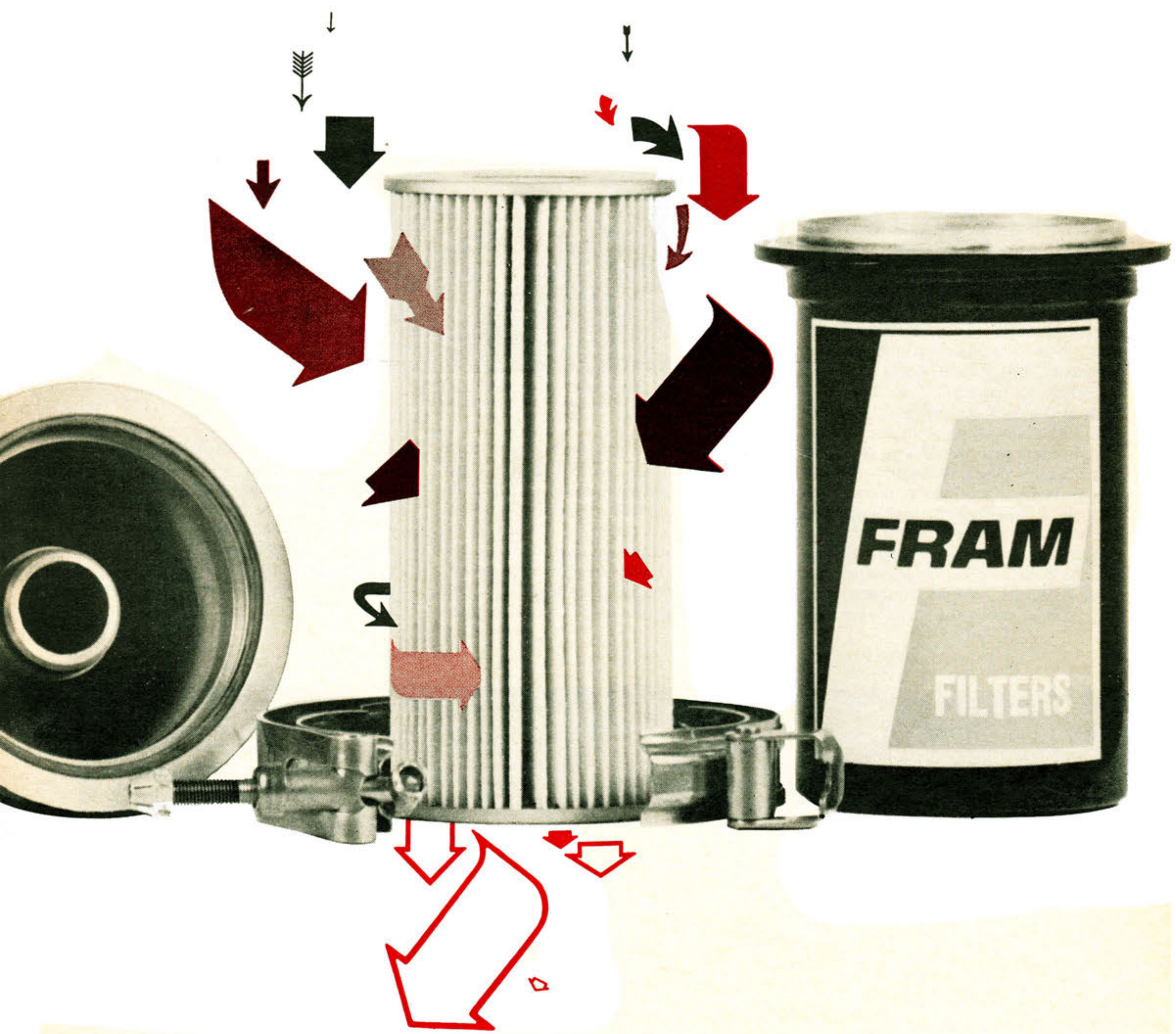


MICRON MAGIC

Some Scientific Sifting For Full-Flow Filtration

BY ALLEN HUNT

MODERN AUTOMOBILE engines, with tight clearances and micro-finished surfaces, could not display their characteristic long life without efficient oil filtration. Any engine, no matter how well built or maintained, will collect an astonishing amount of contaminants in the crankcase oil. Dust enters through the carburetor and crankcase ventilation system and is drawn in through the bayonet gauge sleeve. Carbon particles come down from the combustion chamber with the blowby gases to form sludge and varnish when mixed with water and crankcase chemicals. A new engine has within it tiny metal chips and bits of core sand that are picked up by the oil. These foreign particles destroy the rubbing surfaces very quickly if not immediately removed by high quality oil filtration.

THE IMPORTANCE of oil filtration in high-performance engines was emphasized recently by the entry of the Fram Corp. into major league auto racing. Fram has revolutionized the field in less than two years. The firm's special racing oil filters were on all 33 Indianapolis starters last year. Now they're being used on Formula I cars and sports/racing prototypes and they are starting to be used on drag racing and the oval track competition cars.

In years past, racing engines have not been equipped with anything extraordinary in the way of oil filters. Generally, full-flow types, modified from units designed for passenger cars or trucks, have been employed. There seemed to be no great need for anything more complex. Then came the dohc Ford Indianapolis engine, built like a fine watch. When tuners and drivers started revving this creation to more than 8500 rpm for the 1965 race, trouble started.

The basic problem was that the Ford lubrication system was designed for a very high oil flow rate—up to 12 gal./min.—hence the oil could double as a coolant, to carry off much of the heat generated by lower end friction, with the help of oversize oil cooling radiators. The full-flow oil filters supplied by Ford were unable to accommodate this volume of oil. When the filters became plugged with contaminants, some of the flow was retarded and bearings disintegrated. Filters also weren't filtering finely enough. Bearings were scored by too-large particles that passed through, although identical particles never would have caused trouble in a passenger car engine with lower loadings and looser clearances.

The 1965 problem with Ford engines was solved temporarily by adapting Purolator high-flow aircraft filters with a slightly tighter micron rating. Els Lohn, proprietor of the Eelco Manufacturing Co., carried a number of these in stock and sold them like hotcakes around the Indianapolis Speedway garage area in May. They were efficient, but the filter units were so large that they were mounted outside the bodyshell in most cases.

This is where Fram saw a great need for a special compact, high-flow, high-efficiency oil filter for racing engines that would be small enough to mount on the engine itself. The firm decided to look into the problem as a means of promoting its products with the youth and performance markets. In the months after the 1965 Indianapolis 500, Fram engineers spent a great deal of time in California garages and dynamometer rooms, studying the filtration problems of both Ford and Offenhauser engines. What these engineers produced was an adaption of a $200 filter Fram manufactures for the aerospace industry for use in missiles and military aircraft. Basically a conventional pleated paper filter with a 15-micron rating, it offers over 800 sq. in. of filtering surface area in a casing that can fit on the engine (or almost anywhere nearby). The unit has double O-ring sealing throughout, and is built with space-age materials and machining methods. The original Ford filters had a 25-micron rating and 50 sq. in. of filtering area.

THE NEW filter solved the Ford lubrication problems overnight. Fram is off and running in the performance field. The more accessory manufacturers that become interested in racing, the more quickly race-bred technical improvements will appear on everyday cars.

An examination of oil filtration problems for these everyday cars should start with an explanation of "micron rating." This is an industry measurement for extremely tiny dimensions. One micron is 39 millionths of an inch (0.000039). The width of a human hair is approximately 50 microns. Engine designers continually reduce maximum allowable micron sizes of particles in oil, to meet today's tighter clearances and finer finishes. The latest figure under discussion is 25 microns. This means that an oil filter must remove anything larger than half the width of a human hair. The majority of today's better filters are rated between 15 and 25 microns.

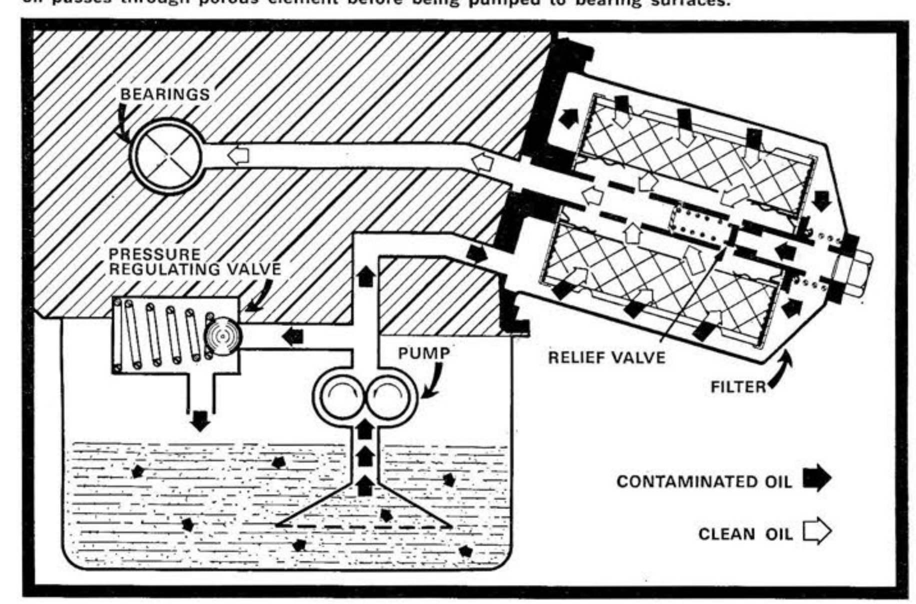
The basic problem in oil filter design is to produce low micron filtering ability with sufficient flow capacity to accommodate the full volume of oil in the engine's lubricating system. The average modern car engine will flow about 2.5 gpm of oil through the system at a road speed of 45 mph. Modern full-flow filters will handle this volume and filter efficiently down to 15 microns. The unit that accomplishes this measures 4 in. in diameter by 5 in. long.

The older bypass (partial-flow) filters were no larger than this—and they would filter down to 2-5 microns, but they could carry only 10% of the oil flow. The bypass filters proved inadequate on new engines, in which a considerable amount of metal chips and core sand enters the oil in the first few miles of driving. With filters able to carry only 10% of the oil flow "per cycle," these foreign particles did great damage to new engines of the 1950s. Carmakers sought full-flow filters for this very reason. Filtering was not quite as fine in the long run, but the engine was better protected in those first few miles and for the full life of the car. Thus overall engine life and reliability were improved.

WHY CAN'T LOW micron rating and large flow capacity be combined in one unit? A filter that could handle up to 5 gpm and filter to 2 microns is possible, but it would be as big as an ashcan!

The principle of an oil filter is to pass the dirty oil through a porous material that will catch and hold the larger particles, while permitting oil, with smaller particles suspended therein, to pass on through with a minimum of ▶

SCHEMATIC SHOWS present-day passenger car filtration system in which all oil passes through porous element before being pumped to bearing surfaces.



FILTERS

pressure drop, or restriction. Generally, there are two types of oil filters. "Depth" units, in which the filtering material is a mass of fibrous material such as cotton, wood chips, synthetic fibers or thread, have very fine filtering ability, but cannot accommodate large flow volumes unless the filter fiber is very coarse. The "surface" filter passes oil through a single layer of a porous material—usually paper. The oil path through the paper is a labyrinth, with sharp twists and turns that trap the particles. The surface filter has a high flow capacity, but a poorer micron rating. The micron rating can be lowered by using a less porous paper, with a larger area of surface for the oil to flow through. This is accomplished by folding the paper into deep pleats and rolling the pleated sheet into a small round casing. A typical Fram pleated paper filter uses porous paper 0.042 in. thick, which offers 650 sq. in. of surface area in a cartridge 3 in. in diameter by 4 in. long. The micron rating is 15.

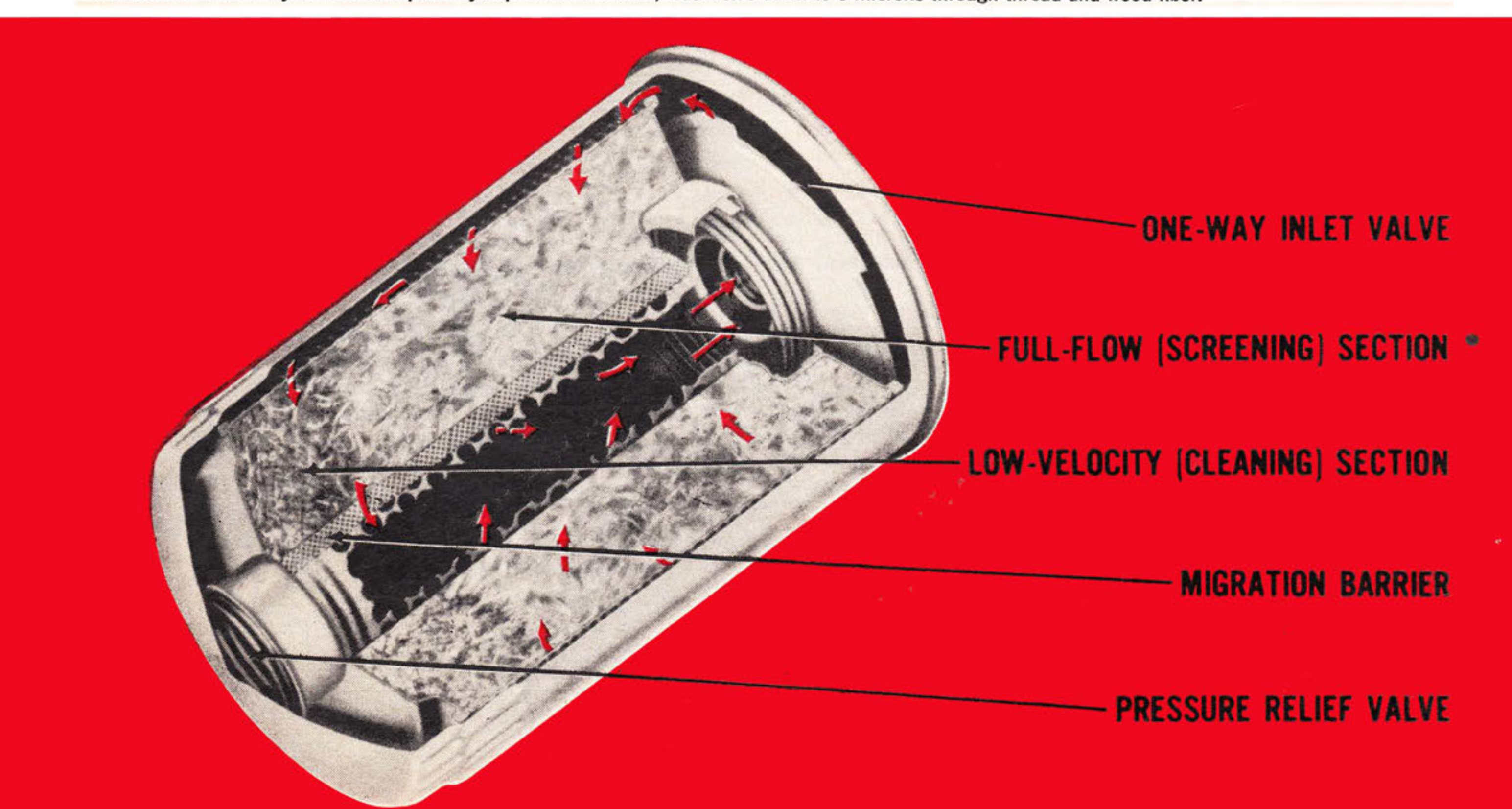
The key to the performance of any oil filter is in the chemistry and mechanics of the filtering material. The majority of manufacturers use pleated paper filters as standard equipment. For example, Fram filters of this type use resin impregnated, heat-cured paper composed of wood and vegetable fibers. Fram has experimented with hundreds of paper compositions based on everything from corn husks to coconut shells. On the other hand, Ford uses an Autolite dual-depth-type oil filter for its cars. This filter employs a very coarse viscose acetate fiber section that carries full oil flow in conjunction with a section of fine cotton threads and wood fiber that takes only a percentage of the flow. The design attempts to combine the benefits of bypass filters and full-flow filters. The depth section of the Ford design filters down to approximately 5 microns.

How long will an oil filter do a good job of filtering? This question is difficult to answer because filter life depends very much on driving conditions. Driving in dust naturally will plug a filter more quickly than engine operation in clean, damp conditions. What happens is that the pressure drop, or restriction, across the filter gradually increases as the element is progressively clogged with dirt. Eventually a relief valve opens and bypasses oil around the filter. There is no danger of the oil flow being cut off. A new filter has a pressure drop of less than 1 psi at rated flow. Relief valves are set for 7-10 psi. Above this pressure, the filter is clogged and is not providing filtering action.

Many carmakers recommend changing oil filters at 6000-mile intervals. This seems to be stretching things a bit, as the carmakers are likely to do in attempting to simplify maintenance requirements. Filter engineers say it is possible to activate the relief valve at well under 5000 miles of normal driving and at less than 2000 miles under heavy dust conditions.

HENCE A DRIVER can't be far wrong if he changes both the oil and filter at 4000-mile intervals for normal driving and 2000 miles for dusty conditions. The oil filter does its most important job in the first few miles of driving on a brand new car when it is removing metal chips and core sand. In this light it may not be a bad idea to make the first filter change at 1000-2000 miles.

AUTOLITE FILTER directs oil through a deep mass of fine fibers and a full-flow screening section of coarse rayon fiber. The low velocity section accepts only a portion of the oil, but filters down to 5 microns through thread and wood fiber.



This could improve the life of the car.

One fact about modern oil filters is that filtering efficiency does not fall off gradually as the pressure drop rises and the element is clogging up. Filter engineers say the micron performance of a filter remains steady, or may even improve slightly as the miles roll up. When the relief valve opens at 7-10 psi restriction, however, filtering action is lost all at once.

Do oil filters remove valuable additives from oil? Definitely not. The action of an oil filter is strictly mechanical, not chemical, and oil additives are chemically compounded with the base oil.

The action of the detergent additive in oil is to coat, or surround, small particles and hold them in suspension. This prevents impurities from collecting in larger masses of sludge that can block passages and score rubbing surfaces. Obviously, the oil filter will catch and hold the additive chemical that surrounds the particles when it catches the particles. However, the detergent additive already has served its function at this point and can do no additional work.

The earlier statement that the action of an oil filter is strictly mechanical throws suspicion on filters that feature "sacrificial anode" units, said to neutralize acids in the oil. It is significant that none of the major filter makers sees much practical value in this principle.

What about oil foaming in relationship to filters? Foaming is the mixing of air with oil, generally due to the violent whipping action of the crankshaft and rods. This is frequently a problem with competition engines turning at high rpm. The lubricating ability of the oil is radically reduced, the effective capacity of the pumps is reduced and foamed oil is easily blown out of the crankcase vent pipes.

UNFORTUNATELY, the oil filter has little ability to correct an oil foaming problem. There may be some effect in breaking up air bubbles as the oil passes through the filter element, but problems of oil pumping and blowing remain. All modern motor oils have antifoaming additives that act by reducing the surface tension of the compound, so air bubbles break as soon as they form.

These additives are very effective. Engine designers say, however, that foaming problems are caused by the oil level in the crankcase being too close to the spinning crankshaft. The crank or rods need not actually touch the oil to cause foaming. The "windage," or turbulence caused by the air whipping action, can do it when the crank is one or two inches from the oil. Also, the oil level tips up in the rear of the crankcase when the car is accelerating, which sometimes brings the oil level up to the crank. Overfilling the crankcase with oil can cause serious foaming. Some drag car designers have made measurable gains in performance by deepening their oil pans to lower the oil level as much as four or five inches below the crank swing.

Thus it is that an oil filter should not be expected to correct an oil foaming problem.

What is the future of oil filters? Auto engineers for some time have discussed the "sealed" engine that would run for 50,000 miles or more with no more attention than filling the tank with gasoline as required. These engines supposedly will use synthetic lubricants in sealed crankcases. Oil consumption would be nil and the oil would be unaffected by dilution with water or raw fuel draining from the cylinders.

There will be no additives to be depleted because the oil compound molecule will be tailored to do exactly the job required. Of course, oil filters/sealed engines will be required to do an efficient job for ten times as long as they do today. Filter engineers know how to build such extended-life filters, but they are huge, three or four times as large as today's filters. Engineers simply must find a way to make them smaller. ■

GRAHAM HILL'S winning effort in the 1966 Indianapolis 500 was aided by Fram's revolutionary new oil filter which offers a 15-micron filtration rating over 800 sq. in. of surface area. The filter is small enough to fit on the engine itself.