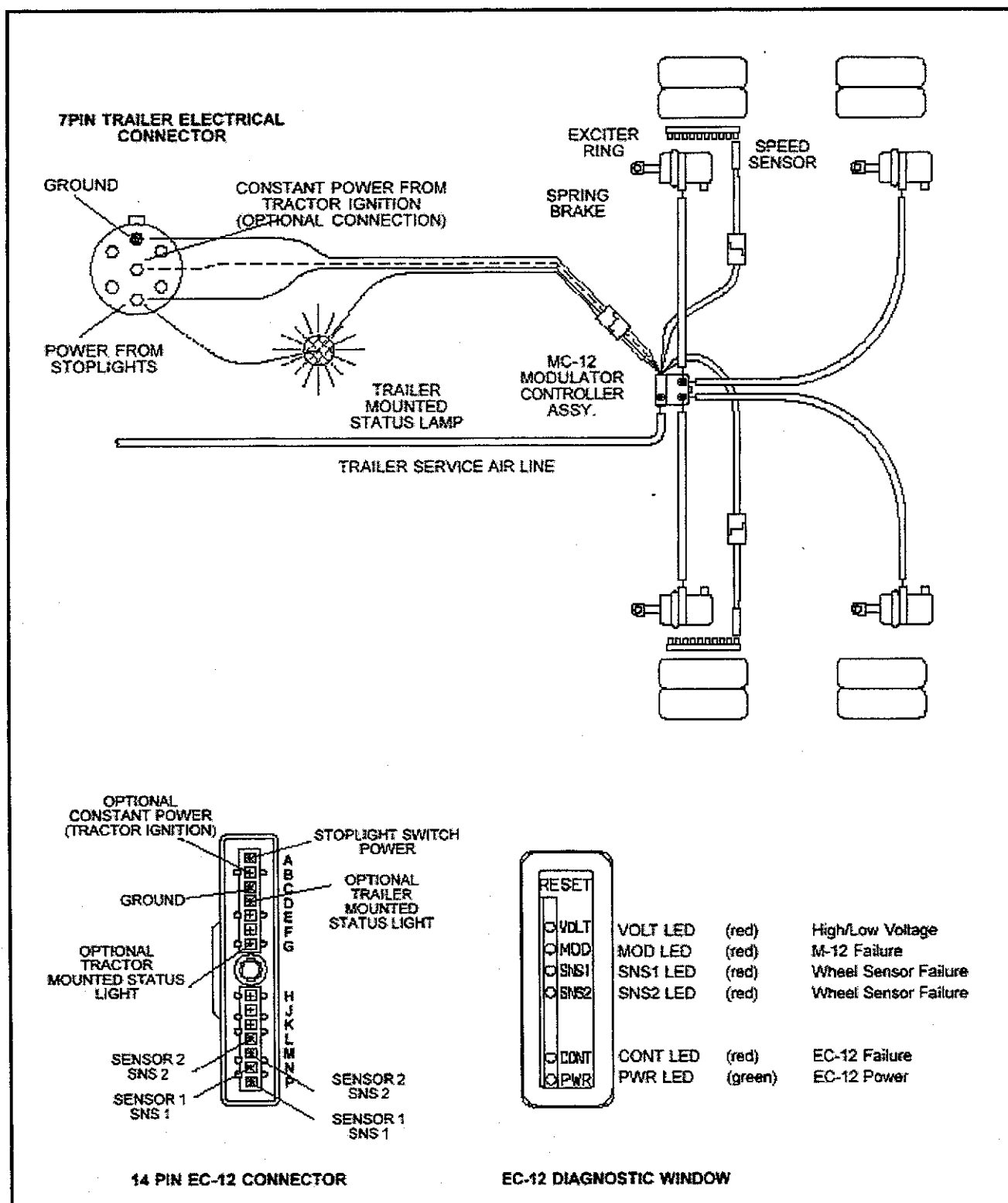


Figure 20—7-Pin and 14 Pin Connectors

Normal Service Brake Application Operation

When a normal service brake application is made, and the EC-12 controller does not sense impending wheel lockup, control air pressure from the brake valve enters the modulator control port.

The air passes through the supply solenoid and acts on the modulator piston. The piston closes the modulator exhaust and opens the inlet, delivering supply air out the delivery ports.

The modulator reaches a balanced position when control pressure acting upon the top side of the piston approaches that of the air acting upon the underside of the piston.

The piston moves upward and closes the inlet valve, while the exhaust remains closed. This prevents the modulator from delivering or exhausting air.

When the brake valve is released, control pressure exhausts through the supply solenoid. Then through the check valve in the solenoid housing and out the exhaust port of the brake valve.

As the piston moves upward, the modulator exhaust opens, allowing air from the piston underside to exhaust through the modulator exhaust port.

If a service brake application is made and the EC-12 Controller senses wheel lockup, the EC-12 will command the antilock system to alter the service brake application.

When activated, shuttles within the solenoids alter the application and exhaust of control air pressure. The supply solenoid closes, preventing control line pressure from entering the modulator.

Then the exhaust solenoid opens, allowing control pressure to exhaust from the topside of the piston through the exhaust port of the solenoid. This action occurs in a pulsating manner, simulating pumping of brakes.

Preventive Maintenance

Caution

Disconnect the battery. Never disconnect any air line or hose without relieving air pressure. Never exceed recommended pressures.

Replace all damaged parts with equivalent size, type and strength. Do not weld or machine parts without approval from the vehicle or component manufacturer.

- Perform service checks every three months 25,000 miles (40234 km), or 900 operating hours.

Caution

Do not disassemble the solenoid assembly.

1. Disassemble the relay valve part of the M-12 Modulator and clean with mineral spirits.
2. Replace all rubber parts and any parts worn or damaged.
3. Check for proper operation before placing vehicle in service.

Service Checks

Ensure that all wiring and connections are secure and free from visible damage. Although the MC-12 assembly contains self-checking diagnostics, the LED display should be inspected to make sure LED is functional.

Activate brakes. A magnet of 800 gauss, capable of picking up three ounces (85.1 g), held to the LED reset area, should cause all LED(s) to illuminate.

If one or more of the LED(s) do not illuminate and the optional status light indicates proper system function, the non-illuminated LED(s) should be recorded for future reference. Although the diagnostic capabilities will be limited, the system will continue to function as designed.

The MC-12 assembly monitors the electronics of the system upon initial trailer brake application. However, the vehicle should be road tested periodically to verify proper solenoid function. Making an aggressive trailer stop from a speed of

20-mph (32.2 kilometer/hour) can test the solenoids. When an antilock stop is made, solenoid pulsation creates an audible burst of air that can be heard from the outside of the trailer.

4. Remove and save the mounting hardware connecting the MC-12 to the vehicle.

Caution

Cover all open ports with a clean cloth.

5. Before disassembly, remove as much contamination as possible from the exterior of the assembly.

Installation of the MC-12

1. Replace the MC-12 assembly on the vehicle using the hardware saved during removal.
2. Connect the airlines to the proper ports, as tagged during removal.
3. Connect the 14-pin connector into the controller and hand tighten screw.

Disassembly of the MC-12

The following disassembly and assembly procedure is reference material. These procedures are assuming that there is a major rebuild of the ABS.

Several replacement parts and maintenance kits are available that do not require full disassembly. The instructions provided with those kit assemblies should be used instead of these instructions.

Caution

The MC-12 may be clamped in a bench vise during disassembly. Over clamping pressure will result in damage, leaking, and/or malfunction.

Caution

If a vise is used, position the MC-12 so the jaws bear on the flat area of the supply port and the opposing side of the body.

1. Remove the EC-12 Controller (1) from the M-12 Modulator by removing the controller's four mounting bolts.
2. Depress the lock tab on the side of the connector and pull the connector from the socket in the controller.
3. Lift the controller off the M-12 Modulator and disconnect the wire harness from the base of the controller.

Note

Discard all old parts from assembly when using new parts from kit.

4. Remove gasket (7) from the EC-12 body.
5. Discard gasket.

Note

If replacement of the controller only is required, proceed to Step 8 of assembly paragraph.

6. Remove sealing ring (4) from the protrusion on the bottom of the solenoid assembly.
7. Remove retaining ring (14).
8. Remove the exhaust assembly (13).
9. Remove O-ring (11) from ID and OD of the exhaust assembly.
10. Discard O-ring.
11. Remove spring (10).
12. Remove spring seat (9) from inlet/exhaust assembly.
13. Press the piston stem and push the piston (6) out the opposite end of the body.
14. Remove O-ring (5) from piston.

Note

Discard all old parts from assembly when using new parts from kit.

15. Discard O-ring.

Cleaning and Inspection

Warning

Solvent is toxic to the skin, eyes and respiratory tract. Skin and eye protection is required. Use in a well-ventilated area.

Do not allow solvent to come in contact with ECU connector or solenoids.

1. Clean and completely dry all parts to be reused.
2. Inspect the interior and exterior of all parts that will be reused for corrosion, pitting and cracks. Superficial corrosion and/or pitting on the exterior of the body are acceptable.
3. Inspect the bores for deep scuffing or gouges.
4. Inspect the pipe threads in the body. Make sure threads are clean and free of thread sealant.

Caution

Any component that has failed in steps 2 to 5 should be discarded and replaced before assembly.

5. Inspect all air line fittings and plugs for corrosion.

Assembly of the MC-12

1. Lubricant O-rings and bores of the valve body with Bendix 291126 lubricant. (See Figure 10—MC-12 Exploded View.)
2. Install spring (9) onto the inlet/exhaust valve (8) so that valve covers the rubber seat of the inlet/exhaust valve.
3. Place the inlet/exhaust valve, large diameter first, into the M-12 bottom bore.
4. Install spring (10) over the barrel of the inlet/exhaust valve (8) so that one end of the spring rests on the spring seat (9).
5. Install lubricated O-rings (11, 8, and 12) into the grooves of the OD and ID of the exhaust assembly (13).
6. Place the large diameter of the exhaust assembly against the spring (10).
7. Compress spring (10) until the exhaust assembly enters the bore of the body and the O-ring (11) seats against the wall of the bore.
8. Depress the exhaust assembly into the bore until the groove for snap ring (14) is exposed.

Note

Make sure snap ring (14) is completely seated.

9. Install snap ring (14) into snap ring groove.
10. Install O-ring (5) into the proper groove in the piston (6).

Note

The piston stem fits into the small hole in the center of the body.

11. Install piston (6) into the M-12 body.
12. Install O-ring (4) onto the protrusion on the bottom of the M-12 solenoid assembly.

Note

The solenoid assembly will fit on the M-12 body in any four orientations, 90 degrees apart. However, if clearance is a problem, make sure the control port is not directly above the valve supply port, that will be nipple mounted to a reservoir.

13. Install the solenoid assembly (2) onto the valve body.
14. Secure the solenoid assembly to the valve body with four 1/2-inch (12.7 mm) bolts.
15. Torque bolts to 120 to 150 inch-pounds (13.56 to 17 N•m).
16. Install gasket (7) onto the EC-12 Controller.
17. Install the Controller (1). (See Figure 11—Electrical Connector.)
18. Plug the electrical connector from the solenoid assembly into the socket in the bottom of the controller. Press in until lock tab engages.
19. Place the controller onto the solenoid assembly and secure with four 1/2-inch (12.7 mm) bolts and lock washers.
20. Torque to 30 to 60 inch-pounds (3.4 to 6.8 N•m).

Operational and Leak Test

1. Chock wheels.
2. Charge the air brake system fully and adjust brakes.
3. Make several brake applications and check for prompt application and release at each wheel.

4. Inspect for leakage around the inlet valve O-ring.
5. Release service brakes.

Note

A one-inch (24.5 mm) bubble in 3 seconds (3000 ms) is permitted.

6. Apply a coat around the exhaust port and the area around the retaining ring with soap solution.
7. Inspect for exhaust valve leaks.
8. Apply brakes.
9. Apply a coat of soap solution around the exhaust port. A one-inch (24.5 mm) bubble in 3 seconds (3000 ms) is permitted.
10. Apply a coat of soap on the outside of the modulator body. Check for seal ring leaks. No leaks permitted.

Caution

If leaks are excessive around the supply and exhaust solenoids, replace the M-12 Modulator. If leaks are excessive where the solenoid assembly and the M-12 join, replace the M-12 Modulator. If leaks are detected at the exhaust port, before replacing the M-12 Modulator, perform the next test.

Performing the M-12 Leak Inspection

1. Place the vehicle in Park by exhausting the air pressure from the emergency side of the spring break.
2. Perform leak check around the exhaust. If air continues to leak from the exhaust, replace the M-12 Modulator.

Note

If a leak exists between the emergency and service sides of the spring brake, the leak at the exhaust will stop when air pressure is exhausted from the emergency side of the spring brake. The air pressure will pass from the emergency side to the service side of the chamber, out the service inlet and out the M-12 Modulator exhaust.

Electrical Test**Note**

Only the voltage LED resets after the condition no longer exists.

When the EC-12 senses a failure, the red LED corresponding to the failure mode will illuminate. A failure is stored in memory until the problem is repaired and the EC-12 is reset.

If the status light remains on after the trailer brakes have been actuated, inspect the EC-12 for illuminated LED. Each LED represents a specific area. (See Figure 12-LED Specific Area.)

EC-15 Antilock Controller Assembly Description

General

(See Figure 21—EC-15/CR-15 Antilock System)

Bendix antilock (ABS) systems using the EC-15 electronic controller assembly provide full service, wheel control braking. By minimizing the potential of brake lockup on all wheels during aggressive braking, the vehicle retains a high degree of stability, steering and stopping distance.

To provide full vehicle, wheel control braking, the EC-15 is used in combination with the listed components:

1. Four individual wheel speed sensors.
2. Four air pressure modulator valves.
3. Anti-lock condition lamp dash mounted.

Physical

The EC-15 electronics that regulate the function of the antilock system are contained in die cast aluminum housing, environmentally protected.

The metal housing, coupled with the design of the digital electronics, is intended to provide a high degree of protection from radio and electromagnetic interference.

A diagnostic display window with nine LED(s) and a magnetically actuated reset switch is incorporated in the housing for troubleshooting. (See Figure 21—EC-15 Electronic Controller.)

Two types of electrical connectors are currently used to connect the EC-15 to the antilock system components:

- A single 30 pin Packard Electric, 150 series
- Metri-pack or a pair of 14-pin Deutsch HD 30 series

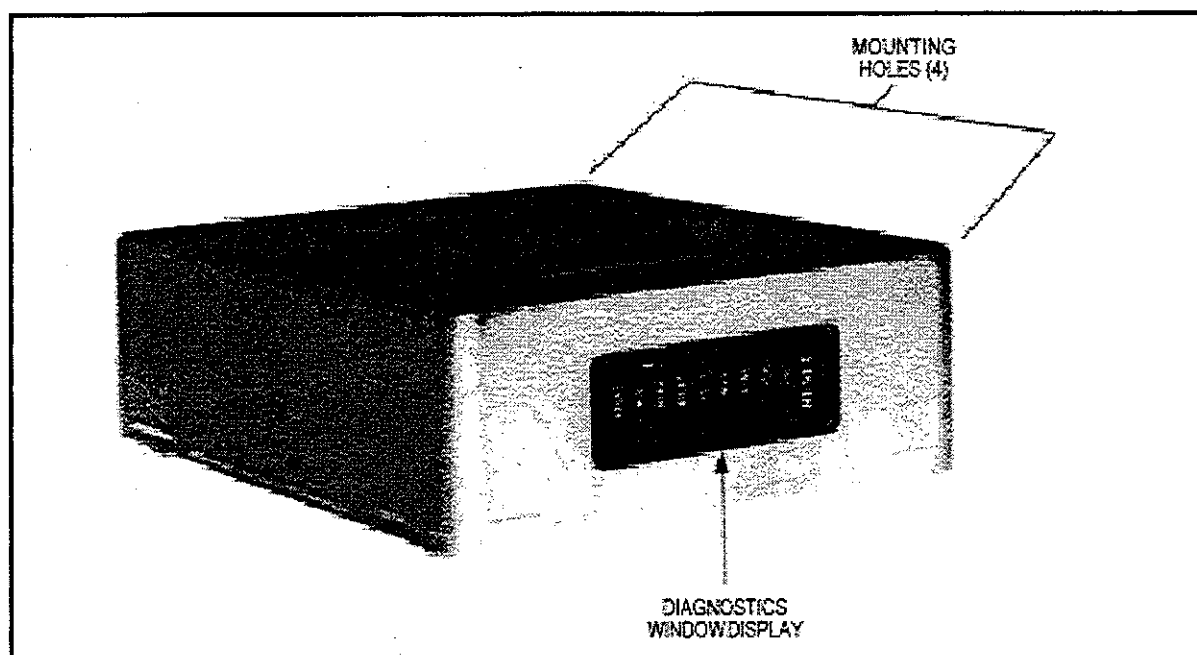


Figure 21—Electronic Controller

Mounting

The CE-15 controller is available in two different mounting styles. One model is designed to be mounted on an antilock relay valve such as the AR-1. (See Figure 22—EC/CR-15 Antilock System.)

The AR-1 is a modified version of the R-12 relay valve. When the EC-15 is mounted on an antilock relay valve, the resulting assembly receives a different designation. (See Figure 23—EC/CR-15 Antilock System.)

For example, when the EC-15 antilock controller is mounted on the AR-1, the resulting assembly is known as a CR-15 antilock controller relay. (See Figure 24—EC-15 mounted on AR-1.)

The other EC-15 model is intended for bracket mounting to a frame member and is not attached to an antilock relay valve.

Controller Inputs/ Outputs

The EC-15 receives data from several components in the antilock system and, based on those inputs, issues commands or delivers information. Some portions of the EC-15 both receive and deliver commands and data.

Input

Wheel speed information is provided to the EC-15 from the wiring harness from individual wheel speed sensors located at or in the vehicle wheels. (See Figure 25—WS 20 Wheel Speed Sensors.)

Working in conjunction with an exciter or tone ring. Wheel speed sensors provide information to the EC-15 in the form of an AC signal that varies in voltage and frequency as the speed of the wheel increases or decreases.

The EC-15 is designed to receive wheel speed information, from various wheel speed sensor models, at the rate of 100 pluses per wheel revolution. The EC-15 is able to simultaneously receive, and individually interpret, speed signals from four wheel speed sensors.

Vehicle power is supplied to the EC-15 from the ignition switch through a fuse or circuit breaker. The electrical ground for the EC-15 is the vehicle chassis.

Output

Modulators, like the Bendix M-21 are the means by which the EC-15 antilock controller is able to modify driver applied air pressure to the service brakes. (See Figure 26—M-21 Modulator.)

The modulator is an electrically controlled air valve. Located near the service actuator(s) it controls the last air valve that air passes through on the way to the brake actuator.

A wiring harness connects the modulator to the EC-15 antilock controller. Solenoid valves contained in the modulator provide the electric interface between the EC-15 controller electronics and the air brake system. The EC-15 is able to simultaneously and independently control four individual modulator assemblies.

A dash light and the electrical relay is connected to, and controlled by, the EC-15. The dash light serves as a means of advising the driver of the condition of the antilock system.

A connection to the engine or transmission retarder is provided on the EC-15 that allows the EC-15 to temporarily disable the retarder during certain modes of operation.

While the EC-15 is capable of this function, and connections are provided, the disable is not always used. Use of the retarder disable function is not essential but highly recommended for vehicles equipped with a retarder.

The data link function enables the EC-15 to report data operating condition to a specialized, external computer in response to certain commands received.

The EC-15 data link configuration conforms to S.A.E. standard J1708 and the protocol, or coded language used, conforms to SAE Standard J1587.

There are two connections to the EC-15 devoted to the data link. While the EC-15 is capable of this function, and connections are provided, it is not always used. Use of the data link is not essential for the EC-15 to be functional.

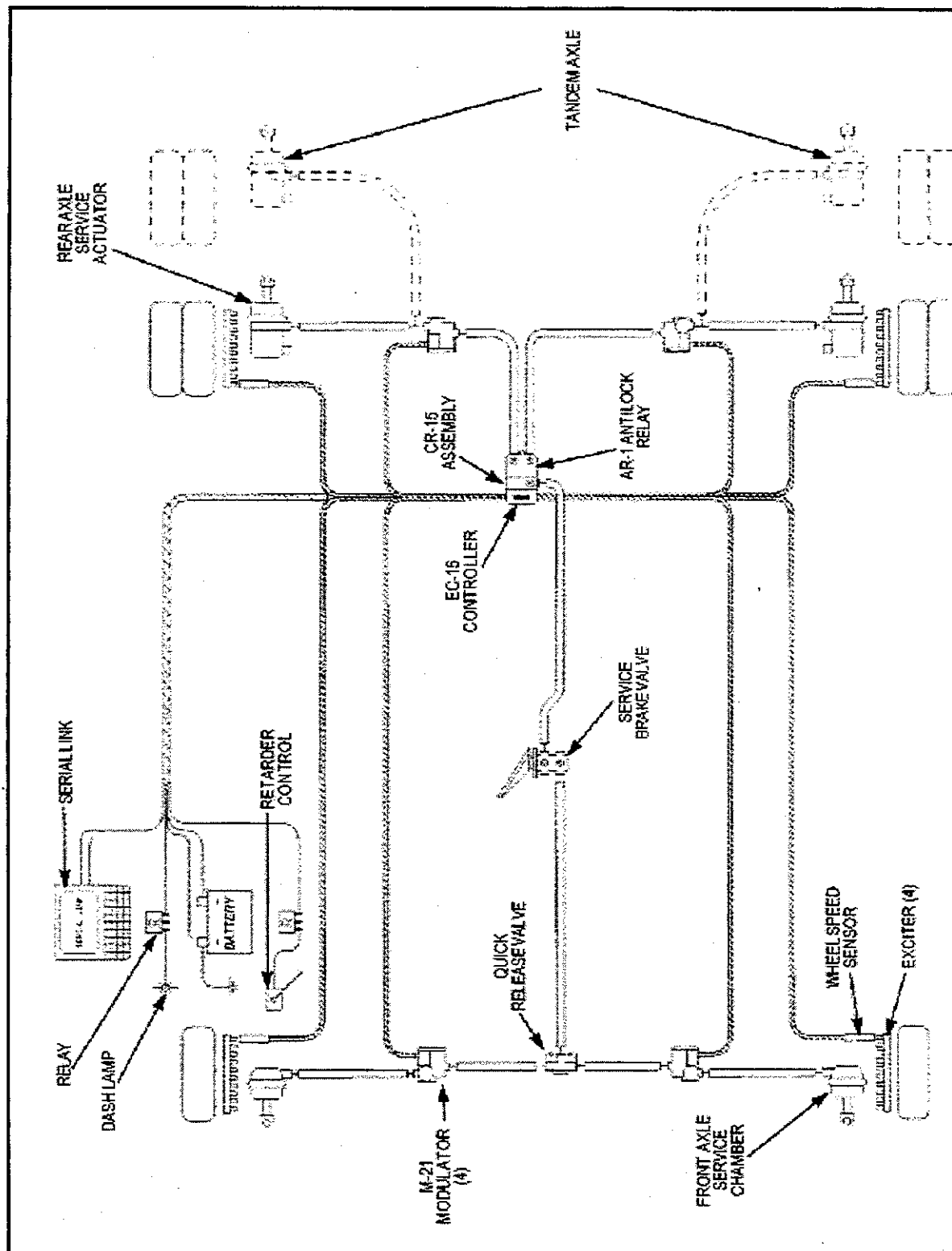


Figure 22—EC/CR-15 Antilock System

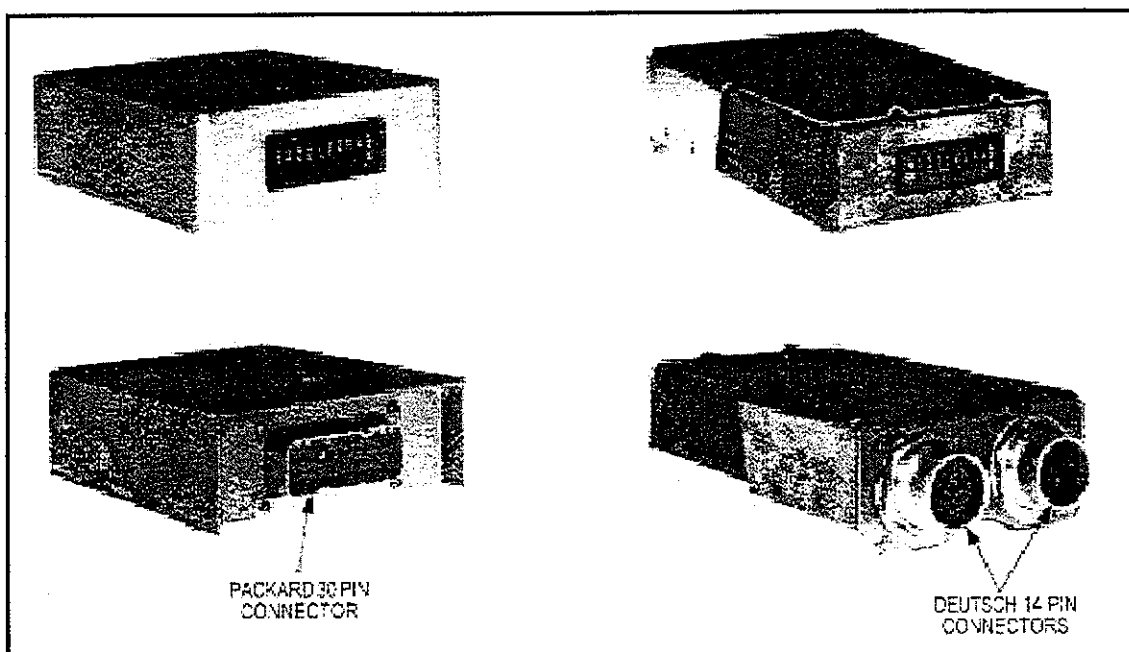


Figure 23—EC-15 Controller and Connector Styles

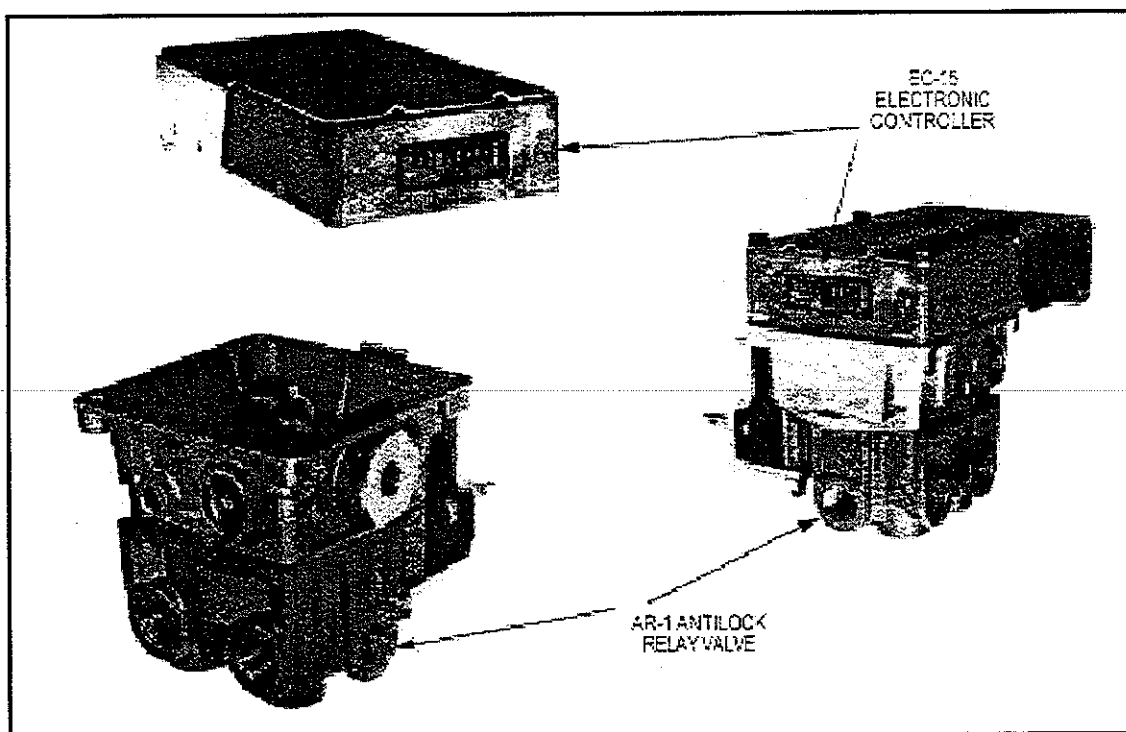


Figure 24—EC-15 Mounted on AR-1

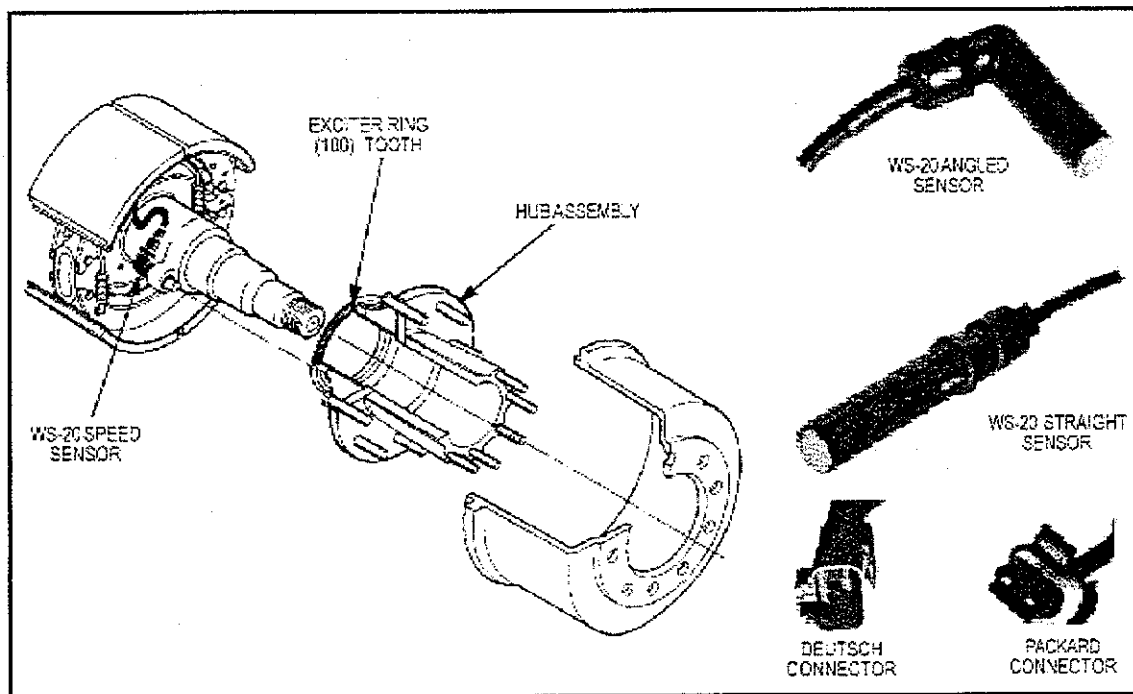


Figure 25—WS-20 Wheel Speed Sensors

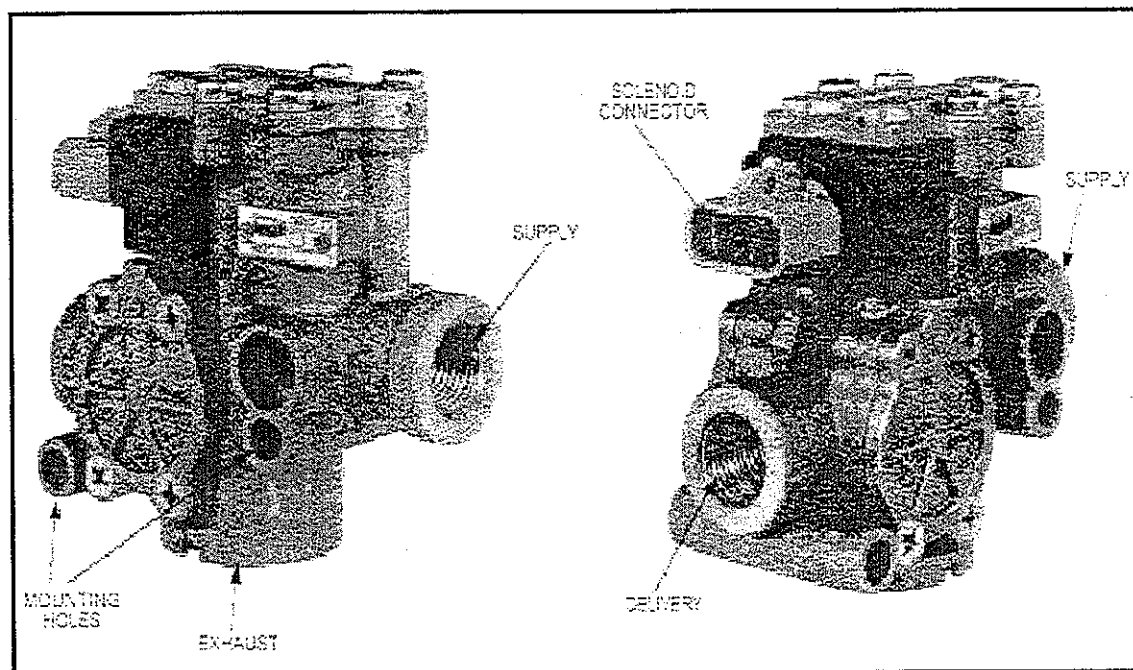


Figure 26—M-21 Modulator

Operation

General

The EC-15 antilock system provides individual wheel control by using a wheel speed sensor and modulator at each wheel. Monitoring the rate of deceleration during braking, and then adjusting the brake application pressure at each wheel, the EC-15 does provide improved braking while maintaining stability.

The rear axle brakes are controlled completely independent of each other. Brake application pressure at an individual wheel is adjusted solely based on wheel behavior on the road surface.

While each steering axle brake is under the control of an individual modulator, the EC-15 does not read these brakes totally independent of each other. The EC-15 USES a modified individual control for the steering axle brakes. This is done in order to minimize steering wheel pull in the event each wheel is traveling on a different road surface.

Essentially the EC-15 controls the braking force differently between the two brakes. The wheel on dry pavement is initially given less braking and is taken up to optimum during the stop, while the wheel on ice attempts to maintain optimum braking during the entire stop.

In the case of vehicles equipped with tandem rear axles, the wheel speed sensors are installed at the wheels on the axles that are most likely to lose traction first.

A single modulator controls both curbside brakes on the tandem, and another modulator controls both brakes on the driver's side of the tandem. With this configuration of the speed sensors and modulators, both brakes on one side of the tandem are treated as one since they will most likely be on the same type of surface.

Non-Antilock Brake Application

During normal braking, air pressure from the brake valve enters the control port of the service relay valve, either an antilock or a standard relay. The service relay delivers air to and through, the antilock modulator located near the braked wheel, and into the brake actuator.

The service brakes are applied. If the wheel sensors do not detect an impending wheel lockup, the EC-15 does not initiate any corrective action and the vehicle comes to a stop in a normal way.

Antilock Controlled Brake Application - System Fully Operational

If a service brake application is made and the wheel speed sensor detects an impending wheel lockup, the EC-15 controller will immediately begin modification of the brake application using the antilock modulator(s) at the affected wheel(s).

Solenoid valves in the modulator are energized and de-energized by the EC-15 controller to modify the brake application. When a solenoid coil is energized a shuttle moves, and depending on the function of the specific solenoid, the shutter opens or closes, causing the exhaust or re-application of air pressure to the brake actuator. The solenoids in each modulator are controlled independently by the EC-15. By opening and closing the solenoid valves in the correct modulator, the EC-15 is actually simulating what the driver does when he/she pumps the brakes.

Unlike the driver, the EC-15 controller is able to pump each brake independently and with speed, and accuracy.

Antilock System Operation - Component Failure

The Bendix EC-15 does equipment failure using a conservative fail-safe. Any single electrical failure of a component devoted to antilock braking, results in an immediate illumination of the antilock condition lamp on the dash. A disabling of all or part of the antilock system, and return to standard braking on wheels no longer under the control of antilock.

Note

Right and left, front and rear are determined from the driver's seat.

- When there is operating wheel equipment, modulator, wheel speed, or sensor/exciter failure, the EC-15 divides and separates the brakes diagonally. The antilock will continue to

function on the left front and right rear wheels and will remain under the control of the EC-15

- Depending on the type of failure and the position of occurrence the EC-15 either disables all, or only a part, of the antilock system.
- A power or controller failure will result in complete disabling of the antilock system and return to standard braking on all wheels. Two or more failures, regardless of the position, will also result in the disabling of the entire system.
- With the failed component, the vehicle will retain improved braking stability after a single failure. A driver must remember that when there is a degraded antilock operation indicated on the dash, there is still standard braking.

Antilock Wiring

The wiring that carries data and power into and out of the EC-15 are grouped and terminate at a connector. The wire groups or wire harnesses along with the connectors are most often specified and or supplied by the vehicle manufacture. (See Figure 27—EC-15 Deutsch Connectors and Figure 28—EC-15 Packard Connectors.)

- Connectors are weatherproof and the wires are sealed to the connector. The wire gauge used in the wire harnesses is specific to the task performed.
- When diagnosing wiring in the antilock system the following general rules apply and should be observed where applicable.
- It is generally advisable to replace a wire harness rather than repair individual wires. If a splice repair must be made, make sure that the splice is properly soldered with rosin flux; do not use acid base flux. Make sure the repair is waterproof.

- Do not pierce wire insulation when testing. Check for power, ground or continuity by disconnecting the connector and testing the individual pins or sockets in the connector.
- Always check the vehicle handbook for wire and connector identification. Individual wire identification will be different depending on the type of connector, manufacturer and the system feature.
- While the retarder, disable and serial link connector three total are on all EC-15 controllers they are not always used.

Preventative Maintenance

Every three months 25,000 (40234 km) miles or 900 operating hours.

1. Inspect all wiring and connectors for visible damage.
2. Inspect EC-15 LED controller for function. Turn ignition on. Hold a 800 gauss magnet capable of picking up 3 ounces (85.1 g) held to the reset switch should cause all of the LED(s) to illuminate. (See Figure 29—Diagnostic Window.)

Note

If one or more of the LED(s) do not illuminate and the antilock condition lamp on the dash indicates the system is functioning properly. Record the non-illuminated LED(s) for future reference.

Although the diagnostic capabilities will be limited, the system will continue to function as designed.

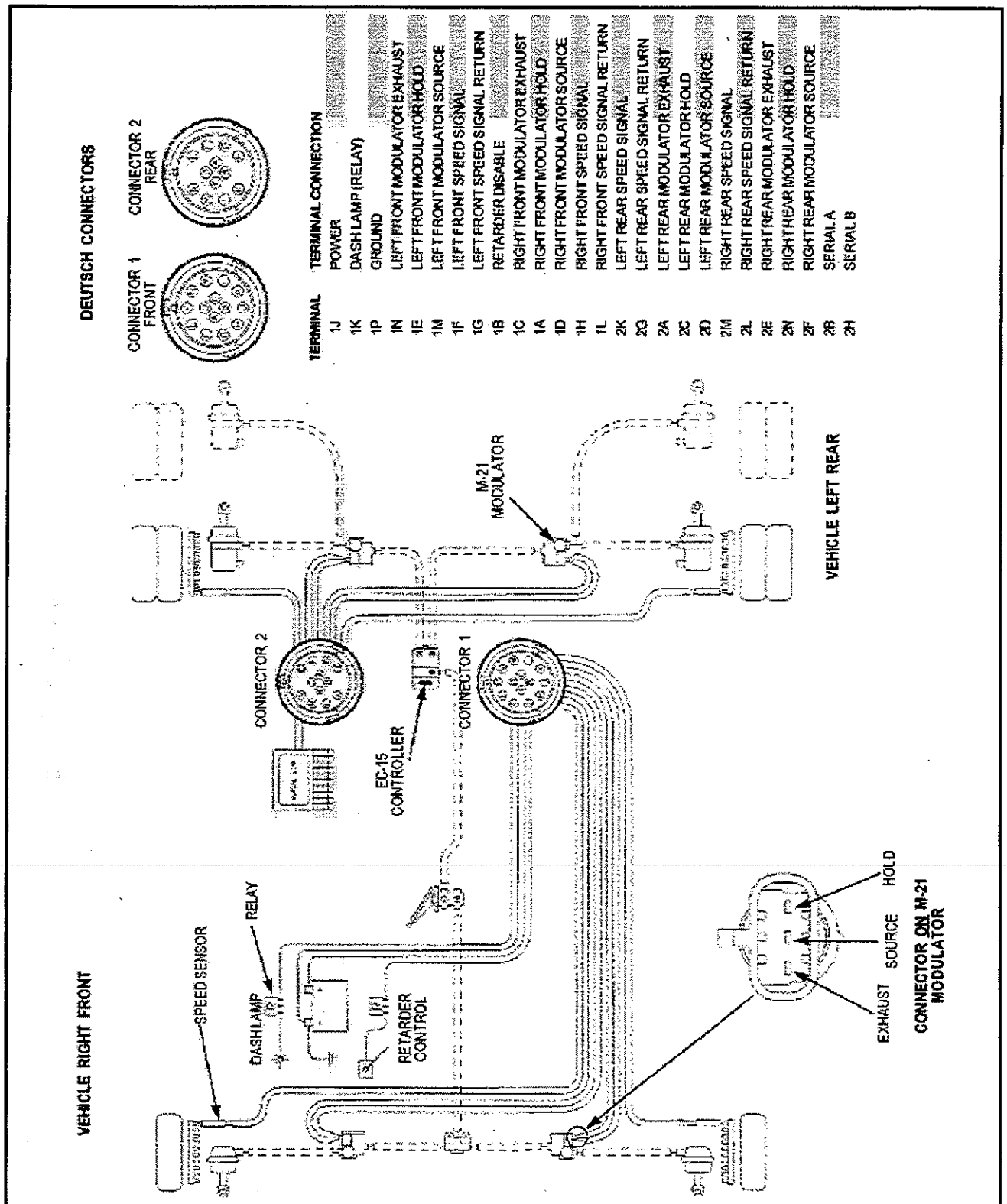


Figure 27—Wiring for EC-15 with Deutsch Connectors

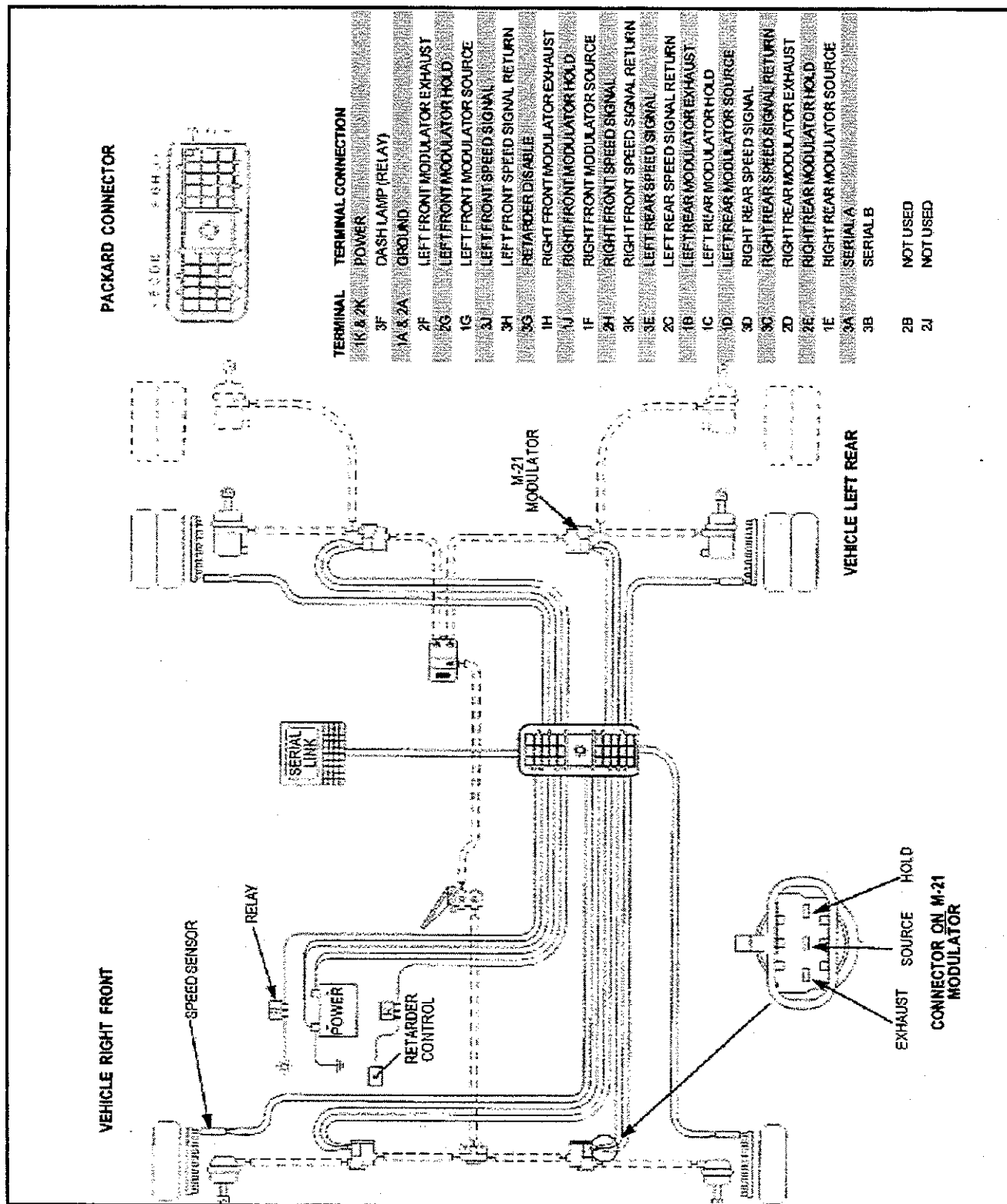


Figure 28—Wiring for EC-15 With Packard Connectors

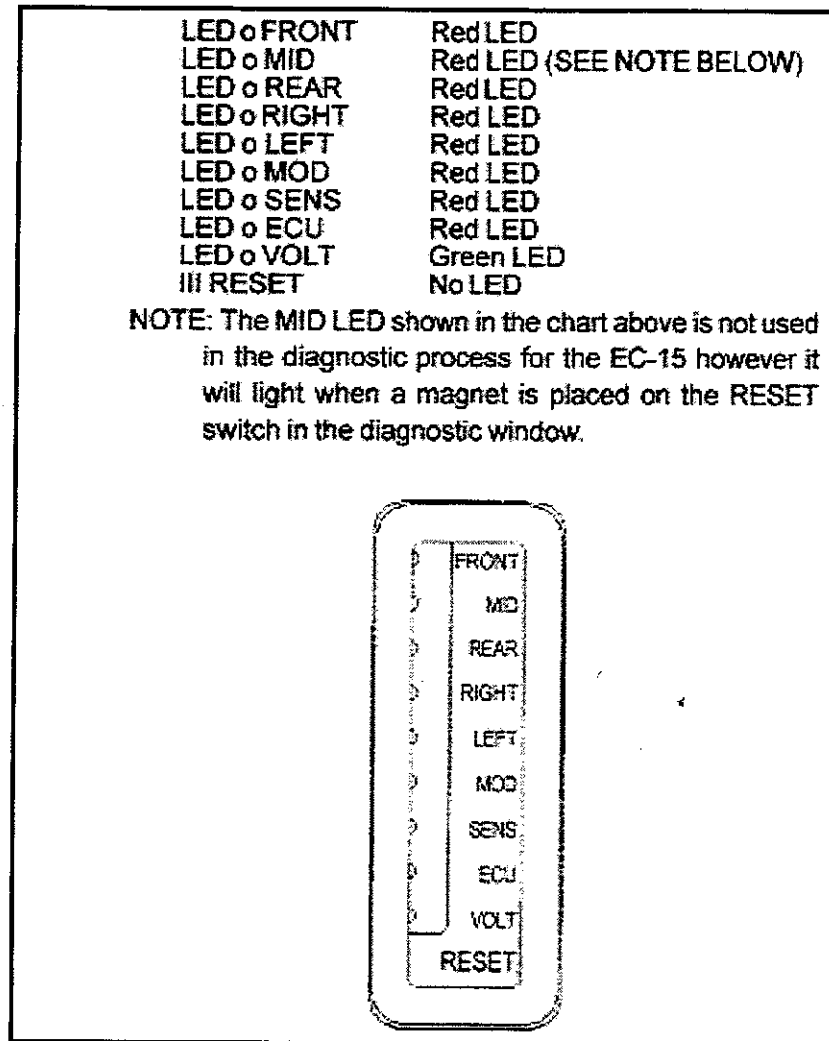


Figure 29—Diagnostic Window

- Road test vehicle by making antilock stop from a vehicle speed of 20-mph (31 km/h). When an antilock stop is made, the modulator solenoids pulsate with a audible burst of air. The wheels should not have a prolonged lock condition.

Caution

Disconnect the battery. Never disconnect any air line or hose without relieving air pressure. Never exceed recommended pressures. Replace all damaged parts with equivalent size, type and strength. Do not weld or machine parts without approval from the vehicle or component manufacturer.

Removing the EC-15 Controller Assembly

EC-15 Mounted on Antilock Relay Valve

- Identify and record all air lines connected to the EC-15.
- Disconnect the electric connector(s) from the EC-15.
- Mark and record all mounting positions of the controller/relay valve assembly on the vehicle.
- Save all removed nuts, washers and all mounting hardware.
- Remove the relay valve and EC-15 controller assembly from the vehicle.

Warning

Solvent is toxic to skin, eyes, and respiratory tract. Skin and eye protection is required. Use in a well-ventilated area.

Caution

Do not allow solvent to come in contact with ECU connector or solenoids.

6. Clean exterior of the assembly.
7. Mark and record the position of the EC-15 relative to the antilock relay valve.
8. Remove and retain the four cap screws that secure the EC-15 to the antilock relay valve.

Caution

Do not damage the gasket between the two components. Discard old gasket if damaged.

9. Remove the EC-15 from the antilock relay.

Bracket Mounted EC-15

1. Disconnect the electrical connector(s) from the EC-15.
2. Mark and record the mounting position of the EC-15 on the vehicle.
3. Remove and save the nuts from the mounting hardware.
4. Remove the EC-15 controller and bracket from vehicle. Retain the four cap screws.
5. Remove the EC-15.

Installing the EC-15 Controller Assembly

Mounted EC-15 to Antilock Relay Valve

1. Align gasket on the EC-15.
2. Align and install EC-15 to the antilock relay valve.

3. Torque the four capscrews 50 to 80 inch-pounds (5.7 to 9.0 N•m).
4. Orient the assembled EC-15 and antilock relay valve as prerecorded on the vehicle.
5. Connect all airlines.
6. Connect the electrical connector(s) to the EC-15.
7. Test the antilock relay valve for operation and leaks before placing vehicle in service.
8. Perform the initial startup procedure. (Reference Troubleshooting section..)

Bracket Mounted EC-15

1. Install the EC-15 to the bracket.
2. Torque four capscrews 50 to 80 inch-pounds (5.7 to 9.0 N•m).
3. Mount the EC-15 on to the vehicle using hardware from disassembly.
4. Connect the electrical connector(s) to the EC-15.
5. Perform the initial startup procedure. (Reference Troubleshooting section.)

Diagnosing and Locating a System Problem

General

The EC-15 contains self-test and diagnostic circuitry that continuously checks for proper operation of the entire antilock system, including wiring continuity.

A dash lamp, controlled by the EC-15, advises the driver of the condition in the antilock. The condition of specific antilock components is provided to the mechanic by a series of labeled, LED(s) displayed through a window in the EC-15 housing.

No special tools or equipment is required to read or interpret the EC-15 diagnostics window. The EC-15 diagnostic display is separate from the antilock condition lamp on the dash. With this separation,

the driver is aware of any problems that occur but is not confused by the diagnostic information.

A special feature of the EC-15 controller is the failure latching and diagnostic system. Intermittent problems, particularly in the wheel speed sensing area, can be difficult to diagnose. When the controller senses a bad condition, whether in the controller electronics, the modulator or wheel speed sensing areas, the controller stores the condition in non-volatile memory. It also disables the antilock function and illuminates the dash mounted antilock condition lamp and the appropriate diagnostic LED(s) on the EC-15.

The failure condition is truly stored and is not cleared by loss of power to the EC-15. The LED(s) will re-light when power is restored and remain illuminated until the failure is corrected. After the actual problem is corrected, maintenance personnel can clear or reset the EC-15 diagnostics by passing a small magnet over the reset point in the diagnostics window.

Diagnostic LEDs

There is nine LEDs plus a magnetically actuated reset switch in the EC-15 diagnostic window. The first five LEDs locate a problem to a specific area of the vehicle while the other four indicate the problem component or the wiring.

Note

Right and left, front and rear are determined from the driver's seat. Left front is the corner closest to the driver.

The LEDs are software driven and are either ON or OFF depending upon their monitor function, see Table 3—EC-15 Diagnostic Window.

Note

The MID LED shown in the Table 2 is not used in the diagnostic process for the EC-15.

Note

The MID LED will light when a magnet is placed on the reset switch in the diagnostic window.

LED	FRONT	RED	LED
LED	MID	RED	LED
LED	REAR	RED	LED
LED	RIGHT	RED	LED
LED	LEFT	RED	LED
LED	MOD	RED	LED
LED	SENS	RED	LED
LED	ECU	RED	LED
LED	VOLT	GREEN	LED
RESET		NO LED	

Table 2—EC-15 Diagnostic Window

FRONT LED	MID LED	REAR LED
The Red LED illuminates and latches ON in order to indicate the location of a problem component or the wiring. The LED will light in conjunction with either the right or left LED and the mod or sensor LED	This Red LED is not used in troubleshooting the EC-15 and should light only when a magnet is held on the reset switch.	The Red LED illuminates and latches ON in order to indicate the location of a problem component or the wiring. The LED will light in conjunction with either the right or left LED and the mod or sensor LED
RIGHT LED	LEFT LED	MOD LED
The Red LED illuminates and latches ON in order to indicate the location of a problem component or the wiring. The LED will light in conjunction with either the right or left LED and the mod or sensor LED	The Red LED illuminates and latches ON in order to indicate the location of a problem component or the wiring. The LED will light in conjunction with either the right or left LED and the mod or sensor LED	This Red LED illuminates and latches ON to indicate a permanent or intermittent open or short circuit in the solenoids of one of the four modulators or the wiring connecting it to the system.
SENS LED	ECU LED	VOLT LED
The Red LED illuminates and latches ON to indicate a permanent or intermittent open or short circuit in the solenoids of one of the four modulators or the wiring connecting it to the system.	This Red LED when illuminated indicates that the controller has failed. It is latched ON for all EC-15 failures except low voltage. For voltages less than 9VDC , the LED illuminates to indicate the controller is inoperative. However, when the voltage again exceeds 9VDC the LED will go out.	This Green LED illuminates and remains ON during vehicle operation to indicate that vehicle power is reaching the controller. If vehicle power is out of range for proper operation (below 11 VDC or above 17 VDC) this LED will flash until power is in range.

Table 3—EC-15 Diagnostic Table

Reset LED
Under the reset area of the window display is a magnetically sensitive switch that is used to reset the diagnostic system. The device will respond to a magnet that has strength sufficient to lift a three ounce weight (85.1 g) . Holding a magnet against the reset will cause all LED(s) to light during the time the magnet is against it.

Table 3—EC-15 Diagnostic Table (continued)

Troubleshooting

General

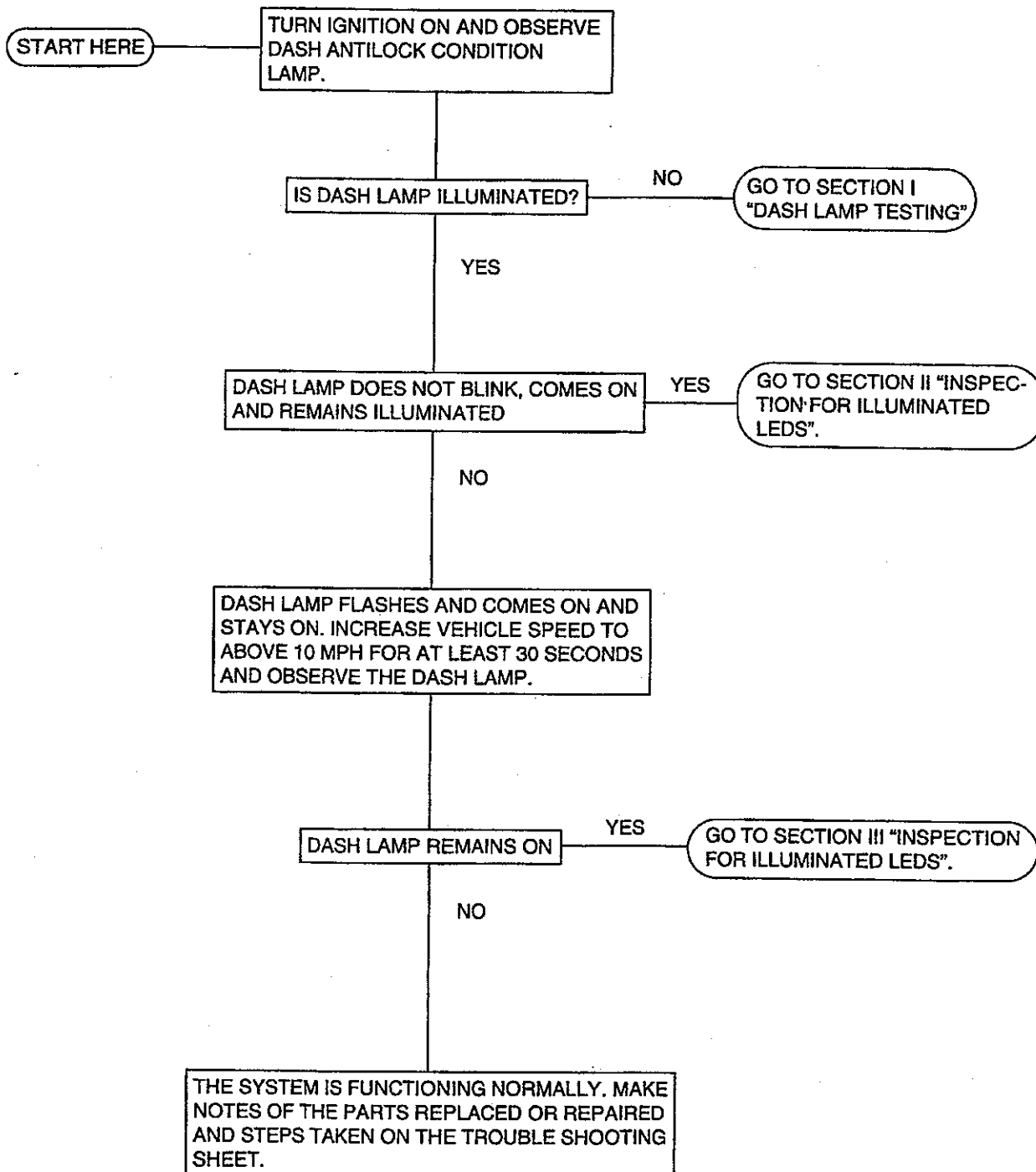
While the EC-15 diagnostic display locates a specific problem area, it is necessary to confirm whether the problem is in the component or in the wiring. The troubleshooting procedure that follows is a flow chart narrowing the problem to either the wiring or a specific antilock component.

Troubleshooting Suggestions

1. All troubleshooting begins by observing the antilock condition lamp on the dash. Troubleshooting should begin by performing the Initial Start-up and observing the flow chart.
2. The troubleshooting technician should record all findings and actions taken during the procedure.
3. No voltage or resistance tests are performed into the EC-15. Beginning at the wire harness half of the connector and moving away from the EC-15 toward an antilock system component, perform all voltage and resistance tests.

TROUBLESHOOTING

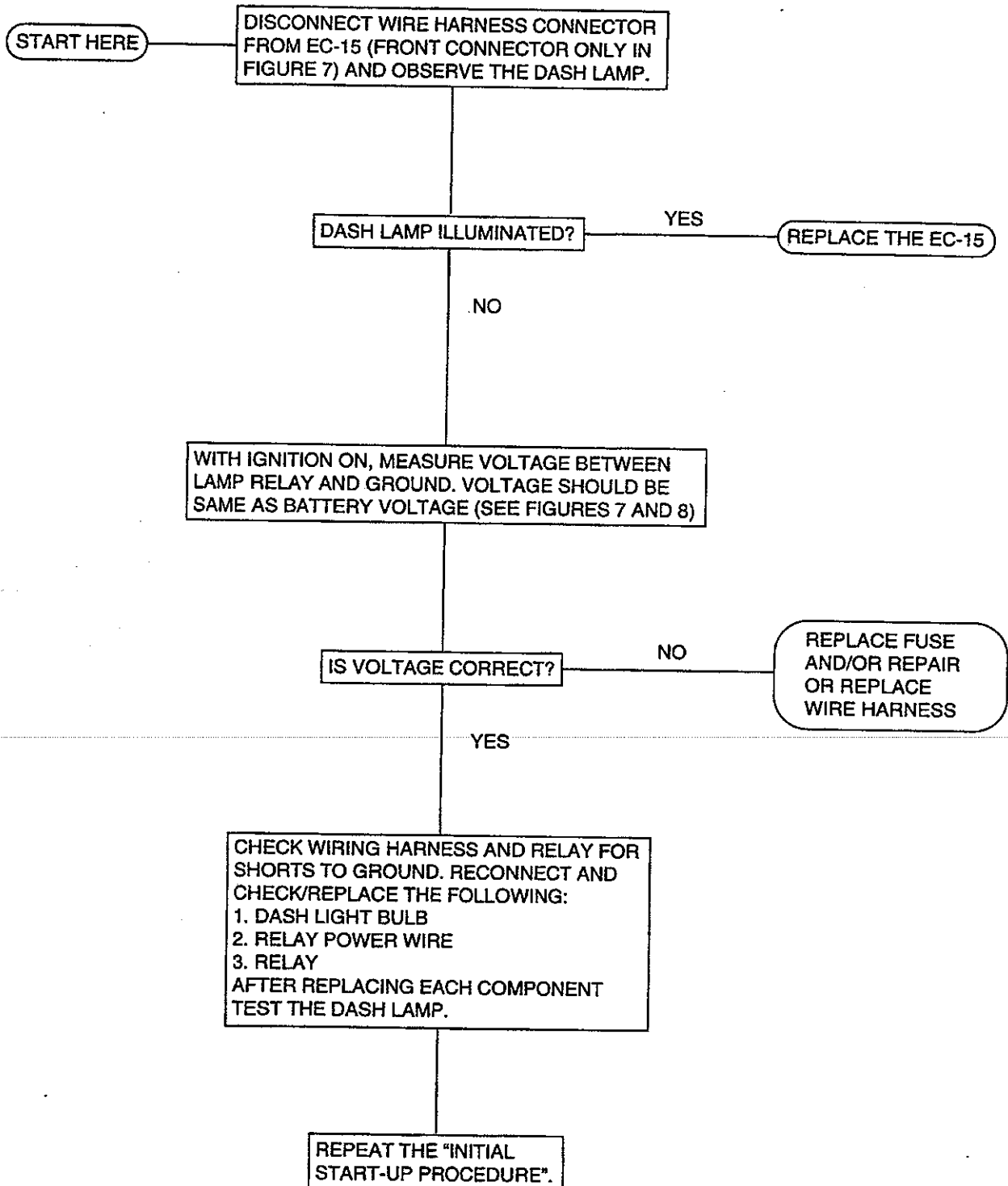
INITIAL START-UP PROCEDURE



Flow Chart 1—Initial Start-Up Procedure

TROUBLESHOOTING

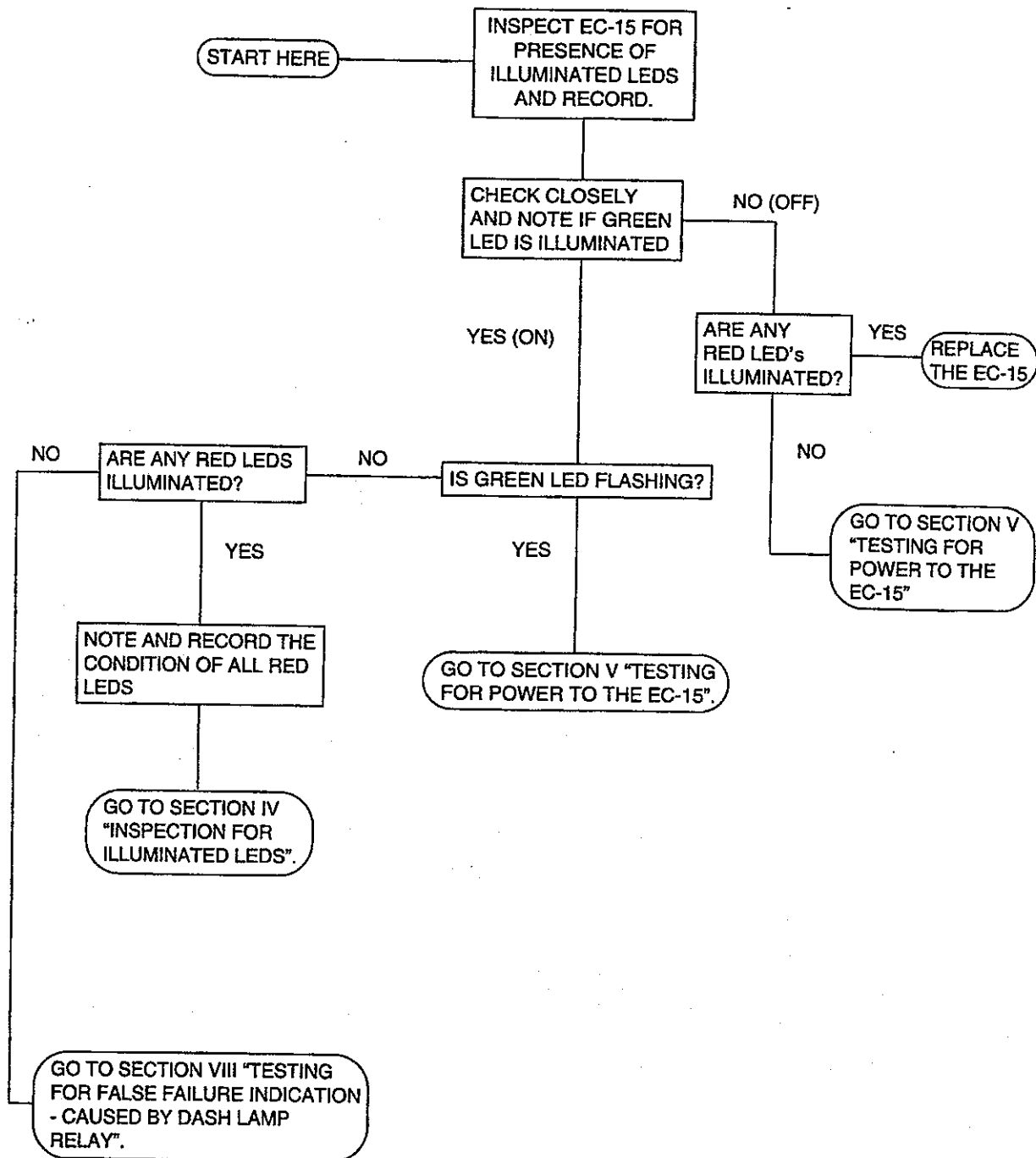
SECTION I - DASH LAMP TESTING



Flow Chart 2—Dash Lamp Testing

TROUBLESHOOTING

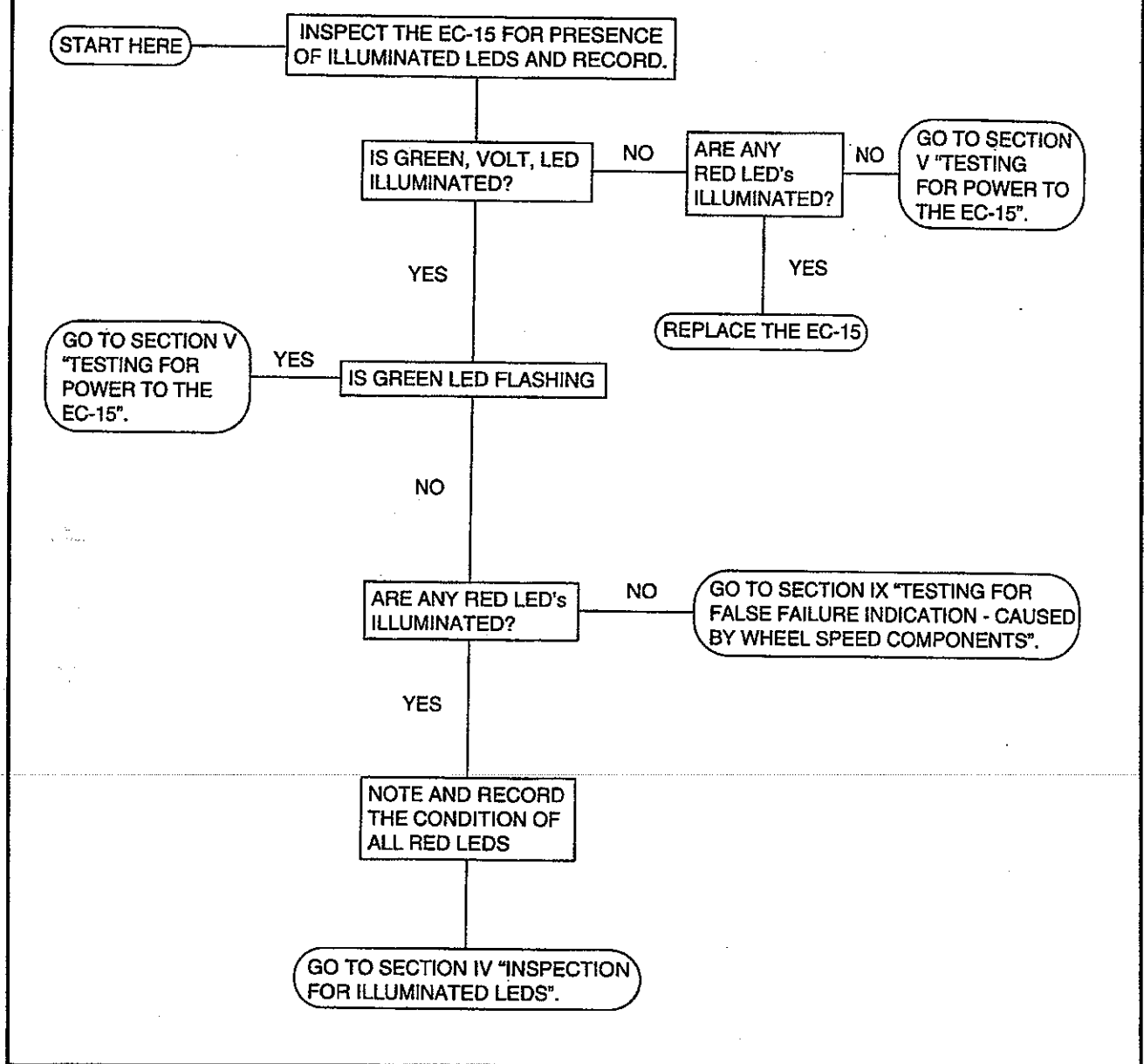
SECTION II - INSPECTION FOR ILLUMINATED LEDS



Flow Chart 3—Inspection for Illuminated LED(s)

TROUBLESHOOTING

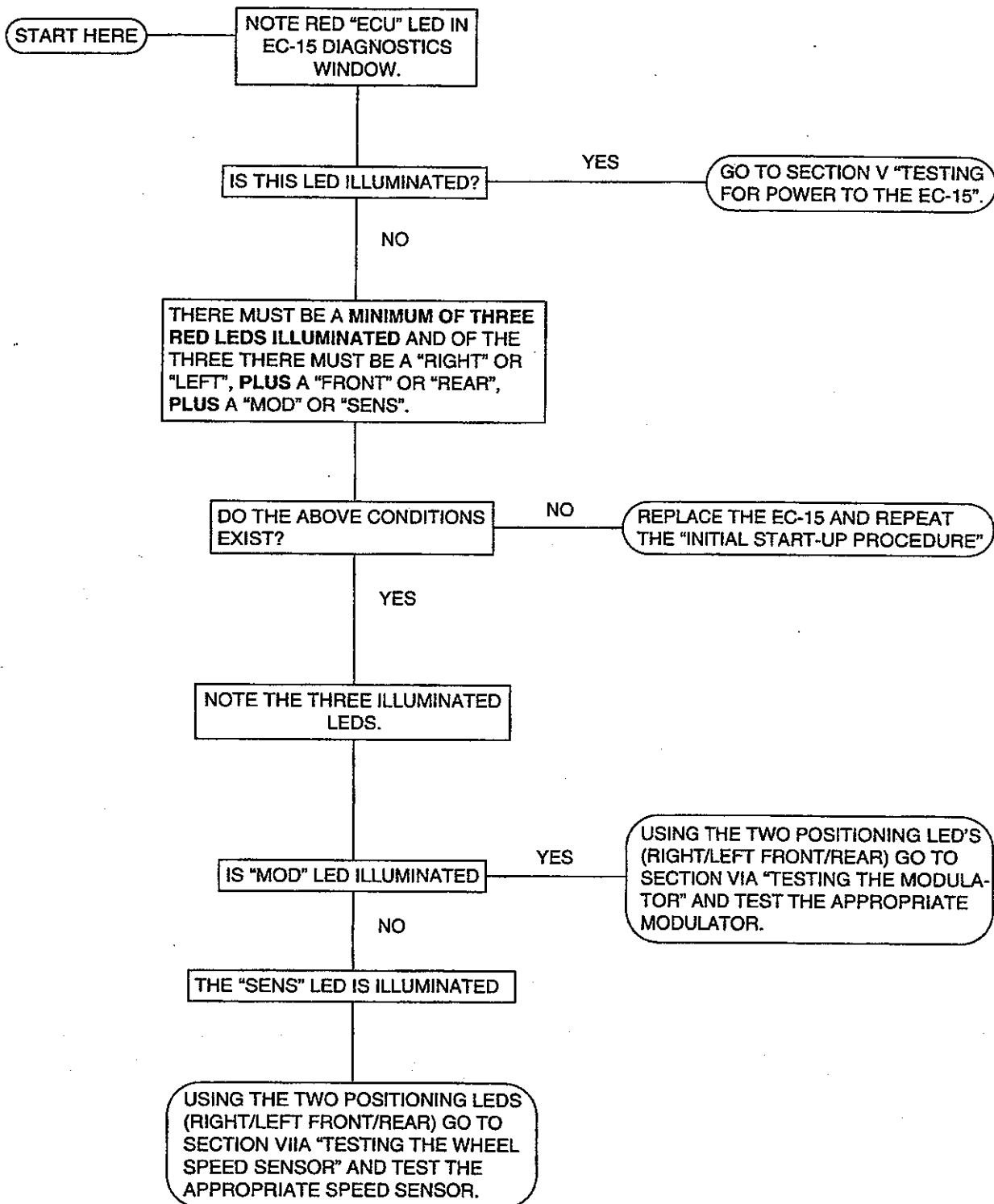
SECTION III - INSPECTION FOR ILLUMINATED LED's



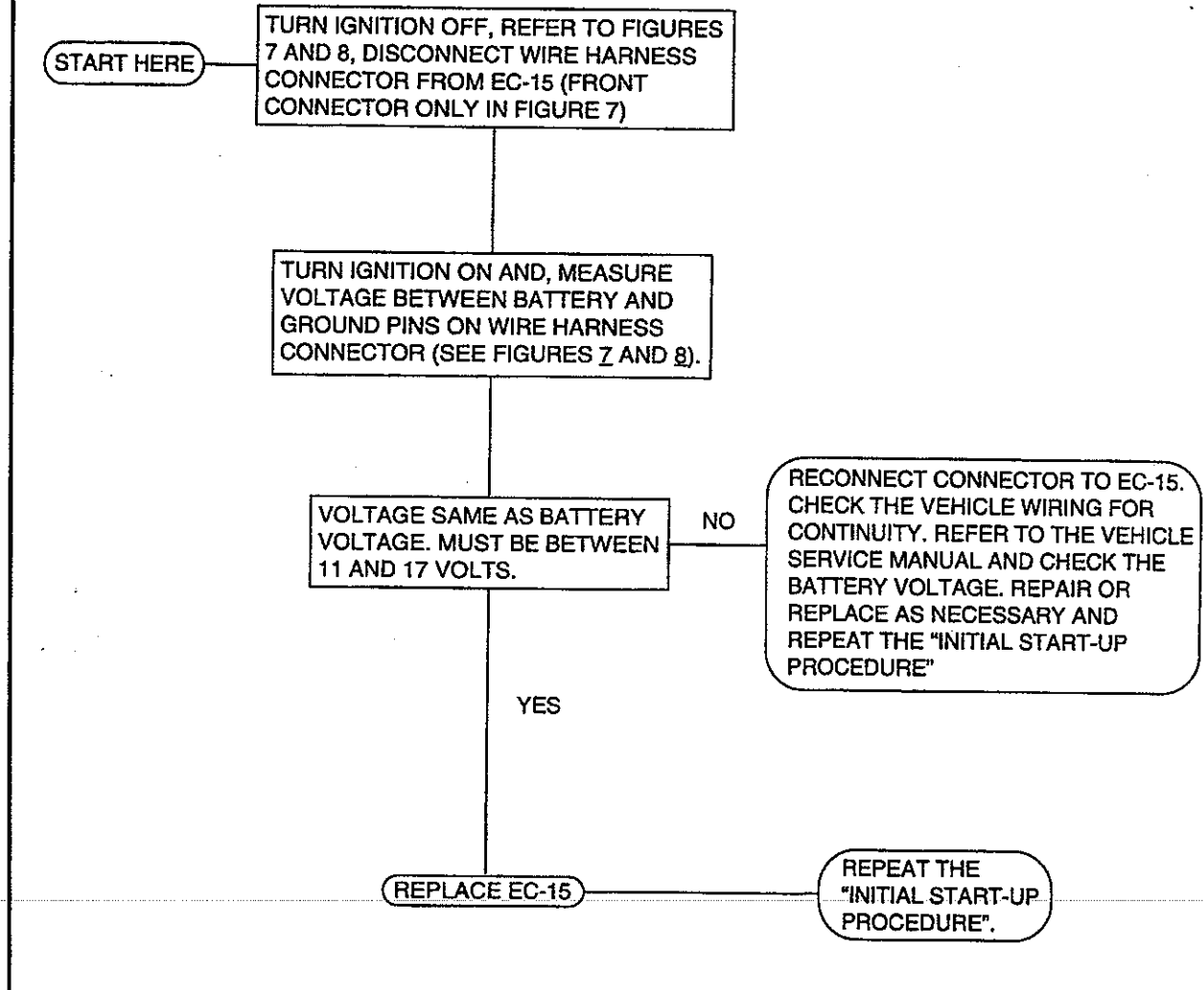
Flow Chart 4—Inspection for Illuminated LED(s)

TROUBLESHOOTING

SECTION IV - INSPECTION FOR ILLUMINATED LEDS

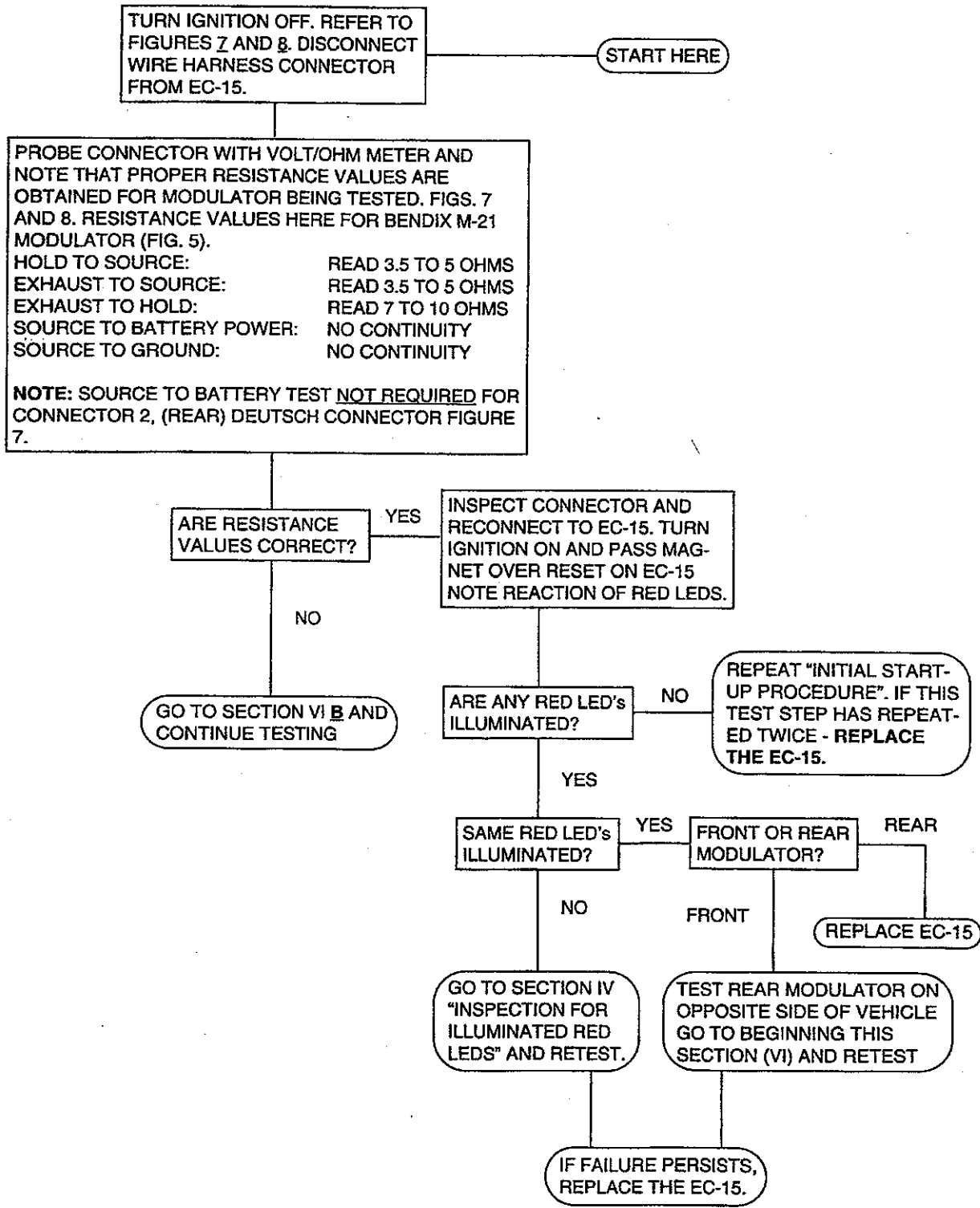


Flow Chart 5—Inspection for Illuminated LED(s)

TROUBLESHOOTING**SECTION V - TESTING FOR POWER TO THE EC-15****Flow Chart 6—Testing for Power to the EC-15**

TROUBLESHOOTING

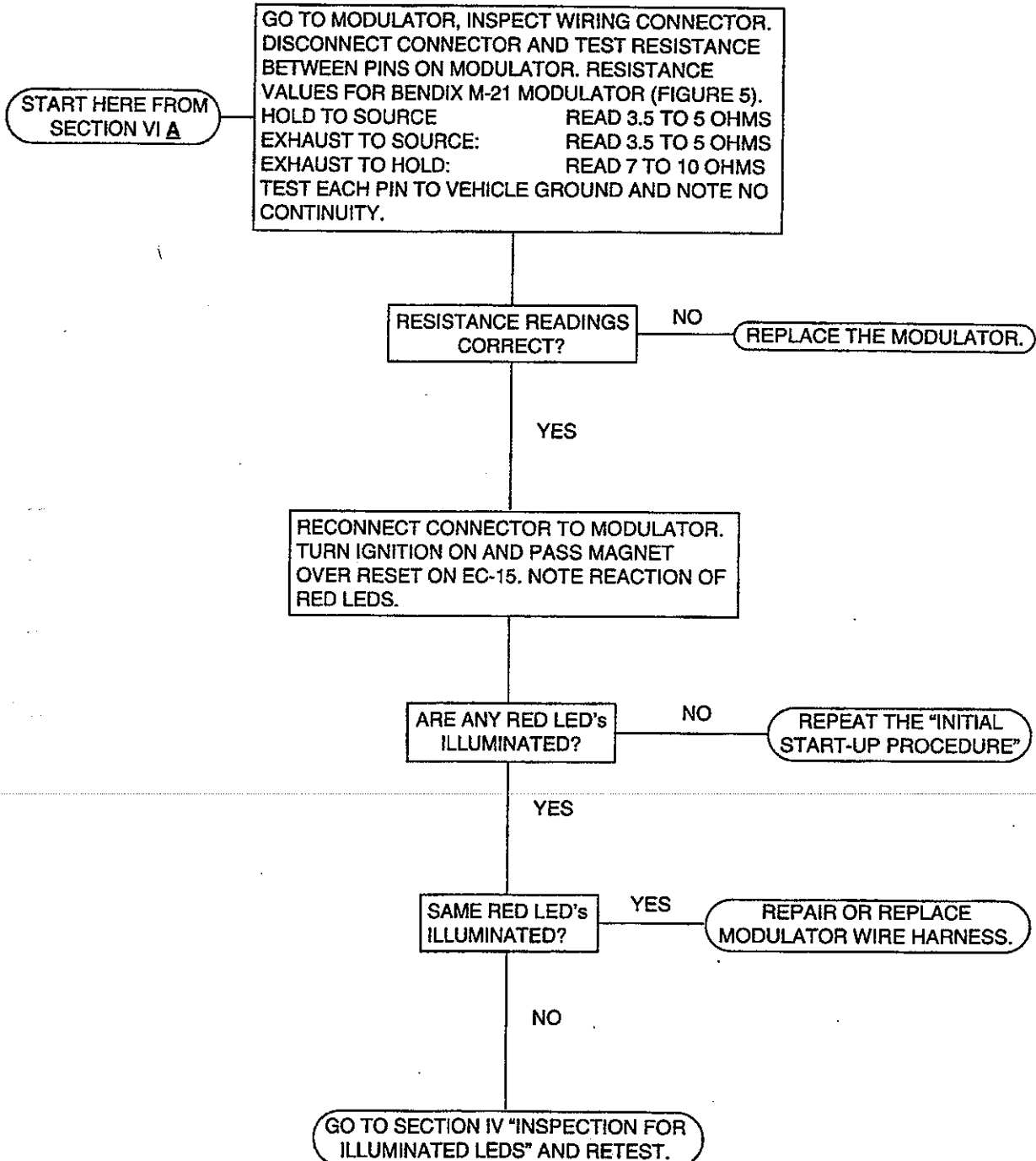
SECTION VI A - TESTING THE MODULATOR



Flow Chart 7—Testing the Modulator

TROUBLESHOOTING

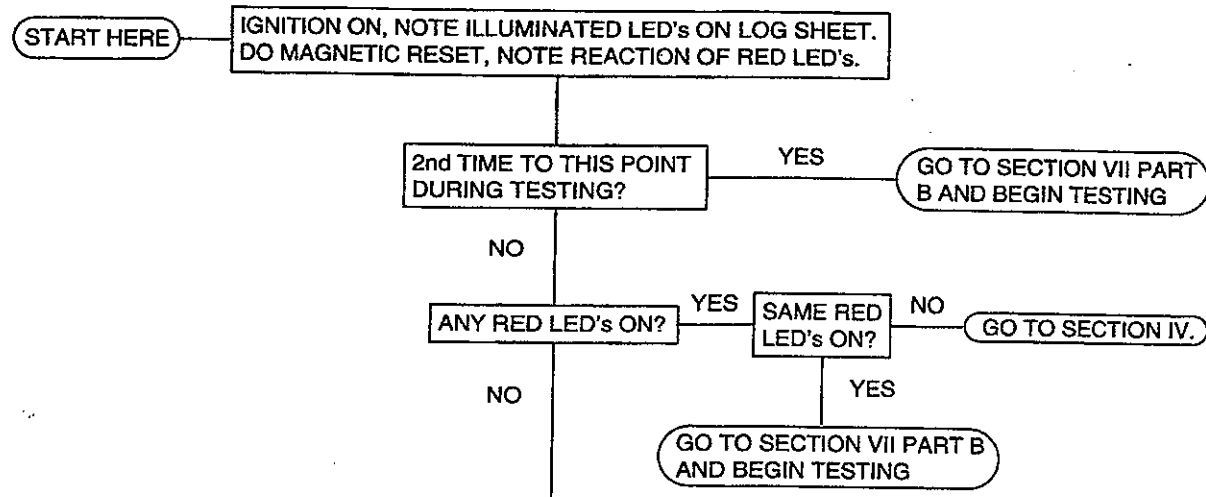
SECTION VI B - TESTING THE MODULATOR



Flow Chart 8—Testing the Modulator

TROUBLESHOOTING

SECTION VII PART A - TESTING THE WHEEL SPEED SENSOR



TURN IGNITION OFF AND CHECK FOLLOWING:

- REMOVE CONNECTOR(S) FROM EC-15 AND MEASURE RESISTANCE BETWEEN APPROPRIATE SPEED SENSOR SIGNAL (+) AND SIGNAL RETURN (-). RESISTANCE FOR BENDIX WS-20 SPEED SENSOR IS BETWEEN 1500-2500 CHMS. REFER TO VEHICLE MAINTENANCE MANUAL IF OTHER THAN THE WS-20 IS IN USE. (REFER FIG. 8) IF RESISTANCE NOT CORRECT, DISCONNECT CONNECTOR AT SPEED SENSOR. INSPECT CONNECTOR, THEN CHECK RESISTANCE BETWEEN PINS ON SENSOR. IF RESISTANCE IS NOT CORRECT (BETWEEN 1500-2500 OHMS FOR THE BENDIX WS-20), REPLACE SENSOR, OTHERWISE PROCEED TO STEP B.
- CHECK "GAP" BETWEEN SPEED SENSOR AND EXCITER OR TONE RING. (GAP FOR BENDIX WS-20, SPEED SENDER IS BETWEEN 0 - .015 INCHES) IF SENSOR GAP MUST BE ADJUSTED, CHECK FOR LOOSE OR WORN WHEEL BEARINGS BEFORE RE-GAPPING SENSOR. REFER TO VEHICLE MAINTENANCE MANUAL FOR WORN BEARINGS.
- IF SENSOR GAP IS CORRECT CHECK WHEEL BEARING FOR FREE PLAY TO VERIFY IT COMPLIES TO MANUFACTURER'S RECOMMENDATIONS.
- MAKE CERTAIN EXCITER OR TONE RING IS IN PLACE AND INSPECT CONDITION. CHECK FOR MISSING OR DAMAGED TEETH AND THAT IT RUNS TRUE AND PERPENDICULAR TO SENSOR FACE.
- CHECK WIRING HARNESS AND CONNECTORS THAT RUN TO SENSOR.
- CHECK FOR DRAGGING BRAKES (OVER ADJUSTED, TRAPPED AIR IN ACTUATOR, OUT OF ROUND DRUMS, FAULTY RETURN SPRINGS, PARKING BRAKE SYSTEM FAULTS, ETC.) AND CORRECT AND RETEST.

RECONNECT CONNECTORS AT EC-15 AND SPEED SENSOR, DO MAGNETIC RESET. NOTE RED LED's.

ARE ANY RED LED's ILLUMINATED?

YES

GO TO SECTION III "INSPECTION FOR ILLUMINATED LED's."

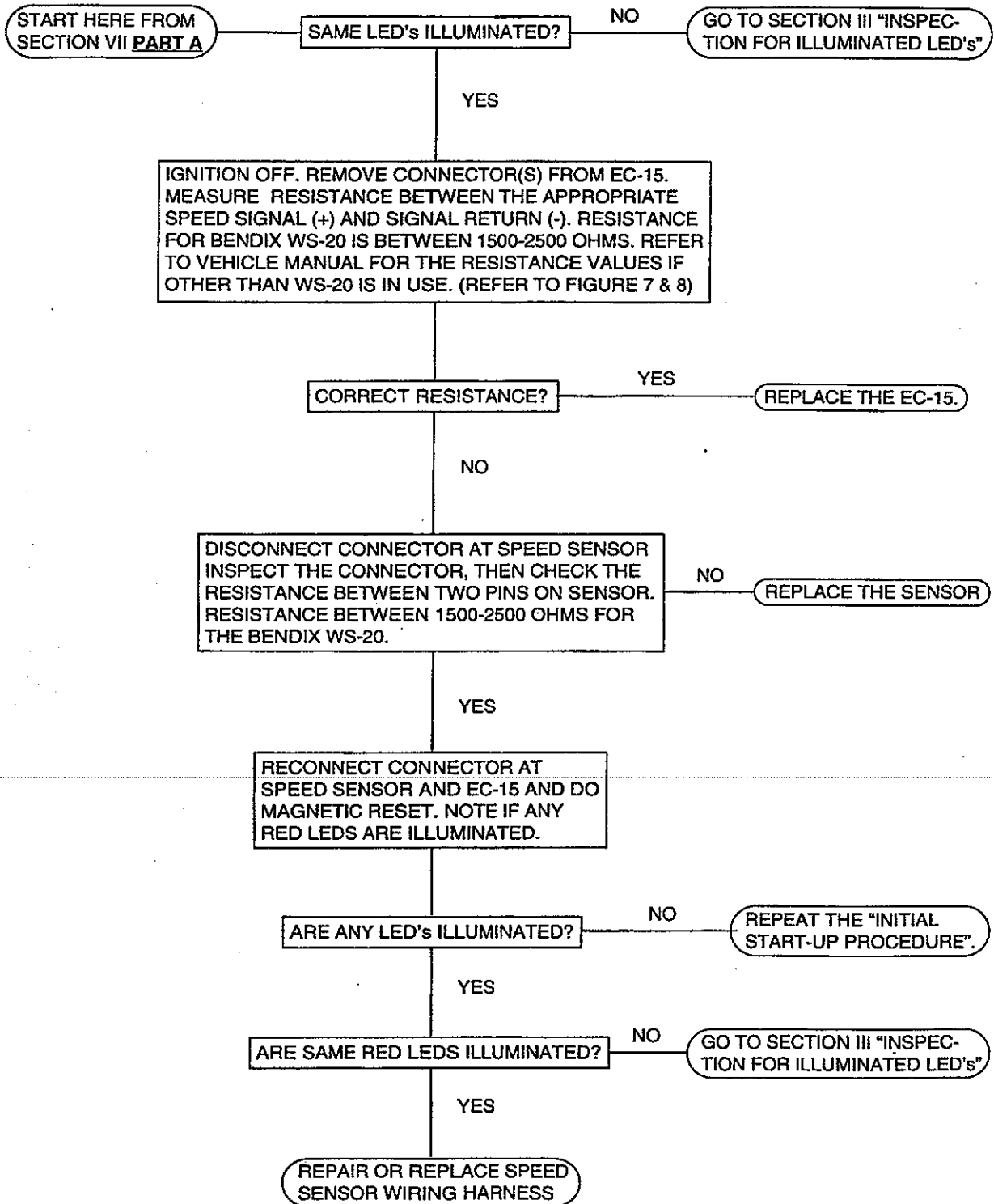
NO

GO TO "INITIAL START-UP PROCEDURE"

Flow Chart 9—Testing the Wheel Speed Sensor

TROUBLESHOOTING

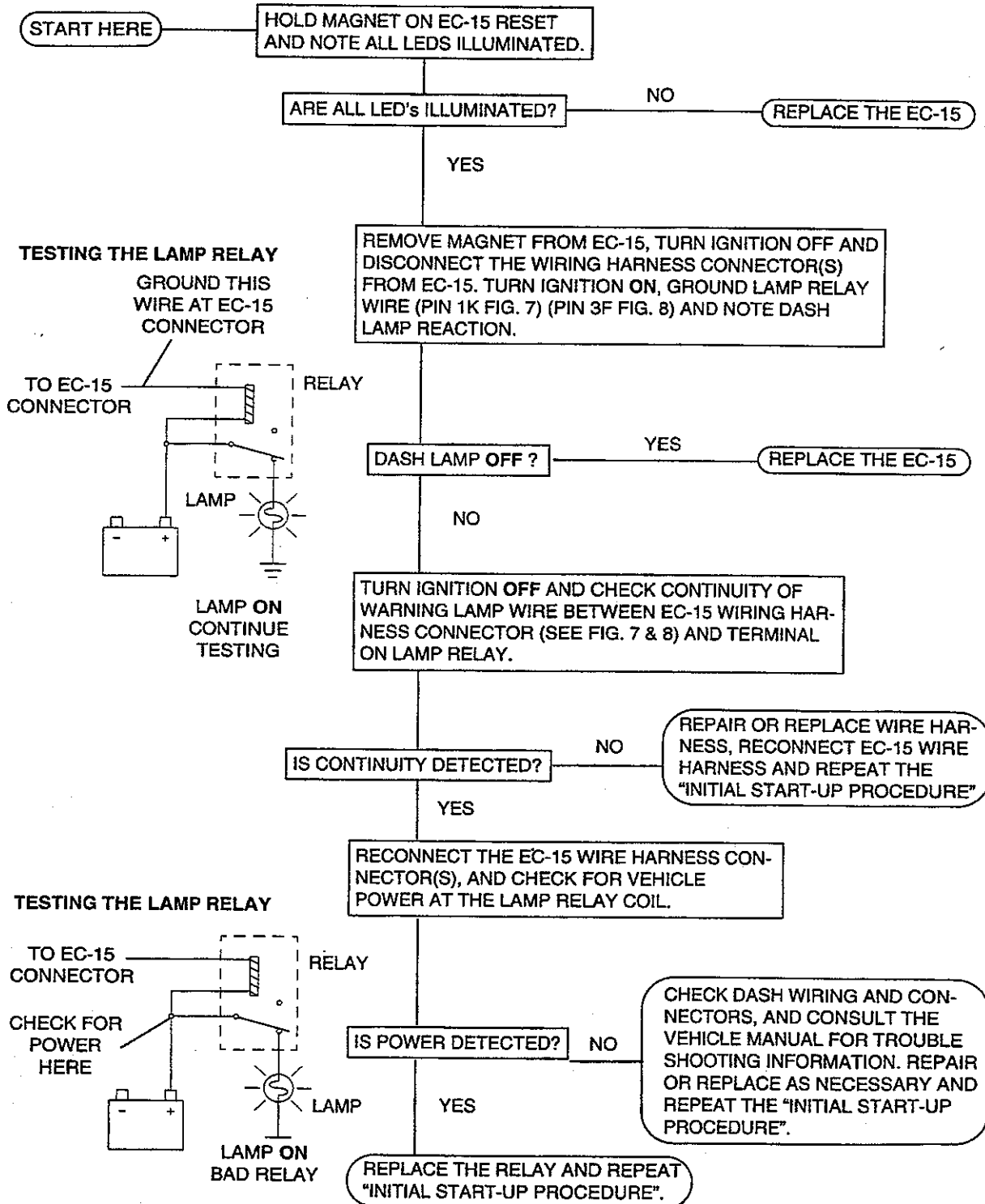
SECTION VII PART B - TESTING THE WHEEL SPEED SENSOR



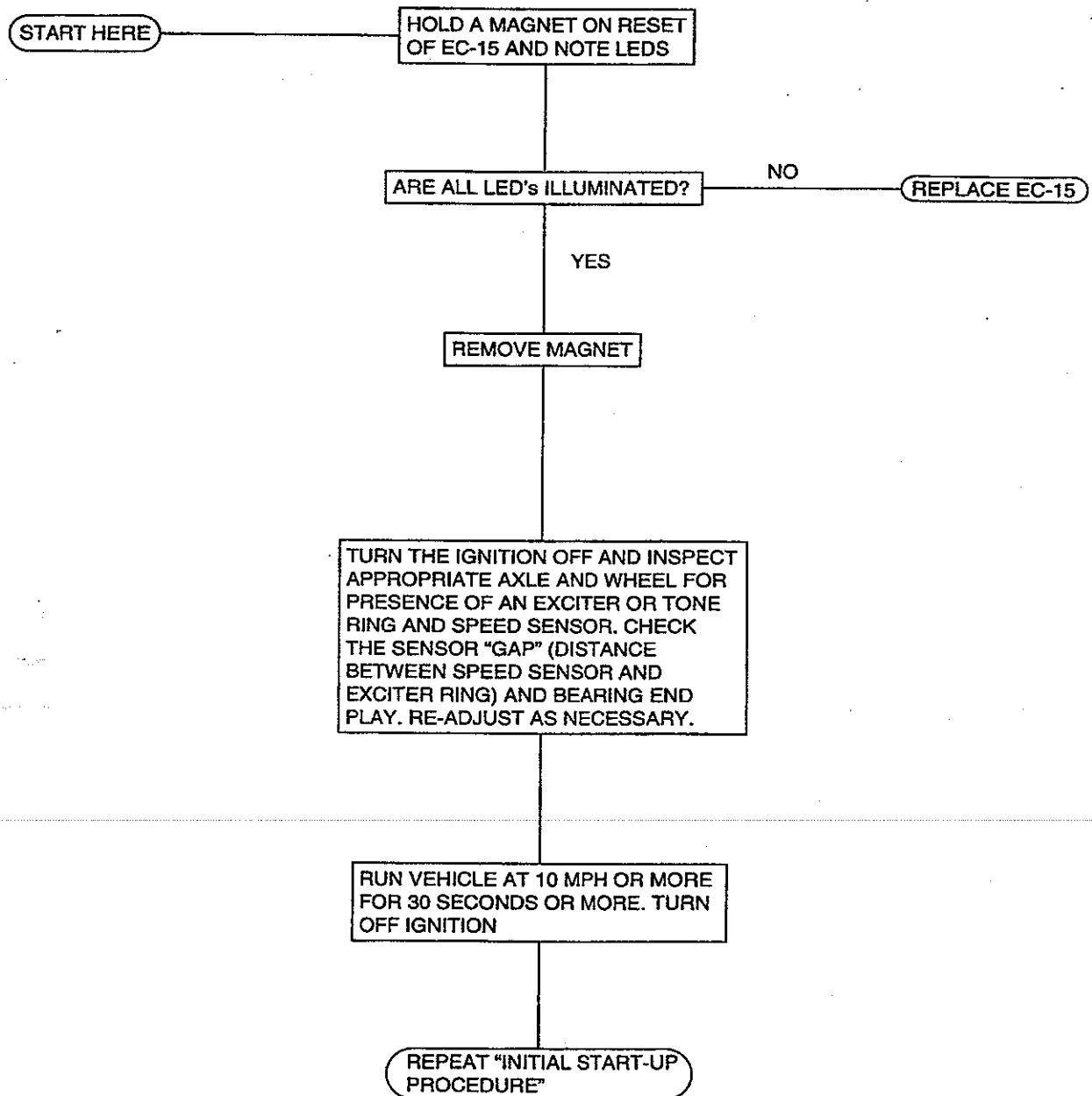
Flow Chart 10—Testing the Wheel Speed Sensor

TROUBLESHOOTING

SECTION VIII - TESTING FOR FALSE INDICATION CAUSED BY DASH LIGHT RELAY



Flow Chart 11—Testing for False Indication Caused by Dash Light Relay

TROUBLESHOOTING**SECTION IX - TESTING FOR FALSE INDICATION CAUSED BY
WHEEL SPEED COMPONENTS**

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Flow Chart 12—Testing for False Indication Caused by Wheel Speed Components

Description of Operation

M-21 and M-22 Modulators.

This subsection contains information and references for the M-21 and M-22 anti-lock modulators.

See Figure 30—M-21 and M-22 Modulators.

See Figure 31—Wheel and Axle Control Systems

See Figure 32—Non-Antilock Application of Service Brakes

See Figure 33—M-21 and M-22 Non-Antilock Application Held Position

See Figure 34—M-21 and M-22 Non-Antilock Exhaust of Service Brakes (Normal)

See Figure 35—M-21 and M-22 Non-Antilock Exhaust of Service Brakes (Rapid)

See Figure 36—M-21 and M-22 Antilock Exhaust of Service Brakes

See Figure 37—M-21 and M-22 Antilock Application Held Position

See Figure 38—M-21 and M-22 Connector View

The M-21 and M-22 antilock system modulators are high capacity, on/off air valves that incorporate a pair of electrical solenoids for control. The solenoids provide the electro pneumatic interface or link between the antilock controller electronics and the air brake system. (See Figure 30—M-21 and M-22 Modulators.)

The modulator can be used to control the braking function on an individual wheel or two service actuators. When used to control both the service chambers on an axle or two chambers on the same side of a tandem axle, the modulator is sometimes mounted ahead of a quick release valve. The valve provides quick exhaust of service applications during normal braking. (See Figure 31—Wheel and Axle Control Systems.)

In individual wheel control applications, the modulator is always the last control valve that passes air on the way to the service brake actuator and a solenoid assembly.

The solenoid assembly contains one normally open solenoid (NOS), one normally closed solenoid (NCS), and two inlet and exhaust diaphragm valves. (See Figure 32—M-21 and M-22 Non-Antilock Application of Service Brakes.)

A Packard 3-pin 280 series weather resistant electrical connector is part of the modulator solenoid assembly. The assembly carries control commands from the antilock controller to the modulator. Two 0.35-inch (9.00 mm) mounting holes are provided for frame or cross member mounting. The single supply delivery and exhaust port on both modulators is identified with a cast, embossed numeral for positive identification. (See Table 4—Identification and Airline Connection.)

M 21 Technical Information

Porting	Supply port from brake, relay or quick release valve
---	Delivery port, brake actuator
Solenoid Voltage	12 volts DC nom.
Max oper pressure	150 psi gauge
Oper temp range	-40 to + 185° F
Pressure differential	1 psi max

Identification	Air Line Connection
1	Supply
	In air from valve or relay
2	Air delivery to service actuators
3	Exhaust
4	Air exhaust during antilock control

Table 4—Identification and Air Line Connection

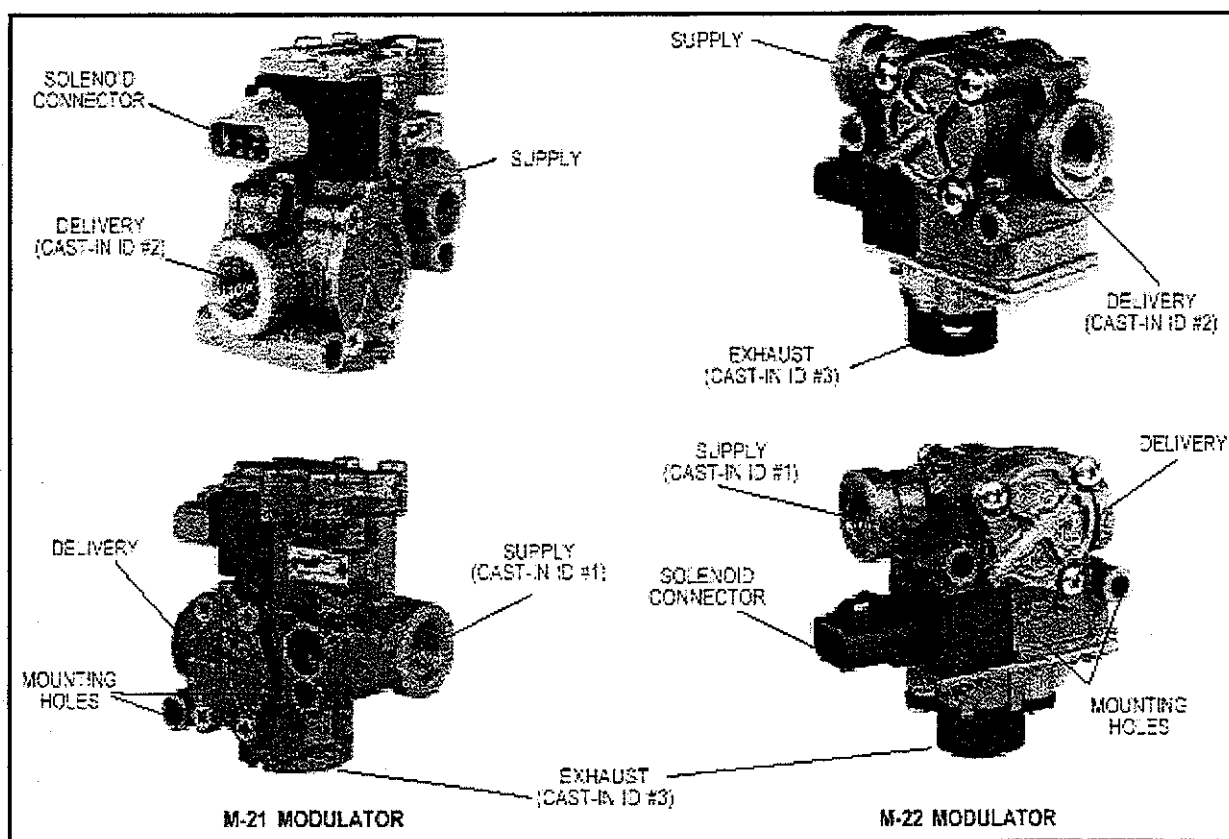


Figure 30—M-21 and M-22 Modulators

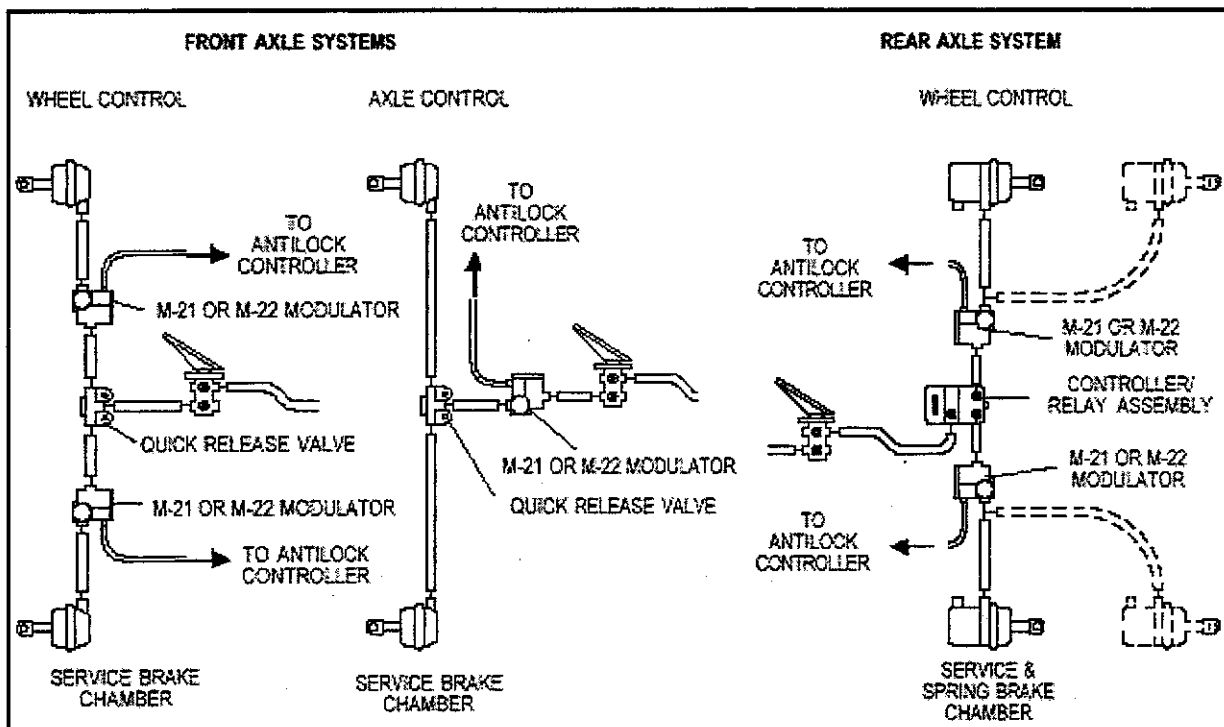


Figure 31—Wheel and Axle Control Systems

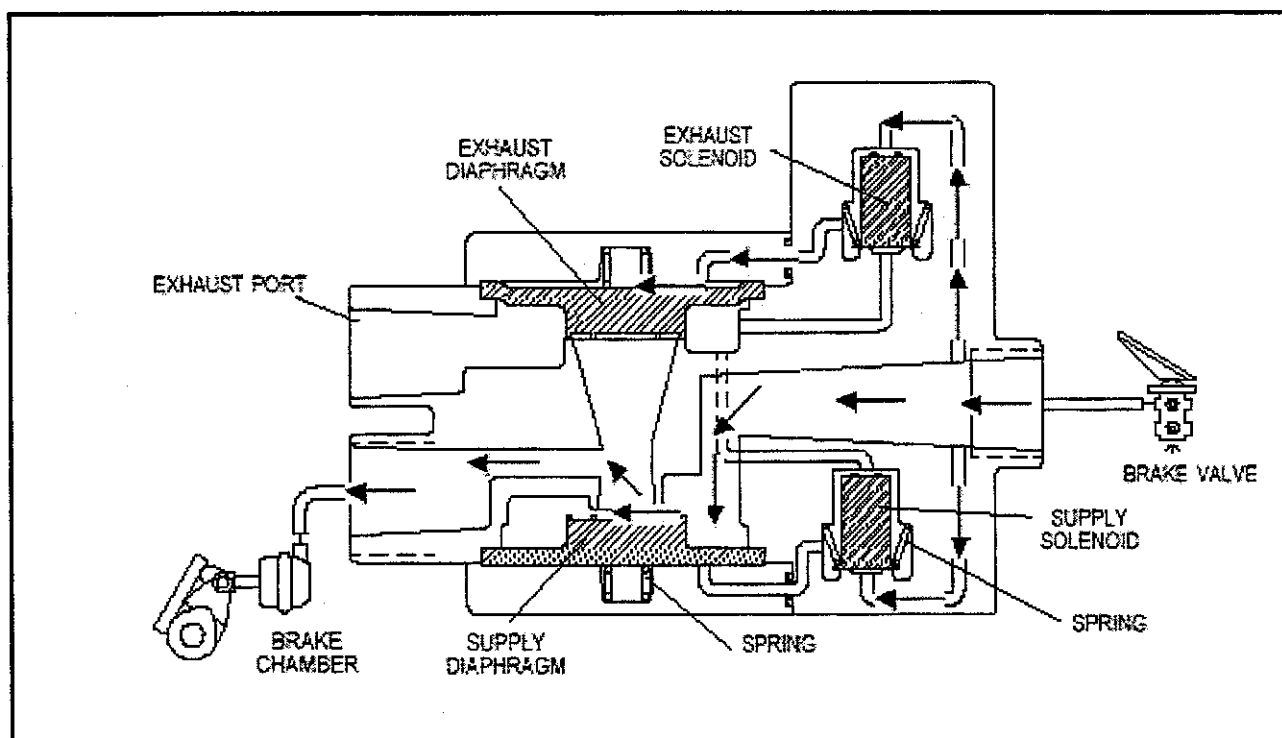


Figure 32—M-21 and M-22 Non-Antilock Application of Service Brakes

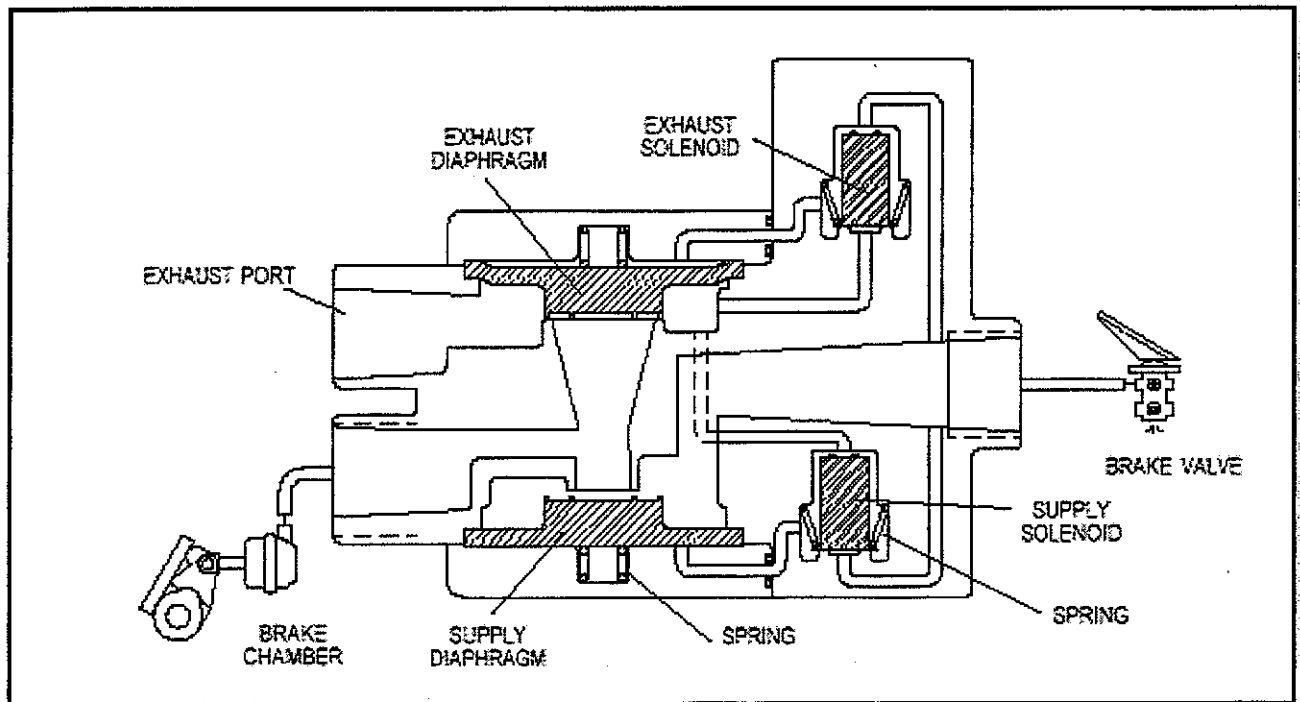


Figure 33—M-21 and M-22 Non-Antilock Application Held Position

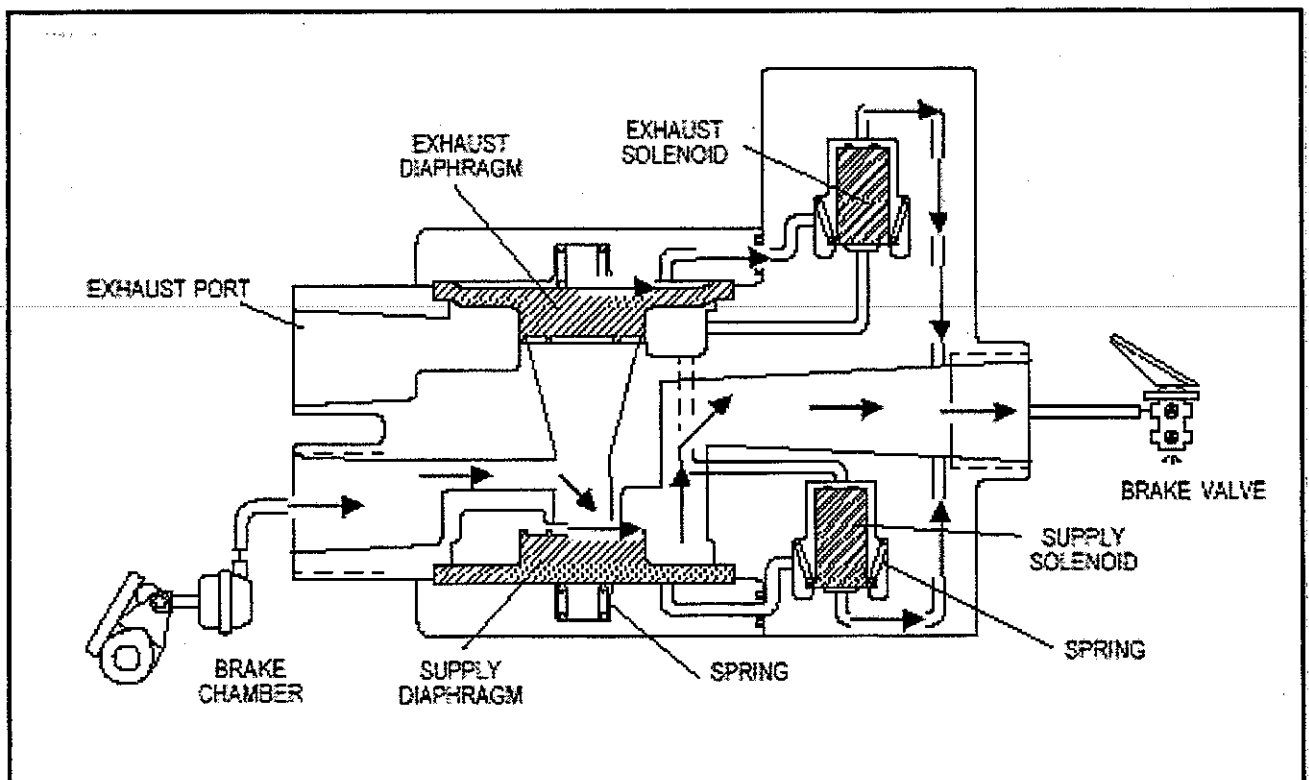


Figure 34—M-21 and M-22 Non-Antilock Exhaust of Service Brakes (Normal)

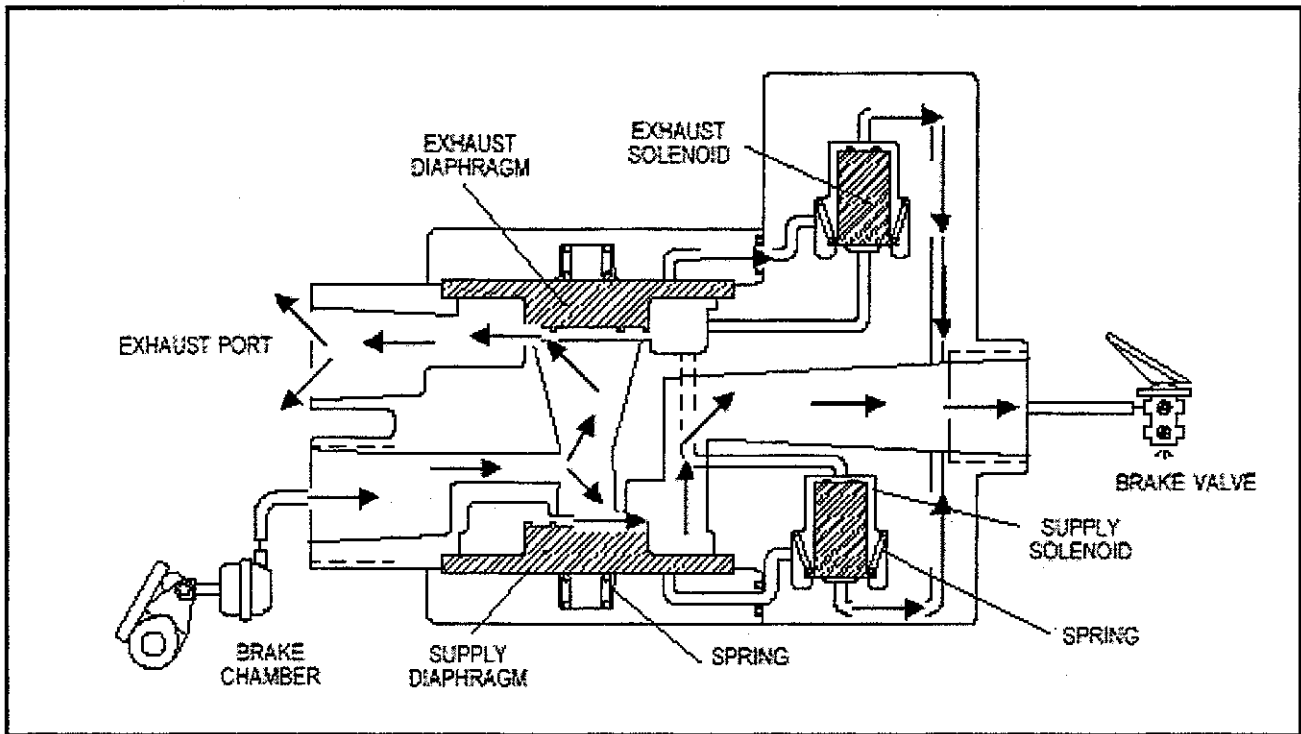


Figure 35—M-21 and M-22 Non-Antilock Exhaust of Service Brakes (Rapid)

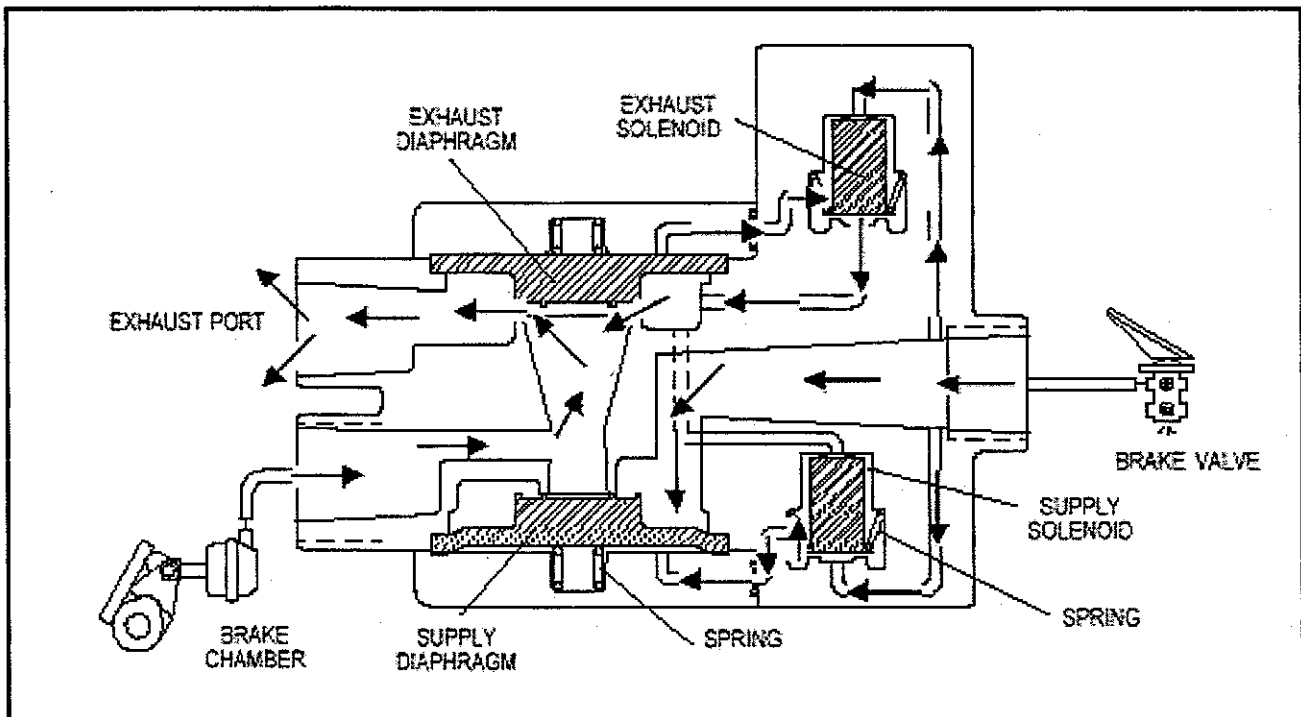


Figure 36—M-21 and M-22 Antilock Exhaust of Brakes

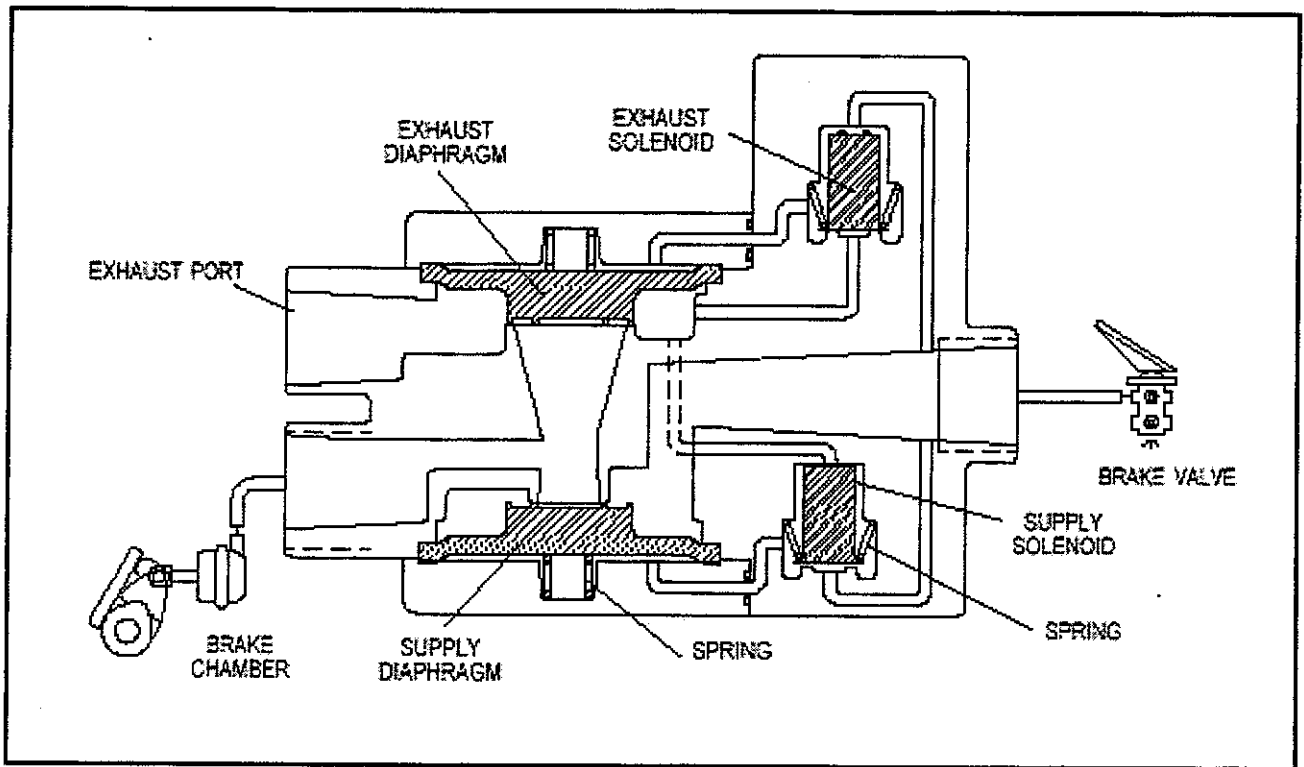


Figure 37—M-21 and M-22 Antilock Application Held Position

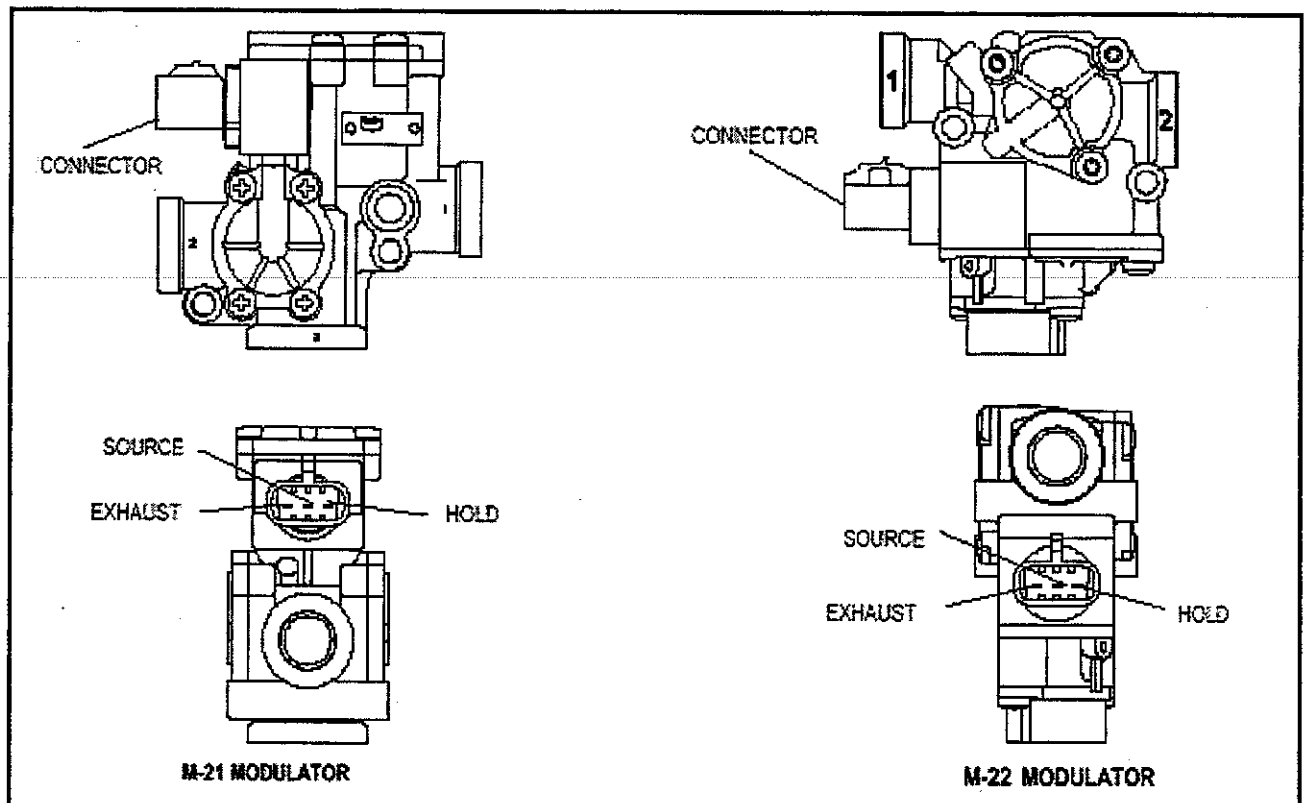


Figure 38—M-21 and M-22 Connector View

Operation of M-21 and M-22

Non-Antilock Applications. (See Figure 30—M-21 and M-22 Modulators.)

During normal antilock braking, both solenoids are de-energized, (no electrical power). Brake application air enters the supply port of the modulator and flows to, and through, open exhaust solenoid then to the exhaust diaphragm.

Non-Antilock Hold. (See Figure 31—Wheel and Axle Control System.)

Air pressure, along with spring force, seats the exhaust diaphragm on the exhaust passage preventing the escape of service air. At the same time application air flows to the supply diaphragm and forces it away from its seat. Air flows past the open supply and out the modulator delivery port to the service brake chambers.

When the desired air pressure is attained in the service brake chambers, the brake system is in the holding position. In the holding position both solenoids in the modulator remain de-energized and the balance of the internal components remain in the same position as they had during application.

Non-Antilock Exhaust. (See Figure 32—Non-Antilock Application of Service Brakes.)

The air exhausts through the modulator differs, depending on how rapidly the brake application is released by the driver.

Normal Exhaust. (See Figure 33—M-21 and M-22 Non-Antilock Application Held Position.)

During a normal, slow brake release, air moves back through the modulator in the reverse direction as it flowed during application. The internal components of the modulator will remain in the same position as they had during application. When the air pressure decreases to about one half psi (3.45 Kpa) then the air supply diaphragm will seat on the supply passage. Air will generally not be expelled from the modulator exhaust port during normal brake release.

Normal Exhaust. (See Figure 34—M-21 and M-22 Non-Antilock Exhaust of Service Brakes (Normal).)

The rapid exhaust operation described occurs when the modulator is controlling two type 30 (or larger) service chambers. During a very rapid brake release, the modulator will exhaust air in a different manner. An example of this would be if the driver made a severe, brake application, then lifted his/her foot from the foot valve. During rapid brake release, air from the exhaust diaphragm flows back through the open exhaust solenoid and to the application device's exhaust.

Rapid Exhaust. (See Figure 35—M-21 and M-22 Non-Antilock Exhaust of Service Brakes (Rapid).)

With pressure removed from the control side of the exhaust diaphragm, air returning to the modulator from the service chambers lifts the exhaust diaphragm from the seat. Returning air flows past the open exhaust and out the modulator exhaust port. Air will also flow past the open supply diaphragm and back to the application device's exhaust.

Antilock Operation

General

If a service brake application is made and the antilock system detects an impending wheel lockup, the antilock controller will immediately begin modification of the brake application, using the modulator.

To modify the brake application, the coils of the two-solenoid valves contained in the modulator are

energized or de-energized using a pre-programmed sequence by the antilock controller. When a solenoid is energized, a shuttle within the solenoid moves. Depending on the function of the specific solenoid, it either opens or closes, causing the exhaust or re-application of air pressure to the brake actuator.

The solenoids in the modulator are controlled independently by the antilock controller. By opening and closing the solenoid valves in the modulator, the antilock controller is able to simulate what the driver does when the brakes are pumped. It must be remembered that, unlike the driver, the antilock controller is able to pump each modulator, along with the brakes connected to it, independently, and with greater speed and accuracy.

Antilock Exhaust

General

(See Figure 36—M-21 and M-22 Antilock Exhaust of Brakes.)

When wheel lock is detected, or imminent, the antilock controller simultaneously energizes both the supply and the exhaust solenoids in the modulator.

Energizing the supply solenoid causes the exhaust to close and inlet to open. With the inlet of the supply solenoid open, application air is permitted to flow to the control side of the supply diaphragm. Air pressure acting on the supply diaphragm causes it to close the supply and prevent further delivery of air to the brake chamber.

Energizing the exhaust solenoid closes the inlet and opens the exhaust. By closing the exhaust solenoid inlet, application air is prevented from flowing to the control side of the exhaust diaphragm.

Air pressure that was present on the control side of the exhaust diaphragm flows out the exhaust port of the monitor. With control air pressure removed from the exhaust diaphragm, brake application air forces the exhaust diaphragm to unseat, which allows it to flow out the modulator exhaust port.

The modulator will remain in the antilock exhaust mode until the antilock controller senses that wheel speed has increased. The modulator can enter the antilock hold or re-apply mode from the antilock exhaust mode.

Antilock Hold

The antilock controller will place the modulator in the hold position when the controller senses that the correct wheel speed braking force has been attained. The antilock controller will also place the modulator in the hold position, before entering the re-apply, when the controller detects recovery from a locked wheel condition.

See Figure 37—M-21 and M-22 Antilock Application Position.

In that mode of operation, the modulator supply solenoid remains energized while the exhaust solenoid is energized. De-energizing the exhaust solenoid opens inlet and closes exhaust. Opening the exhaust solenoid inlet allows application air to flow to the control side of the exhaust diaphragm that seals the exhaust passage. With the exhaust diaphragm seated, further exhaust of brake chamber air pressure is prevented.

Because the supply solenoid remains energized, the supply diaphragm remains seated, preventing application air from flowing to the delivery port and out to the brake chamber. The modulator can enter the antilock exhaust or re-apply mode from the antilock hold mode.

Antilock Re-Apply

If the antilock controller senses that wheel speed has increased sufficiently to require re-application of braking pressure, it de-energizes the supply and exhaust solenoids. With both solenoids de-energized, the modulator re-applies air to the brakes in the same manner it did during a non-antilock application.

Preventative Maintenance

General

Every three months/25,000 miles (40236 km) or 900 operating hours:

1. Remove all accumulated contaminants.
2. Inspect the exterior for excessive corrosion and damage.
3. Inspect all airlines and wire harnesses connected to the modulator for wear and damage.

4. Test airlines fittings for leakage and tighten or replace.
5. Perform all routine operation and leak tests from each section.

Leak and Operation Tests

Leak Testing

1. Park vehicle on a level surface and block or chock the wheels.
2. Release the parking brakes.
3. Build air into the air system to full pressure.
4. Turn engine off.
5. Make four or five brake applications.
6. Record the service brakes apply and release actions.
7. Start the engine.
8. Build system pressure to the governor cut out and turn engine off.
9. Apply and hold service brake application

Note

Leakage should not exceed a one-inch (25.4 mm) bubble in less than three seconds. If leak exceeds that amount, tighten or replace part.

10. Apply a soap solution to the exhaust port of the modulator.
11. Apply a soap solution around the solenoid assembly both top and bottom. Tighten the solenoid cap screws and re-test if leak is found. Replace modulator if the leak will not stop.
12. Apply a soap solution around each diaphragm cover. Tighten the solenoid cap screws and re-test if leak is found. Replace modulator if the leak will not stop.

Operation Testing

To test the function of the modulator will require two technicians.

1. Park vehicle on a level surface and block or chock the wheels.
2. Release the parking brakes.
3. Build air into the air system to governor cut out.
4. Turn the ignition to the off position.
5. Apply and hold a full brake application.
6. Monitor one of the modulators, first technician.
7. Turn ignition to the on position.
8. Make one or two short brake applications.
9. Record any unusual application of all modulators.

Electrical Tests

General

Before testing the solenoid assembly of a suspect modulator, the location on the vehicle should be confirmed using the trouble shooting or start up procedure.

Proceed to the modulator in question and inspect wiring connector. Disconnect the connector and test the resistance between the pins, on the modulator. (See Figure 38—M-21 and M-22 Connector View.)

Hold to source and read 3.5 to 5 ohms

Exhaust to source read 3.5 to 5 ohms

Exhaust to hold read 7 to 10 ohms

Individually test the resistance of each pin to vehicle ground and make sure there is no continuity.

If resistance readings are as shown, the wire harness leading to the modulator may require repair or replacement. Before attempting repair of the wire harness, refer to the test procedure subsection for the antilock controller.

Valve Removal

Note

Do not use air brakes for this procedure.

1. Park vehicle on a level surface and block or chock the wheels.
2. Bleed the air pressure from all vehicle reservoirs.
3. Identify and mark all air lines and their connections on the valve to help installation.
4. Disconnect both air lines and the electrical connector.
5. Remove valve from the vehicle.

Valve Installation

Note

Make sure that that thread sealing material does not enter the valve.

1. Install all airline fittings and plugs.
2. Install the assembled valve on the vehicle.
3. Re-connect both airlines to the valve using the identification recorded during valve removal.
4. Re-connect the electrical connector to the modulator.
5. Test all air fittings for leaks and tighten as needed.

WS-20 Antilock Wheel Speed Sensor Description

The WS-20 wheel speed sensor is an electro magnetic device used to obtain vehicle speed information for the antilock controller. When the wheel rotates, the sensor and exciter generate an AC signal. This signal is sent to the controller, that analyzes the data and commands the antilock.

Specifically, the speed sensor consists of a coil, pole piece and magnet. The exciter is a steel ring or gear-like device that has regularly spaced high and low areas called teeth. The sensor is mounted in a fixed position, while the exciter is installed on a rotating member so that the teeth move, in close proximity, past the tip of the sensor.

The WS-20 is available in straight and right angle versions, to accommodate axle/wheel space limitations. (See Figure 1—WS-39 Wheel Speed Sensors.)

Operation

The sensor's magnet and pole piece form a magnetic field. As an exciter tooth passes near the sensor, the magnetic field is altered which generates AC voltage in the sensor coil. Each time an exciter tooth and its adjacent space move past the tip of the sensor, an AC voltage cycle is generated. (See Figure 40—Speed Sensor Voltage Cycle Output.)

The number of AC cycles per revolution of the vehicle wheel depends on the number of teeth in the exciter, that is programmed into the antilock controller. Using the programmed data, the controller can calculate vehicle speed by analyzing the frequency of AC cycles sent by the speed sensor. The frequency of AC cycles is directly proportional to wheel speed.

The WS-20 is installed in a mounting block that is installed to the axle-housing. (See Figure 41—Typical Antilock System.)

The AC voltage is also proportional to speed, but voltage is not used to determine speed. The amount of AC voltage generated by a specific speed sensor depends on the distance, or gap, between the tip of the sensor and the surface of the exciter. Voltage increases as the sensor gap decreases.

The WS-20 is installed in a mounting block that is installed to the axle-housing.

A spring-loaded retainer bushing provides a friction fit between the mounting block bore and the WS-20. The friction fit allows the WS-20 to slide back and forth under force but to retain the position when force is removed. This feature allows the WS-20 to self-adjust after it has been installed in the mounting block and the front wheel is installed.

When the WS-20 is inserted all the way into the mounting block and the wheel is installed on the axle, the hub exciter contacts the sensor, that pushes the sensor back. A normal bearing play will bump the sensor away from the exciter. The combination of these two actions will establish a running clearance or air gap between the sensor and exciter. (See Figures 42 and 43 WS-20 Wheel Speed Sensor Installation.)

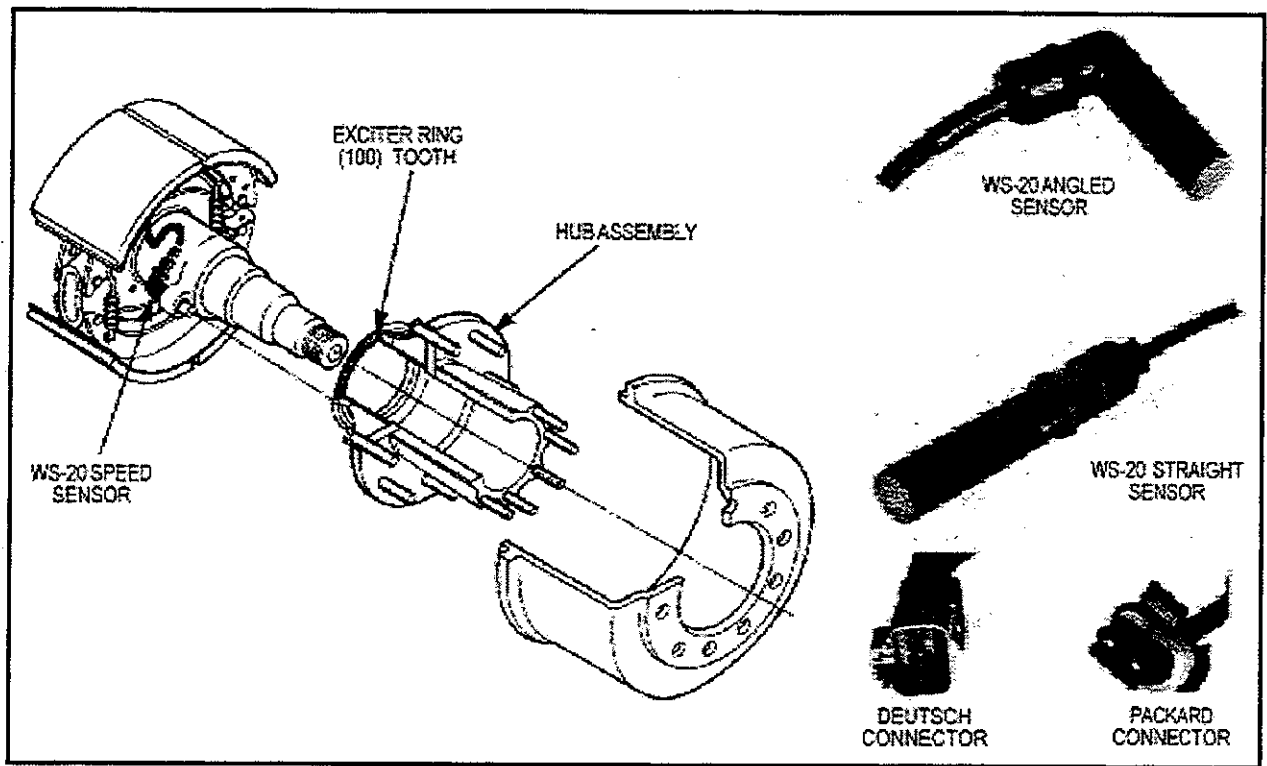


Figure 39—WS-20 Wheel Speed Sensors and Installation

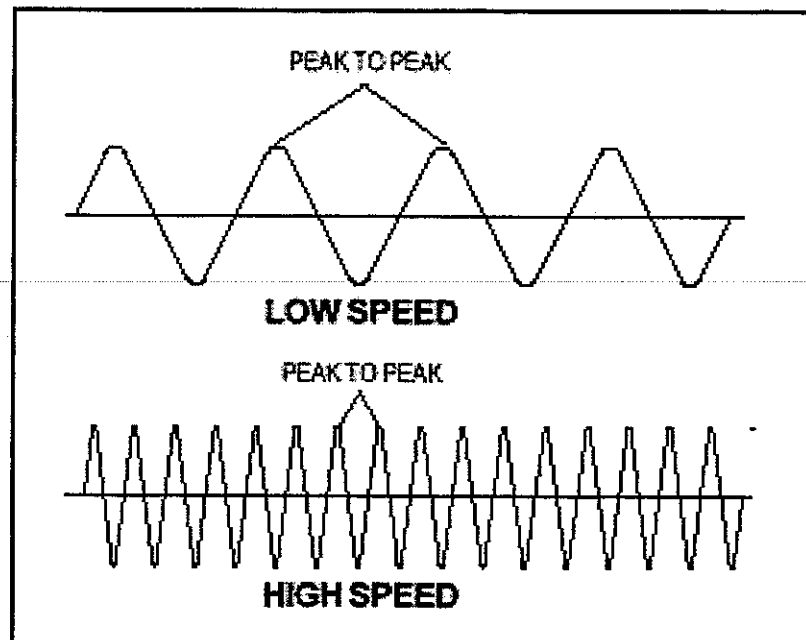


Figure 40—Speed Sensor Voltage Cycle Output

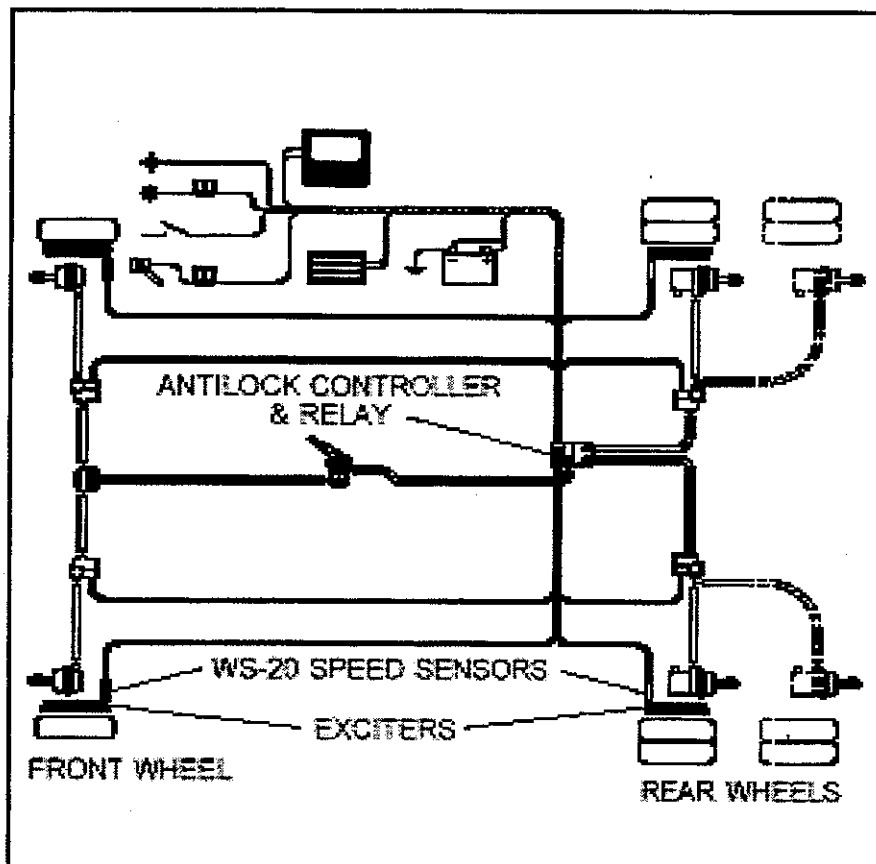


Figure 41—Typical Antilock System

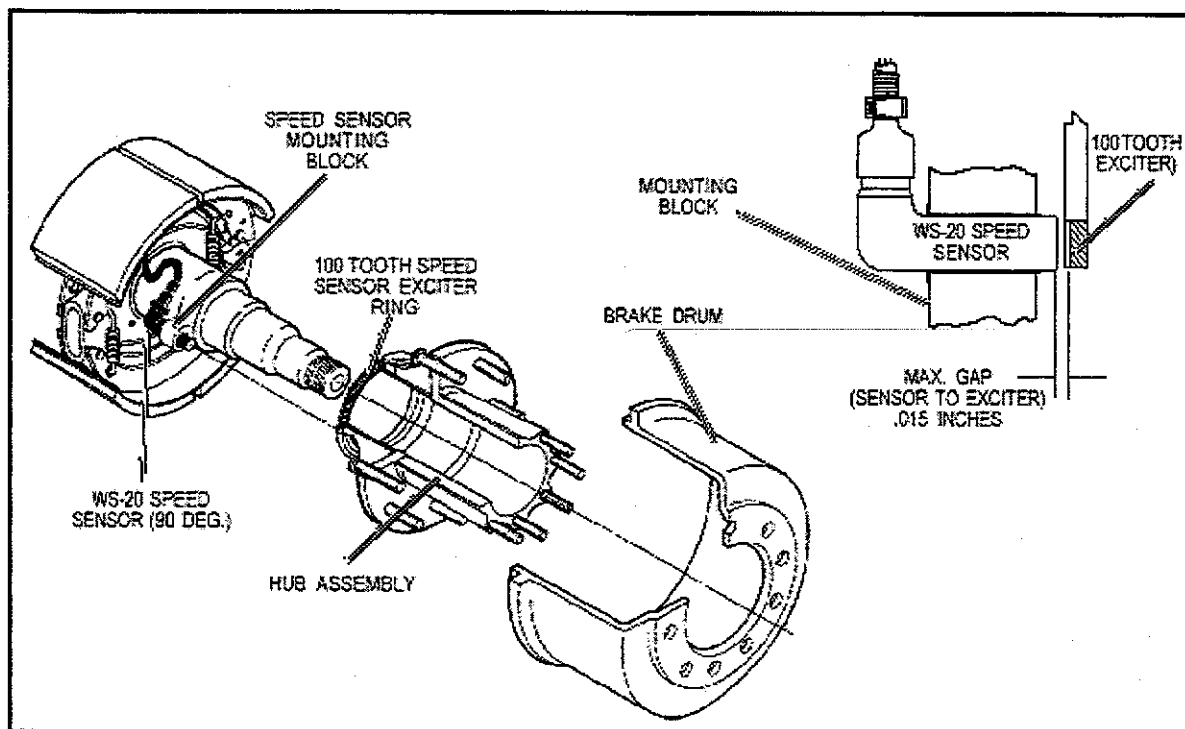


Figure 42—WS-20 Wheel Speed Sensor Installation

Technical Information

Electrical Connector	2-pin
Output Voltage	3,000 ohm resistor across the two sensor leads, output voltage measured on a VOM 0.250 Vac min at 42 Hz, or approximately 5 mph.
Sensor Gap	0 to 0.15 inch
Sensor Body	Formulated Epoxy 0.628 diameter.

Preventive Maintenance on Sensor

Note

Every three months/25,000 miles (40236 km) or 900 operating hours.

Every 12 months, 100,000 miles (160934 km) or 36500 operating hours, perform the operational test in this manual.

1. Remove all accumulated contaminates.
2. Inspect the exterior for excessive corrosion and damage.
3. Inspect all airlines and wire harnesses connected to the modulator for wear and damage.
4. Test airline fittings for leakage and tighten or replace.
5. Perform all routine operation and leak tests from each section.

Service Checks on Sensor

Check all wiring and connectors. Make sure connectors are free from damage.

Examine the sensor. Make sure the sensor, mounting bracket, and foundation brake components are not damaged. Repair/replace as necessary.

Removal of Sensor

1. Unplug the cable assembly connector from the lead.
2. Lift the lock tab and pull the connector until it disengages.
3. Pry gently the sensor and bushing from the mounting block.

Inspection

Inspect for visible damage to the sensor, cable assembly, connector, mounting block and foundation brake.

Repair or replace damaged components. Make sure the block is securely attached to the axle housing.

Sensor Installation

Caution

Adjust wheel bearings to manufacturer's recommendation to ensure that the antilock function does not shut down because of excessive wheel play.

1. Install a new bushing fully into block, with the retainer tabs toward the inside of the vehicle.
2. Push gently. Do not strike the sensor into the mounting block hole until it bottoms out on the face of the tone ring. Secure the cable lead wire to the knuckle/axle housing 3 to 6 inches (76 to 152 mm) from the sensor.
3. Reconnect the connector to the sensor lead by plugging it into the socket on the pigtail harness, and pushing until the lock tab snaps into place.

Operational Testing of Sensor

To test sensor operation, one of two tests can be done.

Test One

Drive the vehicle in a safe area at a minimum speed of 15-mph (24 km). Be sure to apply the brakes several times. Then stop the vehicle and check the LED display on the Bendix controller. If the dash light is out and the sensor LED(s) are not illuminated, the sensor is installed properly.

Test Two

Disconnect the connector from the sensor's socket or from the attached lead. Raise the vehicle wheel so it rotates easily. Connect a volt-ohm meter set to read AC to the pins on the sensor or lead and spin the wheel. Output voltage should read greater than 0.800 AC. If the wheel is spun at one revolution per second, the reading should be greater than 1.0 volts AC.

If the sensor fails to operate as described, check the wiring from the controller to the sensor. Make sure all connectors are properly and tightly installed. Check for frayed or damaged wires. Check (and/or reset) the sensor air gap and distance from sensor tip to exciter ring, as described in this section.

LTC Wheel End Components



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not correctly adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Exposure to Airborne Brake Lining Particles

Warning

Effects of some non-asbestos fibers have not been determined. Current OSHA Regulations cover exposure levels to some components of non-asbestos linings but not all. The following precautions must be used when handling non-asbestos fibers:

Compressed air or dry brushing must never be used for cleaning brake assemblies or the work area.

Proper procedures to reduce exposure include working in a well-ventilated area, segregation of areas where brake work is done and use of local filtered ventilation systems, or use of enclosed cells with filtered vacuums.

Use respirators approved by Mine Safety and Health Administration (MSHA) or National Institute for

Occupational Safety and Health (NIOSH) during wheel end component servicing.

Technicians should wash before eating, drinking, or smoking. Furthermore, technicians should shower after working, and should not wear work clothes home. Work clothes should be vacuumed and laundered separately without shaking.

Occupational Safety and Health Administration (OSHA) regulations regarding testing, disposal of waste and methods of reducing exposure for asbestos are set forth in 29 Code of Federal Regulations 1910.001. These regulations provide information that can be used to reduce exposure to airborne particles.

Introduction

Blue Bird Corporation assumes sole responsibility for ensuring that information provided herein is accurate to the best of its knowledge at the time of printing. In keeping with its policy of continual product improvement, Blue Bird reserves the right to change product information without notice and without incurring obligation.

Publications

Some information contained in this section has been re-published from the following publications:

Eaton® Axle & Brake Service Manual, EB & ES Models, Publication number BRSM-0033: April 1997. © Eaton Corporation, 1997. All rights reserved.

Webb® Wheel Products, Inc. Installation, Service and Safety Instructions Manual, Publication number IM-298 (Supersedes IM-494).

Webb® Wheel Products, Inc. Torque Specifications, and Publication number SD-012: Revised April 1997.

Multiple loose-leaf instruction pages provided by Crewson Brunner®, Inc. on installing and maintaining Automatic Slack Adjusters, no publication number.

Holset® Air Compressor Field Service Manual, no publication number or date.

MGM Brakes Model TR – Tamper Resistant Spring Brakes, © MGM 12/92, Form Number 5026-MGM.

Midland™ EL1300 & EL1600 Air Compressor Service Procedures, Publication Number L30002, Rev. 9-93, © Midland-Grau Heavy Duty Systems.

Allied Signal Bendix® Brakes Air Brake Handbook, Components, Maintenance and Troubleshooting, © AlliedSignal T.B.S. Co. 9/1996, Publication number BW5057.

Allied Signal Bendix® Brakes TU-FLO 550 Compressor Service Data SD-01-333, © AlliedSignal 4/1996, Publication number BW1639.

Allied Signal Bendix® Brakes WS-20 Antilock Wheel Speed Sensor Service Data SD-13-4754, © AlliedSignal T.B.S. Co. 11/1996, Publication number BW1662.

Allied Signal Bendix® Brakes M-21 and M-22 Antilock Modulator Assembly Service Data SD-13-4793, © AlliedSignal T.B.S. Co. 11/1996, Publication number BW1664.

Allied Signal Bendix® Brakes EC-17 Antilock Traction Controller Service Data SD-13-4788, © AlliedSignal T.B.S. Co. 2/1998, Publication number BW1910.

Allied Signal Bendix® Brakes Push-Pull Type Control Valves Service Data SD-03-3611, © AlliedSignal T.B.S. Co. 4/1996, Publication number BW1578.

Allied Signal Bendix® Brakes AD-9 Air Dryer Service Data SD-08-2412, © AlliedSignal T.B.S. Co. 5/1996, Publication number BW1627.

Allied Signal Bendix® Brakes E-6 & E-10 Dual Brake Valves Service Data SD-03-817, © AlliedSignal 6/1996, Publication number BW1427.

Allied Signal Bendix® Brakes R-12 & R-14 Relay Valves Service Data SD-03-1064, © AlliedSignal 6/1996, Publication number BW1431.

Description of Operation

These procedures were documented using a Blue Bird LTC with a Cummins M11 ISM engine and an Allison B500 World Transmission.

Wheel End Component Specification

- See Table 1—Component Measurement and Specification.

Component Measurement and Specification		
Item	Measurement	Specification
Air Chamber Bracket	---	---
Stamped Steel Stud Nuts	Torque	65—85 foot-pounds (88—115 N•m)
Cast Spider Bolts	Torque	65—85 foot-pounds (88—115 N•m)
7/16-20 Nuts	Torque	35—40 foot-pounds (48—54 N•m)
5/8-18 Nuts	Torque	110—115 foot-pounds (149—156 N•m)
Air Chamber Bracket Bushings	---	---
Cam head	Recess	0.281 inch (7.1 mm)
Slack Adjuster	Recess	0.688 inch (17.5 mm)
Air Chamber Clevis Centerline-to-push rod End	Clearance (min)	0.875 inch (22.2 mm)
Air Chamber Clevis Pin Hole Centerline-to-Air Chamber face	Distance	2.625 ± 0.063 inch (68.0 ± 1.6 mm)
Anchor Plate-to-Brake Mounting Flange	---	---
Automatic Slack Adjuster	---	---
Adjusting Nut	Torque	75 foot-pounds (101 N•m)
Slack Arm	Distance	0.375—0.625 inch (9.5—15.9 mm)
Brake Drum	---	---
Back Surface	Diameter (max)	0.120 inch (3.048 mm) over nominal new diameter. Unless otherwise on casting.

Table 1—Component Measurement and Specification

LTC Wheel End Componentents

Resurfacing	Diameter	Allow at least 0.040 inch (1.016 mm) under maximum diameter for additional wear.
Brake Shoe	---	---
Anchor Pin	Elongation	1.400 inch (35.56 mm)
Roller End	Elongation	0.836 inch (21.23 mm)
Cam Shaft	---	---
End Play	---	0.005—0.025 inch (0.13—0.64 mm)
Radial Play	---	0.35 inch (0.91 mm)
Tie Bar to Anchor Plate Screws	Torque	40—50 foot-pounds (54—68 N•m)
Dust Shield-to-Spider Screws	Torque	150—180 foot-pounds (203—244 N•m)
Hub/Drum Assy	Radial Run Out	0.020 inch (0.508 mm)
Hub and Outer Rear Spindle Nut	Torque	250—275 foot-pounds (339—373 N•m)
Spider Anchor Pin	Depth	0.031 inch (0.79 mm)
Spider-to-Axle Flange Bolts and Nuts	Torque	150—190 foot-pounds (203—258 N•m)
Steering Axle Hubcap	Torque	17 foot-pounds (23 N•m)
Wheel Bearing Adjusting Nut	---	---
Initial	Torque	120—140 foot-pounds (163—190 N•m)
Final	Torque	50 foot-pound (68 N•m)
Wheel Bearing	End Play	0.010 inch (0.254 mm)

Table 1—Component Measurement and Specification (continued)

Automatic Slack Adjuster Operation

As the brakes are applied, the slack adjuster's rotation moves the shoes and linings into contact with the brake drum. That movement also lifts the actuation rod through a pre-set, free travel dimension that is normal lining to drum clearance ❶. (See Figure 1—Automatic Slack Adjuster.)

Continuing the brake application rotates a one-way clutch ❷ in an over riding mode, and at the same time causes the large coil spring ❸ to deflect at a specific force.

The spring deflection allows the worm to move axially

- ❹. The clutch movement is restricted by a machine step
- ❺. The movement fully disengages the drive clutch ❻ from the worm and prevents unwanted brake adjustment from occurring.

As the brakes are released, the large coil spring resumes its original load and position. That allows the drive clutch to re-engage. Simultaneous to drive clutch, clutch re-engagement, if any lining wear has occurred, the actuation rod rotates the one way adjuster clutch an amount proportional to lining wear. This motion rotates the worm ❸, worm wheel ❹, and the S-cam shaft resulting in adjustment of the brakes.

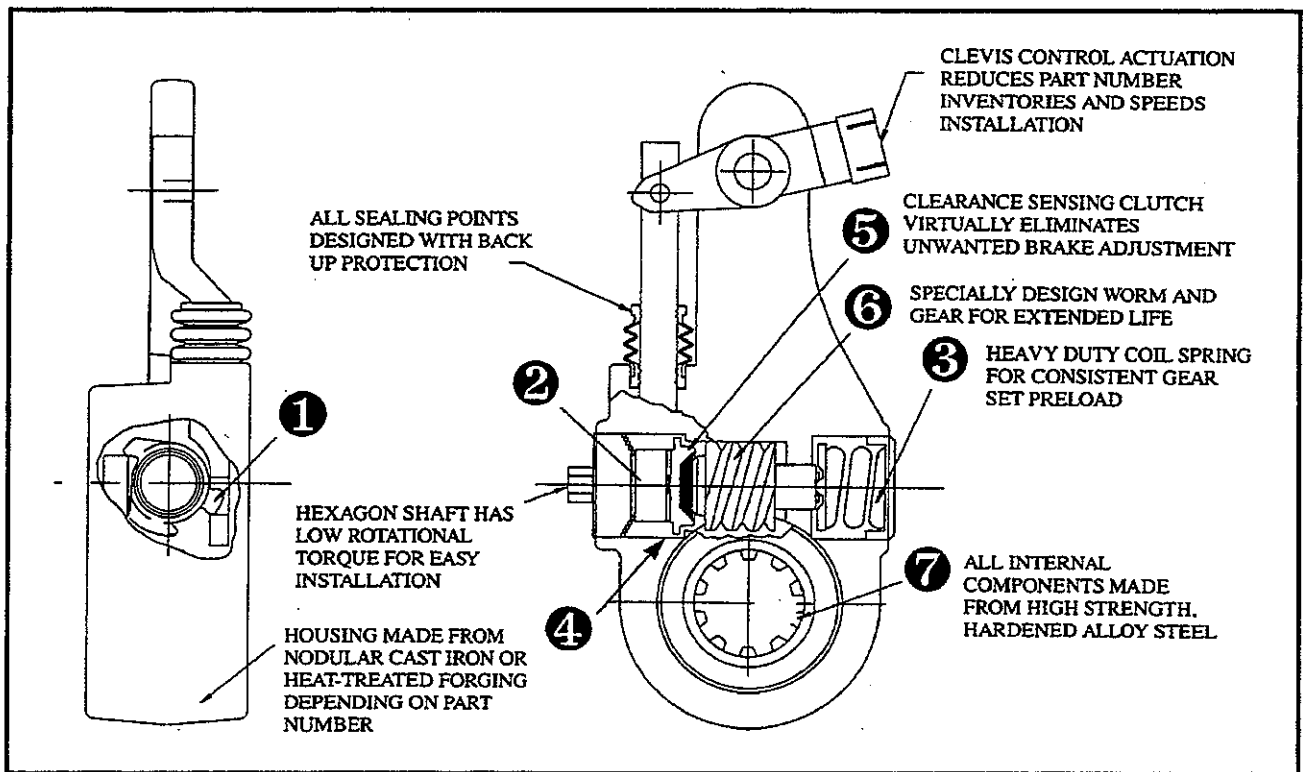


Figure 1—Automatic Slack Adjuster

System Components

- **Dust shield**

The dust shield are used to protect the brakes and drums.

- **Air Brakes**

Brake assembly is mounted on the axle assembly and attached with a washer, spindle nut, locknut, and cotter pin.

- **Hub/Drum Assembly**

The Hub/Drum assembly consists of Hub, Drum, Wheel Studs, and Bearing Race. (See Table 2—Wheel Component Maintenance.)

The arm of the slack adjuster is fastened to the push rod of the chamber with a yoke.

The spline of the slack adjuster is installed on the brake camshaft.

The slack adjuster is a lever, converting linear force of the chamber push rod into torsion or twisting force needed to apply the brakes.

Troubleshooting and Diagnostics		
Wheel Bearing		
Problem	Troubleshoot	Repair
Excessive noise and vibration	Insufficient lubrication	Fill with correct amount of proper lubricant.
---	Incorrect lubricant	Use recommended lubricant.
---	Worn Bearing	Replace bearing.
---	Dirt	Clean Bearing. Replace seals and bearing if damaged.
---	Corrosion	Use lubricant that resists corrosion. Replace bearing.
---	Improper preload	Adjust to Specification.
---	Misalignment	Determine what is misaligned. Shaft may be bent or housing bore not aligned. Replace shaft or housing.
---	Bearing fit too loose	Seating surfaces are worn.
Excessive heat	Insufficient lubricant	Fill with correct amount of proper lubricant.
---	Incorrect lubricant	Use recommended lubricant.
---	Improper preload	Adjust to Specification.
---	Misalignment	Determine what is misaligned. Shaft may be bent or housing bore not aligned. Replace shaft housing.
---	Lubricate has air bubbles	Use less lubricant or use lower viscosity.
Lubricate Loss	Improper lubricant	Use high temperature grease.
---	Leakage through seal.	Replace seal. Check shaft for scratches or burrs.
Shaft will not turn	Incorrect lubricant	Use recommended lubricant
---	Worn bearing	Replace bearing
---	Dirt	Clean bearing. Replace seals and bearing if damaged.
---	Corrosion	Use lubricants that resist corrosion. Replace bearing.
---	Improper preload	Adjust to specification.
---	Lack of lubrication	Add proper lubricant. Check for damage.
---	Seal tight	Use proper size and type of seal.
---	Bearing cocked	Remove bearing and clean all mating surfaces. Re-install bearing if not damaged.
Cracked brake drum (new)	Mishandling	Replace brake drum.

Table 2—Wheel Component Maintenance

Cracked brake drum (used)	Heat checks connect and grow through drum section.	Replace brake drum. Check brake balance, brake return springs, brake adjustment and lining type.
Cracked brake drum (used, low mileage).	Improper shoe contact.	Replace brake drum. Shoe must contact the drum at the center of the shoe.
Heavy heat check	Imbalance brake system dragged brakes or driver abuse. Caused by constant heating and cooling of brake surface.	Replace brake drum. Check brake balance, brake return springs, brake adjustment and lining type.
Fine grooves	Abrasive material or poor quality brake lining.	Re-bore brake drums to normal limits or replace the drum and lining.
Grooves align with rivet holes.	Loose rivets, bolts, or foreign material collecting in rivet holes.	Dust shield cause loose rivets, bolts, and foreign material.
Blue or discolored brake surface	Excessive heat from dragging brakes.	Re-bore or replace brakes drum. Look for weak or broken return springs or binding brake actuation system.
Heat spotted or hard spots in brake surface.	High localized heating and cooling cycles.	Grind hard spot and re-bore brakes drum to normal limits.
Out of round (balance)	Balance weight has fallen off or a balanced drum was not specified.	Replace brake drum. Specify balanced brake drums when ordering replacements.
Out of round (concentricity)	Improper fit to pilot or improper seating on wheel hub.	Clean all mounting surfaces. Check for correct fit and clearance to wheel.
Excessive wear	Abrasive material between lining and drum. Poor quality lining.	Check maximum diameter and re-bore to limit or replace.
Grease stained drums	Leaking oil seal or improper lubrication of brake components.	Repair source of leak. Clean the brake drum and replace the linings.
Polished brake surface	Normal condition for non-asbestos lining or improperly cured brake lining	Remove the glaze with emery cloth of re-bore drum to normal limits.
Faded or diminished brake power.	High temperature in brake system. Improperly adjusted brakes or bad brake lining.	Check brake drum, brake lining condition, and brake adjustment and brake balance. Avoid operating conditions that create excessive brake temperature.
Noise, chatter, or pulsating during normal brake use.	Heat spotted drum, grease-stained drums, and loose brake drum or brake components.	Remove brake drum. Check for one or more of these conditions. Repair or replace if needed.
Crack between the pilot and a bolthole.	Improper handling	Replace brake drum.

Table 2—Wheel Component Maintenance (continued)

LTC Wheel End Components

---	Installation on dirty hub.	Replace the brake drum. Clean the hub before installing replacement brake drum.
Mounting flange separated from hoop section of the brake drum.	Installation on dirty hub.	Replace the brake drum. Clean the hub before installing replacement brake drum.
---	Wheel hitting the drum.	Wrong application. Replace brake drum with correct part number.

Table 2—Wheel Component Maintenance (continued)

Routine Maintenance

• Wheel Bearing Inspection

Caution

Do not use a steel brush or air hose in the cleaning operation. Small particles of dirt or wire can contaminate lubricate significantly reducing service life and performance.

Note

Repack wheel bearings twice a year.

1. Check bearing adjustment with a dial indicator. Endplay should not exceed 0.010 inch (0.25 mm). If bearings are out of adjustment, they should be inspected for wear or damage.
2. Clean old lubricant off bearing and bearing race.
3. Inspect the old lubricant for evidence of foreign or abrasive material. If foreign or abrasive material exist, inspect bearing parts for damage.

Caution

Make sure that all tools are clean and dry

4. Wipe all parts dry with a clean, lint free absorbent cloth.
5. Inspect the bearing races, bearings, and spindle for damage or wear.

• Wheel Bearing Lubrication

Caution

Wheel bearings are precision components. Keep all components clean and lubricated. Be sure not to use too much lubricant, however.

6. Place bearings to be used on a clean dry table or bench.

• Applying Lubrication

Note

When a mechanical grease packer is used, position bearing in mechanical packer. Place the larger end of bearing facing up. Force grease into bearing until grease is seen between all rollers in the bearing cage.

7. Remove bearing and coat all surfaces with a thin layer of grease.

Note

When oil lubricant is used, dip clean bearings in SAE 90 weight gear oil until completely saturated.

8. Inspect bearing adjustment
- After the hub and bearing are assembled in place on the spindle
1. Install the retaining washer and adjusting nut.
2. Tighten the wheel bearing-adjusting nut to 120-140 foot-pounds (163-190 N•m).
3. Rotate hub to seat bearing.
4. Loosen adjusting nut ½ turn.
5. Re-tighten adjustment nut to 50 foot-pounds (68 N•m).

Note

Bearing end play should not exceed 0.010 inch (0.25 mm). When bearing adjustment is correct, the hub should rotate freely without excess play. If hub binds or has excessive endplay, repeat the procedure.

6. Check bearing adjustment with a dial indicator and a magnetic base. Make sure dial indicator is orientated parallel to the vehicle axle.

- **Camshaft Radial Movement Inspection**

1. Mount a suitable dial indicator with plunger. (See Figure 2—Dial Indicator Mounting.)
2. Zero dial indicator.
3. Move cam head up and down and record maximum reading.

Note

If movement exceeds 0.035 inch (0.91 mm), check camshaft bushing and grease seal. If movement or play still exceeds 0.035 inch (0.91 mm) replace camshaft.

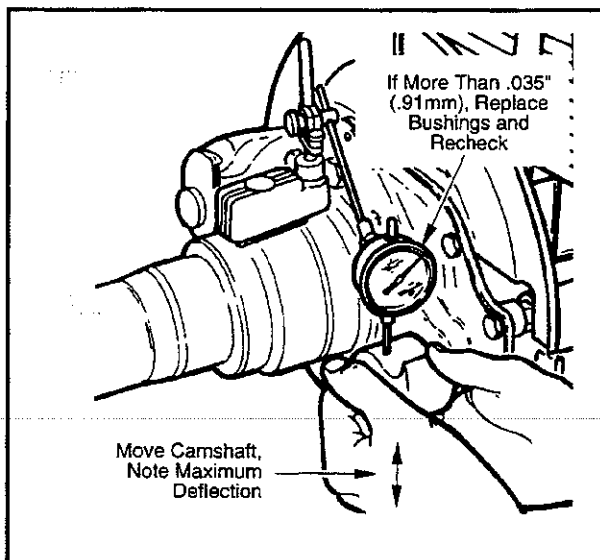


Figure 2—Dial Indicator Mounting

- **Camshaft Radial Movement Inspection**

Caution

When replacing brake drums, always replace the same component on both sides of the axle. Failure to do so will result in uneven braking load on the axle. This condition will reduce the performance and service life.

- **Clean and Inspect Brake Drums.**

- The brake surface should be free of scoring, excessive heat checks and free of cracks.

- The brake surface diameter should be within the maximum diameter cast or stamped on the drum located above the minimum thickness.

- The mounting holes must be round and true.

- The mounting holes and pilot must be clean and flat.

- To resurface the brake surface to remove small heat checks or other small surface defects do the following procedure:

Caution

If any item of the brake surface exceeds the maximum, the item must be discarded. The minimum diameter is 0.120 inch (3.05 mm) over the nominal new diameter unless stated otherwise on the casting.

The maximum diameter cast into the brake drum supercedes all published information.

- **Inspection Limits**

When resurfacing a new brake drum, allow at least 0.040 inch (1.02 mm) under the maximum diameter for additional wear. The drum may be machined a total of 0.080 inch (2.03 mm) over brake surface diameter of a new brake.

LTC Wheel End Components

- The brake drum should be replaced if any of the following conditions exist. Failure to replace the brake drum will result in an unreliable braking system.

1. The brake drum is cracked.
2. The brake surface is heat checked, grooved, or worn beyond the re-bore limit, or the maximum diameter/minimum thickness.
3. The back plate is cracked.
4. The boltholes are elongated.
5. The brake drum is known to have been severely overheated.
6. The brake drum is out of round or the rotor has thickness variations.

• Inspect Drum Shoe Lining

1. Check brake shoes for bent or cracked webs, broken welds or loose rivets. (See Figure 3—Check Shoe Web.)

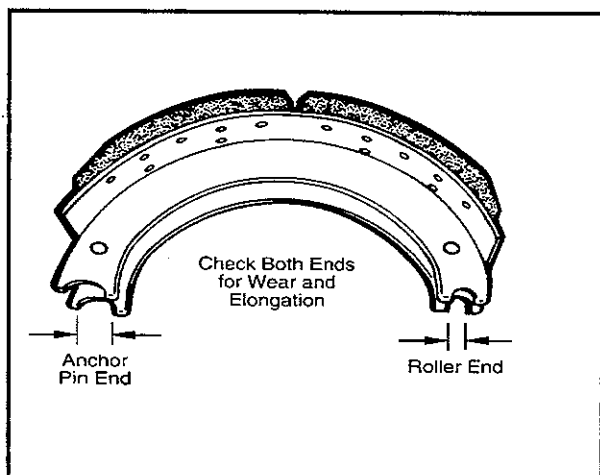


Figure 3—Check Shoe Web

2. Check anchor pin and cam roller contact areas in the shoe webs for elongation or wear. Replace shoe if diameter exceeds 0.836 inch (21.23 mm) (roller end) and 1.400 inch (35.56 mm) (anchor pin end).
3. Check the lining and lining assembly for contamination, crack or wear. If wear is more than 0.250 inch (6.35 mm) at any point, replace.

Note

To eliminate premature lining replacement, use a brake lining wear gauge to accurately measure lining thickness.

4. With brake not applied, place the tip of the gauge between the two lining blocks, between the top of the shoe table and drum. (See Figure 4—Insert Gauge.)
5. Use gauge to scrape away any dirt or other contaminants.
6. Remove the gauge from the brake.

Note

Hook gauge allows insertion around worn drum lip. If the tip of the gauge will not fit between the brake drum and the top of the shoe table, the lining is worn below 0.3125 inch (7.94 mm). Replace lining for inspection limit failure.

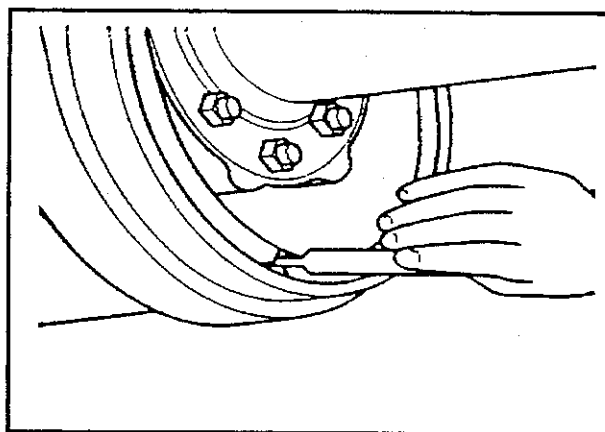


Figure 4—Insert Gauge

7. Apply brakes and try to put the gauge between the two lining blocks and the top of the shoe table.
8. Check all brakes because brakes can wear at different rates.

Wheel Cover

• Remove and Replace Wheel Covers

1. Remove five Phillips head screws. Remove wheel cover.
2. Loosen lock nut.

3. Turn adjusting nut clockwise to reduce the ring to a size smaller than the wheel lip.
4. Remove lock ring.
 - **Replace as Required**
5. Inspect the inside of the curled outer wheel lip to ensure it is free from any dirt, grease or defects.
6. Clean the wheel lip completely before lock ring installation.
7. Install lock ring with screw fastener side of the bracket facing outward. Make sure ring size is slightly smaller than wheel lip.
8. Turn the adjustment nut counterclockwise to expand the ring until it is firmly locked into the wheel lip.
9. Turn the lock nut to tightly lock the adjustment nut into place.
10. Install wheel cover on the lock ring with screw holes in alignment with the fitting brackets of the lock ring.
11. Install screws until all screw heads almost touch the wheel cover.
12. Tighten five screws from side to side until all are firmly secured.
13. Remove wheel cover and wheel.

LTC Wheel End Components

Standard Service Air Brakes

• Remove and Replace Hub/Drum Assembly

1. Remove wheel cover. (Reference Remove and Replace Wheel Cover.)
2. Remove 12 hex head cap screws and split-head lock washers.
3. Remove hubcap and gasket.
4. Remove cotter pin and lock nut.
5. Remove bearing adjustment nut, spindle washer, outer front axle bearing and hub drum assembly.
6. Remove inner front seal. Discard seal.
7. Remove inner front axle bearing.

Note

If necessary, remove bearing cups from inside hub and drum assembly.

8. Inspect bearing and inner front seal, reference Routine Maintenance Wheel Bearing Inspection
9. Inspect brake drums, reference Routine Maintenance Brake Drum Inspection.
10. Lubricate inner front axle bearing. Reference Routine Maintenance Wheel Bearing Inspection.
11. Install inner front axle bearing and new inner front seal.

12. Seat smaller outside diameter of inner front seal in recess of tool adapter.

Note

Plug ensures proper alignment of seal.

13. Insert centering tool of plug in bore of inner bearing cone.

Warning

Solvent is toxic to the skin, eyes, and respiratory tract. Skin and eye protection is required. Use in a well-ventilated area.

14. Clean the bearing cup and seal area in the hubs with solvent.

Note

Use correct disc, from seal driver set with bearing cone and seal in the vehicle center end of Hub/Drum assembly.

15. Hold tool handle firmly and strike until sound of impact changes to indicate seal has bottomed in hub seal recess.
16. Inspect the face of seal for damage, or deformity.
17. Inspect rubber lip for a smooth even surface.
18. Inspect for freedom of movement by manually moving interior rubber components of seal backward and forward. A slight movement indicates damage free installation.

- **Install Hub/Drum Assembly.**

19. Clean spindles before installing wheel end components.
 20. Clean the threads on the spindle with a wire brush.
 21. Coat lip of rubber seal with a thin layer of wheel bearing lubricant.
 22. Grease outer front axle bearing. (Reference Routine Maintenance Wheel Bearing Lubricant.)
 23. Fill the recessed area in the hub or spoke wheel between bearing cups to the level of bearing cups with grease. Do not over fill.
- Pour about 16 ounces (0.47 liter) of SAE 90 weight universal gear oil in each hub.
 - Place axle on level surface to allow time for oil to settle. This should take about five minutes.

Note

When correctly filled, oil level should be between the level line on the hubcap and ¼ inch (6.35 mm) above the line.

Disc wheel hubs are right and left. Due to the threads on wheel mounting studs, disc wheel hubs must be installed on the correct side.

- Slide Hub/Drum assembly straight onto spindle to prevent damage to seal as indicated on the end of wheel mounting stud by R or L.
24. Install the outer front axle bearing. Make sure bearing is properly lubricated.
 25. Place hub and bearings on spindle assembly.
 26. Install retaining washer and adjusting nut.
 27. Tighten the wheel bearing-adjusting nut to 120-140 foot-pounds (163-190 N•m) while rotating hub to seat bearing.
 28. Loosen adjusting nut ½ turn.
 29. Re-tighten adjusting nut to 50 foot-pounds (68 N•m) while rotating the hub.
 30. Loosen adjusting nut ¼ turn.
 31. Inspect for excessive bearing endplay. Bearing endplay should not exceed 0.010 inch (0.254 mm).
 32. Install lock nut and cotter pin. Bend cotter pin to secure nut in position.
 33. Install hubcap gasket and hubcap.
 34. Install lock washers and cap screws.
 35. Tighten capscrews to 17 foot-pounds (23 N•m).
 36. Inspect for Hub/Drum radial run out. Run out should not exceed 0.020 inch (0.508 mm).
 37. Inspect inside of brake drum surface at least 0.25 inch (6.35 mm) from edge of drum.
 38. Install wheel cover. (Reference Remove and Replace Wheel Cover.)

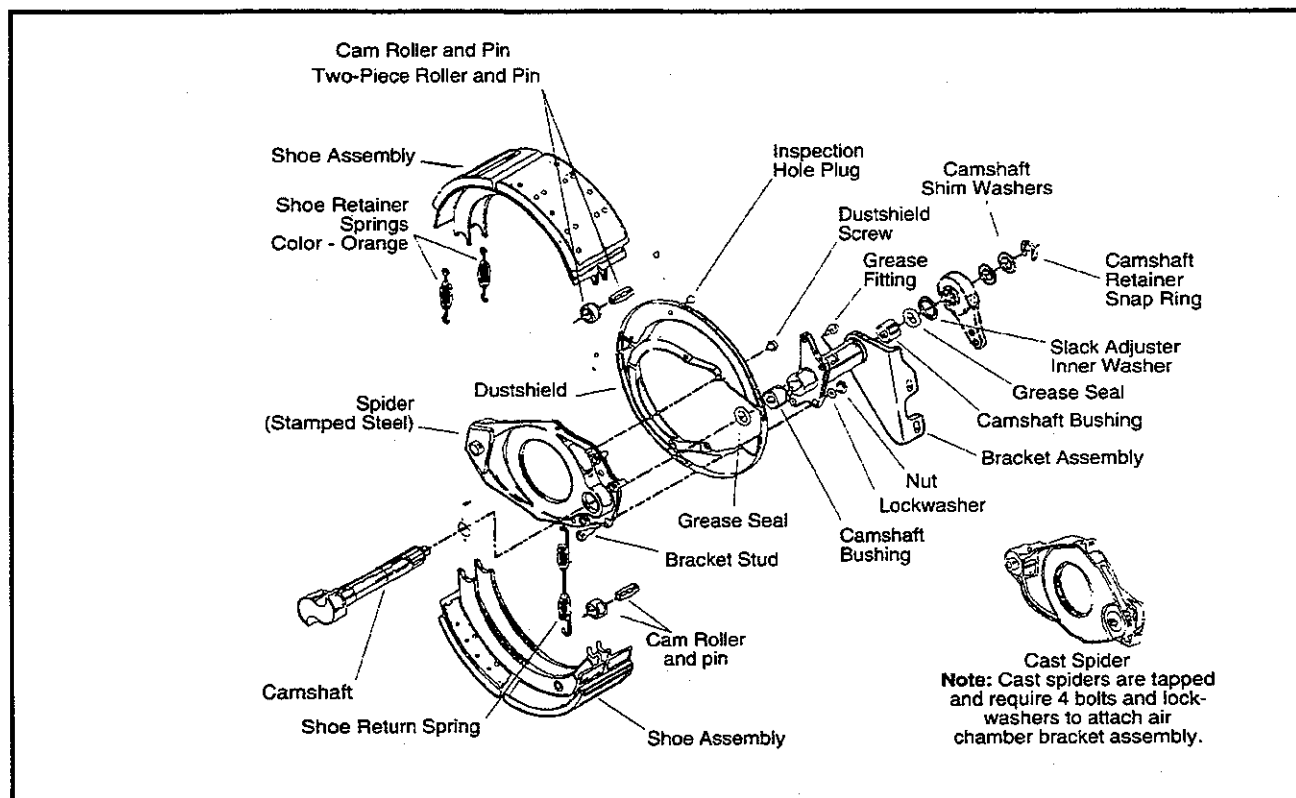


Figure 5—Brake Assembly

- **Remove and Replace Brake Shoes.**
- **See Figure 5—Brake Assembly.**

7. Push cam end of top shoe toward cam.

1. Remove wheel cover. (Reference Remove and Replace Wheel cover.)
2. Remove Hub/Drum assembly. (Reference Remove and Replace Hub/Assembly.)
3. Lift upper shoe to stretch return spring. (See Figure 6—Lift Upper Shoe)

Note

A suitable brake tool is required when removing rollers and return springs.

4. Remove upper cam and roller pin.
5. Remove lower shoe roller and pin.
6. Position a lever or a suitable tool with notch to engage spring rod. (See Figure 7—Engage Spring Rod.)

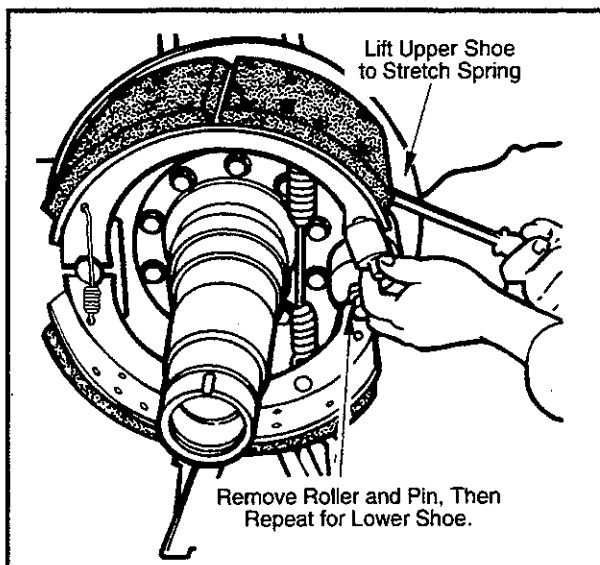


Figure 6—Lift Upper Shoe

8. Apply a downward force on tool to stretch spring.
9. Remove and discard spring.
10. Rotate both shoes around anchor pin and remove brake shoes. (See Figure 8—Rotate Shoes.)

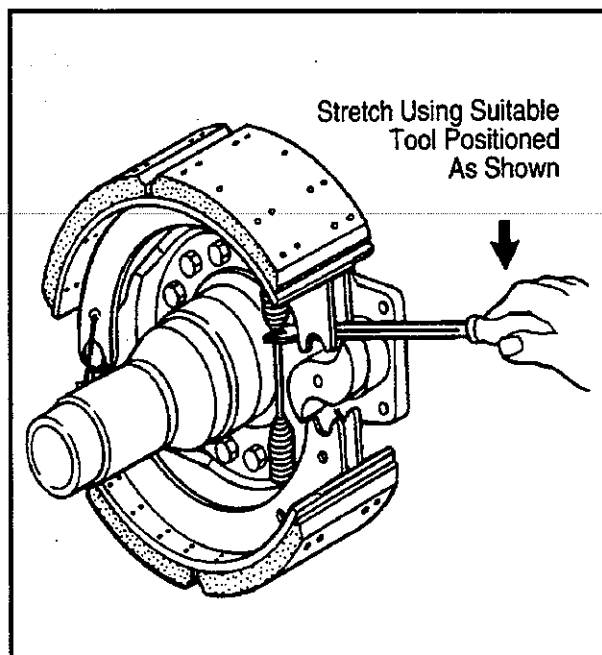


Figure 7—Engage Spring Rod

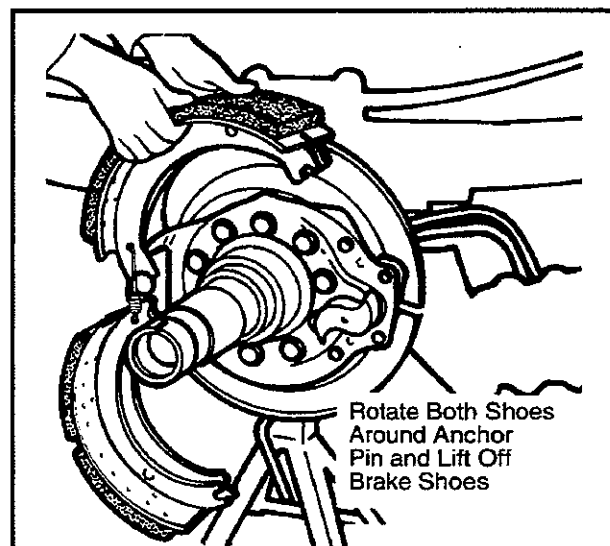


Figure 8—Rotate Shoes

11. Inspect brake shoe and lining, reference Routine Maintenance Inspect Shoe and Lining.
12. Check camshaft radial play, reference Routine Maintenance Camshaft Radial Play Inspection.

Note

Do not lubricate cam head surface. Surface must remain free of oil, grease or other contaminants.

13. Lubricate shoe roller recess and roller ID with NLG1 Grade number 1 high temperature and waterproof grease.
14. Hook ends of new retainer springs into holes in both shoe tables, point hook ends down.
15. Position upper and lower shoes around anchor pin. (See Figure 9—Position Shoes.)

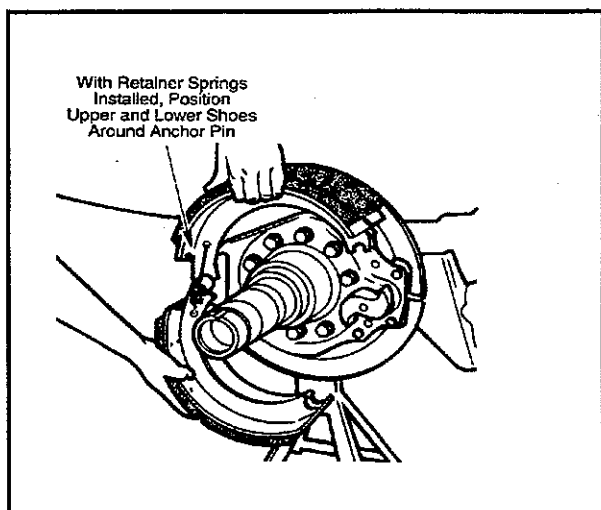


Figure 9—Position Shoes

16. Install a new shoe return spring on lower shoe with hook pointing out.
17. Position a lever or a suitable tool with notch to engage spring rod. (See Figure 7—Engage Spring Rod.)
18. Stretch shoe return spring to allow for insertion of new pin and roller on lower shoe web, repeat for upper shoe. (See Figure 10—Insert Pin and Roller.)
19. Install Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)
20. Install wheel cover. (Reference Remove and replace Wheel cover.)

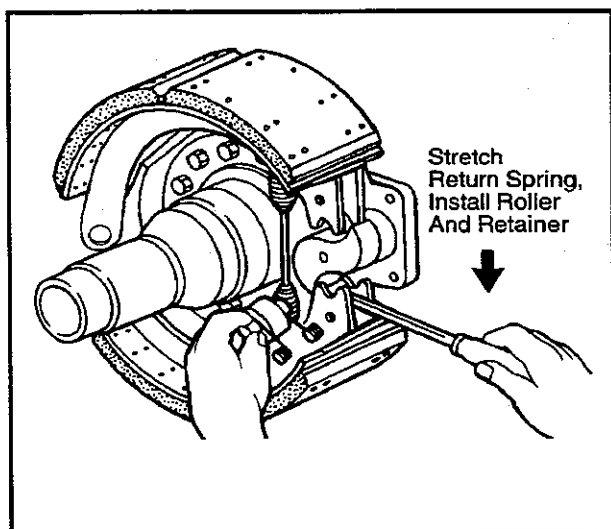


Figure 10—Insert Pin and Roller

Extended Service Air Brakes

- See Figure 11—Brake Assembly
- **Remove and Replace Hub/Drum Assembly**
 1. Remove wheel cover. (Reference Remove and Replace Wheel Cover.)
 2. Remove eight nuts.
 3. Remove axle.
 4. Remove axle flange gasket.
 5. Remove outer rear spindle nut.
 6. Remove rear lock washer.

Note

If necessary, remove bearing cups from inside Hub/Drum assembly.

7. Remove bearing adjusting nut, outer hub bearing and hub/drum assembly.
8. Remove rear axle seal and discard seal.
9. Remove inner hub bearing.
10. Inspect hub bearings and rear axle seal, reference Routine Maintenance Wheel Bearing Inspection.
11. Inspect brake drum. (Reference Routine Maintenance Brake Drum and Rotor Inspection.)
12. Lubricate inner hub bearing. (Reference Routine Maintenance Wheel Bearing Lubrication.)
13. Install inner hub bearing and new rear axle seal.
14. Seat smaller outside diameter of rear axle seal in recess of tool adapter.
15. Insert centering tool of plug in bore on inner hub bearing cone.
16. Use the correct disc from the seal driver set with bearing cone.

17. Hold tool handle firmly and strike until sound of impact changes to indicate seal has bottomed in hub seal recess.
18. Check for movement by manually moving interior rubber components of seal back and forth. A slight movement indicates a damage free installation.

• **Install Hub/Drum Assembly**

1. Clean spindles before installing wheel end components.
2. Clean the threads on the spindle with a wire brush.
3. Coat lip of rubber seal with a thin layer of wheel bearing lubricate.
4. Grease outer hub bearing. (Reference Routine Maintenance Wheel Bearing lubrication.)
5. Fill the recessed area in the hub wheel between bearing cups to the level of bearing cups with grease.
6. Slide hub and rotor assembly straight onto spindle to prevent damage to seal. Disc and wheel hub are left and right.

Note

Due to the threads on wheel mounting studs, disc wheel hubs must be installed on the correct sides as seen in end of wheel mounting stud by R and L.

7. Install the outer rear hub bearing. Make sure bearing is properly lubricated.

8. Inspect for excessive bearing endplay. Bearing endplay should not exceed 0.010 inch (0.254 mm).

Note

Inner wheel nut may be loosened to install lock.

9. Install lock washer (C) against inner wheel nut with locking device positioned on either the flat side or peak of inner nut.
10. Install outer wheel nut and torque to 250-275 foot-pounds (339-373 N•m).
11. Rotate wheel to check for binding.
12. Bend one tang of lock over flat part of outer wheel nut to secure.
13. Install axle flange gasket.
14. Install axle.
15. Install eight nuts. (See Table—1 Component Measurement and Specification.)
16. Inspect Hub/Drum radial run-out, not to exceed 0.020 inch (0.508 mm). Check inside of brake drum surface to be 0.250 inch (6.35 mm).
17. Fill axle housing with correct lubricate.
18. Install wheel. (Reference Remove and Replace Wheel Cover.)

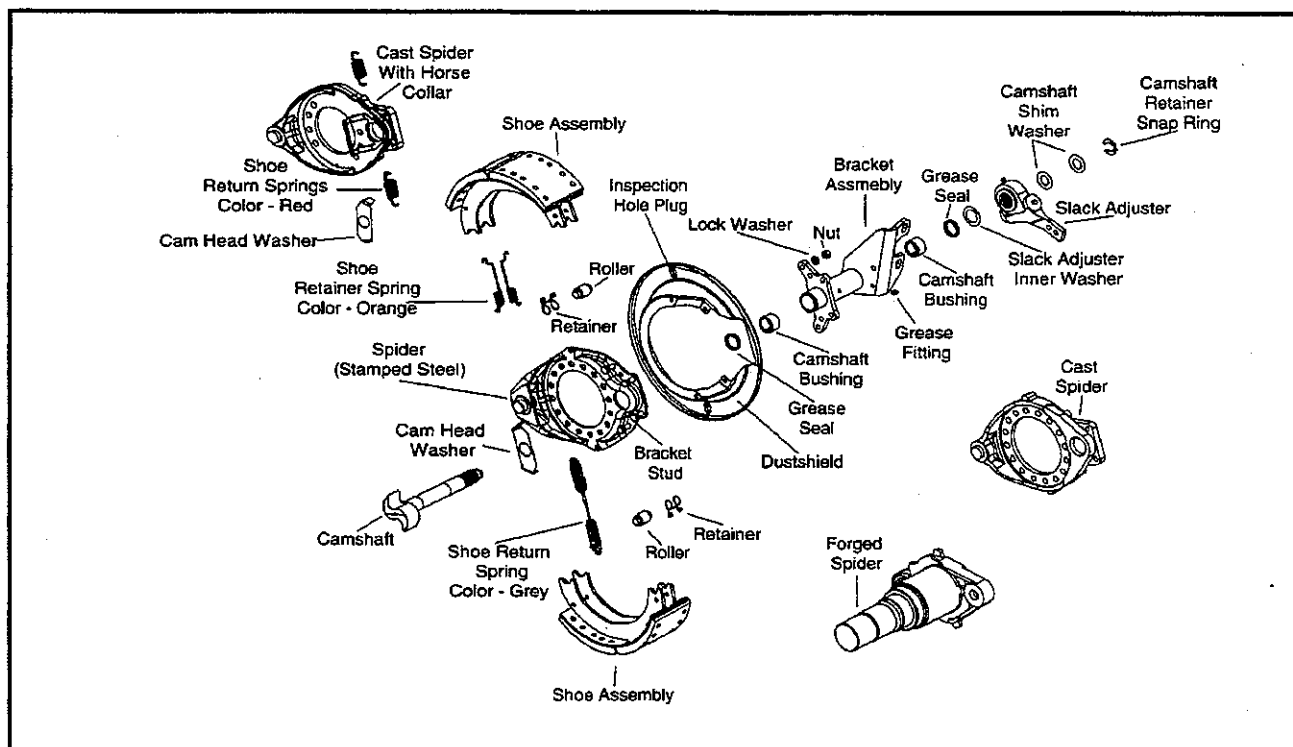


Figure 11—Brake Assembly

• Remove Wheel Cover

1. Remove wheel cover. (Reference Remove and Replace Wheel Cover.)
2. Remove Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)
3. Pry roller retainer coiled loops out of each shoe web holes. (See Figure 12—Pry Roller Retainer.)
4. Remove upper cam and roller pin assembly.
5. Lift upper shoe to stretch return spring. (See Figure 13—Remove Roller and Pin.)
6. Pivot roller retainer to swing loops clear of shoe webs.

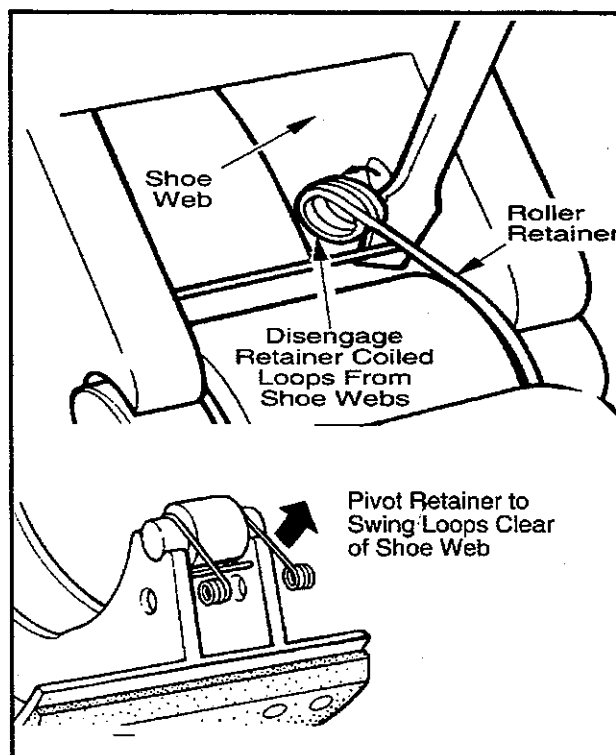


Figure 12—Pry Roller Retainer

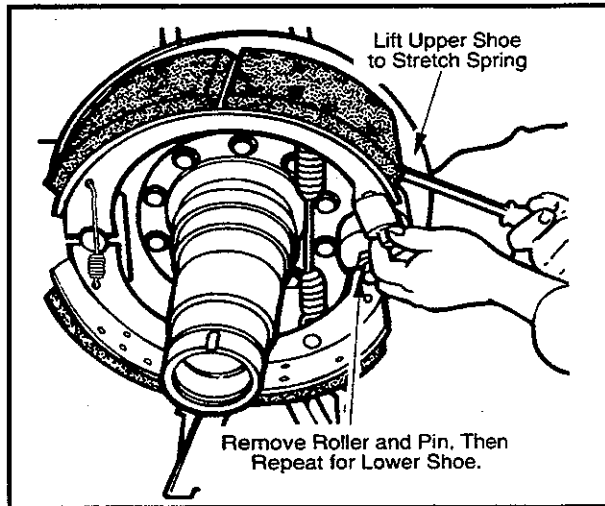


Figure 13—Remove Roller and Pin

7. Repeat steps to remove lower cam and roller pin assembly.
8. Position I lever or a suitable tool with notch to engage spring rod. (See Figure 14—Engage Spring Rod.)

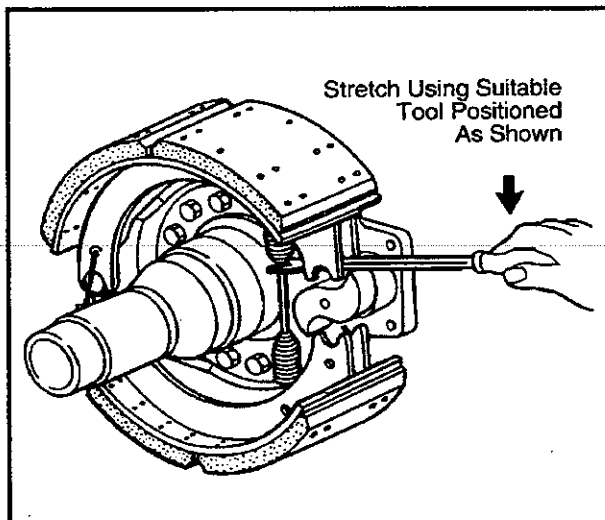


Figure 14—Engage Spring Rod

9. Push cam end of top shoe toward cam.
10. Apply a downward force on tool to stretch spring.
11. Remove and discard spring. (See Figure 15—Return Spring.)

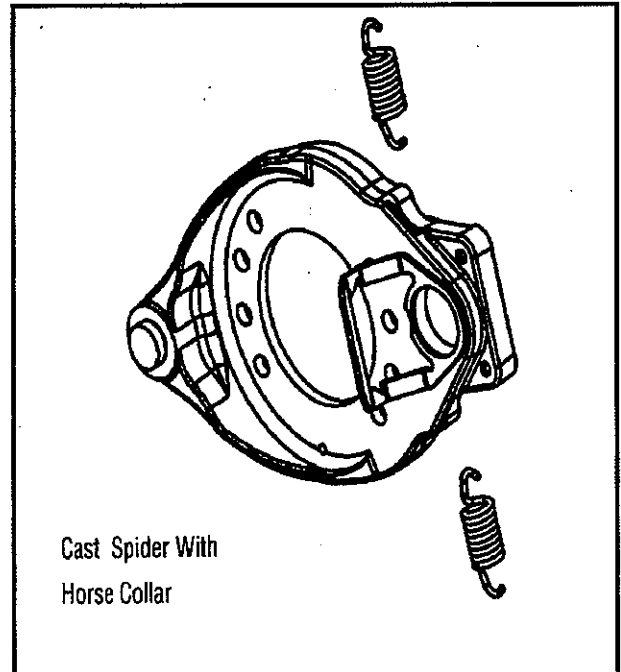


Figure 15—Return Spring

12. Rotate both shoes around anchor pin and remove brakes. (See Figure 16—Rotate Shoes.)

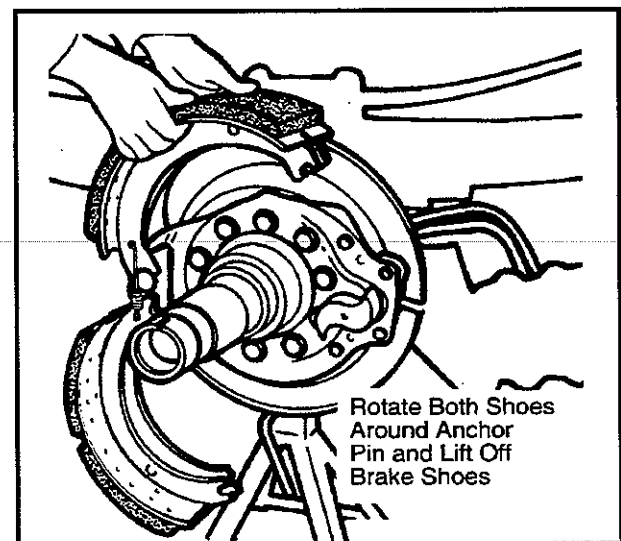


Figure 16—Rotate Shoes

13. Inspect brake shoe and lining (Refer to Routine Maintenance (Inspect Drum Shoe and Lining).
14. Replace parts as necessary.
15. Check camshaft radial play. (Reference Routine Maintenance Camshaft Radial Play Inspection.)

LTC Wheel End Components

Note

Do not lubricate cam head surface with oil, grease or other contaminants.

16. Lubricate shoe roller recess and roller ID NLGI grade number 1 high temperature and waterproof grease.
17. Hook ends of new retainer springs into holes in both shoe tables, hooks pointing out.
18. Position upper and lower shoes around anchor pin. (See Figure 17—Position Shoes.)
19. Install a new shoe return spring on lower shoe with hook pointing out.
20. Position a lever or a suitable tool with notch to engage spring rod. (See Figure 18—Engage Spring.)
21. Apply a downward force on tool to stretch spring, allowing installation of upper spring hook.

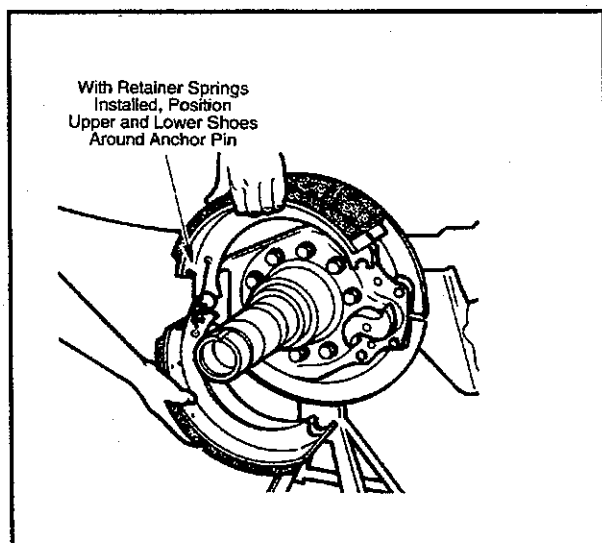


Figure 17—Position Shoes

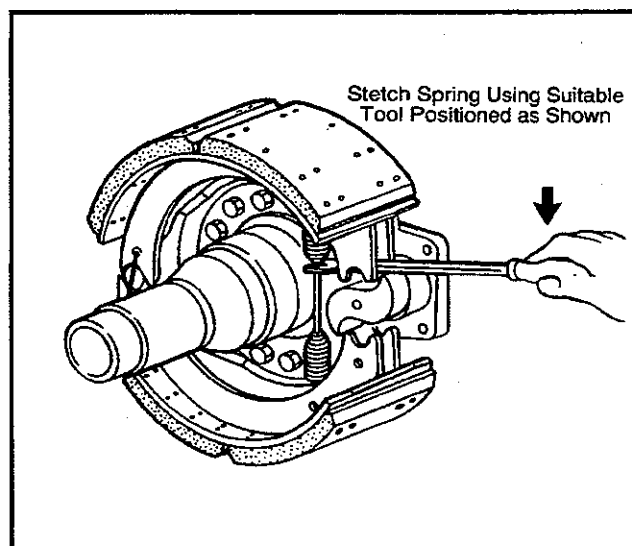


Figure 18—Engage Spring

22. Assemble roller retainer on ends of roller assembly. (See Figure 19—Roller Retainer.)
23. Position assembly in roller recess.
24. Squeeze loops and swing retainer in position to snap loops into webs. (See Figure 20—Squeeze Loops.)

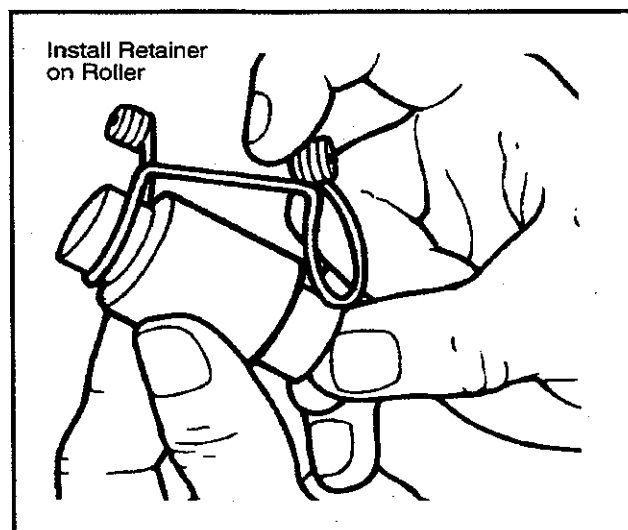


Figure 19—Roller Retainer

25. Verify that both retainer loops are engaged in web holes.

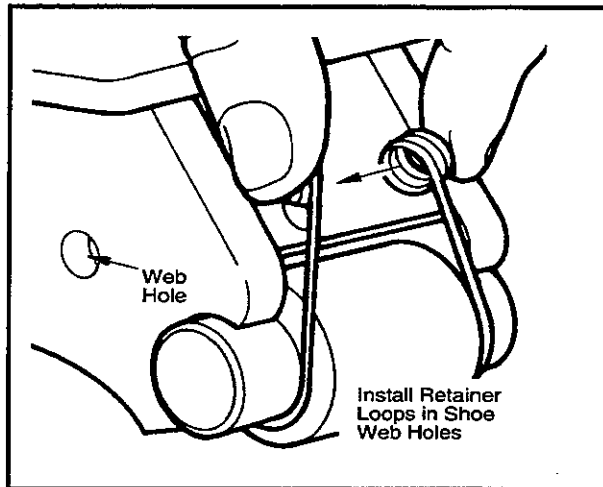


Figure 20—Squeeze Loops

- Repeat Procedure on Upper Shoe.
1. Install Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)
 2. Install wheel. (Reference Remove and Replace Wheel Cover.)

Slack Adjuster

- Remove, Inspect and Replace
1. Remove cotter pin and clevis pin from air chamber push-rod clevis.

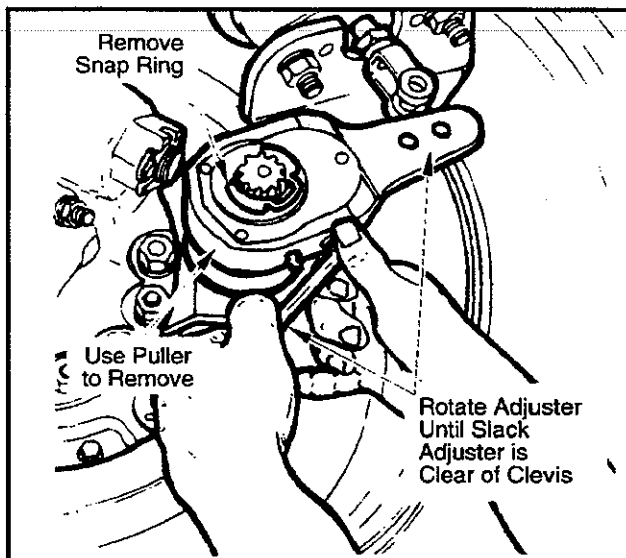


Figure 21—Slack Adjuster

Caution

Do not hammer slack adjuster to remove. Damage to slack adjuster and/or camshaft splines can occur.

Note

Record orientation of slack adjuster with reference to push rod before removing slack adjuster.

2. Depress locking sleeve, turn adjuster nut until slack adjuster is clear of air chamber push-rod clevis. (See Figure 21—Slack Adjuster.)
3. Remove snap ring and outer shim washers from camshaft.
4. Remove slack adjuster.
5. Inspect slack adjuster.
6. Inspect clevis pin bushing for cracks and wear.
7. Inspect splines for chipped teeth and deformation.
8. Replace slack adjuster if damaged.
9. Depress locking sleeve and turn adjustment nut with a wrench at least one turn in each direction. (See Figure 22—Install Slack Adjuster.)

Note

If binding occurs, or if excessive force is required to rotate, replace slack adjuster. Inner washer is 0.060 inch (1.524 mm) thick and has a large hole.

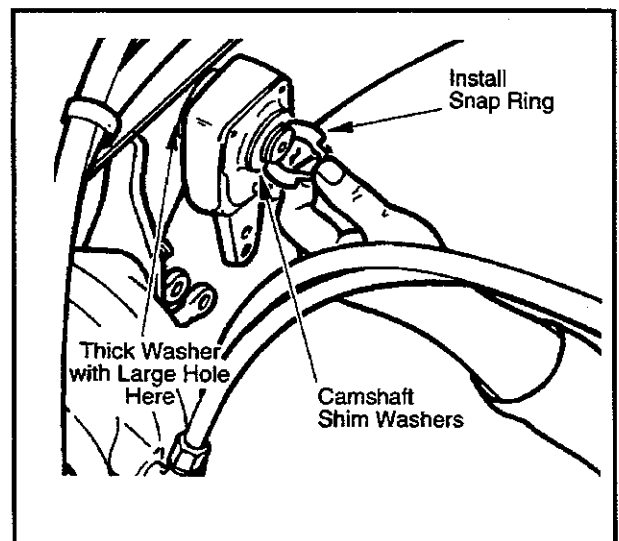


Figure 22—Install Slack Adjuster

LTC Wheel End Components

10. Install slack adjuster inner washer on camshaft.
11. Apply a thin coat of chassis grease to slack adjuster splines.
12. Install slack adjuster on camshaft. (Reference step 2 Note for recorded position.)
13. Install camshaft shim washers and snap ring.
14. Mount a dial indicator with head plunger. (See Figure 23—Mount Dial Indicator.)
15. Pull inboard on slack adjuster end of cam to take up endplay.

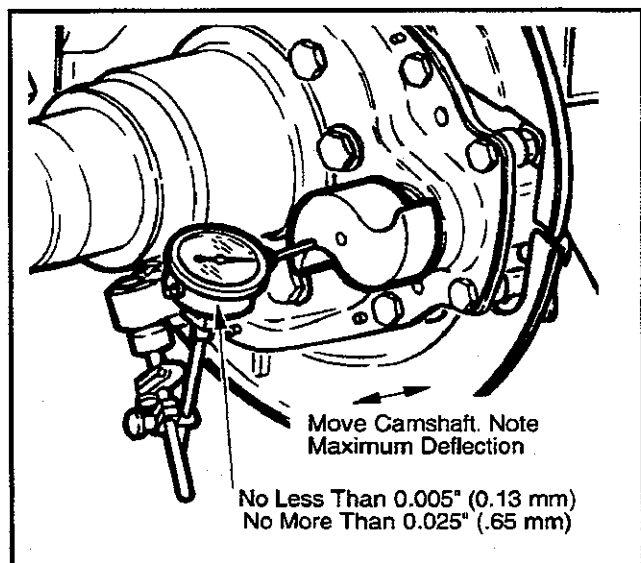


Figure 23—Mount Dial Indicator

16. Zero dial indicator.

Note

If necessary, add or remove camshaft shim washers to obtain end play between 0.005—0.025 inch (0.13—0.63 mm) with slack adjuster centered between air chamber bracket and snap ring groove.

17. Push outboard on slack adjuster end of cam and note maximum reading.

Caution

Grease should not flow out of end of tube toward cam head. If it does, seal is defective and must be replaced.

Do not replace existing grease fitting with a pressure relief type. Only standard non-vented fittings are to be used with spring loaded lip seals.

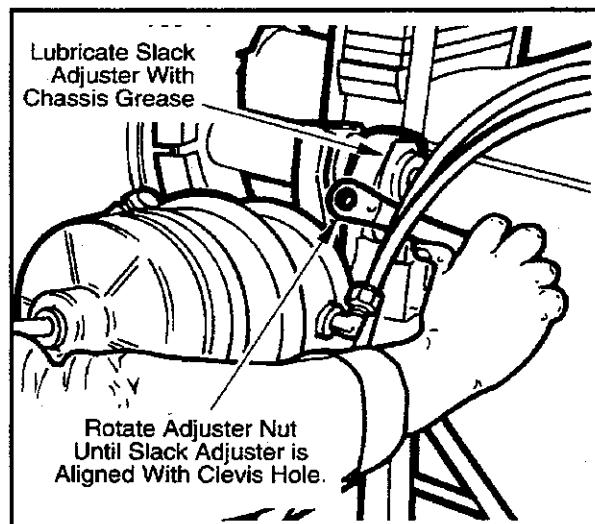


Figure 24—Rotate Adjuster Nut

18. Pressure lubricate slack adjuster.
19. Pressure lubricate air chamber bracket until grease flows out of slack adjuster end of tube. (See Figure 24—Rotate Adjuster Nut.)
20. Verify that air chamber face-to-face centerline dimension is correct. (Reference Remove, Inspect and Replace Air Chamber.)
21. Ensure that clevis lock nut is securely tightened.
22. Rotate adjusting nut.
23. Depress locking sleeve as required until correct hole in slack adjuster is aligned with hole in air chamber push-rod clevis. (See Figure 24—Rotate Adjuster Nut.)
24. Install clevis and cotter pin.

• Automatic Slack Adjuster Inspection on Vehicle

Note

The free stroke is the distance the slack arm moves to make the brake shoes contact the drum.

1. Check the free stroke.

2. Move the slack arm with a small pry bar.

Note

If free stroke is greater than 0.675 inch (17.145 mm), check the brake components.

3. Measure movement distance. The correct distance is 0.375 - 0.675 inch (9.525 - 17.145 mm).
4. Measure the power stroke. (See Figure 25—Measure Stroke.) The difference between when the brake is off and when the brake is fully applied. The pressure should be 80 - 90 psi (551.6 to 620.5 kPa. (See Table 3—Chamber Stroke.)

Note

The chamber type is stamped on the band that is on the air chamber.

Chamber Stroke	
Chamber Type	Adjusted Stroke
9, 12	Less than or equal to 1.375 inch (34.92 mm)
16, 20, 24	Less than or equal to 1.750 inch (44.45 mm)
30	Less than or equal to 2.000 inch (50.80 mm)
36	Less than or equal to 2.25 inch (57.15 mm)

Table 3—Chamber Stroke

Note

The back torque should be measured only when the brake system has no problems, or when the push rod power stroke exceeds the specified values.

5. Measure back torque.

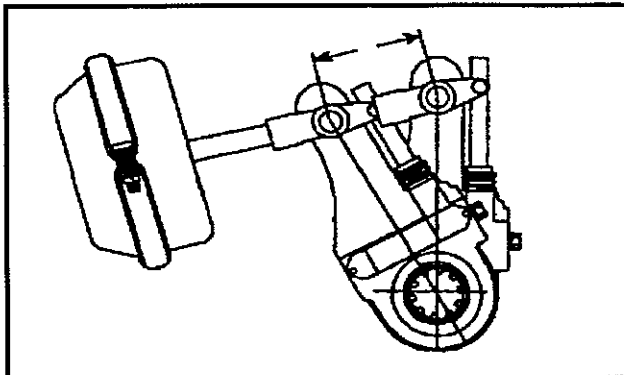


Figure 25—Measure Stroke

Caution

Do not turn the hex adjusting shaft more than five clicks (ratchet teeth) when taking readings. If the back torque reading is below 120 inch-pounds (13.6 N•m) and the push rod power stroke is over the limits, replace the auto slack adjuster. If the back torque exceeds 400 inch-pounds (42.2 N•m), replace the autos lack adjuster.

6. Turn the hex adjusting nut shaft counterclockwise counter clockwise slowly. Back stroke will increase to a peak value, then return to zero as the clutch ratchet disengages. (See Figure 26—Adjust Shaft.)

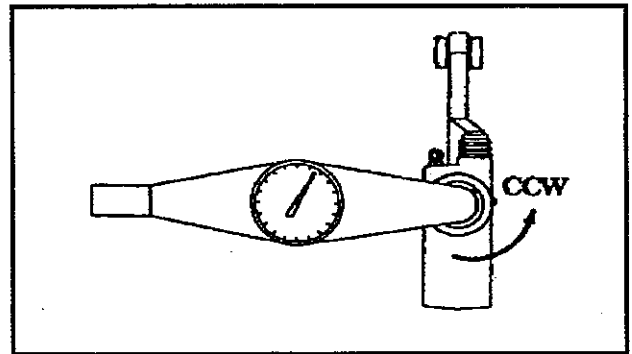


Figure 26—Adjust Shaft

- Automatic Slack Adjuster Inspection Removed from the bus.

1. Verify automatic slack adjuster setup.
2. Select the correct template for spline size and armhole locations.
3. Fit installation template. (See Figure 27—Template Angles.)
4. Swing template to engage 0.50 inch (12.7 mm) pin.

LTC Wheel End Componentents

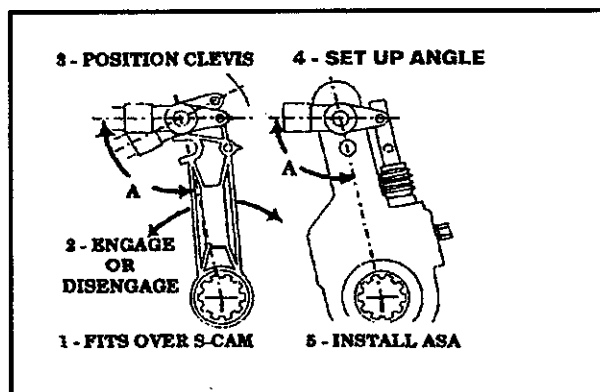


Figure 27—Template Angles

- Template now indicates correct setup angle A. (See Figure 28—Installation Template.)

5. Remove template and 0.50 inch (12.7 mm) pin.
6. Install automatic slack adjuster on S-Cam.

7. Turn hex nut clockwise until the 0.50 inch (12.7 mm) and the 0.25 inch (6.35 mm) holes line up with clevis.
8. Install and secure clevis pin.
9. Turn nut clockwise until shoes contact drum.
10. Loosen hex nut $\frac{1}{2}$ turn counter clockwise to complete setup.

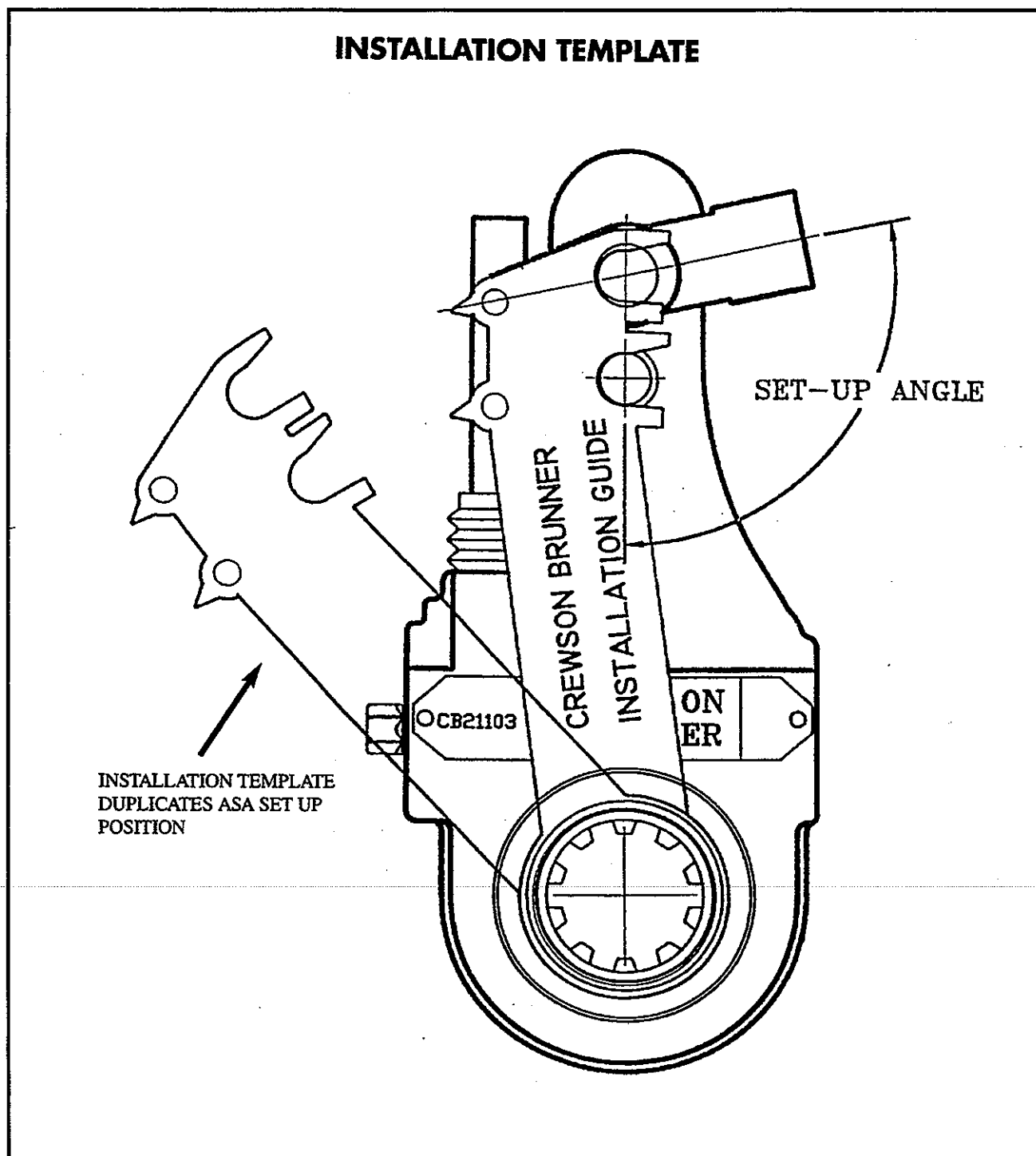


Figure 28—Installation Template

Note

The actuation rod will move as a slight force applied to turn the adjusting shaft hex nut. A $\frac{1}{4}$ turn will cause full movement of the actuation rod. Full movement of the actuation rod is 0.50 inch (12.7). Counter wise movement of the adjusting shaft hex will move the actuation rod into the slack body.

11. Check actuation rod movement. (See Figure 29—Check Rod Movement.)

Note

Replace automatic slack adjuster if actuation rod does not move.

12. Inspect gear movement and front torque.

Note

The spline should rotate about 90%.

13. Rotate adjusting hex nut for six full revolutions. Front torque will increase to a peak value then return to zero several times on each revolution. (See Figure 30—Rotate Hex Nut.)

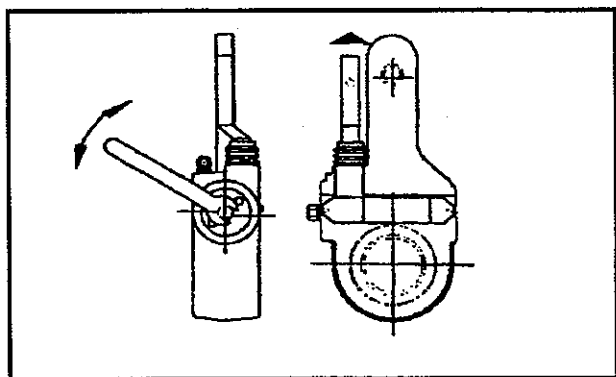


Figure 29—Check Rod Movement

14. Torque front clock wise to less than 75 inch-pounds (8.5 N•m). (See Figure 30—Rotate Hex Nut.)

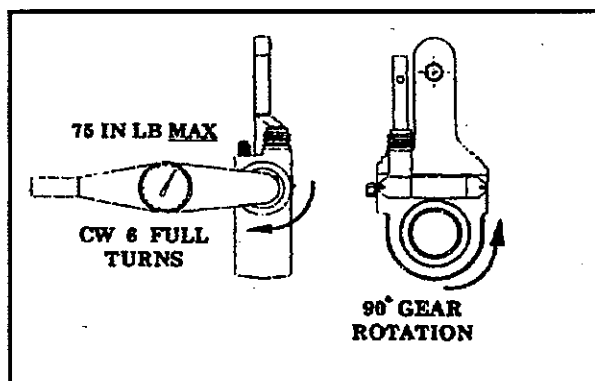


Figure 30—Rotate Hex Nut

15. Replace automatic slack adjuster if spline does not rotate, or if torque readings are greater than 75 inch-pounds (8.5 N•m).
16. Check back torque.

Note

The back torque should be measured only when the brake system has no deficiencies, or when the push rod power stroke exceeds the specified values.

Caution

Do not turn the hex adjusting shaft more than five clicks (ratchet teeth) when taking readings. If the back torque reading is below 120 inch-pounds (13.6 N•m) and the push rod power stroke is over the limits, replace the auto slack adjuster. If the back torque exceeds 400 inch-pounds (45.2 N•m), replace the auto slack adjuster.

Note

Back torque will increase to a peak value, then return to zero as the clutch ratchet disengages.

17. Torque the hex adjusting shaft counter clock wise slowly. (See Figure 31—Turn Shaft.)

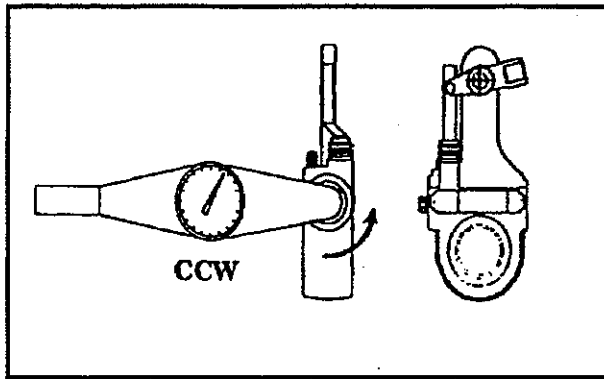


Figure 31—Turn Shaft

• **Camshaft**

1. Remove Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)
2. Remove brake shoes. (Reference Remove and Replace Brake Shoes.)
3. Remove slack adjuster. (Reference Remove, Inspect, and Replace Slack Adjuster.)
4. Grasp camshaft head and pull camshaft outboard to remove.
5. Inspect camshaft. (See Figure 32—Check Spline.)

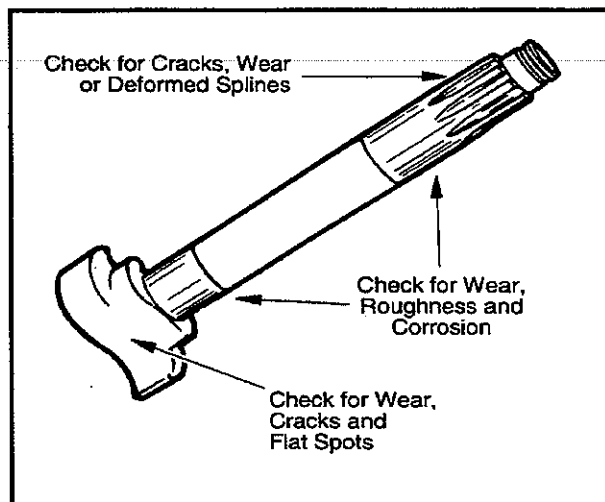


Figure 32—Check Spline

6. Inspect spline end for cracks and worn or deformed splines. Replace as necessary.

7. Inspect camshaft bushing journals for wear and corrosion. Replace camshaft if it shows visible wear or if roughness is felt in journal areas.
8. Inspect camshaft head for cracking or flat spots. Replace camshaft if a ridge can be felt between worn areas and cam head surface.
9. Rotate camshaft in the direction of air chamber push rod extension.
10. Check roller to make sure that roller is riding up on the convex side of cam head. (See Figure 33—Rotate Camshaft.)
11. Install camshaft into mounting position.

Caution

The extended service brakes camshaft uses a special washer between cam head and spider. It is mandatory that the washer be installed correctly. (See Figure 34—Camshaft Washer.)

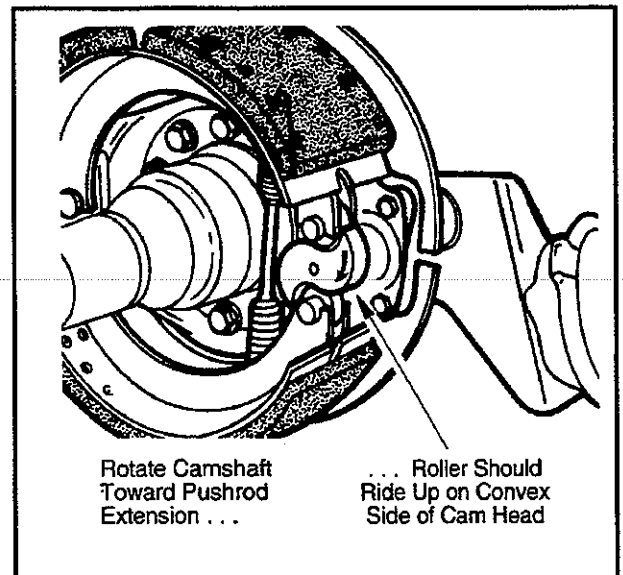


Figure 33—Rotate Camshaft

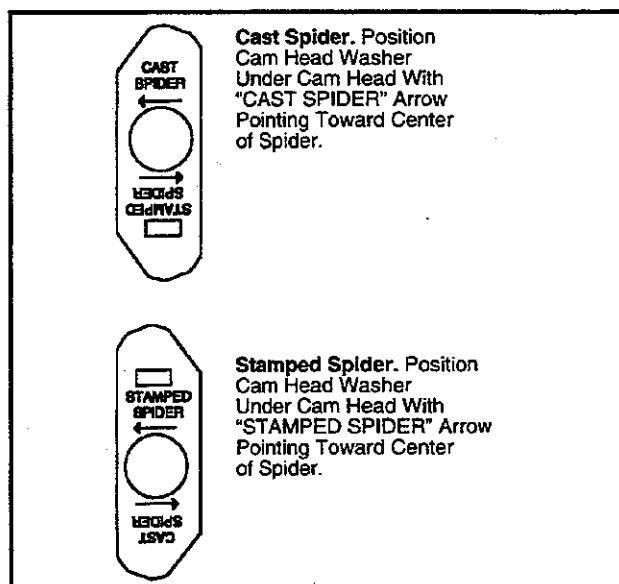


Figure 34—Camshaft Washer

Caution

For extended service, steer axle brakes using the horse collar spring retention system.

12. Install the horse collar over the cam tube first.
13. Install the ES washer.
14. Install the cam. (See Figure 34—Horse Collar.)

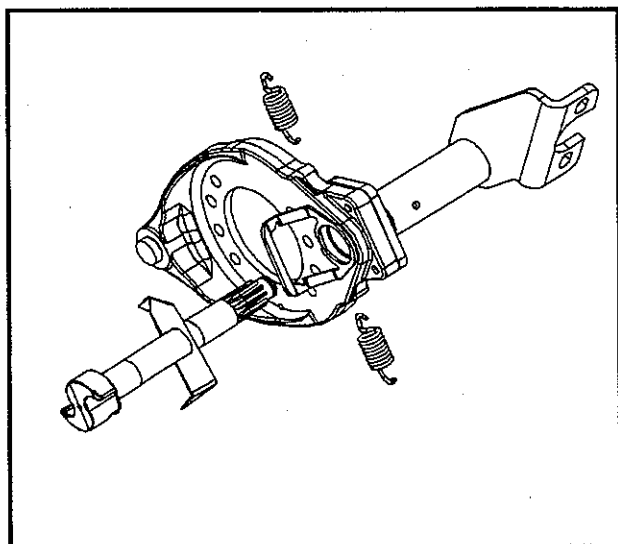


Figure 35—Horse Collar

15. Install slack adjuster. (Reference Remove, Inspect and replace Slack Adjuster.)

16. Install brake shoes. (Reference Remove and Replace Brake Shoes.)
17. Install Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)

• Air Chamber Bracket

1. Remove Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)
2. Remove brake shoes. (Reference Remove and Replace Brake Shoes.)
3. Remove slack adjuster. (Reference Remove, Inspect, and Replace Slack Adjuster.)
4. Remove camshaft. (Reference Remove, Inspect, and Replace camshaft.)

Warning

To prevent injury make sure that spring is caged before removing spring brake type air chamber.

5. Disconnect chamber air line.

Note

The brakes with stamped spiders and the air chamber bracket to spider studs are a press fit. There is no need for removal.

6. Remove attaching nuts and bolts on brakes with cast spider. Pull the air chamber bracket from the spider.
7. Inspect air chamber bracket. (See Figure 36—Air Chamber Bracket.)

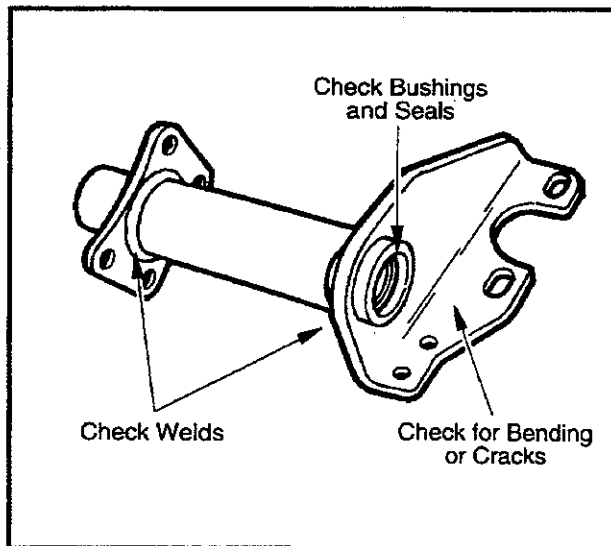


Figure 36—Air Chamber Bracket

8. Inspect for bent, broken or cracked arm and cracked welds. Replace bracket if any are evident.
9. Inspect mounting studs (or bolts) for looseness, damaged threads or a bent condition. Replace mounting stud if any of these conditions are evident.
10. Inspect bushing and seals. (Reference Remove, Inspect and Replace Camshaft Bushing/Grease Seal.)
11. Install air chamber bracket.
12. Orient bracket to align mounting studs with holes in bracket on stamped steel spider.
13. Position bracket against spider.
14. Install lock-washers and nuts.
15. Torque stud nuts to 65—85 foot-pounds (88—115 N•m).
16. Orient bracket to align bracket holes with tapped holes in spider on cast spider.
17. Position bracket against spider.
18. Install bolts and lock washers.
19. Torque bolts to 65—85 foot-pounds (88—115 N•m)

20. Install chamber and torque 7/16 inch-20 Air Chamber Mounting Nuts 35—40 foot-pounds (48—54 N•m), if air chamber was removed.
21. Install chamber and torque 5/8 inch-18 Air Chamber Mounting Nuts 110—115 foot-pounds (149—156 N•m).
22. Install camshaft. (Reference Remove, Inspect, and Replace Camshaft.)
23. Install slack adjuster. (Reference Remove, Inspect, and Replace Slack Adjuster.)
24. Install brake shoes. (Reference Remove and Replace Brake Shoes.)
25. Install Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)

• **Spider**

1. Remove Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)
2. Remove brake shoes. (Reference Remove and Replace Brake Shoes.)

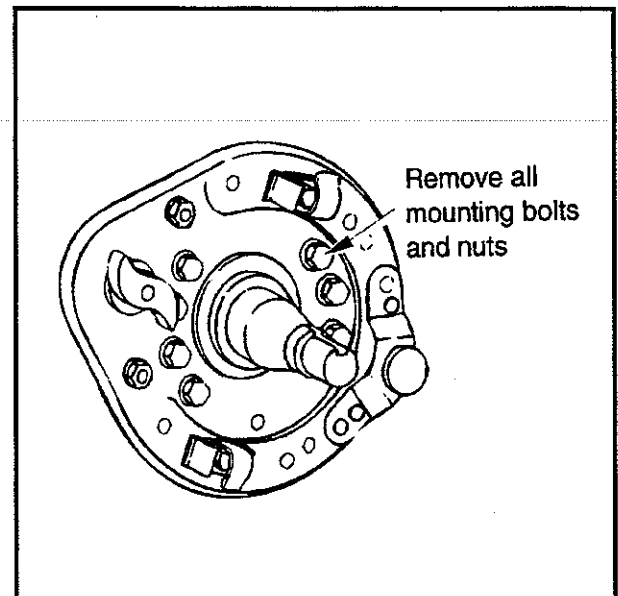


Figure 37—Attachment Nuts

3. Remove spider-to-axle attachment nuts and bolts. (See Figure 37—Attachment Nuts.)

LTC Wheel End Components

4. Remove spider.

- **Inspect Spider.**

1. Inspect visually for cracks around mounting bolt holes, in cam area and around anchor pin. (See Figure 38—Inspect for Cracks.)

Note

Anchor pins are not replaceable.

2. Inspect anchor pin. If loose or grooved more than 0.031 inch (0.79 mm) below original surface, replace spider assembly.

- **Install Spider.**

1. Position spider on axle flange.
2. Install attaching bolts and nuts.

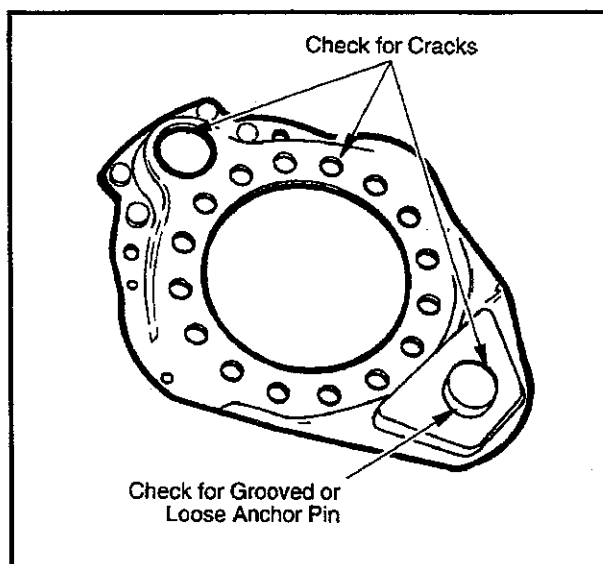


Figure 38—Inspect for Cracks

3. Tighten nuts to 150—190 foot-pounds (203—258 N•m) in sequence shown in Figure 39, Figure 40, and Figure 41—Rear.
4. Install camshaft. (Reference Remove, Inspect and Replace Camshaft.)
5. Install brake shoe. (Reference Remove and Replace Brake Shoes.)

6. Install Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)

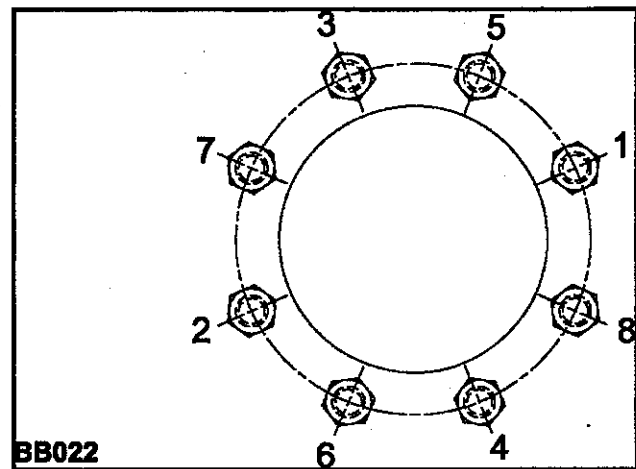


Figure 39—Torque Sequence for Rear

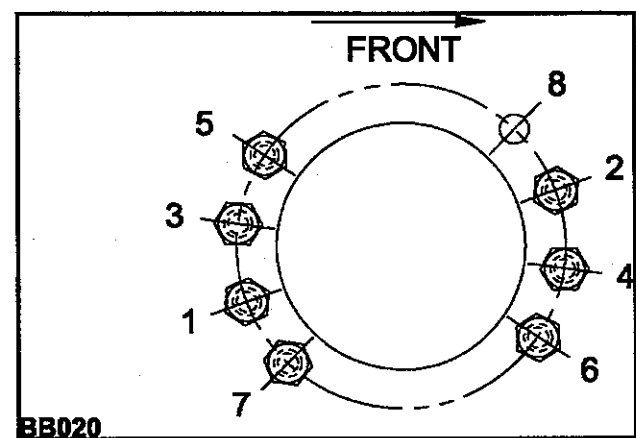


Figure 40—Rear

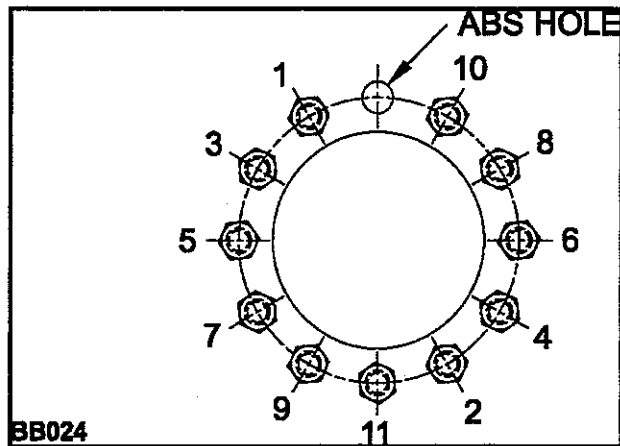


Figure 41—Rear

- Dust shield

1. Remove Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)
2. Remove brake shoes. (Reference Remove and Replace Brake Shoes.)
3. Remove camshaft. (Reference Remove, Inspect, and Replace Camshaft.)
4. Remove spider. (Reference Remove, Inspect, and Replace Spider.)
5. Remove all screws attaching dust shield to spider. (See Figure 42—Remove Screws.)

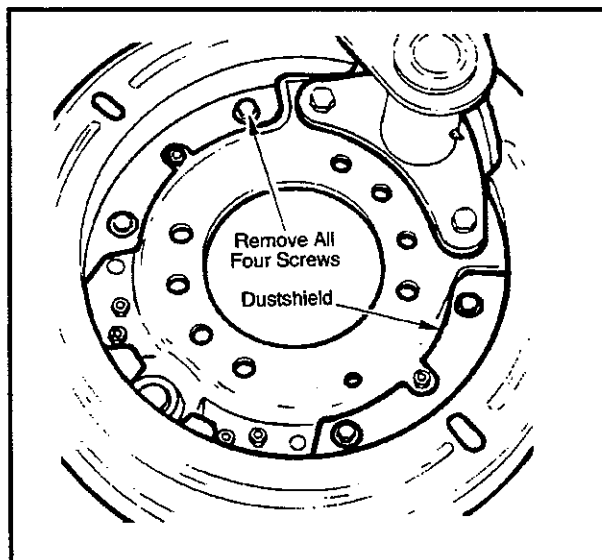


Figure 42—Remove Screws

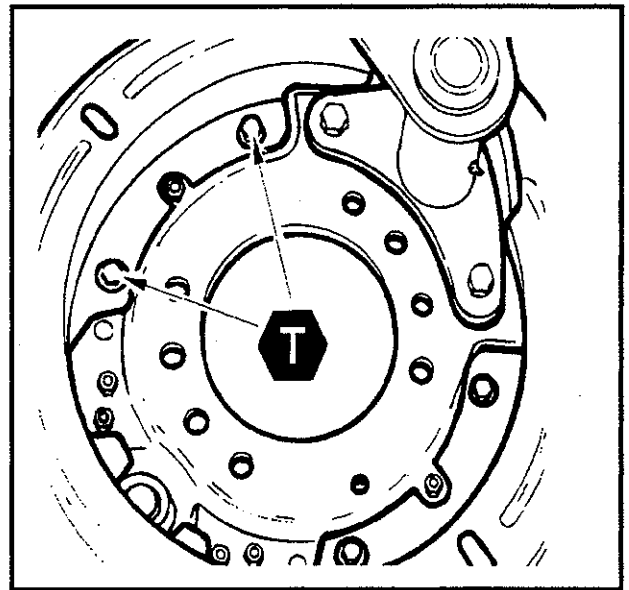


Figure 43—Tighten Screws

6. Tighten screws to 150-180 inch-pounds (16.9—20.3 N•m). (See Figure 43—Tighten Screws.)
7. Install spider. (Reference Remove, Inspect and Replace Spider.)
8. Install camshaft. (Reference Remove, Inspect, and Replace Camshaft.)
9. Install brake shoes. (Reference Remove and Replace Brake Shoes.)
10. Install Hub/Drum assembly. (Reference Remove and Replace Hub/Drum Assembly.)

- Camshaft Bushing/Grease Seal

1. Remove air chamber bracket. (Reference Remove, Inspect and Replace Air Chamber Bracket.)
2. Drive out old bushings and grease seals with a suitable driver. Clean and inspect air chamber bracket. (Reference Remove, Inspect and Replace Air Chamber Bracket.)

Note

Bushings should be recessed 0.281 inch (7.1 mm) at cam head end and 0.688 inch (17.5 mm) at slack adjuster end. (See Figure 44—Recessed Bushings.)

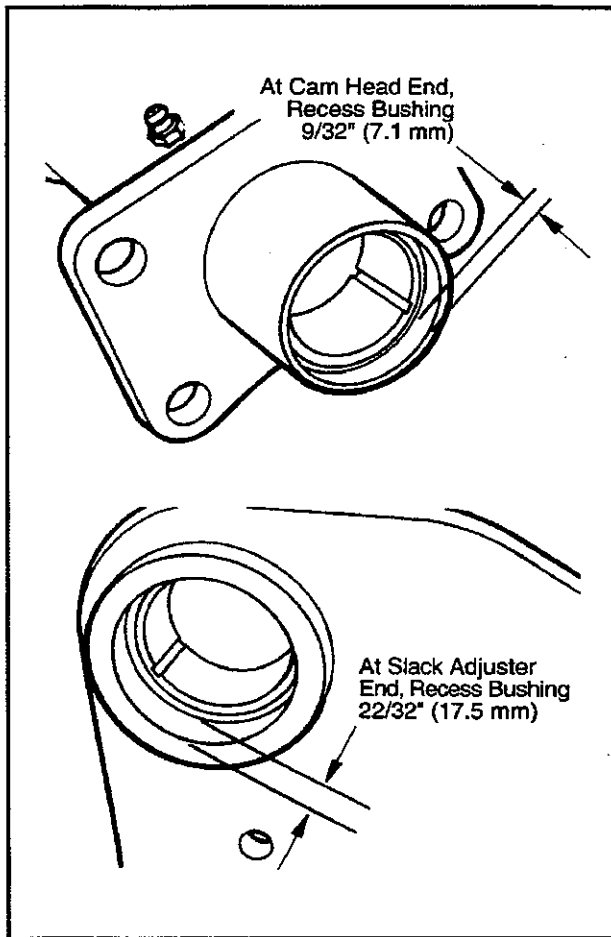


Figure 44—Recessed Bushings

3. Install new bushings in air chamber bracket with a suitable piloted driver. (See Figure 48—Recessed Bushings.)

Note

Seals must be installed as indicated so that lips side (with spring) of both seals faces toward slack adjuster end of bracket. Improperly installed seals can allow grease to exit camshaft head end of air chamber bracket and contaminate lining material.

4. Install new grease seals with a suitable piloted driver so seals are flush with end of air chamber bracket tube. (See Figure 45—Install Grease Seals.)

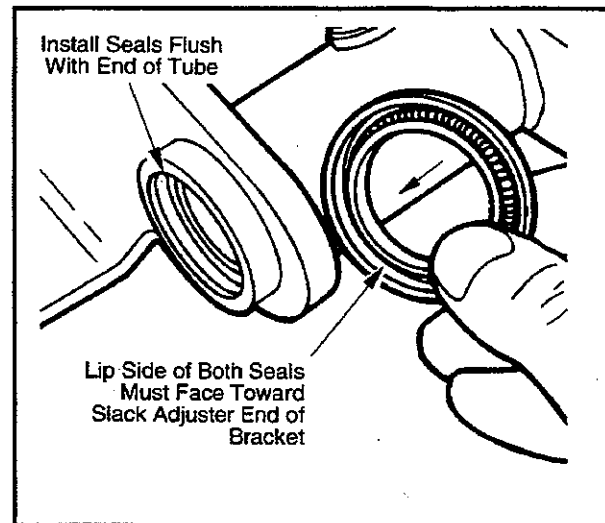


Figure 45—Install Grease Seals

• Air Chamber Inspection

Warning

To prevent personal injury, be sure to cage spring before removing spring brake type air chamber.

1. Inspect for air leaks, cracked housing, bent push rod, loose clamp ring, clogged vent holes or loose air fitting. Repair or replace as necessary.

Note

If air chamber is repaired or replaced, check distance from clevis pin hole centerline to air chamber face. (See Figure 46—Air Chamber.)

Clevis Pin Hole Centerline to Air Chamber. Face
 2.675 ± 0.063 inch (68.0 ± 1.60 mm).

Note

If a new air chamber is installed, ensure that the cut-off of push rod does not project too far into clevis. Minimum clearance of clevis centerline to push rod should be 0.875 inch (22.2 mm).

2. Inspect clevis pin for cracks and wear.

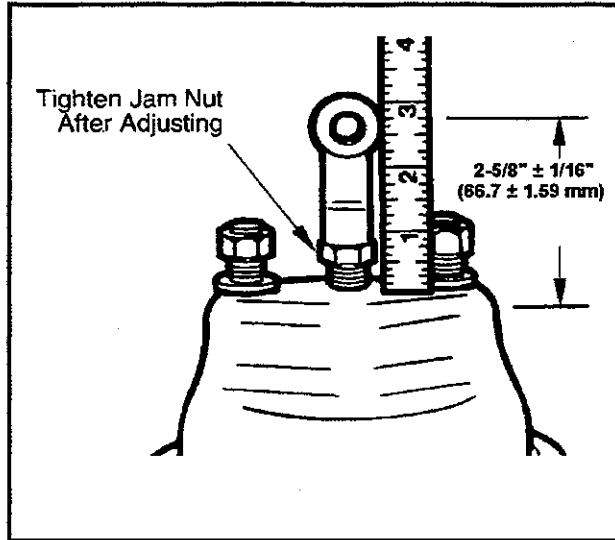


Figure 46—Air Chamber

Note

*Clevis Pin Hole Centerline to Air Chamber Face:
2.675 ± 0.063 inch (68.0 ± 1.60 mm)*

1. If a new air chamber is installed, ensure that the cut-off of push-rod does not project too far into clevis. Minimum clearance of clevis centerline to push-rod end should be 0.875 inch (22.2 mm).
2. Check clevis pin for cracks and wear.

LTC Cooling System



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before performing any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC with a Cummins M11 engine and an Allison B500 World Transmission.

Note

For the Hydraulic Fan Drive system, refer to Section 170 in this Blue Bird Service manual.

Warning

The sudden release of pressure from a hot cooling system may result in a loss of coolant and possible personal injury from the hot liquid or steam.

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

Caution

Coolant should be drained and replaced every two years.

Hoses in vehicles used in a stop and go service should be inspected every 12 months or 12,000 miles (19312 km). Hoses that are worn, chafed, hardened, or cracked must be replaced to prevent a leak.

Do not over tighten any hose clamp; the torque should be 45 to 50 inch-pounds (5.08 to 5.65 N•m).

Caution

Make sure all clamps on hoses or tubes are tight to prevent leaks of air or fluid. Make sure all screws and bolts are tight to prevent damage to vehicle.

Cooling System Removal

1. Remove the cap from the coolant recovery tank (27). (See Figure 1—Cooling System Removal.)
2. Open drain cock (30).
3. Remove clamp (17) from the barbed insert (28) in two places.
4. Remove low coolant sender (16) from the coolant tank (25).
5. Remove low coolant sensor (24) from the coolant tank (25).
6. Remove clamp (17) from the barbed insert (28) that attaches to the engine block.
7. Remove clamp (17) from the barbed elbow insert (20) in two places.
8. Remove silicon hose (29).
9. Remove clamp (22) from heater hose (23) and heater adapter pipe (21).
10. Loosen loaded spring clamp (5) at the hump hose (6) typical two places on the charge air cooler tube (9) typical.
11. Remove nut (36), lock washer (37), flat washer (50) from saddle (44) and U-bolt (43).

12. Remove constant torque clamp (13) at hump hose (14) in two places typical.
13. Remove nut (36), lock washer (37), flat washer (50) from saddle (11) and U-bolt (12).
14. Remove lower radiator hose (10).
15. Remove loaded spring clamp (5) typical and hump hose (6) from charge air cooler tube (7) in two places.
16. Remove alarmstat (31) from charge air cooler tube (7).
17. Remove constant torque clamp (15) from silicone hose (19) and upper radiator tube in two places.
18. Remove constant torque clamp (13) in two places.
19. Remove hump hose (14) from the upper radiator hose (8).
20. Remove the thermostat from the upper radiator hose (8).
21. Remove capscrew (38), flat washer (47) and lock washer (39) from motor mount isolator (4) in two places.
22. Remove nut (36), lock washer (37) and capscrew (35) from radiator bracket assembly (48).
23. Remove cotter pin (2) from clevis pin (1) at the radiator brace assembly (51) in two places.
24. Remove nut (52), flat washer (53), isolator (54) typical in two places from the radiator brace assembly (51).

Reassemble

To reassemble, reverse removal procedures.

Note

Coolant quantities vary depending upon engine type. (See Table 2—Engine Coolant in Section 005—Introduction for appropriate levels.) In addition, coolant must be added for the heater system and the LTC's 20 gallon radiator.



LTC Drive Shaft



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Safety

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Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins M11 engine and an Allison B500 World Transmission.

Description of Operation

The basic function of a driveshaft is to transmit power from one point to another in a smooth and continuous action. The driveshaft is designed to send torque through an angle from the transmission to the axle (or auxiliary transmission).

The driveshaft must operate through constantly changing relative angles between the transmission and axle. It must also be capable of changing length while transmitting torque. The axle of a vehicle is not attached directly to the frame, but rides suspended by springs in an irregular, floating motion.

This means the driveshaft must be able to contract, expand and change operating angles when going over bumps or depressions. This is accomplished through universal joints, which permit the driveshaft

to operate at different angles, and slip joints, which permit contraction or expansion to take place.

Warning

Rotating shafts can be dangerous. You can snag clothes, skins, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle. Use extreme caution to avoid personal injury.

Product Information Updates

Blue Bird Corporation assumes sole responsibility for ensuring that the information provided herein is accurate to the best of its knowledge at the time of printing. In keeping with its policy of continual product improvement, Blue Bird reserves the right to change product information without notice and without incurring obligation.

Publications

Some information contained in this section has been re-published from the following publications:

Dana Corporation Spicer® Universal Joint Division, Spicer® Universal Joints and Driveshafts Service Manual, 1000 through 1880 Series, Light, Medium and Heavy Duty Vehicles, © Dana Corporation, Form #3264.

Diesel Progress Engines and Drives, A Primer on Torsional Vibration, by Carl Stahl, February 1991.

Preparatory Work

Park the vehicle on a level surface. Once parked, set the parking brake and chock the rear wheels. You may find work underneath a vehicle made easier by using a lift of sufficient strength.

Inspection and Lubrication of All Types Driveshaft

Inspection

To keep a vehicle operating smoothly and economically, the driveshaft must be carefully inspect at regular intervals. Vibrations and u-joint and shaft support (center) bearing problems are caused by such things as loose end yokes, excessive radial (side to side or up and down) looseness, slip spline radial looseness, bent shaft tubing, or missing plugs in the slip yoke.

1. Check the output and input end yokes on both the transmission and axle, or axles, for looseness. If loose, disconnect the driveshaft and re-torque the end yoke retaining nut to specification. If yoke replacement is required, check for manufacturer's recommendation regarding replacement frequency of the end yoke retaining nut. (See Figure 1—Driveshaft.)
2. If the end yokes are tight, check for excessive radial looseness of the transmission output shaft and axle input and output shafts in their respective bearings. Consult transmission and axle manufacturer's specifications for acceptable radial looseness limits and method of checking.
3. Check for excessive looseness across the ends of the bearing assemblies and trunnions. This looseness should not exceed .006 inches maximum.
4. Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed .007 inches.
5. Check the shaft for damaged, bent tubing or missing balance weights. Make certain there is no build up of foreign material on the shaft, such as undercoat or concrete. If found, they should be removed.
6. If runout readings are required, they should be taken with the driveshaft mounted in the vehicle, with the transmission in neutral and the axle shafts pulled, or by jacking rear wheels off the ground and placing axles on jack stands. This will allow rotating the driveshaft by hand to check indicator readings. The runout readings taken at the various locations should not exceed an additional .010 T.I.R. over the manufacturer's specified runout.

7. For an inboard and outboard slip yoke assembly design, check to be sure the plug is not loose or missing. If it is, repair or replace it. Loose or missing plugs are commonly caused by not enough driveshaft slip movement. (See Figure 1—Driveshaft.)

Lubrication

Among the most common causes of joint and slip problems is lack of proper lubrication. Properly sized Spicer U-joints that are adequately re-lubricated at recommended intervals will normally meet or exceed vehicle operation requirements. Re-lubrication flushes the joints removing abrasive contaminants from the bearings.

Lubricants for Universal Joints

For a normal application, use a good quality lithium soap base extreme pressure (E.P.) grease meeting the N.L.G.I. grades 1 or 2 specifications. Grades 3 and 4 are not recommended because of their greater thickness.

For a severe application, use a good quality lithium soap base or equivalent E.P. grease having an operating temperature range of +325 to -10 degrees Fahrenheit. In addition, the grease should meet the N.L.G.I. grades 1 or 2 specifications.

Consult your local lubricant source for greases that meet these specifications.

Initial Lubrication and Re-lube Cycles

Spicer replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit prior to assembly into the yokes. Each cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should also be wiped with the same grease; filling all the cavities between the needle rollers and applying a liberal grease coating on the bottom of each bearing assembly. Too much grease may cause hydraulic "lock-up", making installation difficult. After the kits are installed into the yokes and prior to placing into service, they should be re-lubed, through the lube fitting, using the same grease.

Re-lubrication cycles vary depending on the service requirements and operating conditions of the vehicle. A recommended re-lube cycle for "On

Highway" is every 10,000 to 15,000 miles or each month.

Note

"On-highway" is defined as all applications requiring less than 10% of operating time on gravel, dirt or unimproved roads. If longer than 10% operating time off-highway, use off-highway recommendations. For line haul tractors using "10" series (including the 1810 Series) u-joints and Glidecote slip splines, the re-lubrication cycle may be extended up to 50,000 miles. Consult Dana Corporation, Spicer Universal Joint Division, for lubricant recommendations and evaluation of specific operating conditions that may warrant this extended re-lubrication cycle.

Lubrication Procedure for U-Joints (Except Double-Cardan Type Joints)

Warning

Rotating shafts can be dangerous. You can snag clothes, skins, hair, hands, etc. This can cause serious injury or death.

Do not work on a shaft (with or without a guard) when the engine is running.

Do not go up under the vehicle when the engine is running.

In order to avoid becoming entangled, install power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install a guard.

1. Use the proper lubricant to purge all four seals of each u-joint. This flushes abrasive contaminants from each bearing assembly and assures all four are filled. Pop the seals. Spicer seals are made to be popped.
2. If any seals fail to purge, move the driveshaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing assembly that is not purging.
3. Because of the superior sealing capability of the Spicer Seal design, there may occasionally be one or more bearing assembly seals that will not

purge. Release seal tension by loosening the bolts holding the bearing assembly that doesn't purge. It may be necessary to loosen the bearing assembly approximately 1/16 inch minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage.

4. Re-torque bolts to specification

Caution

Half Round End Yoke self-locking retaining bolts should not be reused more than five (5) times. Follow instructions implicitly to prevent serious personal injury or death from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.

Lubrication for Slip Splines

The lubricant used for u-joints is satisfactory for slip splines. Glidecote and steel splines both use a good E.P. grease meeting Grade 1 or 2 specifications.

Re-lube splines at the intervals recommended in the chart for u-joints.

1. Apply grease gun pressure to the lube fitting until lubricant appears at the pressure relief hole in the plug at the slip yoke end of the spline.
2. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.

Caution

In cold temperatures be sure to drive the vehicle immediately after lubricating. This activates the slip splines and removes the excessive lubricant. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize.

Note

There are numerous instances where special lubrication is required by vehicle specification or customer request. The lubrication recommendations listed in this manual are what Spicer U-Joint engineers suggest. Any alternate lubricants, or lubrication procedures, are the responsibility of the user.

Servicing the Driveshaft

Heavy Duty Application
Cross and Bearing Kit
Replacement
Bearing Plate Design

Full Round End Yoke Design

Tools Required

3/8 inch Square chisel
Ball peen hammer
1/2 inch drive socket wrench
Torque wrench (125 lb./ft.)
*Alignment bar / No Go Wear Gauge
Nylon support strap
Owatonna tool kit (#7057)
(Two Jaw Puller)
Hydraulic floor jack

Half Round End Yoke Design

Tools Required

1/2 inch drive socket wrench
1/2 inch, 9/16 inch, 3/4 inch sockets
Nylon support strap
*Alignment bar / No Go Wear Gauge
Torque wrench (200 lb./ft.)
Hydraulic floor jack

Note

The Alignment bar/No Go Wear Gauge is available only from Dana Corporation-Spicer Service Representative.

Note

Before removal of the driveshaft, mark the slip yoke assembly and tube shaft with a marking stick or paint to assure proper alignment when reassembled. This is known as keeping the driveshaft yokes "In Phase".

Caution

Never heat components above normal operating temperatures when disassembling.

Removal of Full Round End Yoke

Style

1. The method of driveshaft removal should be one that assures safety and ease of removal to the

mechanic without damage to the driveshaft, transmission or axle components. Suggested methods include use of a hydraulic jack, nylon strap and the two-jaw puller (Owatonna tool kit # 7057).

2. Bend tabs of lock straps away from bolt heads with a chisel.
3. Remove bolts (four) from each bearing assembly connected to the transmission and axle end yoke.
4. Release bearing assemblies from the yoke cross holes using the Owatonna tool kit.
5. Free the trunnion from the end yoke by tilting the trunnion and collapsing the driveshaft.

Note

If only one end of the driveshaft requires service, disconnect that end, unscrew the slip shaft seal (dust cap) from the slip yoke assembly, and then pull apart or slide off the assembly. When removing the entire driveshaft, disassemble one end at a time, laying the disconnected end on the floor carefully. When reassembling, be sure that the arrows or marks on the shaft and slip joint are in line to keep the driveshaft yokes in phase.

Removal of Half Round End Yoke Style

For half round end yoke disassembly, install a nylon support strap, remove the strap retaining bolts, one end at a time and release the driveshaft.

Disassembly

1. Place the driveshaft in a bench vise, clamping on the tube adjacent to the cross and bearing assemblies being removed.

Caution

Do not distort the tube with excessive grip.

2. Completely remove the cross and bearings from both ends of the driveshaft by disassembling the bearing assemblies from the slip yoke and the tube yoke using the Owatonna tool kit.
3. After removing the cross and bearings, both ends, inspect the cross hole surfaces for damage or raised metal. Raised metal can be removed with a rat tail or half round file and emery cloth. Check the yoke lug cross holes with a No-Go Wear Gauge and then use a Spicer Alignment Bar to inspect for damage by sliding through

both cross holes simultaneously. The alignment bar will identify yoke lugs that have taken a set because of excessive torque. The raised metal or distorted lugs can be a cause of premature cross and bearing problems. At this time, clean the cross holes of the yokes on the transmission and axle and inspect with an alignment bar gauge as described above. If after proper cleaning of the cross holes, the alignment bar will not pass through simultaneously, the yoke lugs are distorted and the yoke or yokes should be replaced.

Reassembly

1. Place each end of the driveshaft, less cross and bearing kits, in a bench vise. Check the paint marking placed on the tube and slip yoke assembly prior to removing from the vehicle to be sure they are lined up or "in phase".
2. Remove the cross and bearings from the box and remove all four bearing assemblies. Rotate the cross to inspect for presence of the one way check valve in each lube hole of all four trunnions. Then position the cross into the end yoke with its lube fitting in line as near as possible with the slip spline lube fitting. Keep the lube fitting on the inboard side.
3. Apply an anti-seize compound to the outside diameter of four bearing assemblies. Move one end of the cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole. Holding the trunnion in alignment with the cross hole, press bearing assembly flush to face of end yoke by hand. If bearing assembly binds in cross hole, tap with ball peen hammer directly in center of bearing assembly plate. Do not tape outer edges of bearing plate. Exact fit of all driveline components is extremely important. The correct parts and clean mating surfaces are essential for safe operation and good repair.
4. When the bearing assembly is completely seated, put the lock late tab in lace and use the "Grade Eight" (Grade 8) cap screws that are furnished with the kit and insert them through the cap screw holes in both the lock strap and bearing assembly. Thread with hand or wrench into tapped holes in yoke. Do not torque down bolts.
5. Move the cross laterally to the opposite side and through the cross holes beyond the machined

surface of the yoke lug. Place a bearing assembly over the cross trunnion and slide it into the cross hole, seating the plate to the face of the lug. Put the lock plate tab in place and thread the bolts with hand or wrench into tapped holes in yoke.

Note

Projecting the trunnion through a cross hole beyond the machined surface of the lug will provide a surface to help align the bearing assembly with the cross hole. This method should also be followed when assembling driveshaft to yokes of vehicle at transmission and axle or axles.

6. Repeat process of installation of cross and bearing kit at opposite end of the driveshaft. Make sure to position the cross in the yoke so that the lube fitting is in line with the lube fitting at the other end.

Caution

Worn bearing assemblies used with a new cross or new bearing assemblies used with a worn cross will wear rapidly making another replacement necessary in a short time. Always replace the Cross, four Bearing Assemblies and Bolts as a Unit.

Installation in Vehicle

The installation of a driveshaft does not present any unusual mechanical difficulties. Before actual installation, the driveshaft should be checked for the following items:

1. Damage or dents on the driveshaft tubing.
2. Splines should slide freely with slight drag from slip shaft seal.
3. Cross should flex and be free from excessive bind. A slight drag is the most desirable condition on a new cross and bearing kit. Excessive looseness is not desirable and will result in an unbalanced driveshaft.

Warning

Rotating shafts can be dangerous. You can snag clothes, skins, hair, hands, etc. This can cause serious injury or death. Do not go under the vehicle when the engine is running. In order to avoid becoming entangled, install power take-off and/or shaft behind the frame rail, tanks, battery box, etc. If power take-off and/or shaft are still exposed after installation, install a guard.

Full Round End Yoke Style

1. Rotate the transmission end yoke by putting the transmission in neutral and the axle end yoke by jacking up one rear wheel, so the cross holes are in a horizontal position.
2. Tilt the cross trunnions of the driveshaft, both ends, with trunnions pointing toward each other from end to end, one side. Install with the slip joint nearest the source of power. Use a nylon support strap to aid in handling the driveshaft.
3. Holding the driveshaft firmly, project a trunnion in an outward position between the lugs of either the axle or the transmission end yoke and through a cross hole. Repeat at opposite end. The driveshaft is being supported at each end by one trunnion surface in a cross hole and the nylon support strap. Tilt a cross trunnion until the opposite side can be inserted through a cross hole. Repeat at opposite end. The driveshaft is now being supported at each end by two trunnion surfaces in the cross holes and the nylon support strap.
4. Apply an anti-seize compound to the outside diameter of the remaining four bearing assemblies. Move one end of the shaft to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole. Holding the trunnion in alignment with the cross hole, press bearing assembly flush to face of end yoke by hand. If bearing assembly binds in cross hole, tap with ball peen hammer directly in center of bearing assembly plate. Do not tap outer edges of bearing plate.
5. Slide the shaft to project an opposite trunnion through the cross hole beyond the face of the end yoke. Again, place a bearing assembly over the trunnion, align and place hands on opposite bearing assembly, and press both inward flush to yoke faces. If assembly binds, tap with ball peen hammer as outlined above. Put the lock plate tab in place and insert the "Grade Eight" (Grade 8) cap screws through the holes in the lock plates and bearing assemblies. Thread cap screws into end yokes. Tighten with wrench until plates are flush against end yoke faces.

self-locking cap screws into tapped holes and torque bolts to specification. Lubricate the cross and bearing assemblies.

Caution

Half Round self-locking retaining bolts should not be reused more than five (5) times. Follow instructions implicitly to prevent danger of serious personal injury or death from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.

Half Round End Yoke Style

For half round end yokes, place the bearing assemblies on the cross trunnions and seat the bearing cups into the end yoke shoulders. Place straps over the bearing assemblies, thread special

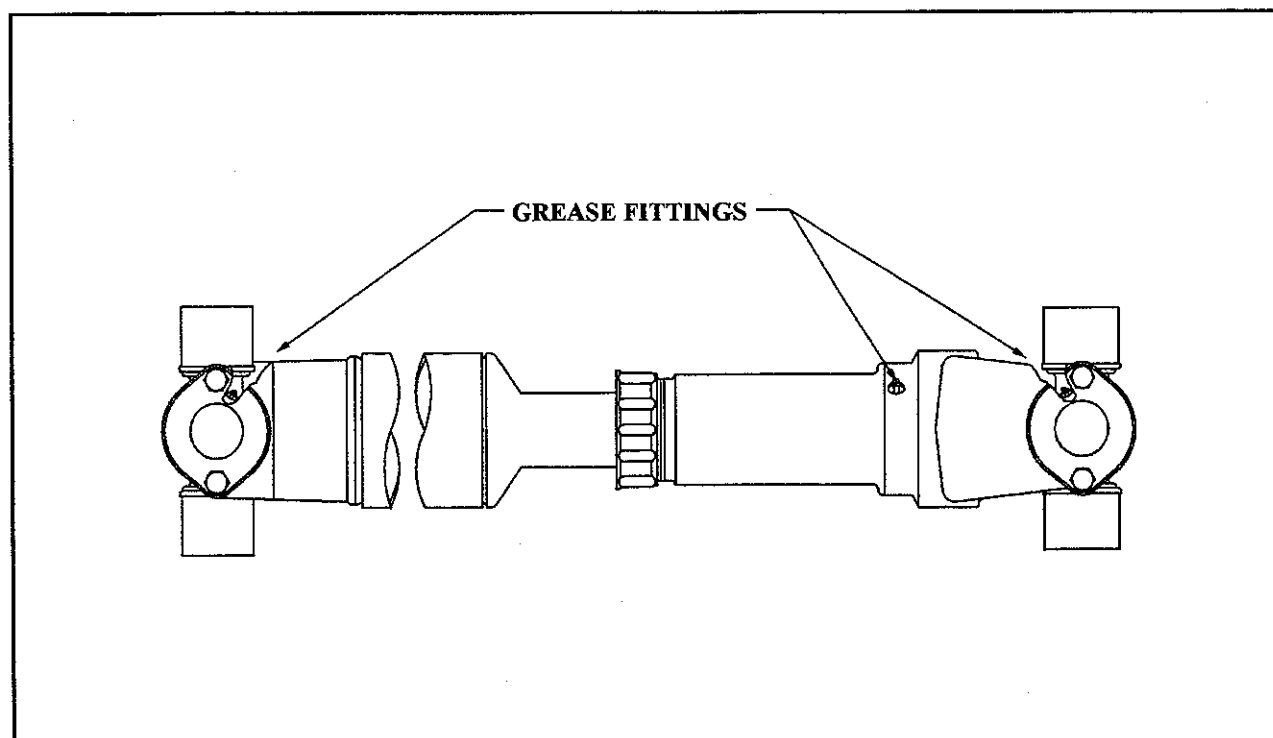


Figure 1—Driveshaft

Full Round End Yoke		
Series	Thread Size	Cap Screw Torque (Lb./Ft.)
1810	(3/8) .375-24	32-42
Half Round End Yoke		
Series	Thread Size	Bolt Torque (Lb./Ft.)
1810	(1/2) .500-20	130-135

Table 1—Yoke Torque Specifications

Position	Bolt Size	Torque
U-Bolts	5/16-24	14-17 foot-pounds (19-23 N•m)
	3/8-24	20-24 foot-pounds (27-33 N•m)
Bearing Strap	1/4-28	32-37 foot-pounds (43-50 N•m)
	5/16-24	40-48 foot-pounds (54-65 N•m)

Table 2—Light and Medium Duty Specifications

Series	Grade	Thread Size	Bolt Torque
1210 CV	8	1/4-28	13-18 foot-pounds (18-24 N•m)
1310/1330 CV	8	5/16-24	22-26 footpounds (30-35 N•m)

Table 3—Double-Cardan Constant Velocity Joint Torque Specification

LTC Engine

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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before performing any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins ISM engine and an Allison B500 transmission. Vehicles with other engines or transmissions will use similar, and in most cases identical, procedures. For variations, refer to the appropriate installation drawing.

Because of options and other variations, not all vehicles will have all the same components described in this procedure.

These procedures are generic for connections, fittings, lines, and other parts. All need to be removed; however, it may not be appropriate, or possible to remove connections, fittings, lines, and other parts on the vehicle. Parts can be removed at any time when necessary.

Tools Required

- Mechanic's common hand tools.
- Engine jack or dolly to lower and manipulate the engine at removal and installation.

- Recovery equipment for engine oil, transmission fluid, hydraulic fluid, and antifreeze.

Note

The engine jack or dolly must be strong enough to take the weight of the engine and transmission as a unit.

Warning

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

Preparatory Work

1. Park the vehicle on a level surface. Once parked, set the parking brake and chock the rear wheels. Work underneath the vehicle would be made easier via use of a lift of sufficient strength.
2. Disconnect the battery.

Warning

Hydraulic fluid, fuel and transmission oil is flammable and toxic to the skin, eyes and respiratory tract. Skin and eye protection is required. Avoid repeated or prolonged contact. Drain fluid in a well-ventilated area.

Note

All engine references are forward looking rear.

3. Drain antifreeze, engine oil and transmission fluid into appropriate recovery containers.

Engine and Transmission Removal

1. Disconnect all cooling tubes and hoses from the engine. (Reference Section 040—Cooling)
2. Disconnect air intake hoses and pipes. (Reference Section 060.1—Air Intake.)
3. Disconnect fuel lines. (Reference Section 100—Fuel System.)
4. Disconnect the hydraulic hose (14). (Reference Section 170 Hydraulic Fan Drive.)

5. Remove drive shaft from the engine and transmission. (Reference Sections 050 Drive Shaft and Section 160—Transmission.)

Remove Alternator

1. Remove all drive belts. (See Figure 1—Alternator.)
2. Disconnect the heater return (6). (See Figure 2—Engine Left Side Forward Looking Rear.)

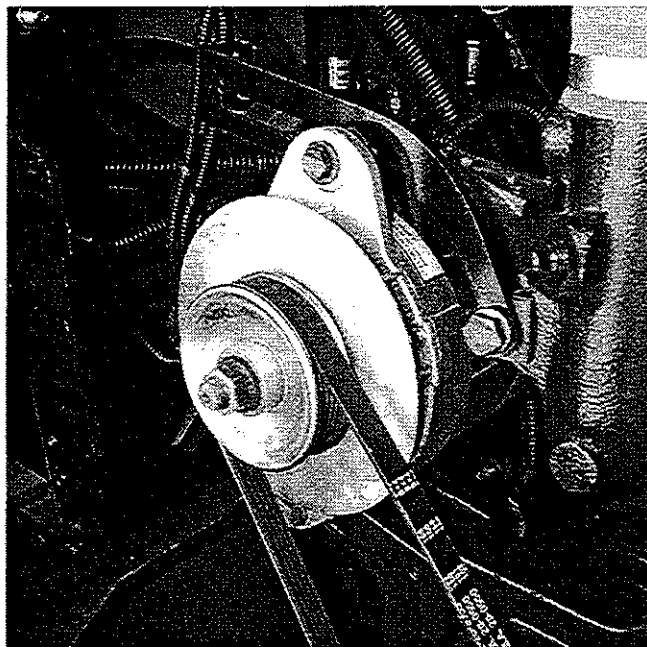


Figure 1—Alternator

3. Remove engine block heater (24).
4. Disconnect heater supply. (See Detail B of Figure 2.)
5. Disconnect pressure oil sender (14).
6. Remove brass bushing (13).
7. Disconnect heater adapter pipe (7).
8. Remove water temperature sender (18).
9. Disconnect oil temperature sender (17). (See Figure 2—Engine Right Side Forward Looking Rear.)
10. Remove the two-pipe bushings (16) and (15).
11. Remove the hydraulic filter.
12. Remove air governor.
13. Remove air compressor.
14. Disconnect power steering hose from steering pump. (Reference Section 120—Power Steering.)
15. Disconnect swivel elbow (30). (See Figure 3—Engine Right Side Forward Looking Rear.)
16. Check the engine and transmission disconnect all electrical connectors.
17. Mark connectors for ease at installation.
18. Disconnect exhaust pipe. (Reference Section 070—Turbo-Exhaust.)

Note

Removal of the universal joint may depend on the vehicle requirements. Disconnect and remove universal joint between 1st drive shaft section and transmission output yoke.

Warning

Make sure the engine and transmission is secure in the jack or removal device.

Do not place any part of your body under the engine or transmission.

Crossmember Bolt Removal (if necessary)

1. Apply pressure with the jack or stand so the bolts securing the engine and transmission can be removed.
2. Remove engine mounting bolts. (See Figure 4—Engine Mounting Bolts.)
3. Remove transmission mounting bolts. (See Figure 5—Transmission Mounting Bolts.)
4. Re-check all connections and removals to ensure that all parts are disconnected or removed.
5. Lower engine and transmission.
6. Cover all exposed holes.

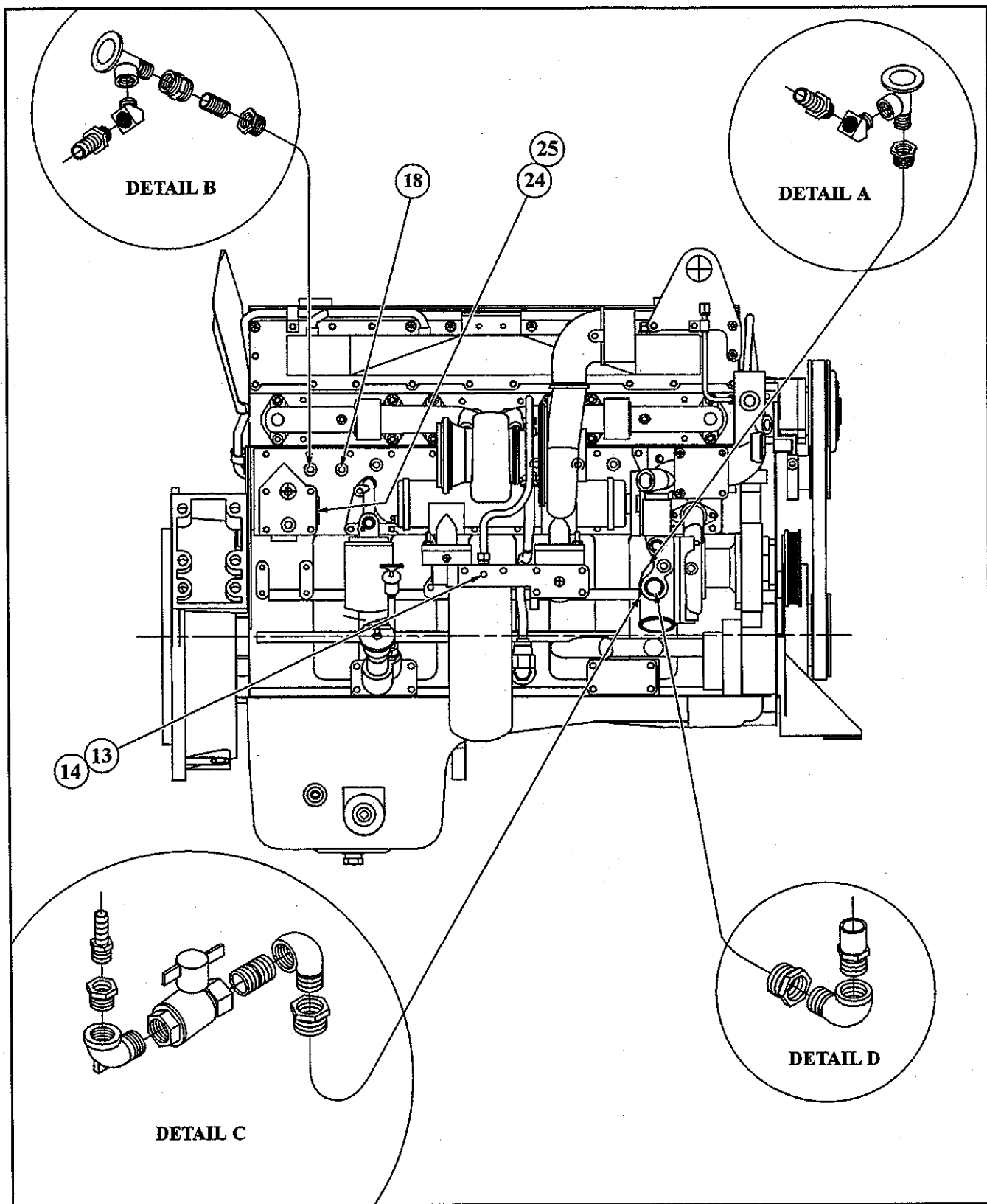


Figure 2—Engine Left Side Forward Looking Rear

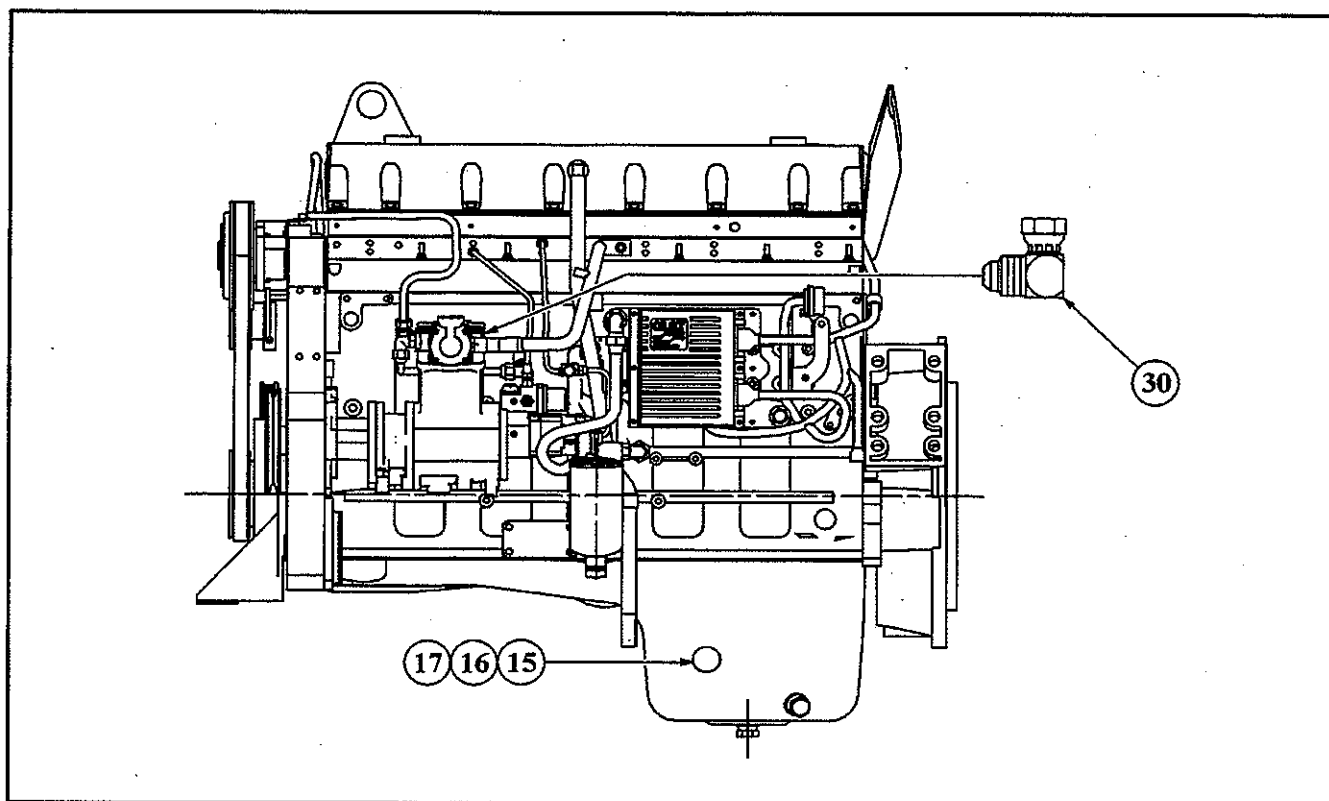


Figure 3—Engine Right Side Forward Looking Rear

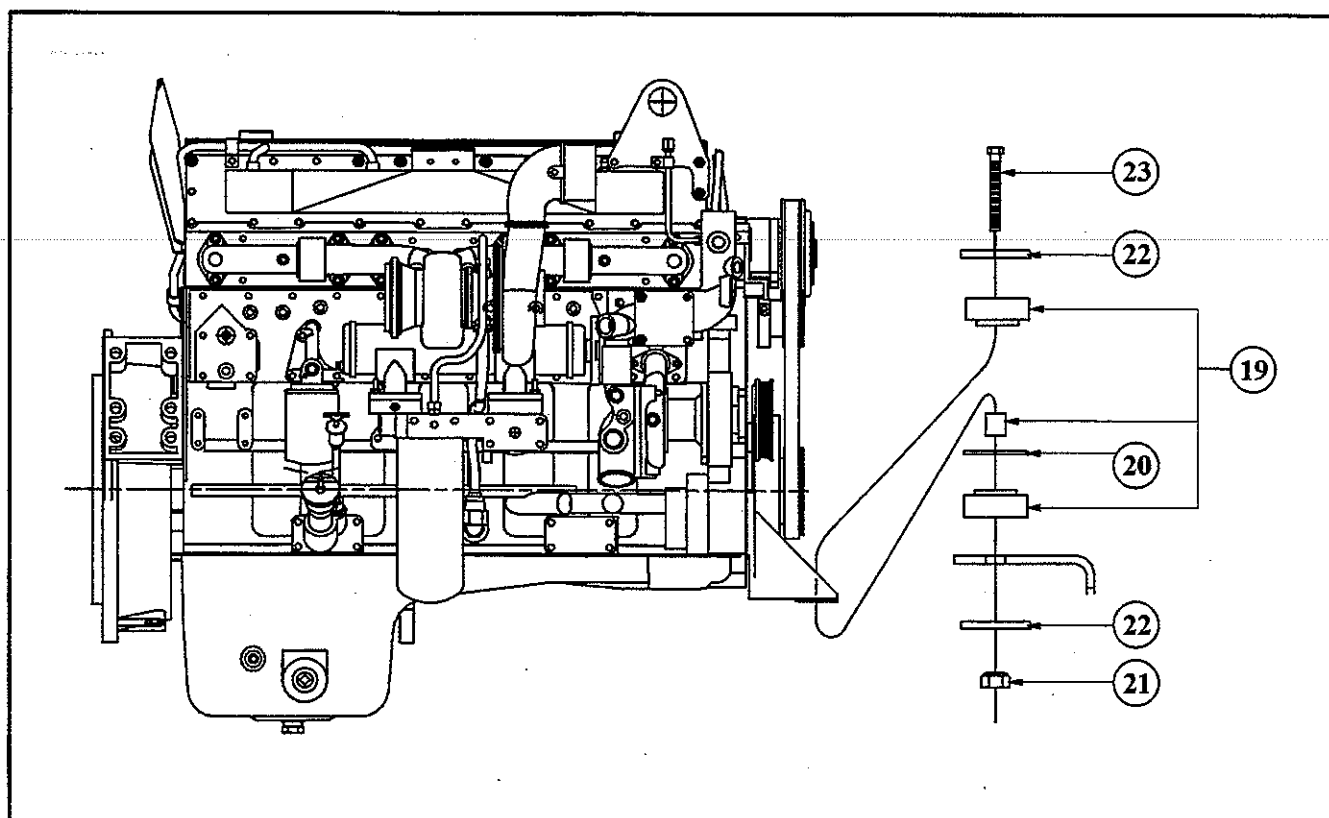


Figure 4—Engine Mounting Bolts

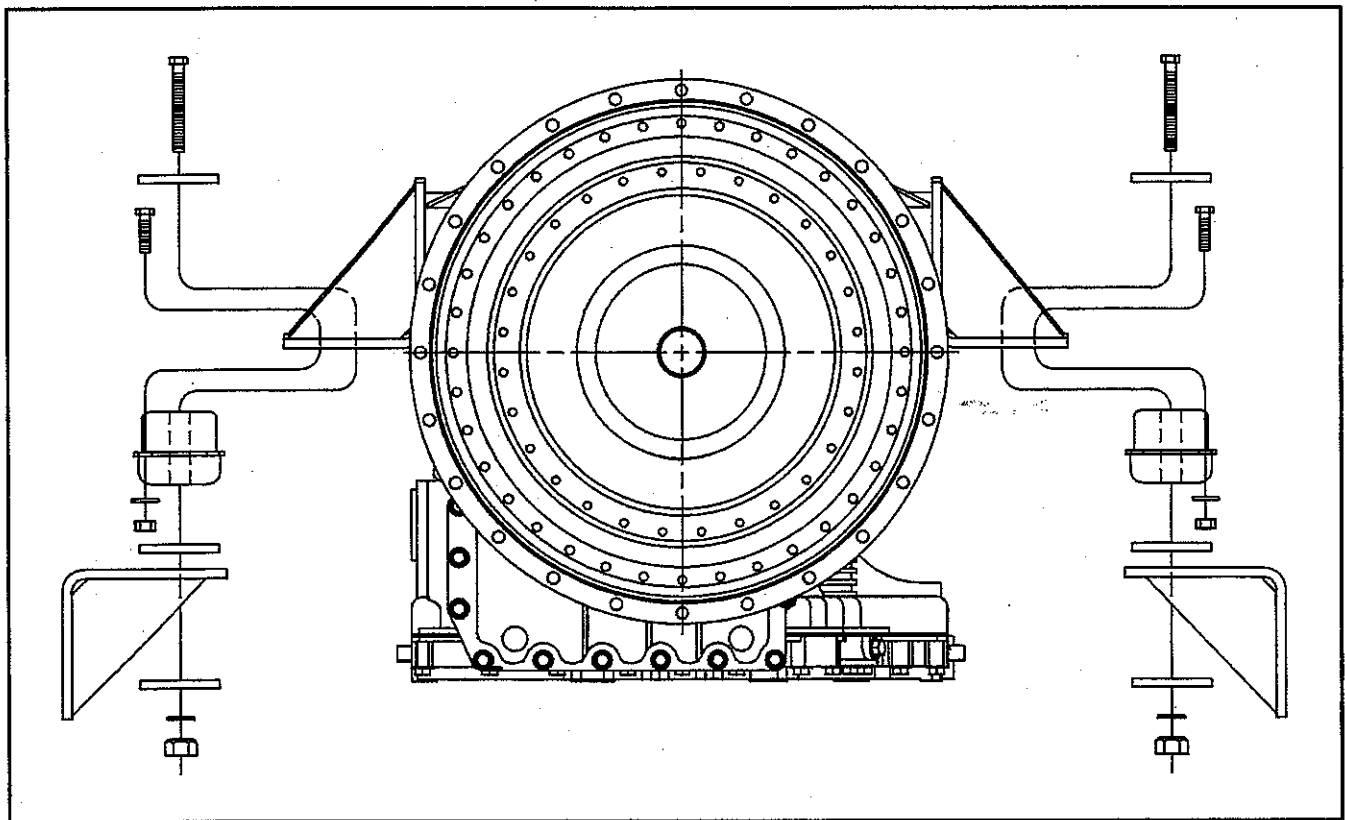


Figure 5—Transmission Mounting Bolts

LTC Air Intake



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Safety

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Warnings

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Notes

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Introduction

These procedures were documented using a Blue Bird LTC with a Cummins M11 engine.

Description of Operation

The Filter Minder® measures restriction in the air intake system. The Filter Minder® has an indicator that measures vacuum restriction up to 25 inches (6.35 mm) of water.

When the indicator displays 25 inches (6.35 mm) of water, the air filter is to be changed.

The engine air intake has a maximum airflow of 974 cubic feet per minute (cfm) (3687 L/m).

Warning

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

Air Intake Filter Minder General Information

The Filter Minder gauge gives a progressive indication of air filter plugging that allows the entire air filter capacity to be used. (See Figure 1—Filter Minder.)

Many air cleaner systems will show very little restriction for 50,000 miles (80467 km) or more. Actual filter service life will depend on operating conditions.

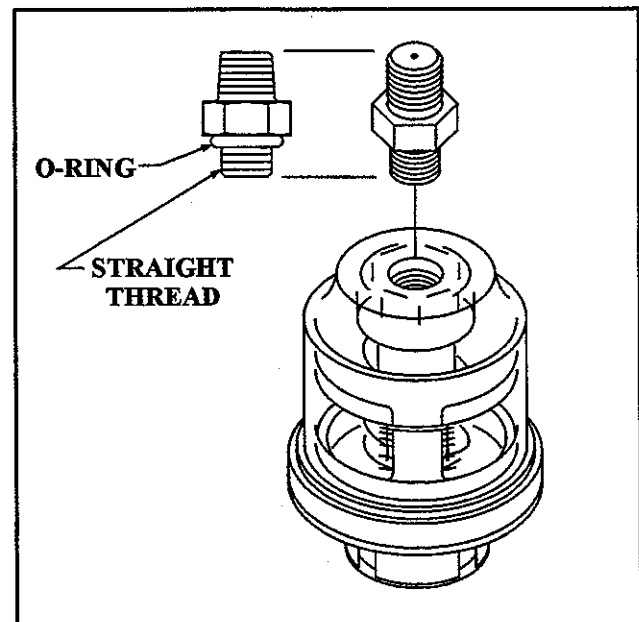


Figure 1—Filter Minder

Air Intake Filter Minder Removal

1. Remove the existing air cleaner gauge from the air cleaner tap.
2. Remove air cleaner tap fitting.

Air Intake Filter Minder Installation

Caution

Make sure that all clamps on hoses or tubes are tight to prevent leaks of air or fluid. Make sure that all screws and bolts are tight to prevent damage to vehicle.

Caution

A pipe sealant should be used on the pipe threads to prevent leakage, the long end of fitting.

New straight thread O-ring design. Please read installation instructions before installing the gauge.

Do not use pipe sealant on the straight thread short end O-ring fitting.

1. Install fitting to the air cleaner or induction piping with the male straight thread O-ring facing out.

Caution

Make sure that the O-ring is installed.

2. Install the Filter Minder® gauge to the fitting.
3. Turn a ¼ turn after gauge makes contact with the base of the fitting.

Air Intake Removal

1. Loosen two loaded spring clamps. (See Figure 2—Air Intake Assembly.)
2. Remove rubber elbow.
3. Remove nut, U-bolt and saddle from bracket.
4. Loosen loaded spring clamp.
5. Remove turbo air intake pipe.

6. Remove air restriction indicator.
7. Loosen loaded spring clamp.
8. Remove rubber hump hose.
9. Open air cleaner clamp.
10. Loosen loaded spring clamp.
11. Remove straight rubber hose.

Air Intake Installation

1. Install loaded spring clamp (10) to air cleaner assembly. (See Figure 2—Air Intake Assembly.)
2. Install straight rubber hose.
3. Install loaded spring clamp to exhaust pipe.
4. Handtighten loaded spring clamps.
5. Install loaded spring clamp to air cleaner assembly.
6. Install loaded spring clamp to air cleaner.
7. Install rubber hump hose to loaded spring clamp.
8. Install loaded spring clamp to rubber hump hose.
9. Install turbo air intake pipe to clamp.
10. Install U-bolt, saddle, and nuts to bracket.
11. Install rubber elbow to loaded spring clamp.
12. Install spacer.
13. Install turbo air intake pipe to loaded spring clamp.

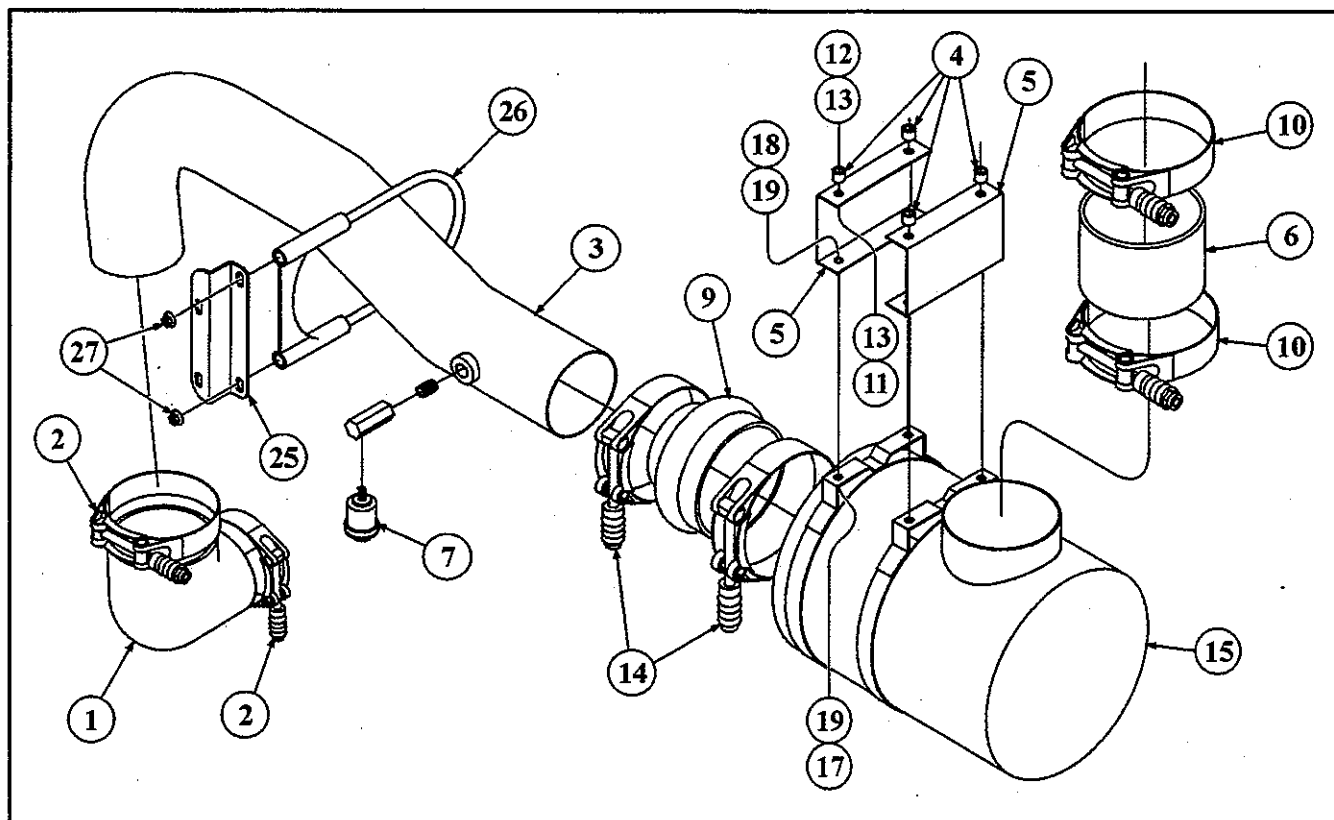


Figure 2—Air Intake Assembly

Air Intake Piping

Inspect the intake piping daily for wear points and damage to piping, loose clamps or punctures that can damage the engine. Replace damaged pipes and tighten loose clamps, as necessary, to prevent the air system from leaking. Check for corrosion under the clamps and hoses of the intake system piping. Corrosion can allow corrosive products and dirt to enter the intake system. Disassemble and clean, as required.

Charge Air Piping

Inspect the charge-air piping and hoses daily for holes, cracks and loose connections. Tighten the hose clamps if necessary.

Air Cleaner Restriction

Turbocharged engines must be operated at a rated rpm and full load to check maximum intake air restriction. Replace the air cleaner element when the restriction reaches the maximum allowable limit, or clean according to the manufacturer's recommendations.

Visually inspect air cleaner for damage and replace if required.

Check the air cleaner service indicator, if equipped. Change the filter element when the red indicator flag is at the raised position in the window. After the air cleaner has been serviced, push the button located near the bottom to reset the service indicator.

Note

Follow the manufacturer's instructions when cleaning or replacing the air cleaner element. If the vehicle is operated in extremely dusty conditions, air cleaner maintenance intervals may become more frequent.

LTC R22 Air Conditioner Compressor



BLUE BIRD
®

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LTC R22 Air Conditioner Compressor

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Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins M11 ISM engine, an Allison B500 World Transmission and a Carrier air conditioning system.

Description of Operation

The air conditioning system aboard Blue Bird's LTC was designed to provide maximum comfort.

Preventative Maintenance

Coil cleaning should be done on a yearly inspection. The electric motors must be accessible for brush maintenance and motor replacement. (See Figure 1 - Air Conditioner Component Location.)

The alternator service will improve and reduce down time due to component failures. Alternators should be located to provide access for brush changes, belt tensioning and troubleshooting of the charging system.

All flexible lines should be kept as short as possible. Check all flex hoses for any kinks. Observe the area of the bend and make sure that the hose is not collapsed.

Warning

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

Preparatory Work

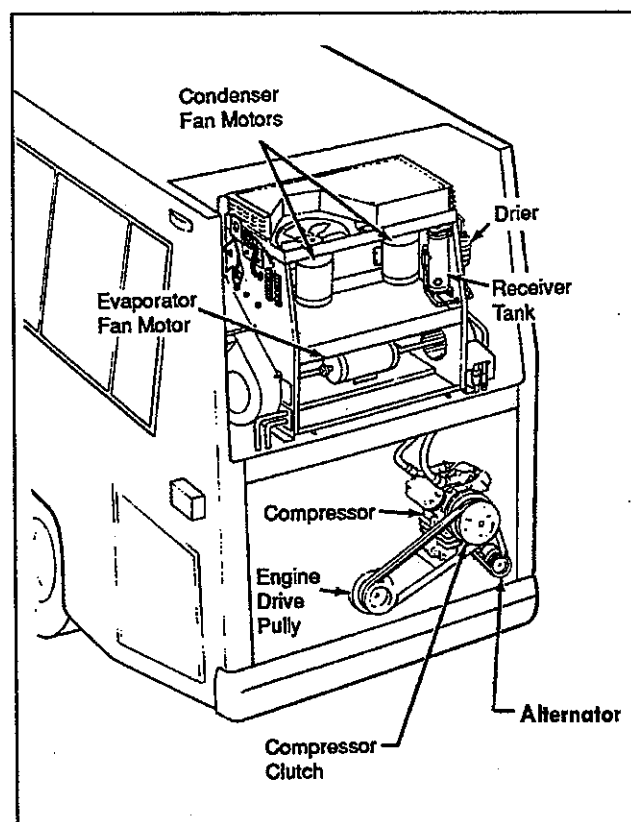


Figure 1—Air Conditioner Component Location

Warning

Serious injury can occur when applying pneumatic pressure. Eye protection is required. Relieve pressure before disconnecting lines or fittings.

Caution

The air conditioner must be off during engine start and engine shut down.

Always tighten the flare fittings using two wrenches; one to tighten flare, and the other to prevent any torsion stress on the hose.

Make sure all air to the compressor is off. Slowly remove the plastic tube (29) from the 90-degree elbow in the air cylinder (1).

Installation

To install, reverse removal procedures.

R22 Air Conditioner Compressor Removal**Note**

Start at the rear and the right side of the motor, and move forward.

1. Release air pressure from cylinder. Remove belt.
2. Remove the nut (35), split ring lock washer (34), two-flat washes (28) and capscrew (27) from the clevis rod (2). (See Figures 2 - 4.)
3. Remove the disconnected air cylinder (1).
4. Remove the two capscrews (26) and two split ring lock washers (23) from the cylinder to compressor mounting bracket (4).
5. Remove the capscrew (26) and flat washer (28) from the cylinder to compressor mounting bracket (5)
6. Remove the compressor to motor drive belt (12). (See Figure 4—Compressor and Mounting Drive.)
7. Remove the nuts (48), washers (24), and bolts (47) from the compressor pivot mounting base (19).
8. Remove the air compressor (49).

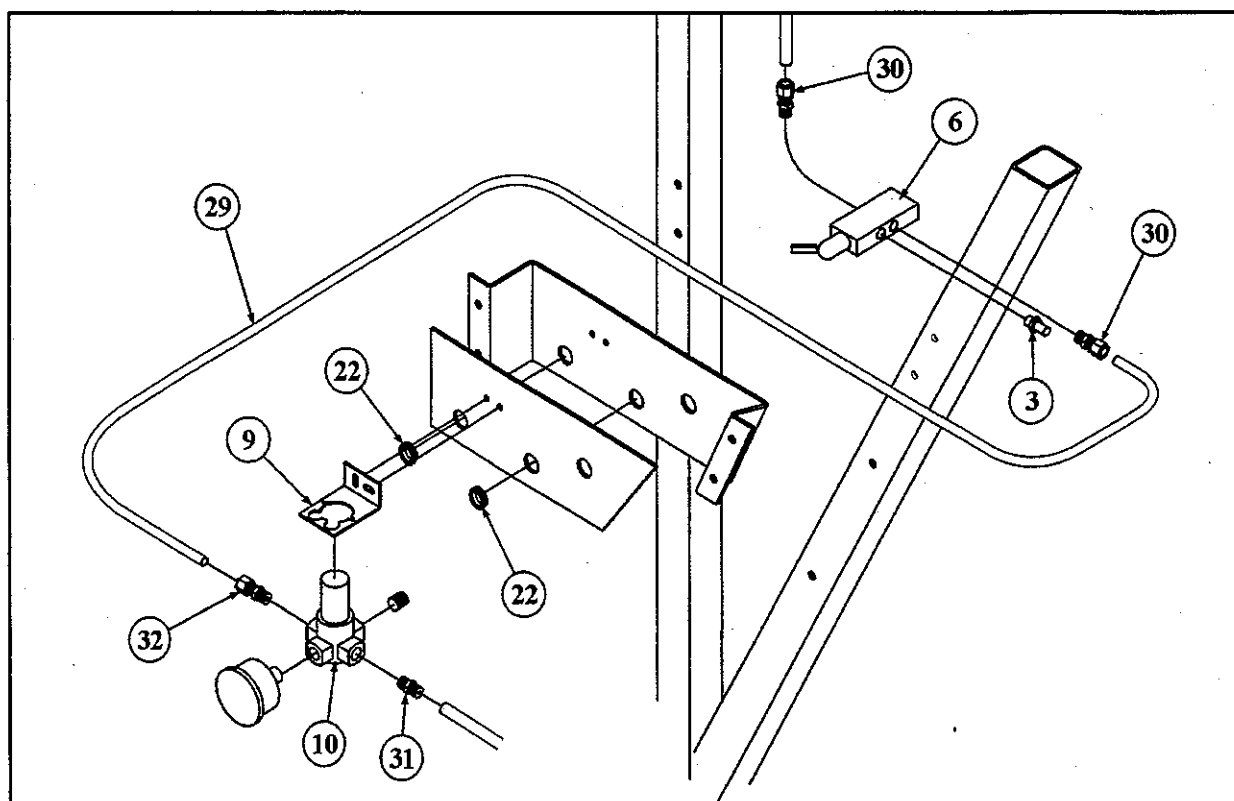


Figure 2—Air Regulator and 2-Position Toggle Valve

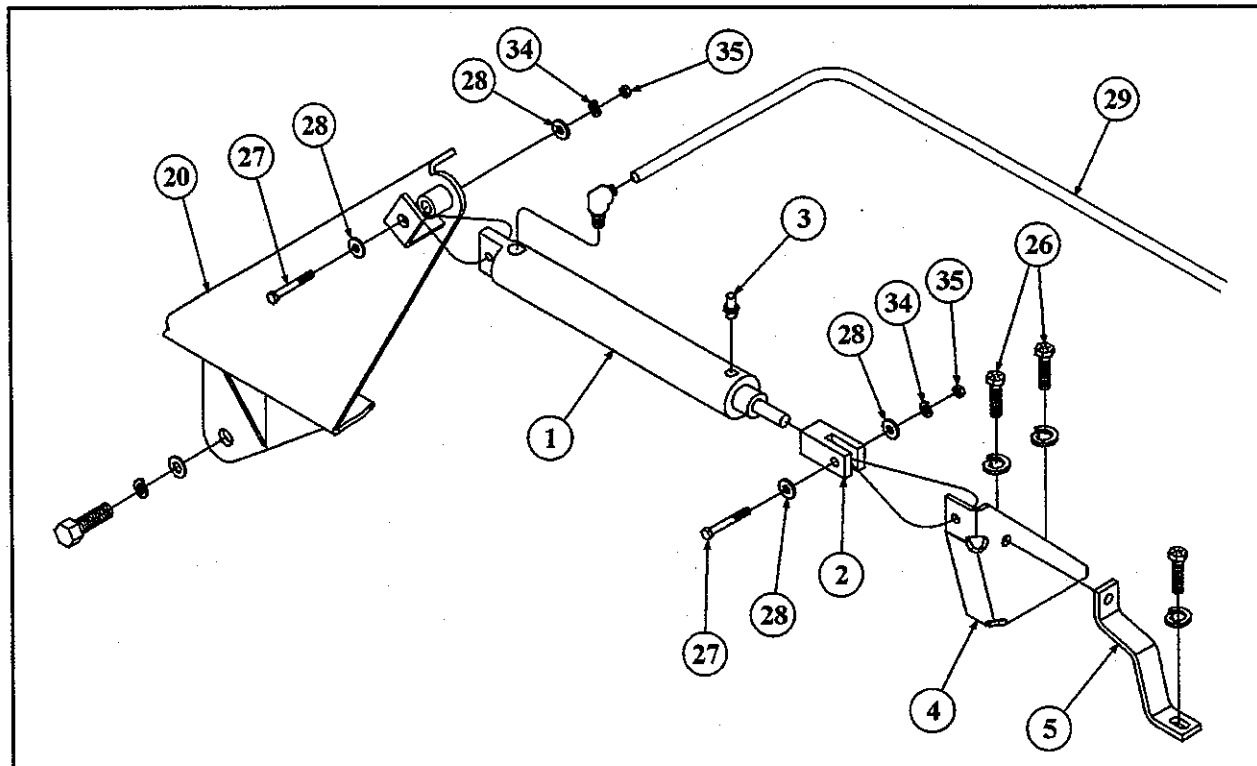


Figure 3—Air Cylinder Removal

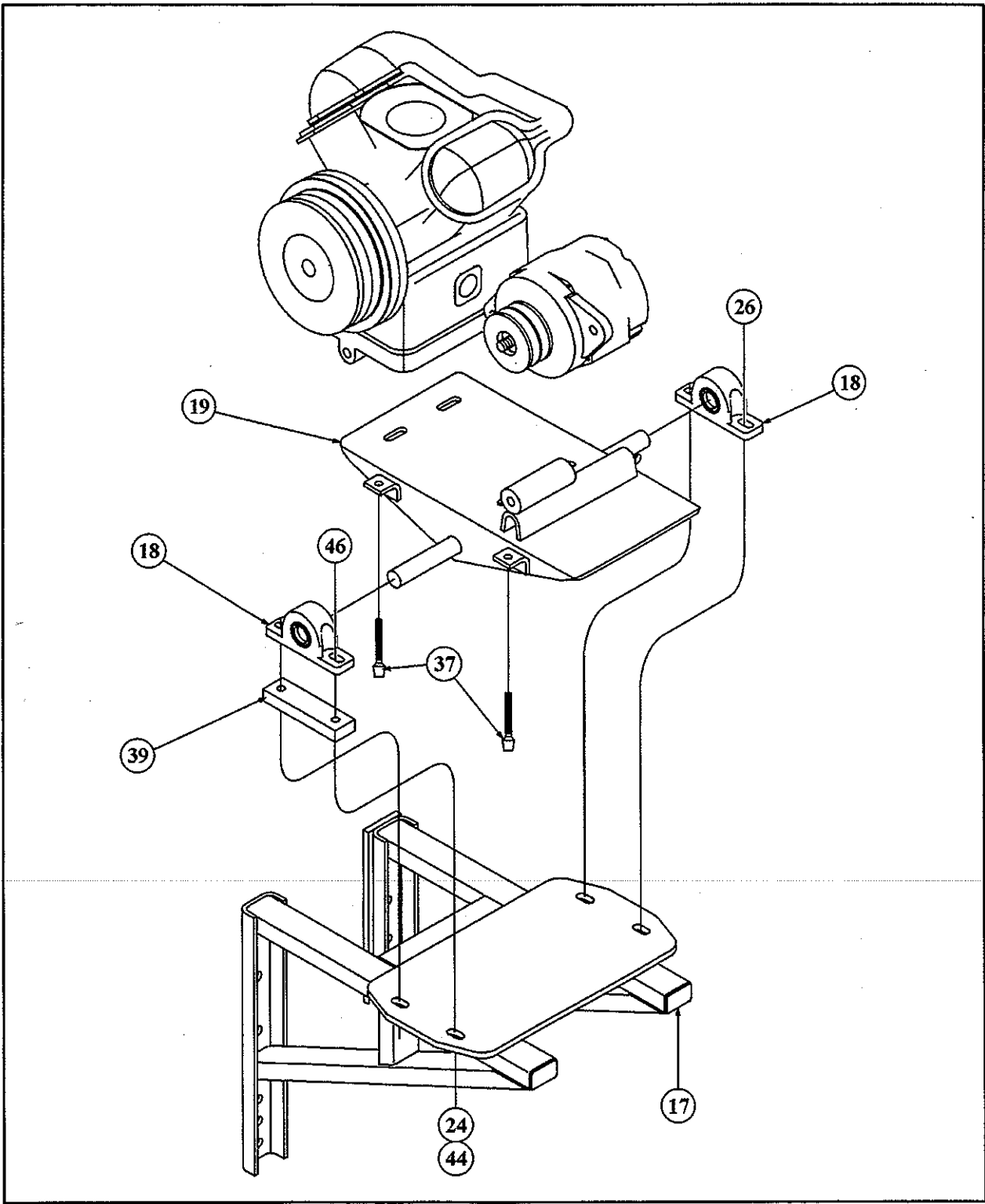


Figure 4—Compressor and Motor Drive



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins M11 engine. For configurations see Figures 1 through 4.

Description of Operation

Warning

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

Warning

Allow exhaust system to cool below 120° Fahrenheit to prevent serious injury.

Preparatory Work

Park the vehicle on a level surface. Once parked, set the parking brake and chock the rear wheels. Work under the vehicle would be made easier by using a lift of sufficient strength.

Configuration Details

There are two configurations; the Cummins M11 ISM and the Detroit Diesel Series 60.

Turbo Exhaust Removal Cummins M11/ISM

(See Figure 1—Cummins ISM Exhaust System Piping and Clamping.)

Note

Remove radiator prior to exhaust removal.

Starting at the engine and working to the roof:

1. Loosen the V-clamp (18) from turbo exhaust pipe.
2. Remove the nut (16) from the U-bolt (11) in two places.
3. Remove the U-bolt (11) from the heat shield (19) in two places.
4. Loosen the wide band exhaust clamp (17) in two places.
5. Remove the turbo exhaust pipe (15).

Note

Some you will have to access through the top plate

6. Remove the exhaust flex pipe (14).
7. Remove the nut (16) from U-bolt (11).
8. Remove the exhaust pipe (12).
9. Remove the nut (18) from the U-bolt (11) at the muffler angle support (2).
10. Remove the nut (18) and washer (9), U-bolt (26) at the muffler angle support (27).

11. Remove the roof exhaust tailpipe (13).

12. Remove the muffler (5).

Turbo Exhaust Installation Cummins M11/ISM

See Figure 1—Exhaust System Piping and Clamping.

Caution

Use Muffler Cement (CMS) Blue Bird Number 0832402 ½-inch (12.7 mm) thick at all joints.

Make sure to overlap all joints 2-inches (50.8 mm).

Note

Leave all connections loose for the possibility of adjustments.

See Table 1—Clamp Torque Values

Starting at the roof and working to the engine

1. Install the roof exhaust tailpipe (13).
2. Install the muffler (5).
3. Install the U-bolt (26), washer (9) and nut (18) at the muffler angle support (27).
4. Install the roof exhaust tailpipe (13).

5. Install the U-bolt (11) and nut (18) at the muffler angle support (2).

6. Install the exhaust pipe (12).

7. Tighten the nuts (18) in four places.

8. Install the wide band exhaust clamp (17).

Note

Item key number (14) to be at full extension to avoid a 75% decrease in life cycle. (See Figure 1 - Exhaust System Piping and Clamping.)

9. Install the exhaust flex pipe (14).

10. Tighten the wide band exhaust clamp (17) at the exhaust pipe to muffler.

11. Install the turbo exhaust pipe (15).

12. Install the wide band exhaust clamp (17).

13. Tighten the wide band exhaust clamp (17) at exhaust pipe (15).

14. Install the U-bolt (11) to the heat shield (19) in two places.

15. Install the V-clamp (18) from turbo.

16. Install the nut (16) and U-bolt (11) in two places.

17. Tighten the V-clamp (18).

18. Tighten the nut (16).

19. Recheck and tighten all clamps and nuts.

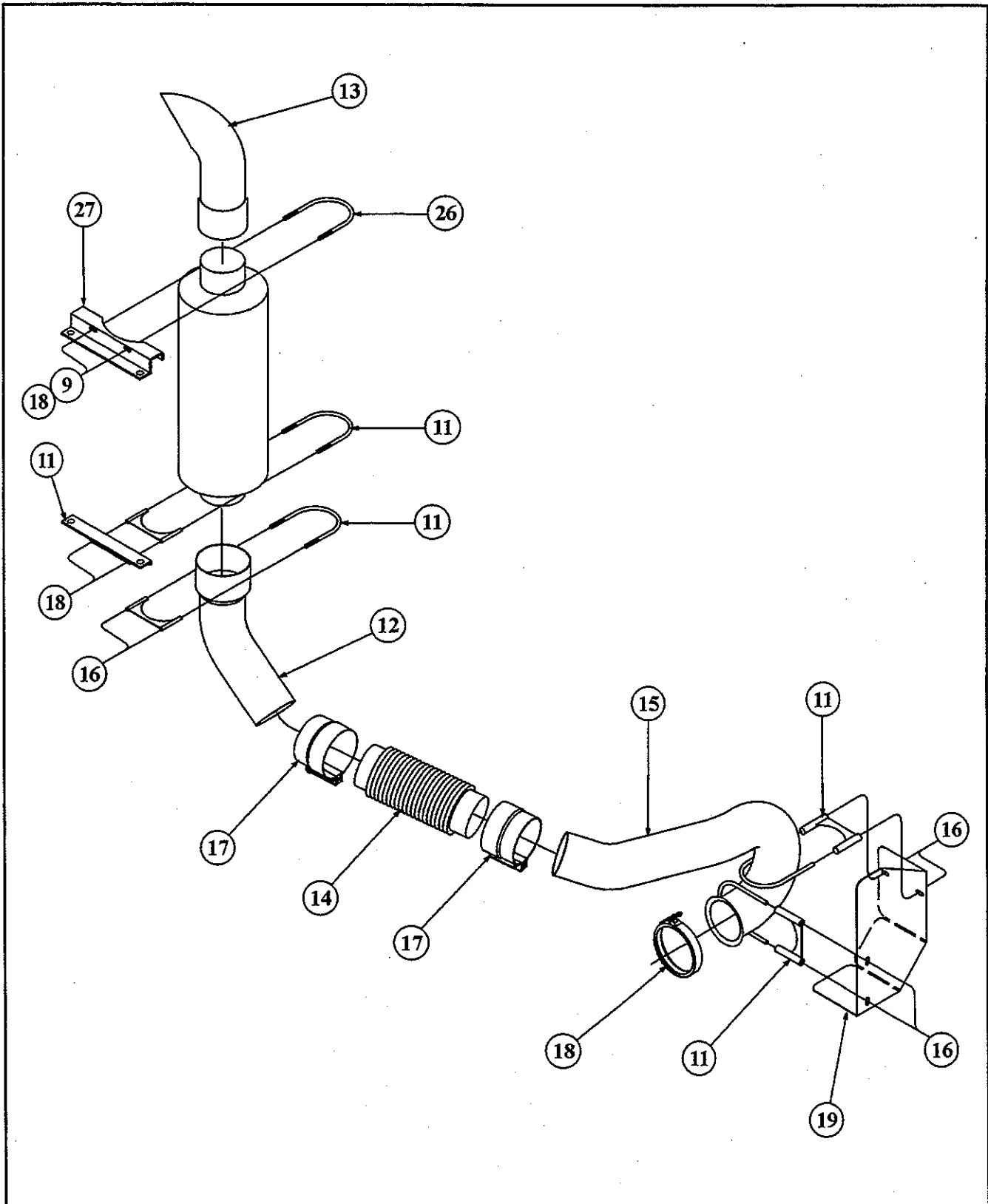


Figure 1—Exhaust System Piping and Clamping Cummins M11 ISM

Turbo Exhaust Muffler Removal Detroit Diesel Series 60

1. Loosen the V-clamp (21) from the turbo exhaust engine.
2. Remove the nut from the U-bolt (22) in two places.
3. Remove the nut (18), saddle (19) and U-bolt (20) from the flexible exhaust connector 914).
4. Remove the thermocouple 916) from the turbo exhaust pipe (15).
5. Remove the turbo exhaust pipe (15).
6. Remove the flex pipe (14).
7. Remove the nut (18) from U-bolt (11).
8. Remove the exhaust flex pipe (12).
9. Remove the nut (18) from the U-bolt (11) at muffler angle support (2).
10. Remove the nut (18), washer (9), U-bolt (26) at muffler angle support (27).
11. Remove the roof exhaust tailpipe (13).

2. Install the U-bolt (26), washer (9) and nut (18), at muffler angle support (27).
3. Install the U-bolt (11) and nuts (18) at the muffler angle support (2).
4. Install the exhaust pipe (12).
5. Tighten the nuts (18) in four places.

Note

Key number (14) to be at full extension to avoid a 75% decrease in life cycle.

6. Install the exhaust flex pipe (14).
7. Install the U-bolt (20) saddle (19) nuts (18) and turbo exhaust pipe (15).
8. Tighten the nuts (18).
9. Install the thermocouple (16) from the turbo exhaust pipe (15).
10. Install the U-bolt (22) and tighten nut.
11. Install the V-clamp (21).
12. Tighten the V-clamp (21).
13. Recheck and tighten all clamps and nuts.

Turbo Exhaust Muffler Installation Detroit Diesel Series 60

See Table 1—Clamp Torque Values

1. Install the roof exhaust tailpipe (13).

Required Torque Values			
Hex Nuts	Lock nuts	V-Band Clamp	Clamp U-Bolts
3/8 Inch—16 (9.525 mm)	5/16 Inch—24 (7.937 mm)	---	---
5 foot-pounds (6.78 N•m)	5 foot-pounds (6.78 N•m)	5 foot-pounds (6.78 N•m)	50-70 foot-pounds 67.8-94.91 N•m)

Table 1—Exhaust Pipe Torque Values



LTC Chassis Electrical



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LTC Chassis Electrical

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Safety

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Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Number	Description	Location
1	P1 to V Transmission ECU	Drivers Luggage Compartment
2	P1 to S Transmission	Drivers Luggage Compartment
3	P1 to Transmission ECU	Drivers Luggage Compartment
4	P2 to VIM	Drivers Luggage Compartment
5	P11 to VIM	Drivers Luggage Compartment
6	P12 to Throttle PS	At the Throttle Pedal
7	P16 to Throttle Pedal	At the Throttle Pedal
8	P13 to High/Low Horn	At Front Left Outrigger
9	P14 to High/Low Horn	At Front Left Outrigger
10	P23 to P23	Behind Instrument Panel Diagnostic Circuit
11	P8 to P11	Behind Instrument Panel Diagnostic Circuit
12	P8 to P8	Side Electrical Panel
13	P5 to P5	Side Electrical Panel
14	P18 to P18	Side Electrical Panel
15	P9 to P6	Side Electrical Panel

Table 1—Interconnect Locations RCDA

16	P7 to P7	Side Electrical Panel
17	P10 to P3	Drivers Luggage Compartment
18	P15 to P3	Drivers Luggage Compartment
19	P2 to SSI	At the Transmission Shifter
20	P24 to P4	Close to Diagnostic Connector Engine/Trans
21	P5 to DDR	Under Left Side of Dash
22	HC4 to P2	On the Transmission Blue Bird Interface Left Side
23	HC4 to P3	On the Transmission, Left Front, Engine Speed Sensor
24	HC4 to P4	On the Transmission, Left Rear, Output Speed Sensor
25	HC4 to P5	On the Transmission, Left Front, Turbine Speed Sensor
26	P20 to P2	At the Thermoking Alternator
27	P19 to P1	At the Fuel Filter
28	P1 to P1	At the Rear Electrical Panel
29	P13 to P13	Above Transmission, on the Outrigger, Left Side
30	P14 to P14	Above Transmission, on the Outrigger, Left Side
31	P1 to Engine ECM	At the Engine ECM, Series 60
32	P3 to Engine ECM	At the Engine ECM, Series 60
33	P2 to Fan Power Control	Between the Hayden Cooler and Left Frame Rail
34	P6 to Oil Pump Sensor	At the Oil Sensor, Front Left of Engine Series 60
35	P7 to Fan Control	Between Radiator and Left Frame
36	P8 to Fan Power	Between Radiator and Left Frame
37	P9 to Coolant Level	On the Aeration Tank
38	P11 to Sensor Harness	At the DDEC ECU
39	---	---
40	---	---
41	P22 to P22	Above Transmission, on Outrigger, Left Side
42	P1 to Engine ECM	At the Engine ECM M11 Cummins
43	P2 to Engine ECM	At the Engine ECM M11 Cummins
44	P3 to Engine ECM	At the Engine ECM M11 Cummins
45	P9 to Coolant Level	On the Aeration Tank
46	P18 to Sensor Harness	On the Aeration Tank
47	---	---
48	P20 to Quick Start A	At Control Valve, on Right Rear Outrigger
49	P6 to P3 ABS	First Cross Member Behind Front Axle, Left
50	P28 to P28	Driver's Luggage Compartment
51	P15 to AC/Compressor	Outside of Left Frame Rail to the Rear of Radiator

Table 1—Interconnect Locations RCDA (continued)

Ref	Description	From	To	Color	Number
1	12v Master Power	BRK	SK-9 Buss	---	---
2	BBC Ign Sol	IGN Buss	SK28-36 Buss	---	---
3	Seat Lights Power	SK4	K3-30	---	---
4	Bus Interior Lights Left	SK5	K2-30	---	---
5	Bus Interior Lights Right	SK6	K1-30	---	---
6	VCP Power	SK20	VCP Unit	Black 10 Gage	
7	Non-Master Breaker	BRK	SK19-27 Buss	Yellow 10 Gage	44
8	Reading Light Right Power	SK16	Reading Light	Black 10 Gage	21
9	Reading Light Left Power	SK17	Reading Light	Yellow 10 Gage	21
10	Top Door Lock Relay	SK30	K6-86	---	---
11	Low Coolant Indicator Power	K6-86	K8-30	---	---
12	Low Coolant Relay	K8-30	K8-86	---	---
13	Roof Vent Fan Power	P9-3	SK9	Pink	3
14	Bath Room Power	P9-4	SK32	Purple	7
15	Receptacle Dash Hot	P9-5	SK31	Green	13
16	Compartment Light	P9-6	SK14	Yellow	8
17	Monitor Power	P9-7	SK33	Green	15
18	Lower Dash Master	P9-10	SK10	Brown	4
19	Step Light Power	P9-13	SK24	Blue	8
20	Drive/Entrance Light	P9-14	SK24	Green	21
21	Radio Memory	P9-19	SK19	Green	19
22	CB Radio Power	P9-20	SK18	Green	8
23	Top Door Lock Neutral Signal	P9-22	K6-85	White/Black	1515J
24	Top Door Lock Power	P9-23	K6-30	Orange/Black	18
25	Hazard Light Switch Signal	P9-24	K10-86	Green/Black	1332B
26	Floor Heat Power	P10-1	SK28	Blue	49
27	Mirror Heat Switch Power	P10-2	SK29	Black/Yellow	25
28	Stop Engine/Low Air Buzzer	P10-3	SK30	Purple	53
29	Load Center Ground	P10-8	K1-85	White	14
30	Load Center Ground	K1-85	K2-85	---	---
31	Load Center Ground	K2-85	K3-85	---	---
32	Load Center Ground	K3-85	K9-85	---	---
33	Load Center Ground	K9-85	K9-30	---	---
34	Load Center Ground	K9-30	K10-85	---	---
35	Bus Interior Lights Right	P10-9	K1-87	Brown/Orange	8
36	Bus Interior Light Relay Right	P10-10	K1-86	Blue	14
37	Bus Interior Light Relay Left	K1-86	K2-86	Blue	14
38	Bus Interior Lights Left	P10-11	K2-87	Yellow/Black	3
39	Seat Light Relay	P10-12	K3-87	Black/Yellow	26
40	Seat Light Relay	P10-14	KE-86	Brown	16

Table 2—Wire List Front Load Center

41	Top Door Lock Wiring	P10-18	K8-87A	Green	25
42	Low Coolant Signal	P10-19	K8-85	Blue	1420D
43	Low Coolant Indicator	P10-20	K8-K7	Blue	20
44	Light Turn Indicator	P10-21	K9-87	Yellow	13
45	Light Turn Signal	P10-22	K9-86	Yellow	1313C
46	Oil Pressure Signal	P10-23	K10-30	Blue/Black	1417B
47	Oil Pressure Indicator	P10-24	K10-87A	Blue	17

Table 2—Wire List Front Load Center (continued)

Ref	Description	From	To	Color	Number
1	Bus Interior Light Relay	P1-1	S3-1a	Blue	14
2	Seat Light Relay	P1-2	S4-1a	Brown	16
3	Seat Light Power	P1-4	S4-1	Brown	4
4	Bus Interior Light Power	S4-1	S3-1	---	---
5	Wiper Delay	P1-5	S27-15	Black	2102C
6	Wiper Delay	S27-15	S27-30/31	---	---
7	Wiper Delay	P1-7	S27-53M	Blue	2102B
8	Up Dash Gauge Dim	P1-9	S20-LT	Blue	1310A
9	Gauge Dim	S20-LT	DS1-1	---	---
10	Gauge Dim	DS2-1	DS2-1	---	---
11	Gauge Dim	DS2-1	DS3-1	---	---
12	Signal Ground	P1-10	S13-1	White	1209D
13	Signal Ground	S13-1	S7-1	---	---
14	Mirror Switch Light	P1-11	S15-9	White	1208T
15	Clear Lights On	P1-12	S14-1b	White	1203B
16	Clear Light Power	P1-13	S14-1	Green/Black	1310B
17	Clear Light Flash	P1-14	S14-1a	Green/Black	1310G
18	Engine Break Low	P1-16	S18-1a	Red/White	1517J
19	Engine Break High	P1-17	S18-1b	Red	1517H
20	Cruise ENB	P1-21	S7-1a	Blue	1504
21	Cruise ENB Light	S7-1a	DS4-Black	---	---
22	Cruise Resume	P1-22	S13-1b	Blue/Yellow	1508A
23	Cruise Set	P1-23	S13-1a	Yellow/Red	1508B
24	Engine Brake Pre-Select	P1-24	S12-4a	Purple	1517D
25	Engine Brake Indicator	S12-4a	S12-a	---	---
26	Engine Brake Select	S12-a	S18-1	---	---
27	Interior Master Power	P2-2	S8-1	Black	1101G
28	Backup Light Power	P2-4	S2-1	Yellow	1322C
29	Backup Lights	P2-5	S2-1a	Blue	1322J
30	Speed Signal	P2-6	M1-8	Blue/Black	1419B

Table 3—Lower Dash with DDEC Engine

31	Tachometer Signal	P2-7	M2-8	Gray	1406
32	Interior Master	P2-9	S8-1a	Red	1519
33	Interior Master Indicator	S8-1a	R2-1	---	---
34	Interior Master Indicator	R2-2	DS5-Red	---	---
35	Mirror Heat	P2-16	S9-1a	Black	7
36	Mirror Heat Power	P2-17	S9-1	Black/Yellow	25
37	Mirror Switch Power	S9-1	S15-1	---	---
38	Drive Light Relay	P2-18	S1-1a	Black	1308D
39	Light Mirror Up/Down	P2-19	S15-3	Red	25
40	Light Mirror Left/Right	P2-20	S15-5	Brown	25
41	Light Mirror Common	P2-21	S15-7	Orange/Black	25
42	Light Mirror Up/Down	P2-22	S15-4	Green	25
43	Light Mirror Left/Right	P2-23	S15-6	Yellow	25
44	Light Mirror Common	P2-24	S15-8	Blue	25
45	Ground Lower Dash	P3-3	S27-31	White	14
46	Ground Lower Dash	S27-31	S12-b	---	---
47	Ground Lower Dash	S12-b	DS3-2	---	---
48	Ground Lower Dash	DS3-2	M2-3	---	---
49	Ground Lower Dash	M2-3	DS2-1	---	---
50	Ground Lower Dash	DS2-2	DS1-2	---	---
51	Ground Lower Dash	DS1-2	M1-3	---	---
52	Ground Lower Dash	M1-3	DS8-2	---	---
53	Ground Lower Dash	DS8-2	DS9-Black	---	---
54	Ground Lower Dash	DS9-BK	S15-2	---	---
55	Ground Lower Dash	S15-2	DS5-Black	---	---
56	Ground Lower Dash	DS5-BK	S1-1	---	---
57	Ground Lower Dash	S1-1	S21-Ground	---	---
58	Ground Light Dash	S21 GR	S20-Ground	---	---
59	Door Lock Relay	P3-4	S26-1a	Orange/Black	18
60	Park Light Power	P3-6	S19-1	Green/Black	1301G
61	Headlight Power	S19-1	S19-4	---	---
62	Headlight Wiring	P3-7	S19-3	Green/Black	1301B
63	Park Light Power	P3-9	S19-5	Brown	1315B
64	Dash Dim Power	S19-5	S20-Battery	---	---
65	El Dim Power	S19-5	F1-1	---	---
66	El Dim Power	F1-2	S21-Battery	---	---
67	High Beam Indicator (+)	P3-10	DS9-Red	Green/Black	1301J
68	Low Coolant Indicator	P3-11	DS8-4	Blue	20
69	High Coolant Indicator	P3-12	DS8-6	Green/Black	1416B
70	Park Brake Indicator	P3-13	DS8-9	White/Black	1515
71	Low Oil Pressure Indicator	P3-14	DS-8	Blue	17

Table 3—Lower Dash with DDEC Engine (continued)

LTC Chassis Electrical

72	High Transmission Temp	P3-15	DS8-7	Green	1405
73	Lower Dash Power	P3-16	S12-3a	---	---
74	Lower Dash Power	S12-3a	S26-1	---	---
75	Lower Dash Power	S26-1	M2-4	---	---
76	Lower Dash Power	M2-4	M1-4	---	---
77	Lower Dash Power	M1-4	DS8-5	---	---
78	Lower Dash Power	DS8-5	D1-A	---	---
79	Lower Dash Power	D1-A	R1-1	---	---
80	Lower Dash Power	R1-2	DS4-Red	---	---
81	Step Light Wiring	P3-17	S5-1a	Yellow	27
82	Hazard Light Switch Signal	P3-18	D2-A	Green/Black	1332B
83	Hazard Light Switch Signal	D2-C	DS8-1	---	---
84	Hazard Light Switch Signal	DS8-1	D1-C	---	---
85	Left Turn Signal	P3-19	DS8-3	Yellow	13
86	Right Signal	P3-20	DS8-11	Green	1323D
87	ABS Warning Signal	P3-21	DS8-10	Green	1430
88	Step Light Power	P3-21	S5-1	Blue	8
89	El Inv	S21-LT	EL INV Input	---	---
90	El Dim Left Dash	Out Red	DS6-Black	---	---
91	El Dim Right Dash	DE6-BK	DS7-Black	---	---
92	El Dim Left Dash	Out White	DS6-White	---	---
93	El Dim Right Dash	Out White	DS7-White	---	---
94	Dest Signal Power	S6-1	S11-1	Brown	4
95	Dest Signal Wiring	P1-18	S11-1	Green	17
96	Floor Heat Temp Cntl	P1-8	S23-C	Red	41
97	Floor Heat Temp Cntl	P1-19	S23-B	Green	42
98	Floor Heat Temp Cntl	P1-20	S23-D	Yellow	44
99	Right Docking Light Power	S26-1	S25-1	Black	1102J
101	Left Docking Light Power	S25-1	S24-1	Black	1102J
102	Right Docking Lights	P2-11	S25-1a	Green	1329A
103	Compartment Lock	P2-12	S10-1b	Blue	2603
104	Compartment Unlock	P2-13	S10-1a	Blue/Black	2603A
105	Compartment Lock Power	S8-1	S10-1	Black	1101G
106	Roof Vent Switch Power	P3-5	S16-1	Pink	3
107	Roof Vent Fan	P3-8	S16-2	Brown	2302B

Table 3—Lower Dash with DDEC Engine (continued)

Ref	Description	From	To	Color	Number
1	Left Speakers (+)	P13-1	12V Harness	Red	1
2	Left Speakers (-)	P13-2	12V Harness	White	1
3	Right Speakers (+)	P13-3	12V Harness	Red	2
4	Right Speakers (-)	P13-4	12V Harness	White	2
5	Map Light Wiring	P13-7	12V Harness	Black	1
6	Bus Interior Light Right	P13-9	12V Harness	Brown/Orange	8
7	Bus Interior Light Left	P13-10	12V Harness	Yellow/Black	3
8	Seat Lights Right	P13-11	12V Harness	Black/Yellow	26
9	Seat Lights Left	P13-11	Line Run	Yellow/Black	26
10	Bathroom Power	P13-19	12V Harness	Purple	7
11	Driver Dome Light	P13-22	12V Harness	Yellow/Black	10
12	Entrance Light	P13-23	12V Harness	Black/Yellow	11
13	Heat Temp Central T/S 41	Heat Mod	Lower Front Harness	Red	41
14	Heat Temp Central T/S 42	Heat Mod	Lower Front Harness	Green	42
15	Heat Temp Central T/S 44	Heat Mod	Lower Front Harness	Yellow	44
16	Heat Temp Mod Power T/S 49	Heat Mod	Lower Front Harness	Blue	49
17	Heat Pump Power T/S 50	Heat Mod	12V Harness	Pink	50

Table 4—12-Volt Harness

Note

All wires are 14 gauge yellow Mil-Spec

Ref	Description	From	To	Color	Number
1	Chassis Ground	P6-1	M1-Ground	White	1201A
2	Chassis Ground	M1GND	DS1-2	---	---
3	Chassis Ground	DS1-2	DS2-2	---	---
4	Chassis Ground	DS2-2	M2-Ground	---	---
5	Chassis Ground	M2GND	DS13-2	---	---
6	Chassis Ground	DS13-2	M3-Ground	---	---
7	Chassis Ground	M3GND	DS3-2	---	---
8	Chassis Ground	DS3-2	DS4-2	---	---
9	Chassis Ground	DS4-2	DS5-2	---	---
10	Chassis Ground	DS5-2	DS6-2	---	---
11	Chassis Ground	DS6-2	M6-Ground	---	---
12	Chassis Ground	M6GND	M7-Ground	---	---
13	Chassis Ground	M7GND	DS7-2	---	---

Table 5—Upper Dash

LTC Chassis Electrical

14	Chassis Ground	DS7-2	DS8-2	---	---
15	Chassis Ground	DS8-2	M8-Ground	---	---
16	Oil Temperature Sensor	P6-2	M6-S	Blue/Black	1410
17	Driver Dome Light Power	P6-3	S1-1	Green	21
18	Entry Light Power	S1-1	S2-1	---	---
19	Water Temp Signal	P6-4	M1-S	Green	1416A
20	Headlight Alert Light	P6-5	DS9-2	Brown	1315B
21	Oil Pressure Signal	P6-6	M2-S	Blue/Black	1417A
22	Transmission Oil Temp	P6-8	M3-S	Green	1405A
23	Gauge Dim	P6-9	DS1-1	Blue	1310A
24	Gauge Light Power	DS1-1	DS2-1	---	---
25	Gauge Light Power	DS2-1	DS3-	---	---
26	Gauge Light Power	DS3-1	DS4-1	---	---
27	Gauge Light Power	DS4-1	DS5-1	---	---
28	Gauge Light Power	DS5-1	DS6-1	---	---
29	Gauge Light Power	DS6-1	DS7-1	---	---
30	Gauge Light Power	DS7-1	DS8-1	---	---
31	Fuel Level Signal	P6-10	M7-S	Tan	1403
32	Driver Dome Light Wiring	P6-11	S1-2	Yellow/Black	10
33	Dc Volts Engine Power	P6-12	M8- (+)	Blue	1434A
34	Entrance Light Wiring	P6-13	S2-2	Black/Yellow	11
35	Low Air Signal	P6-14	DS12-1	Brown	1431
36	Water Temp Power	P6-15	M1 (+)	Black	1102J
37	Oil Pressure Power	M1-(+)	M2(+)	---	---
38	Transmission Oil Temperature	M2 (+)	M3 (+)	---	---
39	Oil Temperature Power	M3 (+)	M6 (+)	---	---
40	Fuel Level Power	M6 (+)	M7 (+)	---	---
41	Low Air Indicator Power	M7- (+)	DS12-1	---	---
42	Headlight Alert Signal	P6-16	DS9-1	White	1208U
43	Fire Alarm Signal	P6-17	DS13-1	Red	1433A
44	El Dim Left Dash	EL INV OUT- RED	DS10	Black	---
45	El Dim Right Dash	DS10	DS11	Black	---
46	El Dim Left Dash	EL INV OUT- WHITE	DS10	White	---
47	El Dim Right Dash	DS10	DS11	White	---

Table 5—Upper Dash (continued)

Ref	Description	From	To	Color	Number
1	VCP Ground	S1-1	S2-1	Black	---
2	VCP Ground	S2-1	VCP Harness	Black	---
3	VCP Volume Up	S2-1	VCP Harness	Orange	---
4	VCP Volume Down	S1-3	VCP Harness	White	---
5	Video On	S2-2	VCP Harness	Green	---
6	Ground	P16-1	S6-1	White	14
7	Tag Dump	P16-2	S6-2	Blue	1808B
8	Entrance Door Power	P16-3	S4-1	Black	1101G
9	Hazard Central Power	S4-1	S5-1	Black	1101G
10	Entrance Door Open	P16-4	S4-2	Brown	8
11	Entrance Door Close	P16-5	S4-3	Black	8
12	Hazard Central	P16-6	S5-2	Green/Black	1332B
13	Shifter Panel Ignition	P16-7	DS2-1	Black	1102J
14	Shifter Panel Ignition	DS2-1	DS3-1	---	---
15	Stop Engine Signal	P16-8	DS2-2	Purple	1427
16	Check Engine Signal	P16-9	DS3-2	Purple/White	1426
17	Stop Engine Overdrive	P16-10	S7-2	Brown/Red	1513A
18	Signal Ground	P16-11	S7-1	White	1209D
19	El Dim	El Inv Red	DS2-Black	---	---

Table 6—Shifter Panel with DDEC

Ref	Description	From	To	Color	Number
1	Warning Light Ignition	P7-1	DS4-1	Black	1102J
2	Warning Light Ignition	DS4-1	DS3-1	---	---
3	Warning Light Ignition	DS3-1	DS2-1	---	---
4	Ground	P7-2	S1-2	White	14
5	Engine Protect Signal	P7-3	DS4-2	Yellow	1424
6	Stop Engine Signal	P7-4	DS3-2	Purple	1427
7	Check Engine Signal	P7-5	DS2-2	Purple/White	1426
8	Dash Fan Wiring	P7-6	P7-5	Red	5
9	Receptacle Dash Hot	P7-7	P7-6	Green	13
10	Dash Fan Wiring	S1-1	S1-1	Green	13

Table 7—Upper Dash Right Side

Ref	Description	From	To	Color	Number
1	Bus Interior Lights Relay	P1-1	S3-1a	Blue	14
2	Seat Lights Relay	P1-2	S4-1a	Brown	16
3	Seat Lights Power	P1-4	S4-1	Brown	4
4	Bus Interior Light Power	S4-1	S3-1	---	---
5	Wiper Delay	P1-5	S27-15	Black	2102
6	Wiper Delay	P1-7	S27-53M	Blue	2102B
7	Wiper Delay				
8	Upper Dash Gauge Dim	P1-9	S20-Light	Blue	1310A
9	Gauge Dim	S20Lgt	DS1-1	---	---
10	Gauge Dim	DS1-1	DS2-1	---	---
11	Gauge Dim	DS2-1	DS3-1	---	---
12	Signal Ground	P1-10	S12-4b	White	1209D
13	Signal Ground	S12-4b	S13-1	---	---
14	Signal Ground	S13-1	S7-1	---	---
15	Mirror Switch Light	P1-11	S15-9	White	1208T
16	Clear Light On	P1-12	S14-1b	White	1203B
17	Clear Lights Power	P1-13	S14-1	Green/Black	1310B
18	Clear Lights Flash	P1-14	S14-1a	Green/Black	1310G
19	Engine Breaker ENB	P1-15	S12-3b	Blue	1517D
20	Engine Breaker Low	S12-3b	S18-1a	---	---
21	Engine Break Low	S18-1a	P1-16	White/Black	1517B
22	Engine Break High	P1-17	S18-1	Blue/Black	1517A
23	Cruise ENB	P1-21	S7-1a	Blue	1504
24	Cruise ENB Light	S7-1a	DS4-Black	---	---
25	Cruise ENB Resume	P1-22	S13-1b	Blue/Yellow	1508A
26	Cruise ENB Set	P1-23	S13-1a	Yellow/Red	1508B
27	Engine Brake Pre-Select	P1-24	S12-4a	Purple	1517D
28	Engine Break Indicator	S12-4a	S12-a	Purple	---
29	Interior Master Power	P2-2	S8-1	Black	1101G
30	Backup Light Power	P2-4	S2-1	Yellow	1322C
31	Backup Lights	P2-5	S2-1a	Blue	1322J
32	Speed Signal	P2-6	M1-8	Blue/Black	1419B
33	Tachometer Signal	P2-7	M2-8	Gray	1406
34	Interior Master	P2-9	S8-1a	Red	1519
35	Interior Master Indicator	S8-1a	RS-1	---	---
36	Interior Master Indicator	R2-2	DS5-Red	---	---
37	Mirror Heat	P2-16	S9-1a	Black	7
38	Mirror Heat Power	P2-17	S9-1	Black/Yellow	25
39	Mirror Switch Power	S9-1	S15-1	---	---
40	Drive Light Relay	P2-18	S1-1a	Black	1308D

Table 8—Lower Dash with M11 Engine

41	Left Mirror Up/Down	P2-19	S15-3	Red	25
42	Left Mirror Left/Right	P2-20	S15-5	Brown	25
43	Left Mirror Common	P2-21	S15-7	Orange/Black	25
44	Right Mirror Up/Down	P2-22	S15-4	Green	25
45	Right Mirror Left/Right	P2-23	S15-6	Yellow	25
46	Right Mirror Common	P2-24	S15-8	Blue	25
47	Ground Lower Dash	P3-3	S27-31	White	14
48	Ground Lower Dash	S27-31	S12-b	---	---
49	Ground Lower Dash	S12-b	DS3-2	---	---
50	Ground Lower Dash	DS3-2	M2-2	---	---
51	Ground Lower Dash	M2-3	DS2-2	---	---
52	Ground Lower Dash	DS2-2	DS1-2	---	---
53	Ground Lower Dash	DS1-2	M1-3	---	---
54	Ground Lower Dash	M1-3	DS8-2	---	---
55	Ground Lower Dash	DS8-2	DS9-Black	---	---
56	Ground Lower Dash	DS9-BK	S15-2	---	---
57	Ground Lower Dash	S15-2	DS5-Black	---	---
58	Ground Lower Dash	DS5-BK	S1-1	---	---
59	Ground Lower Dash	S1-1	S21-Ground	---	---
60	Ground Light Dash	S21-GR	S20-Ground	---	---
61	Door Lock Relay	P3-4	S26-1a	Orange/Black	18
62	Park Light Power	P3-6	S19-1	Green/Black	1301G
63	Headlight Power	S19-1	S19-4	---	---
64	Headlight Wiring	P3-7	S19-3	Green/Black	1301B
65	Park Light Power	P3-9	S19-5	Brown	1315B
66	Dash Dim Power	S19-5	S20-Battery	---	---
67	Electroluminescence Dim Power	S19-5	F1-1	---	---
68	Electroluminescence Dim Power	F1-2	S21-Battery	---	---
69	High Beam Indicator (+)	P3-10	DS9-Red	Green/Black	1301J
70	Low Coolant Indicator	P3-11	DS8-4	Blue	20
71	High Coolant Indicator	P3-12	DS8-6	Green/Black	1416B
72	Park Brake Indicator	P3-13	DS8-9	White/Black	1515G
73	Low Oil Pressure Indicator	P3-14	DS8-8	Blue	17
74	High Transmission Temperature	P3-15	DS8-7	Green	1405
75	Lower Dash Power	P3-16	S12-3a	Black	1102J
76	Lower Dash Power	S12-3a	S26-1	---	---
77	Lower Dash Power	S26-1	M2-4	---	---
78	Lower Dash Power	M2-4	M1-4	---	---
79	Lower Dash Power	M1-4	DS8-5	---	---

Table 8—Lower Dash with M11 Engine (continued)

LTC Chassis Electrical

80	Lower Dash Power	DS8-5	D1-A	---	---
81	Lower Dash Power	D1-A	R1-1	---	---
82	Lower Dash Power	R1-2	DS4-Red	---	---
83	Step Light Wiring	P3-17	S5-1a	Yellow	27
84	Hazard Light Switch Signal	P3-18	DS-A	Green/Black	1332B
85	Hazard Light Switch Signal	D2-C	DS8-1	---	---
86	Hazard Light Switch Signal	DS8-1	D1-C	---	---
87	Left Turn Signal	P3-19	DS8-3	Yellow	13
88	Right Turn Signal	P3-20	DS8-11	Green	1323D
89	ABS Warning Signal	P3-21	DS8-10	Green	1430
90	Step Light Power	P3-23	S5-1	Blue	8
91	Electroluminescence Indicator Volt	S21-Light	Electroluminescence Indicator Volt Input	---	---
92	Electroluminescence Dim Left Dash	Electric Indi Volt Out Red	DS6-Black	---	---
93	Electroluminescence Dim Right Dash	DS6-Black	DS7-Black	---	---
94	Electroluminescence Dim Left Dash	Electric Indi Volt Out White	DS6-White	---	---
95	Electroluminescence Dim Right Dash	DS6-White	DS7-White	---	---
96	Destination Sign Power	S6-1	S11-1	Brown	4
97	Destination Sign Wiring	P1-18	S11-1a	Green	17
98	Floor Heat Temperature Cntl	P1-8	S23-C	Red	41
99	Floor Heat Temperature Cntl	PI-19	S23-B	Green	42
100	Floor Heat Temperature Cntl	P1-20	S23-D	Yellow	44
101	Right Docking Light	S26-1	S25-1	Black	1120j
102	Left Docking Light	S25-1	S24-1	Black	1102J
103	Left Docking Lights	P2-10	S24-1a	Green	1329B
104	Right Docking Lights	P2-11	S25-1a	Green	1329A
105	Compartment Lock	P2-12	S10-1b	Blue	2603
106	Compartment Unlock	P2-13	S10-1a	Blue/Black	2603A
107	Compartment Lock Power	S8-1	S10-1	Black	1101G
108	Roof Vent Switch Power	P3-5	S16-1	Pink	3
109	Roof Vent Fan	P3-8	S16-1	Brown	2302B

Table 8—Lower Dash with M11 Engine (continued)

Ref	Description	From	To	Color	Number
1	Bus Interior Light Relay	P1-1	P10-10	Blue	14
2	Seat Light Relay	P1-2	P10-14	Brown	16
3	Lower Dash Master Power	P1-4	P9-10	Brown	4
4	Wiper Delay Switch	P1-5	Steer	Black	2102C
5	Wiper Delay	P1-7	Steer	Blue	2102B
6	Floor Heat Temperature Cntl	P1-8	Heat Mod	Red	41
7	Upper Dash Gauge Dim	P1-9	P6-9	Blue	1310A
8	Shifter Illumination	P6-9	P11-16	Blue	1310A
9	Signal Ground	P1-10	P23-1	Milspec White	1209D
10	Mirror Switch Light	P1-11	P18-11	White	1208T
11	Clear Lights	P1-12	P5-13	White	1203B
12	Clear Lights	P1-13	P5-12	Green/Black	1310B
13	Clear Lights	P1-14	P5-24	Green/Black	1310G
14	Engine Brake ENB	P1-15	P5-11	Blue	1517G
15	Engine Brake Low	P1-16	P5-3	White/Black	1517B
16	Engine Brake High	P1-17	P5-2	Blue/Black	1517A
17	Destination Sign Wiring	P1-18	Sign	Green	17
18	Floor Heat Temperature Cntl	P1-19	Heat Mod	Green	42
19	Floor Heat Temperature Cntl	P1-20	Heat Mod	Yellow	44
20	Cruise ENB	P1-21	P11-4	Blue	1504
21	Cruise Resume	P1-22	P11-5	Blue/Yellow	1508A
22	Cruise Set	P1-23	P11-6	Yellow/Red	1508B
23	Engine Brake Pre-select	P1-24	P11-19	Purple	1517D
24	Backup Light Power	P2-4	P18-13	Yellow	1322C
25	Monitor Power	P18-13	Monitor	Yellow	1322C
26	Backup Lights	P2-5	P18-17	Blue	1322J
27	Speed Signal	P2-6	P11-12	Blue/Black	1419B
28	Tachometer Signal	P2-7	P11-23	Gray	1406
29	Interior Master	P2-9	P5-19	Red	1519
30	Interior Master	P5-19	Master Board	Red	1519
31	Left Docking Lights	P21-10	P5-17	Green	1329B
32	Right Docking Lights	P2-11	P5-18	Green	1329A
33	Compartment Lock	P2-12	P5-9	Blue	2603
34	Compartment Unlock	P2-13	P5-10	Blue/Black	2603A
35	Mirror Heat	P2-16	Mirrors Org	Black	7
36	Mirror Heat/Switch Power	P2-17	P10-2	Black/Yellow	25
37	Driving Light Relay	P2-18	P18-15	Black	1308D
38	Left Mirror Up/Down	P2-19	Left Mirr White	Red	25

Table 9—Lower Front Harness with M11

39	Left Mirror Left/Right	P2-20	Left Mirror Yellow	Brown	25
40	Left Mirror Common	P2-21	Left Mirror Black	Orange/Black	25
41	Right Mirror Up/Down	P2-22	Right Mirror White	Green	25
42	Right Mirror Left/Right	P2-23	Right Mirror Yellow	Yellow	25
43	Right Mirror Common	P2-24	Right Mirror Black	Blue	25
44	Ground Right Dash	P3-3	Ground Buss	White	14
45	Door Lock Relay	P3-4	P9-23	Orange/Black	18
46	Roof Vent Fan Switch	P3-5	P09-3	Pink	3
47	Park Light Power	P3-6	P8-3	Green/Black	1301G
48	Headlight Wiring	P3-7	P8-4	Green/Black	1301B
49	Roof Vent Fan Relay	P3-8	P18-24	Brown	2302B
50	Park Light/Dim	P3-9	P8-2	Brown	1315B
51	Headlight Alert Power	P8-2	P6-5	Brown	1315B
52	Headlight Alert Buzz	P6-5	Buzzer 2 (+)	Brown	1315B
53	High Beam Indicator (+)	P3-10	P18-8	Green/Black	1301J
54	Low Coolant Indicator	P3-11	P10-20	Blue	20
55	High Coolant Indicator	P3-12	P11-22	Green/Black	1416B
56	Park Brake Indicator	P3-13	P5-8	White/Black	1515G
57	Kneel Switch Power	P5-8	P27-A	White/Black	1515G
58	Low Oil Pressure Indicator	P3-14	P10-24	Blue	17
59	High Transmission Temperature	P3-15	P11-18	Green	1405
60	Warning Lights Power	P3-16	P8-10	Black	1102J
61	Upper Dash Ignition	P8-10	P6-15	Black	1102J
62	Right Upper Ignition	P6-15	P7-1	Black	1102J
63	Step Light Wiring	P3-17	Step Light	Yellow	27
64	Left Turn Signal	P3-19	P10-21	Yellow	13
65	Right Turn Signal	P3-20	P18-6	Green	1323D
66	Abs Warning Signal	P3-11	P11-11	Green	1430
67	Step Light Power	P3-23	P9-13	Blue	8
68	Chassis Ground	P6-1	P5-7	White	1201A
69	Oil Temp Signal	P6-2	P11-1	Blue/Black	1410
70	Driver/Entrance Lights	P6-3	P9-14	Green	21
71	Water Temp Signal	P6-4	P11-7	Green	1416A
72	Oil Pressure Signal	P6-6	P11-2	Blue/Black	1417A
73	Transmission Oil Temp Signal	P6-8	P11-24	Green	1405A
74	Fuel Level Signal	P6-10	P11-13	Tan	1403
75	Driver Dome Light	P6-11	P13-22	Yellow/Black	10

Table 9—Lower Front Harness with M11 (continued)

76	Dc Volt Engine Power	P6-12	P5-6	Blue	1434A
77	Entrance Light	P6-13	P13-23	Black/Yellow	11
78	Low Air	P6-14	P11-20	Brown	1431
79	Low Air Buzzer	P11-20	Buzzer 4 (-)	Brown	1431
80	Headlight Alert Light	P6-16	P18-14	White	1208U
81	Headlight Alert Buzzer	P18-14	Buzzer 2 (-)	White	1208U
82	Fire Alarm Signal	P6-17	P5-20	Red	1433A
83	Fire Alarm Signal	P5-20	Buzzer 5 (+)	Red	1433A
84	Receptacle Dash Ground	P7-2	Ground Buss	White	14
85	Engine Protect Signal	P7-3	P11-3	Yellow	1424
86	Stop Engine Signal	P7-4	P23-6	Milspec Purple	1427
87	Stop Engine Buzzer	P23-6	Buzzer 1 (-)	Milspec Purple	1427
88	Check Engine Signal	P7-5	P23-5	Milspec Purple/White	1426
89	Dash Fan Signal	P7-6	Dash Fan	Red	5
90	Receptacle Dash Hot	P7-7	P9-5	Green	13
91	Bath Power	P9-4	P13-19	Purple	7
92	Compartment Light Power	P9-6	Compartment Light	Yellow	8
93	Monitor Power	P9-7	Monitor	Green	15
94	CB Radio Power	P9-20	CB Radio	Green	8
95	Door Lock Neutral Signal	P9-22	P8-8	White/Black	1515J
96	Kneeling Relay	P8-8	P27-B	White/Black	1515J
97	Floor Heat Power	P10-1	Heat Mod	Blue	49
98	Stop Engine Buzz Power	P10-3	Buzzer 1 (+)	Purple	53
99	Low Air Buzz Power	BUZZ 1 (+)	Buzzer 4 (+)	Purple	53
100	Load Center Ground	P10-8	Ground Buss	White	14
101	Bus Interior Lights Right	P10-9	P13-9	Brown/Orange	8
102	Bus Interior Lights Left	P10-11	P13-10	Yellow/Black	3
103	Seat Lights Right/Left	P10-12	P13-11	Black/Yellow	26
104	Top Door Lock Override	P10-18	Master Board	Green	25
105	Low Coolant Signal	P10-19	P5-5	Blue	1420D
106	Light Turn Switch	P10-22	P18-7	Yellow	1313C
107	Oil Pressure Signal	P10-23	P11-21	Blue/Black	1417B
108	Radio Memory	P12-2	P9-19	Green	19
109	Left Speakers (+)	P12-8	P13-1	Red	1

Table 9—Lower Front Harness with M11 (continued)

LTC Chassis Electrical

110	Left Speakers (-)	P12-9	P13-2	White	1
111	Right Speakers (+)	P12-10	P13-3	Red	2
112	Right Speakers (-)	P12-11	P13-4	White	2
113	Ignition Switch Battery	P12-12	P8-7	Black	1101G
114	Map Light Power	P8-7	P13-7	Black	1101G
115	Interior Master	P13-7	P2-2	Black	1101G
116	Entrance Door/Hazard	P2-2	P16-3	Milspec Black	1101G
117	Roof Hatch Buzzer	P16-3	Buzzer 3 (+)	Black	1101G
118	Ignition Switch Ignition	P12-13	P11-8	Pink	1102A
119	Solenoid Ignition Feed	P11-8	P5-21	Black	1102G
120	Ground	P16-1	Ground Buss	Milspec White	14
121	Tag Dump	P16-2	P18-10	Milspec Blue	1808B
122	Entrance Door Open	P16-4	Entrance Door Solenoid	Milspec Brown	8
123	Entrance Door Close	P16-5	Entrance Door Solenoid	Milspec Black	8
124	Hazard Central	P16-6	P18-5	Milspec Green/Black	1332B
125	Hazard Light Switch Signal	P18-5	P3-18	Green/Black	1332B
126	Hazard Light Switch Signal	P3-18	P9-24	Green/Black	1332B
127	Ignition Switch Start	P12-14	P11-10	Purple	1115A
128	Roof Hatch Buzzer	P18-23	Buzzer 3 (-)	Red/Black	2302A
129	12-Volt Filter	Filter	Load Center	Yellow 10 Gage	44
130	Horn Signal	Horn SW	P11-14	Green	2107A
131	Fire Alarm Buzz Ground	Buzz 5 (-)	Ground Bus	White	14
132	Washer Fluid	Steer	Washer Fluid	Black	2102W

Table 9—Lower Front Harness with M11 (continued)

Ref	Description	From	To	Color	Number
1	Bus Interior Light Relay	P1-1	P10-10	Blue	14
2	Seat Light Relay	P1-2	P10-14	Brown	16
3	Lower Dash Master Power	P1-4	P9-10	Brown	4
4	Wiper Delay Switch	P1-5	Steer	Black	2102C
5	Wiper Delay	P1-7	Steer	Blue	2102B
6	Floor Heat Temperature Cntl	P1-8	Heat Mod	Red	41
7	Upper Dash Gauge Dim	P1-9	P6-9	Blue	1310A
8	Shifter Illumination	P6-9	P11-16	Blue	1310A
9	Signal Ground	P1-10	P23-1	Milspec White	1209D
10	Signal Ground	P23-1	P16-11	Milspec White	1209D
11	Mirror Switch Light	P1-11	P18-11	White	1208T
12	Clear Lights	P1-12	P5-13	White	1203B
13	Clear Lights	P1-13	P5-12	Green/Black	1310B
14	Clear Lights	P1-14	P5-24	Green/Black	1310G
15	Engine Brake EMB	P1-15	P5-11	Blue	1517G
16	Engine Brake Low	P1-16	P5-3	White/Black	1517B
17	Engine Brake High	P1-17	P5-2	Blue/Black	1517A
18	Destination Sign Wiring	P1-18	Sign	Green	17
19	Floor Heat Temperature Cntl	P1-19	Heat Mod	Green	42
20	Floor Heat Temperature Cntl	P1-20	Heat Mod	Yellow	44
21	Cruise EMB	P1-21	P11-4	Blue	1504
22	Cruise Resume	P1-22	P11-5	Blue/Yellow	1508A
23	Cruise Set	P1-23	P11-6	Yellow/Red	1508B
24	Engine Brake Pre-select	P1-24	P11-19	Purple	1517D
25	Backup Light Power	P2-4	P18-13	Yellow	1322C
26	Monitor Power	P18-13	Monitor	Yellow	1322C
27	Backup Lights	P2-5	P18-17	Blue	1322J
28	Speed Signal	P2-6	P11-12	Blue/Black	1419B
29	Tachometer Signal	P2-7	P11-23	Gray	1406
30	Interior Master	P2-9	P5-19	Red	1519
31	Interior Master	P5-19	Master Board	Red	1519
32	Left Docking Lights	P21-10	P5-17	Green	1329B
33	Right Docking Lights	P2-11	P5-18	Green	1329A
34	Compartment Lock	P2-12	P5-9	Blue	2603
35	Compartment Unlock	P2-13	P5-10	Blue/Black	2603A
36	Mirror Heat	P2-16	Mirrors Org	Black	7
37	Mirror Heat/Switch Power	P2-17	P10-2	Black/Yellow	25
38	Left Mirror Up/Down	P2-19	Left Mirror White	Red	25

Table 10—Lower Front Harness with DDEC

39	Left Mirror Left/Right	P2-20	Left Mirror Yellow	Brown	25
40	Left Mirror Common	P2-21	Left Mirror Black	Orange/Black	25
41	Right Mirror Up/Down	P2-22	Right Mirror White	Green	25
42	Right Mirror Left/Right	P2-23	Right Mirror Yellow	Yellow	25
43	Right Mirror Common	P2-24	Right Mirror Black	Blue	25
44	Ground Right Dash	P3-3	Ground Buss	White	14
45	Door Lock Relay	P3-4	P9-23	Orange/Black	18
46	Roof Vent Fan Switch Power	P3-5	P9-3	Pink	3
47	Park Light Power	P3-6	P8-3	Green/Black	1301G
48	Headlight Wiring	P3-7	P8-4	Green/Black	1301B
49	Roof Vent Fan Relay	P3-8	P18-24	Brown	2302B
50	Park Light/Dim	P3-9	P8-2	Brown	1315B
51	Headlight Alert Power	P8-2	P6-5	Brown	1315B
52	Headlight Alert Buzz Power	P6-5	Buzzer 2 (+)	Brown	1315B
53	High Beam Indicator (+)	P3-10	P18-8	Green/Black	1301J
54	Low Coolant Indicator	P3-11	P10-20	Blue	20
55	High Coolant Indicator	P3-12	P11-22	Green/Black	1416B
56	Park Light Indicator	P3-13	P5-8	White/Black	1515
57	Kneel Switch Power	P5-8	P27A	White/Black	1515
58	Low Oil Pressure Indicator	P3-14	P10-24	Blue	17
59	High Transmission Temperature	P3-15	P11-18	Green	1405
60	Warn Light Power	P3-16	P8-10	Black	1102J
61	Upper Dash Ignition	P8-10	P6-15	Black	1102J
62	Shifter Panel Ignition	P6-15	P16-7	Black	1102J
63	Step Light Wiring	P3-17	Step Light	Yellow	27
64	Left Turn Signal	P3-19	P10-21	Yellow	13
65	Right Turn Signal	P3-20	P18-6	Green	1323D
66	ABS Warning Signal	P3-21	P11-11	Green	1430
67	Step Light Power	P3-23	P9-13	Blue	8
68	Chassis Ground	P6-1	P5-7	White	1201A
69	Oil Temp Signal	P6-2	P11-1	Blue/Black	1410
70	Driver/Enter Light Power	P6-3	P9-14	Green	21

Table 10—Lower Front Harness with DDEC (continued)

71	Water Temp Signal	P6-4	P11-7	Green	1416A
72	Oil Pressure Signal	P6-6	P11-2	Blue/Black	1417A
73	Transmission Oil Temperature Signal	P6-8	P11-24	Green	1405A
74	Fuel Level Signal	P6-10	P11-13	Tan	1403
75	Driver Dome Light	P6-11	P13-22	Yellow/Black	10
76	DC Volts Engine Power	P6-12	P5-6	Blue	1434A
77	Entrance Light	P6-13	P13-23	Black/Yellow	11
78	Low Air	P6-14	P11-20	Brown	1431
79	Low Air Buzzer	P11-20	Buzzer 4 (-)	Brown	1431
80	Headlight Alert Light	P6-16	P18-14	White	1208U
81	Headlight Alert Buzzer	P18-14	Buzzer 2 (-)	White	1208U
82	Fire Alarm Signal	P6-17	P5-20	Red	1433A
83	Fire Alarm Signal	P5-20	Buzzer 5 (+)	Red	1433A
84	Receptacle Dash Ground	Recep	Ground Buss	White	14
85	Bathroom Power	P9-4	P13-19	Purple	7
86	Compartment Light Power	P9-6	Comp Light	Yellow	8
87	Monitor Power	P9-7	Monitor	Green	15
88	CB Radio Power	P9-20	CB Radio	Green	8
89	Door Lock Neutral Sign	P9-22	P8-8	White/Black	1515J
90	Kneeling Relay	P8-8	P27-B	White/Black	1515J
91	Floor Heat Power	P10-1	Heat Mod	Blue	49
92	Stop Engine Buzz Power	P10-1	Buzzer 1 (+)	Purple	53
93	Low Air Buzz Power	BUZZ 1 (+)	Buzzer 4 (+)	Purple	53
94	Load Center Ground	P10-8	Ground Buss	White	14
95	Bus Interior Light Right	P10-9	P13-9	Brown/Orange	8
96	Bus Interior Light Left	P10-11	P13-10	Yellow/Black	3
97	Seat Lights Right/Left	P10-12	P13-11	Black/Yellow	26
98	Top Door Lock Override	P10-18	Master Board	Green	25
99	Low Coolant Signal	P10-19	P5-5	Blue	1420D
100	Left Turn Signal	P10-22	P18-7	Yellow	1313D
101	Oil Pressure Signal	P10-23	P11-21	Blue/Black	1417B
102	Radio Memory	P12-2	P9-19	Green	19
103	Left Speaker (+)	P12-8	P13-1	Red	1
104	Left Speaker (-)	P12-9	P13-2	White	1
105	Right Speaker (+)	P12-10	P13-3	Red	2
106	Right Speaker (-)	P12-11	P13-4	White	2
107	Ignition Switch Battery	P12-12	P8-7	Black	1101G

Table 10—Lower Front Harness with DDEC (continued)

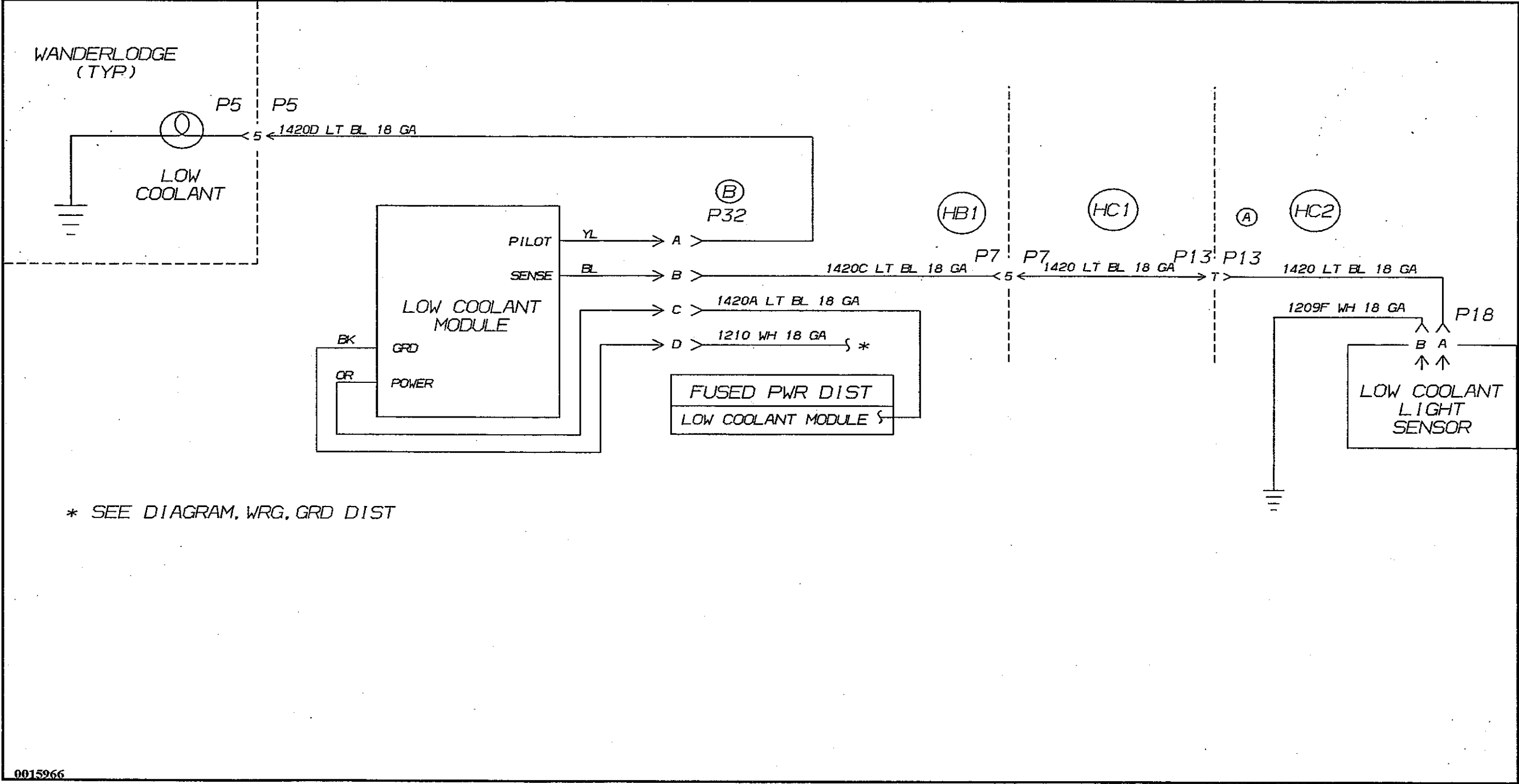
LTC Chassis Electrical

108	Map Light Power	P8-7	P13-7	Black	1101G
109	Interior Master	P13-7	P2-2	Black	1101G
110	Entrance Door/Hazard	P2-2	P16-3	Milspec Black	1101G
111	Roof Hatch Buzzer	P16-3	Buzzer 3 (+)	Black	1101G
112	Ignition Switch Ignition	P12-13	P11-8	Pink	1102A
113	Solenoid Ignition Feed	P11-8	P5-21	Black	1102G
114	Ignition Switch Start	P12-14	P11-10	Purple	115A
115	Ground	P16-1	Ground Buss	Milspec White	14
116	Tag Dump	P16-2	P18-10	Milspec Blue	1808B
117	Entrance Door Open	P16-4	Ent Door Sol	Milspec Brn	8
118	Entrance Door Close	P16-5	Ent Door Sol	Milspec Black	8
119	Hazard Central	P16-6	P18-5	Milspec Green/Blk	1332B
120	Hazard Light Switch Signal	P18-5	P3-18	Green/Black	1332B
121	Hazard Light Switch Signal	P3-18	P9-24	Green/Black	1332B
122	Stop Engine Signal	P16-8	P23-6	Milspec Purple	1427
123	Stop Engine Buzzer	P23-6	Buzzer 1 (-)	Milspec Purple	1427
124	Check Engine Signal	P16-9	P23-5	Milspec Purple/White	1426
125	Stop Engine Override	P16-10	P23-8	Milspec Brown/Red	1513A
126	Receptacle Dash Hot	P16-12	P9-5	Milspec Green	13
127	Dash Fan Power	P9-5	Receptacle	---	---
128	Dash Fan Wiring	P16-13	Dash Fan	Milspec Red	5
129	Roof Hatch Buzzer	P18-23	Buzzer 3 (-)	Red/Black	2302A
130	12-Volt Filter	Filter	Load Center	Yellow 10Gage	44
131	Horn Signal	Horn	P11-14	Green	2107A
132	Fire Alarm Buzz Ground	Buzz 5 (-)	Ground Bus	Black 2102W	
133	Washer Fluid	Steer	Washer Fluid	Black	2102W

Table 10—Lower Front Harness with DDEC (continued)

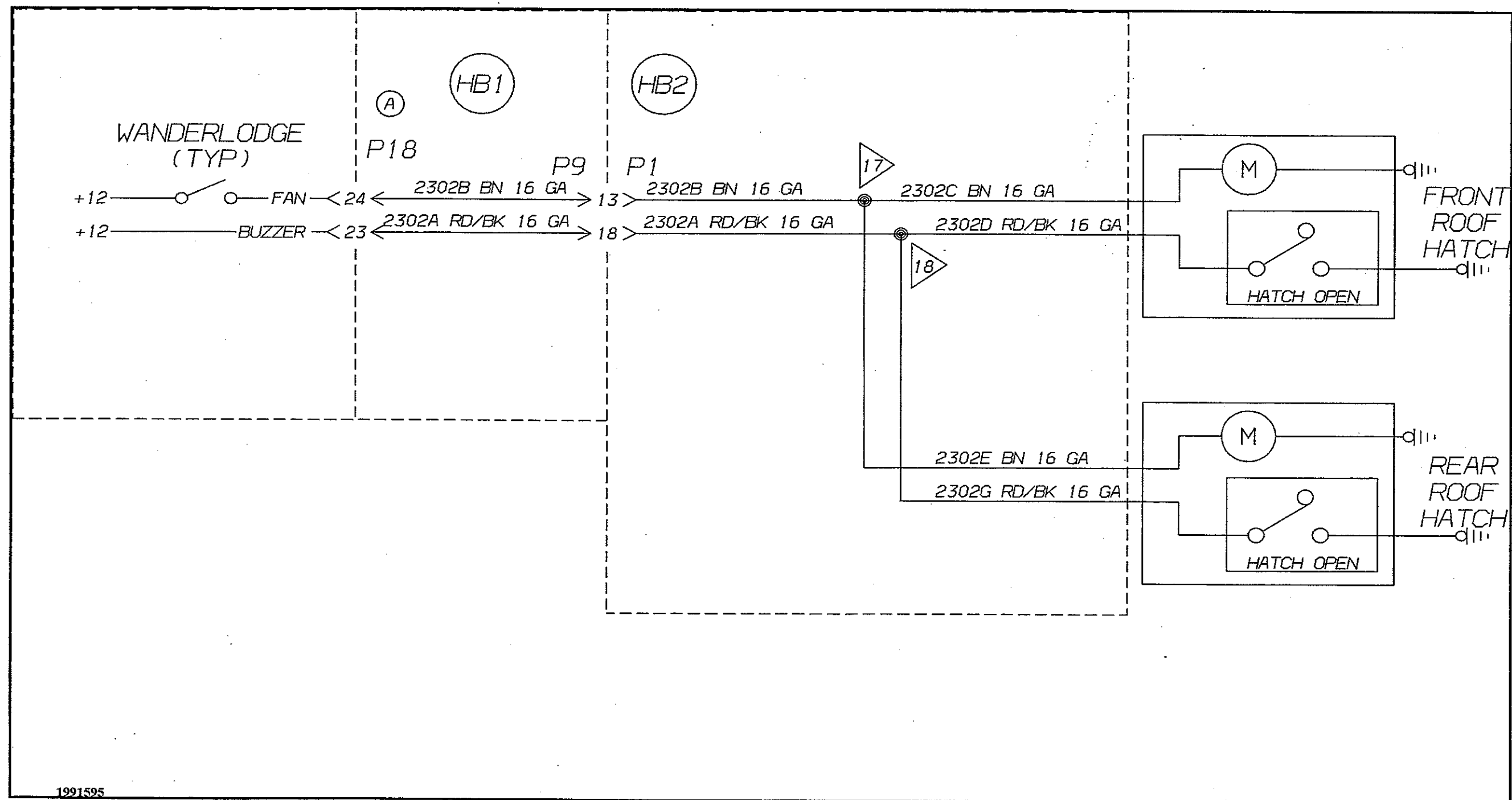
Ref	Description	From	To	Color	Number
1	Kneel Ignition Power	DS1-1	BBC Harness	Black	1189B
2	Kneel Ignition Signal	DS1-2	BBC Harness	White/Black	1288
3	Kneel Power	S3-1	BBC Harness	White/Black	1515
4	Kneel Relay Power	S3-2	BBC Harness	Tan/Orange	3701
5	Dash Fan Power	P16-12	S8-1	Green	13
6	Dash Fan Wiring	P16-13	S8-2	Red	5

Table 11—Optional



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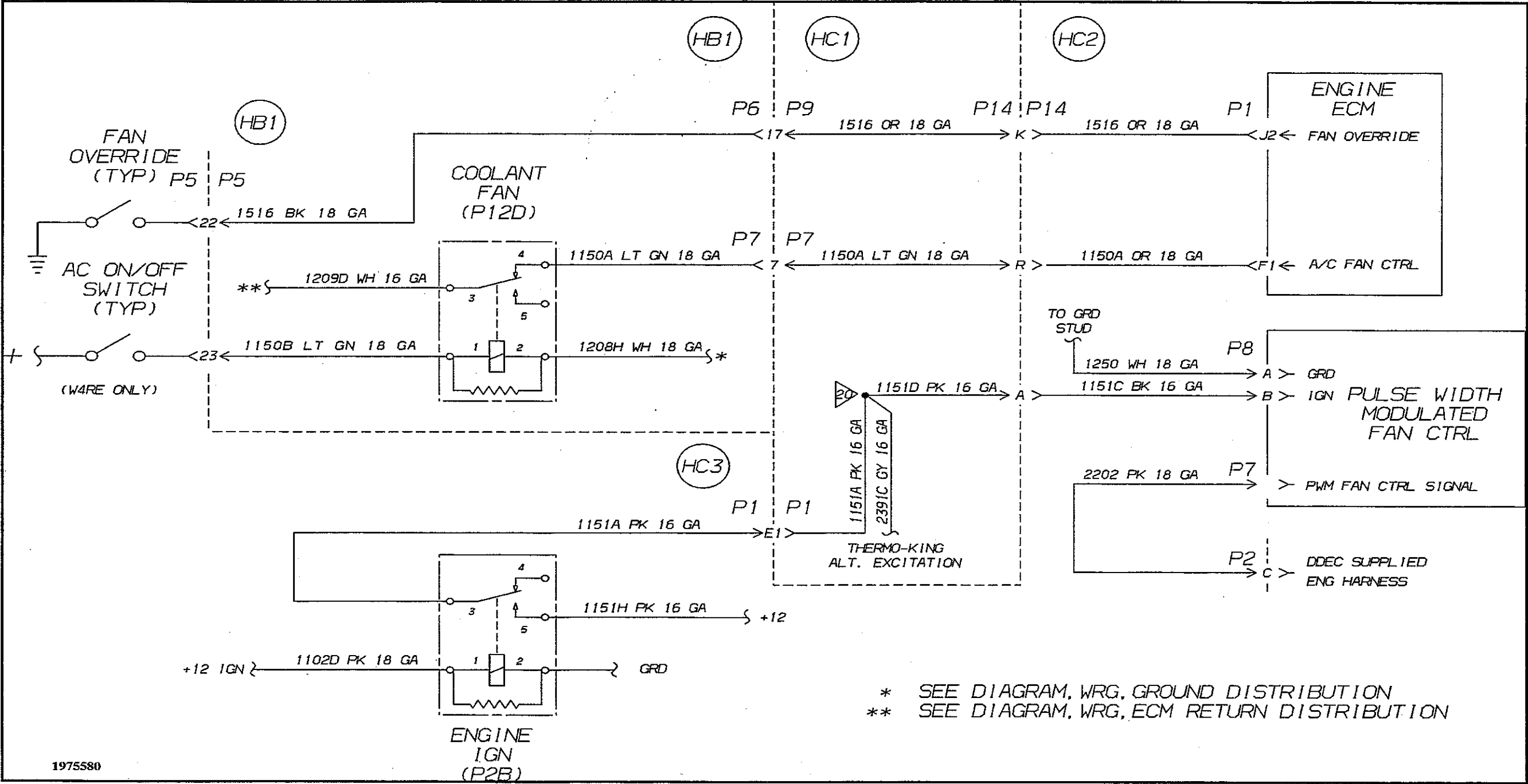
Schematic 21—Low Coolant



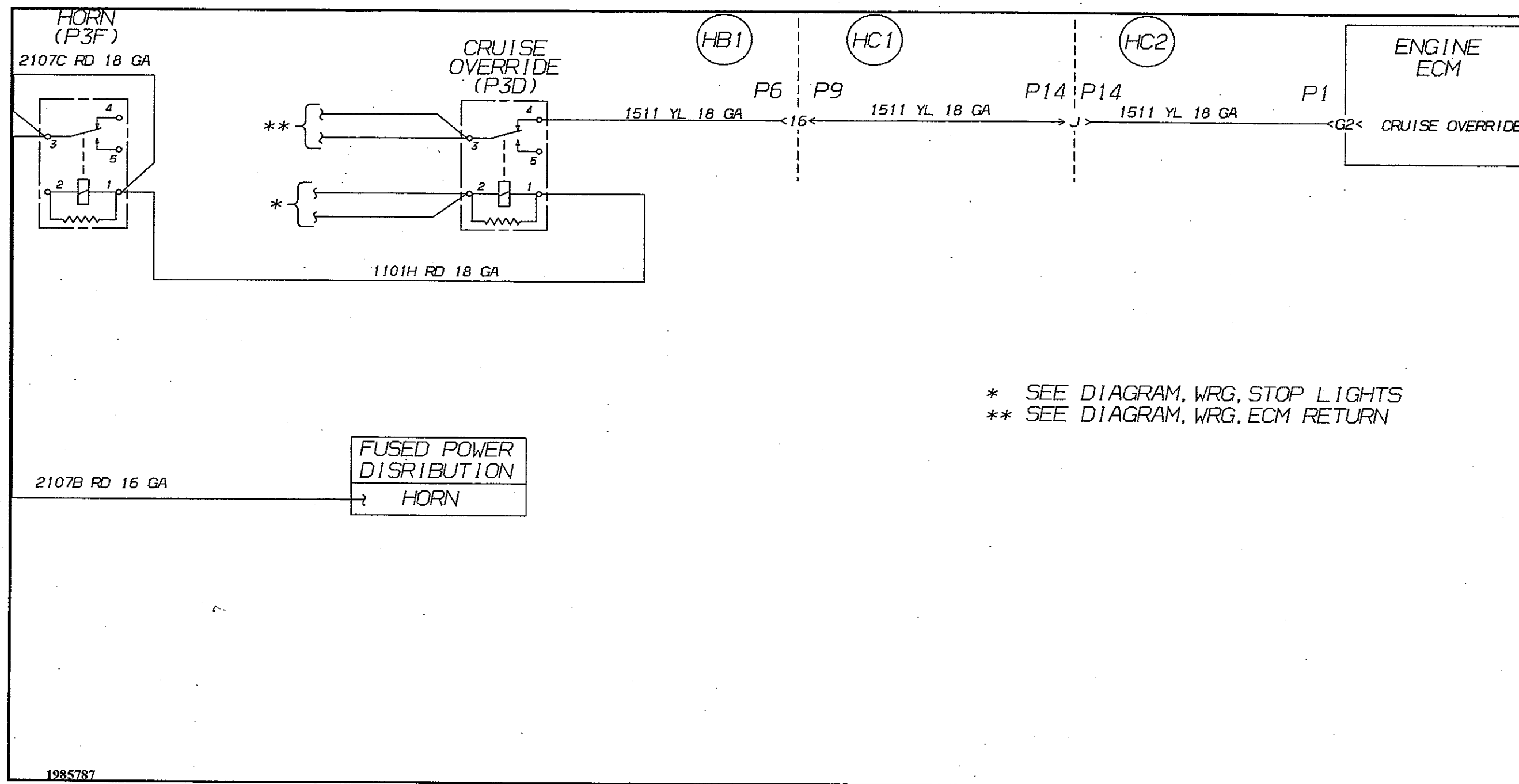
Schematic 22—Roof Hatch



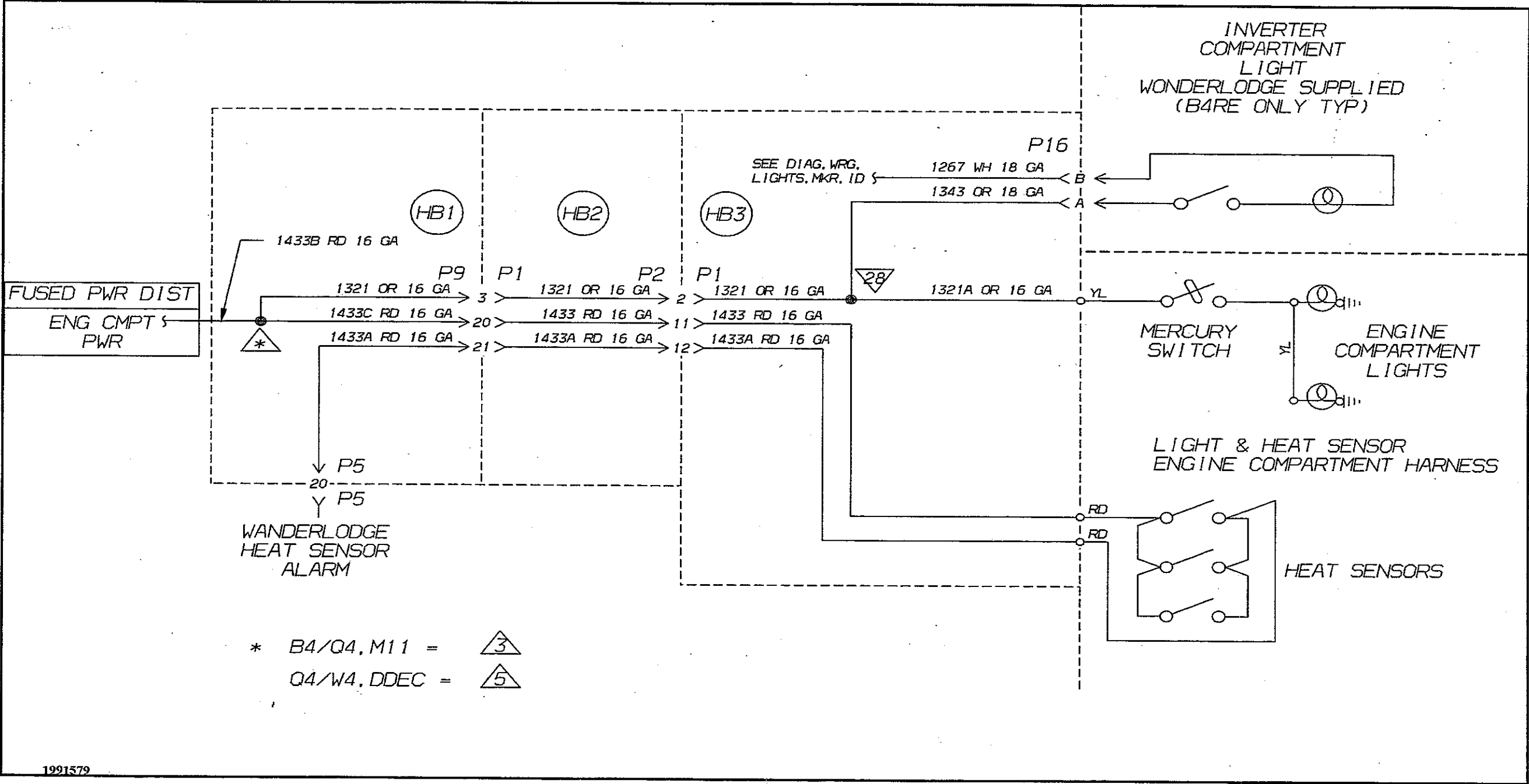
Schematic 23—LTC ABS



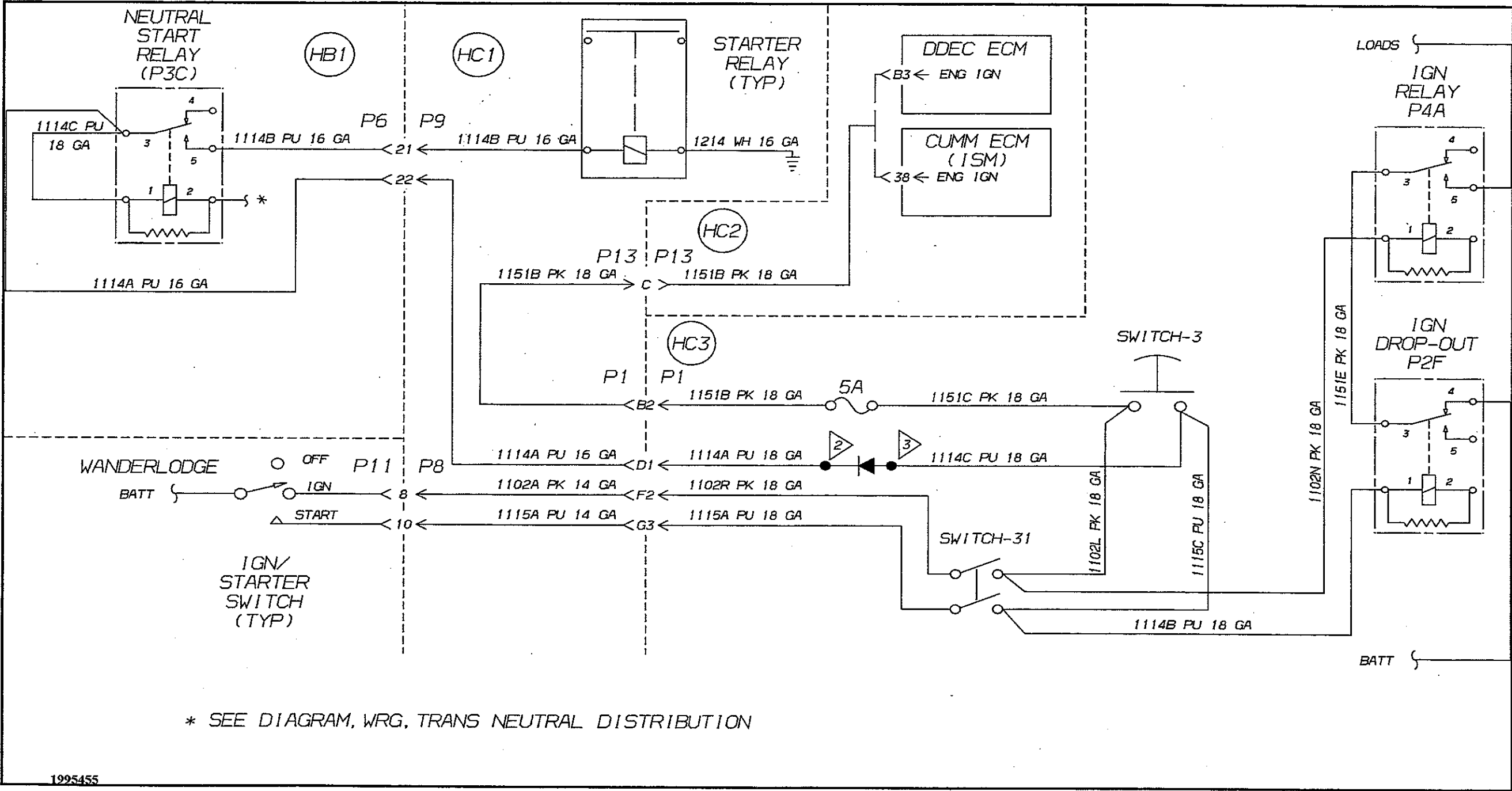
Schematic 24—Fan Control DDEC



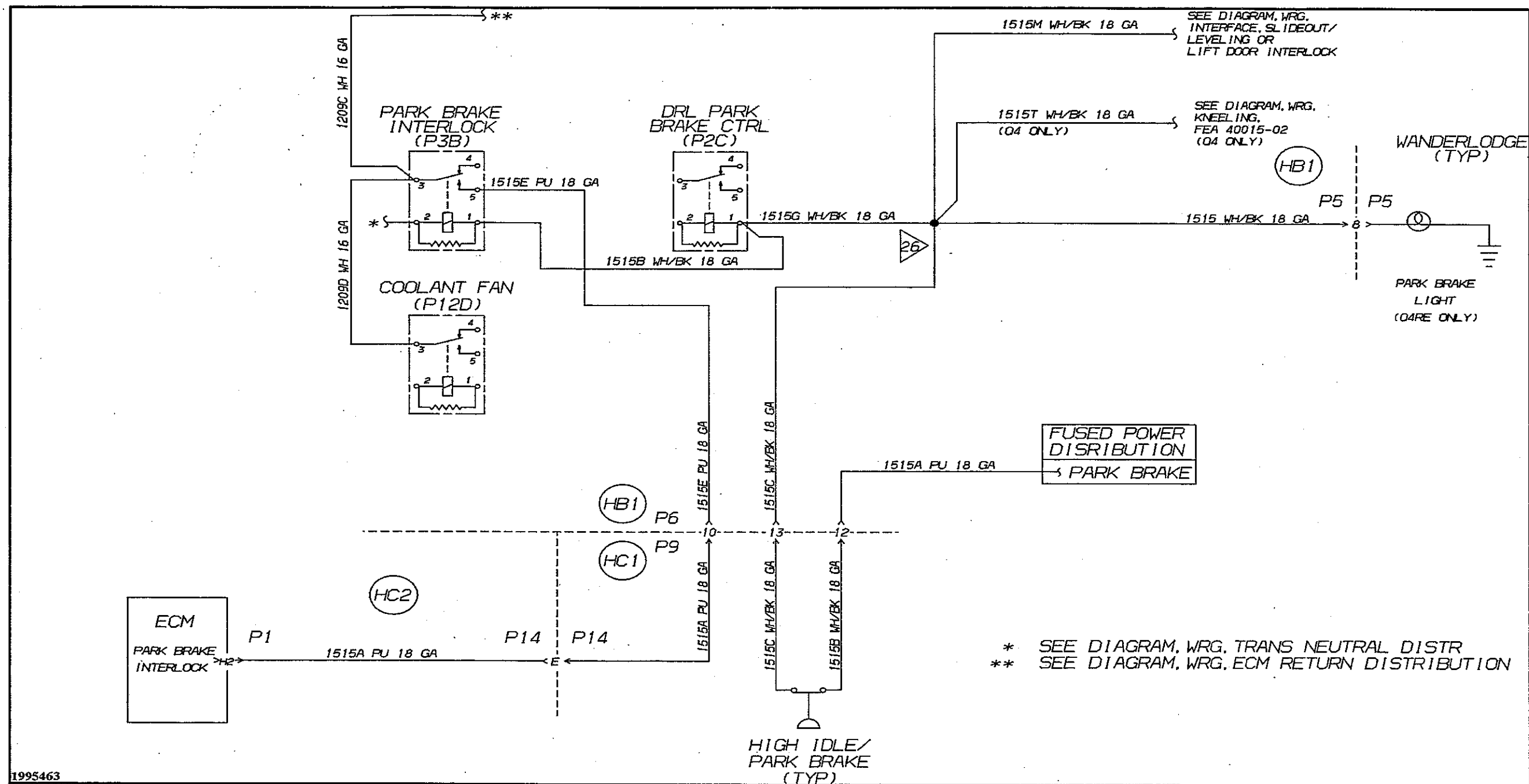
Schematic 25—Cruise Control DDEC



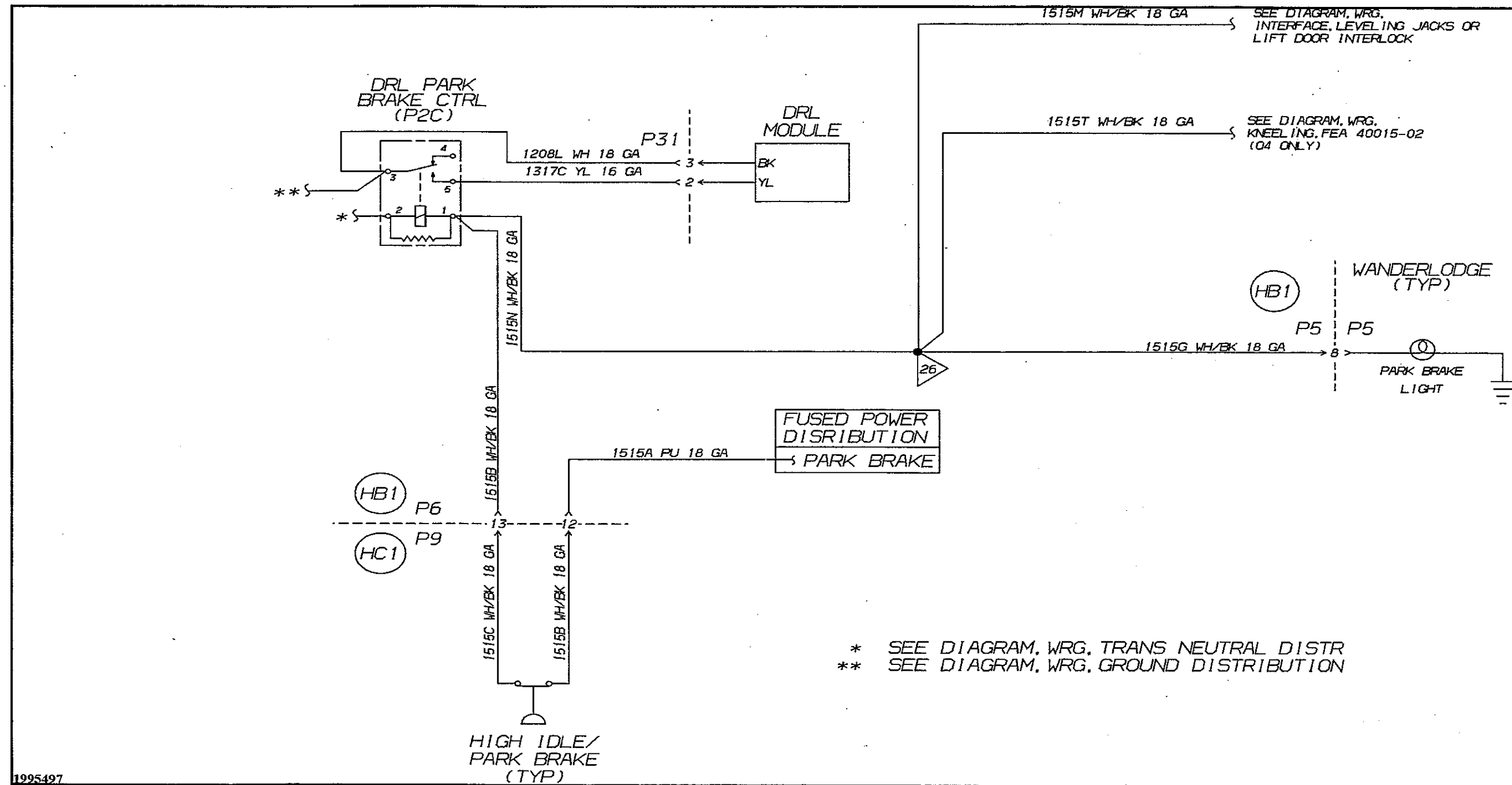
Schematic 26—Engine Compartment Lights



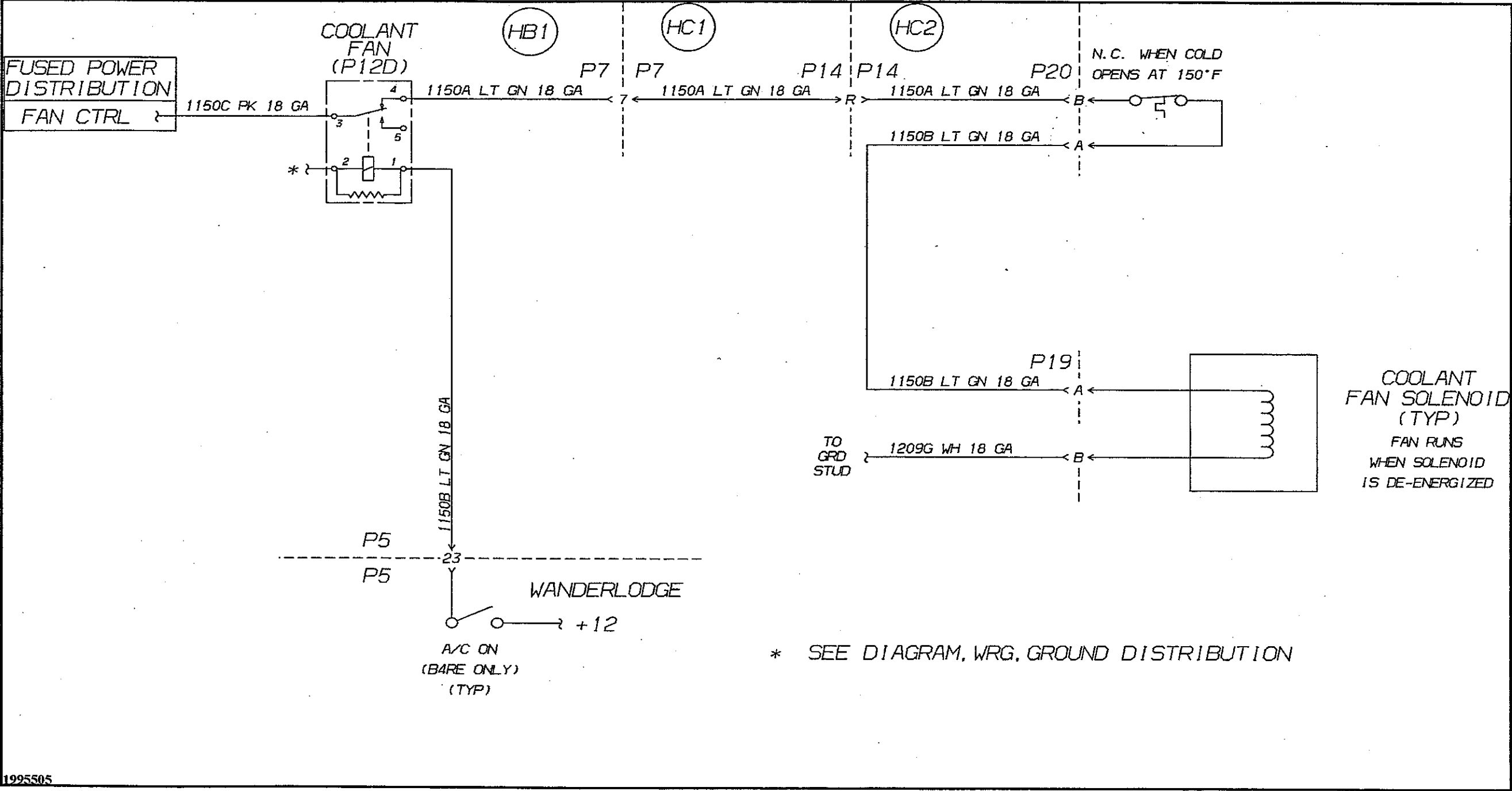
Schematic 28—Starter Interlock Rear Control



Schematic 29—Park Brake Control DDEC

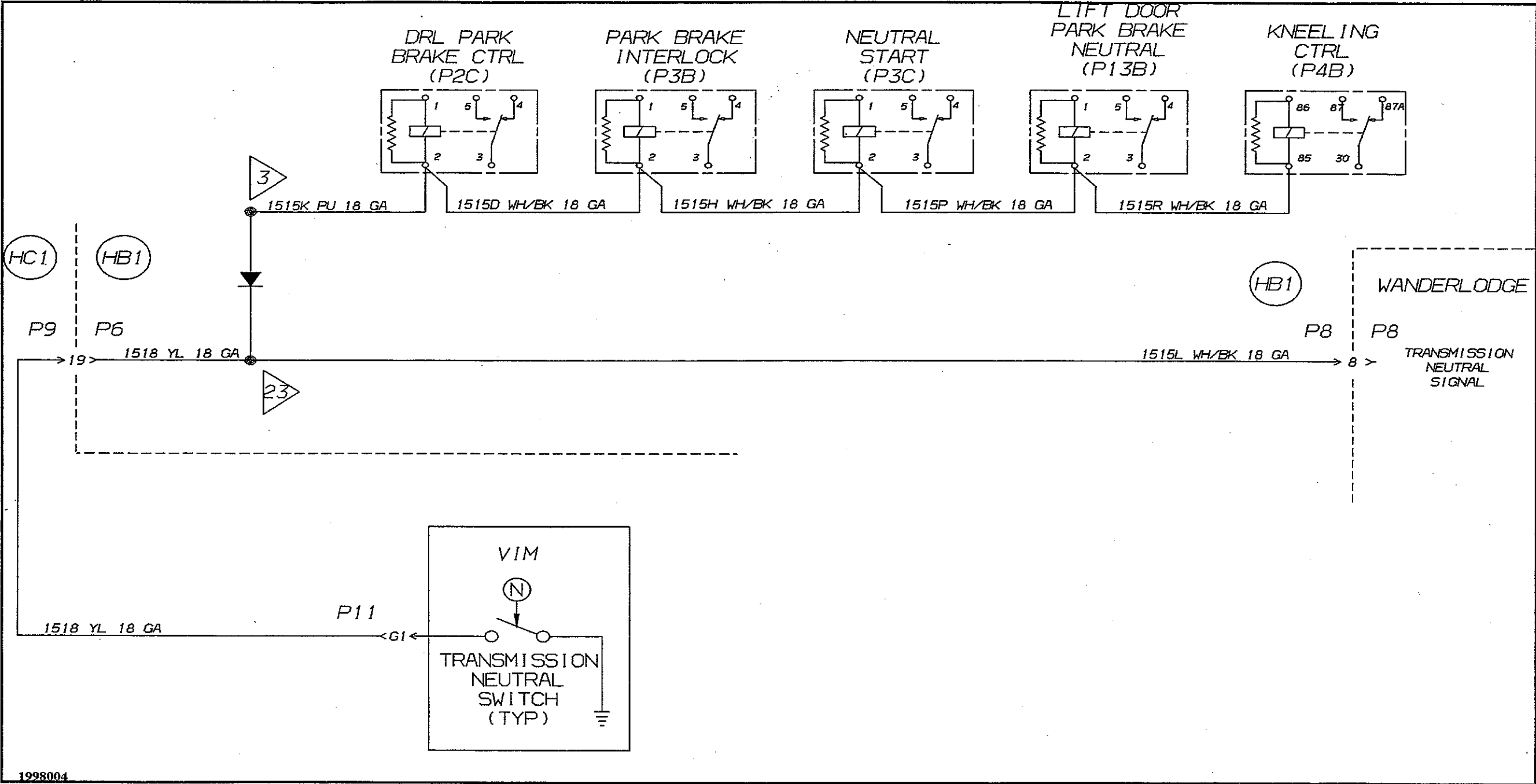


Schematic 30—Park Brake Control Cummins

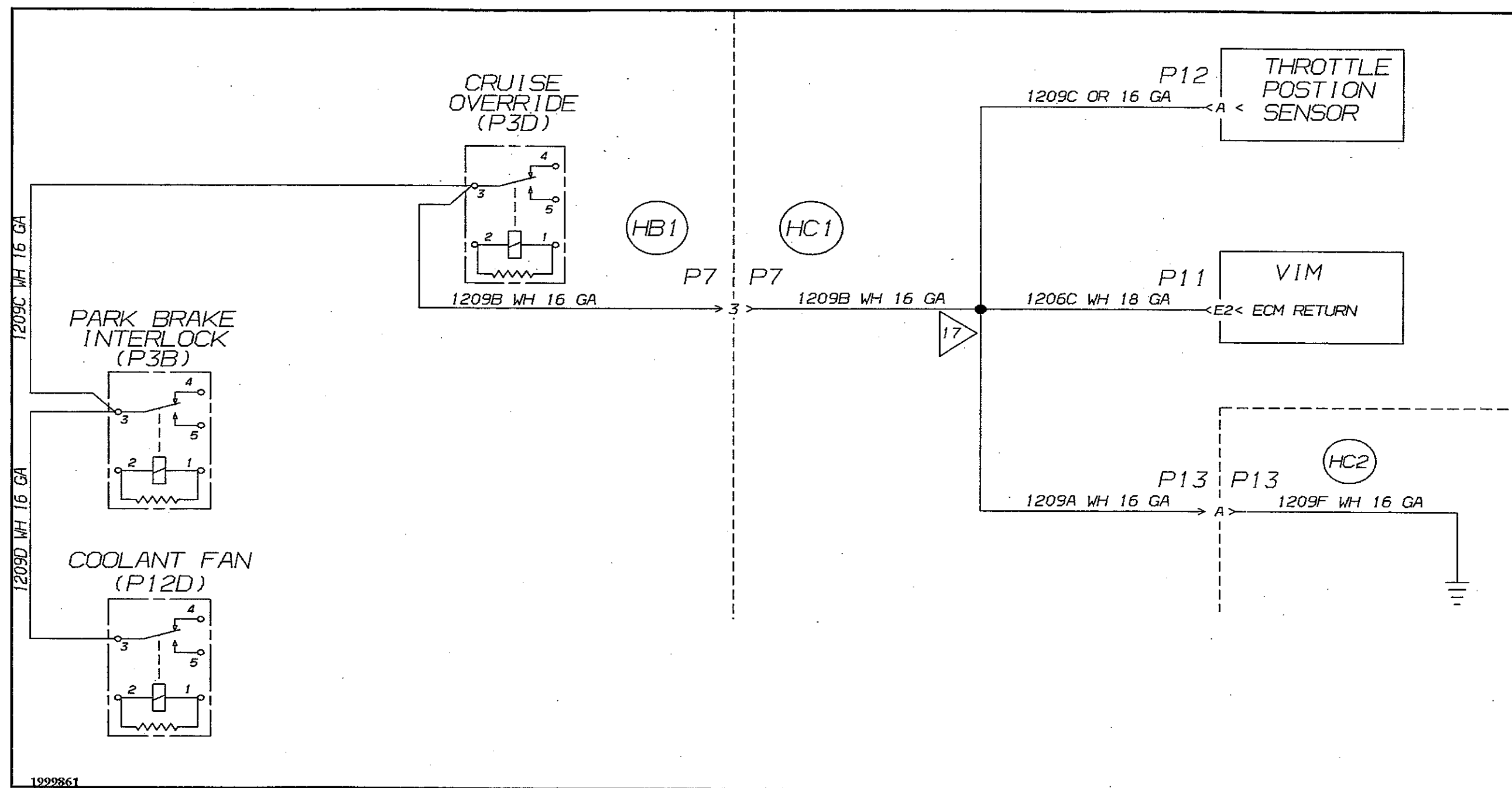


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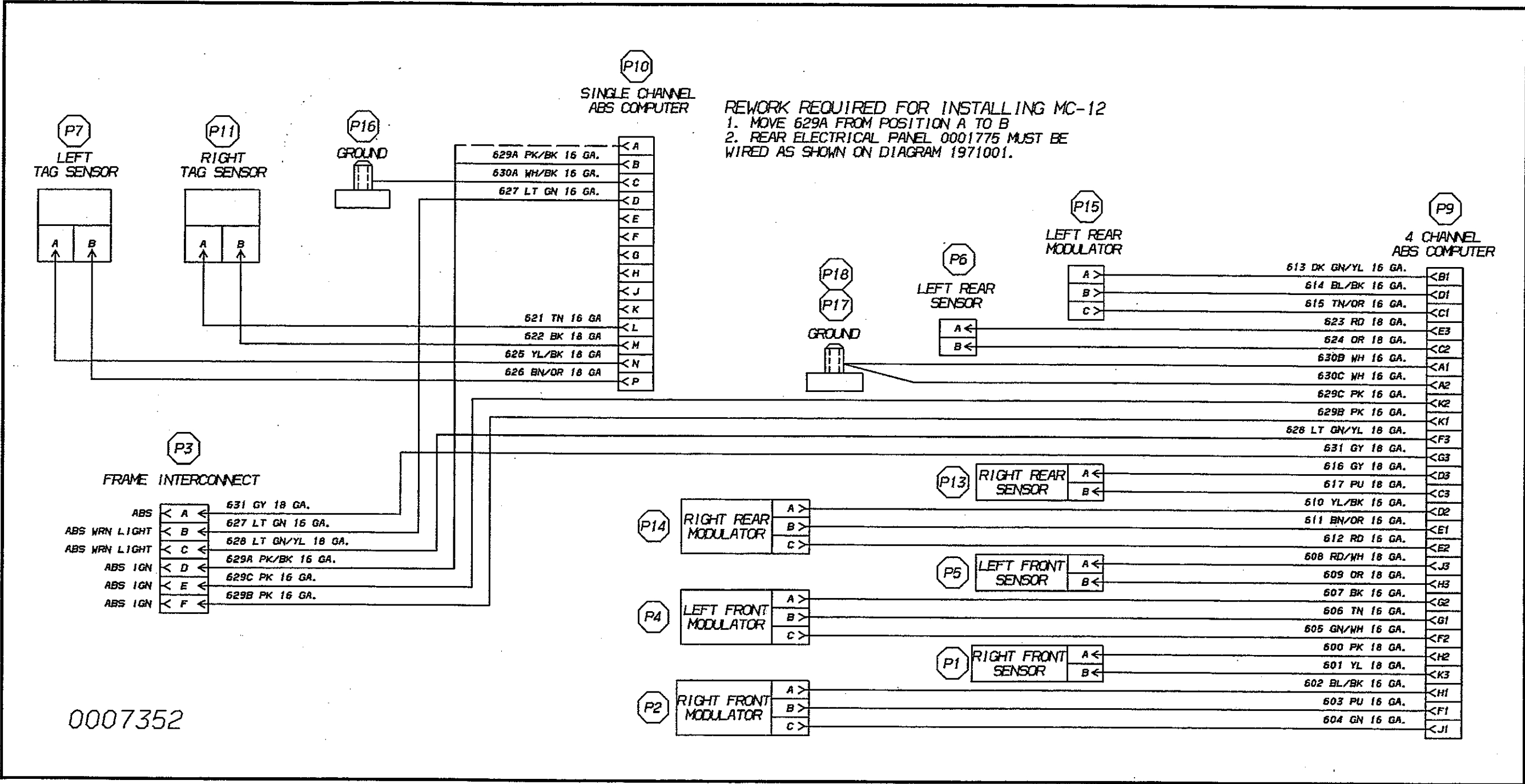
Schematic 31—Fan Control M11



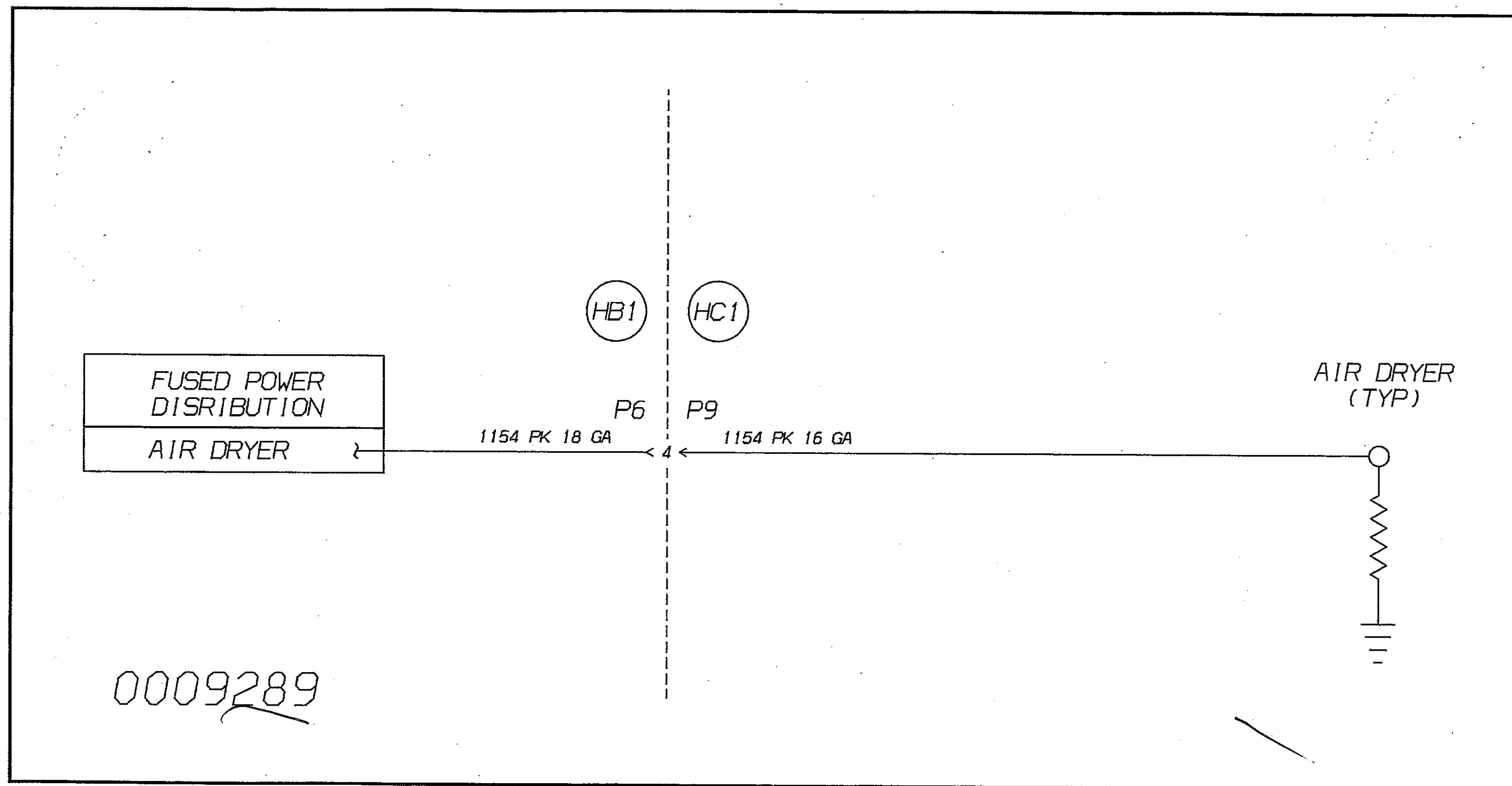
Schematic 32—Neutral Distribution Cummins



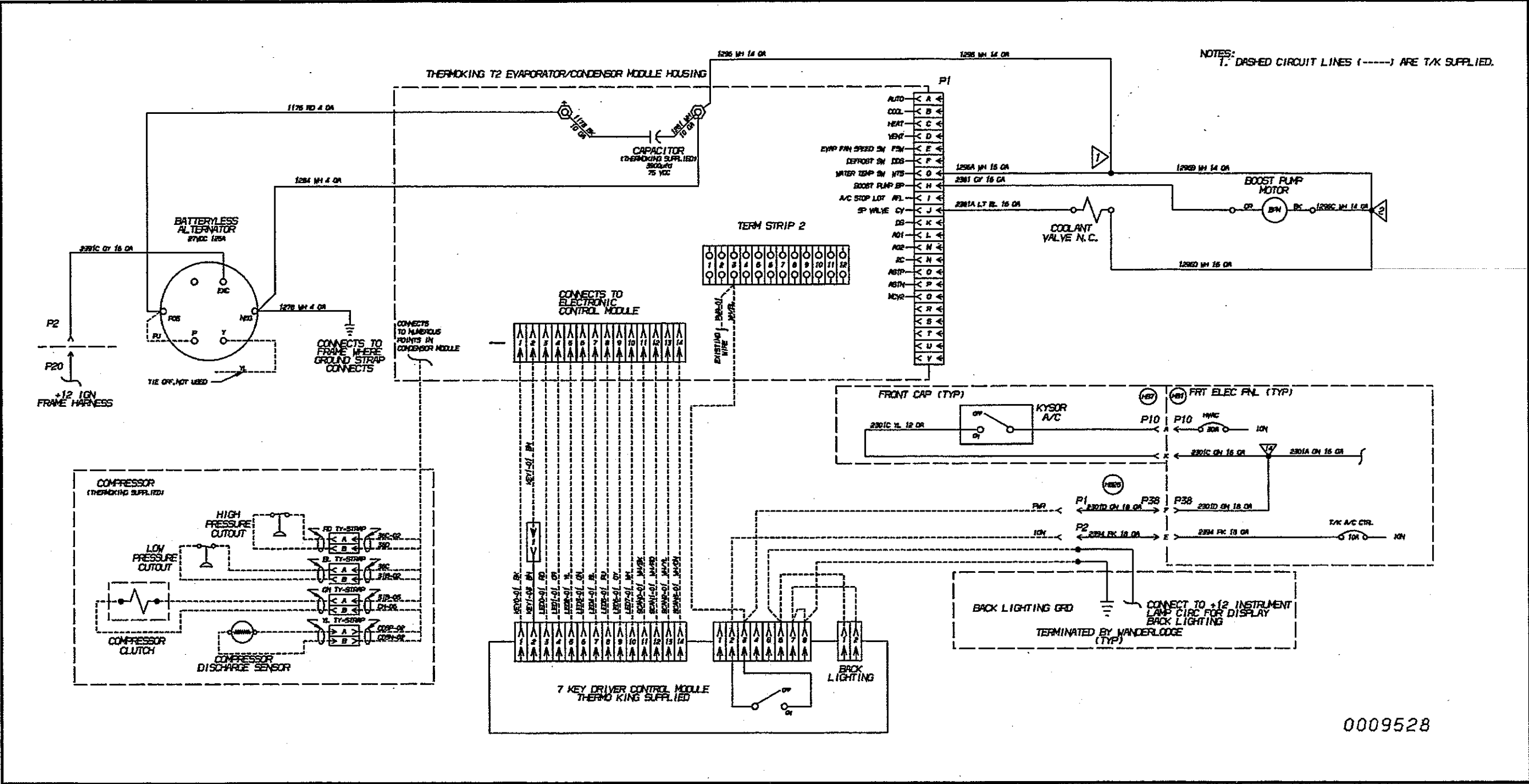
Schematic 33—ECM Return Distribution DDEC



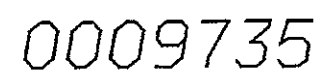
Schematic 34—ABS EC-15 and MC-12 Controller Rework



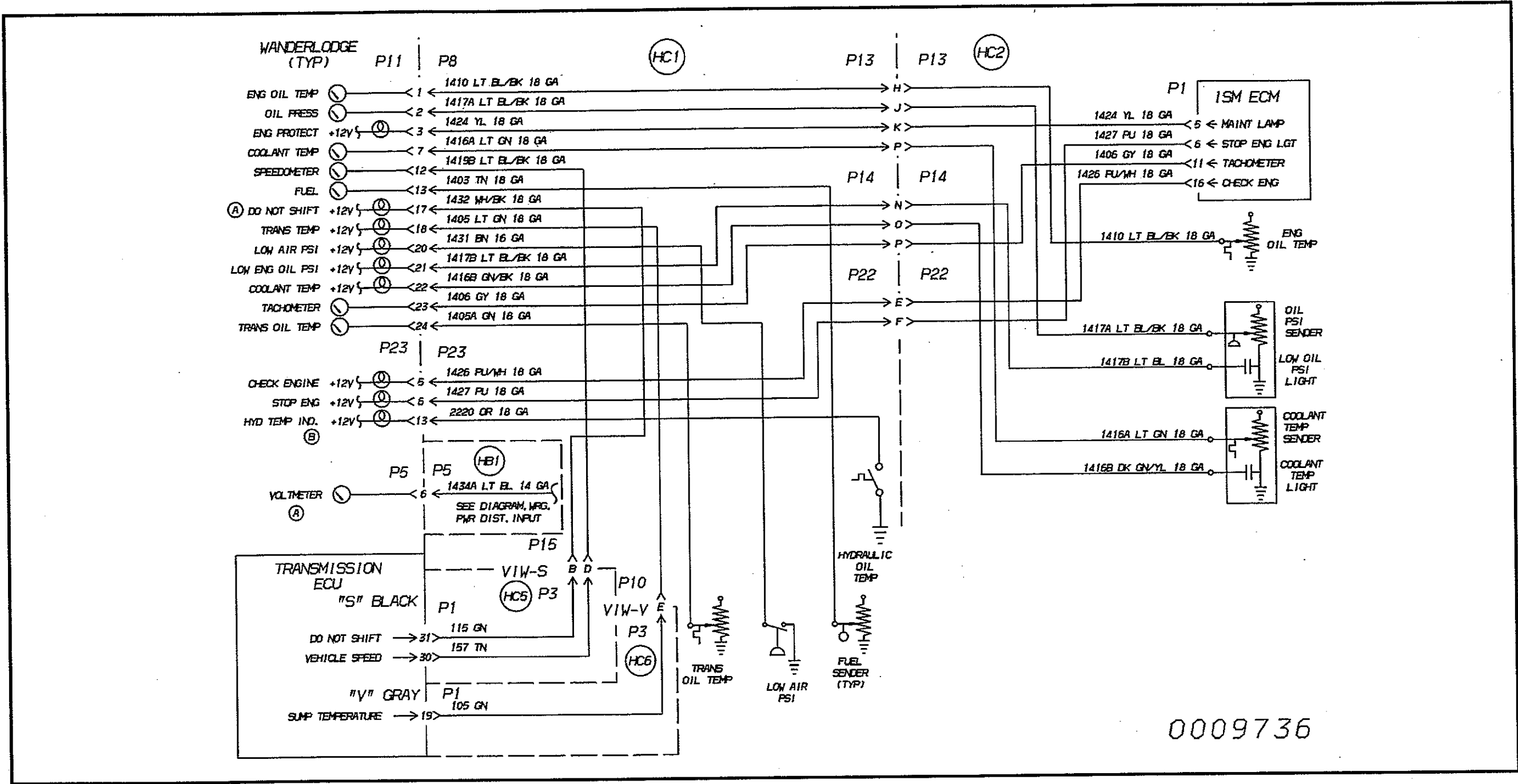
Schematic 35—Air Dryer



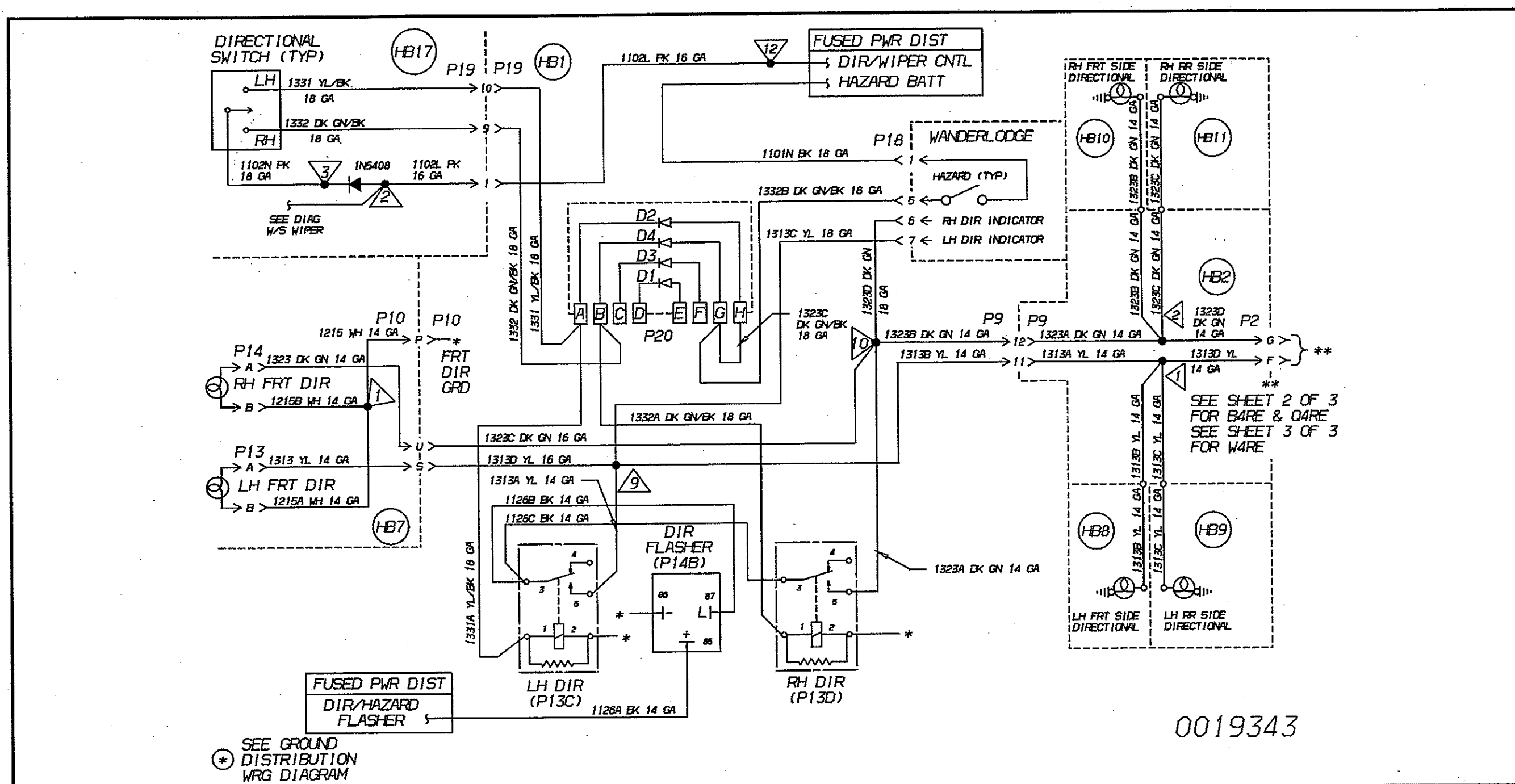
Schematic 36—Thermo King Air Condition System



Schematic 37—Horn

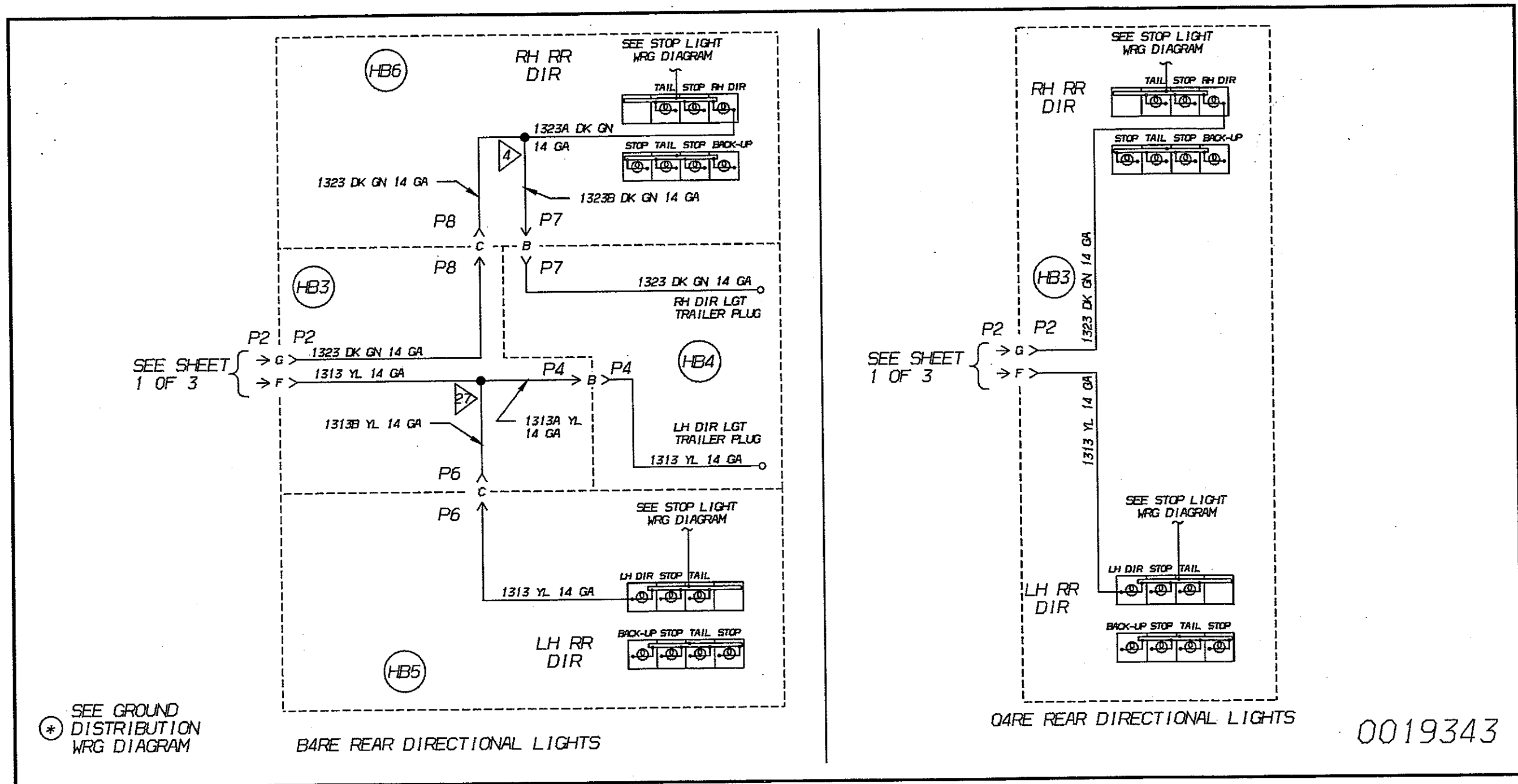


Schematic 38—Cummins Warning Lights and Gauges

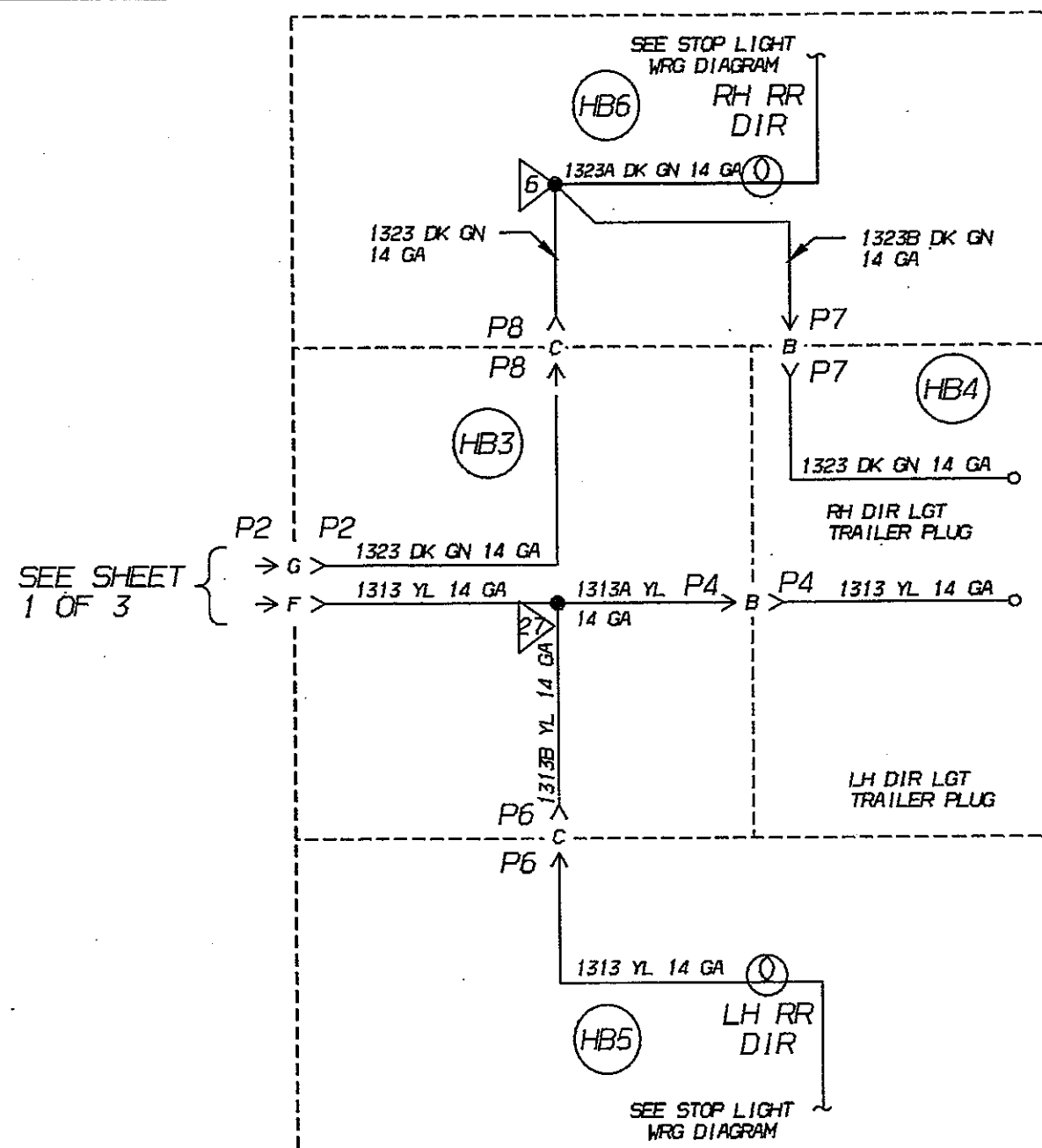


Schematic 39—Directional Lights





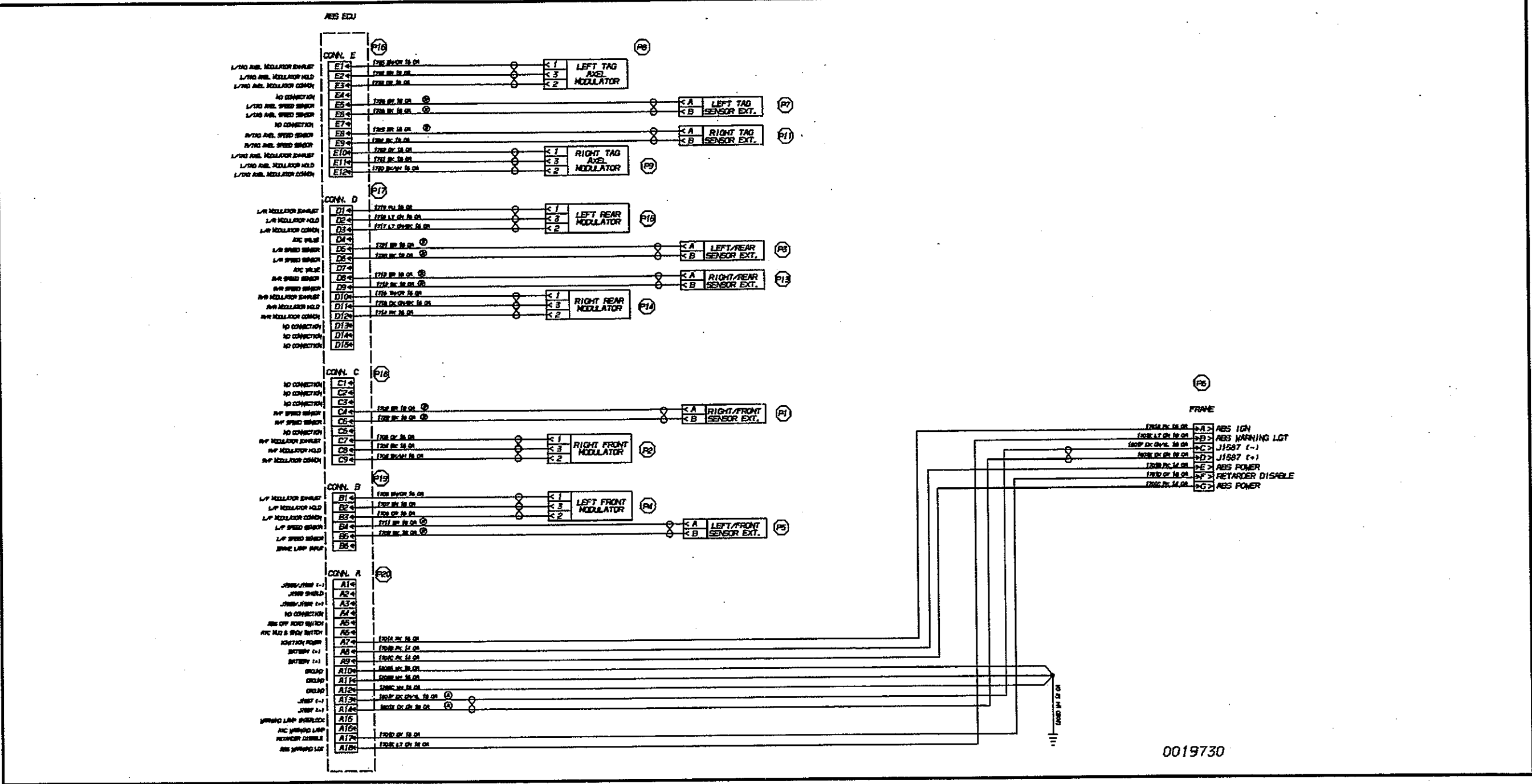
Schematic 40—Directional Lights



W4RE REAR DIRECTIONAL LIGHTS

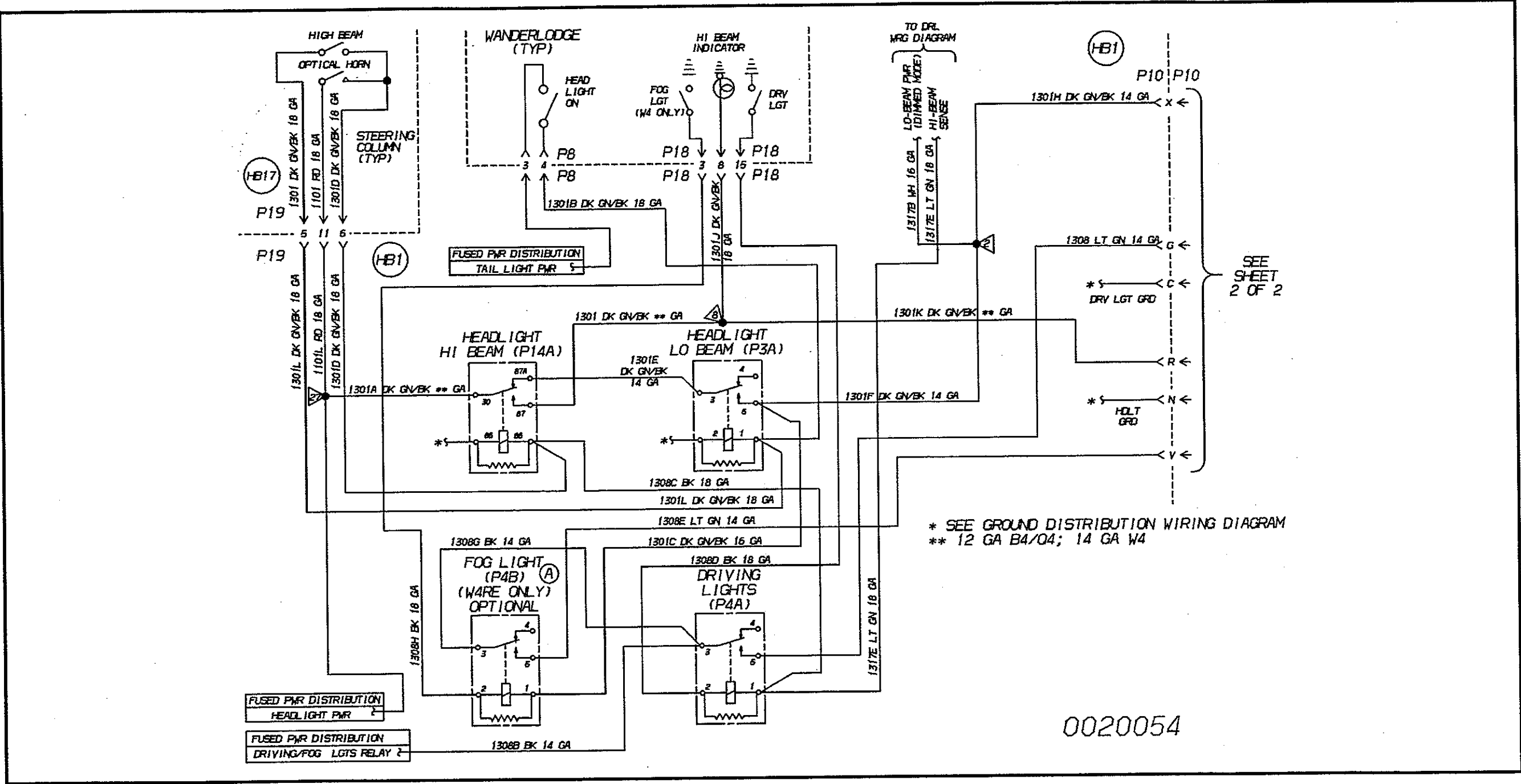
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Schematic 41—Directional Lights

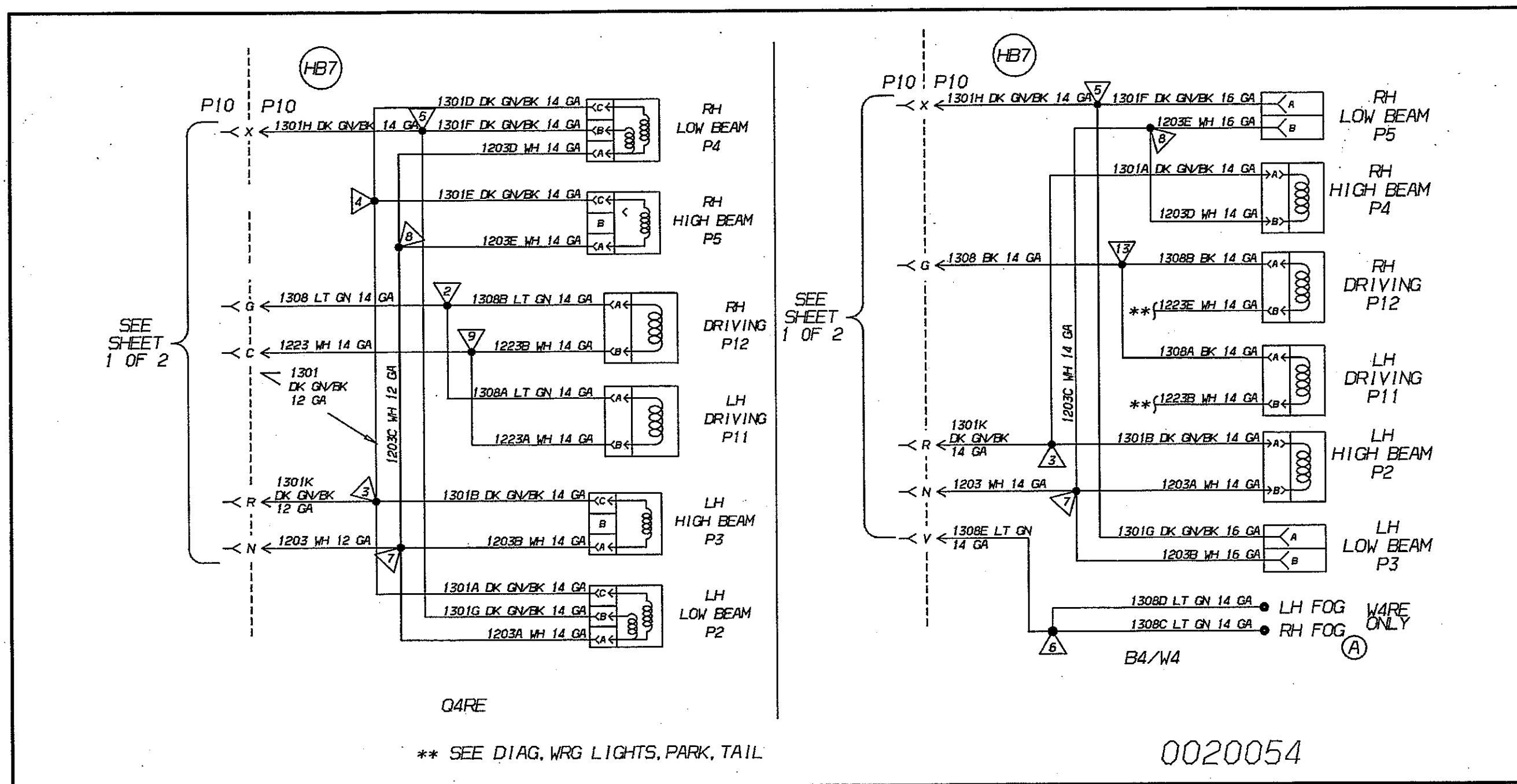


Schematic 42—ABS 6S6M System

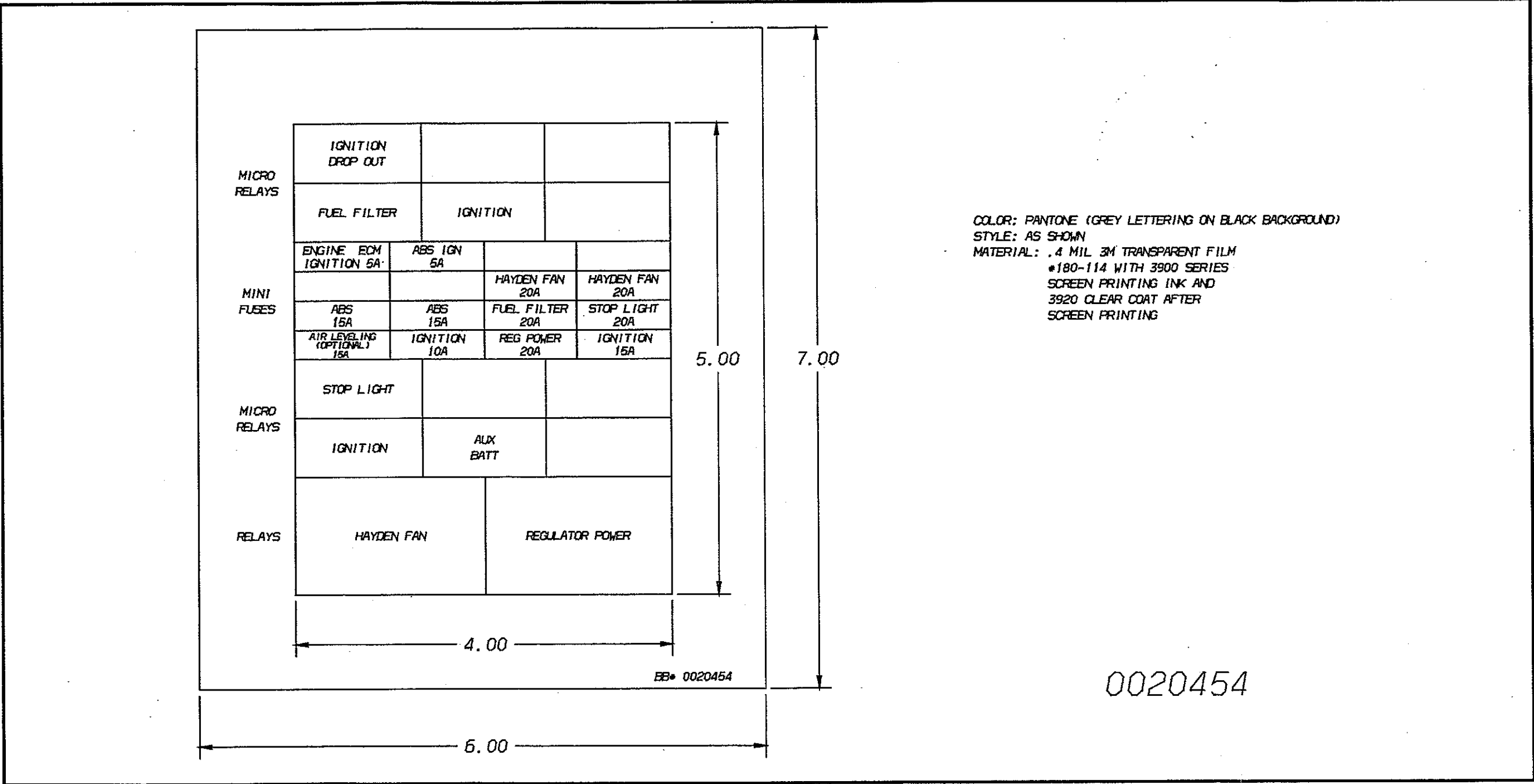




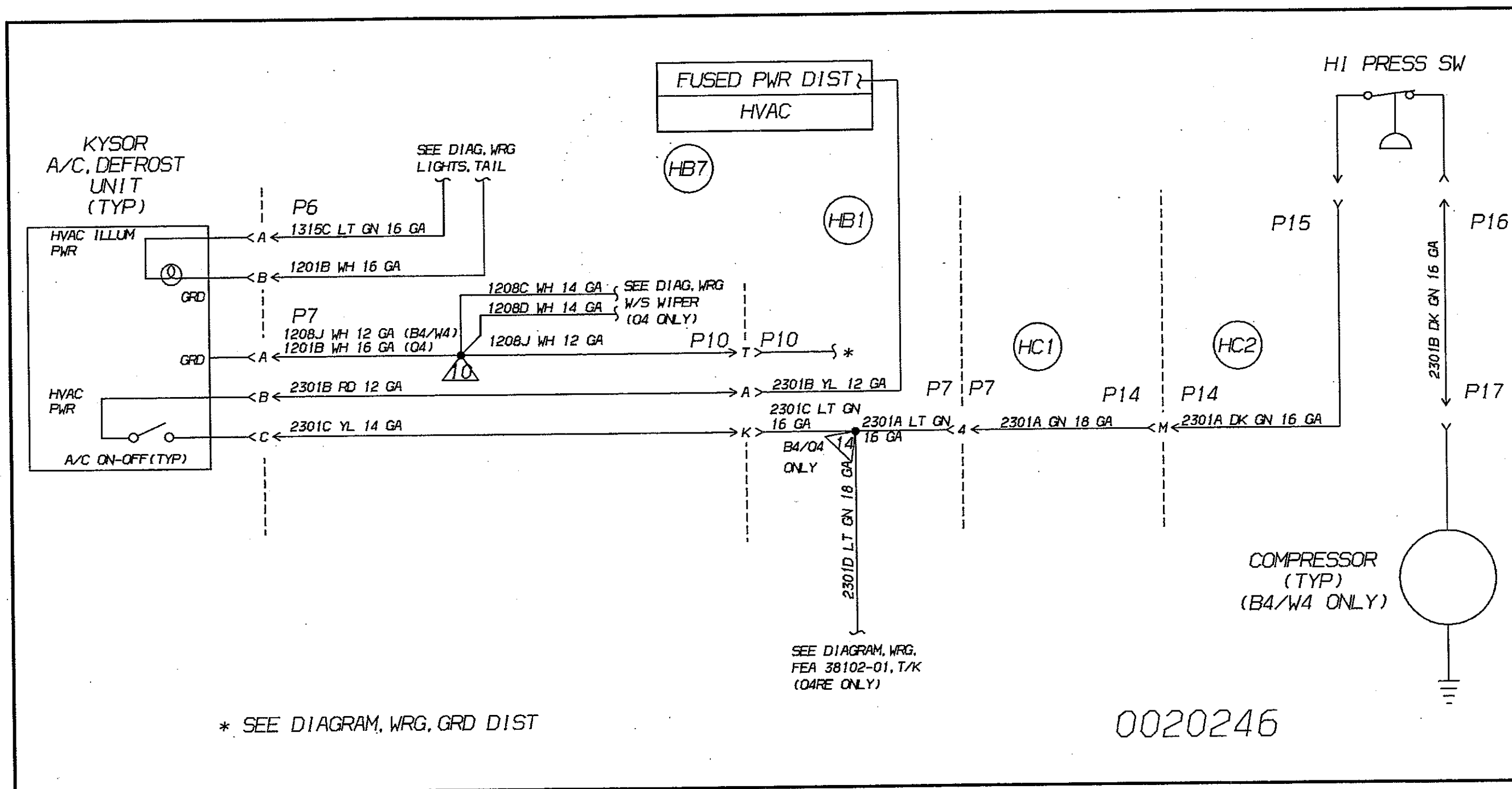
Schematic 44—Headlights and Front Driving Lights



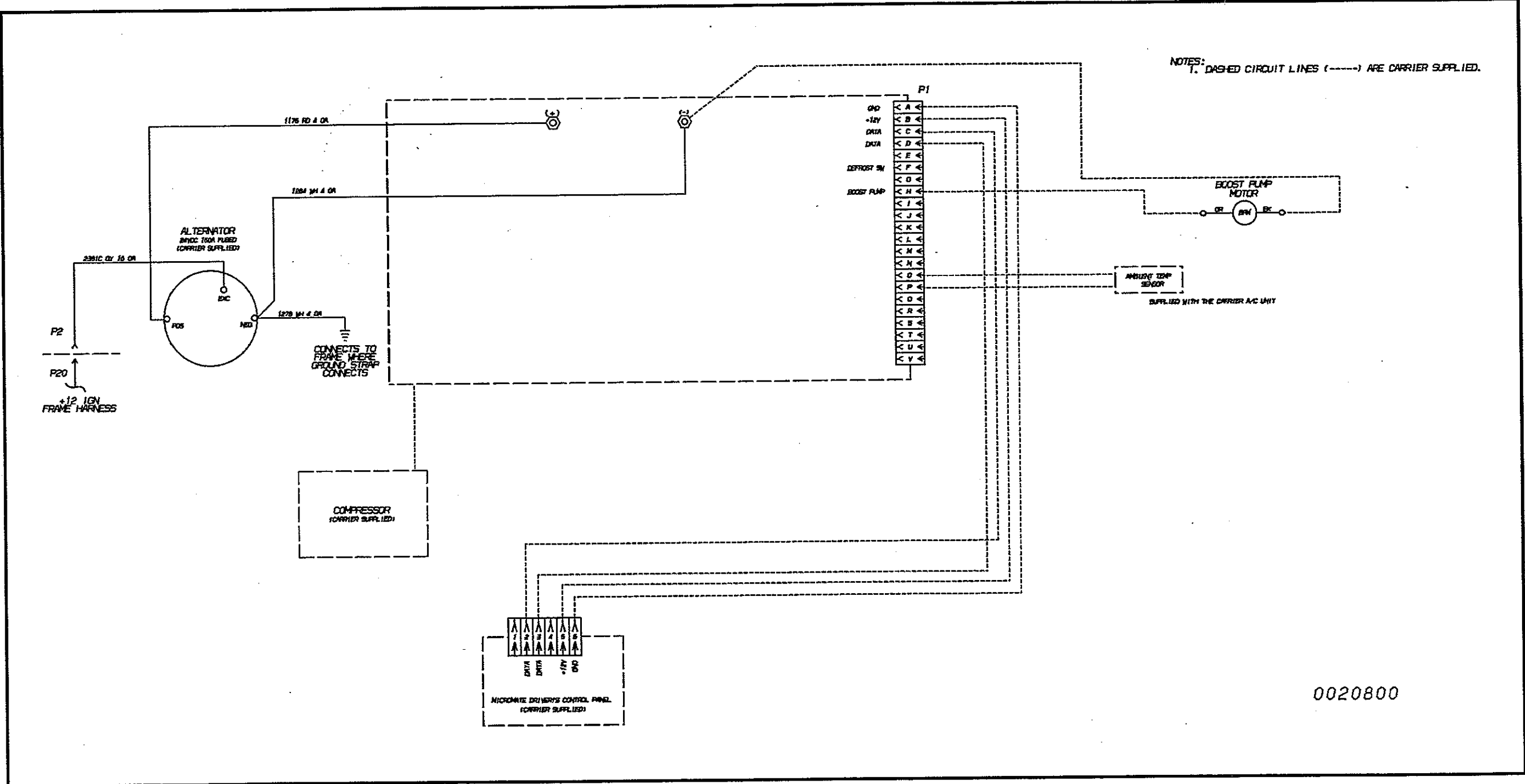
Schematic 45—Headlights and Front Driving Lights

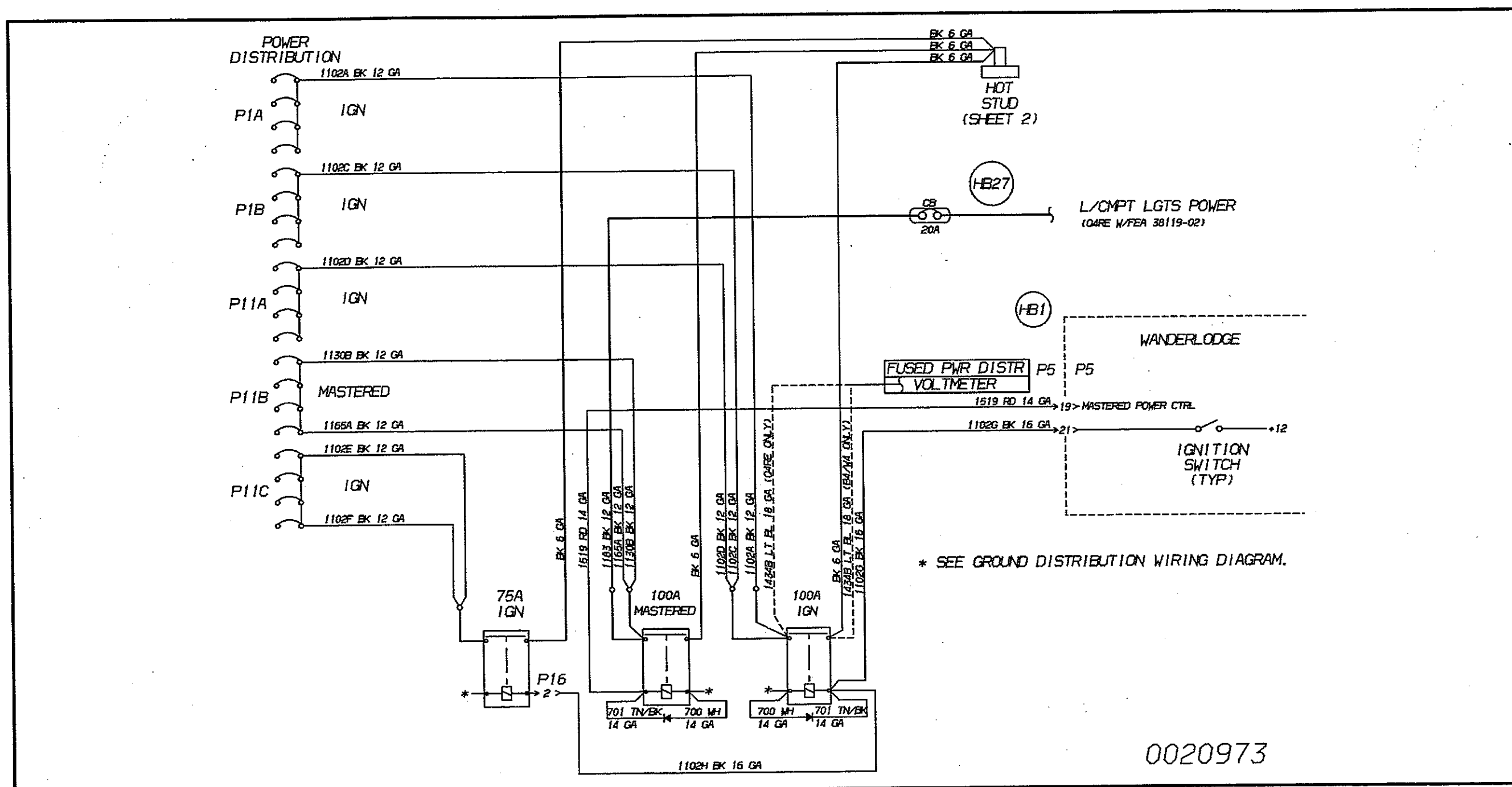


Schematic 46—Headlights and Front Driving Lights

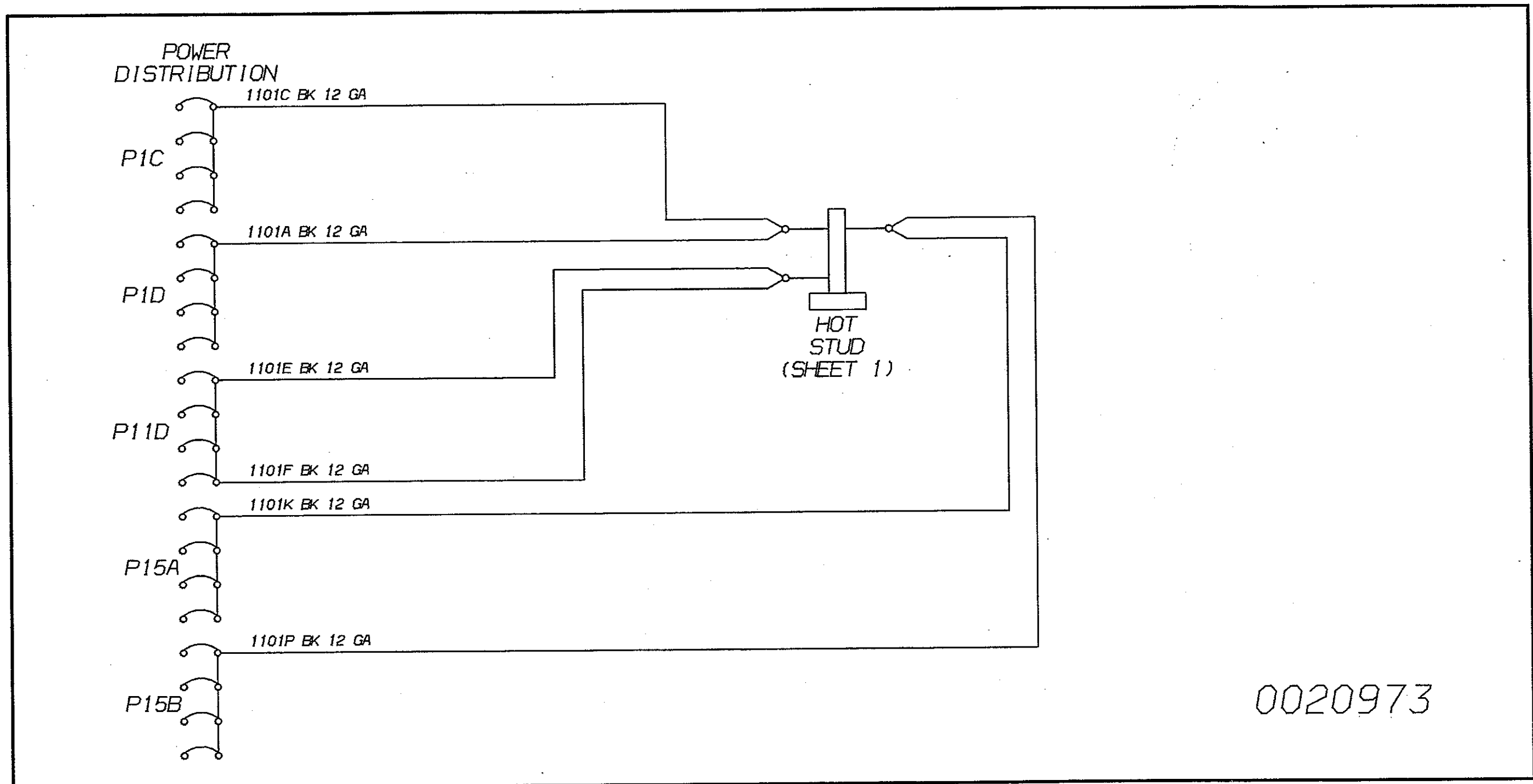


Schematic 47—Kysor® Air Condition Control

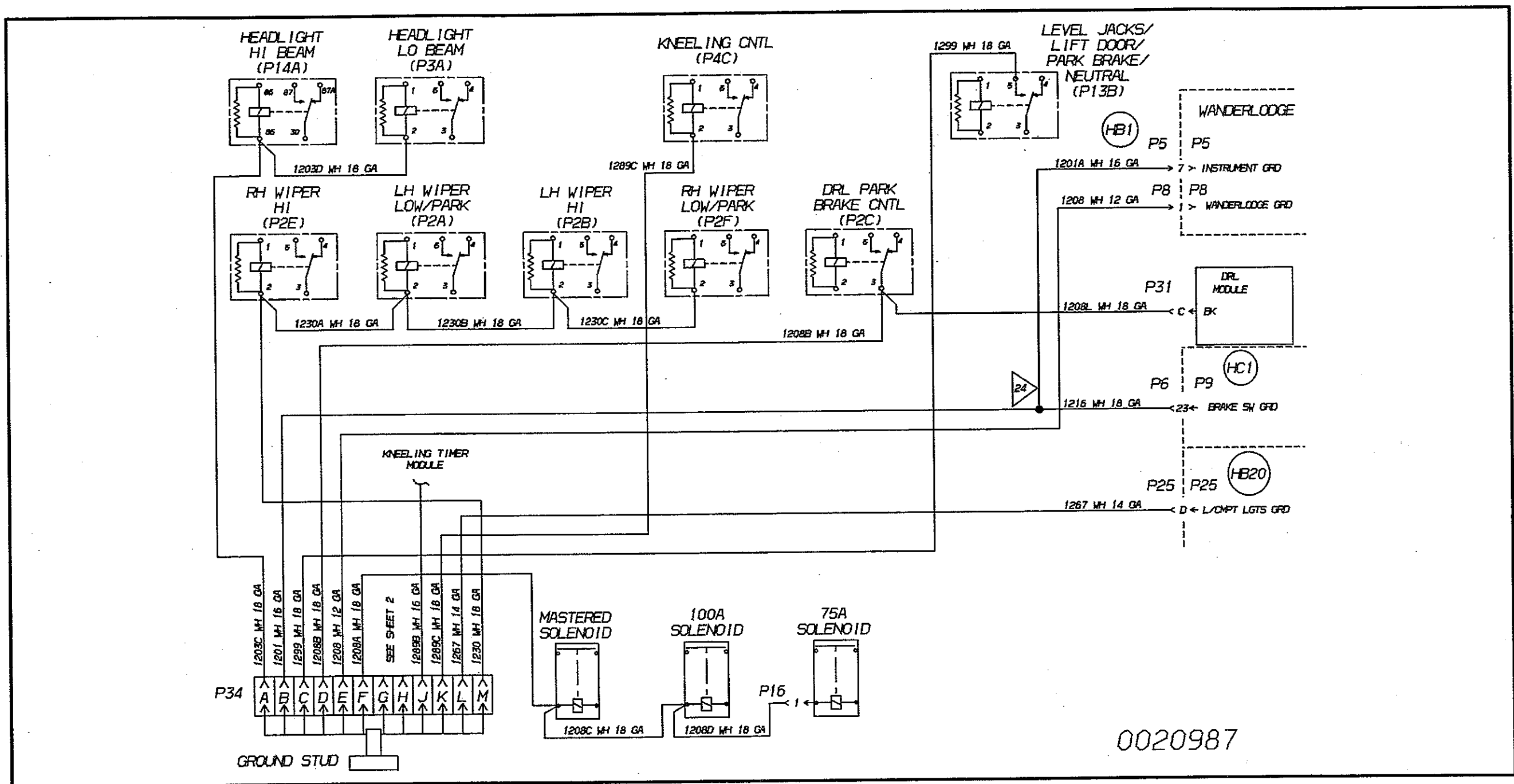




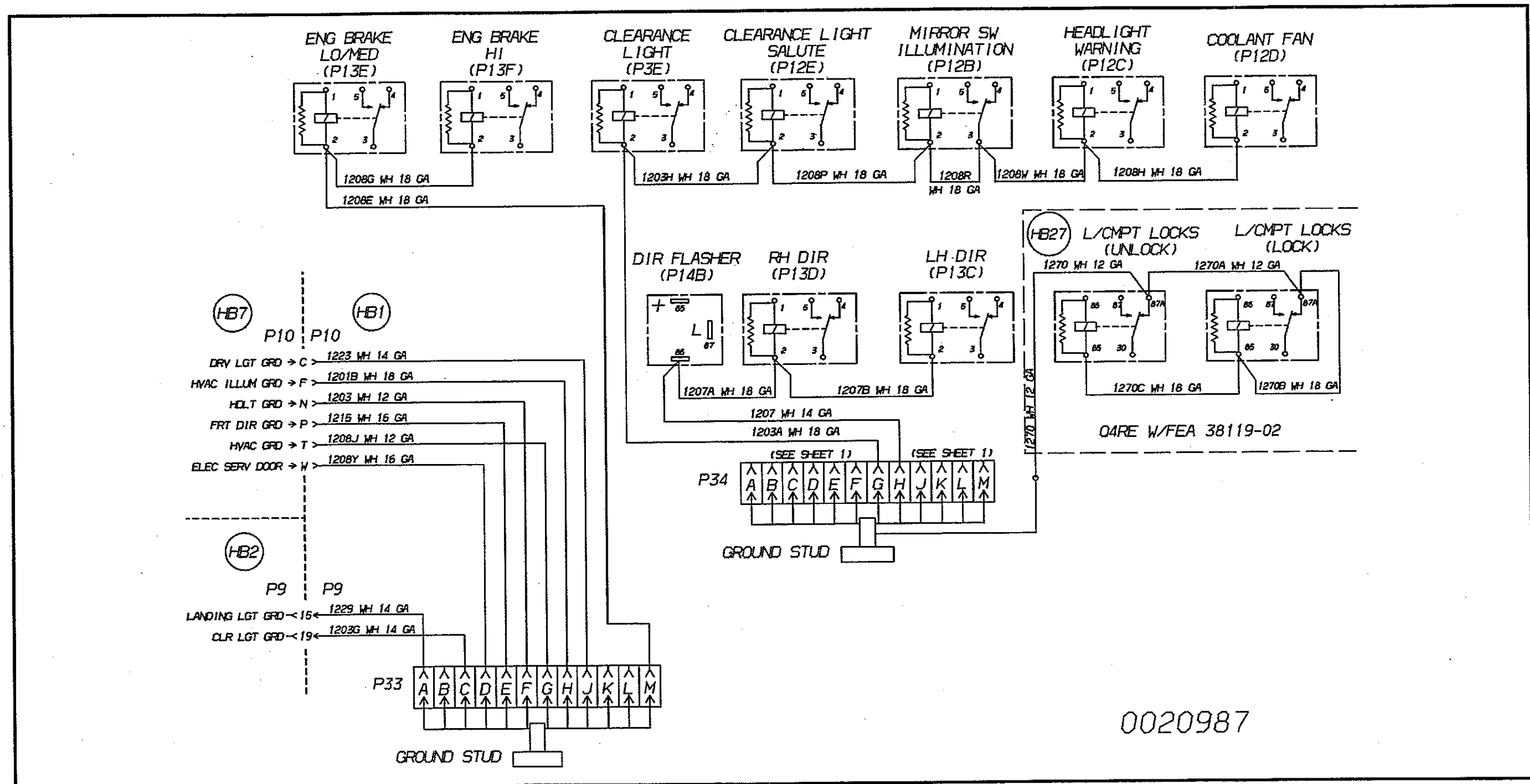
Schematic 49—Power Distribution Input



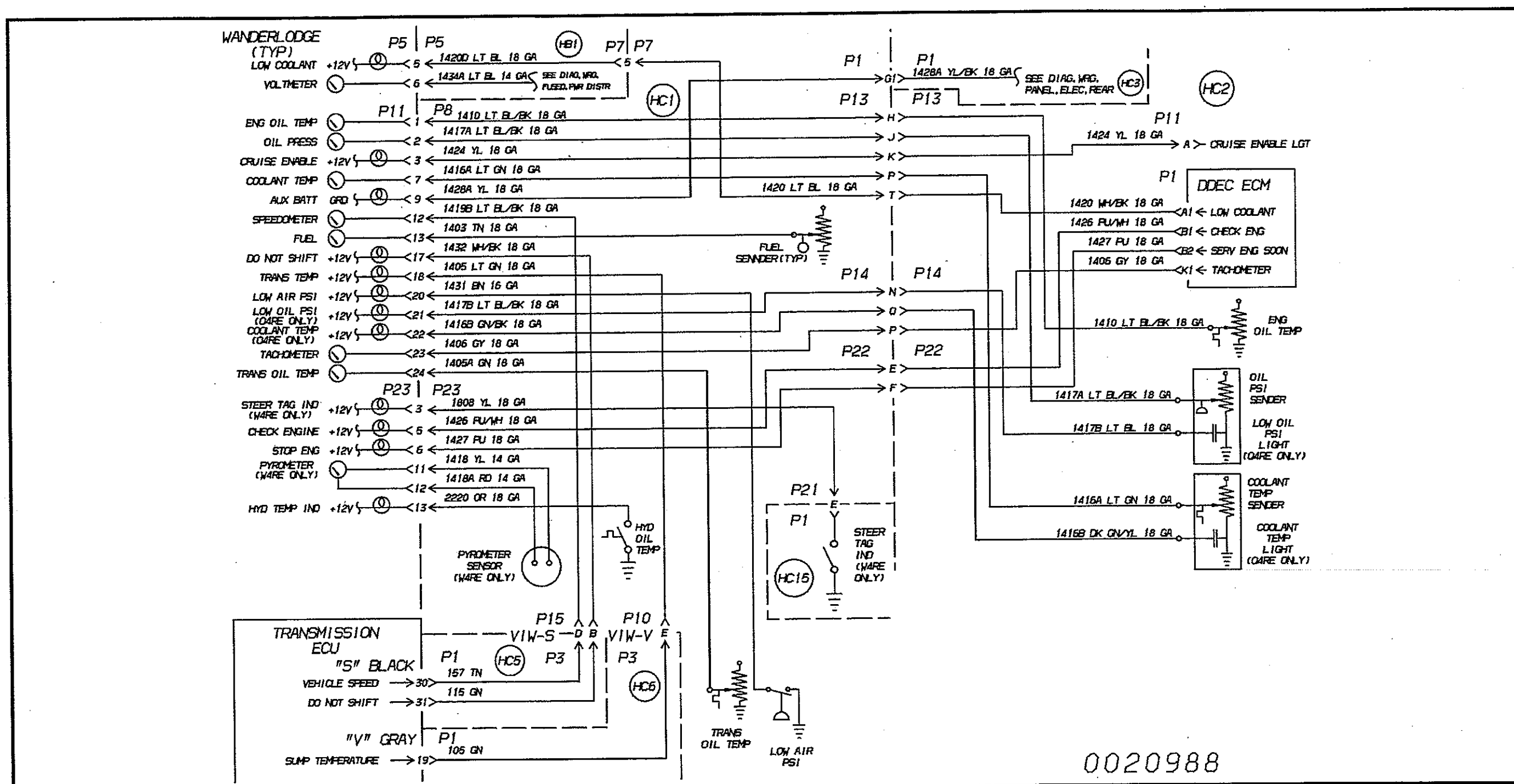
Schematic 50—Power Distribution Input



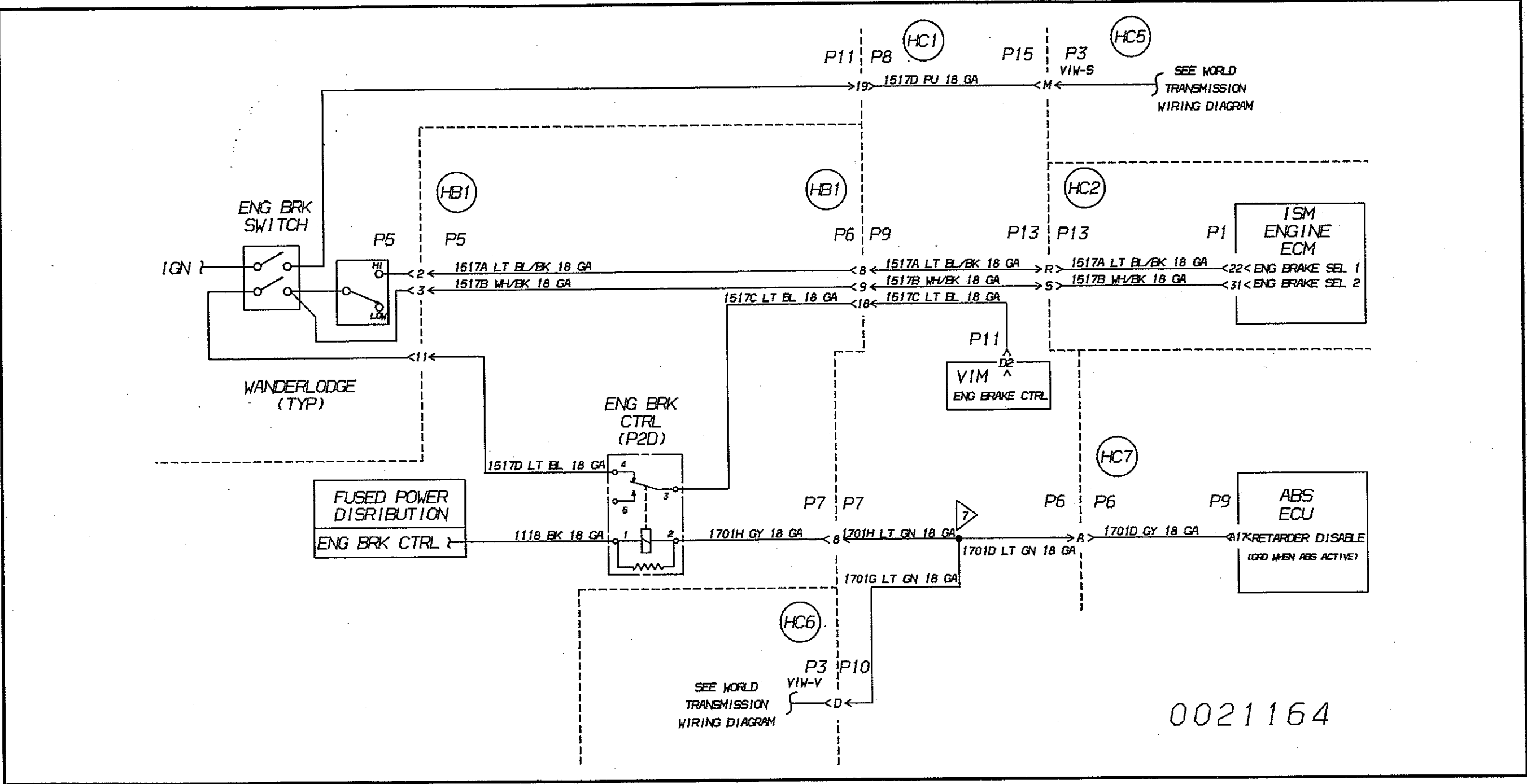
Schematic 51—Ground Distribution DDEC



Schematic 52—Ground Distribution DDEC

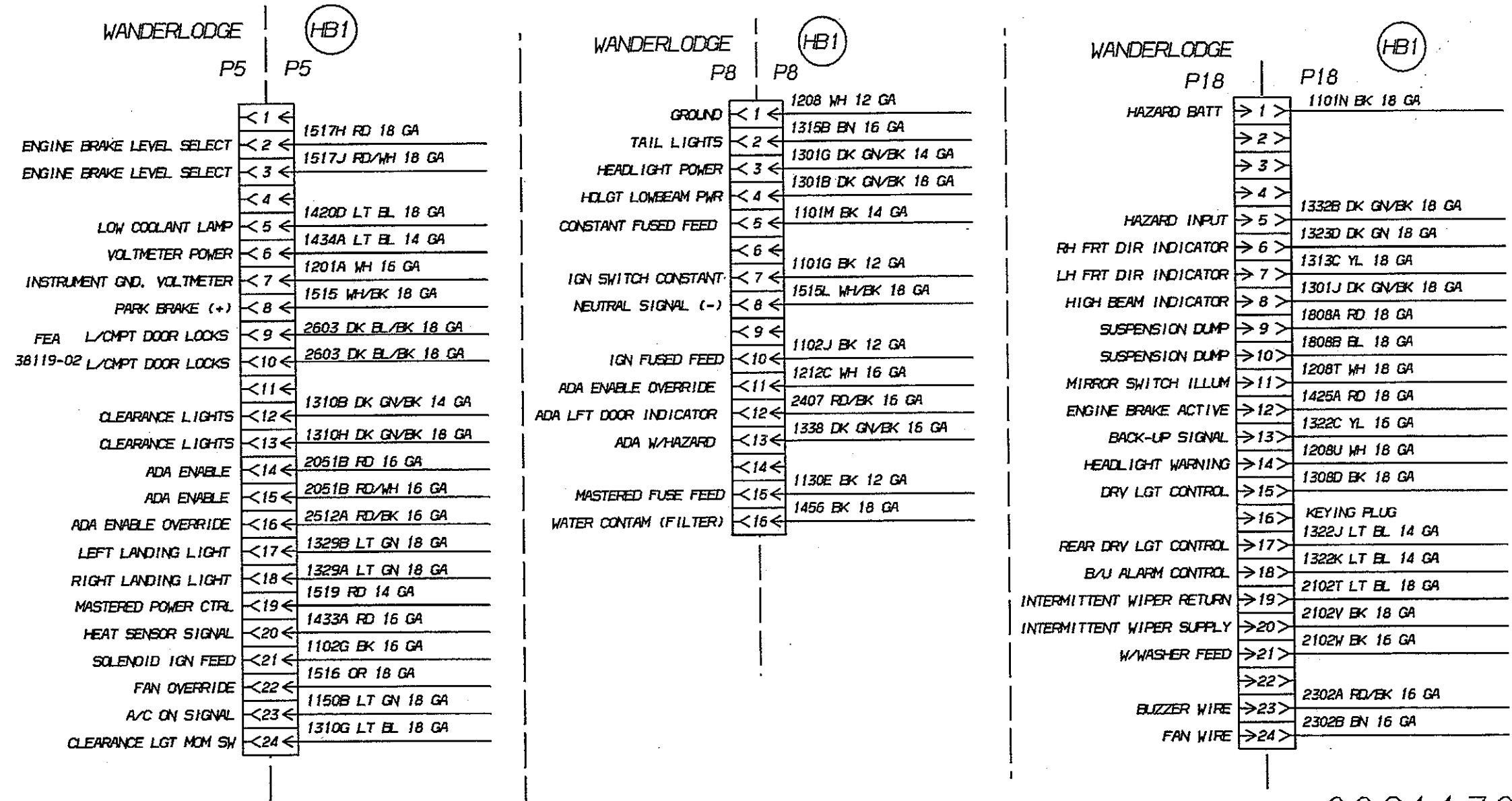


Schematic 53—Warning Light Gauges DDEC



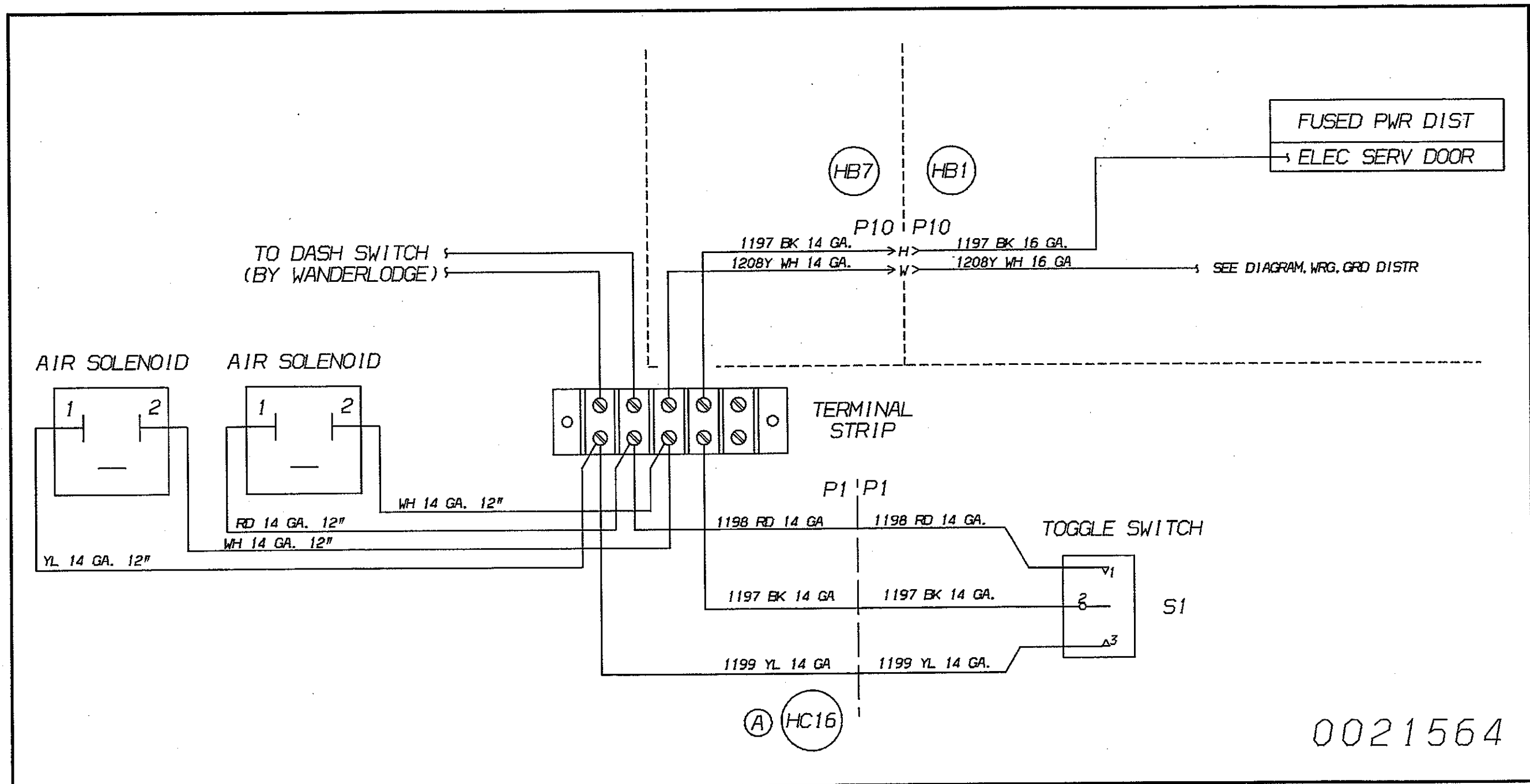
Schematic 54—Engine Brake Control Cummins

BODY INTERFACE IN FRONT ELECTRICAL PANEL

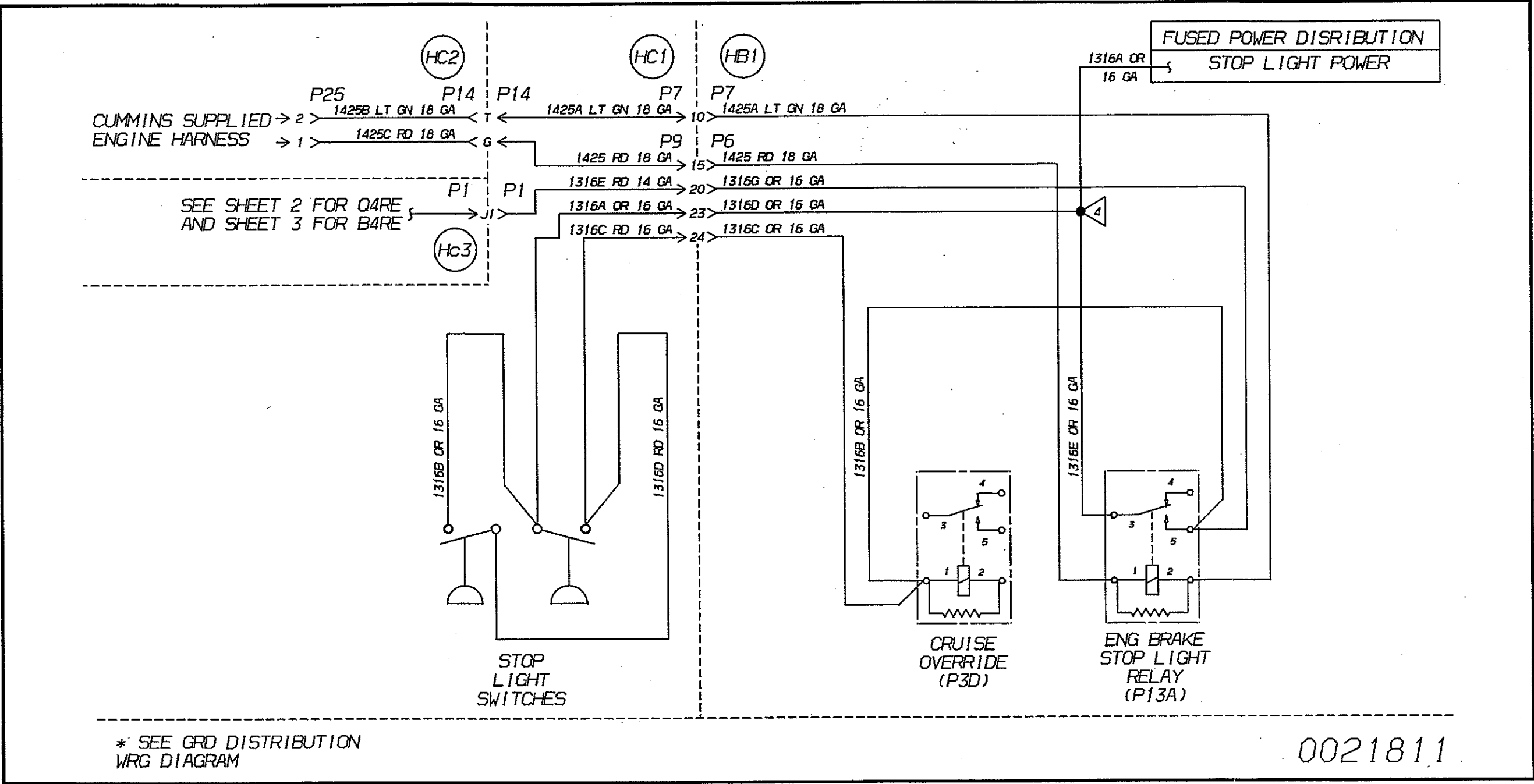


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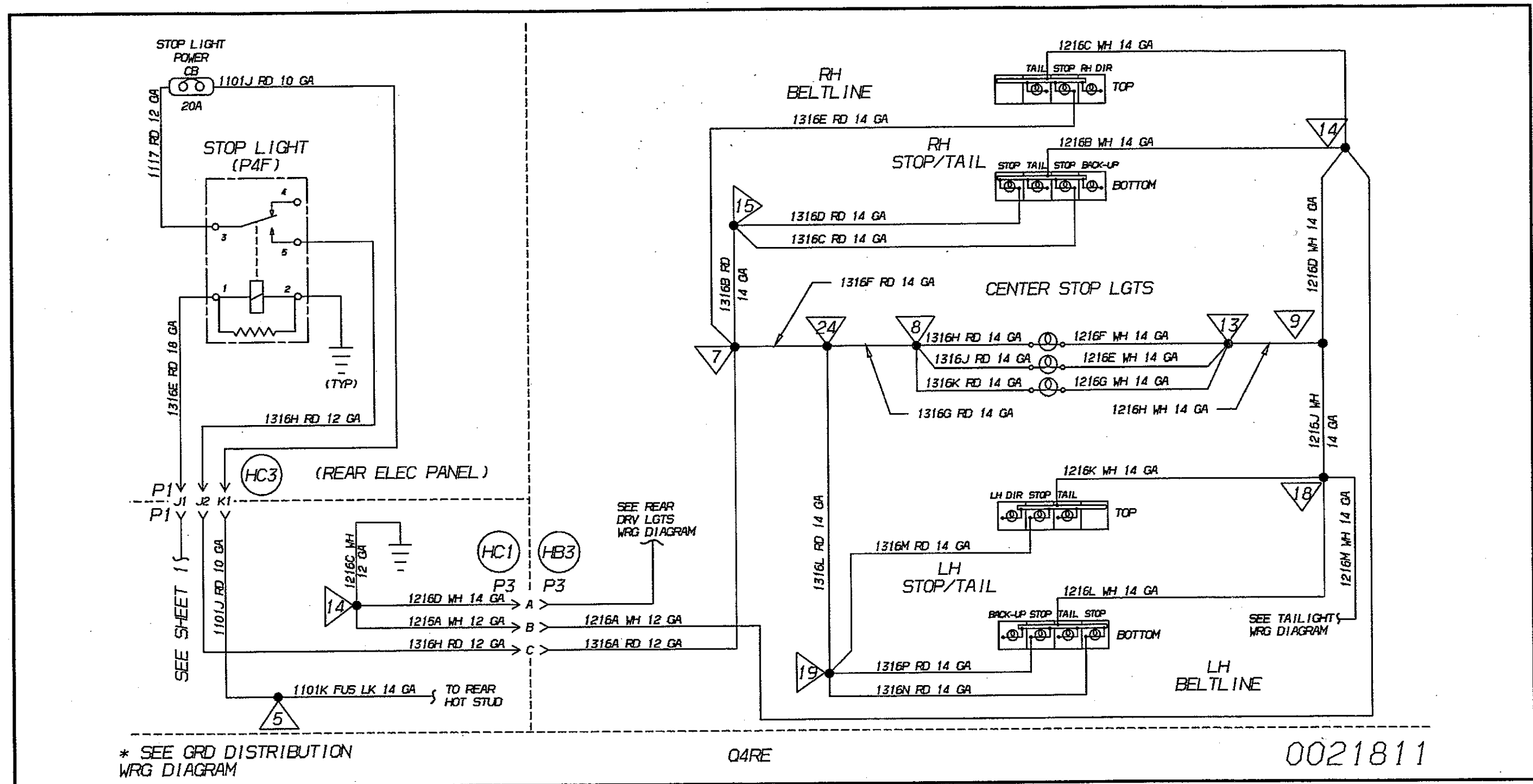
Schematic 55—Wanderlodge Interface DDEC



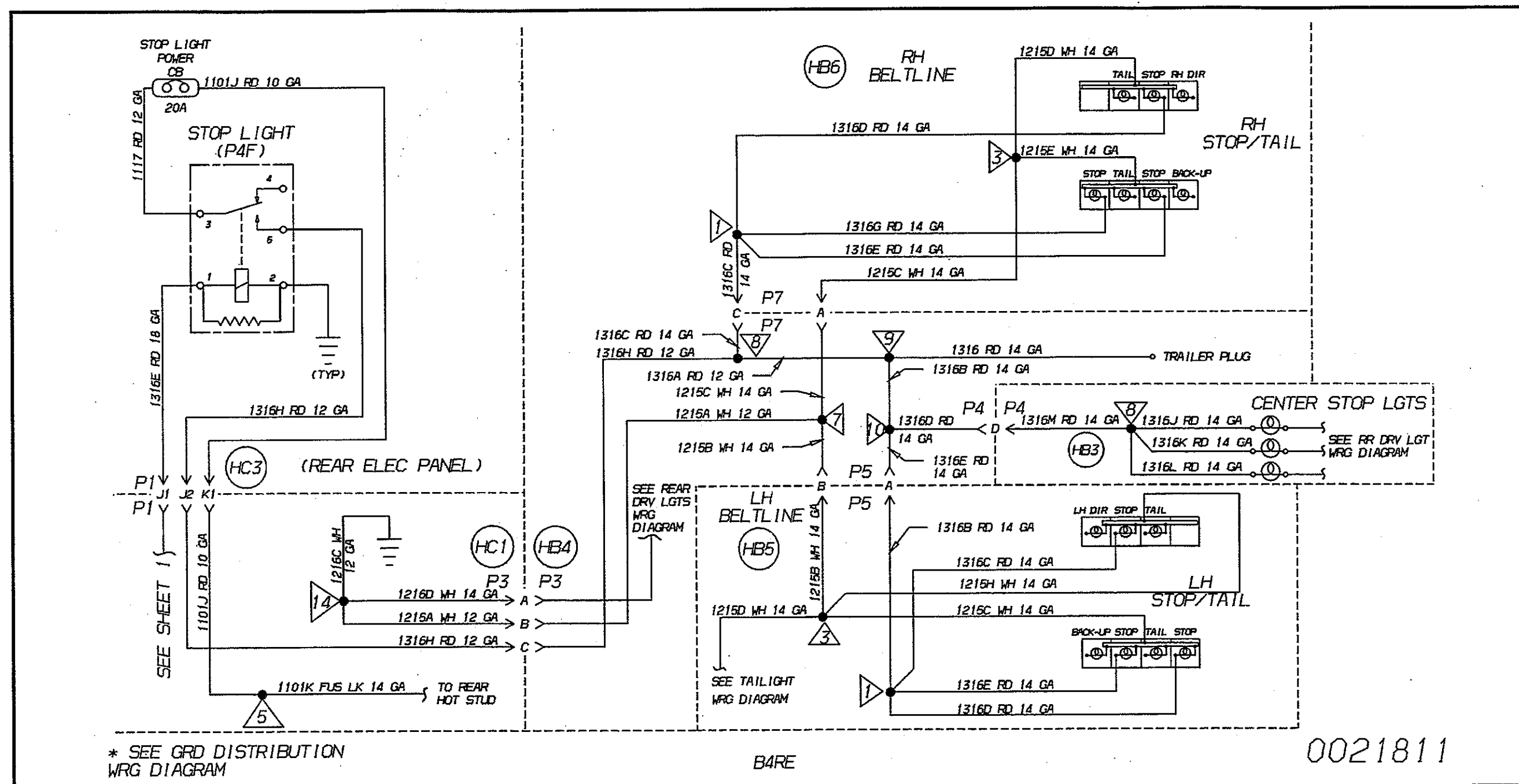
Schematic 56—Service Door



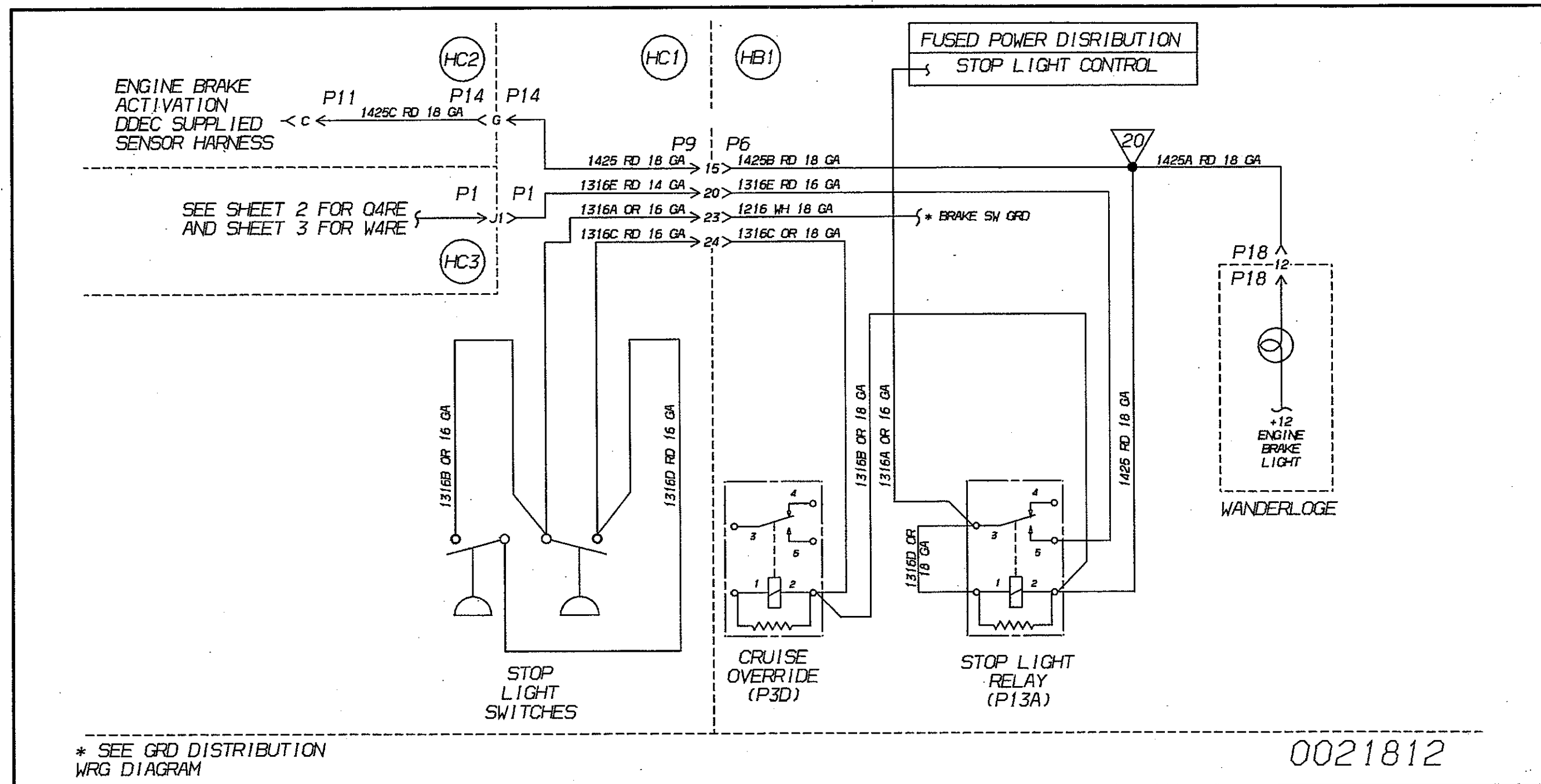
Schematic 57—Stop Lights Cummins



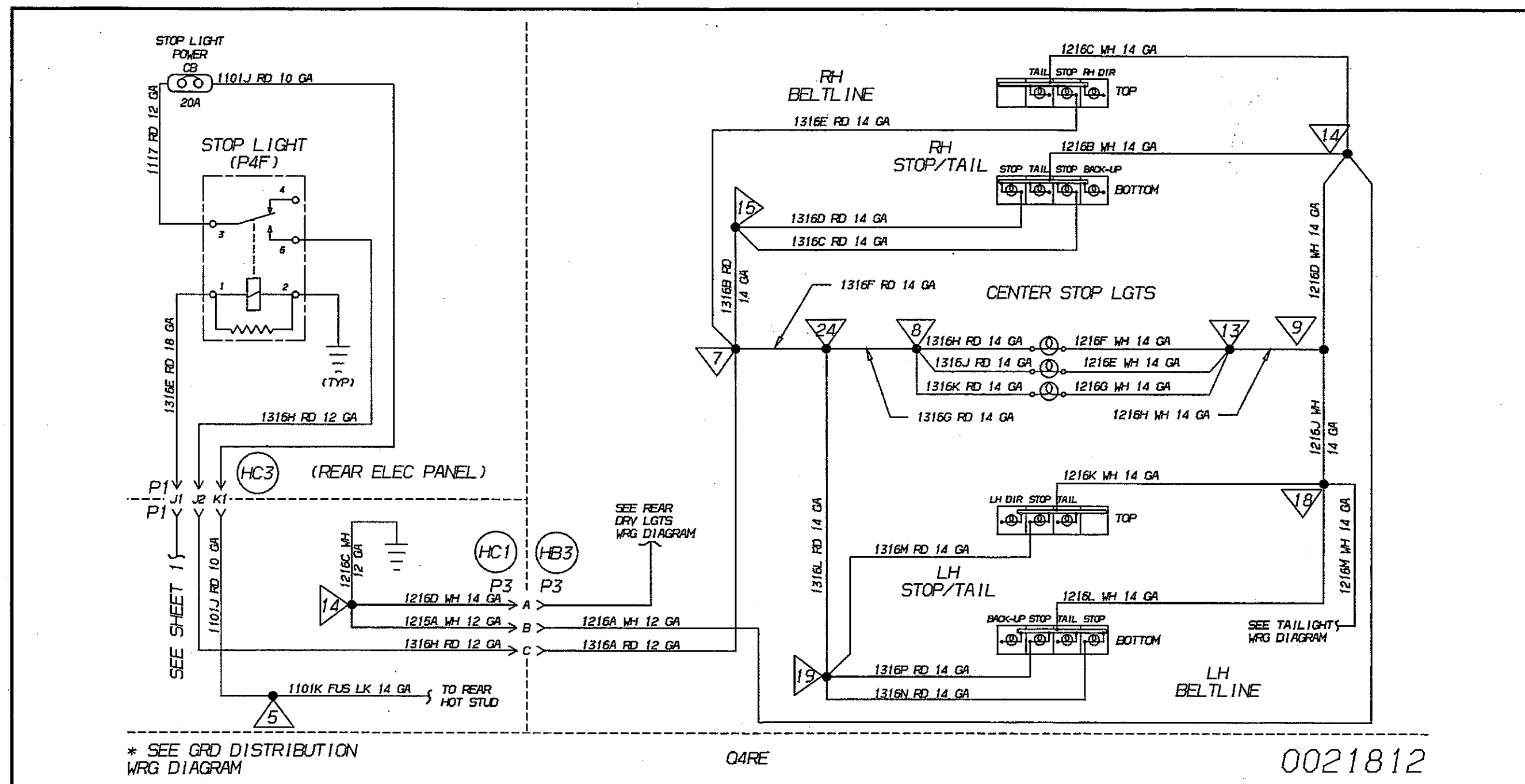
Schematic 58—Stop Lights Cummins



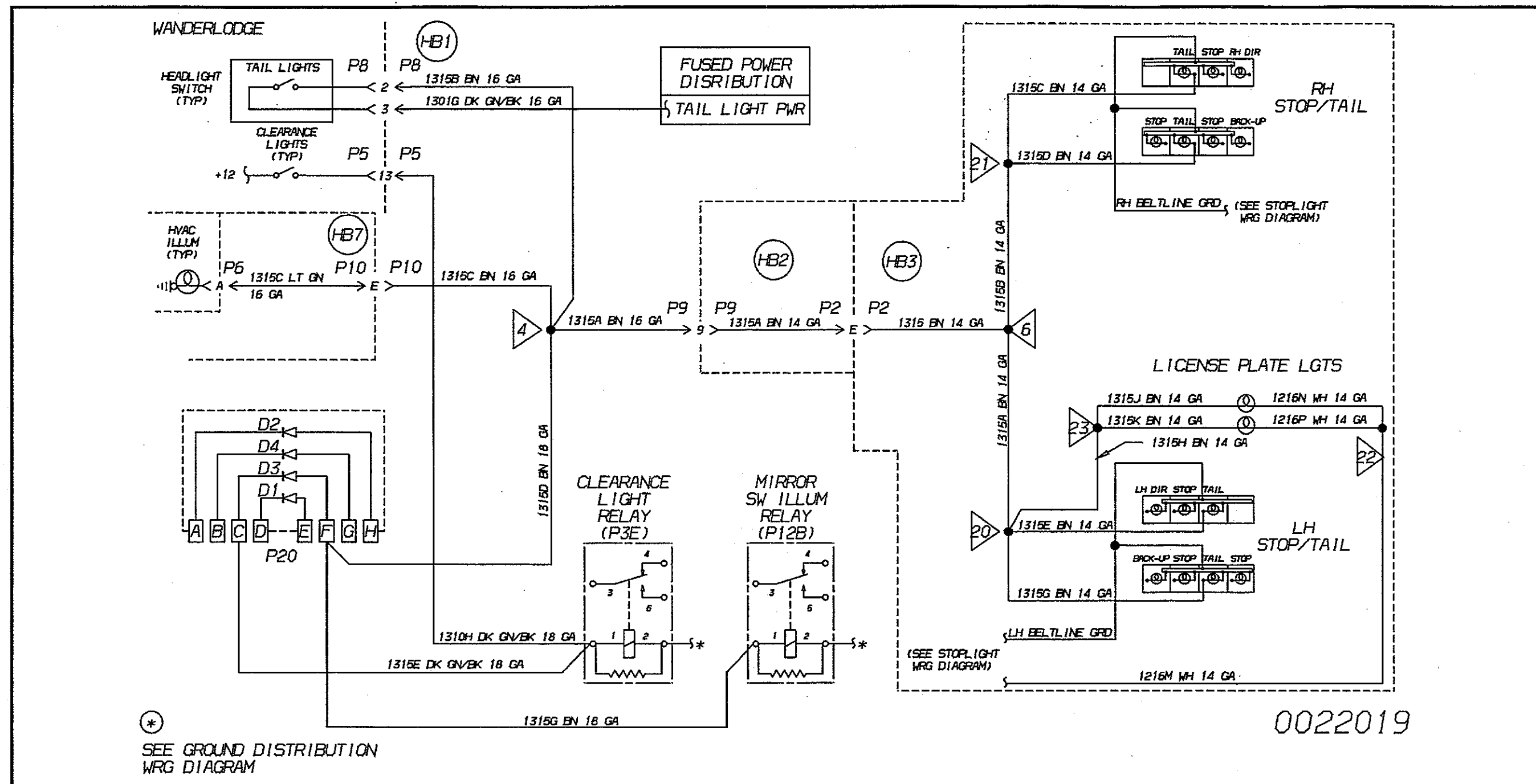
Schematic 59—Stop Lights Cummins



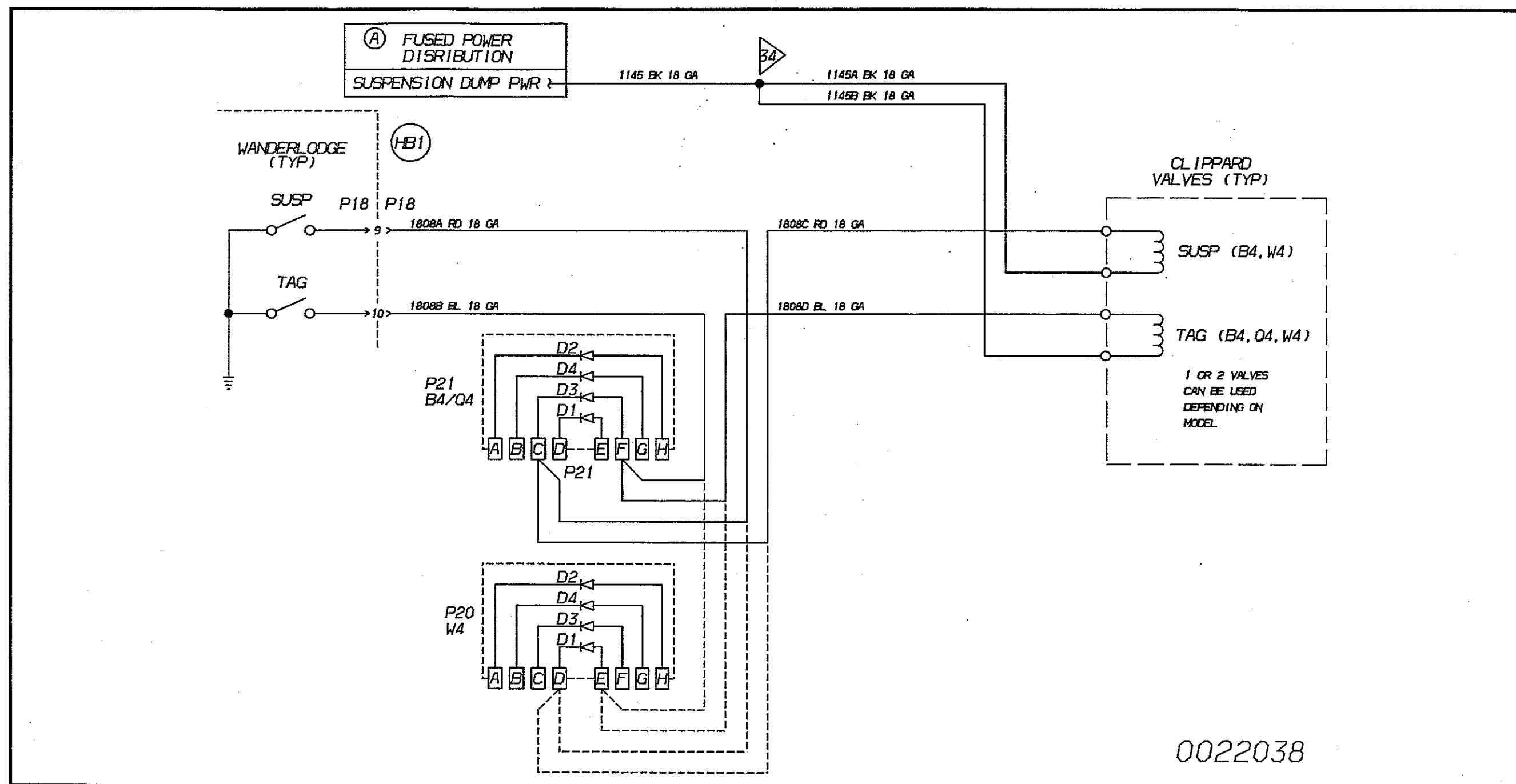
Schematic 60—Stop Lights DDEC



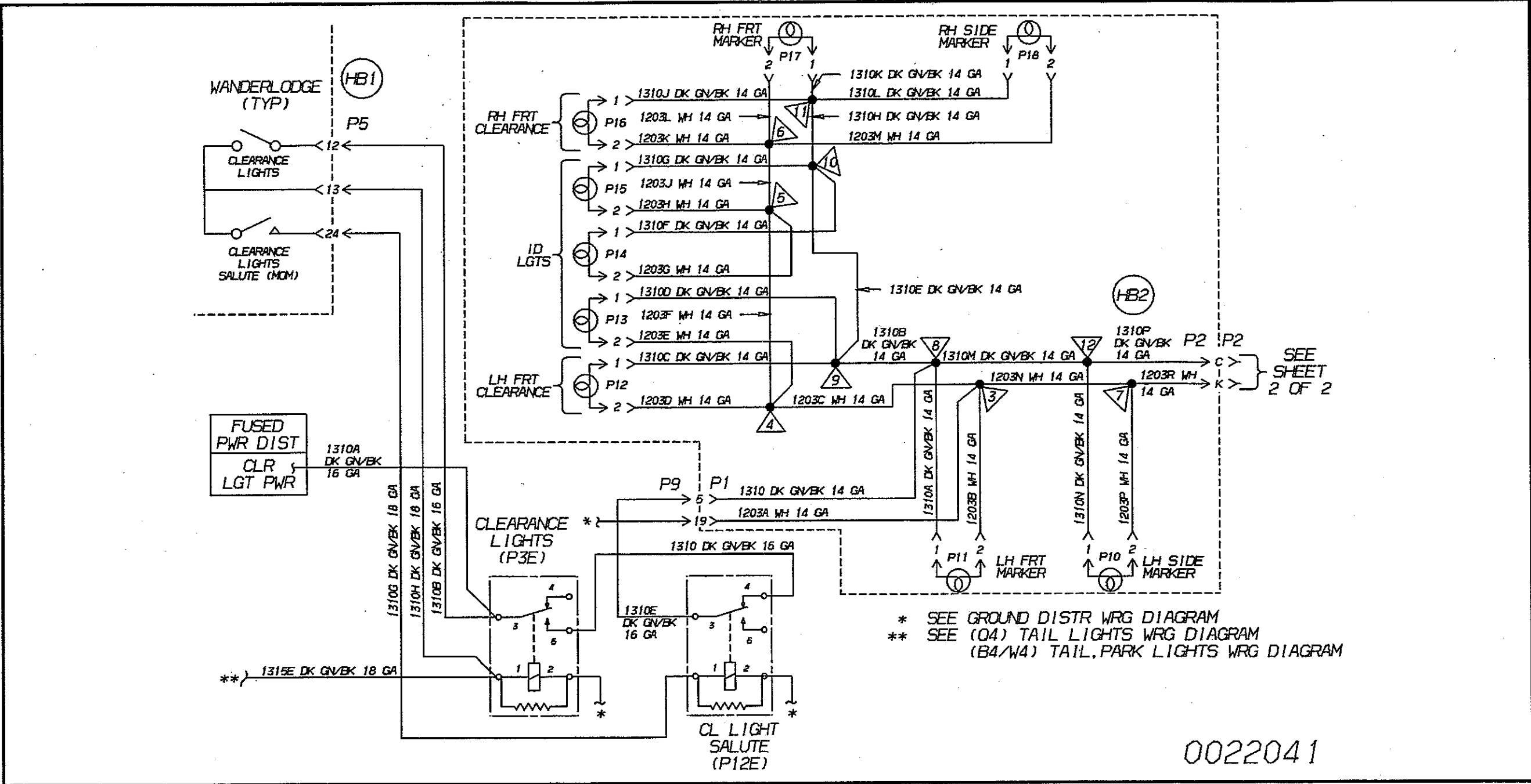
Schematic 61—Stop Lights DDEC



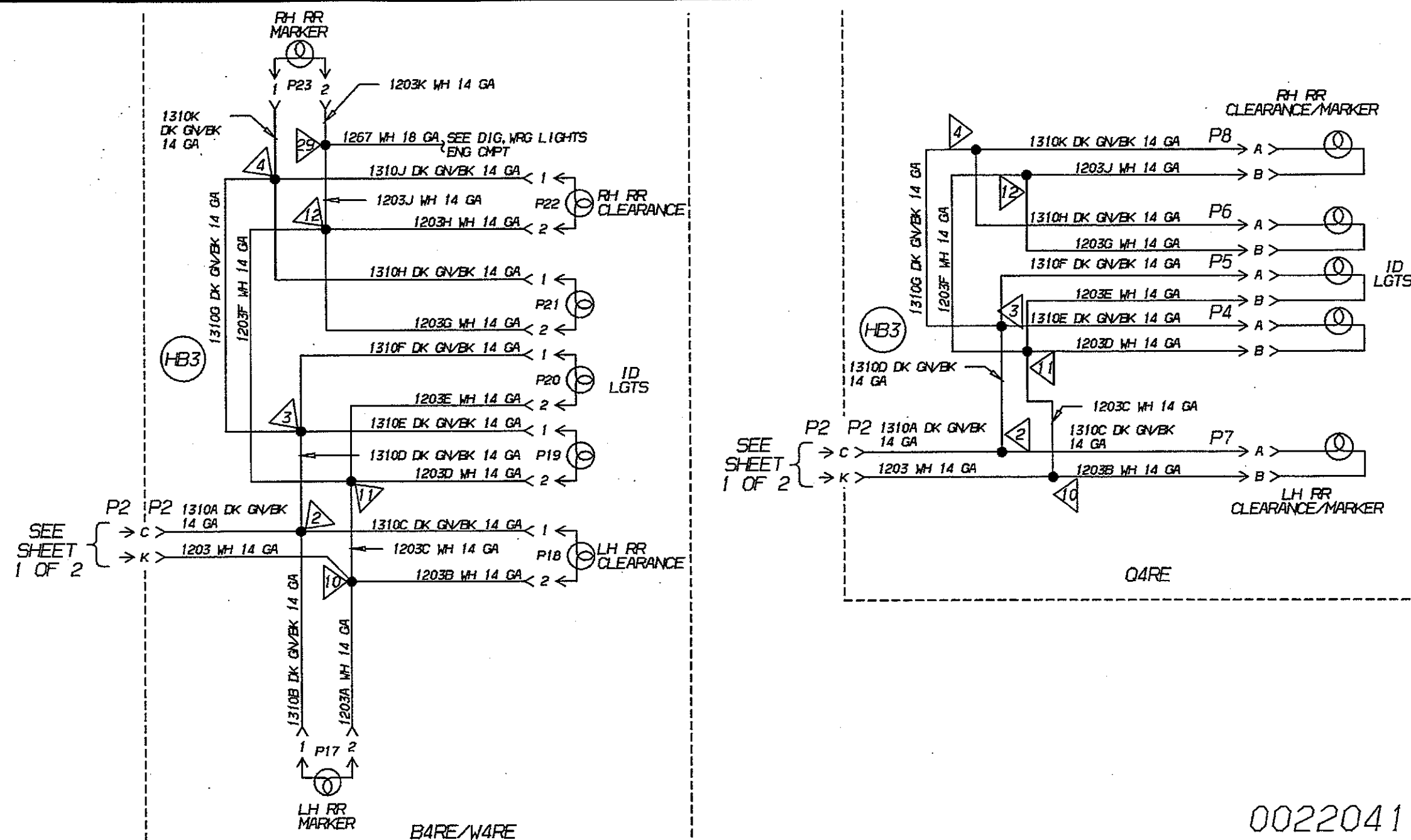
Schematic 62—Tail Lights



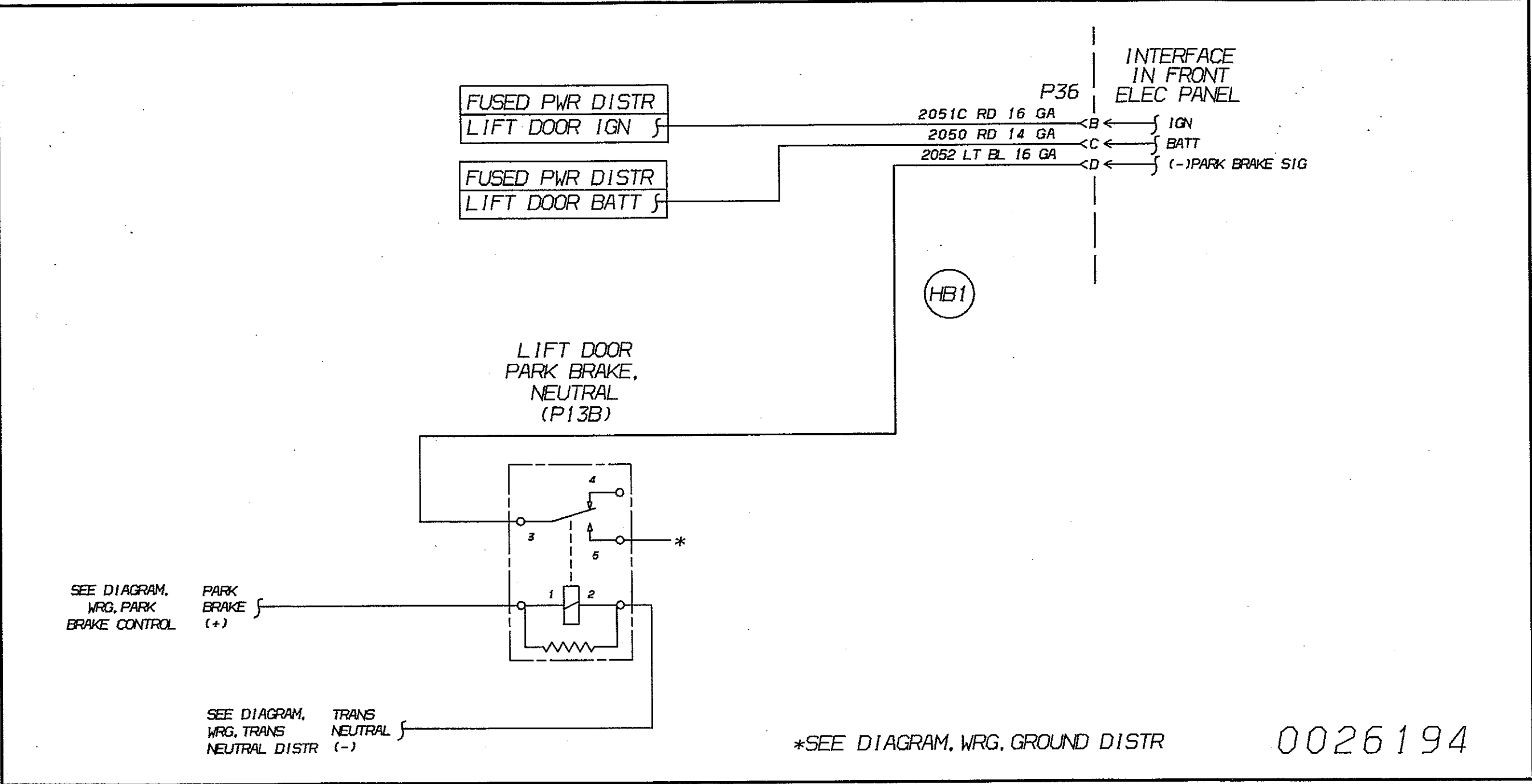
Schematic 63—Suspension Dump



Schematic 64—Marker Lights

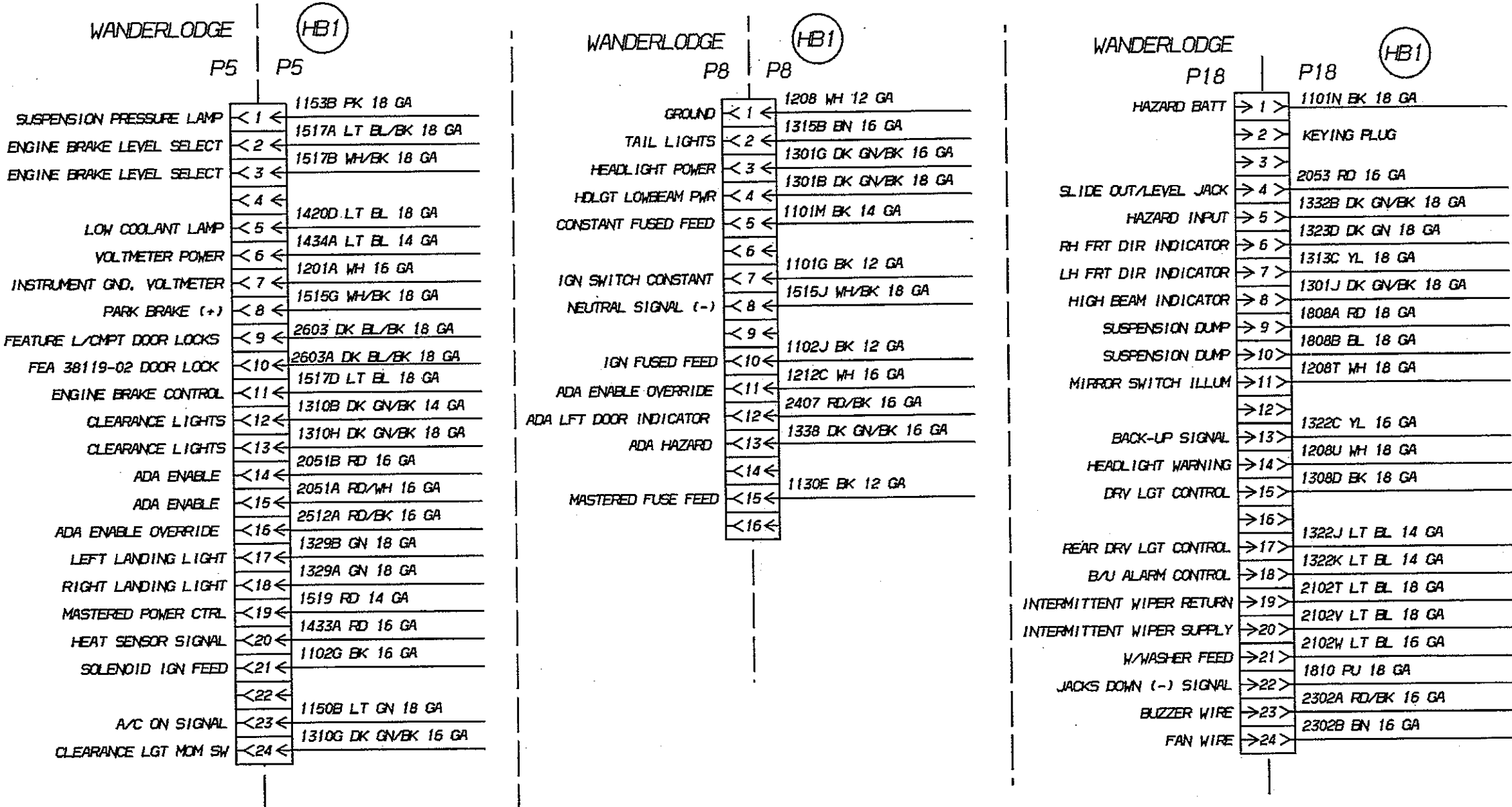


Schematic 65—Marker Lights



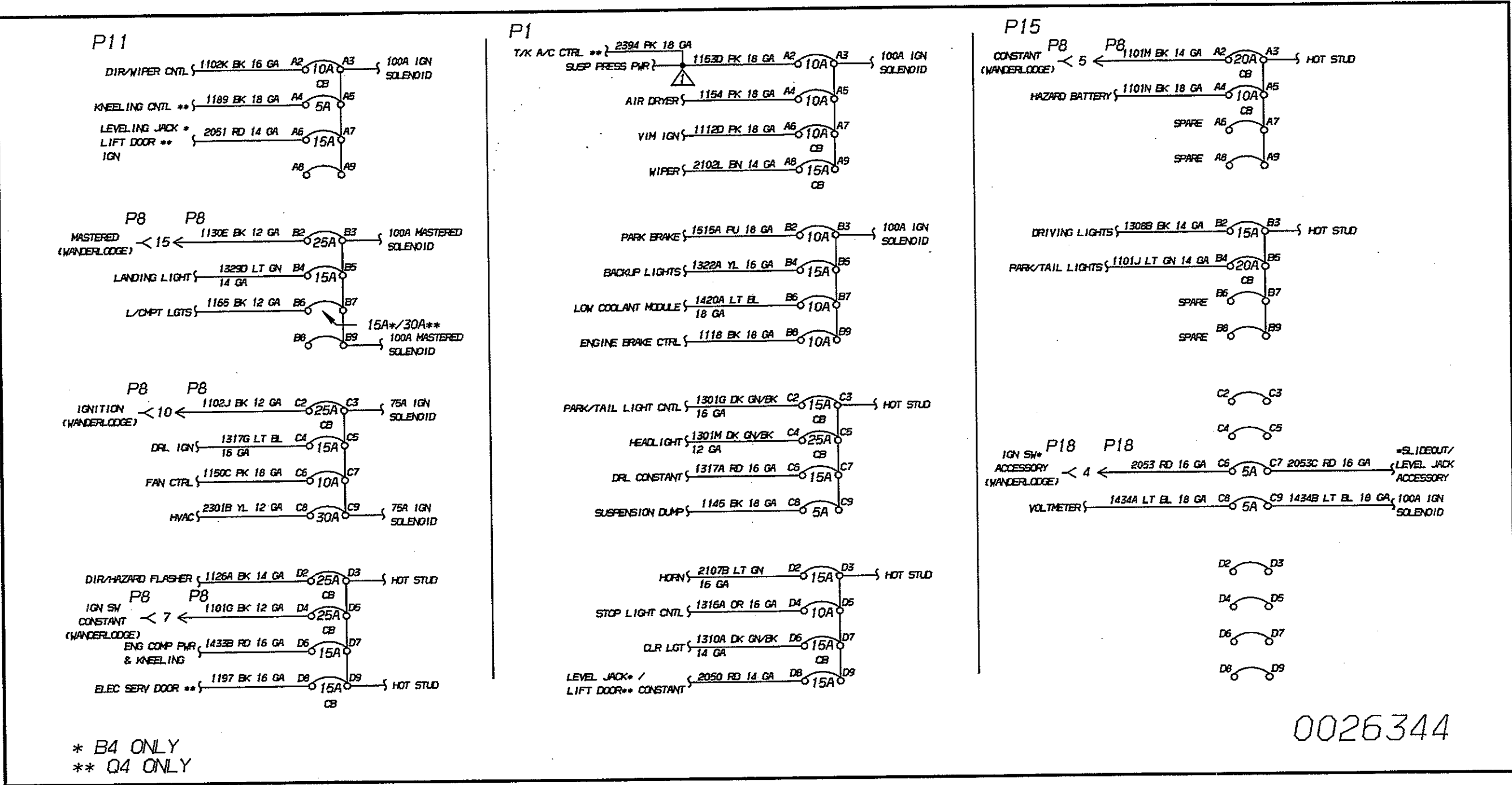
Schematic 66—Interlock Power/Lift Door

BODY INTERFACE IN FRONT ELECTRICAL PANEL

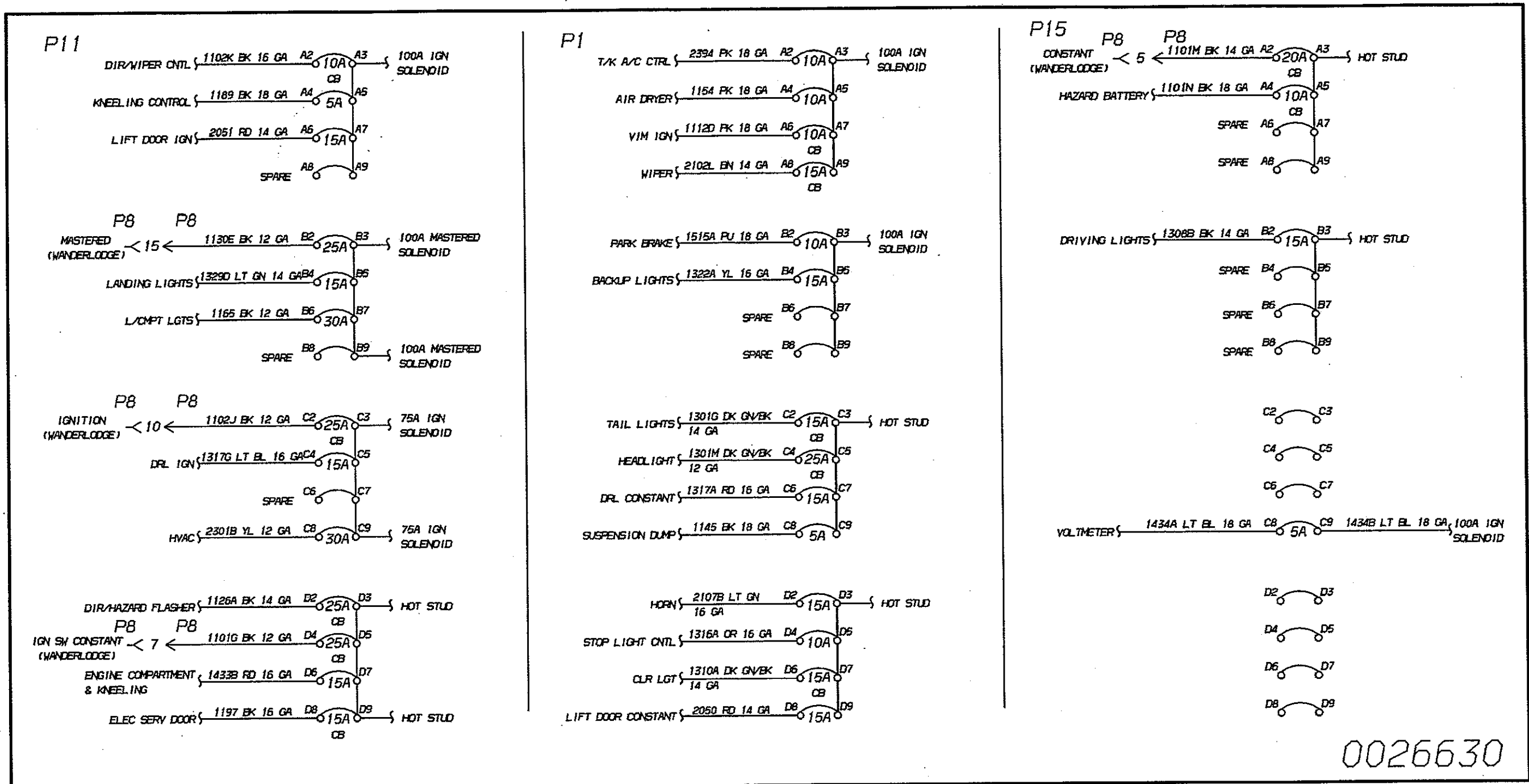


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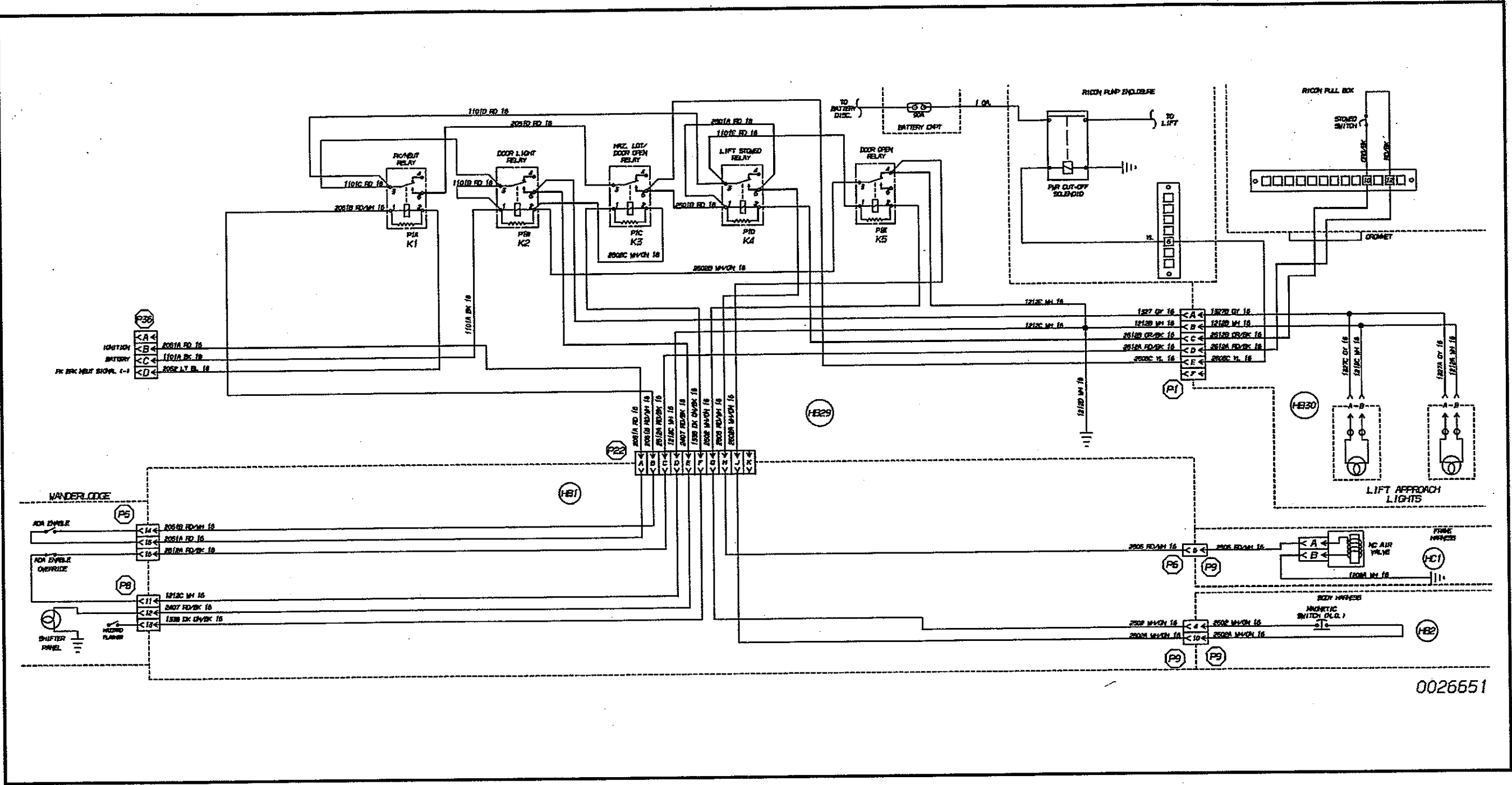
Schematic 67—Body Interface Front Electrical Panel



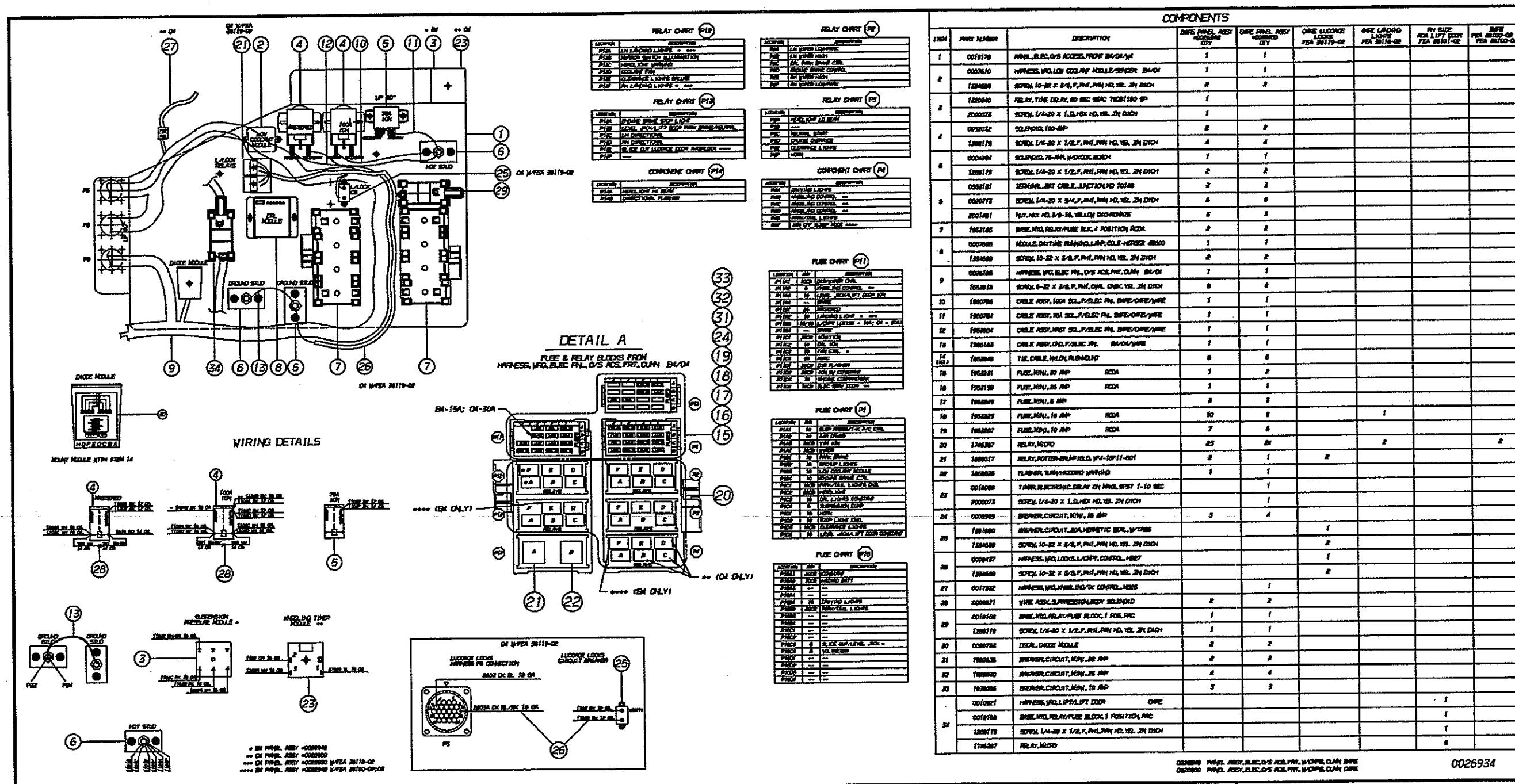
Schematic 68—DDEC Fused Power Distribution



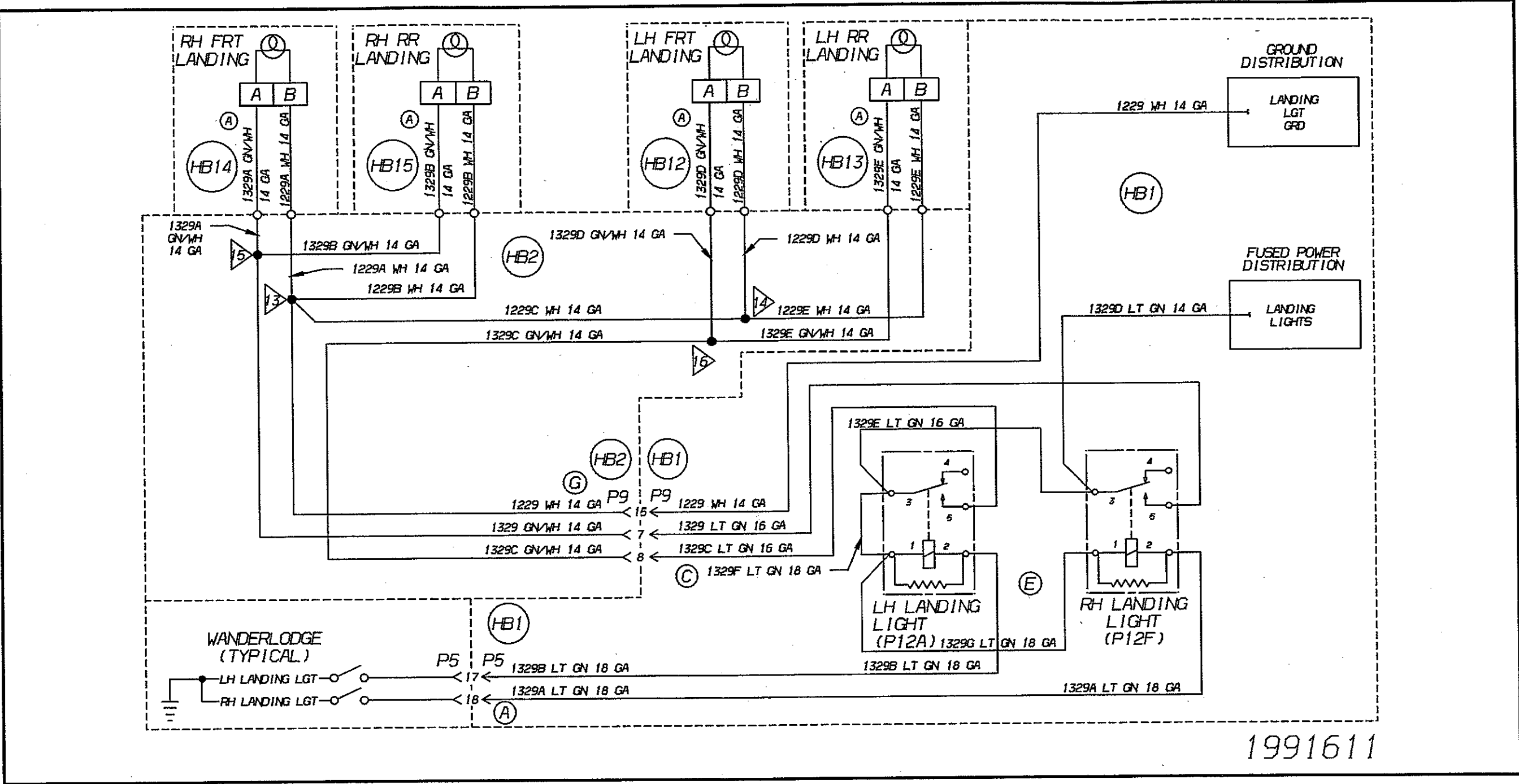
Schematic 69—DDEC Fused Power Distribution



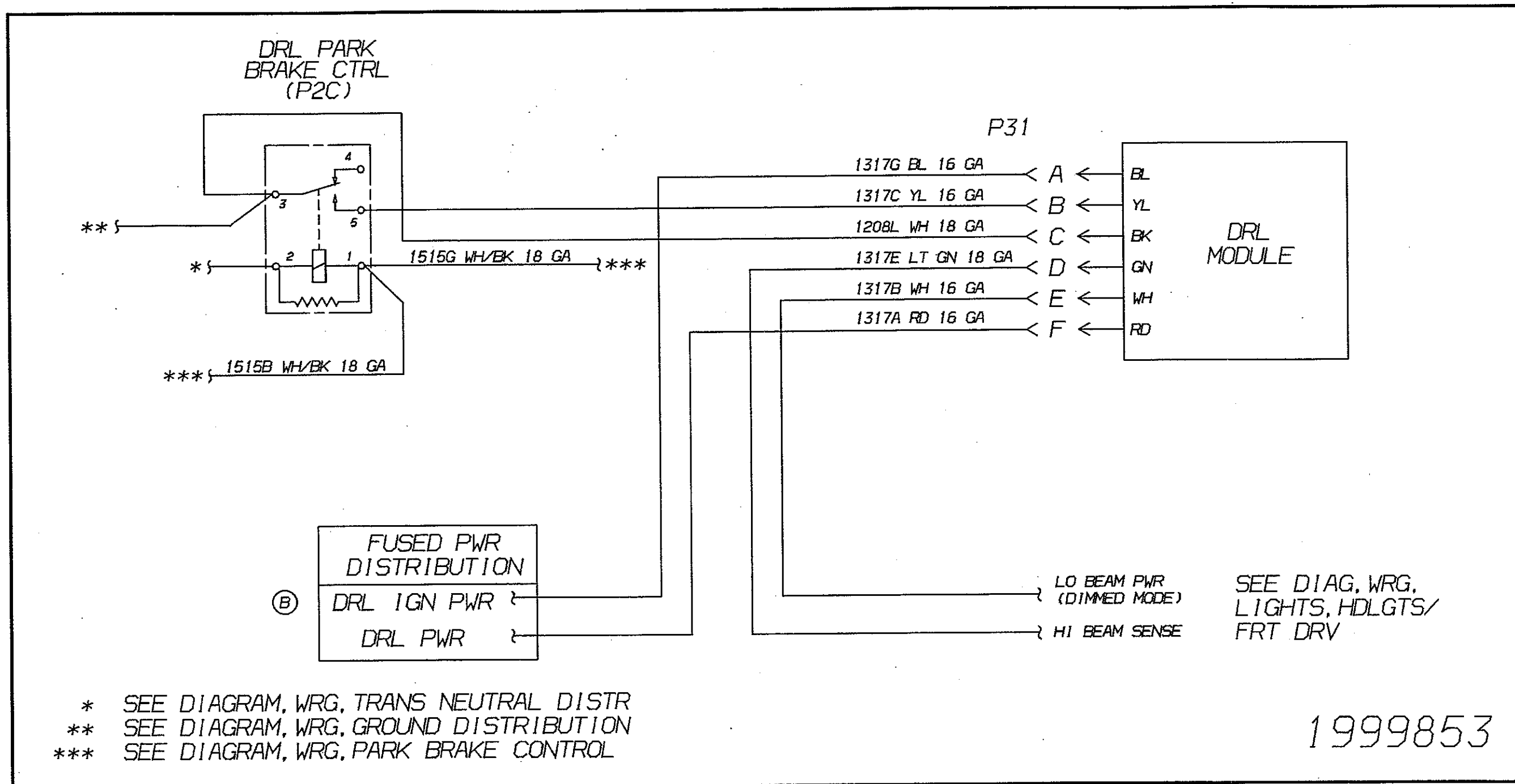
Schematic 70—Lift and Lift Door



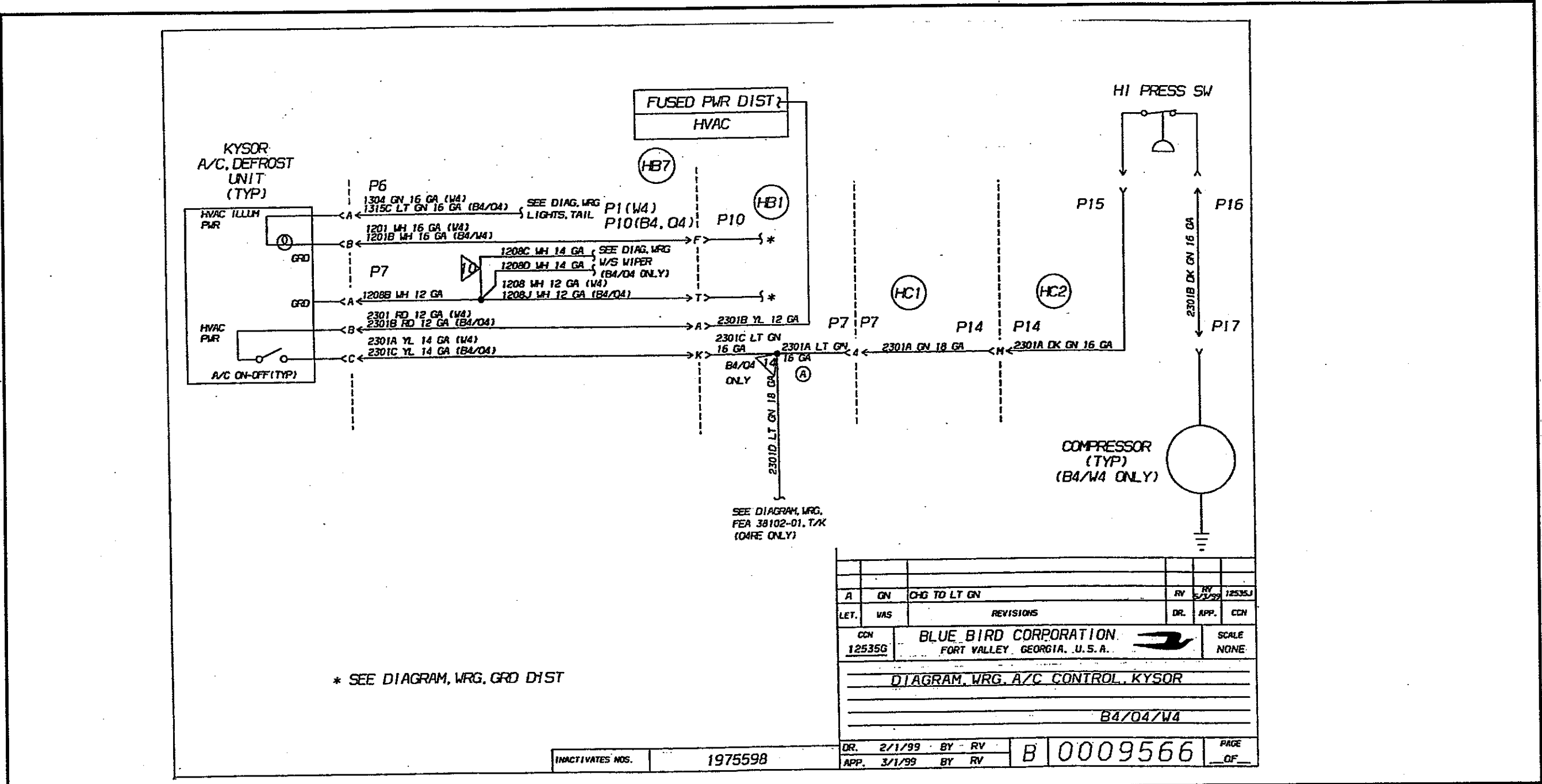
Schematic 71—Front Panel Electrical Assembly



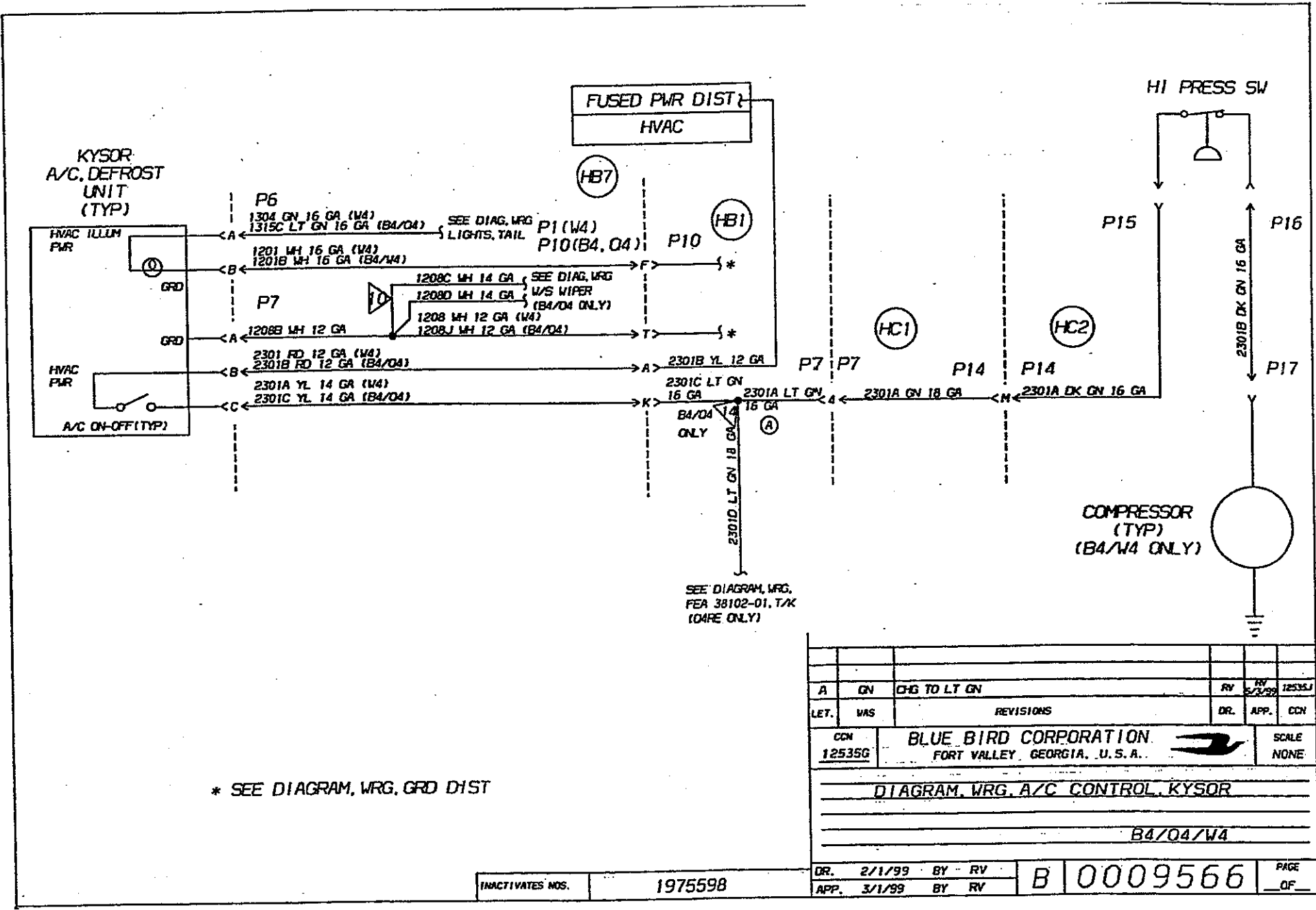
Schematic 72—Landing Lights



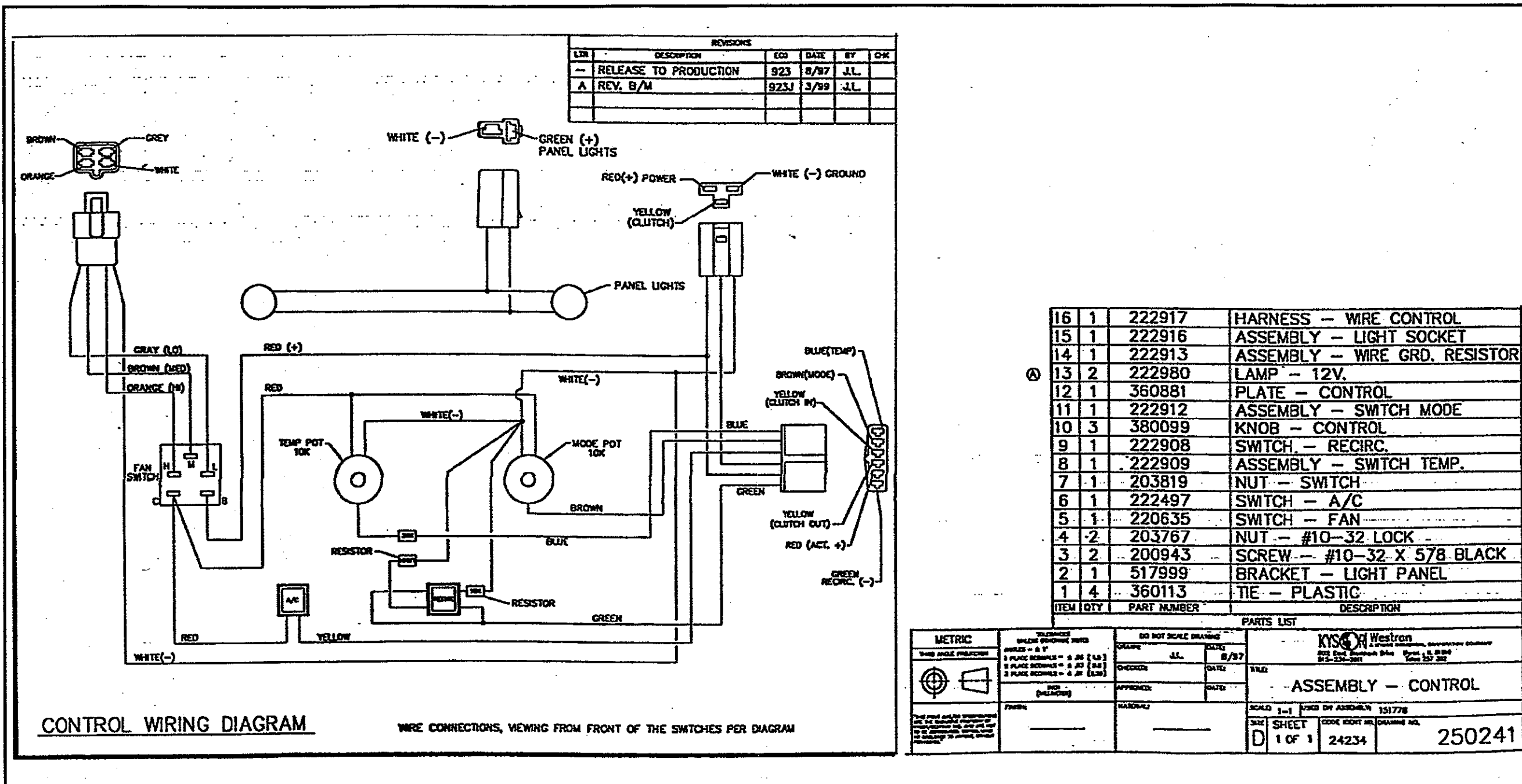
Schematic 73—Daytime Running Lights



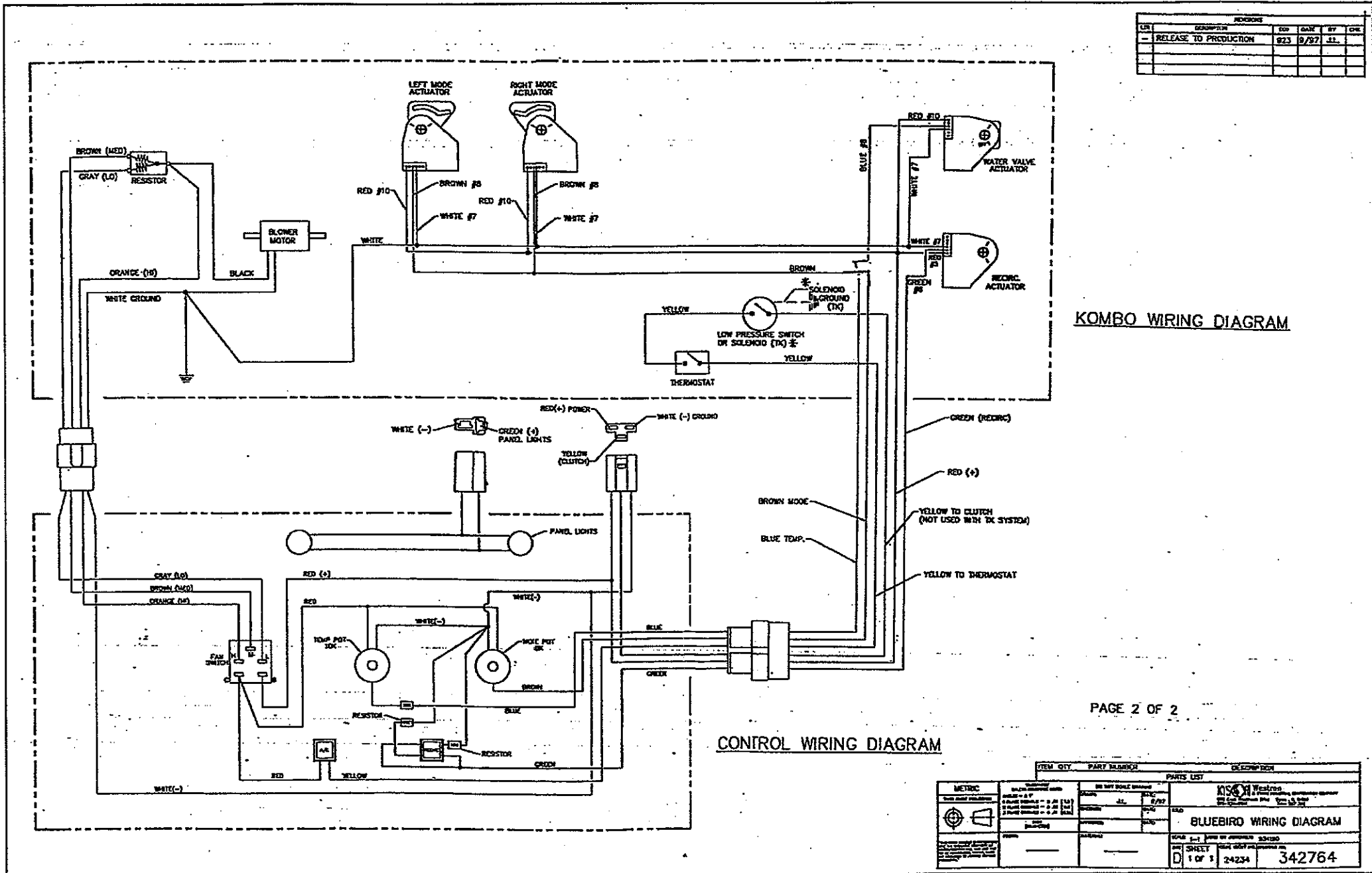
Schematic 74—Kysor® Air Condition Control



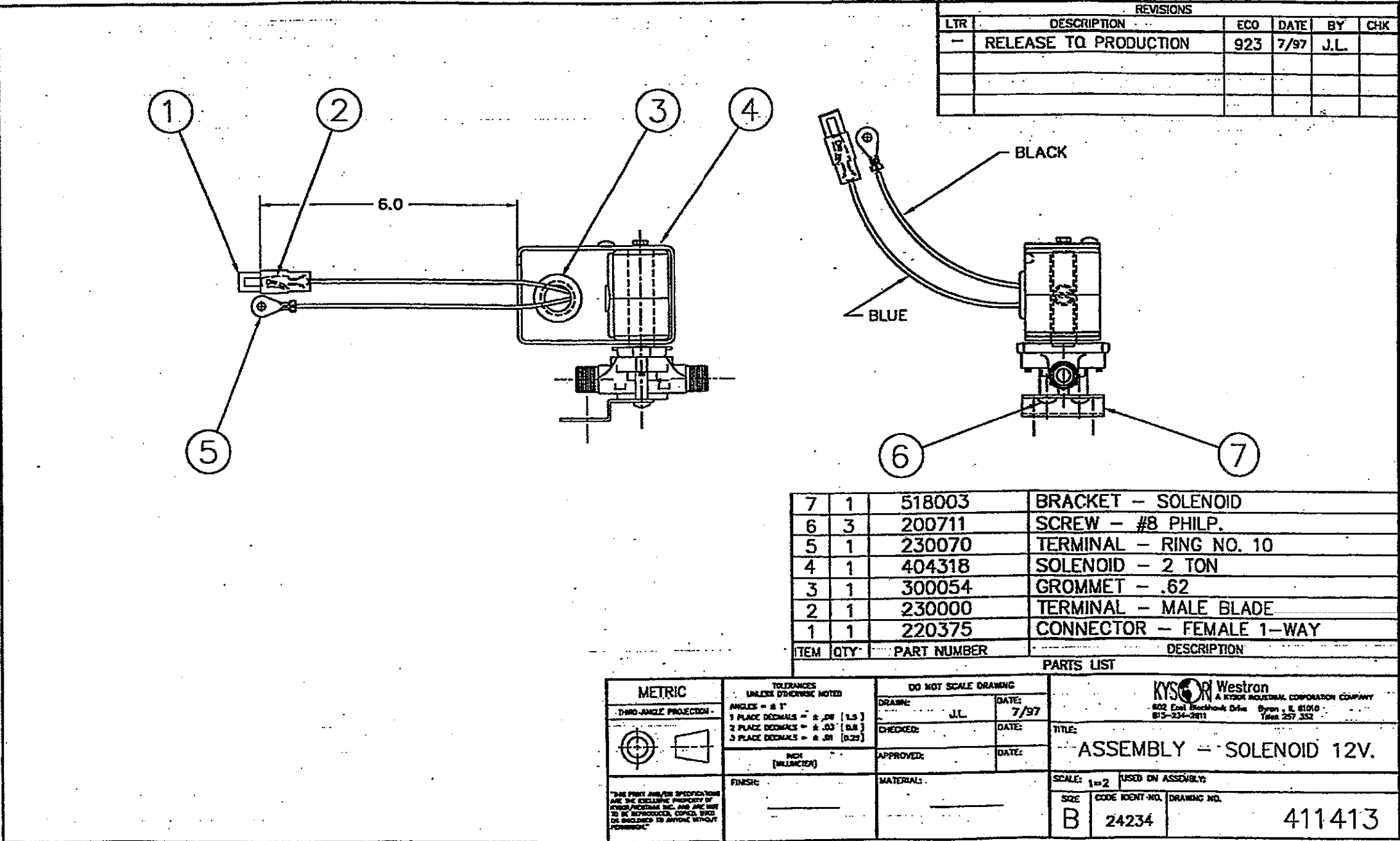
Schematic 74—Kysor® Air Condition Control



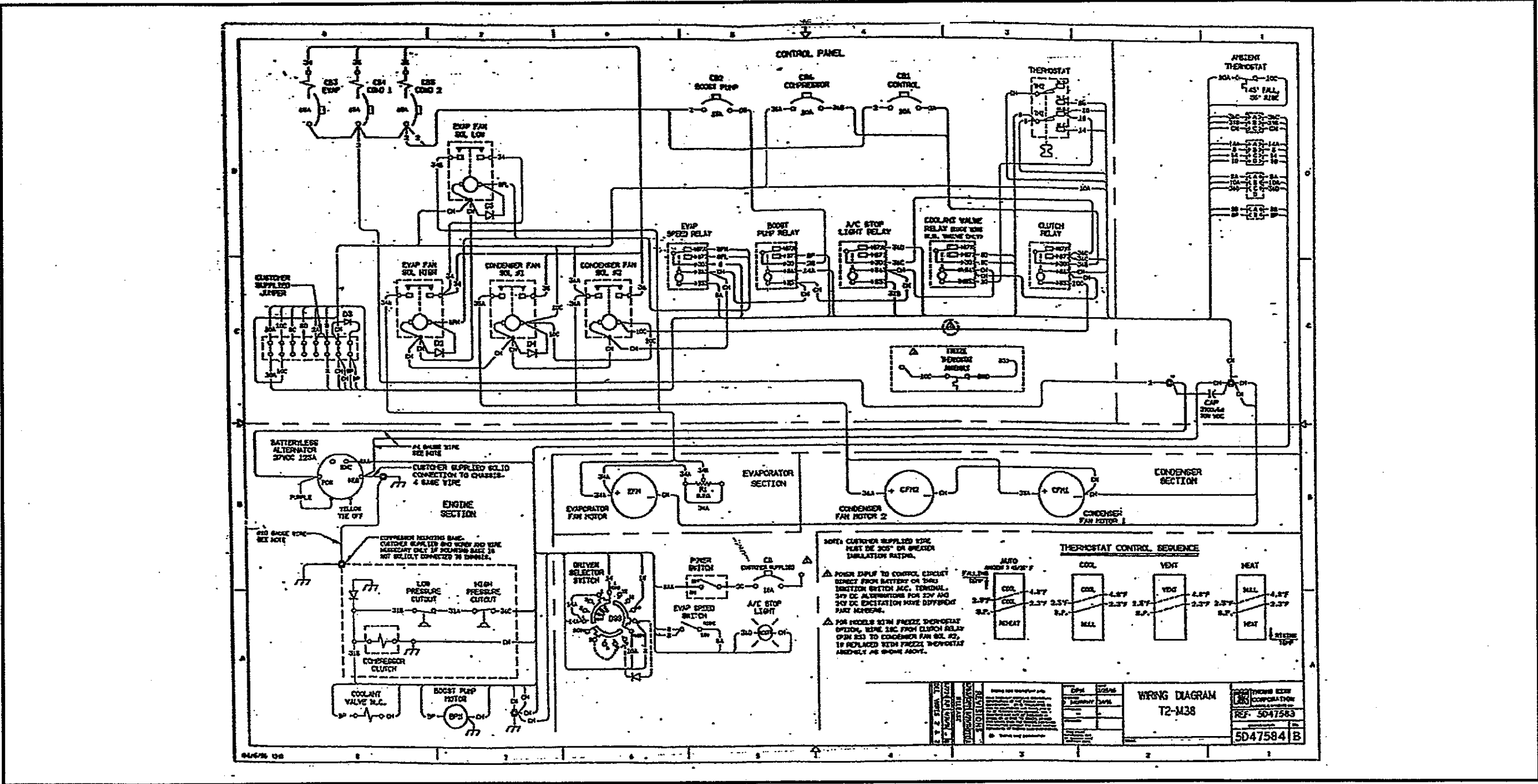
Schematic 75—Kysor® Air Condition Control



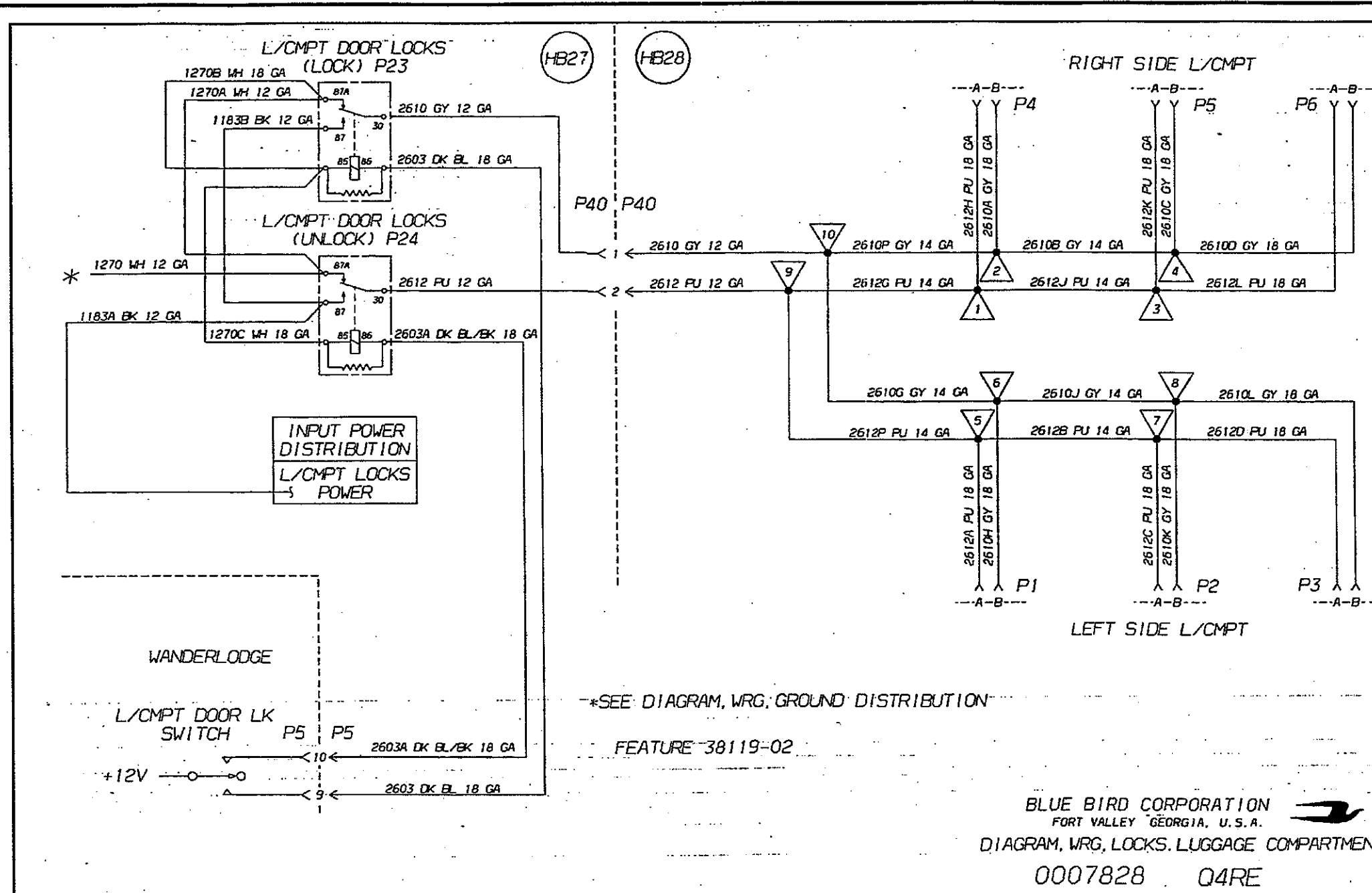
Schematic 76—Kysor® Air Condition Control



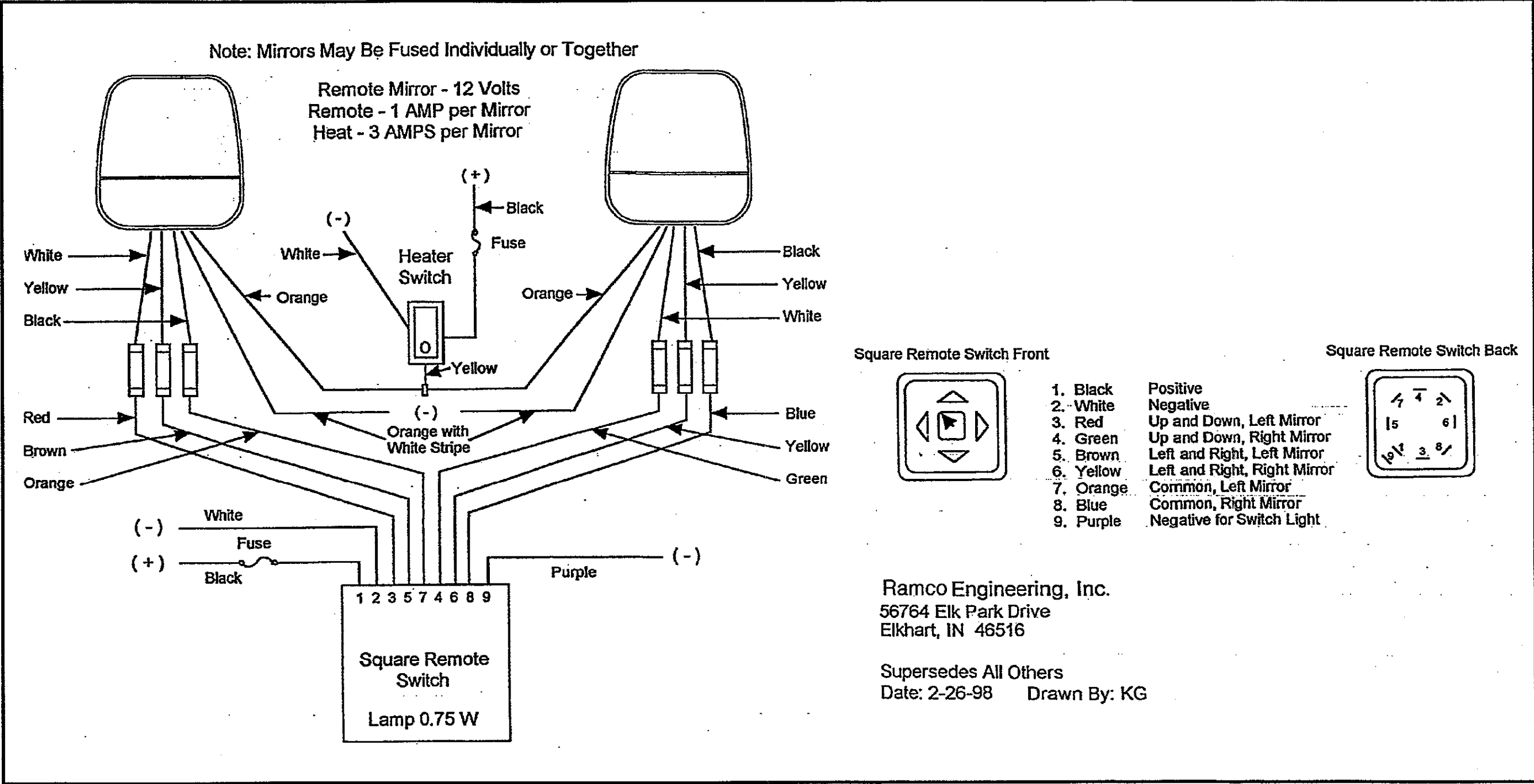
Schematic 77—Kysor® Air Condition Control



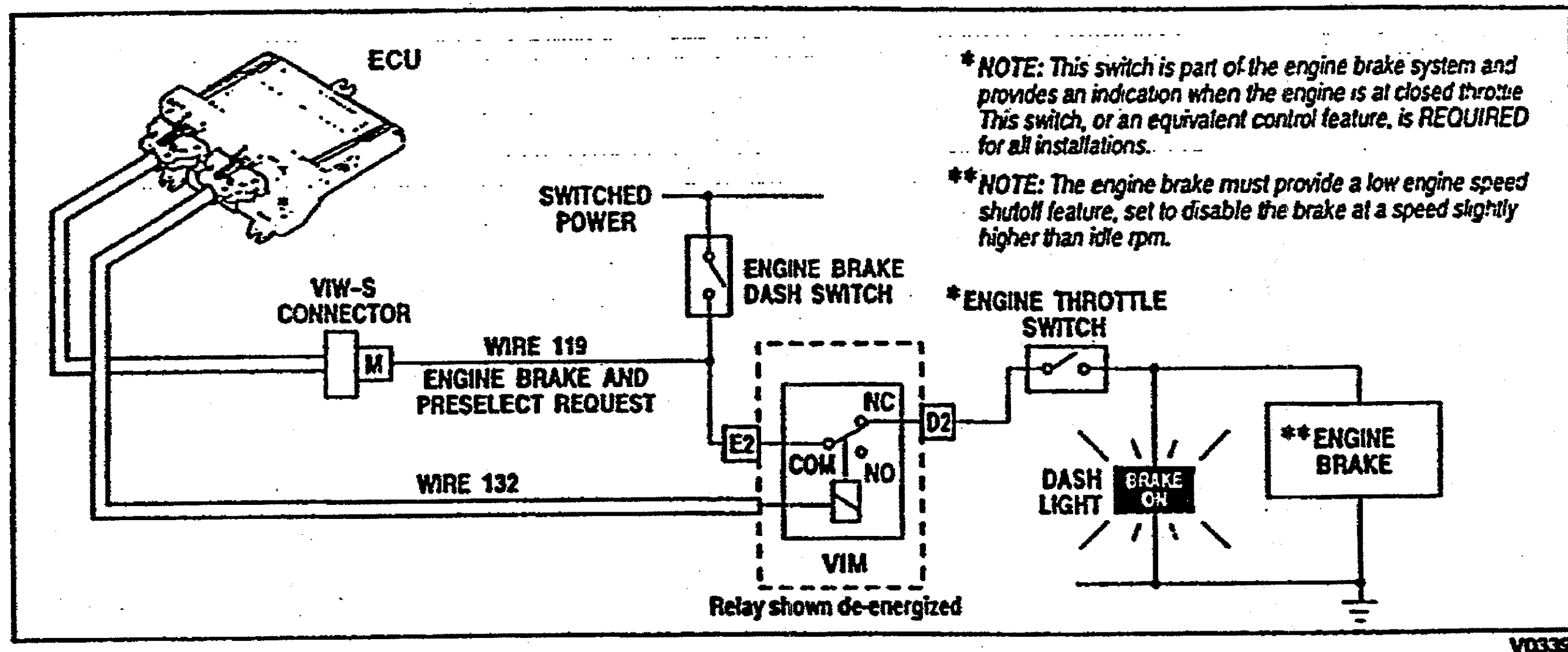
Schematic 78—Thermo King Air Condition T2 System



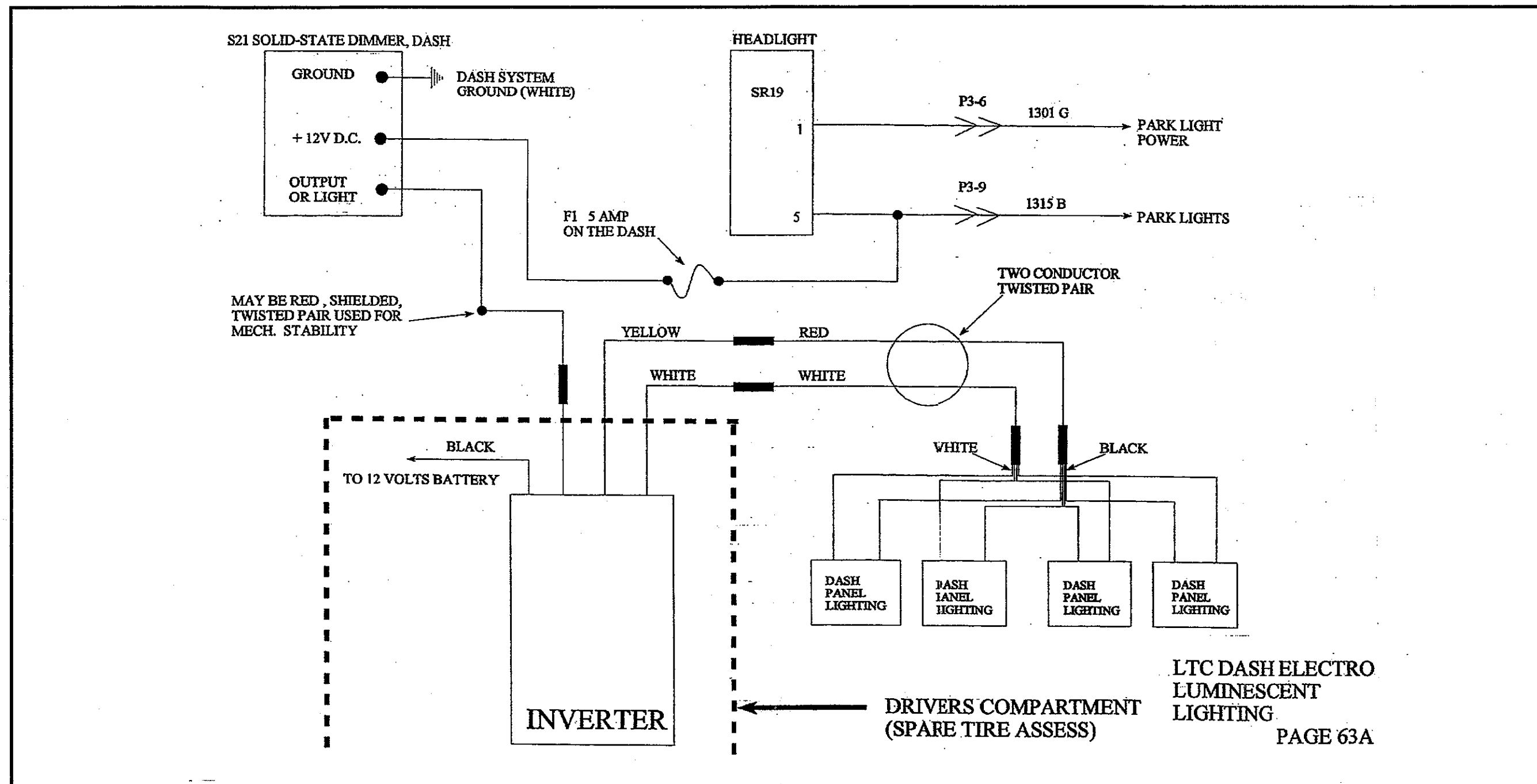
Schematic 79—Luggage Compartment Locks



Schematic 80—Ramco® Heated Mirrors



Schematic 81—Allison World Transmission Vehicle Interface



Schematic 82—Dash Electro Luminescent Lighting

LTC Throttle Circuit



BLUE BIRD[®]

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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before performing any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

The accelerator position sensor is attached to the accelerator pedal. The accelerator position sensor sends a signal to the Electronic Control Module (ECM) when the driver pushes down on the accelerator.

Note

The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensor. The connector pin may vary with equipment manufacturer.

The three wires in the accelerator position sensor circuit must be twisted together.

Description of Operation

The Accelerator Position Circuit

The Electronic Treadle has two connectors and they are shown as connectors Details A, B, and C. (See Figure 1—Cummins 45 Degree Electronic Treadle.)

Troubleshooting

Linear Sensor

Caution

Do not attempt to measure resistance of the PWM sensor. Catastrophic damage could occur to the sensor.

1. Turn ignition off.

Note

Do not remove the TPS from the pedal.

2. Disconnect the connector to the TPS at the pedal mounted TPS.
3. Measure the end to end resistance of the pot.

Note

If the resistance reading is substantially higher or lower, replace the pedal.

Resistance Requirements

Cummins, DDEC-2, DDEC-3, 2.5K Ohms $\pm$ 20 %

4. Measure the resistance from wiper to each end to determine if the wiper is not internally shorted nor open to one of the ends.

Wiper to Near End Resistance Requirement

Cummins, DDEC-2, DDEC-3 , 2.5K; 100 to 600 Ohms

Wiper to Far End Resistance Requirement

Cummins, DDEC-2, DDEC-3 , 2.5K; 1600 to 2200 Ohms

Note

The reason for the wide variation is the $\pm 20\%$ tolerance of the pots and the tolerance of the mechanical pedal parts.

If a short (0-Ohms) or open (infinite Ohms) is found the sensor is bad.

Note

If the engine does not require IVS do not apply IVS resistance measurement.

Note

Cummins engines (CELECT and CELECT Plus) require both idle active and throttle active outputs from the IVS. The Detroit Diesels require idle active.

Resistance IVS Measurement

1. Measure the resistance between the VIS supply pin and the idle active output pin, with the pedal in the closed throttle (CT) position.

The correct values are:

- WCI integrated sensor 20 to 125 Ohms
- Mechanical Switch 0 to 5 Ohms

2. Measure the resistance between the VIS supply pin and the throttle active output pin, with the pedal in the closed throttle (CT) position.

The correct values are:

- WCI integrated sensor infinite Ohms
- Mechanical Switch infinite Ohms

3. Depress the pedal to full open throttle (WOT) position.

4. Measure the resistance between the IVS supply pin and the throttle active pin.

The correct values are:

- WCI integrated sensor 20 to 125 Ohms
- Mechanical Switch 0 to 5 Ohms

5. Depress the pedal to full open throttle (WOT) position.

6. Measure the resistance between the IVS supply pin and the throttle active output pin.

The correct values are:

- WCI integrated sensor infinite Ohms
- Mechanical Switch infinite Ohms

Note

If the IVS switch indicate above 125 Ohms in the made position, or indicates less than 10M Ohms in the off position the integrated sensor or mechanical switch needs replacement.

7. Disconnect the TPS connector.

8. Turn vehicle key **only** to the on position

9. Measure the voltage between TPS Vref (+) and the TPS ground in the harness coming from the vehicle.

The correct voltage values are:

- Cummins and Detroit Diesel 4.75 to 5.25 volts.

Note

If the voltage measured is outside the range limits, the problem is not the TPS. Do not replace the sensor. Work toward the ESM.

10. Turn off the vehicle key.

11. Connect the sensor to the vehicle harness with the breakout harness in-line and turn on key.

Voltage Measurement Procedures

1. Measure and record TPS Vref.

Note

All measurements are TPS ground; not chassis ground. A percentage of this number, as opposed to absolute volts, will be used to determine status of the TPS.

LTC Throttle Circuit

Note

The measurement technique is the same for each type of sensor.

- 2. Measure the voltage at the TPS output pin with the pedal in the CT position.
- 3. Record the voltage.
- 4. Measure the voltage at the TPS output pin with the pedal in the WOT position.
- 5. Record the voltage.
- 6. Calculate CT percent of Vref, divide CT position TPS voltage by Vref voltage, and multiply that number by 100.

- 7. Calculate WOT percent of Vref with WOT position TPS voltage, divide WOT position TPS voltage by Vref voltage and multiply that number by 100.
- 8. Calculate SPAN percent of Vref, subtract CT % from WOT %.
- 9. Compare values measured to the corresponding numbers, see Table 1—Minimum/maximum Limits for Linear Sensor Parameters, Engine Type (ECM).

Note

If the measured values are outside the limits, the sensor is bad; replace the sensor.

Linear Sensor Parameters				
	DDEC-2	DDEC-3	CELECT	CELEC +
CT	8 - 12%	10 - 20%	5% min	5% min
WOT	83 - 92%	70 - 85%	81% max	81% max
SPAN	71 - 84%	60 - 75%	60 - 75%	60 - 75%

Table 1—Minimum/Maximum Limits for Linear Sensor Parameters, Engine Type (ECM)

- 10. Measure the voltage and position of the IVS on Cummins and programmed Detroit Diesel systems.

Voltage Measurement Values of the IVS

- Supply between pins B and F 4.74 to 5.25

With pedal at CT; idle active between pins B and E at least 4.25 volts

Throttle active, between pins B and F; less than 0.5 volts

With the pedal at WOT, idle active, between pins B and E less than 0.5 volts

With throttle active, between pins B and F at least 4.25 volts

Note

If any of the voltages are out of limits, but the resistance measured was correct, the problem is not in the TPS. Do not replace sensor.

The Break Out Box

The LED(s) of the box indicate the state of the idle active and throttle active signals. When actuating the pedal, the LED(s) will transition from on - to - off and from off - to - on as the idle active and throttle active signals, respectively, are switched. By actuating the pedal slowly, an approximate position measurement may be read from the APS signal on a voltmeter.

A nomograph allows minimum and maximum APS values at the switch points based on the CT and WOT voltages measured. Both transitions must occur within the minimum and maximum APS values for the IVS to be acceptable.

Replacement of TPS Procedure

1. Key off in vehicle.
2. Remove the wiring harness connector and the two TPS mounting screws.
3. Remove TPS.
4. Align the new TPS with the rectangular tab that drives the TPS.
5. Start the TPS into the TPS centerline hole.
6. Rotate the TPS to align the mounting screw holes.
7. Seat the TPS into the centerline hole.
8. Re-connect the wiring harness connector.

After Installation

1. Check the CT, WOT, and Span values.
2. Adjustments of a few percent may be made by rotating the TPS within the clearance of mounting screws holes.

Note

Voltage is what the ECM uses as input. Measuring voltage is the most definitive method for determining if a sensor is bad.

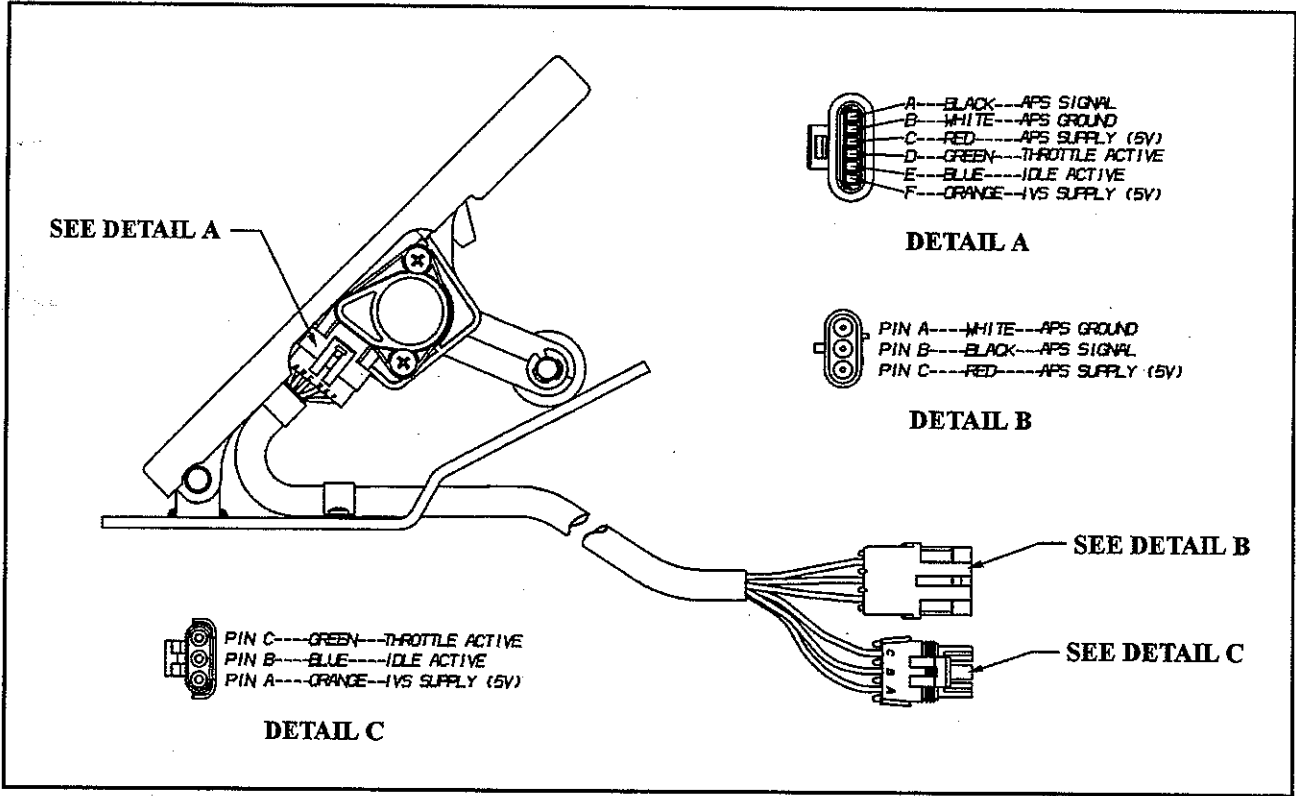
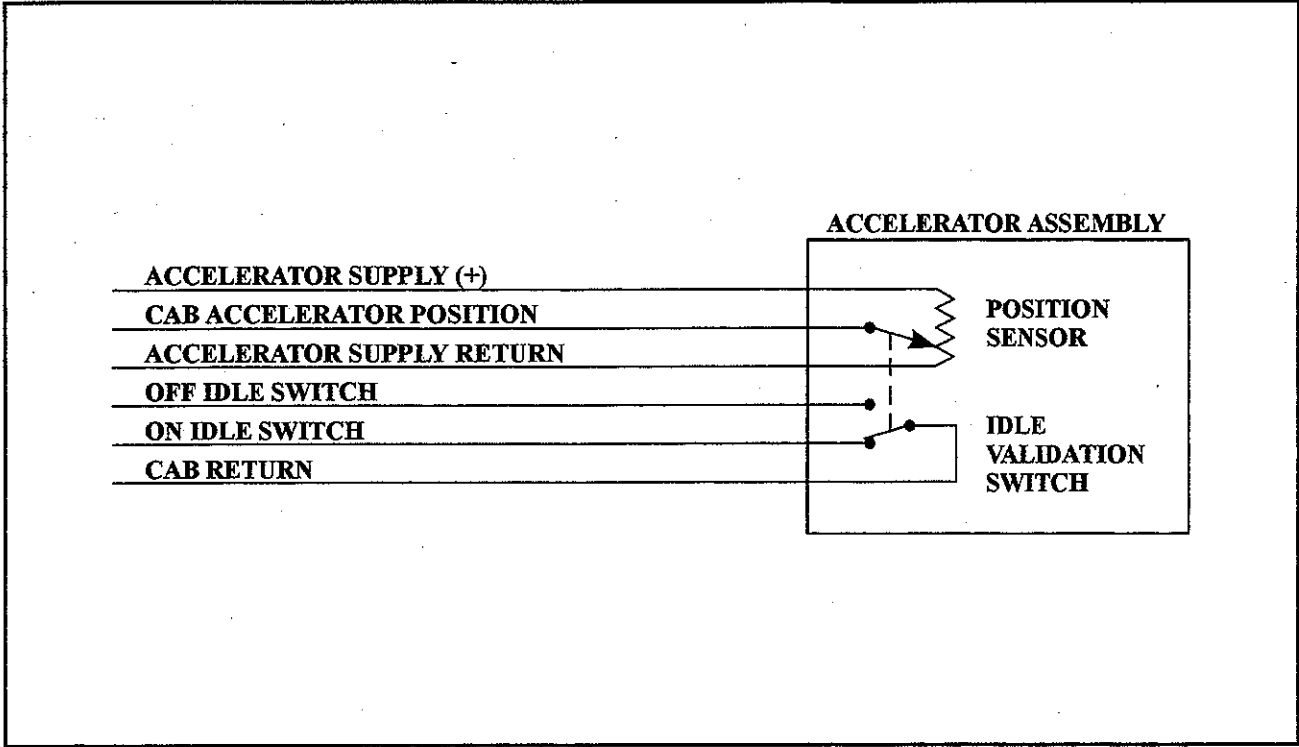
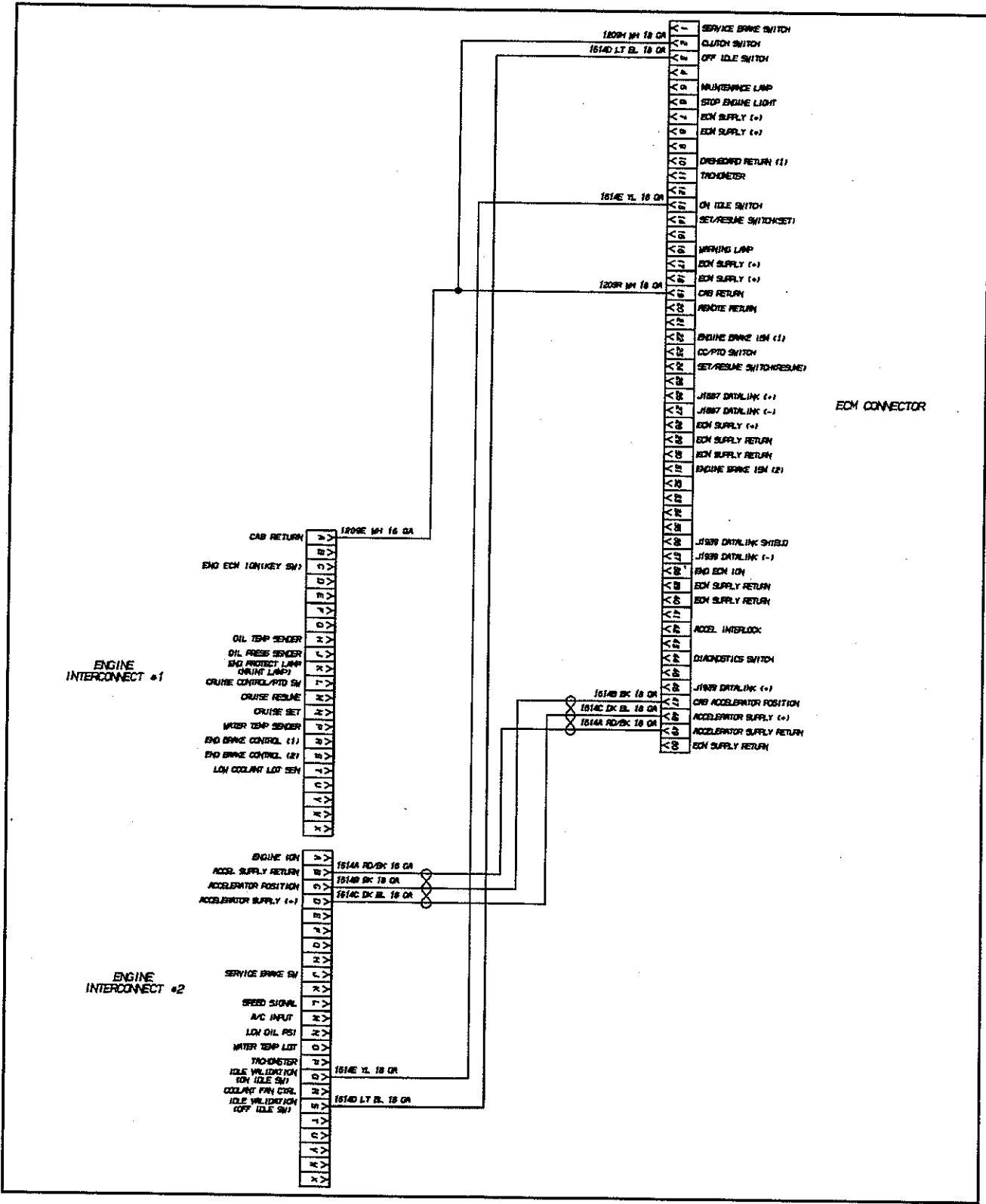


Figure 1—Cummins 45 Degree Electronic Treadle

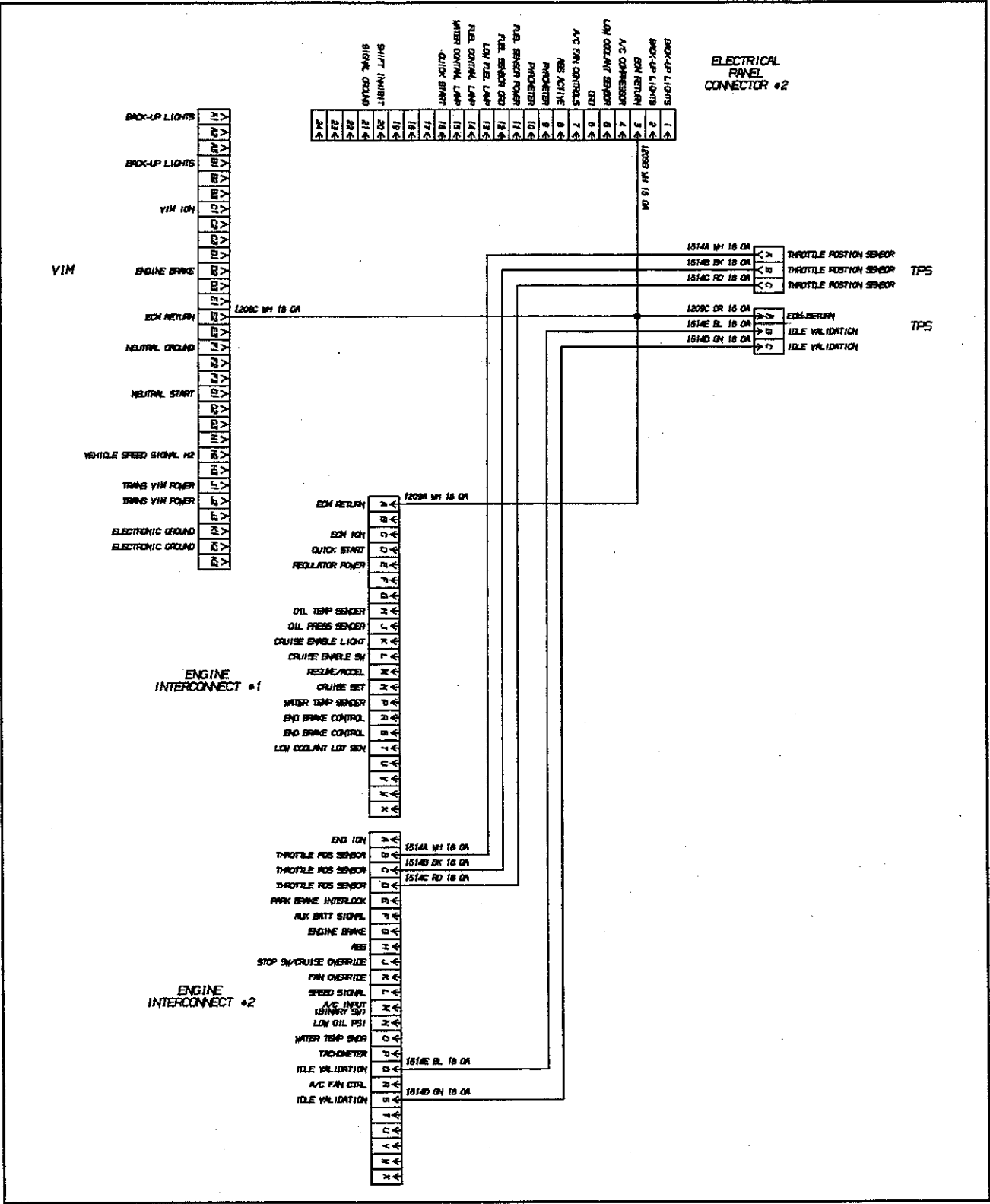


Schematic 1—CM570 Electronic Subsystem Wiring

LTC Throttle Circuit



Schematic 2—Cummins ISM Wiring



Schematic 3—Frame Component Wiring HCI

LTC Electrical Panel Assemblies



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LTC Electrical Panel Assemblies

Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service on and/or operation of this Blue Bird product, and the protection of equipment. Before performing any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

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Caution

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Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures are documented using a Blue Bird LTC with an Allison B500 World Transmission. The Electrical Panels for the LTC Cummins M11 and the Detroit Diesel engines are shown. (See Schematic 1.) Circuit breaker is located in a side mounted electrical box below the driver's seat. If a short occurs and the circuit breaks, the circuit will reset when the element cools.

A blinking of lights or fluctuating gauges may indicate a short. Always correct the short immediately. (See Table 1— Wiring Circuit Color Quick Reference.)

Troubleshooting

- **For access to the electrical panel.**

1. Disconnect battery and remove all battery ground straps
2. Use proper gauge wiring with high temperature insulation, such as chemically cross-linked polyethylene to meet SAE J-1128.

3. Make sure added circuits are protected by the use of a fuse or circuit breaker.
4. Push-on terminals must be insulated.

- **When installing or replacing wiring, other than ground straps.**

Caution

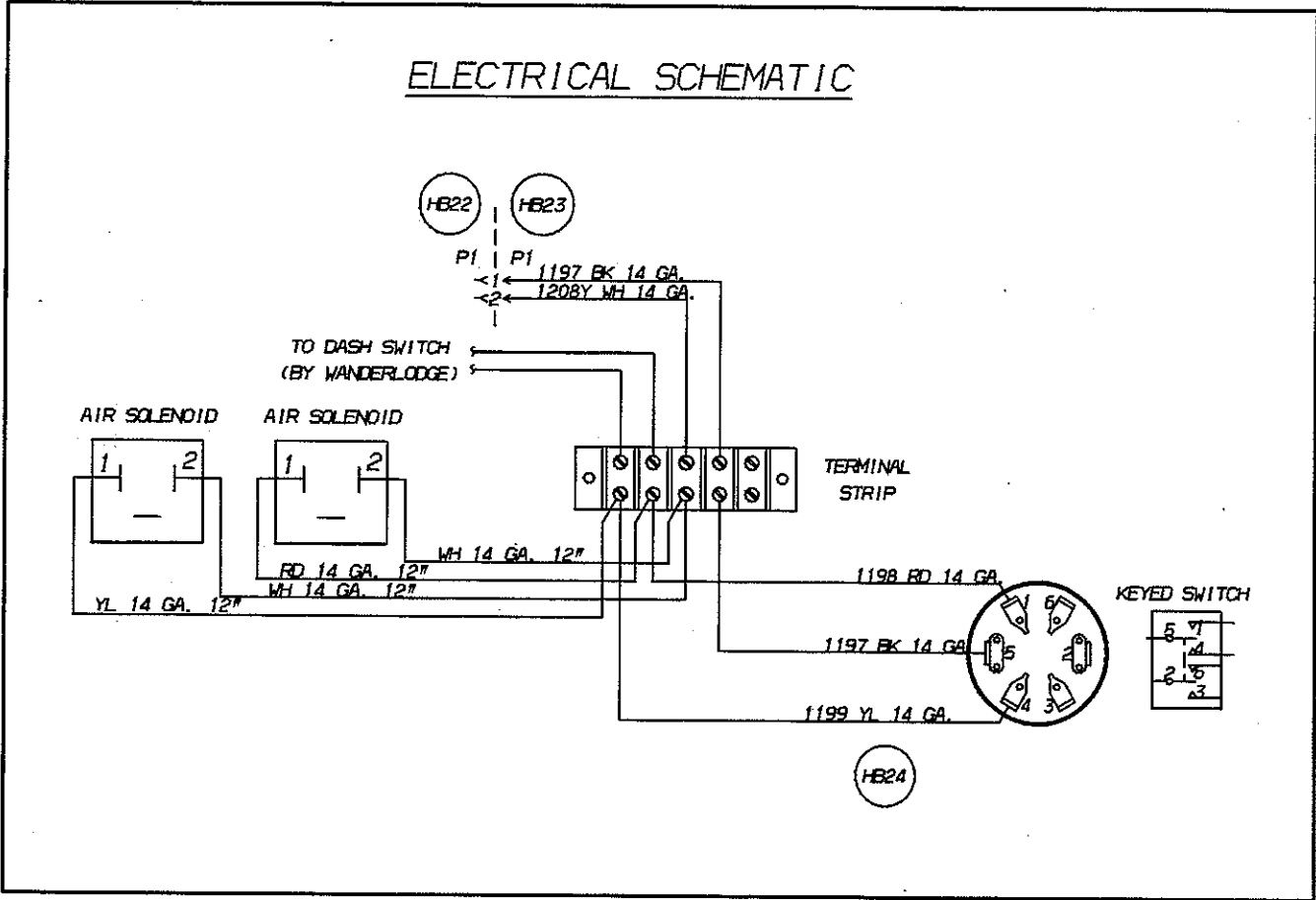
To avoid pin and harness damage, use test leads when taking a measurement.

1. Always use clamps to secure wires away from sharp objects or moving components.
2. Support wires every 30 inches (762 mm).
3. Provide adequate slack loops to allow for motion in all directions.
4. Clamp at both sides of loop.
5. Ensure there is sufficient length in wires so there is no tension.
6. Secured wires must remain at least four inches (102 mm).
7. Use rubber grommets when wires pass through a hole.
8. Cover all full time hot, accessory or ignition hot wires with approved loom.
9. Avoid routing wires in contact with fuel lines, or plastic components.
10. Make sure that all ground straps are connected when performing work on the engine components.
11. Make sure that the alternator has six gauge strap.
12. Make sure that the engine block and transmission has a ground straps.
13. Connect ground strap to the bolt that mounts transmission to rear face of engine block.
14. Use external star tooth washer between cable and frame.

- 15. Do not splice into existing wires. Install full-length wires.
- 16. If accessories must be added, relays may be required, check installation instructions. Use a bank of circuit breakers in the electrical panel unless the accessory must be on during starting. In that case, the hot bar should be used.
- 17. Always use insulated rubber boots over hot six-gauge wiring on the alternator, ammeter shunt, or junction blocks.

Wiring Circuit Color Quick Reference	
Function	Color
Left Rear Directional Light	Yellow
Right Rear Directional Light	Dark Green
Stoplights	Red
Back-up Lights	Blue
Tail lights	Brown
Ground	White
Ignition Feed-Primary Feed	Black

Table 1—Wiring Circuit Color Quick Reference



Schematic 1—Electrical Schematic



LTC Frame



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LTC Frame

Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not correctly adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins ISM engine and the Detroit Diesel Series 60 engine, and an Allison transmission. Vehicles with other engines or transmissions will use similar, and in most cases identical, procedures. For variations, refer to the appropriate installation drawing.

Warning

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

Preparatory Work

Park the vehicle on a level surface. Work under the vehicle would be made easier if a lift of sufficient strength is used. Once the vehicle is parked, set the parking brake and chock the rear wheels.

Configuration Details

All applications are common except the motor mounts for other engine configuration.

Note

When a huckspin is removed, replace with the proper capscrew and a lock nut. Refer to Table 1—Huckspin to Capscrew Conversion.

Frame Components LTC

The two configurations for the LTC frame are the Cummins M11 and the Detroit Diesel Series 60. (See Figure 1—Frame Configuration, Details B and C.)

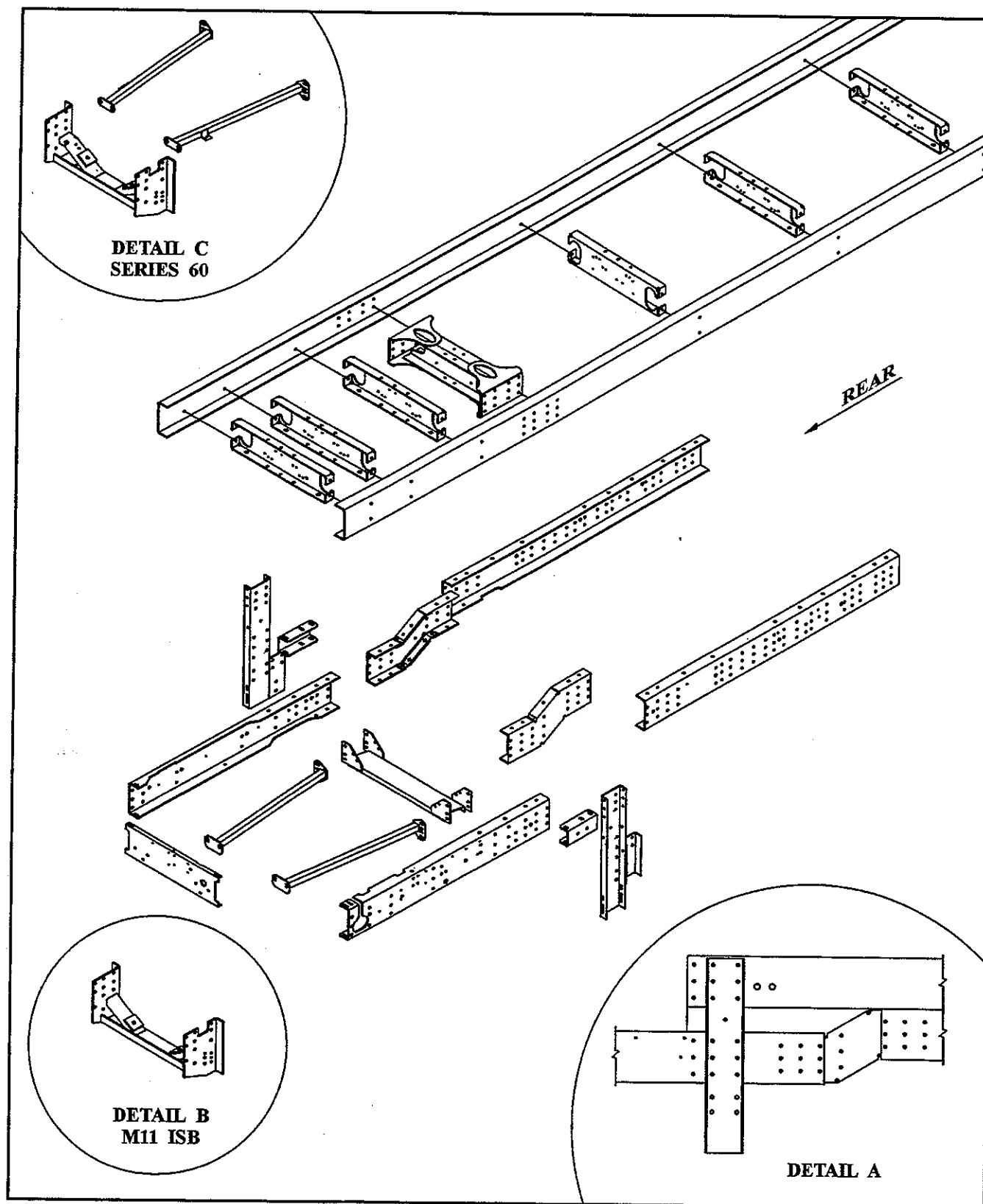


Figure 1—Frame Configuration 1 of 2

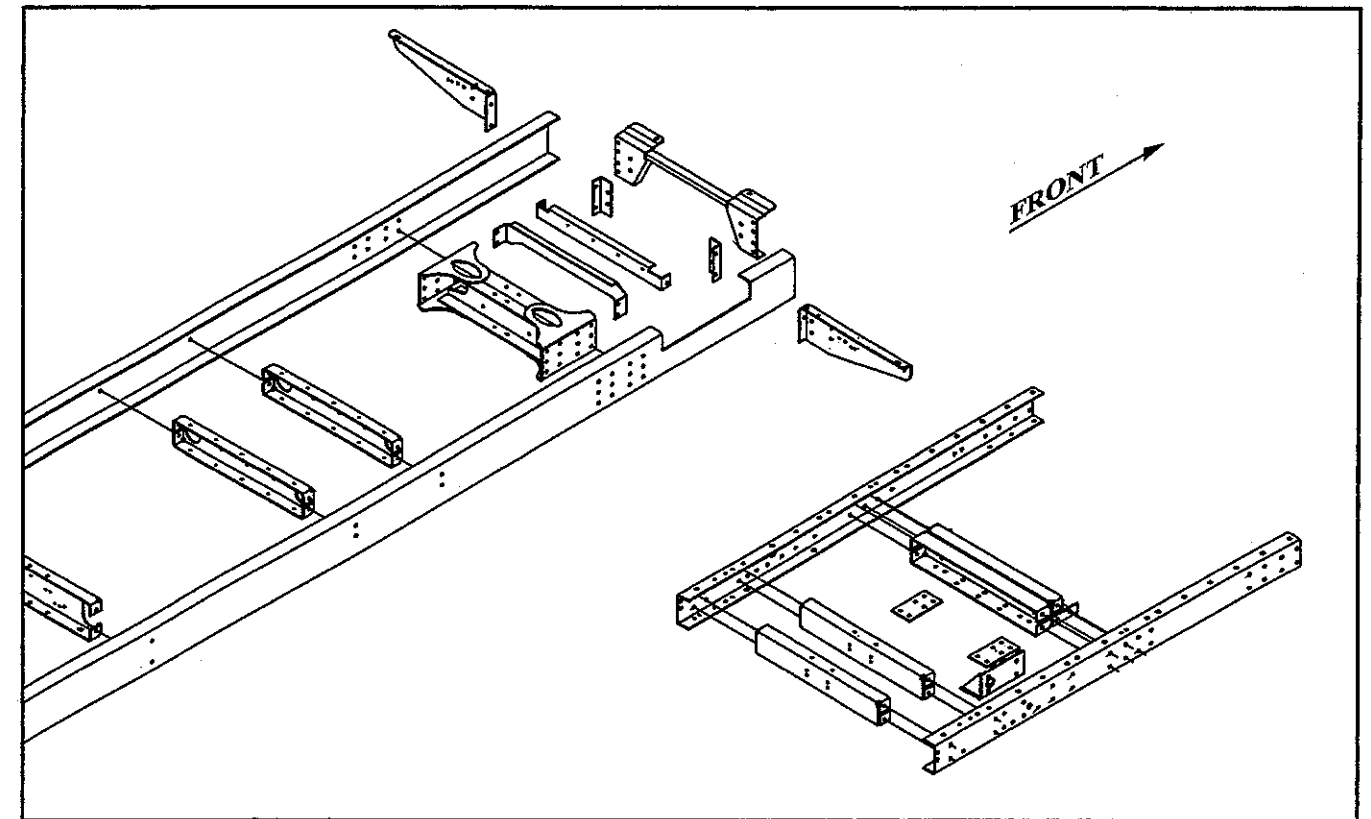


Figure 1—Frame Configuration 2 of 2

Caution

Make sure that a flat washer and a lock nut is used with the capscrew replacing the huckspin.

HUCKSPIN			GRIP RANGE		CAPSCREW GR8		
BB P/N	Huck Number	Nominal Length	Min	Max	Nominal Length	Thread	BB P/N
1636943	-10	2.25	0.43	0.90	1.50	½-13	0803239
1636943	-10	2.25	0.43	0.90	1.75	½-13	0803148
1636950	-16	2.60	0.85	1.25	1.75	½-13	0803148
1636943	-10	2.25	0.43	0.90	1.75	½-20	0959452
1636950	-16	2.60	0.85	1.25	1.75	½-20	0959452
1636950	-16	2.60	0.85	1.25	1.75	½-13	0803205
1746817	-20	2.85	1.09	1.50	2.00	½-13	0803205
CAPSCREW BOLTS THIS MATERIAL THICKNESS		BB P/N	USE FLAT WASHER		USE LOCKING NUT	USE NON-LOCKING NUT	
Minimum	Maximum	---	---		---	---	
0.25	0.75	0803239	1003045		0850800	½-20 GR8	
0.50	1.00	0803148	---		---	---	
0.50	1.00	0803148	---		---	---	
0.50	1.00	0959452	---		---	---	
0.50	1.00	0959452	---		---	---	
0.75	1.25	0803205	---		---	---	
0.75	1.25	0803205	---		---	---	

Table 1—Capscrew to Huckspin Conversion

Front Bumper Removal

- See Figure 2—Front Bumper
1. Remove the nut and the flat washer.
 2. Remove the nut, washer and bolt from the bracket (11).

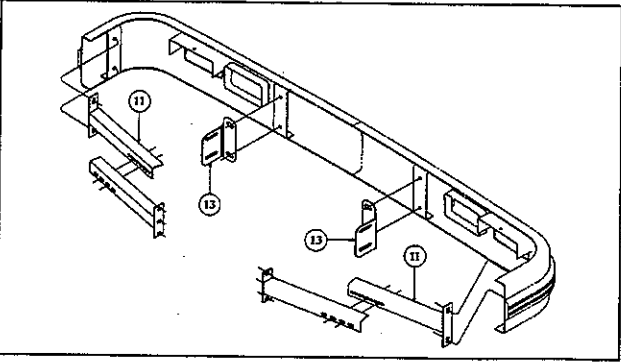


Figure 2—Front Bumper

Front Tow Hook Removal

- See Figure 3—Tow Hook Removal
1. Remove the nut, flat washer, and capscrew (3) from the front bumper support bracket.
 2. Remove the nut, flat washer, flat washer and capscrew.

Rear Bumper Removal

1. Remove the nut and flat washer.
2. Remove the bumper plate spacer and bolt from the bracket.

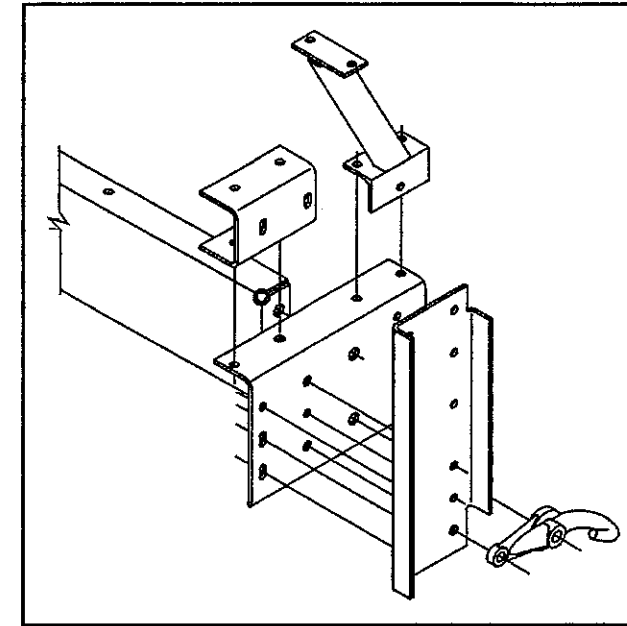


Figure 3—Tow Hook Removal

Frame Repair Preparatory Work

Note

Before welding, disconnect battery cables. If welding is near battery remove battery.

Warning

Do not remove any chassis cross member.

Do not weld on the engine, radiator, fuel tank, transmission or any component mounted on the engine or transmission.

Stable the bus with chocks and jacks.

1. Disconnect the grounding cables.
2. Disconnect ECUs.
3. Attach the welding grounding cable no more than two-feet from the point of weld.
4. Provide the shielding to protect the chassis components from heat damage and welding splatters.
5. After welding, reconnect all ground cables, ECUs and other disconnected components.

Note

Only a current AWS certified welder should weld.

Frame Repair

1. Remove the affected fasteners.

Caution

Frame insert must be 950X HSLA steel or equivalent.

All 0.500-inch (12.7 mm) fasteners should be new coarse thread bolts, hardened washers, one under head, and one under nut. Use new locking nuts. Bolts and nuts to be grade 8 material.

2. Strip and clean the affected area; both sides of the frame.
3. Locate the running tip of weld with a magnifying glass.
4. Stop drill crack. Hole to be 1/8-inch diameter.

Note

Refer to Blue Bird drawing 1746155 for frame insert configuration.

5. Grind crack to 45-degree angle on one side and install 1/16-inch land on opposite side to ensure full penetration.
6. Grind the weld flush to base metal.
7. Install standard LTC 9-5/8-inch rail to be 9.06-inches outside height with 2-3/4 flange and be 1/4-inch thick. The inside bend radius is to be 0.37 to 0.50 inches.

Frame Welding

Warning

It may be necessary to remove all fuel from fuel tank (s) and fuel lines. Cover all hydraulic lines and electrical wires.

- Weld procedure using mig (GMAW). (See Figure 4—Frame Weldment.)

- 0.35 inch (8.5 mm) diameter wire
- E70S3 AWS classification.
- 300 – 350 inches per minute
- 90% Argon – 10% CO² or 92% Argon – 8% CO²
- Arc Volts 18 – 21
- Amps 100 – 130
- Weld procedure using stick process (SMAW)
- E7018, E6012, or E6013 electrode, 1/8 to 5/16-inch electrode reverse polarity, AC, or DC, adjust heat to thickness of material.

Caution

Make sure all slag has been removed before coating.

1. Clean the area with a wire brush.
2. Test drive the bus and re-inspect weld area.
3. Coat area with the Blue Bird recommended coating.
4. Inspect the weld area after 1,000 miles (1609 km) of service.

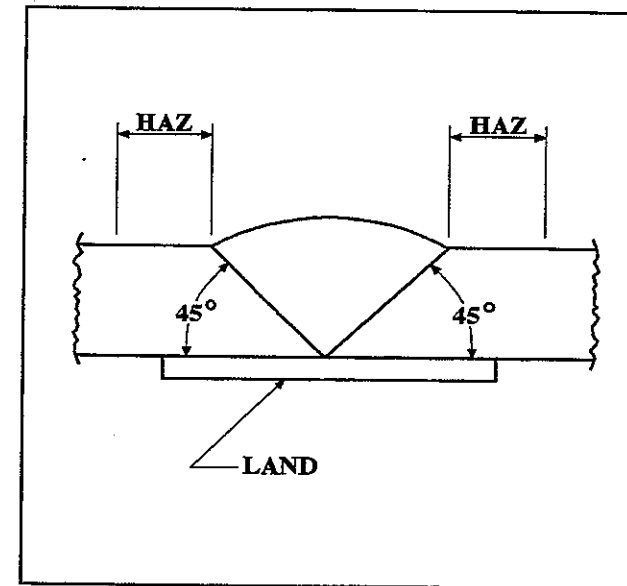


Figure 4—Frame Weldment

LTC Fuel System



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not correctly adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins M11 engine and an Allison B500 World Transmission.

Description of Operation

The LTC has a 176 gallon (666 L) dual fill fuel tank. The fuel system incorporates a Racor 490R-12-10 Fuel Filter/Water Separator.

Warning

Fuel is flammable and toxic to the skin, eyes and respiratory tract. Skin, eye and respiratory tract protection is required. Avoid repeated or prolonged contact. Use in a well-ventilated area.

Make necessary ground connections for fuel tank senders and other electrical components with ground wires.

Fuel Filter/Water Separator Assembly Removal

1. Disconnect the female swivel (8) from the male connector (15). (See Figure 1—Racor 490R-12-10 Filter/Water Separator.)
2. Remove the nut (24), flat washer (23) and capscrew (22).
3. Disconnect the heater from the Filter/Water Separator.
4. Remove the Filter/Water Separator (16).
5. Disconnect the female swivel (8) from the male connector (7) at the fuel and air mounting junction (11). (See Figure 2—Fuel/Air Mounting Junction.)
6. Remove the nut, flat washer, and capscrew from the mounting bracket.

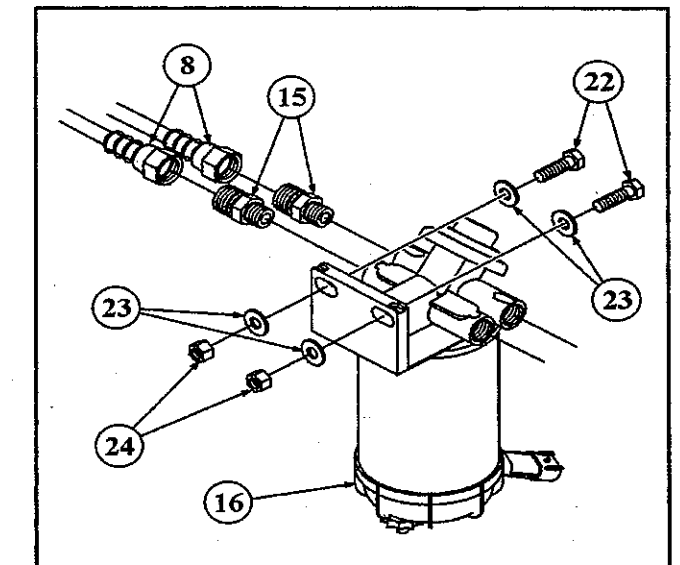


Figure 1—Racor 490R-12-10 Fuel Filter/Water Separator

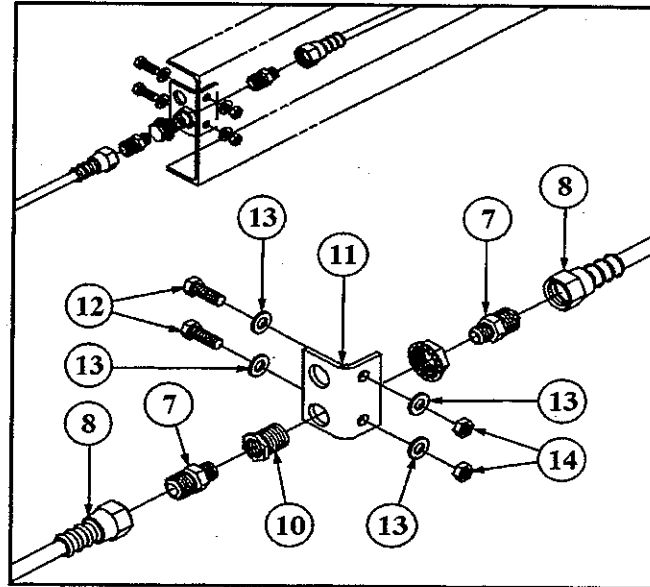


Figure 2—Fuel/Air Mounting Junction

Fuel Tank Removal

Warning

Use correct lifting equipment and techniques. The bus will need to be raised at least 36 inches during tank removal.

1. Remove the access panel (18) from the luggage compartment (11). (See Figure 3—Fuel Tank Fitting Access Panel.)

Note

Access to the fuel sender is through the front luggage compartment on the right hand side of the bus. To access the fuel sender, open up the front right luggage compartment and locate the fuel sender access panel.

2. Raise the bus using jacks capable of loading 40,000 pounds (18144 kg). The weight of the LTC is approximately 40,000 pounds (18144 kg).

Warning

Fuel is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory tract protection is required. Avoid repeated or prolonged contact. Use in a well-ventilated area.

Caution

Do not reuse fuel because of contamination.

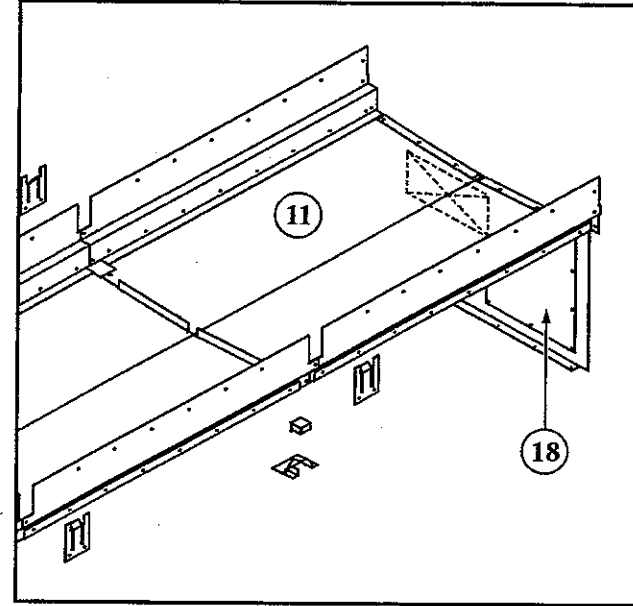


Figure 3—Fuel Tank Fitting Access Panel

3. Drain the fuel tank into suitable containers.
4. Place a jack under the fuel tank.
5. Raise the jack to support the fuel tank.
6. Remove the lock nuts (14), flat washer (13), and capscrew (12) from the angle crossmember (29). (See Figure 4—Fuel Tank Straps and Angle Crossmember.)
7. Move to the front of the fuel tank to remove nylon cable tie (33) from the vent lines (34). (See Figure 5—Fuel Tank Sensor Location.)

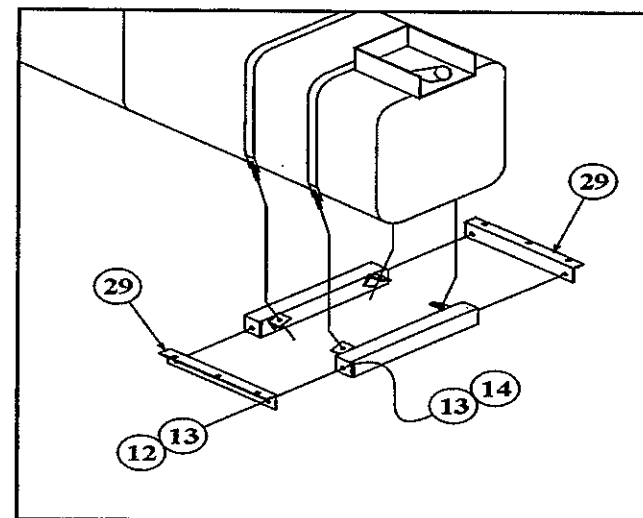


Figure 4—Fuel Tank Straps and Angle Crossmember

LTC Fuel System

8. Remove hose clamps (35) from the fuel tank vents. (See Figure 5—Fuel Tank Sensor Location.)
9. Lower fuel tank enough to see fittings at panel (18).
10. Disconnect fuel lines (5) and (8). (See Figure 5—Fuel Tank Sensor Location.)
11. Re-check all connections and removals.
12. Lower fuel tank and remove.

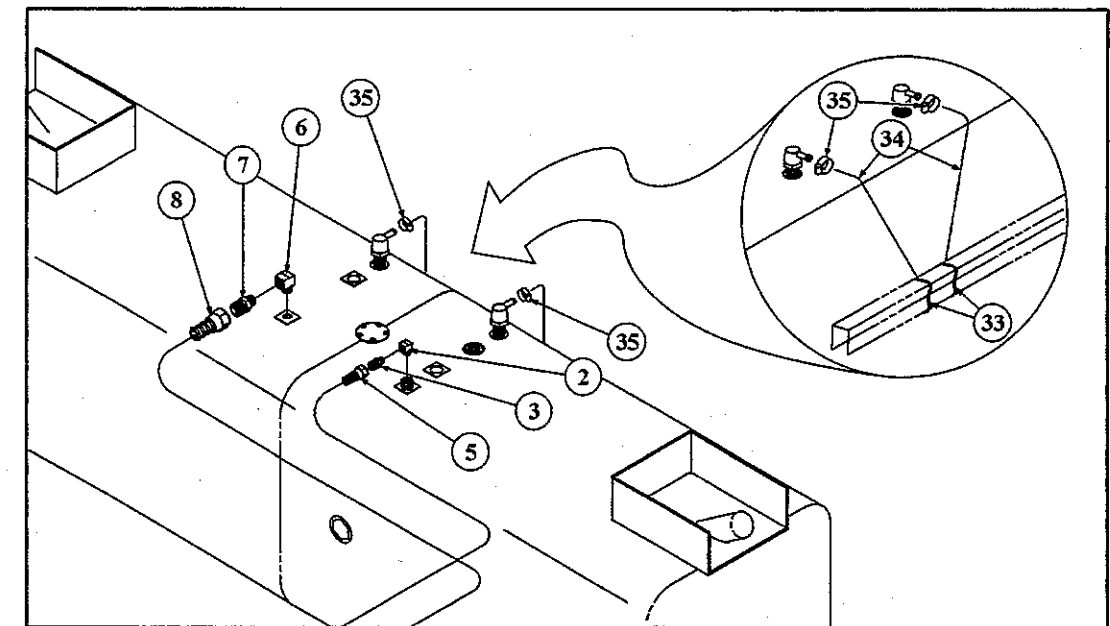


Figure 5—Fuel Tank Sensor Location

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Appendix A
TAS Series Exploded View (Typical)

Appendix B
Service Parts List

Safety

The purpose of this safety summary is twofold. First, it is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product. Second, it is to ensure protection of equipment. Before performing any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warning

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Disclaimer

Blue Bird Corporation assumes sole responsibility for ensuring that information provided herein is accurate to the best of its knowledge at the time of printing. Blue Bird has a policy of continual product improvement. Blue Bird reserves the right to change product information without notice and without incurring obligation.

Description of Service Manual

This service manual is for the TRW Automotive Steering and Suspension System TAS Steering Gear found on the Blue Bird LTC. These procedures apply to a Blue Bird LTC with a Cummins M11 engine and an Allison B500 World transmission.

General Design

Integral Power Steering

TAS power steering gears are the latest design in the TRW Commercial Steering Division family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

Rotary Control Valve

The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute or liters per minute) directed to a cylinder cavity. The control valve controls flow through the steering gear.

The pressure (measured in pounds per square inch, or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the appropriate cylinder cavity in the steering gear (and in the auxiliary cylinder if it is a dual steering system) at the proper flow rate and pressure.

Pressure Means Work, Flow Means Speed

The higher pressure a steering gear can withstand, the more work it can perform. The maximum operating pressure for all TAS gears is 2,175 psi (150 bar), maximum flow rate for all TAS gears is 8 gal/min (30.3L/min).

LTC Steering

The TAS series gears can steer a vehicle within its front-end weight rating through a turn at low speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear. TAS series vehicle front-end ratings are as follows:

Gear	Front Axle Rating
TAS85	18000 lb. (8200 kg)

The recommended minimum flow at 1 1/2 steering wheel turns per second is as follows:

Gear	Minimum Flow Rate
TAS85	3.6 gal/min (13.6 L/min)

If the steering gear valve is controlling an auxiliary cylinder, increased minimum flow is required (generally at least 75%) based on the size of the auxiliary cylinder and the vehicle's steering geometry.

General Operation

What Happens During a Steering Maneuver

When the driver turns the steering wheel, he transmits force from the steering wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve.

Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

Shock Loads to the Gear

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal geometry of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.

Unload (Poppet) Valves

Most TAS gears are equipped with two unloading valves, one at each end of the rack piston. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage. These valves are automatically set to axle stops after installation in vehicle at first full right and left turn.

Relief Valve

Some TAS gears (with or without poppets) are supplied with a relief valve. The relief valve limits maximum supply pressure to protect the power steering gear, but it does not reduce pressure as the steered wheels approach the axle stops.

Bleed Systems

Some TAS gears which are mounted with the output shaft above the rack piston bore are equipped with either an automatic bleed system or a manual bleed screw.

The procedure for air bleeding the system is addressed later in this manual. Replacement of damaged automatic bleed plugs and manual bleed screws is described in the back portion of this manual.

Approved Hydraulic Fluids

Automatic Transmission Fluid Dexron II
Automatic Transmission Fluid Type "E" or "F"
Chevron 10W-40
Chevron Custom 10W-40 Motor Oil
Chevron Torque 5 Fluid
Exxon Nuto H32 Hydraulic Fluid
Fleetrite PSF (Can #990625C2)
Ford Spec. M2C138CJ
Mack EO-K2 Engine Oil
Mobil ATF 210
Mobil Super 10W-40 Motor Oil
Shell Rotella T30W
Shell Rotella T SAE 30
Texaco 10W-40
Texaco TL-1833 Power Steering Fluid
Union 10W-40
Union 15W-40
Unocal Guardol 15W-40 Motor Oil

The steering system should be kept filled with one of the above fluids.

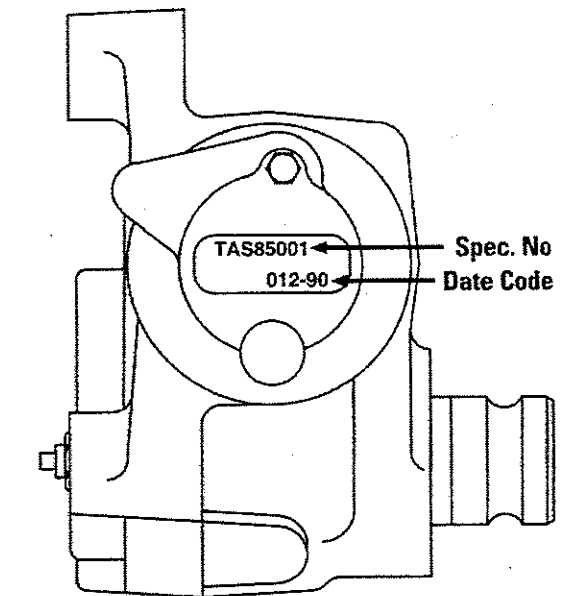
Warning

Completely flush the steering system with one of the recommended fluids above only.

Do not mix oil types. Any mixture or any unapproved oil could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.

Specification Numbers

The steering gear specification number and date code are stamped on a machined surface opposite the input shaft of every TAS gear. An example date code would be 012-90; this means the gear was built on the 12th day of 1990.



Item numbers referenced below are shown on the exploded view.

After tightening to this torque value, the adjuster must be backed off 1/4 to 1/2 of a turn as described in Step 22 of "Valve Housing/Worm Screw Disassembly."

Torque value indicated is using recommended tools.

Note

Special tools can be purchased through:

Kent Moore
Heavy Duty Division
SPX Corporation
29784 Little Mack
Roseville, MI 48066-2298
1-800-328-6657

LTC Steering

Part Name	Item #	Torque Range Dry	Torque Range Lubricated
Auxiliary cylinder plug	54	25-35 lbf-ft (34-48 N-m)	
Ball return guide cap bolts	31	14-22 lbf-ft (19-29 N-m)	
Ball return guide clip bolts	33	14-22 lbf-ft (19-29 N-m)	
Bearing Adjuster	17		11-15 lbf-ft (15-20 N-m)*
Locknut	18		101-122 lbf-ft (137-165 N-m)**
Manual bleed screw	50	27-33 lbf-in (3.1-3.7 N-m)	
Plug, auto bleed	51	38-58 lbf-ft (52-79 N-m)	
Poppet sleeve assembly	22	16-20 lbf-ft (22-27 N-m)	
Poppet sealing nut, service	60	33-37 lbf-ft (45-50 N-m)	
Poppet fixed stop screw	52	38-42 lbf-ft (52-57 N-m)	
Poppet fixed stop screw	52A	38-58 lbf-ft (52-79 N-m)	
Relief Valve Cap	56	25-35 lbf-ft (34-48 N-m)	
Sector Shaft adjusting screw jam nut	47	40-45 lbf-ft (54-61 N-m)	
Side cover bolts (TAS40)	48		108-128 lbf-ft (147-174 N-m)
Side cover bolts (TAS55, 65, 85)	48		160-180 lbf-ft (147-174 N-m)
Valve housing bolts (TAS40, 55, 65)	1		75-85 lbf-ft (102-115 N-m)
Valve housing bolts	1		108-128 lbf-ft (147-174 N-m)

Torque Chart

Initial TAS Installation

1. Bolt gear to frame, torque to vehicle manufacturer's recommendation.
2. Connect return line to TAS return port.
3. Connect hydraulic line from pump to pressure port in TAS unit.
4. Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
5. Install pitman arm on output shaft, torque bolt to vehicle manufacturer's recommendation.

Initial Poppet Setting

For this procedure to work correctly, you must have a new gear received from TRW or your vehicle manufacturer's aftermarket system, or a used gear on which poppet seats have been replaced or reset during gear disassembly procedures. Also: Fixed stop screw installed in housing, or poppet adjusting screw installed so that it duplicates fixed stop screw length.

Caution

The axle stops and all steering linkage must be set according to vehicle manufacturer's specifications, and the pitman arm must be correctly aligned on the sector shaft for poppets to be set correctly.

1. With the engine at idle and the vehicle unloaded, turn steering wheel to full travel in one direction until axle stop contact is made. Maximum input torque to be applied during this procedure is 40 lb rim pull (178 N) on a 20 in. (508mm) diameter steering wheel.

Note

If you encounter excess rim pull effort, allow vehicle to roll forward or jack up the vehicle at the front axle.

- 2. Follow the same procedure while turning the steering wheel in the other direction. The poppets are now positioned to trip and reduce pressure as the steered wheels approach the axle stops in either direction.

Maintenance Tips

Never high-pressure wash or steam clean a power steering gear while on or off the vehicle. Doing so could force contaminants inside the gear and cause it to malfunction.

Make sure vehicle wheel cut or clearances meet manufacturer's specifications, and make sure pitman arm timing marks are aligned properly to **prevent internal bottoming** of the steering gear.

Regularly check the fluid and the fluid level in the power steering reservoir.

Keep tires inflated to correct pressure.

Never use a torch to remove pitman arm.

Investigate and immediately **correct the cause of any play, rattle, or shimmy** in any part of the steering system.

Make sure the steering column is aligned properly.

Encourage drivers to report any malfunctions or accidents that could have damaged steering components.

Do not attempt to weld any broken steering components. Replace the component with original equipment only.

Do not cold straighten, hot straighten, or bend any steering component.

Always clean off around the reservoir filler cap before you remove it. Prevent dirt

or other foreign matter from entering the hydraulic system.

Investigate and correct any external leaks, no matter how minor.

Replace reservoir filters according to requirements.

If you feel the vehicle is developing excessively **high hydraulic fluid temperatures**, consult with your vehicle manufacturer for recommendations.

Maintain grease pack behind the output shaft dirt and water seal as a general maintenance procedure at least twice a year, in Spring and Fall. Grease fitting is provided in housing trunnion. Use only NLGI grade 2 or 3 multipurpose chassis lube, and use only a hand operated grease gun on fitting. Add grease until it begins to extrude past the sector shaft dirt and water seal.

LTC Steering

Filling and Air Bleeding the System

Tools Required	Materials Required
5/16 inch Socket	Hydraulic Fluid
Lbf•in. Torque wrench	

Caution

Make sure poppets are set correctly before beginning this procedure.

1. Fill the reservoir nearly full. Do not steer. Start and run the engine for 10 seconds, then shut it off. Check and refill the reservoir. Repeat at least three times, checking the reservoir each time.

Caution

Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.

2. Start the engine and let it idle for 2 minutes. Do not steer. Shut off the engine and check the fluid level in the reservoir. Refill as required.
3. Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dip stick. Automatic bleed systems should now be free from trapped air. Manual bleed systems continue with step 4. (Do not remove Auto Bleed Plug.)
4. With engine idling, steer from full left turn to full right turn several times. Stop steering and loosen the manual bleed screw about one turn. Allow air and aerated fluid to "bleed out" until only clear fluid is seen. Close the bleed screw, refill the reservoir if required. Repeat this step three to four times until all the air is discharged. Torque manual bleed screw to 30 lbf•in.

Caution

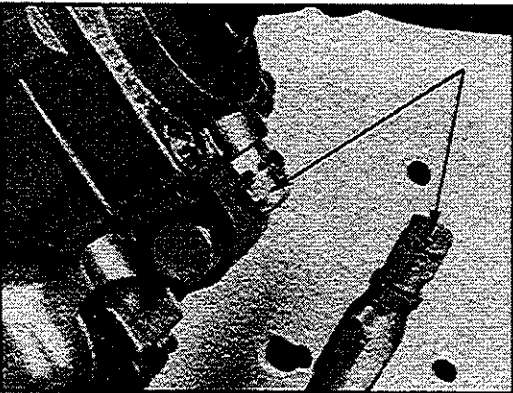
Do not turn steering wheel with bleed screw loosened.

Input Shaft Seal Replacement

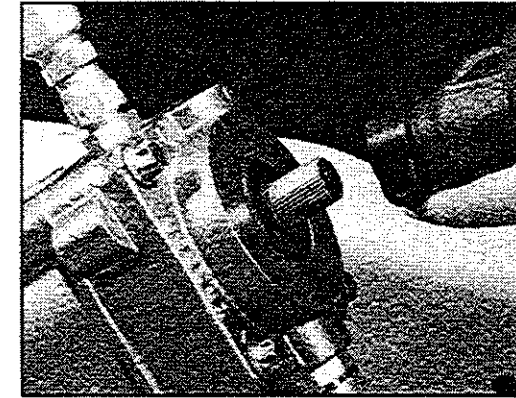
Tools Required	Materials Required
Hammer	Clean Cloth
J37073	Drip Pan
Screwdriver	High pressure fitting
	Hydraulic fluid
	Plug
	Shop towel

This procedure uses the vehicle's power steering pump to force out the input shaft seal. To use this procedure, the power steering pump should have a minimum of 1,500 psi available.

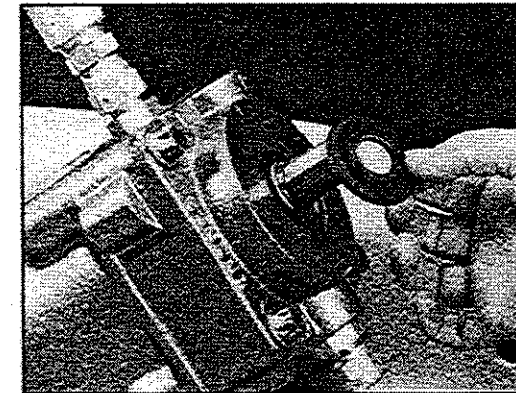
1. Disconnect return line from the steering gear and plug the line. Also, cap the return port of the gear with a high pressure fitting.



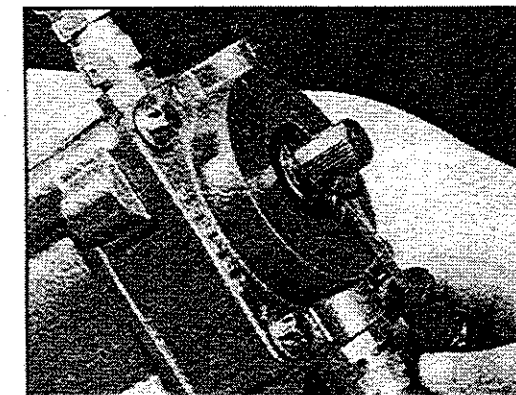
2. Remove the steering column from the gear input shaft.



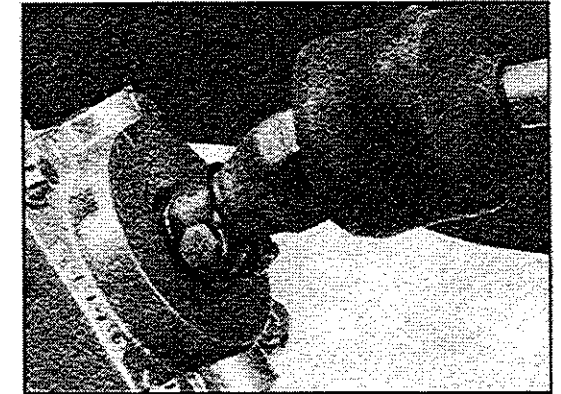
3. Remove the dirt and water seal from the steering gear.



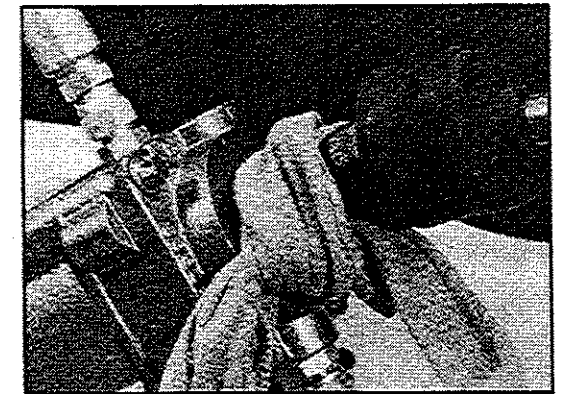
4. Wipe out the grease and then remove the spiral retaining ring. Use a screwdriver inserted into the notch formed in the end of the ring. Be careful not to scratch the bore with the screwdriver.



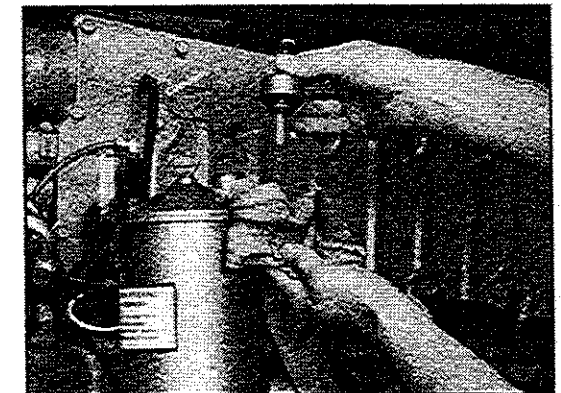
5. Slip the steering column back onto the input shaft with the pinch bolt installed, but not tightened.



6. Tie or wrap a shop towel around the input shaft area and place a drip pan under the vehicle to catch the oil.

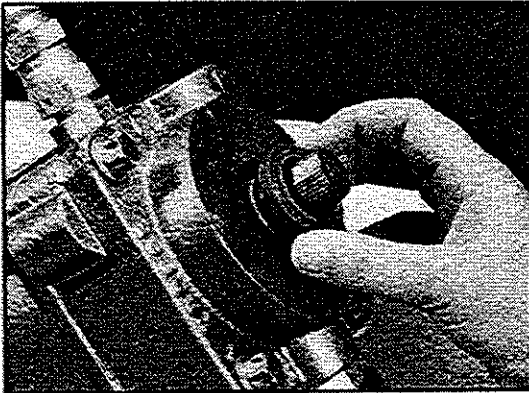


7. Add fluid as necessary, to the full line on the dipstick. Do not mix fluid types.

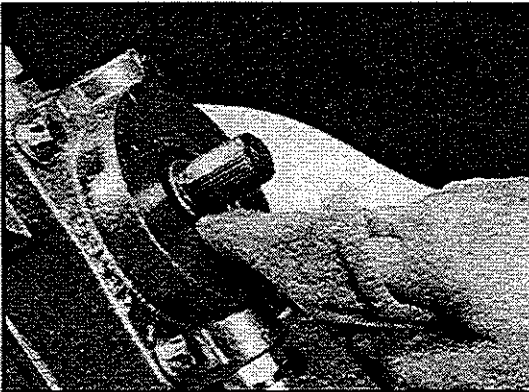


LTC Steering

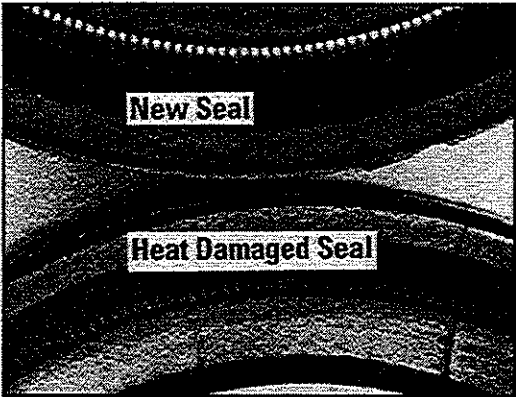
- 8. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).
- 9. Remove the shop towel. Disconnect the steering column, and remove the input shaft seal.



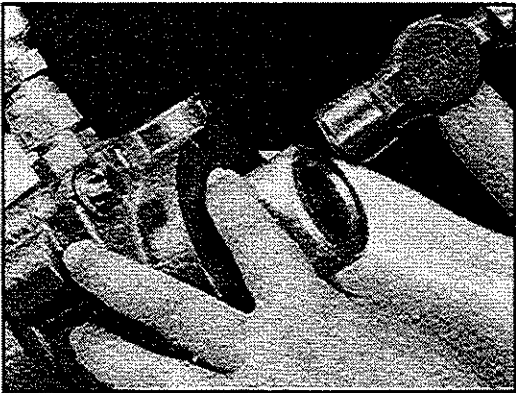
- 10. Check the seal area of the valve housing for any seal fragments. Remove any that are found.



- 11. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. Determine and fix the cause of the excessive heat in the vehicle.

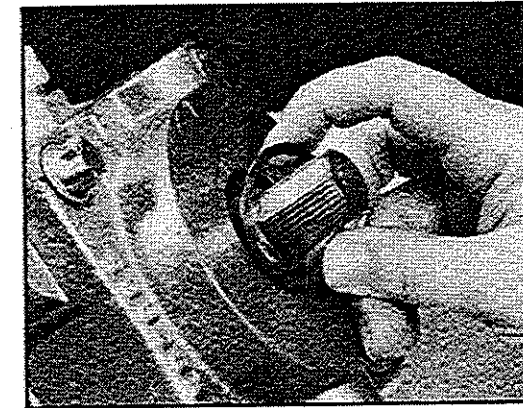


- 12. Put clean grease (Mobil Temp™ 1 or 2 or equivalent) on the inside dia of the new input shaft seal, and place it over the input shaft. With the small dia of tool J37073 against the seal, tap the tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.

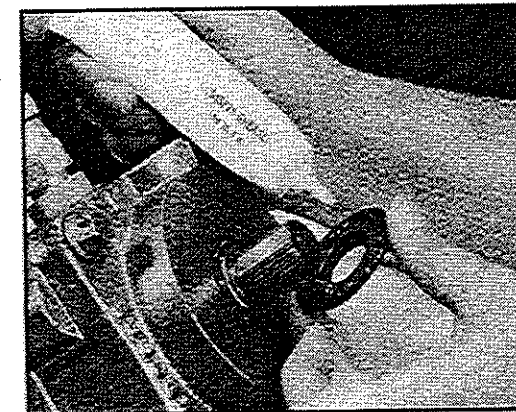


Caution
Do not use a socket to install this seal because you will not be able to control seal installation depth, possibly causing a leak.

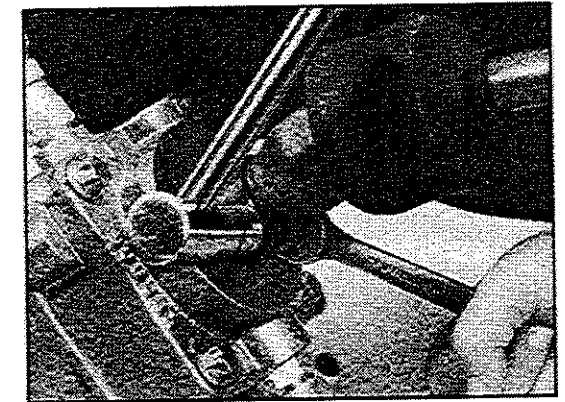
13. Insert new retaining ring into the groove.



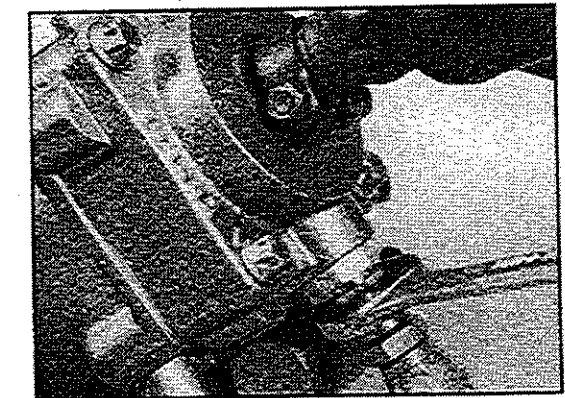
14. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease (Mobil Temp™ 1 or 2 or equivalent). Apply more of the grease to a new dirt and water seal and install it over the input shaft. Seat it in the groove behind the serrations and against the valve housing.



15. Reconnect the steering column to the input shaft and tighten the pinch bolt to torque level specified.



16. Reconnect the return line to the steering gear return port.



17. Air bleed the system using the procedure under the section entitled "Filling and Air Bleeding the System".

LTC Steering

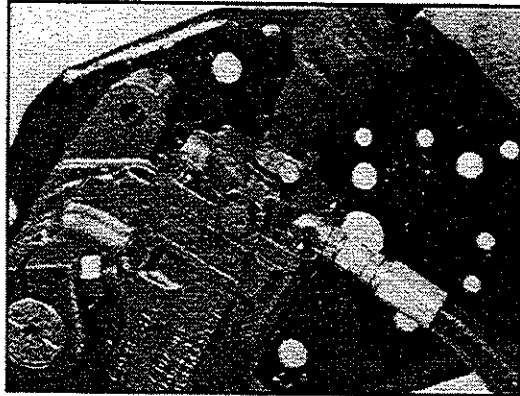
Sector Shaft Adjustment

Tools Required	Materials Required
Screwdriver	
3/4 inch Socket	
3/4 inch Open-end wrench	

This adjustment can only be completed on the vehicle if the adjusting screw jam nut is accessible. This nut is located on the side cover.

Photos in this section were taken on a mock frame rail for clarity.

1. With the engine off, rotate the steering wheel (input shaft) until the timing mark on the sector shaft lines up with the mark on the housing. The line on the sector shaft should be at a 90° angle from the input shaft. The sector shaft is now on its "center of travel".

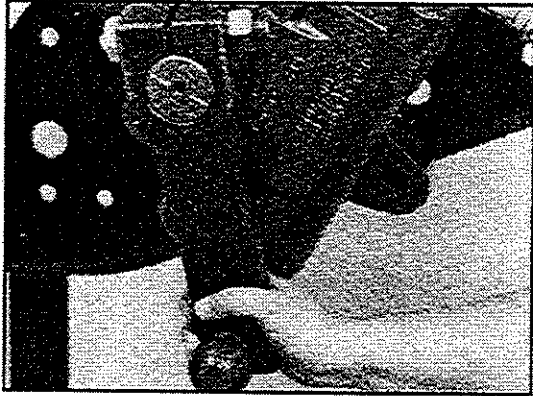


2. Remove the drag link from the pitman arm.

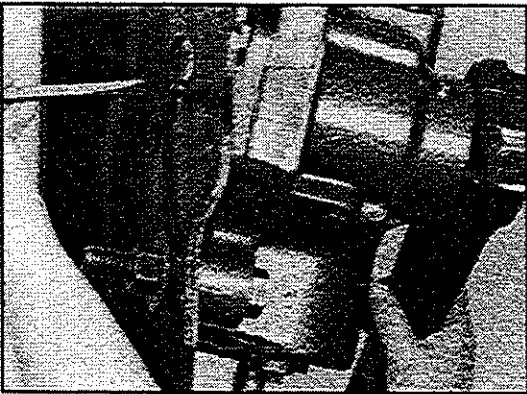
Caution

To avoid resetting the poppets, do not rotate the input shaft more than 1 1/2 turns from the "center of travel" position while the drag link is disconnected.

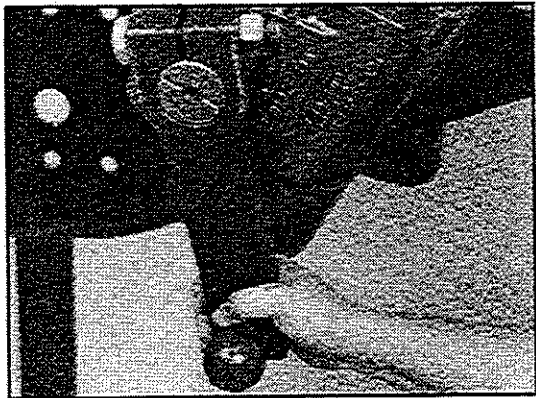
3. From the "center of travel" position, grasp the pitman arm and gently try to rotate it. If looseness or lash is felt at this point, the sector shaft is out of adjustment.



4. Loosen the jam nut.
5. If no lash was detected in step 3, turn the shaft adjusting screw counterclockwise until you feel lash at the output shaft.
6. Slowly turn the shaft adjusting screw clockwise until you feel no lash at the output shaft without using more than 10 lbf•ft (14 N•m) of torque. From this position, turn the screw clockwise 1/8 to 3/16 of a turn more. Hold the adjusting screw in place, and tighten the jam nut. Final torque 43 lbf•ft (58 N•m). (Use 3/4 inch wrench.)



- 7. Turn the steering wheel 1/4 turn each side of center, then back to center and recheck the pitman arm for lash. You should feel no lash. If there is lash, repeat steps 4, 6, and 7.



- 8. Reconnect the drag link to the pitman arm according to manufacturer's specifications.

Caution

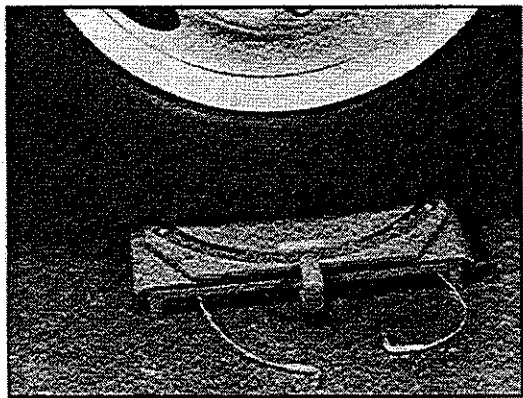
Maintain grease in the sector shaft bearing through the grease fitting in the housing using only a hand operated grease gun. Add grease until it begins to extrude past the dirt and water seal. Do not use a power grease gun because it will supply grease to fast; this could adversely affect the high pressure seal and contaminate the hydraulic fluid.

Poppet Readjustment

Tools Required	Material Required
7/32 inch Allen wrench	Hydraulic fluid
5/8 inch Open end wrench	Jack
3/4 inch Open end wrench	
3/4 inch Socket	
Lbf•lb Torque wrench	

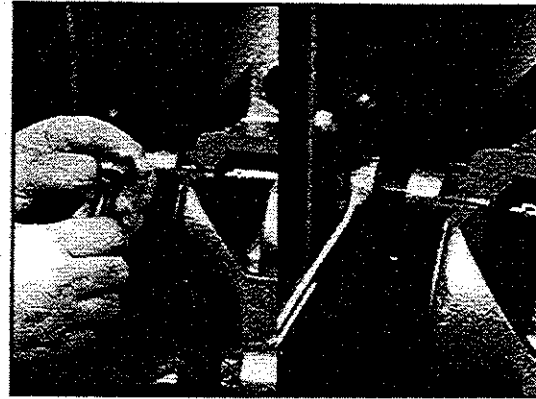
This resetting procedure will work in most cases with at least 1 3/4 hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this service manual.

- 1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications. Start the engine and allow the vehicle to idle for 5 - 10 minutes to warm the hydraulic fluid. Shut off the engine.



- 2. If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut. Your steering gear will have either a fixed stop bolt or an adjusting screw. If the adjusting screw is already part of the steering gear, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

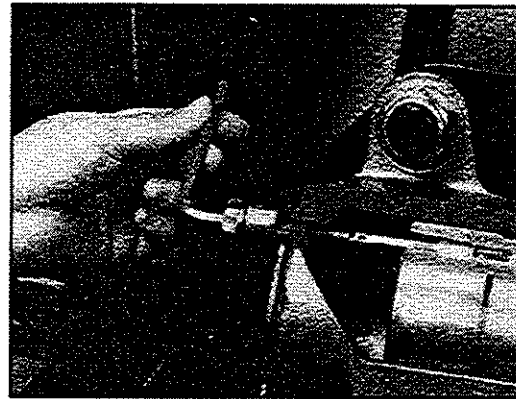
LTC Steering



3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of the housing. If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them. (Use 5/8 inch Open end wrench.)



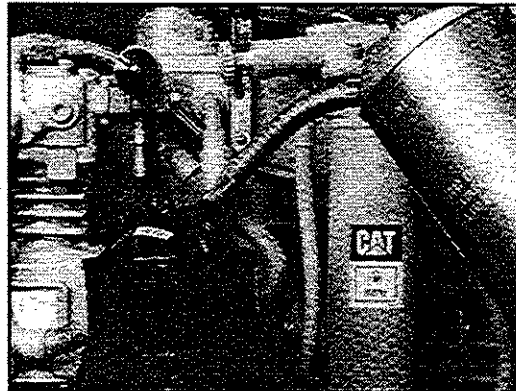
4. Turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 7/32 inch Allen wrench. Tighten the sealing nut against the housing.



Caution

If the drive end of the screw is below the face of the nut, the poppet seat flange will break during step 7d.

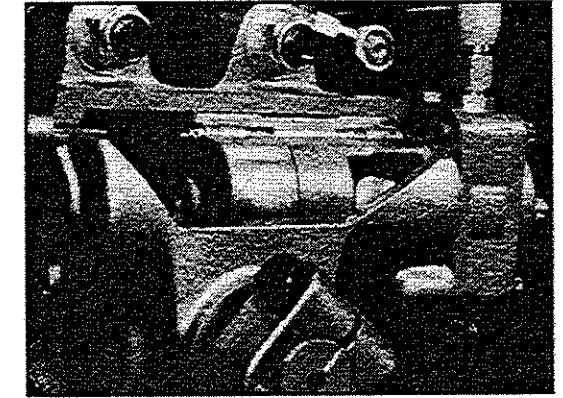
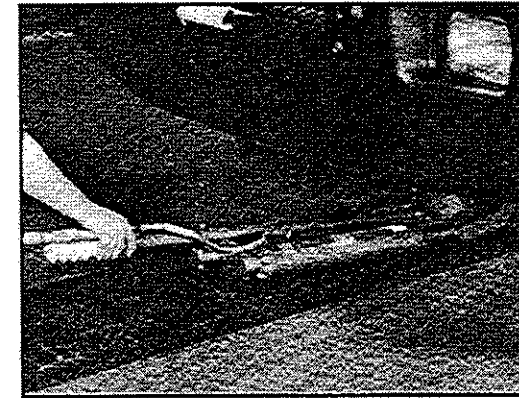
5. Refill the system reservoir with approved hydraulic fluid.



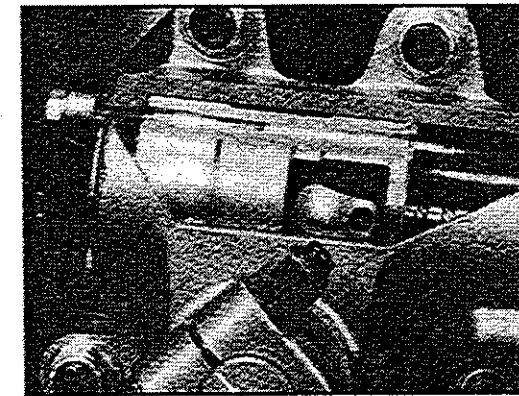
Caution

Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

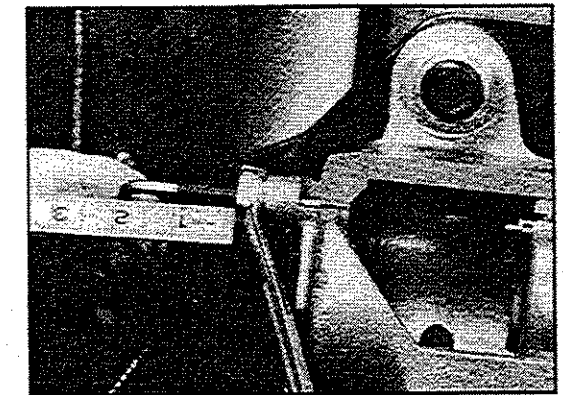


7. Start the engine and let it run at idle speed. Note which output shaft timing mark is nearest the housing piston bore. Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made. Pull hard on the steering wheel (put up to 40 lb rim pull on a 20 inch dia steering wheel) after the axle stop is contacted.



8. Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted. Pull hard on the steering wheel (put up to 40 lb rim pull on a 20 inch dia steering wheel). Release the steering wheel and shut off the engine.

9. Loosen the sealing nut and back out the adjusting screw until 1 inch is past the nut. Tighten the sealing nut against the housing.

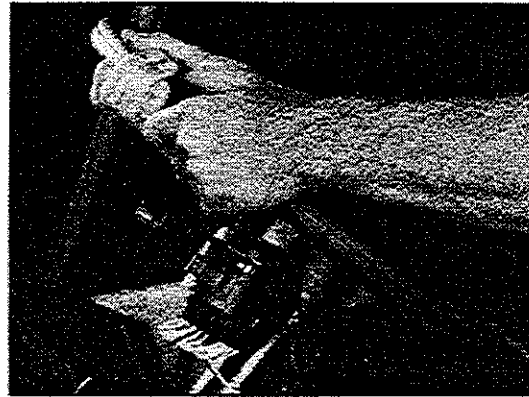


Caution

Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.

10. Start the engine and let it die. Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made. Hold the steering wheel in this position (with up to 40 lb rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 11.

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11. With steering wheel held tightly at full turn loosen the jam nut and hold it in place with a wrench. Turn the adjusting screw in (clockwise) using finger-pressure only (don't use a ratchet), until the Allen wrench stops. Do not attempt to turn it in further. Pause the turning-in process each time the driver releases the steering wheel; continue turning only while the wheel is held at full turn. Back off the adjusting screw 3 1/4 turns and tighten the sealing nut. Torque sealing nut to 35 lbf•ft.



12. The poppets have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

Warning

The length of the adjusting screw beyond the nut must be no more than 1 1/16 inch for proper thread engagement.

Note

The length of adjusting screw beyond the sealing nut may be different for each vehicle.

Dual System

TAS Gear with Linear Cylinder

Reset the TAS gear using the procedures described above.

TAS Gear with Rotary Cylinder

Back out the poppet adjusting screws (leave any fixed stop bolts in place) on the assist cylinder as follows:

RCS Rotary - 1 inch to 1 1/6 inch of poppet adjusting screw protruding beyond the nut.

RCB Rotary - Back both screws out completely, then screw back in 10 - 12 turns.

Set the main TAS gear using the procedures described above. Leave adjusting screws on rotary cylinders in place as described above after poppets on main gear have been reset.

Reseal and Repair

Disassembly Preparation

Stop the vehicle with wheels pointed straight ahead.

Clean off all outside dirt from around fittings and hose connections before you remove the gear.

Remove the input and output shaft connections per vehicle manufacturer's instructions.

Warning

When using a chisel to spread a pinch bolt-type pitman arm boss for assembly or removal from the shaft, maintain a firm grip on the chisel at all times. Failure to do this may result in the chisel flying loose which could cause an injury. Never leave the chisel wedged in the pitman arm boss. If you cannot remove the pitman arm from the shaft with a chisel and your hands, remove the chisel from the arm boss and use a puller only to remove pitman arm.

Caution

Do not use a hammer on the pitman arm to remove it from sector shaft as internal damage to steering gear could result. Be sure there is no spreading wedge left in the pitman arm boss before tightening pitman arm clamp bolt after assembly on sector shaft. Do not pound the universal joint or input shaft coupling on or off the input shaft as internal damage to the steering gear can result.

Caution

Unless the poppet adjuster seat and sleeve assemblies (22) are to be removed and replaced or reset for automatic poppet adjustment, or a manual adjustment with a service poppet adjuster screw (59) and nut (60) is anticipated, do not allow the input shaft on a steering gear with the automatic poppet adjustment feature to rotate more than 1.5 input shaft revolutions from "straight ahead position" when the output shaft is disconnected from the vehicle steering linkage. This could disrupt the poppet setting achieved at initial installation. The steering gear is in the "straight ahead position" when the timing marks on the end of the housing trunnion and sector shaft are aligned.

Remove the supply and return lines from the gear, and immediately plug all port holes and fluid lines.

Warning

TAS steering gears can weigh up to 110 pounds dry. Exercise caution when you remove, lift, carry or fix in a bench vise.

Remove the steering gear from the vehicle and take it to a clean work surface.

Clean and dry the gear before you disassemble it.

As you disassemble the gear, clean all parts in clean, OSHA approved solvent, and air blow-dry them only.

Warning

Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

Warning

Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

Caution

Never steam clean or high-pressure wash hydraulic steering components. Do not force or abuse closely fitted parts. Use care that bearing and sealing surfaces are not damaged by the assembly and disassembly procedures.

Keep each part separate to avoid nicks and burrs.

Discard all seals, o-rings, and gaskets removed from the gear. Replace them with new parts only.

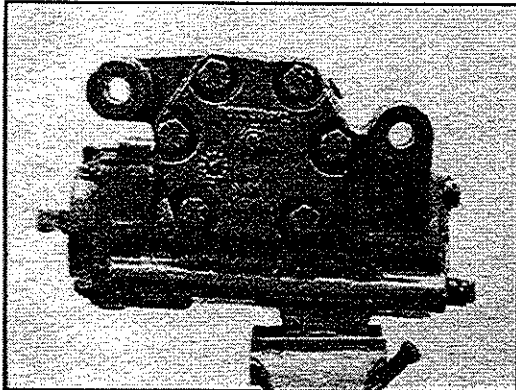
The steering gear should be identified to the vehicle from which it was removed. The poppet adjuster seat and sleeve assemblies are set for that particular vehicle only.

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Disassembly

Tools Required	Materials Required
Allen wrenches	Emery cloth
Pocket knife	Standard sockets
Ratchet	Torx socket
Rolling head pry bar	Vise
Rubber Mallet	

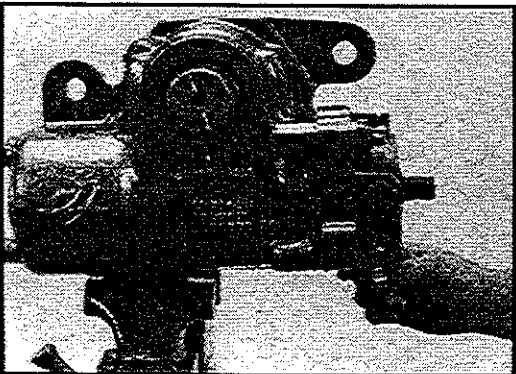
1. Put the steering gear in a vise, clamping firmly against the housing mounting flange or boss. Input shaft should be horizontal; size cover and valve housing are accessible for disassembly.



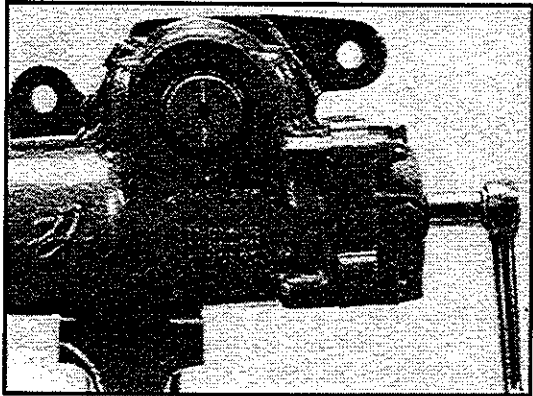
Caution

Do not clamp against body of housing. If mounting boss or flange is not accessible, fabricate and attach a mounting plate to the housing mounting bosses.

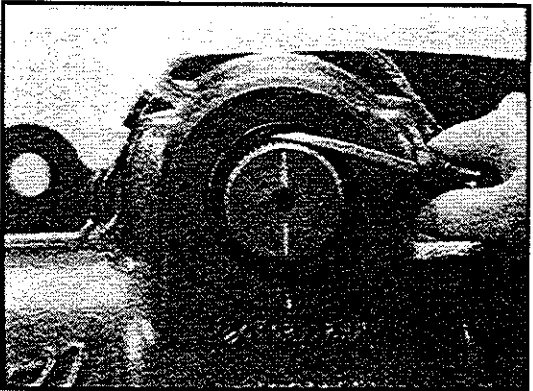
2. Prepare for fluid draining and unplug hydraulic ports.



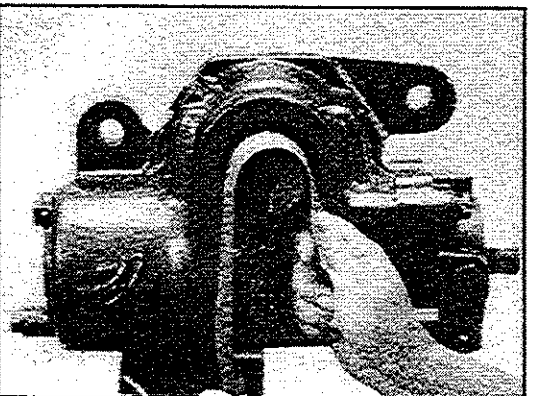
3. Rotate the input shaft until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing. This will position the sector shaft for removal.



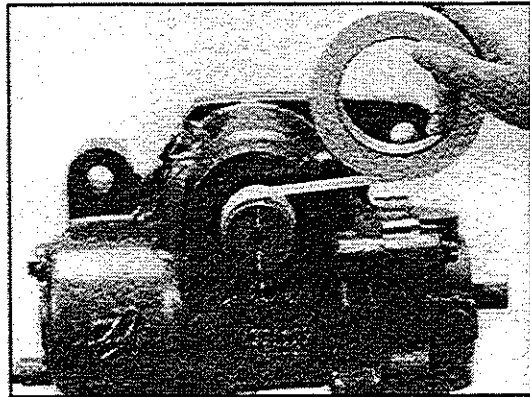
4. Remove and discard dirt and water seal from the housing trunnion.



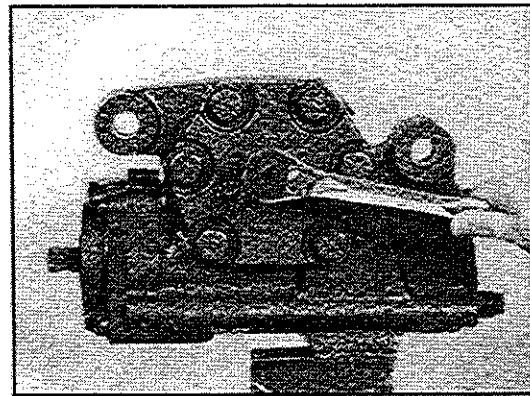
5. Remove any paint or corrosion from the exposed are of the sector shaft.



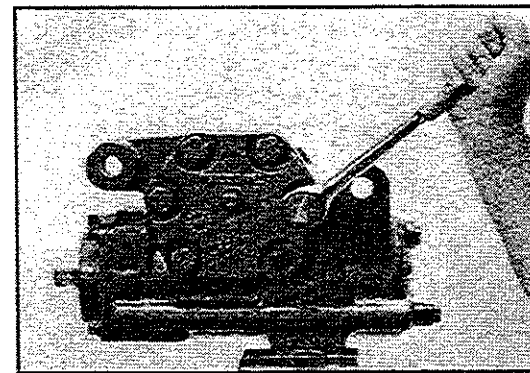
6. Tape the serrations and bolt groove of the sector shaft with one layer of masking tape. The tape should not extend onto the sector shaft bearing diameter.



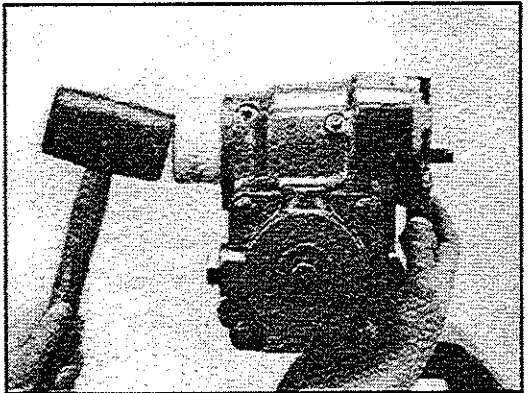
7. Remove the sector shaft adjusting screw jam nut. (Use the 3/4 inch socket)



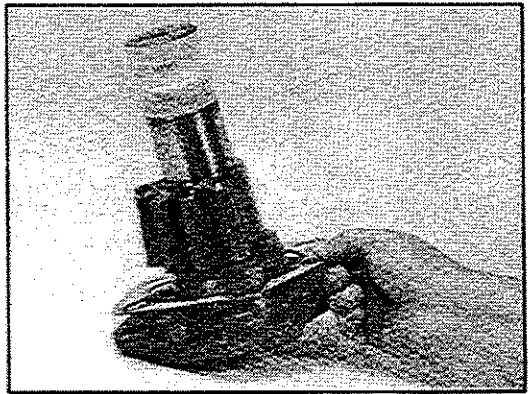
8. Be prepared for more fluid drainage and remove the six or eight special bolts from the side cover.



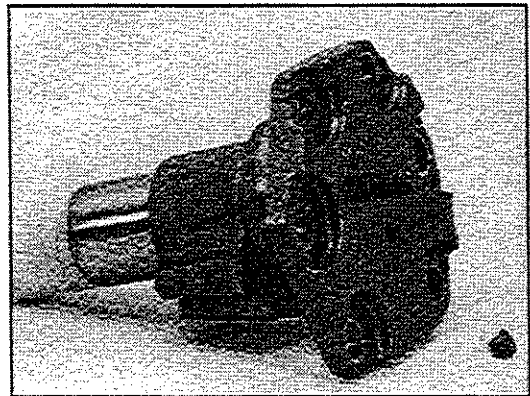
9. Be prepared for more fluid drainage and remove the side cover and sector shaft assembly from the gear. You may start the shaft and cover assembly removal by tapping the end of the shaft lightly with a soft mallet or wooden hammer handle.



10. Remove and discard the side cover gasket.

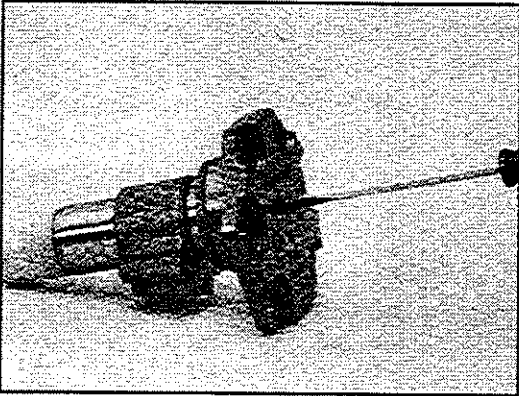


11. Remove and discard the vent plug.



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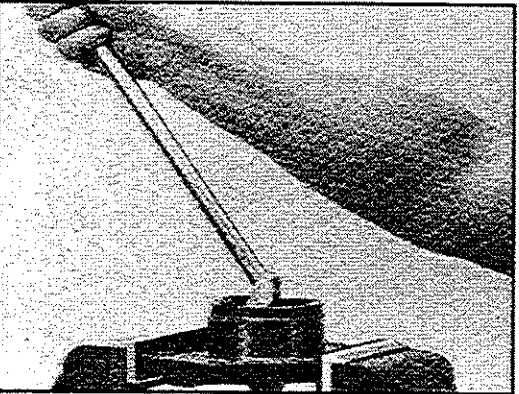
12. Screw sector shaft adjusting screw clockwise through the side cover and pull the sector shaft out of the side cover.



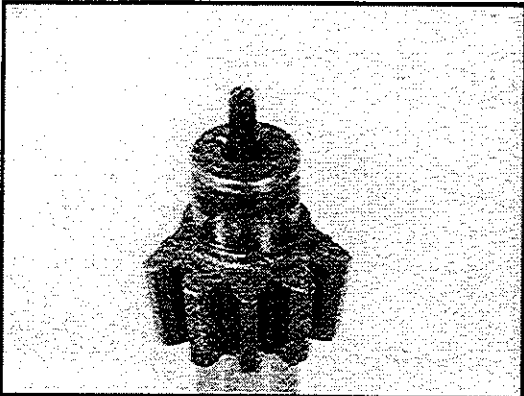
Caution

Don't damage the bore or DU bushing when removing the seal. TAS85 gears are not equipped with the DU bushing.

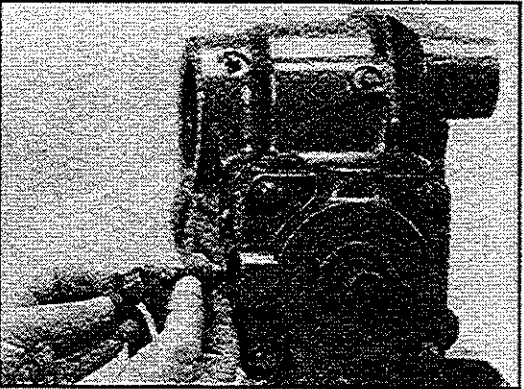
13. Clamp the side cover in a vise. Place a standard 5/8 inch or 11/16 inch - 3/8 inch drive socket in the center of the side cover. Pry the seal out with a rolling head pry bar, using the socket for support. Discard the seal and remove the socket.



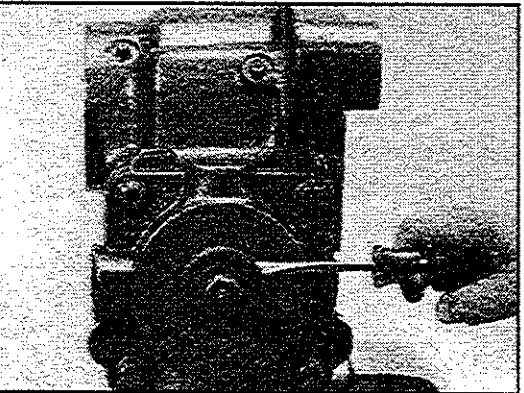
14. Inspect the sector shaft assembly for damaged adjusting screw threads. The retainer must be securely staked in place. The adjusting screw must rotate by hand with no perceptible end play (lash).



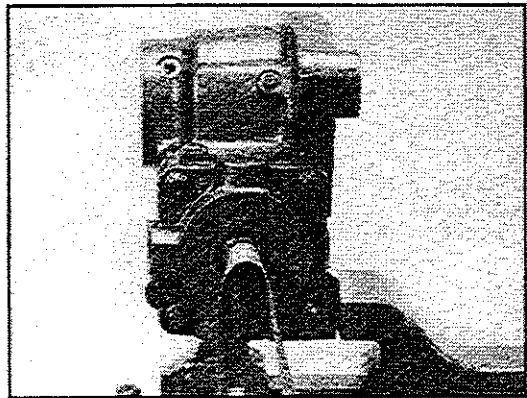
15. If equipped, remove relief valve cap, o-ring and two-piece relief valve from the valve housing. Discard the o-ring.



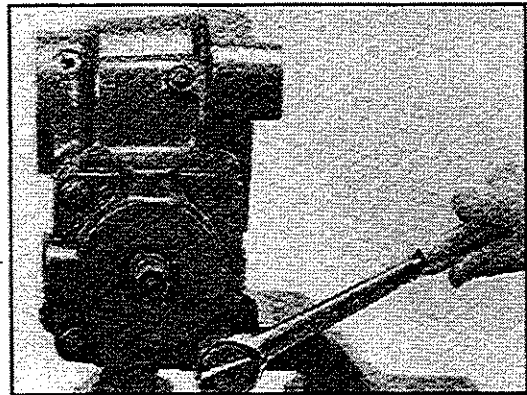
16. Remove and discard the dirt and washer seal from the input shaft.



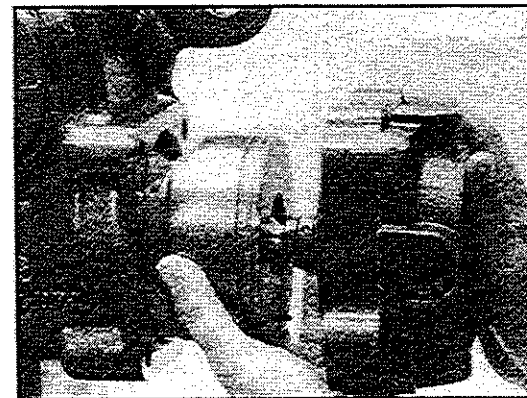
17. Clean any paint or corrosion from the exposed area of the input shaft.



18. Remove the four torx head valve housing bolts.



19. Be prepared for more fluid drainage and remove the rack piston subassembly. Place the assembly on a clean cloth. For the TAS85 it may help to rotate the input shaft to move the rack piston toward the lower end of the housing. This will force the valve housing to exit the main housing.

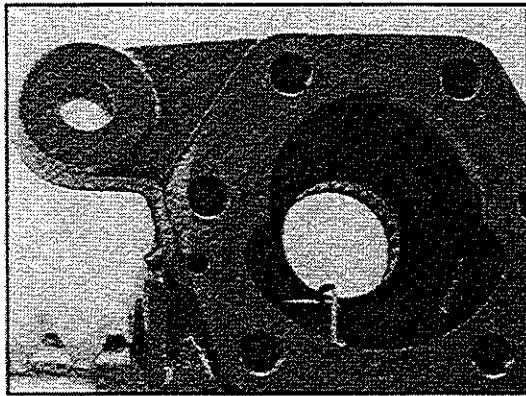


Caution

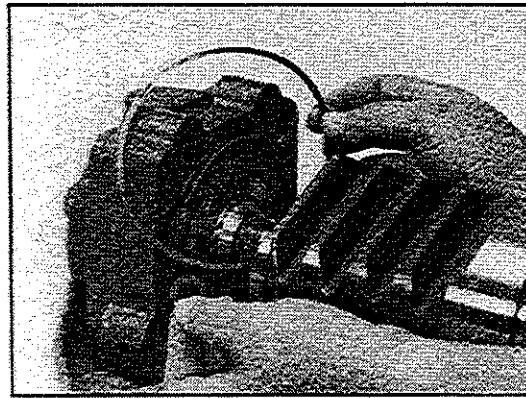
The set position of poppet seat and sleeve assemblies must not be disturbed if the poppets are not going to be replaced or reset during disassembly.

Note

If your gear is short "V" construction, the rack piston seal is on the end of the rack piston farthest from the input shaft. Remove the seal before removing the valve housing assembly to prevent the Teflon rack piston seal ring from "hanging up" when it exits the housing. Expose the seal through the sector shaft cavity, then cut and remove the seal ring from the rack piston.



20. Remove and discard the valve housing seal rings.

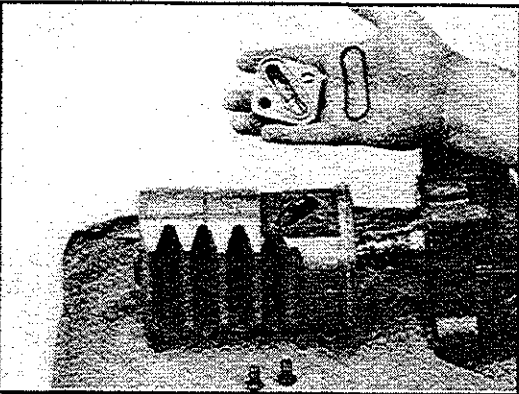


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Caution

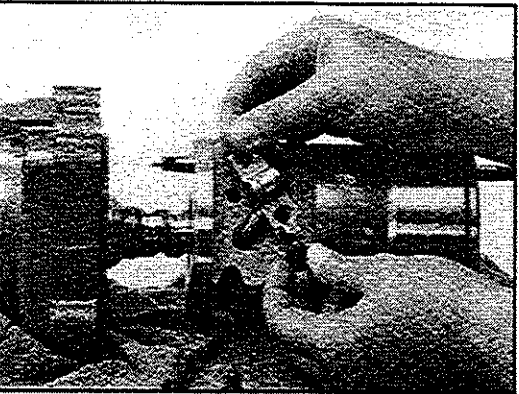
Do not remove the input shaft, valve worm assembly or balls from the rack piston until the ball return guides are removed as damage to the ball guides will occur.

- 21. Remove and discard the two special sealing screws. Remove the ball return cap and cap seal; discard the seal.

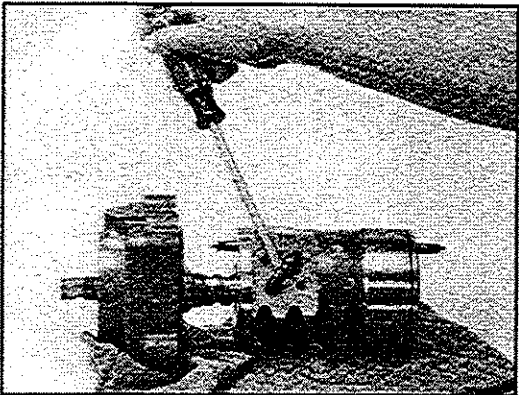


OR

Bend down the two tabs (tang) that are against the hex head bolts. Remove two bolts and the clip; discard the clip.



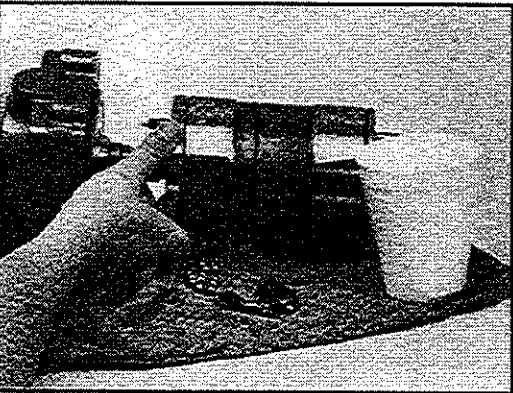
- 22. Make sure the rack piston is on a cloth so the steel balls that fall out won't roll very far. Remove ball return guide halves by carefully inserting a screwdriver between the rack piston and guides.



Note

Left hand ball return guide halves are copper plated for identification and right hand guides are not plated.

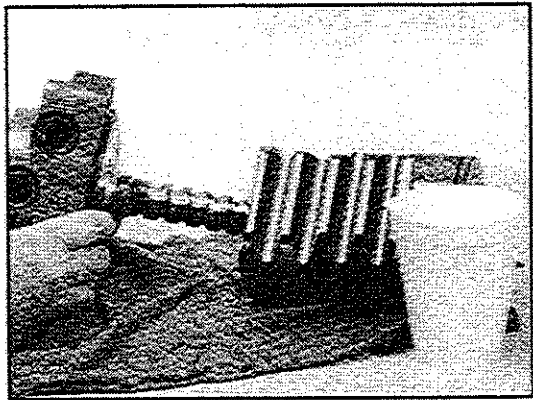
- 23. Remove the steel balls from the rack piston by rotating the input shaft, valve worm assembly until the balls fall out. Place the balls and return guides in a cup or other container. Count the balls, and make sure all have been removed.



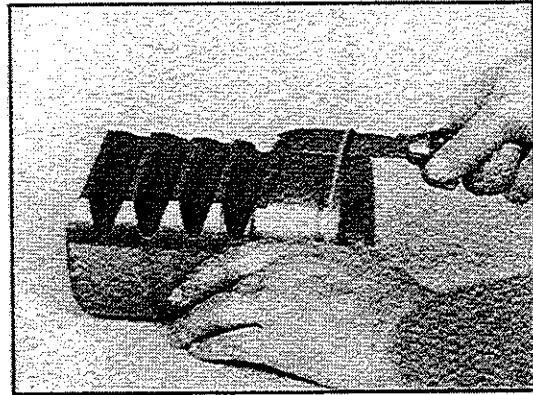
Note

The steel balls are a matched set. If any are lost, the set must be replaced by service balls. Number of factory balls installed: TAS85-34.

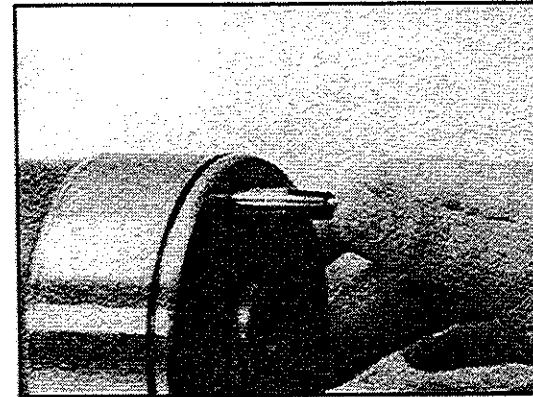
- 24. Remove the input shaft, valve/worm, valve housing subassembly from the rack piston.



25. Cut and remove the Teflon seal ring and o-ring from the rack piston if not removed during disassembly in the "Note" following step 19.

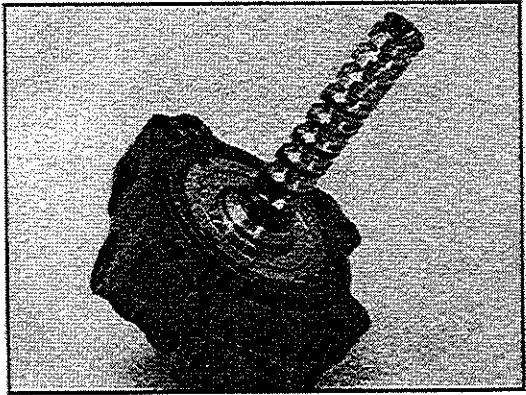


26. Push poppet stems, they should spring back. Push poppet seat, it should not move by hand. If components are bent or broken, poppet stems don't spring back, or poppet seat moves by hand, go to Poppet Component Replacement section. Otherwise, proceed to step 27.

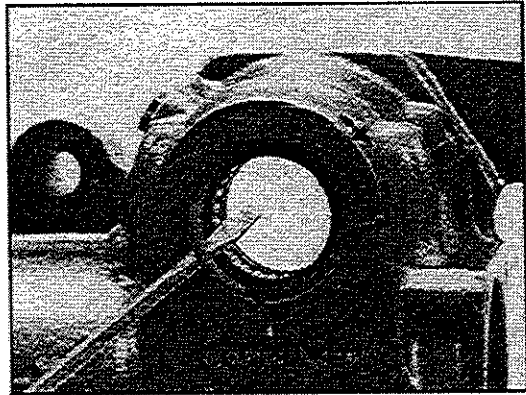


Note
TRW recommends the poppet adjuster seat and sleeve assemblies not be removed unless replacement of poppet components is required.

27. Inspect valve housing/worm screw subassembly for heat damage or bearing roughness. If these conditions are present, or if there was excessive internal leakage, or if preload adjustment is required, go to Valve housing/Worm Screw Disassembly procedures.

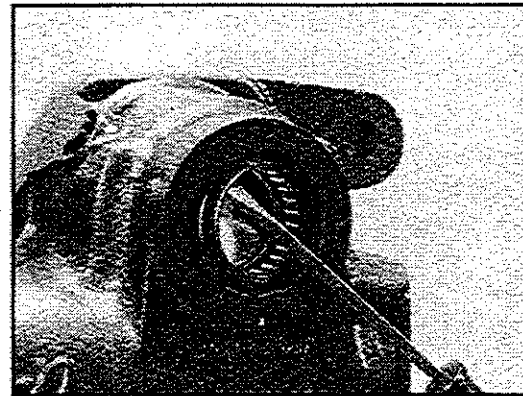


28. Remove the retaining ring that is closest to the output end of the housing trunnion.

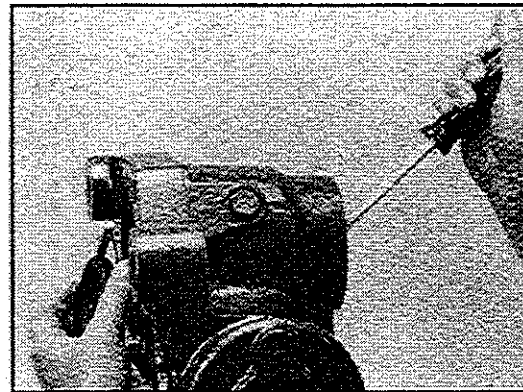


29. Remove and discard dirt seal.

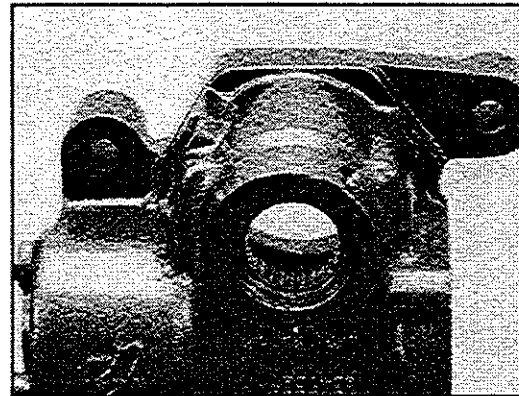
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30. Insert a screwdriver into housing bearing bore from the trunnion end and carefully push seal and spacer washer out of the other end of bearing bore without damaging the sealing area of the bore or the spacer washer. Discard the seal.



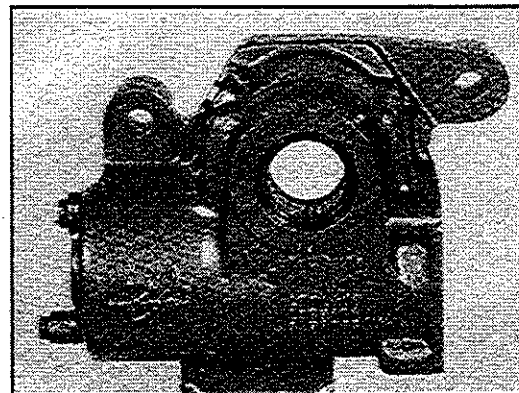
31. Inspect roller bearing in the housing for brinelling or spalling. Inspect retaining ring for damage. If replacement of either part is required, go to Roller Bearing or Retaining Ring Replacement. If not, proceed to step 32.



32. Inspect the following for damage:

Poppet fixed stop screw and washer, if equipped
Poppet adjusting screw and sealing nut.
Auto-bleed plug
Manual bleed screw
Auxiliary port plugs and o-rings

If any are damaged, go to Replace Housing Ports, Plugs and Screws. If not, proceed to the Inspection Section.



Inspection

Make sure all sealing surfaces and seal cavities are free from nicks and corrosion. Any nicked or corroded surface requires part replacement to ensure proper sealing.

Wash all parts in clean, OSHA approved solvent. Air blow them dry only.

Warning

Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

Warning

Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

Warning

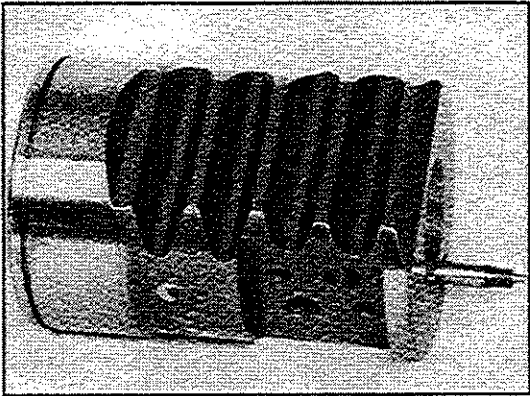
Any of the following conditions present in the steering gear indicates impact damage.

Condition	Area
Brinelling	Ball track grooves of rack piston
	Ball track grooves of worm screw
	Bearing area of sector shaft
	Thrust washers and bearings in valve housing
Cracks or Breaks	Bearing area of sector shaft
	Sector shaft teeth
	Rack piston teeth
	Housing
	Thrust washers and bearings in valve housing
	Worm screw
Twisted serrations	Output shaft serrations

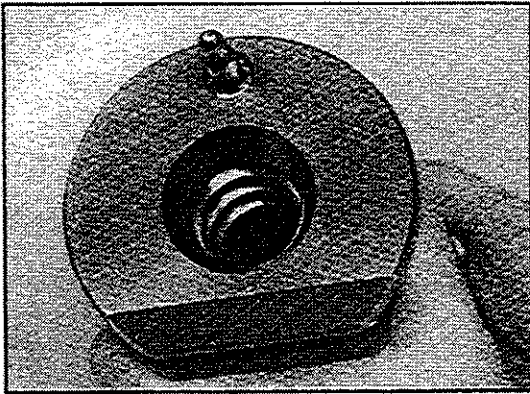
If one of these conditions is found in one component, be sure to inspect all components carefully for signs of impact damage. Replace components noted in individuals inspection steps below if you suspect impact damage. Failure to replace all damaged components could result in a serious vehicle accident.

- 1. Inspect the rack piston teeth for cracks or obvious damage. If teeth are

damaged, replace the rack piston, sector shaft and set of balls.

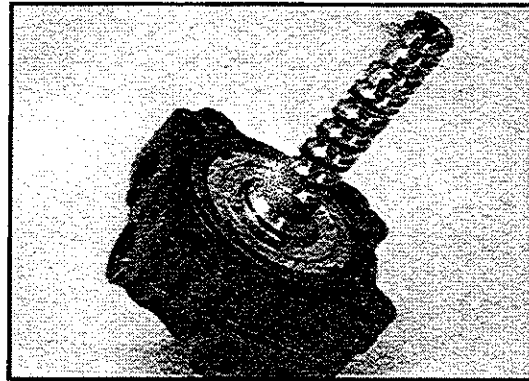


- 2. Inspect the rack piston ball track grooves for brinelling or spalling. If either condition exists, replace the input shaft, valve/worm assembly, valve housing, rack piston subassembly and balls.

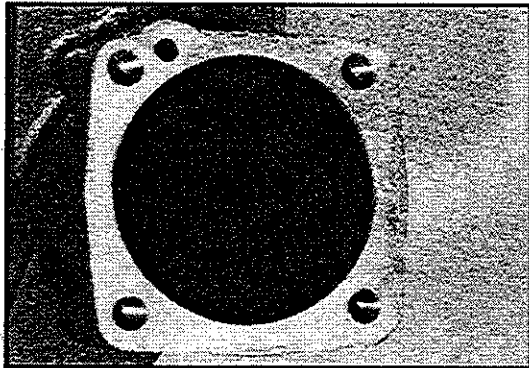


- 3. Inspect the sealing area of input shaft and valve for nicks and damage. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, replace the input shaft, valve worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.

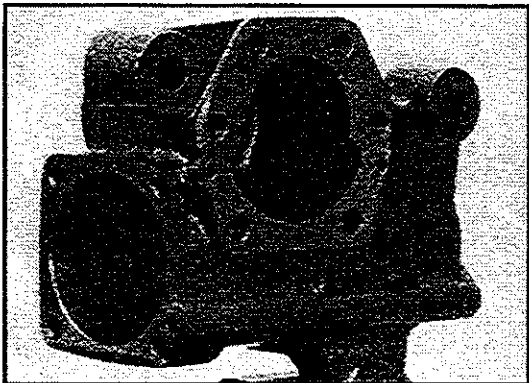
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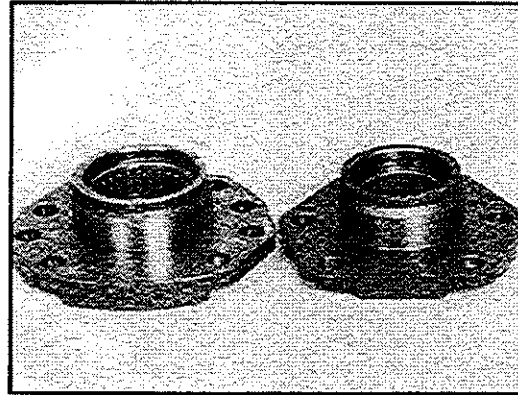
4. Inspect the housing cylinder bore. Some scoring marks are normal. If there was internal leakage greater than 1 gal/min, make sure there are no damaged seals before replacing the housing.



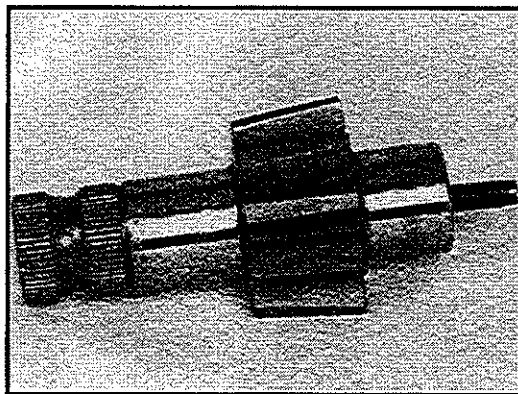
5. Inspect to housing faces for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a fine-tooth flat file without changing the dimensional characteristics.



6. For TAS85, inspect roller bearing in side cover assembly for brinelling or spalling. If either condition exists, replace the side cover and bearing assembly.



7. Inspect the sector shaft bearing and sealing areas and sector teeth contact surfaces for brinelling, spalling or cracks. Run your fingernail edge across these areas to detect steps. Remove masking tape from the shaft and inspect for twisted or otherwise damaged serration. If any of these conditions exist, replace the sector shaft.



Note

A service sector shaft will come assembled with the adjusting screw and retainer.

Assembly Preparation

Wash all parts in clean, OSHA approved solvent. Air blow-dry them only.

Warning

Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

Warning

Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

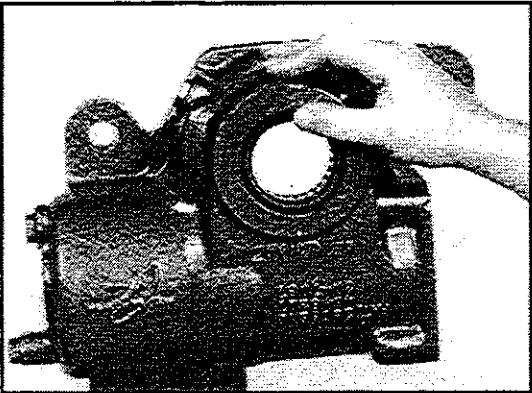
Replace all seals, seal rings and gaskets with new ones each time you disassemble the gear.

TRW Commercial Steering Division does provide individual seals, seal rings and gaskets, as well as complete seal kits. These parts should be available through most OEM parts distributors. Contact your local dealer for availability.

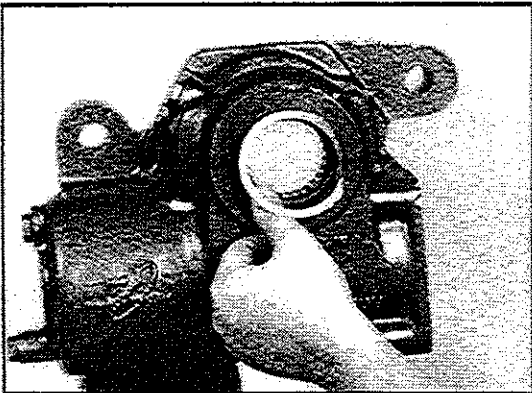
Assembly

Tools Required	Materials Required
5/32 inch Allen wrench	ATF Oil
Lbf•ft Torque wrench	Grease (Mobil Temp™ 1 or 2 or equivalent)
Hammer	Masking tape
J38779 (TAS85)	7/16 inch-14 x 7 1/4 inch All Thread
Press	Seal kit: Ross TAS850002
Punch	
Ratchet	
Screwdriver	
Sockets	
Torx sockets	
Vise	

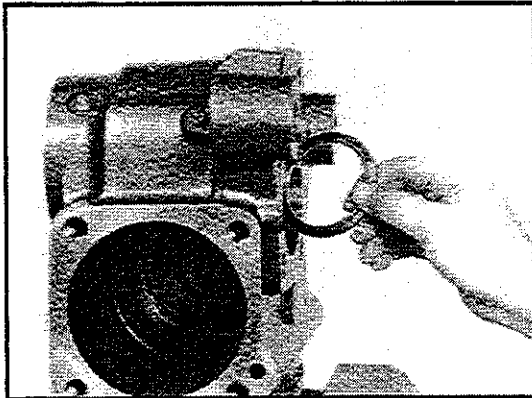
1. Install new dirt seal into the trunnion end of housing sector shaft bore and against bearing with the seal lip out.



2. Install the second retaining ring seating it firmly in the housing retaining ring groove.

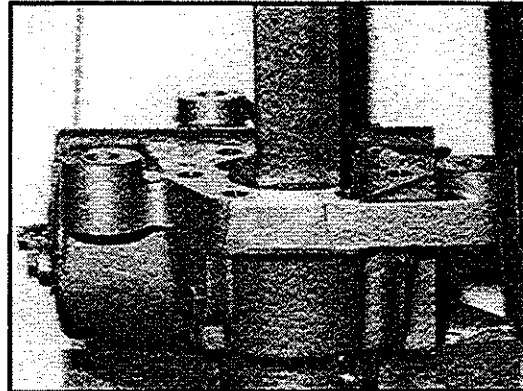


3. Install washer into the side cover side of housing seal bore with small diameter piloted into retaining ring.

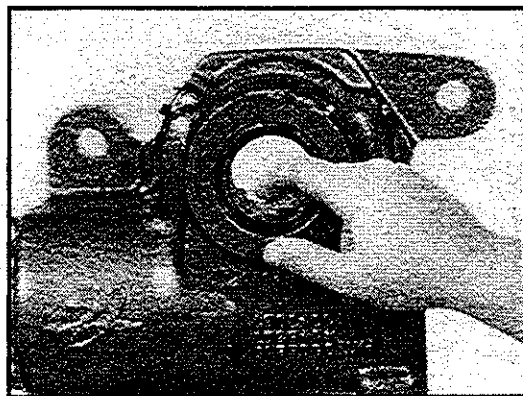


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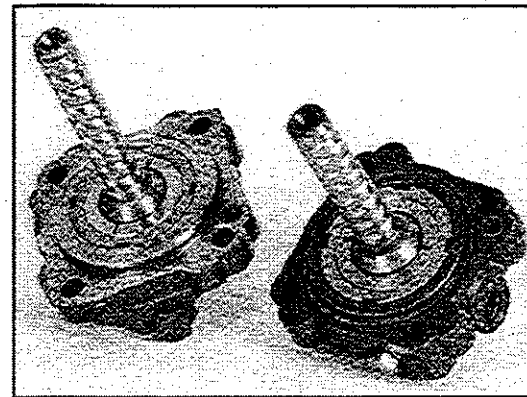
4. Assemble new seal onto bearing and seal tool so the lip with the garter spring is toward the shoulder of the tool. Working from the side cover of the housing, pilot the seal tool into the washer and bearing and press with a force of 100-800 lb (445-3, 560 N) until the seal is seated against washer (TAS85 - J38779).



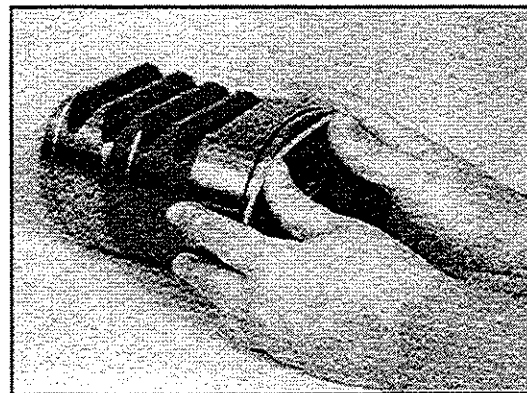
5. Liberally pack the area between dirt seal and pressure seal including roller bearing with clean, high temperature industrial grease, Mobil Temp™ 1 or 2 or equivalent.



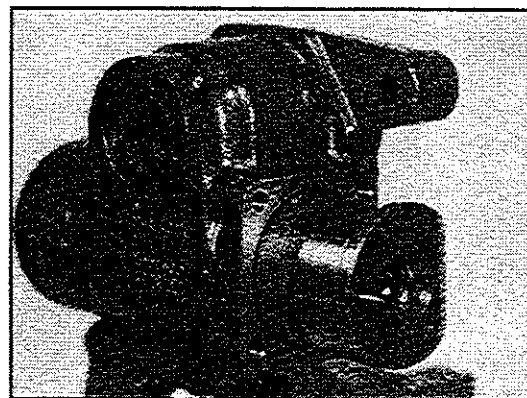
6. Lightly oil new seal ring and assemble in valve housing mounting face groove. For TAS85, oil new seal ring and assemble in valve housing pilot groove.



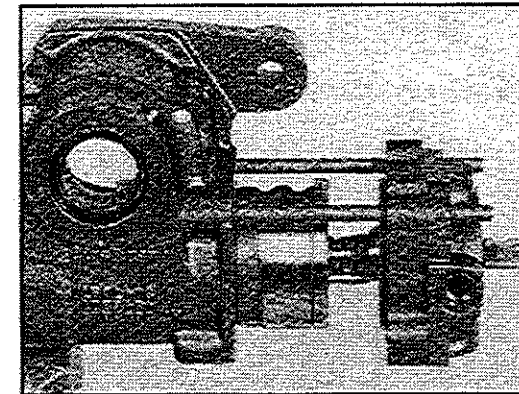
7. Install a new backup o-ring and then a new Teflon seal ring on rack piston. Do not over-stretch these rings as you install them. Do not allow the Teflon seal ring to be twisted.



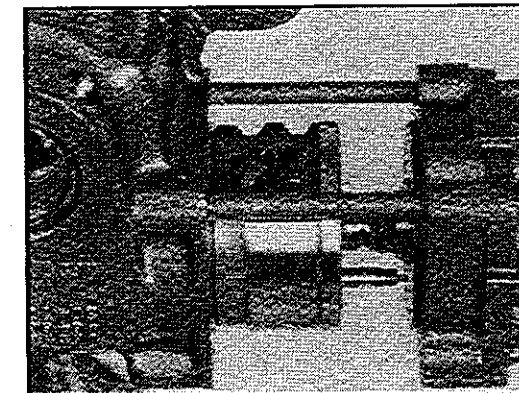
8. Apply clean oil to housing cylinder bore. Place the rack piston in the housing piston bore with ball return guide holes up.



9. Insert the worm screw into the rack piston close to maximum depth, without the valve housing making contact with the poppet stem. Insert two 7/16 inch - 14 All threads through valve housing bolt holes and tighten into housing to support the worm screw. Line up rack piston ball guide holes with the worm ball track grooves by rack piston ball guide holes with the worm ball track grooves by rotating the input shaft.



10. Compare the new guides with the guides removed from the gear, use the ones that look the same. Left hand guides are copper plated, right hand guides are unplated. Assemble the new ball return guide halves into the rack piston until seated, rotate the input shaft slightly if necessary.



Warning

Do not seat guides with a hammer. Damage to guides can result in subsequent lockup or loss of steering.

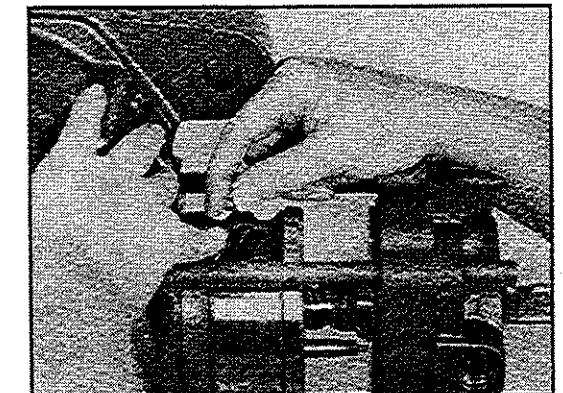
Caution

If a new rack piston or a new input shaft, valve, worm subassembly is being assembled, the balls removed from the unit must be discarded and a service ball kit utilized. The balls in a service ball kit are sized to function in the ball track guide path as altered by component replacement.

Caution

When using the service ball kit, use the correct quantity of service balls: TAS85-34.

11. Hold the ball return guides firmly in place during this entire procedure. Insert as many of the steel balls as you can through the hole in the top of the ball return guides. Rotate the input shaft to pull the balls down and around the ball track guide path. Continue until the correct number of balls are in the ball track guide path.



Warning

Hold down the ball return guides until cap or clip is reinstalled. Failure to hold the guides will result in a trapped ball or balls, which could cause a vehicle accident. If the ball guides become unseated (raise up) at any time, repeat the procedure starting at step 9.

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Warning

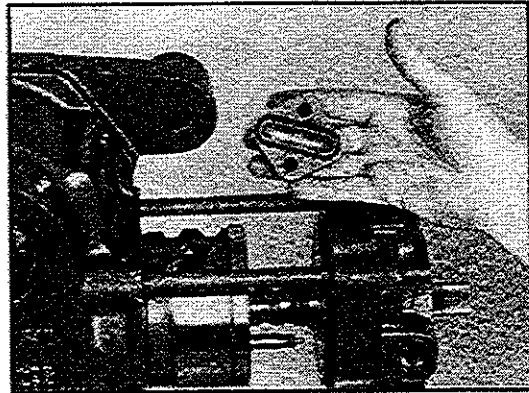
The correct number of balls are required for proper gear operation. Count the balls and insert each carefully as in step 11.

TAS85	
Original	34
Service	34

Caution

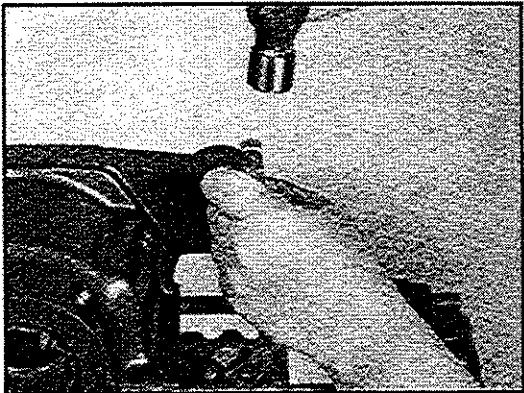
Do not allow valve housing to contact the poppet stem or move more than 2 1/2 inches (69.1 mm) from upper end of rack piston during these procedures. This could incorrectly reset the poppet, or back out worm beyond closed ball loop, trapping balls.

12. If your gear is equipped with the ball return guide cap, grease a new ball return guide cap seal and place it in the seal groove of the cap. Assemble the cap so the seal makes full contact with the rack piston surface. Install two new Allen or Torx head screws and torque each screw alternately until a final torque of 18 lbf•ft (24.5 N•m) is achieved.

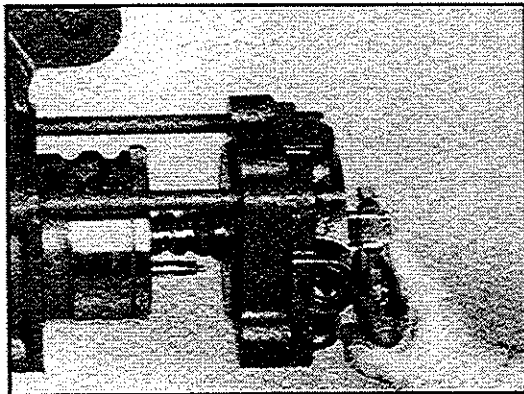


OR

13. If your gear is equipped with a ball return guide clip, instead of a cap, install a new clip so both bolt hole faces are in full contact with the rack piston surface. Install the two hex head bolts. Torque the bolts to 18 lbf•ft (24.5 N•m). Finish by bending the guide clip locking tabs up against the bolt head flats.



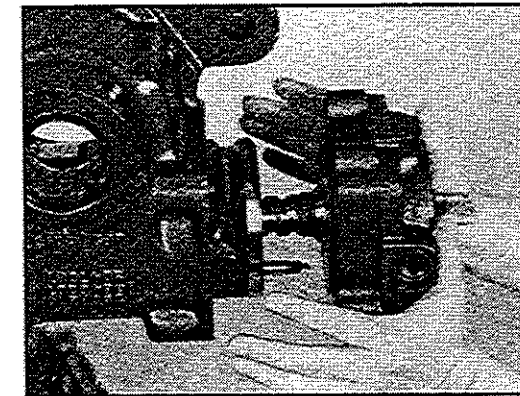
14. Rotate the input shaft from one end of travel to the other without contacting the poppet stem to the valve housing, and without moving the valve housing face more than 2 1/2 inch (69.1 mm) from input end (upper end) of rack piston. If you cannot rotate the input shaft, remove the balls and reassemble them.



Warning

If you install a gear on a vehicle with the worm shaft unable to rotate, the gear will not function correctly. Steering and gear failure may result.

15. Apply clean oil to Teflon seal ring on rack piston. Make sure there is a space of 3/8 to 1/2 inch (10.0 - 13.00 mm) between valve housing and poppet stem to prevent poppet contact at either end. Remove the All Threads, and push the rack piston assembly into the housing with the rack piston teeth toward the sector shaft cavity. Line up the valve housing cylinder feed hole with the gear housing feed hole. Make sure both o-rings in the valve housing remain in position.



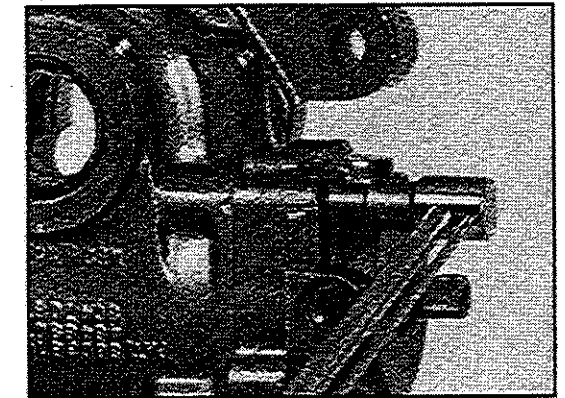
Caution

Do not damage the seal ring while installing the rack piston into housing. If the seal ring end of rack piston enters the housing first, the seal ring will be destroyed when the rack is removed.

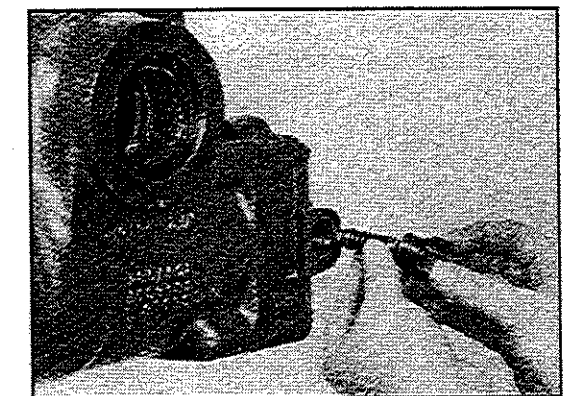
Caution

The poppet seat and sleeve assemblies must not bottom against the internal poppet stops in the steering gear until the gear is installed on the vehicle and the poppet adjustment procedures are performed.

16. Lubricate and install the four valve housing bolts into the housing. Torque the TAS85 bolts to 118 lbf•ft (160 N•m).

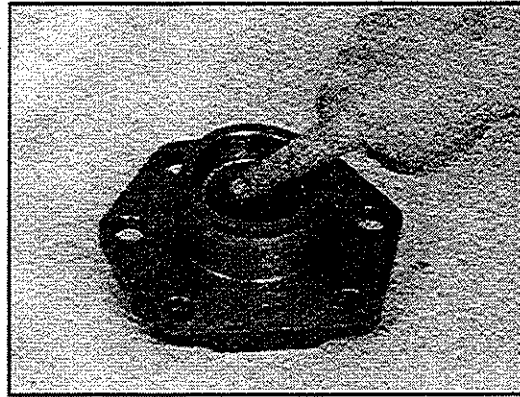


17. If the gear is equipped with a relief valve, assemble a new o-ring on relief valve cap. Assemble the small end of tapered spring onto the pin on the relief valve cartridge and insert the assembly, (large end of tapered spring end first) into the relief valve cap cavity. Turn the relief valve cap as assembled into the valve housing and torque to 30 lbf•ft (41 N•m).



18. For TAS85, apply a generous amount of Mobil Temp™ 1 or 2 (do not substitute another type of grease) to the caged bearing assembly inside the side cover.

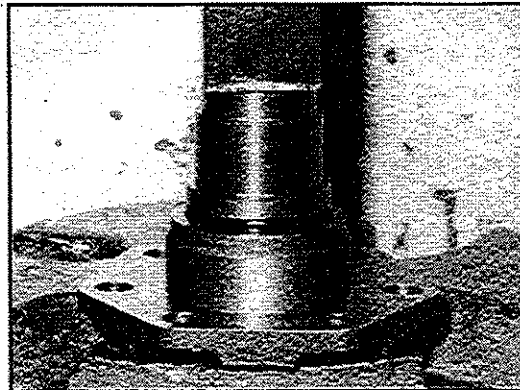
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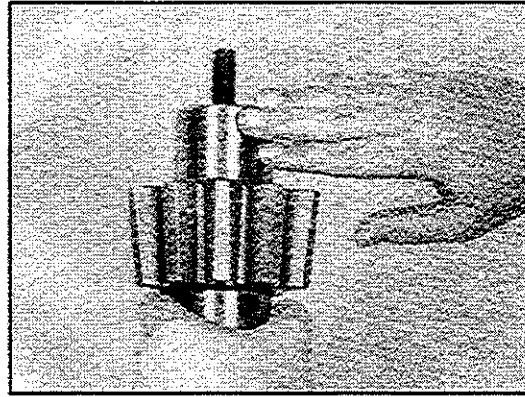
Caution

This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use the proper grease could result in premature bearing wear.

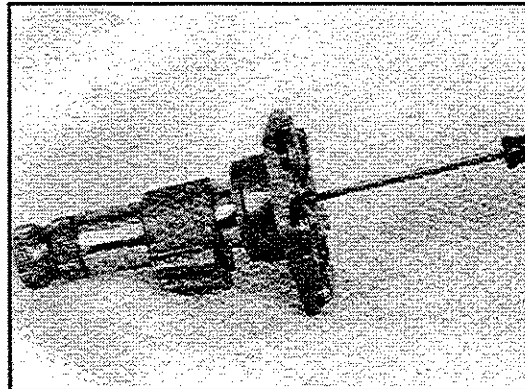
19. Grease and assemble new seal onto installation tool so the side with the garter spring is against the should of the tool. Pilot the tool into the side cover with a force of 100-800 lb (445-3560 N) until it is seated against the bearing or bushing.



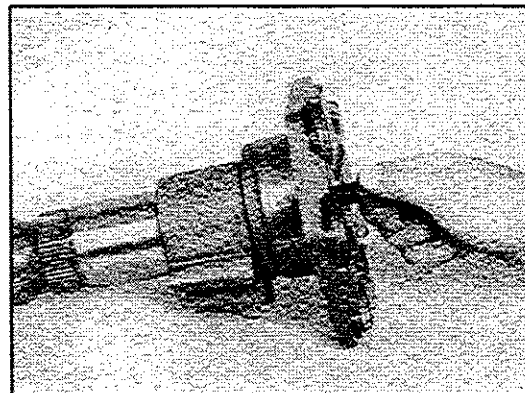
20. For TAS85, apply a generous amount of Mobil Temp™ 1 or 2 or equivalent to the short bearing area of the sector shaft.



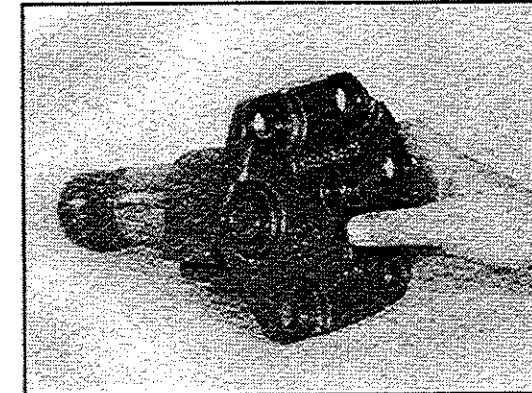
21. Insert the sector shaft into the side cover subassembly, and screw the sector shaft adjusting screw counterclockwise into the side cover until the screw reaches solid height. Rotate the adjusting screw clockwise one half turn so the side cover will rotate freely on the sector shaft.



22. Install the sector shaft adjusting screw jam nut onto the sector shaft adjusting screw a few threads. Final adjustment will be made later.



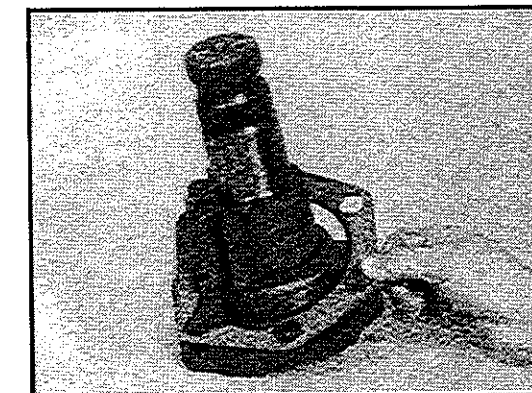
23. Press the new vent plug into the hole provided in the side cover until the plug is bottomed.



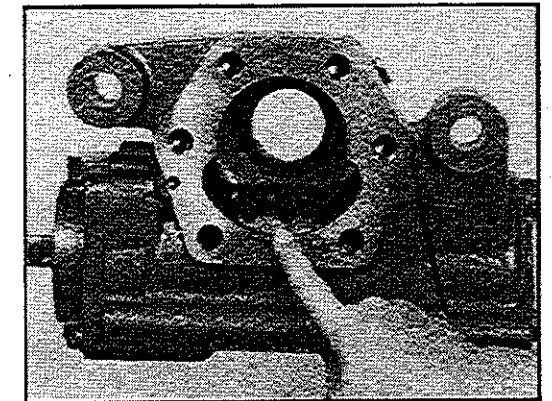
Warning

Do not weld or otherwise plug this hole in any permanent manner. This is a safety vent which functions only if the side covered seal fails. If the seal fails and the plug cannot vent, the steering gear may lock up or otherwise malfunction.

24. Apply clean grease to the new side cover gasket to hold it in place and assemble it onto the side cover.



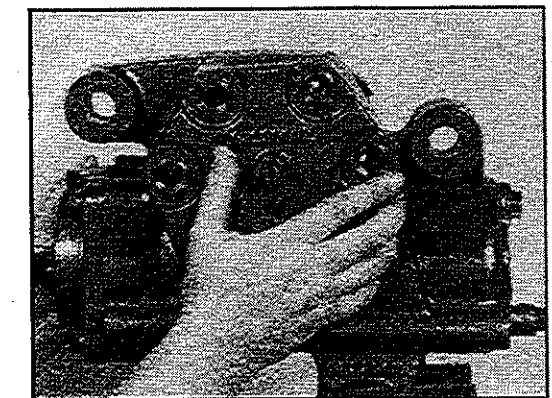
25. There are four teeth on the rack piston. Rotate input shaft to position the rack piston so the space between the second and third tooth is in the center of the sector shaft opening. This will center the rack piston for assembly of sector shaft.



Warning

If the rack piston is not centered when sector shaft is installed, gear travel will be severely limited in one direction. This could result in an accident.

26. Clean off any old tape on the serrations. Reapply one layer of masking tape. Install the sector shaft assembly into the housing. The center tooth of the sector shaft must engage the center space (between the second and third tooth) of the rack piston, with side cover gasket in place.

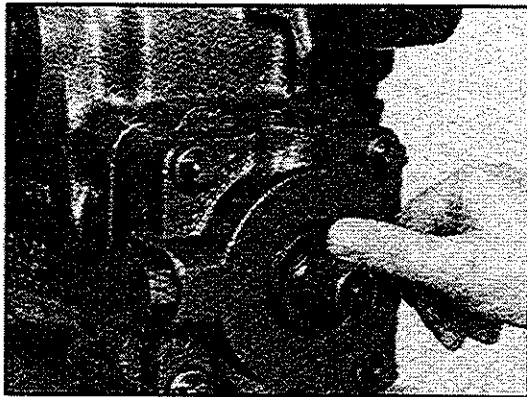
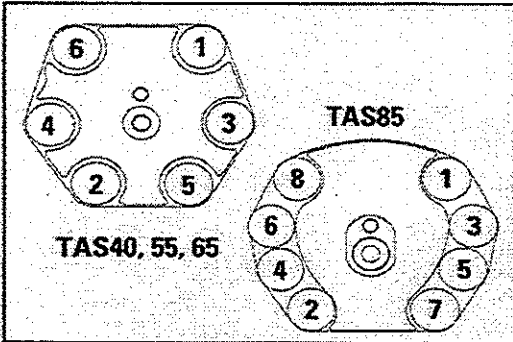


Caution

If the serrations are not properly taped, they will damage the output seal in housing, causing the seal to leak.

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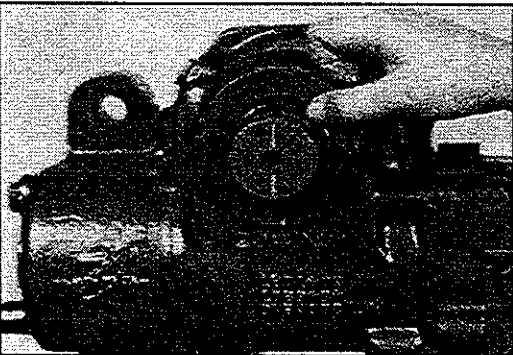
27. Install the special side cover bolts into the side cover and torque them in the sequence shown. If bolts must be replaced, use bolts of the same design, type and length as those you removed. Do not use a substitute. Lubricate side cover bolts and torque TTA85 bolts to 170 lbf•ft (230 N•m).



Proceed to Final Adjustments.

Poppet Component Replacement

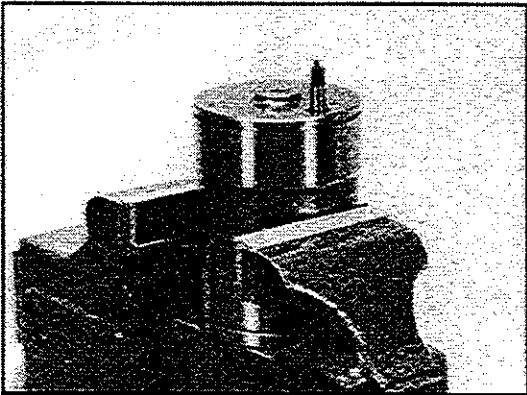
1. Remove tape from sector shaft and pack the end of housing trunnion area at the sector shaft with clean, high temperature industrial grease, Mobil Temp™ 1 or 2 or equivalent. Apply more of the grease to inside of the new trunnion dirt seal and assemble it over the sector shaft and into the trunnion bore.



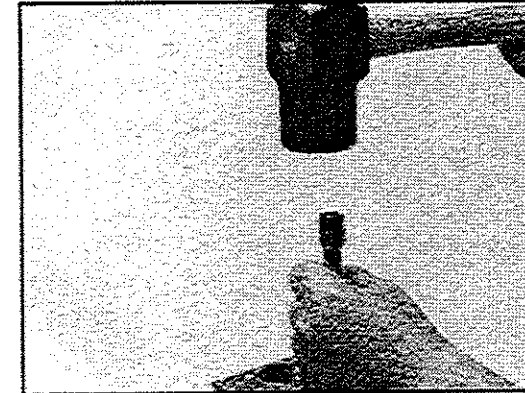
29. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease, Mobil Temp™ 1 or 2 or equivalent. Apply more of the grease to the inside of a new dirt and water seal and install it over the input shaft and seat it in the groove behind the serrations and against the valve housing.

Tools Required	Materials Required
2 lb Sledge	Locquic "T" primer
Lbf•ft Torque wrench	Loctite RC680
J36452-A	
Press	
3/8 inch x 6 inch drill rod	
Ratchet	
Soft-jawed vise	

1. If the poppet assemblies are to be removed for replacement, place rack piston in a soft-jawed vise.



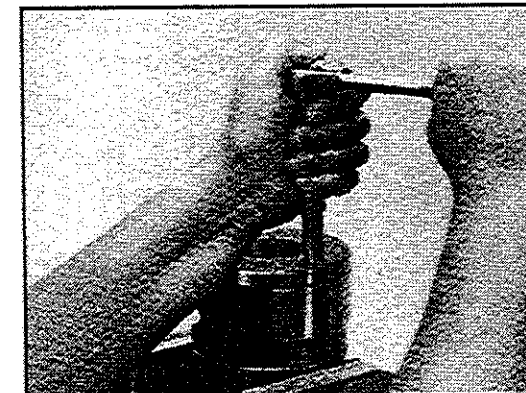
2. Slide special tool #J36452-A over the seat of poppet adjuster seat and sleeve assembly and engage tool in the slots in the threaded sleeve. Hit the end of the tool firmly four or five times with a 2 lb sledge hammer to loosen Loctite.



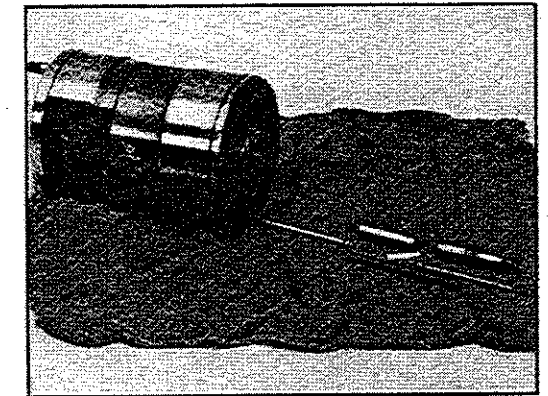
Caution

Poppet adjuster seat and sleeve assemblies are retained by Loctite applied to the threads which makes the assemblies difficult to move.

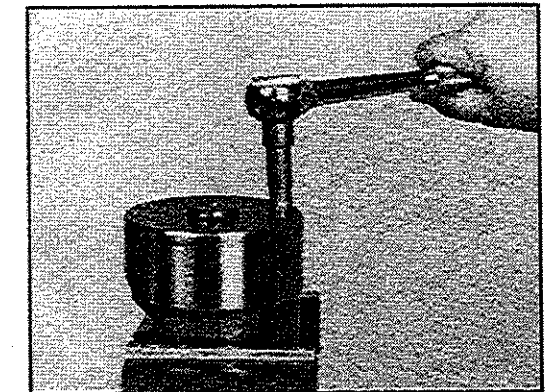
3. With a ratchet applied to the tool, turn one adjuster seat and sleeve assembly out of the rack piston. If the ratchet does not turn easily, strike the adjuster removal tool again with a hammer. If the engaging tangs won't stay in place with torquing, it might be necessary to hold in place with an arbor press while applying loosening torque. Discard poppet seat and sleeve assembly.



4. Remove the two poppets, spring, spacer rod and push tube.



5. Remove and discard remaining poppet seat and sleeve assembly only if required.



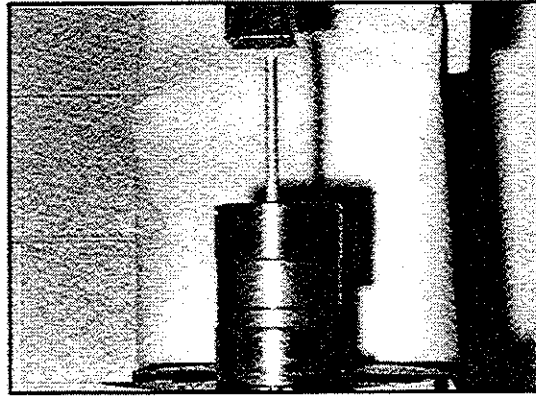
Note

It is possible to reset one poppet adjuster seat and sleeve assembly for automatic poppet adjustment while it is in the rack piston if one adjuster seat and sleeve assembly and the poppets, spring, spacer rod and push tube are removed.

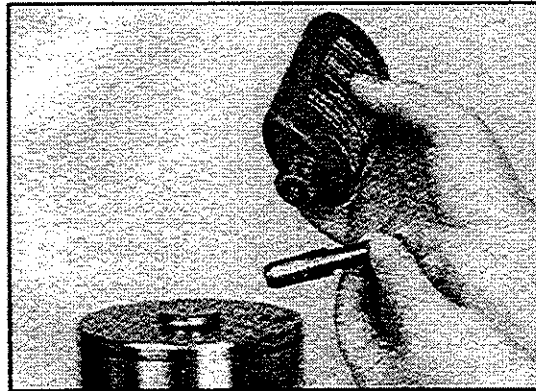
6. If one poppet seat and sleeve assembly was left in rack piston, it can be reset for automatic poppet adjustment by inserting a 3/8 inch (9.52 mm) diameter x 6 inch (152.4 mm) drill rod down through the poppet seat hole at the opposite end of the rack piston and against the adjuster seat to press the seat

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in until it bottoms against the adjuster sleeve.



7. Carefully apply Locquic "T" primer to the threads in poppet holes, and threads on the new seat and sleeve assemblies. Allow to dry for ten minutes; then carefully apply Loctite RC680 to same threads.



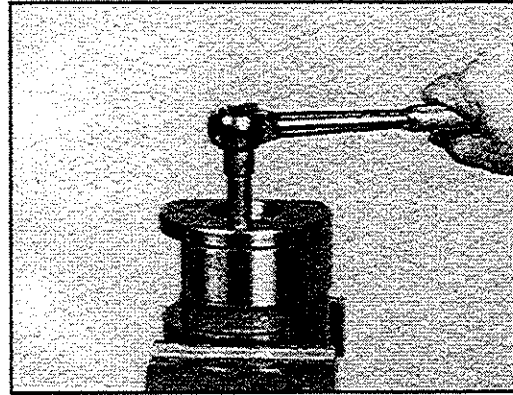
Caution

Do not allow Loctite or Locquic to get on the adjuster seat component of the adjuster seat and sleeve assembly. The poppets will not function properly.

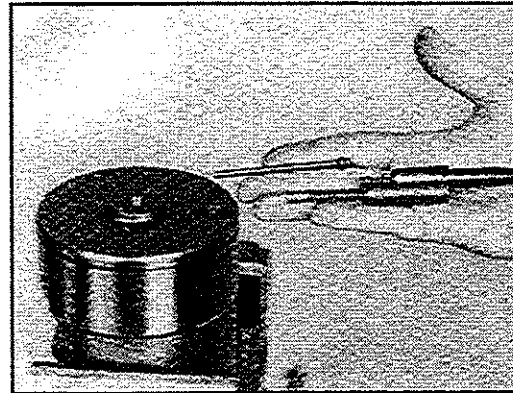
Warning

Wear eye protection while assembling poppets, as spring loaded poppets could eject and cause eye injury.

8. Place rack piston in a soft-jawed vise and turn one new poppet adjuster seat and sleeve assembly (slotted end out) into the poppet hole in one end of rack piston.



9. From the other end of the poppet hole in the rack piston, install: one poppet, poppet spring, nylon spacer rod, push tube, other poppet, and the other new poppet adjuster seat and sleeve assembly.



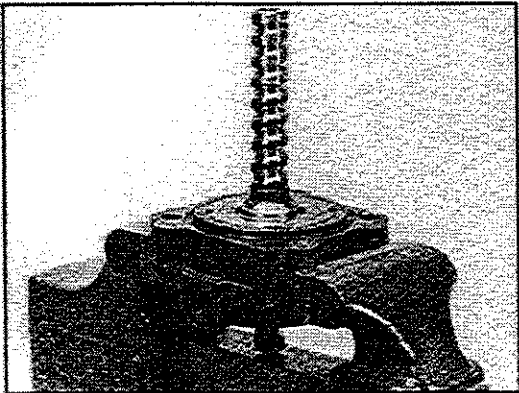
Torque both poppet seat and sleeve assemblies to 18 lbf·ft (25 N·m).

Return to Step 27 under "Disassembly".

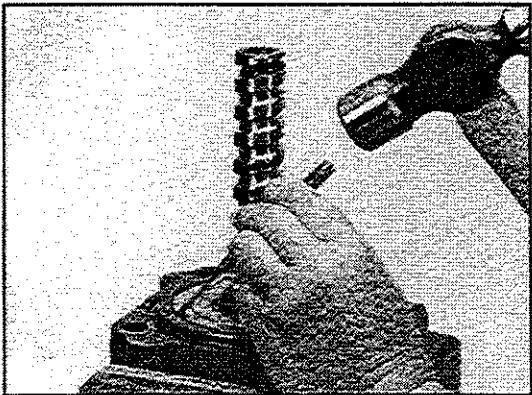
**Valve Housing/Worm Screw
Disassembly**

Tools Required	
Hammer	
Lbf•ft Torque wrench	
Punch, center	
Punch, roll pin	
Lbf•in Torque wrench	
J37464	
J37070	
J37073	
Screwdriver	
Small probe or pick	
Sockets	
12-point sockets	

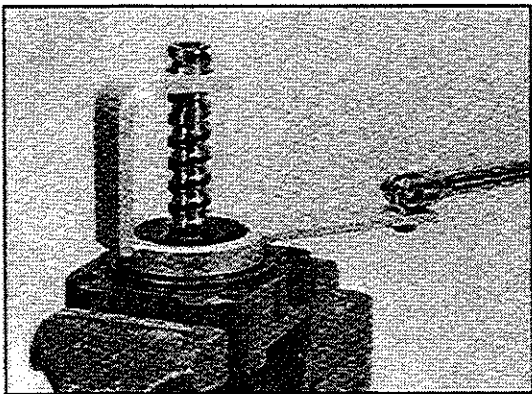
1. With worm vertical, place the valve housing, input shaft, valve/worm assembly in a vise.



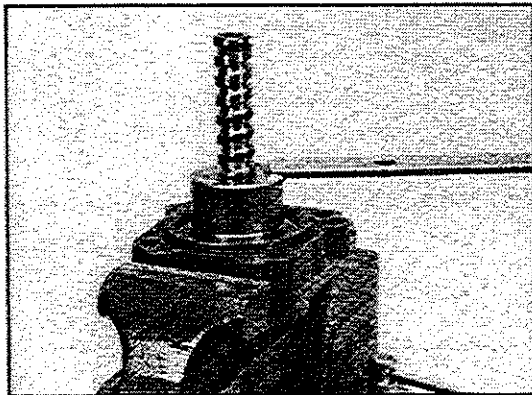
2. Unstake the valve housing where it was upset into the adjuster locknut slot. Also unstake adjuster nut from adjuster.



3. Turn bearing adjuster locknut out of the valve housing.

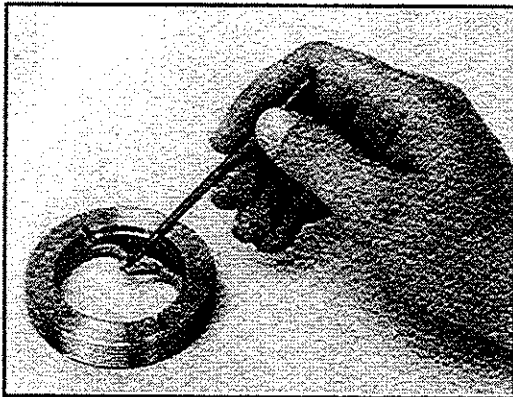


4. Turn bearing adjuster out of the valve housing.



5. Remove and discard seal ring and o-ring from bearing adjuster.

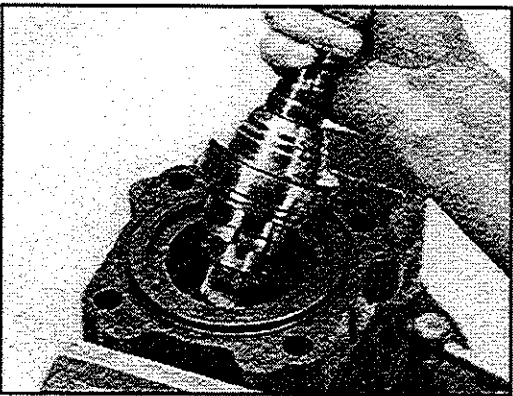
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6. Remove the input shaft, valve/worm assembly from the valve housing.



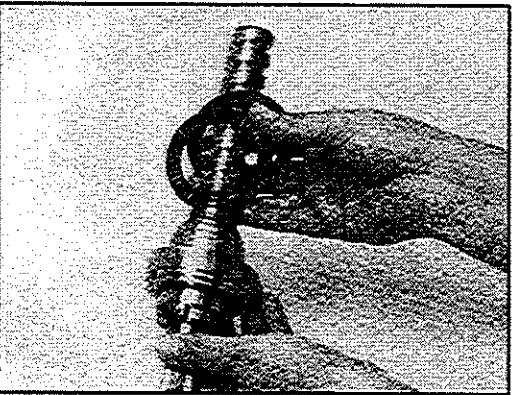
Caution
Input shaft, valve worm assembly must not be disassembled further. The components were a select fit at assembly and are available only as part of this subassembly. If disassembled further, the subassembly must be replaced.



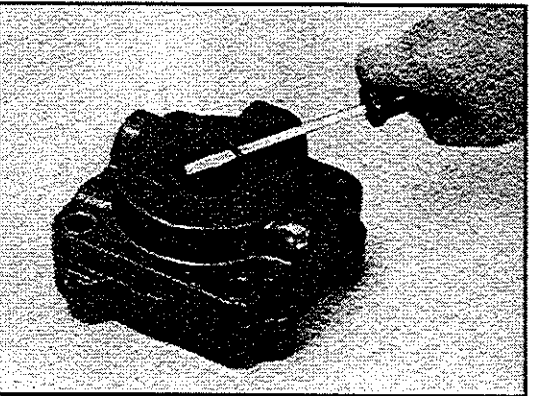
7. Remove thin thrust washer and thrust bearing from input shaft.



9. Remove and discard seal rings and o-rings and from valve housing.



8. Remove thick thrust washer and thrust bearing from valve housing.

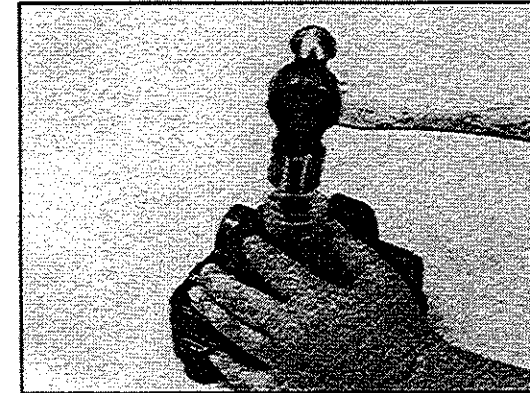


10. Turn over valve housing and remove retaining ring.

Caution

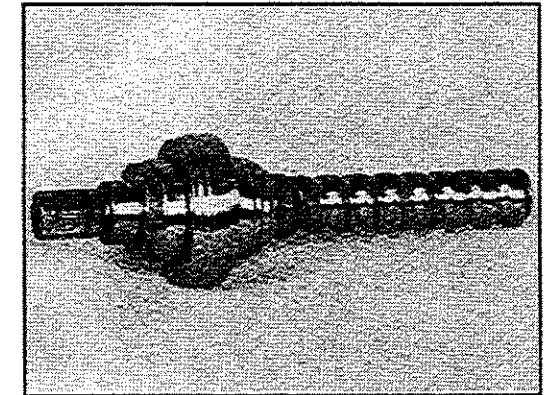
Exercise special care when removing seal to prevent damaging the valve housing seal bore.

11. Tap input shaft seal out of valve housing. Discard seal.

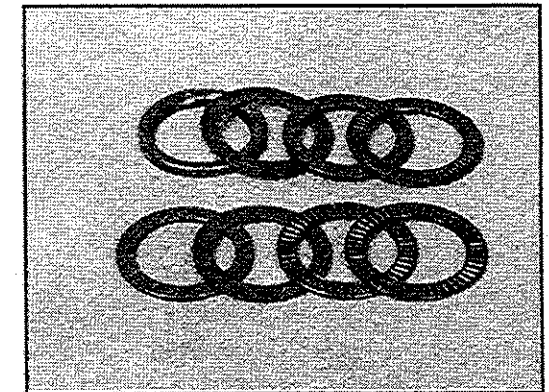
**Note**

The valve housing also utilizes a ball plug for manufacturing purposes that must not be removed.

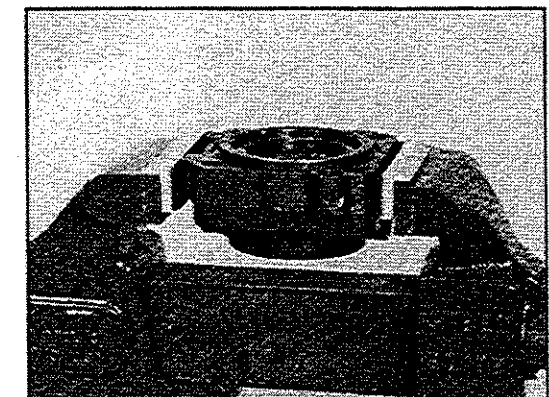
12. Inspect the sealing areas on input shaft and valve for nicks and run your fingernail edge across the sealing surfaces to detect steps. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, you must replace the input shaft, valve/worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.



13. Inspect the thrust bearing rollers for any deterioration. Inspect thrust washers for brinelling, spalling or cracks. Replace any part with these conditions.



14. Place valve housing firmly in a vise so the input shaft, valve/worm assembly can be assembled vertically with the worm end up.



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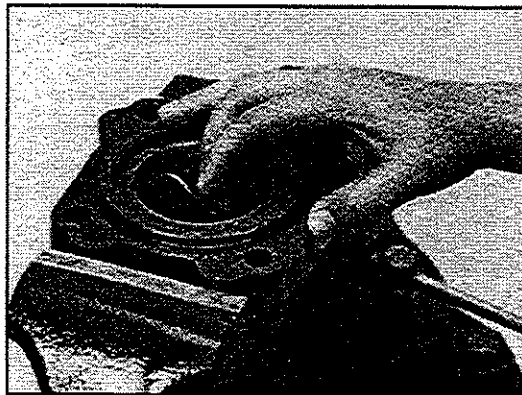
Caution

Do not clamp against threaded port hole or relief valve hole sealing faces when placing valve housing in vise.

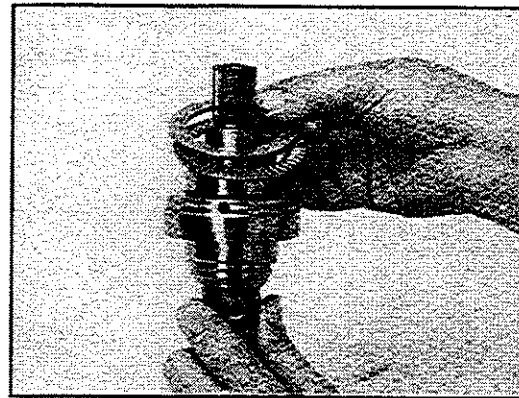
15. Oil and assemble a new o-ring into its counterbore in valve housing.



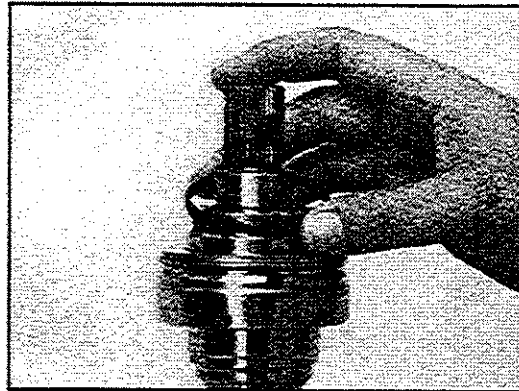
16. Lightly oil and assemble new o-ring and new seal ring into the large diameter seal ring groove in valve housing, bending and working them in and smoothing them out as necessary.



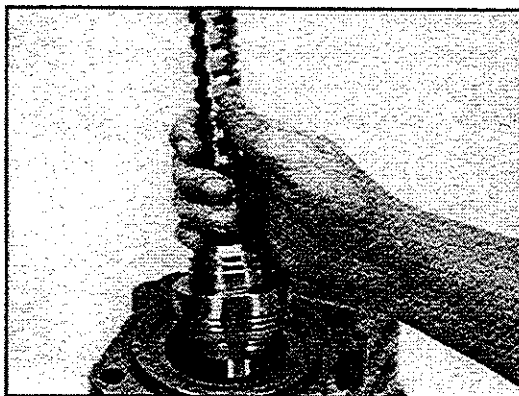
17. Install roller thrust bearing and then the thick washer (square side out) onto input shaft end of input shaft, valve, worm subassembly, seating them against the input shaft thrust face.



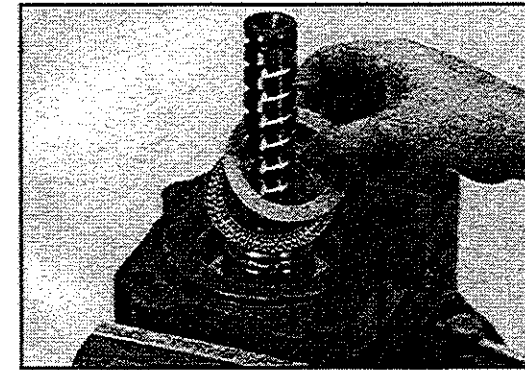
18. Lightly oil and assemble new seal ring onto input shaft and against the thick thrust washer to hold the bearing components in place.



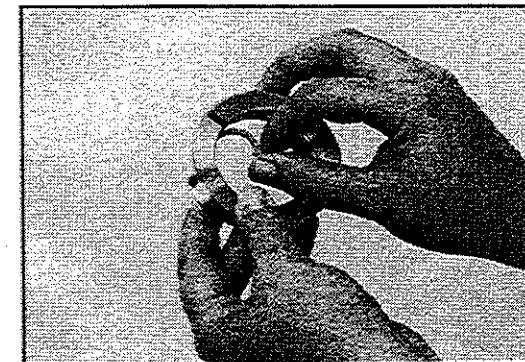
19. Dip the input end of the input shaft, valve, worm assembly into oil up to the worm lead. Assemble the input shaft end of the assembly into the valve housing until it is firmly seated.



20. Apply oil and assemble the other thrust bearing then the thin thrust washer over the ball groove end of worm, and seat them against the shoulder of input shaft, valve, worm assembly.



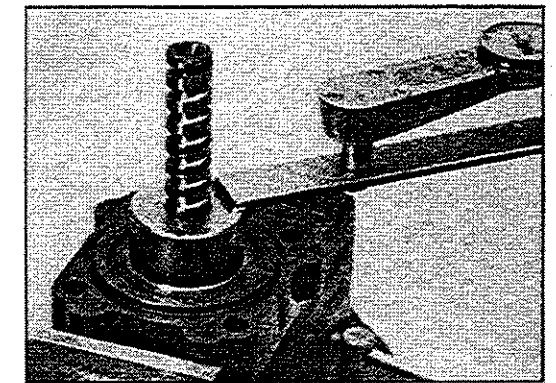
21. Lightly oil a new o-ring and assemble into the seal groove in bearing adjuster. Oil and work a new seal ring into the same groove and smooth it out.



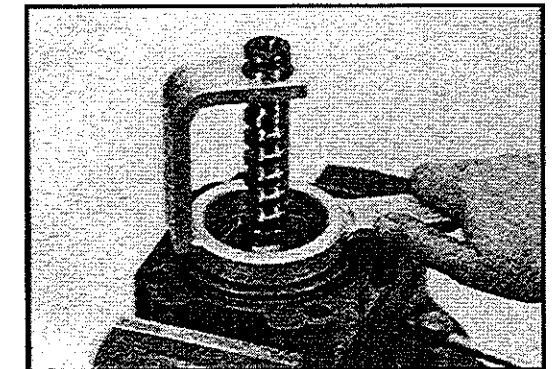
Note

Be sure the valve housing, adjuster locknut and bearing adjuster threads are clean and free of any staking burrs that would impede the locknut from turning freely on adjuster or the adjuster turning freely in valve housing.

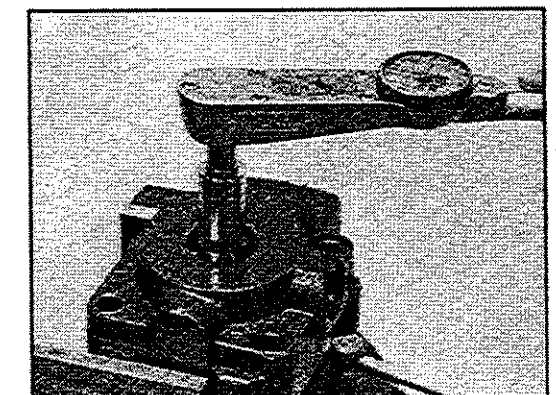
22. Lightly oil and assemble bearing adjuster over worm and into valve housing. Torque adjuster to 13 lbf•ft (18 N•m) indicated torque using a torque wrench inserted in adjuster tool #J37070. This will seat the components. Back off adjuster 1/4 to 1/2 of a turn.



23. Lightly oil and assemble new locknut onto bearing adjuster with radius side down. Tighten slightly to keep the bearing adjuster in place.

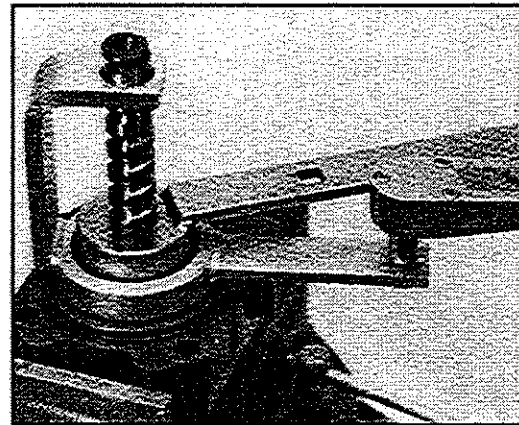


24. Reverse assembly in vise so the worm end is down. With an inch pound torque wrench on the input shaft, note torque required to rotate the input shaft 360° in each direction. Tighten the bearing adjuster to increase the maximum torque at the input shaft 5-10 lbf•in (.5-1.0 N•m) over that which was noted prior.



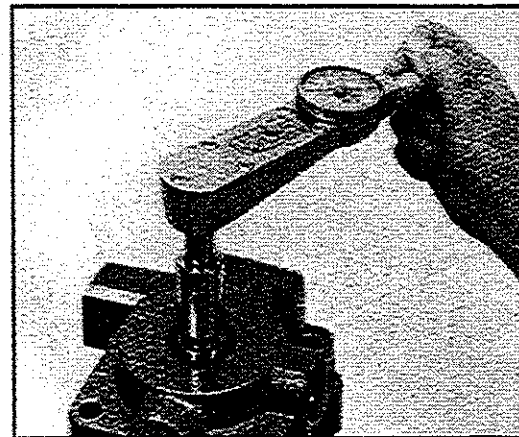
LTC Steering

25. Again reverse the assembly in vise. Torque locknut while holding bearing adjuster in position established in step 24 with appropriate adjuster tool. When using a torque wrench in locknut tool J37464, the torque wrench reading should be 112 lbf•ft (152 N•m).

**Note**

The bearing adjuster, locknut and valve housing flange should be flush. If not, the seal ring or o-ring may be out of position, which will result in axial lash.

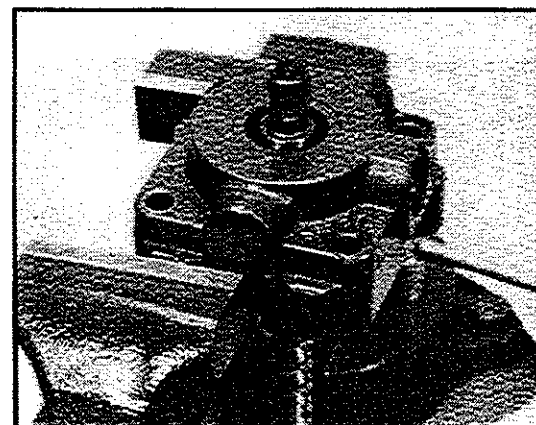
26. Recheck input shaft torque. It should match torque measured in step 24. Repeat steps 24 and 25 if necessary.



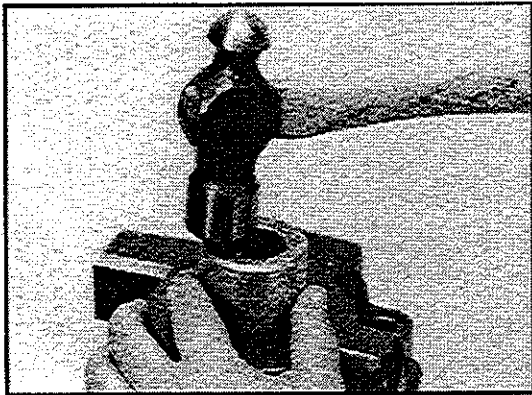
27. Stake valve housing into the clockwise most corner of two opposing slots in locknut. Stake the locknut into the adjuster in two places (180 degrees apart) at threaded area. Choose areas that have not been previously staked. After staking, torque required to rotate input shaft must be between 1-10 lbf•in (.5-1.0 N•m) greater than the torque noted in step 24. Torque value must not exceed 22 lbf•in (2.5 N•m). Unstake and readjust if necessary.



28. Reposition worm screw/valve housing subassembly in soft-jawed vise, clamping tightly against valve housing, so the worm screw is pointing down.

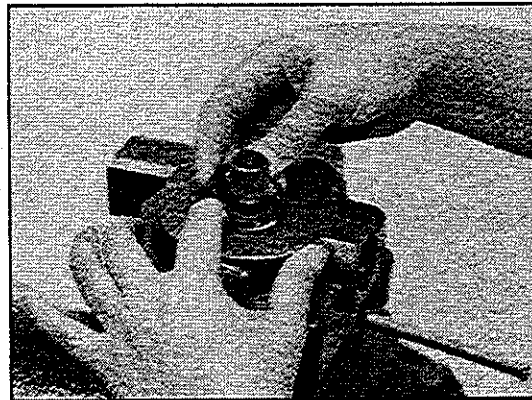


29. Apply clean grease to the outside and inside diameters (fill cavity between the lips) of the new input shaft seal and assemble it, garter spring side first over the input shaft. Align seal in the valve housing seal bore. Assemble seal installer tool #J37073, small diameter end first, over the input shaft and against the seal. Tap the seal installer tool until the tool shoulder is squarely against the valve housing. This will correctly position the seal in the housing bore just beyond the retaining ring groove. Remove any seal material that may have sheared off and is in seal bore and retaining ring groove.



Caution
The input shaft seal must be square in the seal bore and installed to the correct depth.

30. Insert new retaining ring into its groove in valve housing.

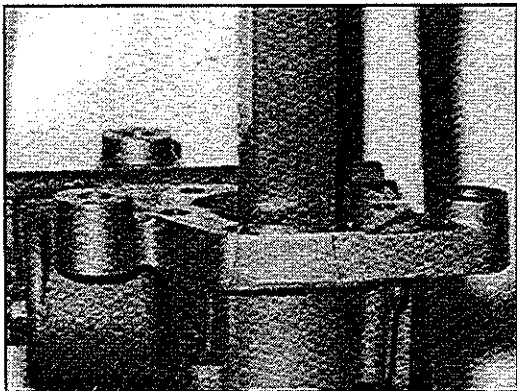


Return to Step 28 under Section entitled "Disassembly".

Roller Bearing or Retaining Ring Replacement

Tools Required	Materials Required
Press	Grease
J38779 (TAS85)	
Screwdriver	

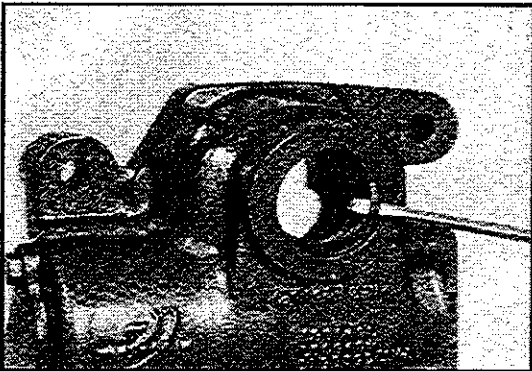
1. If roller bearing in housing needs to be replaced, place the bearing removal end of the bearing and seal tool against the side cover end of the bearing and press it out of trunnion end of the bear bore. Discard bearing.



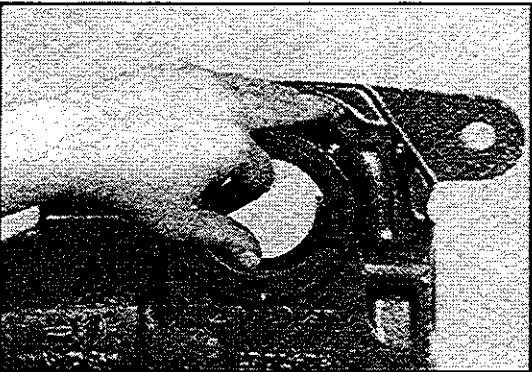
Caution
The bearing must be pressed out from the side cover side to protect the seal counterbore. Be sure to use a bearing removal tool that will clear the retaining ring.

2. If the retaining ring that is still in the housing bearing bore needs to be replaced, remove it through the trunnion end of the bearing bore to protect the pressure seal bore area from being damaged.

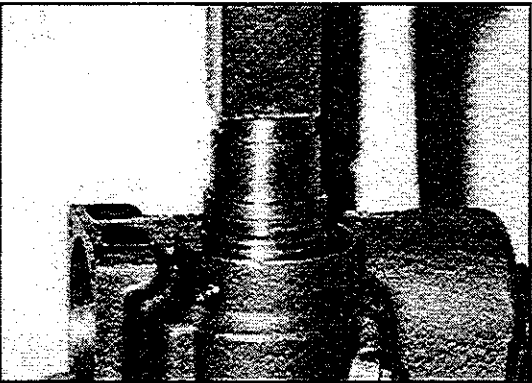
LTC Steering



3. Insert retaining ring, if it was removed, into the housing bore from the trunnion end (to protect sealing area). Make sure it is seated in the retaining ring groove closest to side cover end of the bearing bore. Lubricate the bearing bore.



4. Press the roller bearing into the housing from the trunnion end of bearing bore until it is seated against the retaining ring. Be sure the housing is square with the press base and the bearing is not cocked.



Caution

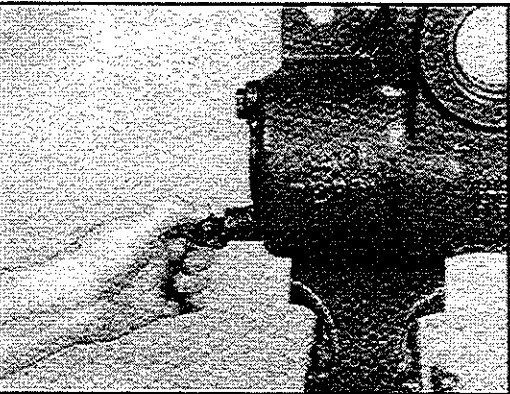
Use the bearing installation end of the tool. If the bearing removal end of the bearing and seal tool is used to press in bearing, the case on the new bearing may be damaged.

Return to Step 32 under "Disassembly".

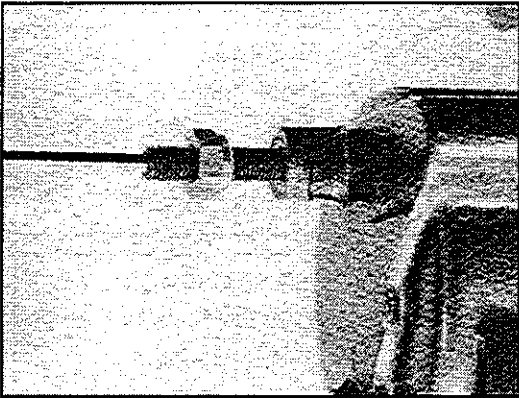
Replace Housing Ports, Plugs, Screws, Fittings

Tools Required	Materials Required
Allen wrench	
Torx sockets	
Sockets	
Lbf•in Torque wrench	
Lbf•ft Torque wrench	

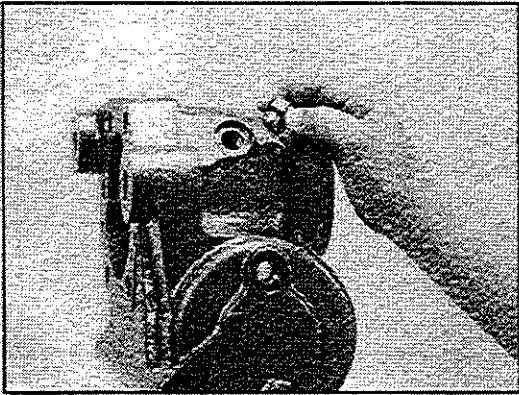
1. If damaged, remove and replace the poppet fixed stop screw and washer if equipped. Replace with poppet fixed stop screw, discard the washer. Torque to 48 lbf•ft (65 N•m).



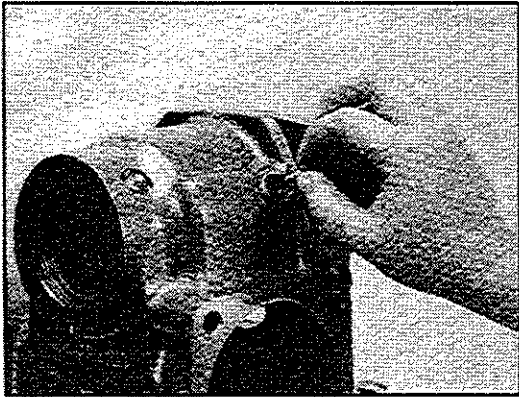
2. If damaged, remove poppet adjusting screw and sealing nut without allowing the nut to change its position on the screw. Assemble the new nut onto the new adjusting screw, matching its position to the nut and screw removed. Torque sealing nut to 35 lbf•ft (47 N•m).



3. If damaged, remove and replace automatic bleed plug. Torque to 48 lbf•ft (65 N•m). If damaged, remove and replace permanent auxiliary port plugs and o-rings. Assemble new o-rings on port plugs and torque to their respective ports in the house or valve housing to 30 lbf•ft (41 N•m).



4. If damaged, remove and replace manual bleed screw. Torque to 30 lbf•in (3.4 N•m).

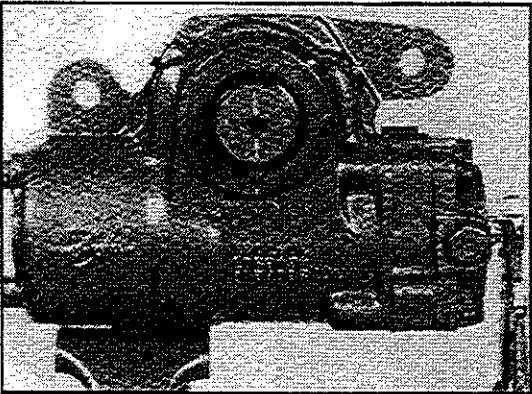


Return to Inspection section.

Final Adjustments

Tools Required	Materials Required
Box-end wrench	
Lbf•ft Torque wrench	
Lbf•ft Torque wrench	
Screwdriver	
Sockets	

1. To center the steering gear, rotate input shaft, valve worm assembly until the timing mark on the end of the sector shaft is in line with the timing mark on the end of housing trunnion.



Caution

Do not rotate the input shaft more than 1.5 revolutions from center position until the steering gear is installed, during poppet setting procedure. Doing so could make the automatic poppets inoperative, which would require disassembly of steering gear to reposition poppet seat and sleeve assemblies.

LTC Steering

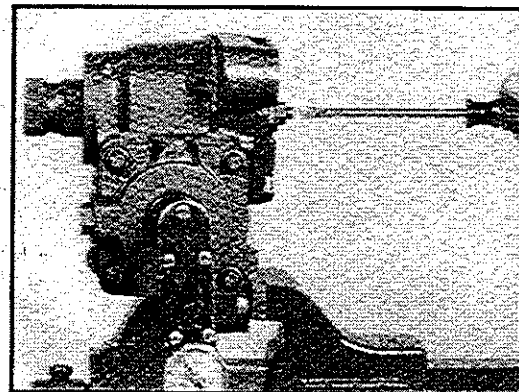
Note

Initial poppet contact will occur at less than one input shaft rotation in one direction from steering gear center position, if new or reset poppet adjuster seat and sleeve assemblies are assembled in the unit.

Note

Worm preload adjustment was set when input shaft, valve and worm were assembled into valve housing.

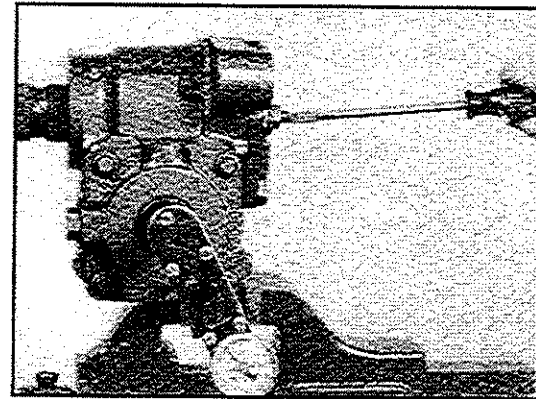
2. With adjusting screw jam nut loose, turn sector shaft adjusting screw clockwise to provide 45-50 lbf•in (5-5.5 N•m) of torque required to rotate the input shaft, valve/worm assembly through one half turn (180 degrees) each side of center.



Note

This procedure will proper mesh and seat the rack piston and sector shaft teeth for final adjustments.

3. Turn sector shaft adjusting screw counterclockwise one half turn and note maximum torque required to rotate the input shaft, valve/worm assembly through one half turn (180 degrees) each side of center.



4. Adjust sector shaft adjusting screw clockwise to increase maximum torque noted in step 3 by 7 lbf•in (.8 N•m). Tighten jam nut firmly against side cover while holding the adjusting screw in position. Final torque jam nut to 43 lbf•ft (58 N•m) and check input shaft, valve/worm assembly torque again. Readjust if input shaft torque exceeds 40 lbf•in (4.5 N•m).

Reinstallation

1. Verify that axle stops are set to manufacturer's wheelcut or clearance specifications.
2. Bolt gear to frame, torque to vehicle manufacturer's recommendation.
3. Connect return line to reservoir in TAS return port.
4. Connect hydraulic line from pump to pressure port in TAS unit.
5. Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
6. Install pitman arm on output shaft, with timing marks aligned. Torque bolt to vehicle manufacturer's recommendation.
7. Connect drag link to pitman arm.

Poppet Resetting

If poppets remain unchanged from when gear was removed from vehicle and gear is being installed on the same vehicle with no change in axle stops or linkage, check (after

installation) to make sure poppets relieve in both turns just before axle stop contact is made. If not, use resetting procedure.

If poppets were replaced with new components or reset during gear disassembly and are ready for automatic positioning, use poppet setting procedure.

If poppets may have been moved during disassembly or reassembly procedures, or gear is being installed on a different vehicle, use poppet resetting procedure.

Glossary

Aerated Fluid - Fluid with air bubbles.

Automatic Bleed Systems - Gears are mounted in such a way that trapped air can be forced out of the system "automatically" without loosening bleed screw.

Axial - In-Out movement along an axis (imaginary straight line on which an object moves)

Date Code - Date the steering gear was built

Discoloration - Change in color.

External Leakage - Fluid Leaking out of the system or steering gear.

Full Turn - Hub contacts axle stop

Integral Power Steering - Steering gear has manual steering mechanism, hydraulic control valve, and hydraulic power cylinder all within gear housing.

Impact - The application of torques and forces to steering gear components during accidents or other similar events which exceed the hydraulic capacity of the steering gear.

Internal Leakage - Fluid leaking inside gear.

Lash - Free play.

Manual Bleed Systems Gears are mounted in such a way that an air pocket could form in one end of the steering gear. The bleed screw is positioned so trapped air can be forced out when loosened.

OSHA - Occupational Safety and Health Administration

Poppets - Unloading valves, reduce pressure in full turns.

Relief Valve - Limits maximum supply pressure.

Return Line - Line that connects steering gear to reservoir to recirculate hydraulic fluid.

Rotary Control Valve - Controls flow in internal cavities.

Scoring - Scratch.

Shock Load - Shake or jar.

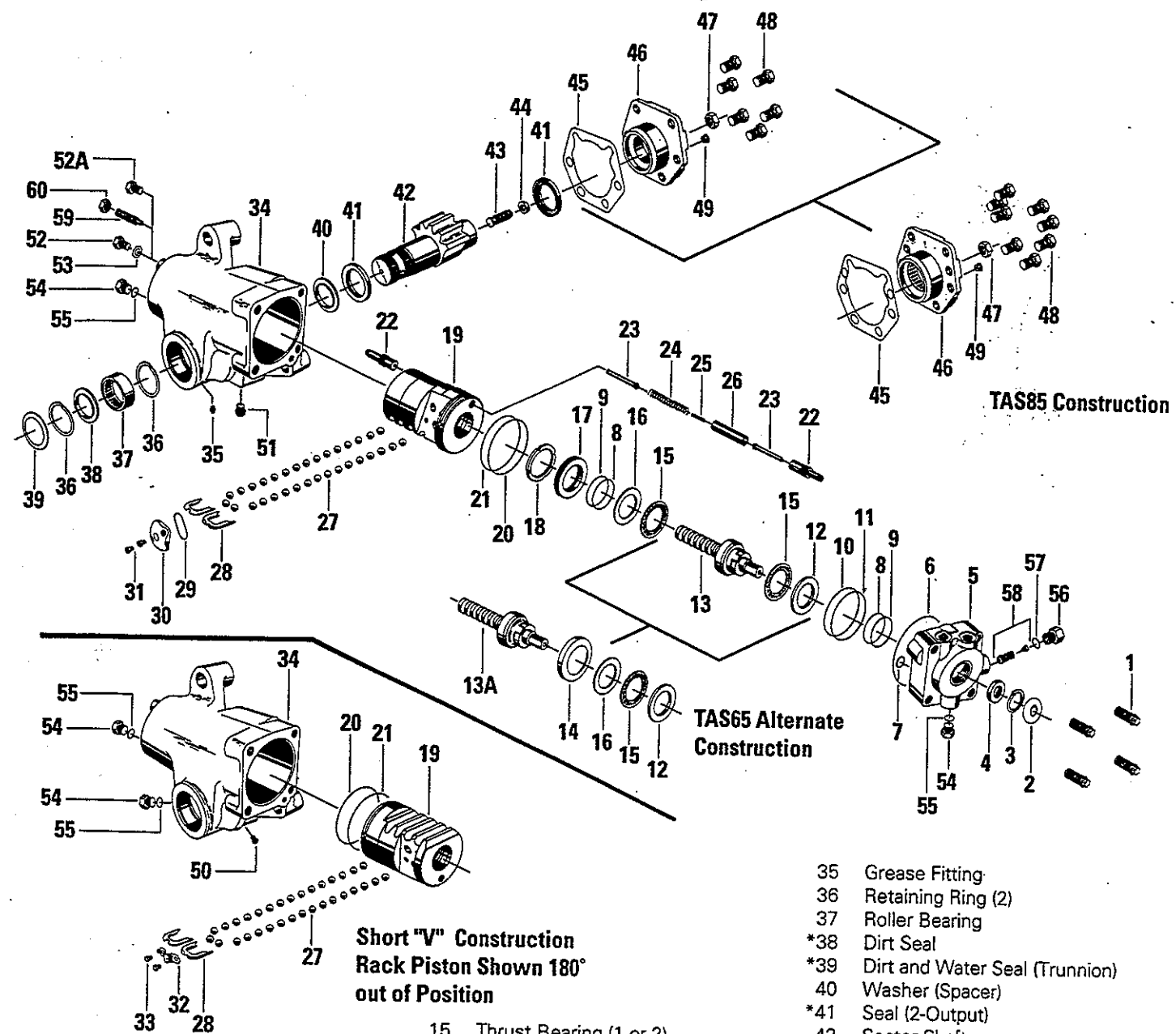
Spalling - Flaking of chipping.

Subassembly - An assembled unit that fits into a larger unit.

Supply Line - Connects pump to steering gear.

Twisted Serrations - Output shaft serrations damaged by impact overload. Serrations can be twisted at the area between the large diameter of the shaft and the end of the serrations.

TAS Series Exploded View -- Typical



Item Description

1	Bolts (4-Valve Housing)	15	Thrust Bearing (1 or 2)	35	Grease Fitting
*2	Dirt and Water Seal	16	Thrust Washer (Thin)	36	Retaining Ring (2)
*3	Retaining Ring	17	Bearing Adjuster	37	Roller Bearing
*4	Seal (Input Shaft)	*18	Adjuster Locknut	*38	Dirt Seal
5	Valve Housing	19	Rack Piston	*39	Dirt and Water Seal (Trunnion)
*6	Seal Ring (Valve Housing)	*20	Teflon Seal Ring	40	Washer (Spacer)
*7	Seal Ring (Valve Housing)	*21	O-ring (Back up; Rack Piston)	*41	Seal (2-Output)
*8	Seal Ring (2)	22	Poppet Seat and Sleeve Assy. (2)	42	Sector Shaft
*9	O-ring (2)	23	Poppet (2)	43	Adjusting Screw (Sector Shaft)
*10	Seal Ring	24	Poppet Spring	44	Retainer (Adjusting Screw)
*11	O-ring (Valve Housing)	25	Spacer Rod	*45	Gasket (Side Cover)
12	Thrust Washer (Thick)	26	Push Tube	46	Side Cover Assembly
13	Input Shaft, Valve, Worm Assy.	27	Balls	47	Jam Nut
13A	Input Sh., Valve, Worm Assy. (Alt)	*28	Ball Return Guide Halves (2)	48	Special Bolts (6 or 8-Side Cover)
14	Spacer Sleeve (Alt.)	*29	Seal (Cap)	*49	Vent Plug (Side Cover)
		30	Ball Return Guide Cap	50	Bleed Screw (Manual)
		*31	Torx Screws (2-Cap)	51	Plug (Auto Bleed)
		*32	Ball Return Guide Clip	52	Fixed Stop Screw (Poppet)
		33	Hex Screws (2-Clip)	52A	Fixed Stop Screw (Poppet-Alt)
		34	Housing	53	Washer (Stop Screw)
				54	Auxiliary Port Plug (2)
				*55	O-ring (2-Aux. Port Plug)
				56	Relief Valve Cap
				*57	O-ring (Relief Valve)
				58	Relief Valve (2 piece)
				59	Service Poppet Adjusting Screw
				60	Service Sealing Jam Nut

*These items are included in seal kits. Kits also include 406015 lubricant and a service bulletin.

Service Parts List

Common Parts

Item	Description	Part Number
1	Bolts (4-Valve Housing)	020251
2	Dirt and Water Seal	478044
3	Retaining Ring	401637
4	Seal (Input Shaft) (High Temp)	478076
7	Seal Ring (Valve Housing)	032823
8	Seal Ring (2)	029123
9	O-ring (2) (High Temp)	032200-158
10	Seal Ring	029116
11	O-ring (Valve Housing) (High Temp)	032200-152
12	Thrust Washer (Thick)	400143
15	Thrust Bearing (2)	070027
16	Thrust Washer (Thin)	400144
17	Bearing Adjuster	400149
18	Adjuster Locknut	027007
27	Balls	216191-X1
29	Seal (Cap)	478042
30	Ball Return Guide Cap	400161
31	Torx Screws (2-Cap)	020228
32	Ball Return Guide Clip	402448
33	Hex Screws (2-Clip)	G179810
35	Grease Fitting	037027
43	Adjusting Screw (Sector Shaft)	021200
44	Retainer (Adjusting Screw)	062005
47	Jam Nut	G9419666
49	Vent Plug (Side Cover)	036201
50	Bleed Screw (Manual)	213705
51	Plug (Auto Bleed)	021397
52A	Fixed stop screw	021426
54	Auxiliary Port Plug (2)	G9410358
55	O-ring (2-Aux. Port Plug)	032229
57	O-ring (Relief Valve)	032200-153
59	Service Poppet Adjusting Screw	021407
60	Service Sealing Jam Nut	025119

Parts Vary by Specification*

Item	Description
5	Valve Housing
13	Input Shaft, Valve, Worm Assy.
13A	Input Shaft, Valve, Worm Assy. (Alt)**
14	Spacer Sleeve (Alt.)**
19	Rack Piston
34	Housing
42	Sector Shaft
46	Side Cover Assembly
56	Relief Valve Cap
58	Relief Valve (2 piece)

*Contact Service/Sales for part numbers
**Applicable to TAS65 gears only

Kits

Items	Description	Part Number
54 & 55	Port Plug & O-ring	415437-A1
56 & 57	Relief Valve Cap & O-ring	411061-A1
59 & 60	Poppet Adj. Scr. & Jam Nut	021407-X1
	TAS40 Seal Kit	TAS400002
	TAS55 Seal Kit	TAS550002
	TAS65 Seal Kit	TAS650006
	TAS85 Seal Kit	TAS850002

Parts Vary by Gear Size

Item	Description	TAS40	TAS55	TAS65	TAS85
6	Seal Ring (Valve Housing)	032829	032829	032616	032834
20	Teflon Seal Ring	032828	032830	032590	032547
21	O-ring (Back up, Rack Piston)	032827	032831	032615	032556
22	Poppet Seat and Sleeve Assy. (2)	409118-A2	409118-A2	409118-A2	409118-A6
23	Poppet (2)	040210	040210	040210	040217
24	Poppet Spring	401662	401662	401662	401684
25	Spacer Rod	040209	040209	040209	040218
26	Push Tube	080154	080154	080154	080158
28	Ball Return Guide Halves (2)	R.H. 400158 L.H. 400159	400160 400165	400156 400157	400162 400163
36	Retaining Ring (2)	401674	401650	401650	401685
37	Roller Bearing	070028	071025	071020	072003
38	Dirt Seal	478052	478041	478041	478057
39	Dirt and Water Seal (Trunnion)	478053	478045	478045	478059
40	Washer (Spacer)	028527	028519	028519	028534
41	Seal (2-Output)	478051	478040	478040	478058
45	Gasket (Side Cover)	HFB529000	HFB649000	HFB649000	TAS859000
48	Special Bolts (6 or 8-Side Cover)	021277	G223734	G223734	G223734

LTC Suspension



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LTC Suspension

Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not correctly adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins M11 engine, an Allison B500 World Transmission and Ridewell Air Suspension.

Description of Operation

The Ridewell Air suspension uses pressurized air, drawn from the conventional vehicle air system, to form the load carrying, shock absorbing springs. Automatic height control valves regulate the air pressure required for varying loads, and maintains a constant vehicle ride at all times. Its basic characteristic is its ability to provide a cushioned ride through the light to loaded range.

Preparatory Work

Caution

Do not use the leveling jacks for this procedure. The leveling jacks are for tire changing and leveling of the bus.

1. Park the vehicle on a level surface.

Warning

Do not place any part of your body under the bus until the jackstands are in place.

Caution

A requirement to loosen all bolts and nuts is a step in the procedure. Do not remove any hardware at Step 4.

2. Install six 15,000-pound (total capacity 90,000-pounds) jacks on the front and rear tires.
3. Raise the bus using four jacks. (See Figure 1—ARI-hetra Mobile Lifting Systems.)

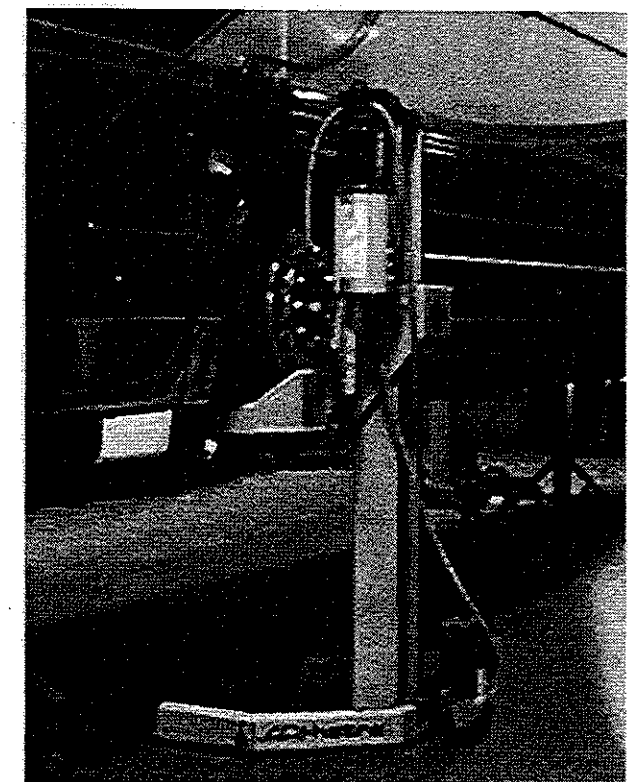


Figure 1—ARI-hetra Mobile Lifting System

Caution

Make sure that the jack stands are in the correct location. Body and/or frame damage can occur if the stands are misplaced.

Place the jackstands under frame rails. Do not use any other parts of the bus for the jackstands.

Be careful when placing the stands so no damage is done to the steering rod and ball joint.

4. Install four tall 15,000-pound jackstands, two in the front and two in the rear. (See Figure 2—Jackstand Locations.)
5. Loosen all required nuts and bolts.
6. Lower the bus enough to put bus weight on the jackstands.
7. Inspect for safe operation in all areas.

Warning

Never place hands or finger between parts of the suspension.

8. Remove all required hardware.

Caution

Do not over heat the frame or suspension hanger. Protect all wiring and fuel lines.

9. Cut the Huckspins. (Refer to Table 1—Huckspin to Capscrew Conversion.)

Caution

When a huckspin is removed, replace with the proper capscrew and a lock nut. (Refer to Table 1—Huckspin to Capscrew Conversion.)

10. Lower the suspension system using the ARI-hetra Mobile Lifting Systems.

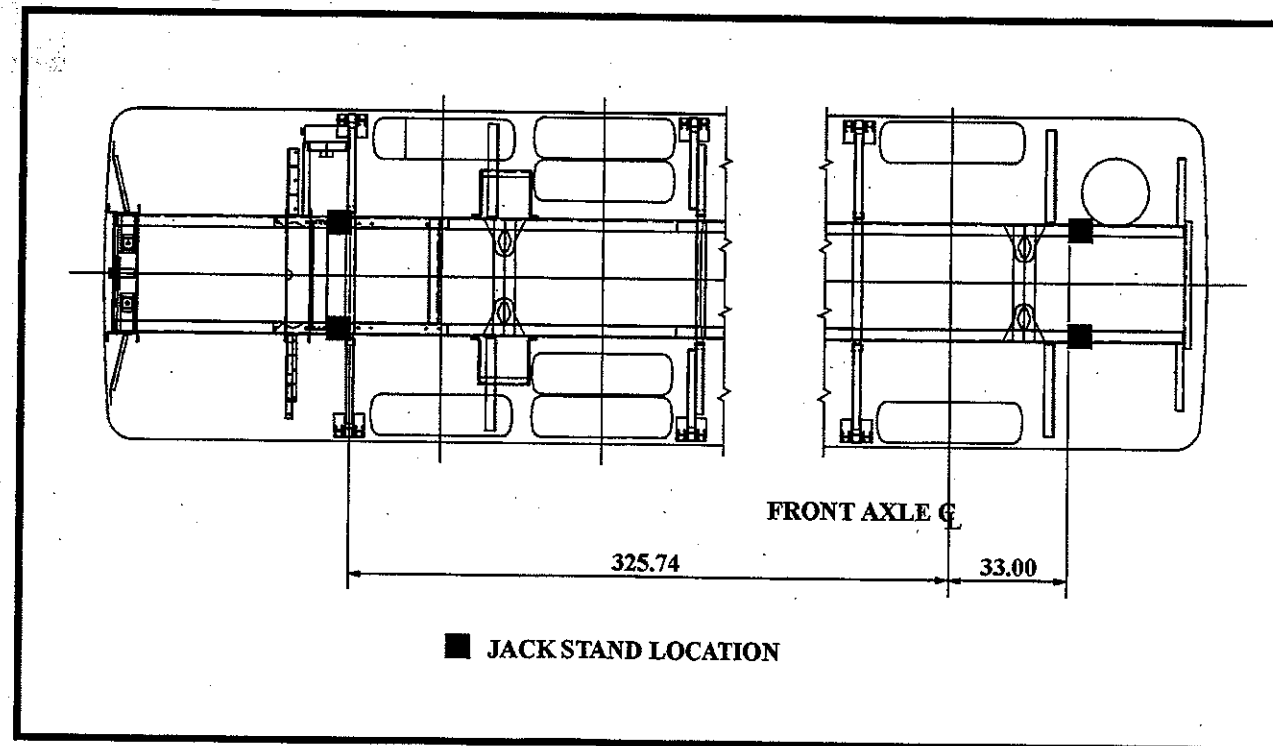


Figure 2—Jackstand Location

LTC Suspension

Caution

*Make sure the top of the bus has height room.
Make sure that antennas are removed or folded.
Make sure that mirrors are clear from obstruction.*

Technical Assembly Information

1. End link bushing orientation tapered bushing fit into stabilizer bar. Flat bushings fit to endlink bracket (6).
2. Coat bar assembly (1) and bushing (4) at contact areas in two places. Use bushing lube supplied with kit.
3. Install bushing over bar with flat face of bushing facing up to match mid-section bracket (3).

• Stabilizer Bar Torque Values

1. 1/2 inch bolts 75 to 85 foot-pounds (102 to 115 N•m).
2. 5/8 inch bolts 106 to 112 foot-pounds (144 to 152 N•m).

• Air Bag Torque Values

1. 1/2 inch bolts 25 foot-pounds (34 N•m).
2. 3/4 inch bolts 50 foot-pounds (68 N•m).

• Front Suspension Torque Values

1. 1 inch bolts 460 foot-pounds (624 N•m).
2. 1-1/4 inch bolts 750 foot-pounds (1017 N•m).
3. 1-1/2 inch bolts 1100 foot-pounds (1491 N•m).

Technical Installation Information

1. Replacement bushing for (21 and 22) is Ridewell Part Number 1110512B000.
2. Replacement bushing for (9) is Ridewell Part Number 1111795B000.

Axle Alignment Procedure

Caution

Mount Suspension with arrow marking on the eccentric bolt (20) at exactly 12 o'clock position.

1. Loosen nut on eccentric bolt (7).
2. Move axle using eccentric bolt head (20). Maximum movement is from 9-o'clock to 3-o'clock.
3. Tighten eccentric bolt (5) at final setting.
4. Weld anti-turn washer (11) over head of eccentric bolt (20).

Air Suspension Ride Height Specification

See Figure 3—Air Suspension Ride

Note

Maintain system air pressure in excess of 100 PSI (689 kPa). Park the coach on a level surface. Air spring height is measured bottom of frame to top of air spring seat.

The correct measurement for the steer axle is eight inches and the correct measurement for the drive axle is eight inches. The tag axle measurement is determined by the drive axle measurement.

Height Control Valve Adjustment

1. Position vehicle on a level surface and maintain air pressure of 100 PSI (689 kPa).
2. Disconnect both height control valve linkage assemblies from the external actuating levers.
3. Move each actuating lever to a vertical down position to exhaust all air from the air springs.
4. Connect one actuating valve to the correct link assembly. Let air spring that is controlled by the matching valve fill until valve shuts off.
5. Measure air spring height. (See Figure 3—Air Suspension Ride Height Specification.)
6. Adjust valve by loosening adjustment lock nut.
7. Move the nylon block until the proper height dimension is correct.
8. Tighten adjustment lock nut.

Note

After moving the actuating lever, 2 to 6 seconds will elapse before air starts to flow through the valve due to a time delay.

9. Disconnect link assembly and deflate air spring about half way.

Note

If necessary, repeat steps 10, 11 and 12 until proper air spring height is accomplished.

10. Re-connect link assembly to inflate spring.
11. Re-check spring height dimension when valve shuts off.

12. Re-measure spring height dimension.
13. Disconnect the properly set height control valve.
14. Move the actuating lever to a vertical down position to deflate springs.
15. Move to the other link assembly and repeat all settings for height adjustment.
16. Connect both valve actuating levers to the correct valves.
17. Re-connect link assembly to inflate spring.
18. Re-check spring height dimension when valve shuts off.

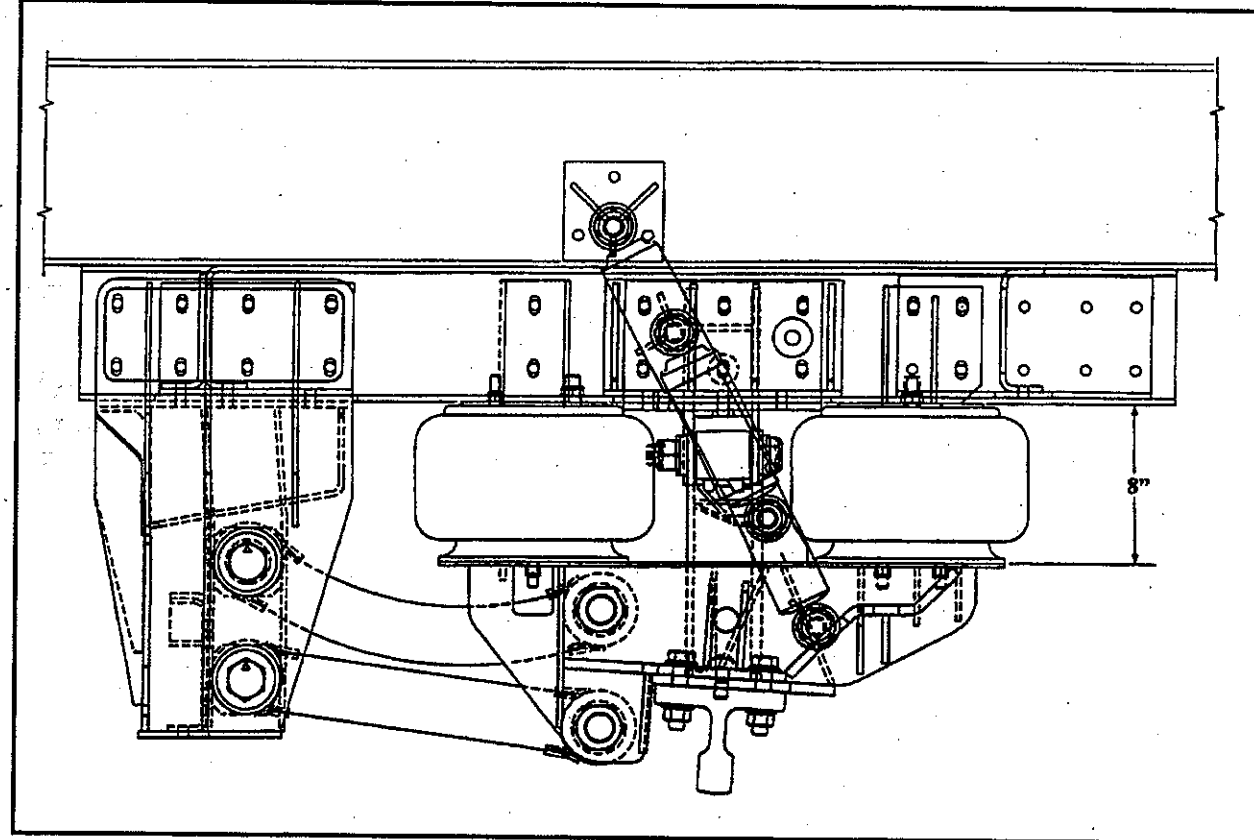


Figure 3—Air Suspension Ride

Front Suspension Disassembly

1. Remove nuts (3) and (4) and washers from air bag bolts. (See Figure 4—Disassembly of Suspension.)
2. Disconnect drag rod from steering arm on steering axle before lowering the bus.

• **Shock Absorber Removal**

Remove nut (5) and washer (7) from shock bracket (15).

• **Transverse Torque Rod Removal**

Remove nut (6) and bolt (2) from sway bar (9). (See Figure 5—Transverse Torque Rod and Bushing Removal..)

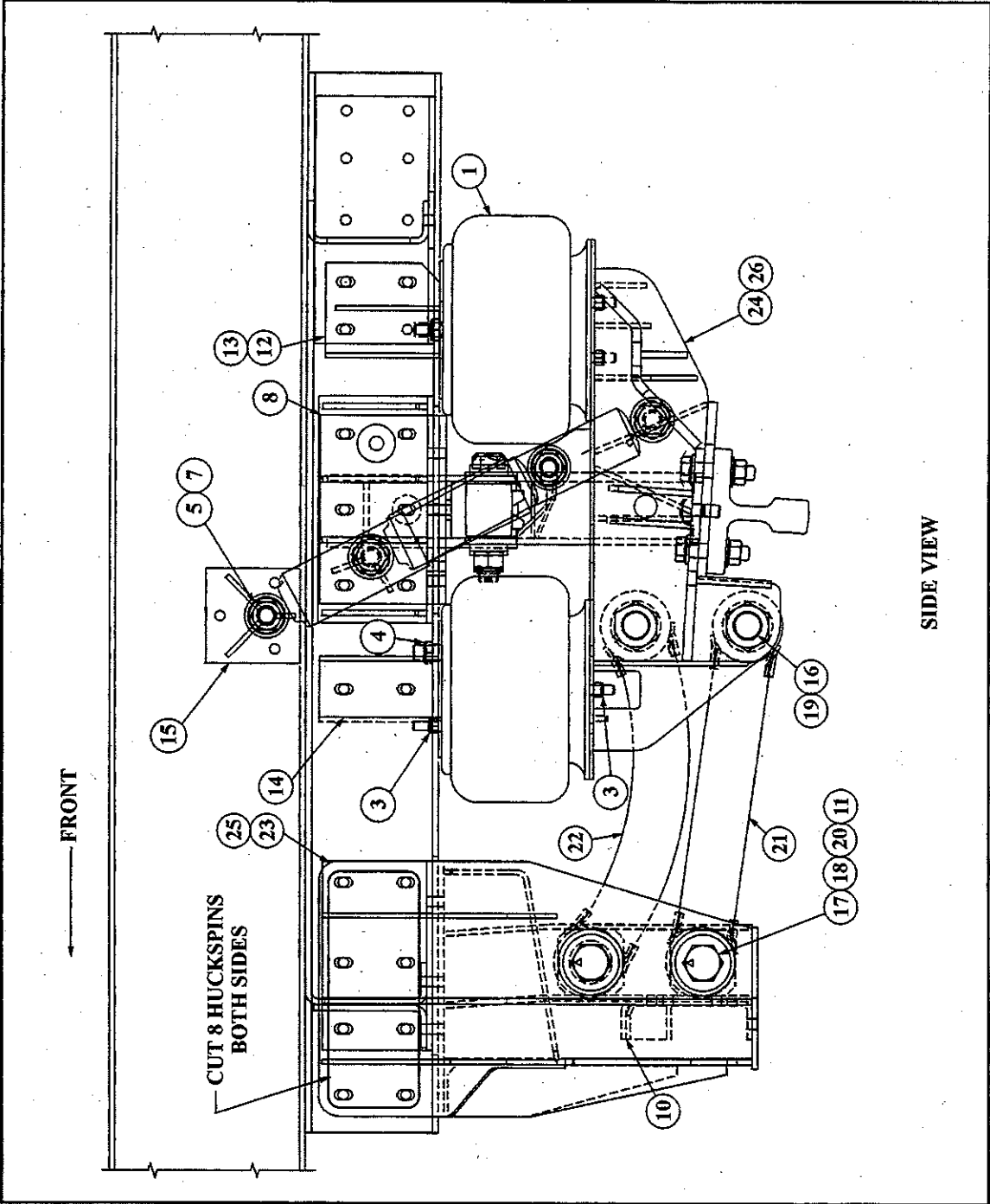


Figure 4—Disassembly of Suspension

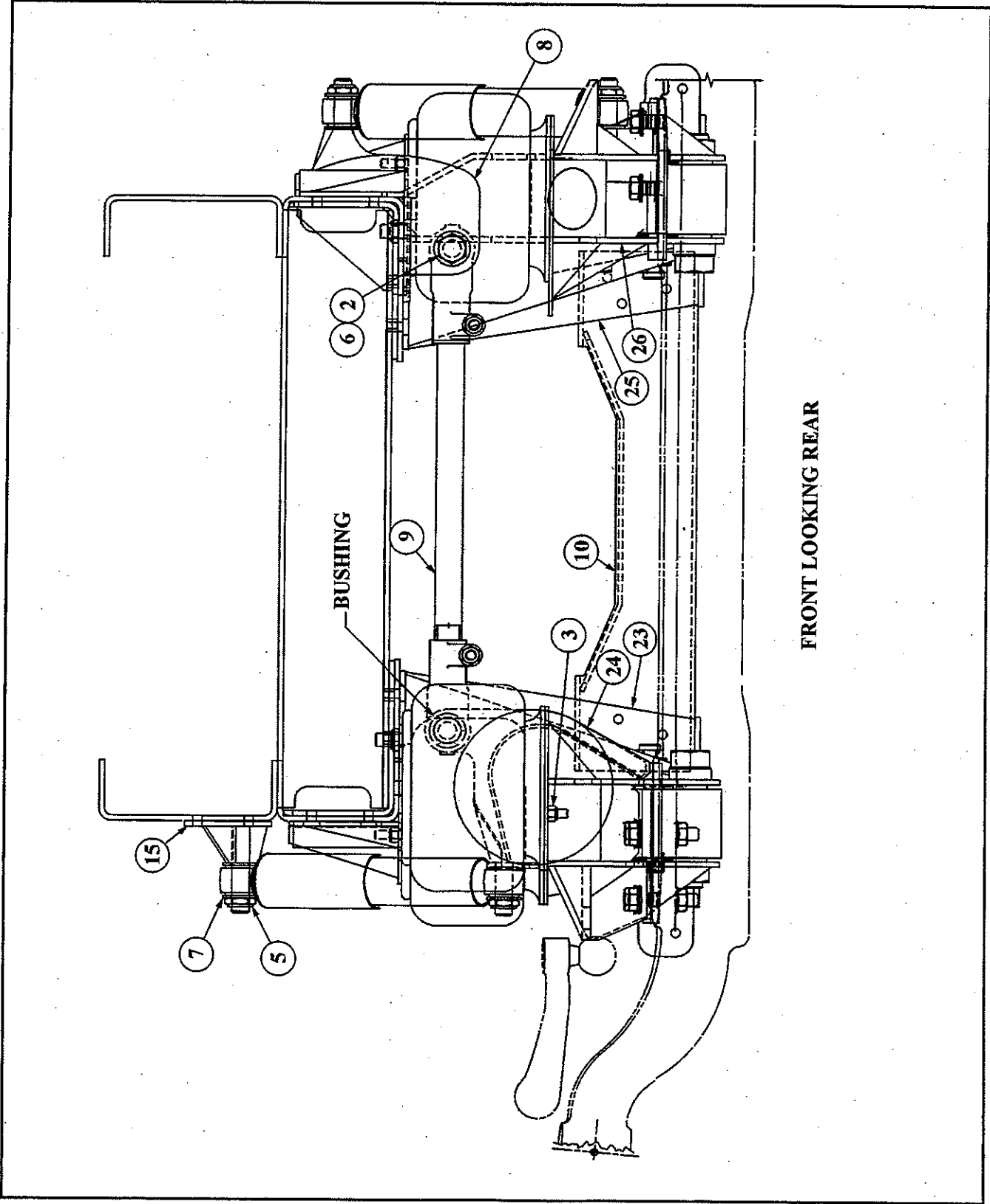


Figure 5—Transverse Torque Rod and Bushing Removal

Caution

Make sure that two flat washers are used, one under the nut and one under the capscrew head. Use lock nut with the capscrew replacing the huckspin.

HUCKSPIN					
BB P/N	Huck Number	Nominal Length	Min Grip Range	Max Grip Range	Nominal Length
1636943	-10	2.25	0.43	0.90	1.50
1636943	-10	2.25	0.43	0.90	1.75
1636950	-16	2.60	0.85	1.25	1.75
1636943	-10	2.25	0.43	0.90	1.75
1636950	-16	2.60	0.85	1.25	1.75
1746817	-20	2.85	1.09	1.50	2.00

CAPSCREW BOLTS THIS MATERIAL THICKNESS		BB P/N	USE FLAT WASHER	USE LOCKING NUT
Minimum	Maximum	---	---	---
0.25	0.75	0803239	1003045	0850800
0.50	1.00	0803148	---	---
0.50	1.00	0959452	---	---
0.75	1.25	0803205	---	---

Table 1—Capscrew to Huckspin Conversion

Front Suspension Stabilizer Bar Removal

• End Link Assembly

1. Remove the nuts (9) and washer (5) from the bolt (2). (See Figure 6—Front Suspension Stabilizer Bar.)
2. Remove the flat bushing (8).
3. Pull the bolt (2) to remove stabilizer bar from the end link.
4. Remove the flat bushing (8).
5. Remove the flat washer (5).
6. Remove the flat bushing (8).
7. Remove the flat washer (5).
8. Remove the sleeve (7).

9. Remove all of the flat washers and bushings.
10. Pull the bolt (2) to remove the stabilizer bar from end link.

• Stabilizer Bar

1. Remove the nuts and bolts securing bracket (3).
2. Disassemble the mid-bushing (4).

Caution

After suspension has been in operation for 6,000 miles (9656 km), all fasteners are to have a re-torque to recommended torque. Repeat procedure every 25,000 miles (40234 km).

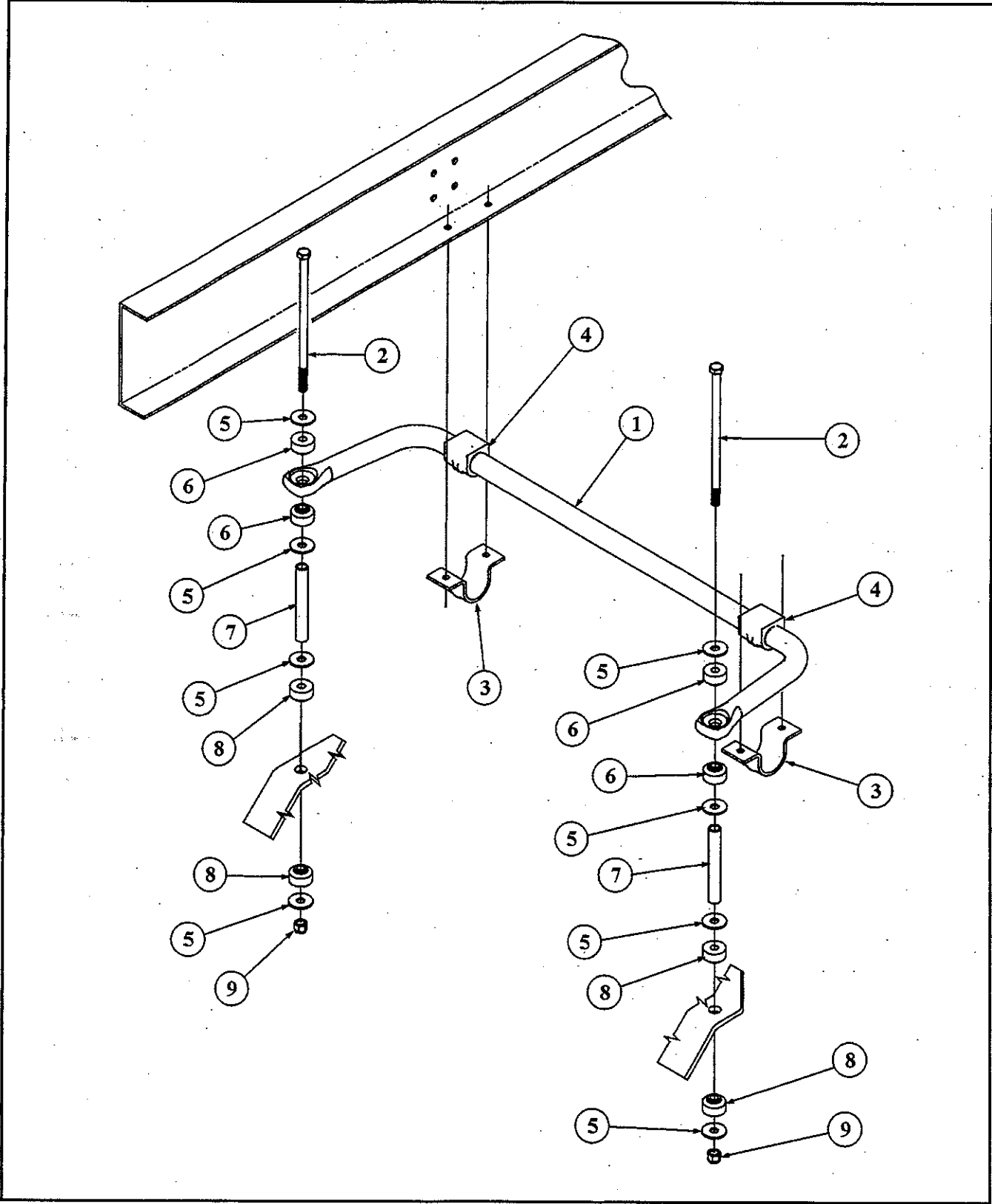


Figure 6—Front Suspension Stabilizer Bar

LTC Suspension

Rear Suspension Removal

Warning

Do not use the leveling jacks for this procedure. The leveling jacks are for tire changing and leveling of the bus.

Caution

Make sure the top of the bus has height room. Make sure the antennas are removed or folded. Make sure the mirrors are clear from obstruction.

1. Park the vehicle on a level surface.

Caution

A requirement to loosen all bolts and nuts is a step in the procedure. Do not remove any hardware at step 4.

2. Install six 15,000-pound (total capacity 90,000-pounds) jacks on the front and rear tires. The ARI-hetra Mobile Lifting Systems are used by Blue Bird (Model HDML 8-6); two lifts per axle.
3. Raise the bus using four jacks. (See Figure 1—ARI-hetra Mobile Lifting Systems.)

Caution

Make sure that the jack stands are in the correct location. Body and/or frame damage can occur if the stands are misplaced.

Place the jackstands under the frame rails. Do not use any other parts of the bus for jackstands. Be careful when placing stands to avoid damage to the steering rod and ball joint.

4. Install four tall 15,000-pound jackstands two front and two rear, see Figure 2—Jackstand Locations.
5. Loosen all required nuts and bolts.
6. Lower bus enough to put bus weight on the jackstands.

Warning

Do not place any part of a body under bus until safety stands are in place. Never place hands or fingers between parts of the suspension.

7. Inspect for safe operation in all areas.
8. Disconnect all air lines to air bags and air brake cambers.
9. Disconnect ABS wiring to axle.
10. Disconnect rear axle from the drive shaft.
11. Disconnect the transverse torque rod from the rear axle housing.
12. Remove the bottom shock absorber nut and bolt.
13. Remove top nuts from air bag.
14. Lower the suspension system using the ARI-hetra Mobile Lifting Systems.

Rear Suspension Disassembly

1. Disconnect transverse torque rod from the rear housing. (See Figure 7—Transverse Torque Rod and Axle Housing.)
2. Remove the top bolt from the shock absorber.
3. Remove the air bags from the beam assembly. (See Figure 8—Shock Absorber and Air Bags.)

Fixed/Tag Suspension Removal

1. Disconnect all air lines to air bags and air brake cambers. (See Figure 9—Fixed/Tag Axle.)
2. Disconnect ABS wiring to axle.
3. Remove the bottom bolt (1) from the both shock absorbers.
4. Remove both air bags (2) from the beam assembly.

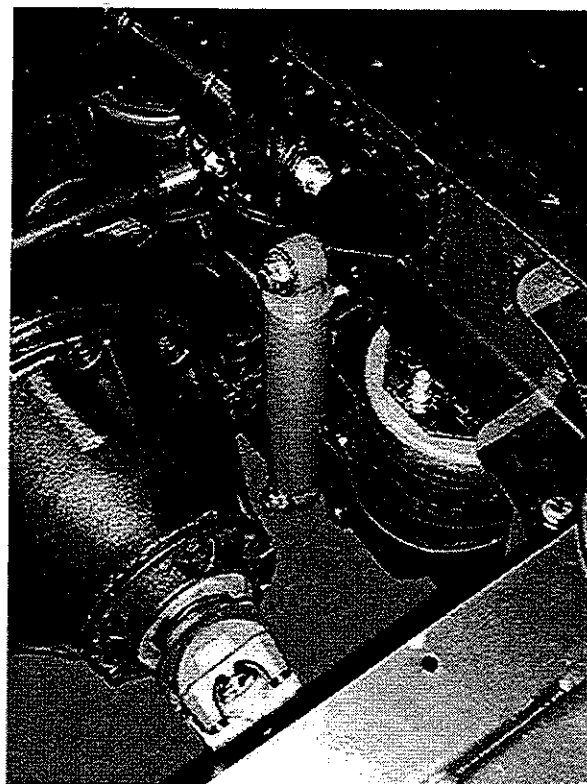


Figure 7—Transverse Torque Rod and Axle Housing

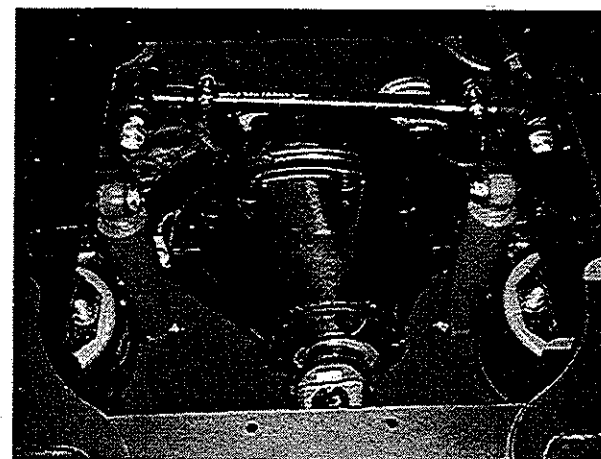


Figure 8—Shock Absorber and Air Bags

5. Remove nut and bolt from beam both bushing (3).

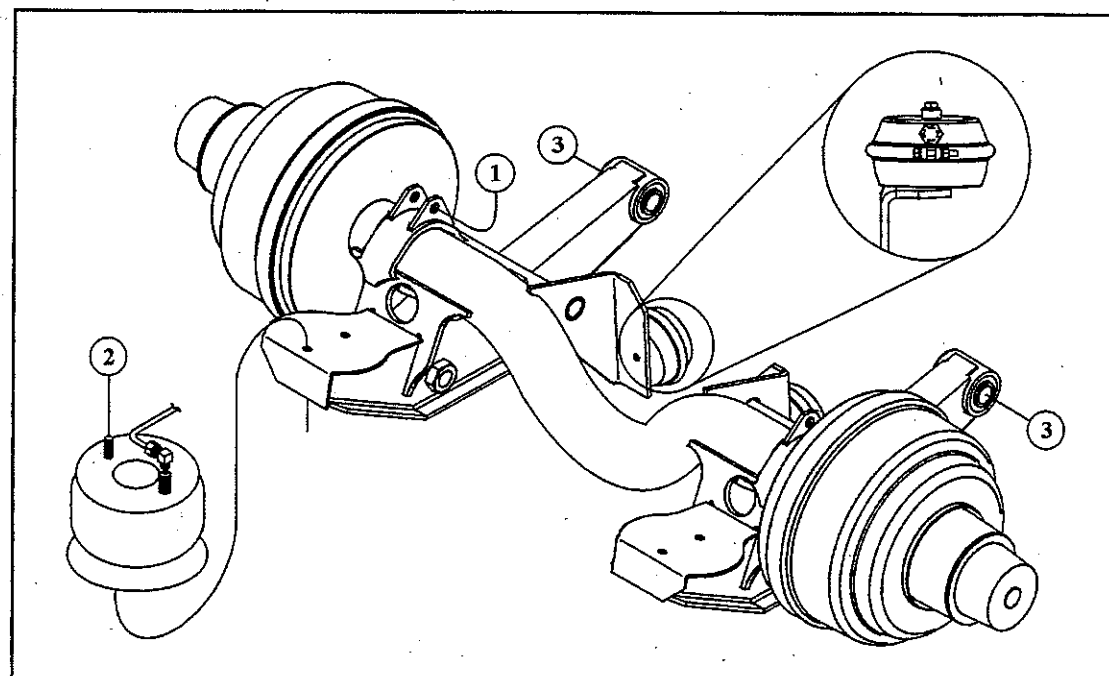


Figure 9—Fixed/Tag Axle



LTC Kneeling Feature



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LTC Kneeling Feature

Safety

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Notes

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Introduction

The kneeling feature design is to lower the front of the entrance doorstep for easier access of boarding the bus.

Description of Operation

Warning

A bus equipped with the kneeling feature can drop suddenly and without warning. Use extreme measures to remain outside of the bus body and not up under the bus. Use jack stands to support the bus.

There is a control valve mounted near the horn on the mounting angle bracket. (See Figure 1—Height Control Valve Kneeling Feature.)

Adjustment is 6 to 12 PSI (41.4 to 82.8 kPa) made at the regulator valve on the Schrader valve. (See Figure 3—Front Air Suspension System with Kneeling Feature.)

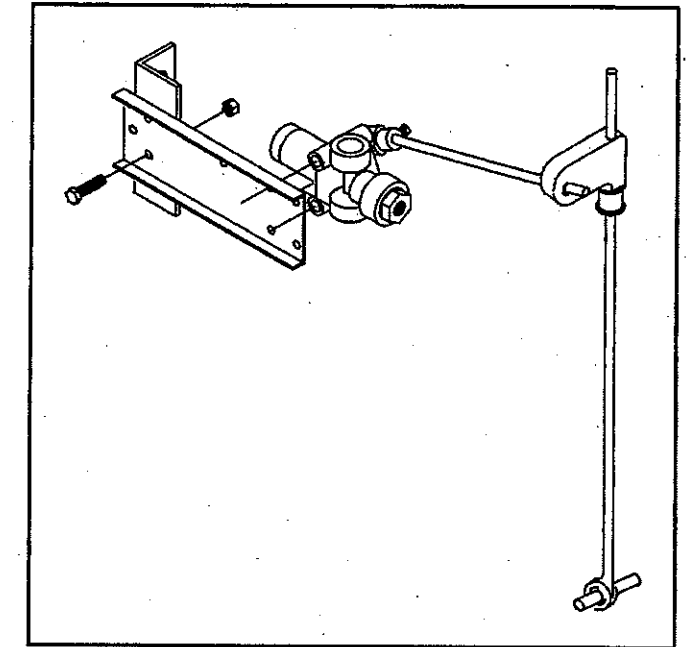


Figure 1—Height Control Valve Kneeling Feature

The kneeling feature is controlled by a kneel switch located on the front face of the shifter pedestal.

Note

The transmission must be in neutral and the parking brake applied for the kneeling feature to operate.

The adjusting positions at the switch are down, off, and up.

See Figure 2—Rear Air Suspension System with Kneeling Feature.

See Figure 3—Front Air Suspension System with Kneeling Feature.

To Lower the Bus**Note**

Air is released from the front air suspension bags very rapidly. The entrance doorstep will drop three inches (76 mm) in three seconds. The horn sounds to give warning, and a light on the dash is illuminated.

1. Place the position switch in the down position.
2. Place the position switch in the off position.

Warning

Attention must be given to passengers' feet before using the kneeling feature.

To Raise the Bus

Place the switch in the up position.

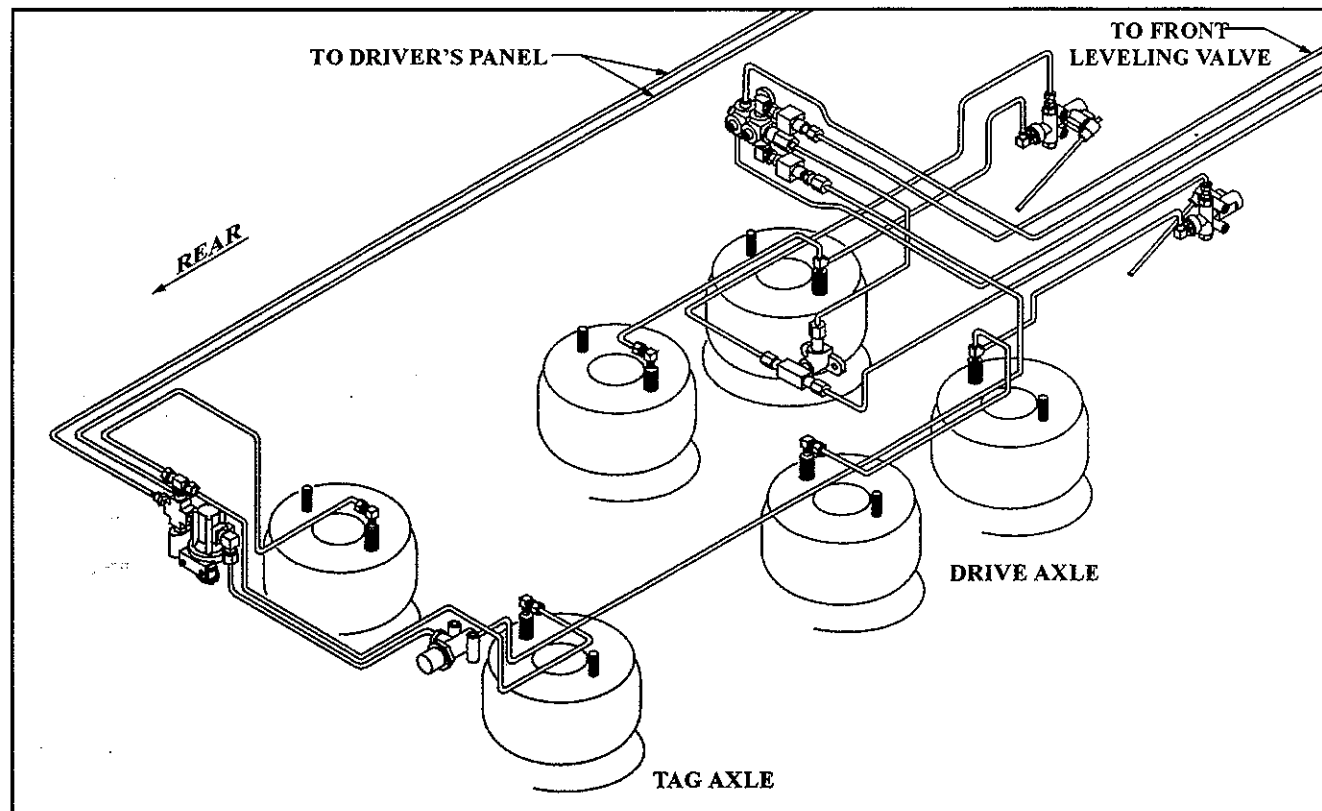


Figure 2—Rear Air Suspension System with Kneeling Feature

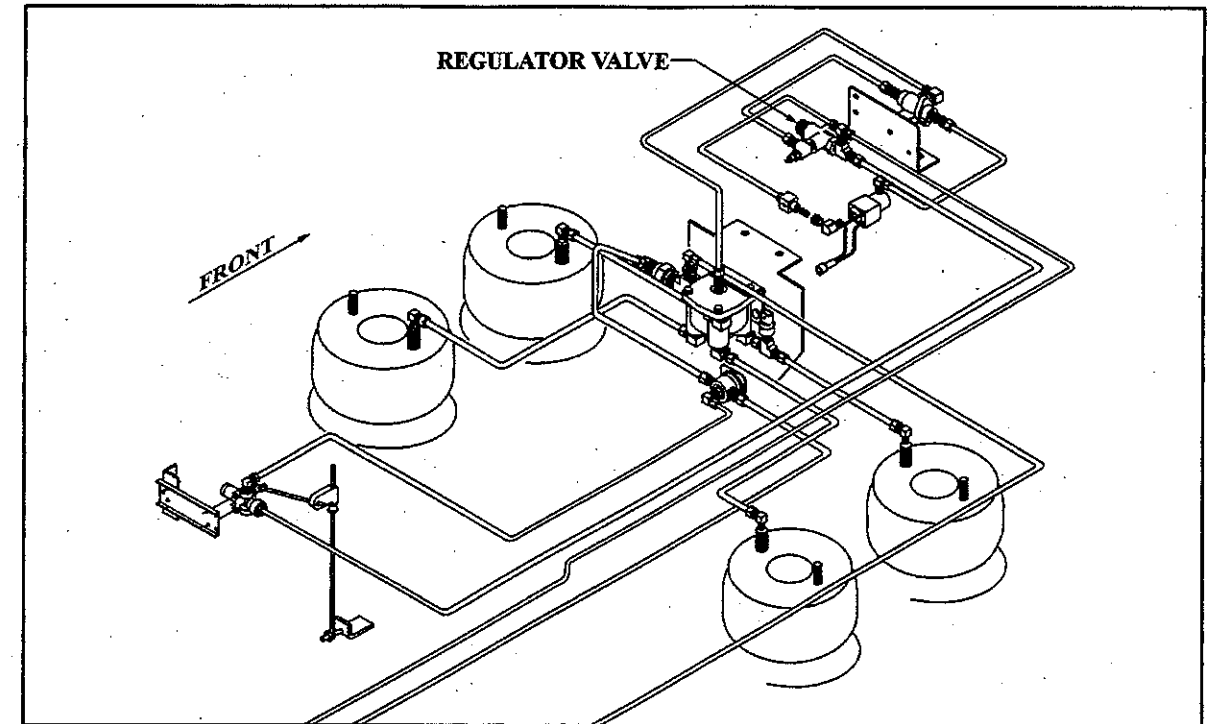


Figure 3—Front Air Suspension System with Kneeling Feature

LTC Transmission



BLUE BIRD®

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Safety

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Cautions

Cautions apply to a procedure or practice that, if not correctly adhered to, could result in damage or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Allison transmission. Vehicles with other engines or transmissions will use similar, and in most cases identical, procedures.

These procedures are generic for connections, fittings, lines and other parts. All need to be removed. However, it may not be appropriate or possible to remove connections, fittings, lines and other parts on the vehicle. Parts can be removed at any time when necessary.

Tools

- Common mechanic hand tools.

Note

The jack or dolly must be strong enough to take the weight of the transmission.

Warning

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

Preparatory Work

1. Park the vehicle on a level surface. Once parked, set the parking brake and chock the rear wheels. Though a lift is not required, much of the under vehicle work would be made easier via using a lift.
2. Disconnect the battery.

Note

If using a hydraulic lift, ensure that there is enough room for the transmission to clear axles.

3. Support the vehicle with jack stands.
4. Place the jack stands under the chassis frame rails.
5. Position the jack stands to balance the transmission.

Warning

Transmission oil is flammable and toxic to the skin, eyes and respiratory tract. Skin and eye protection is required. Avoid repeated or prolonged contact. Drain fluid in a well-ventilated area.

6. Drain transmission fluid into appropriate recovery containers.

Transmission Removal Configuration

All transmissions with Ridewell Suspension.

1. Remove brake air or hydraulic lines and ABS wires.
2. Remove the nuts and bolts directly below transmission and on the left and right side.
3. Secure the steering linkage to prevent damage.

Transmission Electronic Troubleshooting

See Figures 2, 3, 4, and 5 for electronic diagrams.

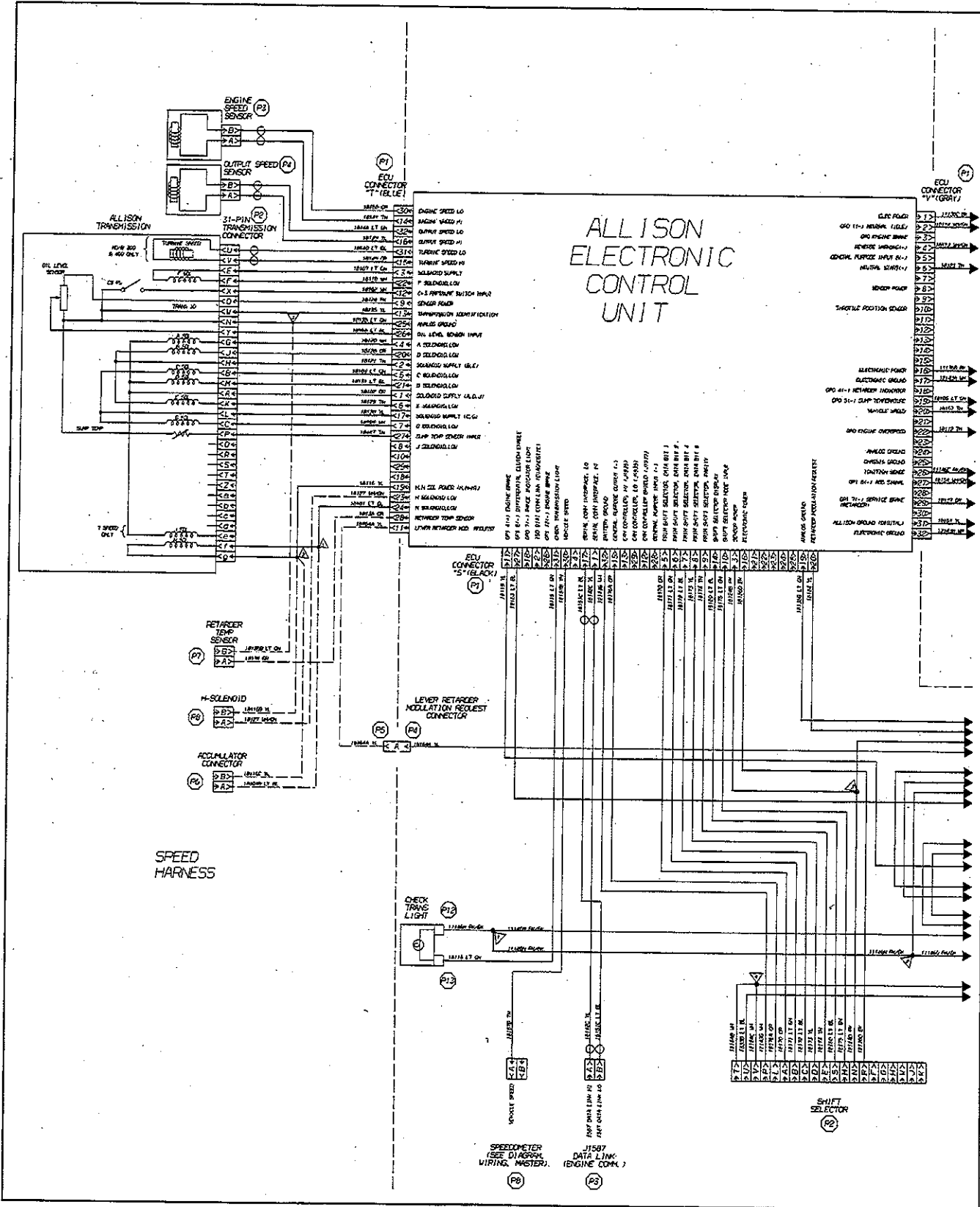


Figure 1—Electronic Control Diagram (1 of 2)

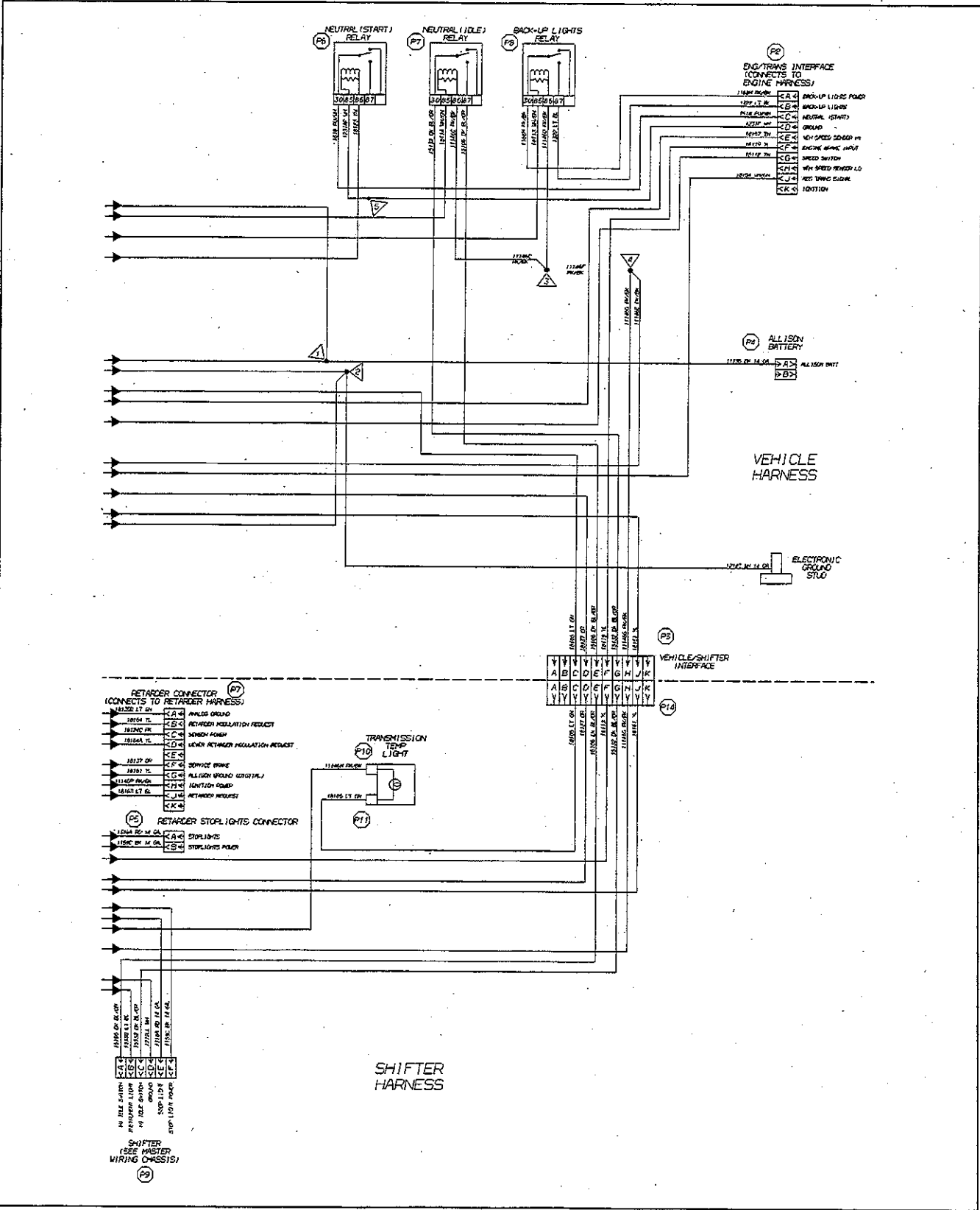


Figure 2—Electronic Control Diagram (2 of 2)

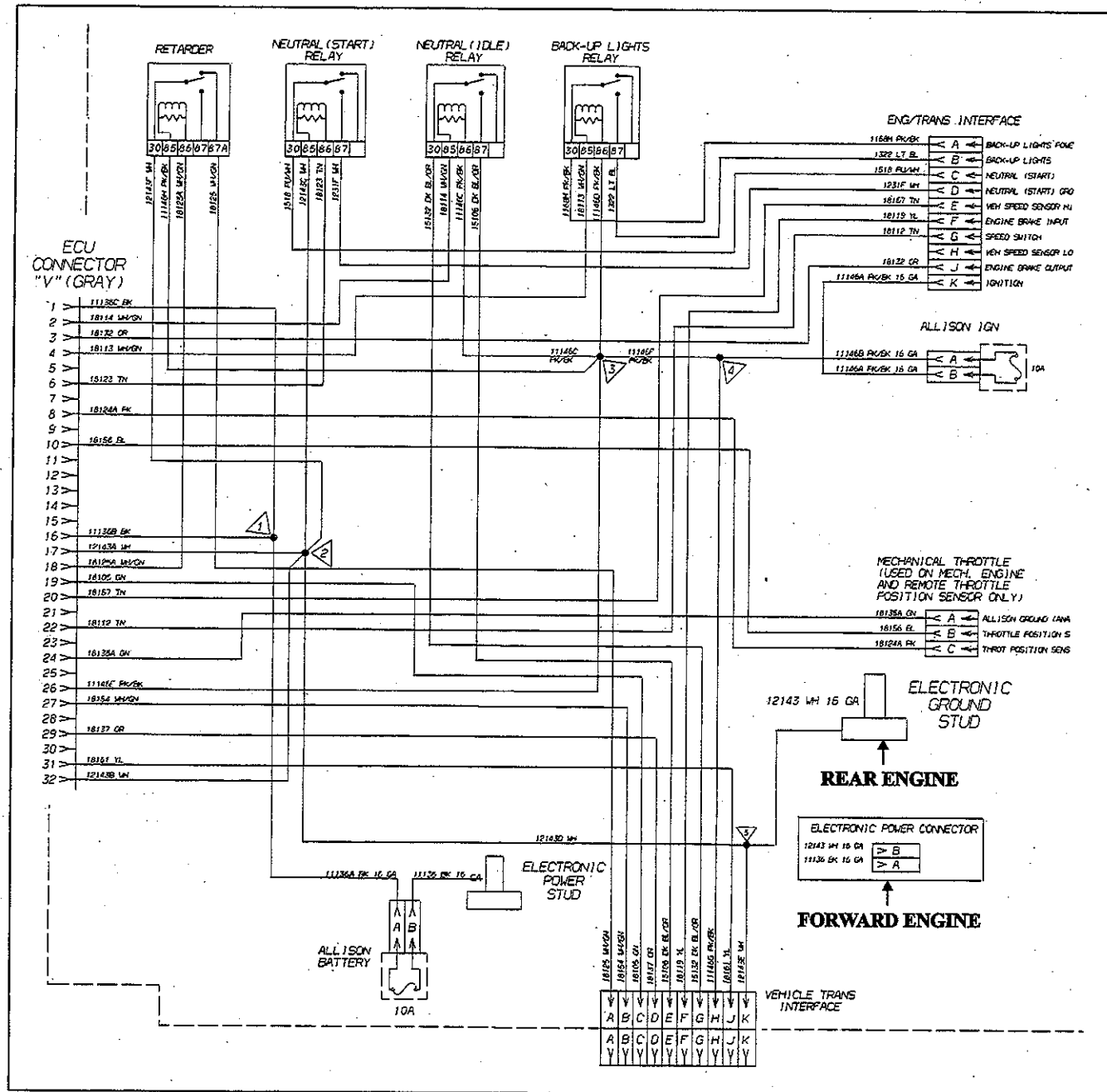


Figure 3—Electronic Control Diagram



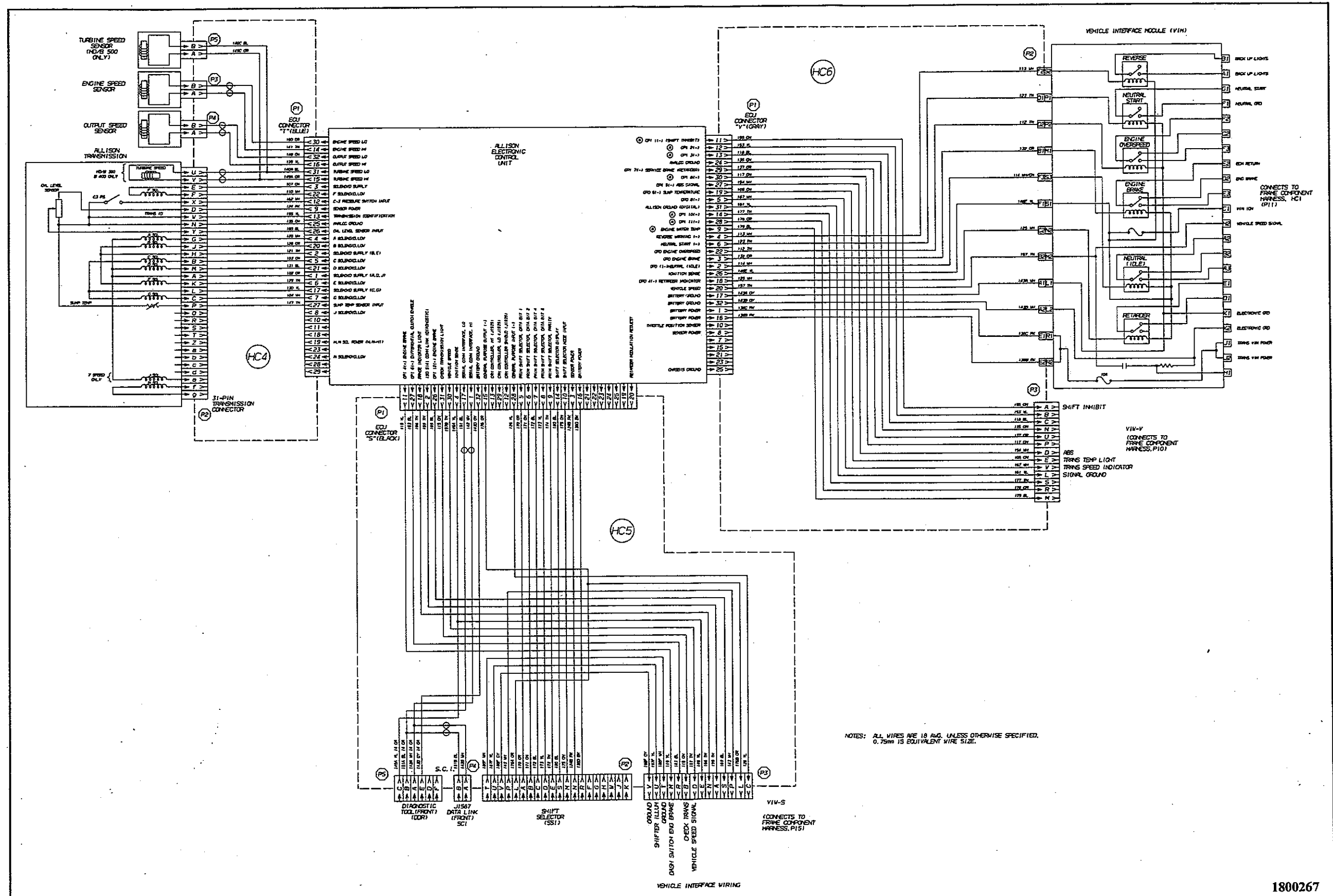


Figure 5 - B500 World Transmission Wiring

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Transmission Removal

Note

If the transmission is removed because of a failure, the fluid system should be flushed. Check with an approved Allison dealer to determine the appropriate flush procedure.

1. Disconnect battery cable.
2. Disconnect backup switch (6), neutral start (5) and speedometer switch (4) for the Allison transmission. (See Figure 6—Backup, Neutral Start Switch and Speedometer.)

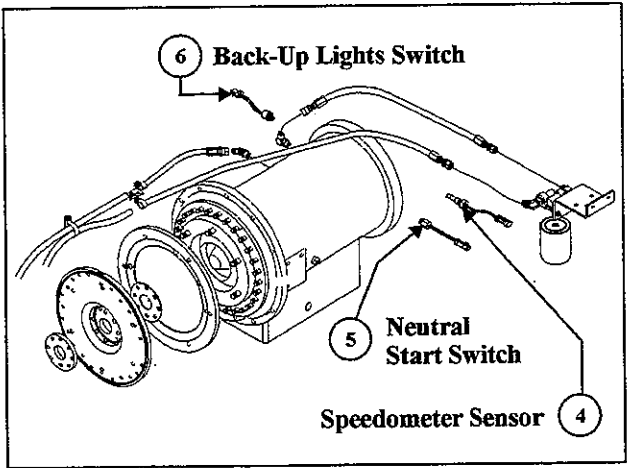


Figure 6—Backup Neutral Start Switch and Speedometer.

3. Disconnect coolant hose (15) from elbow (54) and discard O-ring. (See Figure 7—Transmission Hoses.)
4. Disconnect coolant hose (14) from elbow at filter.
5. Disconnect transmission fluid (13) from elbow (12) at filter.

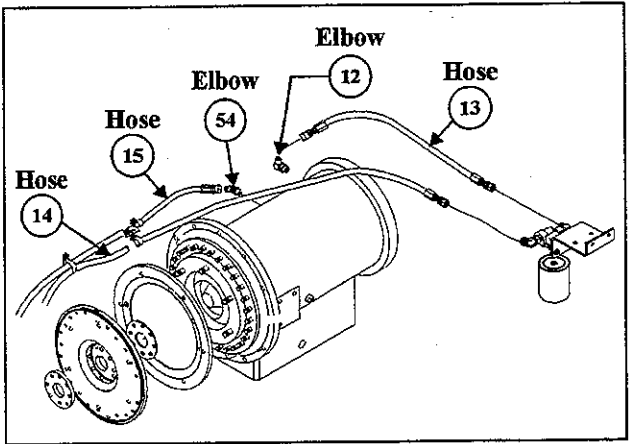


Figure 7—Transmission Hoses

6. Disconnect electronic shift (8A). (See Figure 8—Electrical Connections.)
7. Disconnect transmission air throttle control (8B).
8. Disconnect neutral start switch (5).
9. Disconnect the Allison transmission speedometer (4).
10. Disconnect backup light switch (6).

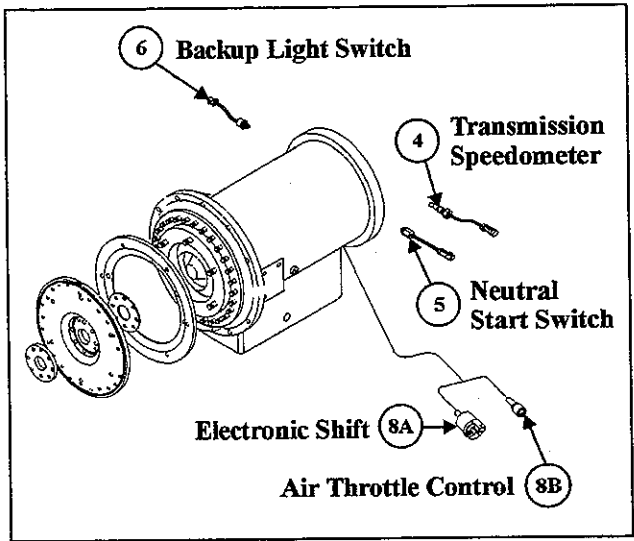


Figure 8—Electrical Connections

11. Remove nut (31), bolt (29) and washer (30) from bracket (20). (See Figure 9—Dipstick Removal.)

12. Remove dipstick tube (16).

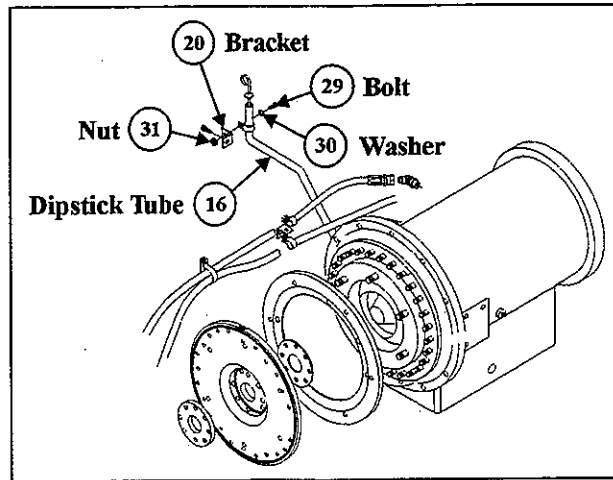


Figure 9—Dipstick Removal.

Caution

Make sure that the transmission is supported before removing bolts.

13. Remove 4-bolts (18) from bracket (17) on drive shaft. (See Figure 10—Drive Shaft Yoke.)

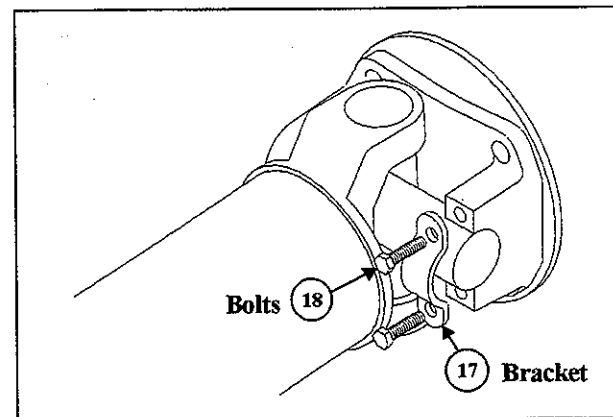


Figure 11—Drive Shaft Yoke

Caution

Make sure that all connections around the transmission are in fact disconnected.

14. Remove six bolts (A) from flange adapter.
15. Remove bell housing capscrews (28) and lock washers (27). (See Figure 11—Bell Housing.)

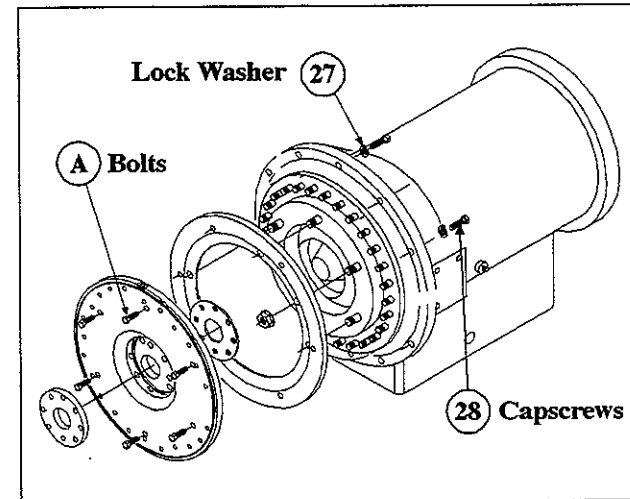


Figure 11—Bell Housing

16. Slide transmission aft to disengage engine.

Transmission Installation

1. Position the transmission directly behind the engine flywheel.
2. Turn the engine by hand to align the hole on the flex plate with the access hole on the engine bell housing. Use a dowel or drift pin to help align the holes.

Caution

Do not install bolts until all holes are in alignment.

3. Turn the torque converter until the attach hole aligns with the dowel or drift on the flex plate.
4. Place the engine and transmission bell housing together.
5. Install washer (27) and bolts (28) AT-545 and torque to 50 foot-pounds (67.8 N•m).

LTC Transmission

6. Install washer and bolts MD transmission torque to 38 to 43 foot-pounds (51.5 to 58.3 N•m).
7. Remove dowel or drift.
8. Install the first flex plate/torque converter bolt, do not torque.
9. Turn the engine crankshaft by hand until boltholes line up.
10. Install bolts torque to 38 to 45 foot-pounds (51.5 to 61.0 N•m).
11. Install bolts MD transmission torque to 18 to 21 foot-pounds (24.4 to 28.5 N•m).
12. Install dipstick tube.

Caution

Make sure that all lines and wires are 2 or more inches away from the exhaust system.

13. Connect the fluid lines and coolant lines.
14. Attach the drive shaft and the universal joint to transmission output shaft yoke.
15. Service the transmission check for leaks.

Notice for Extended Transmission Coverage (ETC)

Most Allison automatic transmissions purchased at retail for use in on-highway vehicle applications are eligible for coverage. ETC may be purchased only within 12 months after delivery of the vehicle to the first retail purchaser.

Use of TranSynd™ or Test Engineering Specification 295 (TES 295) equivalent transmission fluid is a requirement for the full term of the

Extended Transmission Coverage. The use of TranSynd or TES 295 equivalent transmission fluid is required for all transmission models, excluding off-highway transmission models. TranSynd or TES 295 equivalent transmission fluid must be installed during the first initial transmission fluid change or one month following the ETC registration, whichever occurs later. Proof of transmission fluid maintenance may be required. Failure to comply with the use of TranSynd or TES 295 equivalent transmission fluid will result in termination of the ETC contract. Any repairs that occurred outside the standard warranty period will not be honored.

ETC Coverage

ETC is available for one, two or three years with unlimited mileage/hours for the transmission as purchased from Allison Transmission. Allison will pay 100% parts and labor for covered repairs during the ETC coverage period.

Agreement Period

ETC coverage time is measured from the end of the standard warranty period.

Terms and Conditions

The terms and conditions under which Allison Transmission offers Extended Transmission Coverage are set forth on the back of the ETC Agreement Registration available from any authorized Allison Transmission Distributor or Dealer.

LTC Hydraulic Fan Drive System



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Cautions

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Notes

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Introduction

These procedures are documented using a Blue Bird LTC bus with a Cummins M11 or Detroit Diesel Series 60 engine and an Allison B500 World Transmission. The LTC bus uses a Hayden™ dual hydraulic fan cooler. The hydraulic fan cooler stabilizes hydraulic oil temperature to ensure maximum fan performance.

Hydraulic Fan Drive Components

For the Hydraulic System S-60, see Figure 1.

For the Hydraulic System Series M11/ISM, see Figure 2.

Description of Operation

The fan drive system responds to cooling requirements by monitoring engine coolant temperature and charge air temperature.

The system then provides a modulated fan speed to meet cooling requirements for each system. (See Figure 1—Hydraulic System M11 ISM and Figure 2—Hydraulic System Series 60.)

A hydraulic fan motor directly drives the engine-cooling fan. Modulated fan speed will depend on the amount of oil flowing through the fan motor.

The oil flow is measured in Gallons Per Minute (GPM). Low oil flow results in low fan speeds. As oil flow increases, fan speed increases. Oil flow through the fan motor will depend on three main areas of the hydraulic fan drive system:

Pump speed is the amount of oil allowed to bypass the Fan motor Pilot control valve assembly. A pump creates oil flow necessary to operate the hydraulic fan drive system. The pump is a positive displacement gear type pump.

As engine Revolutions Per Minute (RPM) increase, oil flow increases proportionately. As engine RPM decreases, oil flow decreases proportionately.

The fan motor bypass valve controls the amount of oil allowed to bypass the fan motor. The valve is located in the fan motor control valve, which is integrated into the fan motor housing.

The hydraulic pilot operated circuit controls the fan motor bypass valve. The hydraulic pilot circuit is in turn controlled by a charge air override valve and a thermovalve.

Tools Required

- High pressure hydraulic test cut off valve
- 0 to 4000 PSI pressure gauge
- Phototach
- Power steering analyzer
- 0 to 30 gallon per minute flow meter.

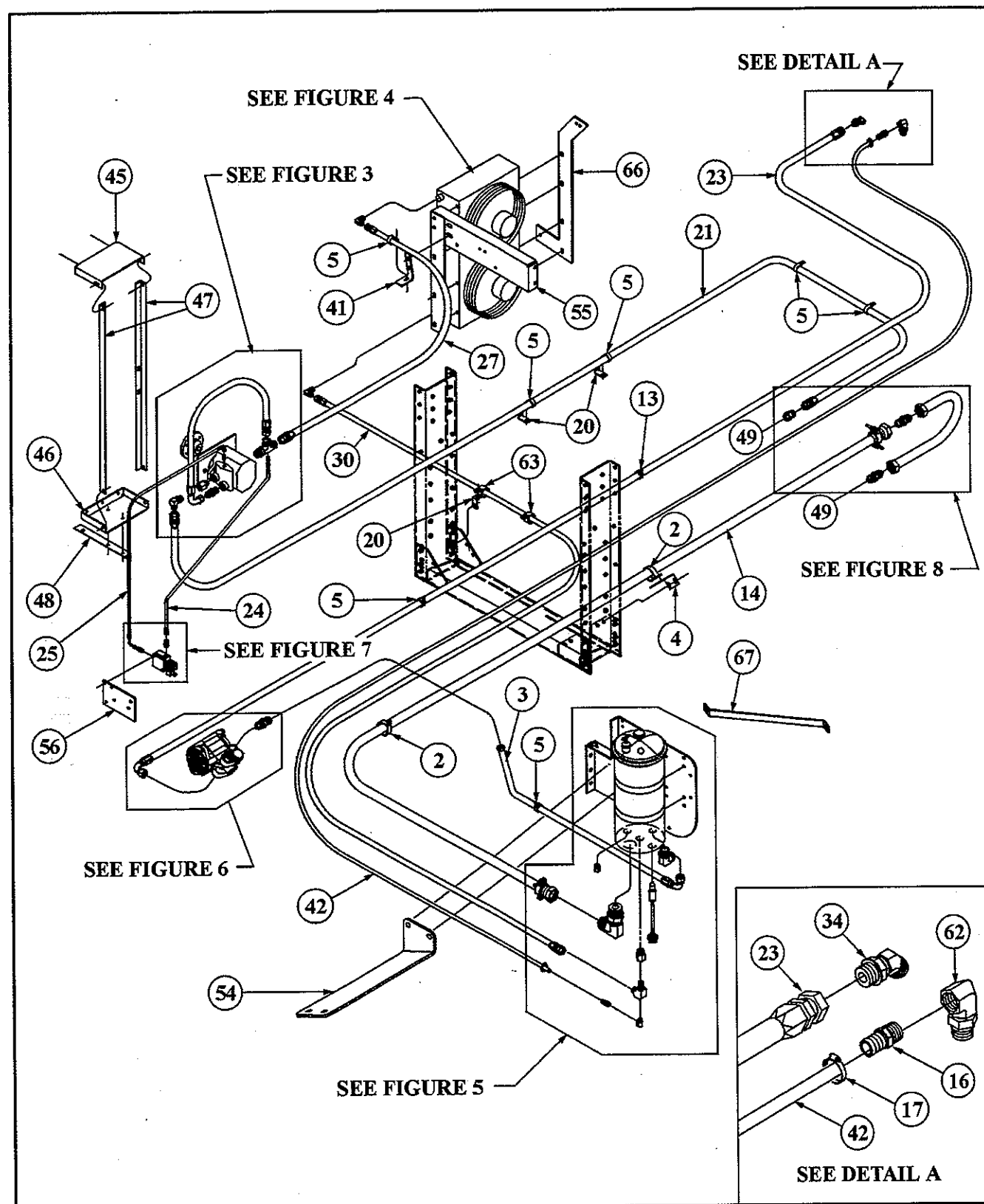


Figure 1—Hydraulic System S-60

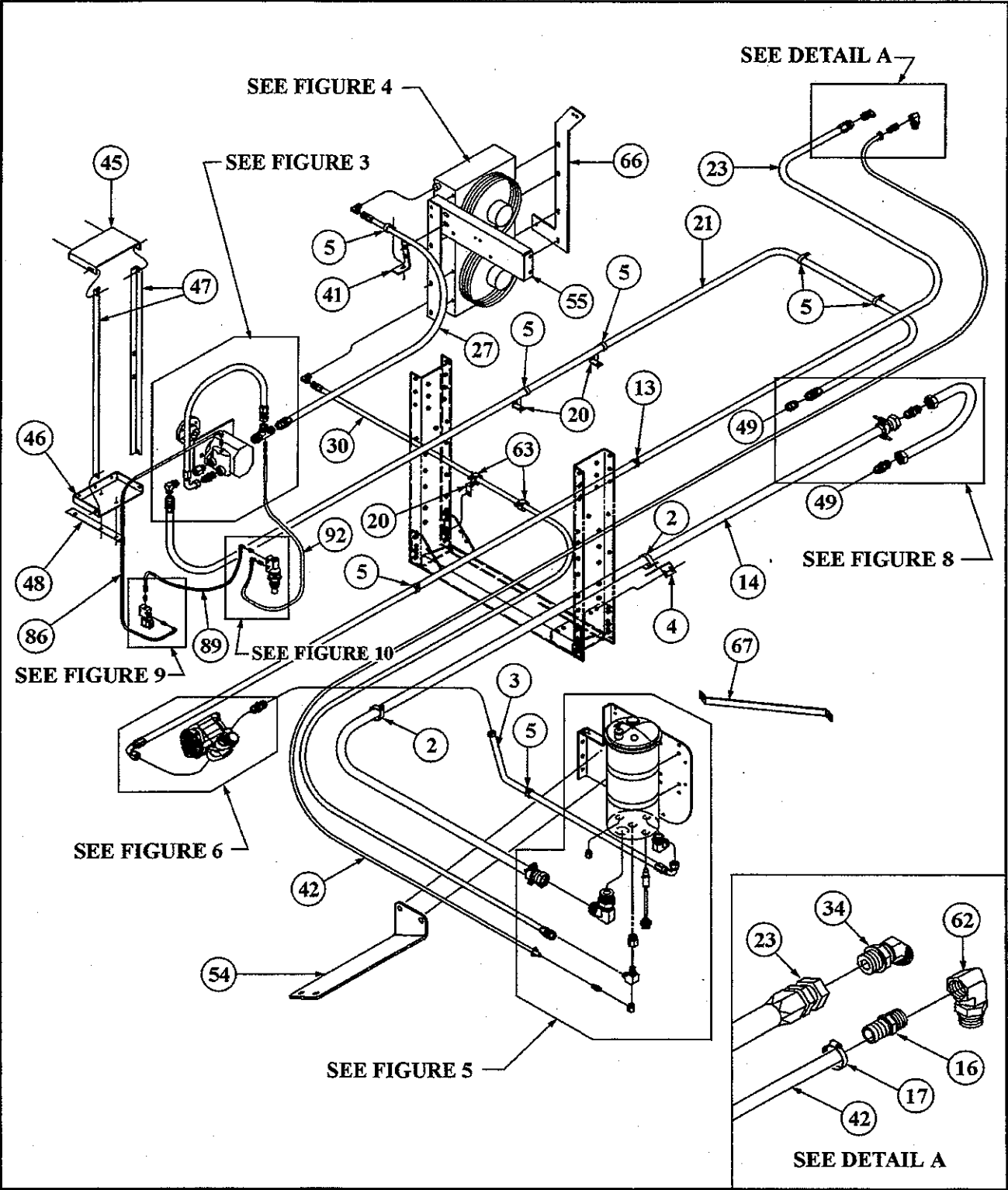


Figure 2—Hydraulic System M11 ISM

Hydraulic Fan Drive Troubleshooting

Problem	Troubleshoot	Repair
Hydraulic oil is not overheating. Hydraulic oil overheat indicator light is on.	Warning circuit or temperature sensor has failed	Disconnect hydraulic oil temperature sensor connector. If light goes off, temperature sensor has failed Replace sensor. If light stays on, the warning circuit is grounded Check and repair circuit.
Hydraulic oil overheat light on.	Hydraulic oil overheating (Hydraulic System Failure) Caution <i>Do not probe temperature sensor. Electronic circuitry can be damaged.</i> Hayden hydraulic oil cooler contaminated externally.	Refer to Hydraulic Fan Drive Troubleshooting Clean the cooler thoroughly
Hayden oil cooler electric fan will not run.	Check Hayden fan fuse for continuity. Check for 12-volt on number 30 pin of the Hayden fan cooler.	Replace fuse if no continuity. If 12-volt is not present, check the circuit between fuse and relay.
	Jumper between terminal 30 and 87 of the fan relay. If the fan does not run, jumper 12-volt to terminal A and a ground to terminal B of the Hayden fan connector. If the fan motor does run. The fan motor and fan circuits are okay. The relay or the hydraulic oil sensor has failed. With ignition on, check for 12 volt on terminal, 86 on the Hayden fan relay. Disconnect the hydraulic oil temperature sensor at connector P2 Jumper a ground to terminal 85 of the Hayden fan relay.	If the motor does not run, the motor has failed. Replace motor If the motor does not run, the motor has failed. Replace motor Check relay and/or temperature sensor. If the fan runs, the hydraulic oil sensor or the circuit is at fault. If the fan runs, the hydraulic oil sensor or the circuit is at fault.

Table 1—Troubleshooting (1 of 2)

Problem	Troubleshoot	Repair
Hayden oil cooler electric fan will not run.	Jumper a ground to terminal C on the temperature sensor connector P2. With ignition on, check for 12-volt on pin B of the temperature sensor connector P2. Check for ground on pin A of the temperature sensor connector P2. If test on pins A, B, and C check okay, the temperature sensor is faulty.	If fan runs, circuit is okay. If the fan does not run, check circuits between sensor and relay. If 12-volt is not present, check circuit. If a ground is not present, check circuit. Replace sensor.
Noisy Fan Drive	Low oil supply	Check oil level and refill.
	Restricted oil supply	Check for restriction to oil supply hose inside of reservoir. Check for restriction in supply line. Check for kinked supply line. Look for obstruction inside of supply hose. Check for a collapsed supply hose.
Air in the oil supply	Note <i>Remove the dipstick, shine a light into the reservoir, and look for bubbles. Oil should be air free.</i>	Check oil level in reservoir. Check for loose fitting on supply lines. Check for restriction in supply hose. Check the hydraulic pump shaft seal.
Mechanical Failure	Note <i>Rotation of fan is done in the normal rotation direction.</i>	Check for excessive metal in filter; this will indicate a mechanical failure. With the engine off, spin the fan by hand and check for free rotation.
Fan not rotating	Hearing excessive noise	Remove and replace motor.
Normal oil color Air in the supply line	Note <i>Oil overflowing will have air mixed with it or will be foamy.</i>	Reservoir may be over filled. Check for loose connection on the supply hose. Check for restriction in supply hose. Check hydraulic pump shaft seal.
Discolored oil is black like engine oil		Check pump shaft seal. Seal has failed allowing engine oil to transfer into the hydraulic system.

Table 1—Troubleshooting (2 of 2)

Caution

Do not operate bus with a coolant leak, engine oil leak, or hydraulic oil leak. Major engine damage will occur.

Make sure that all clamps on hoses or tubes are tight to prevent leaks of air or fluid. Make sure that all screws and bolts are tight to prevent damage to vehicle.

Engine Over Heating.

- **A-Check Engine Coolant Level**

Inspect all hoses for leaks.

Inspect all valves for leaks.

Inspect for radiator blockage.

- **B-Check Hydraulic Oil Level.**

Check reservoir level.

Inspect all hoses for leaks.

Inspect all valves for leaks.

- **C-Check for Air in the Hydraulic Oil**

Remove the dipstick

Shine a light in the reservoir and look for air bubbles. If air bubbles are in the oil:

Check oil level in reservoir

Inspect connections on the pump supply line.

Inspect restriction in supply hose, internal and external.

Inspect hydraulic pump shaft seal.

- **D-Check De-Energize the Charge Air Override Solenoid (CAOS)**

Caution

Do not test if engine temperature is above 212 °F, as major engine damage will occur.

Note

De-energizing the CAOS will cause the fan to operate in a charge air override mode all the time, rather than cycling on and off to meet charge air-cooling needs. In this mode of operation, the hydraulic fan drive system will operate at approximately 50% to 60 % of maximum efficiency.

Override Solenoid (CAOS)

If the fan speed does not increase as engine speed increases, disconnect the electrical circuit at the CAOS or the electrical circuit at the charge air override sensor.

Accelerate the engine to full RPM and observe fan speed.

If there is a large increase in fan speed with the CAOS de-energized, the thermostatic valve is at fault. If so, replace the thermostatic valve.

If there is no large increase in fan speed, go to step I-Check Hydraulic Fan Circuit Pressure.

If the engine temperature is below 200 degrees Fahrenheit, disconnect the electrical circuit at the CAOS. Disconnect the electrical circuit at the charge air override sensor. Test-drive the bus to determine if this resolves the over heating.

If this resolves the problem, the thermostatic valve is at fault. Replace the valve.

If this does not fix the problem, refer to step I-Check Hydraulic Fan Circuit Pressure.

Caution

Do not operate a bus with the CAOS de-energized for long periods. This is a test procedure only. Operating the bus with the CAOS de-energized can result in the following conditions:

Shortening the life of the hydraulic fan drive system

Increasing service requirements for the HFD

LTC Hydraulic Fan Drive System

Decreasing fuel mileage

Over cooling the engine

Shortening the life of the engine thermostat

Decreasing efficiency of the engine

Adversely affecting the engine's emissions system

Caution

Operating the hydraulic fan system in a charge air override mode may provide adequate cooling under light operating loads and cooler weather. Bus may over heat under heavier loads and hotter climate.

- E-Check the Condition of the Fan Blade

Warning

Rotating fan blades can cause serious bodily injury.

- Inspect for cracked, chipped, or broken fan blades.
- Replace the fan if needed

- F-Check the Fan Motor for Free Rotation

Note

The hydraulic fan drive system should be thoroughly flushed when the system has been opened for mechanical repair.

Note

The fan should rotate smoothly with some resistance from oil in the fan motor.

With the engine off manually rotate the fan. A rough rotation indicates a mechanical failure in the fan motor. In this case, repair or replace the fan motor.

- G-Check Radiator for External Contamination

Inspect the entire area of the radiator and the charge air cooler for obstructed airflow using a light source.

Note

The charge air cooler may have to be removed to properly clean the radiator.

Clean the radiator and charge air cooler as necessary.

- H-Check Radiator and Charge Air Baffles

Note

Missing or damaged baffles can cause heated engine compartment air to re-circulate through the radiator causing an overheating condition.

Check the condition of the baffles between the radiator and the charge air cooler.

Check the condition of the baffles between the charge air cooler and the bus body.

Replace or repair baffles as necessary.

- I-Check Hydraulic Fan Circuit Pressure

- Check hydraulic fan circuit pressure with engine temperature between 205 and 210 degrees Fahrenheit.

There are two methods for checking the pressure.

Method 1

Do not exceed maximum pressure ratings for the system. Bodily injury can occur.

Install a test fitting in hydraulic line and pressure gauge that will function from 0 to 4000 PSI.

Start the engine and accelerate to full RPM while observing the pressure gauge.

Compare the pressure with the specifications. (See Table 2—Hydraulic Cooling System Performance.)

If the pressure reading is low, the Hydraulic Fan Drive System (HFDS) is at fault. Go to step I.

If the pressure reading is correct and the fan speed appears to be correct, this is an indication that the over heating is in the cooling system. Refer to step J.

Method 2

Note

This procedure bypasses the thermovalve and should cause fan to run at full speed and full system pressure.

Disconnect hydraulic line G from fan motor control valve.

Install a pressure gauge that will function from 0 to 4000 PSI in port P on the fan motor control valve.

Start the engine and accelerate to full RPM while observing the pressure gauge.

Compare the pressure with the specifications. (See Table 2—Hydraulic Cooling System Performance.)

If the pressure is low, the HFDS is at fault. Go to step J-Check Fan Speed.

If the pressure reading is correct and fan speed appears to be correct is an indication the over heating is in the cooling system, refer to section Cooling System and specific engine manufacture's troubleshooting.

- J-Check Fan Speed

Note

Fan should run at full RPM with engine temperature above 205 providing the engine is at full RPM.

Check fan speed with engine temperature between 205 to 210 degrees Fahrenheit.

Start the engine and accelerate to full RPM.

Check the fan RPM with a Phototach. Compare with specification. (See Table 2—Hydraulic Cooling System Performance.)

If the fan speed is within specification, the HFDS is not at fault.

Check the engine cooling system to determine over heating. (Refer to section Cooling System and specific engine manufacture's troubleshooting.)

If the fan does not run at full RPM one of the following is at fault.

- Thermovalve
- Hydraulic Pump
- Priority Flow Divider Valve
- Fan Motor Control Valve
- Fan Circuit Relief Valve
- Fan Motor

Check fan speed with engine temperature below 200°F.

Warning

The test valve must be capable of withstanding 5000 PSI and designed for hydraulic test purposes. The use of improper test equipment can cause serious injury.

Disconnect hydraulic lines E and F, see figure BB Hydraulic Fan Drive Circuit from the thermovalve.

Note

Make sure the valve is in the full open position.

Connect hydraulic lines E and F to A hydraulic cut off test valve.

Start the engine and accelerate to full RPM.

Observe the fan speed using a Phototach while slowly closing the cut off valve.

If fan speed reaches full RPM. (See Table 1—Troubleshooting, the thermovalve is defective.)

If the fan does not run at full RPM with the test valve closed completely off the fault is in one of the following areas.

- Hydraulic Pump
- Priority Flow Divider Valve
- Fan Motor Control Valve
- Fan Circuit Relief Valve
- Fan Motor

- K-Test the Hydraulic System

Caution

Clean and lubricate all parts before re-assembly.

Note

Careful disassembly, cleaning, and re-assembly of the flow divider valve may resolve the problems. Fine emery cloth dipped in a cleaning solvent may be used to polish spool valves. All spool valves should move freely through the bore inside the valve body.

Disassemble and inspect the fan motor for internal damage. (Replace or repair.)

1. Install 0 to 30 GPM flow meter in H line.
2. Start engine and accelerate slowly to full RPM observe GPM. (See Table 2—Hydraulic Cooling System Performance.)

If GPM is within specifications go to step F.

3. Stop engine and install a power steering
4. analyzer in H line I, (the steering circuit supply line). (Refer to section 120 Steering.)
5. 4. Start engine and accelerate to full RPM; observe the GPM in the power steering circuit.
6. 5. If GPM is within specification the pump is at fault, see Table 2—Hydraulic Cooling System Performance.
7. Replace or repair pump.
8. If GPM is higher than specified the priority flow divider valve is at fault.
9. Re-inspect steering system and hydraulic fan drive system flow rates and fan speed after replacing or repairing the flow divider. Compare data with specifications. (See Table 2—Hydraulic Cooling System Performance.)

If systems are not within specification, proceed with troubleshooting.

If the GPM is within specification, one of the following is at fault:

*Fan Motor Control Valve
Fan Circuit Relief Valve
Fan Motor*

Repair or replace the Fan Motor Control Valve (FMCV).

Repair or replace the fan circuit relief valve (FCRV).

Product Line: RCDA							
Engine Model: ISM							
Horse Power		Idle	Governor	No-Load Governor		Pump Drive	Ratio
450		700	2100	2300		PTO	1.23
Pump Number	Motor Number	Fan Trim Speed	Displacement 100%	Displacement 86%	Displacement 100%	Displacement 90%	
1743947	1758937	2200	2.92	2.51	2.68	2.98	
Relief PSI 2755		P/S 0					
Engine RPM	Pump Flow GMP at 100%	Pump Flow GMP at 86%	Fan Speed Motor 100% Pump Speed 100%	Hydraulic HP	Fan Speed Motor 90% Pump Speed 86%	Hydraulic HP	
700	10.88	9.36	938	17.5	726	15.0	
800	12.44	10.70	1072	20.0	830	17.2	
900	13.99	12.03	1206	22.5	934	19.3	
1000	15.55	13.37	1340	25.0	1037	21.5	
1100	17.10	14.71	1474	27.5	1141	23.6	
1200	18.66	16.05	1608	30.0	1245	25.8	
1300	20.21	17.38	1742	32.5	1348	27.9	
1400	21.77	18.72	1876	35.0	1452	30.1	
1500	23.32	20.06	2010	37.5	1556	32.2	
1600	24.88	21.39	2144	40.0	1660	34.4	
1700	26.43	22.73	2278	42.5	1763	36.5	
1800	27.99	24.07	---	---	1867	38.7	
1900	29.54	25.41	---	---	1971	40.8	
2000	31.10	26.74	---	---	2075	43.0	
2100	32.65	28.08	---	---	2178	45.1	
2200	34.21	29.42	---	---	---	---	
2300	35.76	30.75	---	---	---	---	

Table 2—Hydraulic Cooling System Performance Data

Hydraulic Flushing Procedures

The hydraulic flushing procedures should be used whenever component failures have accrued in the system.

Caution

Failure to thoroughly flush and clean all areas of the hydraulic system after a failure may cause repeat failure of the same component.

1. Remove the hydraulic pump, fan motor, and all hoses.

2. Disassemble, inspect, and clean any component that is to be used again.

3. Flush all hydraulic hoses.

4. Flush the thermovalve.

5. Remove the filter inside the reservoir.

6. Flush the reservoir and install a new filter.

7. Remove the stop bolt in the bottom of the steering gear, and the steering circuit pressure relief valve. (Refer to section 120 Steering.)
8. Place chocks at the rear wheels.
9. Lift the front axle off the ground.
10. Turn the steering wheel to full turn left and right four times.
11. Clean the stop bolt and pressure relief valve.
12. Install the stop bolt and relief valve.
13. Install all removed components and hoses.
14. Fill the hydraulic reservoir with HD32 Hydraulic Oil.

Note

Oil level must be maintained in the sight glass while the engine is running.

15. Start and run the engine for 30 seconds.
16. Stop the engine and refill the reservoir.
17. Repeat steps 15 and 16 until oil level is maintained in sightglass.

18. Disconnect the electrical circuit at the charge air override solenoid valve. This will cause the fan to run at a moderate speed.
19. Run the engine at approximately 1500 RPM.
20. Reconnect and disconnect the electrical charge air override circuit 3 times.
21. Place chocks at the rear wheels.
22. Jack the front axle off the ground.
23. Turn the steering wheel to full turn left and right four times.
24. Run the engine for 10 minutes.
25. Stop the engine.
26. Drain the oil from the reservoir.
27. Remove the filter from the reservoir.
28. Install a new filter.
29. Fill the reservoir with HD32 Hydraulic Oil.
30. Inspect the total hydraulic system for leaks.

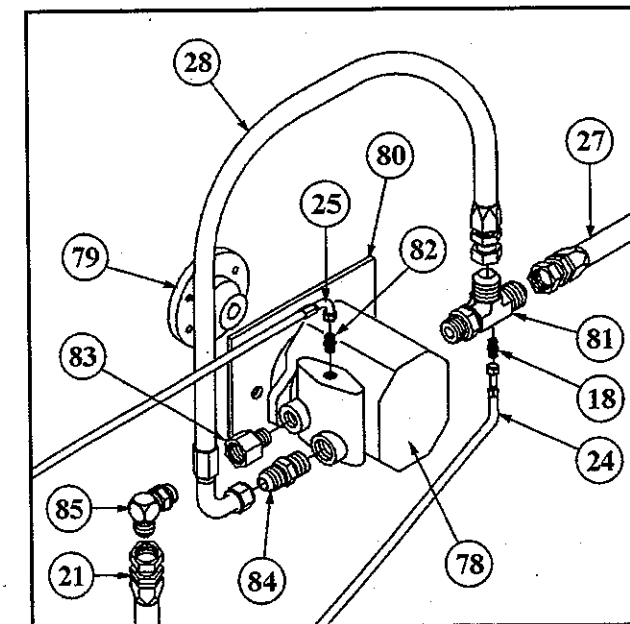


Figure 3—Motor and Switch Valve Assembly

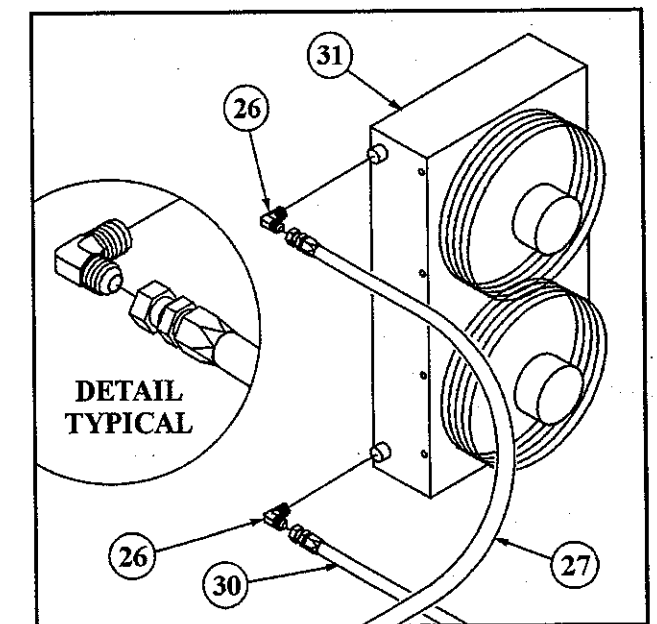


Figure 4—Hayden Air to Oil Cooler

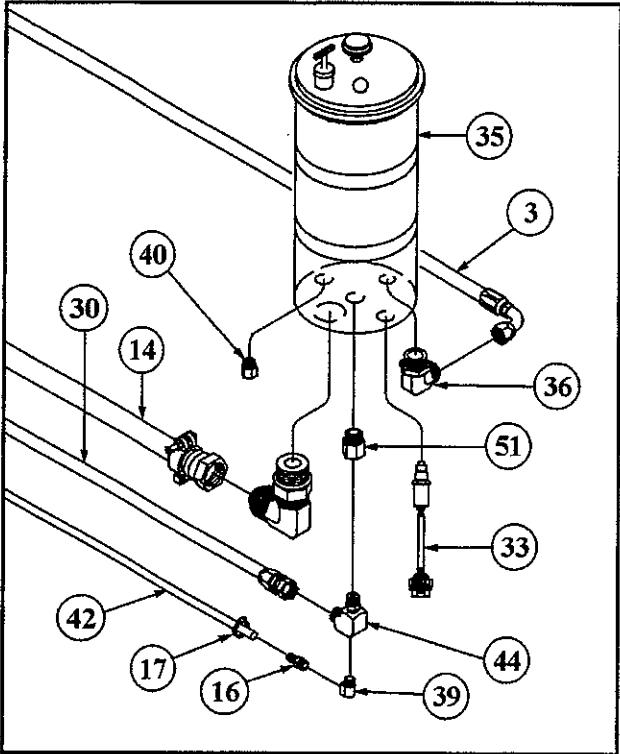


Figure 5—Reservoir 16-Quart with O-Rings

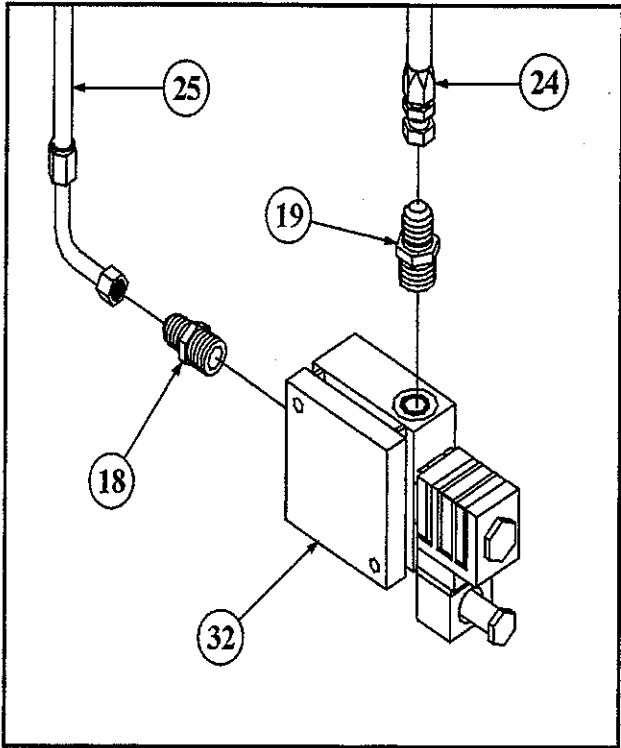


Figure 7—12-Volt Fan Control Valve

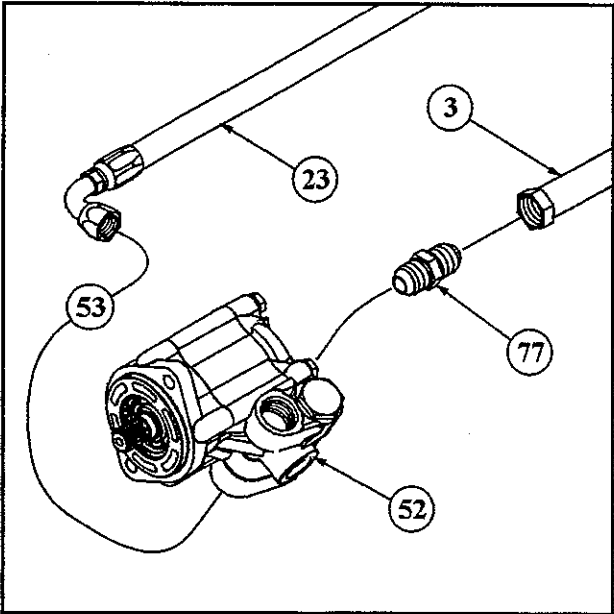


Figure 6—TRW Power Steering Pump

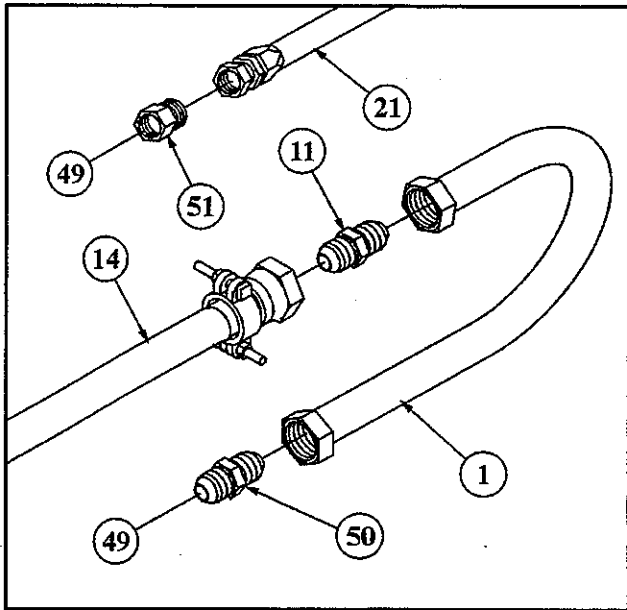


Figure 8—Hydraulic Hose and Tube Pump

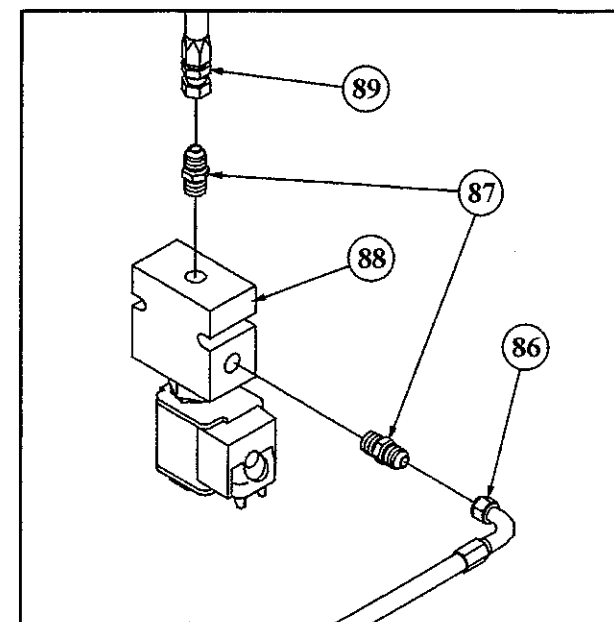


Figure 9—Solenoid Pilot Control Valve

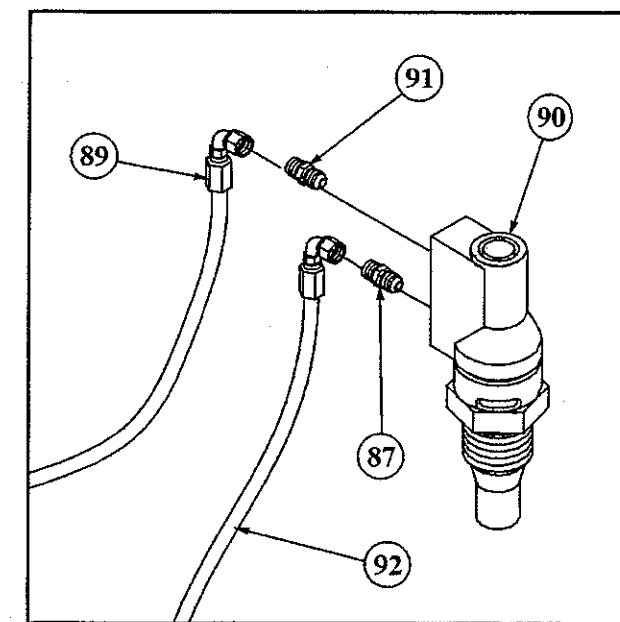


Figure 10—Thermostat Valve

LTC Body General



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation of this Blue Bird product, and the protection of equipment. Before performing any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures are documented using a Blue Bird LTC with a Cummins M11 engine and an Allison B500 World Transmission.

Description of Operation

The method for repairing and replacing damaged bus body panels is intended for authorized dealer, repair, and service organizations.

There are special techniques required for the rivet-bonded joint using a combination of fasteners and adhesive.

The special techniques are required to meet joint strength. Special application and curing are necessary.

The adhesive used in rivet-bonded joints is strong and difficult to remove.

The Blue Bird Body Company requires that any damage be reported so that a trained service organization can assist in the repair.

Warning

Skin, eye and respiratory protection is required. Avoid repeated or prolonged contact. Use in a well-ventilated area.

Caution

Make sure that the area to be repaired is on a solid surface. Do not flex or move the joint during the entire curing cycle.

Stepwell Removal

Warning

Use the parking brake. Use wheel chocks at the rear wheel. Make sure the vehicle is stable before moving under the vehicle.

1. Jack the front of the bus up so that the removed stepwell will clear.
2. Support the stepwell for removal.
3. Cut all sealant at edge of steptread to wall of stepwell.
4. Remove steptread. (See Figure 1—Stepwell and Steptread.)
5. Remove three screws from lower flange of door frame assembly.
6. Remove lower screws from handrail assembly at stepwell and barrier.
7. Remove three screws to light lens retainer.

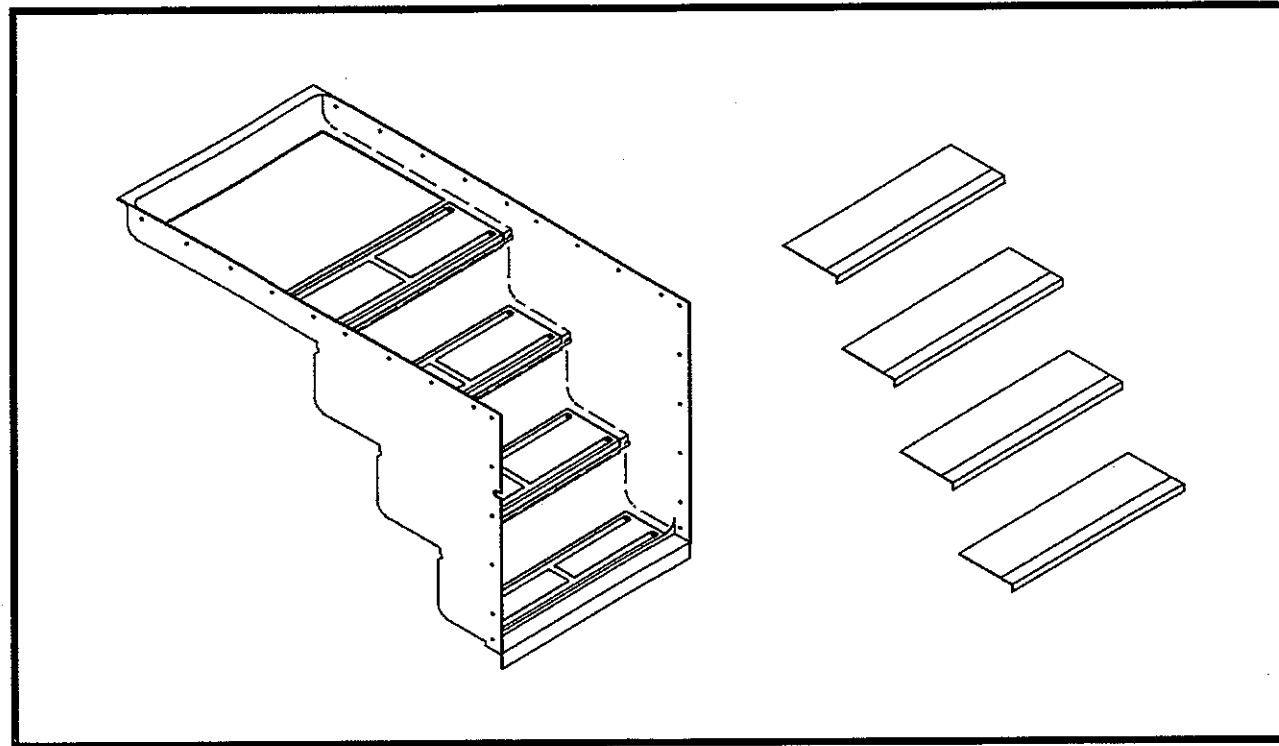


Figure 1—Stepwell and Steptread

8. Remove light lens retainer, gasket, and lens.	6. Reseal edges to prevent moisture seepage underneath steptread.
9. Remove three mounting screws.	7. Install screws to trim around top edge of stepwell.
10. Disconnect gray wire in light assembly.	8. Install screws to handrail assembly at stepwell.
11. Remove all screws from the stepwell.	9. Connect gray wire in light assembly.
12. Raise stepwell and remove.	10. Mount light housing and gasket with three mounting screws.
	11. Install light lens retainer, gasket, and lens.
	12. Install three screws to light lens retainer.

Caution

Do not deform steptread. Floor level steptread should not be removed.

Stepwell Installation

1. Position stepwell in proper position.
2. Install all screws.
3. Lower bus and remove jack.
4. Install three screws to lower flange of door frame assembly.
5. Install steptread.

Other Body Components

For service maintenance procedures on **Doors**, see Section 350.

For service maintenance procedures on **Fuel Fill Door**, see Section 350.1

For service maintenance procedures on **Windows**, see Section 360.

LTC Body General

For service maintenance procedures on **Seats**, see Section 380.

For service maintenance procedures on **Mirrors**, see Section 390.

For service maintenance procedures on **Windshield Wiper System**, see Section 400.

For service maintenance procedures on **LTC Lights**, see Section 420.

For service maintenance procedures on **Luggage Compartment**, see Section 450.

LTC Doors



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Safety

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Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

This section provides maintenance procedures for door equipment on a Blue Bird LTC bus. These procedures are documented using a Blue Bird LTC with a Cummins M11 engine and an Allison B500 World Transmission.

Description of Operation

Doors are in a prefabricated framework that eliminates the effect of body construction variations on door and seal operation. (See Figure 1—Entrance Door.)

The doors are on a full door length hinge located inside a frame. The door has three panels in the door assembly. The inner, filler, and outer panels are illustrated in Figure 2—Door Panels.

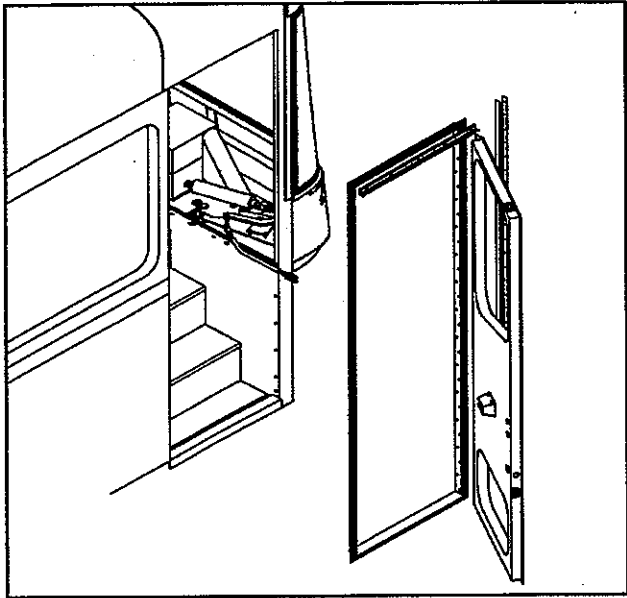


Figure 1—Entrance Door

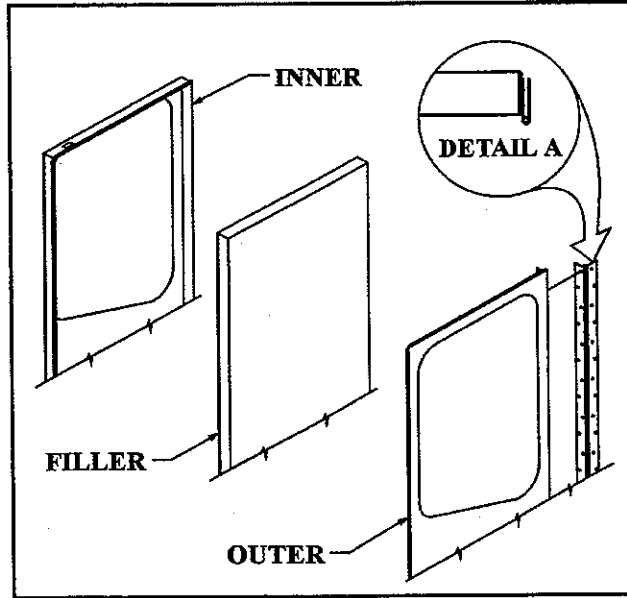
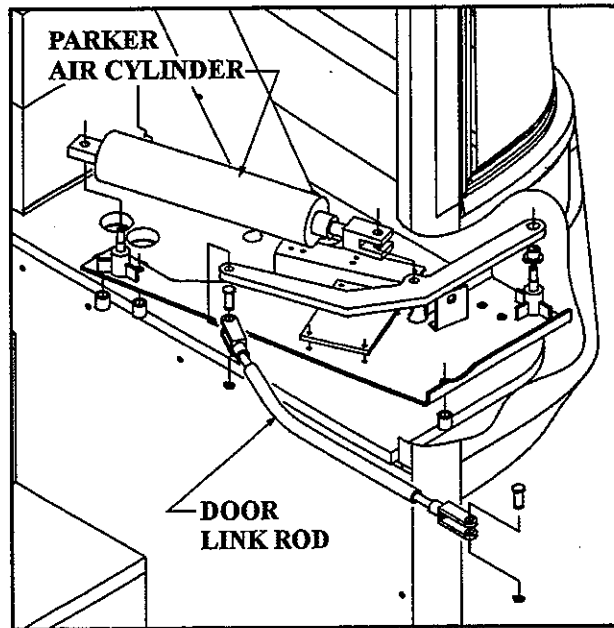


Figure 2—Door Panels



The interlink connection is an assembly with a Park Air Cylinder. (See Figure 3—Parker Air Cylinder.)

There are two air locks, one is at the top of the doorframe, and the other is at the side. (See Figure 4—Upper and Lower Door Air locks.)

Figure 3—Parker Air Cylinder

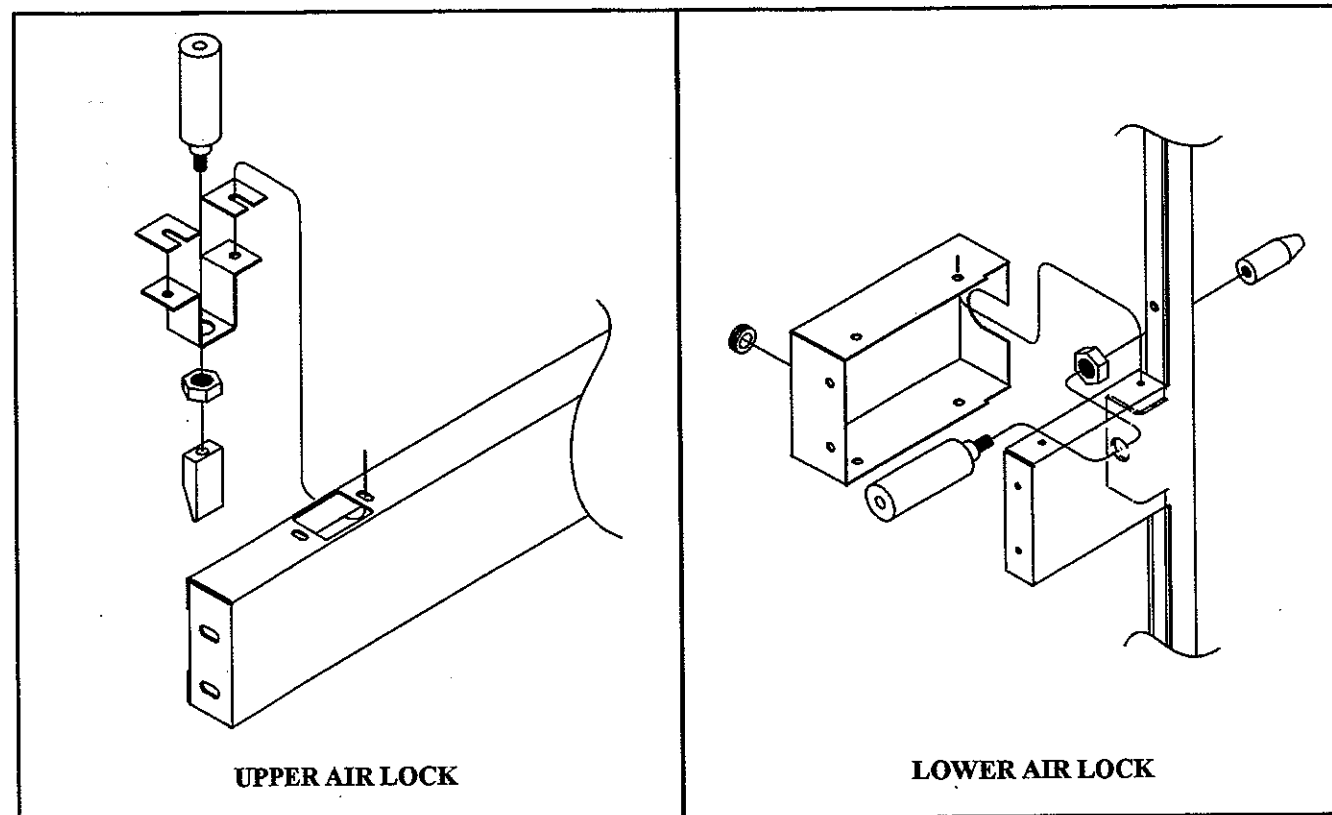


Figure 4—Upper and Lower Door Air Locks

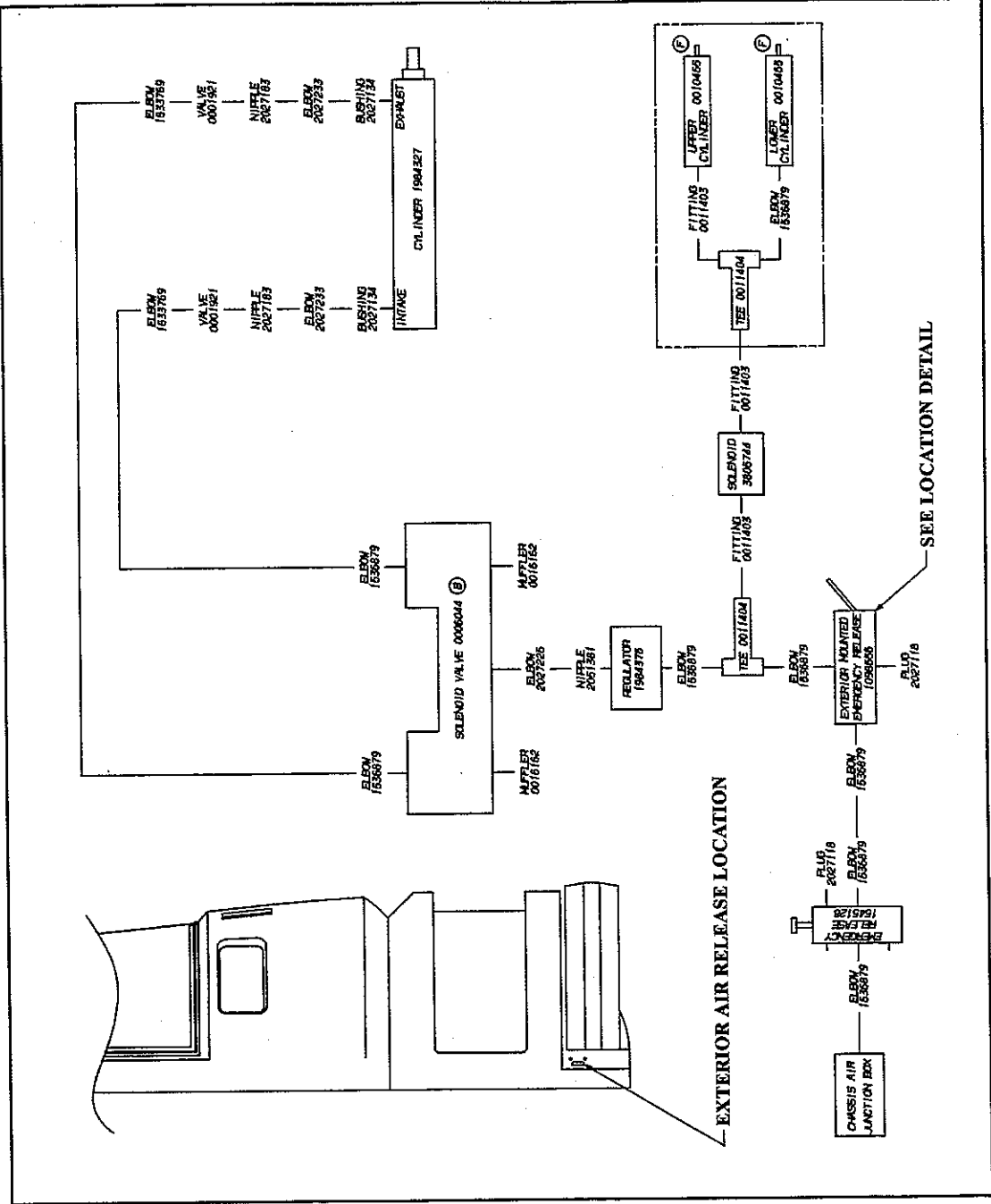


Figure 5—Exterior Air Release

There is an exterior air release and an interior emergency door release. (See Figure 5—Exterior Air Release and Figure 6—Interior Emergency Door Release.)

Interior Emergency Door Release

The Interior Emergency Door Release is located inside the door mounted on the dash.

Push knob down to activate the emergency door release. (See Figure 6—Interior Emergency Door Release.)

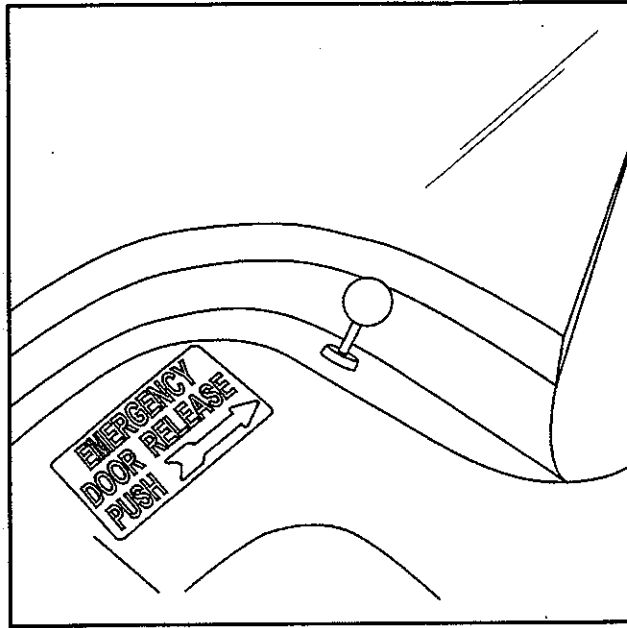


Figure 6—Interior Emergency Door Release

Door Control Assembly Removal

Note

Disassembly and installation of door components are made easier by closing the door.

1. Remove four screws (24) from entrance door link rod door cover (5). (See Figure 7—Door Control Assembly.)
2. Remove retaining ring (47) and clevis rod pin (19) from right door yoke end (11). (See Figure 7—Door Control Assembly.)
3. Open door for easy access to other door assemblies.
4. Remove retaining ring (47) and clevis rod pin (19) from entrance door pivot arm (14). (See Figure 7—Door Control Assembly.)
5. Remove retaining ring (47) and clevis pin (35) from Parker Air Cylinder (15).
6. Remove hex nut (20) from front door pivot arm mounting stud (12).
7. Remove Parker Air Cylinder.
8. Remove hex nut (20) from the inside door pivot arm mounting stud (12).
9. Remove hex nut (20), entrance door pivot arm (14).
10. Remove entrance door pivot arm nylon bushing from the outside door pivot arm mounting stud (12). (See Figure 7—Door Control Assembly.)

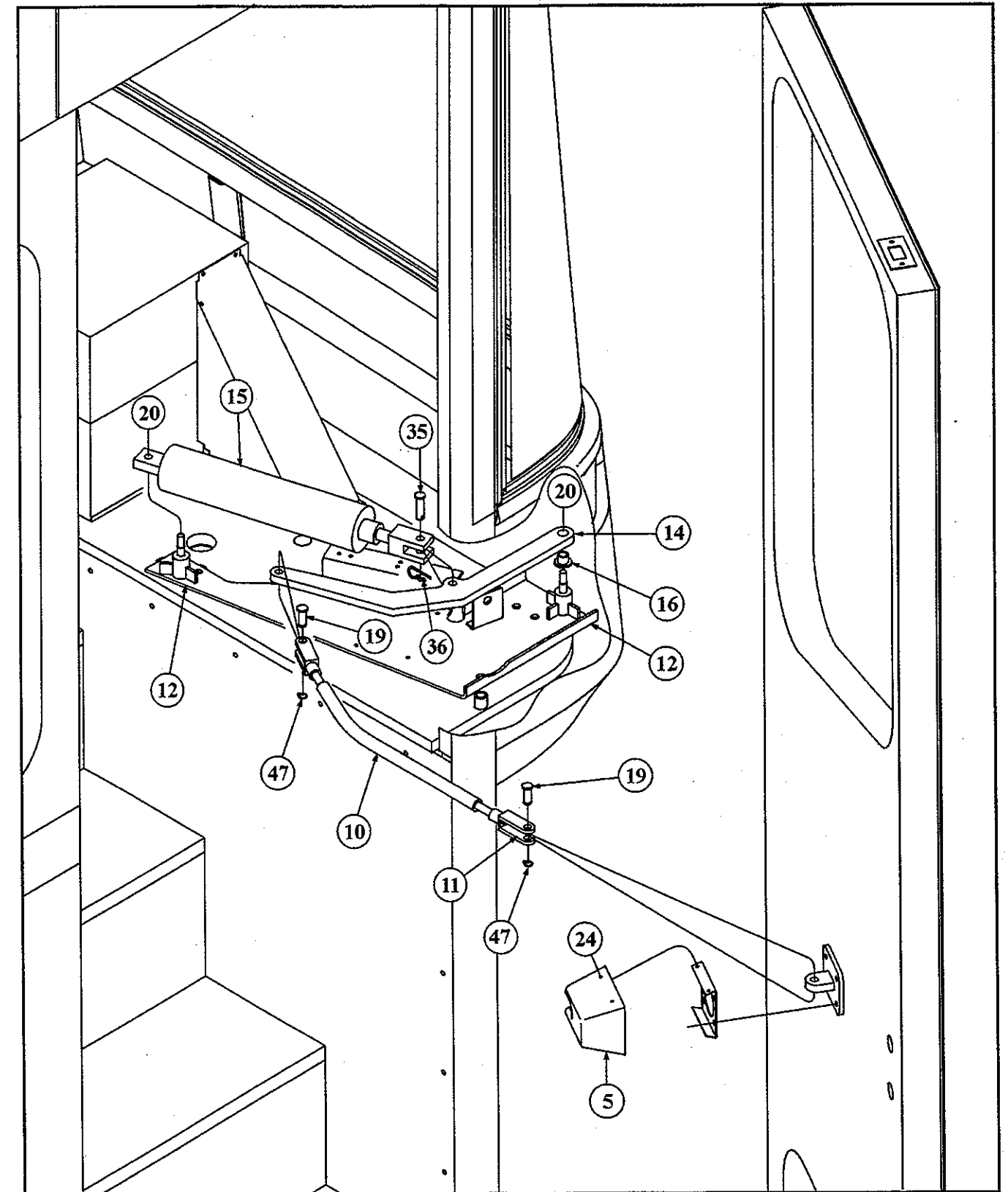


Figure 7—Door Control Assembly

Door Removal

Remove 27 screws (23) from door hinge. (See Figure 8—Door Hinge.)

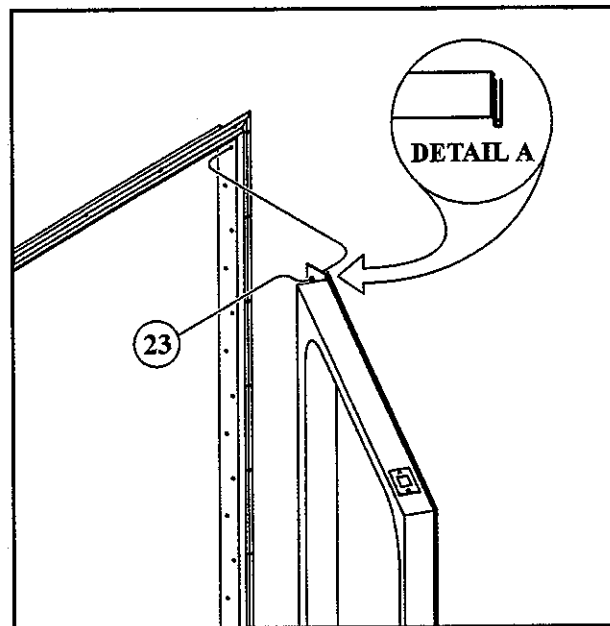


Figure 8—Door Hinge

Door Striker Removal

- **Upper Striker.** (See Figure 9—Upper and Lower Door Striker.)

1. Remove screw (21), door striker (4).
2. Remove rubber seal G-7056 (51).
3. Remove upper retainer seal (52).

- **Lower Striker.** (See Figure 9—Upper and Lower Door Striker.)

Remove screw (57), door striker (56).

Upper and Lower Air Lock Removal

- **Upper Air Lock**

1. Remove air line from upper Parker Air Cylinder (41). (See Figure 4—Upper and Lower Air Locks.)
2. Remove capscrew (44), flat washer (44) spacer bracket (55).
3. Remove bracket (42).
4. Remove jam nut from upper Parker Air Cylinder (41) and top lock pin (43).

- **Lower Air Lock**

1. Remove air line from lower Parker Air Cylinder (41). (See Figure 4—Upper and Lower Air Locks.)
2. Remove screw (21) from lower air cylinder cover (50).
3. Remove lower air cylinder cover (50).
4. Remove jam nut from upper Parker Air Cylinder (41) and lower lock pin (54).

Dead Bolt Lock Removal

1. Remove two screws from the inside lock plate. (See Figure 9—Upper and Lower Striker.)
2. Remove inside lock plate.
3. Remove bolt and lock sleeve.

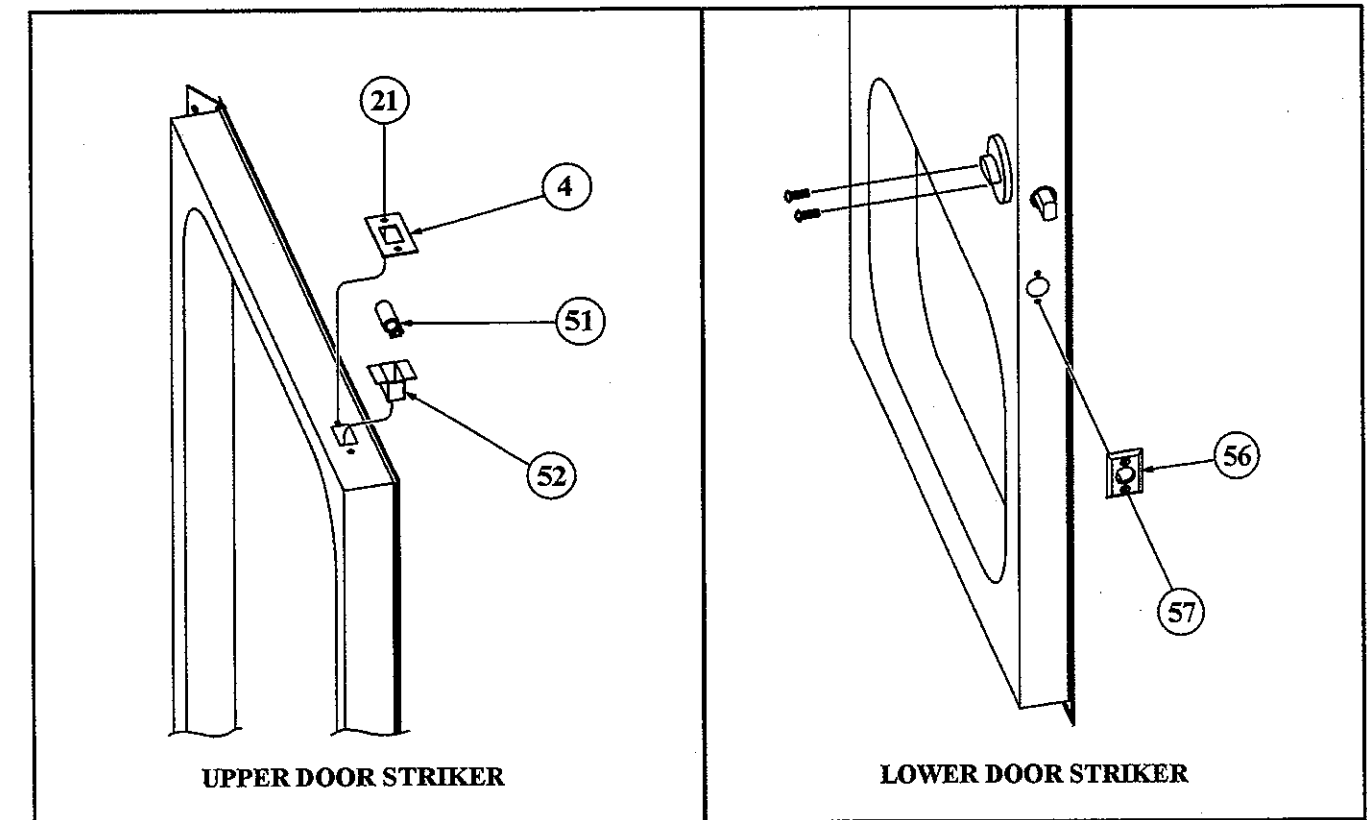


Figure 9—Upper and Lower Door Striker

Rear Door Removal

1. Disconnect the battery.
2. Raise the Rear Engine Door.
3. Support the door at each side so the door can be removed.
4. Cut light wire on rear door.
5. Cut plastic ties from lift cylinder.
6. Remove nuts from lower lift cylinders.
7. Remove nuts from upper cylinders.
8. Remove nuts and bolts from door frame.
9. Lower door.

Installation

Reverse procedures for removal.

Caution

In the repair operations performed by fiberglass manufacturer, only the materials listed are to be used. Do not use lacquer primer or glazing putty on these parts because of incompatibility problems.

Pre-bake assembly for one hour at 180 °F (82.2 °C).

- 285-22 MS primer
- 929-28/1 hardener
- 352-91 or 544-101 reducer
- 839-11 fine body plastic
- DE-15 epoxy primer
- PA-16 Activator

LTC Fuel Fill Door



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LTC Fuel Fill Door

Safety

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Warnings

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Notes

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Introduction

General information is a section for the maintenance of the LTC. Information in this section applies to fuel doors.

Description of Operation

The fuel fill door is fiberglass. (See Figure 1—Fuel Fill Door.)

Fuel Fill Door

• Removal

1. Pry off upper push-nut and discard.
2. Slide rod down through the door.
3. Retain the spacers.

Installation

1. Install the Stainless Steel rod through door bracket and spacers.

Note

The 0.188 inch (4.78 mm) diameter Stainless Steel rod and the round push-on nut is commercially available.

2. Install the upper push-on nut on the rod.
3. Adjust door for fit and finish.

Fuel Fill Door Repair

Caution

In the repair operations performed, only the materials listed are to be used.

Do not use lacquer primer or glazing putty on these parts because of incompatibility problems.

• Mix the Repair Materials.

285-22 MS primer

929-28/1 hardener

352-91 or 544-101 reducer

839-11 fine body plastic

DE-15 epoxy primer

PA-16 Activator

Pre-bake assembly for one hour at 180° F (82° C).

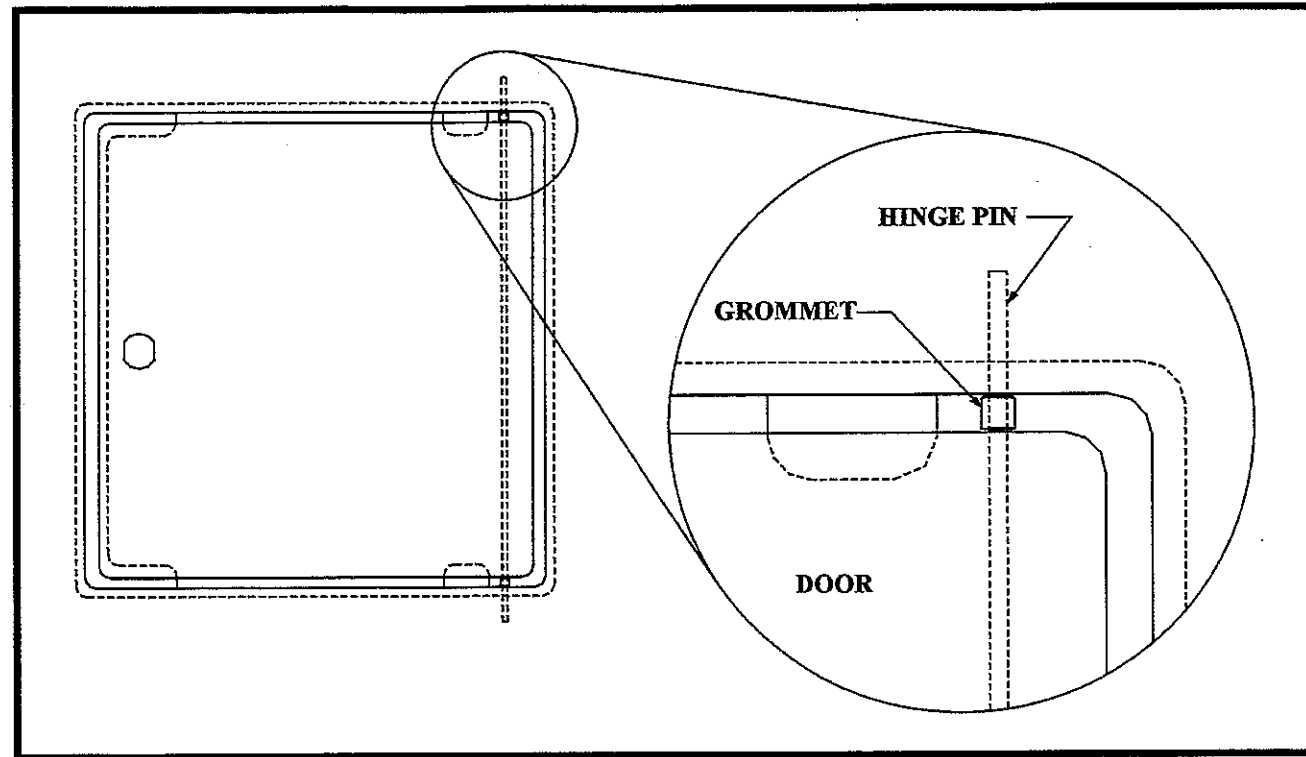


Figure 1—Fuel Fill Door

LTC Windows



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation on this Blue Bird product, and the protection of equipment. Before using this manual to perform any service or operating procedure, individuals should read and adhere to the applicable warnings and cautions throughout this manual.

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Introduction

There are two configurations of LTC transit windows, the push-out (egress) and the stationary. This section applies to both sliding configurations.

Transit Window Removal

1. Remove screws inside the aluminum extrusion.
2. Loosen the sealer between the window frame with a putty knife.
3. Pry out the window using screwdriver.

To Remove Push-Out (Egress) Transit Sliding Window

1. Release window lever located inside the bus at the side of each push-out window. (See Figure 1—Transit Egress Window.)
2. Remove the hinge screws on outside of the body.
3. Lift and pull the window out of the section.

To Remove Stationary Transit Sliding Window

1. Remove all screws between the inner frame and outer frame. (See Figure 2—Stationary Transit Sliding Window.)
2. Loosen the sealer between the window frame with a putty knife.
3. Pry out the window using a screwdriver.
4. Reassemble by reversing removing procedure.

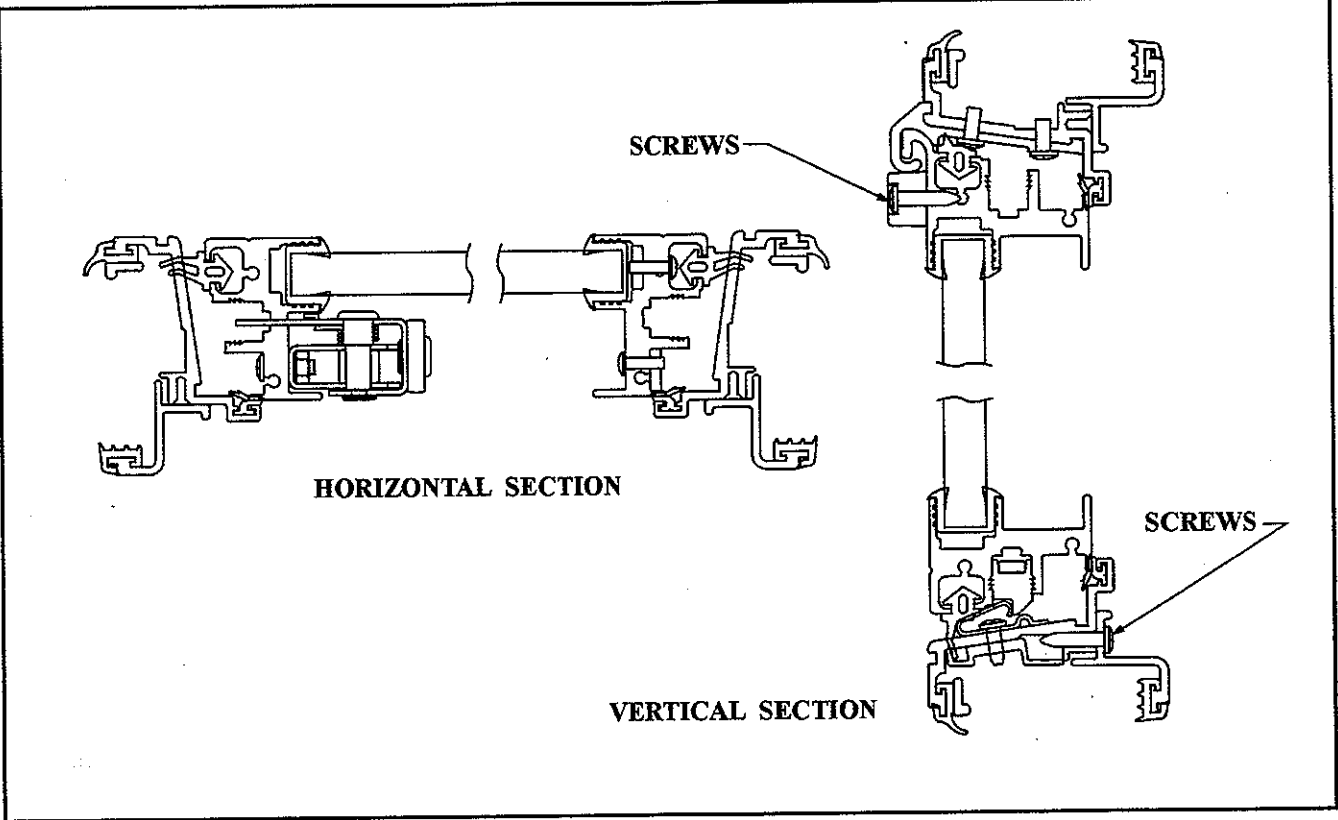


Figure 1—Transit Egress Window

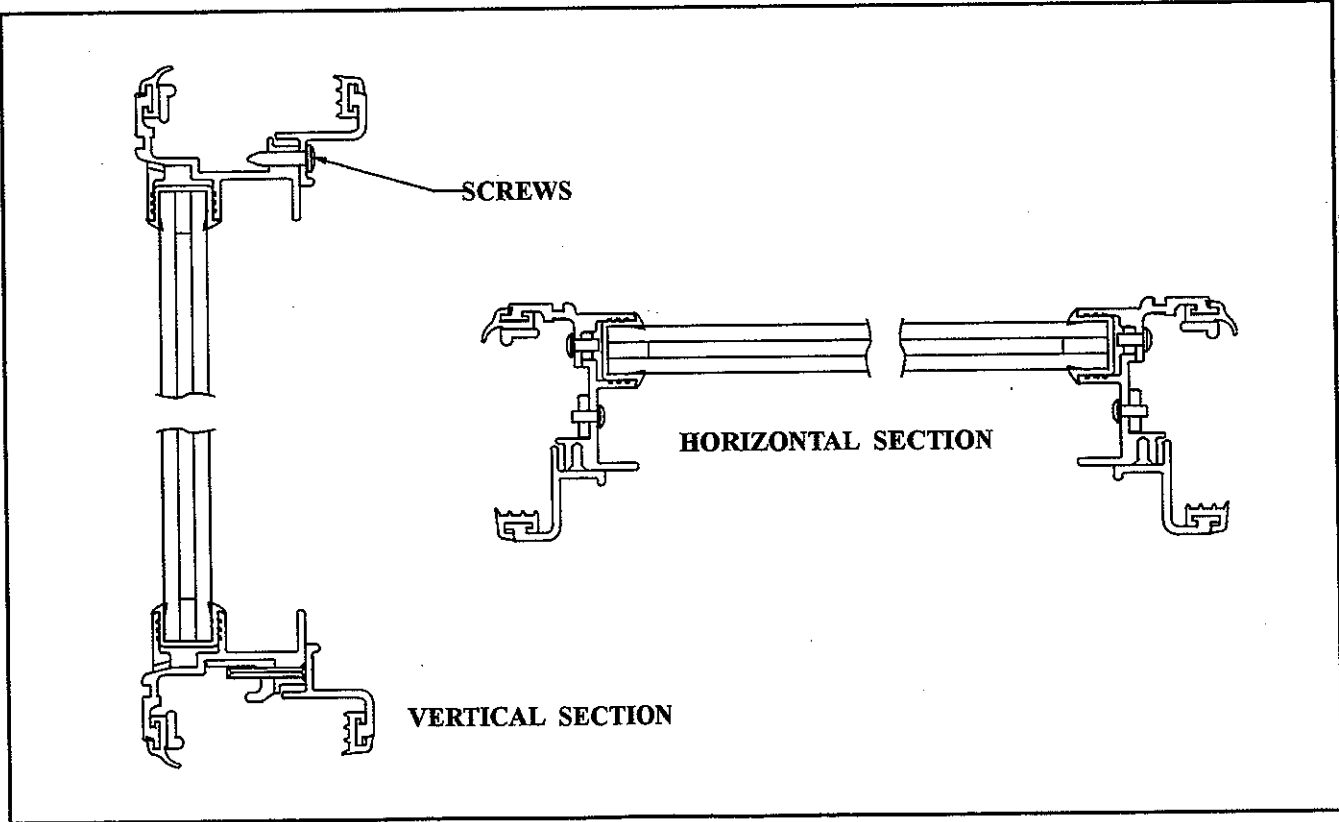


Figure 2—Stationary Transit Sliding Window



LTC Heaters and Defrosters



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Safety

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Notes

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Introduction

These procedures are documented using a Blue Bird LTC with a Cummins M11 engine and an Allison B500 World Transmission.

The major components are listed as follows

- Controls
- Cutoff Valve
- Sidewall Heaters

Description of Operation

This bus uses a hot water type heater. Heat is used from the engine coolant.

Control Panel

The operation/control switch for the heating system is located on the bus console. (See Figure 1—Control Panel.)

Caution

Make sure the engine radiator is full and all coolant flow valves are open.

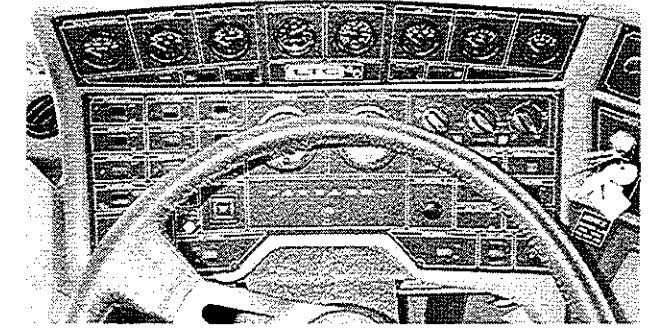


Figure 1—Control Panel

Heater

Performance of body heaters depends on adequate engine coolant temperature. Thermostat rating regulates the heat. The thermostat rating should not be higher than the recommended rating of the engine manufacturer.

The heating system depends on heat generated by the engine to heat the coolant to operating temperature. The coolant is pumped through the heaters inside the bus body, and back to the engine.

Warning

With a hot engine, rapid venting or rapid removal of radiator cap will allow coolant to spray out. To prevent serious burns, slowly vent pressure and then remove radiator cap.

Heater Core

Warning

When using compressed air for cleaning, cooling or drying, do not exceed 30 psi. Wear eye protection and do not direct compressed air at self or others.

Make sure that all clamps on hoses or tubes are tight to prevent leaks of air or fluid. Make sure that all screws and bolts are tight to prevent damage to vehicle.

The heater will be efficient when the core and fins are clean. The core can be cleaned with compressed air or by vacuum. Damaged fins should be straightened with a fin comb to prevent air flow restrictions. Access to core is through removal of the aluminum housing.

Engine Compartment Heater Piping

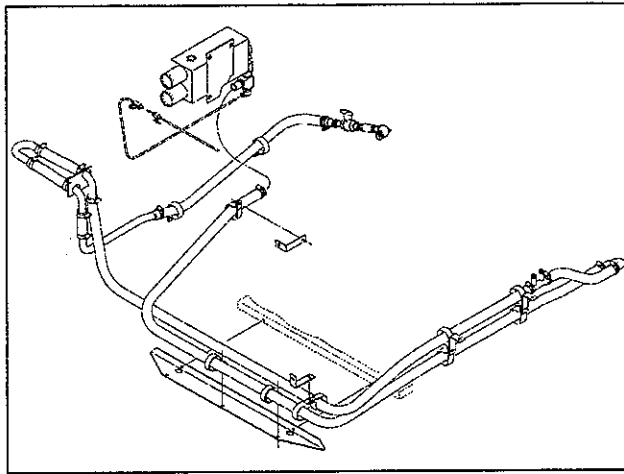


Figure 2—Engine Compartment Heater Piping

Heater Air Bleed Procedure

Use of antifreeze (ethylene glycol type) is recommended for summer or winter operation. (See Tables 1, 2 and 3.)

Use a 50/50 solution of antifreeze and water for freeze protection to approximately 30 °F below zero (-34 °C). Ultimate protection is attained at 68% antifreeze to 32% water. A 68 to 32% ratio will protect to approximately 92 °F (69 °C) below zero.

Warning

With a hot engine, rapid venting or rapid removal of radiator cap will allow coolant to spray out. To prevent serious burns, slowly vent pressure and then remove radiator cap.

During the bleeding process, it is necessary to remove the radiator cap and refill the cooling system. The refill is to ensure adequate coolant is available to replace purged air and coolant lost when bleeding.

1. Turn engine off to cool.
2. Shut all engine heater gate valves or clamp close all heater hoses as close to the engine as possible. (See Figure 2—Engine Compartment Heater Piping.)

Warning

Exhaust gases are harmful and potentially lethal. Do not run engine in an enclosed area. Perform work in a well-ventilated area.

3. Fill cooling system completely, including surge tank with coolant.
4. Run engine until coolant hoses are warm to touch.
5. Open the heater hose supply line gate valve by turning on heater at the control panel or unclamp supply line hose.
6. Check water pump to make sure it is running.
7. Run engine between 2,000 and 3,000 rpm.

Note

Be sure to use a large container for draining coolant.

8. Loosen bleeder valve located in heater hose line. (See Figure 2—Engine Compartment Heater Piping.)

Note

Coolant refill is necessary during bleeding.

9. Bleed air and coolant through bleeder valve until air is eliminated from heater system.
10. Stop bleeding when continuous stream of coolant is discharged.
11. Open gate valve in heater hose return line after all air is purged.
12. Run engine between 2,000 and 3,000 rpm until thermostats open.
13. Refill cooling system including radiator surge tank.

Cutoff Valves

Caution

Do not operate with valve closed and other valves open due to high-pressure build up.

Valves are used to isolate the heater system from the engine to control leaks. (See Figure 3—Heater Cutoff Valve.)

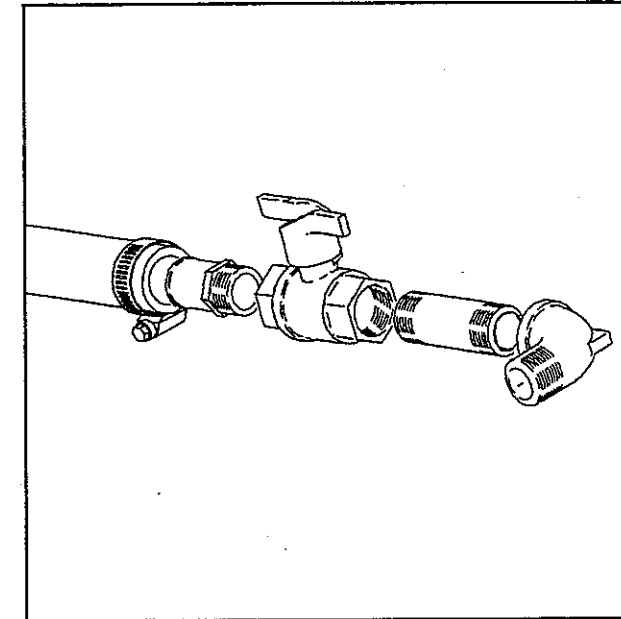


Figure 3—Heater Cutoff Valve

Preventative Maintenance

- **Hoses**

1. Check all water hoses for kinks that prevent water flow.
2. Inspect hoses for hardening of rubber or cracks.

- **Motors**

- Inspect wheels and fans for obstructions or damage by running each fan separately.

- **Switches**

1. Inspect for loose wiring.
2. Inspect for bad or loose connections.

- **Panels and Housings**

- Inspect fasteners that connect and retain structural and access panels.

- **Hose**

1. Repair damaged hose by cutting out the damaged section and installing a four-inch (101.6 mm) brass tube and hose clamps.
2. Replace full length of hose due to aging or heavy damage, if necessary.

Troubleshooting

See Schematic 1—Connection of Pot-5 Low Temperature. See Schematic 2—EasyTerm 92.

Caution

When operating DC voltage, output 2 of the solenoid valve must be grounded. The valve-grounding pin is left disconnected. The valve-grounding pin is used for grounding only when operating AC voltage.

The relay box is fastened with screws. No enclosure is needed because the electronics are well protected. The relay box should be mounted in a dry place for additional protection against humidity and oxidation of the terminals.

The EasyTerm 92 is capable of working in either of two temperature ranges, 44 to 86 °F (7 to 30 °C) or 43 to 176 °F (6 to 80 °C).

The EasyTerm 92 functions as an ordinary thermostat by adjusting the temperature according to the desired value set on the potentiometer. A sensor registers the actual temperature continuously. The EasyTerm 92 sensor is located at the back of shifter cab.

The potentiometer Pot-5 is located at the right lower dash. (See Figure 4—Connection of Pot-5 Low Temperature 45 °F to 86 °F (7 to 30 °C).)

If the temperature is lower than the preset level, EasyTerm 92 will switch on the heating function by de-energizing output 51.

If the temperature is higher than the preset level, EasyTerm 92 will switch off the heating function by energizing output 51.

The solenoid valve is located left rear wheel, well behind angled panel.

To operate EasyTerm 92 in the open/close mode the vehicle's hot water circuit, start/stop heating, a connection must be made. Output 51 is connected to

a solenoid valve to control a pneumatic 2-way valve, type NO, inserted in the heating circuit. (See Figure 5—EasyTerm 92.)

The sequences are activated as the temperature levels are adjusted. (See Table 4—Terminals 47—52 Compulsory Connections.)

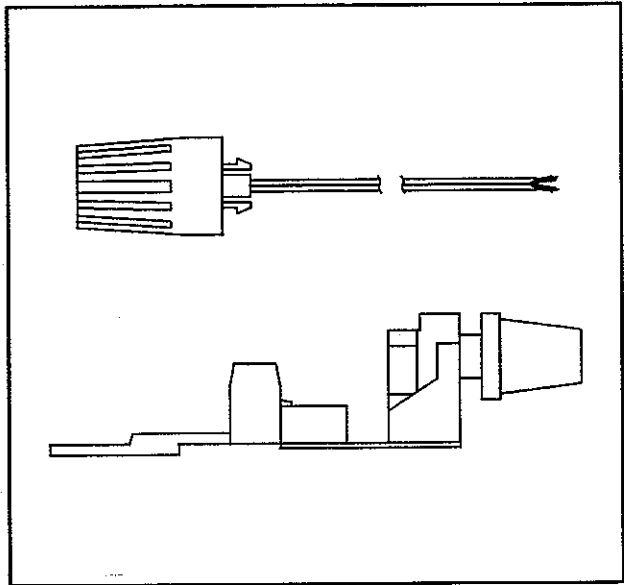


Figure 4—Connection of Pot-5 Low Temperature 45°F to 86°F (7° to 30°C)

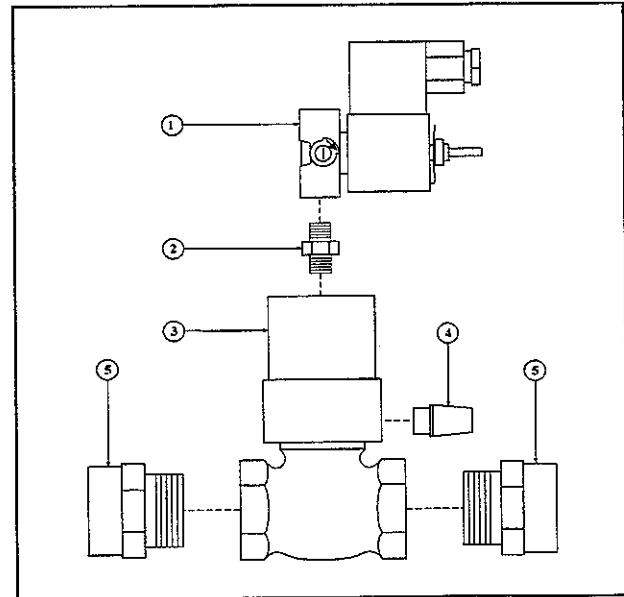
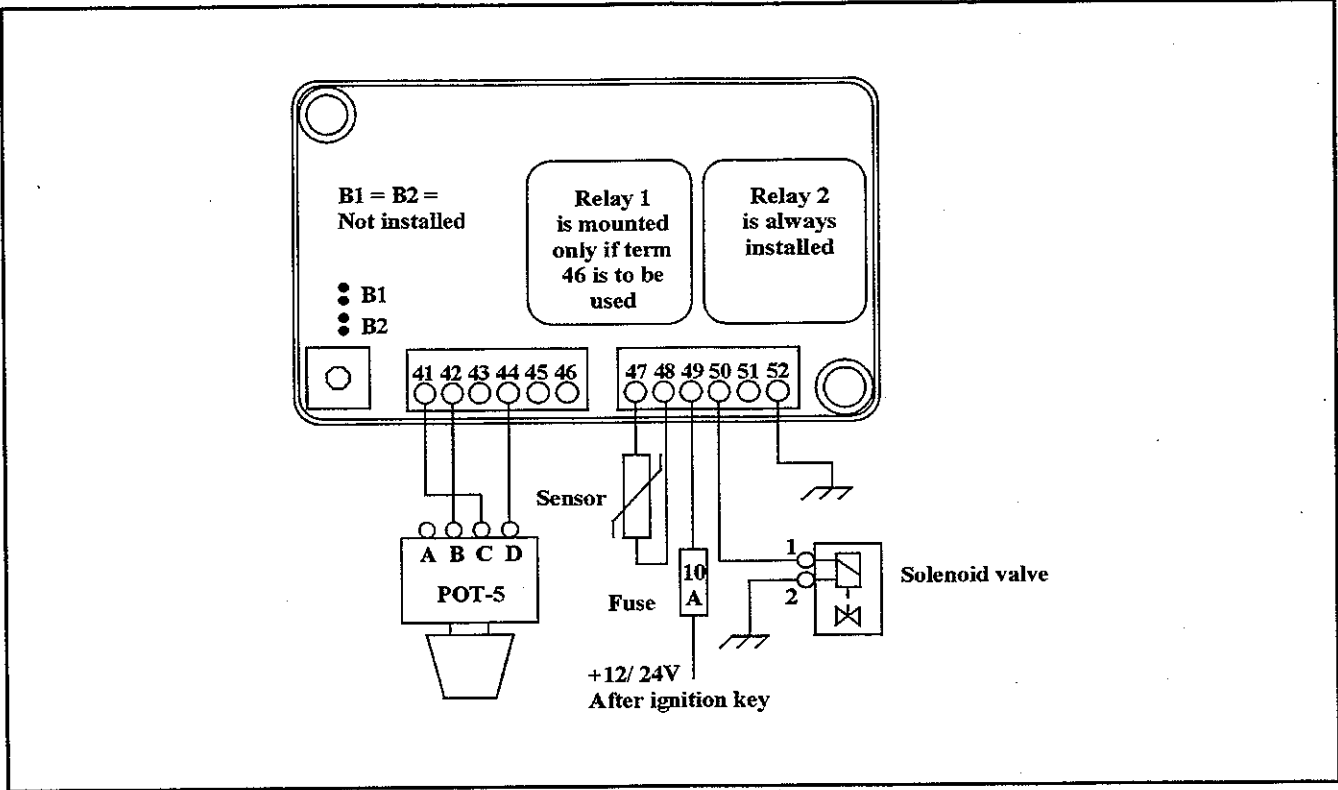


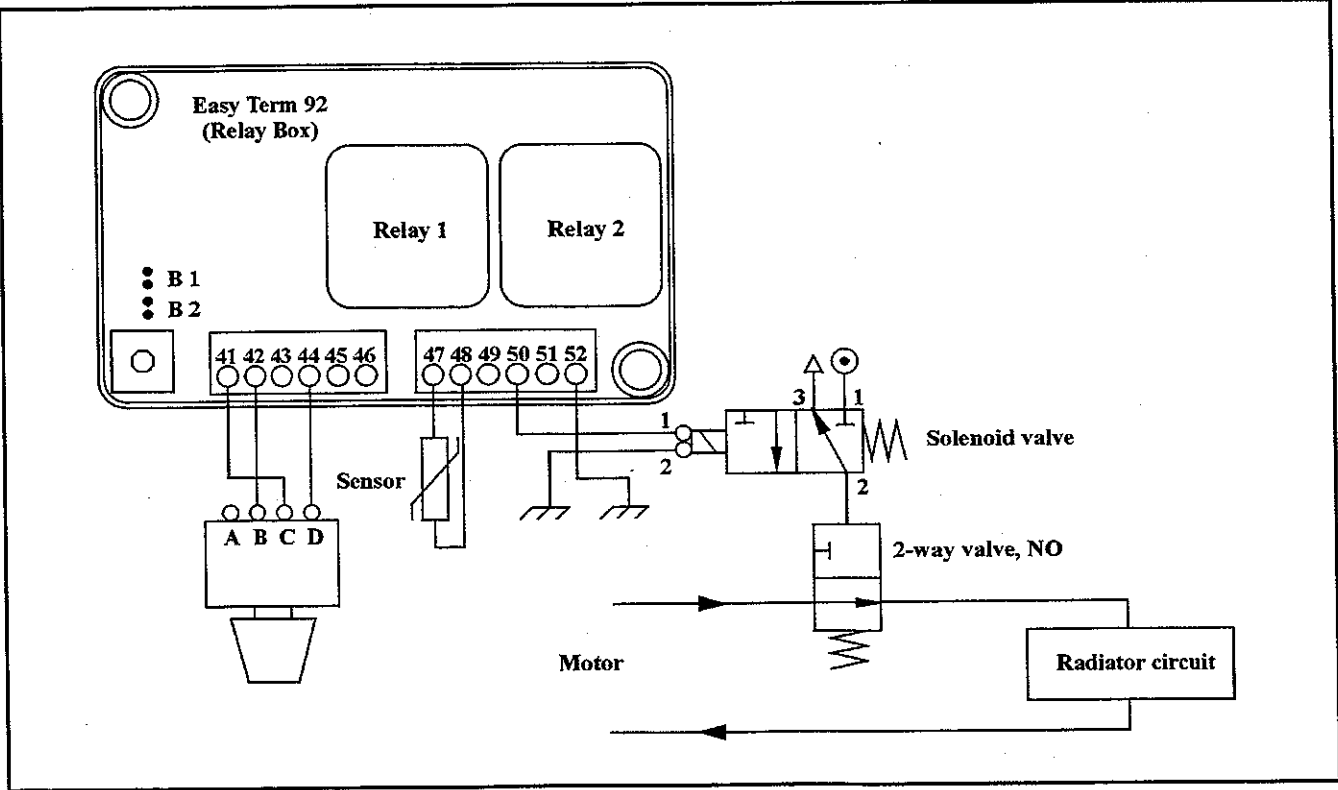
Figure 5—EasyTerm 92

Terminal 46	Power On Used to energize boost pump. Add relay to position number 1.
Terminal 47	Sensor + Source Input or temperature sensor NTC-4k7 (6968 1343 050). When the sensor is correctly connected, the potential is between + 2.5 volt at about 41 °F (5 °C) and is = 0.5 volt at about 176 °F (80 °C), while it is + 5 volt when the sensor is not connected.
Terminal 48	Sensor Ground for temperature sensor. The terminal is connected internally to the unit's power ground (terminal 52).
Terminal 49	Voltage Power supply, +12/24 volt, for the unit as well as external units by relay 1 and relay 2.
Terminal 50	Energized when temperature is below the preset level.
Terminal 51	Energized when temperature is above the preset level.
Terminal 52	Ground Units ground connection
Terminal 45	Not used

Table 1—Terminals 47—52 Compulsory Connections



Schematic 1—Base Board Heater Connection Pot-5 Low Temperature 45 °F to 86 °F (7° to 30 °C)



Schematic 2—Base Board Heater EasyTerm 9

LTC Seats



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LTC Seats

Safety

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Notes

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Introduction

The seating design in your Blue Bird LTC is for safety and comfort. Maintained and kept clean, the seats will have many years of service.

Driver's Seat

Warning

Do not attempt to adjust the driver's seat while the vehicle is in motion. A sudden, unexpected adjustment to the driver's seat while the vehicle is in motion, could result in serious injury or death.

Weight and Height Adjustment

To adjust, push the valve knob in to raise the seat and pull it out to lower the seat. When properly adjusted, the seat should not top nor bottom against the end limits of the vertical travel, under normal driving conditions. Adjustment position should also provide for driving visibility and vehicle control. (See Figure 1—Driver's Seat Adjustment Points.)

Fore and Aft Adjustment

Hold lever to the left to adjust seat position forward or backward.

Back Angle Adjustment

Lean forward slightly to remove pressure from seat back. Hold handle rearward to adjust to any position within the seats range.

Cushion Tilt Adjustment

Rotate seat tilt knob to decrease or to increase seat tilt.

Lumbar Adjustment

Rotate knob forward to increase or rearward to decrease the support in the lumbar area.

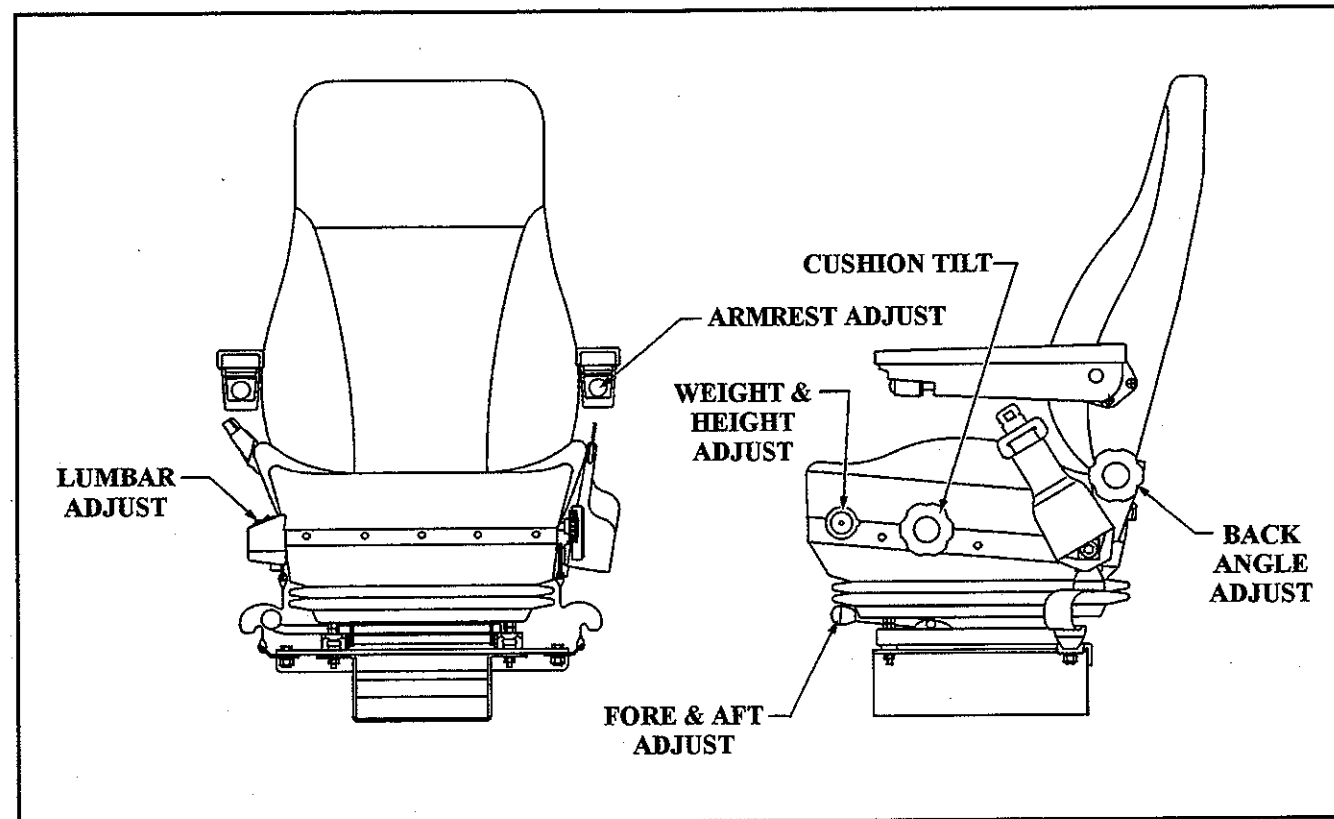


Figure 1—Driver's Seat Adjustment Points

Driver's Seat Lubrication

Caution

Lubricants can damage vinyl. Use caution around upholstery.

- The moving parts of the driver's seat require occasional lubrication for ease of operation, as well as longevity of the seat. Lubrication also prevents excessive wear.
- White lithium-based grease in an aerosol can is currently available, and is used by Blue Bird.
- Motor oil 10W30 or 10W40 will also provide adequate lubrication, although not as convenient to apply.
- All moving part joints, tilt pivots, slide forward, back adjustment and vertical motion pivots (4 total) require lubrication.

Seat Inspection and Maintenance

Seats used in the Blue Bird LTC are built to meet Federal Motor Vehicle Safety Standards.

- To provide safer passenger transportation, the following inspections should be done
 1. Inspect mounting bolts every 90 days.
 2. Inspect cushion attachments each week.
 3. Inspect upholstery for cuts and tears every 90 days.
- If torn, remove upholstery by removing the staples at the bottom front of seat back or bottom of cushion.

Seat Care and Cleaning

- Every-day dirt and soil

LTC Seats

Most soil and dirt can be removed with soap and a warm water solution. If a stain is persistent, a stiff bristle brush may be used. Fabric covered seats should be rinsed with clean water after stain is removed.

Caution

Paint, tar and asphalt stains may become permanent if not cleaned immediately.

- Paint, tar, and asphalt

Remove stain immediately using a damp cloth and kerosene. Rub the stain gently, using small strokes.

- Nail polish and lacquer-based stains

Immediately soak up as much as possible with a dry cloth. Any remaining stain may be removed with a nonflammable cleaning fluid, such **Tuff Stuff™** or **Armorall™** cleanser. Rinse thoroughly with clean water.

- Ink

Immediately remove stain using a damp cloth and alcohol.

Driver's Seat Removal and Installation

1. Remove two bolts and washers.
2. Remove bolts from seat base mount and floor.

• Driver's Seat Installation

1. Clean six bolts removing dirt and grease.
2. Apply Loctite™ 242 Blue to five or six threads.
3. Install six bolts, washers, and nuts into the driver's seat mount.
4. Torque six bolts 15 to 20 foot-pounds (1.70 to 2.26 N•m).

Pedestal Mounted Passenger Seats

• Removal

For an illustration on the Pedestal Mounted Passenger Seat Removal, see Figure 2 (Pedestal Mounted Passenger Seat).

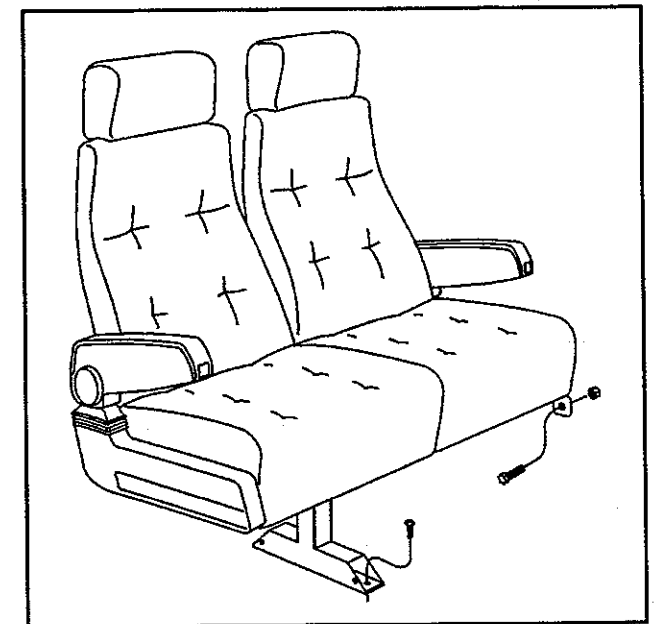


Figure 2—Pedestal Mounted Passenger Seat

1. Remove floor frame cap to expose the anchor bolt.
2. Remove two nuts and washers from floor anchor bolt.
3. Remove nuts, washers and two capscrews from bracket and sidewall. (See Figure 2—Pedestal Mounted Passenger Seat.)

- **Installation**

1. Install nuts and washers on the floor anchor bolt.
2. Torque nuts 34 to 37 foot-pound (3.8 to 4.2 N•m).
3. Install capscrews, washers, and nuts to bracket and sidewall.
4. Torque nuts 34 to 37 foot-pounds (3.8 to 4.2 N•m).

Other Type Passenger Seating

For other types passenger seating installation and removal, including installation and removal of track seating, contact the Blue Bird Service Department.

LTC Interior and Exterior Mirrors



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Safety

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Interior Mirrors

For the interior rearview mirror adjustment illustration, see Figure 1—Interior Rearview Mirror.

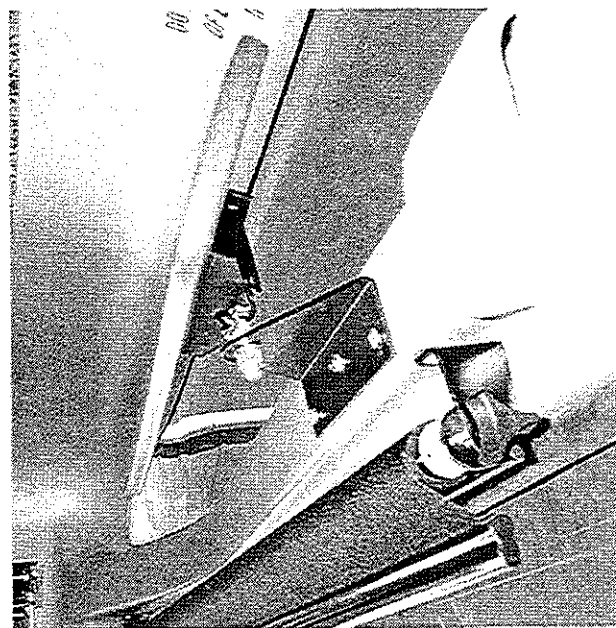


Figure 1—Interior Rearview Mirror

1. Loosen knob on the ball joint.
2. Adjust mirror for the best all round view.
3. Tighten knob hand tight.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures are documented using a Blue Bird LTC with a Cummins M11 engine and an Allison B500 World Transmission.

Description of Operation

Drivers are to adjust mirrors properly for safe driving. The driver must be aware of the limitations on viewing areas. Standard equipment on all Blue Bird LTC buses is two 12-volt heated outside rearview driving mirrors and one adjustable interior mirror. The remote is located on the driver's console.

Exterior Mirrors

Blue Bird LTC buses are equipped with two 8-inch elliptical mirrors, one on the left side of the vehicle and one on the right side. (See Figure 2—Exterior Mirror.)

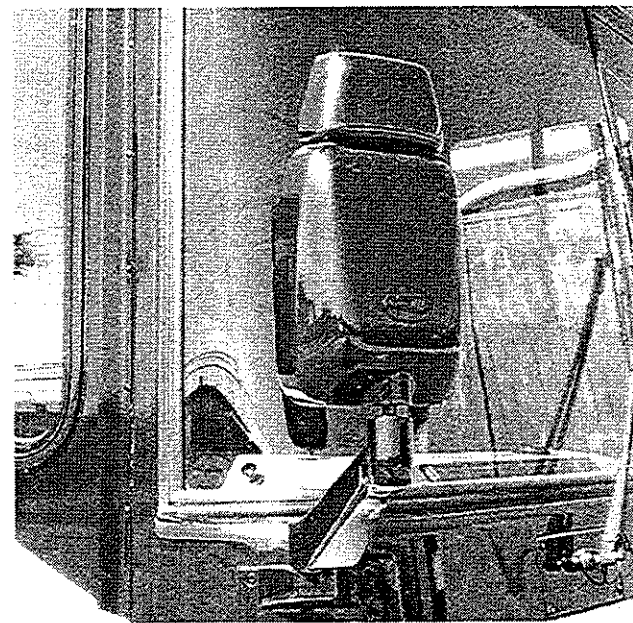


Figure 2—Exterior Mirror

Warning

People or objects seen in a convex mirror look smaller and appear farther away than with a flat

mirror. Do not put the vehicle into motion until persons or objects can directly be seen in a flat mirror.

Mirror Maintenance

Note

Make sure mounting fasteners are kept tight so that mirrors will not vibrate excessively.

1. Clean all mirrors at least weekly.
2. Clean with an ammonia solution to ensure that the mirrors are clean and safe.
3. Check clamps weekly and retighten as needed.
4. Check the entire mirror viewing areas daily, make necessary adjustments as required.

LTC Windshield Wiper System



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Safety

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Notes

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Introduction

Information in this section applies to the LTC Windshield Wiper System.

Description of Operation

The windshield wipers are wet arms with washing nozzle.

See Figure 1—Front Access Panel

See Figure 2—Screw Behind Parlgm

See Figure 3—Windshield Wiper Blade Assembly Bracket Location

See Figure 4—Blade Arm Alignment

Windshield Wiper System

• Wiper Motor Removal

1. Remove the two screws from the first. (See Figure 1—Front Access Panel.)
2. Remove the four screws from the front access panel.
3. Open the front access panel.
4. Remove and discard the sealant tape.

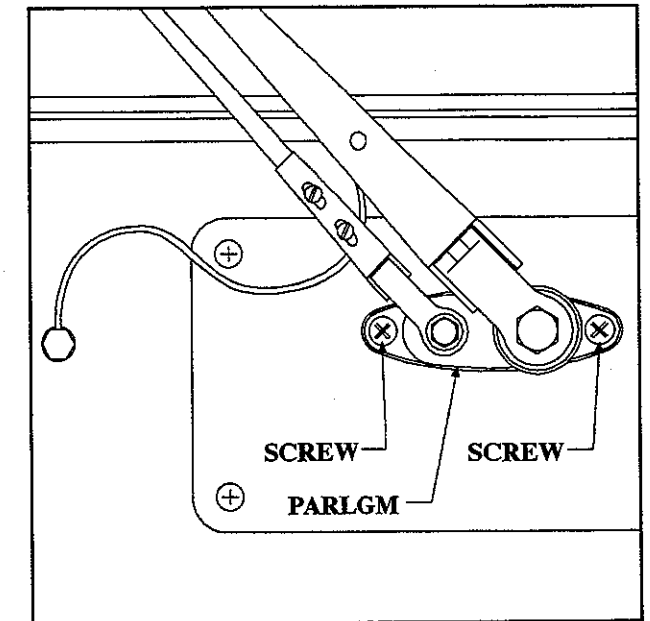


Figure 1—Front Access Panel

5. Disconnect the electric wiper motor in two places.
6. Remove the gasket. Discard if necessary. (If discarded, replace with a new gasket.)
7. Remove one screw from the motor bracket. (See Figure 2—Screw Behind Parlgm.)
8. Remove the electric motor.

Figure 2—Wiper Parlgm

- Wiper System Installation

Note

There is a left side and a right side for the installation of the motor.

1. Install one screw to the motor bracket. (See Figure 2—Screw Behind Parlgm.)

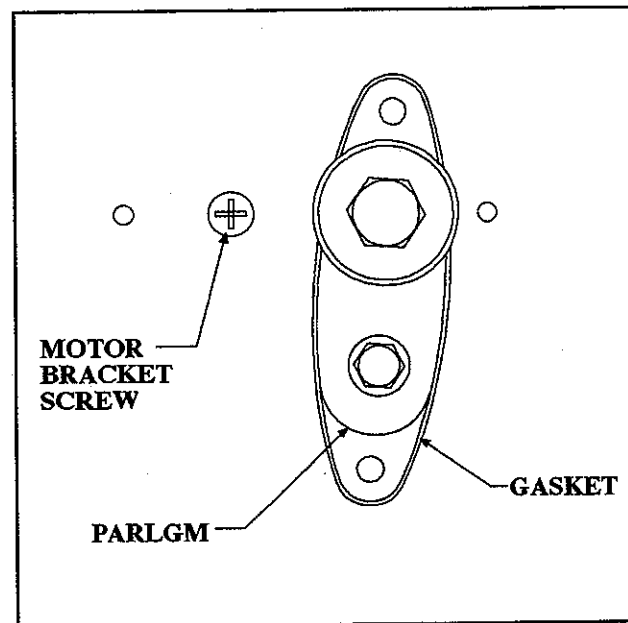


Figure 2—Screw Behind Parlgm

2. Install the gasket.
3. Install two screws to the parlgm. (See Figure 1—Front Panel Access.)
4. Install the new sealant tape.
5. Connect the electric motor.
6. Install the front panel.

Wiper Arm Mechanism

- Removal of wiper blade

1. Remove the bolt from the bracket assembly on the wiper arm. (See Figure 3—Windshield Wiper Blade Assembly Bracket.)
2. Replace the wiper blade.

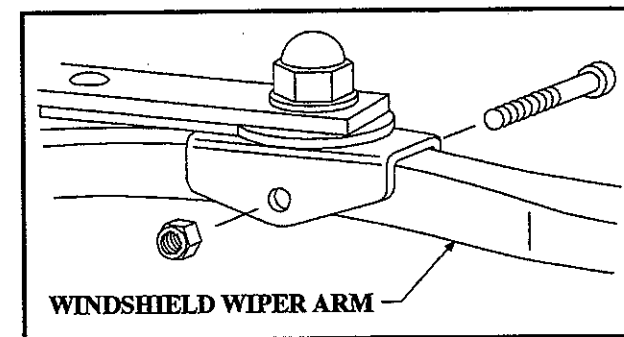


Figure 3—Windshield Wiper Blade Assembly Bracket

3. Adjust the wiper blade for correct alignment. (See Figure 4—Blade Arm Alignment.)
4. Start the wipers and washer to ensure proper cycling.

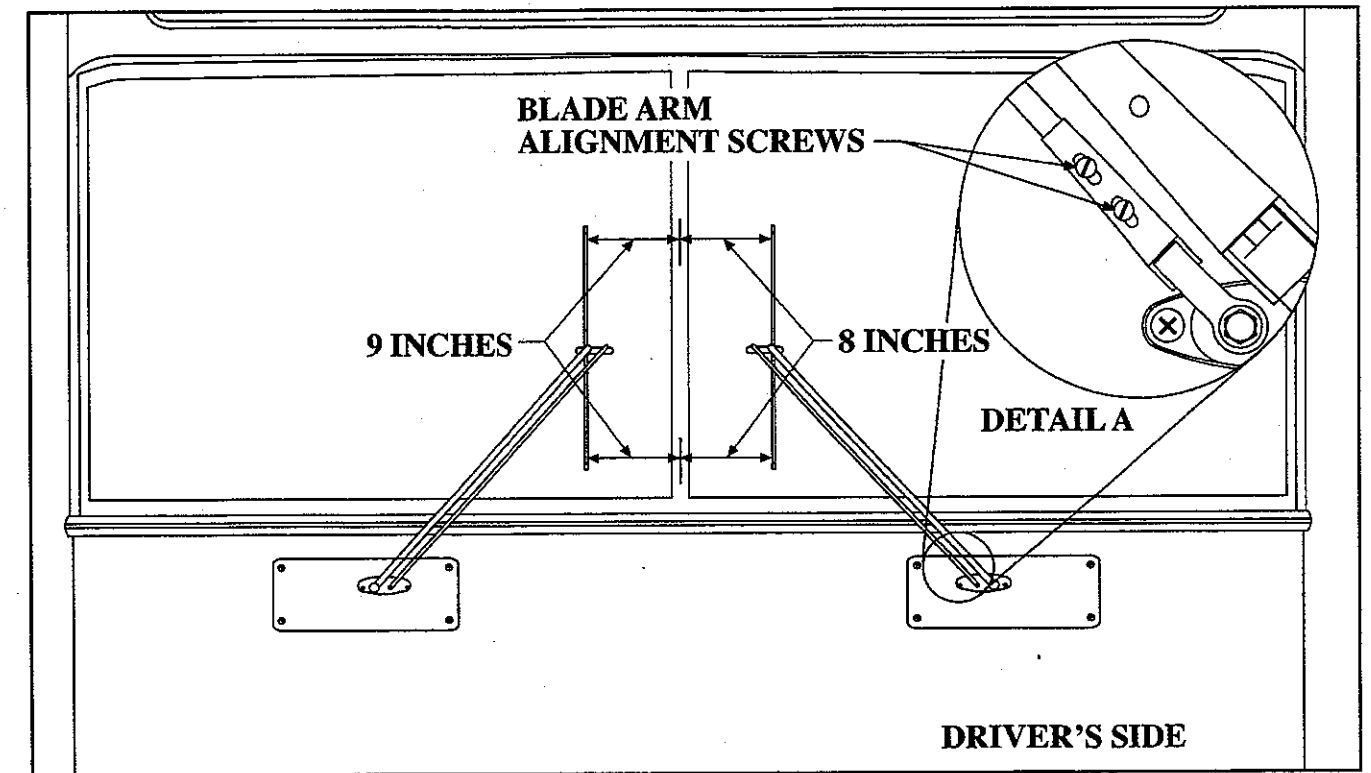


Figure 4—Blade Arm Alignment

Windshield Wiper Reservoir Removal

- Five quart (4.73 L) plastic bottle
1. Disconnect the plastic hose from the reservoir.
 2. Remove the nuts and bolts from the bracket.

LTC Lights



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Safety

The purpose of this safety summary is to ensure the safety and health of individuals performing service and/or operation of this Blue Bird product, and the protection of equipment. Before performing service and/or operating procedures, individuals should read and adhere to the applicable warnings and cautions located throughout this manual.

Warnings

Warnings apply to a procedure or practice that, if not correctly adhered to, could result in injury or death. Particular attention should be paid to sections of this manual where warnings appear.

Cautions

Cautions apply to a procedure or practice that, if not adhered to, could result in damage to or destruction of equipment.

Notes

Notes are used to explain, clarify or otherwise give additional insight for a given subject, product or procedure.

Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins M11 engine and an Allison B500 World Transmission.

Preparatory Work

Disconnect the battery.

Description of Operation

Blue Bird's LTC is equipped with a variety of lights designed for individual safety and comfort. For light bulb replacement, see Table 1—LTC Required Light Bulb Replacement.

Spare Light Bulb Replacement	
Description	Part Number
Bulb 193	0002120
Bulb fe8t9-cw Main Roof Running	0001252
Bulb GE 168	0002123
Bulb 1156	2255651
Amber Clearance Light	1280601
Driving Light GE h9411	4580379
Driving Light Hella Clear	3959079
Bulb 67	2255735
Bulb 53	2277721
Bulb 1157	2255669
Red Clearance Light	1281369
High Mount LED Brake Light	1888804
Single Halogen Headlamp	1949510
Bulb 12V/5 Watt 6418	0011062
Bulb 12V/12 Watt 2005	0011061
Bulb Fluorescent 13 Watt Parcel Rack	0009173
Bulb 12Volt/10Watt	0011167
T-Bulb 2-Pin Base	20011061

Table 1—LTC Required Light Bulb Replacement

LTC Emergency Equipment



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Safety

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Notes

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Introduction

These procedures were documented using a Blue Bird LTC bus with a Cummins M11 engine and an Allison B500 World Transmission. The emergency equipment consists of a First Aid Kit, Fire Extinguisher, Lugwrench and Triangular Warning Device. Generally, these devices are located on the LTC just behind and to the immediate left of the driver's seat.

First Aid Kit

The First Aid Kit is attached to the rear of the shifter cabinet, near the driver's left elbow. Size and contents of first aid kits may vary by option package or differing state specifications. The contents of the kit should be inspected weekly.

Fire Extinguisher

The fire extinguisher is normally located to the left of the driver's seat, on the floor. Your unit may be equipped with a 2.75, 4.5, 5, or 6-pound extinguisher. Inspect the pressure guage every 30 days or as required by individual state fire laws to make sure the

unit is fully charged. Inspect mounting fasteners periodically to be sure they are tight.

Lug wrench

The lugwrench is located in the driver's luggage compartment. Inspect the installation-mounting fasteners every thirty days to ensure that the installation is accessible, unobstructed, and tight.

Triangular Warning Device

For states that require triangular warning devices, the devices are located in the driver's luggage compartment. Inspect contents of the kit (as well as the mounting fasteners) every 30 days, or as required by the local code.

For the recommended warning device positioning, see Figure 1—Triangular Warning Device Positioning.

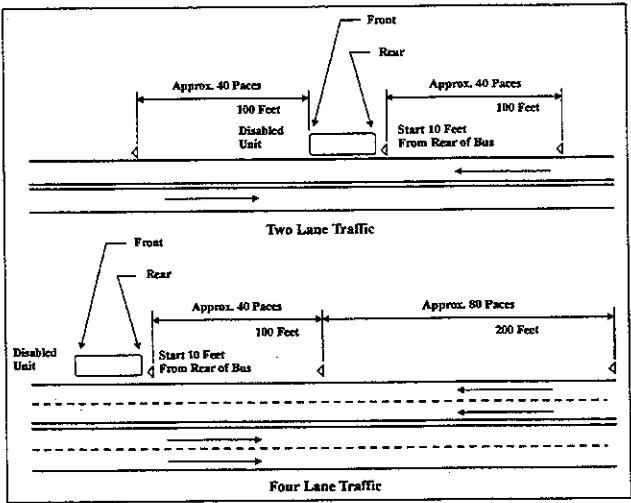


Figure 1—Triangular Warning Device Positioning

LTC Luggage Compartments



BLUE BIRD
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Safety

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Notes

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Introduction

The luggage compartment section on your Blue Bird LTC has six compartments.

Description of Operation

The doors are easy open doors with a 200 foot-pound gas spring to do the work of opening. Each luggage compartment has a key lock for safety.

General Maintenance

See Figure 1—Maintenance Locations and Part Removal.

While maintenance is performed every three (3) months, visual inspections are performed weekly.

Note

Required general maintenance includes cleaning and lubrication.

- **Seals**

General maintenance required includes weekly inspections for evidence of wear or cracking. Cleaning should be done with a nonabrasive degreaser.

- **Top Linkage Assembly**

1. General maintenance required includes weekly inspection and cleaning with a nonabrasive degreaser.
2. Quarterly, lubricate assembly with a graphite type lubricant or a spray type lubricant, such as LPS.

- **Locks**

1. General maintenance required. Weekly, inspect and clean with a nonabrasive degreaser.
2. Quarterly, lubricate locks with a graphite type lubricant or a spray type lubricant, such as LPS.

Installing and Adjusting Luggage Compartment Doors

1. Install bearing composite (6) and bearing flange (5) on mounting luggage door bracket (1,2). (See Figure 1—Pantograph Luggage Door Assembly.)

Note

Part number will depend on the compartment the door is required for (i.e., driver's compartment, luggage bay, etc.).

Note

It is important not to over tighten the bolts on the bearing flange. They must be left loose enough to allow the composite bearing to spin freely inside.

2. Install one mounting door linkage bracket (1,2).

Note

Part number will vary depending on the compartment.

3. Install the shaft collar (4) on linkage assembly.
4. Install the second mounting luggage door linkage bracket (1,2) with linkage assembly (3).

Note

They must be installed together.

5. Install male thread rod end (11) into linkage assembly (3) with jam nut (14).
6. Preset linkage assembly to 18 inches from face of tube to center of rod end. (See Figure 2—Install Latch)
7. Install gas spring rear brackets (8 and 9).
8. Install gas spring stud (16).
9. Install 200 lbf gas spring stud (10).

Note

The spring will need to be compressed approximately 2 inches before installing. A homemade compression tool will suffice.

10. Install gas spring clip (15) on gas spring.

11. Install linkage assembly. Preset the length to 20 inches from center to center of ball joint.
12. Install door assembly. The door can now be fine tuned to fit. Secure all fasteners.

Note

Front to rear adjustment can be accomplished by moving the collar shafts forward or rearward. (See Figure 1—Pantograph Luggage Door Assembly.)

Luggage Compartment Removal

For removal of luggage compartment, reverse installation procedures.

Warning

Gas Spring under pressure. Use compression fixture for removal. Energy from compressed spring is dangerous. Use extreme caution to prevent personal injury.

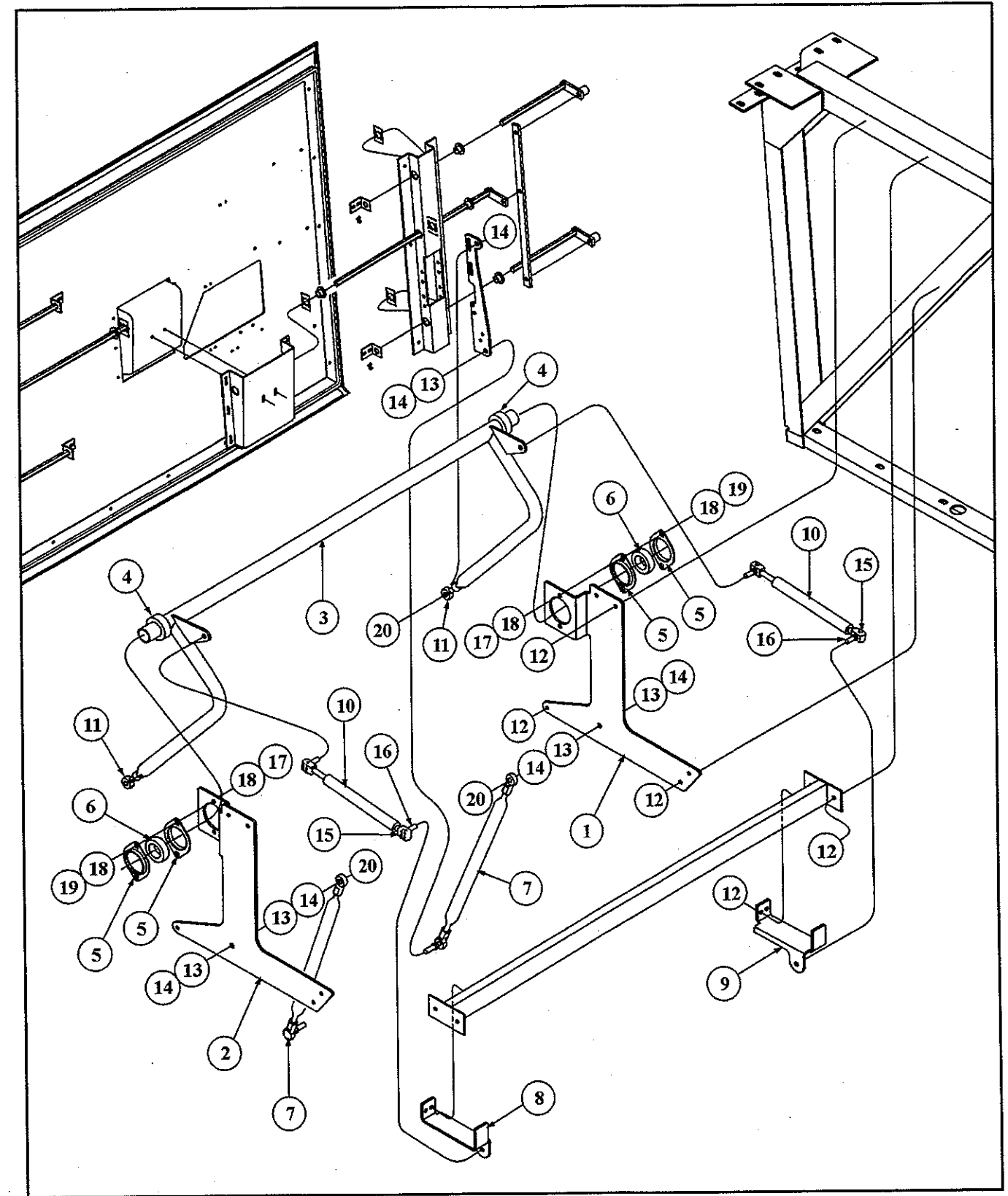


Figure 1—Maintenance Locations and Part Removal

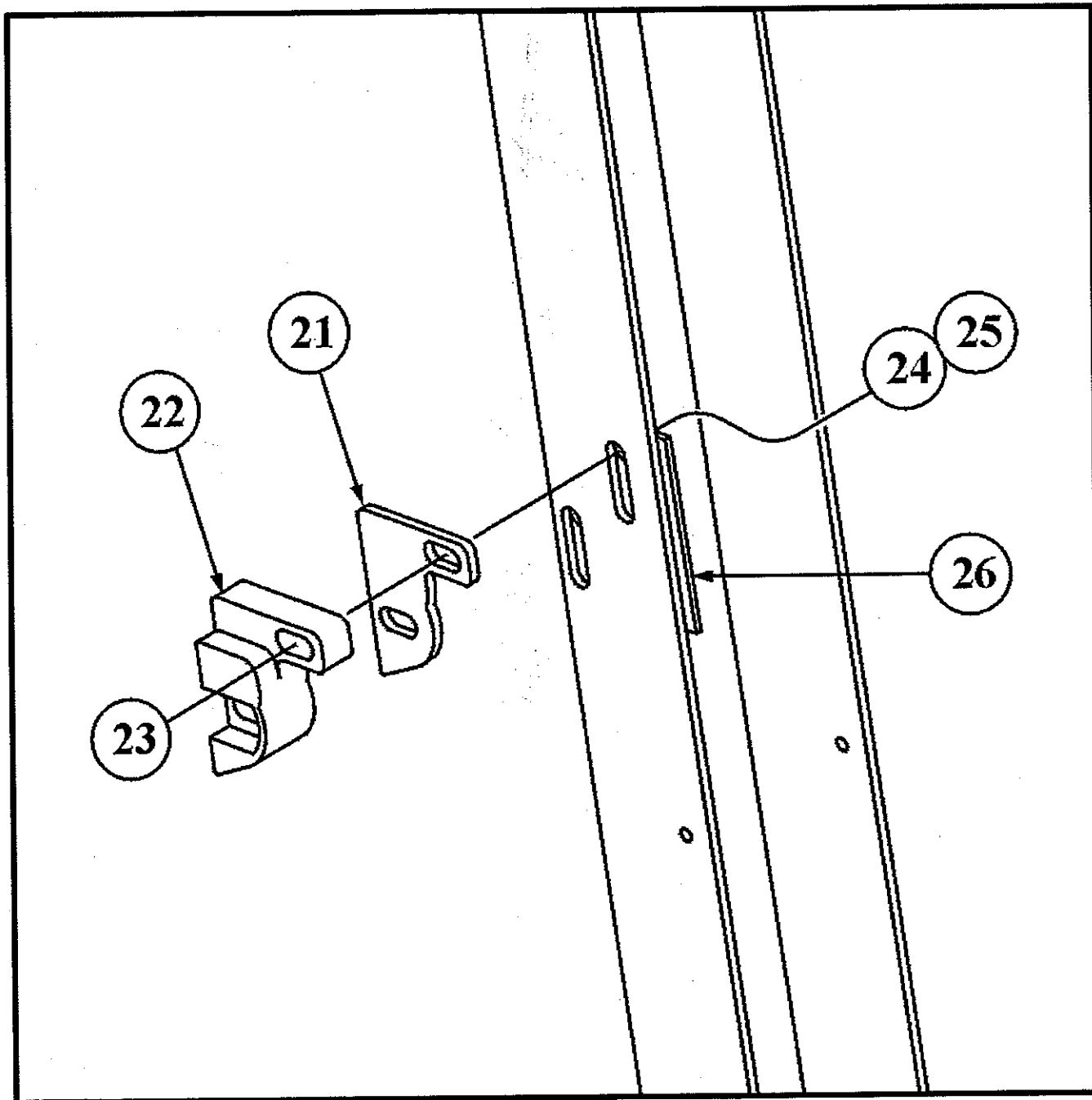


Figure 2—Install Latch

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