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SM Solutions

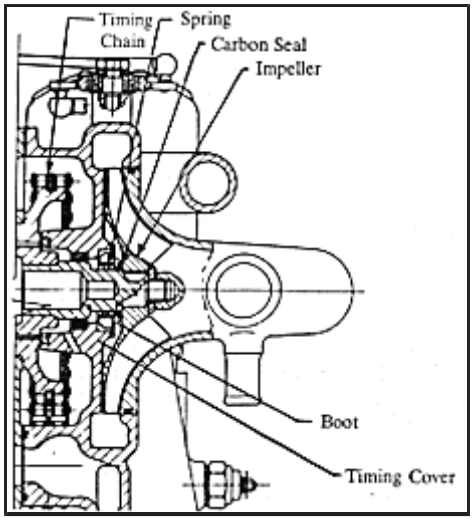
Article by John Titus

Of SMs, Washing Machines, and Water Pump Seals

Here in the desert southwest, a properly functioning cooling system is of the utmost importance. Over the past two years, however, I have been plagued by the persistent inability of the SM engine to retain coolant in its cooling system.

water pump seal but a pretty good one for

The SM water pump seal is a truly bizarre design for a pressure relief valve. I have heard that the seal was adapted from, or is identical to, a seal used in a British dishwasher or washing machine. I don't know if this is true, but it makes for a good story, and anyway the seal looks like a scaled-up version I put in my wife's dishwasher a few years ago.



The seal comprises of a rubber boot seated in the timing cover around the end of the jackshaft on which the water pump impeller is mounted. The boot holds a carbon sealing element at the end opposite the timing cover and encloses a spring that pre-loads the carbon element. Unlike normal water pump seals, which usually have a cast iron or stainless steel seat to ride on, in the SM seal, the carbon element rides directly on the back of the soft bronze water pump impeller. Also, unlike normal water pump seals, which have no taper and are thus ineutral~ to the effects of the water pressure they are sealing, the SM seal has a step and taper from a diameter of 1.70 inches at the timing cover to an outer diameter of 1.25 inches at the sealing face. This provides a pressure area of 1.04 square inches at the sealing face. This system pressure, tends to lift the seal face off the back of the impeller and leak coolant to relieve the

pressure.

Because the spring in the SM seal is inside the engine rather than inside the cooling system, the spring is exposed to the higher engine interior temperatures, which may lead to a loss of spring force. Finally, the outer edge of the carbon on the pressure side is beveled, at least on some units. A bevel on the pressure face will tend to facilitate debris working under the seal, which causes premature scoring of the seal surface.

My particular problems occurred with two different cars, both having freshly rebuilt engines. I had installed a new water pump seal and a re-machined impeller on each engine. The seals had been purchased from two different reputable suppliers and each had arrived in original Maserati packaging. I initially noticed that after the sealswere installed, frequent toppingoffofthe coolant was required. Eventually, I observed that the coolant loss occurred each time I started the engines from cold. As the engine approached operating temperature about 1/4 liter of coolant would leak out of the water pump weep hole at the back of the engine, A cooling system pressure test showed that the new water pump seals were functioning as pressure relief valves, leaking anything over 2 psi. I spoke with a number of people about the problem, but those who had experienced the same problem had for the most part Just learned to live with it. I therefore concluded this was normal operation for the SM engine. So, in desperation, I bought some inexpensive Americanmade radiator caps and trimmed the spring until they relieved at something around 1 psi. This stopped the coolant loss problem for the most part, but 1 psi of system pressure proved insufficient to prevent coolant boiling in Arizona on a hot day. Consequently, I began investigating the possibility of designing my own replacement seal to accommodate a higher cooling system pressure.

Shortly after I began a redesign effort, Don James, of J.B.M. Industries, told me that he was going to reproduce the factory water pump seal, which he tod me had risen in price to something like $180 due to a real or perceived shortage of these critical parts. Don estimated that he could easily sell a reproduction for about $80. Don also had apparently been told that the factory water pump seal did not hold pressure, because he planned to use an improved spring material in his reproduction seal to increase the spring force slightly. Don offered to run off a few really stiff springs if I wanted them for my experiments. So, I bought some of Don's seals as a basis of my redesign effort.

When the seals arrived, I was surprised to see that Don's springs had only 2 1/2 coils and thus would be stiffer than the 3 coil springs in the new factory replacement springs, so I grabbed all of the old SM water pump seals I had (I never throw any uniquely SM part away, no matter how bad the condition) and I removed the springs. Much to my surprise, I discovered that the springs in the older seals were different from the springs in the newer seals. This led me to conclude that some SM water pump seals being sold today as original replacement parts have a substantially weaker spring than the original parts and thus will not hold proper cooling system pressure.

Specifically, the old original seals in my inventory have a spring that is made of stainless steel wire .092 inches in diameter. These seals are marked GACO WPF087 around the perimeter of the seal boot (looking at the seal from the impeller end). The spring has 2 1/ 2 coils with ends closed and ground and has a free length of .485 inches. Both of the "factory replacement" seals that I bought within the past two years were marked, in the same location, GACO CF28783 and have a spring that is made of stainless steel wire .081 inches in diameter. The spring has 3 complete cells with ends closed and ground and has a free length of .470 inches. Both springs have an outer diameter of 1.16 inches.

According to the classical spring design equation:

$$K = \frac{G\,d^4}{64\,R^3\,N_c}$$

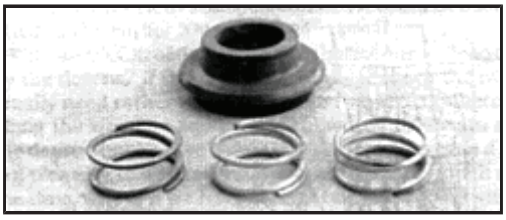
Where K is the spring rate, G is the shear modulus of the material (stainless is 9.6 million psi), d is the wire diameter, R is the mean helical diameter of the spring, and Nc is the number of active coils (which a spring having closed and ground ends is the total number of minus 1.75). Based on this, the original WPF087 spring has a theoretical rate of 95 lb/in and when compressed to an installed height of approximately .28 inches and should exert a force of 19.3 lbs.

By comparison, the "factory replacement" CF28783 spring has a theoretical rate of only 33 lb/in and when compressed to the same installed height of .28 inches will exert a force of only 6.3 lbs! (Suitable use for a washing machine, perhaps, but insufficient for an automobile engine.)

The J.B.M. spring is similar to the WPF087 spring. It uses wire.091 inch in diameter, having2 1/2 coils with ends closed and ground and a free length of .495 inches. However, the J.B.M. spring is made of a high temperature chrome-vanadium alloy. Being made of a chrome-vanadium alloy, the J.B.M. spring has a shear modulus of 11.5 million psi, approximately 20% higher than stainless steel. Accordingly, although it is .001 inch smaller in wire size, it nevertheless has a theoretical rate of 107 lb/in and will exert a force of 23.1 lb when installed. (about 20% more than WPF087).

Them results are set out in tabular form:

SpringType	Rate	Installed Load
WPF087	95 lb/in	19.3 lb
CF28783	33 lb/in	6.3 lb
J.B.M	107 lb/in	23.1 lb



On the left is the J.B.M. spring, which, being made of a chrome-vanadium alloy, is darker then the stainless steel springs. The middle spring is the WPF087 spring and the spring on the right is the flimsy CF28783 spring. An assembled, J.B.M. reproduction seal is shown in the background. Incidentally, the J.B.M. seal is properly designed without an outside bevel, and thus will exclude debris from the seal surface better than the GACO seals with the outside bevel.

I installed the J.B.M. seal in my SM, without remachining the impeller, and I am pleased to report that a cooling system pressure test showed no leakage at a full 7 psi. This means an aftermarket 7 psi cap can be safely used (the remaining seals in the engine can easily operate at twice that pressure, and reproduction reinforced radiator hoses are plentiful.) Higher cooling system pressure may help eliminate impeller cavitation, which I believe to be responsible for the pitting that occurs on the inside surface of many SM water pump impeller covers. Moreover 7 psi caps are available with the coolant recovery feature. Coolant recovery completely purges air from the coolant system and thereby further reduces the chances of impeller cavitation and arrests the oxygen-induced deterioration of permanent anti-freeze. (Now that a 7 psi seal is available, I am in the final stages of testing a newly designed coolant recovery

system that will allow the SM to operate with a sealed system, and will have the added advantage of eliminating the awful SM expansion tank, which obscures the fuses and drips water on the wiring.)

Based on the above data, my advice to any SM owner contemplating a water pump seal replacement is that you check the markings on the replacement seal. If the seal is marked CF28783, or even if it is not, look at the spring inside. If the spring has 3 complete coils, remove and discard the spring and re-use the spring from the seal you are replacing, assuming it is the WPF087 2 1/ 2 coil variety. The spring can easily be removed by grasping the seal at the metal cup end and, using thump pressure on the outside, turn the base portion of the rubber boot inside out to eject the metal cup. Placed side-by-side, the difference in the diameter of the wire used in the two springs is unmistakable. If you have no serviceable springs, my only advice is to buy a new J.B.M seal, which is guaranteed to have a serviceable spring. Save the CF28783 seal in your inventory for the next water pump job and, when the time comes, simply re-use the spring from the J.B.M. seal. If you have your seal replaced by a service facility, give them the above information and demand that a system pressure test be done to verify the integrity of the seal. If it doesn't hold at least 5-7 psi, a defective CF28783 seal was installed. Demand that it be replaced with a WPF087 or a J.B.M. seal.

Finally, for those of you who don't have the number memorized like I do, Don can be reached at J.B.M. 216 678 9537. Incidentally, in what must be deemed a phenomenal coincidence, since Don introduced his reproduction water pump seal, the "shortage" of original seals apparently suddenly ended and the prices have dropped accordingly.

[Don retired from the Citroen parts business several years ago.]