"Hurricane" Engine Specs and Photos

F-head 134 cu.in. (2.2 liter) 4-Cylinder Engine

One of the cars that put the roar in the Roaring 20's was John North Willys' 1926 Overland Whippet with its new 4-cylinder engine, which later became the basis of the "Go-Devil" engine used in the jeeps of World War II. The similar but taller "Hurricane" F-head engine, which Willys began putting in its larger vehicles in 1949, had its intake valves in the head rather than the engine block. The first 1/4-ton Jeep big enough for the new engine was the military M-38A1 in 1951. The first civilian Universal Jeep with the Hurricane engine was the new "high-hood" 1953 CJ-3B.

Seen here with an early F-head is Willys-Overland chief engineer Delmar G. "Barney" Roos, who played an important role in the development of both the Hurricane and its predecessor the Go-Devil.

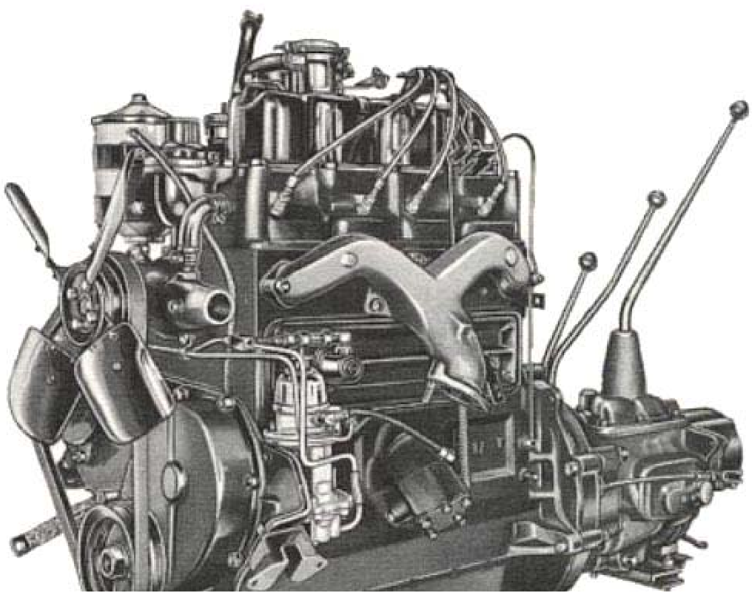
Maintenance Part Numbers

- Rotor cap: Prestolite IAT 1041
- Ignition points: Standard AL 4556P or #AL4556XP (the difference between P and XP is the quality.)
- Points: NAPA CS725A or CS709
- Condenser: NAPA AL 869 or AL 868 (with wire or with copper strap)
- Cap: NAPA AL70
- Rotor: NAPA AL69
- Fan belt: Dayco 22425.
- Oil Filter: Fram C-3P. Wix 51010 or NAPA 1010 or 1006 (1011 is same filter with 2 different size gaskets.) 1980's Mercedes-Benz diesels used the same filter.
- Sparkplugs: Autolite A7, AC Delco 45 or Champion J-8. Note: Current Autolite replacement number is 295. A current Champion 841 (J8C) is suitable. AC has discontinued the 45 plug but hardware stores in small towns may still have stock from the 70's. Modern resistor-type plugs don't perform well on older engines.
- 6-volt Battery: Auto-Lite 1M-100, 100 AmpHour (H 8 5/8" x W 7" x L 8 23/32")
- 12-volt Battery: Auto-Lite 11-HS, 50 AmpHour (H 9 7/32" x W 6 25/32" x L 10 15/64")

Specifications

- Spark plug gap: 0.030 in. (0.762 mm)
- Spark plug torque: 25-33 lbs. ft. (34-44 Nm)
- Firing order: 1-3-4-2
- Distributor rotation: Counterclockwise
- Point gap: 0.020 in. (Prestolite)
- Dwell angle: 42 degrees
- Ignition timing: 5 degrees BTDC

- Bore and stroke :3 1/8 in. x 4 3/8 in. (79.37 mm x 111.12 mm)
- SAE Horsepower: 15.63
- Weight: 470 lbs. with fluids (*Jeep Bible,* Granville King)
- Max. Horsepower: 72 @ 4000 R.P.M. (71 @ 4000 R.P.M. on military M606's)
- Torque: 114 lbs. ft. (15.7 kg-m) @ 2000 R.P.M. (111 lbs. ft. @



2200 R.P.M. on military M606's)
- Compression pressure: 120-130 psi (8.4-9.2 kg-cm2)
- Compression ratio: 6.9:1 (7.4:1 high altitude option).

- Valves: 2-in. intake valves in head, exhaust valves in block.
- Valve clearances:
  Intake: 0.018 in.
  Exhaust: 0.016 in.
- Idle speed:
  YF-938-SD carburetor: 600 rpm
  YF-4002-S carburetor: 650-700 rpm
  YF-4366-S, YF-4941-S, or YF-6115-S:
    IAY-4401A distributor: 650-700 rpm
    IAY-4401B distributor: 700-750 rpm

Surviving examples suggest the engines were painted black, often with an orange sealant coat underneath. Further information on paint is welcome.

Publications Including Further Specs

- F4-134 Engine Specifications (100K GIF) is the complete specs from the Kaiser *Jeep Universal Service Manual* (1965)
- Willys Service Standards, 1952-54 Models for engine specs and tolerances.
- Willys Four: A.E.A. Adjustment Standards, 1960 for tuneup part numbers and standards.
- Chek-Chart Willys 4 Service Instructions for maintenance and lubrication specs.

Engine Numbers

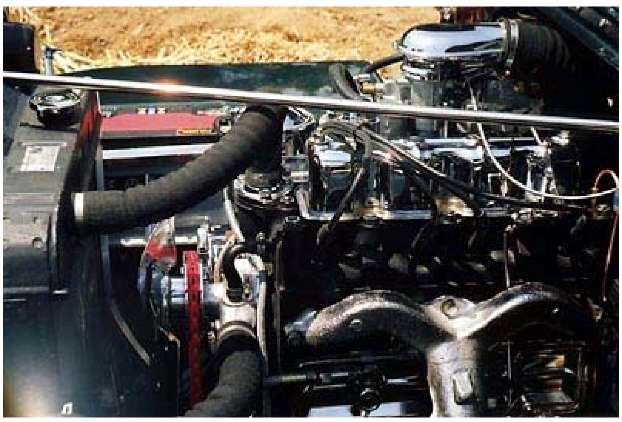
The F-134 engine number (beginning with the prefix 4J for original CJ-3B engines) is found on the water pump boss (20K GIF) on the front of the block. Letters following the engine number indicate odd-sized parts:

- A: 0.010" undersized main and connecting rod bearings
- B: 0.010" oversized cylinder bore
- AB: both of the above
- C: 0.002" undersized piston pin
- D: 0.010" undersized main bearing journals
- E: 0.010" undersized connecting rod bearing journals

See Serial Numbers and Engine Numbers for engine numbers on surviving Jeeps of a specific model year, and Plotting Engine Numbers for more details on identifying original engines.

Engine Photos on The CJ3B Page

Here are direct links to some of the more detailed F-head photos on this website. For more information on a particular owner's Jeep below, use the Search page, or look on Jeep CJ-3B Owners and Photos. The chromed engine shown here belongs to Marcel Vila's 1955 CJ-3B in Spain.



- Doug Anderson's '60 (left)
- Doug Anderson's '60 (right)
- Miguel Onofre's '55 (front)
- Miguel Onofre's '55 (left side without manifold)
- John Ittel's '53 (right side)
- Pat Mcintyre's rebuilt '59 in orange (right side)
- Pat Mcintyre's rebuilt '59 (left rear)
- Kim Boehm's restored '61 (left side)
- Kim Boehm's restored '61 (right side)
- Keith Hepper's rebuilt '54 (right side)
- Keith Hepper's rebuilt '54 (left side)
- Rankine Roth's '60 (left)
- Rankine Roth's '60 (right)
- Rankine Roth's '60 (right without radiator)
- Brett Chitwood's '64 (right)
- Brett Chitwood's '64 (left)
- Randy Merritt's '62 (front)
- Adam Charnok's '63 (left)
- Adam Charnok's '63 (right)
- Steve Chabot's '59 (left)

- Richard Laflamme's '53 (left)
- William Mentz's '62 (front)
- Derek Redmond's '59 (left)
- Derek Redmond's '59 (right)
- Derek Redmond's '59 (front)
- Clint Spaar's '54 (right)
- Turkish Jeep (left)
- Turkish Jeep (right)
- Piet Versleijen's '56 (restored, left)
- Piet Versleijen's '56 (restored, right)
- Piet Versleijen's '56 (original, left)
- Piet Versleijen's '56 (original, right)
- Tony Yuma's '58 (right)
- Josh Kamunen's '54 (Clifford headers)
- Mike Perry's '59 CJ-5 (Solex carb)
- Jack Ahlberg's '54 Complete Engine (left)
- Dan Bever '62 CJ-5 Complete Engine (left)
- Dan Bever '62 CJ-5 Complete Engine (right)
- Eric Lawson's photos of an F-head Engine Rebuild
- Rus Curtis' photos of 1955 CJ-3B Details

From Willys literature:

- Side Illustration (left) (from Facts for Service Stations, 1953)
- Side Cutaway View
- Front Cutaway View
- Internal Parts, Exploded View
- External Parts, Exploded View (all from CJ-3B Parts Illustrations)

Thanks to Wes K., oldtime, Bruce Agan and all the photographers, including Jim Allen, Tom Edwards and Tony Phillipson. -- Derek Redmond

See also my cartoon of the Arrival of the F-heads.

For more engine information on The CJ3B Page, see F4-134 Engine Horsepower and Torque and lots of pages of Tech Tips including the F-head Engine Rebuild.

Elsewhere on the web, see Dane R. Marley's detail pictures of an F-Head from an M-38A1 as he disassembles it.

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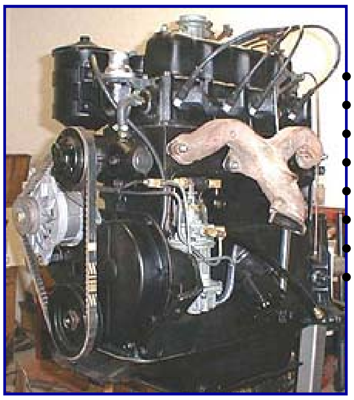
Last updated 23 February 2010 by Derek Redmond redmond@queensu.ca
http://www.film.queensu.ca/CJ3B/Hurricane.html

Rebuilding an F-head Engine

by Eric Lawson



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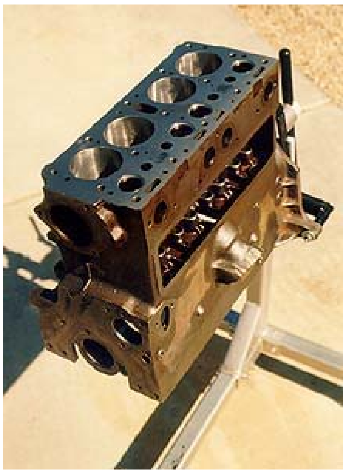
Introduction

I just got a 4F-134 engine back from the machine shop today. Adding up the receipts for parts, machine work and rebuilding/replacing everything on the outside of the engine gave me a grand total of just over $1350 (ouch).



This picture shows the block fresh from the machine shop.

This engine had more than its share of problems--bad cam, bad rod, bad oil pump. The bad cam added not only the cost of the cam, but that of "grinding" the face of the lifter that rides on the cam. The bad rod added the cost of the rod, plus the cost of rebalancing the engine. The unrebuildable oil pump cost around $80.

The typical 4-134 (L or F head) engine would need 4 cylinder sleeves, all new internal parts except cam & crankshaft, a valve job, rebuilding or replacement of ALL external accessories except the oil pump, the crankshaft ground, the flywheel resurfaced, a rebuilt pressure plate and a new clutch.

Subtracting the "abnormal" stuff from the $1350, I would guess the cost for the "typical" rebuild would be around $1000. This price should be nearly the same for both the F and L head engines. If I were to have lucked out, and not needed the cylinders sleeved, the cost would have been around $800. All this assumes that I will assemble the engine myself.

This photo shows all the parts for this engine. -- Eric Lawson (elawson@inficad.com)

Continue to Page 2: Plugging Oil Passage Holes

See also CJ-3B Parts Illustrations, for engine diagrams from the original Parts and Service Manuals.

Elsewhere on the web, see David Hoelzeman's step-by-step photos of F-134 Assembly and Disassembly.

Return to Tech Tips on The CJ3B Page.

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Rebuilding an F-head Engine

Page 2: Plugging Oil Passage Holes
by Eric Lawson

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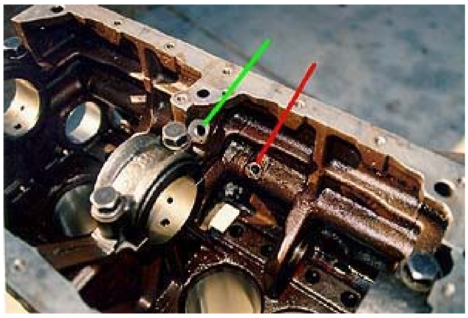
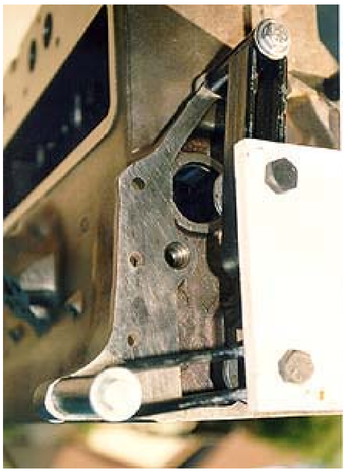
Before installing the oil passage plugs use a flashlight and look through each oil passage to verify that it is clean. A rifle bore brush, soaked in kerosene, on the end of a rifle cleaning rod makes an excellent tool to clean oil passages. If you have to brush out any oil passages use compressed air to blow out anything you may have dislodged and check all of the passages again.

For those unfamiliar with firearms, rifle bore brushes are available in sizes from about .25 inch (6mm) to about .5 inch (12mm) diameter. A gunsmith or firearms shop will have both the cleaning rods and the brushes. Use the cheapest rod and the best brushes you can get. Hoppe's #9 (rifle) bore cleaner or mineral spirits will work well if you don't want to purchase kerosene.

This photo shows two of the holes in the oil passages that must be plugged. The one pointed to by the green line gets a standard 1/8 inch NPT plug. The one pointed to by the red line gets the slotted head 1/8 inch NPT plug. After the crankshaft is installed, check that the crankshaft counterweight will not strike this plug.



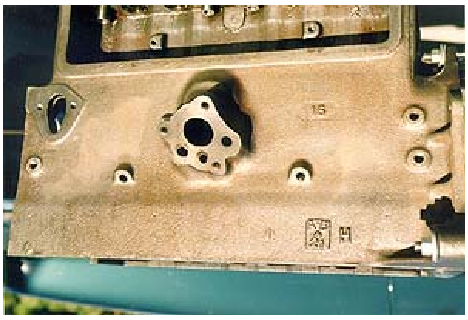


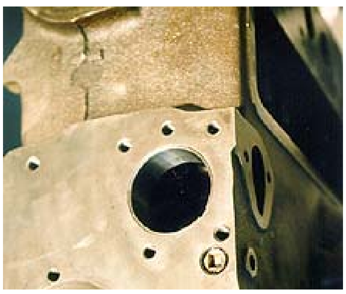
The large hole is the rear cam bore. A "freeze plug", well it looks like one anyway, fills the large hole.

The "medium sized" hole at the 7 o'clock position from the cam bore is another oil passage hole. The plug that fits into this hole is the same type as shown in the cam bearing photo below. Make sure the head of this plug is below the surface of the crankcase.

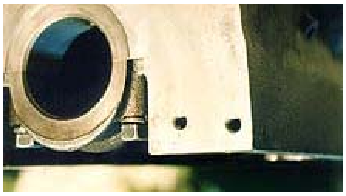
The two holes on either side of the oil pump flange (driver's side of the block) get square head 1/8 inch NPT plugs. The head of the plug on the hole to the right has a small hole drilled in it. This is where the throttle return spring will be attached. The hole to the far left, under the fuel pump, is where a flexible oil line connects. This oil line goes to the side of the oil filter.

The two holes to the far right: the upper one is where a rigid oil line connects, which supplies oil to the rocker arms in the cylinder head. The lower hole is for the oil pressure sender. Both are 1/8 inch NPT holes.





The cam bearing. This was installed at the machine shop. Note the pipe plug at the 5 o'clock position from the cam bore. The square hole in the pipe plug is 5/16 inch and required a special tool to remove and replace it. Make sure the head of the pipe plug is below the surface of the crankcase.



The engine's front plate. Behind the plate is a gasket. To help prevent leaks, use a gasket sealer on the gasket and on the bolt's threads. -- Eric Lawson (elawson@inficad.com)

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Rebuilding an F-head Engine

Page 3: Installing the Valves and Camshaft
by Eric Lawson

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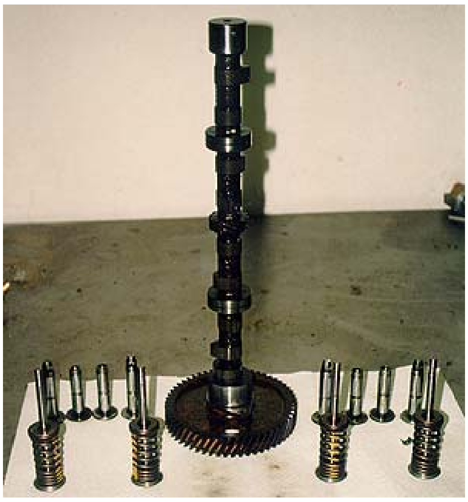


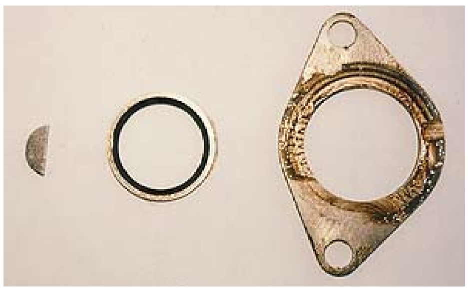
Except for the tappets, all of the parts in this picture are new. Because this is a new cam, the tappets had to be reground. If the old cam is being reused and the tappets are still useable make sure the tappets go back into their original positions in the engine.

These are the ends of the camshaft. At left is the timing gear end of the shaft.

The oil holes in the bearing journals should be checked to be sure they are open. The oil hole shown at left allows oil to flow between the camshaft thrust plate and the face of the camshaft. The hole shown at right allows oil to flow out the port to which the cylinder head oil tube connects.

From left to right: the woodruff key that goes into the slot on the camshaft, the timing gear spacer, the camshaft thrust plate.

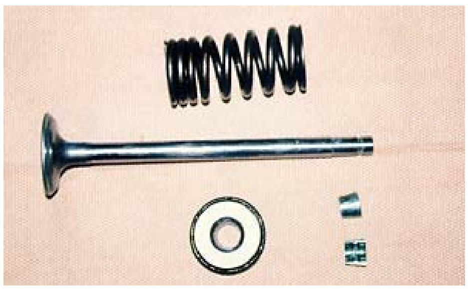
The spacer washer should be about .006 inch thicker than the camshaft thrust plate. On engines that have been rebuilt several times, the camshaft thrust plate becomes worn. If the difference in the thickness of the spacer and the plate is correct, but the end play of the camshaft is too small, try placing the other surface of the thrust plate against the camshaft.



This picture shows the valve spring, the valve, the "Roto-Cap" valve spring retainer (bottom row, left) and the valve locks (bottom row, right).

When the valve spring is properly installed, the two coils that are closest together, toward the left in this picture, should be against the block.

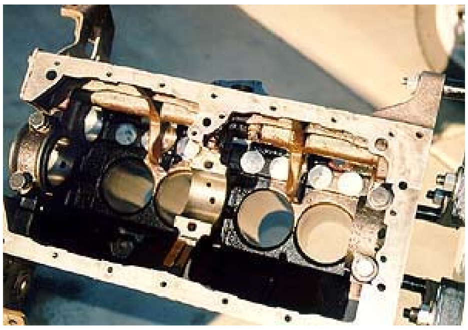
The valve locks are tapered. The narrow end of the taper should be closest to the head of the valve. The Roto-Cap fits over the lock and holds the locks against the valve stem. The ridge in the locks engages in the grove in the end of the valve stem. The taper in the valve lock holds the Roto-Cap in place.



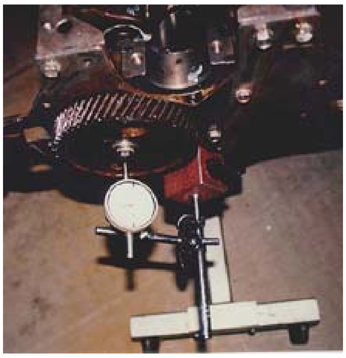
The Roto-Cap causes the exhaust valve to slowly rotate as the valve opens and closes. This helps reduce carbon fouling of the exhaust valve and its seat.

The valve tappets are installed, in the same holes from which they were removed. Use lots of engine assembly lube on all surfaces that contact another metal surface.

The main bearing dowels have not yet been installed.



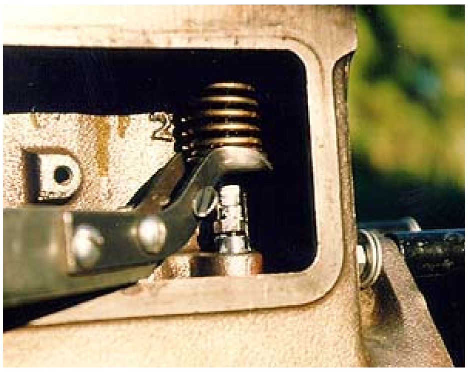
This photo shows the camshaft in place.

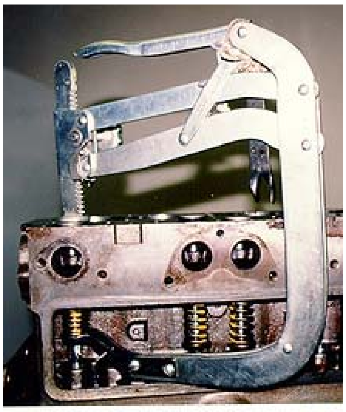


Checking the end play of the camshaft. The thrust plate is bolted into position, the spacer washer is placed on the camshaft, the woodruff key is installed and the timing gear is placed on the camshaft. The smooth surface of the spacer washer faces outward. The side of the spacer that is shown in the picture faces the cam.

The timing gear bolt is used to draw the timing gear into place. Don't forget the washer on the bolt. Torque the bolt to 30 to 40 ft-lbs (40 to 54 N-m). The end play is .004 to .007 inch (.1 to .18mm). I have been unable to think of an easy way to measure the end play of the camshaft that does not involve the use of a dial indicator.

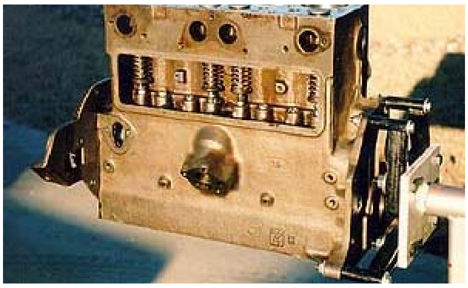
The installation of the valve spring, keeper and locks. The spring is being compressed so the valve locks can be installed. Engine assembly lube is sticky enough to hold the valve locks in place until the spring compressor can be released.





This is a wider view of the C-clamp valve spring compressor, which will work with valve-in-block or with overhead valve springs, but the cylinder head must be removed first. There are two other types that will work with the cylinder head in place on the engine. One only works on valve in block springs and the other only works on overhead valve springs.

The exhaust valves are all installed. -- Eric Lawson (elawson@inficad.com)



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Rebuilding an F-head Engine

Page 4: Starting the Crankshaft Installation
by Eric Lawson

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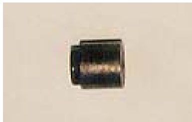
The crankshaft has been chromed. In case you're wondering if I'm building a "chrome monster," I'm not. :-) In this case, the chrome is to build up the worn surface where the front main bearing bears (indicated by the red line in the photo.) This area on this crank was worn about .05mm and I couldn't set the crankshaft end play correctly. The machine shop can plate up to .1mm or so and it is a good way to go as it doesn't warp the crank like welding will do.

I took it to another machine shop to get the wax (they use wax to prevent the chrome from plating on unwanted areas) off the crank. The wax is difficult to remove with just solvent and rags. The best and easiest way to get the wax off is to let a shop with a (very hot) "hot tank" clean it.

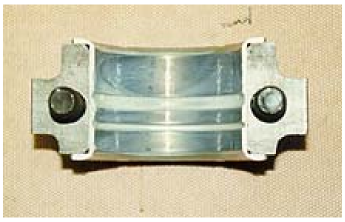
In the center of this picture, in the main bearing bore, is the bearing dowel (see close-up view below). There is only one in the front main. In the remaining bearing bores, there are two--one in the block and one in the bearing cap. Don't lose them when you are disassembling the engine!



Once all five of the bearing dowels have been reinstalled, the main bearings can be installed in the block. Be sure the oil hole in the bearing shell aligns with the oil passage in the block.

Four of the bearing shell halves are identical. These are placed in the middle and rear main bearing saddles in the block. The front main (closest in the picture) bearing is the only one that has the surfaces that extend over the edge of the machined surface on the engine block.

The surfaces that the bearing shells are placed into must be absolutely clean. The slightest bit of dirt behind the bearing will upset the alignment of the bearing and doom it to a quick failure.



The two front main bearing halves are different from one another. Only one will have the holes for the oil passage and bearing dowel.

Be careful not to install the front and middle bearing caps backwards. Take a look at the numbers cast into the bearing caps. They should all face the same direction as the numbers in the rear main bearing cap. Also, the alignment of the edges of the bearing caps will be slightly off if the bearing caps are installed backwards.

It is possible to incorrectly install the front main bearing shell in the bearing cap. To install it correctly, the grooves in both bearing shells should align when the bearing cap is correctly installed.

Do not install the bearing caps yet.

Plastigauge is used to check the bearing clearances. It is a wax "string" of a

certain thickness. When the bearing cap is tightened, the string gets flattened. The more it gets flattened, the less the bearing clearance.

A piece of the plastigauge is cut and placed on the crankshaft. The plastigauge is somewhat sticky. If you lightly press it onto the crankshaft, it will stay in place while you are installing the bearing cap.

Coat the bearing cap bolt threads with a small amount of oil and install the bolts. Torque one bolt a small amount and then the other an equal amount until you reach 40 ft/lbs (55 N-m) of torque.

Loosen each bolt in small amounts until they are loose and remove the bearing cap.

The width of the now flattened plastigauge can be compared with the scale printed on its packaging to determine the bearing clearance. Both inch and metric scales are printed on the plastigauge packaging.

Different Jeep service manuals recommend either .0003 to .0029 (.0076 to .0736mm) or .001 to .0025 inch of clearance for the main bearings. I'm not sure why there is such a difference in the recommendations. I think the .001 to .0025 inch values are more appropriate.

The places where the plastigauge was not flattened are the oil grooves in the bearing shell. Each of the places that the plastigauge is flattened should indicate the same clearance. If not, make sure there is no dirt behind the bearing shells or the mating surfaces of the bearing cap and block. If no dirt is found, then either the crankshaft or main bearings need to be examined.

This procedure should be performed on each main bearing. The plastigauge can be removed by scraping with your fingernail or a flat toothpick. -- Eric Lawson (elawson@inficad.com)

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Rebuilding an F-head Engine

Page 5: Finishing the Crankshaft Installation
by Eric Lawson

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Once all of the main bearing clearances have been checked, reinstall the front main bearing. For the following measurements, it is the only bearing that needs to be installed. It is possible to install the front main bearing incorrectly. The numbers cast into the bearing cap should be as shown in the following picture. Also, the oil grooves in both the top and bottom bearing shells should form a continuous passage around the crankshaft's bearing journal.

Place a .006 inch feeler gauge as shown and pull the crankshaft tight against the feeler gauge. Make sure the feeler gauge is in between the flanges on the bearing and the crankshaft.

Place a straight edge against the front of the bearing as shown and using a feeler gauge, measure the clearance between the straight edge and the face of the crankshaft.

This clearance is the thickness of the shim pack that will need to be used to set the crankshaft end play.

The shims are .002 inch thick. They have a tendency to stick together; make sure you have individual shims. Once you have determined the number of shims that you will need, remove the crankshaft from the engine.

The shims, followed by the thrust plate and the timing gear go onto the end of the crankshaft. The side of the parts that you can see in this picture point toward the bearing journal. After the crankshaft has been temporarily re-installed in the engine, the spacer, oil slinger and pulley can be placed on the crankshaft. If you leave the woodruff keys off of the crankshaft, it will make removal of the pulley and timing gear easier.

This shows a clearer view of the placement of the thrust plate. Note the bevelled side of the thrust washer faces toward the main bearing journal.

Install the front main bearing cap and torque the bearing cap bolts to their rated torque of 40N-m or 55ft-lbs.

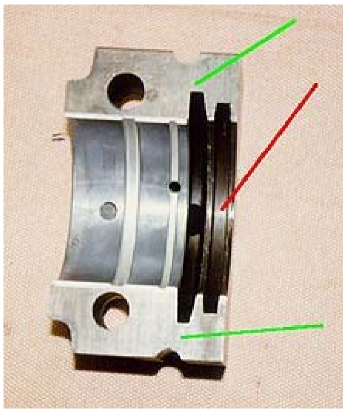
Tighten the crankshaft pulley nut. A wood hammer handle placed between one of the crankshaft counterweights and the block will prevent the crankshaft from turning while you tighten the nut. As you tighten the nut, monitor the crankshaft end play. Tightening the nut without enough shims behind the thrust plate can damage front main bearing.

When the crankshaft pulley nut is tight, push the crankshaft toward the rear of the engine and, using a feeler gauge, measure the clearance between the bearing flanges and the crankshaft counterweight. The feeler gauge is placed in the same place as when the initial shim pack estimation was made. The clearance should be .004 to .008 inch. It should be correct. If not, add or remove shims as necessary. Adding 1 shim will increase the end play by .002 inch, while removing 1 shim will decrease the end play by .002 inch.

Once the end play is set correctly, remove the crank pulley nut, the crank pulley and the crankshaft from the engine. Remove the timing gear.

Put the woodruff key for the timing gear in place and install the timing gear. Light taps with a brass hammer will be needed to get the timing gear onto the crankshaft. Do not force the timing gear tight against the thrust washer; leaving some space here will make the crankshaft installation easier.

Put a SMALL amount of #2 gasket sealer in the entire groove pointed to by the red line. A toothpick works well to apply the sealer. The sealer will glue the seal in place and keep it from spinning. Also put a small amount of #2 gasket sealer at each of the places shown by the green lines. By applying the sealer only to the bearing cap, the seal in the block can, if necessary, be removed without removing the crankshaft from the engine.



Install the rear main oil seal halves in the block and in the bearing cap. The seal goes in the groove indicated by the red line and sticks out over the right side of the bearing cap. When the seal is installed it it best if the two seal halves are rotated slightly so the ends of the seal do not line up with the flat spots (shown by the green lines) on the bearing cap.

In the bottom of the groove that is next to the green lines is a large hole in the bearing cap. Make sure this hole is open. This allows oil leaving the bearing to flow back into the oil pan. If this hole is plugged, you will never be able to keep oil from leaking out the rear of the engine.

Apply a good engine assembly lube to all of the bearing surfaces, including the flanges on the front main bearing. Also lubricate the crankshaft rear oil seal, the teeth on the camshaft timing gear and the teeth on the crankshaft timing gear.

Lube the crankshaft bearing journals and both timing gears with engine assembly lubricant. Install the crankshaft. Rotate the crankshaft and the camshaft as needed so that the two dots on the two gears align as shown.

Put the flywheel attaching bolts into the holes in the flange of the crankshaft. Two of the bolts are either tapered or are larger than the other bolts. Make sure these bolts go into the matching holes in the crankshaft flange.

Dip the threads of the main bearing cap bolts in engine oil. Install the main bearing caps and tighten the bolts to 40 N-m or 55 ft-lb.

Do not rotate the crankshaft for 24 hours. This will allow the gasket sealer to set up and prevent the rear oil seal from moving.

Install the spacer, the oil slinger and the crankshaft pulley woodruff key.

Take a moment to ensure the bearing caps are installed correctly. The casting numbers in the caps should all face the same direction. Also check that the dots on the timing gears are correctly aligned. It is easier to correct any errors now than after the engine has been installed!

After 24 hours, loosen each of the main bearing cap bolts about 1 turn and re-torque the bolts to 65-75 ft-lbs (90-100N-m) of torque. Turn the crankshaft slightly as you tighten each of the bolts. Often excess engine assembly lube will remain under the bearings and cause false torque readings as the bolts are tightened. This step ensures that this does not happen.

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Rebuilding an F-head Engine

Page 6: Rods and Pistons
by Eric Lawson

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It is finally getting cool enough in the garage for me to get back to work on the engine.

Finding a set of rods for this engine was quite an ordeal. One of the original rods had been damaged beyond repair and I couldn't find a single rod that would properly replace it. I ended up buying another set of rods, but a couple of them wouldn't fit correctly onto the crankshaft that I had already installed in the block. I was given a second set of rods and these were the ones that I finally used. The first set of replacement rods fit a crankshaft that will be going into an 4L-134 engine, so I kept them for that project.

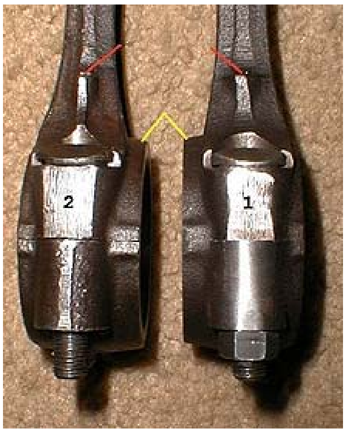
The second set of rods were sent to the machine shop to be reconditioned. The reconditioning consisted of checking for cracks, resizing the bearing bores and balancing them. I believe the crack check and resizing operations are required operations. The balancing of the rods' weights is only needed if you are unsure if the rods came from a matched set.

Note: John McCasland has written to say, "One item of importance that I've discovered (the expensive way) is that if you have the crankshaft turned on engines with long throws on the crank, it is IMPERATIVE that you also have the rods reconditioned meaning that the bearing end must be machined so that it is once again perfectly round, unless you enjoy spinning rod bearings."

Replacing Connecting Rods

If you have to replace any connecting rods here are some things to check when selecting them.

First on the list is whether the rod is odd or even. Next is checking if the amount of side play the rod will have, when installed on the crankshaft, is within specification. Finally is whether the weight of the rod is close enough to the others for a machine shop to be able to make the rods' weight match.



Odd and even refer to the cylinder number in which the rods will be used. The cylinders are numbered 1 through 4, with number 1 being closest to the waterpump. Usually there is a number stamped into the rod that indicates the cylinder where the rod was used. This number is on the side of the rod as shown. The rods that I used for the picture did not have numbers stamped on them. I added the numbers to the image to show where to expect to find the numbers. Rods with even numbers can be interchanged with other even numbered rods. Rods with odd numbers can also be interchanged with other odd numbered rods.

If the rods don't have numbers stamped in them, the offset in the rod bearing bores can be used to determine if you have an odd or even rod. Place the rod as shown and with the oil spray holes facing upward. The yellow lines in the picture show the offset, and the red lines show the location of the oil spray holes. The rod on the left is an even rod. The rod on the right is an odd rod.

To check the side play, an old set of bearings can be used. Install the bearings in the rod and install the rod onto the crankshaft. Tighten the bearing cap nuts to 10 to 15 ft/lbs torque. Slide the rod over to one side of the rod journal and measure the clearance on the other side of the rod. Using a feeler gauge, the clearance should measure .004 to .010 inch (0.1 to .25mm).

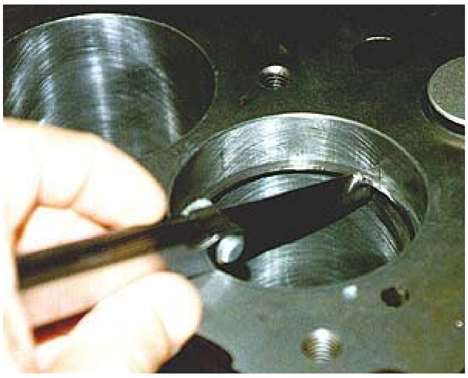
If the diference between the lightest and heaviest rod is within 1/8 ounce (3.5 grams) the rods do not need balancing. A machine shop should be able to balance the rods if their weights are within 1 ounce (29 grams).

Any scale that has the required resolution and a capacity of at least 2 pounds (1Kg) can be used to weigh the rods. A machine shop can do this for you. Before my workplace got a postal scale, I used to take the clean rods to the post office, lay a piece of paper on the scale and weigh them there.

Checking the Rings and Pistons

There is an official procedure to check the clearance between the piston and the cylinder bore. It specifies that the measurements be done at at 70 degrees F (20C). It has not been that cool in my garage for five months, so I don't bother with the official method. I ask the machine shop to hone the cylinders to size and, if needed, to mark each piston so I know which cylinder it is mated to. To check their work I simply slide the upside down piston into the cylinder bore. If the piston moves in the cylinder without having to push it AND there is only a slight amount of side to side play, I assume the machine shop has done the job correctly.

The rings should be checked to ensure you didn't accidently get an incorrect one. As you are working with the rings, be sure to not mix the different rings. Some ring sets have different 1st and 2nd compression rings and they must go in the position indicated.



Take a compression ring and push it into the bore of the cylinder where it will finally be installed. Use a piston to align the ring in the cylinder. Then use a feeler gauge to measure the gap between the ends of the ring. Do this for all eight compression rings. The ring gap should be between .007 and .017 inch (0.18 and .45mm). Some books say the ring gap can be as large as .045 inch (1.15mm). You don't need to check the oil rings. The oil rings are three piece units with one piece that looks somewhat like a spring and the other pieces being very thin rings.

Each ring set should come with a set of instructions. If they are available, use them. If you don't have the instructions, here is a generic set of instructions:

Installing Rings

First install the oil ring expander into the bottom groove of the piston. The expander is the unusual looking ring that looks somewhat like a spring. Make sure the ends of the expander touch one another, but do not overlap. On my ring set, the ends of the ring were painted red and yellow which made this step easy. Most of the time you will have to check very carefully.

Next take one of the oil rings and install it above the expander. The oil ring is the thin ring. Place the ring atop the piston and push one end of the ring down until it hooks under the ring groove. Then push the free end of the ring with your finger so that it will expand the ring and work the rest of the ring into position.

The same procedure is used to install the other oil ring below the oil ring expander.

While you are installing the oil rings, be careful so you don't nick the piston. If you do manage to nick the piston, a piece of emery cloth can be used to smooth the nick.

Next, install the 2nd compression ring. You will need a ring expander to do this. Expand the ring enough to slip it over the piston and position it into the groove above the oil ring set. The rings have a top and bottom side. Look on the part of the ring that will get hidden by the piston for a dot or the letter T. This will be the side of the ring that will face toward the top of the piston.

Finally do the same with the 1st compression ring. This ring also has a top side and will be marked just like the 2nd compression ring.

When you are all finished, the rings will be as shown in the picture. Note there is a thin groove between the top of the piston and the 1st compression ring. This groove is to slow down the transfer of heat from the top of the piston.

The rings will need to be positioned correctly for the best engine performance. Rotate the rings so that their gaps do not occur over the T slot or the piston pin holes. Also, the ring gaps should be staggered so they don't align with one another.

Assembling the Rods to the Pistons

Assembling the rods onto the pistons is fairly simple. The oil spray hole on the connecting rod faces away from the T shaped slot in the side of the piston and the specified torque for the piston pin lockbolt is 45ft/lbs. Here are a few hints that will make the job easier:

Use a tap to clean the threads in the connecting rod's piston pin lock bolt hole so that you can turn the bolt all the way into the rod by hand.

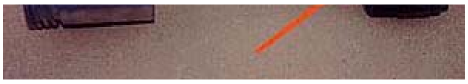
Use new split lockwashers to secure the piston pin lock bolts. Get hardened lockwashers rated for use with grade 8 bolts. Do not use standard lockwashers as they will not work well in this application. You will probably need to go to an industrial hardware supplier to find these lockwashers.

There is a groove in the piston pin. The lock bolt slides along the groove and prevents the piston pin from moving. Move the piston pin as needed so that you can, using your fingers, tighten the lock bolt until the lockwasher prevents further tightening. If you use a wrench too soon in the process, you risk stripping the lock bolt's threads.

Usually the piston pin will not easily slide through the end of the rod. I tap a wedge shaped piece of hard plastic into the slot cut into the rod until the piston pin moves easily through the rod. If you have to use a screwdriver as a wedge, be careful not to gouge or nick the rod. Gouges and nicks can cause cracks to form in the rod.

It takes a special tool on a torque wrench and some calculations to get the correct torque on the lock bolt. I don't have the necessary tool, so I tighten the bolt with a regular wrench until my hands hurt from the efort. This is unscientific, but so far I haven't stripped any bolts or had any bolts work loose.

When the piston is correctly installed onto the piston, it will look like this. The red line points to the oil spray hole. The yellow line points to the T shaped slot in the piston.



Installing the Pistons in the Cylinders

Rotate the crankshaft so that it is at bottom dead center at the cylinder you will be working in.

Remove the bearing cap from the rod. Now is a good time to ensure the oil spray hole in the rod is not clogged.

With the engine block in its normal upright position, lower the rod into the proper cylinder. Make sure the oil spray hole is facing **away** from the camshaft. If everything is correct, the mark in the top of the piston should be facing toward the front of the engine. Also, the longer offset in the rod bearing should be facing away from the nearest main bearing.

I lower the rod into the cylinder and set the skirt of the piston onto the side of the cylinder while I'm getting the ring compressor adjusted.

Put the ring compressor onto the piston and tighten the compressor as much as possible. The ring compressor does not need to cover the entire piston. Lower the piston into the cylinder and hold the compressor tight against the engine block. Use a hammer handle to tap the piston into cylinder. Each tap should move the piston slightly. If it seems like the piston is not moving, stop, reset the ring compressor and try it again.

Turn the block upside down and pull the rod up enough so you can install the rod bearing. Before actually installing the bearing, make sure the bearing area in the rod, the cap and both sides of both bearings are clean. After the bearing is installed in the rod, pull the rod up against the crank.

Install the bearing cap onto the rod. Tighten each bearing cap nut to 10 ft/lbs of torque. The rod should move side to side on the crankshaft. If you push the rod against one side of the crank journal, the end play (side to side movement) should be .004 to .010 inch (.1 to .25mm).

Remove the bearing cap, place a piece of Plastigauge on the crank and reinstall the bearing cap. Tighten each bearing cap nut, a little at a time, until the torque reaches 35 ft/lbs. Remove the bearing cap again and check the bearing clearance.

The clearances are the same as the crankshaft main bearings. Should the Plastigauge show an uneven clearnace, check behind the bearing for dirt or oil.

Once you decide the bearing clearance is correct, push the rod away from the cranksahft and apply engine assembly lube to the bearing surfaces. Reinstall the bearing cap and tighten the bearing cap nuts to a torque of 35-45 ft/lbs. Rotate the crankshaft, loosen the nuts 1 turn and retorque them. As with the main bearings, this ensures that the assembly lube doesn't cause incorrect torque readings.

Repeat this for the other three cylinders. -- Eric Lawson (elawson@inficad.com)

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Rebuilding an F-head Engine

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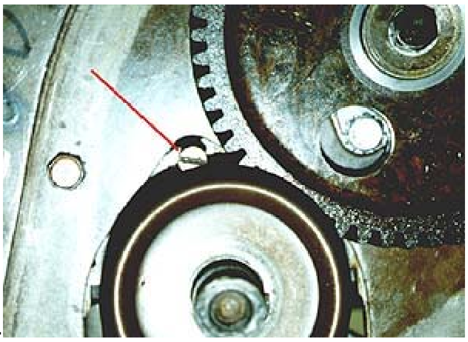
The Timing Gear Oil Jet



Install the oil jet (pointed out in the photo by the red line.) When you install it, ignore the screwdriver slot and use a socket or a wrench. Point the oil jet's hole so its oil stream will hit the fiber gear where its teeth begin to engage those of the steel timing gear.

There were two different oil jets used in the 4F-134 engine. The difference was the size of the oil spray hole. The earlier jet had a .070 inch (1.78mm) hole. The later jet had a .040 inch (1.02mm) hole. If you can insert a 1/16 inch drill into the hole, you have an earlier oil jet.

The smaller oil jet was placed into production engines when it was found that some earlier engines showed signs of their #1 rod bearing being starved for oil. The theory behind this change was that a smaller oil jet would divert less oil from the front main and #1 rod bearings. This engine had the smaller oil jet, so I did not have to make a decision about this "problem".

If your engine has the larger oil jet and you feel it necessary, you can find a new jet, or silver solder or braze the hole shut and redrill it to the smaller size. I don't think replacing the old style oil jet is a major concern.

I think an engine's #1 rod bearing would get starved for oil because the engine is worn, and to make up for low oil pressure readings, a higher viscosity oil is used. The heavier oil, when cold, doesn't flow through the narrow oil passages as well and may actually reduce the amount of oil reaching the bearings. The #1 rod bearing is most sensitive to this problem because its oil supply has to travel the longest path. This path also supplies oil to several other places, each of which reduces the oil supply to the #1 rod bearing.

Fixing Distorted Sheet Metal Covers

If you look at the bolt holes in the oil pan and front cover, you may find that the metal is pushed inward around the bolt holes. This happens because, in an attempt to stop oil leaks, the bolts holding these items are over tightened. When the bolts are over tightened, the gasket gets smashed and the oil leak gets worse. Further tightening bends the sheet metal around the bolt holes and makes it impossible to seal the oil leaks.

I was shown an easy way to fix this. Use a bolt the same diameter as the one normally used in the hole you want to straighten. Put the bolt through the hole with the bolt head on the side of the metal that would normally be against the gasket. Put a washer on the bolt and thread a nut onto the bolt. The washer needs to fit flat against the outside of the cover or pan, so make sure the lip on the metal piece isn't in the way of the washer. If the washer is too big, a large nut that will slide over the bolt can be used.

As you tighten the nut, the bolt head will pull the distorted metal against the washer and back into position. This won't take a lot of effort, so don't over tighten the nut. Also, use a wrench on the bolt head to prevent it from turning and scraping metal from the cover.

To check your progress, lay whatever you are straightening, without the gasket, into position on the engine and check for gaps between the sheet metal and the block. When any gaps are less than about 1/4 the thickness of the gasket, the metal's surface is flat enough.

Installing Front Crankshaft Oil Seal in the Timing Gear Cover

Install the front crankshaft oil seal. The open end of the seal (with the lip) should face toward the block. To help prevent oil leaks, coat the metal sides of the seal with gasket sealer. After installing the seal, clean the seal lips with an alcohol soaked cloth and put some engine assembly lube on the seal lips.

In my gasket set, assembled by Crown Automotive, there were two front crankshaft oil seals. At first I thought an extra seal was mistakenly added to the gasket set, but the seals had different inner diameters. One measured 2.645 inch and the other measured 2.690 inch. The surface of the crankshaft pulley that the seal would seal against measured 2.740 inches. On my engine, with the single groove pulley, I used the seal with the 2.690 inch diameter.

It is possible to install the seal without a seal driver, but it will severely test your patience. A seal driver tool makes this job much easier. A piece of steel plate (not sheet metal) that will completely cover the seal will also work. Set the seal in the hole, set the plate on top of the seal, get the seal aligned with the hole and GENTLY tap it in. If the seal gets turned slightly sideways in the hole and will not move further, simply pull it out with your fingers and try again. It will still take a few attempts, but it is still much quicker than not using any driver at all.

Before Installing the Timing Gear Cover

Make sure the crankshaft spacer, oil slinger, crankshaft pulley woodruff key and timing gear oil jet are installed. Verify the oil jet is pointed the correct direction.

Your engine may have a pointer to the timing notch on the crankshaft pulley. If so, have it ready to install as it is held in place by the same bolts that hold the timing cover in place. When the engine is upright and viewed from the front, the second and third 3/8 inch bolts, counting from the lower left corner of the cover, are the ones that hold the timing pointer.

Check that the timing gear gasket's holes align with the holes in the block. I've noticed about half of these gaskets have at least one hole that doesn't line up correctly. If the gasket is paper, soak it in water for a few minutes, set it onto the engine, gently stretch it as needed and thread the bolts into the holes to hold the gasket in place until it dries. Some of the new gasket materials don't respond to the water treatment, so be prepared to use a paper punch to make new holes.

Once everything is ready, coat the gasket with gasket sealer. Also coat the threads of any bolts that go into holes that extend into the crankcase. This last step prevents oil from seeping around the threads of the bolts.

Timing Cover and Crankshaft Pulley

Install the gasket, timing cover, and if needed, the timing mark "pointer". Don't over tighten the bolts holding the timing cover in place. If the gasket looks like it is getting squeezed out from under the timing cover, the bolts are too tight.

Coat the machined surface of the crankshaft pulley with engine assembly lube. This will ensure the seal doesn't get torn when the engine is first started.

Install the crankshaft pulley. Some light tapping might be needed to get the pulley onto the crankshaft far enough for the large nut to be threaded onto the crankshaft. The 1-7/16 inch socket needed for the large nut makes a nice pulley installation tool. Just don't hit the socket so hard that you damage it and be careful not to damage the threads on the crankshaft.

I have noticed the reproduction pulleys don't always fit well onto the crankshaft. If you are having this problem, first try cleaning the inside of the pulley hub with alcohol. Sometimes the anti-rust coating is sticky enough to cause problems. If that doesn't help, either try another pulley or have the inside of the pulley hub machined to the proper size.

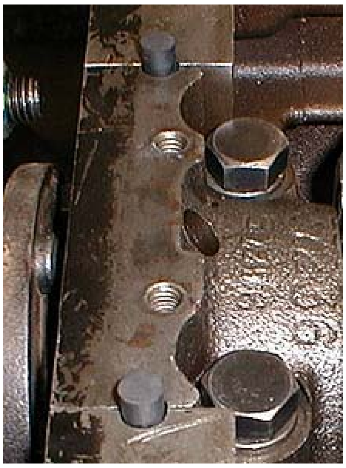
To prevent the crankshaft from turning as you tighten the crankshaft pulley nut, place a wooden hammer handle between one of the crankshaft counterweights and the block

The Oil Pickup

Clean the oil pickup. Bend the tabs holding the screen cover in place and remove it to completely clean the oil pickup. I am always amazed at what I find caught in the screen -- this time some red, orange and blue RTV gasket maker and some oily semi-solid. There is usually a string that seals the screen cover. If it is there, don't lose it. If it is not there, you can make one out of some oil soaked twine. This seal fits into the back of the groove in the sheet metal screen cover.

Reinstall the screen cover and install the oil pickup. When you install the oil pickup, don't forget the gasket that goes between the block and the pickup's flange.

Installing the Oil Pan



Put the rear crankshaft seal packings into the two holes in the rear main bearing cap. The packing will stick out about 1/4 inch (6mm). Sometimes the packing will not easily fit into the holes. Putting water on the packings and twisting it into the hole usually helps with this problem. If that fails, get a different packing set. I've not had any luck with trying to shave off material from the sides of the packings. Whenever I have tried this, I have ended up with an oil leak.

Coat both sides of the oil pan gasket with gasket sealer and lay the gasket into position. Lift the gasket up and place a bead of silicone gasket maker where the front cover gasket will meet the oil pan gasket.

When you install the oil pan, the crankshaft pulley shield goes on the outside of the pan at the front of the engine. The lip of the oil pan interferes with this shield and you will need spacers under each hole of the pulley shield. Two 5/16 inch AN flat washers stacked one atop the other make a suitable spacer.

This summer I lost all of the oil pan mounting bolts. The bolts are 5/16 inch NC, 5/8 inch in length. The 1/2 and 3/4 inch lengths that are commonly available would not work. An industrial hardware supplier had the AN flat washers and these odd length bolts.

Again, watch the gasket as you tighten the bolts. If the gasket looks like it is being squeezed out from under the oil pan, you are over-tightening the bolts. -- Eric Lawson (elawson@inficad.com)

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Last updated 8 November 1998 by Derek Redmond redmond@queensu.ca
http://www.film.queensu.ca/CJ3B/Engine/Rebuild7.html

Rebuilding an F-head Engine

Page 8: Vacuum Lines
by Eric Lawson

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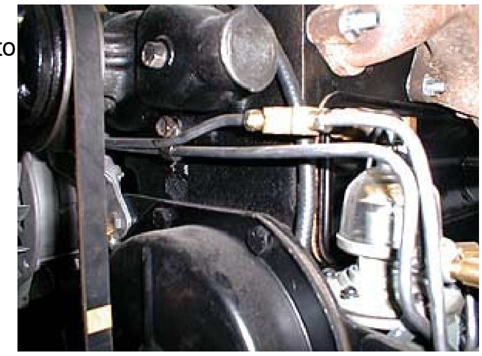
These photos show the PCV system as I've done it on the engine that I'm rebuilding. I think the arrangement of everything is pretty close to how it should be done. I followed the picture from Brochure 62-17 (see Crankcase Ventilation Tech Tips), photos that I took of the PCV system on Derek's Jeep, and notes from looking at as many 4F-134 engines as I could find.

This photo shows the bottom part of the carburetor, and the oil filler tube on the right. The vacuum source is in the intake manifold below the carburetor. One side of the T coming out of the manifold, runs to the PCV valve on the other side of the engine. The tiny tube from the other side of the T, goes to the fitting providing vacuum to the vacuum-operated heater air dampers.

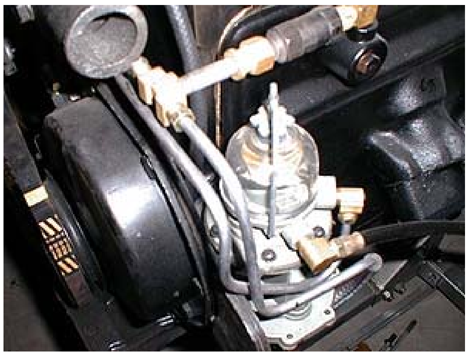
The opening on the oil filler tube will be connected to the air filter as a clean air source for the crankcase.

This shows the fuel and vacuum lines after they pass below the water pump to the left side of the engine, and the clamp under the water pump bolt that holds the fuel line in place. Not shown are the S shaped clips that hold the lines slightly apart so that the lines won't get worn if they begin to wiggle due to engine vibration.



The positive crankcase ventilation valve is on the side of this T that runs to a bell shaped fitting on the side valve cover of the engine.

The remaining side of the T goes to the outlet fitting on the vacuum (bottom) part of the fuel pump. The inlet of the vacuum pump is connected to the vacuum-powered windshield wiper. The vacuum pump augments the engine vacuum when the engine is running at full throttle and high RPMs. This keeps the vacuum wiper running at a reasonable rate. -- Eric Lawson (elawson@inficad.com)



See also Crankcase Ventilation Tech Tips and Windshield Wiper Tech Tips.

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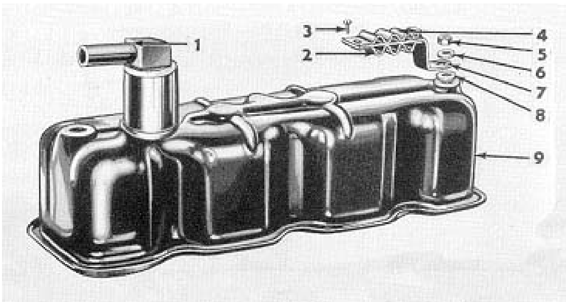
Last updated 28 November 1999 by Derek Redmond redmond@queensu.ca
http://www.film.queensu.ca/CJ3B/Engine/Rebuild8.html

Crankcase Ventilation System

People often ask about the purpose and necessity of the "positive crankcase ventilation" (PCV) fittings found on the F-head engine. The engine was built with a vent either from the top or the side, connected to the intake manifold which would inhale and burn gases from the crankcase.



The 1956 CJ-3B Parts List shows a vent on the rocker arm cover on top of the cylinder head (#1 in the diagram).

Jim Sammons describes the purpose of this system: "Most of the F-heads I've seen vent out the top of the valve cover. A hose runs from the vent to the intake manifold where the crankcase vapors are sucked into the engine and burned. Some kind of crankcase ventilation is necessary or pressure from the pistons going down on the intake or power stroke would eventually blow all the oil out of the engine. If you didn't have any ventilation at all you would know it. Oil would be blowing out of the engine from everywhere it could."

Bart McNeil adds: "As I understand it, the reason for the tube connecting the ventilator to the intake manifold is to use the intake manifold vacuum to create negative pressure in the crank case to draw unburned gases toward the ventilator and eventually into the intake manifold to be burned. It is an effective polution control device.

"Since there is a vacuum in the crankcase, the air has to come from somewhere, and rather than suck it in unfiltered, it sucks it from the oil bath air cleaner, through a rubber tube and into the oil dipstick tube. I guess it is called a closed system in that any air drawn into the engine is filtered and any gasses sucked out are burned.

"Since you have a vacuum in the crankcase then dust will enter the engine through the hose connection on the oil tube if it is open. When I took my L-134 to a mechanic the first thing he did was install a hose from the oil bath air cleaner system to the oil tube. Leaving off the hose negates some of the effect of the air cleaner, allowing dirt into the crankcase."

NEW **Simon B.** asks: "Are there any F-head experts out there? I can't figure out how to connect up the crankcase ventilation -- mine seems different. I have four holes that need pipes:

1. There is a vent pipe coming out the top of the rocker cover.
2. There is a vent pipe on the intake manifold.
3. There is the vent on the oil filler tube.
4. The pipe on the air cleaner body.

"I have no PCV valve on the exhaust valve cover and I don't see how it would connect to the fuel/vacuum pump even if I did have one. I think that I should connect the oil filler tube to the air cleaner, but then what do I do with the manifold pipe and the pipe from the rocker cover? My jeep is a '64. Had they done away with the PCV valve system by then? I have a '50's scrap motor for spares and it has no breather connection on the rocker cover but does have the PCV valve on the exhaust valve cover. Please help!"

Eric responds: "From what I've seen on what I think are 'unmolested' engines, when the rocker arm cover has the PCV port, the side valve cover PCV port is not used. This port is closed with a large fender washer and a bolt, and the bell fitting isn't used. The line that one sees connecting the dip stick tube and the air filter is in place as usual. "The vacuum port under the carburetor has an 'L' angle fitting connected and the male threaded end of a PCV valve is connected to this fitting. The other end of the PCV valve has a hose nipple. A hose connects from here to the port atop the rocker arm cover.

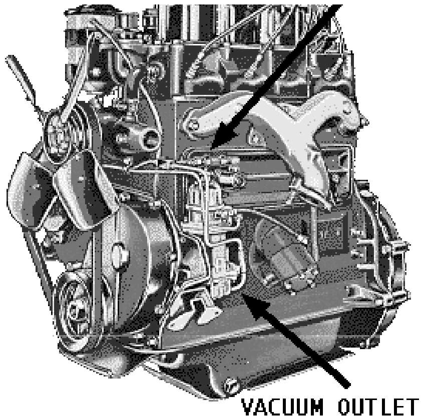
"The reprinted manual for the 'newer' Jeeps (mine has a light blue cover and covers the 4F-134 and the 225 V6 engine, but not the 4L-134) shows this arrangement in the tune up section. You need to make sure that you get a PCV valve that is set up so that the air flow is correct. Jeep valves need the vacuum on the threaded end. "Standard heater hose won't work in the PCV system as it is not resistant to oil and gas fumes. You will need to get some large diameter fuel line for this. I found some suitable hose at a hydraulic line shop."

Combined Vacuum/PCV System

The 1965 edition of the *Jeep Universal Service Manual* (see "Technical Information Sources" on the CJ-3B Specifications page for reprint information) shows the rocker arm cover without a vent. Instead, it details a crankcase ventilation system which vents out the side of the engine into the vacuum line leading from the fuel pump to the intake manifold. See the Service Manual illustration (85K JPEG).

Eric Lawson describes this system (seen here in the Hurricane engine illustration from the 62-17 brochure): "The line going to the fitting in the intake

manifold under the carburetor is the vacuum source. This is usually a steel line. You should have a PCV valve on the side of the T that connects to a bell shaped fitting on the side valve cover of the engine. The remaining side of the T goes to the **outlet** fitting on the vacuum part of the fuel pump.



"The inlet of the vacuum pump is connected to the vacuum-powered windshield wiper. The vacuum pump augments the engine vacuum when the engine is running at full throttle and high RPMs. This keeps the vacuum wipers running at a reasonable rate." (**Note:** If the fuel pump has been replaced with a unit without the vacuum connections, the T in the vacuum line may be conected directly to the hose to the wiper motor. See also Windshield Wiper Problems. -- Derek)

"An unused inlet port on the vacuum pump should be sealed, especially if the outlet is connected to the T fitting. Leaving the port open will make the engine run lean.

"I have seen many Jeeps without the PCV system, and they run just fine although the oil should be changed more often, especially if you are driving in dusty or wet areas. Often the PCV system was replaced with a draft tube that attaches to the rear bolt that holds the exhaust valve cover in place. This tube extends below the oil pan. As the Jeep is driven forward a vacuum is formed and the air flow that this causes removes the blow-by gasses from the crankcase. I think people did this because they thought that the PCV system reduced the engine's horsepower. There are several things wrong with the draft tube idea -- they don't work well at low speeds, they provide a path for water and dust to get into the crankcase, they leak oil, and finally, the draft tube 'just ain't right'."

Bill McCarthy adds, "All CJ engines used PCV systems, but Jeep pickups and wagons used draft tubes, and all 2WD models used the road draft tube. If you have a road draft tube on a CJ, the engine was probably from another Jeep model."

Checking PCV Valve Operation

Pete: "My oil dipstick shows some whitish gunk on it. I seem to remember from my past that this means water vapor is collecting in the crankcase, probably from an improperly working crankcase ventilation system.

"I have the oil filler tube and top of the valve cover vented to the air cleaner for filtered intake to the PCV system, and I have a PCV valve connected to the side of the engine at the bell, which in turn is connected at the manifold below the carb (vacuum source).

"Question: How does one check the valve for proper operation seeing as how it's all screwed together. Do you just unscrew it all and screw it back together as much as needed to feel for a vacuum?"

Rus Curtis answered: "It's important to ensure all the hoses have a good seal and the oil filler cap has a good seal for suction. I had to add a couple of layers of gasket to my oil filler cap/dipstick to seal and my gunk disappeared.

"There are some internal parts to your serviceable PVC valve. Instead of throwing it out like modern valves, you disassemble it, clean it and put it back together. There's a spring and a valve that should be inside. The Service Manual illustration (85K JPEG) shows how the parts fit together."

Another reader posted a link for later systems, and added, "The little fitting on the side of the oil filler tube is where clean air from the air filter enters the crankcase. Disconnect the line and put your thumb over the fitting. At idle, a tiny bit of suction should be felt. Rev up the engine and the suction should increase."

Thanks to all the contributors. See also a 1961 Willys Service Bulletin on installing a PCV system. -- Derek Redmond

Also on The CJ3B Page, see Rebuilding an F-head Engine, Page 8: Vacuum Lines.

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Last updated 14 December 2008 by Derek Redmond redmond@queensu.ca
http://www.film.queensu.ca/CJ3B/Tech/PCV.html

E-114. ENGINE SPECIFICATIONS

ENGINE:

Type	F-Head
Number of Cylinders	4
Bore	3 1/8"
Stroke	4 3/8"
Piston Displacement	134.2 cu. in.
Bore Spacing (center to center):	
1 and 2, 3 and 4	3.437"
2 and 3	4.938"
Firing Order	1-3-4-2
Compression Ratio:	
Standard	6.9:1
Compression Pressure	120 to 130 psi.
Number of Mounting Points:	
Front	2
Rear	1
Horsepower (SAE)	15.63
Horsepower (Max Brake)	68 @ 4000 rpm.
Maximum Torque @ 2000 rpm	113 lb-ft.
Idle Speed	600 rpm.

PISTONS:

Material	Aluminum Alloy
Description	Cam Ground, T-slot, Tin Plated
Length	3 3/4"
Diameter (near bottom of skirt)	3.1225" to 3.1245"
Weight	13.5 oz.
Clearance Limits:	
Piston-To-Cylinder Bore	Selective Feeler Fit
Ring Groove Depth:	
No. 1 and 2 Ring	.1593" to .1655"
No. 3 Ring	.1693" to .1755"
Groove Width:	
No. 1 Ring	.0955" to .0965"
No. 2 Ring	.095" to .096"
No. 3 Ring	.1875" to .1885"
Piston Pin Hole Bore	.760" to .770"
Cylinder Bore - Standard	3.125" to 3.127"
-- max. out of round	.005"
-- max. taper	.005"
-- max. rebore	.040"

PISTON RINGS:

Function:	
No. 1 and 2	Compression
No. 3	Oil
Material:	
No. 1	Cast Iron, Chrome-plated Face
No. 2 and 3	Cast Iron
Width:	
No. 1 and 2	3/32"
No. 3	3/16"
Gap (Std. to .009 Cyl. Bore)	.007" to .045"
Thickness:	
No, 1and No. 2 Rings	.134" to .144"
No. 3 Ring	.115" to .125"
Side Clearance in Groove:	
No. 1 Ring	.002" to .004"
No. 2 Ring	.0015" to .0035"
No. 3 Ring	.001" to .0025"

PISTON PINS:

Material	SAE 1016 Steel
Length	2.781"

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 Diameter................................       .8119" to .8121"
 Type....................................         Locked in Rod
 Clearance in Piston (selective fit)......      .0001" to .0003"

CONNECTING RODS:
 Material................................    SAE 1141 Forged Steel
 Weight..................................           32 oz.
 Length (center to center)...............          9.187"
 Bearing:
  Type...................................         Removable
  Material...............................    Steel-backed Babbitt
  Length Over All........................      1.089" to 1.099"
  Clearance Limits.......................       .001" to .0019"
  Undersize Bearings Available...........            .001"
                                                     .002"
                                                     .010"
                                                     .012"
                                                     .020"
                                                     .030"
  End Play...............................       .004" to .010"
 Installation............................         From Above
 Bore:
  Upper..................................      .8115" to .8125"
  Lower..................................     2.0432" to 2.0440"

CRANKSHAFT:
 Material................................    SAE 1040 Forged Steel
 End Thrust..............................        Front Bearing
 End Play................................       .004" to .006"
 Main Bearings:
  Type...................................          Removable
  Material...............................    Steel-backed Babbitt
  Clearance..............................      .0008" to .0029"
  Undersize Bearings Available...........            .001"
                                                     .002"
                                                     .010"
                                                     .012"
                                                     .020"
                                                     .030"
  Journal Diameter.......................     2.3331" to 2.3341"
  Bearing Length:
   Front.................................            1.64"
   No. 2.................................            1.72"
   No. 3.................................            1.72"
   Out of round and out of taper limits...           .001"
  Direction of Cylinder Offset...........            Right
  Amount of Cylinder Offset..............            .125"
 Crankpin Journal Diameter...............     1.9375" to 1.9383"
 Flywheel Run Out (max.).................            .005"

CAMSHAFT:
 Bearings:
   Material.............................. Steel-backed Babbitt (Front only)
   Number................................              4
   Clearance.............................       .001" to .0025"
   Journal Diameter:
    Front................................     2.1860" to 2.1855"
    Front Intermediate...................     2.1225" to 2.1215"
    Rear Intermediate....................     2.0600" to 2.0590"
    Rear.................................     1.6230" to 1.6225"
   Bearing Diameter:
    Front................................     2.1870" to 2.1890"
    Front Intermediate...................      2.125" to 2.126"
    Rear Intermediate....................     2.0625" to 2.0635"
    Rear.................................      1.625" to 1.626"
 End Play................................       .004" to .007"
 Drive:
  Type...................................        Helical Gear
  Crankshaft Gear........................         Cast Iron
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  Camshaft Gear..........................   Pressed Fiber-Steel Hub

VALVE SYSTEM:
 Valve Rotators..........................      On Exhaust Valve
 Tappets:
  Clearance -- Cold:
   Intake................................            .018"
   Exhaust...............................            .016"
  Clearance for Timing (intake)..........            .026"
  Over All Length:
   Intake................................            2 3/4"
   Exhaust...............................            2 7/8"
 Stem Diameter...........................      .6245" to .6240"
 Clearance in Block......................      .0005" to .0002"
 Timing:
  Intake:
   Opens.................................          9° BTC
   Closes................................         50° ABC
   Duration..............................           239°
  Exhaust:
   Opens.................................         47° BBC
   Closes................................         12° ATC
   Duration..............................           239°
  Value Opening Overlap..................            21°
 Valves:
  Intake:
   Material..............................         SAE 5150
   Length Over All.......................          4.781"
   Head Diameter.........................            2"
   Angle of Seat.........................           45°
   Stem Diameter.........................      .3733" to .3738"
   Stem-to-Guide Clearance...............      .0007" to .0022"
   Lift..................................          .260"
  Exhaust:
   Material..............................       Uniloy 21-12
   Length Over All.......................          5.909"
   Head Diameter.........................           1.47"
   Angle of Seat.........................           45°
   Seat Insert Material..................      Eatonite EMS 58
   Stem Diameter.........................       .371" to .372"
   Stem-to-Guide Clearance...............      .0025" to .0045"
   Lift..................................          .351"
 Springs:
  Intake:
   Free Length...........................          1.97"
   Standard:
    Pressure @ Length:
     Valve Closed........................       73 lb. @ 1.66"
     Valve Open..........................      153 lb. @ 1.40"
   Service Minimum:
    Pressure @ Length:
     Valve Closed........................       66 lb. @ 1.66"
     Valve Open..........................      140 lb. @ 1.40"
  Exhaust:
   Free Length...........................          2 1/2"
   Standard:
    Pressure @ Length:
     Valve Closed........................       53 lb. @ 2.109"
     Valve Open..........................      120 lb. @ 1.750"
   Service Minimum:
    Pressure @ Length:
     Valve Closed........................      47 lb. @ 2 7/64"
     Valve Open..........................      110 lb. @ 1 3/4"

LUBRICATION SYSTEM:
 Type of Lubrication:
  Main Bearings..........................         Pressure
  Connecting Rods........................         Pressure
  Piston Pins............................          Splash
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  Camshaft Bearings.......................        Pressure
  Tappets.................................         Splash
  Timing Gears............................         Nozzle
  Cylinder Walls..........................         Nozzle
 Oil Pump:
  Type....................................      Internal Rotor
  Drive...................................      Camshaft Gear
  Minimum Safe Oil Pressure:
   At Idle................................         6 psi.
   At 2000 rpm. (35 mph.).................        20 psi.
  Relief Valve Opens......................        40 psi.
  Normal Oil Pressure.....................    35 psi. @ 2000 rpm.
 Oil Pressure Sending Unit................        Electric
 Oil Intake...............................        Floating
 Oil Filter System........................      Partial Flow
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These specs come from the Repair Manual for the M38A1 CDN 2 and CDN 3. I have tried to keep the look of the original manual as much as possible.

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