Porsche Limited Slip Differential (PSD)
928 S4/GT

Servicing the PSD System without the use of the "BOSCH Hammer".

Refer to:

Technical Bulletins:

1. **<u>"Servicing the PSD Pressure Accumulator",</u>**

   Model 8 Cyl, Group 3, Part Identifier 3983, Number 9603.
   Models affected: All 928's From Year Model 1990.

Technical Bulletin	Model	Group
	8 Cyl.	3
Subject: Servicing the PSD Pressure Accumulator	Part Identifier	Number
	3983	9603

ATTENTION: Service Manager / Service Technician

Models Affected: ***All 928's From Model Year 1990***

Concern: Correct removal and installation procedure of the pressure accumulator for the PSD system.

General Information:

The following information contains servicing instructions for removal and installation of the pressure accumulator in the PSD system. Due to high operating pressures found in the PSD system, servicing information for the PSD system should be followed precisely along with exercising the necessary safety precautions. Before removing the pressure accumulator of the PSD, you must release all of the hydraulic pressure in the system. See the 928 Porsche Workshop Manual Volume II Group 39, PSD Diagnosis/Troubleshooting.

Removing and Installing Pressure Accumulator

Removal:

1. With the ignition switch in the "0" position, pull off the plug connector on the pump motor (arrow in Figure 1).
2. Slowly remove all operating pressure from the PSD system through the bleeder screw on the magnetic locking valve assembly (# 9 in figure 2).

Caution: The PSD system can have up to 180 bar of internal pressure. Use protective eye goggles and hand gloves when bleeding off pressure.

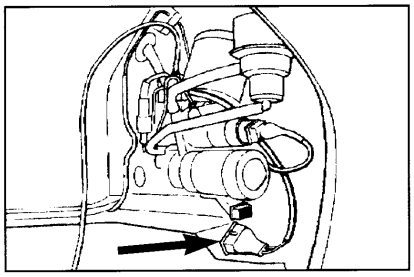

Figure 1

3. Unscrew the pressure accumulator (#5 in figure 2) using a universal strap type oil filter wrench (Hazet # 2171-2 or equivalent). **Under no circumstances should the pressure accumulator be loosened by turning the hex screw on top the accumulator housing. This will allow the gas pressure to escape and will necessitate replacement of the pressure accumulator.**

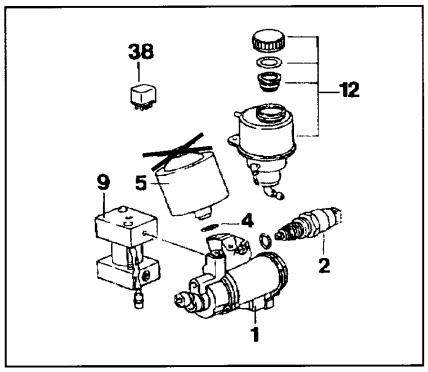

Figure 2

Installing:

1. Install the pressure accumulator with a new o-ring (# 4 in figure 2) lubricated only with brake fluid. Tighten the accumulator with a strap type oil filter wrench to 40 - 46 Nm (29 - 33 ftlbs).

SERVICE

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Installing (cont'd):

IMPORTANT:
Use care not to over tighten the pressure accumulator as damage can occur around 70 Nm (50 ftlbs).
Under no circumstances should the hex screw on top the pressure accumulator be used to torque the pressure accumulator to the motor assembly.
Use only lint free shop towels during repairs. Absolute cleanliness is required!

2. **Bleeding the accumulator and magnetic locking valve.**
Proceed as follows:
Connect a bleeder bottle with a clear hose onto the bleeder screw of the magnetic locking valve and open the bleeder screw. With the ignition on (position 2), reconnect the electrical plug to the pump motor. As soon as the brake fluid leaving the bleeder screw is bubble free, disconnect the pump motor plug and close the bleeder screw.

Fill the accumulator completely. Do so by reconnecting the electrical plug to the pump motor. As soon as the pump motor turns off, disconnect the pump electrical plug. Slowly open the bleeder screw on the magnetic locking valve

Caution: The PSD system can have up to 180 bar of internal pressure. Use goggles and gloves!

Note:
If the bleeding procedure is performed without a pressure bleeder, the fluid reservoir should be constantly checked and topped off as necessary.

3. The bleeding of the accumulator should be performed 2 times or until the escaping brake fluid is bubble free.

4. **Bleeding of the Lock Cylinder and Pressure Line.**
For this procedure, the magnetic locking valve is operated by the Porsche System Tester 9288. The high pressure in the magnetic valve pulses through the pressure line into the check valve and then into the lock cylinder. Attach a bleeder bottle with a clear hose to the bleeder screw of the lock cylinder and allow the brake fluid to escape until bubble free.

5. When the repair and bleeding procedures are completed, top up the fluid reservoir after the accumulator is fully charged.

2. <u>"Fluid Reservoir for PSD System",</u>

Model 8 Cyl, Group 3, Part Identifier 3986, Number 9604.
Models affected: 928 Model Year 1990.

Technical Bulletin

Model	Group
8 Cyl.	3

Subject: Fluid Reservoir for PSD System

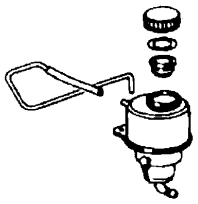
Part Identifier	Number
3986	9604

ATTENTION: Service Manager / Service Technician

Models Affected: ***928, Model Year 1990***

Concern: The reservoir for the PSD System has been superseded to a later version.

General information: The fluid reservoir for the PSD System installed in the 1990 Model Year 928 is no longer available. If replacement of the original version reservoir becomes necessary, a later version reservoir **and vent line** should be installed.



Parts Information:

928 315 013 00	Reservoir (No longer available)
928 315 013 01	Reservoir (Later version)
928 315 097 02	Vent line (Use with later version reservoir)

The following separate parts remain available:

211 611 381 B	Screen
901 355 908 00	Gasket
911 355 905 02	Cap
928 315 097 01	Vent line (Use with original reservoir)

SERVICE

Manuals:

1. POWER TRANSMISSION – Porsche Limited Slip Differential (PSD) 928 S4/GT.

Porsche Limited Slip Differential (PSD)

With Porsche's electronically controlled limited slip differential it is possible to have a locking ratio from 0 to 100 percent depending on dynamic operating requirements. Electronic control is integrated in the ABS control unit for logistic reasons. A hydraulic slave cylinder on the side of the transmission case is activated by the high pressure hydraulic system depending on requirements. The package of plates in the Porsche limited slip differential, which consists of 20 friction surfaces, is compressed with a force of approximately 3 tons (30 kN) for full locking (100 % locking ratio).

Function of Mechanical Parts

Plate-type limited slip differential (2) and operating components are located in differential case (14). Plate-type locks can be closed (up to 100 % locking ratio) and opened again (0 % locking ratio) for certain operating conditions by slave cylinder (8) which is operated by an external high pressure hydraulic system. Intermediate locking ratios are possible in fractions of a second in infinite steps as required.

Operation

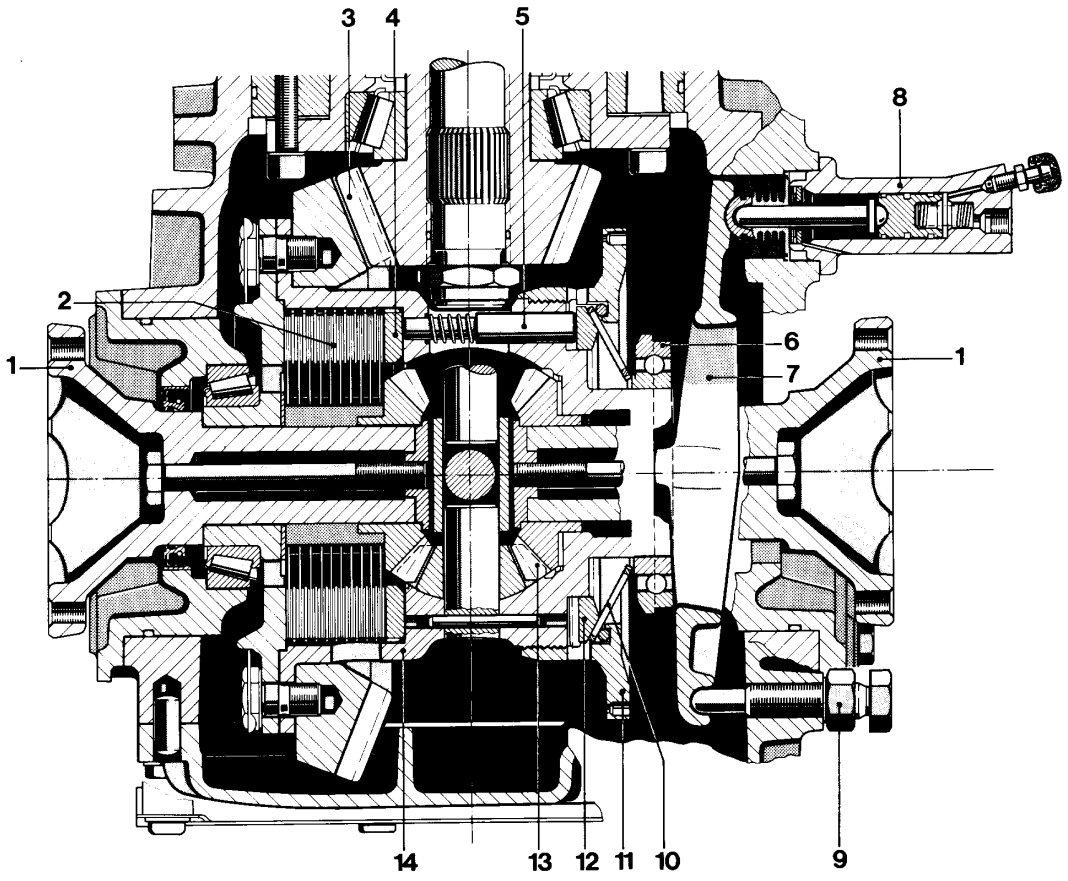
Operating energy is supplied by a hydraulic system with pressure reservoir. Slave cylinder (8) receives **pressure** and moves the adjustable engaging arm (7) and also engaging bearing (6) **in direction of differential case (14)**.

Force is forward via spring-loaded lever (10), pressure ring (11) and four spring-loaded pressure pins (5) to pressure ring (4), which in turn compresses the plate package (2). This produces **friction- type locking** between the left output end (1) and differential case (14). Since there is **positive lock- ing** with the right output end via differential bevel gaers (13), there is also uniform locking effect on the right side.

Pressure in the hydraulic system going to slave cylinder (8) must be reduced or eliminated, when it is necessary to partially or completely eliminate locking in the limited slip differential. This will eliminate or reduce the pressure on plate package (2).

The **bevel gear differential** can then again function normally with "**right to left compensation**".

Limited Slip Differential



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1 - Output Flange
2 - Regulable plate clutch
3 - Pinion/ring gear set
4 - Pressure ring
5 - Pressure pin with spring
6 - Engaging bearing
7 - Engaging arm
8 - High pressure slave cylinder
9 - Adjusting screw
10 - Spring-loaded lever
11 - Adjusting nut
12 - Pressure ring
13 - Bevel gear differential
14 - Differential case

2. RUNNING GEAR – Porsche Limited Slip Differential (PSD) 928 S4/GT

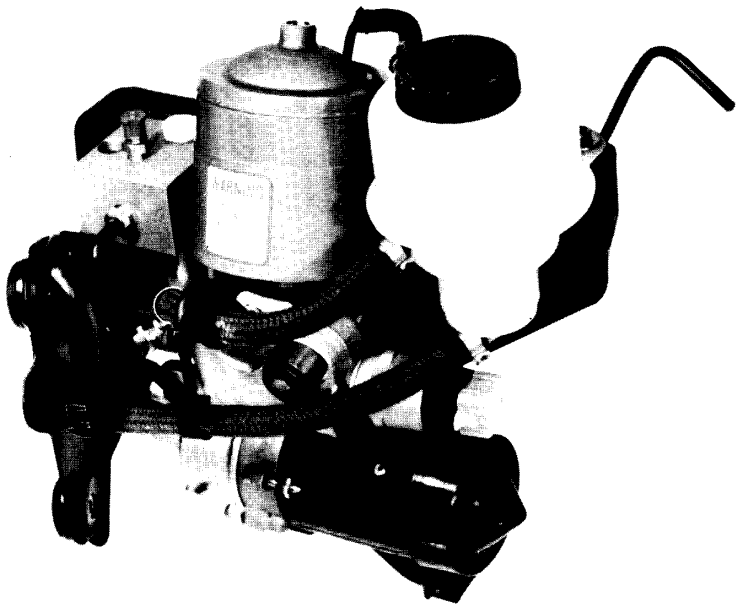
4 RUNNING GEAR

Porsche Limited Slip Differential (PSD)

The Porsche limited slip differential is an electronically controlled rear axle transverse differential lock. Improvement of traction while moving off and driving fast in curves on roads with poor static friction was the objective of this development.
Transverse rear axle differential lock is also employed to reduce the danger of oversteering when the ferraria effect occurs in a curve.
It is based on the plate-type lock in the rear axle differential known from the Porsche 911 Carrera 4.

Hydraulic Lock Operation

The hydraulic system consists of a high pressure pump, solenoid, pressure reservoir and supply tank, and is located on a mutual holder in the left rear wheel house.



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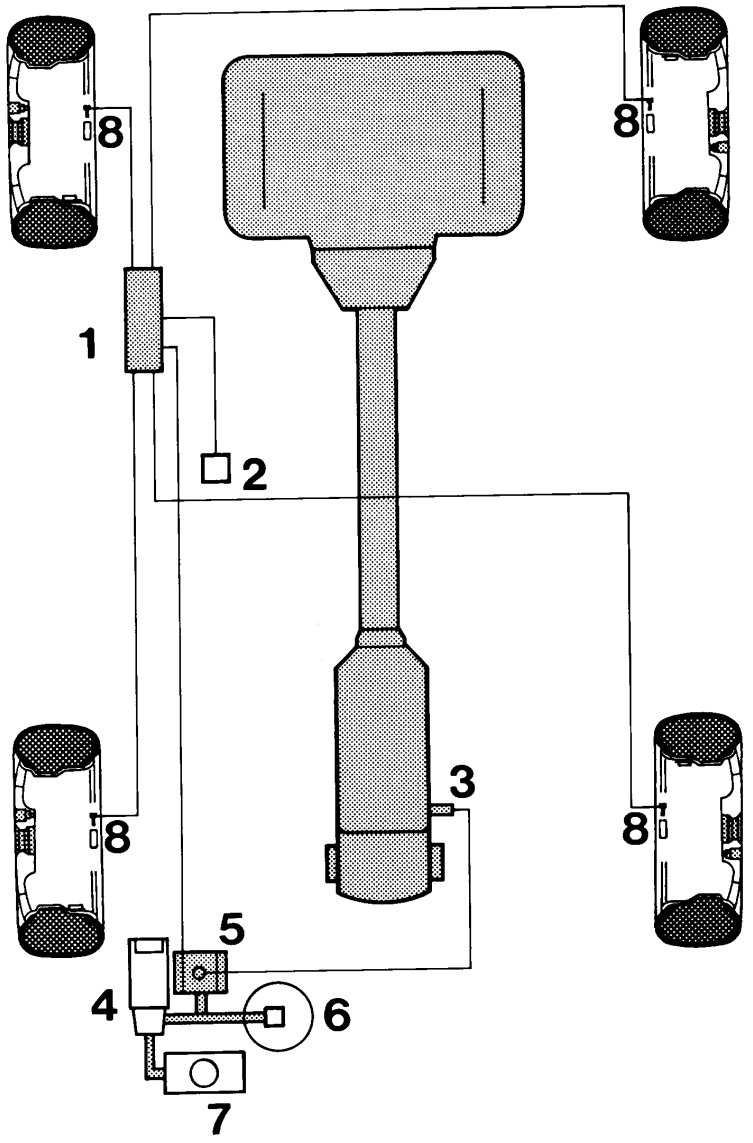
Brake fluid for operation of the transverse lock is taken from a plunger-type reservoir bolted on the high pressure pump. Operating pressure is between 140 and 180 bar. Activation of the pump is accomplished with a pressure switch. Building up pressure, holding pressure and dropping pressure functions are controlled by a solenoid known from ABS, which also delivers pressure for operation of the slave cylinder. A cyclic noise will be heard to indicate that lock regulation is taking place.

Hydraulic Lock Operation

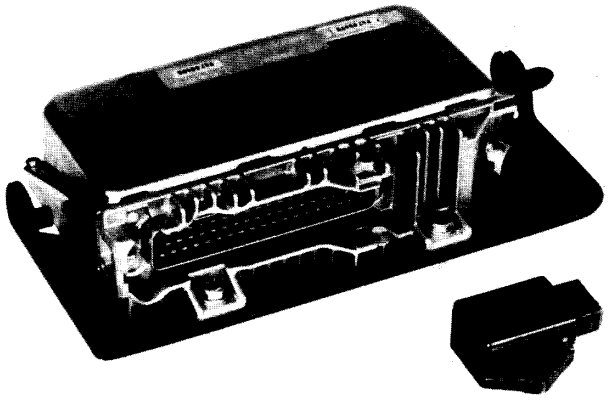


1 - ABS / lock control unit
2 - Transverse acceleration sensor
3 - Transverse lock slave cylinder
4 - Pressure pump with pressure switch
5 - Block of solenoids
6 - Pressure reservoir
7 - Supply tank
8 - Wheel speed sensor

Lock Control

Lock control is provided on an additional platinum board in the ABS control unit. The control unit uses information from ABS wheel speed sensors to calculate

- wheel speed,
- wheel acceleration,
- wheel deceleration,
- mean axle speed (difference in speed front to rear) and
- mean speed of car sides (difference in speed right to left for identification of curve).



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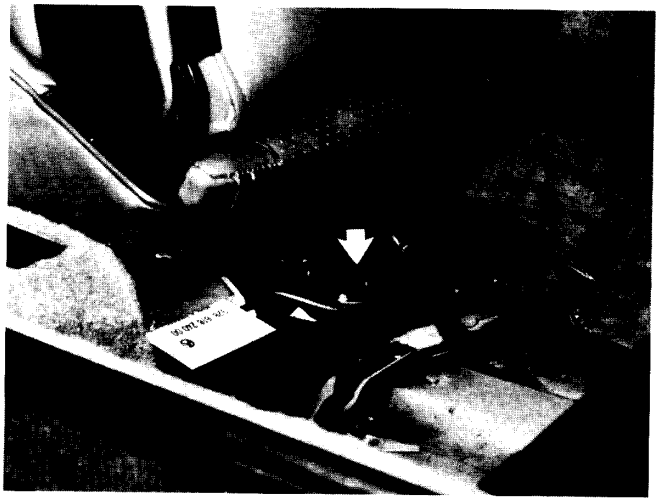
A transverse acceleration sensor (arrow) is located underneath the driver's seat.



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Other Possible Input Information:

- Operation of brakes (stop light switch)
- ABS regulation
- Transverse vehicle acceleration

Control unit works in three different driving ranges.

1. Traction while moving off
2. Acceleration from driving in curves
3. Ferraria effect (accelerator pedal released in curve)

1. Traction While Moving Off

Pressure depending on wheel acceleration is built up in the transverse lock when the control unit recognizes slip of a wheel through comparison of the wheel speed values. System pressure is increased in steps, until the slipping wheel again rotates in the permitted speed range, and then held constant for a predetermined minimum time. Pressure buildup depends on wheel acceleration, in other words the pressure will rise faster when wheel acceleration is fast. The pressure is dropped in small steps.

2. Traction Regulation for Driving in Curves with High Transverse Acceleration

The driven wheel on the inside of a curve tends to slip and propulsion is reduced when driving in curves with high transverse acceleration. A locking torque depending on the vehicle's transverse acceleration, road speed and recognized curve is introduced to prevent this.
Locking torque is lower with a high road speed and high transverse acceleration than with a low road speed. If cornering stability (lateral control) worsens by way of example due to a change in the road surface condition (change from non-skidding to slippery surface), this will be recognized from the rear axle wheel speed values and locking torque will be reduced very quickly in order to prevent load-type oversteering due to locking.
This function is effective in the entire speed range above 25 km/h (16 mph).

3. Ferraria Effect

Rear wheel driven cars tend to oversteer when the accelerator pedal is released suddenly while driving in a curve. This oversteering tendency can be reduced considerably through application of correct transverse locking torque. This function is activated by transverse acceleration input information with right/left curve identification and a comparison of wheel speed (wheels on inside and outside of a curve). The amount of locking torque required is determined by the road speed, transverse acceleration and speed of wheels.
Locking torque is reduced in steps as soon as the car is accelerated again or the brakes are operated, or the activating conditions no longer exist.

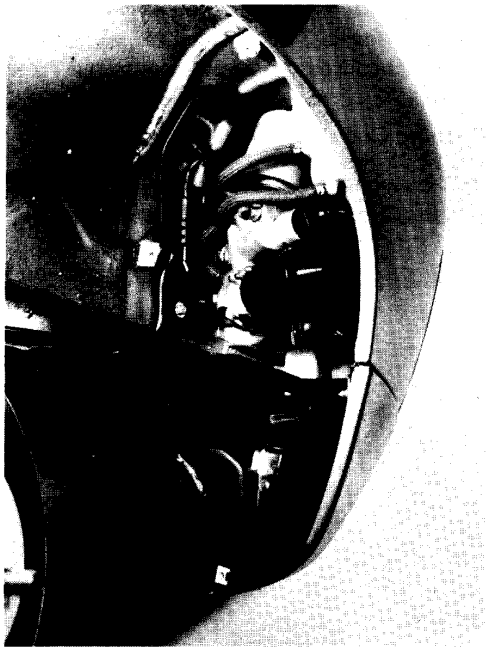
The function of ferraria effect works in the entire speed range from 60 km/h (31 mph) on.

Lock Information Lamp

A lock information lamp in the instrument cluster lights up green each time the locks are operated and when both rear wheels slip.

Location of Hydraulic System

The hydraulic system located in the left rear wheel house is accessible after removal of the wheel house cover.



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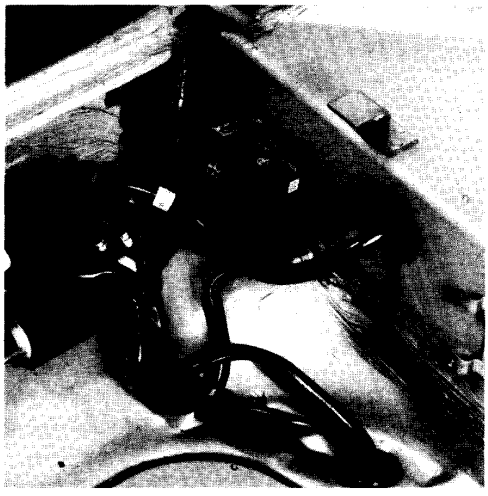
Power Supply for Hydraulic System

Power is supplied to the hydraulic system via a fuse and relay (pump motor relay) located in the spare wheel well.



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PSD Diagnosis

The PSD system is diagnosable. The fault memory can be read with either a Flashing Code Tester 9268 or Porsche System Tester 9288.
In addition, drives can be operated with a Porsche System Tester similar to 911 Carrera 4 models.

Flashing Code Tester 9268

PSD fault memory can be read with the 9268 Flashing Code Tester. Faults are displayed with a four-digit fault code, as already in other known systems.

Explanation of Fault Code Digits

	Display	
1st digit	5	Control unit identification
2nd digit	1	Fault currently exists
	2	Fault was experienced but not currently exist
	5	No faults
3rd digit	1 - 3	Tens digit of fault type
4th digit	1 - 5	Units digit of fault type

PSD Fault Codes

Code (3rd / 4th Digits)	Type of Fault
11	Transverse lock solenoid
12	Transverse acceleration sender - short/break
13	Transverse acceleration sender - not okay
14	Transverse lock - deviation in regulation
15	Control unit - faulty
21	Speed sensor front left
22	Speed sensor front right
23	Speed sensor rear right
24	Speed sensor rear left
31	ABS solenoid front left
32	ABS solenoid front right
33	ABS solenoid rear axle
34	Solenoid relay
35	Return delivery pump

3. **928 Factory Service Manual Section;**

Volume II, Transmission
D39 – 206i

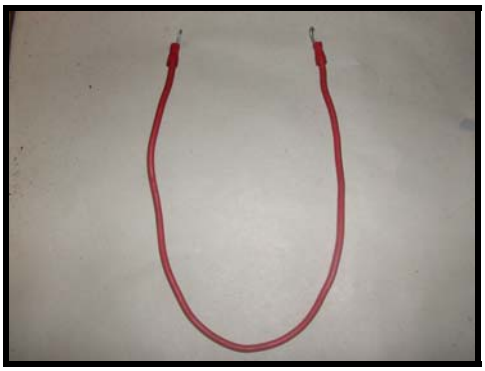
Volume III, Transmission
D39 – 201 through 202b
D39 – 257 through 260.

There is also a very good description of the "PSD Fluid Flushing Procedure" on the 928 Owners Club web site under Journals, however it is for member only at http//www.928oc.org

Safety First:
Caution: The PSD system can have up to 180 bar of internal pressure. Use protective eye goggles and hand gloves when bleeding off pressure.

Legal Notice:
The author accepts no legal liability or responsibility what-so-ever for the work described within this document.

Tools Required:
1. Jumper lead for supplying power to high pressure pump motor via relay.



Picture of Jumper Lead

2. 2 * Jumper leads for powering PSD Solenoide (magnetic locking valve assembly);

Picture of Jumper Leads

3. Ring spanners or short handle open ended spanners;

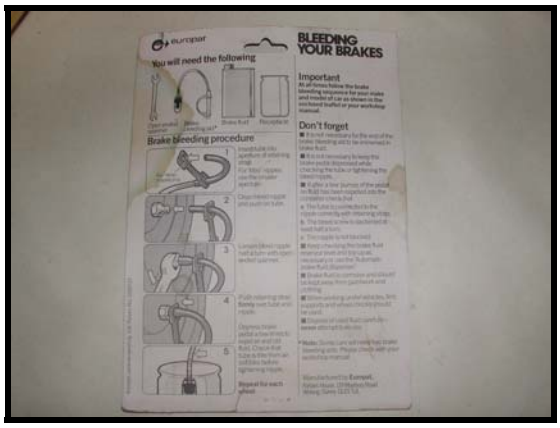
Picture of Spanners

4. 8 mm socket

5. Auto Brake Bleeder as per photograph or clear plastic hose;

Picture of Auto Bleeder

6. Auto Brake Bleeder instructions:



Picture of Instructions

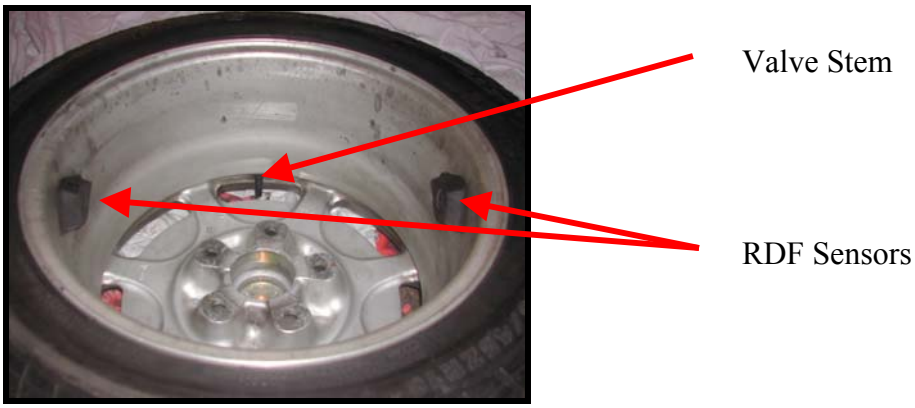
Procedure:

Persons required:
Two persons if using clear plastic bleeding hose or one person with auto brake bleeding gear.

1. With ignition switch in "0" position;
2. Jack up rear wheels and support on jack stands.
3. Rotate Left Hand Rear Wheel until valve stem is at 12 o'clock.

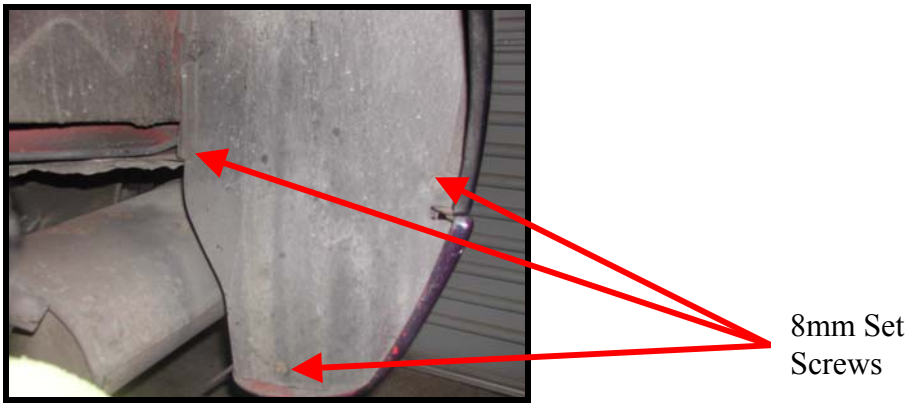
Picture of Wheel with valve at 12 o'clock

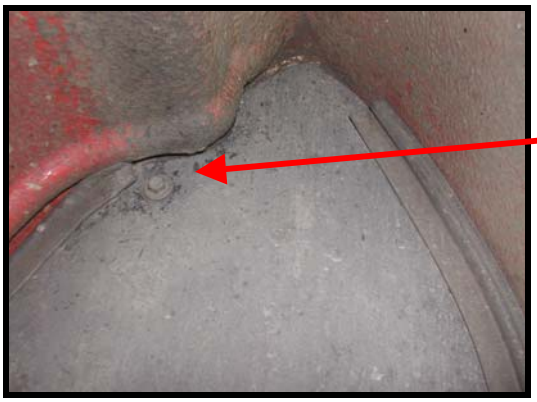
4. Remove LHR wheel (with valve stem at 12 o'clock the RDF sensors are at 9 and 3 o'clock and out of harms way if wheel drops onto brake disk);



Picture of location of RDF Sensors

5. Remove "Wheel House Cover" at back of left hand wheel house, (4 by 8mm set bolts);

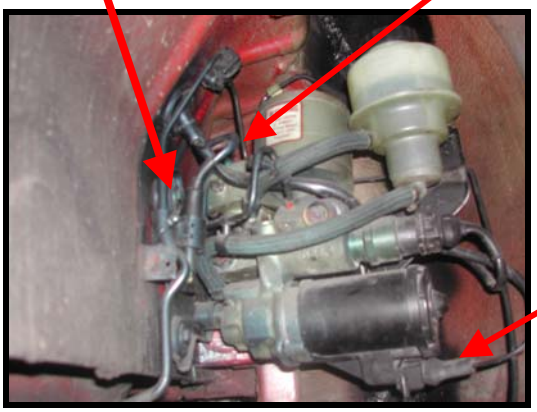




Magnetic Lock Valve
Power Connector

Dust Cover (blue) and
Bleed Screw on
Magnetic Locking Valve

6. Pull off plug connection on high pressure pump motor;



7. Disconnect the power connection to magnetic locking valve assembly;
8. Top up fluid reservoir with new brake fluid as per specification contained in Owner's Manual;

Bleeding the accumulator, magnetic locking valve and high pressure slave cylinder on RH upper side of differential

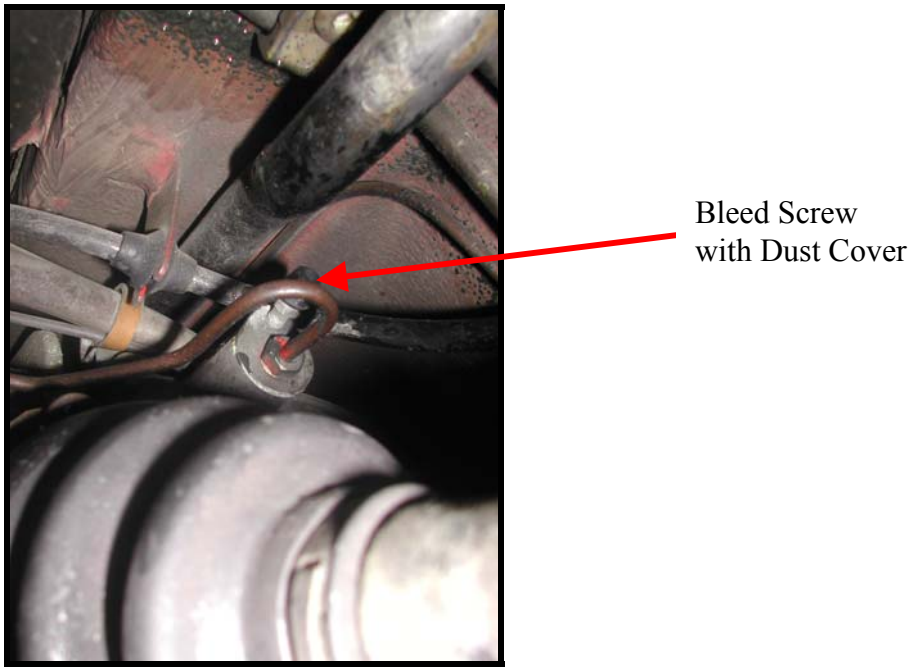
1. Bleeding the accumulator and magnetic locking valve

1. Remove dust cover from magnetic locking valve bleed screw;
2. Clean bleed screw;

3. Place bleeder hose onto magnetic locking valve bleed screw and place end into clear bleeder receptacle;
4. Open bleed screw and slowly bleed off accumulator pressure into receptacle;
5. Shut bleed screw;
6. Turn ignition switch to position “2”:
7. Reconnect the electrical plug to pump motor (high pressure pumps runs);
8. Fill the accumulator completely, until the pump motor cuts out automatically;
9. Remove the electrical plug from the pump motor;
10. Bleed the accumulator, via the magnetic locking valve bleed screw, twice or until clean ‘bubble free’ fluid flows into the receptacle;
11. Shut off bleed screw and disconnect the pump electrical plug;
12. If the bleeding is performed without a pressure bleeder, the reservoir should be continuously checked and topped up as required;

2. Bleeding the High Pressure Lock Cylinder and Pressure Line

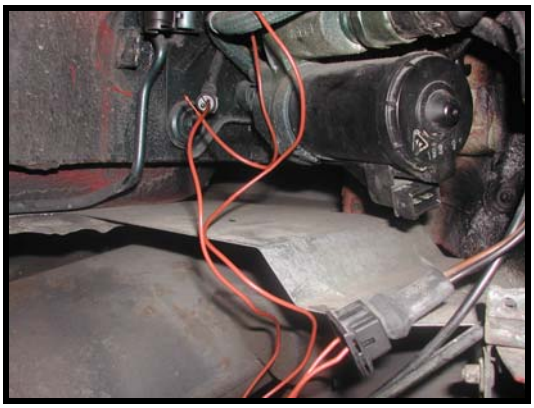
1. Remove dust cover from the bleeder screw of the high pressure slave cylinder;



Picture of High Pressure Slave Cylinder located on RHS of Transaxle just above drive shaft inner dust boot

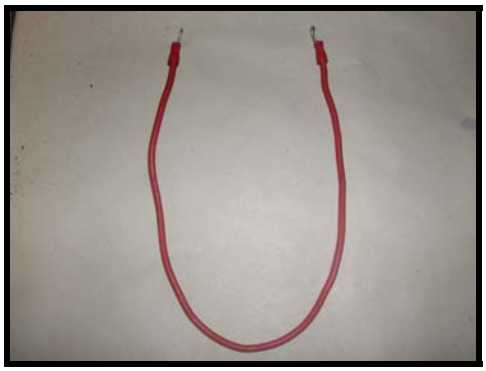
2. Connect the clear auto-bleeder hose onto the bleeder screw and place end of hose into a clear receptacle and open bleed screw and slowly bleed off initial pressure;

3. With ignition on (position 2), reconnect the electrical plug to the pump motor and pump up the accumulator until the pump motor cuts out (high pressure cut-out);
4. Top up fluid reservoir;
5. Disconnect power connection to high-pressure pump;

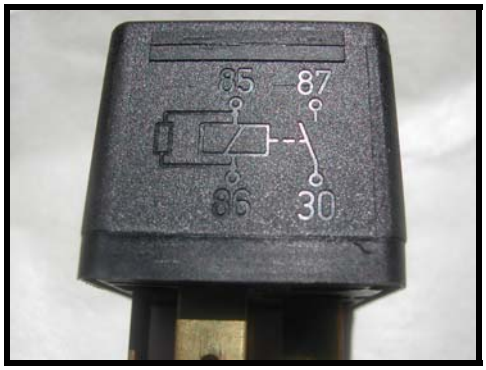


Picture of Jumper Leads connecting the High Pressure Pump power supply to the Magnetic Lock Valve female power connector

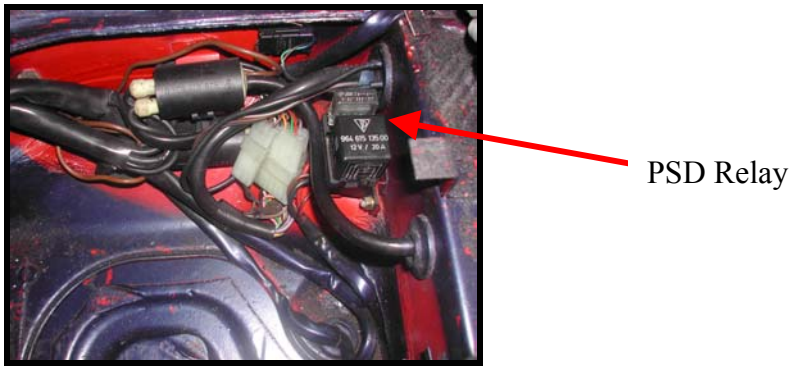
6. Connect the two jumper leads to the pump's power supply connector;
7. Connect the end of one of the leads to the magnetic locking valve electrical plug female connector;
8. Use the other jumper lead to make contact with the male connector thereby activating the magnetic lock valve. This allows high-pressure fluid to bleed out of the high-pressure slave cylinder;
9. Disconnect the jumper lead from male power connector of the magnetic locking valve electrical plug when the accumulator is empty (no flow) or fluid is clean and bubble free;
10. If required re pump up accumulator;
11. Note: If there is no power to the pump electrical connector (due to high pressure cut out switch open circuited) the relay located at the forward end of the spare wheel well will have to be removed and the relay jumper lead connected between terminal 30 & 87;



Picture of Relay Jumper Lead



Picture of PSD Relay schematic



Picture showing Relay location in Spare Wheel Well

Picture showing Jumper Lead Installed

Note: If you use this method to pump up the accumulator then the high pressure cut out switch may be by-passed, so care must be taken not to overpressurise the accumulator. If there are concerns relating to overpressurisation, then when the pressure and fluid is bleed from the accumulator, remove the jumper lead from the relay and reinstall relay and pump up the accumulator by:

i. Turn ignition switch to position "2":
ii. Reconnect the electrical plug to pump motor (high pressure pumps runs);
iii. Fill the accumulator completely, until the pump motor cuts out automatically;
iv. Remove the electrical plug from the pump motor;

12. Reconnect the power connection to the pump and pump up accumulator and continue to bleed fluid and pump up accumulator until the fluid is clean and bubble free as per 5 –9 above;
13. NOTE: Ensure never to allow the level of the fluid to be pumped totally out of the reservoir (this will ensure that no air is drawn into system);
14. When bleeding completed close off bleed screw, remove bleeder hose and reinstall dust cap;
15. Turn off ignition switch to the "0" position and reconnect electrical connections to PSD system pump and magnetic locking valve.
16. Turn ignition switch to the "2' position to pump up the accumulator; and
17. At he completion of bleeding ensure fluid level is to "Max" position in fluid reservoir.

"Box up" by reassembling the parts in the reverse order.