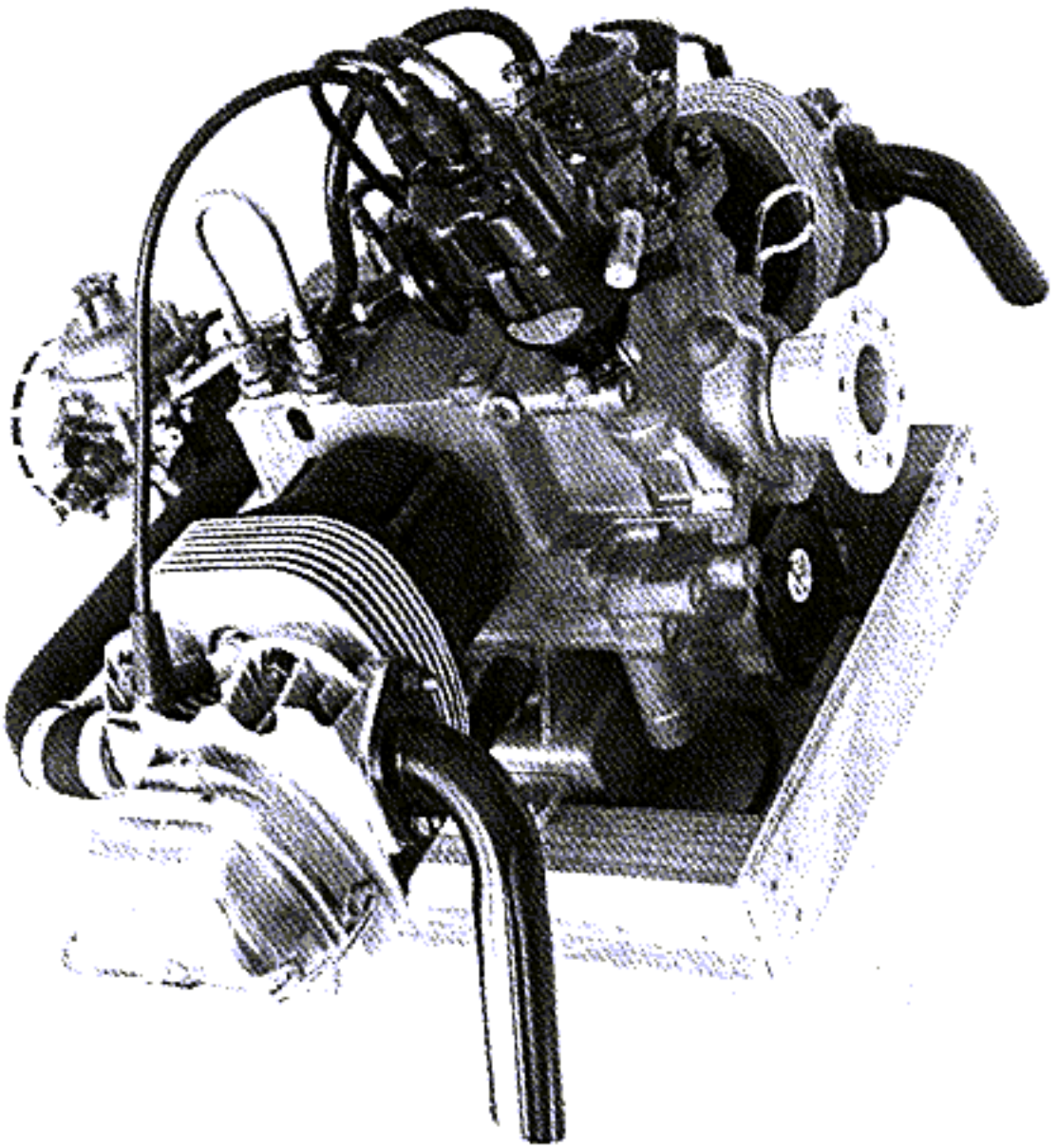
AFFORDABLE 4-CYCLE POWER



2-CYLINDER VW ENGINE CONVERSION PLANS

SAFETY PRECAUTIONS

The item described in this booklet is an aircraft engine. As such it has a certain inherent hazard in its operation. Gary McGill and Associates assumes no responsibility for the ability of any product made from the guidance in this booklet or for the safety in its operation.

Most of the operations described in this booklet are within the capability of a skilled amateur. If you lack the skill or ability to perform an operation consult a professional or a person with the skills to safely perform the task.

Assemble the engine using the torque's, clearances and precautions in an overhaul manual for the engine you are converting. The guidance in this booklet is for hardware modification only. It does not change the good assembly techniques required for a safe operating engine.

Use safety wire, self locking nuts or a material such as Locktite® where required to assure that exterior components remain secure during operation.

Learn to safely hand crank an aircraft engine from an experienced person before attempting to operate the engine. The running propeller can cause severe injury if it contacts your body.

Run the engine on the ground to assure dependable and safe operation prior to attempting flight. The engine must be capable of maintaining sustained full throttle before flight. The engine must obtain and sustain dependable idle prior to flight.

Do not attempt flight without carburetor heat. Carburetor ice can occur in any climate.

VW ENGINE CONVERSION PLANS

GENERAL

The conversion of a Volkswagen engine to a two cylinder ultralight or experimental aircraft engine following these plans is a very simple operation.

Most of the head and case cutting can be done with a hand or band saw, cleaning up the cuts with a file and straightedge. The job is easier if a mill and lathe are available.

Rough cutting of aluminum (heads) and magnesium (crankcase) can be done with a fine toothed wood saw or a coarse toothed hacksaw. Lubrication of the saw blade with WD-40 or candle wax will reduce the tendency of the aluminum to collect on the saw teeth.

WARNING

When cutting and machining the crankcase, *keep your work area clean. Fine magnesium chips and dust are very flammable.* Chips and sawdust should be swept up and kept in a dry closed container. The only effective method for fighting a magnesium fire is to cover the burning material with dry dirt or sand. Do not put water on a magnesium fire.

SELECTING THE ENGINE PARTS

These plans are drawn up around the Type 1 (Beetle) engine. We are certain that other types can be used but we have never tried. If you decide to *use other than a Type 1 engine you are on your* own.

A complete engine is helpful in providing the studs, *spacers* and odds and ends required to build an engine, however the entire engine could be built from after market parts.

We have made arrangements with outside suppliers to provide machining service, parts and kits to builders not wanting to spend time looking for used parts. We have no involvement with these suppliers other than providing the enclosed listings. Please deal directly with them if you are interested in using their parts or services.

CRANKCASE

Look at the plans closely. Any cracks or holes in the end of the engine case being cut off and discarded will not hurt it for this use. Often they can be obtained for scrap price when cracked around the *bell housing or with a hole through it from a thrown* rod. Beat out main bearing bores on the flywheel end are a major reason for scrapping of crankcases that are perfectly usable for the half VW. We have had them given to us while shopping salvage yards.

HEADS

You will need one good dual port head and one junk head or two heads with one good cylinder on opposite ends. We have been lucky buying cracked heads at near junk prices. Just make certain the cracks are on opposite ends.

PISTONS - CYLINDERS

Stock or big bore pistons and cylinders are available new ranging from very cheap to very expensive. In most applications we would recommend a 92mm *bore for low RPM power.* Expensive forged pistons and cylinders are not necessary. Sometimes it is possible to get a local supplier to split a set. If not, they are relatively inexpensive. Maybe you can talk a friend into building an engine also.

CRANKSHAFT

This engine will be a "shaker" unless a counterbalanced crankshaft is used. The midget race and dune buggy people sometimes have great buys on long stroke cranks that have had the dowel pins stripped out on the flywheel end. If you decide to stick with a stock stroke, the stock VW forged *crankshafts are hard to beat. We show how to* balance them later in these instructions. Scat produces a high class, forged & counterbalanced, long stroke crank. Glenn Duffin also produces a quality converted stock crankshaft that would be a good option. A long stroke crankshaft is the simplest way to get low RPM torque required for efficient aircraft engine operation.

CAMSHAFT

We recommend a stock cam. Stay away from long duration high lift cams. They will cost you power at low RPM where these engines are operated.

OIL PUMP

Due to the reduced number of bearings in this engine, a stock pump will provide plenty of volume *and pressure. Some sources of VW parts have an* oil pump cover with a built in oil filter adapter. This is a simple and low cost way to increase the life of your engine with a small weight penalty.

IGNITION

Ours is set up to run on a stock centrifugal advance distributor, fired by a six-volt motorcycle battery.

Some people recommend simply leaving the two unused plug wire receptacles on the distributor cap empty. Others recommend using all four spark plug wires and grounding the unused two to the crankcase. We like the latter idea. Two batteries and a double throw switch to provide alternate power is worth considering. If you want a charging system, you are on your own, however we have seen the alternators from Kubota tractor engines mounted on two cycle engines. It might work here. We would appreciate feedback from anyone trying any idea for a good, light weight and low cost charging system.

MISCELLANEOUS

You will need valves, springs, keepers, rocker arms, rocker covers, bolts, studs, gaskets, etc. You don't need high compression, big valve, lightweight hotrod parts. This engine will run at low RPM and does not need high performance parts. A Volkswagen repair manual for assembly procedures, torque values and clearances is essential. You will want to build this engine like it is for your grandparents car and want it to live forever.

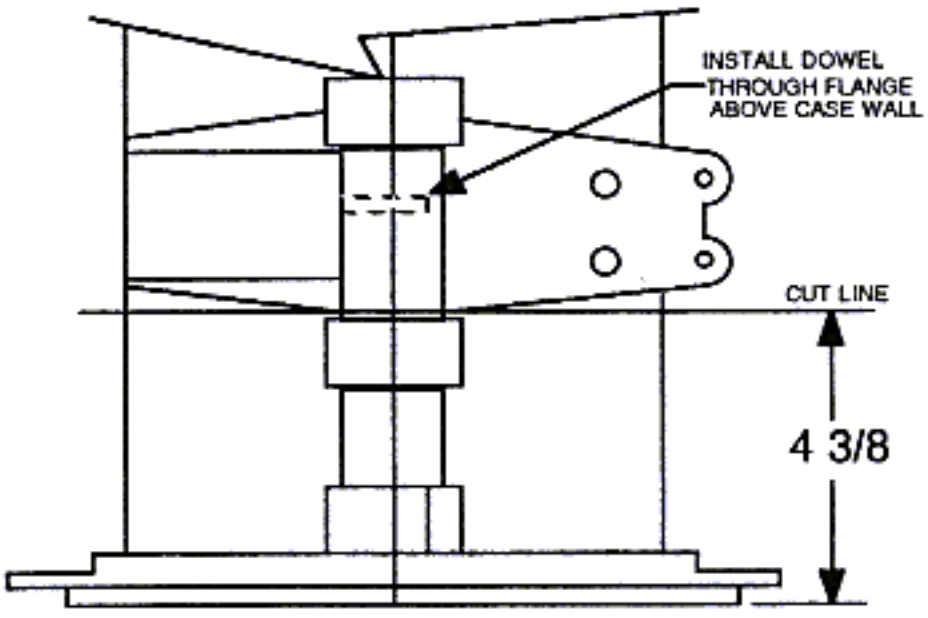
CRANKCASE MODIFICATIONS

If your crankcase needs machine work such as line boring, machining for oversized cylinders or other repair work, get it done before cutting as described below. Some machine shops may have trouble setting up a 2-cylinder crankcase.

The two halves of the crankcase are machined by Volkswagen as a matched set. Alignment is maintained by two dowel pins located in the machined faces. Prior to cutting the case a third pin must be installed. A 1/8" hole drilled completely through one flange and halfway through the other one, fitted with a short piece of drill rod or dowel pin makes a good third dowel. See Figure #1 for recommended location.

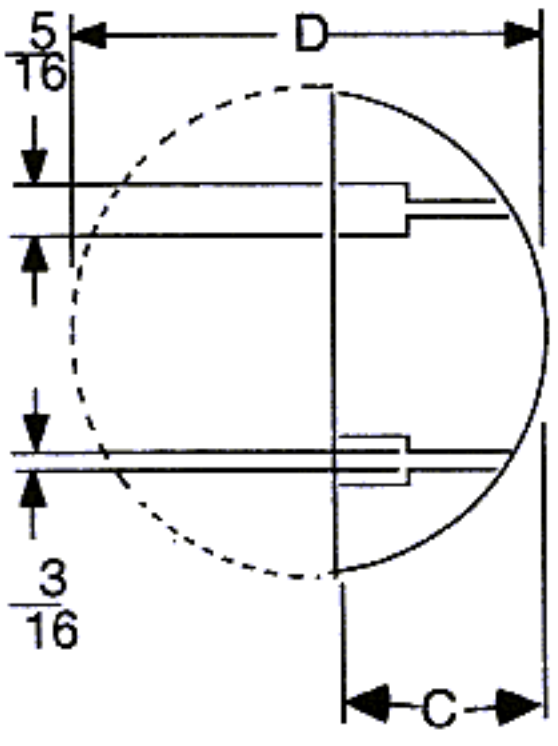
Mark the case 4 3/8" from the flywheel end. Cut completely through the case slightly outside of the 4 3/8" line. This is the "cut line" or "4 3/8 inch line" we will refer to throughout these instructions.

FIGURE 1



Your cut will be through the #1 cylinder mounting hole. Fashion a plug as shown in Figure #2 from 1/2" aluminum. "D" diameter is the size of the cylinder mounting hole. "C" dimension is the distance from the bottom of the cylinder hole to the cut line. Drill the 5/16 counterbores deep enough that the bolt heads will be below the cut line. Space the bolts to miss the old stud holes or case savers that might be left in the case. Leave the flat side slightly oversize. Bolt it in the case with 3/16" socket head cap screws using a good permanent sealer. Machine or file it to the 4 3/8 line when finishing the case.

FIGURE 2



Fabricate engine mount blocks from blocks of aluminum and install in the oil pan area as shown in Figure #3.

Do not drill and tap the 3/8 NC hole at this time. It will be drilled and tapped through the back plate in later operations.

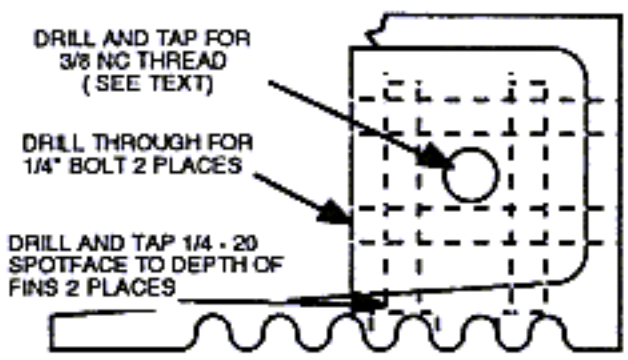
It is desirable to smooth the inside of the casting where these mounts set. The roughness and lines cast into the crankcase area were put there by the foundry to help the casting pour better. They have no function as far as the engine is concerned. Do not remove any webs or walls in this area. Do not thin the walls unnecessarily. This will also help to remove any oil film that may be on the surface.

Make the mount block fit as accurately as possible where it contacts the back plate and the crankcase. It will carry the weight and load of the engine. The more of the load that is carried metal-to-metal rather than through epoxy the better.

Cross bolt and install with plenty of epoxy. Wipe up excess epoxy to keep it from coming loose and getting into the oil system.

Machine or file it to the 4 3/8" line when finishing the case. No dimensions are given for the block. It must be custom fit to the casting variations in the crankcase.

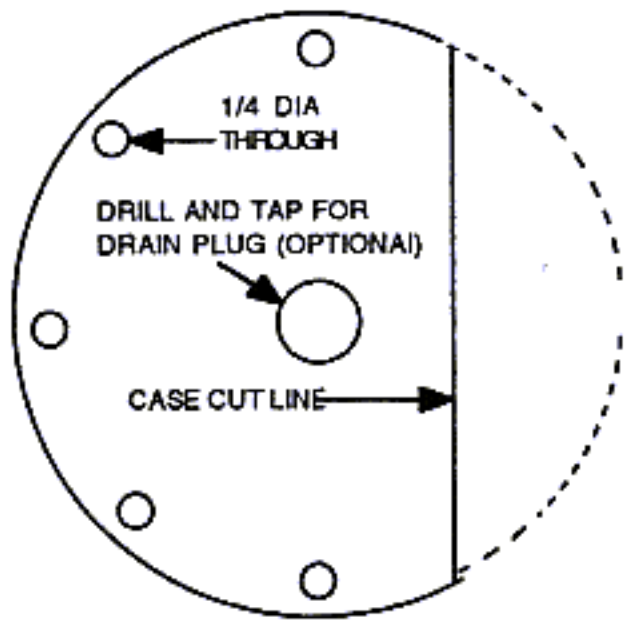
FIGURE 3



Fabricate an oil pick up screen cover plate as shown in Figure #4 from 1/4" aluminum plate. Space the bolt holes to match those of the cover removed from the original engine.. Leave the flat side slightly oversize. Machine or file to the 4 3/8" line when finishing the case. This must be a good surface. It will provide the oil seal with the back cover plate.

The center hole that we mark as optional in Figure 4 is also a good place to mount your oil temperature gauge sender.

FIGURE 4



Drill and tap the oil passages in the crankcase that were cut at the 4 3/8 cut line. After all machining and cleaning of the case is complete, Allen head pipe plugs will be installed in the passages. Install with Locktite or stake in place.

Oil cooler holes may be covered with an after market bypass plate to route to the cooler or holes may be drilled and tapped for installation of hose barbs.

Bolt the case halves together, install the oil strainer cover and machine or file the cut end of the case, plug, motor mounts and oil strainer cover to the 4 3/8" line. This must be a good surface as it will be the sealing surface for the back of the engine.

REAR COVER

Fabricate the rear cover from 3/16" aluminum plate. Set the case, open end down, with the oil strainer cover installed, on the plate and trace around it for the profile of the plate. Saw out plate and smooth the edges.

Drill and tap matching holes around the edge of the plate and the cut end of the crankcase every 1 1/2 to 2 inches around the entire perimeter. Use 10-24 bolts in the areas where the crankcase walls are thinner. Use 1/4-20 bolts in the thicker areas of the walls.

Drill and tap 3/8 NC holes through the back plate and the motor mount blocks previously installed in the crankcase. Be careful not to hit any of the cross bolts shown in Figure 3.

During final assembly the plate will be sealed to the crankcase with a home made gasket or quality sealer. Be certain to seal around all bolts and mount holes during assembly to prevent oil leaks.

OIL PICKUP SCREEN

We build our engines with only an oil pickup tube. We remove the pickup screen and the sheet metal cover over it. Mount the lower end of the tube securely in the crankcase to assure that it does not jiggle loose in time. We secured ours with a steel tab brazed to the end of the tube and bolted to the floor of the crankcase. Also make certain that it is up from the floor of the crankcase 1/4 inch or so to assure that oil pickup is not restricted.

If you wish to use a pickup screen, cut the cover and the screen to clear the 4 3/8" cut line. Weld a piece of sheet metal over the cut. Braze the cut edge of the screen to the sheet metal patch. Make certain that the assembly is free of loose welding slag and pieces of metal.

MAIN BEARINGS

Crankshaft end play of the 4-cylinder engine is controlled by shimming between the flanged main bearing in the clutch end of the crankcase and the flywheel. This is not possible in the 2 cylinder engine. Thrust and end play are controlled as described below.

Use "rear" main bearings for both main journals. These are the flanged bearings used on the flywheel end of the 4-cylinder engine. Sorry, only one flanged main bearing comes in each set.

Cut one flange off of the bearing to be used on the cam gear end as shown in Figure 6. This is necessary to clear the timing gear since the bearing normally mounted in this location is not flanged. The flange does not serve any purpose in retaining the bearing. It is retained in place in the main bearing saddle by an installed dowel.

Some people feel that cutting 3 or 4 radial grooves in the flanges improve lubrication while handling thrust. We do too! See Figure 6 for detail of the main bearing modification.

CRANKSHAFT

Mount the crankshaft in a lathe and machine a 5° taper on the shaft where the generator pulley mounts. If you already have a propeller hub, machine it to fit the hub.

This could be omitted if you want to try a propeller hub that is an interference fit on the straight section of the crankshaft. Be aware that we have not tried one of them. We know they are available for the 4 cylinder engine. You are on your own if you want to experiment here. The 2-cylinder engine has more severe power pulses than the 4-cylinder. Please be aware if you are trying this.

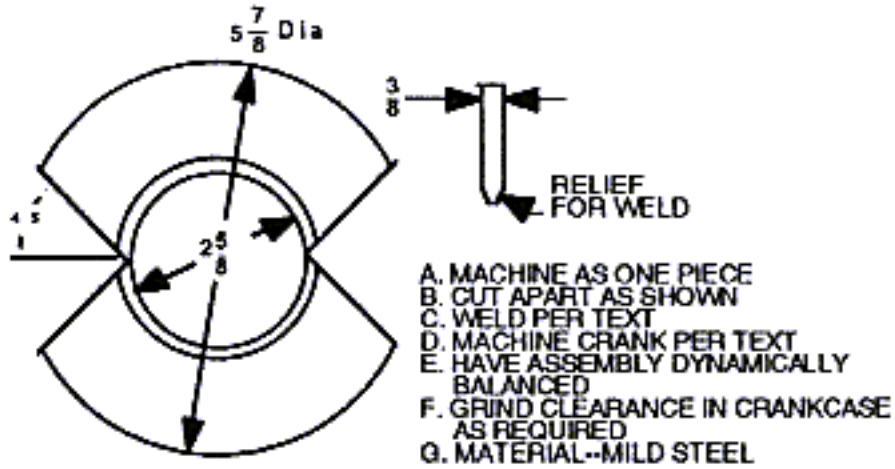
Saw the crankshaft off immediately behind the main bearing journal as shown in Figure 6.

End play can no longer be adjusted by shimming between the rear main bearing (flanged) and the flywheel. This becomes a cut and try operation on the 2-cylinder engine. Place main bearings (with thrust flanges) on both of the main bearing saddles in the crankcase. Determine the amount which must be machined off of the faces of the throws to allow installation of at least three thrust shims between the bearing flange and the throw. Machine off the faces for the necessary clearance. Different thicknesses of shims are available from Volkswagen for fine adjustment during assembly. Establish the same end play for this engine as you would if building a complete 4 cylinder engine.

The center hole of the shims will have to be enlarged to the diameter of the main bearing journal to allow assembly. See Figure 6 for details.

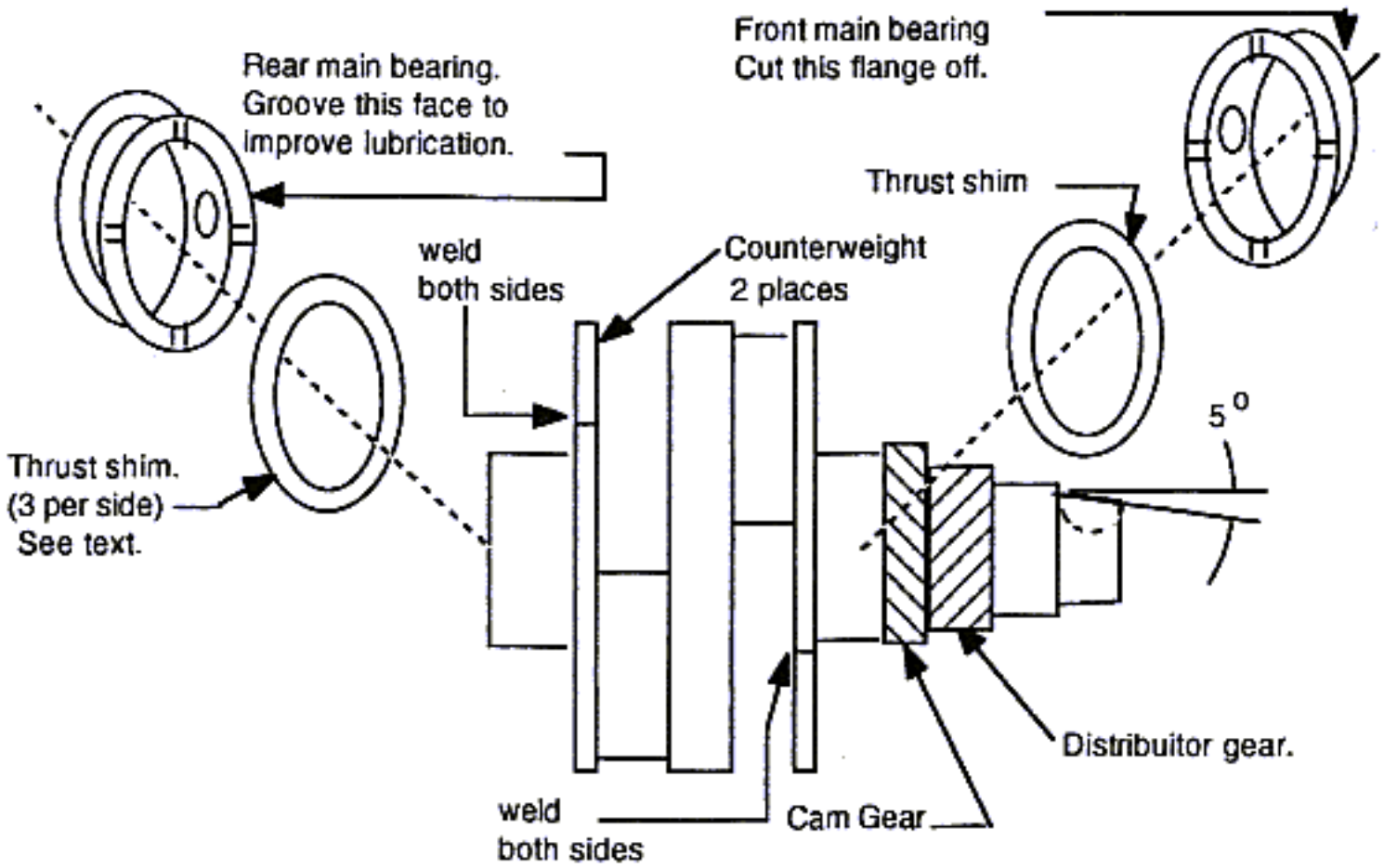
If you are using a stock, non-counterbalanced crankshaft you can make counterbalance weights to weld onto the crank as shown in Figures 5 and 6 The welding should be done prior to machining for thrust shims.

FIGURE 5



Note that there are stock crankshafts available in the after market with counterweights already welded in place. All of those that we have checked do not have enough counterweight to provide balance. Check carefully if you are planning to use one of these crankshafts.

Figure 6



Pre-heat crankshaft for welding, MIG or TIG weld both side of weights in place. Cover or otherwise protect bearing journals from slag or sparks while welding. When finished welding put the shaft back in the oven for 3 hours at 450-500° F and cool slowly in the oven.

Plug the cut oil holes in the crankshaft with weld or drill and tap for socket head plugs. Carefully clean the oil passages before plugging them.

Send the entire rotating assembly to a reputable balance shop for dynamic balancing. This step is critical to assure that the engine will run smoothly with a minimum of vibration.

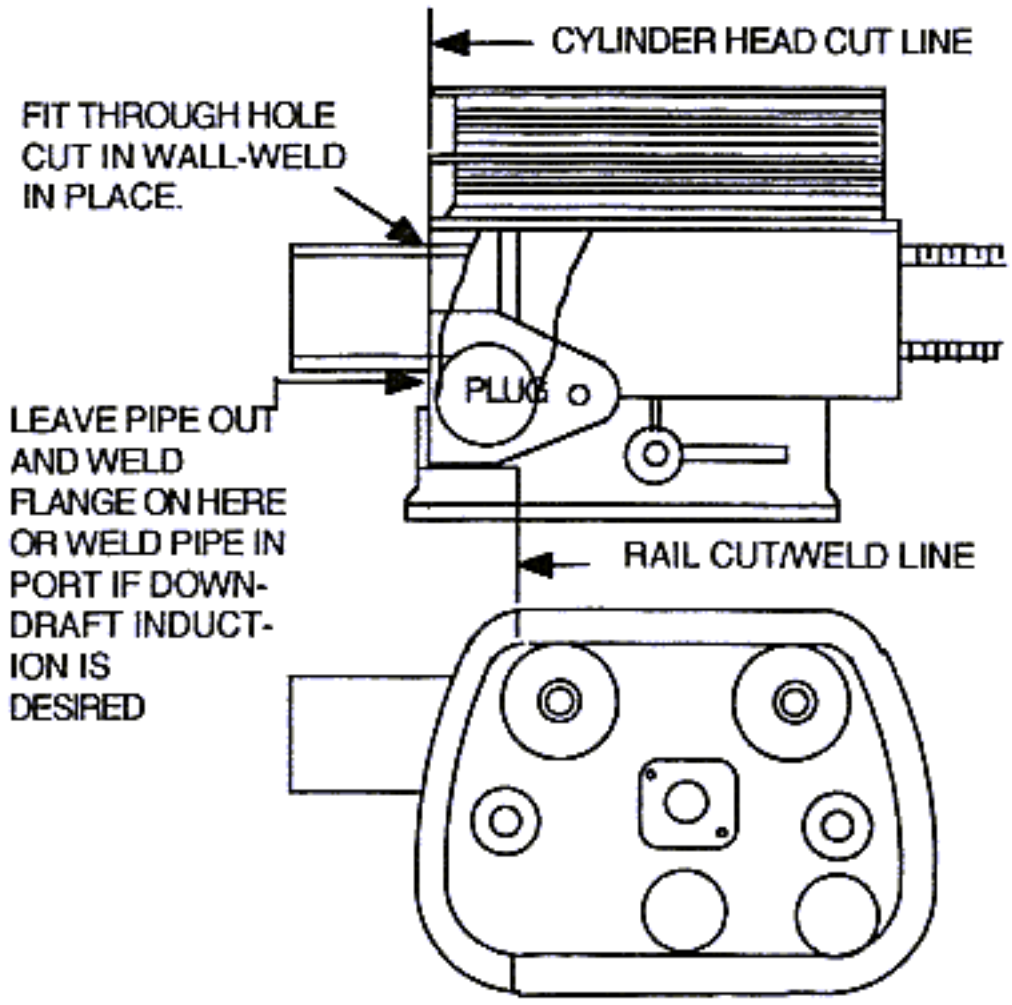
CAMSHAFT

Cut the camshaft off behind the center bearing. No other modifications are required.

HEADS (See Figure 7)

Start cutting between the intake ports on the dual port heads. Cut down between the cylinders without cutting into either intake runner. Stay as near the center between the ports as possible. Cut 1/4" aluminum plugs to fit into the original intake ports. They will later be welded in place.

Figure 7



Using a drill and rat-tail file make a hole through the saw cut surface into the intake runner. Open hole to fit appropriate size aluminum tube to match the

intake runner. Weld tube into hole and weld plugs into original intake ports. Cut the rocker cover flanges off of the unused portion of the heads or the scrap head mentioned earlier. Cut and fit them into the rocker cover flanges remaining on your heads as shown in Figure 7 Weld in place.

If you want a down draft carburetor system, an aluminum tube can be welded vertically into the original port or a flange can be welded onto the cut edge even with the original mounting surface and machined flat

NO WELD HEAD OPTION

We have developed a method for converting heads without the need for welding. This will be at the expense of some cosmetics without giving up any functionality.

Cut the heads exactly as you would for the welded head option except do not cut back or notch the rocker box rail. Let it extend to the center cut.

Fabricate a cover plate to seal the open end of the rocker box from 3/8" aluminum. See Figure 8.

The side wall of the rocker box is very thin. We found it necessary to bolt and epoxy a small aluminum block to the side of the box to provide adequate stock to bolt on the new side plate.

Mount the new side plate to the cut end of the rocker box using small coarse thread bolts and epoxy.

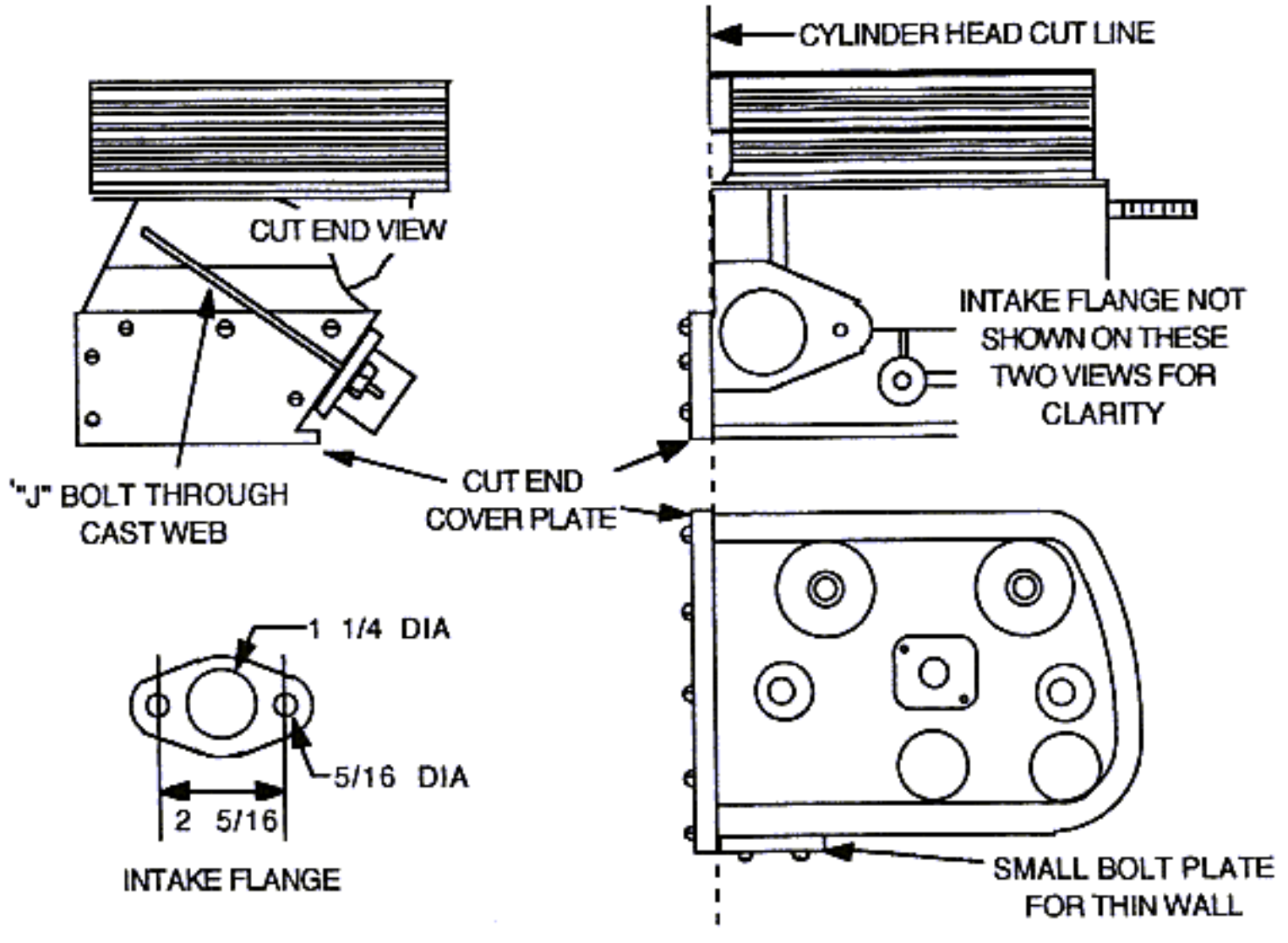
Cut the sheet metal rocker cover the length of the head and the cover plate. Note that this is more than half of the length of the valve cover. You will need two valve covers to make a complete set.

Trace the profile of the cut end of the valve cover on 3/16 inch aluminum and cut out to plug the end of the valve cover. Cut it carefully to fit within the sheet metal cover. Drill and tap through the sheet metal cover into the aluminum plug. Mount the plug into the end of the valve cover with bolts and epoxy.

Finish the sealing surface carefully. Fill any gaps between the plug and the rocker box with epoxy to prevent oil leaks.

Fabricate a wire clip to hold the modified rocker box in position as was done on the original application. The original wire bail can be modified or a new one can be made out of heavy piano wire.

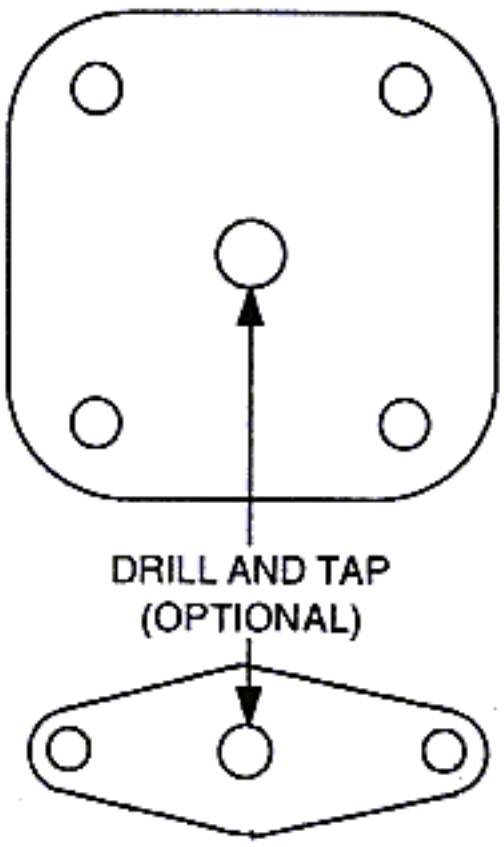
Figure 8



FUEL PUMP & GENERATOR MOUNT COVERS

Cut covers for these pads from 3/16" aluminum. See Figure 9 for approximate size and shape. You may want to run the stock fuel pump which will eliminate the requirement for one of the covers. You may want to drill and tap into one of the covers as a source of crankcase pulse to run a vacuum pulse fuel pump. One of the covers may be drilled & tapped for an oil fill plug.

FIGURE 9



ROCKER STANDS AND SHAFTS

The rocker shaft is supported on the one remaining rocker shaft boss. Drill the boss in the heads as shown on the plans for 1/8" dowels to keep the rocker shaft from twisting. See Figures 7 and 8 for locations of these dowel holes. Cut the rocker shaft for each head making certain that the retainer holes for the springs and rocker arms are not cut away.

VALVE COVERS

Shorten the valve covers by sectioning the center to fit and weld. Shorten the wire bails or bend new ones from piano wire to hold the covers in place. The covers and bails also look great chrome plated.

INTAKE MANIFOLD

There are many acceptable methods. A tubular manifold with rubber hose and clamp joints to mount the carburetor under, over or behind the engine is most common. Two smaller carburetors, mounted one on each head is also a viable alternative. We have had excellent results with a 32mm slide type carburetor from a motorcycle or snowmobile.

Figure 10 provides a simple method of providing a very good and efficient splitter for the intake manifold. It is very important to provide exactly the same fuel-air mixture for both the left and right cylinders. This splitter made from exhaust tubing has proven to work excellent.

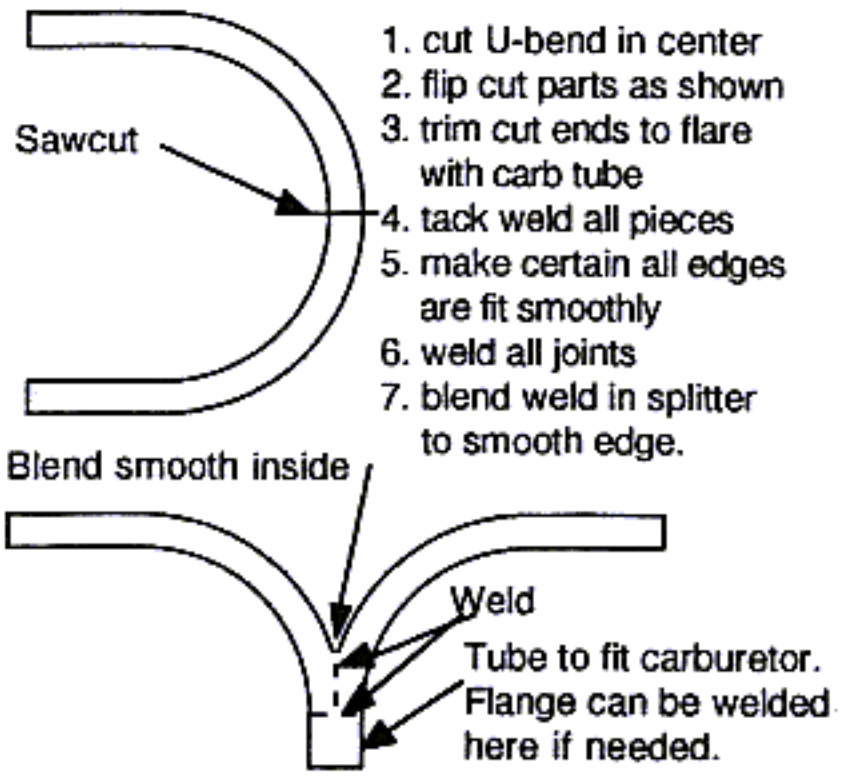
We have also found that large intake runners are a detriment. Experiment with the smallest tubing you think might work for the runners. We have seen them perform well with tubes as small as one inch. Look at what the stock VW uses for runner size. We are running only half as many cylinders and running lower RPM. The smaller tubes keep velocity up, reduce throttle lag, and reduce the tendency of fuel to condense and puddle in the intake runners.

Just be certain to use smooth bends and careful splits when making junctions.

Some builders have used the stock VW intake manifold and carburetor on their engines. It isn't pretty but works quite well. You will need to experiment with smaller main jet size to make one of these carburetors work.

We have seen and tried chrome brass tubing from sink drains used in the intake system. The flared end of them will be retained nicely by VW exhaust flanges. We have found that they are not safe for aircraft use. They are brittle and will crack. Do not use these sink drain tubes for any part of this engine.

FIGURE 10



CARBURETOR AIR HEAT

We have found that carburetor air heat is absolutely necessary. We have even experienced carburetor ice here in the Phoenix area. There are too many variables to provide detailed drawings, but we recommend you rig a heat muff and heat box to furnish heated air to the carburetor. Take a good look at what is found on certificated aircraft and use your imagination. Figure 11 provides a workable solution for a low cost, light weight and easy to fabricate heat box.

A hand propane torch bottle makes a great body for a heat muff.

Make certain that all pressure and propane are out of the bottle. Use hand tools to cut until you are certain that all flammable gas has escaped. Cut one end completely out of the bottle. Cut a hole in the other end the size of the exhaust tubing. Cut a round hole in the side of the bottle near the closed end of the bottle for the carburetor air connection. Wrap the exhaust pipe with a spring such as a screen door spring and slide the muff over the spring wound section of the exhaust pipe. Clamp or weld it securely to the exhaust pipe and connect the side hole near the closed end to the hot air side of the heat box.

EXHAUST

Short stacks or a tuned manifold can be fabricated. We prefer the short stacks for looks and sound. Longer pipes may be necessary in your application for addition of an efficient heat muff. Stock VW exhaust flanges or speed shop header flanges can be used to mount the exhaust. **We repeat the warning concerning chromed brass sink drain pipes for exhaust. They are not air worthy.**

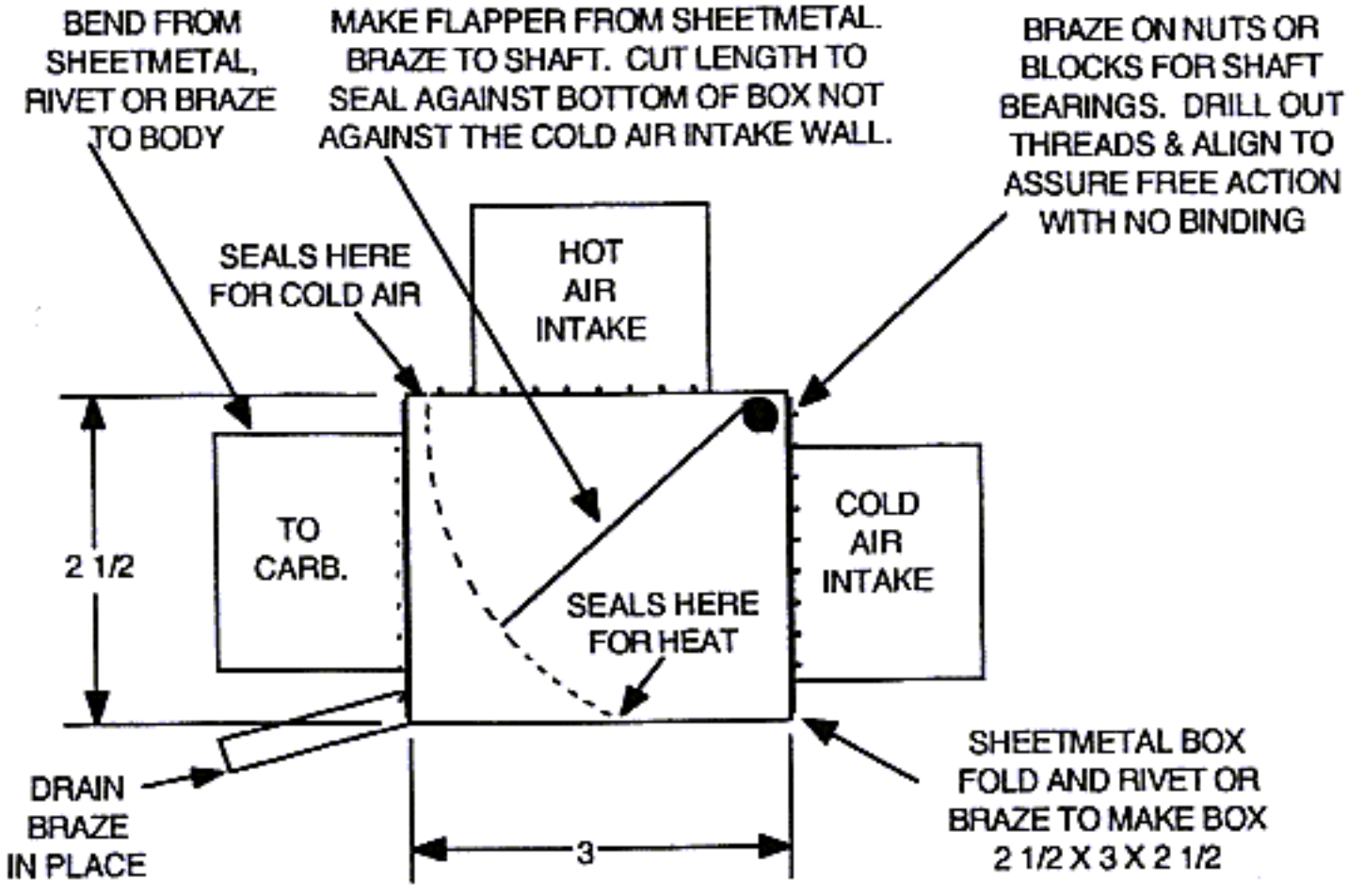
ASSEMBLY

Before starting assembly of the engine drill, tap and plug all oil passages in the crank case and crank shaft that might have been cut in this operation. Take a good look at the cam follower bores. You should have cut between them to leave a clean hole. If not make certain that there are no open tappet bores to leak oil.

Make certain that all engine cavities and oil passages are free of weld slag, machining chips and other foreign material before assembly.

Assemble your engine using the clearances, torque specifications and techniques for your particular engine. See the repair manual for this data.

FIGURE 11



MOUNTING

Mount your engine by bolting to the mounts in the bottom of the back cover and to the stock bolt through the upper crankcase parting line.

Route hoses from the hose barbs in the oil cooler holes to your cooler or connect the hose barbs together with one piece of hose. Do not plug the oil cooler holes since crankshaft lubricating oil passes through them.

PROPELLER HUB

Machine the propeller hub as shown in Figure 12 The bolt needed is from the Type 3 engine. A Type 1 or Type 2 bolt is too short. We used a steel hub. A VW "sand seal" is used to seal oil at the prop hub. Many of our previous customers have gone to an engine converter and purchased a prop hub ready made.

We consider the diameter of this propeller hub to be the absolute minimum due to the heavy power pulses of the half VW engine. If you can go larger on your propeller we recommend it.

To relieve stress risers in the part, machine all inside corners with at least a 1/8" radius. A sharp inside corner can cause premature fatigue and cracking.

Drill a 6 hole pattern in the flange of the hub for 3/8 inch bolts. Machine a matching plate of 1/4" steel to sandwich the wood propeller between the hub and the plate.

The centering spud shown with the hub drawing is made of aluminum. Its only function is to accurately center the propeller while it is being bolted to the hub. It has no load carrying responsibility.

CRANKCASE VENTING

The crankcase volume changes equal to the engine displacement every revolution. A standard VW engine maintains a constant volume since it has 2 cylinders moving in as 2 are moving out. Most areas of the engine have oil splashing around in great quantities. Without the venting it will leak from every joint. Vented where there is too much oil spray will cause a lot of loss through the vent. The best method that we have found to control this was to mount automobile PCV valves on the top of both valve covers. There is less oil spray in the valve covers than in any other location we have found. A through the firewall fitting can be used for the mounting or a short piece of tube can be brazed or welded through the top of both valve covers. Mount the valves so they let pressure out but not back in. They will slobber a little bit of oil vapor but it is minimal. Route hoses to a catch bottle or to an area where the oil vapor will not cause a mess.

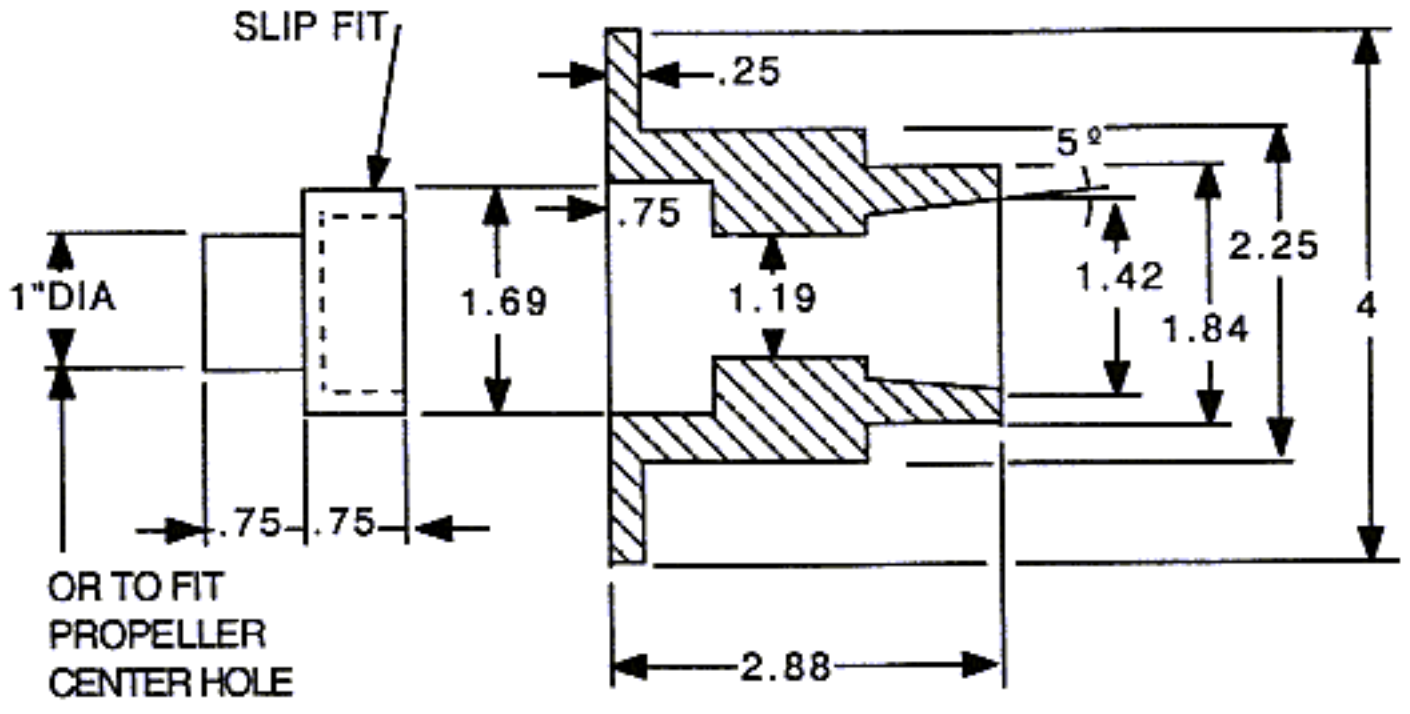
IGNITION TIMING

A degree wheel with appropriate positions for the VW is provided on the inside of the back cover of this booklet. Cut it out or copy it for use.

Remove both spark plugs and the left rocker arm cover. Mount the degree wheel on the prop hub centering spud so it will rotate with the engine. Attach a temporary wire pointer under a convenient engine bolt.

Rotate the engine clockwise (CW) facing the prop hub until the left piston is near top dead center and both valves are closed. If either valve is open, rotate the engine one revolution CW. Use a probe or dial indicator in the spark plug hole to

FIGURE 12



find exact top dead center (TDC). Set the wire pointer to zero on the degree wheel.

Set the initial advance to the timing setting according to your engine manual for your particular engine / distributor combination. Bottom line, no matter what distributor you are using, your engine should reach a total advance by 2800 RPM of 28° - 32°.

If you choose a to disable the advance in the distributor, set your distributor points to open at 30° TDC on the degree wheel. This works well but idle will not be smooth and it will have more tendency for kickback on starting.

Double check your setting by rotating the engine CCW about 90°. Then rotate CW to your timing mark on the degree wheel. An OHM meter or a continuity light will indicate the exact opening of the points.

Replace the rotor and distributor cap on the distributor. The rotor will point to the tower on the cap that must be wired to the left cylinder spark plug. The opposite tower will be wired to the right cylinder spark plug.

STARTING THE ENGINE

The engine will be started by hand propping. If you are familiar with conventional aircraft engines this will seem like an unnatural act. This engine rotates opposite what you will be accustomed to. With some care and practice you will get the knack of it.

If you elected to build your engine with a centrifugal advance distributor it will start easy and gently if all is set up properly. If you built with a fixed 28° advance it will be somewhat of an experience. With the fixed advance it will tend to backfire and will lead to a crack in the knuckles on occasion if you use sloppy propping techniques.

Get someone experienced in hand propping an engine to help or show you how if you do not have any experience. The act of hand propping is nothing to be afraid of if you are experienced and properly trained.

FINAL SETUP

Watch the spark plug color carefully to judge fuel mixture for carburetor settings. The insulator of the plug should be a light brown or beige color. Our VW overhaul manual has a color chart of spark plug mixture readings. It can be very helpful in you find a manual with this chart.

If the engine runs uneven, check that the intake manifold is set so that both runners are exactly the same length. This can cause uneven firing between the cylinders resulting in rough idle. Sometimes this can also be heard in the exhaust note. The uneven fuel mixture will usually show in the spark plug insulator color also. Those of you who have any experience with the old BMW motorcycles will vouch for the necessity of even fuel mixture for smoothness.

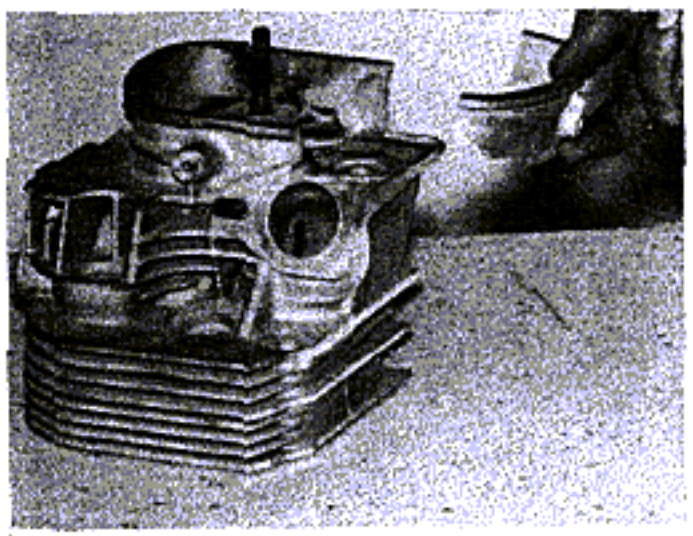
We felt much better with the crankcase dipstick held in place with a small spring stretched between its looped handle and a small bolt on the crankcase. It never jiggled out but the thought of it doing that was enough to induce paranoia.

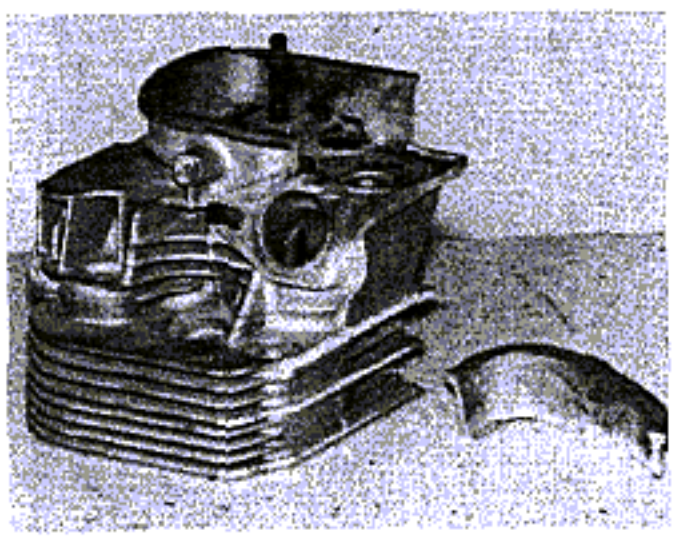
Frequently check torque on all external bolts and screws that are not held by epoxy or Lock tight until you are positive they will not jiggle loose. Any hardware which can be drilled for safety wire should be safety wired. It is a simple operation on most hex head fasteners and will reward you with a lot of comfort.

We have enclosed photos. They provide some detail that is real hard to explain in the text. The cover picture and the one with the stock carbureator were sent to us by our customers and friends who have built one of these engines.

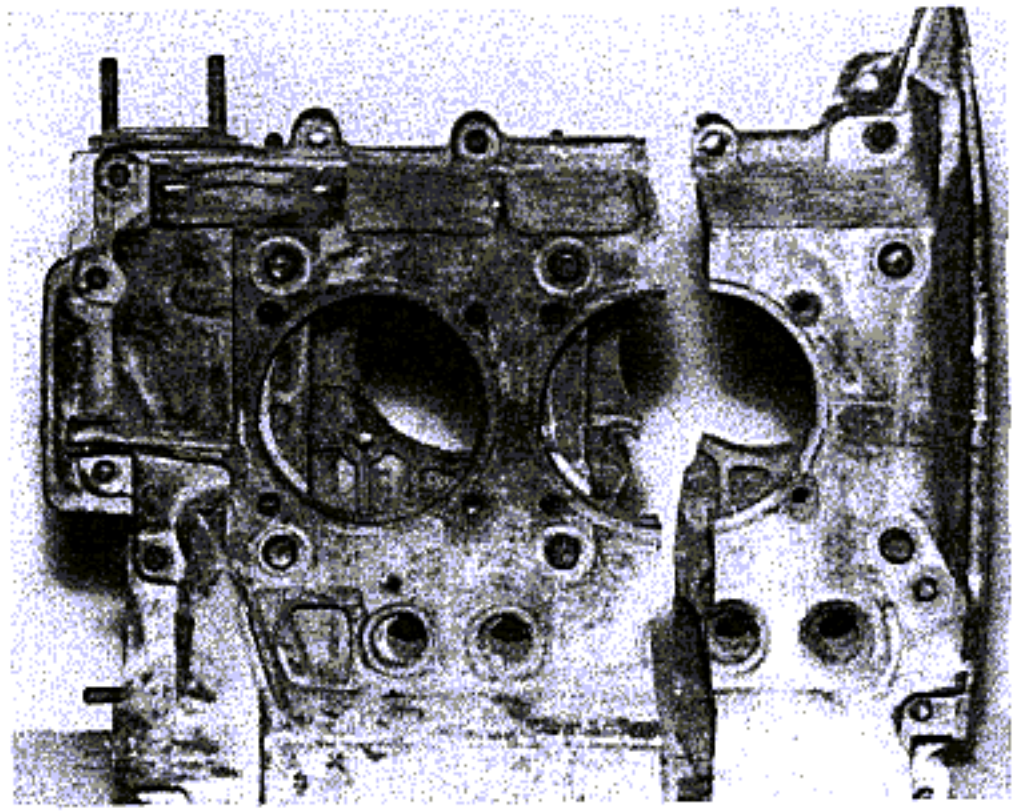
We like to hear from customers and people who have used our plans. We also like pictures of completed project. This version of the plans is the third generation. Many of the improvements and techniques incorporated in these last 2 changes have come from you.

////GOOD LUCK AND GOOD FLYING////

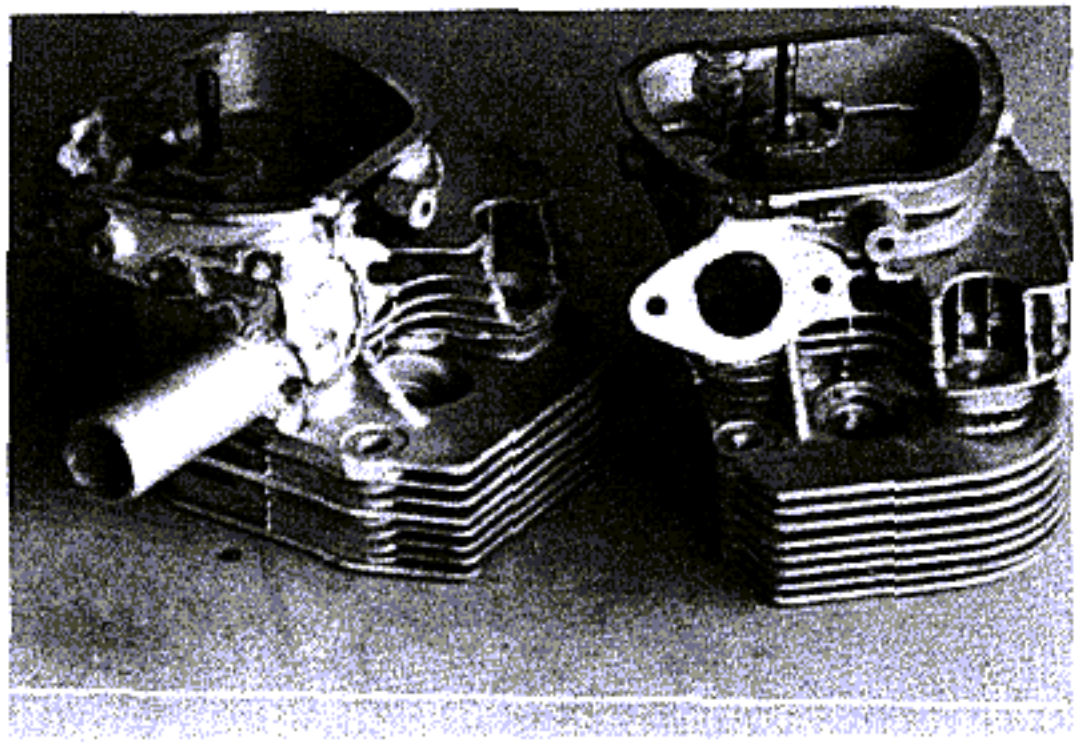




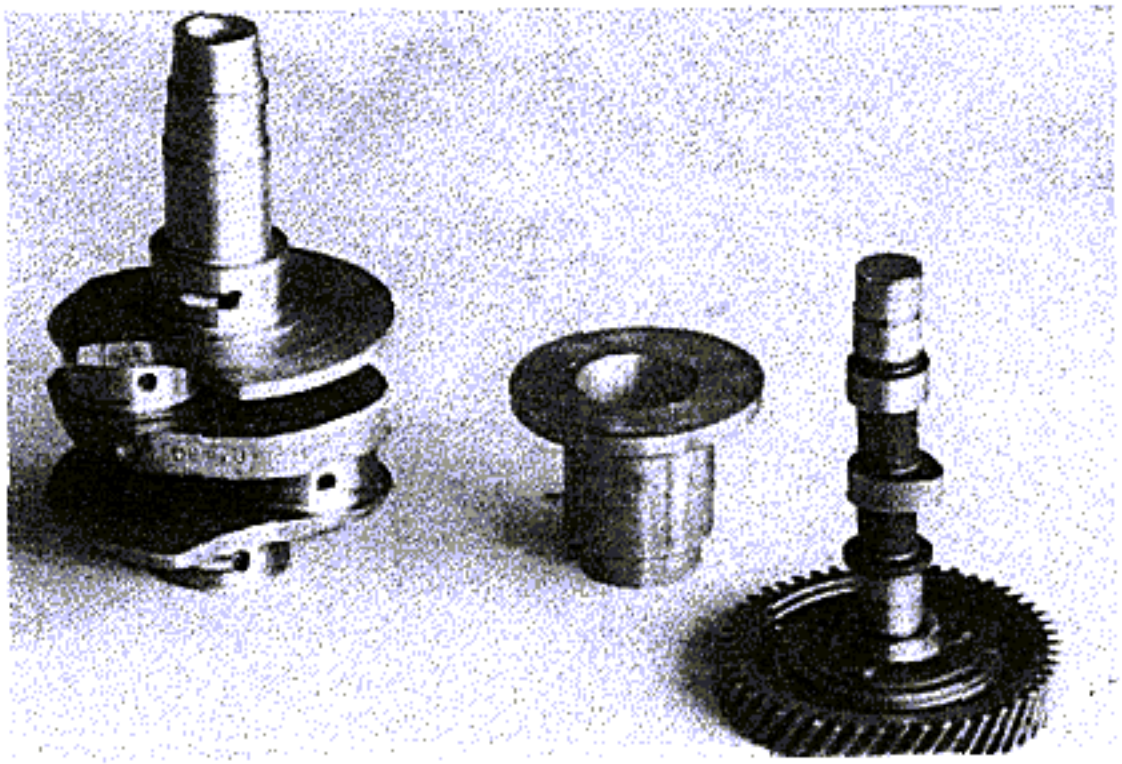
Head with rocker box flange cut & ready for weld. Note how rocker box rails are cut back.



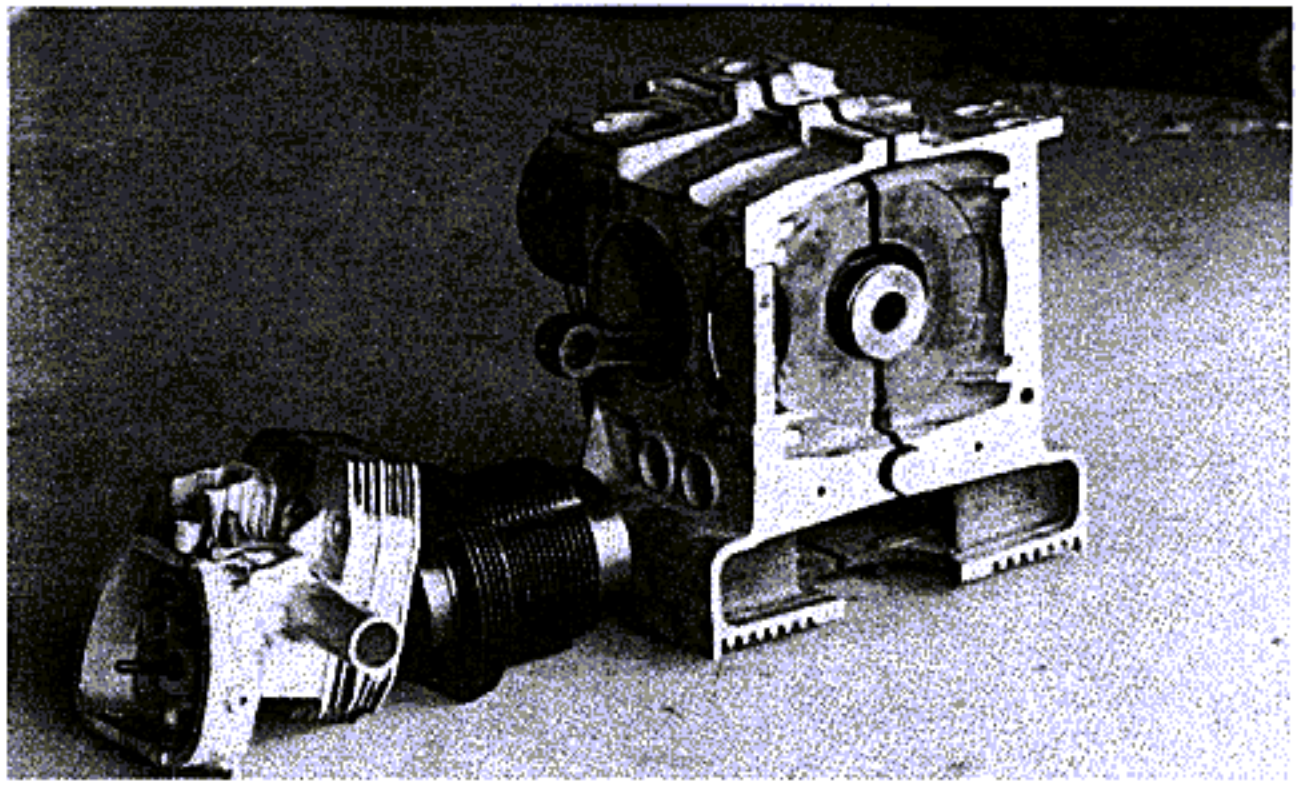
Rough cut case



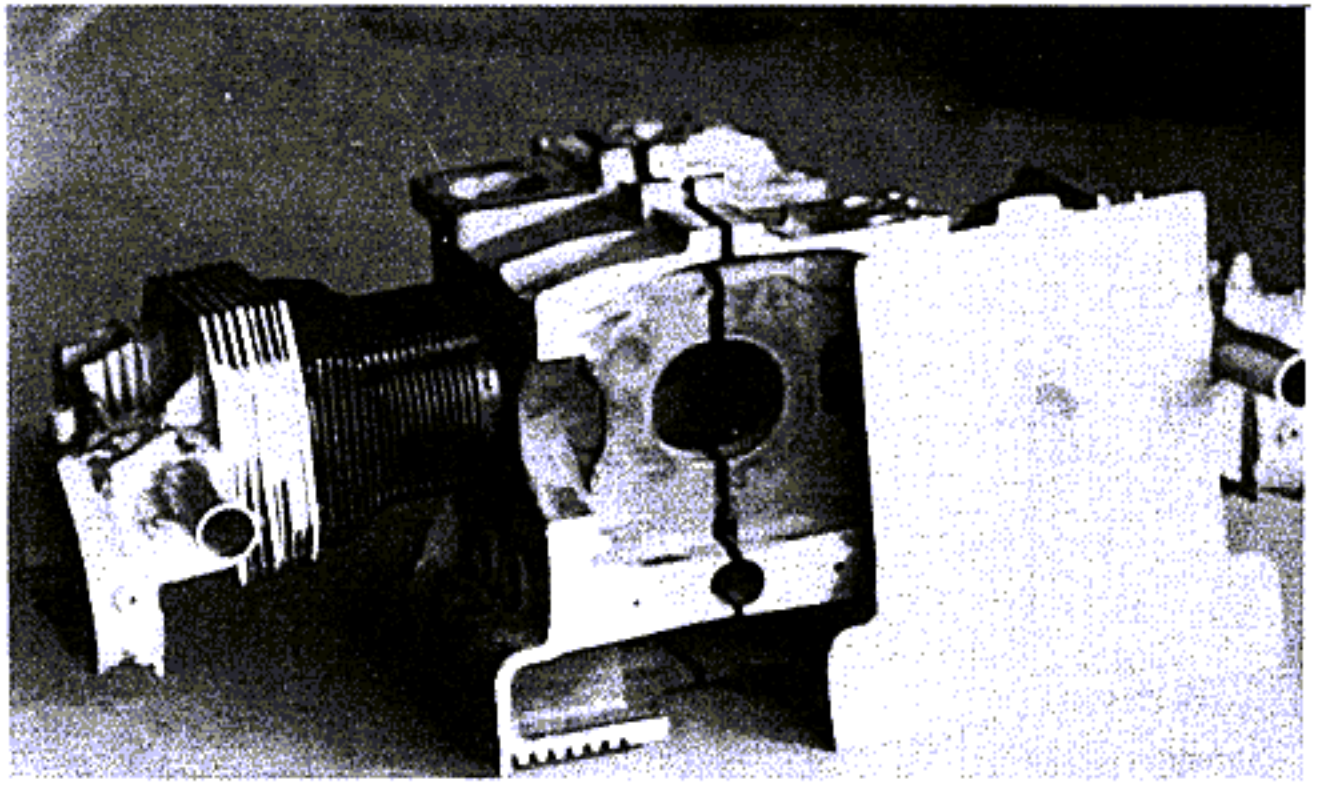
Welded heads with optional intake configurations



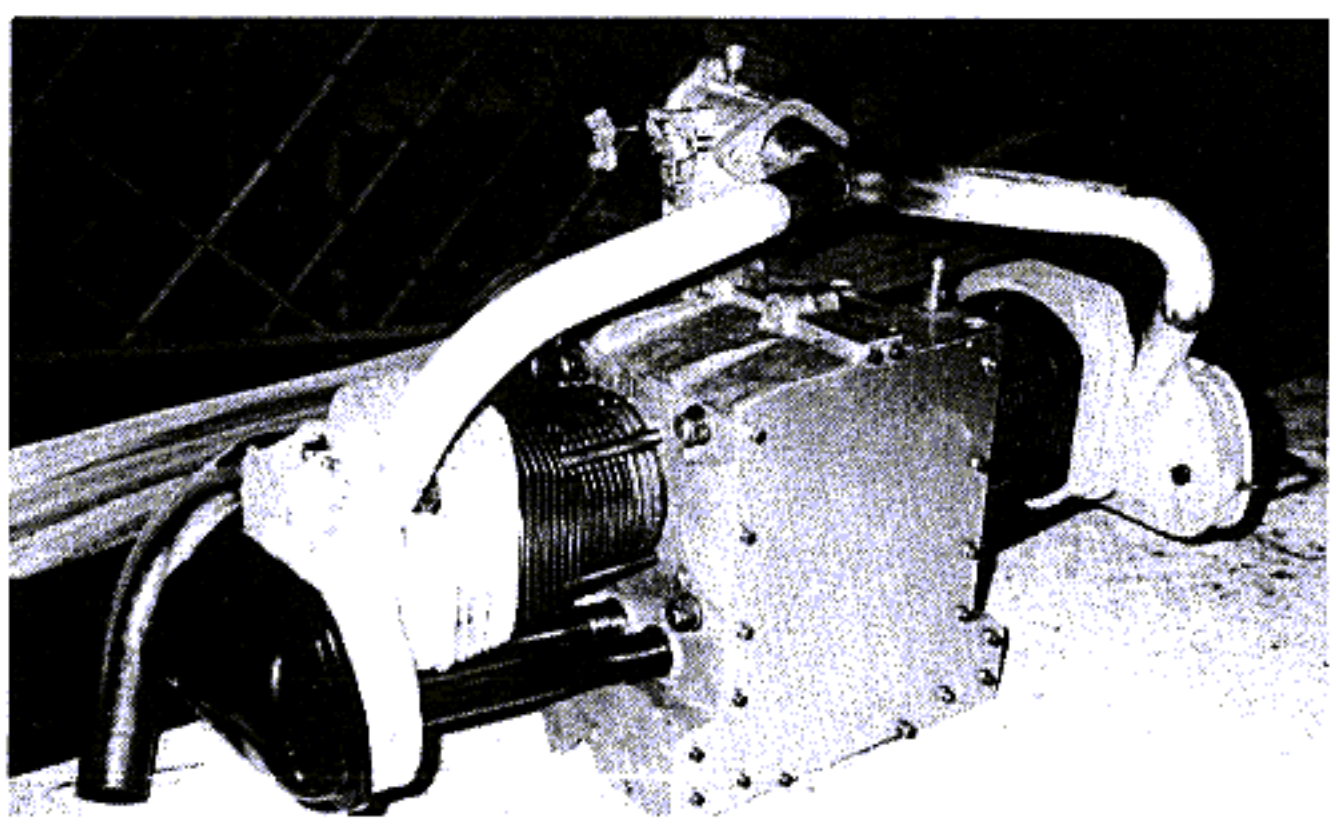
Cut crankshaft with taper, prop hub & cut crankshaft



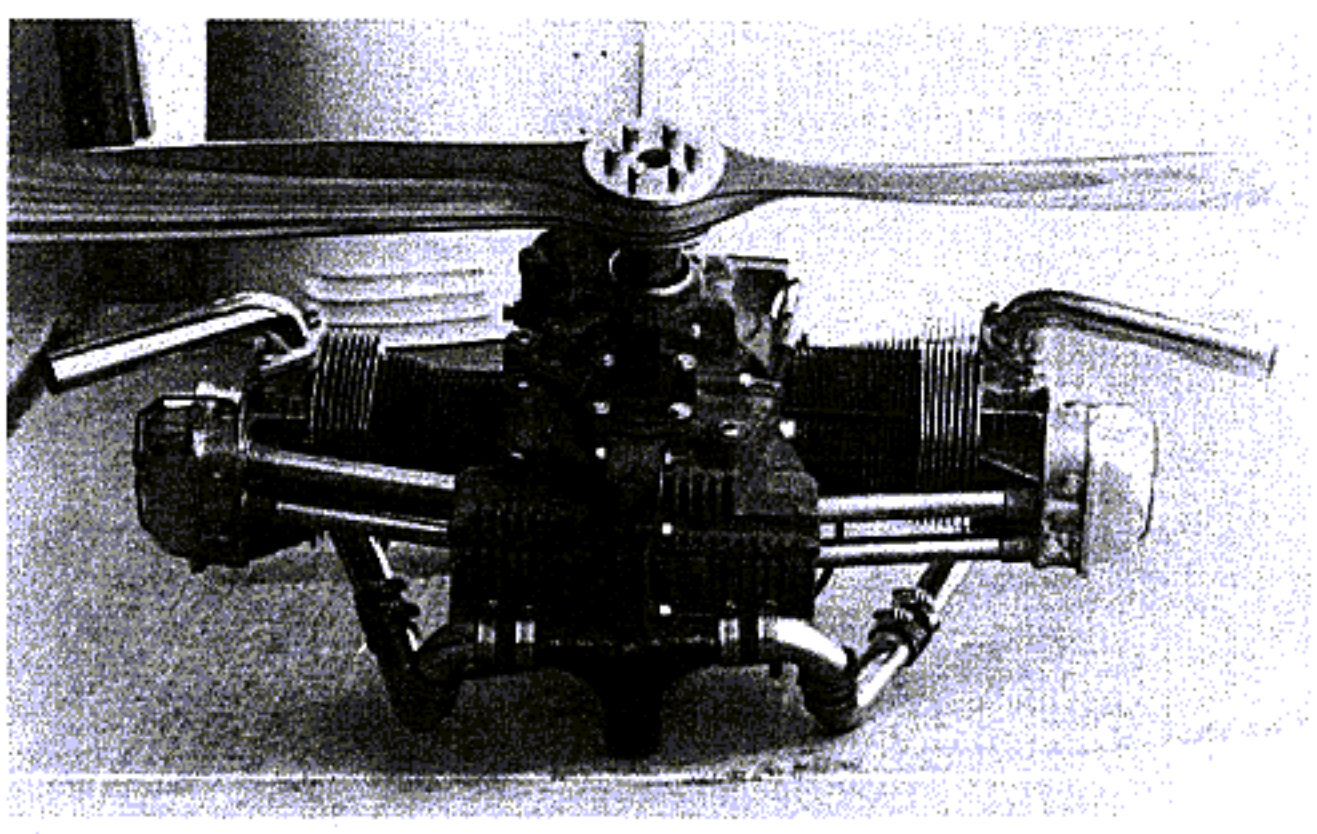
Head, cylinder & crankcase.
Note plug as detailed in Fig 2.



Case with back plate prior to drilling & tapping.
Note thick and thin areas described in text.

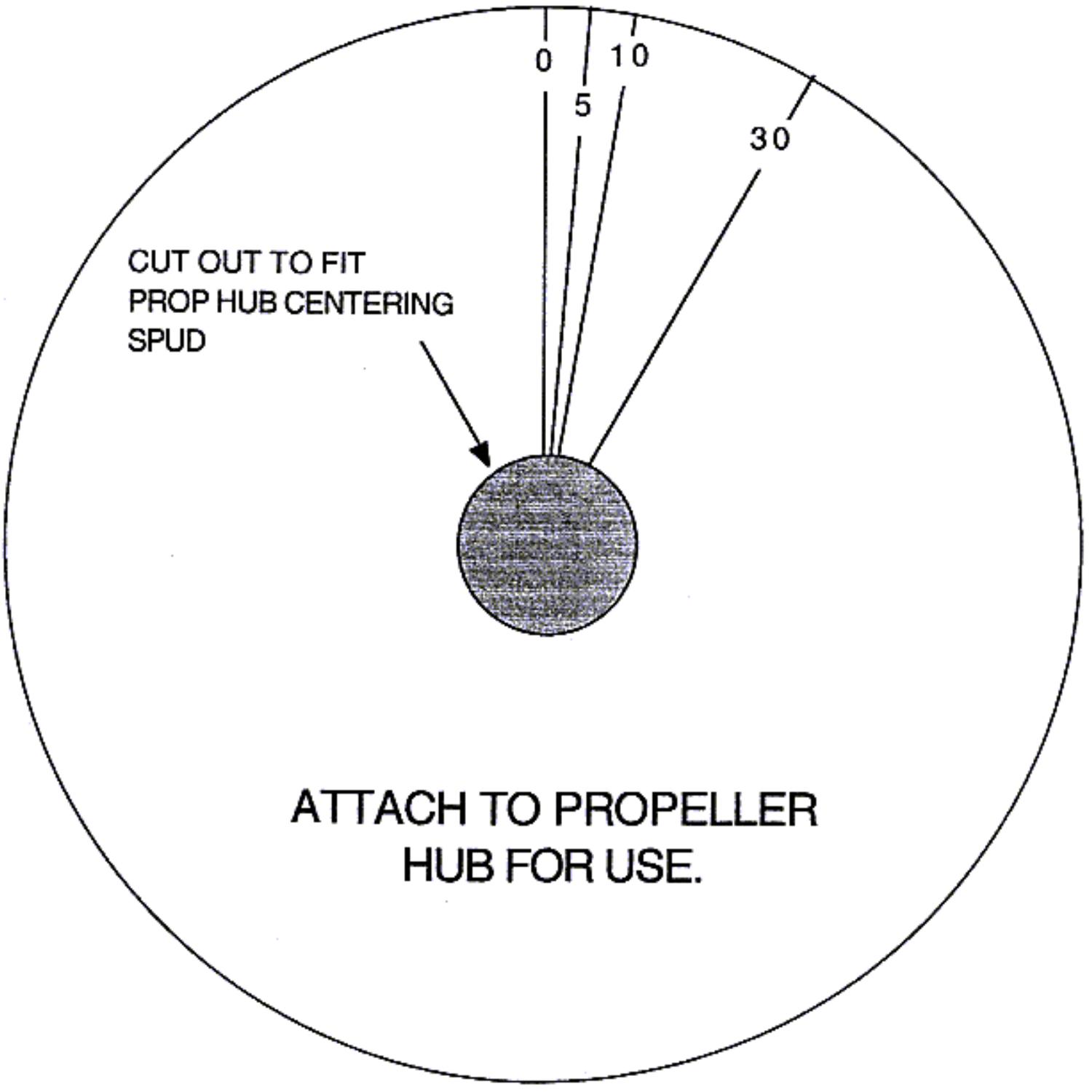


Complete early prototype with downdraft intake. Note the bolt pattern used on back plate. Exhaust is from motorcycle.



Engine with current style heads and updraft induction
DO NOT USE THE CROME BRASS TUBES SHOWN!!!

DEGREE WHEEL



SCAT ENTERPRISES

PO BOX 1220, REDONDO BEACH, CA 90278

2 CYLINDER VW EXPERIMENTAL ENGINE COMPONENT PARTS

CRANKSHAFT AND ACCESSORIES

QTY	PART NUMBER	DESCRIPTION	UNIT COST	TOT COST
1	102242	78MM 2-cyl Forged Crankshaft	$450.00	$450.00
1	111198461	Main Bearings Type 1 std/std (set)	$15.00	$15.00
1	113105701	Standard Rod Bearings (set)	$7.00	$7.00
1	111105227	Lock Ring for Timing Gears	$1.00	$1.00
1	113105249	Woodruff Key Crank Pulley	$1.50	$1.50
1	113105245F	Rear Crank Oil Seal, 40 HP - 1600	$3.50	$3.50
1	113105241A	Crank Oil Slinger	$4.00	$4.00
1	113105209	Crank Timing Gear	$14.00	$14.00
5	111101123	Dowell Pin-Crank Main Bearing	$0.75	$3.75
2	311105401B	Connecting Rod 1500-1600 Rebuilt Stroker	$10.00	$20.00
1	111105213	Woodruff Key-Timing Gear Large	$2.00	$2.00
1	80172	Crank Nose Sand Seal	$8.00	$8.00

Note: CRANKSHAFT AVAILABLE FOR DISTRIBUTOR DRIVE IN STOCK VW LOGATION OR MAG DRIVE OFF OF REAR OF CRANK.

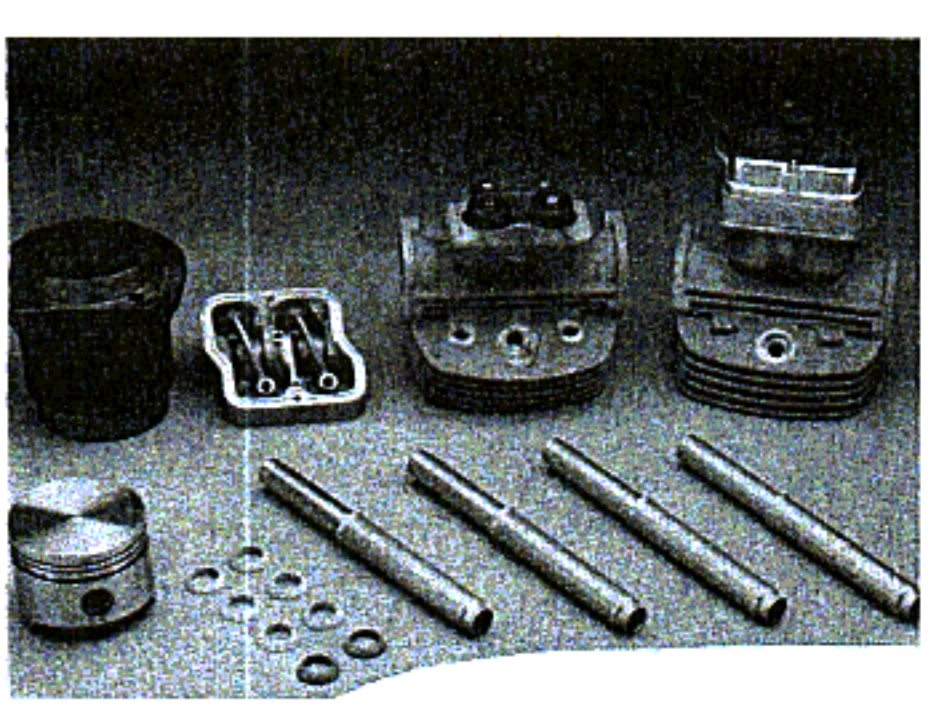
CYLINDER HEAD ASSEMBLY AND ACCESSORIES

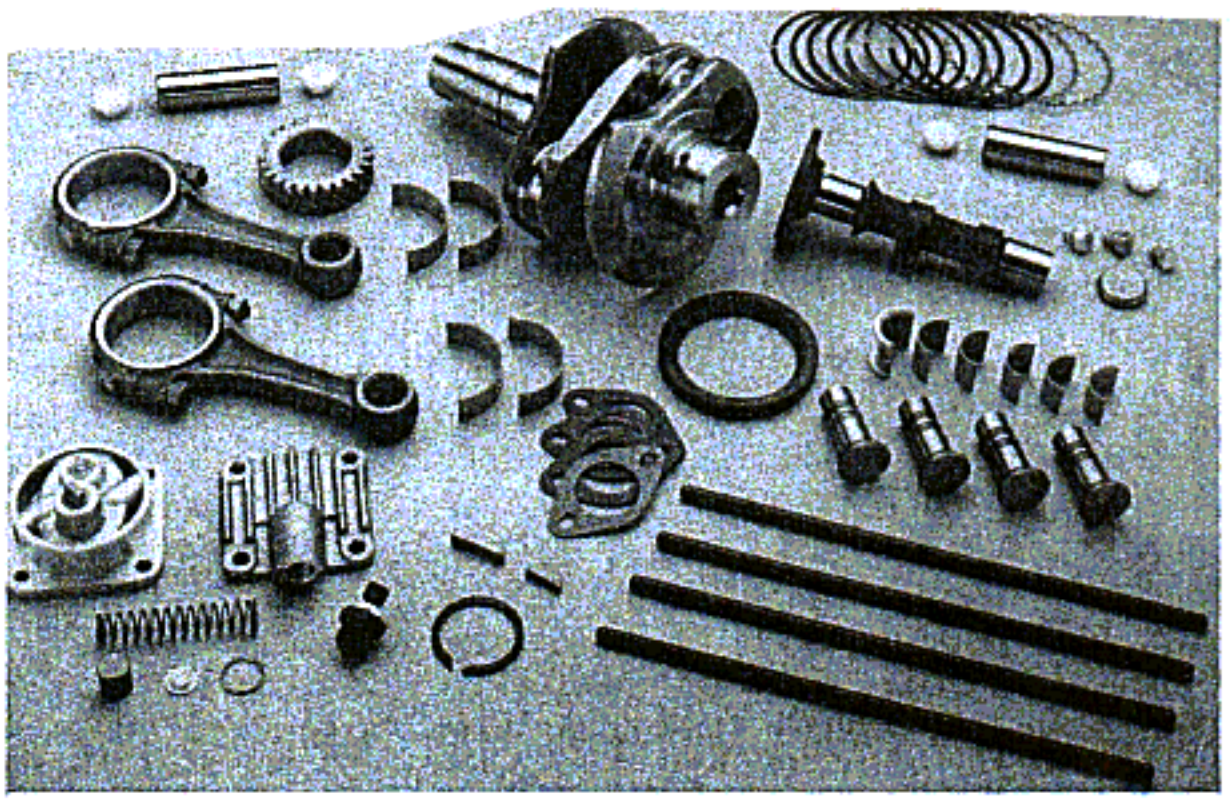
1	25106	Cylinder Head Assembly	$450.00	$450.00
4	311109443B	Rocker 1•1 Ratio 40 HP - 1600 (used)	$4.95	$19.80
4	N11152-1	Lock Nut Rocker Arm Adjustable Screw	$0.25	$1.00
4	2011801	Swivel Rocker Adjustable Screw	$1.75	$7.00
1set	99998	Exhaust Pipes, Intake Pipes and Flange(Matl kit)	$15.00	$15.00
4	85066039	Intake & Exhaust Flanges	$1.50	$6.00
8	22010001	10mm Chromoly Head Studs	$5.00	$40.00
8	22008004	10mm Head Nut	$.050	$4.00
8	22008005	10mm Head Washer	$0.25	$2.00
1	**25106**	**HEAD KIT W/COMPONENTS AS FOLLOWS**		**$450.00**
4	2047401	Adjustable Push Rod Tube	incl	
1	99146	S/S Valve Advisory	incl	
8	99568	HN Fin Mach 5/16-18	incl	
4	113109641B	Steel Valve Spring Retainer	incl	
8	113109651A	113-109-651A Type 1 Keeper	incl	
4	113109623C	Stock Single Valve Spring	incl	
2	25100030	2-048 N100=70 Nitrile O Ring	incl	
4	25100032	2-017 V884.75 Viton O Ring	incl	
2	2511209	Rocker Box Cover - Split Port	incl	
4	99616	5/16-18 X 2 Socket Cap Screw	incl	
2	2018301	Rocker Arm Shaft - .707-Split Port	incl	
2	99618	1/4-20 X 1/2 Socket Set Screw	incl	
2	99513	NH Fin Mach 1/4-20 Plated	incl	
2	22001011	5/16-18 X 1 Socket Cap Cad 1	incl	
8	99530	Stud 5/16-18 X 5/16-24 X 1-3/8 Plate	incl	
8	99528	Internal Tooth Lockwasher 5/16 ID Plate	incl	
2	2500501	Valve 40mm Intake Stainless Steel	incl	
2	2501601	Valve 35.5mm Exhaust Stainless Steel	incl	
8	20130029	Black Oxide Washer Rocker Shaft	incl	
1	2511501-1	Left Rock Box .707 Diameter Shaft	incl	
1	2511501-2	Right Rock Box .707 Diameter Shaft	incl	
1	25106002	Left 2 Cylinder Head 40mm/35.5mm	incl	
1	25106003	Right 2 Cylinder Head 40mm/35.5mm	incl	
4	5506101	VW Standard Exhaust Gaskets	incl	
4	99617	1/4-20 X 1/2 Socket Cap Screws	incl	
4	2504701	Lash Caps For Stainless Valves	incl	

INDIVIDUAL PARTS

QTY	PART NUMBER	DESCRIPTION	UNIT COST	TOT COST
1	111198007AF	Gasket Set	$7.00	$.700
1	10173	Engine Lock Nut Set	$4.50	$4.50
1	10182	Block Off Fuel Pump Hole	$4.50	$4.50
1	50115	Dip Stick	$3.00	$3.00
1	113101157C	Plug Camshaft End 1300-1600	$1.00	$1.00
1	50066	Oil Pressure Adjuster	$7.00	$7.00
1	50075	Oil Cooler Block Off	$10.00	$10.00
8	2017601	12mm X 8mm Case Savers	$0.30	$2.40
8	2013501	1/2" X 10mm Case Savers	$0.30	$2.40
1	111198541	Cam Bearing 40 HP -1600	$4.00	$4.00
4	2001801	Type 1 Lifter	$4.25	$17.00
1	20003R	Cam .338 Lift 278° Duration	$50.00	$50.00
1	50025	Oil Plunger and Spring	$3.00	$3.00
1	50031	Remote Oil Filter Bracket	$10.00	$10.00
1	311115107AK	1500/1600 Oil Pump 21mm	$15.00	$15.00
2	50059	Oil Pump Cover External Outlet	$9.00	$18.00
4	2006801	Cut to Length Push Rods	$1.50	$6.00
4	20068002	Push Rod End	$.050	$2.00
1	311105263	Type III Crank Bolt	$4.95	$4.95
1	111105259	Crank Bolt Washer	$0.75	$0.75
1	040101025	New VW Factory Engine Case	$225.00	$225.00
1	10183	New Engine Case (machined for up to 82mm stroke, bored for 92mm cylinders. Oil passages drilled and tapped)	$400.00	$400.00
1	none	Rear Casting	$150.00	$150.00
1	none	Magneto	$175.00	$175.00
2	15154B	94mm Piston and Cylinder Assembly	$45.00	$90.00
2	15125B	92mm Piston and Cylinder Assembly	$45.00	$90.00
4	1516401	92mm Teflon Button - 75mm Pin	$1.75	$7.00
4	1516501	94mm Teflon Button - 75mm Pin	$1.75	$7.00

Contact Scat Enterprises, PO Box 1220, Redondo Beach, CA 90278 for inquiries or information concerning the kit and individual parts listed. Data in this sheet was extracted from Scat Document "a:\vwengine November 8, 1990". Mention Scat Document when inquiring or ordering hardware.





Ph: 714-920- 0019 **DUFFIN ENTERPRISE** Fax: 714-920-0454

1302 N. PADUA AVE #21, UPLAND, CA 91786

Hello and welcome to the exciting world of experimental engines. With the plans and some machined components you have the ability to build and run an engine that will provide you with many hours of enjoyment. The 1/2 VW engine has proven itself as one of the best power plants for the price and power output.

As an introduction to Duffin Enterprise and our involvement with aircraft, I have worked and supplied parts to the ultralight and homebuilt markets for over 10 years and provided engineering for the assembly of the newest tri-jet on the market, the MD-11, working with McDonnell Douglas.

Currently, the crankshaft that we sell is counterbalanced, ground, shot peened, heat treated and Magnaflux™ inspected. This work is provided to our specifications by one of the VW industries largest suppliers of welded, counterbalanced crankshafts. We can on special order supply strokes up to 86MM and Full Circle counterweights. This can provide a vast improvement in torque output in the engine.

The propeller hubs are designed for the horsepower of the 1/2 VW with a 4"" diameter, 4 X 3/8 dia. holes for the propeller mounting bolts, and includes a front cover plate. If you are interested in a prop flange for a full engine, we can supply one on special order.

If you require additional information regarding the services that we provide and the parts available, please write or call at the above number after 6:00 PM. Leave a message if the answering machine picks up the line and I will return your call.

We at Duffin Enterprise look forward to supplying you with the machine work and the precision parts that you need to complete your 1/2 VW power system and other machining work that you may require.

Sincerely
Glenn R. Duffin, Director of Operations

THE FOLLOWING IS A LIST OF PARTS FOR THE 1/2 VW ENGINE

Crankshaft:	69 MM counterbalanced, welded and Magnafluxed™, ground to .010/.010 undersized and fitted	
with	a taper lock prop flange.	$265.00
	Larger Stroke, up to 86MM	POR
Heads:	Machined from standard duel port VW heads, intake on top, stock rocker arms, rocker covers.	
	Complete set for an engine.	$495.00
	Built from 041 heads. Additional:	$ 79.00
Case:	Machine work to a customer supplied case. Includes cutting rear of case, drill and tap for cover, rear cover, #3 cylinder plug, oil drain adaptor plate, clearance for counterbalanced crankshaft, rear	
engine	mount blocks and alignment pins:	$389.00
	Rebuilt case to start with:	$179.00

ADDITIONAL MACHINE WORK AT THE FOLLOWING PRICES:

Install case savers	$25.00	Bore heads for larger cylinders	$20.00
Bore case for larger cylinders	$25.00	Install -4- shuffle pins	$40.00
Drill and tap rear case	$40.00		

ADDITIONAL PARTS REQUIRED TO COMPLETE ENGINE:

Oil filler cover with machined oil cap	$29.00	Fuel pump blockoff plate	$10.00
Oil drain cover with mini sump	$32.00	Engine mount blocks	$36.00
Rear cover plate	$79.00	Front oil seal	$14.00
4" prop flange kit	$89.00	Engine Kit (one of each fr. above)	$245.00

We offer a complete machine shop service to any other requirements you have using both computer controlled (CNC) and conventional milling, turning, grinding and gear cutting equipment. All prices are subject to change at any time.

SHIPPING AND HANDLING WITHIN THE UNITED STATES:

Crankshaft:	$16.00	Heads	$14.00
Engine Case	$20.00		

The following items can be shipped 2 at a time for the price of one to save on shipping. The price of the highest item shipped will be charged.

Oil filler with cap	$6.00	Fuel pump blockoff plate	$3.00
Oil drain cover with mini sump	$6.00	Engine mount blocks	$6.00
Rear cover plate	$8.00	Front oil seal	$3.00
Prop flange kit	$7.00	Kit consisting of one each	$14.00

This price list, parts, and any other information sent from Duffin Enterprise is to assist in the assembly of an engine to the drawings supplied by Kite Industries (Gary McGill & Associates). As these engines are experimental in all cases, Duffin Enterprise does not warranty the performance of the components or their functions in an assembled engine.

Duffin Enterprise will take all steps needed to supply a quality product; however, it is the responsibility of the engine assembler to assure the function of each component, that it operates as it was designed and that the assembly of the engine is in accordance to the plans and instructions provided by the designer.

We look forward to supplying you with the best parts made that will allow you to build one of the finest engines available in the industry.

Glenn R. Duffin

12-91