Pumped Up For Racing

One Racer Puts the Gear-Style Oil Pump to the Test

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Healeys never cease to amaze and interest me. It always seems that about the time I think I have them all figured out — they show me just how little I really know. There is probably nothing that will accelerate this learning curve faster than taking a Healey out to do a little vintage racing. While the thousands of components that make up a Healey will give years of reliable and enjoyable street service (the kind they were designed for), those same 40-year-old components will give you some very quick lessons in design limits out on the track. Such is the case in racing my 100-6.

Last winter, I was kicking around the garage wondering what I might do to "improve" the performance of my Healey, when I convinced myself I needed a new cam. (Winning races is 70% driver and 30% car; Healey drivers always "fix" the 30%.) Thus I raided the kid's college fund and rang up England to order the latest gee-whiz, hot dog, Big Healey race cam that promised all the performance my imagination could conceive. In addition, I thought I would bolt on a new rotor oil pump as there was S300 still showing in the college fund and since I had already convinced myself that the oil pressure was showing a little low in the last race.

On arrival of my new parts, I carefully bolted them on, triple checking everything. I then fired up the Healey (did a little garage racing), satisfied myself everything looked good and waited for race season.

In July I loaded the 100-6 and the family up and off we went to the Brian Redman International Challenge at Elkhart Lake, WI. This event, as many of you know, is considered the top vintage race event in the Midwest if not the entire US, with 70-plus cars in my group alone. It is always a week of great racing.

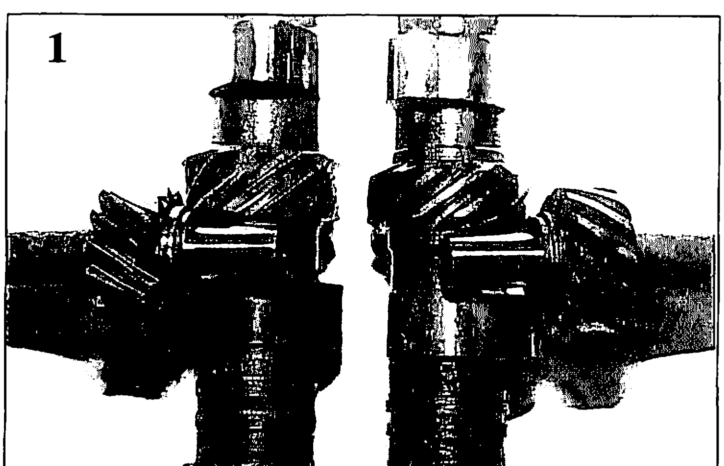
On day one of this event, I was on the track when I lost oil pressure, and I mean completely — the needle wouldn't even bob. It just laid there in the bottom of the gauge like it fell off the shaft — which is exactly what I hoped for as I was towed back to the paddock. It was not to be. After checking the obvious things, I dropped the pan and discovered the oil pump drive gear on both the cam and spindle were completely destroyed. *(See Photo 1)* I couldn't believe my eyes! I was stunned, heartsick and disbelieving all at the same time. My new cam, with only a couple race weekends on it, was now junk and my race week was gone. As I stood there dejected, I wondered what on earth could have done this damage. I first questioned my installation; had I lubed the gears well, did I get the spindle thrust washer in place, was the cam-end play correct, etc. (Later, on disassemble, we could find no evidence I had screwed up on installation).

For racing, I am convinced, a gear pump that has good tolerances is the only way to go.

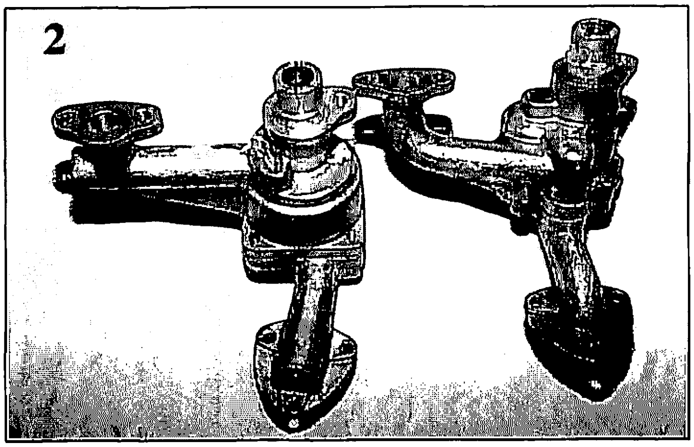
As I stood there, other Healey drivers began to show up. Each would crawl under the Healey for a look-see, and each would come out with a similar story to tell about losing their oil pump drive gear in the past. Bob Biever (recipient of the 1997 cherished Geoff Healey Sportsman Trophy) had lost his gear the year before. George Olson, who has raced big Healeys for years, said that at one point he was so concerned at the extreme wear his gears were showing that he once spent hours blueprinting and lapping the gears together – all to no avail. While almost everyone had a problem at some point with this, there was no consensus as to what caused it.

Tom Kovacs (proprietor of the Fourintune Garage and as many of you remember head mechanic on the Wild West team's awesome 105 and 106 Healeys during the 1990 Healey Challenge) appeared on the scene. Sizing up the situation, Tom imparted a conversation he had with Geoff Healey during one of Geoff's many trips to Fourintune. Geoff had asked Tom if he was experiencing any timing chain and oil pump drive gear problems on his six-cylinder Healey race engines. Tom said he was but could not figure out what was causing it. Geoff went on to say that during campaigning the works cars, they felt the rotor oil pumps heavy pulsing and load was creating premature wear and failure of the oil pump drive gear and the timing chain. Tom switched to the gear pump in his race engines and his problems disappeared.

A bit of history may be in order here. When the six-cylinder engine was first introduced, it utilized the rotor-style oil pump. Later, in April of 1959 a change was made to a gear-style oil pump. *(See Photo 2)* The pumps are completely interchangeable among the six-cylinder engines, and



My new race cam on the left and its drive spindle. You can clearly see the damage compared to the BJ8 cam on the right. The BJ8 cam has thousands of miles on it and is showing almost no wear on the gear.



The rotor style oil pump on the left and gear style on the right.

as the earlier rotor pump is capable of more flow, it is generally accepted to be the better pump. Thus, it has been suggested that the change to the gear pump was a cost-cutting action by the factory. Hmmm....

I really, really, really hate losing a cam and I was not about to see it happen again. Therefore I decided to do some testing to see if I could shed some light on this problem. What follows is a summary of over 50 hours of bench testing four separate pumps and talking to every shop or person I knew of who may have experienced this problem.

The Test: On the advice of my oil supplier I acquired a 50-gallon drum of light weight oil that at room temperature would give the flow characteristics of 40-weight motor oil at 200 degree F. Later, my viscosity testing showed this oil was closer to 30-weight oil at 200 degree F. (Rule No.1 never assume that an expert is an expert.) I wanted to test at room temperature, as I did not cherish the thought of dealing with 200 degree F. oil for hours. Next I set up and equipped a test bench that would give me the ability of testing the gallons per minute (gpm) of each pump at five separate rpm levels (480, 1160, 2100, 3500, and 5840) and at four separate pressure settings (0, 40, 60, 80 psi) within those rpm levels. Amp reading was recorded during all the runs on the drive motor that power draw comparisons could be made. All rpm levels are reported as *Engine RPM*; I have already accounted for the gear reduction through the cam drive. I have provided the amp draws for you at each level. What these draws mean in terms of horsepower, largely depends on what "expert" you ask and the efficiency and size of each electric motor.

Roughly speaking, every 10 amps equals 1 electric horse and every electric horse equals a little more than 2 hp in a gasoline engine. However, what is of concern here is what each pump draws in comparison to another, using the same drive motor. The same electric motor was used in all the testing.

First, I ran a good gear pump and recorded 20 runs to get a baseline. The only thing of note at this time was that the gear pump seemed to be somewhat impervious to the pressure it was asked to work under, at the 5,840 rpm level, delivering the same volume at any of the four pressure levels.

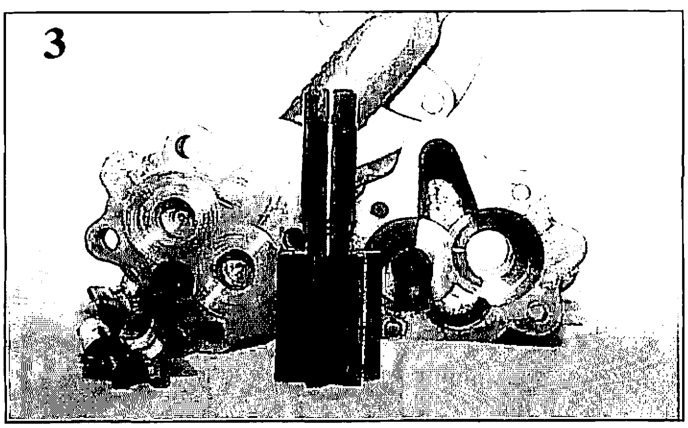
Next up was a new rotor pump. Immediately it became clear that the rotor would deliver about 20% more oil on average in the lower rpm levels. No surprises here as everyone knows a quick (and temporary) fix for a tired engine is to bolt on a rotor pump to get some oil pressure back. If anything, I would have guessed it would flow more. A shocker though, the output flowed in great throbs. This throbbing or pulsing became so violent it destroyed an ultra sensitive pressure gauge I had been using to take my readings. Yet, this gauge had hardly shuttered during the gear pump testing. Furthermore, there was a vibration at the higher rpm runs. Obviously, this was the concern Geoff Healey had expressed to Tom Kovacs.

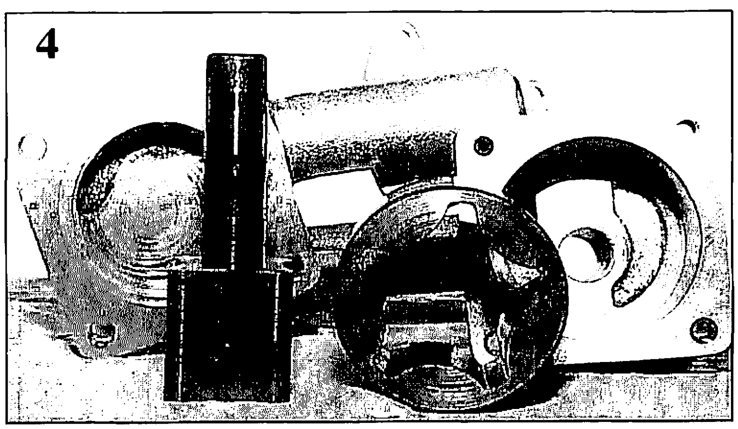
After bolting on another less sensitive pressure gauge, testing proceeded with the rotor and a pattern now became evident. At a calculated 5,500 rpm the rotor pump would begin to flow less oil than the gear. I could test at 5840 rpm and this showed the rotor at 9.52 gpm and the gear a solid 10 gpm at the no pressure level for both pumps. I would love to tell you how the rotor tested under pressure at the 5,840 rpm but it left my drive motor smoking with the breakers tripped. Even at the no pressure level, the rotor was drawing twice the power of the gear and pumping less!

So surprised was I at the rotor's behavior, I wondered if something was wrong with it (there have been reports of pumps with wrong tolerances being sold as late as last summer). To test my doubts, I dug out an old 100-6 engine I have that had been SCCA raced back in the late '60s As I was removing its original rotor oil pump to test, I noticed the oil pump drive gear on the cam was nearly 50% gone. Hmmm....

This old rotor was highly worn and on the test bench it would not quite pump the same volume at the low rpm levels as the new rotor, but still more than the good gear pump. As the rpm increased to the 2,100-level however, all the readings between the new and old rotor became nearly identical. Complete with all the vibration, pulsing and smoking motor.

One question still tugged at me. In 1992, a friend came to me with a newly rebuilt BJ8 engine that was showing very low oil pressure. After making the normal checks to be sure the gauge and pressure relief





Left: *Inter-workings of the gear oil pump. Notice the extensive machining.* ***Right:*** *Inter workings of the rotor oil pump. Note the large rotating mass and the large surface area it must spin on.*

spring were working properly, I concluded a new pump was in order and bolted on a rotor pump as this was all that was available at the time. On start up, the pressure was dramatically improved (a story many of you reading this article can relate to, I am sure). The question that bothered me was how could the small volume difference between the two styles of pumps (20% on average) account for all of that oil pressure success on the BJ8 engine in 1992. I called my friend who graciously mailed me the old pump in the interest of higher learning.

On bolting the old gear pump on the test bench it became evident that radial wear greatly affects flow rate at both pressure and low rpms. At one level it would only flow 60% of what the good gear pump would produce. So bad was it that it could not self prime at the 580-rpm level, a problem I had not experienced with any of the previous pumps. The gear performance is greatly affected by wear in comparison to the rotor. Had I realized this in the beginning, I would have carefully blueprinted my good gear pump, as I knew its tolerances to be good but not perfect. The low speed flow I am sure would have been better.

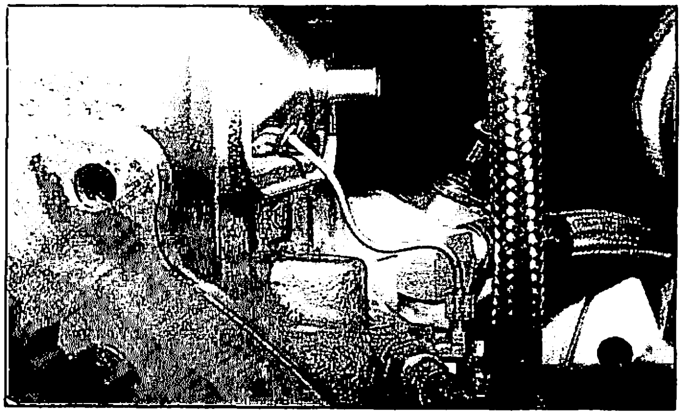
At this point I decided to tear down the pumps and examine their design. The gear pump, as its name implies is made up of two seven-toothed gears, meshing together to draw oil through the housing and onto the engine. *(See Photo 3)* The teeth must pass very close to the housing to maintain a seal and it is this radial clearance that is so important. The manual calls for a radial clearance of .00125 inch to .0025 inch. End float of .0005 inch to .002 inch is also important. A point that the manual does not make is *very critical.* When bolting the pickup plate on, one must carefully center it by rotating the gears with the drive spindle and move the plate around to find the least resistance before tightening the plate down. The plate is capable of moving several thousandths in any direction while sitting on its mounting screws. Should you tighten the plate down with it off-center, you will force the bottom of the gears to bind against the housing – effectively creating premature wear or even locking the pump up.

The gear pump is also of the same design commonly found in American cars. In fact, a common performance improvement on Chevy engines is to change the gears from a seven-toothed to an eleven-toothed. The stated purpose is to smooth the oil flow and to reduce jerking in the oil pump drive system. Hmmm.... I also feel the gear pump is more complex, requiring more machining work. I would have a difficult time believing it was introduced as a cost-cutting measure, unless there was something political going on at the factory.

Examining the rotor pump reveals a rotating mass of nearly twice that of the gear pump. *(See Photo 4)* Worse, this weight is concentrated at a much further distance from its drive axis, giving it what we call a higher rotating moment of inertia. This of course would consume more energy on acceleration and therefore place more stress on the drive gear. It also struck me that the outer rotor ring has a high friction surface that uses the pump housing as its race. High surface areas create higher friction and more drag, especially at high speeds. Synthetic oil may help to reduce this friction. For the record, I have always used Redline 40-weight oil in my race engine. Milling pressure balance grooves in the pump body may help to reduce this pump's pulsing, but it would probably be at the expense of total gpm.

I would like to restate here that we are talking about pumps as they relate to high rpm Healey race engines. In my testing, I feel that the bad side of the rotor pump did not become a huge concern until we started testing it at high rpm. I would not have a problem bolting it on to any Healey engine intended for street use. For racing I am convinced a gear pump that has good tolerances is the only way to go.

There is one more element that I feel contributes to this subject that must be stated, and that is the issue of oil delivery to the cam gear. Most shops I spoke with felt that on a good race day this fragile and highly stressed gear needs more lubrication than the stock system can provide. The gear



Note the little 1/8-copper pipe running through the lifter cover. This line then does a sharp turn and shoots straight down the drain back hole, hosing the oil pump cam gear with high-pressure oil. I call it my better-than-doing-nothing fix. It only cost $2.00, 15 minutes and seems to work. Also, if you wish to check the condition of your cam gear, pull the rear lifter cover off and with a strong light you can see the gear at the bottom of the drain back hole.

CHART 1

Good Gear Pump

RPM	GPM	AMPS
	0 PSI	
480	1.47	No appreciable draw
1160	2.59	No appreciable draw
2100	4.34	8.00
3500	7.69	9.00
5840	10.00	10.50
	40 PSI	
480	1.42	No appreciable draw
1160	2.48	No appreciable draw
2100	4.54	8.00
3500	7.40	9.50
5840	10.00	12.00
	60 PSI	
480	1.33	8.00
1160	2.33	8.50
2100	4.25	9.00
3500	7.31	10.00
5840	10.00	13.50
	80 PSI	
480	0.94	8.50
1160	2.20	9.00
2100	3.85	9.50
3500	7.14	10.50
5840	10.00	14.50

receives lubrication from two sources. One is a tiny hole bored into the drive spindle gear. The path the oil must take to feed this hole allows for plenty of opportunity for the oil to escape before it reaches the gear. It is generally thought this source is dubious at best.

The second source is the rear-most drain back hole in the lifter galley which is located directly above the gear. The oil from this source must first make its way to the head, lubricate the rockers and valves, gravity flow down the push rods, lubricate the lifters and then fall on top of the oil pump drive gear. From this source the gear is the last to receive oil, yet it is one of the first components in the engine asked to work on startup. Also, if you are restricting upper engine oil flow and are using modified lifters as in the works cars, your gear will see even less oil. Jeremy Welch of Denis Welch says he likes to clean this drain back hole up, directing as much flow down it as possible.

In the interest of this gear, Dave Woodhouse of DMD says he will not allow one of his race engines to be revved or leave the starting line without fully warmed oil. DMD are also the only folks I know of that have tackled this problem head-on. During the production of their race cams, DMD bores up the center of the cam from the back to the oil drive gear. This in turn pressure feeds oil to tiny holes that have been bored into the gear. Neat!

In conclusion, my testing has shown me that the rotor pump creates more stress at high rpm and I would not race with it. There are, however, other factors that influence the life of the cam drive gear. Your racing habits, modifications to your engine, oil viscosity, temperature, weight, quality and delivery all play a roll.

My testing has left me with many side issues that I wish I had time to investigate. For example, is spark scatter created by the rotor pump, and if so how much? To what degree is frothing oil a problem. To what degree does expansion rates play inside the pump's housing? So many questions, so little time.

Epilogue: So what did I do with myself the rest of the race week at Elkhart where this story all began? When things looked their darkest – in stepped Tom Kovacs. Tom, after sizing up the situation asked if I had happened to have my old race cam with me. I had and Tom said, "Well, load up the Healey and let's get to my shop. You have got a race first thing in the morning and we have got a lot of work to do." I was stunned with gratitude. We arrived in the evening at Tom's shop where we were met by Scott, one of Tom's employees, who offered to lend a hand. Tom outlined the plan of attack, and we fell on the engine at once. Tom, during this time, was missing the all-important car show back at the track in which he had several cars displayed. Scott quietly went to the phone and cancelled a date he had for the evening (Scott's love life, I am sure, has not been the same).

In the wee hours, we got the old cam and a gear pump back in the car. We bolted everything back together, and I pulled back to the track, going over and over in my mind every bolt, hoping we had not missed something in the rush. I fell into bed at 3:00 a.m., up again at 7:30 a.m. to race. In a sleepy fog, I found myself sitting on the race grid hoping again we did everything right and hoping with the old race cam that I could at least stay on the lead lap. My fears were ill founded; that day I broke my lap record at Elkhart! Thank you, Tom, Scott, Kaye and of course Geoff Healey. Great club, great cars, great people, great racing – life does not get any better than this!

CHART 2

New Rotor RPM	GPM	AMPS
	0 PSI	
480	1.88	8.00
1160	3.44	8.50
2100	5.71	9.00
3500	8.00	11.00
5840	9.52	20.00
	40 PSI	
480	1.85	8.50
1160	3.38	9.00
2100	5.71	9.75
3500	8.00	11.75
5840	Overloaded Drive Motor	
	60 PSI	
480	1.82	8.50
1160	3.33	9.00
2100	5.71	10.00
3500	7.75	13.00
5840	Overloaded Drive Motor	
	80 PSI	
480	1.80	9.00
1160	3.27	9.50
2100	5.71	10.00
3500	7.60	14.00
5840	Overloaded Drive Motor	