V.I.N Standardization
Using 17 Digit Vehicle Identification Number

1980 = A
1981 = B
1982 = C
1983 = D
1984 = E
1985 = F
1986 = G
1987 = H
1988 = J
1989 = K
1990 = L
1991= M
1992 = N
1993 = P
1994 = R
1995 = S
1996 = T
1997 = V
1998 = W
1999 = X
2000 = Y
2001= 1
2002 = 2
2003 = 3
2004 = 4
2005 = 5
2006 = 6
2007 = 7
2008 = 8
2009 = 9

Select the 10^{th} digit in the 17 digit V.I.N and compare to the chart to find the correct model year. On HD models you can also select the fourth letter in the engine numbers
Example V.I.N: 1HD1544A7YZA35315 Y= 2000 Model Year

Harley Notes

T = Touring
R = Rubber

‘36 FL - FLH ‘86	‘71 FX ‘86	‘80 FLT
4 Speed	4 Speed	5 Speed
Solid Mount	Solid Mount	Rubber Mount
16” F - 16” R	19”-21” F - 16” R	16” F - 16” R

‘82 FXR ‘94
5 Speed
Rubber Mount
19”-21” F - 16”R

FL’s and FX’s share the same manual
FLT and FXR share the same manual until 1995
Since ‘95, all bikes have their own manuals

In 1984, First Soft Tail (4 Speed, Kick & Electric Start ’84-’85)
1986 - Soft Tails have 5 Speed and electric start only
All Soft Tails are Solid Mount
Soft Tails have 21” Laced Wheel (In early style)
1998 - Changed 21” lacing pattern to current style (inside spokes in opposite direction) to look nostalgic

1995, the DynaGlide replaced the FXR

All Rubber mounted bike are 5 speeds
All solid mounted bikes are 4 speeds

FLT- Fairing mounted on frame
FLTC- Fairing mounted on Handlebars

FXR-R=Rubber
FLT-T=Touring

-Pushrods too tight will cause the bike to run lean

Roller bearing end play	**Timkin end play**
.003" - .010"	.002"- .006" for Dressers .004" - .012 for Sport bikes

-Not Enough End Float - will weld bearings to axle
-Bad Bearings or too much end play will "rock" the tire
-Three types of bearings: Sealed, Timkin & Roller

Wheel Seals
19"- 21" wheel seals go flush with the hub
16" wheel seals are ¼" countersunk (never push seals to the top of bearings)

-Grease around bearings & Seals before reinstalling
-Every Time you change tires you should measure end play and grease the bearings

21" wheel (low profile) 40-44 PSI air pressure - Never Less (Prevents rim damage)

-1984 - Anti Dive - 1996 , Last Anti- Dive 25-35 PSI

Pull Brake, solenoid traps air in forks

'84 - '87 - fill valve located on engine guard
'88 - '96 - fill valve located on left hand end of handlebar
1997- First Year of air shocks and heavier springs

To Change Dresser Fork Oil:

-Get 8mm bolt, Grind off the head and drill a hole through it

- Drain Fork Oil - bottom of fork tube is drain screw (pump forks a couple of times while draining to shake out all the oil)
- Insert 8mm bolt in drain hole
- Place a hose on a funnel and over the 8mm Bolt

- Measure the fork oil
- Get vacuum pump
- Take out Schrader Valve (bleeder) and install pump over valve
- Use pump to pull oil into the fork tube
- While pumping you will hear a gurgling sound when filling is finished. Keep pumping while replacing 8mm bolt in drain hole

Rims

On 16" spoke hubs

-Lay a straight edge across the hub. Look across hub and decide if the outside hole is either left or right of the line

-Mid '77 and up - outside right

-Mid '77 and down - outside left

Wheel End Float

-Wheel end float should be done every time you change a tire

Zero End Float is BAD

If you have zero end float there are 2 things you can do

Get a larger shim

Get a larger spacer

Too much end float, cut down spacer

Too little end float, get shim

End float clearance

Sportsters and small bikes .004" - .012"

Dressers and large bikes .002" - .006"

Shims are either flat or shouldered. If shouldered, face shoulder down towards bearing in hub.

Engine Types

H - Ironhead
K - Shovelhead
L - Big Twin Evo
M - 883
N - 1100
P - 1200
R - Fuel Injected Evo
V - Twin Cam Carb
W - Twin Cam Fuel Injection
Y - 88B Carb- Softtail only 2000 and up
B- 88B Fuel Injection - Softtail only 2000 and up

88B has a chain balancer (Softtail only)

‘66 - First Shovelhead
‘84 - Last Shovelhead - 1st Softtail
‘86 - First Evo Sportster
‘86 & ‘87 - 883 & 1100
‘88 - First 1200 Sportster
‘85 - Last year of Ironhead (‘57 to ‘85)

To make an 883 into a 1200, bore out ½” and change heads

-Laced wheels always cross 4

- 3 Final Drives: chain, enclosed chain & belt

Until ‘91, Sportsters had engine numbers on right side (‘90 and down , timing hole on left) In ‘91, moved numbers to left side (Timing hole on right)

‘91 - Trans changed to 5 speed from 4 - Belt Drive - Fugi Clutch - 1 piece pushrod tube made tappit block part of the case. Changed from an open wheel lifter (could see whole wheel) to one that you can see only a little (enclosed wheel) Changed lifters
-Rubber mounted bikes handle better than solid mounted bikes because they can flex

Power Train - Engine, Transmission & Swing arm

Rubber mounted bikes have 2 stabilizers that keep your alignment
Front stabilizer moves real wheel left and right
Top stabilizer moves the engine left or right

Dynaglide has a top stabilizer and a rubber block. No need to do alignment

‘36-’84 - FL & FLH were solid mounted, 4 Speed, 16”F-16”R

‘57-‘85 - Ironhead Sportster

‘66-‘84 - Shovelhead (Cast iron pan head with DC Generator ‘66-’69)

‘71-’86 - FX was 4 speed, solid mount, 19-21”F - 16” R

‘80 - FLT gets rubber mounted and 5 Speed, 16”F-16”R

‘82-’94 - FXR gets 5 speed and rubber mounted, 19-21”F-16”R

‘95 - Dynaglide replaced FXR - all bikes get their own manuals

‘84 - Last shovelhead - First soft tail with Evo block, 4 speed, kick &
Electric start ‘84-’85

‘86 - Soft tails get 5 speed and electric start only - first evo sportster 883 &
1100

‘88 - First 1200 Sportster

‘98 - Changed Soft tail lacing pattern

Clutches

Dry Clutch	1941 - 1984 ½	Big Twin
D.C. Clutch	1971 - 1984 ½	
ABC Clutch	1984 ½ - 1989	First wet clutch
A.C. Clutch	1984 ½ - 1990	
Fuji Clutch	1990- Present	

-Kickstart is a total loss system

-First Big Twin alternator in 1970
-First sportster alternator in 1984 ½

-All rubber mounted bikes are "Rotor Friendly" 1980-Present
-All Solid mounted Big Twins are "Rotor Friendly" 1989 - Later (FXST)
Rotor Friendly is not having to remove the inner cover to change rotor

Before you do any clutch job there are 4 things you must do:

1. Disconnect the negative battery cable
2. Turn in the cable adjuster until max free play in lever
3. Try to turn the compensator (if it turns without turning the engine it has bad springs)
4. Check the chain alignment

You disconnect the battery because the started bendix is always powered, If you pull on the bendix with the bendix under power it could result in fingers being cut off

To check chain alignment (.030 and less is good)

-Check the chain link closest to the compensator with a gauge. Next, check the link closest to the ring gear. Subtract the small measurement from the large measurement.

-The end of the bendix is a brass thrust washer that must be installed
-Dry Clutches has oil for the chain

Electric start dry clutches must have a vacuum

To check the vacuum:

Take off the (little cover on primary case) and put a vacuum gauge on the top left bolt hole. Reading should be 20-25 Hg at 2000RPM

-The chain adjuster is thin in the front and thick in the rear
-You adjust the primary chain just like the drive chain
-To remove the adjuster, Remove the large bolt and remove as a unit
-Primary chains get tighter when they get hot
-To work on a big twin clutch, it doesn't need to be off the ground. Sportsters do

-Clean the Fiber plates with lacquer thinner, air dry, then sand
-Clutch plates - Sharp side out
-All Harley clutches start with fiber and end with fiber except ABC
-Stagger the steel clutch plates when installing
-Basket, chain, etc come off as a unit

Sprocket Shaft Extension - Under Compensator
-If you need shims to adjust chain play, they install under the sprocket shaft extension

-The nut on the clutch hub tightens to the left and loosens on the right (Reverse thread)
ALL CLUTCH HUBS ARE REVERSE THREAD EXCEPT D.C. CLUTCH
-There is a seal under the clutch hub nut. The book says 1, install 2

-Jiffy tool can only be used on 4-speed clutches
-Clutch puller necessary for 5 speeds
-Clutch hubs are completely rebuild able
    Check the plate in back, shouldn't move
    Check the fingers - no grooves in studs (minor is ok)
    Check the bearings - re-grease if reinstalling
    Do not reuse the springs if you take them off the hub

-To Adjust the Clutch

1. Take the lever out all the way and the cable all the way in
2. Turn the adjusting screw in until it lightly seats, then turn screw out ¼ to ½ turn and lock it up
3. Now you can adjust the clutch cable
4. From the pressure plate to the clutch release disk, adjust for a 1" gap
5. Squeeze the lever and watch the plate movement. Insure that it

Travels straight. (crooked movement will cause clutch to drag)
Each click of the slotted spring nuts are ½ turn

6. Put bike in neutral (grab lever) and spin clutch to test

Too tight - Clutch drags
Too loose - Clutch Slips

-Whenever the plate is right, adjust the spring nuts.

ABC Clutches 1984 ½ - 1989 First Wet Clutch

Diaphragm Spring Clutch

B - A - C (Tight- Medium - Loose)
-Depending on which hole you place the bolts determines how much tension is on the spring

-Pressure plate removal - ¼ turn on each bolt in a cross pattern until loose
-Spring must be flat when installed

-A diaphragm spring allows a lot of free play when you pull the clutch lever
-It's not the same as a coil spring
-.010 clearance max between diaphragm spring and clutch plate

-This clutch starts with steel and ends with steel. All others start and end with fiber

-Check plates for wear, thickness, etc.
-Replace warped plates
-Sharp side out with all clutches

-Harley part numbers, the last 2 numbers are the year
-On part numbers, if there is a letter after the last 2 number, it is the revisions number (improvements)
-Original fingers were aluminum, new ones are steel

-Pushrod - Flat side is so that the case can be vented to the transmission, which is atmosphere vented
-All wet clutches use a push rod with a flat side

-3 pushrod pieces must be 3 separate pieces. If the weld together, the clutch will not work
-Lightly seat pushrod, then back out a ¼ turn

Do not impact this clutch apart and especially don't impact it together

-Put it in first gear, apply rear brake and loosen hub nut
-Attach clutch puller, apply brake and remove hub

-Hub has a zipper ring which must be installed with a press. A zipper ring will reinforce the keyed are of the hub where the metal is thin. The zipper ring doesn't come on the clutch by default, you must add it if you want to reinforce the thin metal area. It installs flat, interference fit. Support the center of the hub with a socket and install ring. This will add life to the clutch.
-Zipper rings come in gold and silver
-84 hub with aluminum fingers - silver ring
-84 hub with steel fingers - gold ring
-Taper faces up when installing

The main shaft has a tapered shaft. This must be nice and clean (no oil). Use super glue to set the key in the keyway of the main shaft. Slide on the hub and install nut.

Fuji Clutch 1990 - Present

-Clutch tool - "Screws in" to big twin, "screws on" to sportsters
-2 snap rings on the hub, the inner and outer snap rings

-If you change a stator, take out the inner snap ring and the hub nut. Remove hub.

-If the tool on the hub, remove outer ring only
-If the tool is not on, only remove inner snap ring

1998 - no longer need clutch tool on big twins

Do not tighten the tool more than necessary. All you are trying to do is take

off the outer ring

Never reuse snap rings on Fuji clutches

-Use inner ring if you wish to remove whole assembly
-Use outer ring if you wish to disassemble clutch

-Put ring on with shoulder down
-Steel rings, sharp side out

-Spring plate installs in the middle of the clutch pack. Any movement of the plates at all, replace spring plate

-Starts with fiber, ends with fiber (8 fiber / 6 steel)

D.C. Clutch 1971-1984 ½ (Wet Clutch)

-First wet clutch that sportsters used
-No chain alignment necessary - No compensator
-Must be a gasket on the shaft (where foot shifter connects)
-Always supposed to be a thrust washer on the shifter

-Must take out the spark plug
-Must be in 4th gear

-Need to use a D.C. Clutch tool

-Start with fiber and ends with fiber except for the last plate (half plate)
-Half plate is half fiber and half steel. Steel points out.

-Clutch hub nut has a normal thread (loosen left/ tighten right)

-All adjusters go in until they seat, then back out ¼ turn

-Anything from 1990 and down, loosen up the nut on the sprocket before removing transmission

-Clutch adjusting screw must be held with the adjusting bolt

A.C. Clutch 1984 ½ - 1990

-1984 ½ - Present -Adjusting screw
Back the screw out until it seats lightly. Then go ¼ turn. Install lock nut, spring and cover.

-If you put the lock nut on and it doesn't seat correctly, always turn to the right. If you turn to the left you will take out the play that you just put in.

-Ball and ramp mechanism - Reverse action clutch. Pulls clutch apart instead of pushing them apart like most clutches

Collar facing towards you
Dish shape (edges up)
Groove ring - groove towards you
Flat one
Clip

No hub nut - uses clip
Has a spring plate as well

If the lever doesn't slap on the grip when squeezing - the adjusting screw is bad

4 Speed Transmissions

1936 - 1978 - used drum top
1978 & down - the lids are interchangeable
1979 - 1986 - used ratchet top
1986 - last 4 speed on wide glide
1952 - 1st year of foot shifter

-The drum top shifts better than the ratchet top
-The gears are left to right on all 4 speeds - 4-3-2-1
-High Speed on big twins is on the outside left (drive side)
-High Speed on sportsters is on the outside right (drive side)

Gear ratios

	FLH	FX
1st	3:1	2.45:1
2nd	1.82:1	1.82:1
3rd	1.23:1	1.23:1
4th	1:1	1:1

-A 2.45 : 1 First gear is taller and lighter than the 3:1 1st gear (super glide)
-You can swap the first gear between FLH & FX
-Andrew makes a first gear - 1st - 2.44:1

-You can identify the 2.45:1 1st gear by a groove around the center of the gear

-1st thing to do before disassembling the 4 speed transmission is to check the shift fork alignment. It is also the last thing that you do.

-To check the fork shift alignment you use a shift fork alignment special tool
-The round one checks drum top
-The square one w/Dowel pins checks ratchet top - 1979&later
-The tool simulates neutral and lets you center the clutches between the gears

-Shifter clutches are between 1st & 2nd gear and 3rd & 4th gear
-You want to have an equal space between each gear and the shifter clutch. This allows an equal shifting distance between gears.

-Line up the straight lines of the shifting drum. They sit on the shifting fork fingers. (always replace the rollers)

-Shims come in 2 sizes: .007" and .014"
-Only thing you can shim on a 4 speed are the shift forks

-There is a shift shaft
-To take out shift shaft, there is a small screw that you have to take out on the right side.
-1976, No more screw in the shift shaft (changed to clip)

-Both the shaft and the clips are interchangeable

Main Shaft

Put left hand on the main shaft. This is the left side of the transmission.

1. Remove the shift shaft
2. Remove the shift forks. (Shift forks are not identical)
3. Remove the kicker gear.
    A. If you slide the shifting clutches to the end gears it will lock up the transmission
4. Pushrod runs through the center
    A. 1974 & earlier - you can take the rod out
    B. 1974 & later - shouldn't take the rod out(clip holds everything together)
    C. 1978 & down - nuts face out on shift forks
    D. 1979 & up - nuts face in
5. Check the countershaft end float
    A. Check between the variable thickness washer and the end of the countershaft gear
    B. Clearance - check with a feeler gauge .003"-.012"
    C. Never use a variable thickness washer larger than .100"
    D. Never use 2 washers
    E. End float is adjusted by the size of the washer

-Countershaft has .22 bearings on each end (44 total)

Standard size - .125"
Oversizes - .0004" & .0008"
Running Clearance - .0005" - .001"

-Whenever you can change a bearing size, there will be a running clearance measurement

-There are 3 different countershafts:

1936 - Mid 1977 - threaded on right, o-ring groove on left, loose bearings
Mid 1977 - 1978 -threaded on right, 2 o-ring grooves, caged bearings.
1979- 1986 - slot on right, o-ring groove on left, caged bearings

-On the main drive gear there is a spacer. The main drive gear goes through the spacer. The L shaped key is a must. It slides into the space of the main drive gear and locks the spacer.

-Line up the slot in the spacer with the slot in the main drive gear. Insert L

shaped key and lock down. This key keeps the main drive gear and the spacer spinning at the same speed so that the bearings will stay flat. If it wasn't there, the gear would spin faster than the spacer which would allow the bearings to tilt.

-Later models with the caged bearings don't use the L shaped key in the main shaft.

6. Remove bearing retainer on the right side of transmission
   A. If you don't take off the retainer, you can't disassemble the transmission. Counter sink faces out, notch to the right. The drip molding sits in the notch
   And is what oils the kicker gear.
7. Take out the countershaft
8. Gently tap main shaft. 1st gear will take out the bearings, 2nd gear will take out the race.
   A. If it has a 2.45:1 1st gear, it will take out the bearings and the race.
9. Remove the 3rd gear clip. You will have a little space after knocking out bearings and
   Race
10. Main shaft will now come out

-The large shift clutch between 1st & 2nd is not directional
-The small shift clutch between 3rd & 4th is directional. The taper faces back (small end)
-Harley makes a shift clutch with a "high" stamp on it. This stamp faces high gear.

-If you were to rebuild the 4 speed tranny in its entirety (gears and all) it would be cheaper to just buy a new one.

Main shaft has 3 different types:

1964 and earlier - kick start, D.C. Generator (shortest)
1965 - 1969 - Electric start, D.C. Generator
1970 - 1984 - Electric start, alternator

-Each new main shaft is longer than the previous version

-Sportsters have a shift detent that needs to be set before you torque down

the linkage

-Shift the transmission into 3rd gear.

-Push in on the detent with a #0 phillips screwdriver

-Torque down linkage

5 Speed Transmission

1980 - First 5 speed transmission (access door on right side)
1980- 1986 - Fork & Arm Clutch release mechanism
1987- present - Ball and Ramp (adjustment for the clutch is in the cable)
-Drain Bolt is on the bottom except soft tails (right behind the exhaust pipes, right side of transmission)
-Whenever you put in a pipe plug, do not over tighten
-Gear setup on a 5-speed is right to left 4-1-3-2-5

1st thing you do and the last thing you do before disassembly is:

3rd gear

Set shifter ball

-There should be equal space between the balls and the shifter
-5-Speeds are always set up in third gear
-On softtails- the oil tank sits just above the cover. Adjust the shifter balls by "feel" so you don't have to remove the cover.
1989 & later - cam check easily
1988 & earlier - must remove the starter

1989 - Big Twins have square starter (no need to take off the cover to replace the starter)
5-speeds have no need to take out transmission to fix it
4-speeds must take out the tranny to fix it
5-speeds only shift the shift drum
-You shim the shift drum for positioning and end float - only thing you will shim
-To check positioning:

Put in neutral

Measure from outer bearing carrier to the center shift fork groove

1.992"-2.002"- Clearance for positioning

-Mid 1991 - no more positioning measurement
-To shim for positioning - shim goes on inside next to roller
-Measure end float: .003"-.007" (between shoulder and thrust washer)
-The shift forks all face towards the front at a 45 degree angle

-To take out the shift shaft:
    Drain fluid
    Remove cover
    Take out plug on right side

-Always remove shaft from the right side

-Always replace the bearings when looking at the transmission

-Never re-use thrust washers or clips

5-speed transmissions

Gear ratio's

1st	3.24:1
2nd	2.21:1
3rd	1.60:1
4th	1.23:1
5th	1:1

2nd & 3rd are the same size gear

-Main shaft has slotted gears (dogs) - face access door
-Uses a split bearing - always replace (on countershaft)
-There are two conical washers on each shaft - taper faces out

-On main drive gear you dead blow hammer out the bearings. You will need a special tool to replace them.

-The clearance between the race and the pulley is .100"

-New bearings when rebuilding

-Always a thrust washer with a snap ring

-Use Harley - Davidson transmission fluid

-Main shaft has 2 slider gears

-Sliders face toward access door (dogs)

-Counter shaft dogs go away from the access door

Solid Lifters

-All Ironhead sportsters 1957-1985 have solid lifters
-When you do pushrods, you always do two of them
-You must put rods back the same way they came out and in the same direction
-Solid lifters are noisy
-Cut groove 1- 2 - 3 - 4 from left to right

Removal:

Only remove pushrod on the compression stroke

1. Remove sparkplugs and place in 4th gear
2. Spin rear wheel and watch the rear lifter rise up. When it stops moving, you should be able to spin the front lifter with 0 lash (no up and down movement)

Whichever pushrod you move up, you adjust the other pushrod
Always adjust pushrod with the valve closed

3. Loosen locknut on rod, remove rod
   -May need thin tappet wrenches to loosen nuts
   If the pushrod wont come out, use needle nose pliers and leverage the rod out by the ball at the end

If you try to spin the rod and it stops, its too tight

-Bring up rear exhaust then adjust front exhaust

-Only on solid lifters

Hydraulic Lifters

Shovelheads 1966-1984 ½

-All shovelheads have hydraulic rods
-If they use solid lifters, adjust the same as all other solid lifters
-Only hydraulics have to be adjusted on the compression stroke
-When on compression stroke, all valves are closed
-Extremely quite running

2 ways to get on compression stroke

1. Turn wheel, put finger on sparkplug hole and feel the compression
2. High gear, watch intake go up and down, ¼ turn of wheel. If the rods turn in your fingers the valves are closed.

-Loosen locknut, turn nut down (close pushrod), remove pushrod and lifter

-You can rebuild hydraulic rods if tip is good
-You can replace the tip if the rod is good
-Open up to adjust

-Make a wire measuring tool - .520”

-Must push up on check ball to compress tappit
-To clean, push down and turn left and pull apart
-To put back together, push together and ¼ turn

-Do front and back lifters at the same time (intake & exhaust)
-When installing, you are waiting for the oil to bleed out of the tappet

-Get a pan, put clean engine oil in pan
-Push checkball on tappet, push down about half way
-Insert in oil and fill tappet (preload)
-Now, when you install the tappet in the bike and adjust, you can set them to .520”
-When the rod spins, you are good to go
-Do the rear lifter (same jug)

-Treat each jug as a separate engine

-Always adjust tappets ¼ turn at a time
-Measure that each is equal

NEVER TURN BIKE OVER UNLESS YOU CAN SPIN THE RODS!!

<u>Evolution Non-Adjustable</u>
-Evolution Non-adjustable 1984 - 1999 ,Big Twins
1986 - Present ,Sportsters

On FXR's, you have to drop the engine to do the rear lifter. Cant get the bolt out

-Remove spark plugs, 4th gear, compression stroke

Do the front cylinder

1. All hydraulic lifters are done on the compression stroke
2. Check to see if you can turn both lifters
3. Take off the cover, cross pattern bolt removal (4 allens)
4. Take off the spacer
5. Take off the rocker box (9 bolts: (4) ½", (3) 7/16" (2) allens) small ones to big ones - outside in - ¼ turn
6. Remove rods

-When tearing down, always use new gaskets
-Make sure you have top o-ring and bottom o-ring and thrust washer installed (o-ring on top of washer)

-Before torquing rocker box, check torque spec
-Base gasket will weep if you don't warm up your bike. This is due to the jugs moving until they are warmed up
-You should install a bask gasket with a metal/rubber gasket

-Install the tubes (check orientation), rods, rocker box, etc…wait 20 mins or so and check rods to see that they

-DO NOT START BIKE UNTIL RODS TURN

-Rods will adjust themselves to within .01"

-You are actually bleeding the lifters with the rocker box

Longest - Shortest
Front Exhaust - Rear Exhaust - Front Intake - Rear Intake

Assembly - Rocker box wont sit even so tighten bolts ¼ turn at a time

Evolution Adjustable
-Adjustables don't spin as freely as solids

-When you adjust these, remove plugs, go to compression stroke

-Lash (no up and down movement) & 18 flats (six flats is one turn of the 6 sided nut)

Removal:

1. Loosen both adjusting rods (lock nut locks at the bottom)
2. Screw the pushrod closed (can't remove pushrod)
   Crane makes a "timesaver" rod that screws completely closed so you can remove them

Adjustment:

1. Open the rod up until you feel it lightly sear (0 lash) the bottom (lifter)
2. Turn nut 18 flats (3 whole turns)
3. Lock up the nut
4. Wait about 20 minutes for the lifter to bleed, until rod turns
5. Adjust the rear lifter with same procedure as above

-Adjust the rear cylinder in the same fashion

-Depending on how many threads per inch, that is how many flats you will need to adjust (threads on rods)

If you don't know what lifters are being used:

-Blow air into the spark plug hole until you hear air through the intake valve while backing out the rod.

-Next, tighten the rod until you hear the valve close (no more air)

- Repeat on rear lifter after front rod will spin

-Do the rear jug and treat each jug as a separate engine

Timing:
Front cylinder compression stroke (Don't need TDC)
Loosen plate, put in center and run the bike

-Use a test light (one end to ground, one end trigger side of coil)

-Points cam can be moved with your fingers (DON'T USE PLIERS)

-Set timing by moving the plate

-If you go to Harley and ask for a prestolite ignition they will give you a Dyna S

-Hold full advance (to left)

-Bump wheel until test light comes on. Check timing in timing hole if inside the hole you should be good.

.032" plug gap

Ignition & Tune Ups

-The rear cylinder piston comes up first
-The front cylinder burns hotter
-The cam runs at ½ the speed of the crankshaft
-All big twins until 1991, timing hole on left side of bike
-1991 - sportsters moved timing hole on the right side

Timing Marks:
-Mid 1981 & down - line is full advance, dot is TDC (top dead center)
-Mid 1981 &up - Dot is full advance, line is TDC
-Until about 1984, the rear cylinder had a timing mark (3 marks)
-In 1991, return of the 3 timing marks

Anytime there are 3 marks for timing:
-1st mark - rear cylinder advance
-2nd mark - front cylinder advance & rear cylinder TDC
-last mark - front cylinder TDC

-If you have only 2 marks, full advance & TDC for a front cylinder
-All timing is done on the front cylinder

-Timing hole is 7 degrees from one side to the other

Advance Timing:
-If you are on the left side of the bike looking at the timing mark, and the timing mark is on the rear of the hole

Retard Timing:
-If you are on the left side of the bike looking at the timing mark, and the timing mark is on the front of the hole.

Points
1969 & down - all big twins had a distributor
1970 & down- all sportsters had a distributor (opposite nosecone)
1970 & up- turn backing plate to the right to advance timing, to the left to retard timing (anything that has a nosecone)

-The manuals say to put mark in front of the window…BUT…if you put the mark to the back of the window the bike will run better.

-Retard timing - bike sounds like a lean running condition if the timing is too retarded
-Turn the distributor clockwise to retard timing - opposite of a nosecone
-Turn the distributor counter-clockwise to advance timing - opposite of a nosecone

-Points cam has 2 lobes
    -Small is for front cylinder
    -Large is for rear cylinder (180 degrees out)

-Timing is done on the front cylinder first

-With the advance mechanism fully open, put rubbing block on the small lobe and set for .018”
-Front cylinder point gap = .018”
-Rear cylinder point gap = .018” (+,-) .002”

-All points cams have a notch on them. The roll pin must be on the notch
-There is a second roll pin on the inside. If you look at the points cam you will see a flat spot. This spot must rest on the inside roll pin.
-The timing screw holds the entire assembly together (do not exceed torque spec)

-If you are on front cylinder compression, the points cam will be facing the front of the bike (small lobe)
-If installed correctly, you will hear it move around. Incorrectly, no sound is heard

-If the bolt for the advance mechanism is not concentric to the point where you cant adjust the points, you can whack the bolt slightly with a brass hammer to move it a tad and reattempt to set the points
-Points should both be about .018”

-All bikes start retarded. This is due to slow piston speed.

-If your timing is too advance, you will probably be hearing banging from the motor. This is due to the bendix fighting the ring gear. It fires too early and forces the piston back down when it is trying to move up.

-Dwell time - points are closed
-Dwell angle - degrees of crankshaft rotation that the points are closed
-Saturation - when the coil is full of electricity and is ready to fire
- when voltage jumps a gap it increases in voltage
-Ignitions fire when the points are open

-Gap too narrow - points will pit & burn

-Gap too wide- possible high speed miss

-If your timing is too advanced for a distributor, you can adjust gap or pick up & turn the distributor one tooth

-Plug gap - .028” for kick start (magneto) set plug gap to .022”
Prestolite ignition 1978 ½ - 1979
Plug gap = .032”

-Points cam lobes are more pronounced - more voltage
-This is the beginning of electronic ignition with mechanical advance

-In a dual fire ignition, both plugs fire at the same time. Makes no difference which side is the trigger side.

-Blue wire is the trigger
-Red wire is the tach
-White wire is hot

-If you have a hard time starting, try removing the pink wire (tach) to insure that the tach is not grounding out the coil

-Use only brass or plastic feeler gauge, No steel. (magnetism involved)
-Air gap = .006" (+-) .002"

DYNA S has no air gap to set

Modules, relays & regulators must be grounded

-Use a test light to check the white wires at the coils to see if they are hot

Batteries
-32 Amp hour battery - 1965 - 1984 FLH
-32 Amp hour battery - 1967 -1978 XL

-30 Amp hour battery - FLT with EFI
-22 Amp hour battery- All FLT without EFI

-19 Amp hour battery - 1979 & up XL's, all FX's, All FXR's, All FXD's, All Softails, Fatboy

VAT 40 Battery Load Tester (Blue Scale)
Load test:
-Green to ground, red to positive & zero the scale
-Turn knob to 3 times the amp hour rating of the battery
-Run test for either 15 seconds or before reading drops below 9.6 volts
-If battery drops below 9.6 volts before the 15 seconds is up, battery is bad

To Change Battery:
-Set the voltage, turn on charger
-Charger will automatically turn off

-Fuel injected dresser will charge at idle 14.5V

-The battery has to be re-charged after the test is done. The machine sucks the juice right out of the battery during the test

-Plugs - lower the number hotter the plug (Harley Plug)

V- Fire Ignition
-1980 - 1st V Fire Ignition - All Models (until present)

-First fully electronic ignition

- Spark plug gap = .040" (higher voltage)

-Rotor, Sensor & Module

-Rotor has a spot that must be lined up with the cam

-At 800 RPM - Spark 5 degrees before TDC
-At 800 - 1800 RPM - Spark 25 degrees before TDC

-Around 35 degrees is full advance

-Anything after 1700 RPM starts forward advance
-Rev limiter makes it fire every other time when activated

-Evo - around 5200 RPM
-Twin Cam - around 5500 RPM
-Twin Cam B (chain balancer) - around 5300 RPM

-Anything from factor is pre-set

-Air gap is pre set on sensor plate
-Rotor has slots. When the slot hit's the air gap, fires cylinder.
-If it has 2 slots - single fire ignition

-If it has 1 slot - dual fire ignition

-1991 - changed wiring from white & white and blue & pink
TO white & white and pink & pink

-There are 3 wires from module to sensor - Red, Green, & Black
-Always connect these wires to the same colored wires
1989 Evo FXR w/ adjustable pushrods

<u>Crane Hi-4 Single fire</u>
-If you start the bike with a crane Hi-4 and it stalls you must turn the bike off and on again to reset the crane (either kill switch or key)

-If you hook up a tach to the triffer wire, you will read only half of what the real RPM actually is

-Wires on the ignition
Red - center post of ignition coil
Black - front cylinder
White - back cylinder
Brown- Tachometer
Green - VOES

-A little more than 5000 RPM maximum setting for rev limiter
- If you have a rear cylinder timing mark, you can tune the rear cylinder like the front

-1970 & up - all ignitions are interchangeable
You set plug gap based on ignition type

-If hooking up VOES: all OE points settings

-Fold over tachometer wire if not using
-If you put a crane ignition in a kick started bike, install a starter booster for easier starting

-You can statically time the ignition
-Turn on the bike. You should see the timing light come on or you have a problem

To statically time bike:
-TDC compression - front cylinder
-Turn on key, should see timing light come on
-Move adjuster until light goes out
-This will get you close enough to time with a timing light

Single fire ignitions always have 2 pickups
-83 rotor must be used with a crane ignition, must use because the VOES (came out in 83)

-If the module isn't grounded properly, it could lose the electrical connection intermittently and cause the bike to shut off and on

1973 XLH
-Front cylinder compression
(take out points plate only)

-Before setting timing, center the timing base plate before adjusting points
-Turn the points cam to the front love and adjust the points gap to .018"
Set the rear cylinder at .018" (+/-) .002"
-After you set the rear cylinder, go back and check the front cylinder timing

-Don't spin the wheel, just use the wheel like a pendulum or you will fall off the compression stroke

-Make sure condenser is disconnected from the plate
-Get a multi meter and hitch up to the points
-Grab the cam lobe with some pliers and turn all the way to the left to advance the timing while "bumping" the wheel (listen for meter tone)

-You muse hold the advance mechanism so you can time the bike
-You must time on full advance

-The mark anywhere from the top to the rear of the timing hole is acceptable

Tire Changing

1. Break Bead
    -Be sure to use 2x4 so you don't harm the disk when you turn the tire over
    -Break bead and stamp around tire

2. Clamp down rim so wheel doesn't move

3. Push down on tire and soap up tire well

4. Use the bar and hook the tire bead

5. Lock the wheel down (always hold bar and tire when removing)

6. Clean wheel before installing new tire
    - If using spoked rim, paint inner rim to prevent rust
    - Insure there is a new rim band. If not, use a couple of wraps of duct tape

7. Clean rotor before reinstalling tire

Basic Starting System

1. Battery
2. Starter Motor
3. Starter Relay
4. Solenoid

1965 - First Electric Start - Big Twins
1967 - First Electric Start - Sportsters

1981 - Sportsters - Nippon Denso Starter (square starter)
1989 - Big Twins - Nippon Denso Starter

All Rubber mounted bikes are rotor friendly
1989 & later - Solid mount bikes are rotor friendly

When they redesigned the starter (Nippon Denso) they also redesigned the inner primary to make it rotor friendly

3 DIFFERENT SIZE POSTS ON THE SOLENOID:

Large - Battery
Medium - Starter
Small - Relay

Solenoid has 2 functions: Electrical & Mechanical

Electrical - To connect the battery to starter
Mechanical - To connect the bendix to the ring gear

Starter has 3 posts:

1st - Battery - Standing voltage
2nd - Starter Button - Message from switch
3rd - Solenoid- Message out to starter

Generator output test (must perform all three parts):
First, check battery standing voltage
Remove wires from generator

Next, use these tests to check generator:

Part 1. Red wire from meter to A post, Black probe to any ground
Part 2. Residual magnetism test: Start bike and run to 2000 RPM (1-3 VDC residual magnetism)
Part 3: Add a jumper cable to the F post from any ground. Run bike to 2000 RPM

(Should be 25 to 30VDC or until 10 seconds have past, whichever comes first)

If either test above fails, then bad generator

1970 - 1st alternator on Big Twins
1984 ½ - 1st alternator on Sportsters (AC clutch)

All these systems are interchangeable

‘70 - ‘75 - One of the better rotors (magnets screwed in instead of glued in)

Pull plug from regulator (to stator). Should read 0 Volts. If voltage is read, bad zener diode

Stator Testing:
Short - Pin to pin (less then desired reading is bad, more is ok)
Ground - Pin to ground (infinite is good)
Check voltage output - Run bike, test pin to pin (2000 RPM)

NEVER UNPLUG OR PLUG REGULATOR FROM STATOR WITH BIKE RUNNING
(Accel stators break easily, don't use)

Always test at 2000 RPM

<u>Charging System:</u>

Test Regulator:

Use a test light and clip ground to fin of regulator. Poke the wire going from the regulator to the battery as close to the regulator as possible. If lights = bad regulator

Next, if you ground the test light to the battery, poke the wire from the regulator to the battery as closest to the regulator as possible. No light = broken wire

Always check the battery and the stator before checking the regulator

Alternators are better than generators because:

Less maintenance
Less moving parts
More output
Less noise
More ground clearance

To test a starter:

1. Hitch up VAT 40 (directional arrow on inductive pickup away from starter)
2. Crank Bike - Needle will spike, then level out. Take reading from when level

Round Starter - up to 120 A
Square Starter - up to 150 A

Anything more is bad, less is good
If you hitch up the inductive pickup with the arrow the wrong way, the meter will read to the right instead of the left
This is the last test you do before rebuilding the starter

Carburetors

1976 ½ - 1987 Keihn Fixed Venturi - XL's
1978 ½ - 1989 Keihn Fixed Ventrui - Big Twins

-Keihn carbs have a spray tower. (accelerator tower). When you crack the throttle, the jet should spray into the slot in the choke disk. If it doesn't, remove the float bowl to access the adjustment mechanism and re-aim the spray tower so that it sprays directly into the slot.
-Keihn calls the pilot jets a "slow jet"
-Three styles of Keihn fixed venturi carbs:

- -1976 ½ - 1977/78
  - Adjustable fuel screw
  - Single choke mechanism
  - Single throttle cable mechanism
  - 4 midrange holes in a straight line
- -1978 ½ - 1982
  - Non-adjustable fuel screw (high idle cam)
  - Double choke mechanism - single pull
  - Staggered midrange holes - diamond shape (works better then straight)
  - Pull out choke, start bike. Push choke until you feel detent, bike should start at 1500 RPM
- 1983 - 1987 - XL's (best of the three styles)
- 1984 - 1989 - Big Twins
  - Non-adjustable fuel screw
  - Double linkage (choke)
  - Push-pull throttle (2 cables)
  - 4 Staggered midrange holes
  - 1 extra midrange hole
  - Tall skinny fuel sprayer
  - First HD VOES aware carburetor (1983) (Sportster)

1988 - Keihn CV Carb
- XL's got first CV carburetor (constant velocity)
- No accelerator pump

1989 - Added accelerator pump

1990- Big Twin got Keihn CV w/accelerator pump

Installing a CV carb on older bike

-You need to drill out the slow jet (pilot) until the shovelhead stops sneezing (CV carbs run lean) Drill out a little at a time and gradually work larger until it stops sneezing. (usually about a #70 bit). Jet drill bits can only be purchased through snap-on

Rich Condition - Low Throttle (Effect)
- Plugs fouling
- Starts without using choke
- Smoke out the pipes (black)
- Runs poorly when hot

Rich Condition - Low Throttle (Cause)
- Restricted air flow (Air cleaner, passageways, etc)
- Slow jet too large
- Fuel screw too far out (screw in, lessen fuel/screw out, add fuel)
- Insure enlightener is seated properly
- Float bowl fuel level too high

Rich Condition - Wide Open Throttle (Effect)
- Bad gas mileage
- Bike runs cooler
- No power
- Fouled plugs

Rich Condition - Wide Open Throttle (Cause)
- Main jet too big
- Air jet too small
- Choke partially closed
- Restricted air filter
- Elevation (air pressure)

Best way to test fuel level of float bowl:

1. Remove float bowl
2. Put can under needle to catch gas
3. Turn on fuel and push up on float until the gas stops
4. Check float against bottom of carb. Should be horizontally even with the bottom of the carb

High fuel level - fire and death
Low fuel level - lock up the rear wheel

Too lean - coughs through the carb
- Pushrods too tight

Things you can vacuum test:
-Diaphragms
-Inner primary on dry clutch with electric start - 20- 25 HG
-XR1000 - uses vacuum gauge to synch carbs
-Barometric sensor
-Dry Clutch

<u>Scanalyzer:</u>

- Plug into the data link
- Turn on key
- Install chip in scanalyzer
  - -Diagnostics menu
    1. Identifies the system
    2. Trouble codes
       - Current trouble code - current issue
       - Historical trouble codes - stored for 50 trips
       - After 50, FIFO trouble codes
    3. Data

Every sensor has a specified voltage (between 2-5 VDC)

Turn the key on/off/on - can debug without scanalyzer using the blinking light in the dash

There is a breakout box that installs between the scanalyzer and the data link port. This box allows you to use its test points and a multimeter to debug issues

The Delphi system - 2000 Softtails
The Delphi system can use a laptop in place of a scanalyzer and beam the captured information to someone at Harley

- If you are using the scanalyzer and are finished mapping the bike/ don't hit exit. Pull the chip out and you will not use one of the 10 programs in the cartridge

- Fuel injected Buells use single fire ignitions

Important dates and information:

- Up until 1964 - Linkert model M - No jets

- 1965 - 1966 - Linkert model DC, used on last pan and first shovel

- 1967 - 1970 - Big twin got tillotson

- 1967 - 1971 - XL got tillotson

- Tillotson has no float bowl and had the first accelerator pump

- 1971 - 1978 ½ - Big twin had bendix carb

- 1971 - 1976 ½ - XL had bendix

- Bendix has a check ball you should hear rattling

- 1976 ½ - 1978 - XL had fixed venturi keihin carb

- 1978 ½ - 1989 - Big twin had fixed venturi carb

- Keihin carbs have a spray tower for accelerator pump
    -Until '77/'78 single choke, single throttle, midrange holes in a straight line

- ‘78 ½ - ‘82 double choke, choke detent, staggered midrange holes
- ‘83 - ‘87 - XL’s, ‘84 - ‘89 - big twin
    - Double choke, push/pull throttle, extra midrange hole, tall skinny sprayer
        VOES compatible

- 1988 - First keihin CV carb. No accelerator pump

- 1989 - Added accelerator pump to keihin carb

- 1990 - Big twin got CV carb

- ‘83 - ‘84 - Dellortto carb. XR1000

- One carb running 2 cylinders = Erratic fuel signal

- Lean condition = Sneezing out carb

- Rich condition = Sneezing out exhaust

Harley Davidson Engines

Top End

Valve springs

-Always replace springs in sets

Three measurements for each spring:

1. Free Length
    -Don’t measure from the ends/tips (they are thinner and can warp)
    -Too much free length is OK
    -It is possible for a spring to pass the free length test but fail the pressure test. If a spring doesn’t pass free length, don’t even test it for pressure
2. Pressure
    -Determines how much pressure is required to compress the spring

-Set the machine so that the "0" mark is at the 1 inch mark
-Turn the plate as described from the manual
-One revolution = 1/16 of an inch (2/16 in an 8th)
-Pull the torque wrench until it clicks and then double the reading on the wrench
-If the spring is progressively wound the tightly wound portion goes toward the bottom

3. Installed Height (AKA closed height)
-Measures the space occupied by the spring when installed
-Measure from the bottom of the top retainer to the top of the bottom retainer
-Measure with a piece of carburetor spring in place of the valve spring
-On evolution and twin cam exhaust valves use a straight edge at the bottom of the top retainer and measure with the butt end of the caliper because the lower retainer is in a "hole"
-Spring installed height can be fixed by shimming under the lower spring retainer but the stem protrusion must allow for it. If it doesn't allow for it you can replace the valve with one with a larger margin.
-Always check protrusion before you shim the valve spring
-If neither on fixes the problem you must get a valve with larger head or change the valve seat
-A larger valve head wont let the had fall as far into the seat
-Older style shims fit over the valve seat shoulder

Valve stem protrusion

-Stem protrusion is measured from the valve guide shoulder to the top of the stem
-Evo's and twin cams have no shoulder on the guide so you measure from the head surface to the top of the stem
-Valve Float is a result of not having enough spring seat pressure to force the valve to follow the shape of the cam lobe. Excessive valve spring protrusion will result in valve float because it directly effects installed height
-In evolution motors you can use a "service valve" which has a .030" shorter stem

-This will effect stem protrusion and installed height
-Excessive stem protrusion will cause valve float and inadequate spring tension
-On intake it will cause lack of breathing which causes power loss
-On the exhaust valve it will cause overheating and burning of the valve
-Valve spring protrusion cant be shimmed
-Cutting valve seats will also effect spring stem protrusion

Rocker Arms

-Side Clearance (end play): Place a feeler gauge between the rocker block and the end of the rocker arm on either end
-It should be between .005" and .025"
-You cant fix too much end play on evolutions or a twin cam (very rare)
-If you do have too much you have to replace the rocker and/or the box
-Rocker shaft to bushing clearance:
-There is a bushing on each side of the rocker arm
-If there is too much clearance it will act like the valves are bad
-The area between bushings is full of pressurized oil. If there is too much clearance too much oil will get into the rocker box and fill over the valve guides causing smoke.
-The motor will act like the valve guides are bad by smoking on deceleration

1. Measure the inside of the bushing with a ball gauge
2. Measure the shaft at the point that the bushing rubs across
3. Find the difference of the two. This wear limit must be between .003"-.004"
4. Check the shaft for roundness. .150"-.200" is the wear limit

-Do a visual inspection and measure the roundness

The Rocker Arm:

-Inspect the pad where it contacts the valve stem
-Any pitting or wear through the hardened surface cant be repaired and must be replaced
-Shovelhead rockers don't oil the top end through the pushrods
-They have a hole running through the arm on the pushrod side to let oil in to lubricate the ball end

-Evolutions have a 1.6:1 rocker arm to cam ratio

Shovelhead rockers have a 1.43:1 ration

Pan heads have a 1.5:1 ratio, Knuckleheads have a 1:1 ratio

-Evolution rocker arms are longer then shovelhead rocker arms

-Evo and Twin Cam rocker arms and rocker arm shafts are the same

-Evo and Twin Cam rockers don't have a hold to lubricate pushrod ball because the top gets oil from the pushrod

Rocker Blocks

-Evolution rocker blocks are held down with 9 bolts

-If the motor is not at TDC compression the hidden "9th" bolt will break the entire block

Shovelhead Rocker Shafts

-Three styles that are all interchangeable

1. Early: There are two bearing surfaces, a small diameter threaded end cap (5/16x24), the end cap is also a pressed on separate piece

2. Mid (75-E82): There is a large threaded end cap (1/2x20), there are also what appears to be three bearing surfaces. The middle one only works to slow down the oil.

3. Late (L82 ON): It is the same as the middle style except the o-ring seat on the end cap is beveled/tapered not squared off

-The shafts have a 7/16th x20 thread count

-Shovel rocker nuts should be torqued to 18 to 20 FT. Lbs

-If the nut leaks replace the crush washer behind it don't over torque

- Rocker arm end play is very rarely excessive due to the 1 degree angle of the shaft keeps it against the thrust washer

-It should be between .005" - .025"

- Shims shouldn't be used because they can grind into pieces and go to the oil pump

-Countersink one end of the retainer washer slightly if you have excess

-The end cap with a rubber seal

-The o-ring must be installed after the shaft is in the box

- If a new o-ring leaks use a coil of a spiral coiled wrist pin lock

-Place half a spiral behind the O-ring (between the O

ring and the rocker shaft)

Shovel Head Rocker Boxes

-The front and rear boxes are different due to the oil line going to the rear box

-Most of them are marked "R" or "F"

-Push rod angles are also all different on a shovelhead

-Three styles

1.(17511-66A) Has a triangular piece on the bottom for the air cleaner bracket. It is found on '78 and later models

2.(17511-66B) Has one short cylinder stud to keep it from hitting the frame on the rear cylinder

3.(17511-66C) Used from L82 on. Stud holes were counter-sunk on the bottom of the box to prevent oil from leaking

Evolution Rocker Boxes

-Two Types:

1. Early (1984-E92):Umbrella valve is located at the bottom of the crankcase

2.Late (L92-Present): These are called "umbrella valve rocker boxes" or "head breathers" They will fit any model evolution big twin.

-They have a crankcase vent valve in the spacer (Umbrella Valve)

-The umbrella valve lets the crankcase blow air out but not suck it in

-The rubber valve must go on the intake side of the "V" if not the motor will consume too much oil and pump it into the oil filter

-The rubber on some aftermarket valves are too thin so it wont seal and usually has a wave shape at the edge

-When installing a new valve pull its tip down from the bottom until you feel it pop into place

-The center spacer block must be lined up with the rocker box. The holes may not line up exactly so you must move the spacer until it lines up.

-Make sure the center chimney gasket is in place

-The rocker top must have gaskets under the four ¼ 20 allen screw or they will leak

-All top end hardware on Evo's and twin cams should be at least

grade 8

-Rocker box to head gaskets should be one piece steel with the sealing material bonded to them gaskets as they work better then the two piece rubber gaskets

Torque Plates

-The function of a torque plate is to artificially load the cylinder in the same way its loaded in the engine

-You only have to use torque plates on twin cams and evolutions because they are through stud engines. Use the plates when you are measuring, boring and honing

-There are three different size and thread-count bolts used:

1. Kent Moore: 3/8 16
2. S and S: 7/16 20
3. Jims 3/8 24

-Use your old head gaskets and base gaskets

-Large holes line up on the dowels

-Torque it to head bolt torque

1. Use an "N" pattern even if the manual states otherwise
2. Torque all four fasteners to 7-9 ft lbs
3. Torque all four fasteners to 14-16 ft lbs
4. Torque all four fasteners an additional ¼ turn

*The additional quarter turn gives you a repeatable amount of clamping force on the cylinder and head gaskets

Gaskets

-There is no such thing as a reusable gasket

-Self sealing rings will almost always face up (the only exception is the base gasket which faces down towards the crankcase)

*Sealer should not be used on self sealing gaskets or they will leak

-Replace factory base gaskets with James steel gaskets whenever possible

*Modern base gaskets are composition gaskets with a steel center and a blue sealing layer on top of that

-Copper kote spray is the type of sealer to be used on head gaskets that need sealed

*Metal gaskets with no built in sealer must be copper coated to prevent leaking

-Soft type gaskets should be coated with "high tack spray gasket sealant" (It

is stronger then copper kote)

-This can also be used on vertical applications where the gasket needs to be a little sticky to stay in place

-Use heavy Hylomar between case halves because they have no gasket between them

*Permatex grey #4 can also be used for this application

*Never uses RTV for this

-Old style paper gaskets shouldn't be used but need to be soaked in water if they are

Valves

-All modern valves must be hard chromed, titanium nitride coated, or carbonized (case hardened black)

-Valve guides are all cast iron from 1980 to present

-Bronze valve guides will also work well

-Valve stems should be measured in three places. If they are more then .002" out of round replace the valve

-Replace the valve if there is any kind of galling or wear on the stem

-Use anti-seize or red assembly lube on valve stems when assembling

-Five steps to a valve job:

1. Reface or replace the valves
2. Install and ream the guides
3. Cut the valve seats and lap the valves
4. Check the valve springs
5. Assemble the heads

-H-D began using the guide seals in 1981 because of the loss of unleaded fuel

Steps to Cutting a Valve Seat

1. Put a thin, even layer of Persian blue on the valve
2. Place the valve in the head and spin or pop it in the seat
3. Remove the valve and look for an even coat around the valve seat. This is the contact patch.
    -If it is all in one spot that means you have a high spot on the seat
    -On evolutions and twin cams the contact patch should be .040" to .060"
    -On non-evolution or twin cam motors the contact patch should be .050"-.090"
4. Find a pilot shaft that will snuggly fit into the valve guide but is not too tight
5. Make a 45 degree relief cut first to widen the contact patch. When you make any cut place the cutter on the pilot shaft and look to see that all the blades are evenly placed on the cutter.
6. Determine the type of cut you need to make:
    -A 30 degree outside relief will lower and narrow the contact patch
    -A 60 degree inside relief will raise and narrow the contact patch
7. Re-blue the valve to determine if another cut is necessary
8. Lap the valve after you have made your cuts to the seat
    -Place three dots of lapping compound 120 degrees apart on the valve face. Do not get any on the valve stem.
    -Place the valve in the head and rotate it back and forth until the sound it makes changes. Pick it up and rotate it a quarter turn and do the same again. Rotate until you make a full circle.
    -Lapping the valve will make a distinct impression as where the valve is seating
9. Clean all of the components very well

Valve Seat Cutting

-On evolutions and twin cams the contact patch should be 2/3 to ¾ up the face of the valve (towards the head)

-On older models the contact patch should be about ½ up the face of the valve

*Narrow or high contact patch will cause overheating and burning/guttering due to more sealing

*A wide contact patch will cause the valve to not seal which results in the motor running cold and building up carbon and leaking

-Effective spring seat pressure: Determine by the amount of area the springs rate is spread out on. For example, there will be a higher amount of force (rate) if the spring has a smaller contact patch.

*A wider seat spreads the seat pressure out thinner over more area

-Harley valves can be re-faced but you must remember when you reface a valve you lose a portion of the margin.

*HD valves must have at least a .030" margin (to determine margin thickness lay the valve on a flat surface and hold a .030" feeler gauge next to it)

-When you cut a valve seat, valve stem protrusion will change as well.

Removing a Valve Seat in the Shop

1. Run a bead of wire weld around the inside of the seat to shrink it
2. Knock it out of the head
3. Grind the stem top of an old valve to a taper and weld a piece of ½" round stock to the head of the valve
4. Stick the new seat onto the valve so type of epoxy
5. Freeze the entire set up
6. Put the head on a hot plate and cover it with a bucket for about 20 minutes
7. Set the head on a 2x4 crib so that you don't hammer it while its on the studs
8. Drive the seat all the way in until it rings as it bottoms out. If you stop driving before it seats you have to start over again.

Installing a Valve Guide Seal

-Anytime you remove a valve from the guide you must replace the seal

1. Oil the valve stem
2. Place the lower spring retainer in place over the valve stem
3. Place the rubber sleeve over the valve stem

4. Run the new seal over the rubber sleeve
5. Remove the sleeve and drive the new seal into place with a dead stop tool
6. Make sure you don't drive it onto the guide too hard or it will break the seal

Pistons and Rings

-Pistons

*There are three reasons to use directional pistons

1. Valve relief size
    -One valve will have a larger dish on the piston crown
2. Piston skirt shape
    -Some pistons have a shorter skirt side for clearance reasons
3. Offset wristpin
    - Offset pistons help to reduce thrust forces against the cylinder

Shovelhead Pistons:

1. 1941-1980 74 Cubic Inch: Includes pans, Knuckles, and Shovelheads.
    -These motors bore was 3 1/16" with a stroke of 3 31/32"
    -They are cam ground up to .025"-.030"
        *Oval shaped at base of the skirt 90 degrees from the wristpin
    -These are non-directional pistons until you use them
    -Has a steel bridge under the piston to control the direction of expansion
    -The piston to cylinder clearance wear limit is about .007"
        -New spec is .001"-.002" of clearance
        -If the piston to cylinder clearance is out of the wear limit it will cause the piston to rattle when the motor is cold
2. Mid 1978 80 cubic inch:
    -The motors bore was 3 ½" with a stoke of 4 ¼"
    -Because the stoke was so much longer the length of the piston was shortened on the skirt and the crown
    -These pistons we non-directional when new
    -They held about 8:1 compression
3. Late 1982 to the end of the shovelhead production 80 cubic inch
    -In 1982 HD change their piston manufacturer to Mahle
    -These pistons held 7 ¼:1 compression. It was lowered to reduce detonation
    -Late shovelhead pistons were directional meaning they only fir right facing one direction due to an offset wrist pin boss

-They have the word “Mahle” and a directional lug inside the skirt

Evolution Pistons

-Evolution motors have a “D” shaped combustion chamber which allows for a flat-topped piston moving it out of the combustion chamber
-1984 ½-1895: HD used a Mahle piston with directional lug on the underside
-1985 ½-Present: HD began using Schmitt pistons
-These pistons have directional arrow on the top. On both the front and the rear pistons the arrow always faces towards the front of the bike.
-These pistons also have a Schmitt logo inside of them resembling the $ sign
-In the mid 1990’s HD began using black Teflon coated pistons. This coating allowed for less friction which meant less damage/seizing during break-in

Twin Cam Pistons

-Twin cam pistons are the same shape as an Evo piston except they are larger in diameter and shorter due to a larger bore and shorter stroke
-Piston to wall clearance service limit is about .003”
-Twin cam dimensions:
-1. 88” = 3 ¾”bore x 4” stroke
-2. 95” = 3 7/8” x 4” stroke
-3. 103” = 3 7/8” x 4 ¼” (Due to stoke increase you must change the flywheels when converting to 103”)

Piston Rings

-Use total seat rings if possible
-Top ring = compression
*The compression ring may or may not be directional
*If it has markings they will always face up
*The directional compression rings have the bevel facing up. This allows combustion gasses behind the ring forcing it out against the cylinder wall creating a stronger seal
-Middle ring = scraper
*This ring is usually directional
*The dot will always face up so that the beveled edge faces down
-Bottom ring = Oil control ring
*Generally non-directional ring

*Always put the expander in first with end gaps away from each other

Three Piece Oil Control Ring Installation

Oil control rings are made up of two flexible rails and an expander. The expander is a spring

1. Put the expander on first
2. Put your thumb over the expander end gap
3. Place the bottom rail on so that the end gap is not lined up with the expanders gap
4. Place the top rail on so that its end gap doesn't line up with either of the other two end gaps
5. Make sure the ring will move freely when in place

Ring End Gap

-Routinely end gap is .010" - .020" with an absolute maximum of .030"
-Too much ring end gap results in shorter ring life and blow by
-Not enough ring end gap results in ring butting, overheating, and seizure
-Ring side clearance should be .001"-.004". The wear limit is .005"
    -Excessive side clearance will cause the rings to flutter and break
-Don't file rings that are hard coated or treated
-NEVER file down oversize rings to fit a worn cylinder

Wrist Pin Locks

-Wrist-Pin locks can only be used once
-Make sure the open end faces 6 or 12 o'clock on spiral locks and snap rings
-Types of wrist-pin locks

1. Horse collar (1930-1972): Locks fit into the wristpin
    -The pin has a slot in it that allows you to pop them out with a screwdriver
    -TRW pistons used these locks well into the 80's
2. Spiral Locks (Early '50's to Mid '77): These are still found in the aftermarket
    -Put the spiral lock in the big end of the install tool. Put the fat part of the tool in until it bottoms and then run a pick along the installed lock and make sure it seats
    -The aftermarket still uses these today
3. Snap rings: The sharp edge always faces out towards you or they will come out. The open end always faces either the 6 or 12 o'clock position. These are found in the aftermarket a great deal.

-This style of piston can also use a spiral lock but a spiral lock style cant use a snap ring

-Spiral locks can be used on these style pistons but snap rings cant be used on spiral lock style pistons

4. Round Wire C-Clips(1982-Present): This clip is like an O-ring with rounded edges. It requires a special tool for removal. Use a pick instead of the tool to remove or the tool will wear out. These are used on Schmitt and Mahle pistons.

5. Teflon Buttons: These are usually used in aftermarket only and they snap into place

Cylinders

Evolution Cylinders

-All years of evolutions have the same cylinders

-These cylinders are interchangeable when new or freshly bored out

-They are aluminum casting with a cast iron linear

*The bore is cast into the cylinder and not pressed

1. Helps transfer heat
2. Makes the case stiffer
3. Insures that the bore will never move

*These cylinders cant be relined

-Evolution cylinders can be bored up to .030" over in .005", .010", .020", .030" sizes

-Piston life can exceed over 60,000 miles

-Due to through studs you must use torque plates when measuring and honing the cylinders (Don't forget the gaskets when using torque plates)

Twin Cam

-Twin cam cylinders have stiffer cylinder walls due to the cast in cylinder having more grooves that attach to the case then an evolution motor

-They also have a larger fin area to accommodate for a higher oil temperature

*They have more cooling due to piston oilers

1. Lubricates the wrist pin
2. Carries heat away from the piston head

-Twin cam cylinders are interchangeable from the front to rear

-These cylinders have thicker walls that allow for more re-bores

-They have two dowels in them that are top end oil drain back passageways

*While there are two dowels only on of them works. They have two

so that the cylinder can be interchangeable

*The functioning return has an o-ring on the bottom side of the cylinder

-They have o-rings instead of base gaskets. O-rings work much better.

Shovelhead

-These cylinders differ from front to rear

*The rear cylinder has two narrow sides and two wide sides surrounding the bore

*The front cylinder has four narrow sides surrounding the bore at the base

-Notches on both of the cylinders go towards the intake side to determine which way the cylinders go on

-Early style (66-M78): Have 10 fins and -66 part number

*These were used on 74 C.I. Shovels (3 7/16 x 3 31/32)

*They used a "high nut" style base nut that uses a 5/8 wrench with 7/16 x 20 threads/inch

-Late: Has thicker base and only 9 fins and a -78 part number (3 ½ x 4 ¼)

*These cylinders were necessary because if the old style was used on an 80" you could only re-bore once. This style can be re-bored three times (.030" over).

*These use a shorter base nut with triangular, directional lock washers

*These use a 9/16 wrench but still have 7 1/26 x 20 threads

-The early head bolts (1948-E78) were 7/16 20 with a 9/16head. They had a special HD only loose washer

-The 78 ½ - 84 head bolts were the same size but they had an attached washer

*If these bolts get rounded uses a Snap On "S" wrench, part #SPXM1415, (14mm and 15mm) to remove them

*These nuts must be torqued using a dog-bone adaptor to 60-65 ft/lbs

Evolution and Twin Cam Head Bolts and Studs

-1984-1985 Evo's used a stud with a male bottom and a female top

-These used a head bolt not a head nut

-The nut was 3/8 with a 12 point head marked "CP". They also used a specialized washer

-L85 Evos went to a double male threaded stud

-1987 the stud got a shoulder on the top

-1992 they went to a stud with the shoulder on the bottom
    *This is the only stud you can get today
    *It is used on all current twin cams and evos
-Any style of stud will interchange
-Always replace the studs if they get any nicks or damage
    *You don't have to replace all of the studs if you replace one

Changing a Head Stud

1. Remove the old stud
    -Try to use two locknuts or a stud puller (Get the puller as low on the stud as possible)
2. Use a short Evo head nut with a ball bearing dropped into it
3. Run the stud onto the nut and then run it into the case
4. This should be torqued to 120 inch pounds
    *Make sure you support the stud while you torque it
5. Remove the head nut making sure you don't drop the ball bearing into the case

Head Nuts

-The early style had 12 points and a ½ head
-1988 they added an integrated washer to the nut
-L92 to present the nut is marked "92". They are about .300" longer on the short side

Head Nut Torque Sequence

1. Put a drop of motor oil inside the nut and rub it around the washer
2. Torque in an "N" pattern on all evos and twin cams. This supersedes the manual
3. Never over-torque or the expansion can rip the stud from the case

Twin Cam Rocker Boxes

-The boxes are pie wedge shaped so you don't need a center spacer as there is on evos
-There are 6 hold down bolts on the rocker cover
-These use the same rocker arms and shafts as the evolutions but the rocker carrier is different so the rocker covers aren't stressed members
-The crankcase vent umbrella valve is triangular shaped and located between the rockers
    *'99-E01 Vent had a bolt together housing made of aluminum

*L01 they went to a plastic glued together unit that is not serviceable

*In L03 they went back to the aluminum unit due to the extra strength it gave the rocker housing

*Make sure the upper head gasket is in the right way and vocers up the vent passageway in the head or oil will leak there. The gaskets are marked "front" and "rear". These markings should face up

-Take the same measurements on these that you would on an evo rocker assembly

Twin Cam Cylinder Heads

-The castings are the same for every year

-Up to '03 valve guides are the same as evolutions

*The intake valve, valve springs, guides and seals are also the same as evos

-Twin cam exhaust valves have a black dot on the head for ID purposes

-In late 2003 the twin cam valve train changed

*The guides changed because the valve stem became considerably smaller

*The valves went to three keeper grooves

*The exhaust valve has a dished face and the letter "D" stamped on it

*The spring went to a "beehive" single spring set up

*The guide seal is now combined with the lower retainer to form one solid piece

-If you have all of the new valve train equipment you can retrofit it to old set ups

-Exhaust ports

-The studs are 5/16 24 x 16/18 in the head

-Never use air or a breaker bar to remove a stuck exhaust nut. The stud will break off in the head

-Head the nut with a small torch if you cant loosen it by ratchet

-Put anti-seize on the nuts when you are reinstalling them

-Don't forget to remove the old exhaust gaskets. They become black from exhaust and are usually hard to see

-If you break off an exhaust stud in the head use a Jims exhaust tool:

1.Remove the old gasket

2.File the broken stud so that its flush with the head

3.Place the tool over the port and fasten it to the good stud

4.Use a ¼ inch drill bit and drill the stud out

5.Run a tap into the head to clean out the threads. You may have to

put in a helical

V-Twin Oil

-If you consistently run an oil temperature over 220-230 degrees you need an oil cooler
-An engine should run at a minimum of 180 degrees when it is warm. If it doesn't it will not "cook" out the dirt and impurities it collects
-If you have to sit for extended periods of time use synthetic oil. It will survive and maintain lubricity under hotter conditions and it will do it longer.
-Mineral oil will allow for long engine life if you change it regularly and don't abuse the engine while its cold
-When buying oil for a Harley Davidson, look for an API rating of SGCC or SGCD

*These oils are turbo diesel approved

*Castrol 20w50 will work in a Harley Davidson

-Never use any kind of oil additive in a V-Twin

*Its ok to put a shot of marvels mystery oil for every three gallons of gas, this will help lubricate the upper cylinder. Don't put any of it in the oil.

Rocker Arm Bushing Installation

-Bushings need replaced when the shaft to bushing clearance is too great. This can be cause of black smoke due to an over oiled top end
-Hold the old bushing in a vise
-Use a cheap 5/8 x 11 tap

1.Run the tap in the bushing 4-5 turns

2.Knock out the bushing and tap from the other side with a drift and hammer

3.Clean inside the rocker arm

4.Put the new bushing in, driving it into place with the proper tool until it bottoms out

5.Shovelhead rocker arms have a small oil hole near valve arm. If you have one of these line up the hole in the bushing with this hole. If your new bushing doesn't have the hole drill it in after installation using a 3/32" drill bit.

6.Install and ream the bushings one at a time to make sure they stay aligned

7.A rocker arm bushing reamer is a solid pilot reamer. The long piece

fits in the old bushing that hasn't been removed yet

-Always ream from new to old

-Use cutting oil on the reamer so it lasts longer

-Turn the reamer clockwise with a T-handle

8.Install and ream the other bushing

9.Final size the bushings with a 5/8 240 grit ball hone

-Use a 60 degree cross hatch

-When installing the shaft, if the clearance is too tight then re-hone

When using a reamer follow these rules:

1. Don't turn it backwards (counter clockwise): this causes fast dulling
2. Don't force it: They are very brittle and will break
3. Don't run them without cutting oil

Pushrods

-Shovelhead

-'48 and later shovelhead pushrods are hydraulic

-On '70 and up alternator models all four pushrods are the same length

-Despite this if you re-install pushrods that have been run put them back where they came from

-They are made of steel with a bottom adjustment and a split locknut

-There is no hole running through the pushrod because on shovels they don't oil the top end

-When adjusting either use a .520" tool or adjust to 0 lash plus 4 turns

-The aftermarket now offers "solid" shovel pushrods to allow for radical cam profiles

-Set these to 0 lash

-Evolution

-Each pushrod is a different length

-Longest = front exhaust

-Next longest = rear exhaust

-Next longest = front intake

-Shortest = rear intake

-Stock units are non-adjustable

-They have an oil hole running all the way through them to oil the top end

-The aftermarket offers "time savers" and "quick installs"

-Always double check that they have the oil holes running through

them

-Twin Cam
-The black longer pushrod is for the exhaust valve
-The plain metal shorter pushrod is for the intake valve
-Aftermarket adjustable are also available

When adjusting aftermarket pushrods and you don't know the brand, adjust to: 0 lash plus 3 turns

Shovelhead Heads

-1966-1974 used a 3/8" short reach plug. This is the same plug used on panheads
-In 1975 they went to a ¾" plug and thickened the castings of the head
    -Always use a dab of anti-seize on spark plugs
-In 1978 the fins were removed from between the valves. This was done to cut down on the number of rejects from the factory. It only cause a 3 degree temperature increase.
-1980 they went to cast iron valve guides with a larger diameter
    -The old outside diameter was .561" (9/16)
    -The new outside diameter was .625" (5/8)
-The 1980 style also went to a flat intake flange
    -In 1978 the factory changed to a rubber band o-ring on the intake port so the lip was no longer needed
-Casting dates are stamped on the heads
    -Early ones are marked by the pushrod cut outs
    -Late ones are marked by the serial number between the valves
-Always run a 7/16 20 tap in the head bolt holes and wire wheel the bolts
-A common problem on shovelheads is the exhaust bolt hole stripping out
    -Repair this with a heli-coil not a time-sert
    -Don't tap out the hold and use a bigger bolt
    -Mount an exhaust stud into the hold because this will take stress off the casting
-These heads commonly get a low spot on the head to cylinder surface close to the exhaust flange
    -Anytime you mill the head the spigot on the cylinder also needs to be milled down an equal distance
        -Always check clearance if you change your head or your cylinder

Changing Connecting Rod Bushings Out of the Case

**.002" oversize bushing are available if the rod hole is worn

1. Hold the rod in a vise making sure to never hold it by the lower "big" end
2. Use Jims bushing removal tool
    -It has a sleeve that will catch the old bushing and a threaded shaft
    -Always oil the threads before using
    -While you can, don't put the old bushing in the same time you remove the old one
3. Make sure you align the oil hole on the bushing with the hole or slot on the pushrod end
4. Push the old bushing out and install the new one using the tool
    -Use the shoulder on the tool so you don't go in too far
5. Ream the new bushing
    *There are two reamer sizes for two sizes of wrist pins
    Early: .791" Late .792"
    -Hold the reamer in the vise
    -Place the rod on the reamer
    -Apply a liberal amount of cutting oil to the reamer and the bushing
    -Hold a piece of tubing over the reamer to push the rod as you turn it
    -Add oil again when your half way down
6. Use a ¾" ball hone to final size the bushing
7. The wrist pin should just slide through the bushing by its own weight but it shouldn't rock back and up and down it (.0003" - .0009")

Changing a Connecting Rod Bushing in the Case

1. Install the connecting rod clamping tool to the connecting rod. Tighten this with the old head bolts
2. Try to keep chips out of the case
3. Follow the same instructions above to install and ream bushing
    - Stuff clean rags into the case and run and oily rag around these
4. Use a ratchet on the reamer and push with the heel of one hand while the other turns

Crankcases

Timing Side

-Cam needle bearings
    -Install these with the specific Jims tool not a socket
    -The lettered side of the bearing faces out
    -Drive new bearing in until you hear a pitch change
    -There are two types of cam needle bearings
        1.Torrington(1958-E92): These are the recommended style
        2.New Style(L92-present): There are fewer needles and they are held in a cheap plastic cage
    -Change these bearings anytime you do a cam change
    -Wash the bearings with brake clean when they are new out of the package
    -Lube them with motor oil on installation
-Cam thrust plate washers
    -These go in after the bearings between the cam and the bearings
    -The early style has one flat edge and two arms sticking out
    -The late style is round
    -These should be .0625” (1/16”) thick (the thickness will affect cam end play)
    -Use variable thickness washers to adjust end play
        -The factory stopped using the washers in 1987
        -Most aftermarket cams require the use of the washers
-Measuring cam end play
    -Measure through the pushrod holes
    -The measurement is taken between the cam and the cam thrust plate with the timing cover torqued in place
    -Normal cam endplay is about .001”to .016” on models with variable thickness washers
        -Stay above .005” if you can
    -Normal end play is about .001” to .050” on engines without the washer
        -Stay above .005” if you can
    -Excessive cam end play causes the cam to rub on the tappet block and roller wear
    -Not enough cam end play will cause the cam to weld the bearings making them spin in the case
-Breather gear end play
    -The breather gear allows scavenge oil from the crankcase to the timing chest
    -L82-Present single cam motors use a plastic breather gear. These can

trap metal shavings in the plastic and cut into the case. Use an aftermarket steel gear to prevent this

1.When measuring end play place a nylon variable thickness washer on the end of the gear. Don't use a steel washer.

2.Put on the new gasket you're going to use with the motor

3.Place a straight edge across the timing box

4.Measure the space between the washer and the straight edge with a feeler gauge

5.Subtract .006" from this to account for the seal compressing when torqued

Too much end play will cause over-oiling the bottom end

Camshafts

Shovelhead

-1970-E77

-These cams have a smooth gear face and the letter "H" on the front lobe

-L77-E82

-The shape of the gear teeth changed to reduce mechanical noise

-There is a single groove in the gear face and an "H" on the front lobe

-L82-End of shovelhead production

-The cam lobe profile changed

-There is a single groove on the gear face and an "S" on the front lobe

Evolution

-1984 ½-1986

-These have a single groove in the gear face and a "V" on the front lobe

-1987 -1989

-There is a single groove in the gear face and an "L" on the front lobe

-1990-E92

-The shape of the gear teeth changed

-There are two grooves on the gear face and an "L" on the front lobe

-L92

-Cam had lower cam profiles

-There are two grooves on the gear face and an "O" on the front lobe

-California Cam

-These cams allow for no valve overlap

-They are identified by a "C" on the front lobe. They can have one or two grooves on the gear face

Cam Shaft Order

1.Intake Lobe
2.Intake Lobe
3.Exhaust Lobe
4.Exhaust Lobe
5.Cam Gear

Measuring a Cam

1.Lobe surface condition and inspection
-Usually one lobe will begin to pit/wear
2.Lobe surface dimension
-Use a caliper and measure from the heel to the top of the lobe
-The loves should be the same within .005”-.006”
3.Bearing surface condition and inspection
4.Bearing surface dimension

Cam Bearing Surface
-The small end is the needle bearing surface
-The large end runs in the bushing
-The bearing surface must be round to .001” when measuring at the X and Y axis
-Inspect the bearing surface for any type of pitting

<u>Timing Side of the Motor</u>

-The cam and the pinion shafts are supported by bushings in the timing cover
-Timing Cover Bushings
-Normally you wont have to change the timing cover bushings
-The wear limit is about .004” clearance
-Excessive pinion shaft bushing clearance will result in the bottom end not getting enough oil
-Oil travels down the pinion shaft and out the flywheel to the crankpin
-If you have too much clearance the oil will come out instead of going into the flywheel
-Camshaft Bushings
-If this bushing wears the cam will begin to wobble
-Too much cam to bushing clearance will result in erratic timing causing an erratic idle
-Oil will eventually get into the ignition cavity and seep out the cover

-The cam bushing wear limit is .004”

-Changing a Timing Cover Bushing

1.Remove the old bushing

2.Install a new bushing

3.Pin the new bushing

-There is a small pin that fits into the bushing and the case. If there is no hole for it, drill one

-Pin the bushing before you ream it or it will create a high spot

4.Ream the bushing

-Pinion Shaft Bushings

-1958-1972: These have a side drilled hole on the pinion shaft

-The bushing has a hole in it that lines up with the oil galley in the timing cover

-1973: The shaft got an oil hole on the end of it running through its length

-The bushing got a flat machined side. This side must be lined up with the oil gallery in the timing cover. This allows it to oil the bottom end all the time.

-Late 1992: The oil hole came in under the bushing. This allows for a round, unmachined, bushing that looks like a copper spacer

-Pinion Shaft Gears

-Early Style (1954-E92)

1.Left handed thread nut

2.Pinion Gear

-You must use a puller to remove the pinion gear

3.Spacer (these are made of plastic or steel)

4.Oil pump drive gear

-These gears are directional with the bevel facing towards the flywheel. Some of the gears have a bevel on each side.

Pinion Gears (1954-E77)

-These gears have longer teeth

-They have 2 timing marks on 1969 and earlier models. The second mark was to time the old style ignition system

-When timing these styles one mark should be at 2 o’clock position and the other should be at the 12 o’clock position

Pinion Gears (L77-1989)

-These have shorter teeth and only one timing mark

Pinion Gear Removal

1.Use a half circle style puller

-Oil the threads on the puller before using

Late Model Pinion Shafts

-In 1990 the pinion shaft lost its taper and went to a straight design

-The bearing race is pressed on because the shaft became a made-to piece of the flywheel

-Pressing it on allows it to be removed and changed if necessary

Pinion Shaft Gear Set Up

-1990-E92: This model has only one woodruff key groove

1.Oil pump drive gear

2.The woodruff key

3.Spacer with the keyway over the woodruff

4.Pinion gear

5.Left handed nut

-This nut can be identified because it is shorter then the early style. It wont fit on the early style pinion gear groove length

L92-Present: This style has no spacer. The shoulder on the pinion and oil pump gears got longer to make up for it.

-This woodruff key doesn't need to be removed since the keyways goes all the way through both gears

-This style used a normal right handed hex nut

-Use red lock tight when reinstalling

-The pinion gear has no counter bore in it to accept the left handed style nut. It is flush like a regular nut.

Timing Covers

Always use a nose cone puller to remove this cover or it may break

-1970-1972: The oil gallery hole is higher up on the inside of the cover

-1973-E92: The oil gallery hole is lower down on the inside of the cover

-L92-Present: There is no vent tube or baffle plate on this model

Breather Gears: This gear allows scavenge oil to go from the crankcase

into the timing chest where the scavenge side of the oil pump picks it up
-Metal variable thickness washers cant be used on plastic gears and the other way around
-Too much end play will cause over-oiling the bottom end, improper oil scavenging, and cause oil to puke out the crankcase vent
-Not enough endplay damages the gear, damages the timing cover, and destroys the washer
    -If the end play is off the hole in the breather gear wont line up with the oil hole in the case
-1936-1950: There was no washer on gear just a made-to extension on it
-1951-E77: These have a straight timing mark on the gear face and a small shaft to hold the variable thickness washer
-L77-1979: The gear has to be changed to match the teeth on the new style cam.
    -These has a letter "T" shaped timing mark and a small shaft for the variable thickness washer
-1980-E82: This style of gear has a steel gear with a large shaft for the variable thickness washer
-L82-1985: These had a plastic breather gear (quieter and cheaper)
    -They early plastic breather gears have 14 slots and 2 round holes
-L86-1992: 12 slots and 2 holes
    -These can be interchanged with the 14 slot style
-L92-Present Crankcase Breathers: 12 slots and no round holes
    -These cant be used on any earlier engines due to no round holes

Breather Gear Bore Damage

Slight Damage: Remove the plastic gear and replace it with an aftermarket steel gear
Major Damage: Ream out the hole and replace it with a .030" oversize breather gear
Extreme Damage: Send it to Dragon Enterprises to be welded and machined on

Tappet Blocks

-Up to 1977: Used countersunk head screw with a counter bored hole in the

case (¼ 24)
-1978 and up on Shovelheads: Used a 12 point heads screw (¼ 20)
-In the aftermarket you will get two sets of screws for either style. You must use the right one or you will damage the threads in the case
-Always clean out and visually inspect the blocks
-Measure the outside diameter of the tappet and inside of the tappet block on the x and y axis
-On pans/shovels the wear limit is .008"
-Excess clearance will cause noise similar to the tick a loose pushrod makes. If you adjust the pushrods and it still makes noise replace the blocks.
Evolution Tappet Blocks
-These are made of cast iron or aluminum
-Most of the time they are marked "front" or "rear"
-You must use a tappet block alignment tool when installing these

1. The tool (long, tapered screw) goes in the tappet block hole closest to the oil hole
2. Put all the screws in loosely
3. Snug the tool and tighten the other three bolts
4. Replace the tool with the bolt and torque all four nuts

<u>Tappets</u>
Evolution Tappets
-All evolution tappets are interchangeable
-L84-1987: Had three dots 120 degrees apart in the tappet cup
-1987-Mid 90's: Had two square dots 180 degrees apart in the tappet cup. The oil hole location was also in a different place. The oil change made no difference because it still fed
-Both of these styles had a small axle where it goes through the roller
-Both of these styles can be rebuilt
-Mid 90s-Present: "big axle tappet" these are not rebuild able

Cam Follower Inspection:

1. Look for wear/damage on the roller surface
2. Look for up and down radial movement in the roller bearing
3. Look for wear/damage on the tappet body
4. Look for side to side clearance at the roller (end play)
   -Shouldn't be more then .020"
   -Evident by a grove worn in the tappet body

Shovelhead Tappets

-Should be taken apart, cleaned and tested (Do NOT take apart and clean more then one at a time. Some pistons will not work with some cylinders. Do one at a time.)

1. Twist and pull and it will come apart
2. There is a check ball in the end of the tube. Clean out the tube until you hear it rattle around. When you reassemble the pushrod will be springy. If it is washed and dry you can hold it for 10 seconds and if it pops up at all it is good.
3. Lube the assembly before reassembly
4. Push a small straw up the end of the assembly and trip the check ball. Push it in until you hear it click and turn a ¼ turn.

-L82 Harley used a "quick fill lifter". It has a heavier wire on the spring. Either style may be used

-L53-84 ½: has a separate hydraulic unit that comes out

Tappet Screens

-Located under screw driver head plug near rear tappet block on all single cam models.

-Use the JIMS tool to remove the plug. The aftermarket makes plugs with either a hex head or an allen head

-Acts as a last filter before it goes to the tappets. It keeps dirt out of the hydraulic lifters

-Check this screen second if you have hydraulic tappet failure

-If the lifter is bad look for oil and oil pressure at the lifter. The oil check light activates at 5lbs. The lifter requires 5 lbs.

-If it is neither of these problems you probably have a bad filter

-Check the tappet screens every time you change the oil and replace them or clean with brake clean

-When you put back in, the open end of the screen always faces down

Pushrod Tubes

-Pushrod tubes have the same parts on all big twins but they are not

interchangeable

The bottom tube > Top Tube > Cup > Spring > Washer > Clip

There are three seals on each tube

1. The O-ring on the bottom (largest)
2. The O-ring in the cup
3. The O-ring in the top head cup

Before 1978 there was no top and bottom lip on the pushrod tubes. These models used a flat quark seal. A regular O-ring cant be used due to no lip for it to seat on.

Twin Cam Cam Followers

-The oil hole on Twin Cam cam followers faces in towards the crankcase
-There are no repair parts at all for these you must replace the whole assembly
-They have flats for anti-rotational pins that keep the tappet assembly from spinning around and destroying the cams

Flywheel Disassembly

-Create a cradle out of 2x4's to support the flywheel assembly as much as possible on the press
-Always disassemble the flywheels from left to right. Reassemble from the right to the left
-On newer style flywheels the pinion and sprocket shafts are built to the flywheels
-All oil passages are on the right side of the flywheels

1. Remove the wheels from the left case assembly by pressing directly on the pinion shaft.
2. Make sure you keep the variable thickness spacer for the pinion shaft
3. Remove the bearing with the guillotine puller and harmonic balancer

-Put the guillotine under the bearing and tighten to finger tight. Make sure it is not under the shoulder of the sprocket shaft

-Put the harmonic balancer on the end of the shaft and connect it to the guillotine puller

- Rotate it clockwise until the bearing pulls off

4. Remove the left side crankpin nut (1 5/16 or 1 ½) This nut is normally torqued to 185-210 ft/lbs
5. Hold the sprocket shaft and hit the wheel with a heavy hammer

until the wheel breaks loose

6. There is a brass thrust washer that is pressed in to the wheel half but shown separately in the manual

7. Hold the bearing cages in place and lift and lift the rod directly off of them. If you pull them off with the rods the rollers will fall off.

8. The rods are directional. The part number on the front rod will always be on the right or rear rod will always be on the left if you're looking at them as if you're sitting on the bike

9. There are three bearing cages. The two skinny ones are on the outside and the fat one is in the center.

10. Remove the crankpin by removing the right hand crank pin nut.

11. Press out the crankpin or hit it with a lead hammer

12. Keep the woodruff key in the pin

13. The pinion shaft nut is 1 3/16 and is tightened to 140-170 ft/lbs

14. If you remove the motor sprocket shaft from the left flywheel use a 1 5/8 socket. This is usually tightened to 360-440 ft/lbs.

Flywheel Re-Assembly

1. Clean, dry and make sure all tapers are free of any grease or they wont align. Clean the threads and the taper with break clean.
2. Put the motor sprocket shaft in the left flywheel and then set the left wheel aside and work from left to right

-The nut is directional. The machined flat goes against the flywheel.
-Put red locktite on the threads and the face

3. Put the nut on. If the sprocket shaft spins hold the splined part of the shaft in the soft vise jaws
4. Make sure there is some space between the sprocket shaft and the flywheels. If not the shaft or they flywheel is bad.
5. Clean the taper and threads on the right flywheel. Make sure you also clean out all of the oil passageways in the pinion shaft. If it wont fit polish the key with a piece of emery cloth
6. Properly seat the woodruff key on the pinion shaft. If it wont fit polish the key with a piece of emery cloth.
7. Clean the pinion nut. Put red locktite on the threads and the face. The flat side fits against the flywheel.
8. Tighten the nut to 140-160 ft/lbs with an 1 3/16 socket. Use a machined flat socket because the nut is so thin.
9. Make sure there is space between the shoulder on the pinion shaft and the flywheel. If you don't the taper or the shaft is bad.

10. Clear the oil passage in the pinion shaft
11. Make sure the taper is clean, dry and free of any grease
12. Put the crankpin in place and make sure the woodruff key is fully seated
13. Put red locktite on the crankpin nut threads and face and install with the flat against flywheel
14. Tighten the nut to 185-210 ft/lbs
15. Clear the oil passage through the crankpin
16. Place the rod bearings on. The skinny bearings go on the outside and the fat one goes
in between them.
17. One looking at the motor as if your riding it the front rod part number will be on the right while the rear rod will be on your left
18.Re-Clean the taper
19. Set the left flywheel on the crankpin. There should be a space between the crankpin shoulder and they flywheel surface. If the shoulder is flush with the flywheel surface your flywheel is bad.
20. Clean the nut and apply red locktite to the threads and the face.
21. Put the flywheel alignment tool on the wheels and tighten it snugly
22. Tighten the crankpin nut 185-210 ft/lbs
23. Check the rod side clearance
    -Place a feeler gauge between the side of the female rod and the thrust washer
    -This should be about .005“-.0025”

<u>Connecting Rod Clearance</u>

-This is the clearance between the female connecting rod and the thrust washer
-If you have excess clearance you can:
    -Get a ,005” or .010” oversize copper thrust washer
        *The stock washer is .065”
-The reasons you don’t have enough side clearances are:
    1. Oil and grease on the flywheel taper
    2. A worn out taper
    3. Improperly seated thrust washer
    4. A thicker then stock thrust washer
    5. Over torqued crankpin nuts
    6. Short crankpin
-When truing flywheels get them to within .001” if they are new. Get them to .002” of they or old, worn flywheels

Installing Flywheels back in the Left Crankcase

1. Put the variable thickness spacer on over the lower bearings
2. Set the left side crankcase on the wheel
3. Use the bearing installer to replace the drive side bearing
4. Drive the bearing down until it bottoms on the variable thickness washer
5. Lubricate the bearing and the seal with the motor oil
6. Make sure the shoulder of the spacer goes towards the bearing

Twin Cam Timing Side Removal

1. Remove the tension on the cam chain tensioner
    -The tool fits on the tensioner
        -Pull against the spring
        -Place the holding pin in the tensioner hole
2. Put a rubber sprocket lock between the two gears
3. Remove the bolts on the shafts. When they are loose remove the rubber sprocket block
4. Pull of the sprockets and the chain
5. A variable thickness spacer is behind the large cam gear
6. Pull the chain slipper block and place it with the small gear so you remember it on installation
7. Remove the allen head cam plate bolts
    -Don't mix these up with the timing cover bolts, they are different length and will damage the cover and plate if mixed up
8. Pry at the two points provided on the cam plate and it should fall out

Twin Cam Timing Side Installation

1. Unload the inside cam chain tensioner
2. Place a holding pin in from the outside of the plate
3. Put a new oil pump O-ring in
4. If you don't pull out the cams they will stay in time with each other
5. Put the cam plate back on the case and put in all the bolts but the four that hold the oil pump in place
6. Oil bolt holes are marked with the torque sequence
    -Put in bolts one and two snuggly and then back them out a quarter of a turn
7. Snuggly put a tappet alignment tool in holes three and four
8. Turn the engine over 3-4 times
9. Snug bolts one and two and remove the alignment tools replacing them with the bolts and then torque
10. Support the cam chain tensioner from the top with a screwdriver and remove the support pin
11. Put the tensioner from the top with a screwdriver and remove the support pin
12. The black link in the chain should face the same direction as when you pulled it ou
13. Put in the bolts and torque them to spec using the rubber block tool
14. Pull the outside chain tensioner pin

Pinion Shafts

1958-1972: This was a side-oiler pinion shaft meaning the oil feed hole is on the side of the pinion shaft
1973-M81: This was an end-oiler pinion shaft. The oil feed hole is at the top of the shaft and runs all the way through it
March of 1981: (Communized taper shafts) All flywheel shafts tapers went to 6 degrees
    -The oil hole and keyway in the taper are 90 degrees apart
    -The woodruff key is much smaller in communized taper shafts
    -These shafts also had a different thread pitch
1989-Present: The pinion shaft became made to flywheel

-When measuring the bearing surfaces of these shafts there shouldn't be any more then .002"-.003" of out of round

Crankpins

-Crankpins should be tightened to 185-210 ft/lbs

1. Communized Taper: The oil hole and the keyway are 90 degrees apart
2. Non-communized Taper: The oil hole and the keyway are 130 degrees apart

Motor Sprocket Shafts

1970-71: These shafts have a small taper and a large keyway. They also have a small nut
1972-E81: These shafts are identified by their large taper
March 1981: These shafts became communized
-To tell if a shaft is communized measure the fat part of the taper. If it is 1.320" it is communized. Non-communized shafts are 1.420"
-In L85 the sprocket shaft became made-to the flywheel
-The torque specs for sprocket shafts are:
1970-71: 140-170 ft/lbs
1972-E81: 360-440 ft/lbs
L81-E85: 290-320 ft/lbs

Flywheel Parts

Connecting Rods

-1941-82: These rods are marked XA
-L82-Present: The front rod is directional
-82A- There is more metal around the small end of the connecting rod. This model requires a .792" wristpin and has a larger oil hole in it.
-The flywheels were trimmed at an angle to accommodate the larger rods
-An earlier style flywheel must be trimmed to use L82 connecting rods. You must rebalance the flywheels.

Rod Bearings: Install these with the fattest in the middle of the two thinner bearings
-All of these bearings will interchange if you have all of the parts
1. Four Piece Steel Bearings (1941-72)
-Have 54 rollers
-The middle piece of the bearing slides over the long rollers for replacement
2. 3 Piece Aluminum (1973-86)
-Have 51 rollers
-You will usually get this style of bearings in aftermarket rod sets
-These can replace the old style or rod bearings if you have all of the

pieces
3. Black Bearings (1987-Present)
-These are 3 piece steel bearings
-Individual parts of these are not available. You must buy the entire bearing.
-These bearings are not available in oversizes

The Pinion Side Main Bearing

1958-86: These have two cages and two washers held in place with a spiral lock
-They are installed in the following order:
(Make sure each bearing is installed with the open end up)

Washer>Bearing>Second Bearing>Washer>Spiral Lock

1987-E92: These are not obsolete and cant be bought
-This style is held only with a snap ring
L92-Present: This is a long one piece cage bearing
-It can be a direct replacement of the 1987-E92 style of bearing but it wont replace the 1958-86 style
-These bearings are held in place with a flat snap ring

Flywheels

"78" style is for an 80" motor
-The number is stamped on the right side flywheel
"70" style is for a 74" motor
-The number is stamped on the left side flywheel
"41" style is for the 74" motors from 1941-80
-1976-E81: Flywheels don't have a communized taper
-In L85 the sprocket shaft became cast into the flywheel
-In L89 the pinion shaft became cast into the flywheel
-Communized Taper Flywheels
-Right flywheel: The oil hole and the keyway are 90 degrees apart
-Left flywheel: The ignition timing marks are reversed
-The dot became the full advance firing mark
-The line became the top dead center mark
-To determine this bump the motor around until the line if its at TDC it is communized.
-A communized crankpin has the oil hole and key way 90 degrees

apart

Used Lower End Testing

Rod Side Clearance: Back and forth movement of the rods

-This is a major issue if there is no movement at all

1. Measure at the top of the rod from a stud. Move the rod back and forth.
2. The wear is .125" at the front and .080"-.090" at the rear

Rod Radial Movement

1.Hold the crank so it doesn't rotate and put a rod in the middle of the side clearance and move it up and down

2. Any movement means something is wrong. It should be .002" when dry.

Pinion Shaft Runout

1. Place a dial indicator on top of the pinion shaft and rotate the flywheel.
2. The wear limit is .003"

-Excessive runout will cause pinion bushing wear.

-Runout is caused by:

- -Flywheel misalignment
- -Pinion shaft end is worn out of round
- -Pinion shaft is bent
  - -There is more common in 1990 and later flywheels with attached shafts

-Runout is characterized by:

- -Noise
- -Vibration
- -Damage to the pinion side main bearing
- -Damage to the pinion side bushing

Pinion Shaft Deflection

-This is a measurement of the condition of the main bearing

1.Keep the dial in place from the runout test above

2.Pry under the shaft up and down with a screwdriver while reading the dial

3.The wear limit is .003"

-Excessive deflection indicates a problem with:

- -The pinion shaft main bearing
- -The pinion shaft
- -The races

Flywheel Endplay

-This tests the left shaft bearings

1. Place the dial on the top of the pinion shaft
2. Attach a bearing install tool to the main drive shaft
3. Pull hard on the tool hand back and forth
4. The wear limit is .007" if the bearing is quiet. It is ,001"-.004" when new. If it is noisy it must be replaced.

-A bad Timken bearing will sound like a bad wheel bearing

-Be careful because noise could also be coming from a worn out compensating sprocket

-L04-05 models have different left bearing assemblies (Straight roller bearings)

-1955-1968: Used round spacers not "C" shaped spacers

-1969-Present: Uses "C" shaped spacers

-The two assemblies are not interchangeable

-The whole assembly must be changed and matched together except the variable thickness spacer which can be sized to the application

Square Connecting Rods

-This test insures the small end of the connecting rod is square with the case mouth

1.Use a jims or S&S rod checking pin and two thin strips of paper

2.Run the check pin through the connecting pin and two thin strips of paper on each side of the case

3.Rotate the flywheels to BDC. The check pin should be on top of the strips of paper. If the paper slides out on one or both sides the rods are not square.

4.Make sure you always check on both sides as the rods may be twisted. They can be bent, twisted, or both.

-Twin Cam connecting rods cant be straightened you must replace the entire flywheel assembly. The book says not to straighten evo rods but it is ok

-Don't straighten severely bent rods. To straighten rods use a pry bar the same diameter of a wristpin and pry in the proper direction

-Symptoms of un square connecting rods:

-There will be a polished section of the piston skirt or above the top ring

-The wristpin locks will come out and damage the cylinder

Check Flywheel End Play When Installing Left Hand Main Bearing

-Use a bender cycle tool

1. Fix the tool in the vice with the shaft sticking up. Slide the inner bearing over the shaft
2.Put the left crankcase cover over the inside bearing and then put the variable thickness spacer in the case. Put the outer bearing on the top of this.
3.Snug the top side of the tool with the counter bore facing down
4.When you can feel movement measure it with a dial gauge set up
5. You should get .001”-.004” of clearance
6.If not change your variable thickness spacer until you do
    -A thicker spacer will give you more clearance
    -A thinner spacer will give you less clearance

Single Cam Oil Pumps

-Harley uses two stage gear type oil pumps in single cam motors
-There is a feed and a scavenge side of the pump
    -If something is wrong one side might work while the other doesn’t or both side may not work
-There are four common types of stock oil pumps:
    -All of these oil pumps have a slot and a tower located in the same place
1.1968-1972: There is a big round hole at the tower (top) end of the slot
    -This is a pressure relief outlet
2.1973-1980: These don’t have a big round oil hole at the top of the slot
3.1981-1991: There is an extra hole above the slot at the base of the tower
4.1992-Present(Umbrella Valve Motors): The pattern and distance between the mounting bolts changed
    -There is usually a part number (-92) on models with a late style bolt pattern
    -The other three models usually don’t have a part number on them but sometimes the do, it is random
-When removing an oil pump take the snap ring off the inside timing chest 24 or 25 tooth gear then unbolt the pump and slide it off the motor
-Use a magnet to pull out this woodruff key
-When assembling, set the gear in place and slide the pump assembly in place lining up the keyway in the gear
-Put the key back on last with needle nose pliers

Common Oil Pump Problems

-If debris gets in the pump it will put and cut into the pump body
    -Damage is more often on the scavenge side of the oil pump because

it picks up oil out of the timing chest
-If the body looks ok check the pump for gear protrusion:
-This test is done without a gasket in place
1.Your idler gear doesn't have a keyway on the idler shaft. There is also a drive gear that does have a keyway that sits next to the idler gear
2.Run a straight edge across the pump body
3.Stick a feeler gauge in the space. Protrusion should be about the same on both sides (,001"-.004" above the pump housing). A new unit may have to .006"
-Too much gear protrusion will cause the pump to lock up
-Inadequate gear protrusion will cause a lack or loss of oil pressure
-There is a small seal on the pump shaft that you should change when you have the pump apart. This seal separates the feed and scavenge sides of the oil pump.
-The larger (taller) gears are the scavenge or return gears and the smaller gears are the feed gears.
-The scavenge side is always the larger side because they must pump oil up hill and they have to pump it faster then the feed gears pump. If not the crankcase will fill up with oil (wet sumping). Wet sumping cause the motor to smoke, lose power, gurgle, and blow oil out the crankcase vent.
-If the motor seems to wet sump only on start up then the feed check ball in the oil pump is not seating properly. This will happen in any motor that sits for a long time (months).
-There is a light spring holding the check ball against the seat. This keeps the oil in the tank from entering the engine when it is turned off.
-If the check ball leaks you can do two things:
1. Take the oil feed line off the pump and clamp it closed. Remove the check ball and spring and get a new set up. Wash the cavity out with the brake clean. Use the old ball and set a bolt on top of it. Lightly drive the ball into the seat with a hammer. This will iron out the check seat. Replace the ball and spring.
2. Remove the oil pump. Use a specialized small valve seat cutter or make a seat tool with an old ball welded to a rod. Coat the ball with coarse valve grinding compound and use it to lap the check ball seat. Clean it very well after lapping.
-In the large cap of the tower is the pressure relief piston/valve under a spring. It relieves oil pressure by using fluid pressure against spring pressure. When oil pressure pushes the piston against the spring and overcomes the spring pressure excess oil leaves out the relief hole to the

scavenge side of the pump.

-Without this valve oil would excessively leak on cold start up. These pumps make up to 150lbs of pressure on cold starts which is not too much. The valve does little when the motor is hot. Normal idle oil pressure should be 7-9 psi and it should be 12-35 psi at 2000 RPM when hot.

Oil Pump Gaskets

1. White plastic: These should be torqued to 40-50 inch pounds
2. White paper: These should be torqued to 60-70 inch pounds
3. Black paper: These should be torqued to 95-120 inch pounds

-Torque differences are because of the compressed thickness of the gaskets must be the same for all of the gaskets. If not your gear protrusion will be off.

-The only types of sealer you can use on these gaskets are spray hi-tack or copper coat

-When assembling a new oil pump smear the gears with motor oil. When it is on the bike, pump oil into the feed fitting with a hand held pump. Don't use grease, vaseline, or assembly lube.

-H-D marks the feed fitting with an "F", S&S does it with an "S" (supply)

-When starting an engine with a dry pump you should get oil pressure within 30-40 sec.

-If you don't stop the engine and re-prime the pump

-Take the feed check spring and ball out and put the cap back on hand tight and run the engine briefly

-On an initial start it is normal for the lifters to hammer hard and then suddenly quiet down. Usually one lifter will continue to click. You should turn the engine off and let it sit for a few minutes and then try running it again.

Oil Pump Assembly Errors:

1.Packing the pump with grease

2.Putting the inside gear snap ring in the c-clip slot inside the pump on the wrong side of the shaft. This will lock up the pump.

3.Trying to knock the pump off the motor with the woodruff key still in the shaft.

4.Make sure you put the plug on the side of the pump in before you install the pump or you must pull it off again.

-In the aftermarket most of the pumps are the 1980-91 style. You can use these on the earlier models or aftermarket crankcases if you drill the extra

relief hole in the case

-Always use a drill plate because this hole is drilled at an angle with a 1/8" bit. Try to use a smaller drill and a new bit very slowly.

-When you buy an aftermarket pump the usually have two sets of bolts.

-Up through 77 used ¼ 24

-1978-On uses a ¼ 20 (most of the time)

-1984 and earlier pumps have a tube coming from the top of the body to oil the primary

-The hold with a screw next to it is a rear chain oiler. If the customer can handle it turn the oiler off and put a BB in line to plug it up. Have them oil it manually.

Twin Cam Oil Pumps

-There are types of twin cam oil pumps but they all interchange

1.-99: This unit has a housing >2 scavenge rotors>2 feed rotors>1 washer

-Always look for any damage to the gears

-Check for rotor tip clearance

1. Place a feeler gauge between all the rotor tips on the 2 gears

-Wear limit is .004"

-On reassembly the scavenge rotors go on first

-There is then a separate washer

-Next are the feed rotors

2.-99A: The scavenge rotors are slightly shallower and the pump body is a little deeper

-All of the rotors have two dots on them indicating the side faces out on assembly

-There is an extra washer and a wave plate in this assembly

-Scavenge gears>Washer>Wave Plate>Washer>Feed Gears

-The pump body will interchange with -99 pumps but the internals wont

3.-99B: The only difference between a -99A is the -99B has a longer scavenge pick-up tube and it is beveled

-Twin Cam Cam Plates

-The oil pressure relief valve is located in the cam plate

-These plates act as the front of the oil pump housing

-They must be inspected whenever you change the oil pump

-There are two types of wtin cam cam plates

1.-99

2.-00 (99B): This plate was designed for the "B" model twin

cam

-It has an extra hole to feed the balancers in the “B”

-This oil hole must be plugged if you install one of these earlier engines or in “A” type motors

Installing New Timing Cover Bushings

Remove>Install>Pin>Ream

1. Heat up the cover with the jims blue plate attached. Make sure the plate is on the heat source, not the timing cover.
2. Use a blind hole bushing puller and a 3/8” wrench to hold the flat on the puller. Don’t use vise grips to hold the flats or it will damage your tool. Oil the threads.
3. Crib the cover and the plate on 2x4’s
4. Knock the bushings out
5. Lock the plate in the vise
6. Make sure the bushing pin doesn’t stay in the cover
7. Make sure the flat in the pinion bushing lines up with the oil gallery in the cover.

-If it is a later model cover the bushing will go in flush. You must watch this because the tool is designed to give it an inset.

-If it is a newer model cover the bushing will have an inset

8. Drill a new pin hole in the bushings

-Use a jims tool and a #31 bit (.120”)

-Drill anywhere in the bushing but the oil passageway

-Get the pin in flush with the bushing. This is difficult on pinion shaft bushings if they are inset

-Drive the pin in with a drift. It should be interference fit

-On the cam bushing you can file off any of the pin sticking out over the bushing so depth is less important than on a pinion bushing

-Drill the oil hole in the cam bushing before you ream it

-When you buy new bushings they don’t come with new pins. You must re-use the old pins

Reaming and Fitting Timing Cover Bushings

1.Install the new bushing
2.Bolt the timing cover to a jims blue plate
3.Put the cam reamer in an old right case half cam bearing

4.Squarely bolt down the timing cover with 3-4 bolts
5.Push the reamer to bushing lock assembly in the vise by the blue plate
6.Always pin the bushing before you ream it
7.Put cutting oil on the reamer and ream the bushing
8.Pull the cam cover holding cam reamer so you don't drop it
9.Use the adaptor on the pinion reamer
10.Mark the new bushing length on the shaft of the reamer so you know when you reach the bottom
11.Use vise grips to work the pinion reamer out (Remove in the direction it cuts)
12.Only ball hone the bushing if it fits tight (Wear limit is .004")
13.Clean the cam cover very carefully to keep metal out of the oil passage

Removing and Installing Valve Guides on an Evolution or Twin Cam

-The install tool has a threaded shaft and two hardened washers and a small thrust bearing. It is made by Rowe. Order extra shafts when you buy the tool.
-Pre-sized valve guides don't work. Do not use these.
-A shovelhead has a shoulder on the valve guide so you use the tool you use to knock it out to install the new guide. Freeze the guide before installation. Make sure you clean all the carbon from the bottom of the guide before installation. Make sure you clean all the carbon from the bottom of the guide before removal.

1.Oil the bearing and the threads on the tool
2.On evolution guides there is no shoulder so you must use a depth stop tool
3.The guide may fit tightly on the tool so you have to force in on there
4.Put never seize on the end of the guide before installation
5.Heat the head on a hot plate to about 250 degrees
6.Screw a handle into the plug hole to hold it
7.Place the head on a 2x4 crib and use the guide driver to knock the guide out of the head
8.Use the tool and wrench to prevent cracking the guide from shock as you would if you drove it in with a hammer
9.Knock the old guide out and put the head in a vise
10.Run the guide into the head and keep turning it until the tool bottoms out

11.If the fit is extremely tight don't stop running it in or the head will cool and you will have to start over. Run it on with a ratchet if you have to.

12.Wind the tool out. If it gets stuck knock it out.

Reaming a Valve Guide

1.Let the head cool before you ream it
2.Put a T-handle and cutting oil on the reamer
3.Put the smaller piloted section of the reamer down in the guide
4.Run the reamer clockwise all the way down the guide
5.All evolution and twin cam valve guides must be ball hones to finished size and create a 60 degree cross hatch

Installing Twin Cam Cams

Removal

1.Stick a small piece of welding rod in as a pin to relieve the chain tensioner
2.Remove the cam bearing retaining plate before removing the cams. (There are four torx bolts holding this in)
3.Remove the large snap ring on the short cam gear side
4.Use a jims three piece cam tool. The first piece fits to the ends of the cams
5.Press the cams out in the hydraulic press
6.Knock the cam bearings out of the plate

-The drive cam has roller bearings and the drive cam has ball bearings. Never re-use the ball bearings

-Hold the driven cam in the soft vise jaws and use a harmonic balancer/giotine puller to remove the ball bearings

Installation

1.Mark the tooth where the timing mark is on the opposite of the cam
2.The long cam is a drive cam and the shorter cam is a driven cam

-The driven cam goes closest to the two towers on the plate

3.Large plate from the tool set fits on the cam plate to act as a bearing stop and guide
4.The needle bearing goes in with the drive gear

-Tap it in with a hammer

-Drive both bearings in. You may need the press to accomplish this

5.The black plate on the chain should face the same direction it faced during removal
6.Load the roller bearing with Vaseline
7.The cam should drop into the ball bearing
8.Make sure the timing marks face each other
9.Press the shorter cam into the bearing. It is interference fit. Make sure you hold the tensioner shoe out of the way of the press
10.Reinstall the cam thrust plate
    -Blue lock tight the screws and tighten them to 30 inch pounds
11.Install the snap ring once again

Installing Shovelhead Intake Manifolds

-Manifolds made for O-rings will work with rubber bands but manifolds made for rubber bands wont work with O-rings.
1.Set the intake manifold against one head. Look at the other side and see if the gap is even from front to back. If not you may have to move the heads to get a tight fit. When building a motor leave the head bolts a little loose for this reason.
2.On the o-ring style roll the rings onto the manifolds over and put the manifold in place.
3.Pop the o-rings into position. Place a screwdriver in the manifold mouth and press your chest against it to hold it in place.
4.Unwind the clamps and roll them into position around the seals
5.Snug the clamps back and forth to keep the manifold from pulling one way or the other
6.Run your finger in the intake and make sure the manifold fits flush
7.When using the rubber band style seals put one on the manifold and one on the head. Take something round, such as a filed off spoke, and stick it in between the manifold and the seal and pull it around the seal.
8.Don't put any water or lubricant on the seals to install or they will leak

Installing an Evolution Intake Manifold

-E89 evos had a plastic intake manifold (these are rarely seen)
-L89 evos manifolds can be fit to any year of evolution
1.Inspect the sealing surfaces of the manifold

2.Notice the manifold says “R” and “F”. The plastic seals are beveled to fit on the beveled ports on the engine
3.Put the two bottom bolts in the case
4.Slide the manifold in over the two lower bolts with the numbers going down
5.Put the bolts in finger tight and make sure the manifold is seated. Tighten the bolts down with a kastar manifold wrench
6.Tighten each bolt a little at a time in a cross pattern. Pull them snugly but no so tight that it will damage the flanges
7.Stick your fingers in the manifold and make sure the port lines up with it

Removing Outer Timkin Bearing Races

-1990 and later cases don’t have supportive steel sleeve to hold the races
-These style races go directly into the aluminum of the case so you must heat them up to remove and install the races. You must also use the Jims tool.
1. Use the Jims puller to pull the bearing races. It has two “C” shaped pieces that fit into the race during removal.
2. Lay the case on an old cylinder in the hydraulic press with the bearing removal tool against the shaft of the press.
3. Begin pressing the races out of the case. If they begin to get tight back off the press and inspect your setup.
4. Repeat this for the other side of the case
5. Place the two piece snap ring removal tool on the snap ring in the case. Tighten both sides of the tool creating a “V” angle between them.
6. Use the snap ring pliers that come with the tool in the two halves and carefully remove the ring

Installation

1.Make sure the opening in the snap ring lines up with the oil hole opening in the case half (This is around the 12 O’clock position)
2.Use the outer race install tool that looks like a round driver
3.Place a bolt on top of the tool and press run the press down on the bolt
4.Make sure the race isn’t tilting as it goes in. If it does start to tilt on installation hit the high side with a hammer
5.It will stop when the race hit’s the snap ring

Pinion Side Main Bearing Races

-These races are pressed into the crankcase and come in two styles

1.1958-E92: These have a single notch with an oil hole in it. When installing you must line the oil hole up.
2.L92-Present (Long Bearing): These have an oil groove that goes all the way around them with several oil holes. This allows constant oil in the middle of the race. This will interchange with the older style but cant be replaced by the older style.
-These races are available in standard or +.002", .005", .010" over for damaged bores
    -S&S races are longer and wont fit in Harley cases
-When installed these races must be sized and lapped with a lapping arbor
    -This will make the race round, the right size, and will align the center line of the bearings when installed

Aligning/Lapping Pinion Side Main Bearing Races

-The three case alignment bolts must be in place to align the races
-Anytime you interchange case halves line and lap the races and make sure the case decks and the motor-mounts are square
1.Run the adaptor through the race from the inside of the case
2.Rub lapping compound on the fattest part of the shaft (don't get compound on the rest of the shaft)
3.Run the tool through the case from the side fitting the lapping head in the race
4.There should be some drag on the handle when installed
5.Turn it clockwise running it in and out as you rotate it
6.If you lapping used races, lap until the shiny spots in the race are gone
    -Clean and measure the races to determine the size of bearings needed
7.When you finish back the lock nuts of the lapper all the way down so there is no tension on the lapping head
8.Split the case and clean both halves thoroughly. Lapping compound will destroy the motor if it run.

Removing and Installing Main Bearing Races

1.Place a piece of 3" steel tube on a non-flexible steel plate in the press. Place the case half on this
2.Use an old #1or #3 sporty cam running in the bearing race from the timing

side
3.Make sure the dowel pins on the case half don't sit on the metal plate on the press
4.Use an old big twin cam to press the race into the case
5.Make sure the shoulder is flush all the way around the race
6.Lap the races

Boring Bar

-When boring a cylinder you must know the piston to wall clearance
-Leave a small amount of bore on the cylinder that can be finished honed out
    -Pre Evolution motors = .0015"-.002" (Leave .002" to hone out)
    -Evolution motors = leave .003" to hone out
-Bore from the bottom to the top of the cylinder. This allows for any deflection error to occur below the ring travel position
-Don't bore motorcycle cylinders clockwise

1. Oil the three parts of the machine
2.Install the bit tip by loosening the set screw and changing out the bit. These have six cutting edges
3. Make sure the table surface on the machine and the gasket surface on the cylinder are clean
4. Set the cylinder on the bar and run the boring shaft to the top of the cylinder
5. Place the centering cone in the cylinder over the shaft
6. Clap down the cylinder using jack bars so that you don't clamp on the cooling fins of the cylinder
    -Make sure the jack bars are 1 notch higher on the clamp side then the cylinder side
7. Loosen the three allen screws that hold the bit in place
8. When standing in front of the machine the bit should face to your right with the cutting edge facing away from you
9. Install the bit and bit guard and then tighten the allen screws
10. Run the bar down into the cylinder with the hand wheel
11. Place the pin in the drive position and turn the bar listening to where is

scratches the cylinder
12. Adjust the bit so that you get an equal amount of scratch all the way around the cylinder bore

13. Place the pin in the hole closes to the center and turn it until the bar drops into the cylinder
14. Turn the machine to the fast setting and run the first scratch bore
15. When the machine stops place the pin in the outside position and run the bar back to the top of the cylinder
16. Put the boring bar mic. Over the bit and loosen the outer two set screws on the bit
17. Run the mid to the bit and push the bit out to the correct cutting length

Cylinder Honing

-Rigid (Parallel) hones will cross hatch and remove material from the cylinder
-Always use stones as a set from the same group
-On Harleys use 280-320 grit stone
    -Follow this with a 240 grit ball hone
1.Adjust the stones out with the fine adjustment until they snugly fit in the cylinder
2. Run at a stoke speed of about 120 strokes/min, counting the amount of stokes you do on one side
3. Perform the same amount of stokes on both sides of the cylinder alternating every 30 strokes
4. Try to finish with a 45 - 60 degree cross hatch

Flatheads

-Side valve motors were ran from 1909-73
-The W model began in 1937. It hada 45 cubic inch motor with a 2 ¾" bore and 3 3/16" stroke. It was found on the standard solos.

-WLA = Army Edition W
-WLC = Canadian Edition WLA
-WLD = (Deluxe) Appearance package
-WLDD and WLDR = Racing applications with big cams and ports but still had the full road equipment
-WR = (Racing Only) No brakes and flat style tappets
-WRTT = (Racing Only) This model had brakes

-The K model ran 1952-69. It was a 45 cubic inch with a 2 ¾" bore and a 3 13/16" stroke
-KR = Racing
-K = Road Model
-This had a swing arm with rear shocks and telescoping forks
-There was a foot shift
-KK = (1953) Performance package
-Large valve ports and higher compression
-In 1954 the engine size increase to 55 cubic inch
-KHK = Was a hot rod version of the K. It had a 2 ¾" bore and a 4 9/16" stoke
-In 1957 the K was replaced with the XL

-The U model ran from 1937-1948. It had 74 cubic inches with a 3 5/16 bore and a 4 9/32 stroke
-The U only differed from Knuckle in the engine
-It was the same as the W only larger

-The servi-car ran from 1937-73. These are called G models.
-They hade 2 ¾" bore and 3 13/16" stroke

<u>Twin Cam B Balancer Removal and Installation</u>

-Only solid mounted twin cams have balancers
-The balancers are two weights that rotate with the engine, as the piston goes up the weights go down

1. Remove the nuts and washers on the balancers
2. The sprockets are marked front and rear
3. Compress the chain tensioner and pin it down
4. The upper tensioner will be marked “F” and “R”. Grab them with needle nose pliers and push the tab with a screwdriver and pull it out
5. Pull the sprockets and chains. The three black links will always face out with these systems
6.Pull the variable thickness spacer from under each sprocket

-These spacers are used to align the balancer chain. Don’t mix them up!

-Put the sprocket and spacer on with the nuts

-Screw the tool on the crankshaft and twist it to each side. The tool should slide on the sprocket with a slight drag but not compress the spring

7. Remove the bottom chain sleeve tensioner
8. Remove the three Torx bolts on each side under the sprocket
9. Pull the housing and pull the balancers. The balancers are the same front and rear and are marked “F” and “R”
10. The red triangle on the crankshaft is the timing mark

Reassembly

1. Replace the six Torx bolts in the plate with red lock tight
2. Replace the lower chain tensioner
3. Set the variable thickness spacers on the shafts
4. Line the red arrow on each sprocket with a black link and put the chain back on the shafts
5. Put the nuts back on and run the pins (5/16” bolts) in the holes at the bottom of the balancers and torque them to prevent turning
6. Replace the chain tensioners