These are selected extracts relating to supercharging the VW engine from the 1959 book "Souping the Volkswagen" by Dick Morgan.

SECTION TWELVE

ENGINE PERFORMANCE

In this section we will discuss what you can expect in power output with different modifications. Although the best approach would be actual dynamometer tests of every change or modification, one at a time, this is impractical because of the amount of money and time required. Instead we will present those combinations of modifications that are popular and readily available, or particularly interesting.

Fortunately, Dr. Porsche did much of this work himself when souping the VW engine to be used in the Porsche automobile. Thus we already have a guide to the amount of power we can expect from the basic design.

Wolfgang Denzel is another name to look up to in the VW souping field. Denzel has surpassed Porsche in obtaining maximum power out of the VW "block". Super versions of the Denzel claim 65 and 85 DIN horsepower for the 1300 cc and 1500 cc sports cars, compared with the latest VW output of 30 DIN horsepower.

Figures 15 and 16 show ten different steps in modifying for more power. Many more combinations of course are possible but these cover the power range nicely and are either well proven or perfectly feasible. Only one plan utilizes supercharging. Although good reliable superchargers are available it is significant that of the experts we have mentioned none selected the supercharger for the VW engine as the way to more power.

The Judson is about the best supercharger for the VW today as it is both reasonably priced and well engineered. Others come and go year by year but Judson is always available for parts and service. The unit is a vane type that gives a six psi boost to the manifold pressure thus boosting more weight flow of air through the engine with a resultant increase in power. Even though it is a positive displacement type it is characteristic of the design to have a rising pressure curve so that the maximum boost pressure is not reached until about 80 per cent of peaking speed.

The Judson supercharger is a simple piece of bolt-on equipment for the VW and represents the largest power increase you can get for your dollar, for just about any automobile built today. It is certainly the best buy if you want the maximum amount of power available, and you are operating on a budget limit around $150.

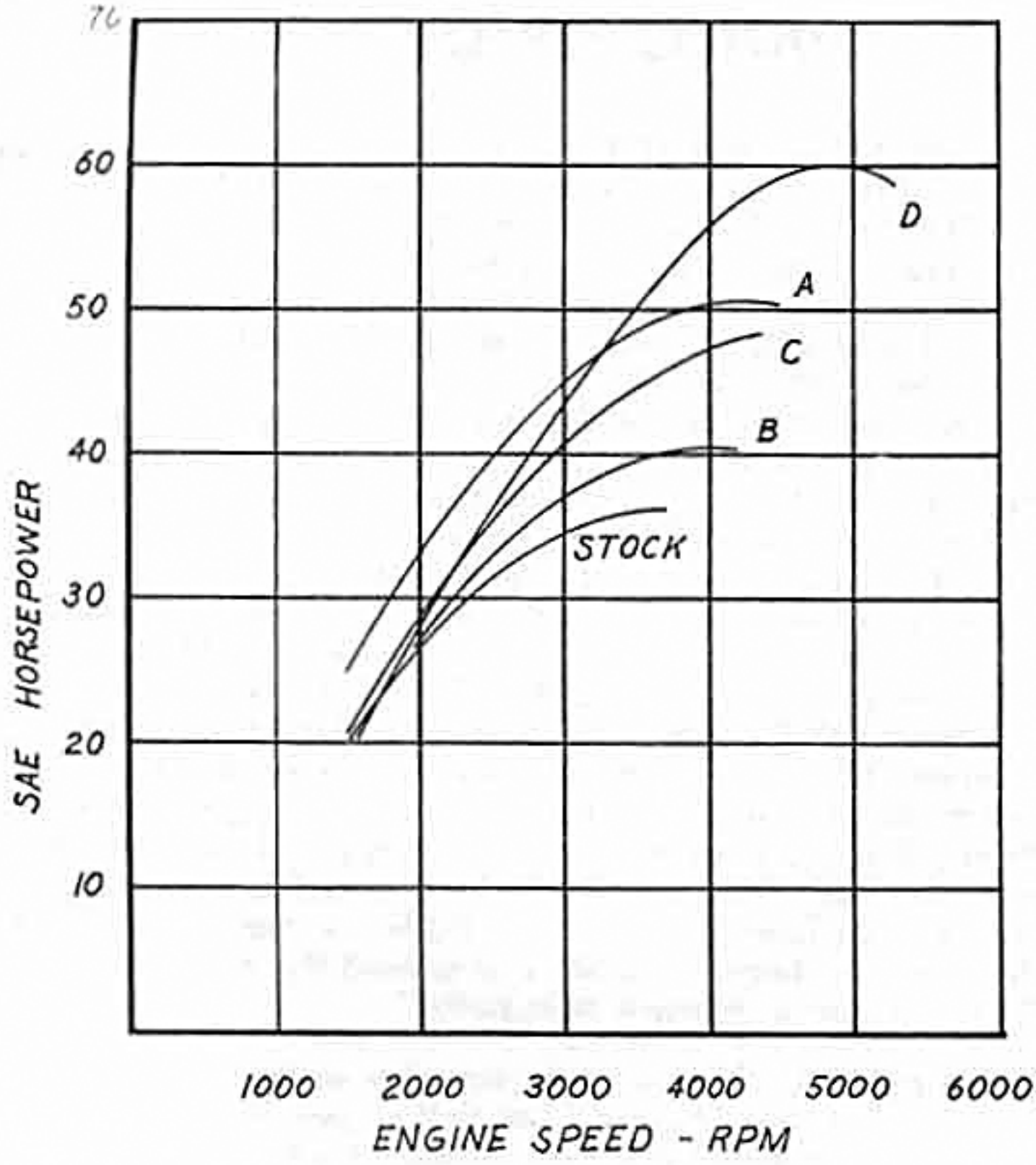

FIGURE 15. *This chart depicts the changes which may be expected from increasing the compression ratio in the stock Volkswagen engine*

Curve	Description	Comp. ratio	Carburetion	Cam
A	Judson supercharger	6.6	1-28 mm	stock
B	Dual carburetors	6.6	2-28 mm	stock
C	Okrasa	7.5	2-32 mm	stock
D	Okrasa Super	8.5	2-32 mm	super

One peculiar advantage of supercharging the VW is that it allows you to obtain the maximum increase in power without digging into the expensive bottom end. As we know the stock VW crank is the major weakness in obtaining more power from the engine. Crank stresses are more a function of speed than any other factor. The added boost that a positive displacement supercharger gives you from 1500 rpm on up means that you do not have to go to the high revs for the extra power. By observing the factory recommended limit of 3400 rpm, with occasional spurts to higher speeds during emergencies, you will probably get through the crank problem without any trouble.

Two other areas of concern must be considered before you invest in a supercharger. The first concerns overheating which is due to the extra "stuff" that you are forcing through the engine whenever under full throttle operation. Although the fan has considerable reserve capacity the higher cylinder and piston temperatures encountered during sustained full throttle operation may lead to piston seizure and ring breakage. Piston clearance recommended by the factory is .0014 to .0022 inches which is rather close for an air-cooled engine. When running temperature is reached the clearance decreases even further, as the aluminum pistons expand more than the cast iron cylinders. The factory, of course, does not know that you are going to supercharge your engine. They have made the clearances as close as possible to eliminate clatter when starting cold, and to allow as much wear as possible for a long life.

The VW fan has enough reserve capacity so that the engine does not overheat to the point of damage and you need not be afraid of piston seizure when supercharging provided you have a clearance of at least .003 to .004 inches when cold. This point probably does not occur naturally until your car has about 20,000 to 30,000 miles on it. A good plan, if you wait to this point, is to install new rings and have the valves ground about 1000 miles prior to installation of the blower. Also include new exhaust valves. While the engine is apart, clean all of the cooling fins so that you will get maximum cooling capacity.

The second serious problem is concerned with combustion chamber deposits induced by the use of leaded gasoline. The higher combustion pressures that are built up with a supercharger necessitate the use of premium gasoline. While regular gas may contain small amounts of tetraethyl lead, premium gas always contains an appreciable amount of it. With the higher head temperatures encountered in air-cooled engines lead from the gas will deposit in the combustion chamber, building up in rough points and sharp

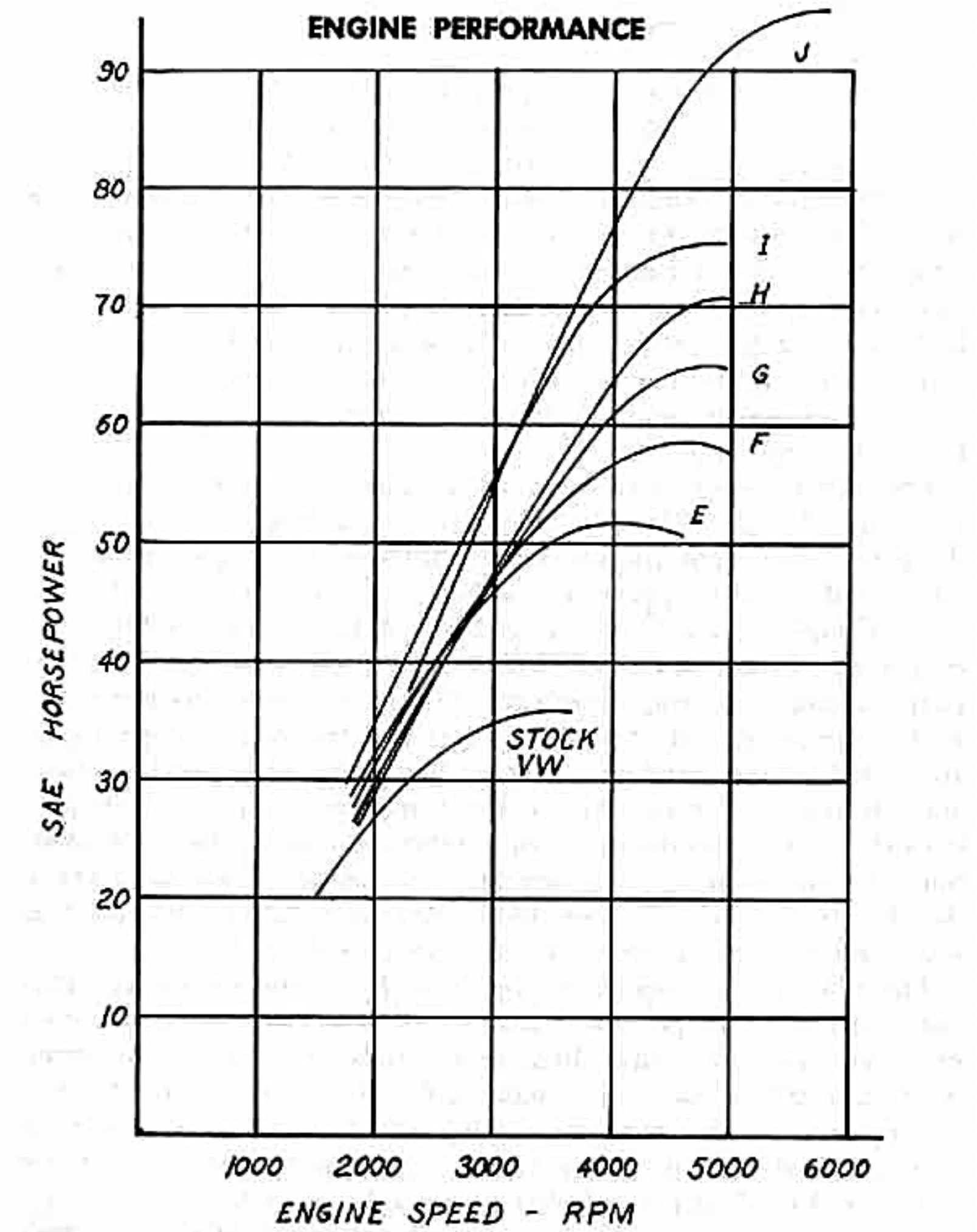

FIGURE 16. *This chart depicts the changes which may be expected from changes in bore and stroke of the stock Volkswagen engine. These include the factor of operation at higher top revolution rates.*

Curve	Description	Bore mm	Stroke mm	Disp. cc	Comp. ratio	Carburetion	Cam
E	Okrasa 1300	77	69	1285	8.5	2-32-mm	stock
F	Denzel 1300 (kit)	78	67	1281	8.2	2-32 mm	stock
G	Okrasa 1300S	77	69	1285	8.5	2-32 mm	super
H	Denzel 1300S (kit)	78	67	1281	8.2	2-32 mm	super
I	Okrasa-Weber 1500S	79	76.6	1500	8.5	2-40 mm	super
J	Denzel 1500SS	—	—	1500	9.5	2-40 (dual)	wild

edges. This is "murder" in any piston engine. The resulting pre-ignition and rough combustion give power a real knockout blow in the solar plexus.

These deposits build up over a certain period of time depending upon the gas and other operating factors but they have become serious in cars with only 10,000 to 20,000 miles under their wheels.

Airlines with air-cooled engines use premium fuel but it is a blend of natural high octane ingredients and contains no tetraethyl lead. Whenever tetraethyl lead is added to aviation gas, spark plug fouling and combustion chamber deposits descend like a plague of locusts.

Of course the deposits are easy to remove and if you are the tinkerer type you may have the heads off every year anyway. You may even be buying a gas that will give you trouble-free service for a much longer time.

Superchargers are a source of several minor irritations that may or may not bother you depending on your own private brand of neuroses. One of these is the oiling system. In order to insure the proper supply of clean oil to the sliding vanes the Judson people have included a separate oiling system. Oil consumption of the separate system varies between one quart per 500 and 1000 miles depending upon how you drive. Since the average VW goes for 1500 to 2000 miles without needing engine oil and naturally needs no water, most owners just forget about the engine compartment entirely and overlook proper oiling of the supercharger.

Noise:—at full power most blowers are not noticeable and the Judson is very commendable in this respect. At idle speed, however, you will swear that there are a few loose screws bouncing around with the vanes. Not loud, but still apparent. If you have overcome the grating on your nerves from the normal whine of a stock VW transmission in fourth at 35 mph then you will not be bothered.

If you are the tinkerer type try a larger carburetor on your Judson. The Ford V-8 60 has been used with success.

Curve A in Figure 15 shows the added power that you may expect with about six pounds of boost pressure such as you get from the Judson.

A point that we should have mentioned earlier is the muffler. One of the first things to do before undertaking any souping is to improve the exhaust system. Either get a good "free breather" as mentioned previously or weld on two larger tail pipes.

All subsequent methods of souping will consider non-supercharged methods of power increase. Free-breathing induction sys-

tems, moderate to high speed cams, and boring and stroking will be the route we will follow.

As mentioned previously the BMEP is the most important single fundamental parameter. Figure 16 shows the BMEP plotted for the stock VW, Okrasa, Porsche, and Denzel engines. The problem of the stock VW immediately becomes obvious when all are compared. Although the stock VW has as good BMEP as the other engines when compared on an equal compression ratio basis, the drop-off is extremely rapid at high speed. Our plan will then be to keep the BMEP up, and move the curve to the right as far as possible without sacrificing too much at the lower end.

Free breathing depends on large induction passages with minimum restriction. However, we must be careful of not to use too large carburetors or low speed performance will be extremely poor because of bad fuel-air ratio control and improper atomization.

Table II shows the valve port sizes taken from Iskenderian's chart as a function of different engine sizes at 5000 rpm. This is an arbitrary selection of speed but it represents what will be easy to attain without valve float problems and without overstressing the engine.

The subsequent power curves represent both test data and estimated performance based on similarity factors such as BMEP, valve port sizes, cam timing, carburetor size, displacement, etc. All data are in SAE or gross horsepower units (to make a maximum impression on the fellow occupying the bar stool next to you).

Without altering the breathing an immediate 4 per cent jump in power can be achieved by increasing the compression ratio from 6.6, to 7.5 to 1.

This is about the limit with 85-90 octane regular fuel in an air-cooled engine. Premium 95-100 octane will let you go to 8.5 to 1, but the extra cost starts to cut into the economy angle of the VW.

Don't run right out yet and buy higher compression pistons as this is an uneconomical way to spend your hop-up dollar. Wait until you have to change the pistons for some other reason and then take advantage of the boost in compression ratio. Also, some of the conversion kits will boost the compression ratio by reducing the head volume or increasing the stroke without even changing the pistons.

The first improvement in breathing incorporates the use of dual carburetors feeding through short individual manifolds. This is so fundamental that it is used on all subsequent plans. However, it pays off handsomely only in the higher rpm ranges so that not too much can be expected if you are stuck with the factory rev limit of 3400. However, for intermittent use, or if you have a sound bottom end, you can run higher.

Duals will give you up to a 15 per cent increase in power at about 4200 rpm. Starting is greatly improved, idling is still good, and you may find it gives you the little extra kick you want, if you are not power mad. Installation is usually easy, and can be accomplished with only a few tools. Dual carbs may be had for as little as $80. Curve B of Figure 15 illustrates two-carb performance.

Curve C of Figure 15 is the next one of interest. Output is 48 hp at 4200 rpm with the Okrasa dual carb head kit. This is a 33 per cent increase still using stock bore, stroke, and cam. Compression ratio increase from 6.6 to 7.5 accounts for 4 per cent of the power increase. Money involved is $250, but you are buying a high quality piece of equipment that will last a long time, and may even be modified for better output. Even if you don't do anything to the bottom end you can install the Okrasa heads and drive around town until something pops. Then tear into both the crank and cam. This is like the installment plan with a lot of fun from the beginning.

Figure 15 is intended to show how far you can go with a reliable and smooth running engine with stock bore and stroke. Curve D is about the limit, and we are calling this an Okrasa "Super" since it uses the Okrasa kit with an 8.5 to 1 compression ratio and an Iskenderian 2J camshaft which is very close to the Porsche Super grind. Peak power is a fat 60 horsepower which will amaze your Porsche 1500 America coupe friends and give fits to your MG A enemies. This is a "best buy" in engines. Cam, crank shot-peening, and balancing will run about $85, which puts you in the $330 bracket for parts with a healthy 67 per cent power increase.

If your budget is tight and your car doesn't have over 20,000 miles on it, you can use your old bearings and pistons. If you care to drop 2.5 hp and buy *regular* instead of *premium* gas, then stick with 7.5 to 1 compression ratio.

The next batch of modifications including bore and stroke changes are shown in Figure 16. If you are the squeamish type who are appalled by putting up to 90 horsepower in a VW, then do not look. However, if you are power-mad like we are, then the curves will really look voluptuous.

Curve E is first and shows what happens when you use the Okrasa heads and 5 mm stroker crank and the stock VW cam. The crank accounts for an 8 per cent increase over curve C. The crank is $140 which puts you in the $390 outgo bracket. However, once you have the bottom end apart we recommend that you skip this step entirely and jump to curve G, install the 2J cam, and reap another 25 per cent power jump for only $35.

Curve F shows the output of the Denzel kit for the VW. A neat boost of 64 per cent over stock can be had for a rather shocking price of $600. The Denzel kit does give phenomenal value in that it includes new pistons, Porsche-type aluminum cylinders, crank, and Porsche-size heads with big valves and more cooling fin area. By all means do not install this set-up without a super-type cam as the 2J. In other words skip to curve H for a 100 per cent power increase over stock. Now the $600 does not look quite so bad. The Denzel heads are not available separately from the rest of the kit but a lot of people are jumping into the VW market and do not be surprised if individual heads similar to these are available soon. If possible, stick on larger carbs such as the 40 mm Solexes, but in any case use at least 26 mm venturis.

Combining the Okrasa heads with .10 inch larger valves together with Weber ½-inch stroker kit we can now work ourselves up to a brutish 75 horsepower output with a full 1500 cc engine. This is still somewhat a makeshift engine since we do not have the breathing capacity that we would like, but as of this writing no other equipment is made specifically for souping the VW. This engine would cost about $500 for parts alone but would give you fantastic performance.

Curve J shows the probable ultimate that can be wrung out of the basic crankcase. We call this one a Denzel 1500 "Super Super." The cam will probably be some wild grind that has a lumpy idle and won't come in until about 3500 rpm but you could sure bring the trophies home. Curve J indicates about one hp per cubic inch which is about all there is in any push-rod engine.

All the conversions will give you equal, or better, gasoline mileage than the stock VW—that is, 30 to 35 mpg, for the same stock VW performance. However, if you take advantage of the extra power continuously you should expect a drop of two to five miles per gallon.