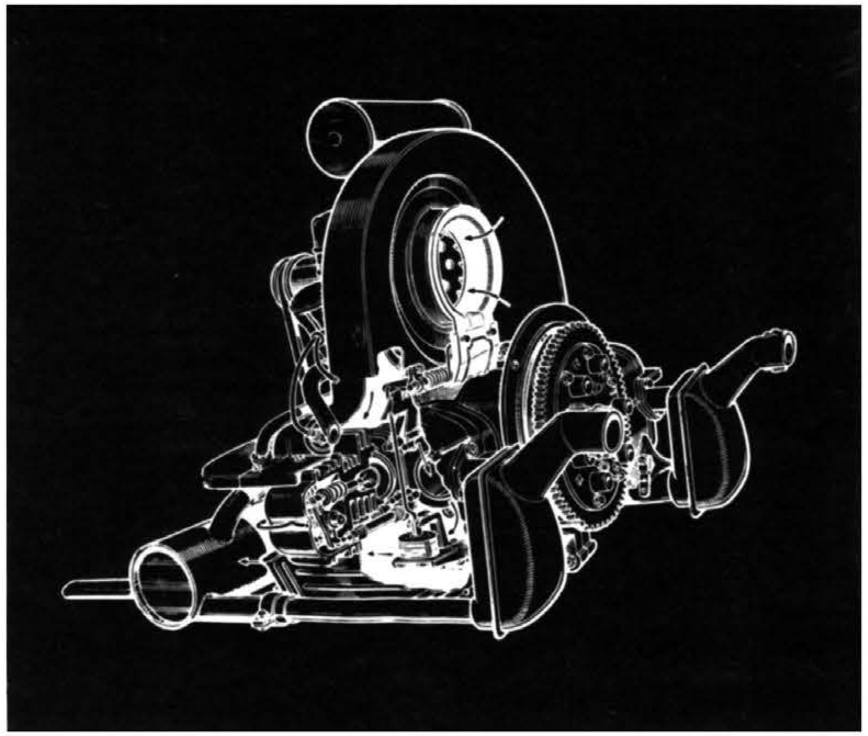


*Cutaway of VW engine shows path of cooling air as it is forced around cylinders, oil sump, and transversely seated muffler.*

# Vitality for the VW

**By RUSS KELLY**

IF THERE'S anything in the world that the top brass at Volkwagen 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.

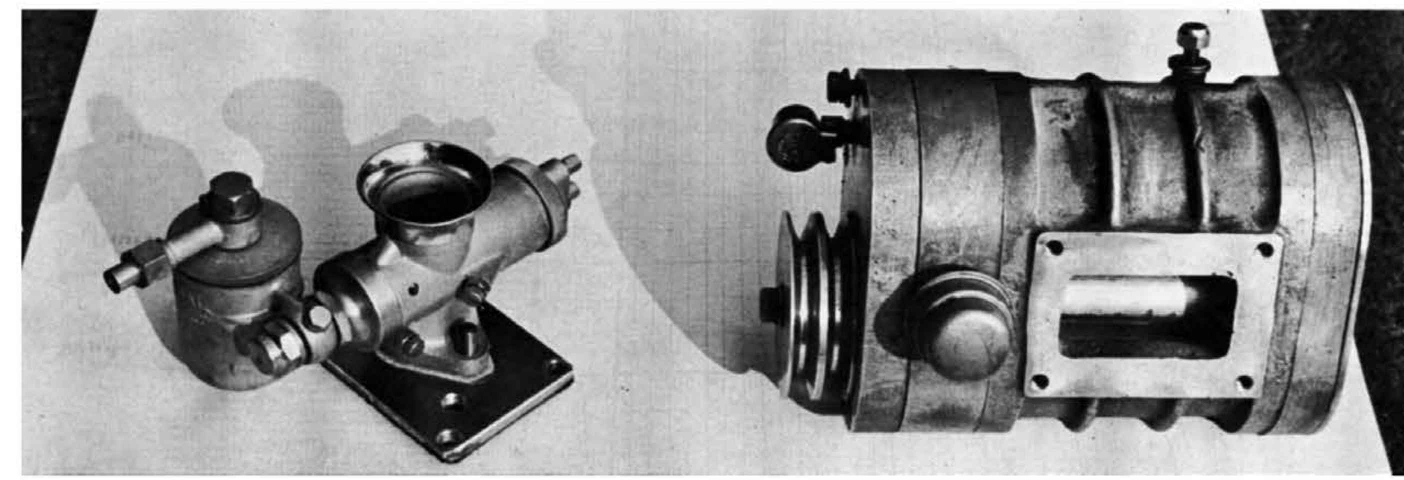
At the same time, however, not even the most fanatic VW devotee – and there are lots of them – would deny that the car could use some additional power. Innocent passengers are sometimes completely shattered by their first experience with a grimacing, muttering VW driver, rowing his little car along with 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.

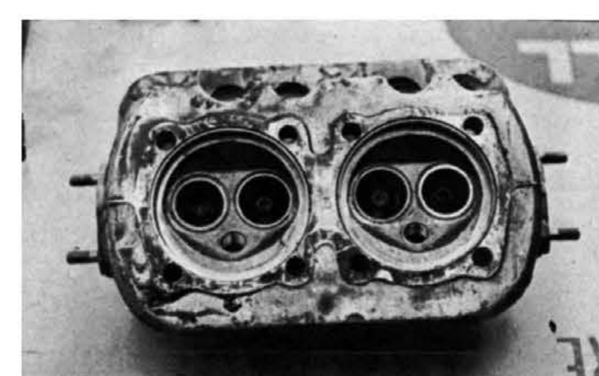
The intake port is siamesed, entering the head as a single port and then branching to feed the two cylinders. Since a single port to each cylinder is generally considered necessary for good volumetric efficiency, standard hop-up procedure is to enlarge a siamesed port throughout and then divide it with 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.

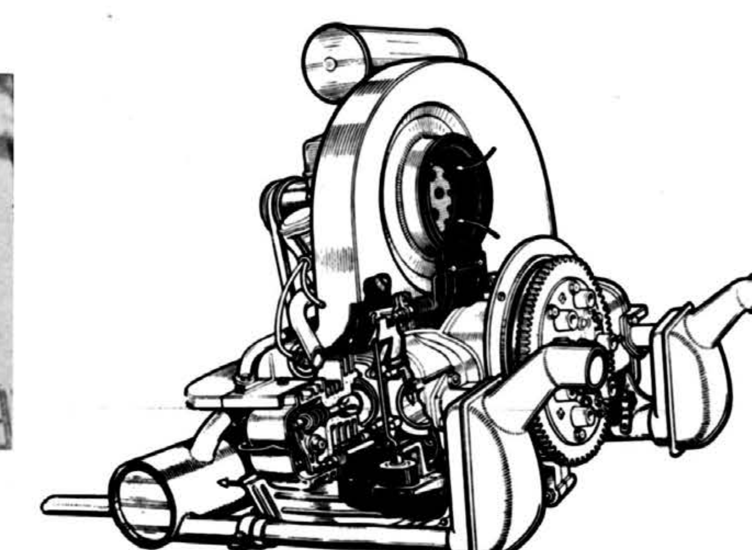
Aside from its built-in throttling the VW engine is an excellent base for hop-up operations, and it is anything but stressed. Engines produced before January of '54 were rated at 25 bhp at 3300 rpm and later models pull 30 at



*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 | 2½° BTDC | 37½° ABDC | 37½° BBDC | 2½° 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 | 2½° BTDC | 37½° ABDC | 37½° BBDC | 2½° 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 | 2½° BTDC | 37½° ABDC | 37½° BBDC | 2½° 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.*

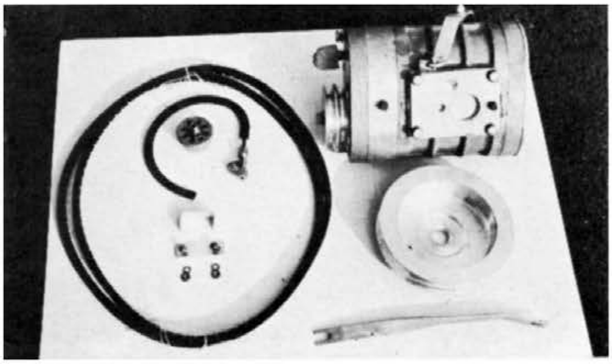
3400. At this crankshaft speed, piston speed is a paltry 1500 feet per minute — almost as low as the power output. With standard tires the 3.5 to one top gear ratio gives a road speed of about 21 mph for every 1000 rpm and a top speed of about 65 mph.

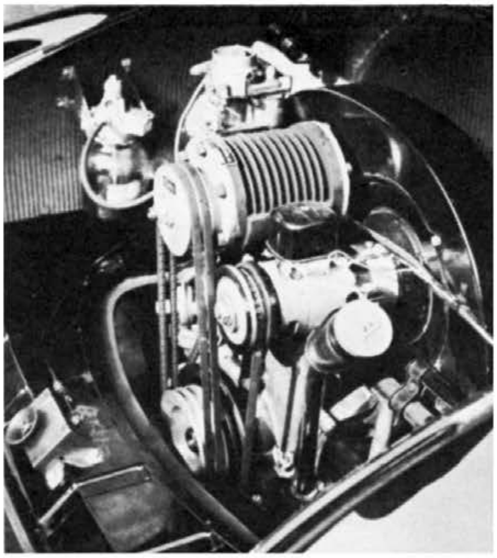
Then engine base itself is of rugged design. The horizontally opposed four cylinders are mounted on a rigid, barrel-shaped, built-up aluminum crankcase. This case splits down the center line of the four main bearings. Mains 1, 3 and 4 are of the bushing type and No. 2 is a split-insert shell. The short, 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.

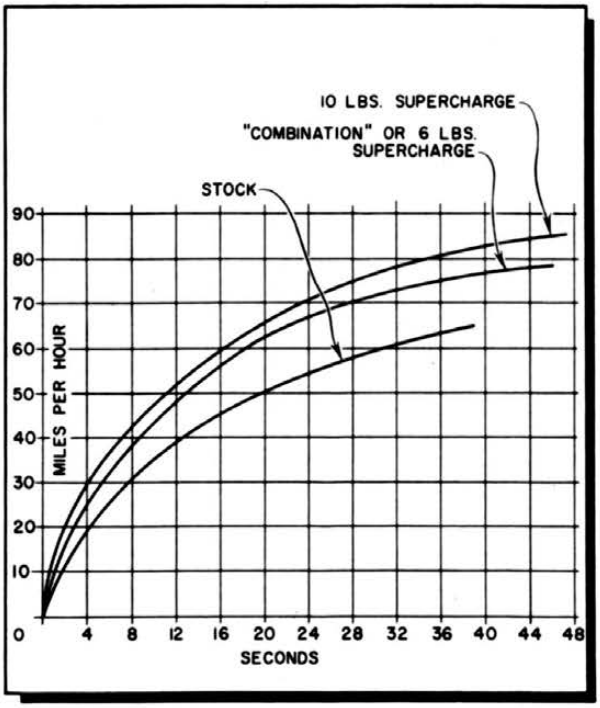
The first step is the fitting of oversize, high compression pistons. 3.15-in. (80 mm) pistons are used in both the large and small bore engines. They bring the cubic capacity up to 78 cu. in. (1284cc) — a seven percent increase for the big-bore job and 13 percent for the pre-'54 engine.

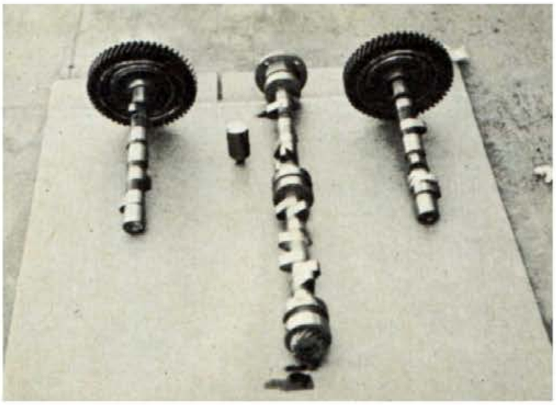
BELOW: *Complete Pepco kit is simplicity in itself. Shown here are belts, brackets, crankshaft-pulley and tiny pop-off valve to smother any backfire effects.*





*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.*



*Semi-race cam on left, Iskenderian "404" with radiused tappet in the center, and full race grind on the right. The "404" grind forms basis for VW cams.*

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.

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 64)*

# Renault

(Continued from page 45)

save a lot of work by taking the parts off and laying them out in sequence. Try the other way and find out why.

A replacement manifold is available from Renault and is actually the optional '55 manifold. It is perfectly satisfactory and could be easily modified to a two-carburetor set up but we haven't reached this stage yet.

The new manifold requires two extra studs in the head. The studs that come in the kit have metric threads so you are better off using 5/16" into the head. The muffler installation presents no particular problem. On our own job we used a Hollywood muffler, cut out the holding brackets from the Renault muffler, made brands from 1/16 strap iron to hold the brackets to the muffler, welded up the pipe to go from the manifold to the muffler, and assembled the works. If you are wondering about the tail pipe, we have a consolation for you. The stock Renault doesn't have one either.

Last but not least, comes the carburetor. The stock one is a small Solex without an accelerating pump and has little to recommend it except a very excellent choke system that consists of a secondary carburetor and no obstructions in the carburetor throat. It can be used with the replacement manifold with a small adaptor at considerable loss of power. The factory recommendations call for a 32mm Solex, PBIC, a very fine carburetor indeed and it should be for a $34.00 list price. It can be replaced successfully by a 431 RS Carter carburetor for less than $12.00 and it fits and works perfectly. It has a universal mounting flange which must be centered before installation. The main jet is adjustable from the outside and it is otherwise a stock W.O. Carter.

A distributor setting of five to eight degrees in advance of factory timing is advisable. The factory tappet clearance (set hot) of .008 and .012 can be modified to an even .010 all the way around. For competition a hot .006 setting will improve the performance. The valves are adjusted more easily by making a little slot in an old wrench to fit the flats of the adjusting screws. This completes the engine work.

We made a few modifications to the suspension, like installing a '55 Renault stabilizer bar and heavy duty airplane type shock absorbers borrowed from a Plymouth.

The Renault factory puts out souping up equipment of their own under the brand name of Autobleu. Their kit, for $265, includes a reground cam, a modified cylinder head, a manifold slightly larger than the one we used and the 32 PBIC carburetor. They also offer a larger distributor with a tachometer take-off and a tachometer. The cylinder head they offer has larger valves and ports than the stock head and is sold on an exchange basis. A word to the wise: The intake valve on the old head is exactly the same size as the exhaust valve on the new head. The new head gives remarkable performance considering the fact that the original 7.25:1 compression ratio has been retained. However, the workmanship on the exchange head leaves a lot of room for improvement. The manual spark control we incorporated with the distributor is a great help in starting. Autobleu considers their valve timing top secret.

Top speeds were increased from:

15 miles to 22 miles an hour in 1st.

35 miles to 60 miles an hour in 2nd.

68 miles to 80 plus miles an hour wide open in high.

Not bad for an engine that fits in your vest pocket.

With the old manifold and stock setup the engine puts out 21 hp at 4100 rpm. With the new manifold the power is boosted to 28 hp at 4500 rpm. while with the complete Autobleu kit 35 hp at 5500 rpm is claimed.

With an extractor type tuned exhaust and larger carburetor, a compressor and a strong tailwind — oh well, a fellow can dream, can't he? #

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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 404 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 content 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 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, unsubtle 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 manifold 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 skimped 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. #

## Corvette

*(Continued from page 53)*

supposed to be available as optional equipment.

Tire rolling resistance was another vital factor in the top speeds made by the Daytona Corvettes. They would have been lucky to reach 135 mph with the factory-equipped tires. Few of us realize that it requires about 160 hp to roll these tires at 150 mph — under the weight of the Corvette and inflated to 28 lbs./sq. in. Rolling resistance is caused by the violent flexing and stretching of the tire casing and tread layer under rolling and centrifugal forces. We can reduce it by increasing inflation pressure, using stiffer 6-ply casings with a steep cord weave angle, and with a lighter, thinner tread layer. The special Firestone Bonneville tires have the lowest rolling resistance factor of anything available in this country, and they compare favorably with the European super-speed types for record cars (Dunlop, etc.). They have only a fraction of the drag of regular passenger tires, and seem to be substantially below the conventional full-tread racing tires like the Firestone Super Sports 170 and Goodyear models. Most of the really fast cars at Daytona, including the Corvettes, were on Bonneville rubber for their top-end runs, running inflation pressures anywhere from 40 to 65 lbs.

Add up all these drag-reducing gimmicks — stripped windshield and competition screen, cockpit cover, partially masked grille opening, headrest fin, Bonneville tires at 50 lbs. pressure — and it would take roughly 190 hp at the clutch to move the competition Corvette 150 mph in still air on pavement. So you see, things begin to fall into place. The absolute top speed potential of this combination on pavement, using the 3.27:1 rear-end ratio, is definitely *over 160 mph*. Duntov clocked 163 mph at 6300 rpm on the Arizona test track. An honest 245 hp should account for this — which appears to be well within the capabilities of the engine in stock form, with options.

The best two-way average on the beach was 150.53 mph. Duntov feels the true potential here is over 155, given excellent beach and wind conditions. Rolling resistance on the sand is definitely higher than on hard pavement — and, as beach conditions deteriorate, resistance goes up and traction comes down. Also, wind is a problem at Daytona. *Any* kind of wind component parallel to the course acts to chop down the two-way average; the wind holds you back more on the upwind run than it boosts you downwind. Coast-wise winds of 35 mph are not unusual at Daytona.

Conditions weren't perfect on any of the runs. On his 150 mph runs prior to Speed Week Duntov had little wind, but only a fair beach; he was getting five percent wheel-spin. On Fitch's official two-way runs with the production Corvette during Speed Week the beach was good, but there was a 20 mph coast-wise wind. He turned 155 mph downwind, but the two-way average came out to 145.51. Duntov averaged 147.3 mph in the modified class that day. He figures if he could have switched to a 3.08:1 axle ratio for the downwind run he could have increased his speed from 156 mph to more than 160. At any rate, it appears that the true top speed *potential* of the competition Corvette on Daytona Beach is a good five or 6 percent below the speed on hard, smooth pavement. That should answer some burning questions!

I have listed a set of road test figures which I obtained personally on a friend's strictly "showroom" '56 Corvette . . . then for comparison I've *calculated* the corresponding figures for the Sebring Corvette, using slide rule, graph paper, and a planimeter (area measuring instrument for graphical analysis). I think I hit the true performance of the Sebring cars pretty close with this method, by using all available technical data on the cars and carefully estimating the "unknowns."

Incidentally, the calculations on this car are based on a gross weight of 2900 lbs., 3.55:1 axle ratio, and a shift point of 6500 rpm in the gears. (This was used by Duntov on his standing mile runs, but might be a little high for a long race.) The showroom Corvette had stick shift, 3.55:1 axle, but not the Duntov cam. It seemed to run well in all rpm ranges, but there was no special tune-up for the test. It had about 700 miles on the odometer.

Here are the figures on the two cars for comparison:

| | *Sebring* | *Huntington* | *SCI Test* |
|---|---|---|---|
| 0-30 mph. . . . | 3.2 secs. | 3.2 secs. | 3.4 secs. |
| 0-60 . . . | 6.3 secs. | 7.5 secs. | 7.5 secs. |
| 0-80 . . . | 9.6 secs. | 12.4 secs. | 12.5 secs. |
| 0-100 . . . | 15.1 secs. | 21.2 secs. | 19.3 secs. |
| Standing ¼-mile . . . | 14.9 secs. | 16.0 secs. | 15.9 secs. |
| Speed at ¼ . . . | 99 mph | 89 mph | 91.0 mph |
| Top speed . . . | Approx. 148 mph | (top speed) 121 mph | 120.0 mph |

And there you are. There's a pretty big difference between the performance of our production-line Corvette and the Sebring job, but obviously both of them can hold their own in pretty quick company. The showroom job would have strictly no trouble with its arch-rival, the showroom T'bird — and the Sebring cars, I think, might even raise a few eyebrows on the California drag strips.

No doubt about it . . . the new Chevrolet Corvette is America's fastest stock car. #