

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## EXECUTIVE SUMMARY

This report with procedures covers the failure and repair by replacement of the B2 Brake Band Piston Assembly, the maintenance undertaken whilst access was available and the re-assembly procedure with clearance checks for a 1990 928 S4 Automatic Gear box type A28.16/Mercedes Benz 722.3 Series Automatic Transmission.

In March 2005 the vehicle suffered a transmission failure and no forward movement was available in any of the forward gears, however, reverse gear was still operable.

Fault Finding Diagnostic research all pointed to the B2 Brake Band Piston Assembly failure with a possibility of a B2 Brake Band failure.

To check all aspect of the diagnosis it was decided to remove the B2 Piston Assemble, disassemble and inspect the B2 Piston, inspect the B2 Brake Band for breakage and wear and the B2 Clutch, measure the B2 Brake Band clearance and reset if required to Porsche's recommended clearance, change the ATF, filter and oil pan gasket, whilst the automatic transmission remained in situ within the vehicle.

The finding was that the B2 Brake Band Piston Assembly suffered a catastrophic failure that was repaired by replacement, using a new assembly with all modifications as undertaken by Mercedes-Benz since the 1980s to prevent such failures.

The B2 Brake Band and B2 Clutch were inspected and were both in near new condition and on installation of the new B2 Brake Band Piston Assembly the clearance of the B2 Brake Band with the existing thrust pin was measured and the clearance was at the lower valve as specified by Porsche.

The Automatic Transmission was boxed up, tested and worked satisfactory.

In conclusion there are three aspects to these procedures contained in this report:

1. If preventative maintenance is undertaken by any 928 Porsche owner to change out the B2 Brake Band Piston Assembly, due to the reported failures by Mercedes-Benz over many years, this can be done without removing the oil pan, filter, valve body or lower cover and the procedure to undertake this is covered in section 5 of the report.
2. However, if a decision is taken to also renew the B2 Brake Band Piston lip seal as well, it is difficult to remove and replace the seal without removing the oil filter, valve body, lower cover, intermediate plate and the B2 Brake Band Guide. The procedures for this are covered in sections 5 through 11 of this report. Currently the writer is designing a lip seal and bush removal puller that should work by installing it through the B2 Piston housing aperture.
3. If the automatic transmission suffers a catastrophic failure of the B2 Brake Band Piston Assembly, this report and procedures will assist the DIY owners

## **1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure**

---

of the 928 to accomplish the task of its replacement together with the recommended inspection and renewal of various parts.

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## Table of Contents

1990 Porsche 928 S4 Auto B2 Piston Failure.....	4
1. Background.....	4
2. Failure.....	4
3. Diagnostics.....	4
3.1 Initial checks and adjustments.....	4
3.2 Outcome of initial checks and adjustments.....	5
3.3 Further research.....	5
3.4 Wally's advice from the WSM.....	5
3.5 WSM group 38, page 112.....	5
3.5.1 Condition.....	5
3.5.2 Cause/Correction.....	5
3.6 Outcome.....	5
3.7 Articles to support outcome decision.....	6
3.7.1 GarthS/GS535i advised:.....	6
4. Vehicle Automatic Transmission make and model.....	6
4.1 A28.16 model.....	6
4.2 Mercedes-Benz Automatic Transmission 722.3 Series.....	6
5. Disassembly.....	7
5.1 General Instructions.....	7
5.2 Tools.....	8
5.3 B2 Piston Removal.....	8
5.4 Removal B2 Cover Plate.....	9
5.5 Removal and disassembly of B2 Piston Assembly.....	10
5.6 Examination of B2 Piston Assembly.....	11
5.7 The B2 Piston Assembly consists of:.....	13
5.8 B2 Brake Band Piston Assembly Damage.....	14
5.9 Description and History of Old B2 Piston Assembly.....	15
6 Oil Pan and ATF.....	18
6.1 Removal the filter Element.....	19
6.2 Valve Body.....	19
6.4 Lower Cover.....	21
6.4.1 Removal of Lower Cover.....	22
6.4.2 Removal of Lower Cover-Cover Plate and gasket.....	22
6.4.3 Brake Guide Removal.....	24
7 Inspection of Brake Band and Clutch Housing.....	25
8 Parts requiring replacement and other parts selected for replacement.....	25
9 Purchase of Parts.....	25
10 Replacing B2 Brake Band Piston & Checking Clearance of B2 Brake Band ..	26
11 Cleaning and Reassembly.....	27
11.1 Reassembly.....	27
12 Hypothesis of Failure.....	29
13. Legal Notice.....	29

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## 1990 Porsche 928 S4 Auto B2 Piston Failure

### 1. *Background*

The vehicle is a 1990 Porsche 928 S4 Automatic and at the time of the incident it had traveled 81,209 kilometres. The vehicle has been owned since November 1999 and at the date of purchase it had approximately 47,000 kilometres on the odometer. In February 2005 the 80,000 kilometre service was carried out, which included camshaft timing belt change, coolant change, engine oil and filter change, checking of all other fluid levels, flushed and recharged the PSD, starter motor and the alternator overhauled, flex plate checked for end loading on the engine thrust bearing, battery box cleaned and coated with 'fish oil' and all other items checked and serviced as per the Maintenance Schedule. All maintenance has been carried out by the writer except for the initial timing belt change, water pump and tensioner rollers renewal, just after the vehicle was purchased.

The Automatic Transmission was serviced in August 2003 at 71,018 kilometres.

### 2. *Failure*

On 7<sup>th</sup> March the automatic transmission lost forward motion from all forward gears, however, reverse still remained operational. The vehicle was towed home and reversed into the garage. ATF level was checked whilst car was still warm and in neutral 'N' as well as moving gear selector lever through all gears and again checked in 'N'. The level was satisfactory; sitting between the top two indicator marks. Reversed rear wheels onto portable ramps, jacked vehicle up at the front by trolley jack under the two tow/skid points forward until the vehicle was level. Whilst supporting the vehicle forward by jack stands the vehicle was jacked up higher at the rear with the trolley jack and placed on jack stands. The trolley jack was replaced with a jack stand under the rear suspension support member and the ramps moved forward and placed under the front wheels, which were chocked on their rear side to prevent any forward or rearward movement.

With the vehicle supported by 5 supports it was deemed safe to work under for an extended period.

### 3. *Diagnostics*

Workshop Manuals, Technical Articles, Technical Specifications, Service Information Technik, PET5 for clarification of locations and Porsche 928 forums were used.

#### 3.1 **Initial checks and adjustments**

Whilst awaiting a reply from one board the following checks and adjustments were carried out:

1. Checked idle speed – OK within specifications (675 rpm +/- 25).

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

2. Checked throttle linkage and adjusted as per WSM.
3. Adjusted Control Pressure Cable as per WSM.
4. Checked vacuum line to Pressure Modulator – OK no leaks or blockages.
5. Checked drive range selector lever operation on box and verified each indent position for each gear.
6. Checked setting of Starter Interlock Switch and Drive Range Selector Lever with 4mm drill shank.
7. Warmed up auto transmission and checked all forward and reverse gears.

## 3.2 Outcome of initial checks and adjustments

Still no forward motion in any forward gear, however, reverse gear was still operable.

## 3.3 Further research

Wally Plumley of 928 Specialists and GarthS/GS535i responded to a request posted on a Porsche Forum. Wally advised the Porsche Fault Finding Diagnostic advice from the WSM and GarthS/GS535i advised links to various web sites. By using this information, undertaking my own review of the WSMs and ‘surfing the web’ a host of information was found.

The Porsche Fault Finding Diagnostic search turned up three sets of information.

## 3.4 Wally’s advice from the WSM

1. Brake band B2 seriously worn or broken.
2. Adjust brake band B2 by installing a longer pressure pin.
3. Replace brake band, if seriously worn or broken.

### No power flow for a brief time after cranking the engine

4. Torque converter drains partially via leaky or defective lubricating ring or valve in put shaft.

## 3.5 WSM group 38, page 112

### 3.5.1 Condition

1. Transmission slips when moving off in 1<sup>st</sup> or 2<sup>nd</sup> gear, or moving off not possible in forward gear. Reverse gear is still good.

### 3.5.2 Cause/Correction

1. Service shift valve B2, replacing shift valve housing if necessary.
2. Replace brake band B2 Piston.
3. Adjust brake band B2 by installing a longer thrust pin. Replace brake band in case of excessive wear or broken brake band.

## 3.6 Outcome

All advice pointed to problems with the B2 Brake Band Piston Assembly.

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## 3.7 Articles to support outcome decision

### 3.7.1 GarthS/GS535i advised:

1. B2 Piston is often implicated in failure and he suggested reading the article <http://transmission.articles.mbz.org/b2/> and following the links contained within the article.
2. B2 Piston Failure in Mercedes-Benz 722.xxx Automatic Transmissions at [http://business.baylor.edu/Richard\\_Easley//autofaqs/b2piston.htm](http://business.baylor.edu/Richard_Easley//autofaqs/b2piston.htm).
3. A Google search located an excellent article titled AUTO TRANS DIAGNOSIS – 722 SERIES relating to a 1996 Mercedes-Benz C220 at <http://transmission.articles.mbz.org/akp722.pdf> , as well as various other articles. This article directly relates to the MB 722.3 series transmissions.
4. “The B2 Piston” article by Richard Sexton with photographs and an update titled: “B2 Odyssey Updated”.

Armed with all the above data together with information from the “Porsche 928S Automatic Transmission A28-Description of Operation” manual and the WSM’s Group 37 pages 1 to 179 relating to the six bolt pan 4 speed transmission and the Technical Publications contained in the Jim’s CDs, CD No.1 version 2.15, it was deemed time to proceed with the a course of action, **investigate the B2 Brake Band Piston Assembly.**

**Note:** In assessing data make sure the correct model/series and serial number of the transmission fitted to the vehicle is correctly identified.

## 4. *Vehicle Automatic Transmission make and model*

The Automatic Transmission installed is:

### 4.1 **A28.16 model**

The Porsche gearbox number on the transmission was located at the aft end of the transmission on the intermediate casing at the junction of the transmission and the transaxle and is: **A2816 3L02446.**

On checking the specification obtained from the local Porsche Centre the original automatic transmission fitted was A2816 3L01363, so the gear box was a newer transmission. The automatic transmissions fitted to the Porsche 928s are manufactured by Mercedes-Benz and MB’s production numbers and gear box type and serial numbers are stamped on the horizontal surface just above the oil pan landing on the RHS of the gear box just forward of the B2 Piston Cover, so the transmission also has a MB Serial number for reference.

### 4.2 **Mercedes-Benz Automatic Transmission 722.3 Series**

The transmission production and serial number is:

**722 270 3201 722 360 03 371586.**

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

It is believed the first 10 numerals are MB production numbers (This is not confirmed however Porsche states “The digits stamped on the right side of the transmission case above the ATF sump are for production purposes only) and the last 14 numerals can be interpreted as follows:

1. 722 is the type of transmission and designated that it is an Automatic Transmission.
2. 3 is the Model of Transmission and in this case it is designated as a 722.3 series, which is a 4 Speed/6Bolt/Large Case type transmission.
3. 60 designates the Type of Automobile or Version Number.
4. 371586, the last six numbers, is the Serial Number of the Transmission. There is no explanation of what the 03 means.

This information was gathered from Mercedes-Benz Transmissions and Oil Reference Guide found on the web.

The spare part numbers used in Porsche’s PET5 are Mercedes-Benz spare part numbers, so parts are in fact identical. This statement contradicted advice received from an independent transmission mechanic during investigations, that they were not identical.

## **5. Disassembly**

### **5.1 General Instructions**

Remember a safe work place and a safe attitude is extremely important when working under a vehicle.

During any work on any automatic transmission cleanliness is paramount. Prior to commencing work make sure all surrounding surfaces are as clean as possible, so when the transmission is opened up, either whilst in the vehicle or removed, minimise the ingress of foreign matter especially around the valve body, the galleries and the other internals of the transmission.

In this instance the internal inspections and the subsequent repair was undertaken with the transmission remaining in situ. This was very good as most foreign matter fell away from the transmission, as the majority of the work is in the main body of the transmission and entry if from underneath via the oil pan area, however, when removing the B2 Piston it is located in a horizontal plan and debris can enter.

Care must also be exercised that items do not fall out of their location within the transmission.

Adequate lighting is required and in this case a 50 watt quartz halogen work lamp, a battery powered lantern and a torch were used.

Ensure that the work area is clean and that paper is available to spread out under the gear box during disassembly with a quantity of lint free rags.

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## 5.2 Tools

The following assortment of tools were used during the work:

1. Various screwdrivers and Phillip-headed screwdrivers.
2. Circlip pliers.
3. Socket sets, 1/2", 3/8" and 1/4" drives including a deep socket set.
4. Tension wrench. Two were used, one is a micrometer adjusted tension wrench and the other is an analogue pointer gauge wrench. Preference was for the micrometer type for ease of operation especially during incremental torquing up of bolts and nuts as required.
5. Various hammers especially a soft headed hammer.
6. Metric Allen Keys with a ball head for ease of removing Allen headed set screws.
7. Multy Grip pliers.
8. Vernier Caliper.
9. Air Compressor and blow gun.
10. A clean work bench (a portable bench was used which was install in front or at the back of the vehicle to hold all the tools required and provide a clean disassembly area). Cleanliness was enhanced by the use of white 'butchers' paper on the working surface of the bench and the garage floor under the transmission.

In fact not many actual tools were required to complete the work.

## 5.3 B2 Piston Removal

1. Remove the RHS exhaust pipe section in way of the transmission to gain unimpeded access to AT.
2. Remove heat shield located above exhaust pipe. This shield is held in place by hexogen headed set screws.
3. Clean up vehicle's under body area in way of transmission as well as transmission in way of the B2 piston.



# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## 5.4 Removal B2 Cover Plate



*B2 Piston Assembly Cover Plate*

4. The cover plate is held in position by a circlip and is held against the circlip by the spring loaded B2 Piston.
5. Inwards axial pressure applied to cover plate and circlip removed by using a small screwdriver. To assist in its removal the circlip was moved circumferentially round in its recess until an end was within the gap in the retaining flange. The tang of the screwdriver was placed under the end of the circlip and it was worked out of its retaining groove.
6. Cover plate removed by the use of two small screwdrivers to lever the cover plate out. During removal the plate canted and jammed several times, which required it to be relocated square within the housing. It was not a difficult operation.

During investigations, some owners reportedly had problems pushing the B2 Piston Assembly Cover against the spring load and they made a small apparatus using a longish bolt and nut, fitted a old shock absorber washer behind the nut and cut a length of copper tube to fit between the vehicle body and the shock absorber washer with the bolt head butting against the Cover Plate with the nut fully screwed up against the bolt inner side of its head. This apparatus could be used in either direction. By using two open ended spanner the nut can be turned anticlockwise, and this will push the cover against the spring tension as required to relieve the pressure on the circlip.

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*B2 Piston aperture showing black lip seal behind which is located the plastic guide bush. The location of the thrust pin into the brake band is also visible in the centre of the hole. Also visible is the cover O-ring seal (red)*



*Bush and lip seal for B2 Brake Band Piston are located at the end of the bore in the aperture into the transmission as shown in the preceding photograph.*

### 5.5 Removal and disassembly of B2 Piston Assembly

7. With the cover plate removed, it exposes the cover plate O-ring seal and the B2 Brake Band Piston Assembly, both of which can be easily removed.
8. Once removed it should be examined for damage. Initially the piston assembly looked satisfactory until a thorough strip-down and evaluation was undertaken.
9. The strip down of the B2 Brake Band Assembly was undertaken on a clean work bench on white paper.
10. Removed the internal piston circlip and withdrew the thrust pin thimble piece, which came away in two pieces.
11. Removed the spring.

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

12. Viewed the internals and noted pieces of metal (4 quadrants of a circular piece of metal) laying on the inner face of the non-return valve.
13. Withdrew the piston, however, there was no piston crown and the piston jammed a little whilst being withdrawn.
14. Removed the 4 pieces of material from on top of the non-return valve.
15. Removed the large circlip at the other end of the B2 piston assembly.
16. Removed the large spring with its retaining ring.
17. Removed non-return valve conical spring and its associated cruciform locating washer.

### 5.6 Examination of B2 Piston Assembly



*B2 Brake Band Piston Assembly  
With a view of thimble piece and retaining circlip*

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*B2 Brake Band Piston Assembly  
with a view of retaining washer, spring, "T" plastic seal ring and OD of piston cylinder  
where lip seal seals*



*B2 Brake Band Piston Assembly  
with spring retaining ring, circlip and cruciform piece holding the conical spring and  
non-return valve that can be seen through centre hole*

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*The B2 Piston Assembly disassembled*

### 5.7 The B2 Piston Assembly consists of:

1. Circlip,
2. Conical spring,
3. Non return valve disc,
4. Spring and Retaining Ring,
5. B2 Piston Outer Assembly (brake band piston),
6. B2 Piston (inner piston),
7. Piston spring,
8. Thrust pin thimble piece,
9. Thrust Pin, and
10. Circlip.

This unit can be purchased as a single unit (6) as displayed in PET5 illustration 307-45 part number 107 270 003 2 for 89 model 928 S4 and onwards.

Individual parts can also be purchased such as:

1. Item 4 part number 900 906 037 00 Circlip A 42.
2. Item 5 part number 126 277 245 5 sealing ring.
3. Item 6 part number 124 270 003 2 piston brake band (this is the major assembly item and appears not to include the B2 internal Piston, the internal spring or the thrust pin thimble piece).
4. Item 7 part number 126 277 095 5 sealing ring (for internal piston). **Note:** If a new ring is installed the ring must be installed in the correct manner with the angled edge of the ring facing inboard in the Brake Band Piston Assembly. (Refer to the WSM for clarification and confirmation).
5. Item 8 part number 900 042 005 01 lock ring (to retain internal piston, spring and thimble piece).

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

The thrust pin comes in four different lengths:

1. Item 9 part number 126 277 171 5 pin 47.2 mm long
2. Item (9) part number 126 277 271 5 pin 48.0 mm long
3. Item (9) part number 126 277 371 5 pin 48.8 mm long
4. Item (9) part number 126 277 471 5 pin 49.6 mm long

These various lengths allow for adjustment of the brake band clearance.

### 5.8 B2 Brake Band Piston Assembly Damage

As can be seen from the picture below the inner B2 Piston crown had fractured into four pieces. It fractured circumferentially around the inside diameter of the piston. The thimble piece (no part number or name given or located in PET5) had the large diameter flange fractured off just under the flange. The inside of the cylinder liner located in the Brake Band Piston Assembly appears to be a press fit (steel cylinder liner in this case) showed a slight seizure mark about one third the circumference of the bore approximately at mid length where the piston appeared to have canted and seized. The hypothesis of the the contributing events, that led to the failure of the B2 Piston will be discussed later in this report.



*B2 Piston Assembly damage*

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*B2 Brake Band Piston Cover “O” ring, Piston Assembly Bush and lip seal*

### 5.9 Description and History of Old B2 Piston Assembly



*B2 Piston Old model Piston Assembly  
appears to be cast iron*

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*Old B2 Piston Assembly on LHS & Modified B2Piston Assembly on RHS*

The old model B2 Brake Band Piston Assembly appears to be a cast iron assembly and it can be noted that the plastic type sealing ring is very similar to a piston ring (rectangular cross section). It was reported that the Brake band Piston Assembly was redesigned in the late 80s into a more robust unit and manufactured from aluminum. This seal ring was reportedly modified by MB in the late 1993/4 into a “T” shaped seal ring and the cylinder liner was modified to a plastic material replacing the steel liner. Both these modifications were reported to have been made to reduce the instances of seizure/binding due to canting of the outer and inner pistons and to reduce bore wear which could increase the instance of binding.

The above modifications are explained in the Document “B2 Piston Failure in Mercedes-Benz 722.xxx Automatic Transmissions” which can be found at:

[http://business.baylor.edu/Richard\\_Easley//autofags/b2piston.htm](http://business.baylor.edu/Richard_Easley//autofags/b2piston.htm)

**Note:** There is an under score \_ between Richard and Easley in the above address.

Richard recommends that any pre-1994 MB should be fitted with the new version of the B2 Brake Band Piston Assembly with the above mentioned modifications as a preventative maintenance precaution. No recommendations are made or inferred by this report. The report covers what was done when the transmission was opened up for investigation of the failure and the repairs and maintenance carried out to return the AT to good working condition.

It will be noted from the photograph above that the B2 Brake Band Piston Assembly as removed from the vehicle had the more robust aluminum assembly, it was fitted with the “T” seal ring, however, it still had the steel cylinder liner fitted for the thrust pin actuating piston.



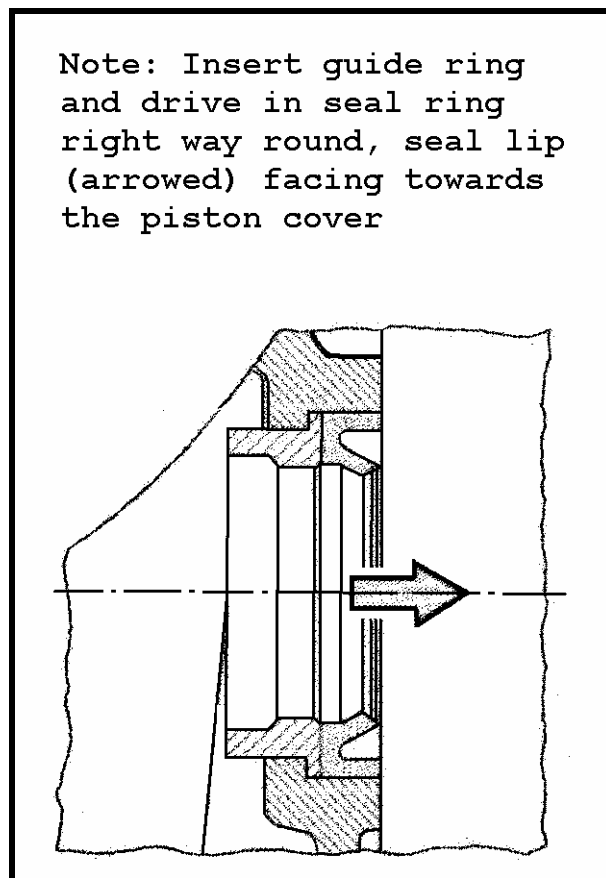
## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

It was decided to renew the B2 Brake Band Piston Assembly, as a total replacement unit, to renew the Cover Plate O-ring seal as well as the lip seal item 7, part number 006 997 734 7, as shown in PET5 illustration number 307-55. To renew the seal it necessitated driving the bush and seal out from the inside the transmission case.

### **Important Note:**

PET5 illustration 307-55 shows an incorrect location of items 6 & 7, the bush (Part Number 126 277 085 0) is installed after item 7 sealing ring (Part Number 006 997 734 7) when in fact it is the opposite as shown in the WSM Page 37-153 where the illustration below clearly shows the bush is installed first and the sealing ring in the top of the bush with the lip seal facing towards the B2 Piston Assembly Cover. This is because the pressure within the B2 Piston cylinder is approximately 90psi when the B2 Brake is applied. If this seal is installed with the lip seal toward the internals of the transmission the ATF could bypass the lip seal and the Piston could fail to activate the B2 Brake Band, which could cause the same failure of no forward motion in any of the forward gears.



*Sketch of location of bush and lip seal facing outwards towards piston cover*

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*B2 Brake Band Piston Lip Seal and Bush*

### **6 Oil Pan and ATF**

The ATF was drained from the oil pan drain plug and the pan was removed by removing the ATF reservoir and the 6 retaining bolts.



*View of internals of AT with Pan and Filter Removed.*

*On lower LHS space between centre is the oil pipe, detent quadrant leaf spring and Range (Gear) Selection Valve with Slide Head can be seen*

On removal of the oil pan there was some debris from the failed B2 small Piston crown laying in the bottom of the pan, however considering everything the pan was quite clean. The ATF removed was still in very good condition as the AT was serviced in August 2003 at 71,018 kilometres, which consisted of a filter change, gasket change, and a total

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

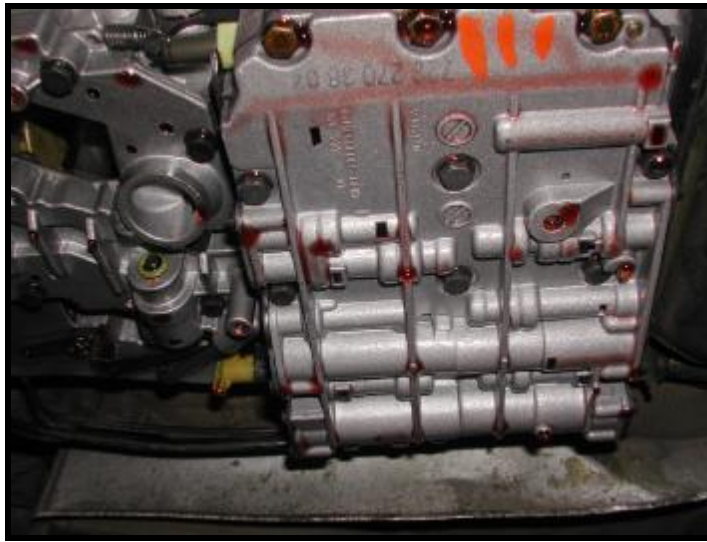
---

ATF change. The good condition of the oil would indicate that there was no clutch slipping or overheating of the clutches or brakes within the transmission.

### 6.1 Removal the filter Element

The filter element Phillips-headed securing screws were removed and filter element inspected. The filter element, viewed via the outlet orifice, and the wire screen viewed from the suction orifice was relatively clean in view of the service period of approximately 9,500 kilometres and approximately 1.5 years in service.

### 6.2 Valve Body



*Automatic Transmission Valve Body*

The next step was to remove the valve body. To insure the correct replacement of the holding set bolts a white cardboard template was made and the holes were cut out with a wad punch to accommodate the set bolts in their correct positions.

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*Valve Body Template to hold set bolts*

Prior to removing the valve body the garage floor directly under the transmission was cleaned and white paper was laid out to catch any parts that may have fallen out. There are numerous parts contained within the valve body interface section with the transmission. The valve body was removed extremely carefully and thankfully no items fell away from the transmission or sprung out from the valve body inner face.

**Note:** With reference to the WSM and the Auto Trans Diagnosis – 722 series pdf article mentioned above it is suggested that the position of the valves, oil injector, oil deflector, strainers, one way check valve, temperature throttle, filler piece, locating pin etc., as shown in the various sketches, are noted to ensure that they are all present and accounted for and installed in the correct places and in the correct plane when reinstalled.

Once removed the valve body was placed on the prepared clean work bench covered with white paper and then it was covered with another sheet of white paper.

As a further precaution the central vacuum cleaner was isolated as the motor and dust catcher are located in the garage.

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## 6.4 Lower Cover



**Lower Cover showing Controlled Pressure Control Valve Piston and Lever in the top RHS foreground with spring loaded actuating lever, Range (Gear) Selector Valve in the lower RHS background with its plastic slide that fits on pin of the detent quadrant and the suction and delivery orifices from the oil filter**

Again to insure the correct replacement of the holding set bolts a white cardboard template was prepared with holes made to accommodate the set bolts in their correct positions.



*Lower cover template retaining bolt holder*

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

Again the dripping ATF from the transmission was wiped away, as much as possible, and clean white paper was again laid out on the garage floor under the transmission to allow careful scrutiny of any way ward parts during removal.

### 6.4.1 Removal of Lower Cover

1. Removed the leaf spring and bracket for the detent assembly quadrant.
2. Removed the Controlled Pressure Control Valve actuating lever spring.
3. Slackened off the retaining set bolts for the lower cover and as each set bolt was removed it was placed in its respective hole in the cardboard template.
4. Lower cover was very carefully removed together with the oil pipe.
5. Removed the intermediate plate with its cover plate and the intermediate plate gasket ensuring the Range Gear Selector Valve slide end attachment came free from the detent lever pin.

Fortunately no parts fell out or sprung loose, however, the gasket tore as one section stuck to the transmission casing and the other section stuck to the intermediate plate.

**Note:** The locating pin for the leaf spring and bracket for the detent quadrant sits into the transmission case and there is nothing holding it in position except from suction caused by the ATF. There is potential for this to fall out and be lost.

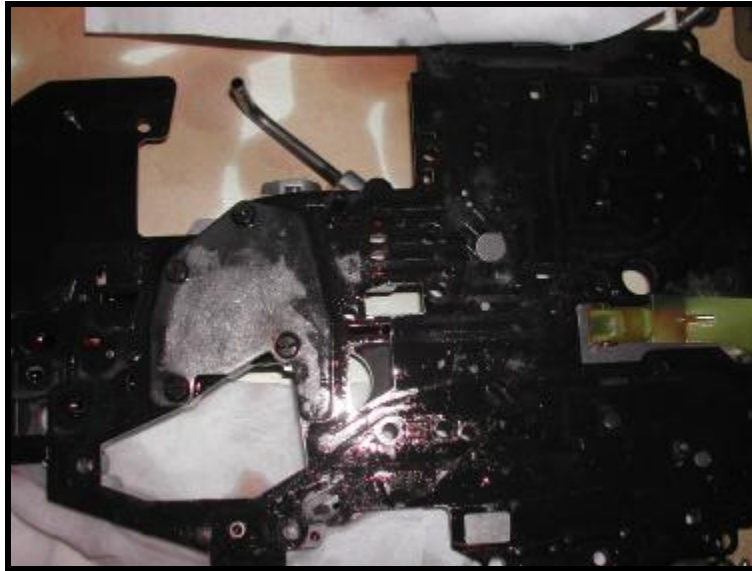
The lower cover and intermediate plate assembly (removed as one piece) was placed on the workbench and covered with white paper.

### 6.4.2 Removal of Lower Cover-Cover Plate and gasket

1. The lower cover - cover plate was removed by undoing the Phillip-head screws.
2. The gasket was separated from the intermediate plate and lower cover.
3. The oil injector was not removed from its location in the cover plate.

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*Intermediate Plate with Lower Cover-Cover Plate (left of centre with Phillips-head screws) and Lubricating Oil Tube (centre top)  
Difficult to discern the various items as the gasket was very stained with ATF.  
RHS just off centre shows the plastic oil injector*

With all these parts removed a better view of the internals of the transmission was obtained, however, to visually inspect the B2 Brake Band and the outer surface of the B2 Clutch cylinder the plastic brake band guide had to be removed.



*Transmission with Valve Body, (Lower Cover & Intermediate Plate removed) showing Brake Guide and B2 Brake Band  
The leaf spring set bolt hole and locating pin hole can be seen adjacent to the lower transmission case edge, to the upper left of the flash reflection*

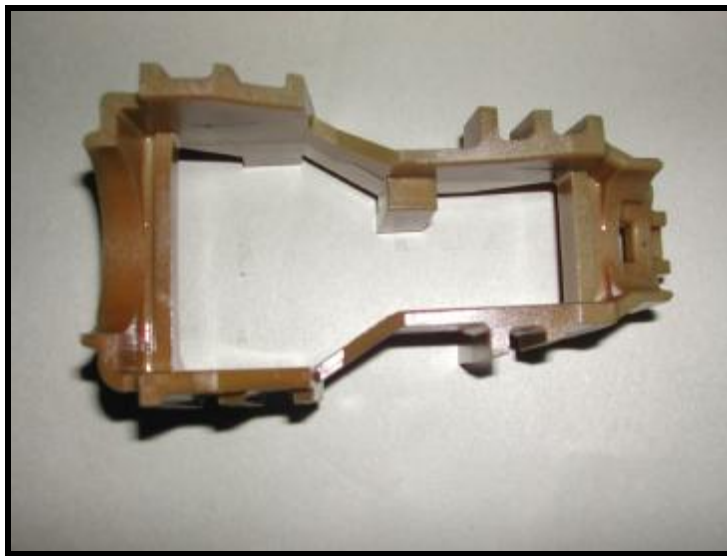
# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

## 6.4.3 Brake Guide Removal

To remove the B2 Brake Guide it required the removal of the detent quadrant shaft, so as to allow the detent quadrant to be lowered to obtain clearance.

1. Removed the Range/Gear Selection Lever from the side of the transmission.
2. Removed the starter lock out switch.
3. Removed the detent assembly Allen-headed lock set screw.
4. Slide detent shaft outboard out of transmission case with care so as not to damage the seal.
5. Lowered detent quadrant to allow clearance for removal of brake band guide piece.
6. Slid out B2 Brake Band Guide across the top of the detent quadrant.



*B2 Brake Band Guide  
Plan view*



## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---



*B2 Brake Band Guide  
Side elevation view*

### **7 Inspection of Brake Band and Clutch Housing**

Inspected brake band and outside diameter of clutch housing and there was no noticeable wear to the brake band or cylinder. As a matter of fact the original machining marks on the clutch housing OD were still visible. All appeared in excellent condition and there was no discolourisation or burn marks on the clutch cylinder, no wear particles at the edge of the brake band or any sign of this type of debris in the oil pan.

### **8 Parts requiring replacement and other parts selected for replacement**

The following parts were replaced:

1. B2 Piston Assembly Cover o-ring seal.
2. B2 Brake Band Piston Assembly.
3. B2 Brake Band Piston Assembly face seal.
4. Intermediate plate gasket.
5. Filter.
6. Oil Pan Gasket.
7. Oil Pan Drain Plug copper gasket.
8. Torque Converter copper gasket.

### **9 Purchase of Parts**

The following parts were purchased from the Local Porsche Centre:

1. Automatic Transmission Service Kit.

The following parts were purchased from the local Mercedes Benz Dealership

2. B2 Brake Band Piston Assembly.
3. B2 Piston Assembly lip seal.

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

### 4. Intermediate Plate gasket.

The purchase of the parts was an interesting undertaking. The Porsche Centre cost quotation for a B2 Piston was nearly 50% more expensive than the MB dealer and Porsche required one week delivery ex Germany, whereas the MB dealership offered next day delivery.

Needless to say the MB dealership was chosen to supply the B2 Piston Assembly, its lip seal, B2 external Cover "O" ring and the intermediate plate gasket, however, they did not sell an AT Service Kit. Their quoted for the cost of an oil filter and gasket as separate items and was close to double the price of the full Service Kit from Porsche, so the AT Service Kit was purchased from the PC.

All the parts were picked up during one morning and reassembly commenced the same day.

When the items were picked up from the local MB dealership, whilst checking to see whether the new B2 Piston was the same dimensions as the failed item the forman mechanic came to the counter and inquired what had happened. The failure details were related as he viewed the failed B2 Piston parts. He was surprised to see this type of failure and offered a free old B2 Piston Assembly, as he advised he had a drawer full in his office, thereby saving the cost of a new unit. His offer was accepted for the old B2 Piston, however, the new B2 Piston Assemble was also purchased to insure that the latest modified version, as described above was fitted (good insurance).

A fully serviceable B2 Brake Band Piston Assembly has been made up using the removed B2 Piston and the old B2 Poston from MB. This spare has all the modifications except for the plastic cylinder liner. This will be kept as an emergency spare.

### **10 Replacing B2 Brake Band Piston & Checking Clearance of B2 Brake Band**

1. Replaced the B2 piston bush in the transmission case - a hand push fit - and installed the lip seal with the lip facing outwards. Installation was by applying ATF to the outside diameter of the seal and driving it home using a suitable diameter socket and hammer. A proper mandrel, as shown in the Porsche Special Tools in the AT section of the WSM, could have been machined on the lathe, but the socket was considered sufficient for this one-off installation.
2. B2 Piston assembly outer "T" seal ring coated in ATF, as well as the surface of the outside diameter of the thrust pin cylinder liner. Installed the thrust pin into the thimble piece and inserted the B2 Piston into the transmission case ensuring the thrust pin engaged the Brake Band correctly.
3. Renewed the Piston Cover O-ring and coated its outside diameter with ATF.
4. Replaced the Piston Cover.
5. Replaced the external circlip.

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

6. Applied pressure on the Brake Band support lug by a screwdriver and pushed the B2 Piston Assembly hard up against the external Cover.
7. Measured the clearance of the Brake Band by applying pressure on the support lug towards the B2 Piston and measured the distance between the inner surface of the lug and outside of the semi circular section of the other side of the brake band. Unfortunately the vernier caliper jaws were not large enough to fit into the transmission to measure this distance, so a set of inside calipers were used to determine the distance and then measured with the vernier calipers.
8. Applied pressure the other way on the support lug, toward the opposite side of the transmission and again measured the distance. On subtracting one from the other a clearance of 6 mm was ascertained using the existing thrust pin, the length of which was 48mm long. Please refer to sketch on page 54 of the Auto Trans Diagnosis – 722 Series article, as it shows how to take this measurement. The MB forman advised that MB usually set up the clearance to 5.5mm, but Porsche recommend 6 to 7mm. Porsche likes to have a second or so pause between the take up from drive to reverse and visa versa whereas MB like a shorter pause.
9. This clearance reaffirmed that the wear of the brake band and clutch cylinder outside diameter were negligible as the clearance is the minimum recommended by Porsche. The brake cylinder outside diameter also confirmed this as it still showed the original machining marks and there was still plenty of thickness to the brake band. Unfortunately no measurement of the thickness of the brake band was taken.

### **11 Cleaning and Reassembly**

Prior to reassembly all parts were cleaned. Porsche recommends that the parts be air blown. This was satisfactory for parts like the B2 Piston Assembly, however when air was applied to the valve body upper surface and oil galleries a small item was displaced. The recovered item was a small strainer. There are 2 installed in the top of the valve body. All air blowing was stopped as it was considered too dangerous as there are numerous other small parts that could be easily lost.

Cleaning was confined by a full inspection of the galleries, valves, strainers and they were considered sufficiently clean for reinstallation.

Wiped clean the intermediate plate, lower plate cover, all bolts, locating pin and all internal parts, that had been removed.

#### **11.1 Reassembly**

1. Installed gasket onto intermediate plate.
2. Centered gasket and installed lower cover plate and tensioned up Phillips-head screws.
3. Installed oil deflector into aperture in transmission housing.
4. Installed intermediate plate with lower cover whilst inserting oil tube into location in transmission housing.

## 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

5. Inserted lower cover set bolt in correct locations and nipped up lightly into transmission housing.
6. Install valve body into position and insert bolts in identical positions as removed. **Note:** Whilst the valve body was being lifted into position a finger extended over the gallery section on top of the valve body and dislodged a very small rectangular shaped spring loaded non return valve. Fortunately its location was identified and it could only fit one way into the top of the valve body. On checking the underside of the intermediate plate its location was confirmed by the polished rectangular area on the intermediate plate.
7. Re-engaged spring into its hole in the transmission case and attached the other end to the actuating lever for the Controlled Pressure Control Valve Piston ensuring spring was located in its correct orientation, as removed.
8. Replaced detent quadrant and slid actuating shaft into position, whilst ensuring the pin on the detent lever engaged the Range Gear Selector Valve slide correctly.
9. Inserted Allen headed locking set screw into detent quadrant hub and tightened to specified torque (8Nm).
10. Replaced Starter Motor Lockout Switch and hand tightened the 2 lock bolts.
11. Replaced Range Gear Selector Lever and tightened locking bolt and nut to correct torque (8Nm). (**Note:** Specified torque applied to lock bolt nut caused the lever to close in the lower section of lever. I believe torque setting is too high).
12. Reconnected actuating cable to Range Gear Selector Lever.
13. Adjusted Lock out switch as per WSM using a 4mm diameter drill shank through holes in lever, switch lever and transmission casing.
14. Tensioned up Lockout Switch lock bolts to specifications (8Nm).
15. Installed the detent leaf spring and bracket ensuring engagement of locating pin in casing and nipped up set screw after also ensuring leaf spring roller correctly engages detent quadrant detents. Final torque for set bolts 8Nm.
16. Re tensioned set bolts by lightly tightening the RHS forward bolt and the LHS after bolt to centrally locate the valve body.
17. Torque up valve body bolts in increments of 0.5Nm using a diagonal format until specified torque of 8Nm was obtained. Care should be taken that no bolts strip the threads out of the transmission housing. **Note:** If bolts do not appear to be reaching the incremental increasing torque applied, **STOP** as the bolts may be stripping out the aluminum thread. (Lesson learnt the hard way from engineering experience with aluminum castings).
18. Tightened lower plate bolts again in 0.5 incremental torque setting as well as the leaf spring to 8Nm to ensure no stripping of threads.
19. Installed filter and torque up the 3 Phillips-headed set screws to 4Nm.
20. Installed new pan gasket after lightly smearing with ATF to 8Nm again in 0.5 incremental torque setting on the micrometer torque wrench in a diagonal format until torque setting was reached.
21. Added new ATF fluid as per WSM instructions. **Note:** There are a lot of threads, in the Porsche Forums as well as in the archives of the Rennlist Forum for 928 covering adding ATF to 928s.
22. Car test driven and all appeared to work satisfactory. Take-up into reverse gear is around 1 second and the changes in the forward gears are not as harsh as

# 1990 Porsche 928 S4 Auto B2 Brake Band Piston Failure

---

previously. The modulating pressure valve may have to be adjusted to get a gear change without any shock.

## **12 Hypothesis of Failure**

On examination of the parts the deduction was that the thimble piece had probably fractured first due to the binding of the small piston within the cylinder (this was indicated by the small semicircular ridge that was evident approximately half way down the cylinder).

The failure of the thimble piece allowed the lower section of the thimble to sit on the inner surface of the piston crown. Whether the B2 Piston Assembly continued to operate with this extra couple of mm clearance it is difficult to say, however, it was noted that it was taking longer to go from reverse to drive than normal, say 2 or 3 seconds or more. The small raised circular section on the inside of the piston crown was polished and this suggests that the thimble piece was riding on the inner surface of the piston crown for some time.

While the continued activation of the B2 Brake Band Piston with an operating pressure of 90psi, when changing up and down through the forward gears could have been causing an intermittent shock load to be applied to the inner surface of the piston crown, as the excess clearances was quickly taken up without any shock absorbing action. This continuous shock loading was possibly sufficient to break the piston crown out of the piston causing the total failure of the B2 Piston to operate.

The final failure possibly occasioned when the automatic transmission changed down a gear which necessitated the activation of the B2 Brake Band whilst turning a corner. Prior to the failure a slight slippage was detected and then complete failure of all forward gears. Maybe at this juncture the final failure of the piston crown removed all force from being applied by the thrust pin to apply the B2 Brake Band.

## **13. Legal Notice**

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