



Souping the VW and Renault

SPORTS CARS ILLUSTRATED

JULY 1956

14 PAGE
SPECIAL
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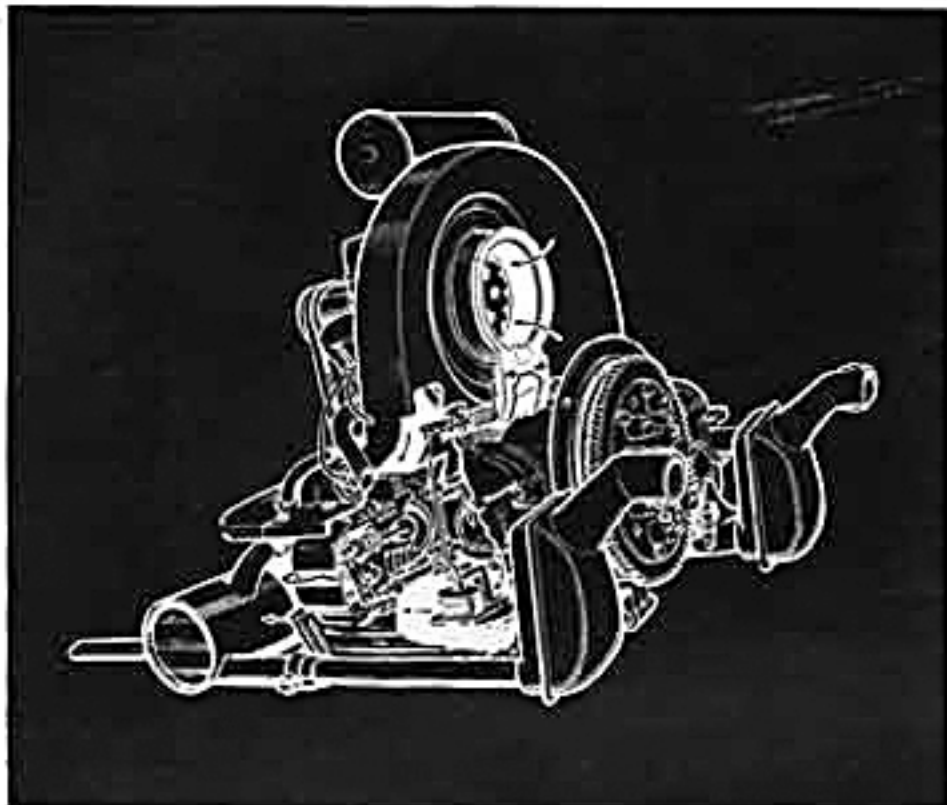
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Tech Report:
PBX Special



Cutaway of VW engine shows path of cooling air as it is forced around cylinders, oil sump, and transversely seated muffler.

Vitality



for the

By **RUSS KELLY**

IF THERE'S anything in the world that the top brass at Volkswagen has strong feelings about it is the owners who mess with VW engines. The factory has announced, for example, that dual carbs may be fine for the Porsche, but they're no good for the VW. The VW owner's manual bristles with warnings and admonitions that add up to the statement, "You want to soup it? DON'T!"

There are plenty of good reasons for this policy. The little car is known all over the world for its unbeatable reliability and economy, and this is a reputation that the factory does not want to have marred by souping attempts that may destroy the sound, sensible balance of VW engineering.

At the same time, however, not even the most fanatic VW devotee — and there are lots of them — would deny

that the car could use some additional power. Innocent passengers are sometimes completely scattered by their first experience with a grimacing, muttering VW driver, rowing his little car along with the gear lever, in mortal combat with a head wind. Or, there's the unforgettable experience of getting out in the middle lane to pass a car and suddenly finding yourself trapped and marooned, without enough acceleration to escape back to safety. Or, there's the familiar VW rolling-country technique of winding the needle off the speedometer dial going downhill in order not to have creep snail-like up the other side.

When the VW first appeared in this country many enthusiasts thought it looked like a natural for hot-rodding, but they found very quickly that the engine's designer had done his utmost to outwit them. He had built restrictions

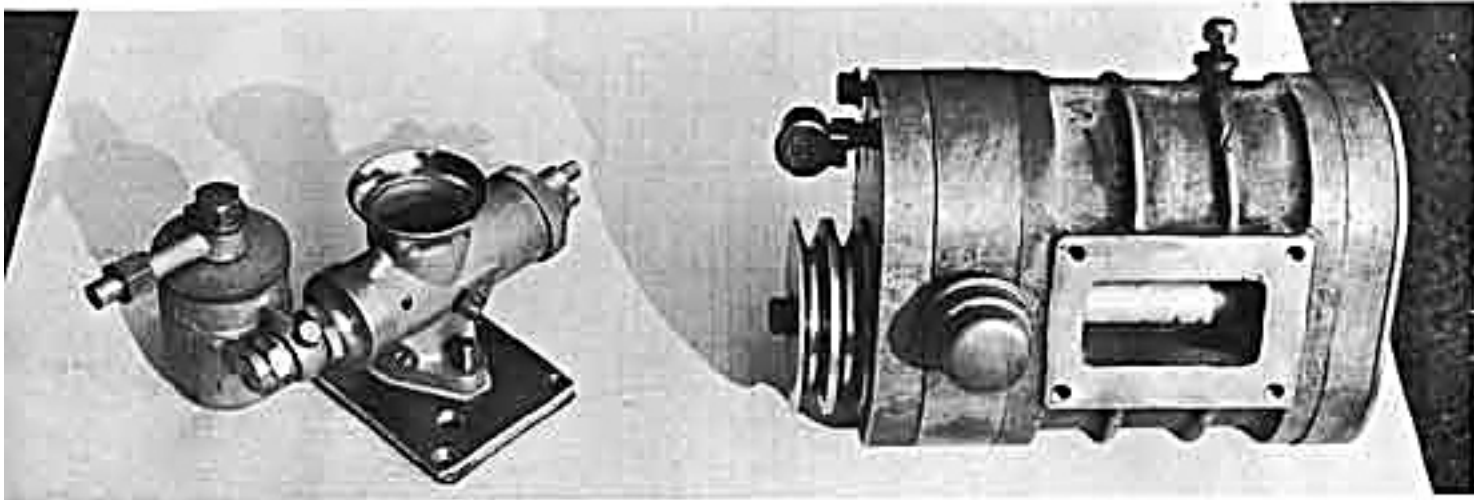
into the engine that are incompatible with high output per cubic inch. The head porting and valve arrangement are enough to make a strong man weep. The valves stand vertically in the heads and are of very small diameter. They can be enlarged, but then you're whipped at the ports.

The intake port is siamesed, entering the head as a single port and then branching to feed the two cylinders. Since a single port to each cylinder is generally considered necessary for good volumetric efficiency, standard hop-up procedure is to enlarge a siamesed port throughout and then divide it with a fabricated wall. But on the VW even this simple modification can't be carried out because of the thinness of the metal around the ports. An Austrian manufacturer makes special heads for his limited-production

VW-based cars, but their price is prohibitively high.

However, a number of U.S. speed specialists have found ways to make VW souping pay, and they're doing it economically. They're doing it by *ignoring* the limitations of the heads. They're concentrating on (1) supercharging or (2) combinations of valve timing, compression ratios, carburetion, and exhaust manifolding. Either treatment can make of the VW a pretty exciting poor man's *gran turismo* car, with far better torque and acceleration, good road averages, top speed of from 80 to 85 mph — and with no adverse effect on economy and reliability.

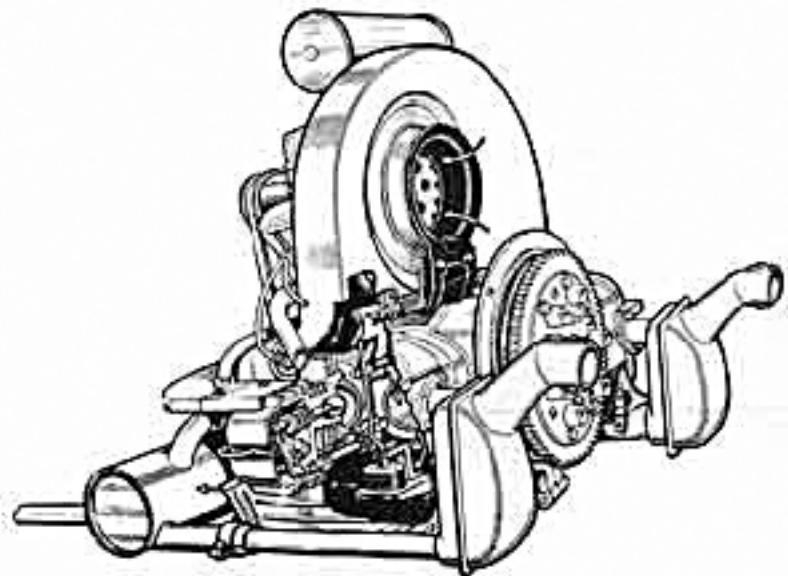
Aside from its built-in throttling the VW engine is an excellent base for hop-up operations, and it is anything but stressed. Engines produced before January of '54 were rated at 25 bhp at 3300 rpm and later models pull 30 at



Pepco three lobe Roots type blower, and a 1-1/64 inch throat diameter Amal-type carburetor. Because of air "slippage," blower is more efficient at upper rpm scale.



Stock head shows small sized valves. Any possible gain made by the installation of larger valves is effectively nullified by barrel spigots which cannot be relieved.



SPECIFICATIONS FOR VW

| | BORE | STROKE | PISTON AREA | SWEPT VOLUME | COM- PRES- SION | IGNITION | CARBURE- TION | IN. OPENS | IN. CLOSES | EX. OPENS | EX. CLOSES | BHP |
|----------|-------------------|-------------------|--------------|----------------------|-----------------------|----------|------------------------------------|-------------|--------------|--------------|-------------|--------------|
| 1953 | 75 mm 2.96 in. | 64 mm 2.52 in. | 27.4 sq. in. | 1131 cc. 69. c.i. | 5.8 | BOSCH | Single Solex 28 PCI | 2 1/2° BTDC | 37 1/2° ABDC | 37 1/2° BBDC | 2 1/2° ATDC | 25 @ 3300 |
| 54-55 | 77 mm 3.03 in. | 64 mm 2.52 in. | 29. sq. in. | 1192 cc. 73. c.i. | 6.6 | BOSCH | Single Solex 28 PCI | 2 1/2° BTDC | 37 1/2° ABDC | 37 1/2° BBDC | 2 1/2° ATDC | 30 @ 3400 |
| 1956 | 77 mm 3.03 in. | 64 mm 2.52 in. | 29 sq. in. | 1192 cc. 73. c.i. | 6.6 | BOSCH | Single Solex 28 PCI | 2 1/2° BTDC | 37 1/2° ABDC | 37 1/2° BBDC | 2 1/2° ATDC | 30 @ 3400 |
| Modified | 80 mm 3.15 in. | 64 mm 2.52 in. | 31.2 sq. in. | 1284 cc. 78 c.i. | 7.0 | BOSCH | Dual Solex or Dual Amal type | 19° BTDC | 55° ABDC | 54° BBDC | 20° ATDC | 40-45 @ 4400 |



Abarth dual exhaust system is an excellently engineered piece of equipment. Consensus has it as a must on stock, blown or modified VW's.

Special 80mm 7-1 piston on left slightly domed. Piston on right has concave head and a compression ratio of 5.8-1. Barrel is stock cast iron.



3400. At this crankshaft speed, piston speed is a paltry 1500 feet per minute — almost as low as the power output. With standard tires the 3.5 to one top gear ratio gives a road speed of about 21 mph for every 1000 rpm and a top speed of about 65 mph.

Then engine base itself is of rugged design. The horizontally opposed four cylinders are mounted on a rigid, barrel-shaped, built-up aluminum crankcase. This case splits down the center line of the four main bearings. Mains 1, 3 and 4 are of the bushing type and No. 2 is a split-insert shell. The short, husky connecting rods carry lead-bronze steel backed inserts. The firing order is 1-4-3-2 and out of balance forces within the engine are almost non-existent. All this is reassuring to the owner interested in improved performance.

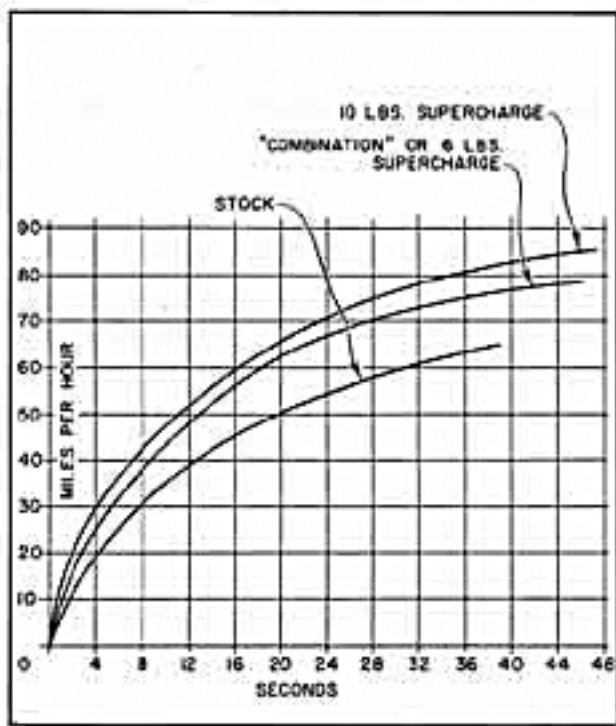
Probably the country's leading practitioner of factory-permitted modifications to VW engines is JEM Engineering of Sherman Oaks, California. Their combination yields an increase in power output of about 40 percent and incorporates most of the major changes possible from the standpoint of practicability. Non-factory-permitted methods can be equally reliable.

The first step is the fitting of oversize, high compression pistons. 3.15-in. (80 mm) pistons are used in both the large and small bore engines. They bring the cubic capacity up to 78 cu. in. (1284cc) — a seven percent increase for the big-bore job and 13 percent for the pre-'54 engine.

BELOW: Complete Pepco kit is simplicity in itself. Shown here are belts, brackets, crankshaft-pulley and tiny pop-off valve to smother any backfire effects.



The Judson vane type compressor installed using a stock 28 PCI carburetor. The little Ghia coupe accelerated from 0-60 in 15 seconds, half of stock time.



The resulting compression ratio is only seven to one. Higher ratios have been tried but without success.

This increase in bore also has the theoretical advantage of increasing the piston area. The higher compression ratio — stock is 5.8 — aids mainly in two ways. First, it improves the pumping action and so improves volumetric efficiency. Second, by compressing the gasses more tightly it increases burning efficiency. All of these advantages, with perhaps the exception of the last, are unfortunately directly dependent upon the rather primitive induction setup. This is where the second factor is introduced and the word "combination" becomes significant. This factor is altering the valve timing.



Semi-race cam on left, Iskenderian "401" with radiused tappet in the center, and full race grind on the right. The "401" grind forms basis for VW cams.

The problems of camshaft engineering are not just confined to the opening and closing of valves. Among other things the all-important consideration of getting the valve to follow the contour of the cam at high engine speeds must be dealt with. The position of the engineer who must face the additional handicap of modifying another man's design is not an enviable one.

Iskenderian Racing Cams of Los Angeles have developed not one but three refinements on the VW cam: a road grind, a semi, and a full-race. Norris Baronian, the firm's knowledgeable young engineer was very generous with hard-to-get information.

He explained that the VW designers, following the dic-

(Continued on page 61)

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VW

(Continued from page 49)

tates of low weight and compactness, chose a radius-type cam follower. This design is excellent for use with the hollow-flank or constant-acceleration cam which happens to be an Iskenderian specialty. Using the same principles applied in their 101 and Offenhauser grinds, the VW cam lift was increased and the rate of opening and closing accelerated. The popular road grind has a lift of .318-in. at the cam. The opening rate is such that at top dead center the valve is already .060-in. off the seat and is fully open at 90 degrees after TDC, when the piston has reached maximum velocity. This in itself is a tremendous step in overcoming the disadvantages of the VW's small valves and restricted porting.

The inevitable loss of power at low speeds associated with high-performance valve timing has been kept to a minimum here because the stock VW is so "under-cammed" that the low-speed characteristics of the modified

camshaft are almost within the limits of "normal stock" practices. A smooth idle is possible and if anything is lost "at the bottom" the increase in compression ratio effectively offsets it. The drawings show the various grinds compared to stock VW timing. Naturally, increased overlap is exploited as a means of improving breathing efficiency. But to take full advantage of this modification, a well-engineered exhaust system is essential, and that's the third important part of the combination.

Actually, it's the most important single factor and, by itself, it makes a big improvement in performance. It is interesting that even the factory relented on this point after reportedly being against it earlier, and has fitted dual exhausts to its latest models. But most tune-up experts continue to swear by the excellently-engineered Abarth exhaust system for all VW's.

The stock VW intake manifold's extreme length and small diameter exaggerates all the classic ills of carburetion. Pulsation, wall-friction, uncontrollable column inertia are only a few of the maladies that deliver unbalanced volumes and mixtures to the VW's cylinders. Some owners are con-

tent to settle for the limited top speed of the single-carb modified unit, feeling that the extra expense of fitting dual carbs is not worthwhile for only a few mph gain in top speed and very little improvement in acceleration. But the marked reluctance of the engine to rev freely with the single *vergaser* actually takes a lot out of overall performance figures. Higher shifting points reached sooner in second and third gears make this final change very desirable.

It's true that the fitting of two carbs, even with their short manifolds, will not completely cure all the VW's breathing problems, but it does increase the venturi or carburetor throat area. The importance of this at high revs becomes clearer when it is realized that throttle action is simply a method of varying the effective throat area. For the dual-carburetor conversion, two stock Solex 28PCI carbs with stock jets may be used, which involves the fabrication of special manifolds and throttle linkage. A complete kit, containing two Amal-type carbs and all necessary incidentals, is available from Competition Chemicals, Iowa Falls, Iowa, for \$80.

The cost of the complete "VW rou-

combination treatment" will naturally vary from shop to shop but should cost in the region of \$300, including dual carbs. What you get for this sum is a horsepower increase ranging from 40 to 50 percent, with a proportional, gratifying improvement in performance.

Equal or better gains can be made by the simple, bolt-on technique of adding a supercharger. In fact, with high boost pressures, the meek VW becomes a Chevrolet-hunting tiger!

Supercharging has often been maligned in the automotive world but, like the two-stroke cycle, has fascinated some of the world's ablest engineers. The principles of supercharging are simple; their application is complex.

The function of a supercharger is to deliver to the cylinder more fuel-air mixture by weight than is possible by normal atmospheric induction. In simpler terms, the fuel-air mixture is compressed, increasing the weight for any given volume, and then is delivered to the cylinder in this state. Since an internal combustion engine's power potential depends on the amount of fuel-air mixture by weight that it can burn in a given time, supercharging obviously is a very direct way to improve performance.

Also, supercharging is a simple, un-subtle method of over-riding defects, intentional or otherwise, in atmospheric induction systems. It works like a pulmotor; the patient and its response to this therapy is dramatic.

The problems of developing a supercharger perfectly suited to the VW's requirements have been solved by several qualified manufacturers. The prices vary and the results vary, but all are equally simple to install.

The maximum boost with the Judson unit is about 6.5 lbs., which provides a hp boost of about 50 percent. The added urge with this low boost pressure is readily explainable. A really efficient ohv engine with its highly developed induction system would register little response to blowing. But the VW, having been deliberately throttled at the valves, shows great improvement. It's worth keeping in mind here that even with an increased output of 50 percent the supercharged VW still is producing less bhp than most other *stock* engines of similar displacement.

The Judson blower gives the VW about the same performance as the internal "combination" treatment. It costs \$159.50, installed.

Another popular answer to blowing the VW is the Roots-type, U.S.-made Pepco unit. Like the Judson, it's bolted directly to the stock VW mani-

fold and is driven off the crankshaft by twin belts. Like the Judson, it utilizes the stock carb, but its claimed boost comes as a distinct shock: 10 lbs. After a little reflection this pressure doesn't seem excessive. Remember, we're still dealing with mixture weight delivered and burned. Ten lbs. maintained against the recalcitrant VW manifolding will result in considerably less weight delivered to the cylinders in a given time than would be the case with a free-flowing induction system.

The Pepco Roots blower suffers slightly from mechanical inefficiency at low rotor speeds. This is due to the slip-loss or leakage past the necessary clearances between the rotors and the casing. However, this forms a diminishing fraction of the total volume of air pumped as speeds go up. Overall efficiency with this blower is very high. The results are profoundly, overwhelmingly apparent. In fact, they're shatteringly convincing.

Pepco superchargers are made in Dayton, Ohio. They and the Judson units are available on the West Coast through Bill Corey's Empire Motors, Pasadena, Calif. The persuasive Pepco supercharger, with all necessary components, sells for \$199.50.

I remember the days when superchargers on American race cars were accurately referred to as vacuum cleaners. This was because they sucked up everything in their path that wasn't nailed down. When you buy a blower you want it to last as long as your engine. The suppliers have skimmed in the air-cleaner department. But that's something you can correct yourself for a buck or two. What counts the most is that means actually have been found to confound even the most careful plans of the VW factory. #