928 Owners Club

THE 928 TIMING BELT AND TENSIONER SYSTEM

Wally Plumley — 928 Specialists

The toothed camshaft drive belt, more commonly referred to as the timing belt, and its tensioner, make up one of the most critical of the 928's subsystems. This toothed rubber and fabric belt is responsible for driving the camshafts (two cams, operating sixteen valves, up through model year ("MY") 1984 for US-spec cars and MY 1986 for Euro-spec cars; four cams, operating thirty-two valves, for US-spec cars for MY 1985 and later and all 928s worldwide from MY 1987), the water pump and the oil pump, and is one of the longest timing belts ever used on a production automobile.

While a timing belt failure is serious on any 928, it can be a disaster on a later model. At some point, the 928 engine changed from a "free-wheeling" to a "interference" or "valve-crash" design, but there is not universal agreement on exactly when this change occurred. This means that on all except the earliest two-valve cars, timing belt failure or slippage can cause the pistons to hit the valves, resulting in major damage to the engine. A toothed belt tension warning system, which can give early warning of a belt problem, was added in MY 1985.

The factory-recommended replacement interval for the timing belt is 60,000 miles, but more conservative or pessimistic owners often observe shorter intervals, such as 40,000 miles. There is general agreement that age should also be a factor, with replacement suggested at no more than every four years, no matter how much or little you've driven in that time. If you don't know when your belt was last replaced, you should seriously consider replacing it, especially on a 32-valve engine. You should also occasionally pull off an air tube and visually inspect the belt at idle (MY 1986 and up only).

Replacing the timing belt is within the capabilities of a competent "DIY" (do it yourself) owner, but access to the shop manuals and some special tools are required. Typical shop cost for timing belt and water pump replacement runs from $500 (all amounts in US dollars) to $1000, while the DIY cost should run from $250 to $300. This article merely gives some helpful information not found in the manuals, and does not by itself furnish sufficient information to perform the replacement operation. We recommend that you do not try to replace the timing belt without the manuals and special tool.

There are many things that you should check while you are in there ("WYAIT"). This is a good time to inspect and, as needed, replace the accessory drive belts. On the four-cam engines, take a very careful look at the distributor caps and rotors. Especially if you are paying a shop to replace the timing belt, give very serious consideration to replacing the water pump at the same time. The extra labor charge should be minor, since removing the belt fully exposes the water pump, while replacing the water pump alone requires removal and reinstallation of the timing belt. The pump should be about $125 or so from an independent vendor, although a shop will usually charge more. This small investment could help you avoid a flatbed charge and an expensive repair bill later.

Check the crank pulley seal, the camshaft seals, and the oil pump seal for leakage. Thirty-two-valve engines have cam sealing plugs **(FIGURE 5)** on the front ends of the second cams; these often leak, and now is the best time to replace these. Similar sealing plugs are also on the rear ends of all cams, and are often responsible for oil leaks down the back of the engine. The old-style O-ring seals are discontinued. You can either try to find a suitable O-ring replacement, or replace the plugs and their retainers with the new design. See shop manual page 15-120 for an illustration of the old style, and 15-128a for the new style.

FIGURE 5:

The front cam seal and cam drive with timing marks.

Since you will be working around 12 volt dc connections and removing the alternator, it is a good idea to disconnect the battery ground strap. Keep track of the timing cover bolts, as they are not all the same.

The tensioner **(FIGURE 1)** deserves special mention. This little device serves to tension the belt, adjusting automatically for temperature, and hydraulically dampens belt vibrations and fluctuations. On the 32-valve engines, it also triggers the belt tension warning light **(FIGURE 2 AND FIGURE 12)**. The tensioner should be rebuilt every time that you replace the timing belt. This is a simple, inexpensive job that could pay big dividends. Pages 15-20 through 15-25 in the shop manual show this operation. One of the tensioner bolts goes into the water jacket, and coolant will drain out when it is removed, so thread locking compound is used on this bolt during reinstallation. Observe carefully and make notes or photos as you disassemble the tensioner arm **(FIGURE 2)**, especially the sequence of spring, switch piece and bushings on the 32-valve units—this isn't shown in the manual!

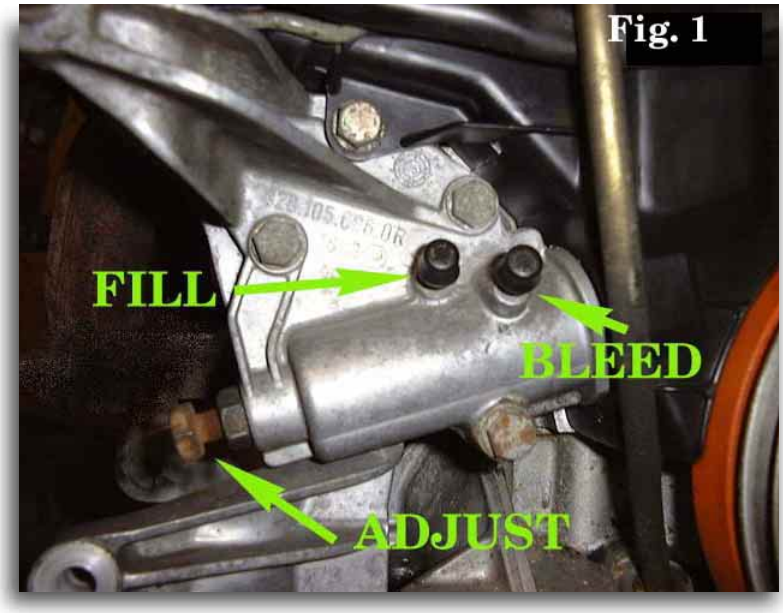

FIGURE 1:

The timing belt tensioner in place.

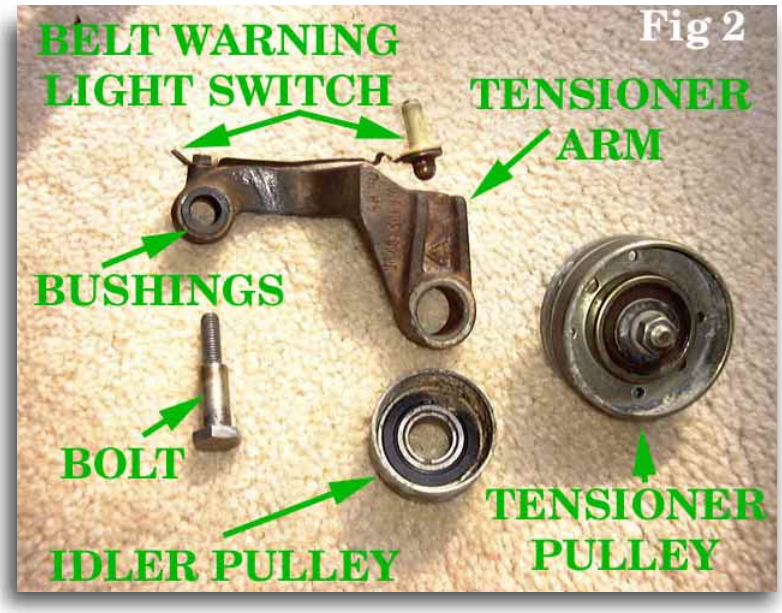

FIGURE 2:

The timing belt tensioner disassembled (arm and pulley).

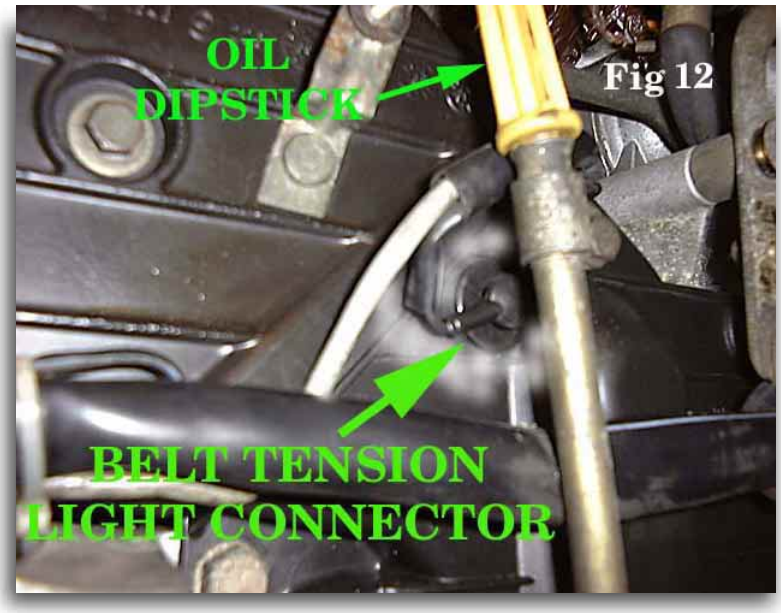

FIGURE 12:

Electrical connection for the "BELT TEN" warning light.

You will need an O-ring (32-valve only), a rubber boot, a boot clamp, and a gasket. Some of the 928 vendors offer a rebuild kit for the tensioner that contains all needed parts. The rubber boot **(FIGURE 3)** is one of the most critical parts. It gets brittle with age and heat, and if it cracks, the oil leaks out and the dampening action is lost. On earlier cars, pour the housing almost full of 90-weight gear oil before installing the boot. End nipper pliers (electrical cutters with the blades running across the end) work well to tighten the boot clamp. Be careful to keep the gasket **(FIGURE 4)** from bending or slipping—installation can be a little tricky. Gluing the gasket to the tensioner housing helps.

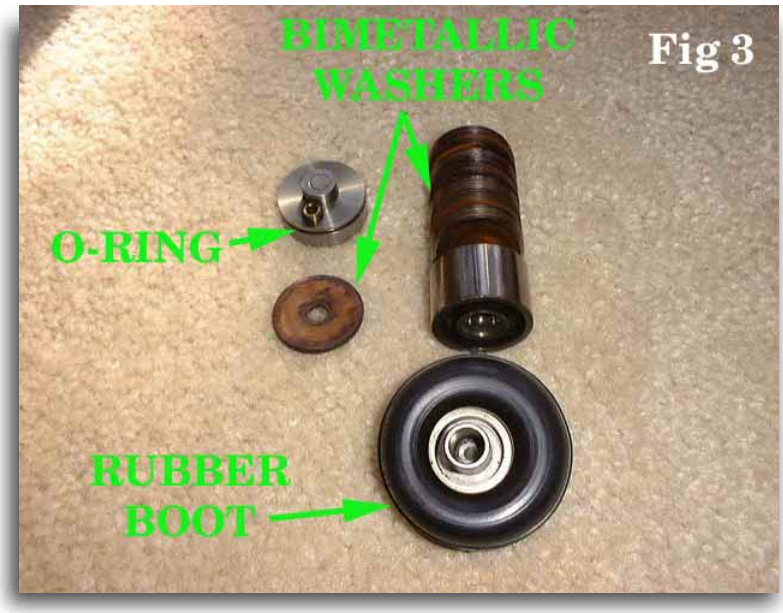

FIGURE 3:

The timing belt tensioner disassembled (bimetallic disc stack).

After installation, a trigger-type oilcan and a piece of plastic hose helps greatly in refilling the tensioner with 90-weight gear oil, using the fill and bleed screws **(FIGURE 1)**. Be patient and hold pressure on the oil until the housing is full; the oil is thick and the housing passages are complex. Earlier cars have plugs rather than fill/bleed fittings, but their less-complex passages are easier to fill. Note that all illustrations of the tensioner in this article are of the later type.

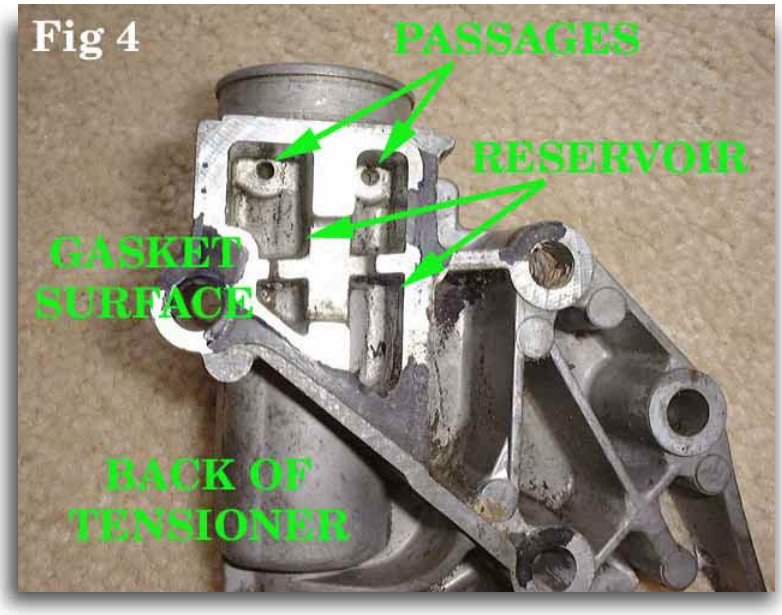

FIGURE 4:

The timing belt tensioner disassembled (oil passages and galleries).

The following procedure should be followed on any engine that has a 45-degree mark on the crank pulley, and for certain on any 32-valve engine! After removing the top timing belt covers, but before removing the crank pulley, turn the engine (ALWAYS in the normal clockwise direction!) until the top dead center mark on the crank pulley is aligned with the pointer, and the notches on the back of the cam shaft wheels are aligned with the dimples in the backing plates **(FIGURE 5)**. Note that Figure 5 is at the 45-degree position, not the top dead center position! Then turn the crank 1 7/8 turns, aligning the 45-degree mark with the pointer ***(FIGURE 6)***. Carefully add a new 45 degree mark **(FIGURE 5)** to each of the camshaft pulleys, so that you can install the belt with the engine in the 45 degree position later.

The first special tools needed are a 3/4" drive socket and pull handle, and the flywheel stop (p/n 9161 to MY 1982, p/n 9161/1 for MY 1983 and up). The flywheel stop can be rented from some of the 928 vendors, but it is such an inexpensive tool that you probably want to buy it. While you might get the crank pulley bolt off without these tools, it is torqued to 218 lb-ft, and it will take considerably more torque to break it loose. We have snapped 1/2" Craftsman pull handles, extensions, and adapters trying, but a 3/4" drive socket and handle worked fine. The bolt is 27 mm, but a 1 1/6" socket also fits. No puller should be needed to remove the pulley—just pry gently and wriggle.

FIGURE 6:

The position indicator on the crank damper.

Follow the manual and remove the covers and the belt. Check for leaks, then clean the area. Remove, rebuild, and reinstall the tensioner housing as detailed earlier.

Inspect all pulleys and sprockets for wear or damage. Check the bearings in the timing belt tensioner and idler pulleys **(FIGURE 2)** very carefully. There should be no looseness, grittiness, or roughness. Check the plastic bushings in the tensioner arm **(FIGURE 2)** very carefully, and replace them if there are any signs of wear. Check the bolt for wear **(FIGURE 2)**. Clean, lube, and prepare the tension arm assembly for reinstallation.

With the marks that you added **(FIGURE 5)**, you can install the new timing belt at the 45 degree position. Since this is the only position that is certain to allow camshaft movement with no danger of valve crashing, and since the cams want to move suddenly and unexpectedly (due to valve spring pressure), this is the safest position at which to install the belt. Remember that all belt slack should be at the tensioner. Stuff a rag under the crank pulley to hold the belt on the pulley and make installation much less frustrating. Pull the belt tightly over the oil pump, then the driver's side (for left-hand drive cars) cam sprocket, and apply a spring clamp or clothespin to hold it in place.

Go around the water pump, and pull the belt tightly over the passenger's side (for left-hand drive cars) cam sprocket, applying another spring clamp to hold it in place. Check the cam timing marks. Reinstall the tensioner arm and tensioner, and run the tensioner bolt up to snug the belt. Remove all rags and clamps, remove the flywheel lock, and temporarily install the crank pulley. Turn the engine to top dead center and check all timing marks. Remember that the cam timing marks are on the back side of the cam sprockets—these are the ones that you can see through the air tubes on the MY 1986 and up engines. Their positions are indicated in the illustration, but you can't see the marks from this angle **(FIGURE 5)**. Turn the engine two turns, and check all timing marks.

Calibrate the tension tester tool (p/n 9201) **(FIGURE 7)**, using the calibration bar **(FIGURE 7)** that should accompany a rental tool, or that you should have bought when you bought the tool. This will give you a good feel for how the tool works **(FIGURE 8)**. Check to be sure that the locking pin **(FIGURE 9)** smoothly and easily enters its hole in the sliding gauge pin. The calibration value is 4, and is set by turning the knurled calibration-adjusting wheel behind the dial **(FIGURE 8)**.

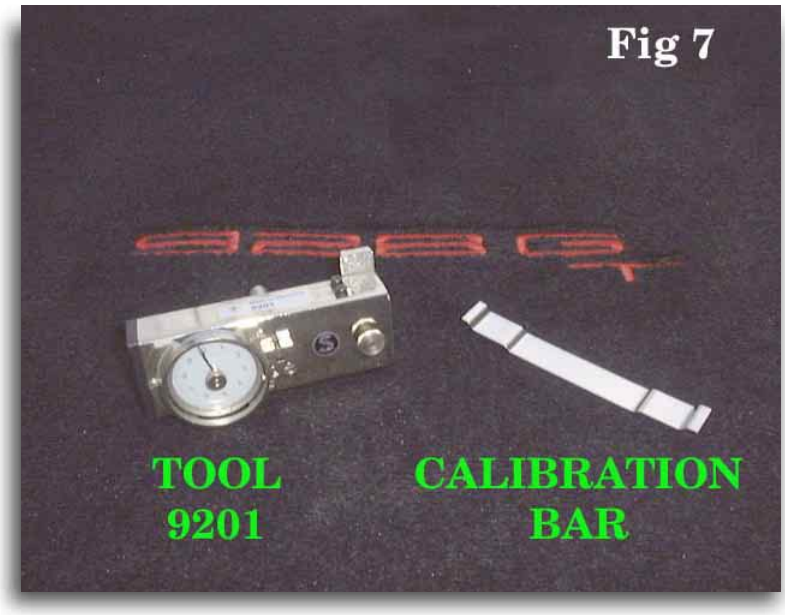

FIGURE 7:

The timing belt tension measuring tool (front view).

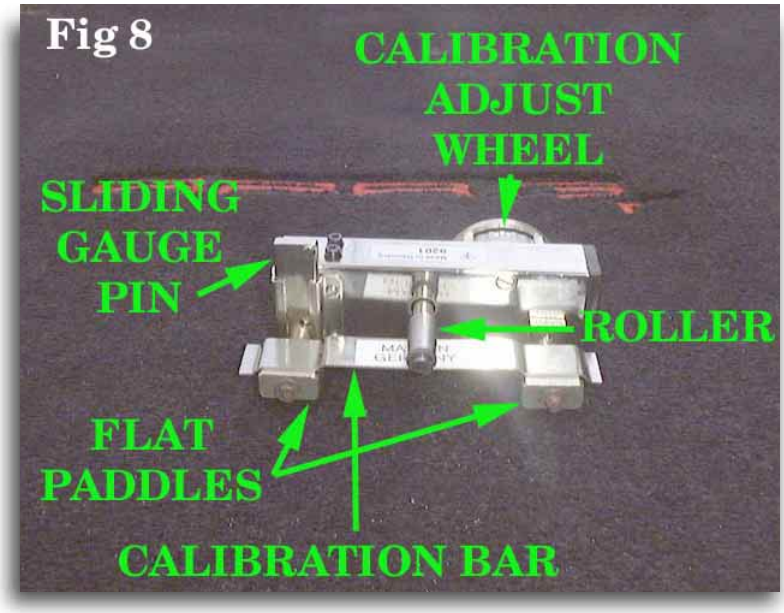

FIGURE 8:

The timing belt tension measuring tool (rear view).

FIGURE 9:

The timing belt tension measuring tool (detail).

First and most importantly—you are reading the loose side of the belt. There are either sixteen or thirty-two valves pressing on the camshaft lobes, with each applying a couple of hundred pounds of spring pressure onto smooth, lubricated inclined planes. This pressure tries to make the cams rotate, which will change the tension readings that you get. This means that the first requirement for getting repeatable readings is to turn the engine in the direction of normal rotation (ALWAYS!!) until it is on top dead center, firing position. That is, the marks on the crank damper and the cover should show top dead center, and the marks on the backs (not the 45 degree marks that you added) of both the cam wheels should be aligned with the dimples on the flanges. If you are even a little bit off, it will change the reading, due to the valve spring pressures on the cams. You must not back the engine up, even a tiny bit to align the marks, as this will seriously change the tension read!

If you get the engine position precisely right, you will discover that the teeth on the belt are then in the same position each time. This allows the elimination of another variable, the distance of a belt tooth notch from the cam pulley. There will be either one or two notches where you can place the tension gauge roller, and one of them will better center the sliding gauge pin on the pump bracket **(FIGURE 10)**. Be certain that the end of the gauge never hits the lower belt cover, if it is installed.

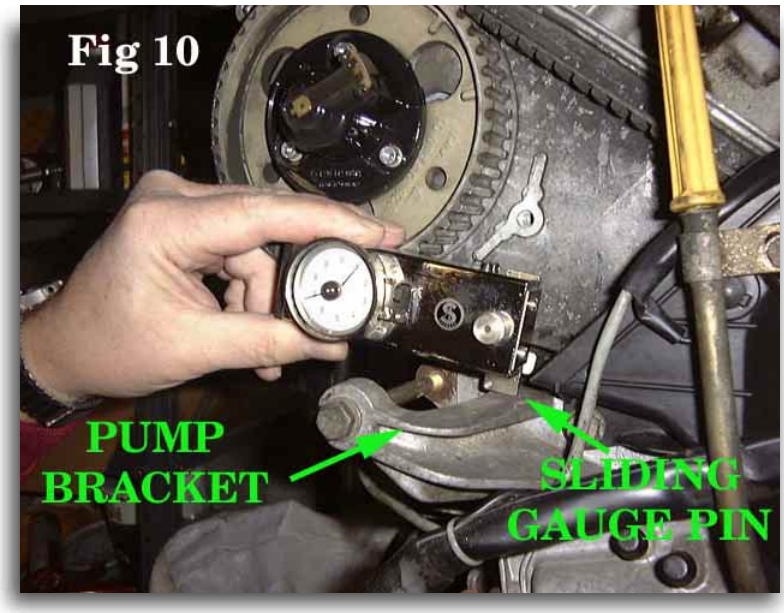

FIGURE 10:

Placing the timing belt tension measuring tool.

Pull the locking pin, and gently turn the small knob in the center of the dial face counterclockwise so that the max reading hand is atop the indicator hand. Put the tool in place, trying to hit the same tooth valley with the round roller each time. As shown on page 15-18c in the manual and Figure 11 of this article, you support the dial end of the gauge with your left thumb and index finger, pressing up only enough to support the weight of the tool, and carefully keeping the tool's flat paddles (sliding shoes) and roller **(FIGURE 8)** parallel to the belt.

Press down on the sliding gauge pin (right) end **(FIGURE 9)** of the tool with your right index finger **(FIGURE 11)**, being careful to avoid tipping or twisting the tool, until the locking pin slips into its hole in the sliding gauge pin. Do not press down further on the gauge after the locking pin slips into its hole! Read the value on the dial. You can then turn the max reading hand counterclockwise with the central knob until it touches the indicator hand, pull the locking pin, and carefully remove the tool so that you can more easily read the max reading indicator, but the in-place reading seems more trustworthy. The 16-valve models should be set to 4.5, while the 32-valve models should be set to 5.0 - 5.3.

FIGURE 11:

Using the timing belt tension measuring tool.

Rotate the engine two turns (to run all valves through one full cycle), and repeat the measurement. You should be able to get very repeatable readings, and even small adjustments to the tensioner bolt should make a noticeable difference in the tension. Check all timing marks one more time.

Reassemble the engine. Check the electrical connections **(FIGURE 12)** on the 32-valve units, slightly bending the connectors as necessary to ensure good contact. If these connections are loose, you will get intermittent false belt tension warnings. Use the tensioning tool to set the tension on the toothed alternator belt (MY 1982 and up) to 9.2 on a new belt or 8.4 to 9.2 on a used belt (which will be much tighter than you would have thought).

The timing belt must be retensioned after it is broken in. The shop manual says to retension after 1000 km, but a slip included with your belt will probably give a longer period, such as 2000 miles. Much less disassembly is needed to check the tension, as only the top passenger side (for left-hand drive cars) cover must be removed.

There is a lot of understandable concern over the durability and reliability of the 928 timing belt and tensioner system. If the system is properly installed and maintained, it is a very reliable, durable system. While random mechanical failures can and do occur on any complex, highly stressed system, knowing that the timing belt and tensioner system is correctly installed and adjusted will make those high-RPM blasts a lot more comfortable!

THE AUTHOR

Wally Plumley is a retired aerospace engineer, now working with David and Jeannie Roberts at 928 Specialists. He has been involved with sports and racing cars since 1960, building, crewing, or driving in many of the racing organizations. In 1991, Wally set three world speed records Bonneville in a car of his own design. His 1986 928S is his first German car, and he reports that it is very different from his British cars. Wally especially enjoys exploring the more technical aspects of 928 maintenance.