

**Instruction Sheet No. 2000**  
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## 3<sup>7</sup>/<sub>16</sub>"/3<sup>1</sup>/<sub>2</sub>" Bore Big Twin Stroker Kit Installation Instructions OHV Engines 1936 and Later

### Safe Installation and Operation Rules:

Before installing your new S&S stroker kit it is your responsibility to read and follow the installation procedures in these instructions and follow the basic rules below for your personal safety.

- Gasoline is extremely flammable and explosive under certain conditions and toxic when breathed. Do not smoke. Perform installation in a well ventilated area away from open flames or sparks.
- If compressed air is used during installation, be particularly careful. Compressed air and particles dislodged using compressed air are harmful to eyes and body. Wear protective goggles, and always direct air stream away from body parts such as hands and eyes and other people near you.
- When using solvents, degreasers and other chemicals during cleaning and installation, read manufacturer's instruction label for proper use. Exposure of some chemicals to skin, eyes and/or other body parts may be harmful. Many items are flammable and present a fire hazard. Use in well ventilated area and wear protective clothing when using them to avoid personal injury.
- If motorcycle has been running, wait until engine and exhaust pipes have cooled down to avoid getting burned before performing any installation steps.
- Before performing any installation steps disconnect battery to eliminate potential sparks while working on electrical components.
- Read instructions thoroughly and carefully so all procedures are completely understood before performing any installation steps. Contact S&S with any questions you may have if any steps are unclear or any abnormalities occur during installation or operation of motorcycle.
- Consult an appropriate authorized H-D service manual for correct disassembly and reassembly procedures for any parts other than those outlined in these instructions.
- Use good judgement when performing installation and operating motorcycle. Good judgement begins with a clear head. Don't let alcohol, drugs or fatigue impair your judgement. Start installation when you are fresh.
- Be sure all federal, state and local laws are obeyed with the installation.
- Be sure all fuel lines, supply and overflow, are routed correctly and fuel line clamps are in place and tightened. Lines must not contact exhaust pipes or other extremely hot surfaces where they could melt or leak and catch fire.
- Before starting engine and riding motorcycle, be sure throttle opens and closes smoothly. Turn handlebars to left and test throttle. Then, turn bars to right and test throttle. To avoid possible loss of control of motorcycle and potential personal injury to yourself or others due to throttle sticking in open position, throttle must work smoothly and return to a fully closed position when hand is removed from throttle grip.
- Motorcycle exhaust fumes are toxic and poisonous and must not be breathed. Run motorcycle in a well ventilated area where fumes can dissipate.

### IMPORTANT NOTICE:

Statements in this instruction sheet preceded by the following words are of special significance:

#### WARNING

**Means there is the possibility of injury to yourself or others.**

#### CAUTION

**Means there is the possibility of damage to the engine or motorcycle.**

#### NOTE

*Other information of particular importance has been placed in italic type.*



**Denotes change in instructions since last revision.**

**S&S recommends you take special notice of these items.**

### WARRANTY:

All S&S parts are guaranteed to the original purchaser to be free of manufacturing defects in materials and workmanship for a period of six (6) months from the date of purchase. Merchandise that fails to conform to these conditions will be repaired or replaced at S&S's option if the parts are returned to us by the purchaser within the 6 month warranty period or within 10 days thereafter.

In the event warranty service is required, the original purchaser must call or write S&S immediately with the problem. Some problems can be rectified by a telephone call and need no further course of action.

A part that is suspect of being defective must not be replaced by a Dealer without prior authorization from S&S. If it is deemed necessary for S&S to make an evaluation to determine whether the part was defective, a return authorization number must be obtained from S&S. The parts must be packaged properly so as to not cause further damage and be returned prepaid to S&S with a copy of the original invoice of purchase and a detailed letter outlining the nature of the problem, how the part was used and the circumstances at the time of failure. If after an evaluation has been made by S&S and the part was found to be defective, repair, replacement or refund will be granted.

### ADDITIONAL WARRANTY PROVISIONS:

- (1) S&S shall have no obligation in the event an S&S part is modified by any other person or organization.
- (2) S&S shall have no obligation if an S&S part becomes defective in whole or in part as a result of improper installation, improper maintenance, improper use, abnormal operation, or any other misuse or mistreatment of the S&S part.
- (3) S&S shall not be liable for any consequential or incidental damages resulting from the failure of an S&S part, the breach of any warranties, the failure to deliver, delay in delivery, delivery in non-conforming condition, or for any other breach of contract or duty between S&S and a customer.
- (4) S&S parts are designed exclusively for use in Harley-Davidson motorcycles. S&S shall have no warranty or liability obligation if an S&S part is used in any other application.

**PRESENT S&S CRANKCASES AND FLYWHEELS ARE NOT COMPATIBLE WITH HARLEY-DAVIDSON ELECTRONIC FUEL INJECTION (EFI) MODELS.**

Installation of an S&S Big Twin Stroker Kit is comparatively easy and can be performed by any average Harley-Davidson repair shop equipped to do complete engine overhauls. No special tools other than those used in normal overhaul operations are required.

Read instructions thoroughly before starting work. When they are completely understood proceed with installation.

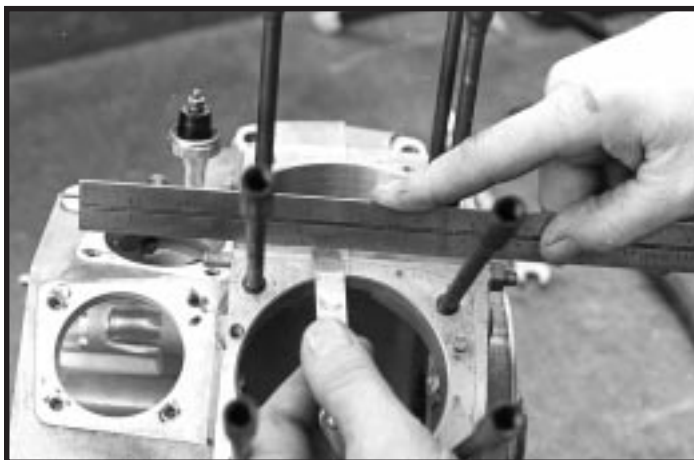
**Installation Steps:**

1. Crankcase Alignment & Cylinder Mounting Studs (All)
2. Lower Oil Return Holes (Pan & Shovel)
3. Piston and Cylinder Fitting (All)
4. Crankcase and Piston Skirt Clearancing (All)
5. Breather Timing (All)\*
6. Cam, Lifters and Tappet Blocks (All)
7. Connecting Rod Preparation (All)
8. Lower End Assembly (All)
9. Connecting Rod Alignment (All)\*
10. Piston to Valve Clearancing (All)
11. Final Top End Assemble and Engine Installation (All)
12. Timing, Carburetion, Exhaust, Gearing & Break-in (All)

*\*NOTE - S&S recommends that engine builder consider performing some steps during initial engine disassembly. Breather timing check requires that most components be assembled, and performing check upon disassembly may save reassembly and cleaning time. While some or all related parts concerned in connecting rod alignment check may be replaced, it is helpful to check original parts combination and note discrepancies which may alter installation of new parts.*

**1. Crankcase Alignment & Cylinder Mounting Studs (All)**

*NOTE - Some H-D crankcase base gasket surfaces on which cylinders are positioned do not align properly. This usually occurs when crankcase halves used are from different crankcase assemblies and were not paired and machined together at Harley-Davidson. It is recommended to check for crankcase misalignment even if crankcase halves are correctly matched to prevent potential oil leaks and other mechanical problems.*



Picture 1

**CAUTION - Mismatched gasket surfaces due to improperly aligned crankcase halves may cause unwarranted stress on cylinder base flanges which could result in cylinder flange failure.**

- A. Clean cases thoroughly and assemble both cases without flywheels and tighten all case bolts as in final assembly.
- B. Place straight edge across base gasket surface. **See Picture 1.**
- C. If any misalignment exists, remove cylinder base studs and place masking tape over cam and mainshaft bearings to keep chips out.
- D. Place cases squarely in mill and take minimum cut necessary to clean up.
- E. If stock cylinder studs are to be used, reinstall to original height. If studs are provided in kit, install to height that equals: thickness of cylinder base flange, plus base gasket, plus cylinder base plate, plus washers, plus base nut. Use Loctite Stud and Bearing Mount to secure studs.

**2. Lower Oil Return Holes (Pan & Shovel)**

Big Twin cylinder oil return holes must be lowered in those stroker conversions where oil ring crosses stock oil return hole. This is necessary to prevent oil from returning above oil ring which will cause engine to smoke.

*NOTE - Oil rings will usually touch and/or cross oil return holes with installation of stroke 4 1/2" or longer. Strokes shorter than 4 1/2" do not require this step.*

For strokes 4 1/2" and longer, perform following steps:

- A. Directly in line with return hole in bottom of cylinder flange, drill 1/4" diameter hole centered 1/2" away from base gasket surface through cylinder sleeve. **See Figure 1.**
- B. Place base gasket on cylinder base gasket surface, and punch 1/4" hole in gasket directly in center of oil return hole in base gasket surface.
- C. Remove gasket from cylinder, and place on driveside crankcase half in its respective position. Mark crankcase gasket surface through 1/4" diameter hole that has been punched in gasket.
- D. Drill 1/4" diameter hole perpendicular into crankcase gasket surface 5/8" deep. **See Figure 2.**
- E. Perform steps A through D on other cylinder.
- F. Bolt front and rear cylinders on drive side crankcase half.

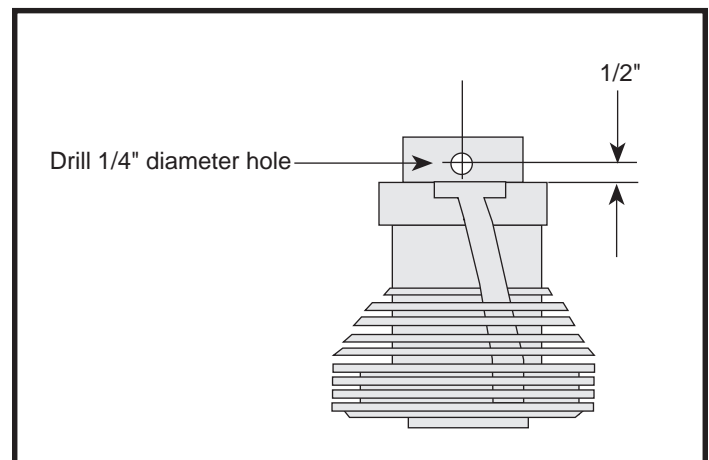


Figure 1

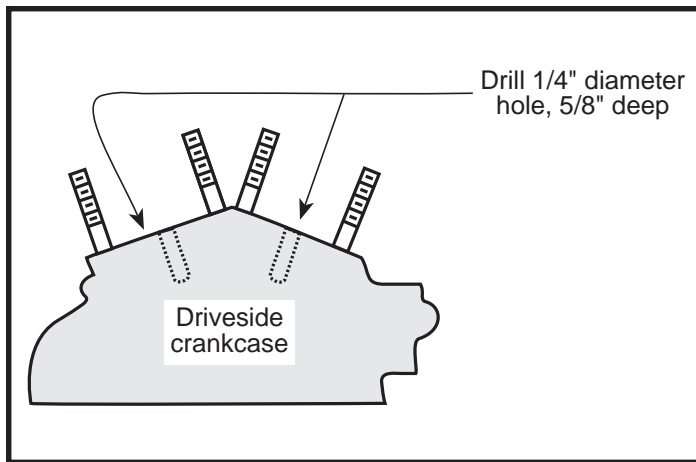


Figure 2



Picture 2

- G. Using hole drilled through sleeve in step A as a guide, drill a connecting hole to intercept hole drilled  $\frac{5}{8}$ " deep in step D on each cylinder.

*NOTE - If base plates are to be used, be sure they are in place.*

- H. Clean dirt, filings, etc. out of passageways.  
 I. Press one piece of  $\frac{3}{4}$ " long x  $\frac{3}{8}$ " O.D. steel tubing provided in kit into oil return hole in base gasket surface until tubing is flush with surface. "Ream" hole slightly with drill to remove any burrs that may exist.

*NOTE - A very tight press fit with 100% seal is not critical as tube will sufficiently divert oil flow to new hole. Loctite may be applied to tube if fit seems too loose.*

### 3. Piston and Cylinder Fitting (All)

Fit pistons to cylinders using piston fitting instructions provided. Check ring end gap and adjust as necessary. After gapping rings, keep them separate so they can be installed in their proper locations later.

#### Piston Series #92-2700, #92-2730

*with slotted oil ring groove*

Close fit – .0015" to .002"

Loose fit – .0025" to .0035"

#### Piston Series #92-2500, #92-2510, #92-2600, #92-2610

Close fit – .002" to .0025"

Loose fit – .003" to .0035"

#### Piston Series #92-2720, #92-2730

*with holed oil ring groove*

Close fit – .002" to .003"

Loose fit – .0035" to .004"

#### Piston Series, #92-2400, #92-2420,

Close fit – .0008" to .0013"

Loose fit – .002" to .0025"

#### Piston Series #92-2800

*with slotted oil ring groove*

Close fit – .0025" to .003"

Loose fit – .0045" to .0055"

#### Piston Series, #92-2800, #92-2900

*with holed oil ring groove*

Close fit – .0035" to .004"

Loose fit – .005" to .006"

**CAUTION - Failure to follow instructions and perform required clearancing, installation and/or break-in procedures correctly**

**may result in damage to pistons and/or other engine components. S&S voids its guarantee if pistons are not installed and/or broken in properly.**

- A. For maximum piston and ring life, fit pistons using appropriate close fit dimensions. Close fit requires absolute adherence to new engine break-in as outlined.  
 B. For immediate drag strip use, fit pistons using loose fit dimensions. Attempt to break in rings and pistons with 50 easy miles if possible. Piston and ring life will be reduced when using loose fit dimensions.  
 C. Measure all pistons across thrust faces 90° to wristpin holes. Make a series of measurements starting directly below oil ring groove and ending at extreme bottom of skirt. Use widest measurement to represent size of piston. Some pistons measure widest at extreme bottom of skirt. Others measure widest somewhere between oil ring groove and extreme bottom of skirt. If piston is notched for placement in rear cylinder, use measurement directly above notch as extreme bottom of skirt measurement.  
 D. S&S recommends the use of #220-#280 grit stone for final honing of cylinders for all stock-bore stroker engines.  
 E. Follow procedure recommended in H-D service manual for boring and honing V<sup>2</sup> type cylinders. S&S Cylinder Torque Plate Kit, S&S Part #53-0016, or H-D torque plates, H-D Part #33446, are required when fitting V<sup>2</sup> cylinders to simulate engine operating conditions. Cylinders may distort more than .001" if torque plates are not used.

### 4. Crankcase and Piston Skirt Clearancing (All) Crankpin Nut Clearance

Bosses on inside of cam side crankcase half must be clearanced for crankpin nut. **See Picture 2.**

*NOTE - Crankpin nut will usually clear on 80 Shovel head and V<sup>2</sup> cases when 4 1/4" or 4 3/8" stroke is used. When stroke 4 1/2" or longer is used, nut will usually hit. S&S recommends all cases be checked no matter what stroke is used. S&S Crankpin Nut Clearancing Gauge, Part #53-0005, for cases 1958 and later, and Part #53-0009 for cases 1957 and earlier are designed to mark crankcase that allows sufficient crankpin nut clearance for specific stroke to be used.*

If S&S gauge is not available, perform following procedure:

- A. Paint bosses with machinist's blue.
- B. Use divider to scribe arc on blued bosses. **See Figure 3.** Formula for spread of divider is:  
Distance = ( $\frac{1}{2}$  Flywheel Stroke) + ( $\frac{1}{2}$  Diameter of Crankpin Nut Measured Across Points) + ( $\frac{1}{16}$ " Clearance) - ( $\frac{1}{2}$  Outside Diameter of Race)

*NOTE - On Panhead engines, above procedure is recommended to insure removal of minimum material necessary.*

**Caution - Early Pan cases are not as strong and are machined with oil supply passageways to heads closer to surface of boss. Removal of excessive material may weaken thinner cases and/or break into oil passage.**

- C. Place masking tape over both ends of camshaft and mainshaft bearings to keep out chips.
- D. Grind shaded areas to adjacent machined depth.
- E. Mock up right side flywheel in crankcase half with mainshaft and crankpin installed with bearings, thrust washers, etc. in place.
- F. Rotate flywheel and note any contact.
- G. If flywheel does not rotate freely, check contact areas and grind more clearance.
- H. Repeat procedure until sufficient clearance is obtained.

*NOTE - A minimum of  $\frac{1}{16}$ " clearance is required.*

**CAUTION - Insufficient clearance between crankpin nut and crankcase will cause contact and may damage components.**

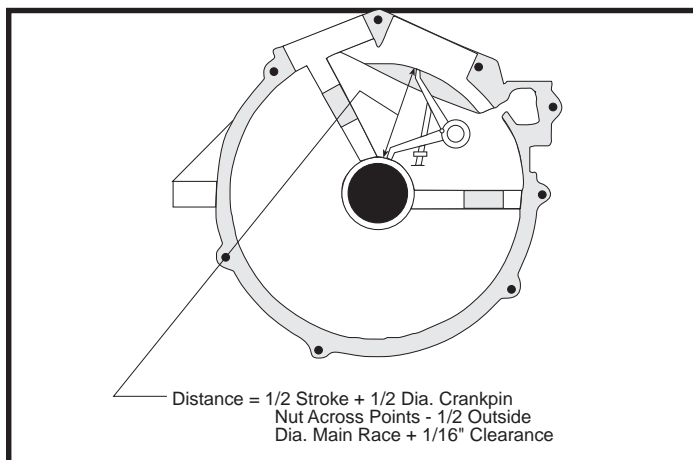
#### Connecting Rod Clearance

Front and rear of flywheel cavity inside crankcases and cylinder spigots must be clearanced for connecting rods. **Picture 3** shows rear side of flywheel cavity.

*NOTE - Clearance must be checked and filed if needed on front side also.*

Procedure to check these points is performed as follows:

- A. Mock up right side flywheel in crankcase half with mainshaft and crankpin installed with bearings, thrust washers, etc. in place.
- B. Assemble pistons without rings on their proper connecting rods, and place connecting rods on crankpin. Installation of wristpin clips is not necessary.



**Figure 3**

*NOTE - If pistons have piston to piston clearance notches ground on thrust face edges, place notches toward center of engine. Consult piston installation instructions included with pistons for proper piston direction placement.*

- C. Install both cylinders and secure each with one nut.

*NOTE - If base plates are to be used, be sure they are in place.*

- D. Rotate flywheel until rods contact areas to be clearanced. Note angle that must be filed.
- E. Disassemble cylinder and connecting rods and file crankcase and cylinder spigot for clearance.

*NOTE - A minimum of  $\frac{1}{16}$ " clearance is required.*

- F. Reassemble and check clearance.
- G. This procedure must be done for both crankcase halves.

**CAUTION - Insufficient clearance between connecting rods and crankcases will cause contact and damage to components.**

#### Piston Clearance

Pistons must be clearanced to avoid contact with each other and with flywheels. **See Pictures 4 and 5.**

#### Piston to Piston Clearance

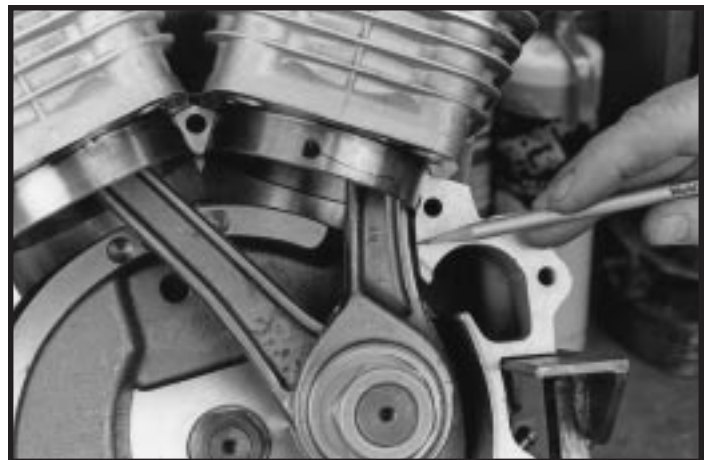
- A. Perform steps A through C in "Connecting Rod Clearance" above.
- B. Rotate flywheel to position where pistons are closest to each other. **See Picture 4.**
- C. Check clearance between pistons.

*NOTE - A minimum of  $\frac{1}{16}$ " clearance is required.*

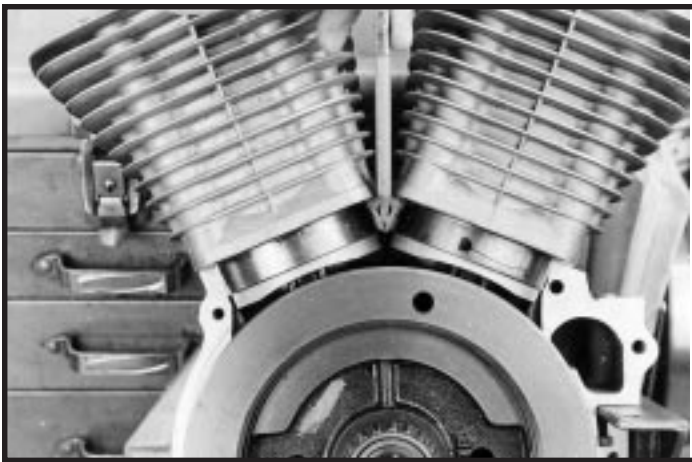
- D. Disassemble cylinders and pistons, and carefully file edge of piston skirts until clearance is obtained.
- E. Reassemble and check clearance.

#### Piston to Flywheel Clearance

- A. Perform steps A through C in "Connecting Rod Clearance" above.
- B. Rotate flywheel to position where front piston is closest to flywheel. **See Picture 5.**
- C. Check clearance between piston and flywheel.



**Picture 3**



Picture 4



Picture 5

**NOTE** - A minimum of  $\frac{1}{16}$ " clearance is required.

- D. Disassemble cylinder and piston, and carefully file piston skirt until clearance is obtained.
- E. Reassemble and check clearance.
- F. Repeat procedure for rear piston.

**CAUTION** - Insufficient clearance between pistons and pistons and flywheels will cause contact and damage to components.

#### NOTES

- Material removed from pistons for clearancing purposes will not adversely affect flywheel balance.
- Some S&S kits utilize flywheels with diameters smaller than stock (stock Big Twin flywheels are  $8\frac{1}{2}$ "). This is done to maximize piston skirt length. Our experience has shown that when small diameter flywheels are used it is desirable but not absolutely necessary to build up flywheel scraper. If flywheel scraper is not built up, oil thrown off flywheels may cause excessive oil burning in the rear cylinder.

#### 5. Breather Timing (All)

To maximize efficiency when scavenging oil from flywheel cavity in Big Twin engines, it is necessary to check and usually modify crankcase breather timing.

#### NOTES

- Breather timing can be checked after other crankcase clearancing is done or during initial disassembly.
- Early crankcase breather opening is a rough cast elliptical hole. In mid 1970s some care was taken to improve breather timing at H-D. Consequently, later vintage crankcases have a breather opening that is square.
- Objective of this step is to modify cases so that hole in cases is located in same position as hole in breather gear with opening and closing sides of hole in case in correct location for proper breather timing.
- S&S Part# 53-0020, Degree Wheel Kit, was designed to aid in checking breather timing. Procedures below assume an S&S degree wheel is used.
- S&S recommends grinding hole to maximum timing specifications. If there is any doubt and timing falls within specs, leave breather opening alone. **See Figure 4** for breather timing specifications.

**CAUTION** - Improper breather timing causes poor oil scavenging from flywheel cavity and incorrect crankcase air pressure. These conditions may cause unwarranted engine oil leaks around gaskets and seals and probable oil burning due to oil blow by past piston rings. Removal of excessive material from breather gear opening is irreversible and damage to crankcases may result.

To check and modify breather timing perform following steps:

- A. Bolt degree wheel pointer to drive side crankcase half using center case stud and nut. Position pointer towards sprocket shaft.
- B. Install degree wheel assembly on sprocket shaft. Rotate flywheel assembly so front piston is at TDC, top dead center. Position degree wheel on sprocket shaft so pointer indicates  $0^\circ$  TC, top center, and tighten set screw.
- C. Rotate flywheels in normal direction of travel to  $10^\circ$  before TC as in **Picture 6**. Observe breather gear and hole in crankcase through tappet block opening to determine hole in breather gear and hole in case relationship.
- D. Rotate flywheels to  $7^\circ$  after TC. Again note relationship. If edge of hole in gear appears in hole in crankcases during this span of degrees, then cases have proper opening specs. If not, then opening side of hole in cases must be ground. Grind hole to  $7^\circ$  before TC, maximum timing specifications.
- E. Rotate flywheels to  $55^\circ$  after BC, bottom center.

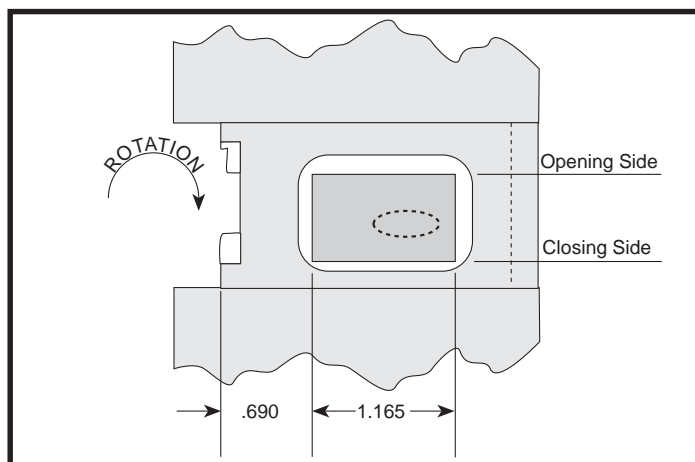
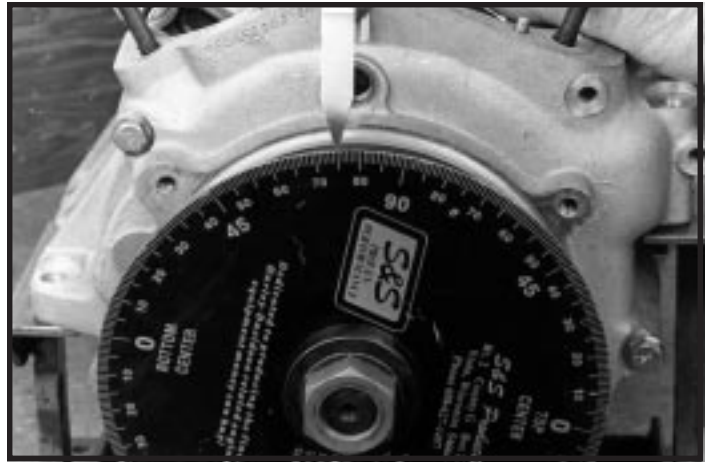


Figure 4



Picture 6



Picture 7

Observe breather gear and hole in crankcase to note their relationship.

- F. Rotate flywheels to 92° after BC and note relationship. **See Picture 7.** If back edge of hole in gear disappears from view during this span of degrees then cases have proper closing specs. If not, then closing side of hole in cases must be ground. Grind hole to 92° after BC, maximum timing specifications.
- G. Note location of hole in gear as opposed to hole in crankcases. **See Figure 4.** Grind hole in cases so location matches holes in gear with respect to where toothed portion of gear hits cases. **Picture 8** shows finished breather gear opening.
- H. Optional Step

**NOTE** - To further maximize breather efficiency some engine builders modify or remove screen in breather gear.

**CAUTION** - Breather gear screen stops foreign material from getting into gear side cavity where material could possibly stop oil pump and/or damage other parts. No oil to engine will result in damage to engine components.

#### To modify screen:

- a. Early gears - Remove clip that holds screen in place.
- b. Early gears - Turn screen so it covers hole made by removing clip.
- c. Early gears - Spot weld screen in place.
- d. All gears - Drill all holes in screen as large as possible without weakening screen.

**NOTE** - This procedure increases area that air and oil have to pass from breather gear cavity to gear side.

## 6. Cam, Lifters and Tappet Blocks (All)

### NOTES

● Big inch, stroked H-D engines with compression ratios of 8 1/2+ to 1 or more respond well to higher lift, longer duration cams. Engines with lower compression ratios should have shorter duration cams. S&S offers cams for all Big Twins except Knuckles that we have run in our test engines. We recommend their use along with S&S high performance valve springs and retainers. These components along with other valve train parts are available in kits that not only satisfy most any degree of rebuilding required but also make valve spring spacing and high

lift cam installation an easy job. If you are using a high lift camshaft perform any required head work and valve spring spacing per manufacturer's instructions.

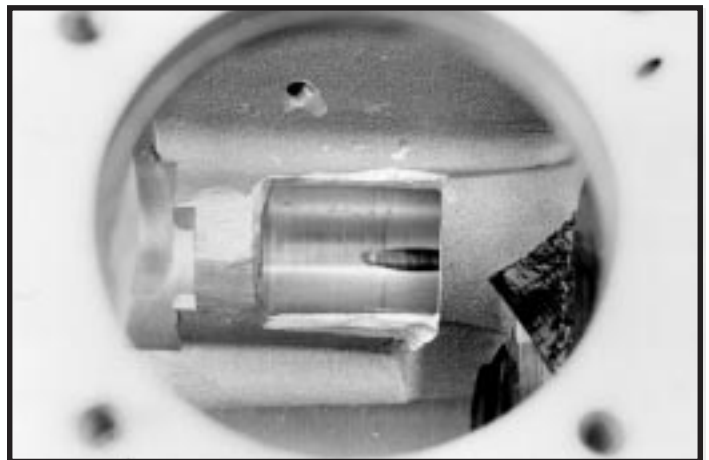
● Knucklehead strokers built using 1936 to '47 cases may use any aftermarket Knuckle cam such as an Andrews "S" or "K" grind. Knuckle heads installed on later crankcases, 1948 and up, should use cams such as "575" Sifton. In Pan or Shovel 575's lift is much higher, but when used with Knuckle heads, lift is only .400" since Knuckle rocker arm ratio is 1 to 1.

● Evolution V<sup>2</sup> strokers have been tested using both solid lifters and hydraulics. We recommend using stock hydraulic assemblies in all V<sup>2</sup> applications. They are far superior to early style Pan/Shovel assemblies and hold up extremely well under most conditions. To maximize efficiency and reduce potential valve float in high rpm situations, S&S HL<sub>2</sub>T Hydraulic Lifter Limited Travel Kit should be used in all V<sup>2</sup> performance applications. Part #33-5338 for 1985 and #33-5339 for 1986 and later.

● Panhead, 1953 and later, and Shovelhead strokers with solid lifters should have tappet block hydraulic lifter oil feel holes plugged to prevent excess oil escaping above lifters from filling pushrod tubes causing potential oil leaks.

#### To do this, perform following steps:

- A. Starting at gasket surface end of oil feed passageway in tappet block base, thread 8-32 tap into oil passage hole. Turn tap until tap end just starts to enter cam follower hole.
- B. Screw 8-32 x 3/16" allenhead set screw in passageway until it stops.



Picture 8

- C. Perform steps A and B to other tappet block.

*NOTE - If hydraulic lifters are ever reinstalled, plugs must be removed.*

**CAUTION - Restricted oil flow to hydraulic lifter assemblies causes lifters to operate with improper oil pressure which may damage them or other valve train components.**

## 7. Connecting Rod Preparation (All)

*NOTE - If S&S connecting rods are used, follow instructions that accompany rods since rod preparation below has already been done.*

**If S&S rods are not used, perform following steps:**

- To insure adequate oil on sides of rods and matching thrust surfaces of flywheels, S&S recommends that four grooves be ground on each side of both front and rear connecting rods. **See Figure 5.** Make these grooves .020" to .030" deep and .030" to .040" wide and should be ground 90° from each other. After making grooves, remove all sharp edges and burrs with emery cloth.
- With rods assembled, measure distance between rods at closest points in wristpin holes. If measurement exceeds 2.950" as shown in **Figure 5**, grind female rod at points where male rod makes contact to achieve sufficient clearance.

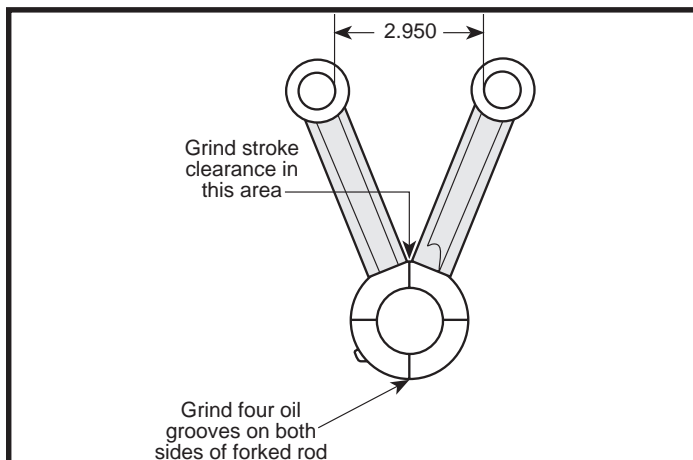
*NOTE - Rods clearanced to this dimension provide adequate clearance for strokes up to and including 5". Do not remove any more material than is necessary to obtain required clearance.*

**CAUTION - Inadequate clearance between rods or too much clearancing on rods will cause unwarranted stress on connecting rods, rod bearings, pistons, etc. resulting in possible failure of one or all aforementioned parts.**

- C. Thoroughly clean all parts to remove dirt, filings, etc.

**CAUTION - Burrs, dirt, filings, etc. left on connecting rod components may circulate in oil damaging other parts possibly causing engine failure.**

## 8. Lower End Assembly (All)



**Figure 5**

## NOTES

- S&S Big Twin flywheels with serial numbers that start with a letter or those numbered 1382 or higher are made from closed die, heat treated, steel forgings. They do not have connecting rod thrust washers like earlier S&S flywheels, because present flywheel material is harder than thrust washers previously used.
- S&S flywheels come with either one or three timing marks. A single timing mark represents front cylinder. On flywheels with three timing marks, an "F" stamped by a mark means front cylinder, an "R" means rear cylinder and a "TF" means top dead center front cylinder. In both cases, when front or rear mark is placed in center of timing hole it means that that cylinder is timed at 35° before top dead center. We recommend that big inch H-D Big Twin engines be timed at 35° initially. See Step 12, "Ignition Timing".
- Usually S&S flywheels are balanced before leaving our facility. Some customers prefer to do their own balancing or to have another balancing shop do the work for them. This is acceptable in most cases. However, we have had some bad experiences with dynamically balanced flywheels that have forced us to void our guarantee if flywheels have been balanced in this fashion.

**CAUTION - Flywheels assembled improperly prior to being dynamically balanced may sustain irreversible damage to mainshaft and crankpin tapers during actual balancing. S&S voids its guarantee if flywheels have been balanced in this fashion.**

- Assembling flywheels, mainshafts and connecting rods can be easy or difficult. Degree of difficulty is determined by builder technique and parts at his disposal. While S&S flywheels have been noted for their easy truing qualities, they can be difficult to true if a defective part is used that should have been detected before assembly.
- Cleaning parts prior to and during assembly and keeping parts clean after final assembly are imperative to minimize contaminants that may circulate in oil and shorten engine life. Use cleaning agents that do not leave harmful residues, and be sure to read and follow manufacturer's instruction label before use. Use drills and compressed air to clean all oil passageways of dirt, filings, etc. whenever possible.

## WARNINGS

- Some solvents, degreasers, gasoline and other chemicals are harmful to skin, eyes and other body parts. Many items are flammable and present a fire hazard. Read manufacturer's instruction label for proper use. Use in well ventilated area and wear protective clothing when using them to avoid personal injury.
- Compressed air and particles dislodged using compressed air are harmful to eyes and body. Wear protective goggles when using compressed air and always direct air stream away from body parts such as hands and eyes and other people near you.

**Perform following steps when assembling flywheels:**

- Thoroughly clean all parts to be used. This includes mainshafts, main bearings, connecting rods, rod bearings, crankpin nut retainers and screws if they are to be used, keys and flywheels including tapers and keyways.

**CAUTION - Burrs, dirt, filings, etc. left on flywheel assembly parts may circulate in oil damaging other parts possibly causing engine failure.**

- B. Check both mainshafts between centers for taper surface to bearing surface concentricity. Make sure centers on shafts are clean beforehand. If tapers and bearing surfaces are concentric with each other and with center, then truing will be easier. **See Picture 9.**

*NOTE - Current H-D specs. allow maximum of .001" runout between taper and bearing surfaces. We feel this is too much and prefer to see .0003" or less with an absolute maximum of .0005". S&S shafts are .0003" or less.*

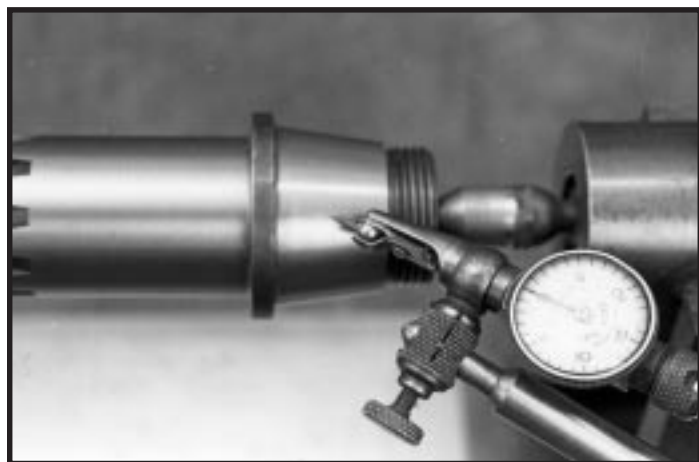
- C. Inspect keyways and oil holes for burrs in flywheels and remove if necessary.
- D. With key in shaft, insert into respective tapered hole in flywheel and check to see that key does not bottom in groove. If key bottoms out, file flat side of key, not rounded side, until shaft with key in place fits in flywheel without bottoming out. Check crankpin and crankpin key also.
- E. Reclean mainshaft tapers, crankpin and flywheel tapers with lacquer thinner.
- F. Assemble mainshafts in respective flywheels. Coat taper and threads of each shaft with green Loctite during assembly. Install crankpin in camside flywheel using Loctite also. Tighten all nuts to at least factory torque specs minimum. When S&S shafts are used, follow instructions included with them.

*NOTE - S&S recommends to tighten nuts very tight. We use a 3/4" drive breaker bar and a five foot piece of pipe when assembling flywheels.*

After right side flywheel, pinion shaft and crankpin are assembled, blow air through pinion shaft oil feed hole to check for blockage.

**CAUTION - Partially or completely blocked oil feed passageways may cause irreversible damage to bearings and other engine components.**

- G. Measure width of female rod on crankpin end. **See Picture 10.** Measurement should be 1.743" to 1.745".
- H. Assemble left and right flywheels and moderately snug nuts. Do not worry about them being true. Measure distance between connecting rod thrust pads. **See Picture 11.**



Picture 9

*NOTE - S&S recommended rod side play is .015" to .035". Rod Side Play = (Distance from Pad to Pad) - (Female Rod Width)*

**CAUTION - Incorrect connecting rod side play may cause excessive rod side thrusting and potential damage to rods, flywheels and other engine components.**

If difference is less than .020", female rod must be ground on sides as final tightening will pull wheels closer together. Rod side play diminishes about .015" when crankpin nut is final tightened. Take equal amounts off each side if amount to be removed is more than .010". If there is no rod side play try different crankpin. If rod side play is more than .035", try different crankpin. We have run side play of as much as .045" without serious consequences. If crankpin is changed check rod bearing clearance. If side play is excessive and different crankpins do not correct problem, contact us.

*NOTE - If material is removed from sides of female rod, overall width of bearing cages must be reduced so bearings and cages are free to float with rods without contacting flywheel thrust pads. Bearing cage side clearance of .008 to .020 less than rod width is recommended.*

**CAUTION - Connecting rod bearing and cage assemblies that are wider than female rod may become damaged upon contact with flywheel thrust pads. Damaged rod bearing assemblies and/or foreign material from damaged components circulating in oil could cause further destruction and possible failure of other engine parts.**

- I. Finish assembling flywheels and rods. Flywheel assemblies 1972 to early 1981 may be more difficult to true because of the 8 1/2° sprocket shaft taper. Following above procedures will help diagnose problem if difficulty should arise.

## 9. Connecting Rod Alignment (All)

After flywheel assembly is installed in crankcases, rods must be checked for straightness. S&S Rod Checking Pin, Part# 53-0002, was designed to help perform this procedure. It may also be necessary, to fabricate a rod bending tool as illustrated in **Figure 6.**

*NOTE - The purpose of this procedure is to correct for machining tolerance discrepancies in components which may lead to pistons*



Picture 10



not running true in cylinder bores. While rods may be straight and true, it is sometimes necessary, to bend them to correct for these machining discrepancies. Do not bend rod by using tool in wristpin hole as this method may distort wristpin bushing. We also feel that using a piston in lieu of a checking pin may prove inaccurate due to variations in lengths of piston skirts from one side of piston to the other.

**CAUTION - Pistons which do not run true in cylinder bores may cause excessive connecting rod side thrusting. This in turn may lead to premature ring, piston, connecting rod and rod bearing wear and eventual failure of these parts.**

#### Checking Pin Procedure

- Insert checking pin into wristpin hole. Place strips of paper between checking pin and crankcase cylinder gasket surface and apply slight downward pressure to wristpin end of rod by rotating flywheels. Pull papers out slowly. Drag on papers should be equal.
- Rotate flywheels in opposite direction until checking pin contacts cylinder gasket surface again. Repeat procedure to rod again. If drag on papers is equal no bending is required. If one paper is loose, use rod bending tool to tweak rod in direction of loose paper and recheck. **See Picture 12.**
- Repeat checking and bending procedure for other rod.

#### Visual Procedure

- Install pistons on rods without rings or wristpin clips. Bolt cylinders with gaskets in place.
- Move piston tight towards camside of engine.
- Turn engine over in normal direction of travel 2 or 3 revolutions and observe piston during process.
- Move piston towards driveside of engine and repeat Step C. If inaccuracies are present due to machining variations in cases, cylinders or pistons, top land of piston deck will appear closer to cylinder wall at one point around circumference. This means that piston is cocked in cylinder bore and can be corrected by bending rod in opposite direction. **Figure 7** shows an exaggerated side view of this condition.
- Repeat Steps B to D for other cylinder.

*NOTE - All engines should be checked upon disassembly for incorrect piston alignment. This applies to those which are receiving new pistons as well as those being completely rebuilt. Observe pistons for wear spots on sides above top compression*



Picture 11

ring. If one side near wristpin is worn clean while side opposite is carboned up, then piston was not running straight and true in cylinder bore. Piston will also generally show diagonal wear pattern on thrust faces of skirts and possibly signs of connecting rod to wristpin boss contact inside piston.

We feel that not enough emphasis is given to checking piston alignment in cylinder bore. Proper piston alignment means connecting rods will thrust to sides less minimizing added stress on pistons, rings, rod bearings and other related parts.

#### 10. Piston to Valve Clearancing (All)

*NOTE - All valve spring spacing, rocker arm to collar and rocker arm to rocker cover clearancing must be done before piston to valve clearancing can be checked.*

*S&S pistons have sufficient valve clearance when used with most street high performance cams with lifts up to .525". However, we recommend that valve clearancing be checked if other than stock cam is used.*

##### Check piston to valve clearance in following manner:

- Assemble engine with exception of cylinder heads.
- Turn engine over until piston in front cylinder is at top dead center. Paint area around valve pockets on pistons with machinist's blue.
- Place valves in cylinder head leaving off springs and retainers. Place head on cylinder and secure with one bolt.
- Lower valves until they contact piston. Rotate valve marking painted area.
- Remove head and check points of contact. Valve should fit in recessed area machined in piston dome.

*NOTE - S&S recommends at least .060" clearance around periphery of valve.*

- If insufficient clearance exists, remove piston and grind valve pocket until head of valve fits flush with proper clearance.
- Repeat procedure for other cylinder head.
- Spread layer of putty into valve pockets in both pistons.
- Assemble cylinder heads and bolt assemblies on cylinders with head gaskets in place. Install pushrods and adjust to simulate final assembly.
- Turn engine over in normal direction of travel two complete revolutions.

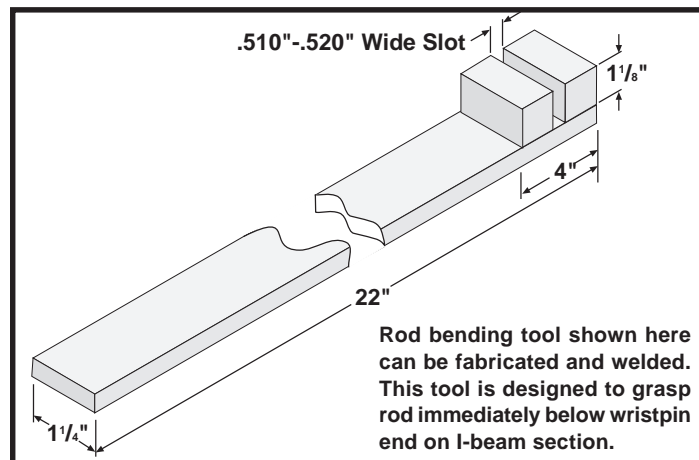


Figure 6

- K. Disassemble engine and check thickness of putty in valve pockets.

*NOTE - S&S recommends at least .060" clearance between valve and piston valve pocket recess. While .060 clearance is recommended minimum, it is advisable to have .080 and up, if possible.*

**CAUTION** - Insufficient clearance between piston and valves may cause them to contact each other during operation resulting in damage to piston and valve train components.

- L. If less than .060 clearance in any area exists, grind area until proper clearance is achieved.

## 11. Final Top End Assembly and Engine Installation

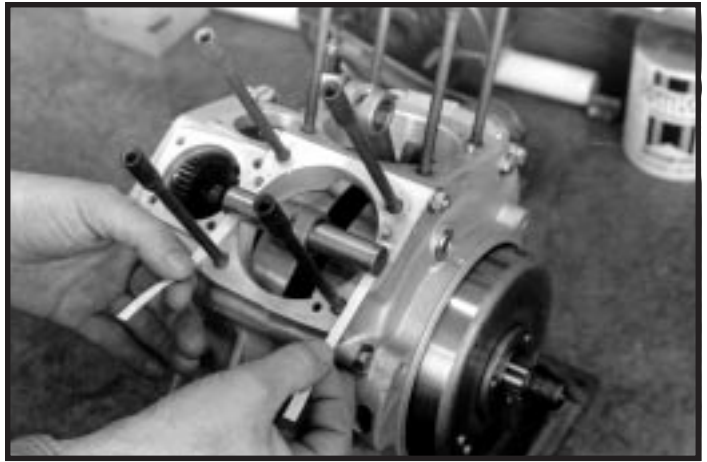
*NOTE - All previous steps must be completed. On engines other than Evolution Big Twins, we recommend installing cylinders without heads bolted to cylinders for two reasons:*

1. Combined weight of cylinder and cylinder head makes assembly cumbersome and hard to handle during installation.
2. Separate installation of cylinders and cylinder heads permits more leeway for adjustment to achieve a better manifold fit.

**CAUTION** - Installation of cylinders and cylinder heads as assemblies may result in damage to rings and piston assemblies. Improper intake manifold fit may cause intake air leaks/improper fuel mixture and resultant damage to engine components.

### Piston Installation

1. Pistons Series #92-2400, #92-2420, #92-2500, #92-2510, #92-2600, #92-2610, #92-2700, #92-2720 and #92-2730 have offset wristpins and must be installed with dimple cast in piston dome toward right or cam side of engine.
2. All other pistons series have no special features and can be installed any way the builder desires unless there is a piston to piston clearance bevel on one skirt thrust face. If there is, this bevel must go towards center of engine.
3. Some pistons series have all of the piston to piston clearance in the rear piston. Install rear piston with notch



Picture 12

toward front piston. Make sure dimple in piston dome is in correct position if piston is offset wristpin type.

4. Check all installations for a minimum of .060" clearance between pistons at bottom of stroke.
6. Check all installations for a minimum of .060" clearance between pistons and flywheels at bottom of stroke. New 4 5/8" stroke stock bore installations should come with proper piston to flywheel clearance. Replacement pistons may or may not come with adequate clearance. Compare replacement pistons with ones being replaced and make corrections accordingly.

### Wristpin Retainer Installation

1. If wristpin clips are to be used, make sure groove is free of burrs and foreign material.
2. Round "wire" style clips which are identical to and interchangeable with stock H-D V<sup>2</sup> clips require a specially chamfered end wristpin. Install clips using H-D recommended procedure. Special indexing of clip is not necessary. Be sure clip is fully seated in groove.
3. "Tru-Arc" style clips should be installed using proper tool. Clips should not be used with wristpins with chamfer on end that is greater than 1/8". Install clip with open side facing downward and sharp edge of clip to outside of wristpin hole away from wristpin. Be sure clip is fully seated in groove.
4. "Spiral-Loc" style clips are installed by slowly working clip into wristpin hole using thumb nail in a screwing motion. Once entire clip is in hole, use another wristpin to push clip into groove. Be sure clip is fully seated in groove.

*NOTE - Spiral-loc type wrist pin retainers must not be used with wrist pins with beveled ends.*

**CAUTION** -Use of Spiral-loc type wrist pin retainers with wrist pins with beveled ends could result in wrist pin retainer failure and major damage to engine. Teflon wrist pin buttons must only be used in pistons where buttons are fully supported by wristpin hole. They are used in place of and not in conjunction with conventional wristpin retaining clips. Recommended wristpin endplay is .010" to .060" and is determined by subtracting length of wristpin with a button on each end from finished cylinder bore. To make fitting easier S&S buttons come in two widths for stock bore applications. "A" buttons are thinner and "B" buttons are

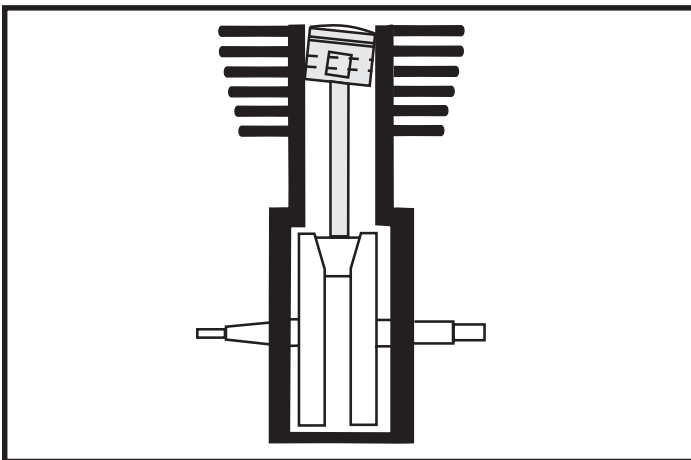


Figure 7

thicker. Use two A buttons, Part #94-9251, for bore sizes  $3\frac{1}{16}$ " std. to  $3\frac{7}{16}$ " +.040, two B buttons, Part #94-9252, for bore sizes  $3\frac{1}{16}$ " +.050 to  $3\frac{1}{16}$ " +.090.

### Ring Installation

1. Piston ring widths have changed on some piston series from time to time. It is recommended that ring parts supplied with pistons be recorded for future reference in the event replacement rings are required.
2. Oil rings are three piece circumferential expander cylinder type. End gap on all rails except those for V<sup>2</sup>s with  $3\frac{1}{2}$ " ( $3\frac{7}{16}$ " +.060) bore is .010" to .040". On V<sup>2</sup>s with  $3\frac{1}{2}$ " bore it is .015" to .065". Grind end gaps as necessary. **Do not leave burrs as they will scratch cylinder walls. Do not shorten expander for any reason.** Place end gaps as follows: Expander – gap in center of thrust face 90° to wristpin. Bottom rail – gap 2" to right of expander gap. Top rail – gap 2" to left of expander gap.
3. Compression rings may be cast iron type, chrome faced cast iron type, moly faced cast type and chrome type. The most common combinations supplied are two chrome faced cast, one chrome faced cast and one cast iron, and one moly faced cast and one cast iron. Chrome faced or moly faced ring always goes in top groove. Cast iron type usually goes in second groove. Cast iron type is usually a reverse torsion style ring distinguished by an inside diameter bevel on one side of ring with a "dot" or oversize mark on other side of ring. If two cast iron compression rings are supplied in set, check to see if one is reverse torsion style ring. Reverse torsion style ring always goes in second groove. The following rules apply to compression ring identification and placement. Rules are listed in order of priority.
  - a. Chrome or moly ring goes in top groove.
  - b. Cast iron regular or reverse torsion goes in second groove.
  - c. Any identifying "pip" marks, dots or oversize marks go to top of piston.
  - d. One dot goes in top groove, two dots go in second groove.
  - e. If both have one dot or two dots, they can go in either groove.
  - f. If ring has dots and inside diameter bevel, dots go to top of piston.
  - g. If ring has no dots and inside diameter bevel, bevel goes to top of piston.
  - h. If ring has not dots, etc. and no bevel, it can go either way.

End gap on all compression rings except V<sup>2</sup>s with  $3\frac{1}{2}$ " bore is .012" to .030". On V<sup>2</sup>s with  $3\frac{1}{2}$ " bore end gap is .008" to .030". In certain instances, the next oversize ringset may be supplied with pistons, ie. +.060" oversize rings with +.050" pistons. This is permissible but end gaps must be filed. Place end gaps on all compression rings as follows: Second groove – 3" to right of oil expander gap. Top groove – gap 3" to left of oil expander gap.

4. When rings are compressed for piston installation in bore, be sure oil ring expander ends do not overlap and ring stays assembled properly.

### Final Assembly

♣♣ **CAUTION - To avoid parts damage and obtain accurate torque readings, clean head bolt threads thoroughly before installation. For Knuckle, Pan, or Shovelheads, head bolt threads and area of bolt head that contacts washer (if applicable) or cylinder must then be lubricated with Permatex Anti-Seize Lubricant or similar anti-seize compound. S&S has received reports of thread damage in these engines associated with use of engine oil to lubricate head bolts. Use of clean engine oil is preferable for V<sup>2</sup>-style headbolts only.**

- A. Install and tighten cylinders, cylinder heads and manifold as in standard assembly.

*NOTE - Retighten cylinder base nuts and head bolts as necessary after engine has been run.*

- B. Install engine in frame and check for engine to frame and/or gas tank contact.

*NOTE - Engine with longer cylinders than stock due to cylinder base plates may contact rigid mount frame and/or right gas tank with rear rocker box. S&S recommends there be .060" minimum clearance between engine and other chassis components on rigid frame installations. Rubber mount chassis have adequate room for any engine combination. Up to .060" or .070" may be ground from rocker box cover in some areas for clearance. Additional material may be sparingly removed from frame if rocker cover clearancing is inadequate.*

**CAUTION - Excessive material removed from rocker cover may damage cover causing oil leaks.**

**WARNING - Excessive material removed from frame may cause structural damage and possible failure resulting in personal injury to you or others near you.**

- C. Install engine head mount.

*NOTE - Stock head mount will be short if you are installing S&S stroker kit with cylinder base plates thicker than .0625" ( $\frac{1}{16}$ "). If  $\frac{1}{16}$ " thick or less plates are used, modify stock mount. If plates thicker than  $\frac{1}{16}$ " are used, install S&S heavy duty head mount, part #93-4054. This mount is heavy duty and designed especially to provide support for tall, big inch engines. Its two piece design permits precise head to frame alignment which reduces stress and potential head mount failure.*

**CAUTION - Improper mounting of engine in frame may cause engine to come loose resulting in damage and/or failure of engine motor mounts and/or other engine mounting brackets.**

### 12. Timing, Carburetion, Exhaust, Gearing and Break-in (All Engines)

#### Ignition Timing Notes

- See Step 8, "Lower End Assembly", for explanation of S&S timing marks.
- S&S flywheels have timing marks that position pistons at 35° before top center, same as stock, when mark is in center of timing hole. Placing mark to right side of hole or just entering hole

advances timing almost 5°. Vice versa, if mark is just leaving hole, timing is retarded almost 5°.

● Maximum performance in early engines traditionally has been with timing set at 37° to 39°, but because of poor gasoline, detonation, etc. it is advisable to stay with 35°. Some builders will even retard ignition timing slightly because of aforementioned problems, but if you do, watch heat build-up. If there is any doubt, stay with H-D factory recommended settings.

● Evolution V<sup>2</sup> SIDEWINDER tests conducted on our dyno have indicated that the best horsepower will be produced with timing set from 30° to 35°, depending on cylinder head design, compression ratio and type of fuel. Evolution 98" engine used was equipped with point type ignition system which allowed us maximum flexibility to advance or retard ignition timing. It also removed RPM limitations set by stock "black box". If stock electronic system is retained, contact your local H-D dealer for part number of ignition module that is recommended for high performance, high rpm usage.

● Whatever ignition system is used, the best rule of thumb for most situations is to follow stock timing specs and watch for signs of detonation and/or excessive heat.

● Ignition timing for engines with dual plugged heads should generally be retarded 5-8° from the stock setting. However, due to the large number of variables involved, optimum ignition timing is impossible to accurately predict and must be determined for each engine by experimentation

**CAUTION - Improper ignition timing may cause excessive engine heat which may damage pistons and/or other engine components.**

#### Carburetion Notes

● All S&S test engines have been run with S&S carburetors. A Super E or Super G carburetor is recommended for most strokers. Consult carburetor jetting instructions for specific jetting recommendations.

● If another type carburetor is used, it must be made to run rich enough so engine is not damaged. Other carburetor types are a personal problem and we cannot answer questions concerning them. It is best to call carb manufacturer if you have any questions.

#### Exhaust Systems Notes

● To establish performance guidelines, S&S used 30" long stock diameter drag pipes on pre-Evolution engines with good results. We suggest you try them on these engines to establish a baseline to compare with other systems. Evolution engines are easier to carbureate with muffled systems.

● You might ask the manufacturer of the exhaust system you are considering if he has had any experience with S&S strokers. Many systems are made for looks with little consideration given to performance. Most stock systems and many aftermarket ones tried are too restrictive for good performance. Harley-Davidson does offer a series of mufflers that can be used with stock header pipes. These work very well in most situations and offer an inexpensive alternative to a new exhaust system. We prefer their tapered and baloney cut styles. Evolution engines should use a system equipped with a crossover pipe that connects front and rear header pipes.

#### Gearing Note

● Gearing depends on total weight of machine and rider/s, size of engine, caming, exhaust system and type of riding to be done. Most strokers are capable of pulling more gear. We suggest

you break engine in with stock gearing to **minimize lugging engine**. After engine is broken in you will have a better feel of its potential and can change gearing accordingly.

● For those who wish to determine their final drive gear ratio the formula is as follows:

$$\text{Engine Revolutions Per One Revolution of Rear Wheel} = \frac{(\text{Clutch Sprocket}^*) \times (\text{Rear Wheel Sprocket}^*)}{(\text{Motor Sprocket}^*) \times (\text{Transmission Sprocket}^*)}$$

\*Number of teeth on each sprocket

#### Break-In Procedure

This procedure applies to all engines with close fit pistons.

*NOTE - These engines must be broken in. They will feel extremely strong so resist the impulse to turn it on. Break it in properly.*

**CAUTION - Lugging engine at low rpms and/or running engine prematurely at high rpms may result in damage to pistons and/or other engine components. S&S voids its guarantee if engine is not broken in properly.**

1. On initial engine startup, don't just sit and idle motor while you admire your work, or tinker with minor adjustments. Heat buildup can be excessive. Do not let engine overheat.

*IMPORTANT NOTE - V<sup>2</sup>s ONLY - Proper first time engine start-up and break-in for first 15 minutes is critical to achieve permanent and lasting head gasket seal. Upon initial start-up, idle engine at 1000-1500 rpm until cylinder head temperature reaches about 250°. Do not crack throttle or put any load on engine during this time. Heat buildup is necessary to cause heads and cylinders to expand and seal. Do not let heat get excessive. Prior to initial start-up, a .003"-.005" "feeler gauge" will fit between head gasket and head and cylinder gasket surfaces stopping at fire ring on head gasket. Warming engine as instructed will tightly close this gap producing a good, lasting seal. Most V<sup>2</sup> head gaskets are blown at this time.*

**CAUTION - Improper initial V<sup>2</sup> engine start-up may cause head gaskets to fail prematurely.**

2. First 50 miles are most critical for new rings and piston break-in. Most engine damage will initially occur during this period. Keep heat down by not exceeding 2500 rpm. Vary speed. **Do not lug engine.**

*NOTE - Retighten cylinder base nuts and head bolts as necessary after engine has been run.*

3. Next 500 miles should be spent running engine no faster than 3500 rpm or about 50-55 mph. **Do not lug engine** and continue to vary speed.
4. For balance of first 1000 miles, speed can be run up to 60-70. Continue to run engine at all different speeds including lower 40-45 mph ranges. Do not lug engine.
5. 1000-2000 miles basically same as before but a little more liberal with rpm range. Avoid overheating and **lugging** engine – no drag racing, trailer towing, etc.
6. 2000 miles and up – have fun!

