

# Willow Green

*Jaguar musings and other miscelany.*

March 10, 2008

## Jaguar Early XJ6 Head Reinstallation

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### **Installation of the Jaguar Head:**

#### **Early Series one XJ6**

**A compilation of various manuals and emails from XJ-Lovers**

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There are companion videos at Vimeo

<http://www.vimeo.com/user414729/videos>

and at You-Tube

<http://www.youtube.com/watch?v=LE4m8cHLOb8>

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*Warnings about removing and refitting the head*

Before removing or dismantling the Jaguar cylinder head, read the three warnings below to avoid the possibility of bent valves.

- 1. Do not rotate the engine or the camshaft after the camshafts have been disconnected from the drive until the cylinder head has been removed.**
- 2. Once the cylinder head has been removed, do not rotate either camshaft unless the other has been**

removed.

**3. Before replacing the cylinder head, follow the instructions for positioning the camshafts in relation to each other and to the crankshaft.**

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*A.) Removing the Core Plugs*

It's desirable, but not necessary to remove the core plugs and clean the interior of the block before installing the head. Dirt collects around the base of the head studs and the best way to get it out is through the core plug (also called freeze plugs or Welsh plugs) openings.

To remove core plugs, place a center punch at 9 PM position on the plug and whack it with a hammer. After a few hard blows, the plug rotates on the 12-6 axis. Grab a protruding edge with locked vice-grips and rock it back and forth while pulling outward.

*B.) Cleaning the engine web*

There are passageways behind the core plug openings, where coolant water flows around the cylinders. Dirt and precipitate minerals collect in the bottom of the webs, around the base of the head studs, reducing heat transfer from the cylinders to the coolant water.

Use compressed air from a shop compressor to blow, and a shop vacuum to suck out all the dirt from the areas around the cylinders. Remove the studs and clean out the threads similarly. If a water source and floor drain are available, wash the areas under moderate pressure while agitating with a brush.

Replace the core plugs after reinstalling the cylinder head but before putting the intake and exhaust manifolds on. The plugs are hammered into place and require considerable force to seat. Clean the opening thoroughly, you can use a small wire wheel in a drill chuck, to remove scale and rust before installing a new plug. You may use a light bead of GE silicone sealant around the plug before seating although its not required. Start the seating process with a few light taps to around the edges to "set" the plug and then hammer around the periphery in a series of blows to gradually drive the plug in evenly around its circumference.

*C.) Painting the Studs*

Bare steel studs corrode when in place. Painting before installation with a good grade of metal paint reduces corrosion. Use new studs if possible.

Sand the studs, then use metal prep to open the metal pores, coat with a good rust resistant primer and two coats of finish. Be as creative as you wish with color as only the next head changer will see your color selection.

*D.) Stud Placement*

There are fourteen studs, four short and ten long. Four of the ten long studs (let's call them the longest studs for discussion purposes) are about 3/16" longer than the remaining six. These longest studs hold the lift brackets.

The four short studs are easy to place as they go in the four corners. Moving in toward the center of the head from each end, next comes the four longest studs. And finally the remaining six long studs are in the middle. Graphically it is:

(Front of car) A B C C C B A (rear of car)

A B C C C B A

Length

A = 6 7/16"

B = 12 15/16"

C = 12 11/16"

The exhaust side "B" front stud should be a dowel stud. There is some clearance around the studs. As a result, the head could be slightly out of place. A dowel stud is fatter where the head slides on so as to "locate" the head on the block.

#### *E.) Studs at front of chain cover*

There are four bolts that hold the front of the head to the area of the block around the chain cover.

#### *E.) Studs; which end is up?*

The short head studs have a 1/16" wider band at one end. This side goes down

The longer head studs are threaded at both ends, but one end has an un-threaded tip. This end goes down.

You'd want to thread and tighten the studs into the block so if you remove the head again the studs stay in the block while the dome nut comes off, instead of the stud and nut coming out as a unit. Be careful bottoming the stud out, as you don't want to damage the first thread of the stud on the threads that won't be fully formed at the bottom of the block.

#### *F.) Positioning the Pistons*

Turn No. 6 (front) piston to the Top Dead Center position with the distributor rotor arm opposite No. 6 cylinder segment.

Be sure it is at the top of its compression stroke rather than exhaust stroke by checking distributor rotor position (if your dist is still fitted). Looking from the right hand side of the car, the rotor should be at about 7 o'clock and the timing marks should be about 0 degrees as shown in Fig B.

FIG. B



#### *G.) Ready the Block*

Remove all oil and grease from the mating surfaces by means of a cloth dampened with gas or other volatile grease solvent, wiping dry with a clean cloth.

The head gasket is stamped with the word "Top" to ensure that it is fitted with the correct side facing upwards. The timing chains have to be raised up through the hole in the gasket which, in turn, has to be lowered evenly over the front and rear studs.

Used the long cotton swabs, available at a hospital supply store, to get some hi-temp grease on the block stud threads.

Cover the lower stud ends with a thin hi-temp grease layer, and screw them in at 20 ft-lb.

Used a small bead of GE Silicone II around each of 10 interior studs at interface with gasket.

This is a good time to clean the splined plates in the two timing chain sprockets removing old grease and particulate matter. If the plates are not already out of the sprockets, push them forward from the back side exposing the splines on both the plate and sprocket. Use a spray cleaner around the circumference of both.

#### *Positioning the Camshafts*

B.) Accurately position the camshafts with the timing gauge, as illustrated in FIG D. Ensure that the gauge is seated on the camshaft cover faces at the points indicated by the arrows. Position this camshaft as shown in Fig D, using the cam gauge, with the keyway at the right angles to the cover face. The second cam positioned nest with the keyway at right angles to its cover face, fitted finally with the torque nuts tightened up. From this point forward, the camshafts must not be rotated until the timing procedure has been completed.



FIG D

#### *H.) Fitting the Head*

If the rebuild shop fitted your cams and you have some feeler gauges, for your own peace of mind you should check the valve clearances. Also check camshaft bearing tensions, it should be a mere 9 ft/lb. Some unknowing person might be a little heavy handed on those.

Beware when lowering the head onto the studs, NOT to contact that one open valve with the top of the studs. The valves **WILL BEND**, very easily.

Wrap the studs with a thin turn or two of electrical tape to protect the surface of the head. Make it into the shape of a cone at the tip. (From Ted on the XJ-Lovers list)

The easiest way to fit the head is to have two people lowering it evenly on to the block (otherwise it may bind on the studs).

Alternately, use a hoist with a rope through the cam sprocket orifices at the front, and around the oil feed inlets at the back of the head.

First, remove any bolts from the camshaft flanges and place the timing chain sprocket assemblies in the top loops of the chains. Rest the sprockets in the supporting brackets and tie them together with a length of wire or plastic strap so that the head can be lowered over them.

Alternatively, there is a threaded "stud" in the center of each Cam Chain Sprocket, the stud "lives" in the slots of the "ears" of the upper chain "housing." One takes a hex nut and threads it on to the stud to secure the sprocket in a "up an in" position (I believe the correct thread of the studs/nuts is BSF).. This keeps the sprockets in a position that the head will clear during removal or reinstallation. The studs and "ears" are "built-in holders", so to speak. ( From Charles on the XJ-Lovers list)

Get a head gasket set & Copper Coat sealant. Some people recommend the Payen gasket set.

Use a generous amount of hi-temp grease on upper portions of all 14 studs.

Use thin layer of Copper Coat on surfaces around chains. Some people recommend it also for the entire block and on top of the gasket, others say only the area around the timing chains.

Drop the head down quickly after the grease and copper coat, adding washers, engine lifting brackets and high tension lead support bracket to the studs. Place a thin layer of grease on top of the head washers

under the dome nuts. It helps give a more accurate reading when torquing the nuts.

Fit the spark plug lead carrier to some of the studs on the right hand side and the '0' washers to the remaining ones. The washers are part of the sealing system that keeps the water in the block. The thicker ones should be on all but the lifting eye studs but if a previous owner didn't bottom the studs, the extra washers were likely a quick and dirty solution to the problem of water seeping out round the base of the nuts.

Put the lifting lug against the head, and a washer under the nut, but not a washer either side of the lifting lug. If you have sufficient thread, you shouldn't need two washers per stud.

Grease the top of the washers under the nuts. It will give you a more accurate torque reading. For the engagement length, use is the diameter of the stud. Thus, if you have a 1/2" diameter stud, the nut should be threaded on 1/2".

Torque the Domed head nuts in stages, 1/2 turn at a time, to 54lb/ft working from the center of the head towards both ends. See FIG. A. Tighten the six nuts at the front of the cylinder head.

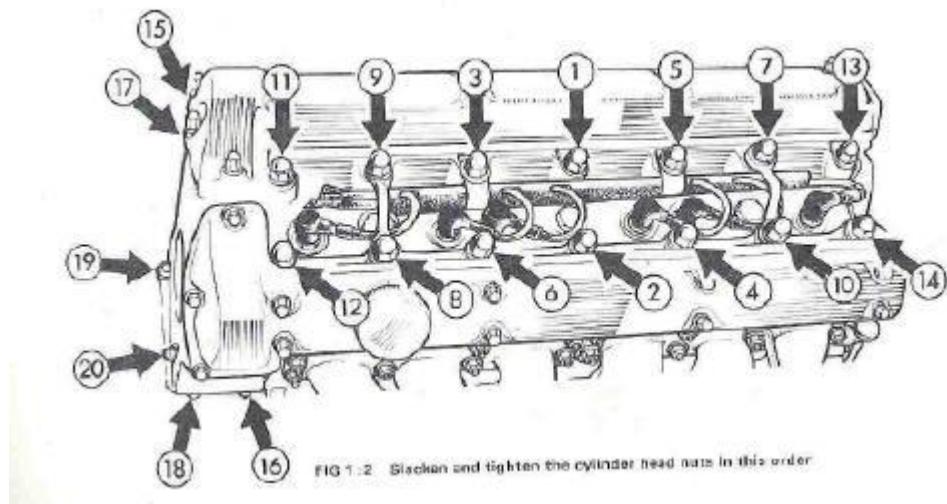


Figure A

Use 2 stainless bolts at front down into chain cover.

After installation of the dome nuts, wait a few hours and then re-torque in correct order. The studs stretch a significant amount.

On 4.2 liter models fitted with air conditioning equipment, mount the alternator and the compressor to access to nuts 16 and 18.

An alternative to the above method of dropping the head is to install only two studs, one in the front and one at the rear to act as an index. Once the head is in place, install the balance of the studs using the double nut method.

### I.) The Camshaft Flange and Adjuster Plate

A word about aligning the holes in the camshaft flange and adjuster plate

The manual says, in essence, that if you can't line up the hole in the adjuster plate with the hole in the camshaft flange, to rotate the plate 180 degrees and that hole will work. I assumed from that statement, incorrectly, that the holes were not at the 0 degree and 180 degree marks, but slightly off, and therefore you had to match up the holes with its mate.

To test this, I tried bolting a spare adjuster plate to the flange of a spare head. The chain sprocket was not attached and therefore it was easy to try bolting the plate to the flange in any of four locations. I discovered that the holes ARE at the 0 and 180 degree marks (in the plate) and at the 0, 90, 180 and 360 mark on the flange. Without the splined sprocket, you can bolt it easily any way.

What the manual is saying is that the splines are such that only one of the two ways may work (I'm not sure if it's a "may" or a "will.") The point being is that you are not mating up the two plates in the correct orientation, but rather making certain that the relation between the holes and serrations are correct. And if not, turning the plate 180 degrees will expose serrations in the correct location.

I'm sure it says that somewhere in the manual, but it was not obvious to me and wanted to share it with others who may struggle with this issue.

#### Bolting the plate and flange

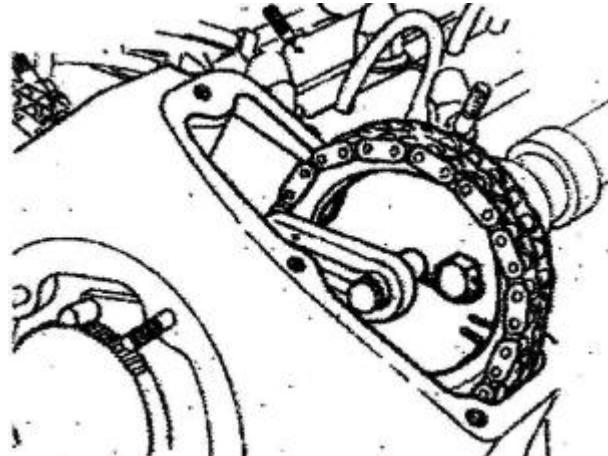


FIG. A

If you have not already done so, wash the splines on the adjuster plate and those on the chain sprocket with a spray cleaner.

Be certain that the cams are at #6 TDC by checking the cams with a cam gauge and checking the timing indicator is at 0 degrees.

The chains were tightened on the central tensioner at this stage but only to a sufficient extent to remove excessive slack, so that there was no risk of them jumping the cogs.

Remove the circlips from the sprocket assemblies and the push the adjuster plate clear of the sprockets, resting on the supporting brackets. Turn the plate until the bolt holes are aligned with those of the camshaft flange, then push the plate into splines in the sprocket and fit the circlip. Do likewise with the second plate. Rotate the crankshaft (it requires a 1/5/16" socket) so the employ hole in the plate is accessible. Thread the second bolt. If the second bolt will not thread, again rotate the engine so the bolt is accessible. Remove the bolt, rotate the plate 180 degrees and reinsert the plate.

Turn the craft shaft 180 degrees again and try the bolt again. It should work. Install both bolts.

## Re-tension the timing chains.

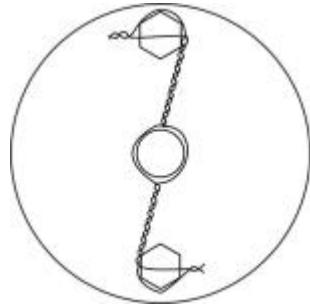
Following is the procedure for wire lacing the bolts used to connect the adjuster plates to the camshaft flanges.

Before proceeding, stuff rags into the timing chain cavity so that debits and/or loose parts cannot fall into the cavity. Position the rags so they are not caught when turning the timing sprockets. The process will require a pair of needle nose pliers and a side cutter. It will also be helpful to have a 1 5/16" socket with appropriate handle to turn the engine by hand for access to the bolts.

The series 1 XJ6, unlike later engines, employs wire lacing to prevent the connecting bolts from loosening while in use. Each adjuster plate/camshaft flange connection is made with two bolts set at 180 degrees to one another in the adjuster plates and threaded into the flange. Once the bolts are in place draw them snug but not tight and adjust the heads such that the wire passageways, which are drilled through the side of the head, are turned parallel with the center shaft.

Use aircraft type wire which is made specifically for this purpose, .032 stainless steel safety wire. The process begins with the bolts at the 12 noon -6 PM position. Thread the wire through the bolts taking care not to kink it. Set the wire in the configuration shown in the below drawing. In twisting the wire ends, do not twist the wire tight. The finished product should resemble a string of tiny pearls with space between the wires. There is a tool, variously called lacing pliers or wire twisters to make the twist.

Fit appropriate wire through the hold in the two bolts heads in the pattern below.



The timing chains cannot be tensioned finally until the head has been tightened down fully.

J.) Refer to FIG E and install the four nuts 54 which secure the breather housing. Collect the spring washers 55. Tighten the hose clips and insert the breather pipe 56. Insert the breather housing. Apply the tension in the top camshaft drive chain as described in Section 1:6.

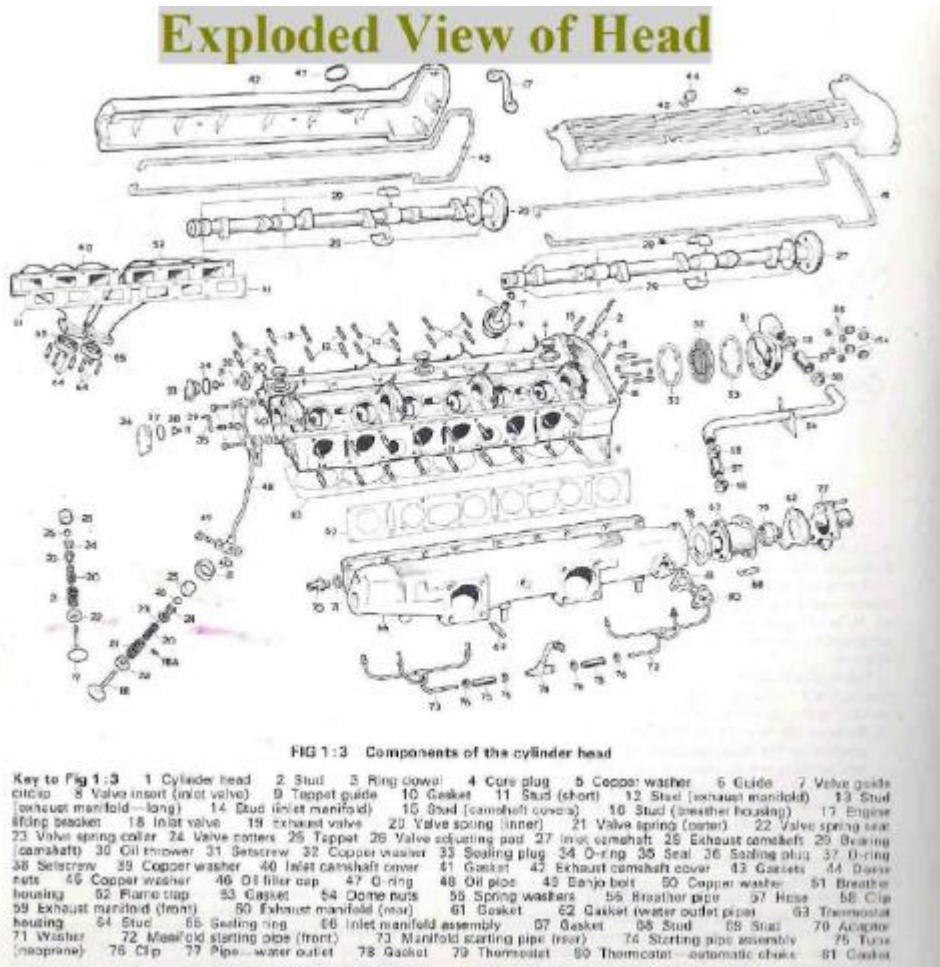


Figure E

## J.) Tension the top camshaft drive chain.

Refer to figure C and, through the breather aperture, slacken the locknut which secures the serrated adjustment plate. Depress the locking plunger and rotate the adjustment plate by means of the two holes in an anticlockwise direction. When correctly tensioned there should be slight flexibility on both outer sides below the camshaft sprockets, that is, the chain should not be dead tight. Rotate the crankshaft slightly each way and recheck that chain tension. Release the locking plunger and tighten the locknut. The use of Churchill tool no. J2 for this procedure as shown in FIG C. The tension of the chain may be released by following this procedure except by turning the adjustment plate in a clockwise direction

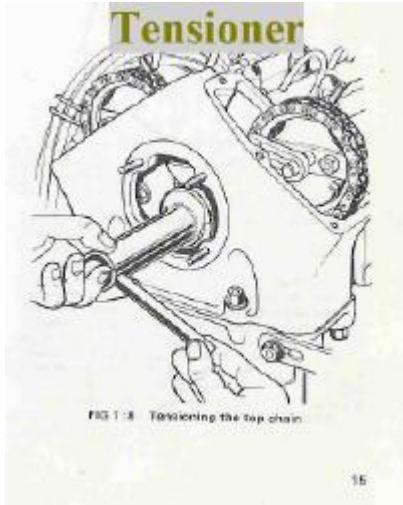


FIG. E

### *K. Exhaust Manifolds*

#### *Preparing the exhaust manifolds*

It's a good idea to clean up the cast iron manifolds while they are off the car. Sand the manifolds with 80 grit sandpaper to remove loose paint and rust. Wire brush or lightly sand face to remove old gasket. Wire brush the circular gasket holders and bolts at the bottom of the manifolds with small wire wheel mounted in a drill.

Wash the manifolds with solvent and paint with hight heat paint

Clean the threads of the studs with a wire wheel. Clean the nuts and washers. Install the manifold

#### *Heat Shield*

If the manifold includes an aluminum heat shield at the front, clean the shield with a wire wheel, hammer out any dents, wash with solvent, sand with 400 and 1000 paper and spray with clear, heat resistant coating.

Install the sixteen studs which hold the two exhaust headers in place. Coat with never seize first. If your car is equipped with air conditioning, the top front stud is longer than the rest to accommodate the A/C hanger plate.

#### *Installing the exhaust manifolds*

Each of the two manifolds has a gasket. Coat the gaskets on both sides with moly graphite or moly disulfide grease to make it easier to remove them. Install the rear manifold first to facilitate access to the bottom bolts. Install the front manifold. Keep all bolts loose.

Remove existing gaskets from the exhaust header and install new gaskets. Use a trolley jack to push the header up into place. Wiggling the header helps to seat the head pipes in the manifolds. Install the retaining plate and four bolts on each exhaust pipe. Once all bolts are in place, gradually tighten all bolts. It may help to place a small mirror near the retaining plate to maintain its four corners equidistant from the manifold plate. Use a socket, open, box and stubby wrench as needed to access the four bolts.

Tighten the sixteen nuts on the two manifolds.

### *Starter Rebuild*

Before installing the intake manifold, this is a good time to clean and rebuild the starter motor.

The motor is held in place by two bolts with heads that face the rear of the car. The lower bolt is somewhat difficult to remove. Remove the lower first using a "L" shaped distributor wrench. Remove the top bolt with a ratcheting box wrench.

Disassemble, clean, rebuild, repaint and reassemble the starter as needed. Reinstall.

This is also a good time to paint and renew the heater hose running behind the carburetors.

If you have taken out the thermostat housing this is a good time to renew the thermostat including two new gaskets. Clean the metal faces to remove the former gaskets. Spray the metal with a copper coat gasket spray or other appropriate material. Tighten the bolts sparingly as the housing is all aluminum. The front portion of the housing connects to several heat hoses. It's almost impossible to slide the hoses on one at a time since they come from several angles. Coat the aluminum tubes and the inside end of the rubber hose with liquid dish detergent. Position hose clamps in place along the length of the hose taking care to position the clamp bolt so you can access it once the hose is in place. Attempt to wiggle all the hoses on simultaneously.

Install the eighteen duplex manifold studs into the head. The three at the read of the head are longer than the rest to accomdate the throttle control that will give over the manifold. Use copper coat the studs for the next person doing the head (it could be you). Hand the manifold on the studs and put one or two nuts with split washers to hold it in place loosely. Three all the nuts and split washers. Begin tightening the bolds from the center as with the head blots. There does not appear to be a recommended torque so make it mechanics tight.

### *Throttle Controller*

Hand the throttle controller from the three ear studs and fasten with nuts and split washers. The throttle cable fits into the controller. There is a switch that tells the transmission to downshift when the accelerator is fully de[aressed. Set the location of the swicth so that an almost complete throttle opening activies the switch. Electrical conncections are to a green and black wire.

### *Vacuum Hoses*

Before installing the carburetors, connect the three main vacuum hoses to the underside of the duplex manifold. There are five connectors under the manifold; three large and two small. The rearmost connector is large and is for the transmission connection. You can locate the transmssion connnector becuase it's a thin, aluminium tube that makes an inverted "U" behind the throttle controoler and tnen

goes under the manifold. It's make is at the rear of the maniold and is an elbow facing toward the rear. The connectino is made with a 2" pieice of hose with clamps.

The vacuum reserve tank is located on the exhaust side of the engine, in a fender recess. A rubber hose traverses the firewall and after goin ghtoug a one way air valave, winds under under the duplex manifold. Connec it to the cetner large connector with a clmap. The brake booster hose runns from the booster forward, then under the radiator and then back towards the firewall again about1' The tubing eds in a bend two ard the engine and a rubber hose fitted. This hose connects to the font, large connector.

There are two samll vacuum connections that onnect the emission equipment. One attaches to the emission eqiupment on the carburettor. The other connects to the carburettors. The final connection is to the distributor. You may not be putting that equipment in just yet. If so, be sure to seal off the two small nipples under the duplex manifold with rubber boots. They are avable from auto supply stores as an inexpensive kit of various sizes and types.

Once all the manifold connections are done, replace the fan and clutch by hanging the fan on the belt pulley. Put the clutch in position and bolt the clutch onto the pulley.

#### *Install the distributor.*

Clean the sixteen studs, nuts and washers that hold the intake manifold using a wire wheel or parts tumbler. Coat the duplex manifold gasket with moly bend um or moly disulfide grease on both sides and install.

Install the throttle control at the rear of the engine after disassembly and cleaning with a wire wheel.

Install the duplex manifold and tighten the nuts.

Place the carburettors including the gaskets and tighten eight nuts. Connect the vacuum hoses as required.

#### *Carburettors*

The two carbureters should be rebuilt using a kit avaiable from the usual suspects. Once rebuilt, connect together with the throttle spindles. Hand the crbureeros from the suds you threaded into the duplex manifold. Put one nut and split washer to keep them in place. Install four nuts and split washing on each using whatever wrench makes sense, from an ordinary box wrench to an open end, stubby and socket. Connect the manifold from the duplex on each side. Connect the thrttole control rod and gas line using a "T".

#### *L. Miscellaneous*

1.) Install the belt from the power assisted pump, moving the pump inboard to its position.

2.) Install the two banjo connections from the branched camshaft oil feed pipe at the rear of the head. This pipe is item 48 in FIG E. Include the four washers and two banjo bolts 49 and 50. Install eleven dome nuts and copper washers 44 and 45 and, in the case of 4.2 liter engines one countersunk screw from each

camshaft cover and after installing the covers.

3.) Install the plugs and leads from the sparking plugs. Connect the HT cable from the coil and install the cap from the distributor.

4.) Refill the cooling system. Connect the top water hose and bypass hose at the front of the inlet manifold water jacket. Connect the heater pipes from the bulkhead unions and at the pump connection. Connect the cable from the water temperature transmitter

#### *L.) Camshaft Covers*

Camshaft cover gaskets are tacked in place on the head with engine oil. Install the two studs at the front of each side of the head taking care not to drop them down the chain cavity (stuff a rag in the opening before attempting to install.)

Clean the cam cover mating surfaces with a light abrasive and spray the cover with a copper coat gasket material. Place a dab of GE silicone sealant in each hold in the cam covers so that the studs are surrounded by sealant after the covers are pushed into place. Set the covers in place. Place the annealed copper washers on cover studs. Place brass or stainless steel washers over the copper and apply the castle nuts with only light torque, about 7 ft. lbs.

#### *M) Peripherals*

The alternator is mounted on a hinged bracket. One half of the hinge is bolted to the block and the other leaf moves in order to tighten the belt. If your car is equipped with an aluminum shield that blocks the heat coming from the exhaust manifold towards the alternator, make certain to install that before installing the alternator as access to the two bolts (actually the two front bolts on the front exhaust manifold) will be blocked by the alternator. The alternator is swung outward from the hinge top to tighten the drive belt. There is an adjustable brace that holds the alternator in position. It bolts to the front of the block at one end and the underside of the alternator at the other. A bracket attached to the underside of the alternator slides along this shaft and is locked in place by two nuts, one on either side of the bracket.

The power steering pump, which you probably did not remove, is simply pulled into place and the fixing nut tightened.

The exhaust manifold is covered with a polished metal shield that collects heat and ducts it over the cams to the intake manifold. It's held in place by two short bolts. Interestingly, the bolts are not the same size and thread.

The head breather has a rubber cap that connects to the carburetors via a metal tube. Short right angle hoses connect from the tube to each carburetor.

The charcoal canister is connected to the head blowby via a second metal tube that is attached to the exhaust manifold cover by metal clips. A short rubber hose connects the tube to the canister.

The heat exchanger, used in cars with air-conditioning, is mounted above the duplex manifold. It's held in place with a short bolt at the front. The rear attaches to one of the four the duplex manifold phillips head machine screws. The front gas line inlet connects to a hose, which in turn is connected to the metal line coming from the gas tank. The rear outlet is connected to a hose that goes to a metal "T" between the two Stromberg carburetors and then via very short hoses to the carburetors. The exchanger is mounted with the gas inlet and outlet facing away from the engine.

Te choke cables are connected to the two carburetors by a 1/4" bolt passing through a sleeve. One cable, for the front carburettor is longer than the other. The bare cable is placed in the sleeve, and held taught by a pair of needle nose pliers beneath the sleeve. While still holding the cable with the pliers, the bolt is tightened, locking the cable in the sleeve. Both front and back cables are attached in the same way. The cable is then held firm to the top edge of the carburettor by a removable clip that grasps the cable cover.

#### *M.) Install Core Plugs*

When installing the new core plugs, clean the surface of the core plugs well and make sure they are smooth. Then apply some sealant to the surfaces of the new core plugs and core plug holes and using a socket about the size of the inner dimension to of the new plugs tap the new plugs into place. There are 3 different sizes of the core plugs so make sure you get a complete set of new ones when you are ready to put them back in. The old ones should be tossed out.

Replace the core plugs after installing the reworked cylinder head but before putting the intake and exhaust manifolds on so as to observe the studs being torqued down.

*N.)* This is a good time to do some distributor maintenance. Remove the old rotor, condenser and point. Clean the top plus with some spirits and a cloth. Make sure the vacuum advance is free by pushing on the lower plate where it connects to the vacuum advance.

Install the points and secure with the short bolt. Install the condenser with a small brass machine screw. Fit the condenser and coil wire on the insulated stud and instill the small nut. Please a drop of oil on the enter stud and in the opening next to the center hub. Rub Vaseline on the rotation shaft where it contact the points.

Check the connections on the distributor cap and clean if needed. Apply dielectric grease to all connections aftdr cleaning. Install the distributor and tighten the pinch bolt. Install the cap.

Route the spark plug cables under the piping next to the head and into the valley between the cams. No. 1 and 2 are installed facing backward, 3-5 face forward. The original wire race is a cardboard slip that runs up the side of the valley.

Prior to starting, it may be worthwhile to check things one more time. Set the ignition to 0 degrees before top dead center on the crank damper by rotating the crankshaft by hand. The nut is 1 5/16" and you will need a long box wrench with an offset in the handle. Turn the engine clockwise until you see the 0 at the pointer. Some people put a white dot of paint at that point to make it easier to see.

Remove the distributor cap. The rotor should be pointing to the number six wire location. Open the oil filler cap on the exhaust side camshaft cover and look inside toward the front of the camshaft. The lobe should be pointing outwards. If the rotor is 180 degrees from the #6 cylinder and the lobe is pointing inward, you need to turn the crankshaft around one more time as each cylinder fires once every two revolutions of the engine. If everything lines up, close the distributor and oil filler. Rotate the engine by hand using a wrench on the crankshaft nut.

Disconnect the gas line from the carburetor and rotate the engine several times using the starter.

Reconnect the gas line.

Start it up and drive it away.

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