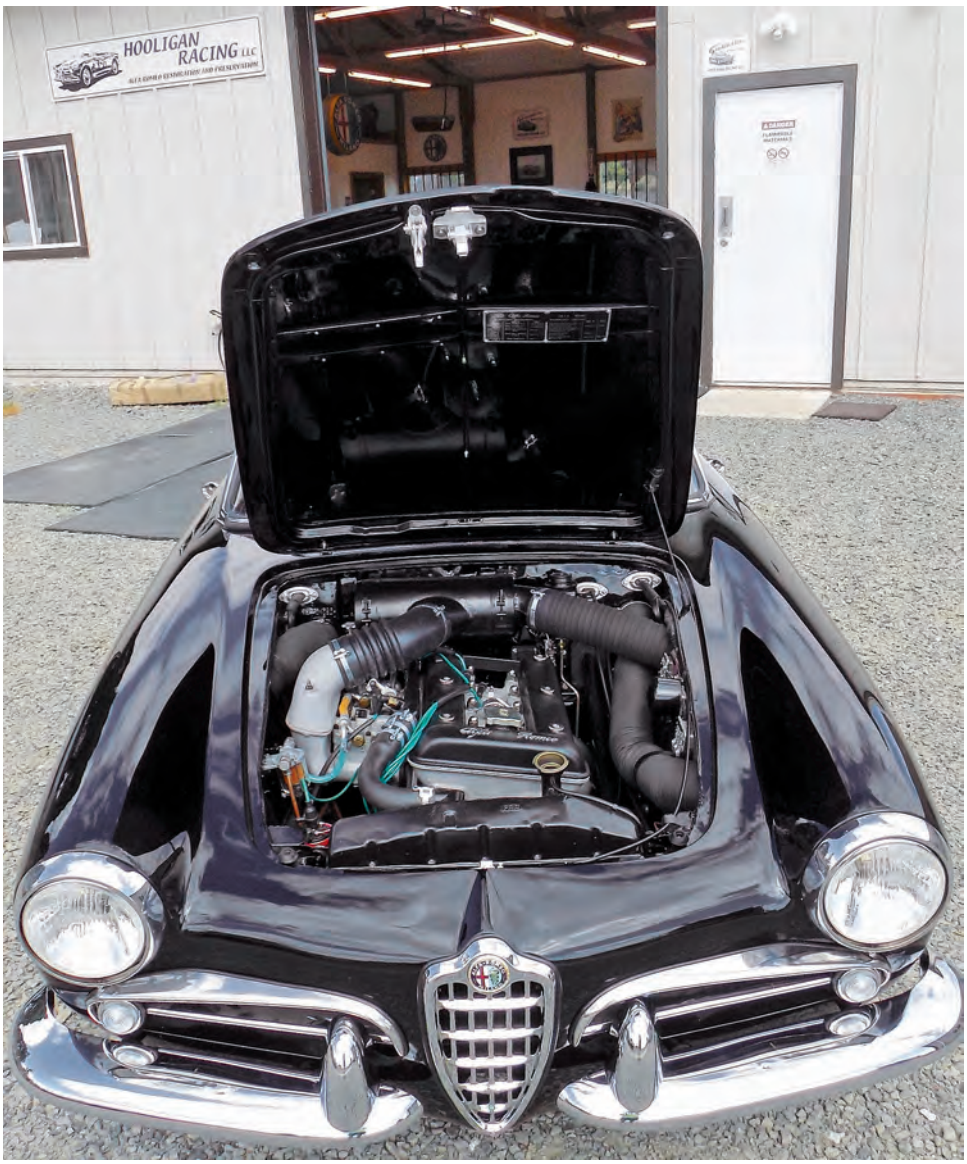
Rebuilding My 750 Veloce Engine: Part 3

Camshafts – I'll need two to go, please

The camshaft performs the most important timing function in a four cycle engine. It plays the valves like fingers do on a wind instrument. It has more influence on the personality of an engine's character than any other single component. I expected to simply choose, buy, and install new cams like everybody else.

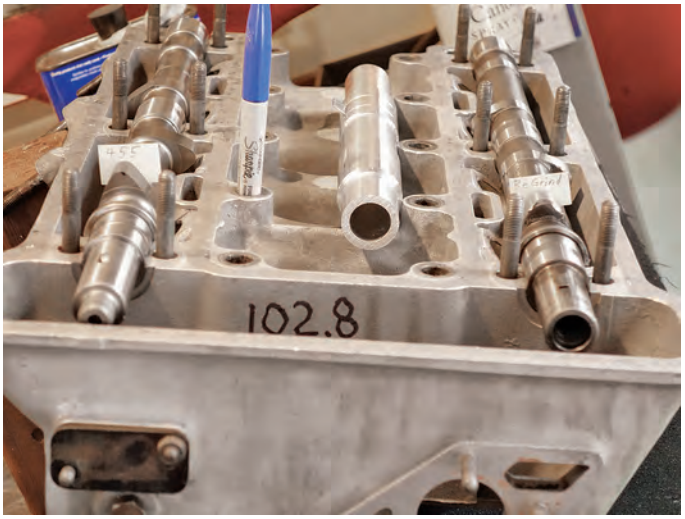


Outside Bill Gillham's workshop in 2018, my 750F #04396 resurrected with original engine #31377 installed – photo Bill Gillham

I literally felt how camshaft timing has a drastic effect on performance many years ago. My wife found a great deal on a Maserati at a used car lot in Wisconsin. She was attracted by its Italian Mustang looks, its fancy wire wheels, and it sounded wonderful. But she was too timid to notice during her test drive that it had absolutely no torque! After delivery, I hoped it would light up over 4000 rpm, nada. I checked everything – twin spark ignition, the Webers that replaced Lucas fuel injection, compression, and leak-down. Dismayed to discover that there were no timing marks on the cam bearings, I needed two dial indicators and a degree wheel glued to the crank pulley. I finally discovered that the cams weren't opening the valves soon enough. That's why it was so cheap. Most Americans preferred simple cars back then.

Now I'm finishing two old Alfa projects. While I was already searching for a pallet and a shipper to deliver my engine to Bill Gillham in Oregon, I was completely dumbfounded again by cams. There was not enough gap for standard shims to adjust the lash of my new cams from Centerline. I installed proper new valves and those pricey but smaller 750 followers from Classic Alfa. What the heck? My cylinder head is almost like new (as explained in Part 2). Still the gap between the heel of the cam and every valve was less than a millimeter. Shims that thin would shatter quickly. "Tipping," or shortening, the valve stems is the last resort option. The spring keepers are very close to the top of the valve stem. That is the cheap solution when overworked seats should be replaced. I still don't know why I had this problem.

But I do know that I quickly got a wonderful 750 Veloce engine because I found the right camshaft grinder to reduce the base circle on my PC455 Street Performance cams by one millimeter in diameter. Not



Camshaft lobes on cylinder head

only did that do the trick, but I ended up with cams that run quieter. I'll explain my dumb luck and a bit about the diabolical cam lobe. Even the data used to describe their shape varies.

My problem was solved when I called the best accessible custom cam grinder in the U.S. I explained my problem to Ken Quale at Delta Camshafts in Tacoma, WA. His shop was able to keep Claus Menzel happy reconditioning old factory cams. Ken quickly understood my problem and had apparently serviced a lot more Alfa owners than Claus. That cheered me up. He runs the latest cam analyzer and could add current asymmetrical ramp and crown design to what I have if I give him about half a millimeter of valve lift to work with. Within two weeks, I received my revised cams with a very detailed data sheet showing they are essentially modern renditions of Veloce cams, but with 10 mm, or 15 percent more valve lift. This compensates for the 100 cc or 8 percent displacement that I added. Plus they sound modern because the new ramp design allows for 0.2 and 0.3 mm, or 40 percent tighter, valve lash. Yes, my recovery from a technical show stopper was easy and reasonable because I tapped into modern cam design and machining and still improved cylinder filling to boost torque some more.

I'll never again call them "bump sticks"! This is what I think happened to camshaft design in the second half of the last century – lots of design testing to meet emission, mileage and durability goals, and then computers. Digital instrumentation, machining, simulation and big data created a knowledge base and precise repeatability while testing that never existed before. Variable cam timing was one result, but unfortunately, not applicable for us. Tradition and willful engineering is no longer the gold standard. Our engines can benefit from some of that modern technology now.

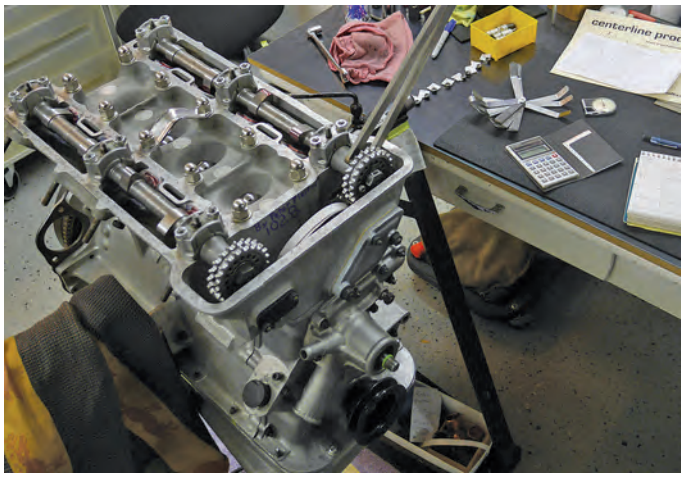
The most common engine designs use a single camshaft. The cam lobes used to be the same for intake and exhaust valve motion. Separate cams for intake and exhaust opens the door to clearer thinking about function. It is not logical to make both types of valves behave as if there is no difference in their function. Most old engine designs already recognize this by at least making the intake valve larger.

The next step in cam profile development was how much, when, and how long the valve is opened by the cam lobe. A seemingly trite detail is how fast it opens and closes (determined by the shape of the ramp and flank).

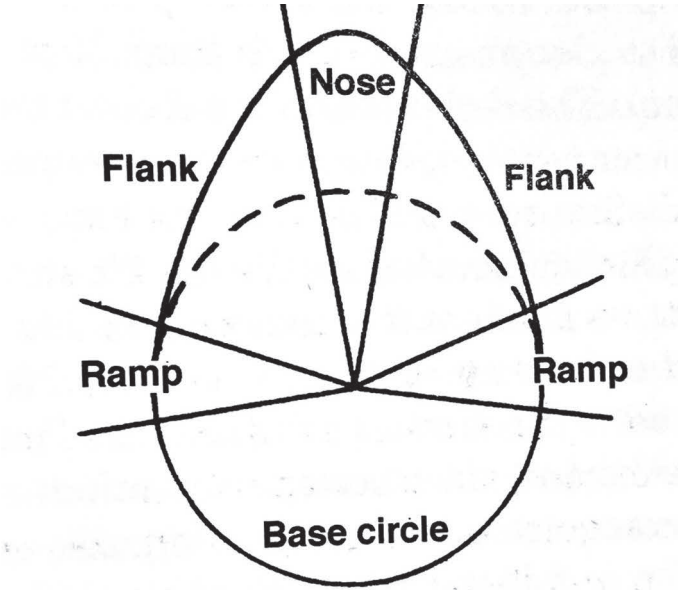
When our Giulietta engines were developed, cam lobe design was based upon dyno testing, then balancing of torque vs. horsepower plotted with rpm. For stop and go and utility duty, the engineer would favor maximizing torque in the 2000 to 3000 rpm range and sacrifice power above 5000 rpm. For spirited driving and racing, low-down torque would be sacrificed for more power at high rpm to boost acceleration at speed.

And not to be slighted, it's the valve spring's job to assure that the cam follower can do exactly that – maintain contact as the valve closes. When valves lose touch (float), exhaust gas pushes back against intake mixture and power drops instantly. Spring and valve head failures used to be a common reason for DNFs with high-revving engines. I've seen extreme modern measures to rev higher and fail less, such as titanium valves and spring keepers, and softer "yellow metal" valve seats in qualifying engines.

Jim Kartalamakis' book "How to Power Tune Alfa Romeo Twin Cam Engines for Road & Track" (ISBN 874105448 by Veloce Publishing) is a bit dated and he focuses on building 2L engines and 105 Alfas for racing. Still he has much to teach about what cam specifications mean. He plotted performance curves of



New cams reground to make room for shims



Cam nomenclature

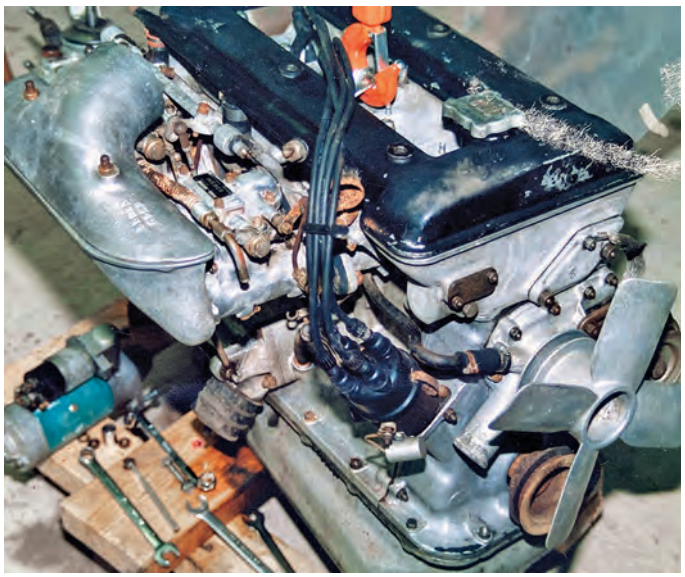
valve lift and valve acceleration and ranks a dozen cams including 101 Veloce and Ti. His text and illustrations helped me to explain to a professional my problem and what I want.

Still there is a big elephant under our old bonnets called flat tappet failure. Not only is there an oil chemistry issue, there are also older and pesky durability problems traceable to metallurgy, heat treating, and almost lens-like surface finishing. The scope and cost of reliability issues with flat tappet cams have forced manufacturers to use steel instead of cast iron cams and roller followers, increasing unit production costs by hundreds of dollars (huge!), just to control warranty costs. For my peace of mind, I'll occasionally have my oil analyzed.

On your marks at #1 TDC with chain snug

The ignition distributor – timing that needs to adapt but not go dizzy

The 750 Veloce engine was equipped with a Marelli S73A distributor. Spark timing must advance as a function of rpm. Veloce carburetors limit us to old school mechanical advance in two stages, quickly from idle to 2000 rpm then more gradually. This is commonly illustrated by a steep straight line followed by another line segment with a less aggressive slope up to 5000 rpm, then horizontal, indicating no further advance. Small coiled tension springs restrain two flyweights to control this function. An electric on-off switch is above the advance mechanism. It consists of sprung contact points which are opened and closed by a square-ish cam that switches the ignition coil on/off four times per two revolutions of the crank. As it is switched off, a high-voltage arc jumps to ground at one of four spark plugs at precisely the optimal time. This can only occur when everything is as new, is lubricated, and adjusted with precision. But an old distributor always has a worn-out bushing underneath the points. This causes erratic timing. Also the electrical contact points will wear in three ways which causes drift of timing and reduced coil performance. All those foibles can be eliminated by electronics and the advance curve can also be much more sophisticated. For now, my Marelli is rebuilt and tested but it is on probation.



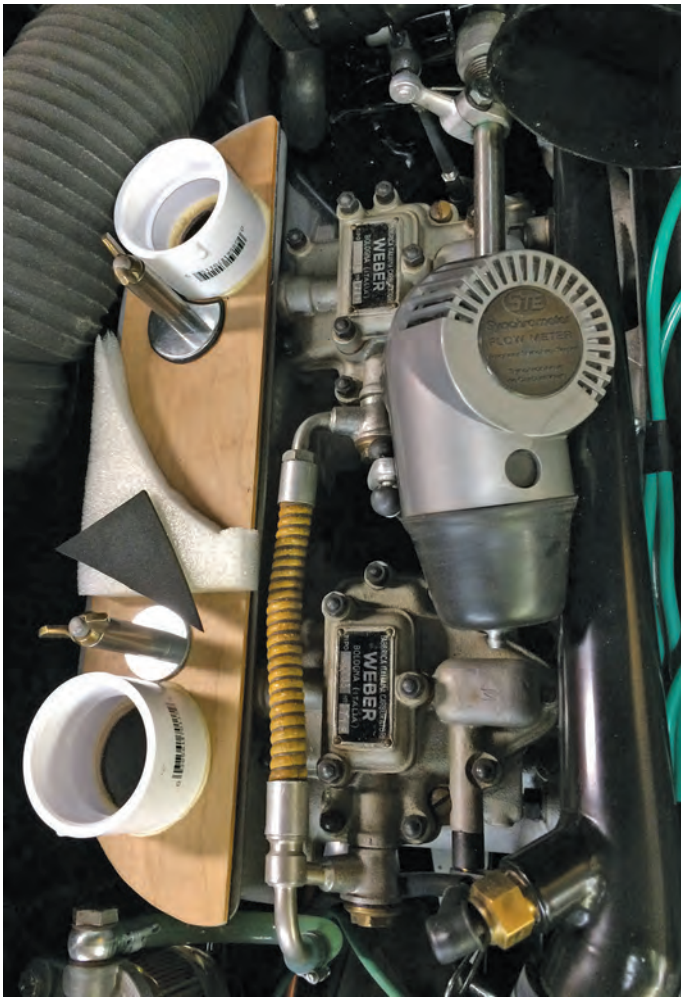
In 1990, had to be retired but not dead

The benefit of points and condenser is that failure is almost always gradual, but also inevitable, even with good maintenance. But they are easy to diagnose and service. The benefits of electronic ignition are precision, consistency, a modern curve, and better spark. The downsides are cost and black box failure mode.

Also, I've motored long enough with restored cars to caution that an ignition coil's failure modes are devilish and life expectancy is not much better than an ordinary light bulb. Start with a fresh one. I spent Ferrari money on a couple of old Marelli coils with proper "Tootsie Roll" resistors. When Bill Gillham offered to paint and dress up a blue Bosch coil with a nice looking placebo resistor, I knew that this is the smarter option I will not regret.

Carbs: Those Precious But Pesky DCO3s

Of course, my DCO3s had worn and leaking throttle shafts but they were also ruined by the previous gorilla with a screw driver and wrench. He crunched the venturis oval and destroyed the idle jets that he screwed into their seats. But expensive repairs came with a bonus fix for poor idle. New adjustment needles came in cartridges, installed cleverly not flush, but projecting about 1.5 mm into the relatively slow airstream at idle. I suspect this reduces wetting of the walls – the "rich" part of the mixture that the ignition fails to burn. AEM (Advanced Engine Management), in Costa Mesa CA, developed this kit to improve the bad manners of old race cars when driven on golf courses.



Balancing DCO3s after linkage was improved

Carburetors are passive listening devices designed to flow and meter fuel then vaporize it into a stream of air sucked into a cylinder by the piston. I say listening, because sound, or air pressure, is their only information about what is needed. Their purpose is to deliver fuel as a mist in air, 13 parts mass (weight) to 1 part fuel. A venturi is usually used to create negative air pressure proportional to its velocity to suck out the appropriate amount of fuel from various sources in the carburetor. DCO3s have no mixture-enriching feature nor air choke. Only good ignition and engine cranking, while squirting extra fuel with the accelerating pump via the gas pedal has to do the job. This is very primitive, but it will start, even in sub zero weather I'm told.

Balancing those carbs is another difficult matter compared to the more sophisticated DCOEs with mechanical enriching function. Their split, but common, throttle linkage and threaded plugs over transition ports are designed to easily balance those carbs (drawing the same amount of air). Not so with the DCO3s, on two counts. Each has its own cantilever from a common throttle shaft (make sure they can't easily slip!). The factory's threaded link from them to each carburetor is too simple. I replaced mine with two LH/RH threaded rods and two LH sockets to make fine adjustment possible. I also made an adaptor for the air box to measure airflow individually.

750 Headers

I'm happy, but sorry to tell you that the only part of my engine rebuild that is impossible to repeat, is my beautiful tapered-tube header (see Part 1). I found it on eBay two weeks before Bill Gillham installed my engine. My original headers were dented and light weight – cratered like the moon but by rust – but dressed in a silver ceramic coating. My treasure from eBay was like new, tapered, in satin gray ceramic, with flanges inscribed "Abarth!" Bill said they fit perfectly and saved hours of time. You can find a 20-second video with sound of my engine's first run at Hooligan Racing at www.enjoyclassiccars.com/videos.html.

Conclusion

My lessons learned were not easy to describe succinctly and this still is probably more than you want to know about the true cost of originality. The smart choice for a needy older Giulietta used to be to fix her up with a 101 engine. And for me it still is, unless the car will be driven with respect for her age. That's why my Normale Sprint has both. Most of her 750 engine (and transmission) is in the attic.

Peter Pleitner