THE 928 HVAC SYSTEM
Basic Operation and Troubleshooting

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INTRODUCTION

The HVAC (Heating/Ventilating/Air Conditioning) System in the 928 started with a relatively simple system in the earlier cars, and only added a minimal automatic temperature control, optional at first, standard in the later cars. There are surprisingly few changes thru the years. This paper will concentrate on the automatic system, since virtually everything in the earlier systems is still used in the later systems. Repairs are not covered.

The 928 HVAC system is made up of 4 subsystems: Refrigeration System; Electrical System; Temperature Control System; Vacuum System; and an optional Rear Air System. We will examine each of these separately.

REFRIGERATION SYSTEM

The 928 refrigeration system is an absolutely standard auto air conditioning refrigeration system - nothing exotic at all.

BASIC OPERATION

Cool refrigerant gas (usually R-12 on original systems up through 1992, now often R-134a, rarely something else) from the evaporator in the dash flows freely to the compressor. The compressor compresses the cool, 30 psi gas, making it a hot 150 - 250 psi (varies) gas. (Each cubic inch of the cool gas contains a given amount of heat. Compressing it packs that heat into a much smaller space, increasing the temperature.) The hot compressed gas flows to the condenser, the small radiator in front of the standard radiator.

There, the hot gas is cooled by dumping heat into the air going thru the condenser, and as a result the hot refrigerant gas condenses into a warm liquid. The warm liquid flows to the top of the receiver/dryer, the round can in front of the radiator and condenser.

The warm liquid Freon dribbles down to the bottom of the receiver/dryer can, passing thru a cloth or paper filter and a cloth or paper container of desiccant (moisture absorbent) on the way. (This desiccant is the primary reason for replacing the receiver/dryer. The desiccant can typically hold only a small amount of moisture, and if it is saturated, the desiccant degrades, sending a fine powder thru the system. Moisture is death for a refrigeration system.) The outlet tube is at the bottom of the can, so it normally picks up pure liquid. If the refrigerant level is very low, there won′t be pure liquid in the bottom of the can, and the stream will contain bubbles (more so with R-134a than with R-12). This can be seen in the sight glass, a 1/4" window in the outlet tube fitting (sometimes painted over).

The warm high pressure liquid stream flows to the thermostatic expansion valve, a metal block located under the plastic shield at the base of the windshield. The expansion valve acts as a variable orifice, or variable restriction. From the expansion valve, the refrigerant expands into the evaporator, the small radiator/heat exchanger inside the dash. Since the compressor is pulling refrigerant out of the evaporator, and the expansion valve is limiting the flow into the evaporator, the pressure (30 psi) in the evaporator is much lower than that at the expansion valve inlet (150 -250 psi). This makes the expanding refrigerant boil, and as it flashes into gas, it absorbs large quantities of heat from the air going thru the evaporator. The resulting cool refrigerant gas flows thru the fuel cooler, the Coke-can shaped unit just behind the engine, then back to the compressor, and the cycle starts over again.

POTENTIAL PROBLEMS

The most common problem is a loss of refrigerant. When the refrigerant level gets low, there is not enough to boil away heat in the evaporator, and the output air gets warmer. If the level gets low enough, the compressor will be cut off by a safety switch. It is also possible for the low refrigerant level to lower the evaporator temperature below freezing, causing the evaporator to ice up, cutting off air flow. The most common leaks are from old O-rings. Every joint in the system is sealed by an O-ring. The old black O-rings get hard due to age, oil and heat, and then they leak. Best approach is to change all O-rings to the new green or blue material. The 928 vendors have a list of the O-rings needed, and can supply them. 928 Specialists have complete O-ring kits for each model.

Another problem can arise if there is not enough airflow thru the condenser to carry off the heat and condense the refrigerant.

Another problem can arise if the radiator is overheated, which can then overheat the condenser.

The compressor can fail, usually from lack of lubrication caused by low refrigerant flow. Since the oil flows thru the system with the refrigerant, low refrigerant means low lubrication.

The pulley on the front of the compressor has a large ball bearing, as the pulley turns any time that the engine is running. The bearing rarely fails, and it can be replaced separately, without having to bleed/recharge the system. The bearing is not available from Porsche, but can be matched by a bearing supply house.

TROUBLESHOOTING THE REFRIGERATION SYSTEM

The refrigeration system is relatively trouble-free, except for leaks. If the compressor is running, and is not making terrible noises, the system is probably functional. The quickest test is to remove the plastic shield at the back of the engine compartment, and to feel of the return line coming out of the firewall. If this line is cold, you usually have enough refrigerant, and the refrigeration system is almost certainly OK.

The best test is to hook up a set of refrigerant gauges to the system. The high pressure connection is normally on or near the receiver/dryer, and is hooked to the red hose and the red gauge. The low pressure fitting is hidden under the upper radiator hose on the passenger side between the engine and the radiator. It is hard to get to, and is surrounded by hot, sharp objects. The fittings are required by Federal regulations to be different for each different refrigerant gas, so you must change them if you convert to R-134a. The high side pressure depends heavily upon the ambient temperature, and can run from as low as 125 psi to as high as 350 psi. In most cases, it should be somewhere around 175 - 225 psi. The low side pressure should be near 30 psi. Pressures are checked with good airflow over the condenser, full blower on max cooling, and engine at 1500 rpm.

ELECTRICAL SYSTEM

For the purposes of this paper, the HVAC electrical system is considered to be only that electrical wiring, fuses, relays, and controls that operate the compressor clutch, the cooling fans, and the HVAC blower. The other electrical devices will be covered in the Control System section.

THE A/C COMPRESSOR CLUTCH

The A/C compressor is driven by a V-belt thru an electrically operated clutch. The clutch activation is controlled by the A/C button thru a small (too small!) relay inside the HVAC Controller head.

From the control relay, the power flows to the anti-freeze switch, located next to the expansion valve. The function of the anti-freeze switch is to keep the temperature of the evaporator above freezing, so as to prevent it from icing over. This switch monitors the temperature of the evaporator, and if the temp falls below zero deg C, it will open, interrupting the compressor clutch power.

From the anti-freeze switch, the power flows to the refrigerant pressure switch on the receiver/dryer. There are two switches on the receiver/dryer - the pressure switch is the one that is on the side of the can, visible thru the front grille. The function of this switch is to save the compressor if the refrigerant level gets too low. Since compressor lubrication depends upon the refrigerant carrying the oil into the compressor cylinders, if there is no Refrigerant flow, there is no oil flow. When the refrigerant pressure drops to an unsafe level, this switch opens, interrupting the compressor clutch power.

From the refrigerant pressure switch, the power flow to the compressor clutch, and then to a ground connection.

POTENTIAL PROBLEMS

The slides and switches on the A/C Controller don′t often fail, but can do so. Problems have been reported with hardened grease causing bad contact on the slider switches. The controller can be disassembled and cleaned, which normally cures internal contact problems. The small internal relay, however, is one of the more common failure points. One point is that this relay can furnish 12 vdc, thus passing a simple trouble-shooting test, but still not provide sufficient power to operate the compressor clutch. The little relay can be replaced separately, and dr. bob′s (Bob Fuelleman) instructions for doing so are available on the 928 Owner′s Club web site. If the small relay is still working, you can add a heavier in-line relay to operate the clutch. The same relay can operate the cooling fan, eliminating another common problem.

The antifreeze switch doesn′t fail often, but can do so.

The refrigerant pressure switch doesn′t often fail, but it is all too common to have low refrigerant pressure due to leaks.

The compressor clutch doesn′t fail often, but can do so.

TROUBLESHOOTING THE A/C COMPRESSOR CLUTCH ELECTRICAL SYSTEM

If the A/C compressor clutch does not engage, remove the plastic shield from the rear of the engine compartment, and find the antifreeze switch. With the ignition switch on and the A/C on max cool, test for 12 vdc on both of the switch terminals. If there is no power on either terminal, the most likely problem is the small relay in the control head. If there is power on only one terminal, the switch is either bad or misadjusted. If there is power on both switch terminals, go to the refrigerant pressure switch.

With the ignition switch on, and the A/C on max cool, reach in thru the front grille, pull the wire harness from the refrigerant pressure switch, and check for 12 vdc at the terminals in the wire harness - there should be 12 vdc on one of the terminals. If there is power here, temporarily jumper the wire harness terminals together. The compressor clutch should then operate. If it does, the refrigerant pressure is probably low. Do not operate the system longer than required for troubleshooting and charging with the low pressure switch by-passed! Doing so can very easily destroy the compressor thru lack of lubrication.

If the clutch does not operate, stop the engine, then turn the ignition back on, but DO NOT crank the engine. Test for 12 vdc at the clutch connector. If there is no power here, the wire between the pressure switch and the clutch is probably bad. If there is power here, but the clutch doesn′t work, check the ground connection. If everything appears to be OK, the clutch may be bad, or the relay may not be furnishing enough power to operate the clutch. One test is to use any 12 vdc device that pulls several amps as a tester. This can be a headlamp bulb, blower motor, etc. If the device appears to be receiving insufficient power, the relay is suspect.

THE COOLING FANS (UP THRU ‵86)

The earlier cars (up thru ‵86) used a puller belt-driven fan and a pusher electric cooling fan.

The belt-driven fan includes a temperature-operated silicone-filled clutch to reduce noise and power absorption at higher engine speeds.

The electric fan is relay-operated and triggered by one of either two or three switches.

The fan relay is a simple single-pole single-throw electrically-operated switch. A coil is provided power thru a circuit (86) that is controlled by the ignition switch. The coil is grounded (85) thru one of either two or three temperature operated switches. When one of these switches closes, completing the circuit thru the relay coil, the relay contacts close. One side (30) of the contacts is fed thru a fuse, and the other side (87) feeds the power to the fan motor.

One switch is located in the lower driver′s side forward face of the radiator, and is operated by coolant temperature. The standard switch only operates if the coolant is overheated. A lower-temp switch is available from the vendors.

Another switch is located on the stem running up the side of the receiver/dryer. This switch (early cars, up thru ‵86) is operated by refrigerant temperature, and should trigger the fan when the refrigerant gets hot. This switch does not appear to be very effective, and the fan often does not run even though the A/C is operating.

The last switch, found on ‵85 - up cars, is located in the intake plenum, and is operated by intake air temperature. This switch is primarily intended for engine cool-down after shut-down, to prevent fuel boiling and coking in the intake tract. This is the only switch in the system that will operate the fan with the ignition switch turned off. It is not involved in A/C operation.

The fan motor is a standard 12 vdc motor.

The fuse used to feed the fan, and the relay used to operate the fan, vary with the year model of the car. A list of fuse and relay locations should be found on the door to the central power panel under the passenger′s feet. If it is missing, the charts may be downloaded from our web site at www.928gt.com.

POTENTIAL PROBLEMS (UP THRU '86)

The primary problem with the belt-driven fan is clutch slippage. With age, fan clutch slippage increases, reducing cooling at low speeds. While replacement is an effective cure, the clutch is expensive (approximately $275 in 2004 from 928 Specialists), and refilling the clutch with heavy silicone oil from a Toyota dealer can help. Procedures for doing this are available on the 928 Owners Club web site.

As is often the case with a 928, the most common problem with the electric cooling fan seems to be bad connections on the fuse or a bad relay. The fan motor, coolant temperature switch, refrigerant temperature switch, and wire harness can all fail, but these failures are much less common than fuse and relay problems.

Another problem with the electric cooling fan is that the refrigerant temperature switch seems to be ineffective. It would be better if the electric fan ran any time that the A/C compressor was operating. One way to accomplish this would be to install a heavy-duty in-line relay, triggered by the A/C compressor signal, to operate both the compressor clutch and the cooling fan. A diode should be used at the fan, to prevent triggering the compressor when the temperature switches operate the fan.

TROUBLESHOOTING THE COOLING FANS (UP THRU '86)

There is no good test for the clutch on the belt-driven fan. The only check is to bring the engine to full operating temperature, raise the hood (bonnet), and then to increase the engine speed to 2000 rpm and hold it there for fifteen seconds. If the clutch is good, there will be a noticeable increase in the noise and air movement within five or ten seconds.

The electric cooling fan may not run as often as you expect. On cars up thru '86, the fan does not automatically run when you turn the A/C on. It only runs when the coolant is very hot or when the Refrigerant temperature switch is triggered.
To check the electric cooling fan, turn the ignition switch on, pull the connector from the refrigerant temperature switch (located on the stem sticking up from the receiver/dryer between the radiator and the bumper), and jumper between the contacts in the wire harness. The fan should run.

If the fan does not run, replace the connector, and pull the cooling fan relay (not the blower relay). Jumper between terminal 30 and 87 in the relay socket - the fan should run. If not, check for 12 vdc at the fan motor connector. If there is 12 vdc at the fan connector and the ground is good, but the motor does not run, the fan motor is probably bad.

THE COOLING FANS ('87 AND UP CARS)

The S4, GT and GTS cars do not have a belt-driven fan, nor a pusher electric cooling fan, using instead two variable-speed puller electric cooling fans. The fan motors are operated by individual solid-state electronic output stages, located on the front valence panel between the radiator and the bumper. The output stages are operated by a control box located beside the passenger seat. Both fans should normally run at the same time and at the same speed. If one fan fails, the other fan is automatically operated at full speed.

The fans are triggered by a coolant temperature sensor located in the lower left forward face of the radiator; by a transmission fluid temperature sensor; by Refrigerant pressure (not temperature) in the A/C system; or by an intake air temperature sensor located in the intake plenum. The hood (bonnet) switch prevents the fans from operating while the hood is open in most circumstances.

With the ignition switch on, the fans are triggered on at low speed at approximately 78 deg C coolant temp, and reach full speed at approximately 95 deg C. They are triggered on at low speed at approximately 110 deg C transmission fluid temp. They are triggered on at low speed at approximately 3 bar refrigerant pressure, and reach full speed at approximately 20 bar.

With the ignition switch off, the fans are triggered on at low speed at approximately 85 deg C coolant temperature, and off at approximately 83 deg C. They are triggered on at approximately 87.5 deg C air temperature in the intake plenum, and off at approximately 82.5 deg C.

Most S4 and GTcars also included a cooling air flap control system to improve the aerodynamics and to hasten warmup. The flaps are positioned at 0%, 30% or 100% open by the same sensors, control system and output stages.

When the fans are not running, the cooling air flaps should be closed. When the fans are running at low speed, the cooling air flaps should be 30% open. When the fans are running at high speed, the cooling air flaps should be fully open.

POTENTIAL PROBLEMS ('87 AND UP CARS)

While any part of the system can and will occasionally fail, the system is relatively trouble-free. The most common problem is the usual bad fuse or bad contact at the fuse. Remember that each fan has its own fuse.

TROUBLESHOOTING THE COOLING FANS ('87 AND UP CARS)

Turn the ignition switch on, but don't crank the engine. Turn the A/C on, with the blower on speed 2. Both cooling fans should run at low speed.

If there is a problem, the first thing to do is to check the fuses. There is a fuse for the fan control unit, one for the flap control, and one for each cooling fan. The only relay directly involved in cooling is the one for the cooling air flaps. There should be a chart on the door of the central power panel showing the fuse and relay positions. If it is missing, download the charts from our web site at www.928gt.com.

If one fan is running at full speed and the other is not running at all, try switching the plugs on the fan motor. If the running fan continues to run, and the non-running fan still doesn't run, the non-running fan is probably bad. If the non-running fan now runs, and the other one doesn't, the fan output stage on the non-running fan is probably bad - you did check the fuses very carefully, didn't you?

If neither fan runs, and you have checked and double-checked all of the fuses, time for some serious checking.

Unplug the fan motor connections. Using jumper wires, apply power from the jump start terminal and ground from a chassis or engine connection directly to one of the fan motor connectors. Repeat on the other fan motor connector. If the fans run, replace the connectors. A non-running fan motor is probably bad.

Remove the cover from the control unit on the floor between the passenger seat and the door, and remove the cover from the outboard plug, leaving the plug attached to the control unit. Warm the engine to full operating temperature. With the ignition switch on, A/C on, and the air distribution slide in floor/dash position, use a high-impedance voltmeter to measure the voltage between pins 7 (ground) and 6 (plus). (The top row of pins are 1, 3, 5, 7 starting at the inboard end, with pins 2, 4, 6, 8 on the bottom, starting at the inboard end.) There should be approximately 7 volts between pins 6 and 7. Then check between pins 7 (ground) and 8 (plus) - there should be approximately 7 volts between pins 8 and 7. If these voltages are correct, and the fuses are all good, and neither fan will run, the output stages or the wire harness are probably bad. If the voltages are not present, the control unit or the wire harness is probably bad.

THE HVAC BLOWER

The HVAC blower is located at the top of the firewall above and forward of the passenger's feet. It is powered thru either of two fuses and relays, the blower switch, and a resistance group. There should be a chart on the door of the central power panel showing the fuse and relay positions. If it is missing, download the charts from our web site at www.928gt.com.

The blower relay is a simple single-pole single-throw electrically-operated switch. A coil is provided power thru a circuit (86) that is controlled by the ignition switch. The coil is grounded (85) thru switches in the HVAC control head. When one of these switches closes, completing the circuit thru the relay coil, the relay contacts close. One side (30) of the contacts is fed thru a fuse, and the other side (87) feeds the power to the blower motor, and back to the HVAC control head and A/C switch. If the blower relay fails, the A/C will not function.

Power for the blower flows from the blower relay to the blower switch and also directly to a thermal switch contact on the resistance group. The blower switch sends power on one of four wires to the resistance group.

The resistance group, located near the center of the blower plenum under the hood (bonnet) just forward of the windshield, consists of a block with three coils of Nichrome resistance wire. An output wire runs from the resistance group to the blower motor.

With the blower switch on 1, power to the blower motor flows serially thru all three resistance groups (max resistance), so the blower receives a low voltage for low speed. As the blower switch is turned to each successively higher number, an additional resistance coil is bypassed, lowering total resistance, increasing the output voltage, and increasing blower speed. At the highest speed, all resistance is bypassed for maximum blower speed.

The resistance group includes a thermally-operated bypass switch to protect the resistance group and the intake plenum from overheating. If the thermal switch operates on cars up to 1990, it bypasses all resistance, running the blower at the highest speed. This increases airflow over the resistance group, lowering its temperature, so that the thermally-operated bypass switch opens, restoring normal operation. This is the so-called "magic blower syndrome". If this thermal switch operates on 1990 and later cars, it simply cuts the blower off entirely.

The blower is also powered thru the defrost relay. When the air distribution lever is placed in the DEFROST position, the defrost relay is energized, sending 12 vdc directly to the blower motor, bypassing the blower switch and the resistance group.

POTENTIAL PROBLEMS

As usual, the most common problems are bad relays, bad fuses and bad connections. The resistance group can also cause problems, either because of a broken resistance wire or connection, or because of an overly-sensitive thermal protection switch.

The blower motor can fail in high-mileage cars, since it runs most of the time. Worn or sticky brushes are most common, but bearings can wear or gall.

TROUBLESHOOTING THE BLOWER MOTOR SYSTEM

If the blower will not operate on any speed, move the air distribution lever to the DEFROST position. If the blower operates, the blower motor is good, and the problem is probably the blower relay or the blower fuse. Check the blower fuse and its connections carefully. If this is not the problem, pull the blower relay. Install a jumper between terminals 30 and 87 in the relay socket. If the blower now operates, the relay is probably bad, or there is a problem inside the HVAC control head (less likely).

If the blower will not run on the DEFROST position or the normal positions, the blower motor or the wire harness is probably bad. Apply 12 vdc and ground directly to the motor connections. If the blower motor doesn't run, you may try opening it up and cleaning or replacing the brushes. It is possible, but difficult, to remove the blower without pulling the hood.

If the blower motor will run only on the highest speed setting, either the resistance group (most likely) or the blower switch is bad. With the ignition switch on, and the blower switch on 1, pull the connector from the resistance group, and check for 12 vdc on each of the terminals in the harness - one terminal should have power. Turn the blower switch to 2, and repeat the check of the terminals - a different wire should have power. Repeat on each blower switch setting - a different terminal should have power at each setting. If so, the resistance group is probably bad. You can remove the group by peeling back the rubber sleeve and reaching in - it won't be easy, but it is possible. You might be able to repair a broken wire - soldering won't work on Nichrome, by the way.

THE TEMPERATURE CONTROL SYSTEM

The automatic air conditioning system was originally an option, but later became standard equipment, and is found on most USA cars. The "automatic" refers only to temperature control, as the system does not control air distribution or fan speed. The sensor portion of the automatic system consists of a sensor circuit, with an outside air temperature sensor located in the alternator cooling hose in the left front fender, an inside air temperature sensor located in the dash, and a temperature control lever located in the HVAC control head. This sensor string uses variable resistors and thermistors to sense the temperatures and the desired setting, and to furnish input to the control or setting unit. The setting unit, located inside the center console just by the drivers right leg, electrically moves internal flaps to blend hot and cold air in order to control the output air temperature. The setting motor also will open or close the air recirculation door..

POTENTIAL PROBLEMS

The outside air temperature sensor is exposed to a harsh environment. The sensor is a thermistor, mounted in a short section of aluminum tubing in the alternator cooling hose, located in the left front fender under the headlamp. The hose occasionally gets ripped off by ground contact or debris. The electrical connector is subject to corrosion.

The inside air temperature sensor includes a small blower to move cabin air over a thermistor from the small round grille mounted in the face of the dash. The small blower sometimes fails, and smoke and fuzz can build up on the sensor.

The temperature control lever in the HVAC control head operates a variable resistor, which rarely gives problems.

TROUBLESHOOTING THE SENSOR CIRCUIT

The usual effect of a bad sensor string is "all or nothing" temperature control. If this occurs, the first thing to check is the connection for the outside air temp sensor under the left headlamp. If that doesn't help, go to the next paragraph.

Remove the left side panel from the central console by moving the driver's seat all the way back and down, and removing the two Phillips screws.

Locate the setting unit, and remove the inner electrical plug.
Turn ignition switch on, and move the temperature control lever to the lowest temperature setting. Use an ohmmeter to check the resistance between terminals 4 and 12 - the resistance should be approximately 3.7 Kohms.
Move the temperature lever to the highest temperature setting - the resistance should smoothly change to approximately 4.7 Kohms.

If the resistance is infinite (no connection), the sensor string is broken - the most likely place is the connector for the outside air temperature sensor. If the resistance is much lower than specified, there is a short circuit in one of the sensors or in the control head.

THE SETTING MOTOR AND FLAPS

The sensor string is connected to the setting motor, located inside the center console next to the driver′s right leg. The setting motor electrically moves linkage on the HVAC body that sets flaps to control air flow thru or around the heater core, thus controlling the output air temperature.

POTENTIAL PROBLEMS

The setting motor and flaps rarely fail. A few owners have reported that the flaps needed adjusting.

TROUBLESHOOTING THE SETTING MOTOR AND FLAPS

Remove the left side panel from the central console by moving the driver′s seat all the way back and down, and removing the two Phillips screws.

With the ignition switch on, move the temperature lever all the way to the highest setting. Find the setting motor and observe the linkage coming out of the top of the control unit. Move the temperature control lever to the lowest temperature setting - the linkage should retract.

To adjust the flaps:
With the ignition switch on, move the temperature lever all the way to the lowest temperature setting.
Disconnect the setting motor link from the operating lever.
Move the operating lever to the lowest possible position.
On the right side of the HVAC box, loosen the securing screw in the center of the connecting link.
Move the upper lever all the way down and forward, move the lower lever all the way down and forward, and tighten the securing screw.
Adjust the setting motor link until it will just fit into the operating lever, and engage pin.

THE HVAC VACUUM SYSTEM

THE VACUUM SOURCE

The vacuum source for the HVAC system, as well as the cruise control on earlier cars, is a very small line coming off of the vacuum brake booster check valve. A 1" diameter black/blue check valve a couple of inches down the small line is intended to maintain a high vacuum level in the system. Next on the line is a rubber four-way connector. One leg is the inlet, one is blocked, one goes to the left front fender for the vacuum reservoir and the cruise control (tempostat), and the last leg goes thru the firewall to feed the HVAC system thru a black line.

POTENTIAL PROBLEMS

The small vacuum check valve rarely fails completely, but it is all too common for it to fail partially, limiting vacuum flow. This would be no problem if the entire HVAC vacuum system was leak-free - but it almost never is. The check valve has also been know to cause a very irritating and hard-to-locate buzzing sound if there is a leak in the system.

The four-way rubber connector can develop cracks and leaks at the point where the legs join.

The plastic vacuum reservoir can develop leaks.

TROUBLESHOOTING THE VACUUM SOURCE

One of the tools that is almost required for HVAC maintenance on a 928 is a vacuum tester. The most common - and one of the best - testers is called a Mity-Vac. It is a gauge-equipped hand vacuum pump, and the kit includes several adapters and sometimes a brake-bleeding kit. The tester is available in both metal and plastic, with the cheaper plastic version acceptable for most 928 owners.

Using the Mity-Vac, remove the small blue/black vacuum check valve, and test in both directions. There should be very free flow toward the brake booster, none in the other. If you don′t have the tester, you can use mouth vacuum, but be careful to avoid inhaling any fuel or fumes.

Using the Mity-Vac, test the line going into the left front fender - it should hold vacuum indefinitely (it will take MANY pumps to pull a vacuum, as you are having to empty the reservoir). If not, find and fix the leak.

There should be a strong vacuum at the line going into the firewall to feed the HVAC system. Be sure to check the rubber connector carefully for cracks.

THE VACUUM CONTROL SYSTEM AND ACTUATORS

The black vacuum feed line runs to a vacuum manifold, located inside the center console, just forward of the radio. There are six electrically-operated vacuum solenoids on the earlier cars, five on the later cars. Each of these solenoids feeds a vacuum actuator.

In the earlier cars, these are (left to right):
Footwell Flap - Yellow Line
Defroster Flap - Green Line
Center Outlet Stage I - Orange Line
Center Outlet Stage II - Brown Line
Mixing Flap and Heater Valve - Red Line
Fresh Air /Inside Air Flap - Blue Line

On the later cars, these are (left to right):

Footwell Flap - Yellow Line
Defroster Flap - Green Line
Center Outlet - Orange Line
Heater Valve - White Line
Fresh Air /Inside Air Flap - Blue Line

The function of each of these is obvious from its name, except perhaps for the two-stage actuator on the Center Outlet on the earlier cars. This was simply an attempt to fine-tune the air flow so that you could have more air to your feet and less air from the center outlet.

One point on the heater valve - the flow of hot water to the heater core is cut off by vacuum, not turned on by vacuum. This means that the failed condition is heat on.

POTENTIAL PROBLEMS

Oh, yes. In many owner's opinions, the vacuum-actuated HVAC system is one of the few real design flaws of the 928.

The most common problem is leaking diaphragms in the vacuum actuators. In fact, very few 928s do not have this problem to some extent.

The electrical portion of the vacuum control system rarely gives problems.

TROUBLESHOOTING THE VACUUM CONTROL SYSTEM AND ACTUATORS

Again, the Mity-Vac tester is a virtual necessity.

Testing the vacuum system is simple in concept, slightly difficult in execution. You just apply vacuum to each actuator with the Mity-Vac, and see if it holds vacuum or leaks.

It is possible, but somewhat difficult, to move the vacuum manifold and solenoid valves out enough on the driver's side to access the vacuum lines for testing. The unit is retained by a screw on each end. If you do this, be careful to ensure that none of the vacuum lines or electrical wires are displaced during re-installation.

It is easier to cut the colored plastic vacuum lines for testing, splicing the cut ends with short sections of rubber hose afterwards. The most common failure seems to be the center vent actuator. Use a sharp razor knife to cut the orange line, and vacuum test the line running up into the dash. It should hold vacuum. If so, splice the line and continue to test the blue, yellow and green lines. Do not cut the black (supply) or the white (heater valve on the later cars) lines. If the actuator leaks, plug the lower end of the line - the end that runs forward to the vacuum solenoid - until you replace the actuator. It is not necessary to plug the upper end of the line - the one that you tested.

The heater valve is cheap and easy to replace. It is located just behind the engine, under the air filter box. The black end goes toward the engine, and it does make a difference. If it is installed correctly, water flow pushes the valve more tightly closed, if installed backwards, water flow pushes the valve open.

REAR AIR CONDITIONING UNIT

BASIC OPERATION

The rear air conditioning unit shares the compressor and condenser with the normal front unit, but has its own expansion valve, evaporator, blower, and control system. A solenoid valve, located on the right rear floor, controls refrigerant flow to the rear unit.

The expansion valve is located on the front of the evaporator, located in the rear center console. It is a normal thermostatic expansion valve, holding an evaporator pressure of approximately 30 psi.

The blower, located in the rear of the console, recirculates inside air only. There are no provisions for outside air flow.

There are two controls for the rear air conditioning unit, a blower switch and a temperature control. The blower switch functions as the off/on switch for the rear unit and as the blower speed switch. The temperature regulator knob operates the control unit, located on the right rear of the evaporator unit.

POTENTIAL PROBLEMS

The rear air conditioning system rarely presents problems, other than leakage from old and hardened O-rings. Again, replacement O-rings are available from the vendors. There have been some reports of leakage from the tubing joints on the rear evaporator. This can often be repaired using wicking Loctite and/or JB Weld applied with vacuum in the evaporator.

TROUBLESHOOTING THE REAR AIR CONDITIONING UNIT

If the unit fails to operate, check the fuse.
With both front and rear air conditioning units set for maximum cooling, if the air from the rear unit is colder, the front unit probably has bad vacuum actuators, with the vacuum leakage causing the heater valve to remain open. The heater valve is another common failure. If the air from the rear unit is not cold, the first suspicion should be low refrigerant level.

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