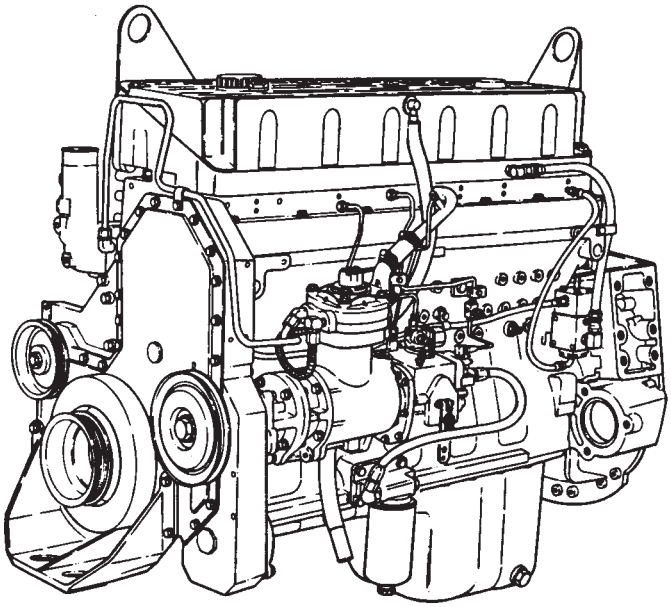
Alternative Repair Manual
L10 and M11 Series Engines



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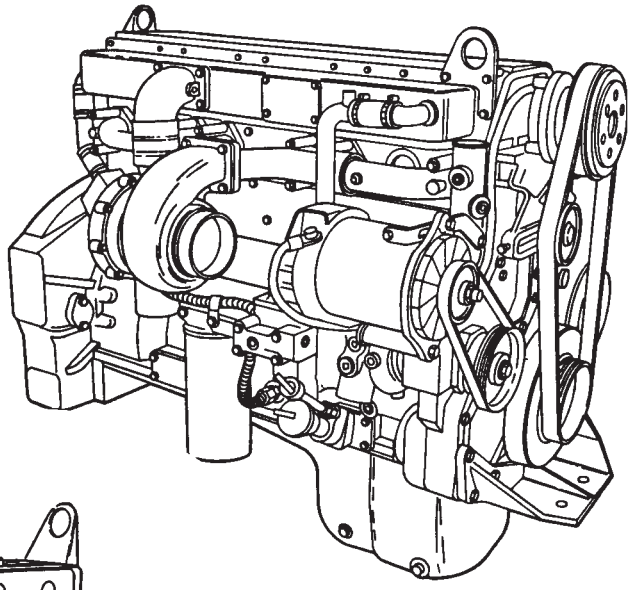

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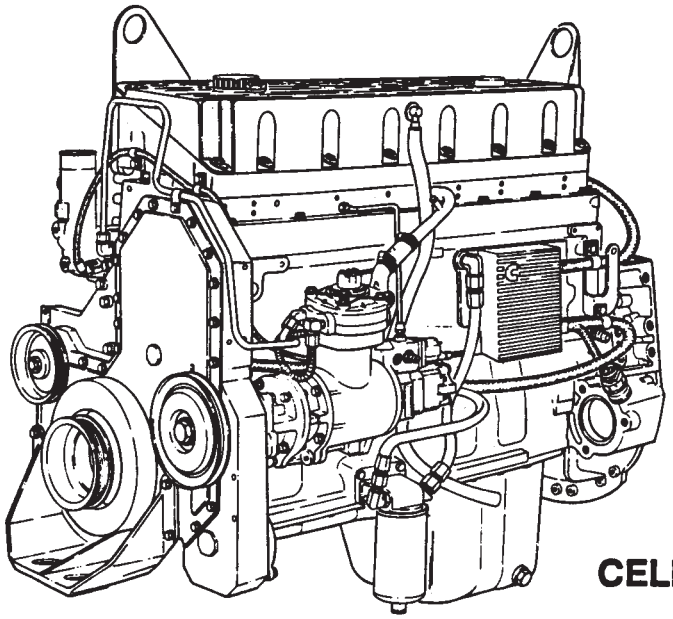

CELECT

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Foreword

This alternative repair manual contains specifications and instructions for repairing damaged or worn components. The repair procedures are based on the engine being repaired with approved machining and grinding equipment. Some procedures require the use of special service tools. Make sure the correct tools and equipment are used as described in the procedures.

Read and follow all safety instructions. Refer to the WARNING in the General Safety Instructions in Section i - Introduction.

When a specific brand name, number, or special tool is referenced in this manual, an equivalent product can be used in place of the recommended item.

A series of specific service manuals (for example: Shop, Troubleshooting and Repair, and Specifications) are available and can be ordered by filling out and mailing the Literature Order Form located in Section L - Service Literature.

Cummins Engine Company, Inc. encourages the user of this manual to report errors, omissions, and recommendations for improvement. Please use the postage paid, pre-addressed Literature Survey Form in the back of this manual for communicating your comments.

The specifications and rebuild information in this manual is based on the information in effect at the time of printing. Cummins Engine Company, Inc. reserves the right to make any changes at any time without obligation. If differences are found between your engine and the information in this manual, contact a Cummins Authorized Repair Location or call 1-800-DIESELS (1-800-343-7357).

The latest technology and the highest quality components are used to manufacture Cummins engines. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts. These parts can be identified by the following trademarks:

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About The Manual

The procedures in this manual were developed for a shop environment. A Group System has been used to subdivide the instructions by major components and systems. Refer to the Section Contents for the various groups. Wrench sizes and shop tooling are identified in the procedure when needed.

This publication provides general repair information, cylinder block repair, and cylinder head repair. Subsequent versions of the manual will include alternative repairs for additional components as they are developed.

The contents of this manual are based on information in effect at the time of publication and are subject to change without notice.

How to Use the Manual

This manual is divided in the same group system used for Cummins' engine shop manual. Each group is organized in a way that all mechanics, both those who are and are not familiar with the L10 or M11 engine models can reference the manual. Refer to the Table of Contents at the front of the manual to determine the group that details the desired information.

Each group contains the following in sequence:

- Section contents at the beginning of each group to quickly aid in locating the information desired.
- Service tools list with recommended tools needed to rebuild the components.
- General information to aid in repairing the component.
- Step-by-step rebuild instructions for cleaning, inspection and salvage of the component.
- Symbols which represent the action outlined in the instructions. The definitions of the symbols, listed in four languages (English, Spanish, French and German), appear on pages i-4 through i-7.

Topics will be listed alphabetically on the Section Contents page. All procedures are described using the text-symbol-picture (TSP) format.

Both metric and U.S. customary values are used in this manual. The metric value is listed first, followed by the U.S. customary in brackets. An example is 60°C [140°F].

Engine Identification

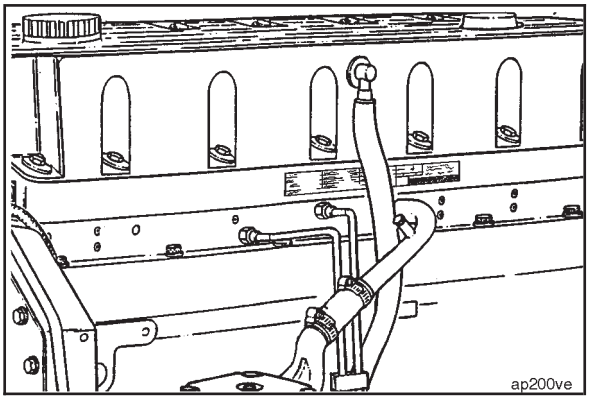
The model name provides the following data:

M 11 - 330 E

- E = Electronic Fuel System
- 330 = Brake Horsepower
- 11 = Displacement (Liters)
- M = Engine Model Designation

Engine Dataplate

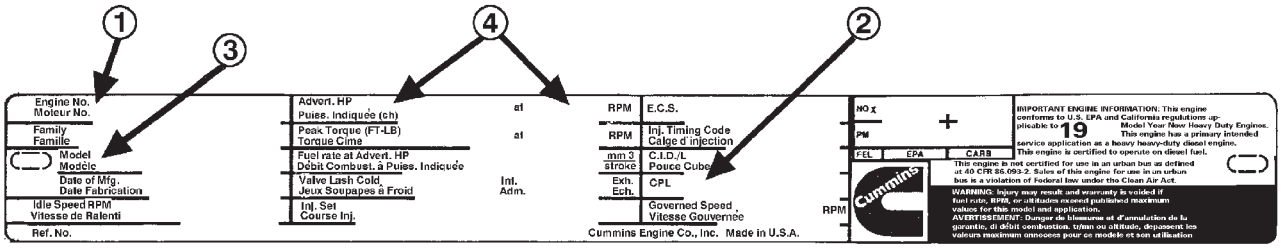
The engine dataplate is located on the fuel pump side of the rocker housing.



The engine dataplate provides model identification as well as other important information about the engine.

Have the following engine data available when communicating with a Cummins Authorized Repair Location. The information on the dataplate is **mandatory** when sourcing service parts.

1. Engine Serial Number (E.S.N.)
2. Control Parts List (CPL)
3. Model
4. Horsepower and RPM Rating



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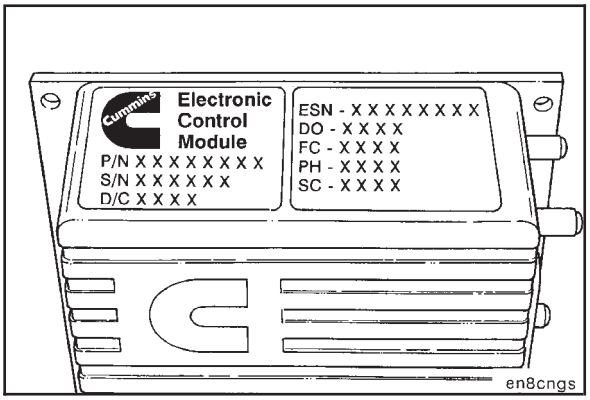
Electronic Control Module (ECM) Dataplate

On CELECT™ engines, there are two dataplates on the top of the electronic control module (ECM).



en8cngs

The dataplate on the left contains the part number (P/N), serial number (S/N) and the date code (D/C) of the ECM.

The dataplate on the right contains the engine serial number, fuel code and engine calibration information.

Symbols

The following symbols have been used in this manual to help communicate the intent of the instructions. When one of the symbols appears, it conveys the meaning defined below:

WARNING - Serious personal injury or extensive property damage can result if the warning instructions are **not** followed.

CAUTION - Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are **not** followed.

Indicates a **REMOVAL or DISASSEMBLY** step.

Indicates an **INSTALLATION or ASSEMBLY** step.

INSPECTION is required.

CLEAN the part or assembly.

PERFORM a mechanical or time **MEASUREMENT**.

LUBRICATE the part or assembly.

Indicates that a **WRENCH or TOOL SIZE** will be given.

TIGHTEN to a specific torque.

PERFORM an electrical **MEASUREMENT**.

Refer to another location in this manual or another publication for additional information.

The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

Simbolos

Los símbolos siguientes son usados en este manual para clarificar el proceso de las instrucciones. Cuando aparece uno de estos símbolos, su significado se especifica en la parte inferior.

ADVERTENCIA - Serios daños personales o daño a la propiedad puede resultar si las instrucciones de Advertencia **no** se consideran.

PRECAUCION - Daños menores pueden resultar, o de piezas del conjunto o el motor puede averiarse si las instrucciones de Precaución **no** se siguen.

Indica un paso de **REMOCION** o **DESMONTAJE.**

Indica un paso de **INSTALACION** o **MONTAJE.**

Se requiere **INSPECCION.**

LIMPIESE la pieza o el montaje.

EJECUTESE una **MEDICION** mecánica o del tiempo.

LUBRIQUESE la pieza o el montaje.

Indica que se dará una **LLAVE DE TUERCAS** o el **TAMAÑO DE HERRAMIENTA.**

APRIETESE hasta un par torsor específico.

EJECUTESE una **MEDICION** eléctrica.

Para información adicional refiérase a otro emplazamiento de este manual o a otra publicación anterior.

El componente pesa 23 kg [50 lb] o mas. Para evitar dano corporal empleen una cabria u obtengan ayuda para elevar el componente.

Symbole

In diesem Handbuch werden die folgenden Symbole verwendet, die wesentliche Funktionen hervorheben. Die Symbole haben folgende Bedeutung:

WARNUNG - Wird die Warnung **nicht** beachtet, dann besteht erhöhte Unfall- und Beschädigungsgefahr.

VORSICHT - Werden die Vorsichtsmassnahmen **nicht** beachtet, dann besteht Unfall- und Beschädigungsgefahr.

AUSBAU bzw. **ZERLEGEN.**

EINBAU bzw. **ZUSAMMENBAU.**

INSPEKTION erforderlich.

Teil oder Baugruppe **REINIGEN.**

DIMENSION - oder **ZEITMESSUNG.**

Teil oder Baugruppe **ÖLEN.**

WERKZEUGGRÖSSE wird angegeben.

ANZUG auf vorgeschriebenes Drehmoment erforderlich.

Elektrische **MESSUNG DURCHFÜHREN.**

Weitere Informationen an anderer Stelle bzw. in anderen Handbüchern.

Das teil weigt 23 kg [50 lb] oder mehr. Zur vermeidung von koerperverletzung winde benutzen oder hilfe beim heben des teils in anspruch nehmen.

Symboles

Les symboles suivants sont utilisés dans ce manuel pour aider à communiquer le but des instructions. Quand l'un de ces symboles apparaît, il évoque le sens défini ci-dessous:

AVERTISSEMENT - De graves lésions corporelles ou des dommages matériels considérables peuvent survenir si les instructions données sous les rubriques ″Avertissement″ **ne** sont **pas** suivies.

ATTENTION - De petites lésions corporelles peuvent survenir, ou bien une pièce, un ensemble ou le moteur peuvent être endommagés si les instructions données sous les rubriques ″Attention″ **ne** sont **pas** suivies.

Indique une opération de **DEPOSE.**

Indique une opération de **MONTAGE.**

L'INSPECTION est nécessaire.

NETTOYER la pièce ou l'ensemble.

EFFECTUER une **MESURE** mécanique ou de temps.

GRAISSER la pièce ou l'ensemble.

Indique qu'une **DIMENSION DE CLE** ou **D'OUTIL** sera donnée.

SERRER à un couple spécifique.

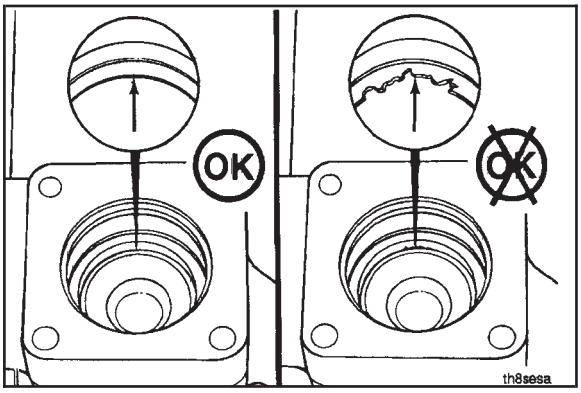
EFFECTUER une **MESURE** électrique.

Se reporter à un autre endroit dans ce manuel ou à une autre publication pour obtenir des informations plus complètes.

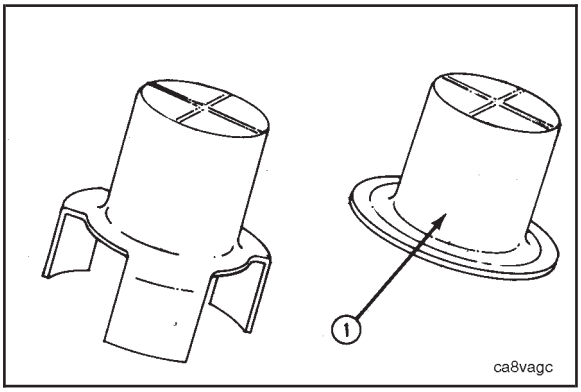
Le composant pese 23 kg [50 lb] ou davantage. Pour eviter toute blessure, employer un appariel de levage ou demander de l'aide pour le soulever.

Illustrations

The illustrations used in the ″Repair Sections″ of this manual are intended to give an example of a problem, and to show what to look for and where the problem can be found. Some of the illustrations are generic and might **not** look exactly like the engine or parts used in your application. The illustrations can contain symbols to indicate an action required, and an acceptable or **not** acceptable condition.



The illustrations are intended to show repair or replacement procedures. The illustration can differ from your application, but the procedure given will be the same.



General Safety Instructions

Important Safety Notice

⚠ WARNING ⚠

Improper practices or carelessness can cause burns, cuts, mutilation, asphyxiation or other bodily injury or death.

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that **must** be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

- Make sure the work area surrounding the product is dry, well lit, ventilated; free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- **Always** wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do **not** wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a ‘‘Do **Not** Operate’’ tag in the operator’s compartment or on the controls.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do **not** attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before you slowly loosen the filler cap and relieve the pressure from the cooling system.
- Do **not** work on anything that is supported ONLY by lifting jacks or a hoist. **Always** use blocks or proper stands to support the product before performing any service work.
- Relieve all pressure in the air, oil, and the cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do **not** check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To prevent suffocation and frostbite, wear protective clothing and ONLY disconnect liquid refrigerant (freon) lines in a well ventilated area. To protect the environment, liquid refrigerant systems **must** be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capture and recycling refrigerant.
- To avoid personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. **Always** use a spreader bar when necessary. The lifting hooks **must not** be side-loaded.
- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do **not** get the substance in your eyes. Avoid prolonged or repeated contact with skin. Do **not** swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and **must** be used with caution. Follow the manufacturer’s instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.
- To avoid burns, be alert for hot parts on products that have just been turned OFF, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use them before performing any service work. Use ONLY genuine Cummins or Cummins ReCon® replacement parts.
- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lessor quality if replacements are necessary.
- Do **not** perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.

General Repair Instructions

This engine incorporates the latest diesel technology at the time it was manufactured; yet, it is designed to be repaired using normal repair practices performed to quality standards.

- **Cummins Engine Company, Inc. does not recommend or authorize any modifications or repairs to engines or components except for those detailed in Cummins Service Information. In particular, unauthorized repair to safety-related components can cause personal injury or death. Below is a partial listing of components classified as safety-related:**

  Air Compressor
  Air Controls
  Air Shutoff Assemblies
  Balance Weights
  Cooling Fan
  Fan Hub Assembly
  Fan Mounting Bracket(s)
  Fan Mounting Capscrews
  Fan Hub Spindle
  Flywheel
  Flywheel Crankshaft Adapter
  Flywheel Mounting Capscrews
  Fuel Shutoff Assemblies
  Fuel Supply Tubes
  Lifting Brackets
  Throttle Controls
  Turbocharger Compressor Casing
  Turbocharger Oil Drain Line(s)
  Turbocharger Oil Supply Line(s)
  Turbocharger Turbine Casing
  Vibration Damper Mounting Capscrews

- **Follow All Safety Instructions Noted in the Procedures.**
  - Follow the manufacturer's recommendations for cleaning solvents and other substances used during the repair of the engine. Some solvents and used engine oil have been identified by government agencies as toxic or carcinogenic. Avoid excessive breathing, injestion and contact with such substances. **Always** use good safety practices with tools and equipment.
- **Provide A Clean Environment and Follow the Cleaning Instructions Specified in the Procedures**
  - The engine and its components **must** be kept clean during any repair. Contamination of the engine or components will cause premature wear.
- **Perform the Inspections Specified in the Procedures.**
- **Replace all Components or Assemblies Which are Damaged or Worn Beyond the Specifications**
- **Use Genuine Cummins New or ReCon® Service Parts and Assemblies**
  - The assembly instructions have been written to use again as many components and assemblies as possible. When it is necessary to replace a component or assembly, the procedure is based on the use of new Cummins or Cummins ReCon® components. All of the repair services described in this manual are available from all Cummins Distributors and most Dealer locations.
- **Follow The Specified Disassembly and Assembly Procedures to Avoid Damage to the Components.**

Complete rebuild instructions are available in the shop manual which can be ordered or purchased from a Cummins Authorized Repair Location. Refer to Section L, Literature, for ordering instructions.

Welding on a Vehicle with an Electronic Controlled Fuel System

⚠ CAUTION ⚠

Disconnect both the positive (+) and negative (-) battery cables from the battery before welding on the vehicle. Attach the welder ground cable no more than 0.610 meters [2 feet] from the part being welded. Do not connect the ground cable of the welder to the ECM cooling plate or ECM. Welding on the engine or engine mounted components is not recommended.

Welding on a PT Pacer™ Controlled Vehicle

Caution: When welding on a PT Pacer™ controlled vehicle, to protect the PCU computer circuits, the procedure below MUST be followed:

1. Remove the plus (+) 12 volt supply wire from the fuel shutoff solenoid or wherever the +12 volt power supply is connected.
2. Remove the harness ground wire from the engine block.
3. Disconnect the positive (+) and negative (-) battery cables from the battery.
4. Do **NOT** connect the welder ground cable to the PCU.

Welding on a PACE™ Controlled Vehicle

Caution: When welding on a PACE™ controlled vehicle, to protect the PTCM computer circuits, the procedure below MUST be followed:

1. Remove both connectors going to the PTCM.
2. Disconnect the positive (+) and negative (-) battery cables from the battery.
3. Do **NOT** connect the welder ground cable to any part of the PACE™ control system.

General Cleaning Instructions

Solvent and Acid Cleaning

Several solvent and acid-type cleaners can be used to clean the engine parts. Experience has shown that the best results can be obtained using a cleaner that can be heated to 90 to 95 degrees Celsius [180 to 200 degrees Fahrenheit]. A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results. **Cummins Engine Company, Inc. does not recommend any specific cleaners. Always** follow the cleaner manufacturer's instructions.

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful **not** to damage any gasket surfaces. When possible, steam clean the parts before putting them in the cleaning tank.

⚠ WARNING ⚠

Acid is extremely dangerous, and can damage the machinery. Always provide a tank of strong soda water as a neutralizing agent.

Rinse all of the parts in hot water after cleaning. Dry completely with compressed air. Blow the rinse water from all of the capscrew holes and the oil drillings.

If the parts are **not** to be used immediately after cleaning, dip them in a suitable rustproofing compound. The rustproofing compound **must** be removed from the parts before installation on the engine.

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good way to clean the oil drillings.

⚠ WARNING ⚠

Wear protective clothing to prevent personal injury from the high pressure and extreme heat.

Do **not** steam clean the following parts:

1. Electrical Components
2. Wiring
3. Injectors
4. Fuel Pump
5. Belts and Hoses
6. Bearings
7. Electronic Control Module (ECM)
8. ECM Connectors

Glass or Plastic Bead Cleaning

Glass or plastic bead cleaning can be used on many engine components to remove carbon deposits. The cleaning process is controlled by the size of the glass or plastic beads, the operating pressure, and the cleaning time.

⚠ CAUTION ⚠

Do not use glass or plastic bead cleaning on aluminum piston skirts. Do not use glass bead cleaning on aluminum ring grooves. Small particles of glass or plastic will embed in the aluminum and result in premature wear. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.

NOTE: Plastic bead blasting media, Part No. 3822735, can be used to clean aluminum ring grooves. Do **not** use any bead blasting media on pin bores or aluminum skirts.

Follow the equipment manufacturer's cleaning instructions. The following guidelines can be used to adapt to manufacturer's instructions:

1. Bead size:
   - Use U.S. size No. 16-20 for piston cleaning with plastic bead media, Part No. 3822735.
   - Use U.S. size No. 70 for piston domes with glass media.
   - Use U.S. size No. 60 for general purpose cleaning with glass media.
2. Operating Pressure:
   - Glass: Use 620 kPa [90 psi] for general purpose cleaning.
   - Plastic: Use 270 kPa [40 psi] for piston cleaning.
3. Steam clean or wash the parts with solvent to remove all of the foreign material and glass or plastic beads after cleaning. Rinse with hot water. Dry with compressed air.
4. Do **not** contaminate the wash tanks with glass or plastic beads.

Acronyms and Abbreviations

AFC	Air Fuel Control
API	American Petroleum Institute
ASA	Air Signal Attenuator
ASTM	American Society of Testing and Materials
°C	Celsius
CARB	California Air Resources Board
C.I.D.	Cubic Inch Displacement
cm	Centimeter
CPL	Control Parts List
cSt	Centistokes
ECM	Electronic Control Module
ECS	Emission Control System
EPA	Environmental Protection Agency
EPS	Engine Position Sensor
°F	Fahrenheit
ft-lb	Foot Pound
GVW	Gross Vehicle Weight
Hg	Mercury
hp	Horsepower
H_2O	Water
in-lb	Inch Pound
kg	Kilograms
km	Kilometers
km/l	Kilometers per Liter
kPa	Kilopascal
l	Liter
LTA	Low Temperature Aftercooling
m	Meter
mm	Millimeter
MPa	Megapascal
mph	Miles Per Hour
mpq	Miles Per Quart
N•m	Newton-meter
OEM	Original Equipment Manufacturer
ppm	Parts Per Million
psi	Pounds Per Square Inch
PTO	Power Takeoff
RPM	Revolutions Per Minute
SAE	Society of Automotive Engineers
SCA	Supplemental Coolant Additive
STC	Step Timing Control
VS	Variable Speed
VSS	Vehicle Speed Sensor

NOTES

Section 0 — General Repairs

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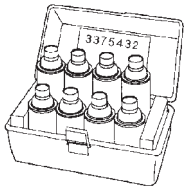
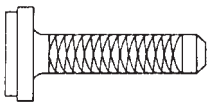
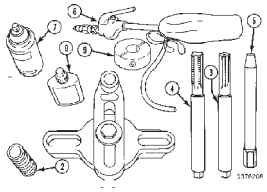
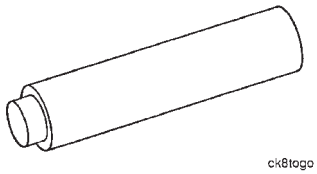
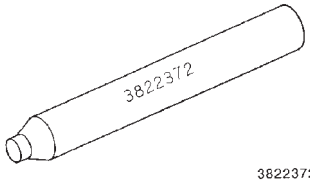
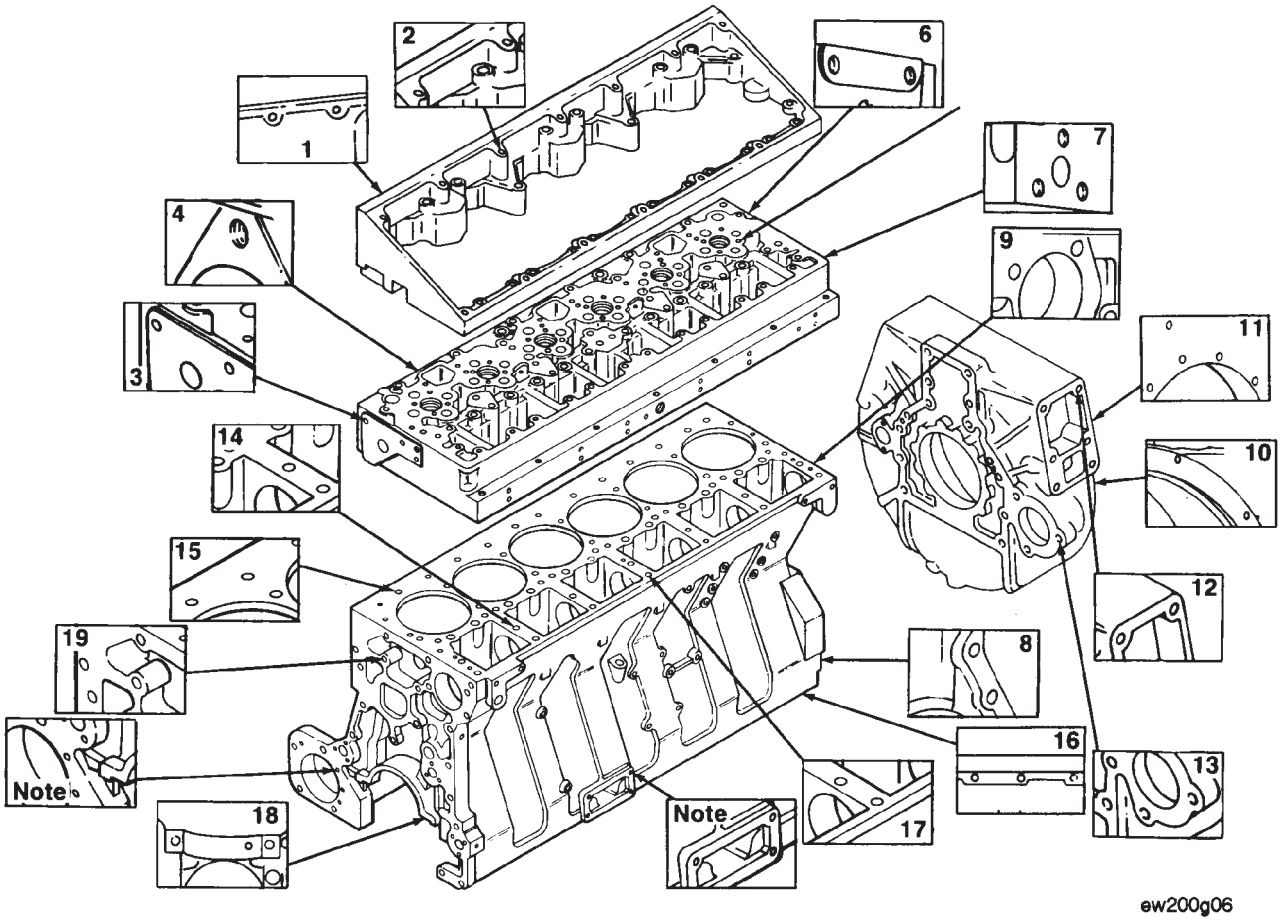
Service Tools — General Repairs

The following special tools are recommended to perform procedures in Group 00. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
3375021	**Threaded Insert Kit** The kit contains the installation tools and associated thread inserts.	 3822709
3375432	**Crack Detection Kit** Inspect components for cracks. The kit consists of spray cleaner, Part No. 3375433, developer, Part No. 3375434, and penetrant, Part No. 3375435.	 3375432
3376058	**Expansion Plug Driver** Install the 2.263 inch diameter plugs in the cylinder head.	 3376058
3376208	**Thread Repair Tool Kit** Repair damaged capscrew threads. The kit contains the service tools required to salvage capscrew thread holes.	
3376816	**Expansion Plug Driver** Install the 1.010 inch diameter plugs in the cylinder block. Used with handle, Part No. 3376795.	 ck8togo
3822372	**Expansion Plug Driver** Install the 0.380 inch diameter expansion plugs in the cylinder block.	 3822372

Straight Thread Holes — Exploded



Ref. No.	Mounting Capscrew Thread Location	Thread Size	Ref. No.	Mounting Capscrew Thread Location	Thread Size
1	Aftercooler	M10 x 1.50	11	Rear Crankshaft Seal	M8 x 1.25
2	Rocker Cover	M8 x 1.25	12	*Mounting Pad	M16 x 2.00, M12 x 1.75, 5/8 x 11UNC or 3/4 x 10 UNC
3	Fan Support	M12 x 1.75	13	*Starting Motor Mounting	M16 x 2.00 or 5/8 x 11 UNC
4	Exhaust Manifold	M10 x 1.50	14	Cam Follower Mounting Studs	M10 x 1.50
5	Injector Hold Down Clamps	M8 x 1.25	15	Cylinder Head	M14 x 1.50
6	Lifting Bracket	M12 x 1.75	16	Lubricating Oil Pan	M10 x 1.50
7	Cover Plate	M10 x 1.50	17	Small Cylinder Head	M10 x 1.50
8	Flywheel Housing	M16 x 2.00	18	Main Bearing Cap	M14 x 1.50
9	Camshaft Cover Plate	M10 x 1.50	19	Gear Cover Plate	M10 x 1.50
10	*Transmission	M10 x 1.50 or 7/16 x 14UNC			

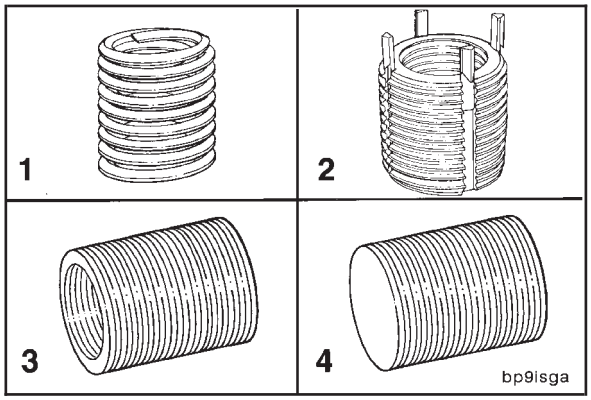
* To determine the thread size, inspect the capscrews that were removed.

NOTE: Miscellaneous threaded holes for mounting accessories are M10 x 1.50 thread size.

Straight Thread Hole Repair

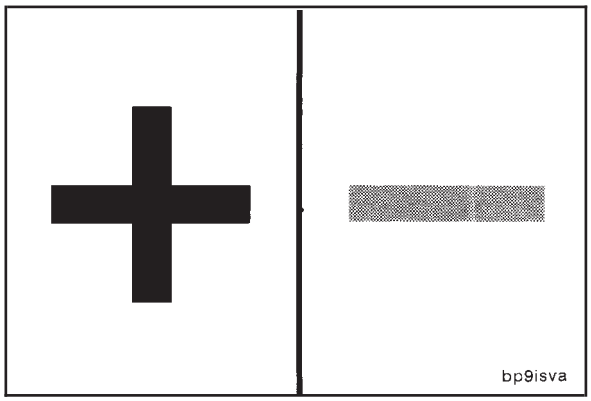
General Information

These repair procedures can be used for repairing damaged capscrew threads on all engine components. Most of the capscrews used on the L10 and M11 engines are metric. However, some external engine components, such as the air compressor and fuel pump, are installed using U.S. Customary capscrews. All capscrews are right hand threads unless otherwise specified. If the thread size is **not** specified, inspect the capscrews that were removed to determine the correct thread size.



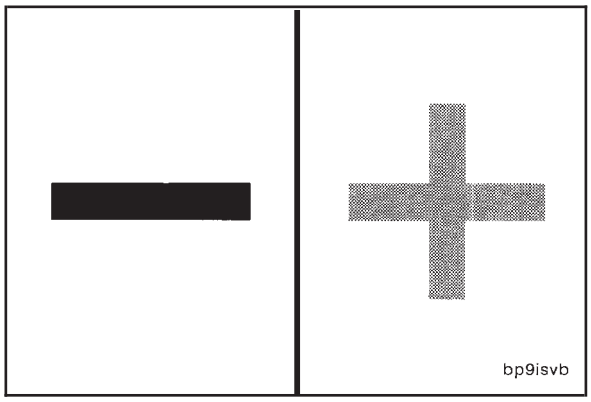
Four different types of thread insert can be used to repair damaged capscrew threads:

1. Coiled Thread Inserts
2. Keylock Thread Inserts
3. Open End Thread Inserts
4. Closed End (Blind) Thread Inserts



Coiled thread repair inserts have the following advantages:

- Can be installed in locations that have minimal thickness around the threaded hole
- Made of materials that resist and prevent galvanic action
- Sealants are **not** required when installing repair inserts
- Equivalent to or exceeds the strength of the original threads
- Finish machining is **not** required

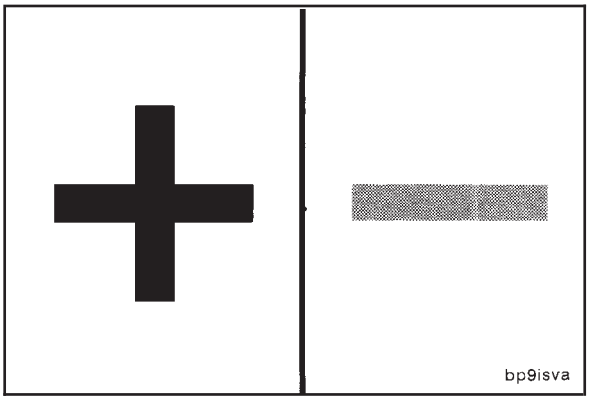


Coiled thread repair inserts have the following disadvantages:

- Special sized tap drills or reamers are required
- Special taps are required
- Special installation tools are required
- The repair insert **cannot** be reused if it "backs out" after installation
- The coiled thread insert has no bottom and provides no sealing capabilities

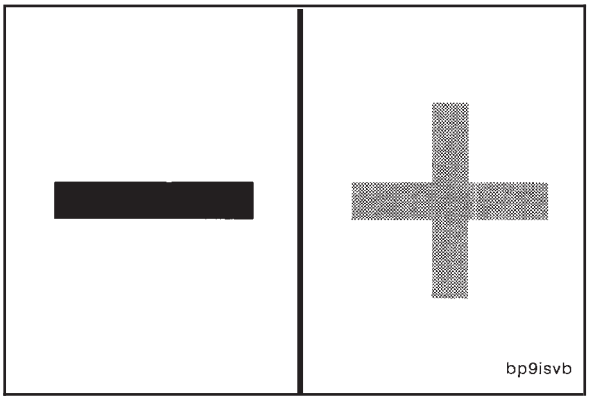
Keylock inserts have the following advantages:

- Standard, commercially available, drills and taps are used during installation
- Relatively inexpensive and available from several sources
- Can be removed and replaced without requiring modification or rework to the component



Keylock inserts have the following disadvantages:

- Generally apply to repair of components that have thicker wall sections
- Installation requires a locking key driver



NOTE: Inserts can be used in cast iron, steel, copper, brass, bronze, aluminum, magnesium, plastic and wood.

For special installations, call or write the following manufacturers:

Perma-Thread	Heli-Coil	Coil Thread
Microdot Inserts 1025 N. Armanda St Anaheim, CA 92806 (714) 870-6650	Heli-Coil Products Shelter Rock Lane Danbury, CT 06810 (203) 743-7651	Tridair Industries 3000 West Lomita Blvd. Torrance, CA 90505 (213) 530-2220

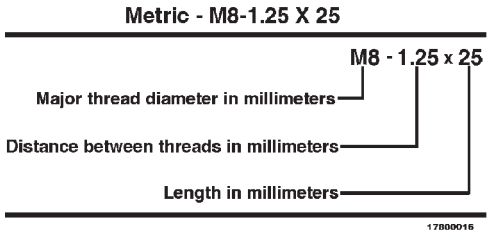
Capscrew Markings and Torque Values

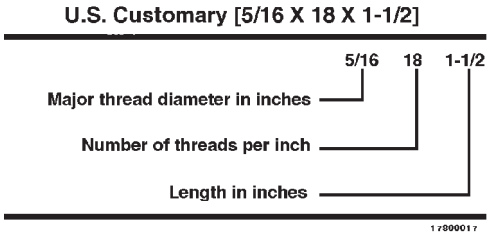
⚠ CAUTION ⚠

When replacing capscrews, always use a capscrew of the same measurement and strength as the capscrew being replaced. Using the wrong capscrews can result in engine damage.

Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts. U.S. Customary capscrews are identified by radial lines stamped on the head of the capscrew.

The following examples indicate how capscrews are identified:

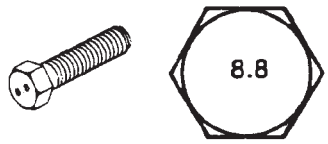
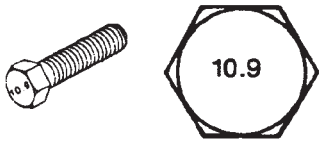
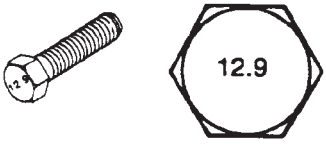




NOTES:

1. **Always** use the torque values listed in the following tables when specific torque values are **not** available.
2. Do **not** use the torque values in place of those specified in other sections of this manual.
3. The torque values in the table are based on the use of lubricated threads.
4. When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

Capscrew Markings and Torque Values - Metric

Commercial Steel Class	8.8	10.9	12.9
Capscrew Head Markings			

Body Size	Torque				Torque				Torque			
Diam.	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	12	9	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	25	18	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	60	45	30	25	70	50	30	25
12	80	60	55	40	105	75	55	40	125	95	55	40
14	125	90	90	65	165	122	90	65	195	145	90	65
16	180	130	140	100	240	175	140	100	290	210	140	100
18	230	170	180	135	320	240	180	135	400	290	180	135

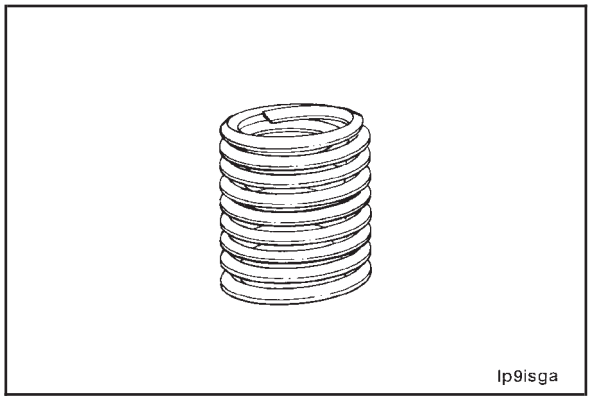
Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5	8
Capscrew Head Markings These are all SAE Grade 5 (3 line)		

Capscrew Body Size	Capscrew Torque - Grade 5 Capscrew				Capscrew Torque - Grade 8 Capscrew			
	Cast Iron		Aluminum		Cast Iron		Aluminum	
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4 - 20	9	7	8	6	15	11	8	6
- 28	12	9	9	7	18	13	9	7
5/16 - 18	20	15	16	12	30	22	16	12
- 24	23	17	19	14	33	24	19	14
3/8 - 16	40	30	25	20	55	40	25	20
- 24	40	30	35	25	60	45	35	25
7/16 - 14	60	45	45	35	90	65	45	35
- 20	65	50	55	40	95	70	55	40
1/2 - 13	95	70	75	55	130	95	75	55
- 20	100	75	80	60	150	110	80	60
9/16 - 12	135	100	110	80	190	140	110	80
- 18	150	110	115	85	210	155	115	85
5/8 - 11	180	135	150	110	255	190	150	110
- 18	210	155	160	120	290	215	160	120
3/4 - 10	325	240	255	190	460	340	255	190
- 16	365	270	285	210	515	380	285	210
7/8 - 9	490	360	380	280	745	550	380	280
- 14	530	390	420	310	825	610	420	310
1 - 8	720	530	570	420	1100	820	570	420
- 14	800	590	650	480	1200	890	650	480

Pipe Plug Torque Values

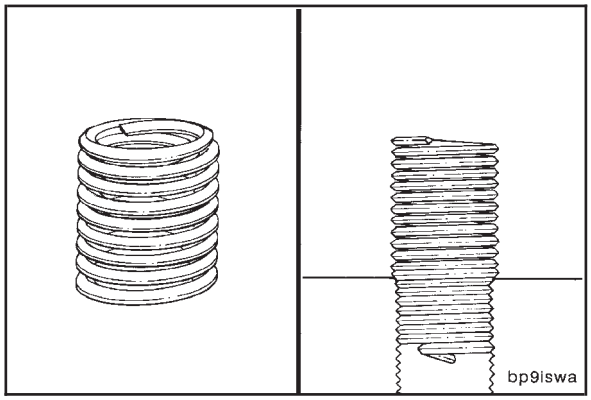
Size		Torque		Torque	
Thread	Actual Thread O.D.	In Aluminum Components		In Cast Iron or Steel Components	
in	in	N•m	ft-lb	N•m	ft-lb
1/16	0.32	5	45 in-lb	15	10
1/8	0.41	15	10	20	15
1/4	0.54	20	15	25	20
3/8	0.68	25	20	35	25
1/2	0.85	35	25	55	40
3/4	1.05	45	35	75	55
1	1.32	60	45	95	70
1-1/4	1.66	75	55	115	85
1-1/2	1.90	85	65	135	100



Coiled Thread Inserts

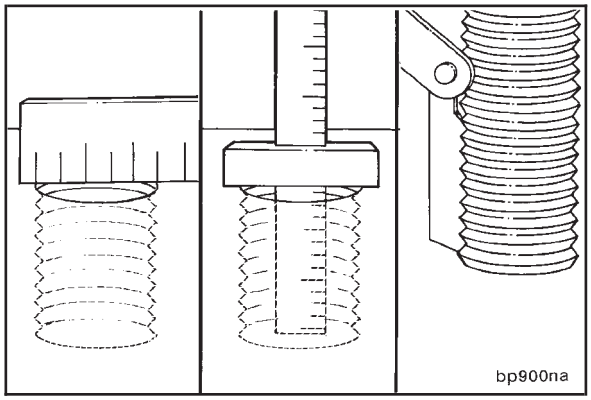
General Information

This repair procedure provides useful information and installation instructions for coiled thread inserts. Coiled thread inserts are a precision wound wire insert for repairing failed or mutilated internal threads.



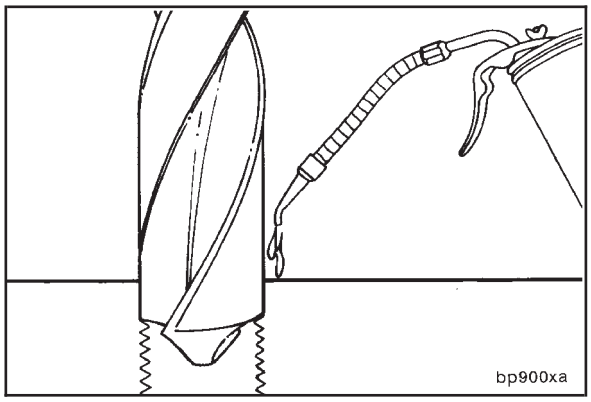
These coils in their free state are designed to be larger in diameter than the tapped hole. After installation, the insert conforms to the outer wall of the tapped hole. This compressed fit holds the insert in place.

NOTE: Inserts are normally made of stainless steel wire. However, other materials are available to meet special installation requirements.



Repair Procedure

Determine the diameter, depth, and pitch of the original threaded hole. Refer to Straight Thread Holes at the front of this section for locations and hole sizes.

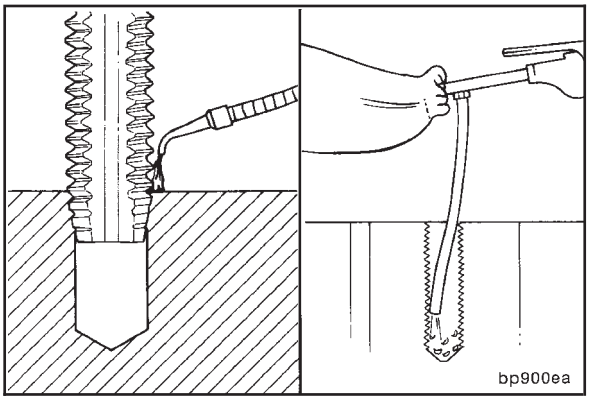


Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

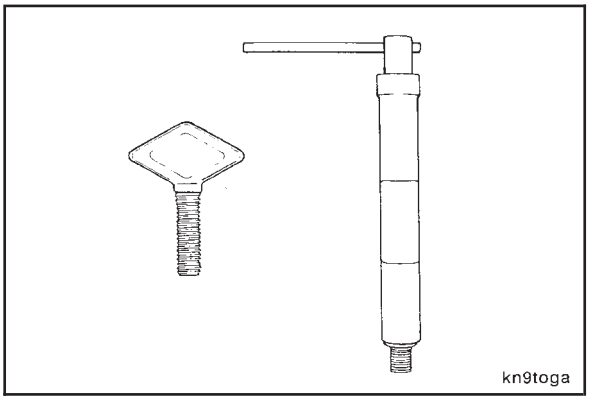
Use a cutting oil while drilling the capscrew hole to the specified diameter. Refer to the charts in the back of this procedure for drill size diameter specifications. Drill to the bottom of blind capscrew holes.

Use the special tap specified in the chart, according to the thread size needed, to cut the threads in the capscrew hole.

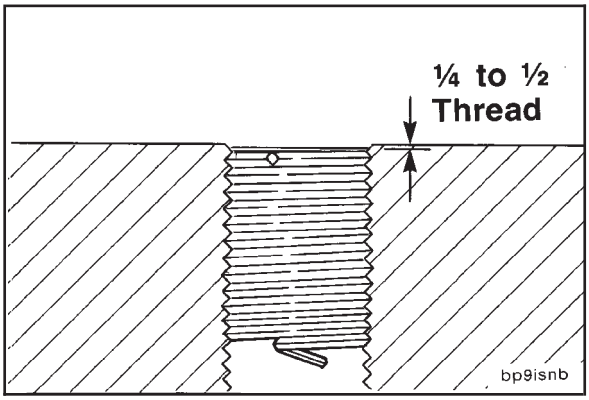
NOTE: Use a cutting oil when tapping the capscrew hole. Clean the capscrew hole before installing the repair insert.



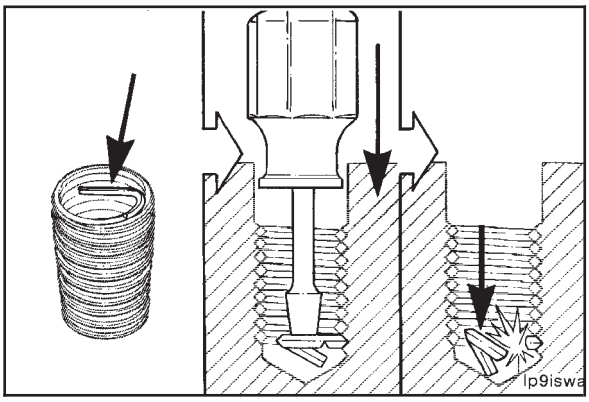
Select the type of installation tool required for your specific thread insert and space limitations.

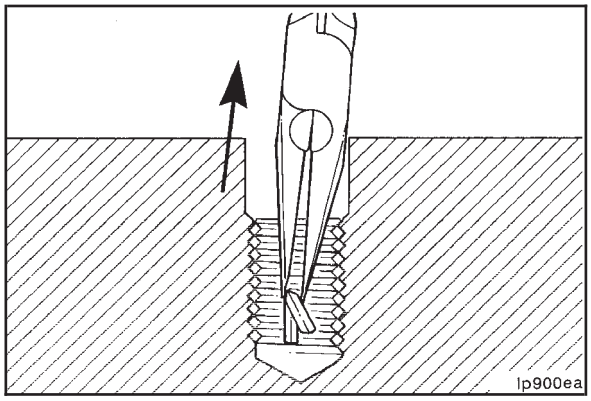


Install the repair insert into the prepared hole. The top of the insert **must** be one-fourth to one-half of a thread below the surface of the part.



Break the installation tang off of the thread repair insert. Position a punch or screwdriver near the free end of the installation tang. Strike the tool to break off the tang.





Remove the installation tang from the repaired hole.

Coiled Thread Insert Part Numbers — Metric Threads

Thread Size	Thread Length — mm	Heli-Coil Part No.	Perma Thread Part No.
M6 X 1.00	9	1084-6CN-0070	206M-8C-0090
M6 X 1.00	12	1084-6CN-0120	206M-6C-0120
M6 X 1.25	12	1084-8CN-0120	206M-8C-0120
M6 X 1.25	16	1084-8CN-0160	206M-8C-0160
M10 X 1.50	15	1084-10CN-0150	206M-10C-0150
M10 X 1.50	20	1084-10CN-0200	206M-10C-0200
M12 X 1.75	18	1084-12CN-0180	206M-12C-0180
M12 X 1.75	24	1084-12CN-0240	206M-12C-0240
M14 X 2.00	21	1084-14CN-0210	206M-14C-0210
M14 X 2.00	28	1084-14CN-0280	206M-14C-0280
M16 X 2.00	24	1084-16CN-0240	206M-16C-0240
M16 X 2.00	38	1084-16CN-0320	206M-16C-0320

Drill Sizes

Thread Size	Suggested Drill Size — Metric		Suggested Drill Size — Inch	
	Aluminum	Steel	Aluminum	Steel
M6 X 1.00	6.25	6.3	D [0.2460]	1/4 [0.2500]
M8 X 1.25	8.3	8.4	21/64 [0.3281]	Q [0.3320]
M10 X 1.50	10.5	10.5	Z [0.4130]	Z [0.4130]
M12 X 1.75	12.5	12.5	31/64 [0.4844]	1/2 [0.500]
M14 X 2.00	14.5	14.5	37/64 [0.5781]	37/64 [0.5781]
M16 X 2.00	16.5	16.5	21/32 [0.6562]	21/32 [0.6562]

Tap Part Numbers

Thread Size	Heli-Coil Plug Tap Part No.	Heli-Coil Bottoming Tap Part No.	Perma-Thread Plug Tap Part No.	Perma-Thread Bottoming Tap Part No.
M6 X 1.00	2087-6	2093-6	5043-060CP5	5043-060CB5
M8 X 1.25	2087-8	2093-8	5043-080CP5	5043-080CB5
M10 X 1.50	2087-10	2093-10	5043-100CP5	5043-100CB5
M12 X 1.75	2087-12	2093-12	5043-120CP5	5043-120CB5
M14 X 2.00	2087-14	2093-14	5043-140CP5	5043-140CB5
M16 X 2.00	2087-16	2093-16	5043-160CP5	5043-160CB5

Coiled Thread Insert Part Numbers — Unified Threads

Thread Size and Pitch	Thread Length-Inch	Cummins Part No.	Heli-Coil Part No.	Perma-Thread Part No.	Coil Thread Part No.
1/4-20	0.500	113759	1185-4CN-0500	208C4-0500	TNC-4C-0500
5/16-18	0.625	68372	1185-5CN-0625	208C5-0625	TNC-5C-0625
5/16-24	0.625	69003	1191-5CN-0625	208F5-0625	TNF-5C-0625
3/8-16	0.563	67184-A	1185-6CN-0563	208C6-0750	TNC-6C-0562
3/8-16	0.750	67184-B	1185-6CN-0750	208C6-0750	TNC-6C-0750
3/8-16	0.938	67184-C	1185-6CN-0938	208C6-0938	TNC-6C-0938
3/8-16	1.125	67184-D	1185-6CN-1125	208C6-1125	TNC-6C-1125
3/8-24	0.375	67235-A	1191-6CN-0375	208F6-0375	TNF-6C-0375
3/8-24	0.563	67235-B	1191-6CN-0563	208F6-0562	TNF-6C-0562
3/8-24	0.750	67235-C	1191-6CN-0750	208F6-0750	TNF-6C-0750
3/8-24	0.938	67235-D	1191-6CN-0938	208F6-0938	TNF-6C-0938
3/8-24	1.125	67235-E	1191-6CN-1125	208F6-1125	TNF-6C-1125
7/16-14	0.656	67234-A	1185-7CN-0656	208C7-0656	TNC-7C-0656
7/16-14	0.875	67234-B	1185-7CN-0875	208C7-0875	TNC-7C-0875
7/16-14	1.094	67234-C	1185-7CN-1094	208C7-1094	TNC-C7-1094
7/16-14	1.312	67234-D	1185-7CN-1312	208C7-1312	TNC-7C-1312
1/2-13	0.750	67183-A	1185-8CN-0750	208C8-0750	TNC-8C-0750
1/2-13	1.000	67183-B	1185-8CN-1000	208C8-1000	TNC-8C-1000
1/2-13	1.250	67183-C	1185-8CN-1250	208C8-1250	TNC-8C-1250
1/2-13	1.500	67183-D	1185-8CN-1500	208C8-1500	TNC-8C-1500
9/16-18	1.125	69070	1191-9CN-1125	208F9-1125	TNF-9C-1125
5/8-11	0.875	101541	1185-10CN-0875	208C10-0875	
5/8-11	1.250	101540	1185-10CN-1250	208C10-1250	TNC-10C-0938
5/8-18	0.938	163398	1191-10CN-0938	208F10-0938	TNF-10C-0938
3/4-10	1.125	101542	1185-12CN-1125	208C12-1125	TNC-12C-1125
3/4-16	1.500	132672	1191-12CN-1500	208C12-1500	TNF-12C-1500
7/8-14	0.875	100292	1191-14CN-0875	208F14-0875	TNF-14C-0875
7/8-14	1.312	100854	1191-14CN-1312	208F14-1312	TNF-14C-1312
1-8	0.680	200845	389-16CN-0680	1328-16-0680	
1 1/8-7	2.250	102588	1185-18CN-2250	208C18-2250	TNC-18C-2250

Drill Size and "Plug" Tap Part Numbers — Unified Threads

Nominal Thread Size and Pitch	Tap Drill Size-Inch Aluminum	Cast Iron	Heli-Coil Part No.	Coil Thread Part No.	Perma-Thread Part No.
1/4-20	H (0.2660)	H (0.2660)	4CPA H3	CTC-4SRP-H3	1043-4CP2-H3
5/16-18	Q (0.3320)	Q (0.3320)	5CPA H4	CTC-5SRP-H4	1043-5CP2-H4
5/16-24	21/64 (0.3281)	21/64 (0.3281)	5FPA H2	CTF-5SRP-H3	1043-5FP2-H3
3/8-16	X (0.3970)	X (0.3970)	6CPA H4	CTC-6SRP-H4	1043-6CP2-H4
3/8-24	25/64 (0.3906)	25/64 (0.3906)	6FPA H3	CTF-6SRP-H3	1043-6FP2-H3
7/16-14	29/64 (0.4531)	29/64 (0.4531)	7CPA H4	CTC-7SRP-H4	1043-7CP2-H4
1/2-13	33/64 (0.5156)	17/32 (0.5312)	8CPA H4	CTC-8SRP-H4	1043-8CP2-H4
9/16-18	37/64 (0.5781)	37/64 (0.5781)	18193-9 H4	CTF-9SRP-H4	1043-9FP2-H4
5/8-11	21/32 (0.6562)	21/32 (0.6562)	18187-10 H4	CTC-10SRP-H4	1043-10CP2-H4
5/8-18	41/64 (0.7656)	41/64 (0.7656)	18193-10 H4	CTC-10SRP-H4	1043-10CP2-H4
3/4-10	25/32 (0.7812)	25/32 (0.7812	18187-12 H5	CTC-12SRP-H5	1043-12CP2-H5
3/4-16	49/64 (0.7656)	49/64 (0.7656)	18193-12 H4	CTF-12SRP-H4	1043-12FP2-H4
7/8-14	57/64 (0.8906)	57/64 (0.8906)	18193-14 H4	CTF-14SRP-H4	1043-14FP2-H4
1-8	1-1/32 (1.0312)	1-1/32 (1.0312)	18187-16 H6	CTC-16SRP-H6	1043-16CP2-H6
1 1/8-7	1-11/64 (1.1719)	1-11/64 (1.1719)	18187-18 H6	CTC-18SRP-H6*	1043-18CP2-H6*

* These taps are for aluminum and magnesium metals only.

NOTE: All taps are class 2B unless otherwise specified.

Drill Size and Bottom Tap Part Numbers — Unified Threads

Nominal Thread Size and Pitch	Tap Drill Size-Inch Aluminum	Cast Iron	Heli-Coil Part No.	Coil Thread Part No.	Perma-Thread Part No.
1/4-20	H (0.2660)	H (0.2660)	4CBA H3	CTC-4SRB-H3	1043-4CB2-H3
5/16-18	Q (0.3320)	Q (0.3320)	5CBA H4	CTC-5SRB-H4	1043-5CB2-H4
5/16-24	21/64 (0.3281)	21/64 (0.3281)	5FBA H3	CTF-5SRB-H3	1043-5FB2-H3
3/8-16	X (0.3970)	X (0.3970)	6CBA H4	CTC-6SRB-H4	1043-6CB2-H4
3/8-24	25/64 (0.3906)	25/64 (0.3906)	6FBA H3	CTF-6SRB-H3	1043-6FB2-H3
7/16-14	29/64 (0.4531)	29/64 (0.4531)	7CBA H4	CTC-7SRB-H4	1043-7CB2-H4
1/2-13	33/64 (0.5156)	17/32 (0.5312)	8CBA H4	CTC-8SRB-H4	1043-8CB2-H4
9/16-18	37/64 (0.5781)	37/64 (0.5781)	20193-9 H4	CTF-9SRB-H4	1043-9FB2-H4
5/8-11	21/32 (0.6562)	21/32 (0.6562)	20187-10 H4	CTC-10SRB-H4	1043-10CB2-H4
5/8-18	41/64 (0.6406)	41/64 (0.6406)	20193-10 H4	CTC-10SRB-H4	1043-10CB2-H4
3/4-10	25/32 (0.7812)	25/32 (0.7812)	20187-12 H5	CTC-12SRB-H5	1043-12CB2-H5
3/4-16	49/64 (0.7656)	49/64 (0.7656)	20193-12 H4	CTF-12SRB-H5	1043-12FB2-H4
7/8-14	57/64 (0.8906)	57/64 (0.8906)	20193-14 H4	CTF-14SRB-H4	1043-14FB2-H4
1-8	1-1/32 (1.0312)	1-1/32 (1.0312)	20187-16 H6	CTC-16SRB-H6	1043-16CB2-H6
1 1/8-7	1-11/64 (1.1719)	1-11/64 (1.1719)	20187-18 H6	CTC-18SRB-H6*	1043-18CB2-H6*

* These taps are for aluminum and magnesium metals only.

NOTE: All taps are class 2B unless otherwise specified.

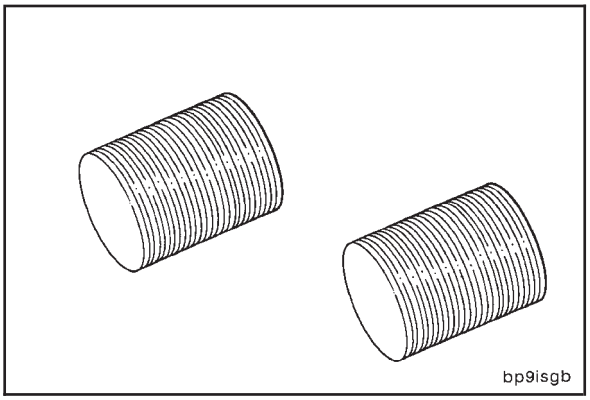
Closed End "Blind" Inserts

General Information

This procedure provides the instructions for installing closed end "blind" inserts.

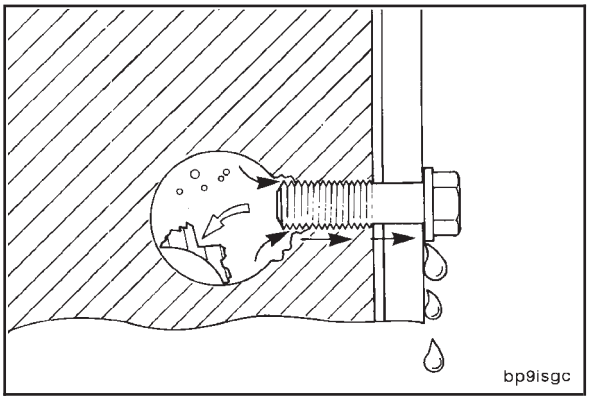
The charts in the back of this procedure lists the two types of blind inserts.

- SAE internal and external threads
- Metric internal with SAE external threads



Closed end inserts are generally used in cases where the bottom or side of a hole has been pierced. They can be used to repair any kind of hole or thread if desired.

NOTE: Closed end inserts **cannot** be used to repair top deck cracks that run into cylinder head capscrew holes.

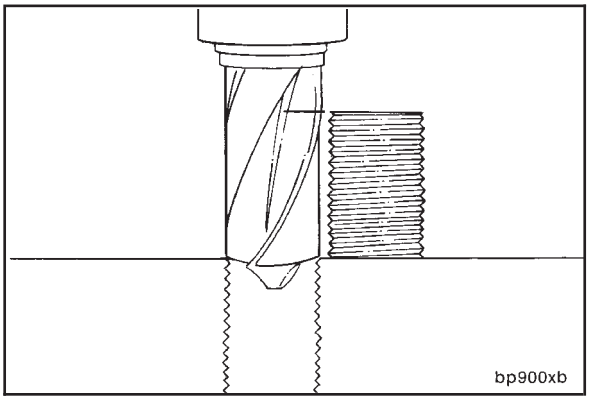


Repair Procedure

Obtain the required reamer or drill size for the hole to be repaired. Refer to the charts at the end of this procedure for size specifications. Install it in the drill.

Set the drill depth by placing the insert to be installed between the top of the hole and the drill chuck.

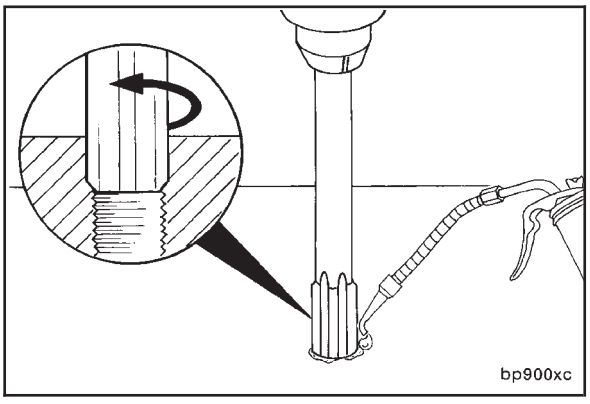
NOTE: If the drill is too long, make a mark on the drill bit to indicate the correct depth.

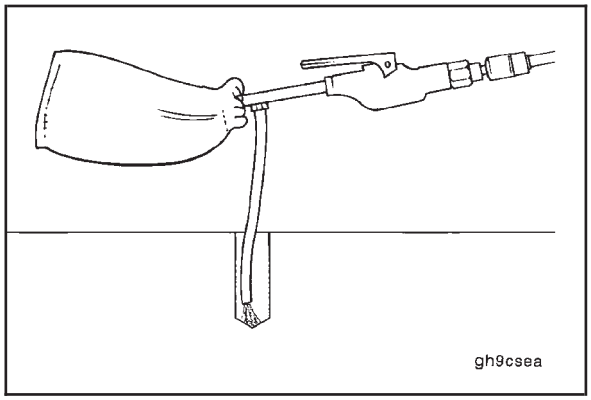


Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

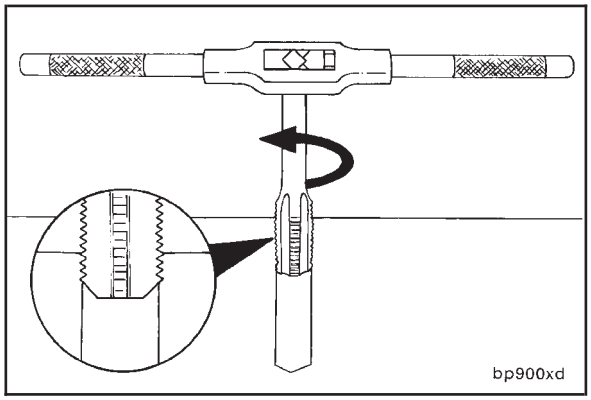
Use cutting oil. Drill or ream the hole to the proper depth.

NOTE: In some cases when using a drill, the proper depth will pierce the bottom of the hole.



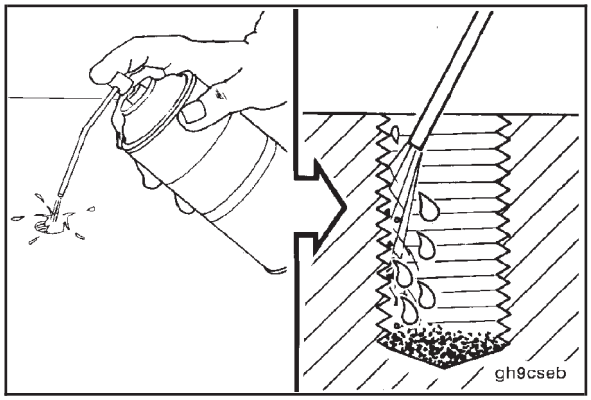


Use chip removing unit, Part No. ST-1272-11, to remove machining chips from the capscrew hole.

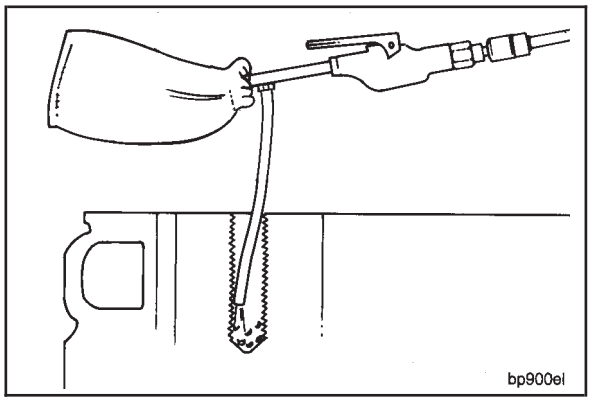


Use cutting oil. Tap the hole to the required depth. Refer to the charts in the back of this procedure for tap sizes.

NOTE: The correct depth will allow the insert to be installed flush, to slightly below the surface.



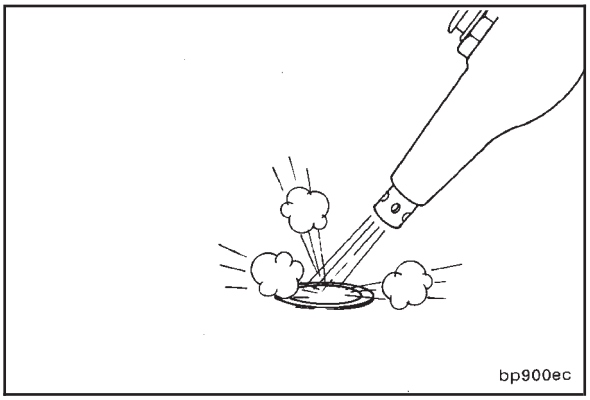
Use a spray cleaner to remove the oil film and clean the newly cut threads.



Use chip removal unit, Part No. ST-1272-11, to remove any debris from the hole.

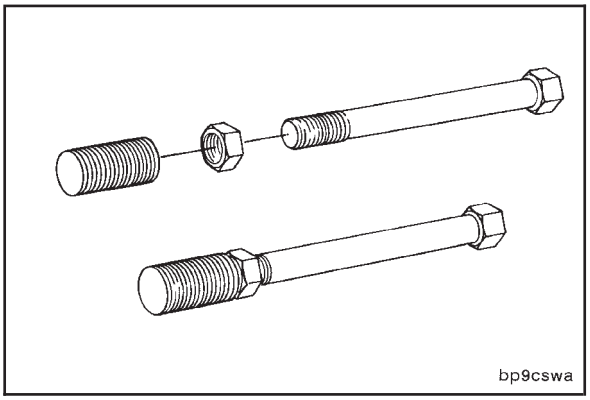
Warning: When using compressed air to dry capscrew holes, always wear safety glasses or a face shield to protect the eyes. Personal injury can result.

Dry the threads with compressed air.



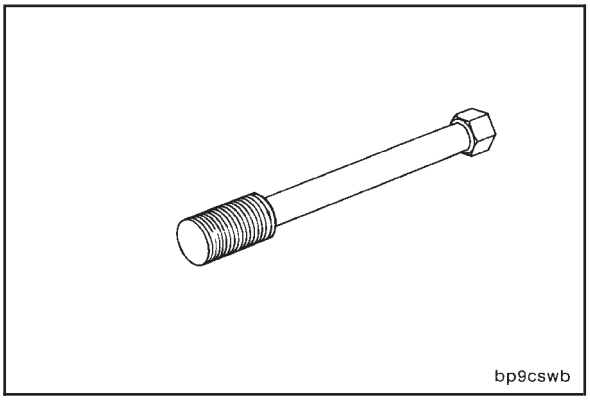
Obtain a capscrew and nut with the same size threads as the insert inside diameter. Install the nut first then the insert on the capscrew.

NOTE: The nut should have a straight shoulder which, when installed against the insert, will allow the insert to be installed slightly below the surface.

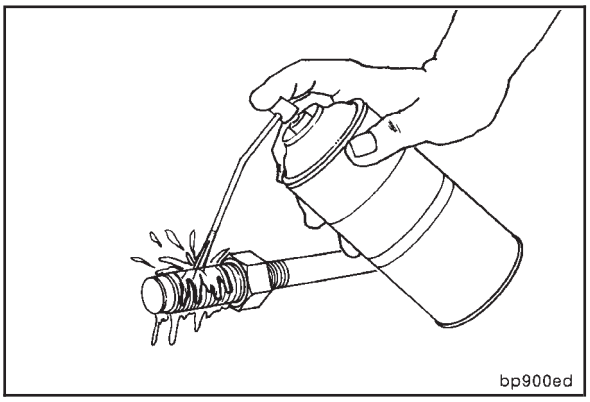


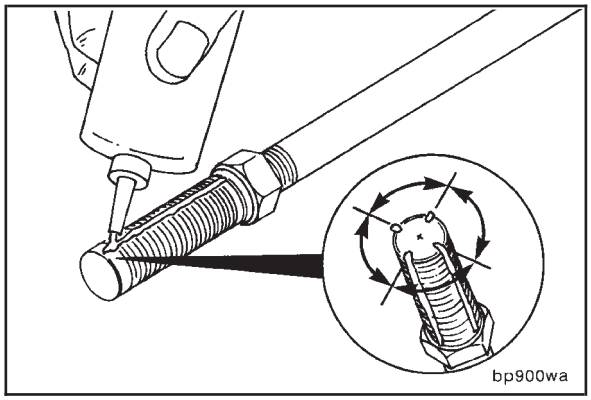
If a nut is **not** available, it is acceptable to bottom the capscrew out in the insert for installation.

NOTE: This type installation will require time for the sealant to setup before removing the capscrew from the thread insert.

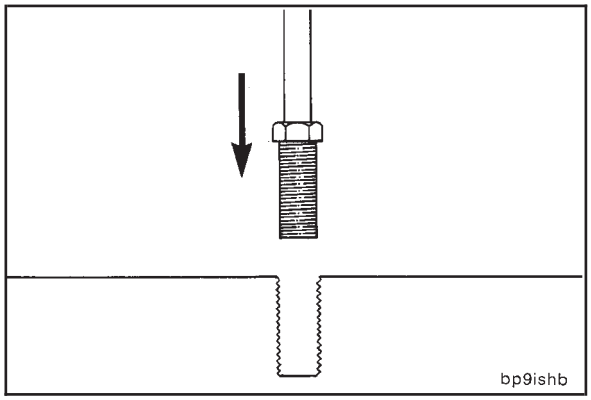


Use a spray cleaner to remove the preservative coating from the outside diameter of the insert.

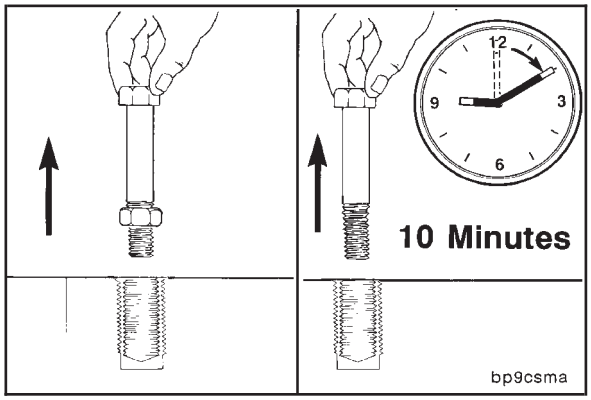




Apply four beads of sealant, Part No. 3375068, to the outside diameter of the insert. The beads of sealant **must** be about 0.8 mm [1/32 inch] wide and spaced 90 degrees from each other.

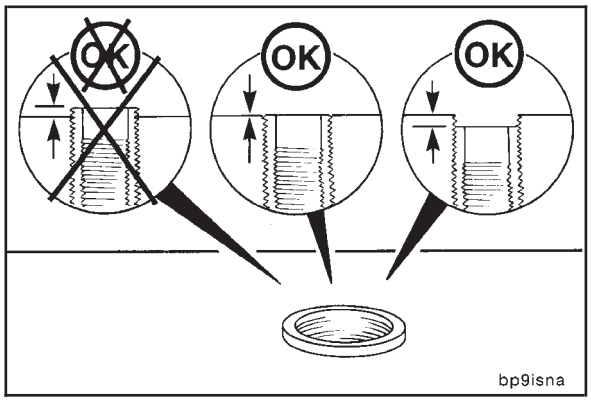


Install the repair insert.



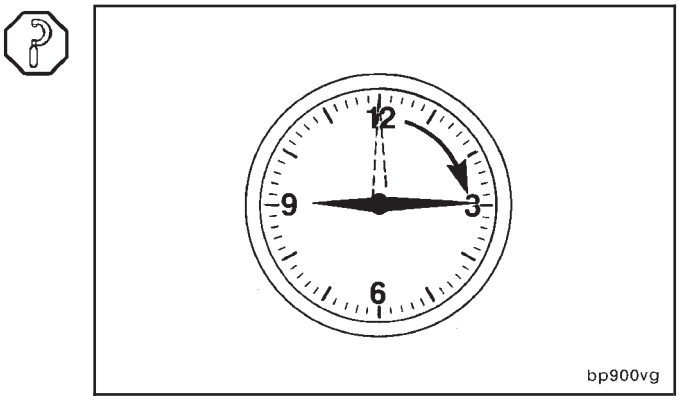
Loosen the nut and remove the capscrew.

NOTE: If a capscrew without a nut was used, allow 10 minutes for the sealant to cure before removing the capscrew.

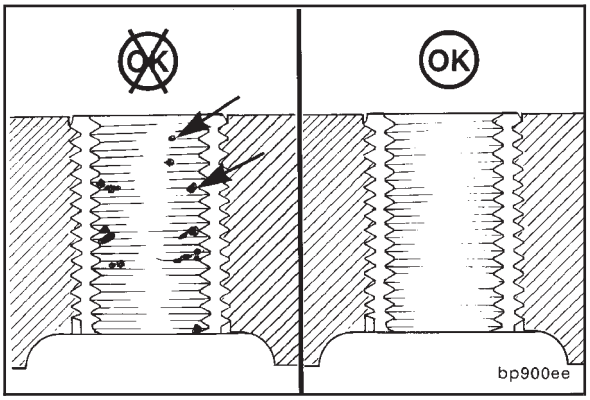


The insert should be flush to slightly below the surface.

Allow the sealant to cure for 15 minutes before use.



Clean the insert threads to remove any debris.



Closed End Inserts — SAE Internal and External Threads

Cummins Part No.	Internal Thread (Size It Repairs) Class 2B	External Threads (Tap Size) Class 2B	Tap Drill (Reamer) Dia.-Inch	Nominal Overall Length-Inch
3376437	1/4-20 UNC	3/8-16 UNC	0.332	0.750
3376438	5/16-18 UNC	7/16-14 UNC	0.397	0.930
3376439	3/8-16 UNC	1/2-13 UNC	0.453	1.130
3376440	3/8-24 UNF	1/2-13 UNC	0.453	1.070
3376441	7/16-14 UNC	9/16-12 UNC	0.516	1.150
3376442	7/16-20 UNF	9/16-12 UNC	0.516	1.210
3376443	1/2-13 UNC	5/8-11 UNC	0.578	1.510
3376446	1/2-20 UNF	5/8-11 UNC	0.578	1.190
3376444	5/8-11 UNC	13/16-16 UNC	0.766	1.640
3376445	5/8-18 UNF	13/16-16 UNC	0.766	1.360
3376447	9/16-18 UNF	11/16-11 UNC	0.641	1.180

Closed End Inserts — Metric Internal Threads, SAE External Threads (3822709 KIT)

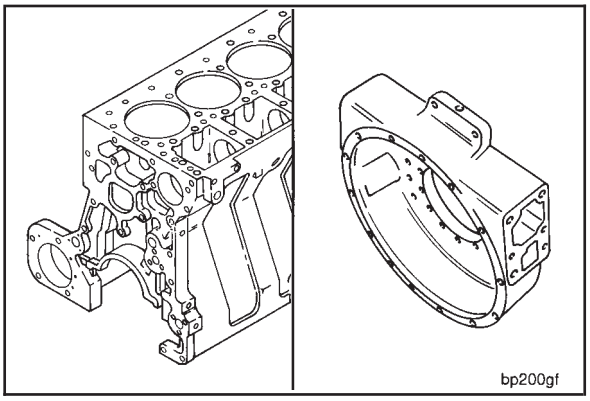
Cummins Part No.	Internal Threads (Size It Repairs)	External Threads (Tap Size) Class 2B	Tap Drill (Reamer) Dia.-Inch	Nominal Overall Length — Inch
3822698	M 6X 1.0-6H	3/8-16 UNC	0.3125	0.75
3822699	M 8X 1.25-6H	1/2-13 UNC	0.421	0.94
3822700	M 10X 1.50-6H	9/16-12 UNC	0.484	1.12
3822701	M 12X 1.25-6H	5/8-18 UNF	0.578	1.37
3822702	M 12X 1.50-6H	5/8-18 UNF	0.578	1.37
3822703	M 12X 1.75-6H	5/8-18 UNF	0.578	1.37
3822704	M 14X 2.00-6H	3/4-16 UNF	0.687	1.50
3822705	M 16X 1.50-6H	7/8-14 UNF	0.812	1.75
3822706	M 16X 2 00-6H	7/8-14 UNF	0.812	1.75

Keylock Open End Thread Inserts

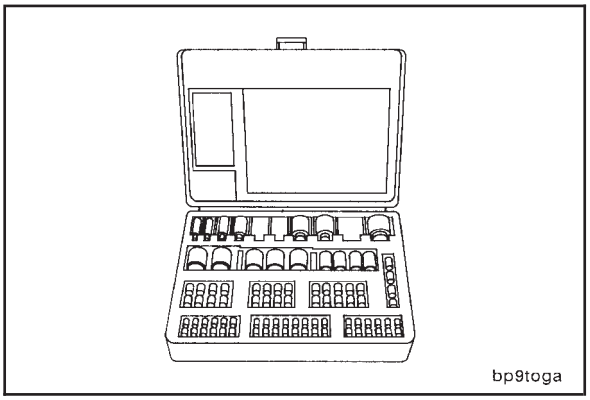
General Information

This procedure provides guidelines for using keylock inserts.

Keylock inserts can be used to repair threads in cast iron, steel and aluminum components.

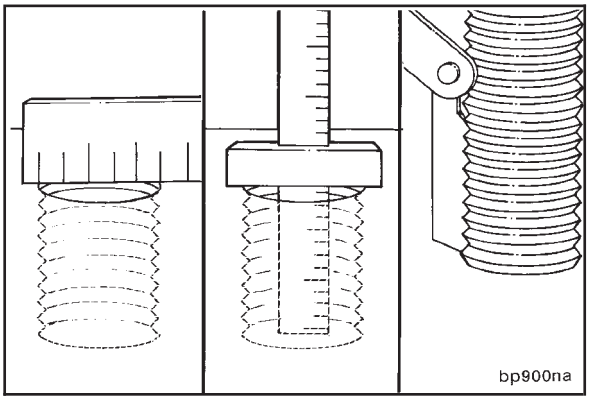


Thread repair kit, Part No. 3375021, contains keylock inserts. The inserts are internally and externally threaded metallic cylinders which have captive locking keys. The keys prevent the insert from rotating after it has been installed.



Repair Procedure

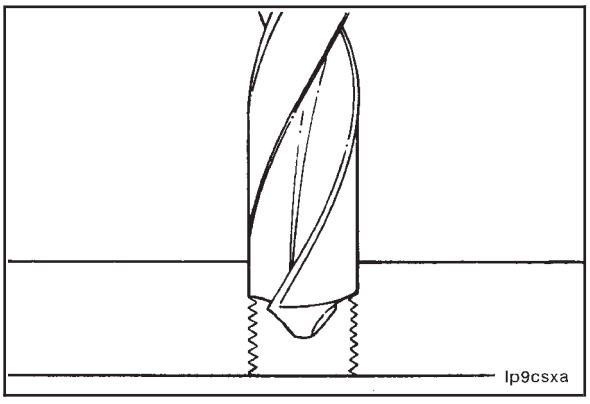
Determine the diameter, depth, and pitch of the original threaded hole. Refer to Straight Thread Holes at the front of this seciton for locations and hole sizes.

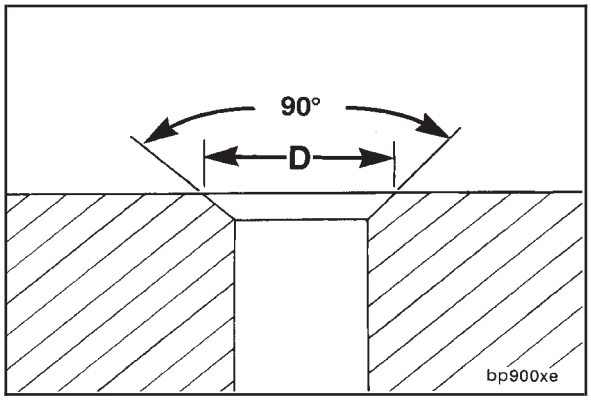


Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

Use cutting oil. Drill the hole to the specified diameter. Refer to the charts in the back of this procedure for drill size diameter specifications. Drill to the bottom of blind holes.

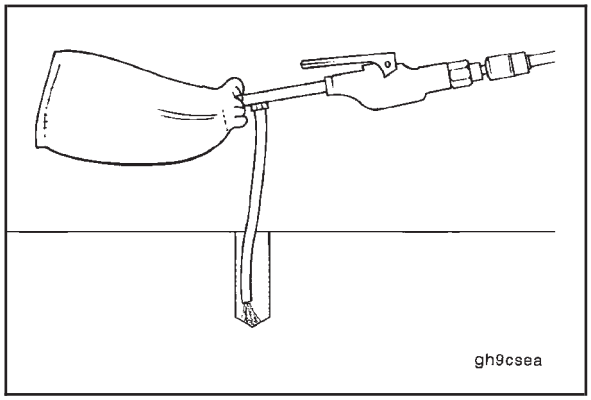
NOTE: The drill **must** be in proper alignment when drilling the capscrew hole.



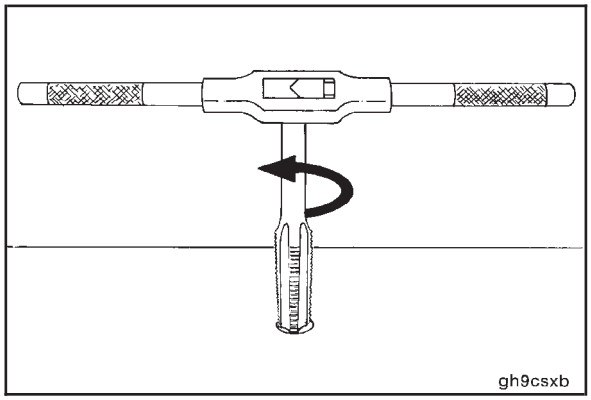


Countersink the hole to the diameter specified on the chart. The correct angle is 82 to 100 degrees.

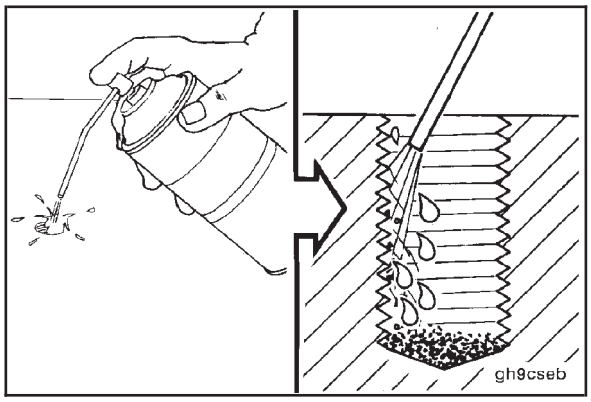
NOTE: Use cutting oil when countersinking the capscrew hole.



Use chip removal unit, Part No. ST-1272-11, to remove any debris from the hole.



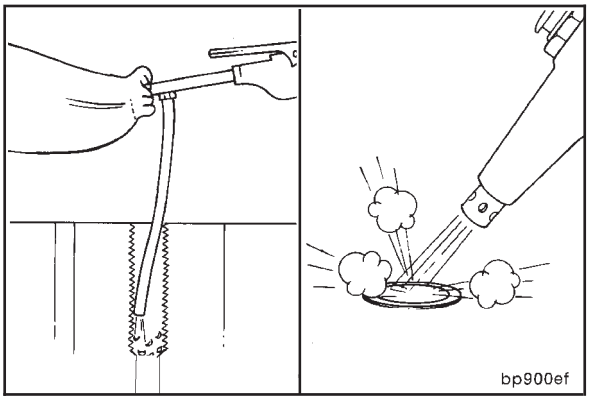
Use cutting oil. Tap the hole to the correct diameter, pitch and depth. Tap size and depth information is included at the end of this procedure.



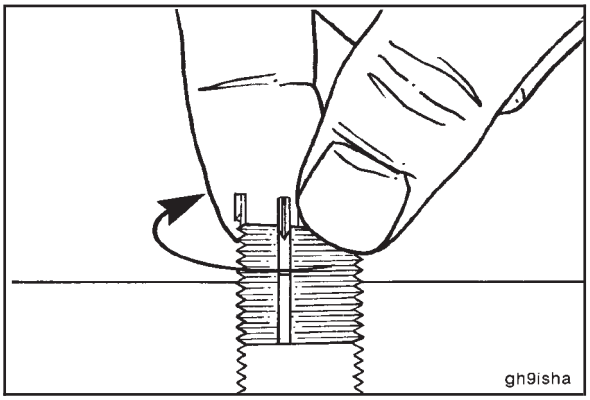
Use a spray cleaner to clean the oil from the capscrew hole and flush the newly cut threads.

Warning: When using compressed air to dry capscrew holes, always wear safety glasses or a face shield to protect the eyes. Personal injury can result.

Use chip removal unit, Part No. ST-1272-11, to remove any debris from the hole. Dry the threads with compressed air.



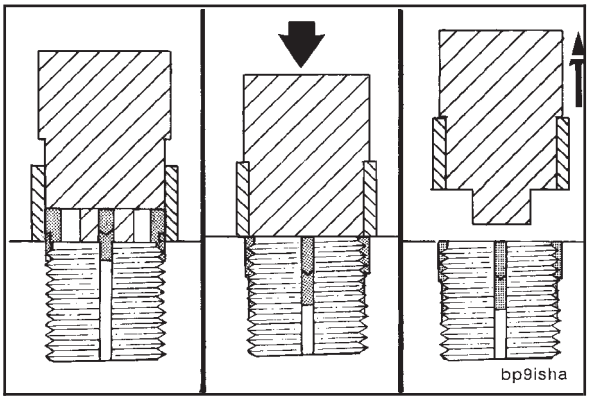
Install the insert into the prepared hole. Turn the insert **clockwise** until the insert stops at the specified depth.



Put the staking tool over the insert. Slide the sleeve of the tool over the keys.

Use a hammer to strike the installation tool until the keys are driven down to their full depth.

Remove the tool. The repair is now complete.



Keylock Thread Inserts — Unified Threads

Cummins Part No.	Internal Thread Size Class 2B	Tap Drill Size-Inch	Tap Size-Inch Class 2B	Installation Tool Part No.	Min. Tap Depth-Inch	C'sink Dia.-Inch	Overall Length-Inch
3375141	1/4-20	0.332	3/8-16	3375142	0.43	0.385	0.37
3375022	5/16-18	0.397	7/16-14	3375023	0.50	0.447	0.43
3375430	5/16-18 (Heavy Duty)	0.453	1/2-13	3375026	0.56	0.510	0.43
3375024	3/8-16	0.453	1/2-13	3375026	0.56	0.510	0.50
3375025	3/8-24	0.453	1/2-13	3375026	0.56	0.510	0.50
3375027	7/16-14	0.516	9/16-12	3375029	0.62	0.572	0.56
3375028	7/16-20	0.516	9/16-12	3375029	0.62	0.572	0.56
3375030	1/2-13	0.578	5/8-11	3375032	0.68	0.635	0.62
3375031	1/2-20	0.578	5/8-11	3375032	0.68	0.635	0.62
3375143	5/8-11	0.766	13/16-16	3375034	0.87	0.822	0.81
3375033	5/8-18	0.766	13/16-16	3375034	0.87	0.822	0.81
3375035	3/4-16	1.062	1 1/8-12	3375036	1.18	1.145	1.12
3375037	1-18	1.312	1 3/8-12	3375038	1.56	1.395	1.37

Keylock Thread Inserts — Tridair Keenserts — Unified Threads

Part No.	Internal Thread Size Class 2B	External Thread Size Class 2A	Length Inch	Tap Drill Dia.	C"sink Dia.	Tap Size Class 2B	Insert Tool Part No.
RKKA 1/4-20	1/4-20	3/8-16	0.37	"Q"	0.38	3/8-16	TRKA 1/4
RKKA 5/16-18	5/16-18	7/16-14	0.43	"X"	0.44	7/16-14	TRKA 5/16
RKK 5/16-18 (Heavy Duty)	5/16-18	1/2-13	0.43	29/64	0.51	1/2-13	TRK 5/16
RKKA 3/8-16	3/8-16	1/2-13	0.50	29/64	0.51	1/2-13	TRKA3/8
RKKA 3/8-24	3/8-24	1/2-13	0.50	29/64	0.51	1/2-13	TRKA3/8
RKKA 7/16-14	7/16-14	9/16-12	0.56	33/64	0.57	9/16-12	TRKA7/16
RKKA 7/16-20	7/16-20	9/16-12	0.56	33/64	0.57	9/16-12	TRKA7/16
RKKA 1/2-13	1/2-13	5/8-11	0.62	37/64	0.63	5/8-11	TRKA1/2
RKKA 1/2-20	1/2-20	5/8-11	0.62	37/64	0.63	5/8-11	TRKA1/2
RKK 5/8-11	5/8-11	7/8-14	0.87	53/64	0.88	7/8-14	TRK5/8
RKK 5/8-18	5/8-18	7/8-14	0.87	53/64	0.88	7/8-14	TRK5/8
RKK 3/4-10	3/4-10	1 1/8-12	1.12	1 1/16	1.14	1 1/8-12	TRK3/4
RKK 3/4-16	3/4-16	1 1/8-12	1.12	1 1/16	1.14	1 1/8-12	TRK3/4

Keylock Thread Inserts — Tridair Keenserts — Metric Threads

Part No.	Internal Thread Size	External Thread Size	Length mm	Tap Drill Dia.	C'sink Dia	Tap Size	Insert Tool Part No.
KNM 6 x 1 F	M6 X 1.0	M10 X 1.25	10	8.8	10.25	M10 X 1.25	TRKM 6
KNM 8 x 1.25 F	M8 X 1.25	M12 X 1.25	12	10.8	12.25	M12 X 1.25	TRKM 8
KNM 10 x 1.5 F	M10 X 1.50	M14 X 1.5	14	12.8	14.25	M14 X 1.5	TRKM 10
KNM 12 x 1.75 F	M12 X 1.75	M16 X 1.5	16	14.75	16.25	M16 X 1.5	TRKM 12
KNHM 14 x 2 F	M14 X 2.0	M20 X 1.5	20	18.75	20.25	M20 X 1.5	TRKHM 14

Keylock Thread Inserts — Microdot K-Serts — Unified Threads

Part No.	Internal Thread Size Class 2B	External Thread Size Class 2A	Length-inch	Tap Drill Dia.	C'sink Dia.	Tap Size Class 2B	Insert Tool Part No.
K51240-420	1/4-20	3/8-16	0.37	0.331-0.336	0.39	3/8-16	KT51240-4
K51240-518	5/16-18	7/16-14	0.43	0.376-0.401	0.45	7/16-14	KT51240-5
K51241-518 (Heavy Duty)	5/16-18	1/2-13	0.43	29/64	0.51	1/2-13	KT51241-5
K51240-616	3/8-16	1/2-13	0.50	29/64	0.51	1/2-13	KT51240-6
K51240-6	3/8-24	1/2-13	0.50	29/64	0.51	1/2-13	KT51240-6
K51240-714	7/16-14	9/16-12	0.56	33/64	0.57	9/16-12	KT51240-7
K51240-7	7/16-20	9/16-12	0.56	33/64	0.57	9/16-12	KT51240-7
K51240-813	1/2-13	5/8-11	0.62	37/64	0.64	5/8-11	KT51240-8
K51240-8	1/2-20	5/8-11	0.62	37/64	0.64	5/8-11	KT51240-8
K51241-1011	5/8-11	7/8-14	0.87	53/64	0.89	7/8-14	KT51241-10
K51241-10	5/8-18	7/8-14	0.87	53/64	0.89	7/8-14	KT51241-10
K51241-1210	3/4-10	1 1/8-12	1.12	1 1/16	1.15	1 1/8-12	KT51241-12
K51241-12	3/4-16	1 1/8-12	1.12	1 1/16	1.15	1 1/8-12	KT51241-12

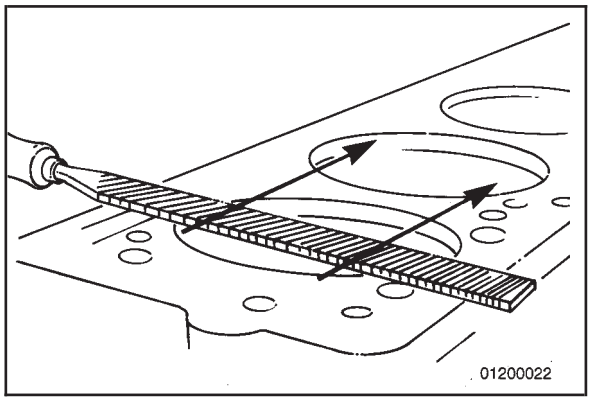
Keylock Thread Inserts — Microdot K-Serts — Metric Threads

Part No.	Internal Thread Size	External Thread Size	Length - mm	Tap Drill Dia.	C'sink Size	Tap Size	Insert Tool Part No.
KM9900-060	M6 X 1.00	M10 X 1.25	10.0	8.8	10.25	M10 X 1.25	KTM9000-060
KM9900-080	M8 X 1.25	M12 X 1.25	12.0	10.8	12.25	M12 X 1.25	KTM9000-080
KM9900-100	M10 X 1.50	M14 X 1.50	14.0	12.8	14.25	M14 X 1.50	KTM9000-100
KM9900-120	M12 X 1.75	M16 X 1.50	16.0	14.75	16.25	M16 X 1.50	KTM9000-120
KHM9900-140	M14 X 2.00	M20 X 1.50	20.0	18.75	20.25	M20 X 1.50	KHTM9000-140
KHM9900-160	M16 X 2.00	M22 X 1.50	22.0	20.50	22.25	M22 X 1.50	KHTM9000-160

Open End Thread Repair Inserts

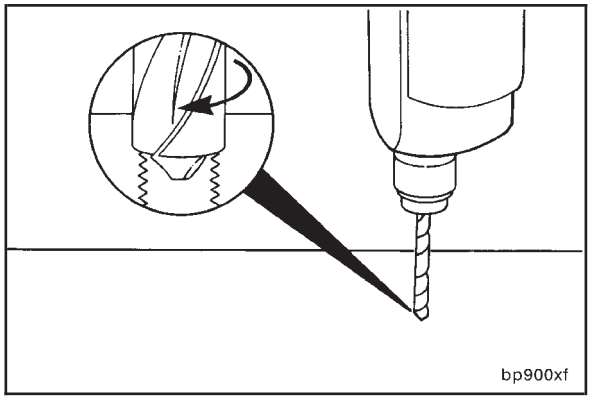
General Information

This procedure describes the method recommended for repairing damaged metric threads. Installing metric open end thread repair inserts is an approved method for warranty repairs and can be performed without removing the engine from the chassis. Use care to prevent contaminants from entering the engine during this process.



Inspection

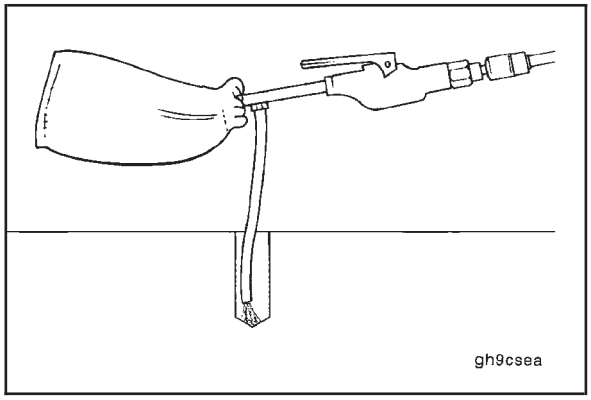
Inspect the area around the threaded hole that is to be repaired. Remove any burrs from the surface. A flat mill file is very effective for this process. Burr removal is necessary so that an accurate fixture location can be obtained.



Repair Procedure

Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

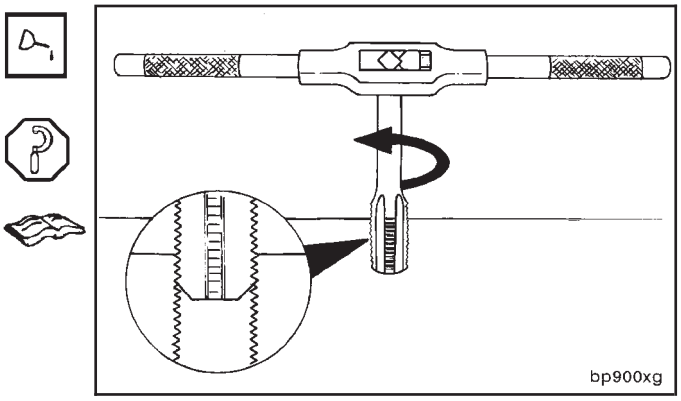
Use a cutting oil when drilling the damaged threads to the specified diameter and depth dimensions for the specified repair insert. A listing of installation requirements is included at the end of this procedure.



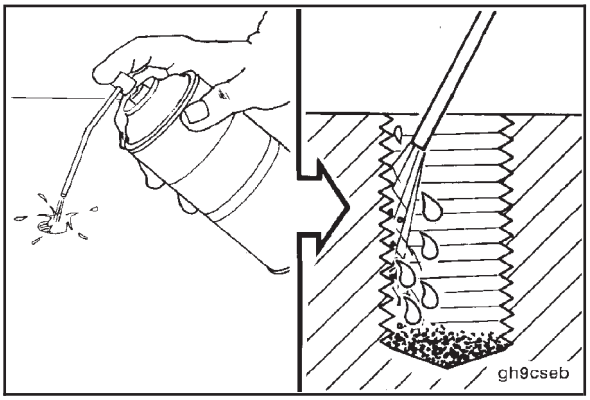
Use chip removal unit, Part No. ST-1272-11, to remove any debris from the hole.

Use cutting oil. Tap the hole for the repair insert. The correct thread depth will allow the insert to be installed 0.0 to 0.25 mm [0.00 to 0.010 inch] below the surface of the component.

Measure the insert and refer to the data sheet at the end of this procedure for insert length specifications.



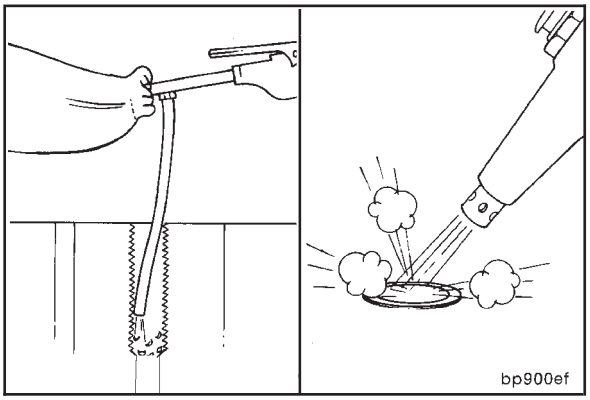
Use a spray cleaner to clean the oil from the capscrew hole and flush the newly cut threads.



Warning: When using compressed air to dry capscrew holes, always wear safety glasses or a face shield to protect the eyes. Personal injury can result.

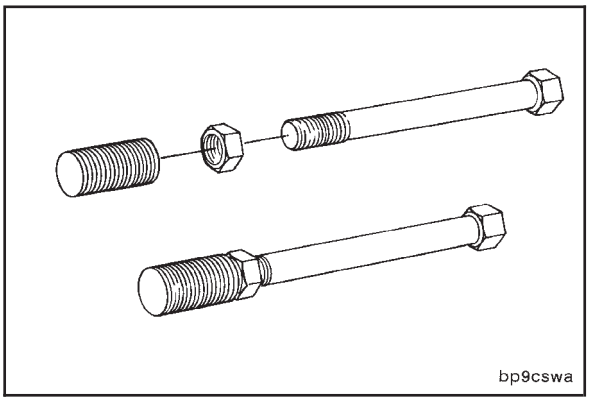
Use chip removal unit, Part No. ST-1272-11, to remove any debris from the hole.

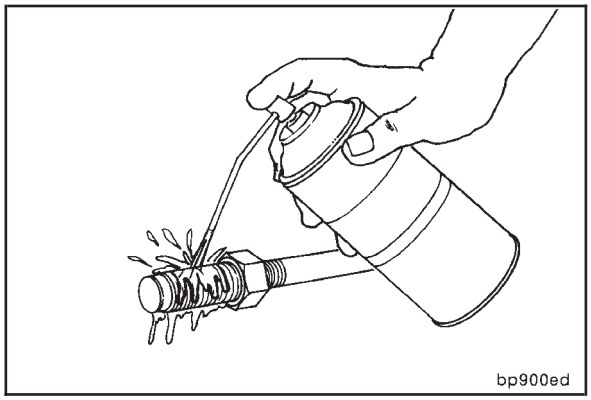
Dry the threads with compressed air.



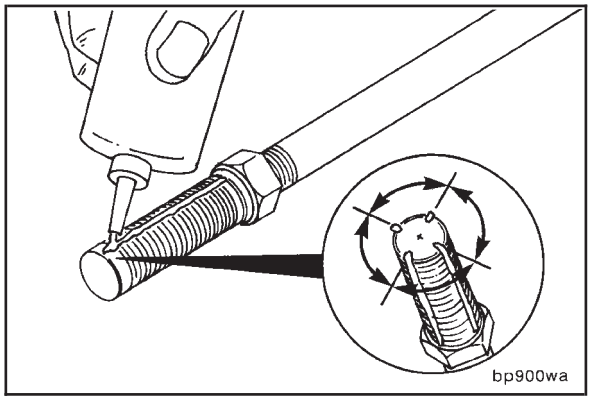
Obtain a capscrew and nut with the same size threads as the insert inside diameter.

Install the nut and insert on the capscrew.



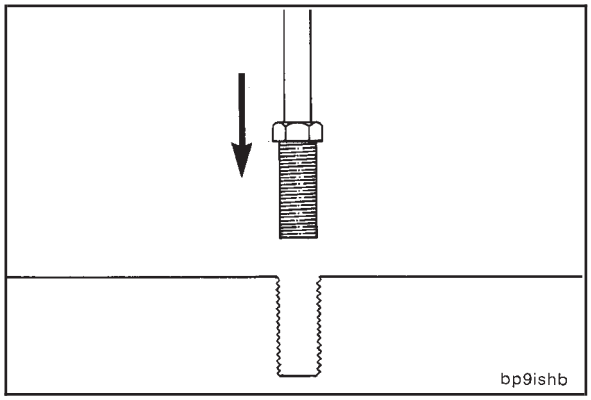


Use a spray cleaner to remove the preservative coating from the outside diameter of the insert.

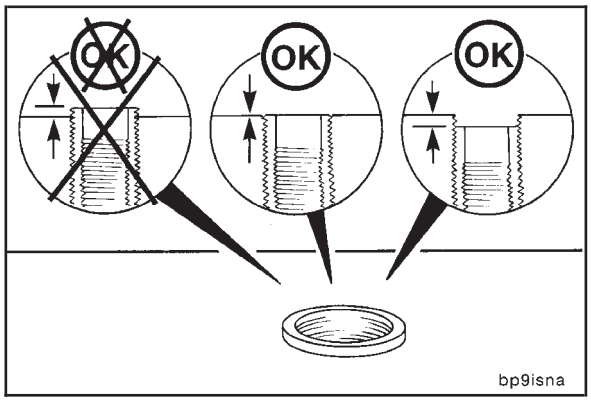


Apply four beads of sealant, Part No. 3375068, to the outside diameter of the insert.

NOTE: The beads of sealant **must** be about 0.8 mm [1/32 inch] wide and spaced 90 degrees from each other.

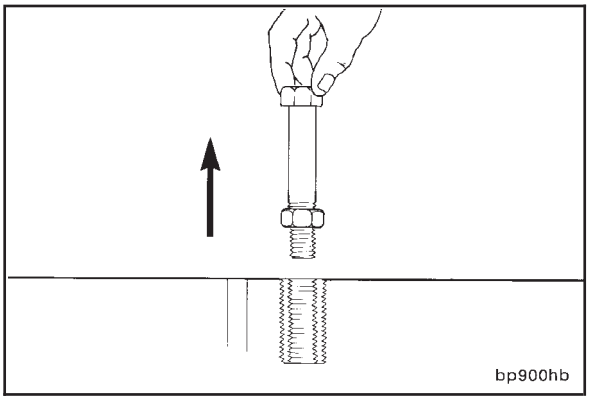


Install the repair insert.

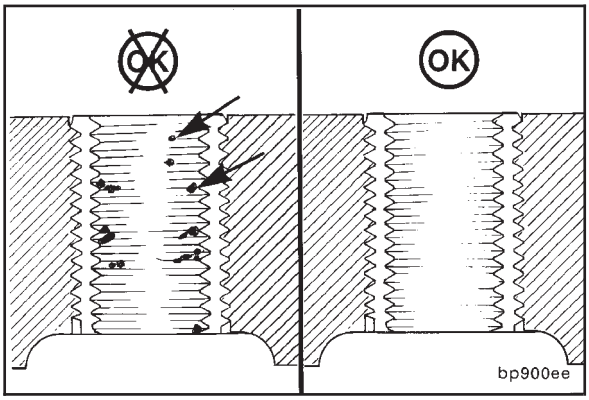


The insert **must** be 0.0 to 0.25 mm [0.00 to 0.010 inch] below the surface.

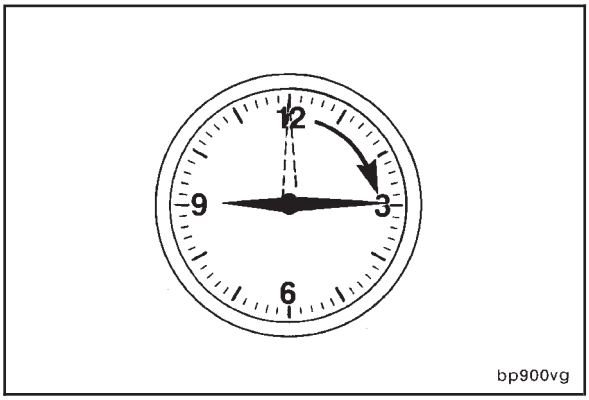
Loosen the nut and remove the capscrew.



Make sure the inside portion of the repair insert is clean. Remove any file shavings or debris.



Allow the sealant to cure for 15 minutes before use.



Reference Data And Functional Checklist

Cummins Part No.	Internal Thread (Size It Repairs)	Overall Length-mm	Tap Drill Dia. mm	External Thread (Tap Size)
3376701	M6 X 1.00-6H	12.0	8.8	M10 X 1.25-6g
3376702	M8 X 1.25-6H	12.0	10.8	M12 X 1.25-6g
3376703	M8 X 1.25-6H	17.0	10.8	M12 X 1.25-6g
3376704	M8 X 1.25-6H	20.0	10.8	M12 X 1.25-6g
3376705	M10 X 1.50-6H	08.0	12.8	M14 X 1.50-6g
3376706	M10 X 1.50-6H	12.5	12.8	M14 X 1.50-6g
3376707	M10 X 1.50-6H	14.0	12.8	M14 X 1.50-6g
3376709	M10 X 1.50-6H	18.0	12.8	M14 X 1.50-6g
3376710	M10 X 1.50-6H	20.0	12.8	M14 X 1.50-6g
3376711	M10 X 1.50-6H	24.0	12.8	M14 X 1.50-6g
3376712	M12 X 1.25-6H	08.0	14.75	M16 X 1.50-6g
3376713	M12 X 1.75-6H	08.0	14.75	M16 X 1.50-6g
3376714	M12 X 1.75-6H	21.0	14.75	M16 X 1.50-6g
3376715	M14 X 2.00-6H	30.0	16.5	M18 X 1.50-6g
3376716	M16 X 2.00-6H	30.0	18.0	M20 X 2.00-6g

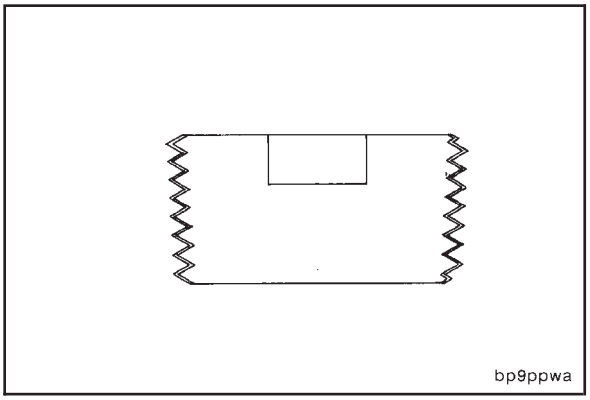
Pipe Plug Hole Repair Using Oversize Copper Plated Plugs

General Information

This repair procedure provides information on repairing pipe plug holes that are leaking due to the threads being worn. This repair allows a slightly oversize pipe plug to be installed as an alternative to drilling and re-tapping the hole for a larger standard size plug.

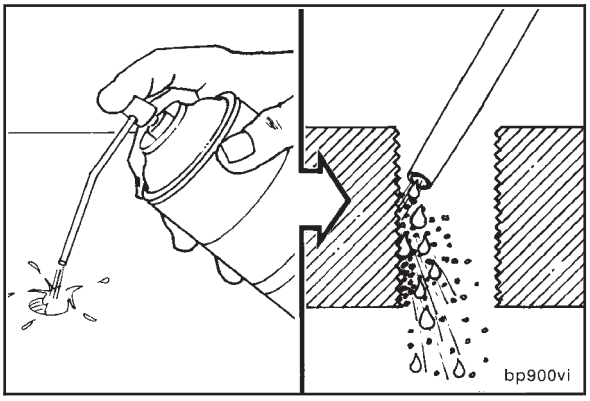
NOTE: Use care to prevent contaminants from entering the engine when using this procedure.

The pipe plugs described in this procedure are standard size steel plugs that are covered with a thin copper plating thus making the plug slightly oversize.



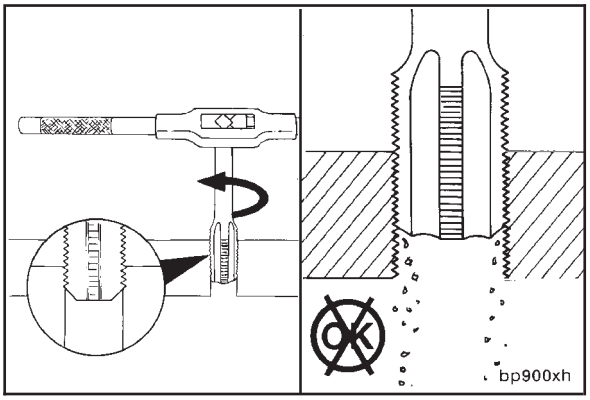
Repair Procedure

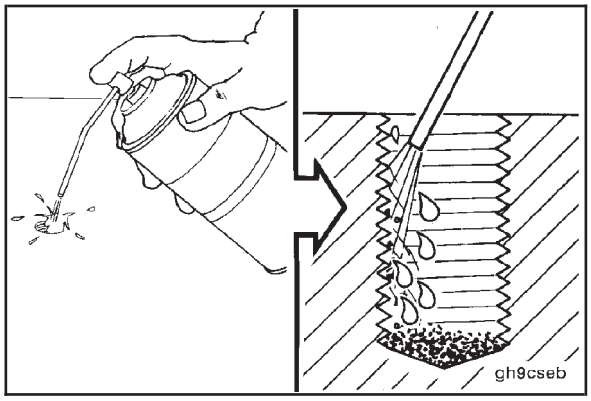
Clean the hole with an evaporating type spray cleaner.



Chase the threads with the correct size pipe tap.

NOTE: When chasing the threads, do **not** allow any metal shavings to fall into the engine.

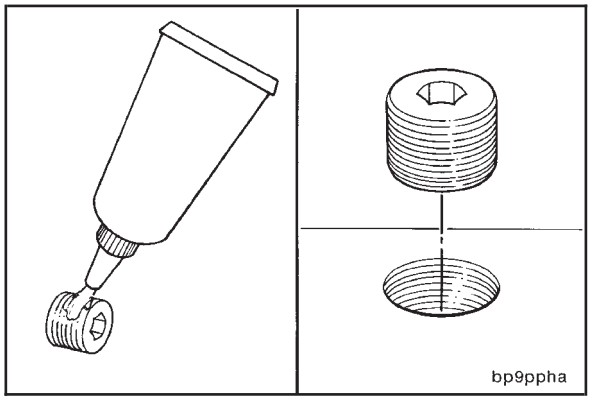




Warning: When using compressed air to dry capscrew holes, always wear safety glasses or a face shield to protect the eyes. Personal injury can result.

Use a spray cleaner to clean the threads.

Dry with compressed air.



Coat the pipe plug with pipe sealant, Part No. 3375066, and install it in the hole.

Tighten the pipe plug to the torque specified in the chart at the end of this procedure.

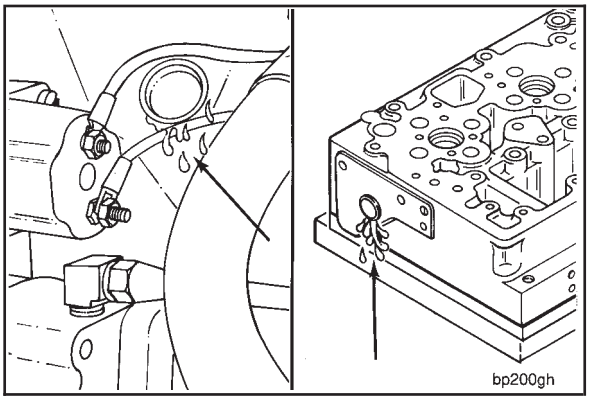
Oversize (Copper Plated) Pipe Plugs — Torque Values

Size (NPT)	Torque Value Aluminum N•m	ft-lb	Steel/Cast Iron N•m	ft-lb
1/8-27	9	85 in-lb	20	15
1/4-18	20	15	25	20
3/8-18	25	20	35	25
1/2-14	35	25	55	40
3/4-14	45	35	75	55
1-11 1/2	60	45	95	70

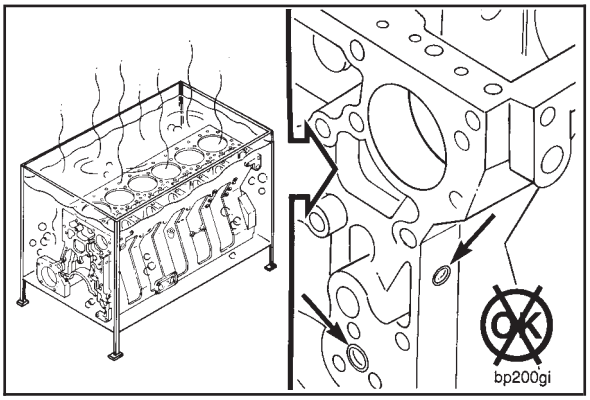
Cup Plugs

General Information

This repair method pertains to components that have leakage at a cup plug due to incorrect fit of the cup plug in the cup plug bore.



All cup plugs **must** be replaced if the component is cleaned in a "hot tank", spray washer, or similar equipment. This cleaning activity can interrupt the sealing capacity of the sealant.

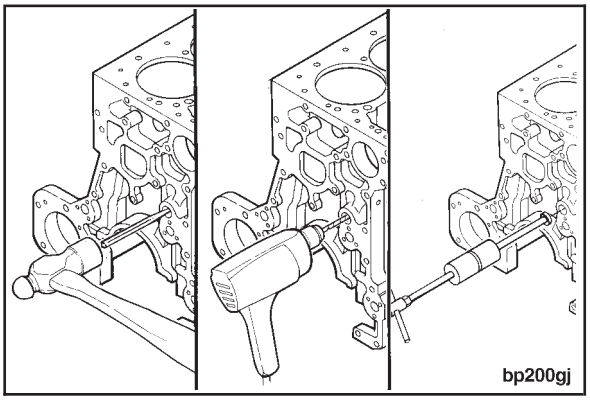


Cup Plug Removal

Cup plugs can be removed by using a center punch to mark the cup plug for drilling.

Drill a 3 mm [1/8 inch] hole in the cup plug.

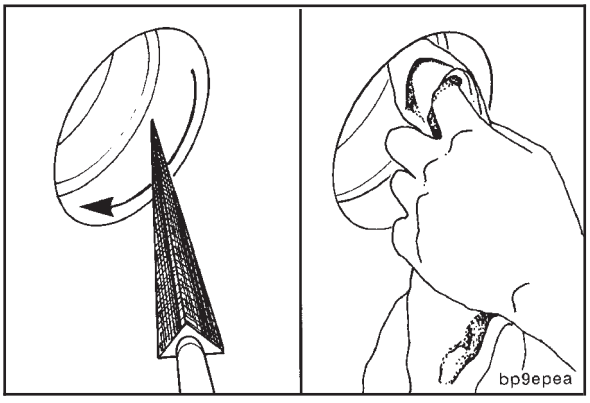
Use a dent puller to remove the cup plug.

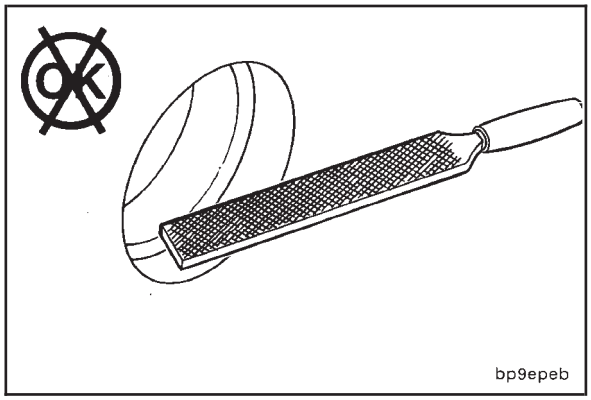


Cup Plug Bore Inspection

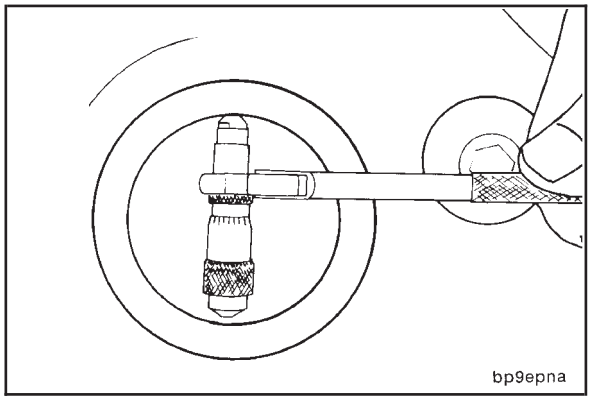
Lightly scrape the bore to remove any corrosion or carbon buildup.

Wipe the bore with a cloth saturated with a spray cleaner.

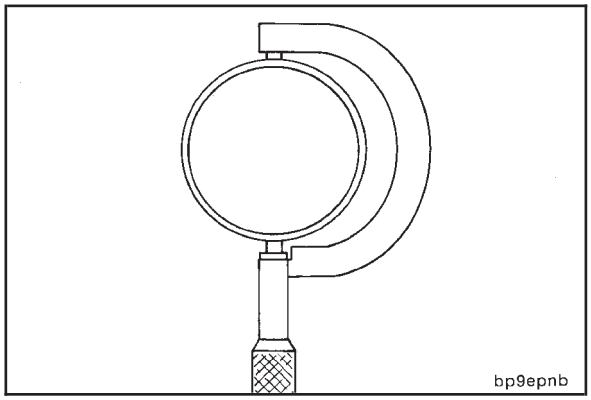




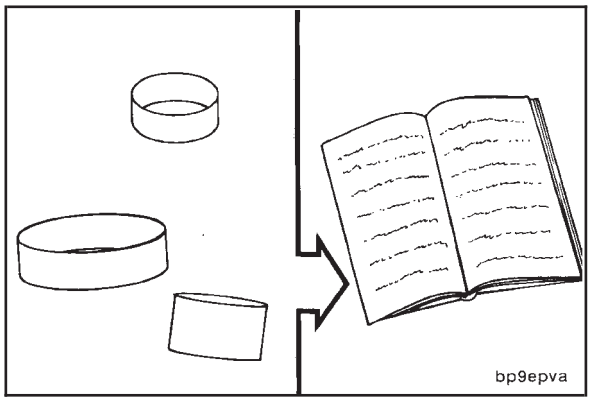
Caution: Do not use a file to remove the built up material. The cup plug bore can be damaged.



Measure the bore diameter in the vertical direction and in the horizontal direction. Both axis measurements should be within 0.02 mm [0.001 inch] of each other.

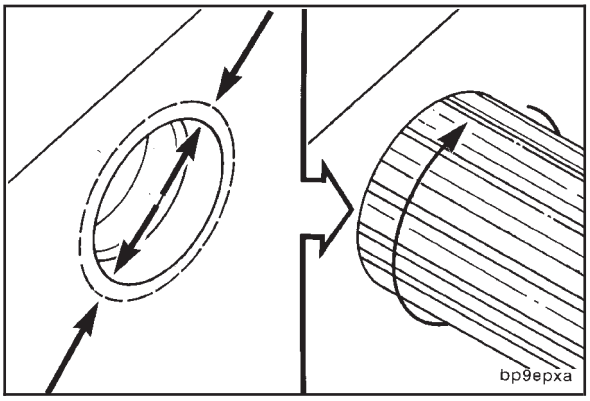


Compare the bore diameter with the recommended bore size of the cup plug being used. Refer to Cup Plug Specifications at the end of this procedure.



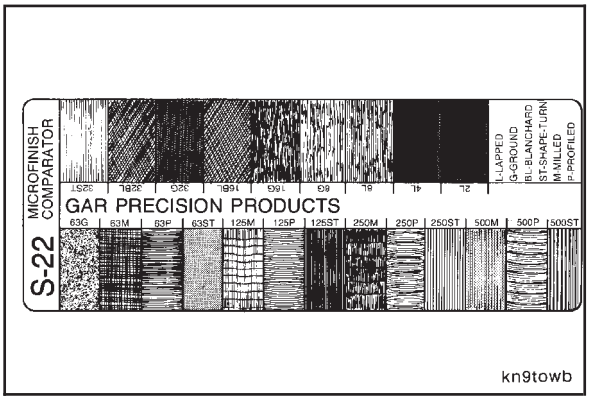
NOTE: If the correct cup plug is being used, but the bore is incorrectly sized, repair of the bore is necessary. The recommended repair method is to enlarge the bore for the next larger cup plug size. A listing of available cup plugs and their dimensions is provided at the end of this procedure.

Enlargement of the cup plug bores can be accomplished by reaming or boring the faulty bore. Use the existing bore for location reference when enlarging the bore.



The surface finish of the enlarged cup plug bore is very important in making a successful repair. The surface finish of the bore **must** be a minimum of 2.03 µM [80 µ inch]. A surface finish comparator can be used.

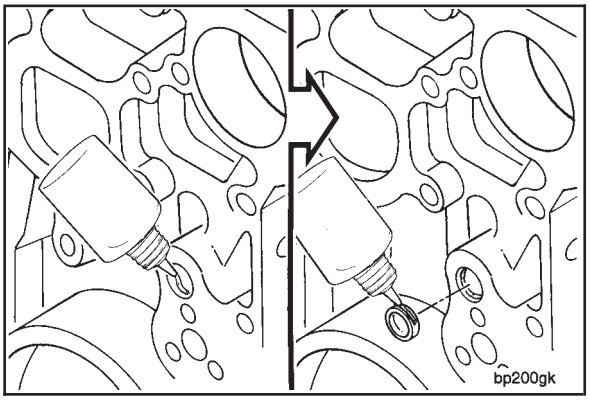
NOTE: Units of measurement are: Micro-meter [Micro-inch].



Cup Plug Installation

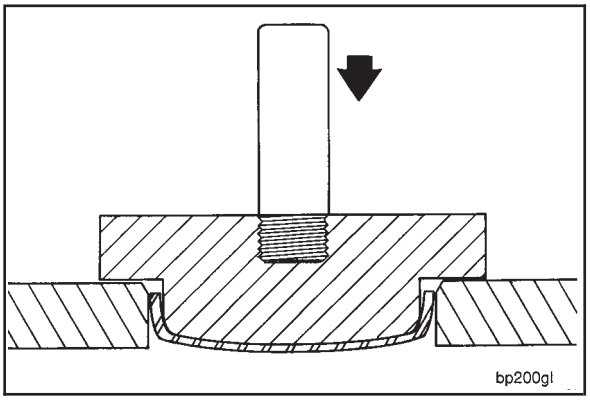
Caution: Excessive sealant application can run back into the engine and cause damage to other components.

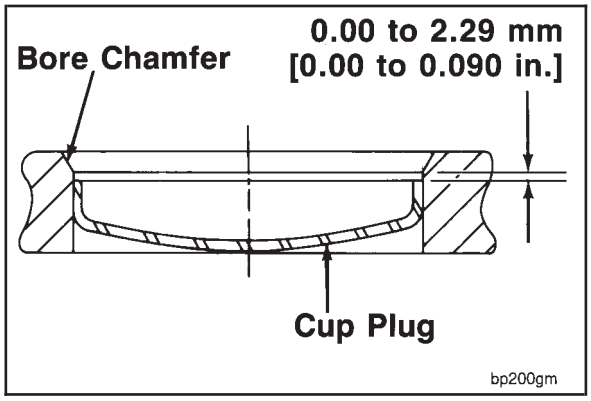
Apply a 2 mm [1/16 inch] bead of cup plug lock'N seal, Part No. 3375068 or equivalent, to the outside diameter of the cup plug and the inside diameter of cup plug installation bore.



Install the replacement cup plug.

Use a suitable driver or mandrel to correctly position the cup plug.





Check to make sure the cup plug is correctly installed. The top of the cup plug **must** be 0.0 to 2.29 mm [0.00 to 0.090 inch] below the entrance chamfer.

Cup Plug Specifications

Part No.	Outside Diameter mm	inch	Height mm	inch	Use in Bore Dia mm	inch
203933	6.55 to 6.60	0.258 to 0.260	3.17	0.125	6.40 to 6.45	0.252 to 0.254
3007632	9.77 to 9.82	0.385 to 0.387	4.77	0.188	9.62 to 9.68	0.379 to 0.381
210036	11.35 to 11.40	0.447 to 0.449	4.77	0.188	10.92 to 11.15	0.439 to 0.443
147416	12.95 to 13.00	0.510 to 0.512	6.34	0.250	12.80 to 12.85	0.504 to 0.506
213395	25.65 to 25.70	1.010 to 1.012	7.87	0.310	25.45 to 25.53	1.002 to 1.005
3007635	25.70 to 25.80	1.012 to 1.016	7.87	0.310	25.45 to 25.53	1.002 to 1.005
3004259	27.12 to 27.17	1.068 to 1.070	7.36 to 8.38	0.290 to 0.330	26.92 to 27.00	1.060 to 1.063
3032693	28.72 to 28.77	1.131 to 1.133	6.60	0.260	28.54 to 28.59	1.123 to 1.125
143066	28.92 to 28.77	1.135 to 1.137	7.87	0.310	28.62 to 28.67	1.128 to 1.132
156075	30.37 to 30.42	1.196 to 1.198	7.87	0.310	30.18 to 30.25	1.188 to 1.191
206741	60.50 to 60.60	2.382 to 2.386	9.52	0.375	60.30 to 60.35	2.374 to 2.376
3895479	51.18 to 51.28	2.015 to 2.019	8.89 to 9.91	0.350 to 0.390	50.80 to 50.88	2.000 to 2.003

Liquid Penetrant Inspection

General Information

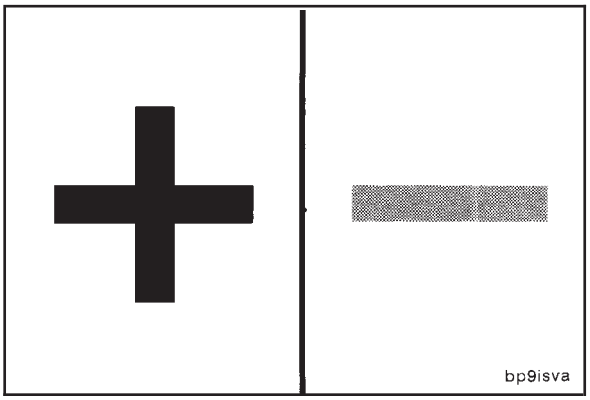
This procedure describes the method and application of dye penetrant inspection. The procedure explains the application and use of crack detection kit, Part No. 3375432. This inspection kit is the solvent removable, visible dye category of penetrant inspection methods. This category of penetrant inspection is formally described as Type II Method C, commonly called Spotcheck.

Solvent removable, visible dye penetrant inspection is used to detect surface cracks and porosity.

Solvent removable, visible dye inspections uses a colored liquid penetrant to enter the crack so the extent and location of the flaw is shown directly on the part.

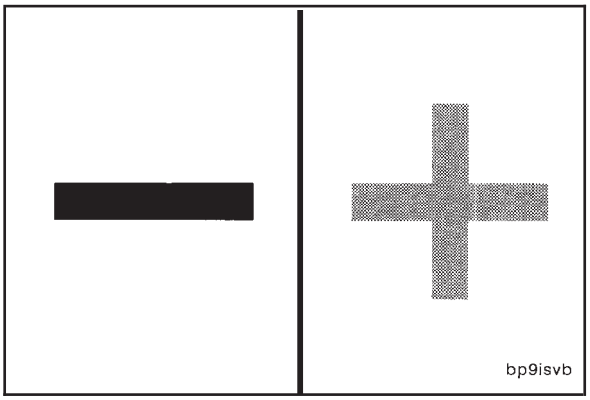
The advantages of this inspection method are:

- Simple to apply and understand
- The flaw indication appears on the actual part
- Sensitive to extremely fine tight cracks
- Relatively rapid and inexpensive
- The complete inspection kit is portable and lightweight
- Parts do **not** have to be capable of being magnetized
- A visual record of inspection results is possible



The disadvantages of this inspection method are:

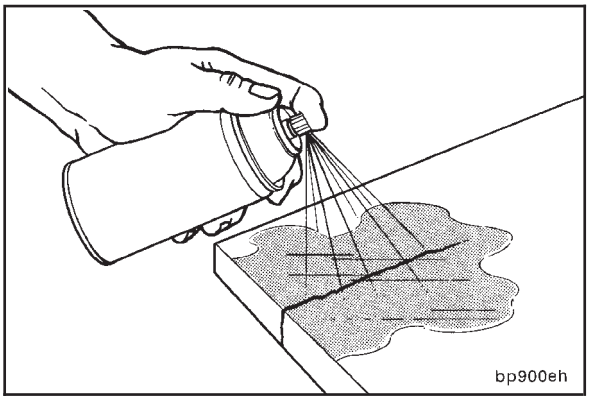
- Limited to surface flaw detection
- The test specimens **must** be solid and non-porous
- The part **must** be thoroughly cleaned and dried
- Penetrants and developers from various suppliers may **not** be interchangeable
- Visible dye penetrants are **not** as sensitive as flourescent penetrants
- Part processing cleanup is sometimes difficult and time consuming especially on rough castings and intricate shapes

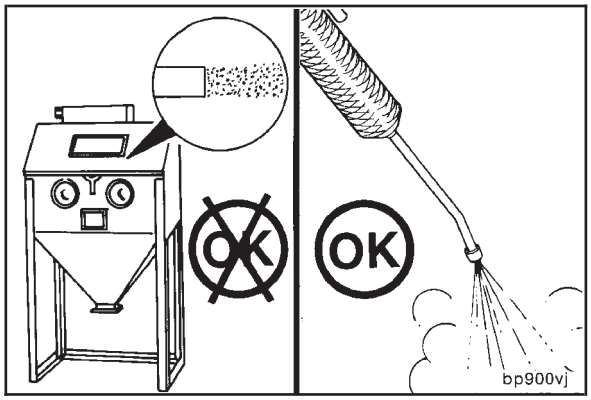


Inspection Procedure

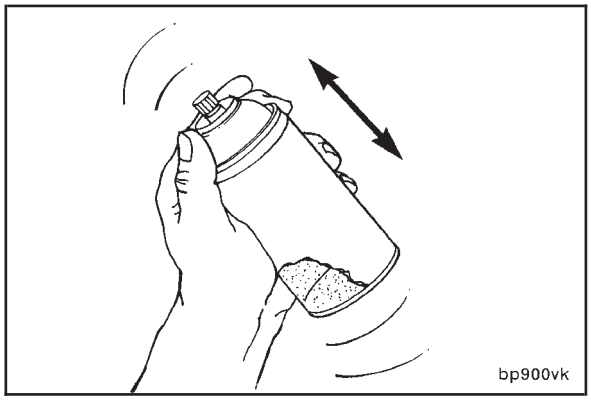
Thoroughly clean the part. The surface of the part **must** be physically and chemically clean.

NOTE: Detergent baths, vapor degreasing, solvent cleaning, or steam cleaning are recommended cleaning methods.



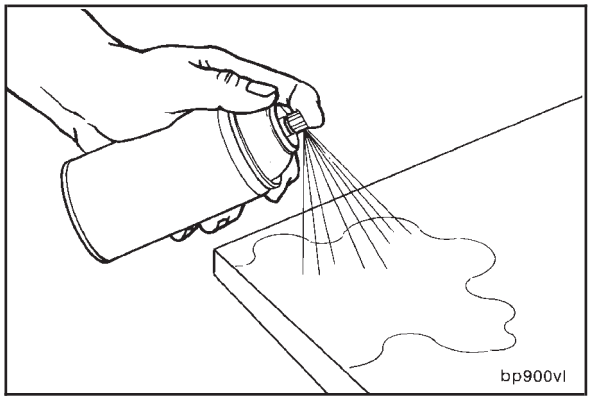


NOTE: Do **not** use sand blasting, bead blasting, or shot peening as cleaning methods. These methods can close or partially close the surface opening of the crack.



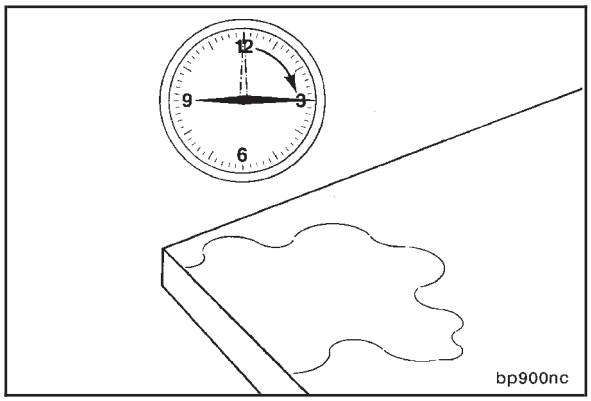
Shake the can of penetrant, Part No. 3375435, thoroughly.

NOTE: Do **not** be alarmed if you do **not** hear a mixing ball in the can. Most penetrants do **not** use mixing balls.



Apply the penetrant to the area to be tested. The volume of penetrant required varies with the type of material being tested. However, a shiny continuous light film of liquid applies to most configurations and materials.

NOTE: Penetrants enter surface flaws by capillary action; consequently, overhead or vertical surfaces can be inspected by this method.

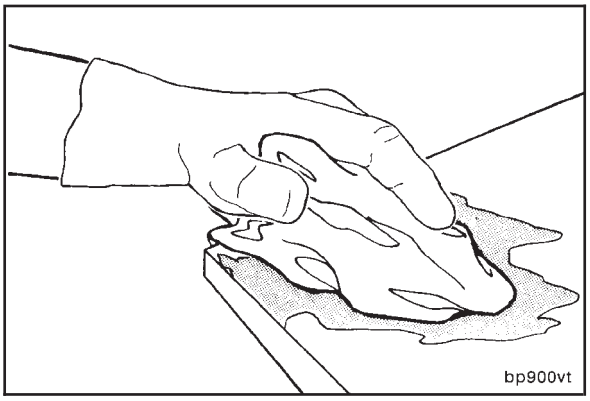


Allow the penetrant to soak on the surface of the part for at least 15 minutes.

NOTE: The longer the soak time the more the opportunity for the penetrant to enter the flaw. Good inspection results on cylinder blocks and cylinder heads are generally obtained with a 15 minute soak time. Excess penetrant removal becomes more difficult as soak time increases.

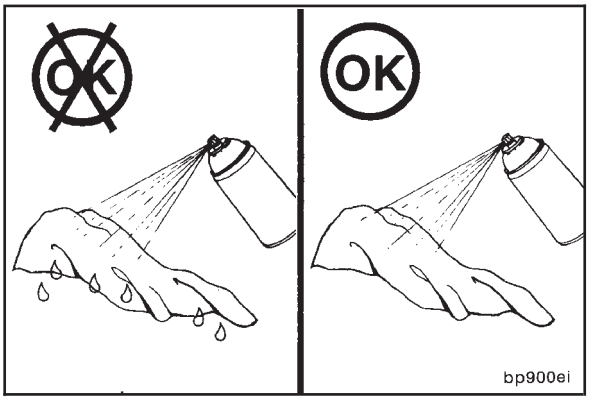
Wipe the excess penetrant from the surface of the part. Use a clean, dry, lint free cloth for this operation.

NOTE: Most penetrants have a staining effect on the skin. Wear rubber gloves to prevent skin discoloration.

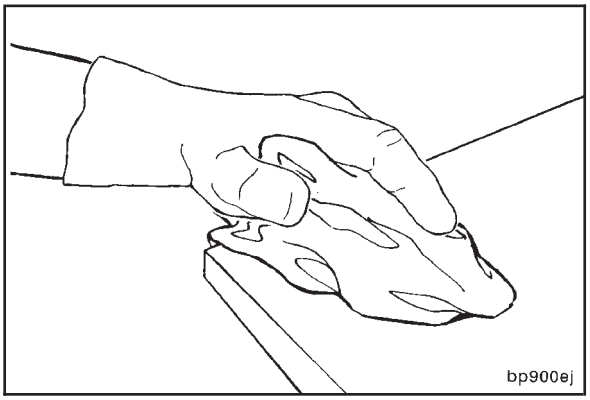


Lightly dampen another clean lint free cloth with a spray cleaner.

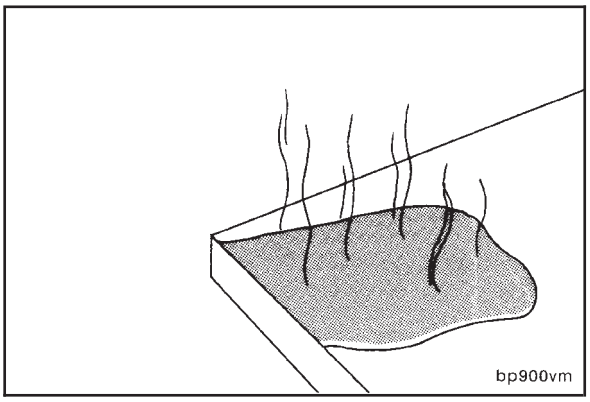
NOTE: A damp cloth is **not** the same as a soaked or wet cloth. A correctly dampened cloth should **not** leave a pool of liquid when put on a work surface or drip from the cloth. Too wet a cloth will remove the penetrant in the flaws.

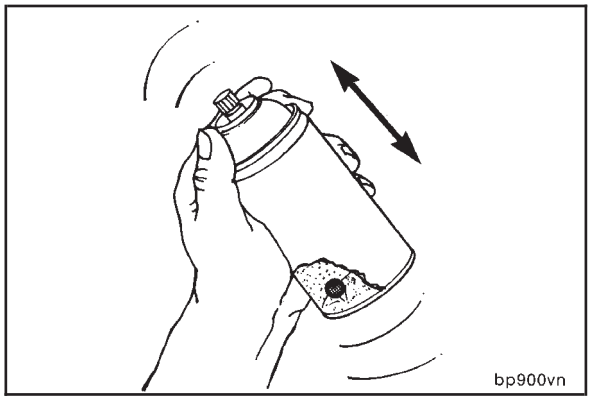


Wipe, **do not scrub**, the residual penetrant stain from the area.



Allow any surface dampness to evaporate.

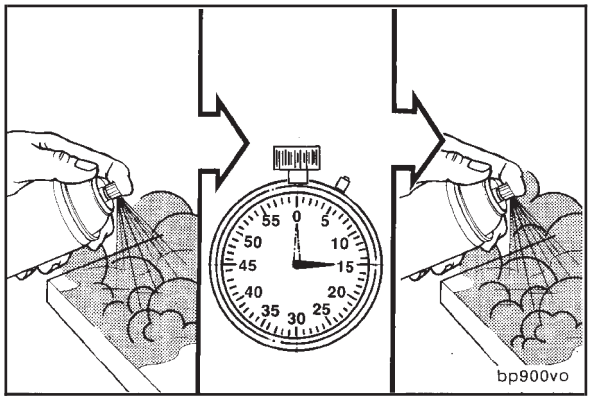




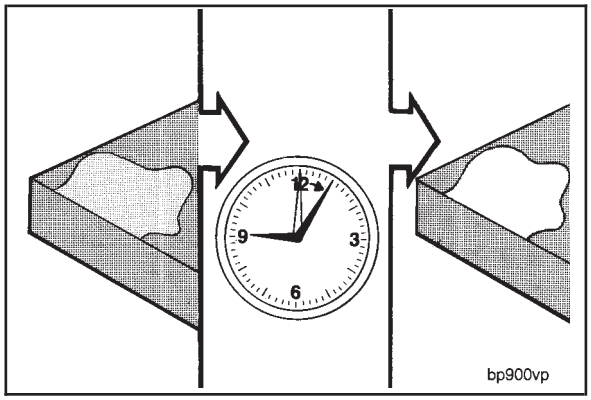
Thoroughly shake the can of developer, Part No. 3375434.

NOTE: Most developers have a mixing ball in the spray can.

Shake the can approximately one minute after the mixing ball begins to freely move in the can.

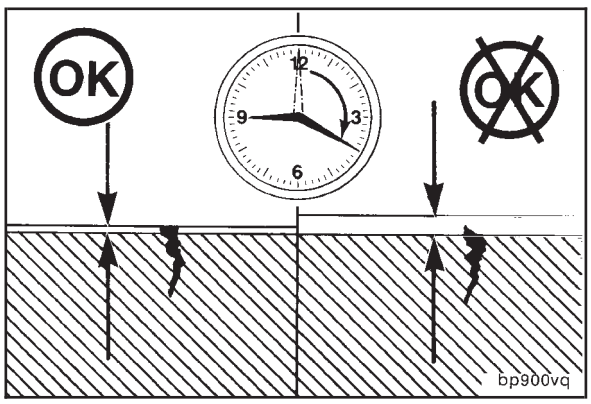


Apply a light coat of developer to the suspect area. Wait 15 seconds then apply a second coat. The appearance of the area will be clear and transparent.



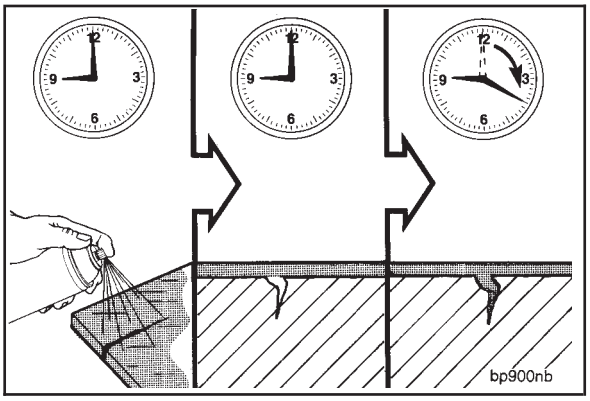
The developer will turn to a dull white color after about five minutes.

NOTE: If the suspect area does **not** show an even covering, apply another light coat of developer to the portion that is **not** evenly covered.



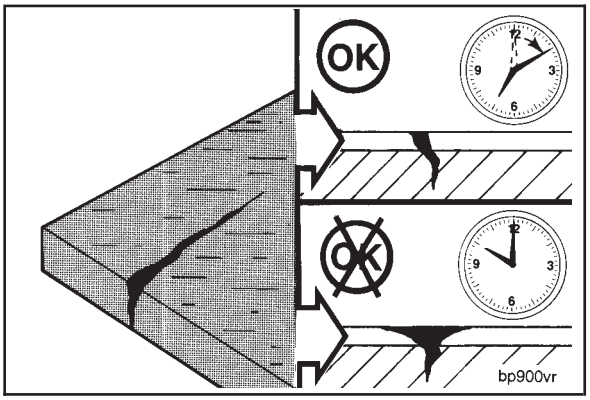
NOTE: Applying too thick (heavy) a coating of developer will hide some defect indications.

Allow 15 to 20 minutes for the penetrant to soak through the white developer background. Any colored spots or lines indicate possible defects in the surface of the part.

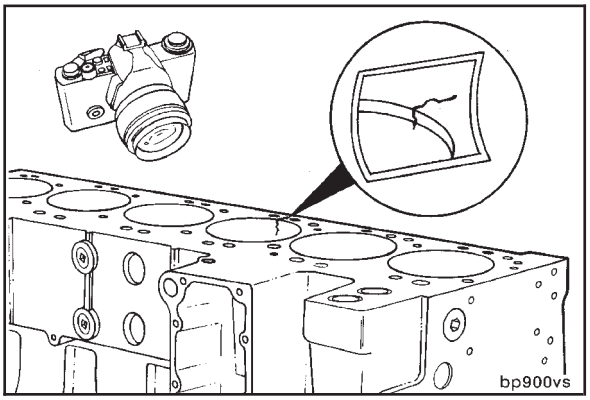


NOTE: Visually inspect the suspect area within 30 minutes of developer application. Inspection results after that time period are less accurate because:

- Diffusion of the dye into the developer will exaggerate the defect size
- Visual sharpness of the indication is lessened
- The developer background loses its color contrast as it becomes contaminated with penetrant



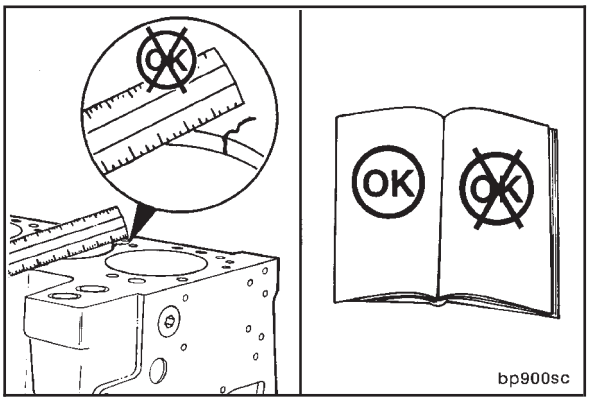
Take a photograph of any suspect indications. This will allow evaluation of the inspection results without performing the inspection a second time, or it will document the results of the inspection process.

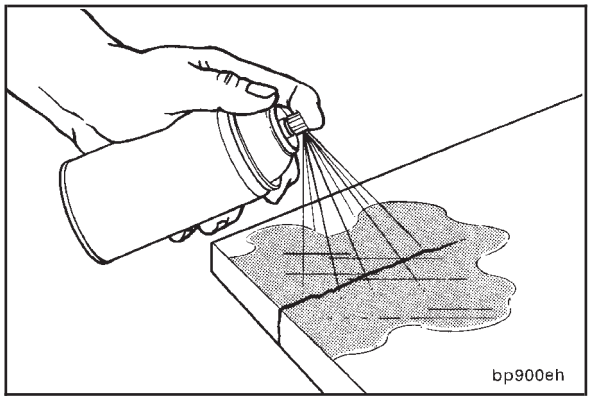


NOTE: Some types of minor cracks are acceptable (OK).

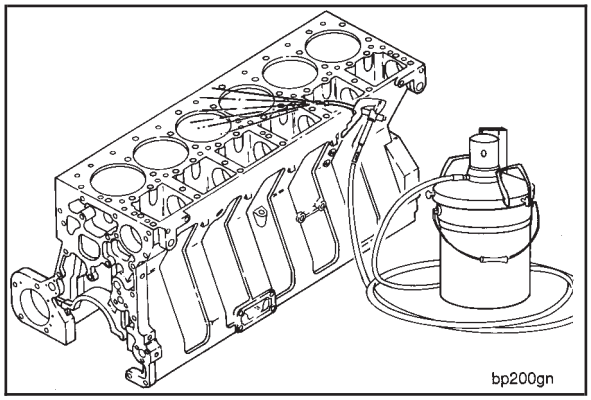
Compare the type and size of the crack to the reuse guidelines. Refer to the following manuals:

Bulletin No. 3379347 - Internal Damper L10 Engines
Bulletin No. 3810476 - External Damper L10 Engines
Bulletin No. 3666075 - M11 Engines
Bulletin No. 3810303 - Parts Reuse Guidelines





Clean all developers and penetrants from the inspected area.



Apply a rust preventing coating if the component is to be stored for later use.

Epoxy Metal Fillers

General Information

This repair procedure provides information on metal filler compounds and guidelines for their use in repairs. Repairs made by using metal fillers **must not** take the place of more permanent repairs or part replacement.

NOTE: This repair procedure can be a warrantable practice, but requires prior approval by the warranty department.

Metal filler compounds can be used to correct surface imperfections or to replace a missing section. Successful repairs have been made in flywheel housing, starting motor bores, lubricating oil pan mounting flanges, machining marks (all areas), gasket surface irregularities and pitted, eroded or fretted surfaces.

Warning: Epoxy metal fillers must not be used to repair safety related components. Read and follow the package instructions and safety warnings.

Different metal based metal fillers are available such as ferrous, brass, and aluminum. Make sure to use a metal filler which is correct for the material that is being repaired. The filler **must** be capable of withstanding the same temperatures, stresses and pressures as the material being repaired. Only the repair of non-load bearing, or non-stress areas should be considered as repairs. An example of this is the repair of a deeply gouged or eroded mounting surface of a cover plate or a dented sealing surface.

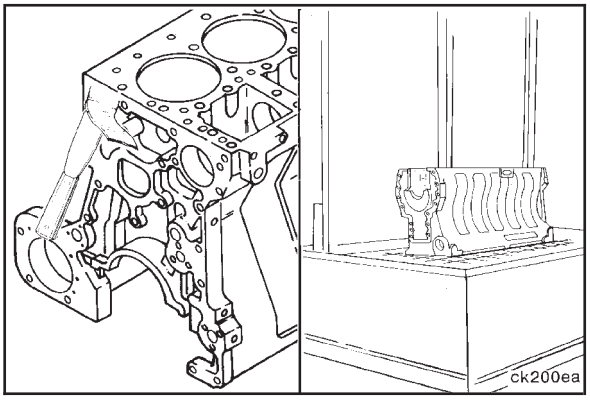
Some filler compounds are multipurpose and have the ability to bond dissimilar metals, others do **not**. The manufacturer's recommendations **must** be followed for best results.

These products are available through industrial or automotive supply stores and are sold in conveniently packaged quantities. Corporate headquarters of each company are provided for reference at the end of this procedure.

Application Guidelines

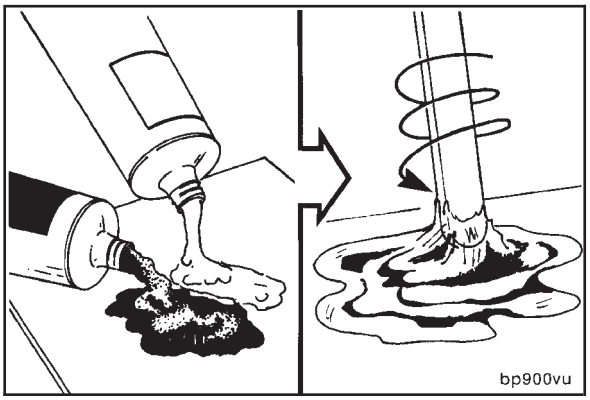
Remove all greases, oils and waxes to prepare the surface for proper adhesion.

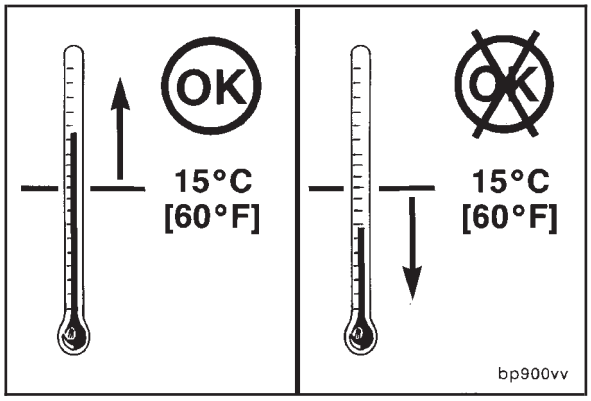
NOTE: Maximum adhesion is obtained on a roughened surface.



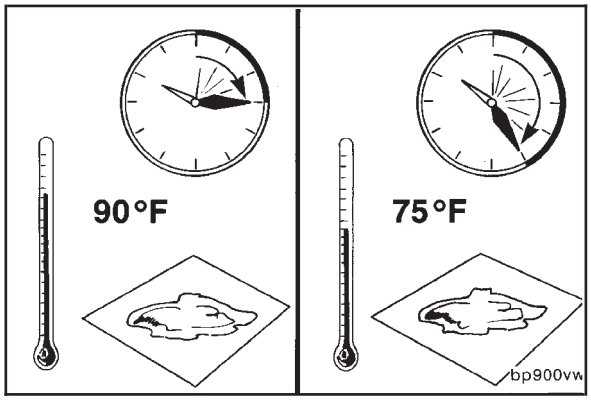
Mix the filler material to the manufacturer's specifications.

NOTE: Read carefully; some instructions are by volume while others are by weight. In either case, mix the contents thoroughly before application to the part to be repaired.

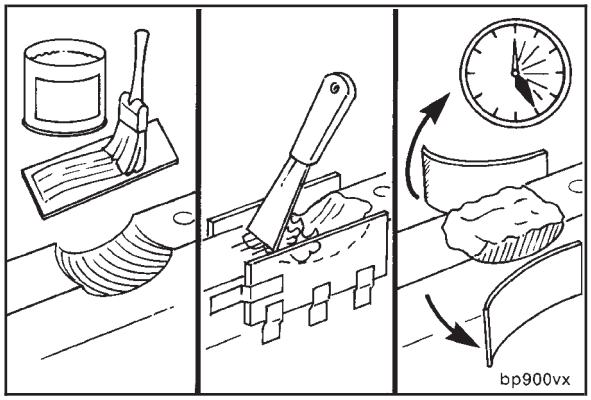




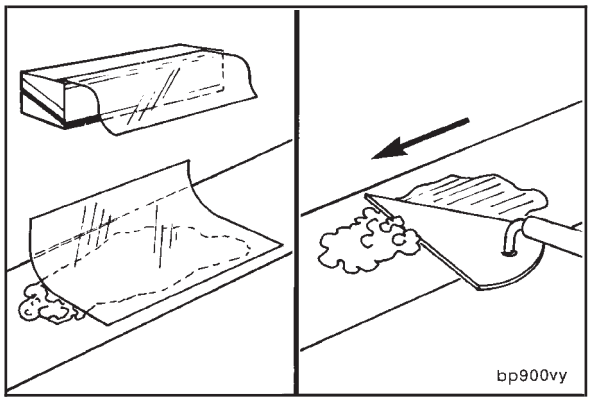
NOTE: Filler materials do **not** cure properly when used in ambient temperatures of 15°C [60°F] or below. Place a heat lamp approximately 18 inches from the work surface to improve curing properties.



When making repairs in ambient temperatures of 32°C [90°F] or higher, be aware that the filler material will have a shorter working time and will cure more rapidly. Average working time at 25°C [75°F] is approximately 30 minutes.



Put wax or the release agent (enclosed with some products) on areas adjacent to the repaired area to prevent sticking.



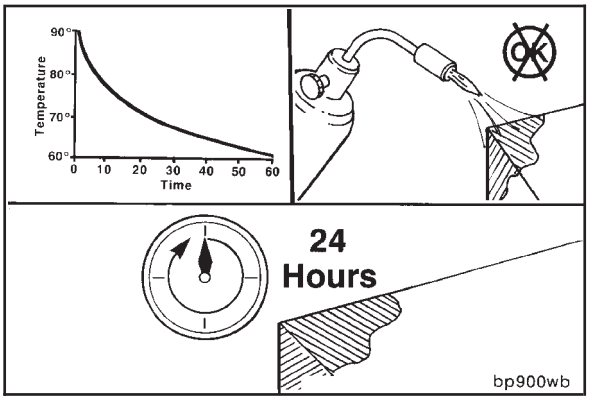
A smooth repaired surface finish can be achieved by:

- Covering the filler material surface with a sheet of waxed paper
- By drawing a trowel across the surface of the filler material

NOTE: A trowel moistened with water usually works best

General information about epoxy filler materials:

- The higher the temperature, the faster the cure time
- The larger the mass of filler material, the slower the cure time
- Never expose the filler material to a direct flame
- Let the filler material cure overnight before further processing



Epoxy Metal Filler Suppliers

Epoxy Metal Suppliers

Achim Sultz
Diamont Kitle
Schultz GMBH & Co.
(Rheydt) P.O. Box 70
D4050 Monchengladbach 2
Federal Republic of Germany
Telex: 852353-DIAM-D

Alvin Products, In.
20-22 Hougton St.
Worchester, MA, 01604
Phone: (617) 754-8604

American Velodur Metal, Inc.
P.O. Box 156
Scituate, MA, 02066
Phone: (617)545-9100
Telex: 94-0249

A.W. Chasterton Co.
Middelsex Industrial Park
Route 93
Stoneham, MA, 02180
Telex: 94-941

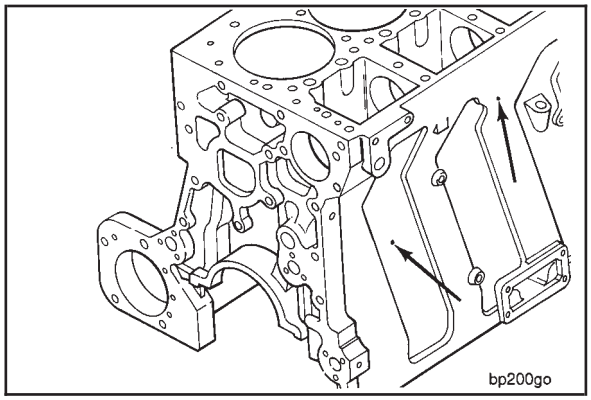
Devcon Canada Ltd.
22 Golden Gate Ct.
Scarbough, 707, Ontario, Canada
Phone: (416) 291-3501
Telex: 389-065-25458

Devcon Corporation
61 Endicott St.
Danvers, MA, 01923
Phone: (617) 777-1100
Telex: 94-04-57

Devcon I.T.W., Ltd.
Brunel Close
Park Farm Estate
Wellingborough, Northants, England
Phone: Wellingborough 675299
Telex: 851-317465

Fel-Pro, Inc.
Chemical Products Division
Dept. No. NED-281
7450 N. McCormick Blvd.
Box C 1102
Skokie, IL, 60076

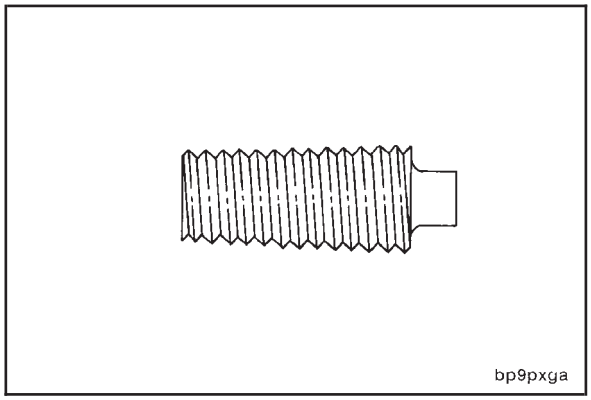
J.B. Weld Co.
P.O. Box 483
Sulphur Springs, TX 75482
Phone: (214) 885-7696



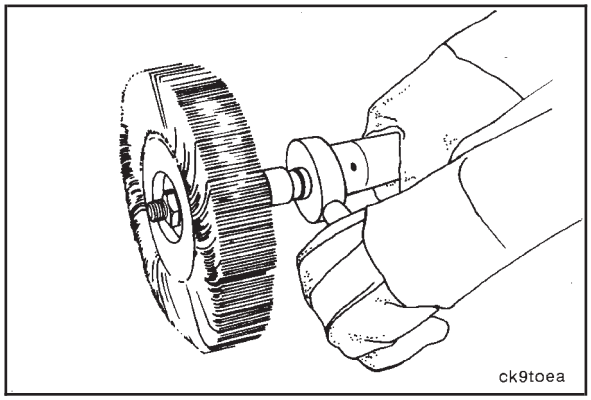
Taper Threaded Plugs for Minor Defect Repair

General Information

The following guidelines are for using taper threaded plugs to repair minor defects such as pin holes, blow holes, and sand, slag or dirt pockets which cause leaks in castings. Although taper threaded plugs are also used to repair cracks, this repair procedure will **not** give guidelines for repairing cracked castings.



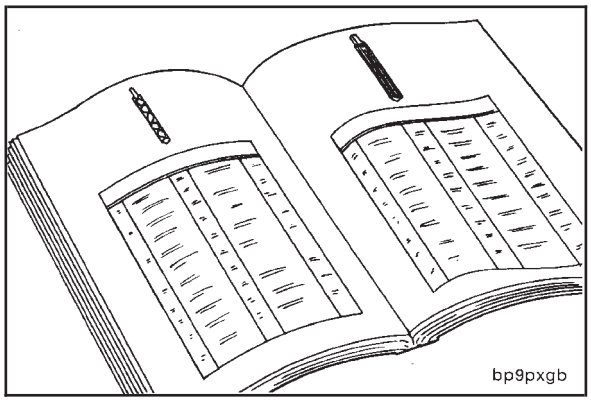
The specifications and suppliers of taper threaded plugs are listed at the end of this procedure.



Repair Procedure

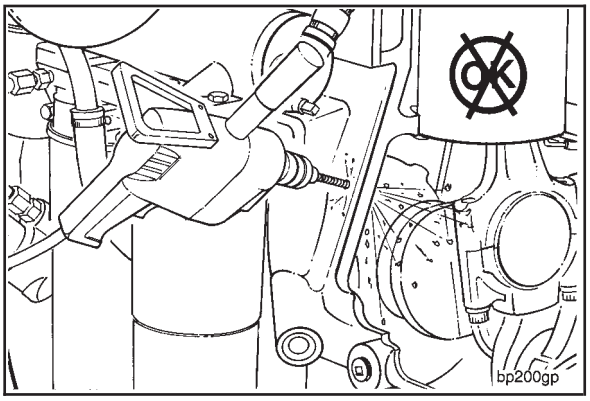
Warning: To avoid possible eye damage, always wear protective eye goggles when using a flap wheel or a wire brush to clean metal surfaces.

Use a hand held flap wheel or wire brush to remove paint or rust from around the defective area.



Each taper threaded plug size requires a special tap drill size and tap size. Refer to the chart at the end of this procedure for the correct drill and tap sizes.

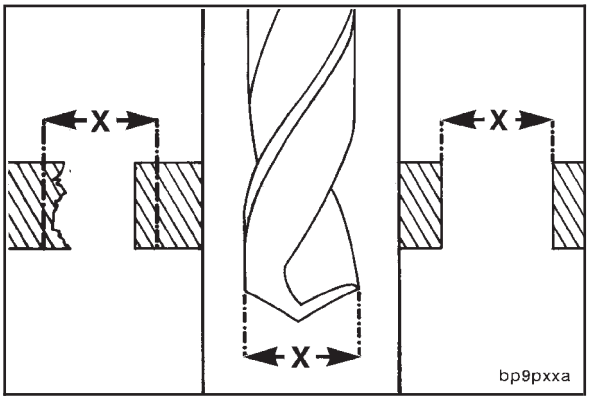
If this repair procedure is done while the engine is still in chassis, do **not** allow shavings to enter the engine.



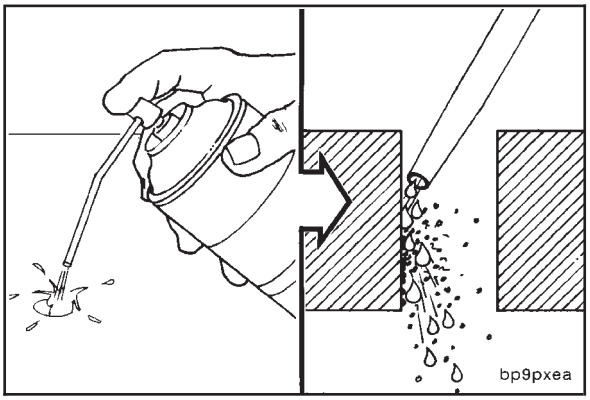
Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

Drill the hole with the correct tap drill size for the plug that will be used.

NOTE: Make sure the size of the drill bit is large enough to completely remove the defective area.

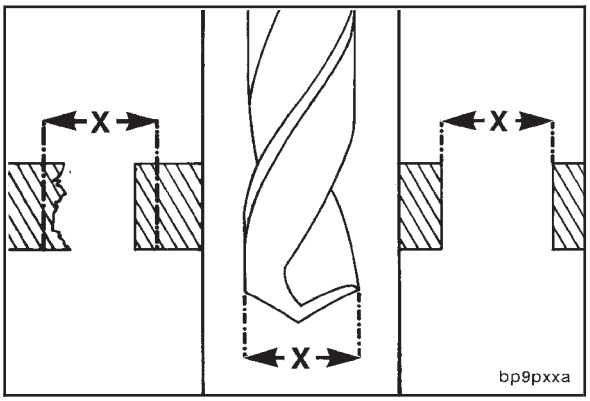


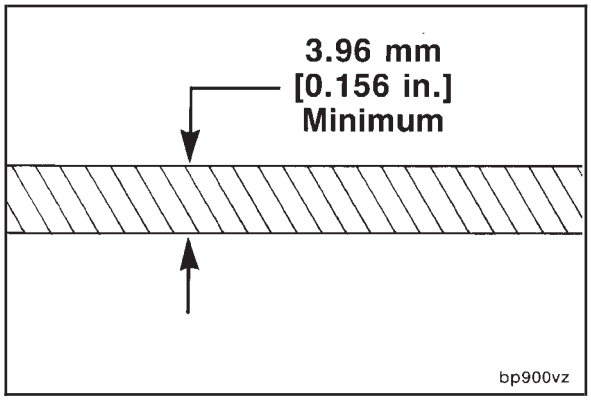
Use a spray cleaner to remove the drill shavings and clean the newly drilled hole.



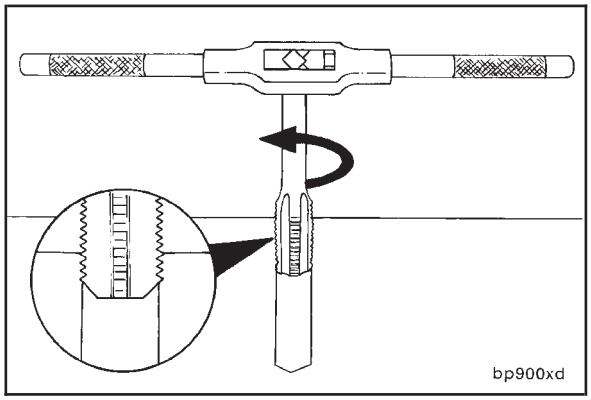
Visually examine the drilled hole.

If any defects in the wall of the drilled hole are found, drill the hole for the next larger plug. Repeat this step until no defects can be found in the wall of the hole. Do **not** exceed a maximum hole diameter of 25.4 mm [1.00 inch].



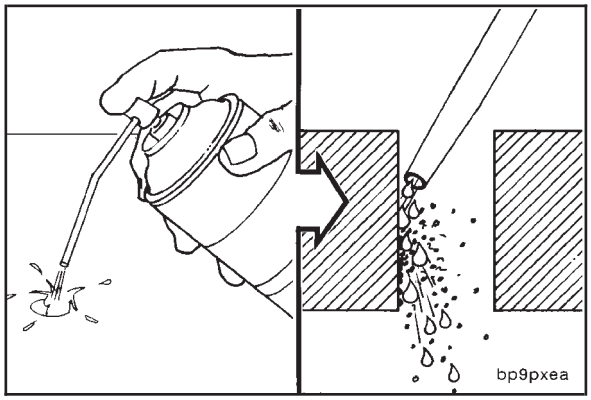


Measure the casting wall thickness. The wall thickness of the casting in the defective area **must not** be less than 3.96 mm [0.156 inch].

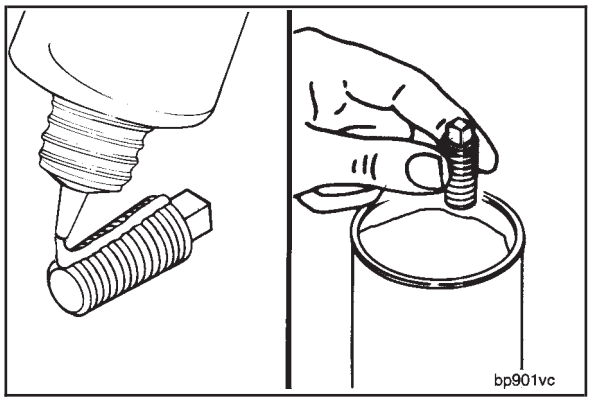


Use clean cutting oil to lubricate the tap when cutting the threads. Use the correct size tap to cut threads in the hole.

NOTE: A minimum of four full threads is necessary for the plug to hold and seal effectively.

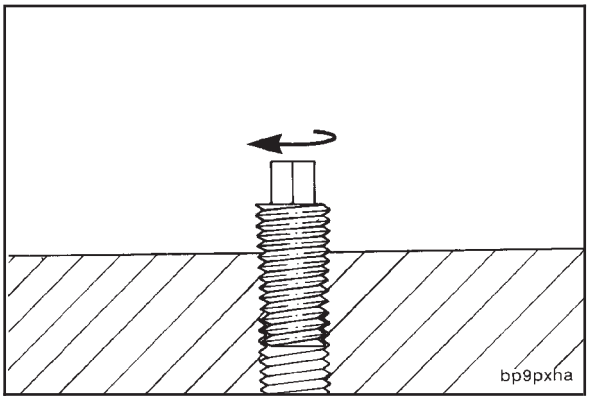


Use a spray cleaner to clean the newly cut threads.



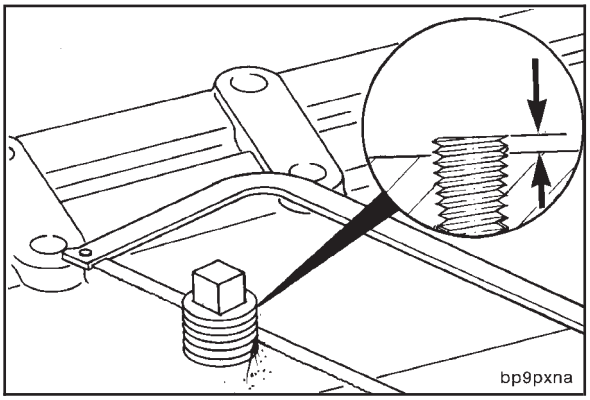
Apply sealant, Part No. 3375068 or equivalent, to the threads of the plug.

Install and tighten the plug to the recommended torque value. Refer to the charts at the end of this procedure for torque specifications.



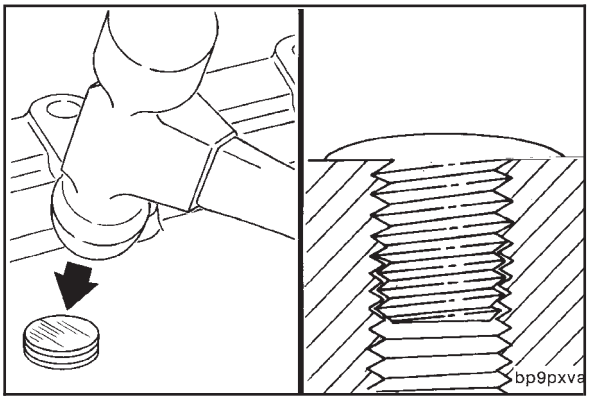
NOTE: Leave a minimum of 0.79 mm [0.031 inch] of the plug above the surface of the material.

Cut off the upper portion of the plug. Do **not** cut the plug off flush with the adjacent material.

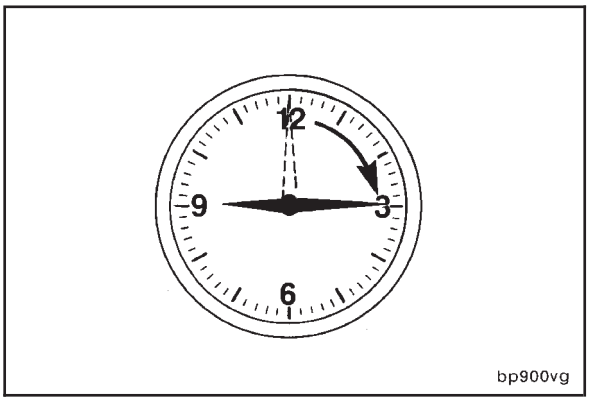


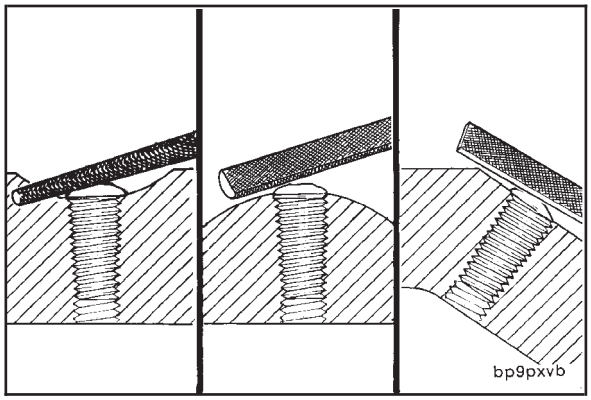
NOTE: The plug **must** be spread out enough to seal the top threads of the plug with the top threads of the hole. An air powered peening hammer is recommended; however, the rounded head of a ball peen hammer can be used.

Spread out (peen) the protruding part of the plug.

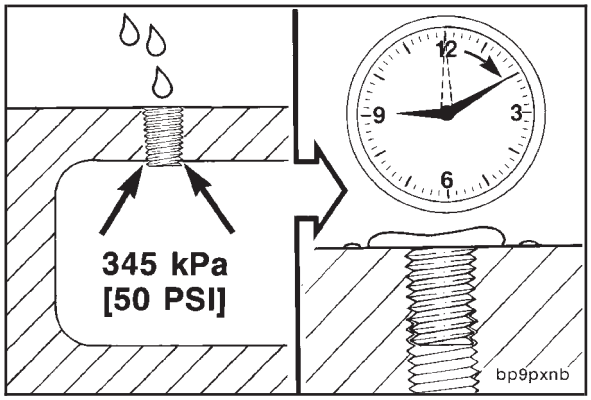


Allow the sealant to cure for at least 15 minutes.





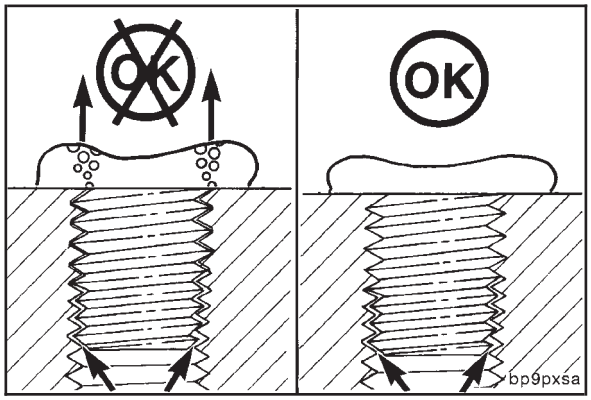
Contour the plug to match the surface of the part. A hand held grinder or file can be used.



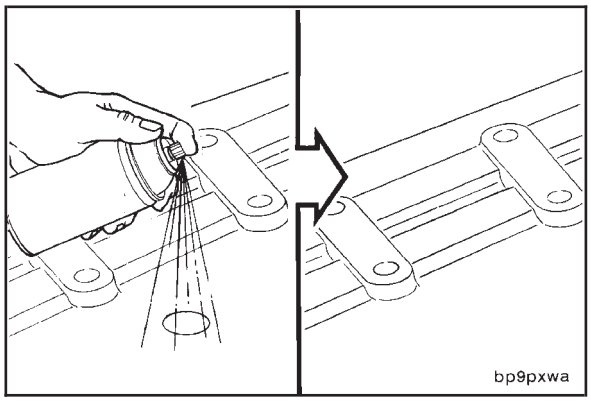
If a water or oil passage wall has been repaired, the plug **must** be tested with 345 kPa [50 psi] air pressure. With the pressure applied to the passage, put a soap and water solution at the junction of the plug and the repaired part.

Visually inspect the repaired part for air bubbles.

NOTE: Do **not** remove the air pressure for at least ten minutes. This will allow time for seepage through the threaded repair plug.



If air bubbles appear, the leak has **not** been repaired. Repeat this procedure and install the next oversize taper threaded plug to repair the areas that display air bubbles.



Finish the repair by painting the repaired area with the necessary color and type of paint.

Listed below are some of the known suppliers of tapered threaded plugs. These products are usually available through industrial or automotive supply stores, and are sold in conveniently packaged quantities. Corporate headquarters of each supplier are provided for reference.

Suppliers

Irontite Products Co.
9858 Baldwin Place
El Monte, CA 91734
Phone: (818) 443-0296

Versnick Manufacturing
P.O. Box 470
Madisonville, KY 42431
Phone: (502) 821-5560

Seal-Lock International, Inc.
P.O. Box 308
Glenside, PA 19038
Phone: (215) 572-5565

Tapered Plugs

Diameter Small End		Thread Length		Irontite Part No.	Versnick Part No.	Seal-Lock Part No.
mm	Inch	mm	Inch			
5.08	0.200	23.8	15/16	210200	TP-1	-
5.72	0.225	25.4	1	-	-	10111
5.97	0.235	23.8	15/16	210235	TP-2	-
7.62	0.300	34.9	1 3/8	-	-	10112
8.31	0.327	36.5	1 7/16	210327	TP-3 & TP-7	-
10.67	0.420	25.4	1	210420	TP-4	-
10.67	0.420	36.5	1 7/16	210421	TP-4	-
12.45	0.490	25.4	1	210490	TP-5	-
12.45	0.490	36.5	1 7/16	210491	TP-5	-
14.99	0.590	25.4	1	210590	TP-6	-
19.81	0.780	25.4	1	260780	TP-9	-
27.35	1.085	25.4	1	261080	-	-

Tap Drill Part Numbers

Nominal Size	Irontite Part No.	Versnick Part No.	Seal-Lock Part No.
11/64	510200	T-270	-
13/64	510235	-	-
5/16	510327	-	-
25/64	510420	T-276	-
15/32	510490	T-277	-
9/16	510590	-	-
23/32	510790	-	-
1.00	511080	-	-

Tap Size

Diameter Small End		Thread Length		Irontite Part No.	Versnick Part No.	Seal-Lock Part No.
mm	inch	mm	inch			
5.08	0.200	23.8	15/16	530200	T-271	-
5.72	0.225	25.4	1	-	-	12111
5.97	0.235	23.8	15/16	530235	-	-
7.62	0.300	34.9	1 3/8	-	-	12113
8.31	0.327	36.5	1 7/16	530327	-	-
10.67	0.420	25.1	1	530420	T-272	-
10.67	0.420	36.5	1 7/16	530240	-	-
12.34	0.490	25.4	1	530490	T-273	-
12.45	0.490	36.5	1 7/16	530490	-	-
14.99	0.590	25.4	1	530590	T-274	-
19.81	0.780	25.4	1	530780	T-290	-
27.35	1.084	25.4	1	531080	-	-

Torque Specifications

Approximate Midpoint Diameter of the Tapered Threaded Plug		Torque	
mm	inch	N•m	ft-lb
6.5 and smaller	1/4 and smaller	7 to 14	5 to 10
8 to 9.5	5/16 to 3/8	20 to 27	15 to 20
11.2 to 12.2	7/16 to 1/2	34 to 68	25 to 50
14.3 to 15.9	9/16 to 5/8	68 to 136	50 to 100
19	3/4	136 to 204	100 to 150
22.2	7/8	305 to 339	225 to 250
25.4	1	339 to 407	250 to 300

Group 01 — Cylinder Block

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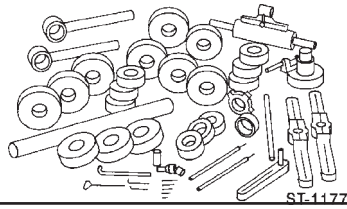
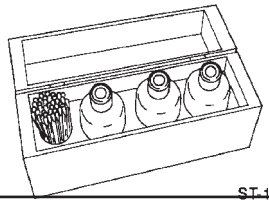
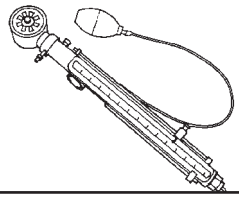
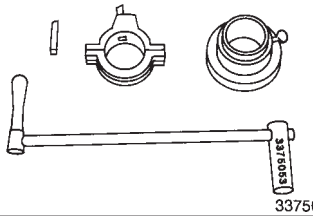
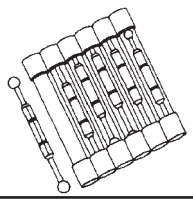
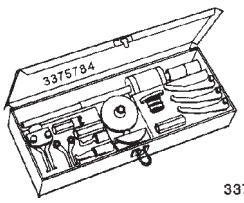
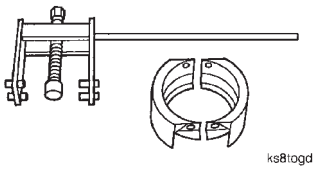
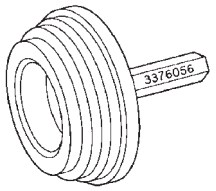
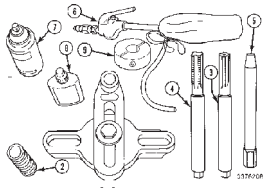
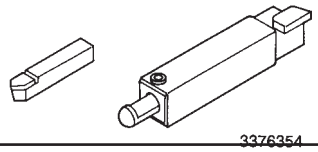
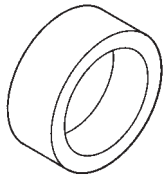
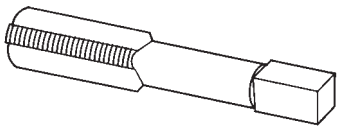
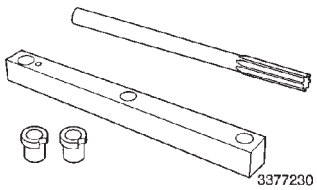
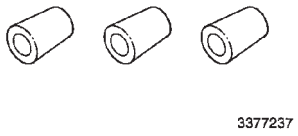
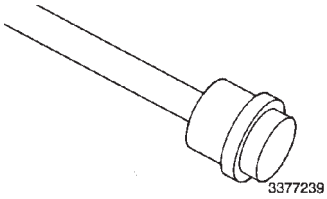
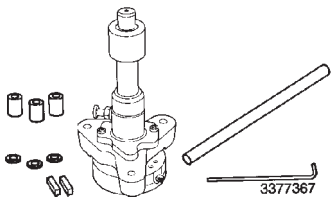
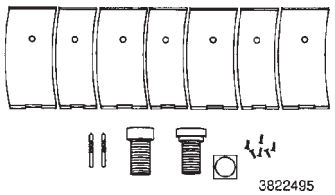
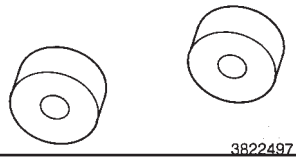
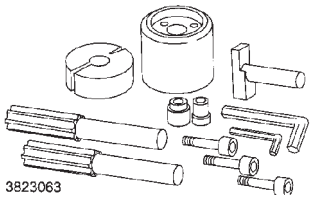
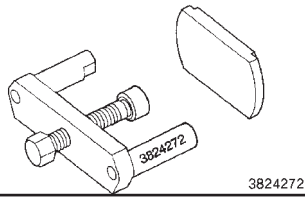
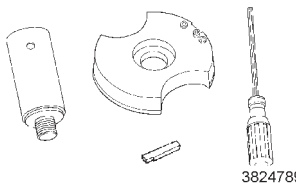
Service Tools — Cylinder Block

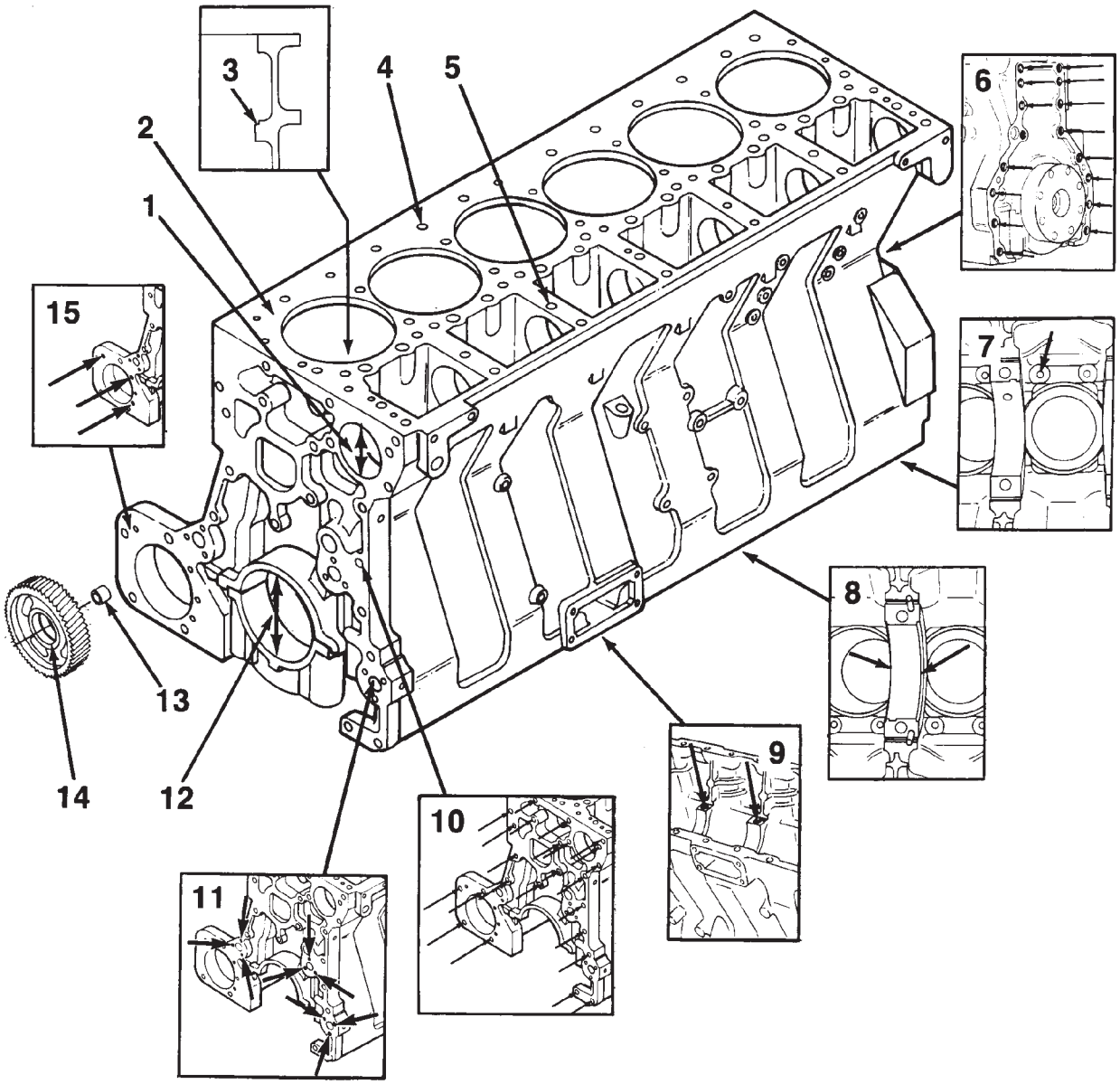
The following special tools are recommended to perform procedures in Group 01. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
ST-1177	**Main Bearing Bore Tool Kit** This kit contains the tools required to inspect the alignment and to re-bore the cylinder block main bearing bores.	
ST-1195	**Crankshaft Etching Kit** The etching kit is used to inspect reground crankshafts for grinder burn damage.	
ST-1196	**Crankshaft Hardness Tester** A portable hardness tester used for checking crankshaft journals.	
3375053	**Thrust Surface Cutter Kit** Used with the ST-1177 Main Bearing Bore Tool Kit to restore the thrust surface of the cylinder block and main bearing cap.	
3375240	**Fillet Ball Gauges** Used to check the radius of connecting rod and main bearing fillets in the crankshaft.	
3375784	**Puller Kit** Remove the idler gear ring dowels.	

Tool No.	Tool Description	Tool Illustration
3375840	**Crankshaft Gear Puller Kit** Used with jaw, Part No. 3375839, to remove the crankshaft gear.	
3376056	**Cylinder Liner Driver** Install the cylinder liner in the cylinder block.	
3376208	**Capscrew Thread Salvage Kit** Used to repair cylinder blocks with damaged cylinder head capscrew threads.	
3376354	**Camshaft Bore Cutter Tool** This tool is part of kit, Part No. 3822385, and is used with ST-1177 Main Bearing Bore Tool Kit to re-bore the cylinder block camshaft bore. NOTE: Cutter tool, Part No. 3376239, is used for camshaft bores larger than 778.74 mm [3.100 in.].	
3376355	**Micrometer Setting Ring** This tool is part of kit, Part No. 3822385, and is used to set the camshaft bore cutter tool.	
3376997	**Tap (M18 x 1.50)** This tap is a part of kit, Part No. 3377256, and is used to cut threads in the cylinder block for the main bearing and cylinder head capscrew repair thread inserts.	
3377200	**Reamer Set** The reamers in this set are used to ream capscrew holes to the specified size before tapping the holes for thread inserts.	
3377230	**Main Bearing Capscrew Thread Repair Kit** The kit contains fixture, Part No. 3377231, reamer bushing, Part No. 3377232, tap bushing, Part No. 3377233, and reamer, Part No. 3377234, used to repair main bearing capscrew threads.	

Tool No.	Tool Description	Tool Illustration
3377237	**Camshaft Bore Centering Rings** These rings are a part of kit, Part No. 3822385, and are used with main bearing bore tool kit, Part No. ST-1177, to re-bore the cylinder block camshaft bore.	
3377239	**Camshaft Bushing Driver** This driver is a part of kit, Part No. 3822385, and is used to install the new camshaft bushing into the camshaft bore salvage sleeve.	
3823558	**Cylinder Liner Counterbore Repair Tool Kit** Used to machine the cylinder counterbore ledge by hand.	
3822495	**Main Bearing Saddle Repair Kit** The kit contains repair sleeve, Part No. 3822491, hardware kit, Part No. 3822496, drill bits, Part No. 3377437 and 3822493, washers, Part No. 3822494, bolts, Part No. 3822492, and rivets, Part No. 3376426, used to repair the main bearing bore saddles.	
3822497	**Main Bearing Bore Tool Kit** The kit contains two centering rings, Part No. 3376781, and checking ring, Part No. 3376811, used with main bearing bore tool kit, ST-1177.	
3823063	**Idler Shaft Bore Repair Kit** The kit contains reamer guide, Part No. 3823064, rough reamer, Part No. 3823065, finish reamer, Part No. 3823066, depth set gauge, Part No. 3823067, reamer stop, Part No. 3823068, ring dowel (with gear plate), Part No. 3823069, ring dowel (without gear plate), Part No. 3823070, and three allen head capscrews, Part No. 3823071.	
3824272	**Cylinder Liner Clamping Tool** Used to seat the liner in the cylinder block while measuring cylinder liner protrusion.	
3824789	**Counterbore Cutting Tool Adapter Kit** The kit is used with drive unit, Part No. 3823352, to cut counterbore ledges with a power tool.	

Cylinder Block — Exploded View

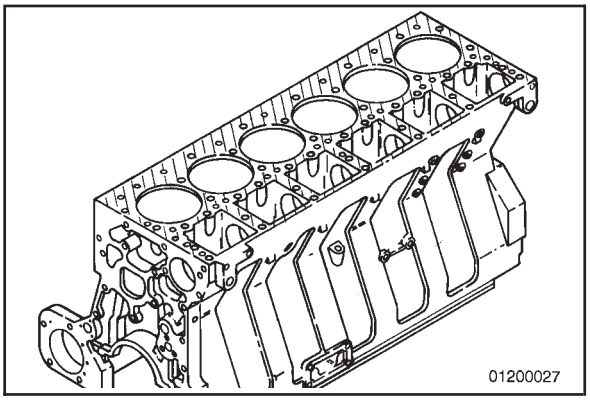


Ref. No.	Description	Ref. No.	Description
1	Camshaft Bore	9	Main Bearing Capscrew Holes
2	Top Deck	10	Gear Plate and Gear Cover Capscrew Holes
3	Cylinder Liner Counterbore	11	Idler Gear Capscrew Holes
4	Cylinder Head Capscrew Hole	12	Main Bearing Bore
5	Cam Follower Stud Hole	13	Idler Shaft Ring Dowel
6	Flywheel Housing Capscrew Holes	14	Idler Gear Bushing
7	Piston Cooling Nozzle Capscrew Hole	15	Lubricating Oil Pump Capscrew Holes
8	Thrust Bearing Surfaces		

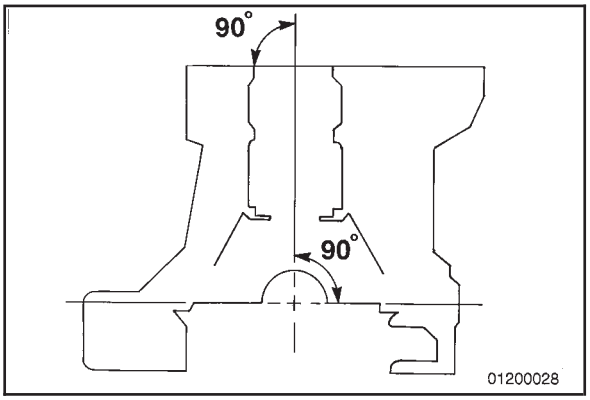
Cylinder Block Resurfacing

General Information

This procedure describes the method for resurfacing the top deck of an L10 or M11 cylinder block.

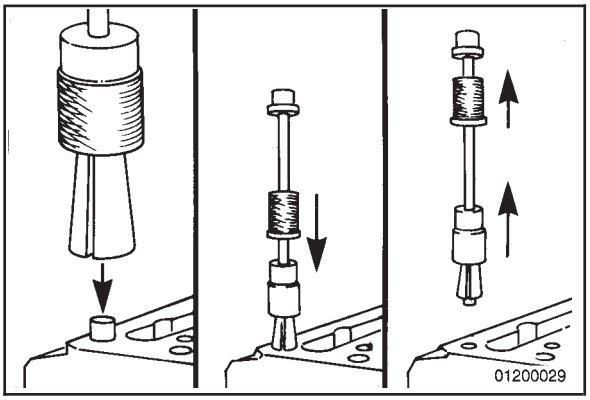


Resurfacing the cylinder block restores the sealing ability of the top deck surface.



Initial Preparation and Inspection

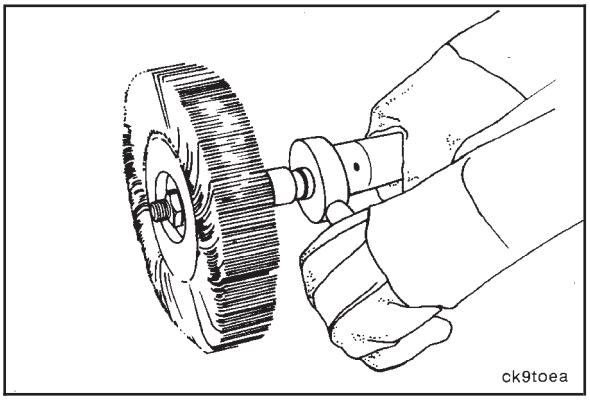
Use dowel pin extractor, Part No. ST-1134, to remove the dowel pins from the cylinder block top deck surface.

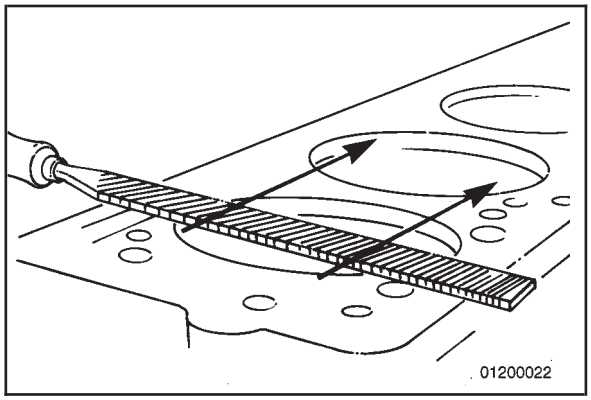


Warning: To avoid possible eye damage, always wear protective eye goggles when using a flap wheel or a wire brush to clean metal surfaces.

Remove the rust and dirt from the top deck surface, the upper cylinder liner bore, and the lower counterbore.

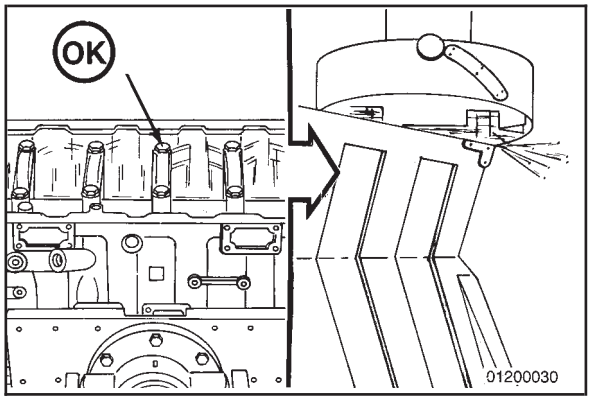
NOTE: This is necessary to obtain accurate pre-machining measurements. A flap wheel or a rotating disk of Scotchbrite® can be used.



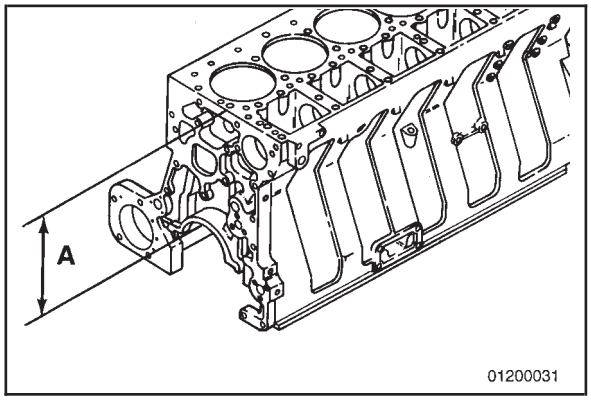


Remove any burrs from the top deck surface and cylinder liner bore areas. A 12 inch flat mill file can be used.

NOTE: This is necessary to obtain accurate pre-machining measurements.

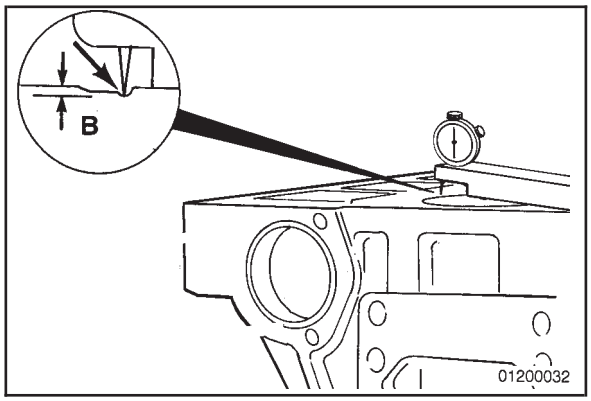


If any of the main bearing bores require repair, repair them before resurfacing the top deck. Refer to Main Bearing Bore Repair.



Measure and record the top deck height through all six cylinder liner bores.

NOTE: The top deck height is determined by measuring the vertical perpendicular distance from the top of the main bearing bore to the top deck. This distance will be referred to as dimension ″A″.

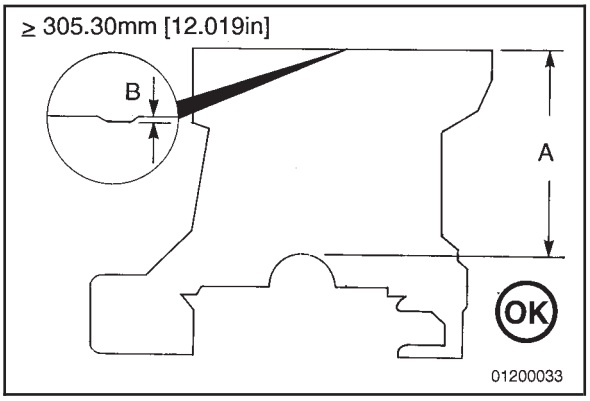


If the cylinder block is being resurfaced because the top deck is fretted, eroded, or warped, measure the depth of the corosion and the extent of the warping.

NOTE: Record this number. This will be referred to as dimension ″B″.

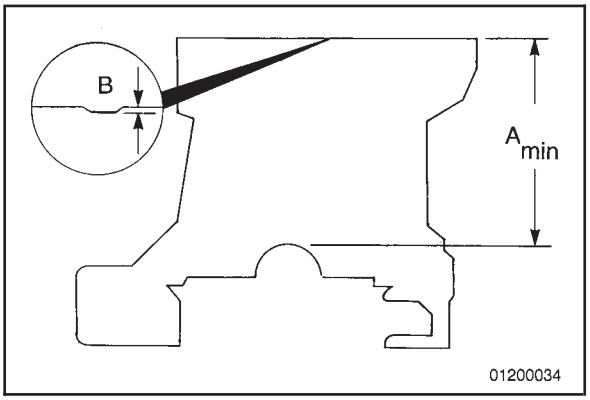
Dimension A minus Dimension B **must** be greater than or equal to 305.30 mm [12.019 inch].

NOTE: The minimum distance after resurfacing between the top of the main bearing bore and the top deck is 305.30 mm [12.019 inch].



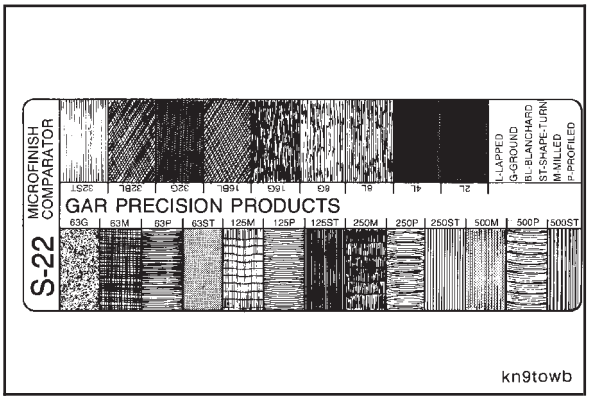
Caution: Removing more material from the top deck than is allowed will cause performance problems and possible clearance problems resulting in damage to the engine.

Oversize head gaskets are **not** available; therefore, the minimum distance from the top of the main bearing bore to the top deck **cannot** be deviated from.

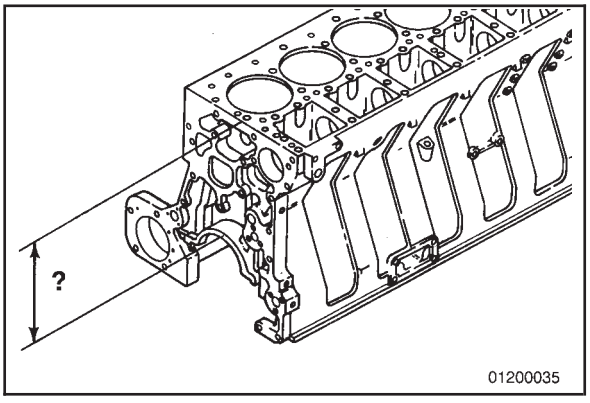


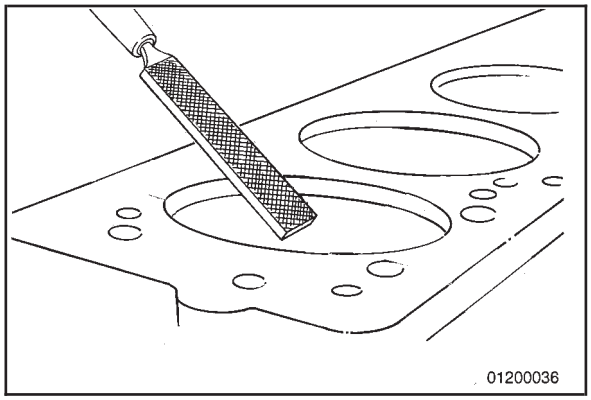
Inspect the surface finish of the top deck after resurfacing. A surface finish comparator can be used.

NOTE: The surface finish **must** be between 2.03 and 3.18 µM [80 and 125 µ inch].

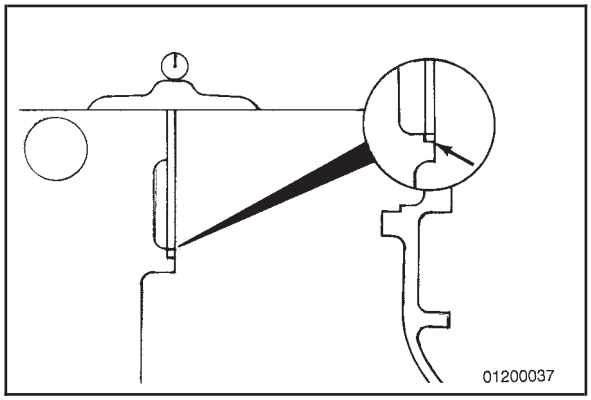


Measure the deck height above the top of the main bearing bore. It **must** be at least 305.30 mm [12.019 inch].



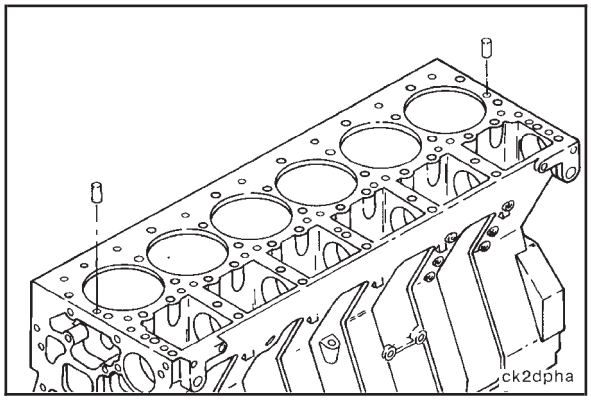


Use a flat mill to remove the sharp edges from the cylinder liner bores.

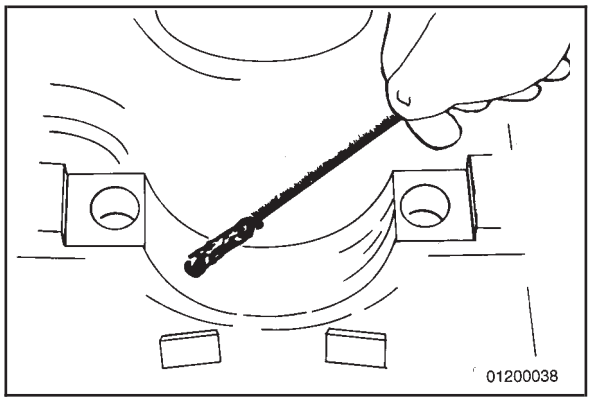


Measure the cylinder liner counterbore depths.

NOTE: If the counterbore depths are **not** between 99.930 and 100.000 mm [3.9343 and 3.9370 inch], refer to Counterbore Machining for machining instructions.



Install the dowel pins in the top deck surface.



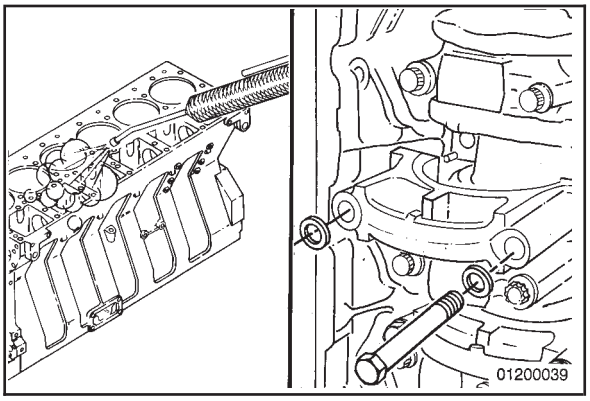
Use a nylon bristle brush to remove any trapped debris from the main bearing oil supply holes.

Thoroughly clean the cylinder block of all machining debris. Use a high pressure washer or hot-tank type cleaner.

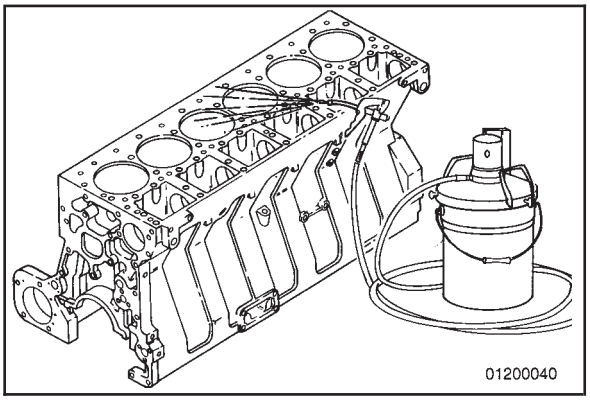
Warning: When using compressed air to dry capscrew holes, always wear safety glasses or a face shield to protect the eyes. Personal injury can result.

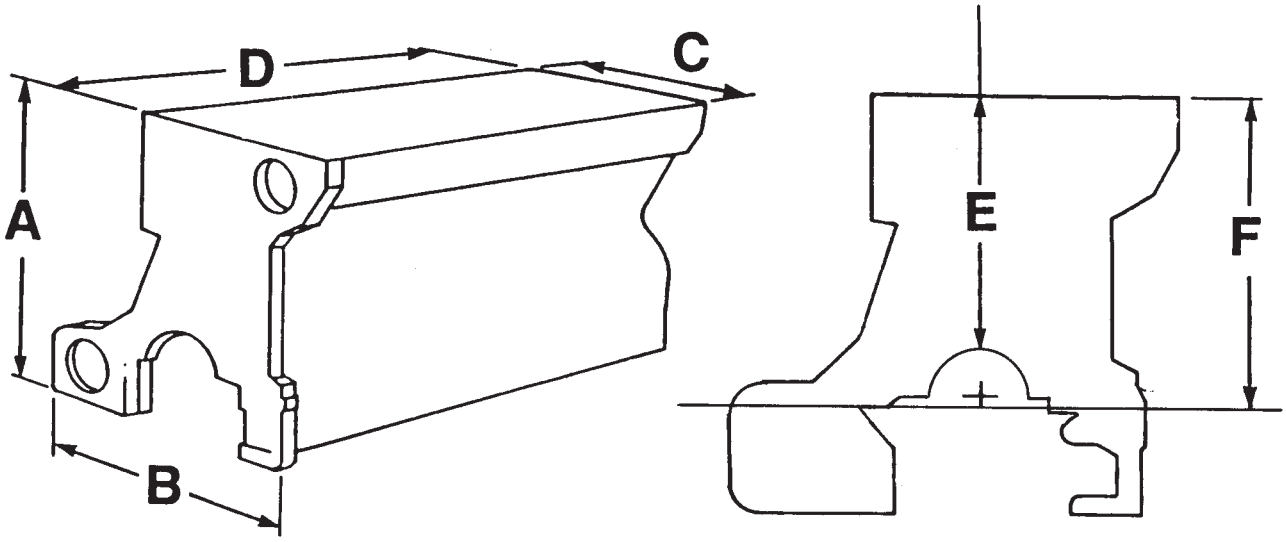
Use compressed air to dry the cylinder block.

Install the main bearing caps and main bearing capscrews.



Spray the block with a rust preventative solution if it is **not** to be used immediately.





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Specification — Cylinder Block Resurfacing

Cylinder Block Dimensions			
Ref.	**Description**	**mm**	**in**
A	Total Height	467	18.4
B	Total Width	497	19.6
C	Top Deck Width	332	13.1
D	Top Deck Length	946	37.2

Distance from Main Bearing Bore to top Deck			
Ref.	**mm**		**in**
E	305.30	MIN	12.020
	305.60	MAX	12.031
Distance from Main Bearing Bore Center Line to Top Deck			
Ref.	**mm**		**in**
F	366.30	MIN	14.421
	366.60	MAX	14.433

Use a standard head gasket.

NOTE: Oversize head gaskets are **not** available. Do **not** deviate from minimum dimensions.

- Surface Finish - 2.03 to 3.18 micro meter [80 to 125 micro inch]
- Flatness - Maximum of 0.02 mm [0.001 inch] for each 254 mm [10 inch] of top deck surface

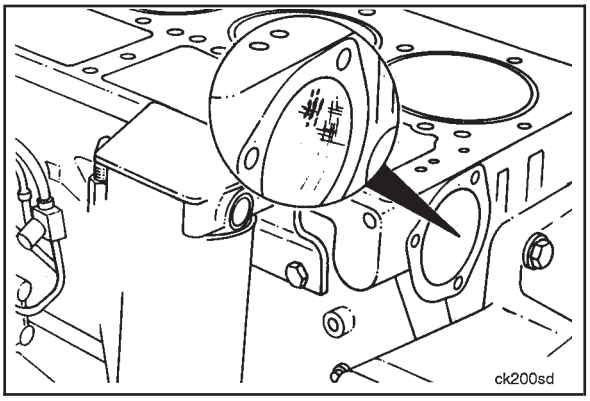
Camshaft Bore Repair

General Information

This procedure describes the method for repairing damaged camshaft bores.

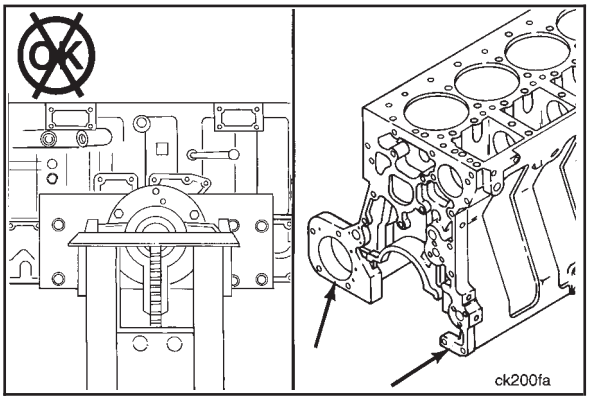
The procedure is used when one of the following conditions exists:

- The camshaft bore is damaged as the result of a spun camshaft bushing
- Misalignment between the camshaft bores exists



This repair can only be performed with the engine out of the chassis.

NOTE: The engine **must not** be mounted on an engine stand as camshaft bore distortion will result. The engine **must** be resting on the oil pan rails when machining is performed.

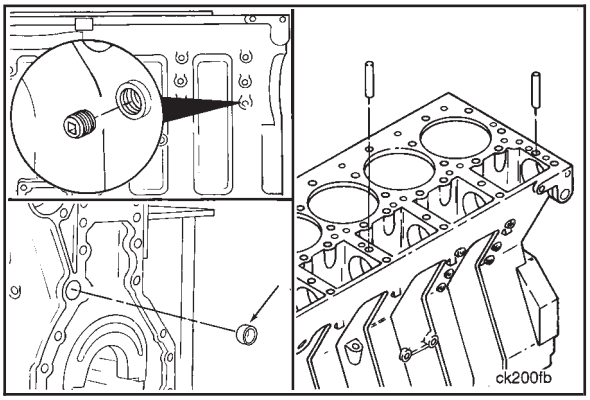


Initial Preparation and Inspection

Disassemble the engine. Remove all pipe plugs, cup plugs and main bearing caps. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.

Remove cam follower studs.

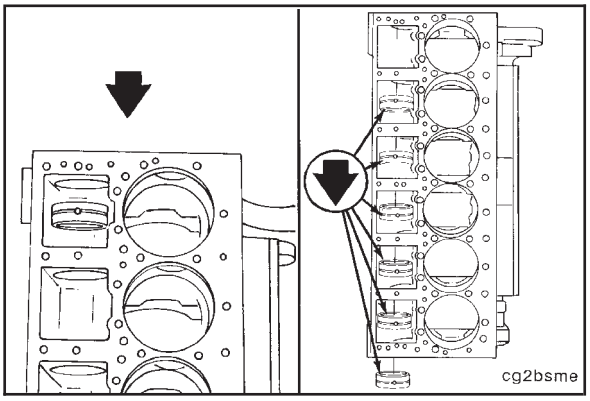


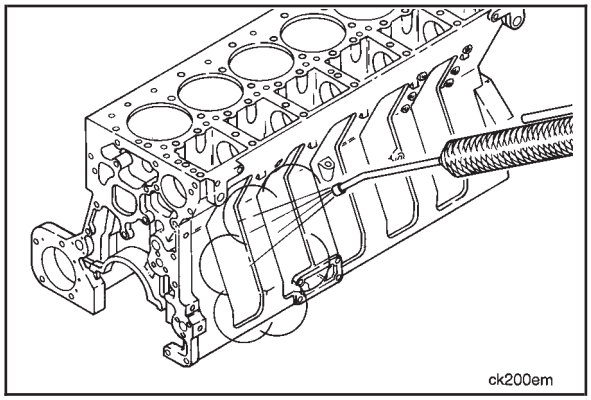
Remove all of the camshaft bushings. Refer to the following shop manuals for the correct procedure:

Bulletin No. 3379347 — Internal Damper L10 engines,

Bulletin No. 3810476 — External Damper L10 engines,

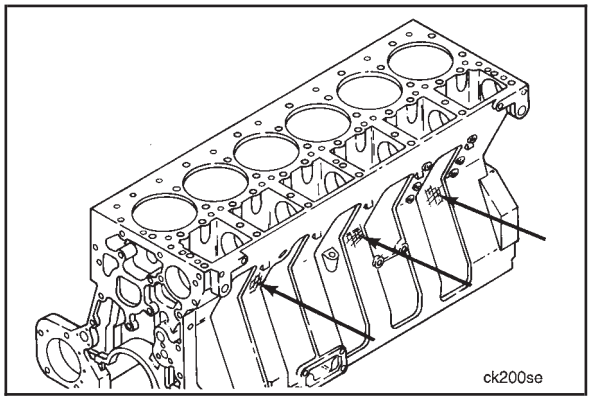
Bulletin No. 3666075 — M11 engines.



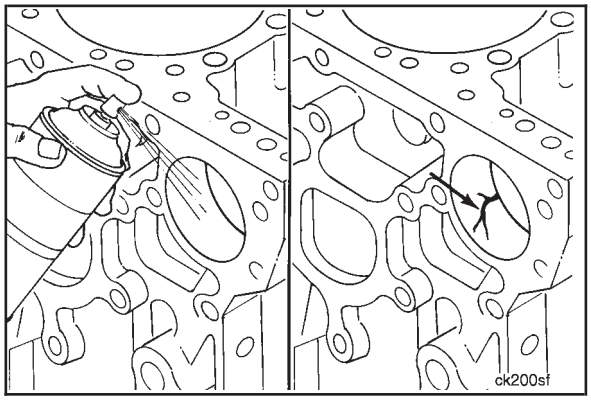


Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use steam to clean the cylinder block and dry with compressed air.

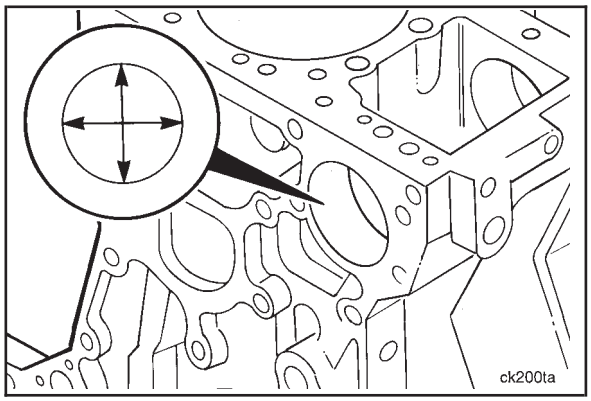


Inspect the outside of the cylinder block for discoloration or darkened paint. If either conditions exists, the camshaft bore has been exposed to high temperatures.



If discoloration exists, inspect the camshaft bores for cracks.

NOTE: Cracks deeper than 2.54 mm [0.100 in] **cannot** be repaired.

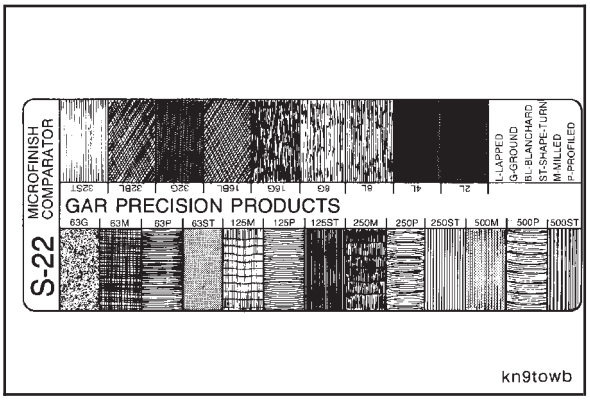


Measure and record the inside diameter of the camshaft bores.

Cylinder Block Camshaft Bore I.D.		
mm		**in**
76.987	MIN	3.0310
77.040	MAX	3.0331

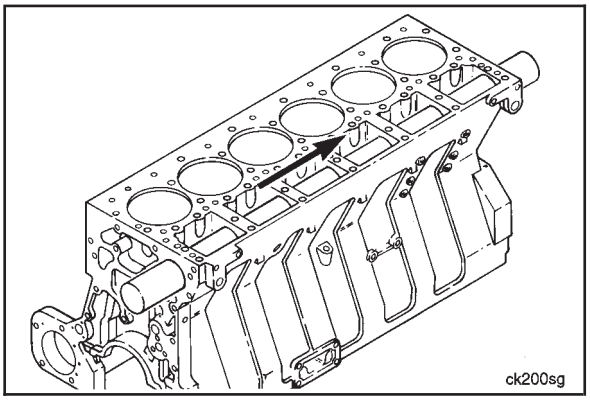
NOTE: If the inside diameter of the camshaft bore is larger than the maximum specified, the camshaft bore **must** be repaired.

Check the surface finish of the camshaft bores with a surface finish comparator. The surface finish **must** be 2 µM [80 µ inch] or less.



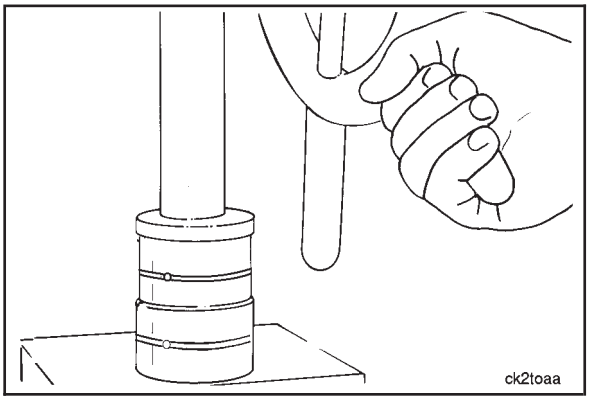
Check the bore alignment. A solid bar with 76.962 mm [3.030 inch] outside diameter can be used for this.

NOTE: The bar **must** slide freely through all seven camshaft bores. If the bar does **not** slide freely, the camshaft bore **must** be repaired.



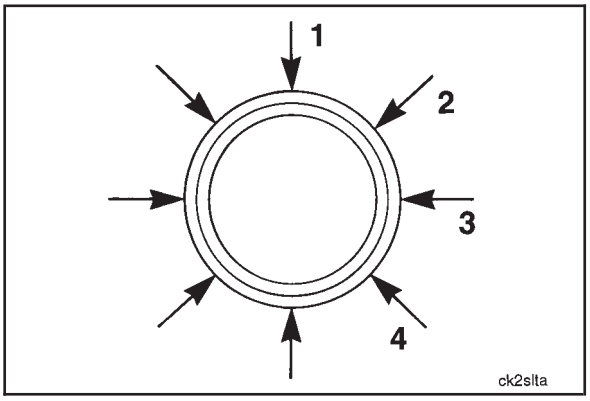
Camshaft Bushing and Salvage Sleeve - Assembly

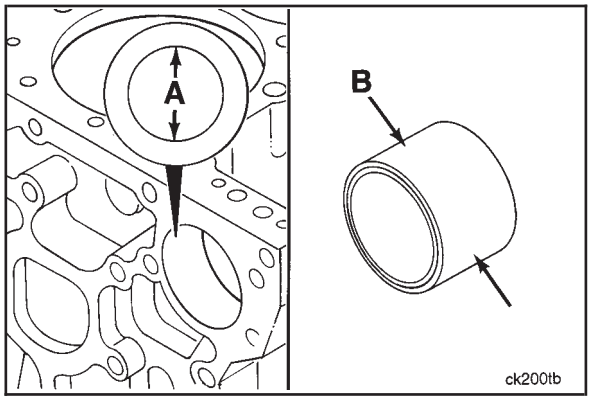
Use driver, Part No. 3377239, to install a new camshaft bushing, Part No. 3017325, in a new salvage sleeve, Part No. 3822384.



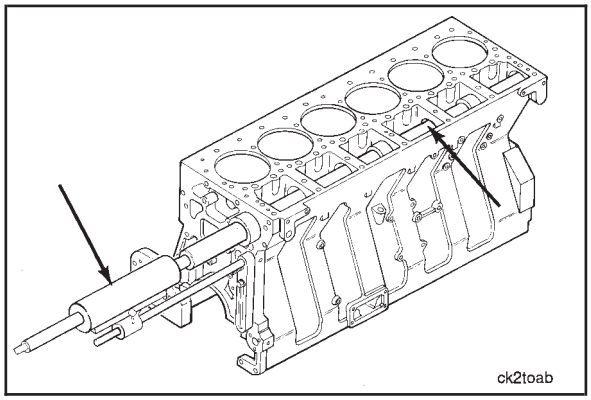
Measure the outside diameter of the bushing and salvage sleeve assembly in four places.

Take an average of the four outside diameter measurements.



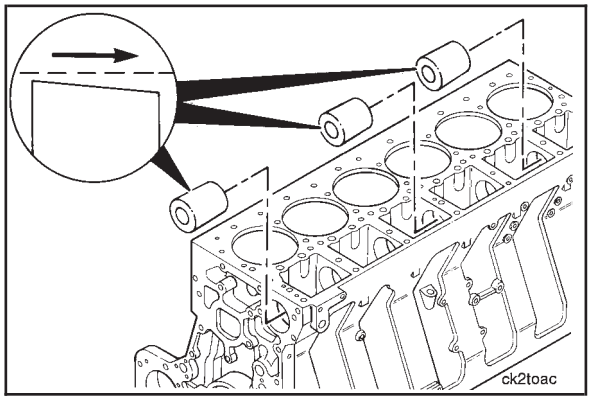


The camshaft bore in the cylinder block (A) **must** be bored to a diameter that will provide a 0.08 mm to 0.13 mm [0.003 to 0.005 inch] press fit for the bushing and salvage sleeve assembly (B).



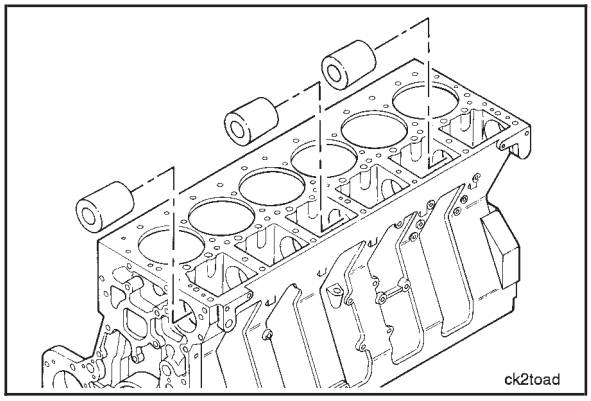
Camshaft Bore Cutting Tool — Installation

The drive unit from the main bearing bore tool, Part No. ST-1177, **must** be installed on the end of the cylinder block farthest from the bore to be repaired. For example, the drive unit **must** be installed on the front face of the cylinder block for No's. 4, 5, 6 and 7 camshaft bores and on the rear face for No's. 1, 2 and 3.



Install the three centering rings, Part No. 3377237.

NOTE: The centering rings **must** pilot into undamaged camshaft bores from the drive unit side.

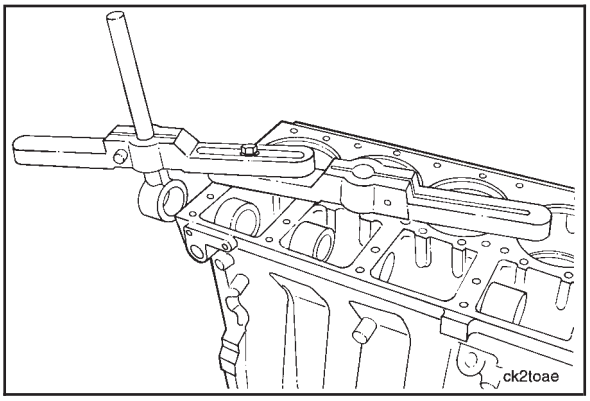


The centering rings **must** be installed so one is on either side of the camshaft bore being repaired and the third is in the end camshaft bore closet to the drive unit.

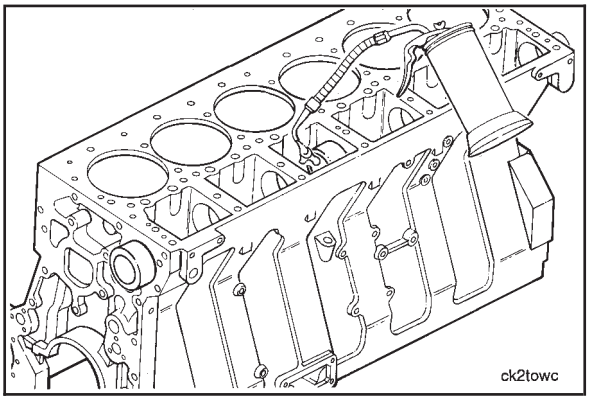
Example: If No. 5 is being repaired, install centering rings in No. 4 and No. 6 and the third in No. 1.

If No. 1 or No. 7 camshaft bore is being repaired, it is necessary to attach an end support to the cylinder block.

Attach two bore bar bridges, Part No. ST-1177-18, and one bearing bar, Part No. ST-1177-22, to the cylinder block deck using a cylinder head capscrew as shown.

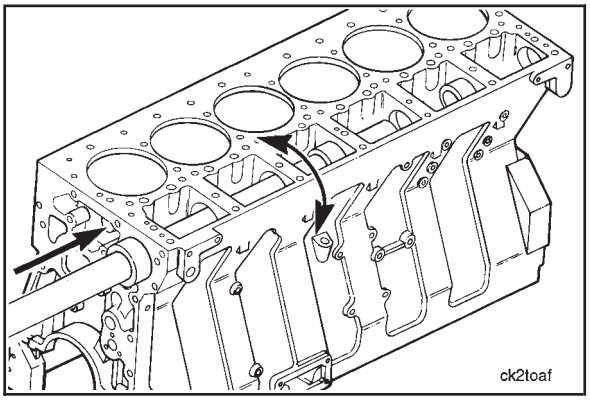


Use clean 15W-40 oil to lubricate the inside diameter of the centering rings.



Slide the boring bar, Part No. ST-1177-16, through the centering rings.

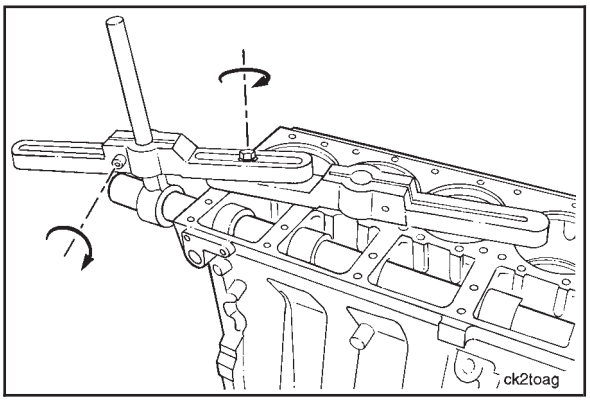
NOTE: Make sure the boring bar rotates freely.

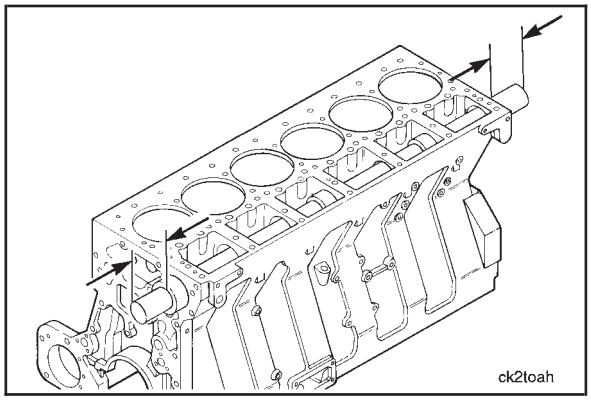


If No. 1 or No. 7 camshaft bore is being repaired, tighten the end support assembly.

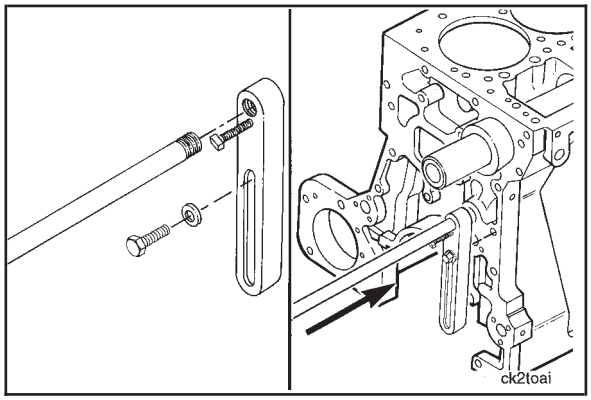
Tighten the capscrews holding the bridge to the cylinder block.

Tighten the socket head capscrew in the middle of the outer bridge to lock down the bearing bar, Part No. ST-1177-22.





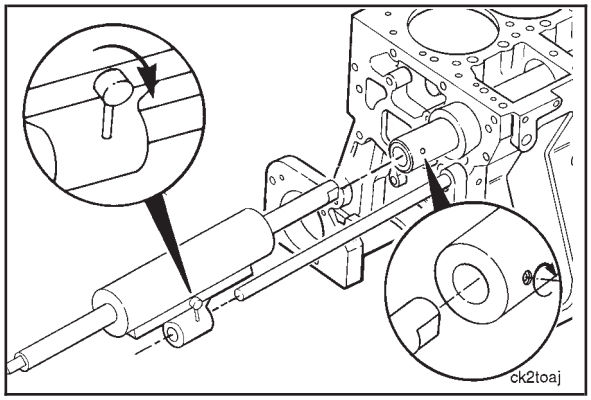
Center the boring bar in the cylinder block.



Assemble the torsion bar, Part No. ST-1177-33, in the torsion bar bracket, Part No. ST-1177-34.

NOTE: Use a gear cover capscrew to mount the assembly to the front of the cylinder block, or a flywheel housing capscrew to mount the assembly to the rear of the cylinder block.

Install the torsion bar bracket assembly to the cylinder block.

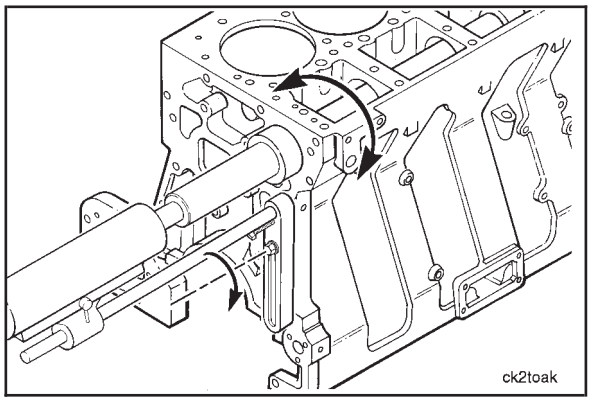


Assemble the drive unit, Part No. ST-1177-17, to the boring bar while guiding it onto the torsion bar.

Align the flat on the drive unit shaft with the set screw on the boring bar.

Tighten the set screw.

NOTE: The directional valve lever **must** be in the open position.

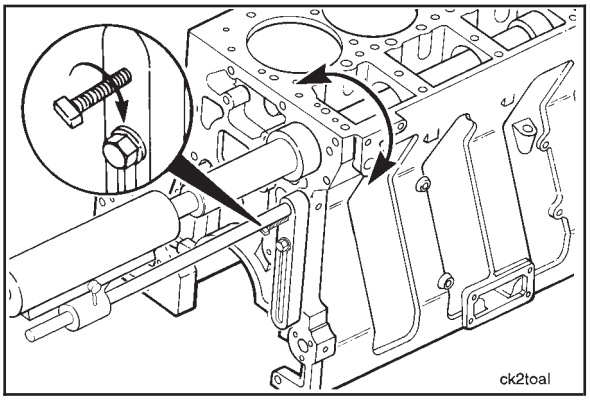


Tighten the capscrew holding the torsion bar bracket to the cylinder block.

NOTE: Rotate the boring bar by hand while tightening to make sure it rotates freely.

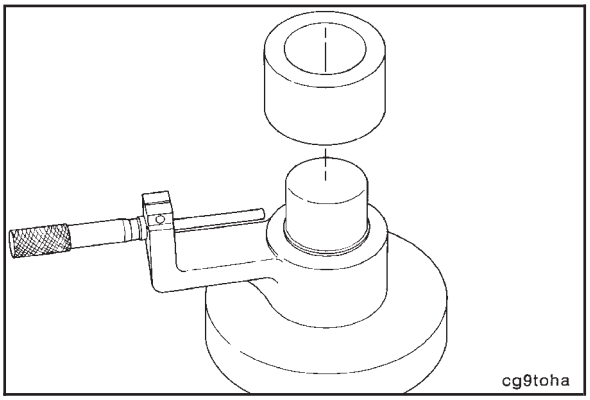
Snug tighten the square headed screw.

NOTE: Make sure the boring bar rotates freely.



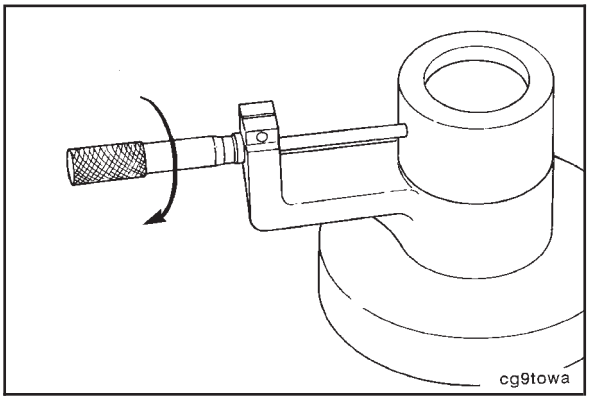
Camshaft Bore Cutting Tool — Setting Cutter

Install the micrometer setting ring, Part No. 3376355, in the micrometer base assembly, Part No. ST-1177-5111.



Adjust the micrometer thimble until light contact is made with the setting ring.

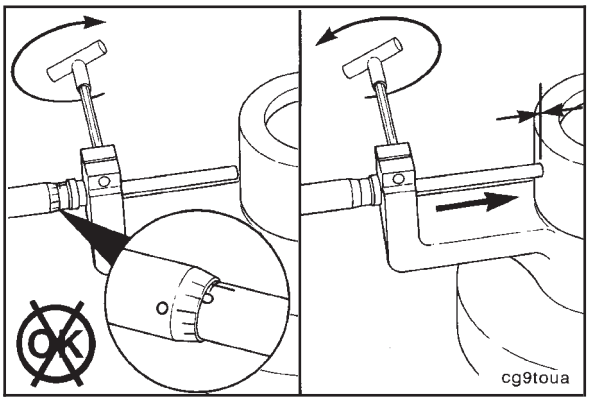
NOTE: If the micrometer does **not** indicate 76.2 mm [3.00 inch], it **must** be recalibrated.

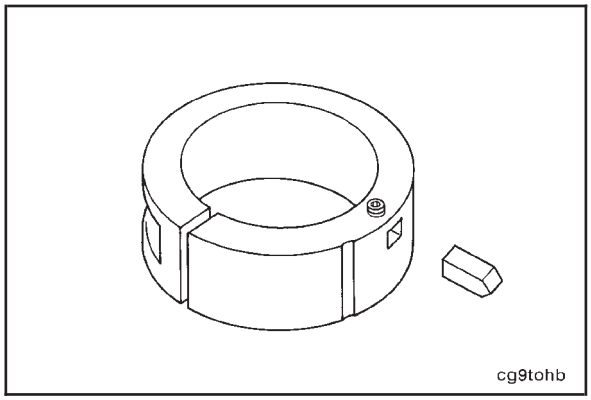


If recalibration is necessary, loosen the socket head capscrew holding the thimble.

Set the micrometer indicator to "0".

Move the micrometer in the holder until light contact is made with the setting ring and tighten the capscrew.

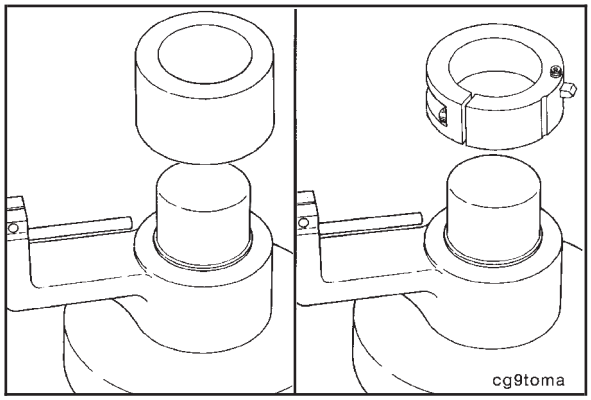




Install the cutter tool, Part No. 3376354, in the cutter holder, Part No. 3377238.

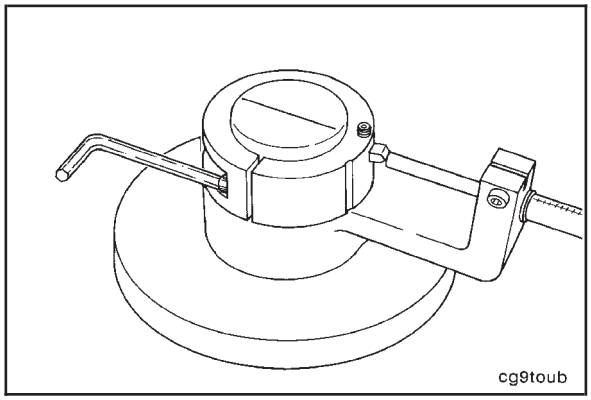
The point of the cutter tool **must** be on the leading edge (centerline) for **clockwise** rotation.

NOTE: The cutter, Part No. 3376354, is used to enlarge the bore to 78.74 mm [3.100 inch]. The cutter, Part No. 3376239, is used for larger bores.



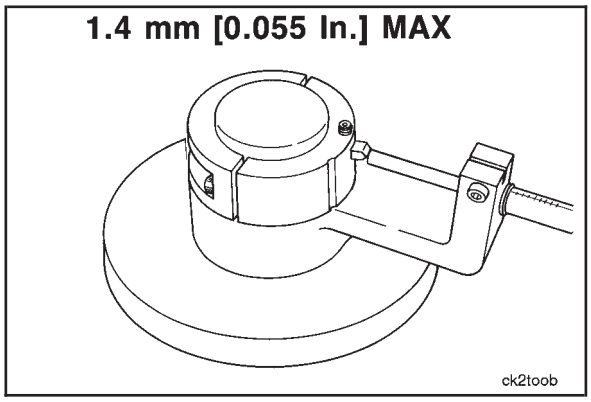
Remove the setting ring from the micrometer base assembly and replace it with the cutter and cutter holder assembly.

NOTE: The set screws in the holder **must** be facing up.



Align the centerline of the cutter tool with the line on the micrometer base assembly.

Tighten the socket head capscrews to lock the cutter holder to the micrometer.



Set the micrometer to the desired hole size.

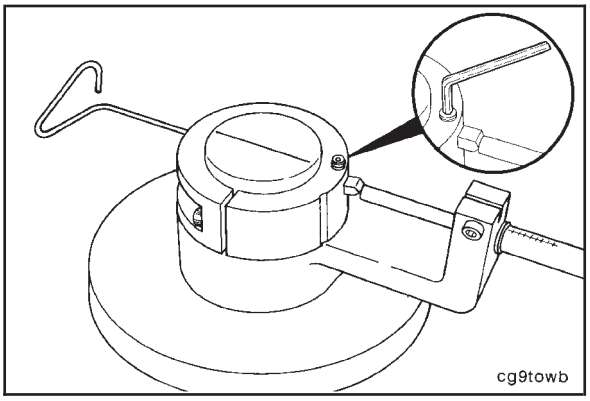
NOTE: The maximum amount the diameter of the camshaft bore can be enlarged per cut is 1.40 mm [0.055 inch].

Align the center of the micrometer shaft to the point of the cutter tool.

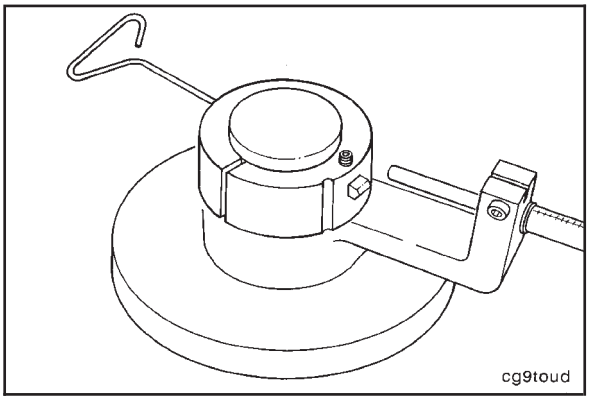
Caution: Care must be taken when pushing the cutter tool against the micrometer shaft. The carbide tip of the cutter tool is extremely brittle and can chip if excessive force is used.

Push the cutter tool out with the wire provided until it makes light contact with the micrometer shaft.

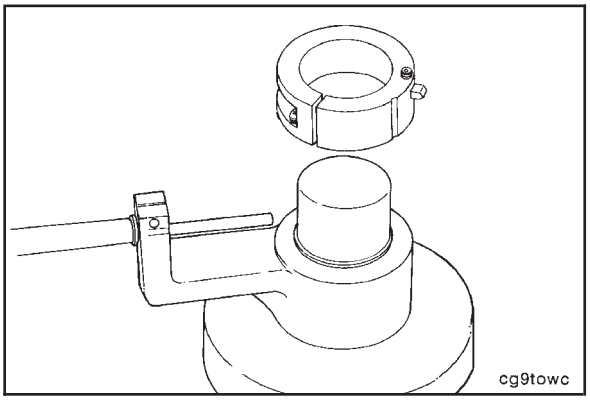
Tighten the set screw to lock the tool in place.



Verify the size by backing off the thimble slightly and then moving it forward gradually while swinging the micrometer back and forth gently until light contact is made with the cutter tool.

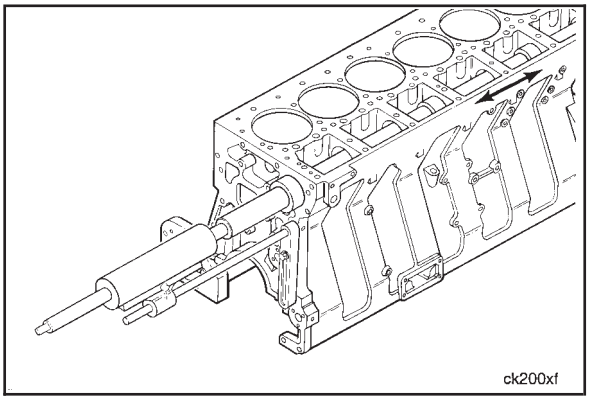


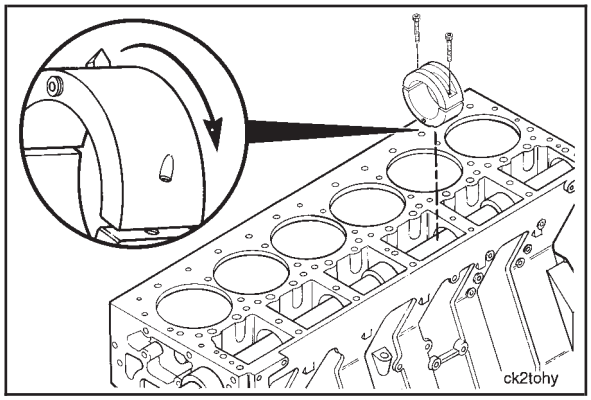
Swing the micrometer away from the cutter tool and remove the tool holder from the micrometer base assembly.



Camshaft Bores — Machining

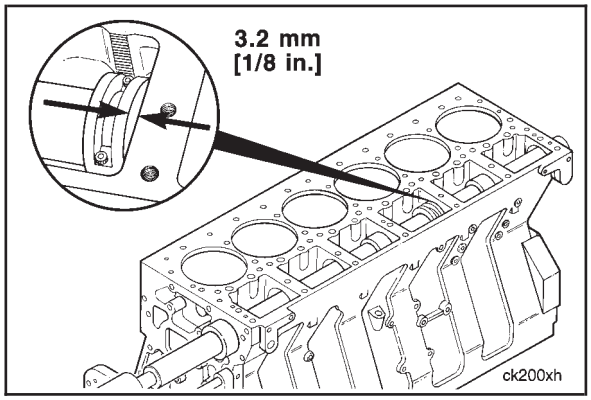
Install the boring bar and the drive unit shaft so that enough travel is available to allow the cutter to machine the complete length of the bore to be cut.



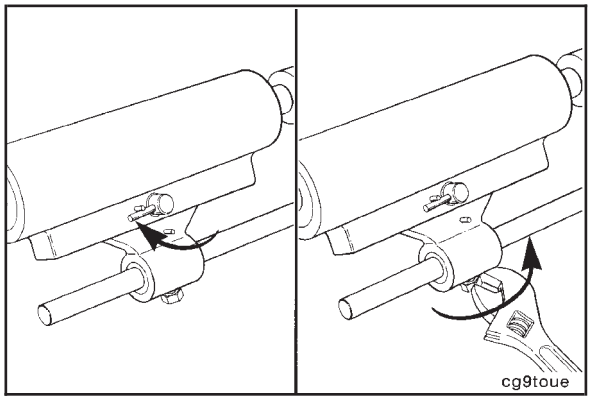


Install the cutter holder and cutter tool assembly on the boring bar on the drive unit side of the bore.

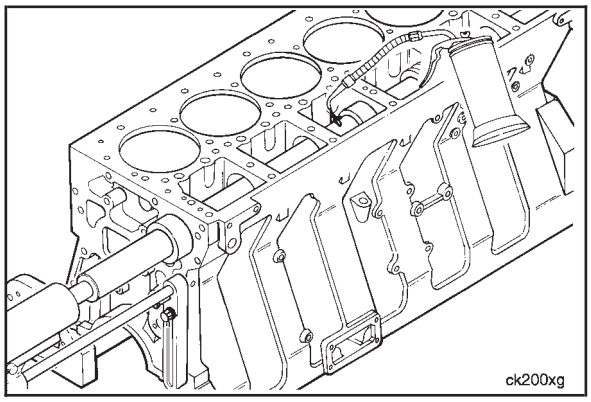
Position the cutter for a **clockwise** rotation.



Move the drive unit, boring bar and cutter assembly until the cutting tool is approximately 3.2 mm [1/8 inch] from the bore to be cut.



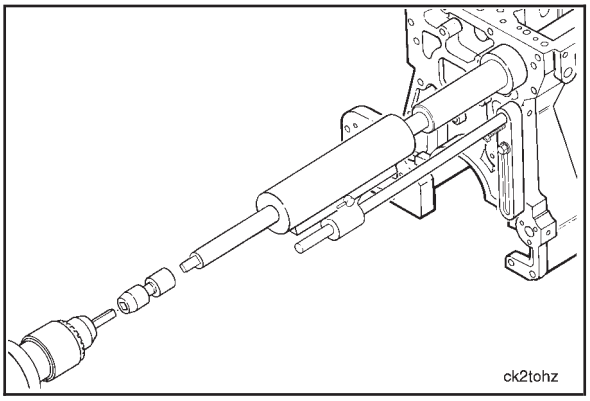
Turn the directional valve lever on the drive unit to the "Closed" position. Tighten the thumb screw on the drive unit to lock the drive unit to the torsion bar.



Use clean 15W-40 oil to lubricate the boring bar and centering rings.

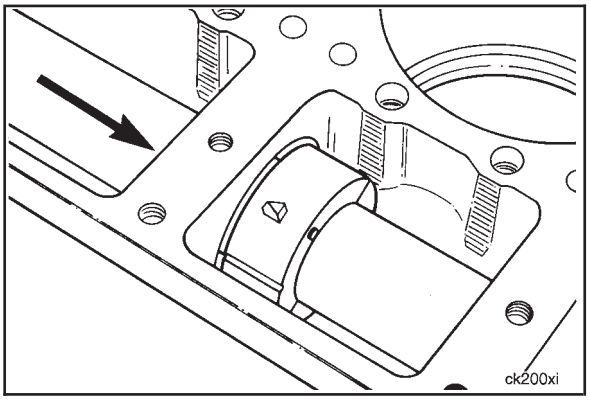
Install the swivel joint, Part No. ST-1277-27, into the chuck of a heavy duty 1/2 inch 450 to 500 RPM drill motor.

Attach the drill motor and swivel joint to the drive unit.

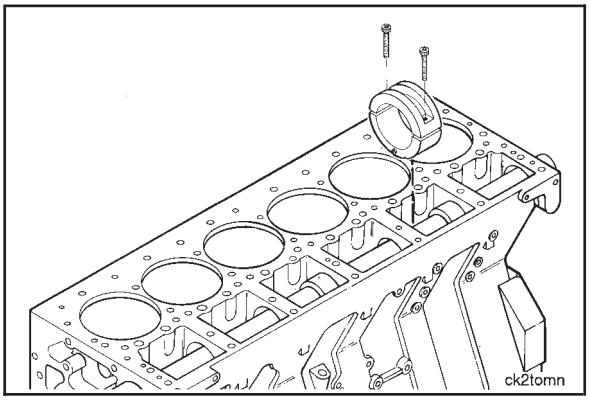


Caution: Do not force the cut. Allow the drive unit to control the feed speed to prevent damage to the cutter assembly.

Use cutting oil. Cut the camshaft bore completely through.

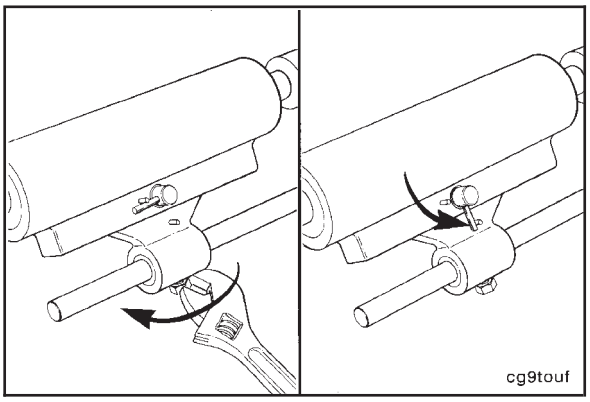


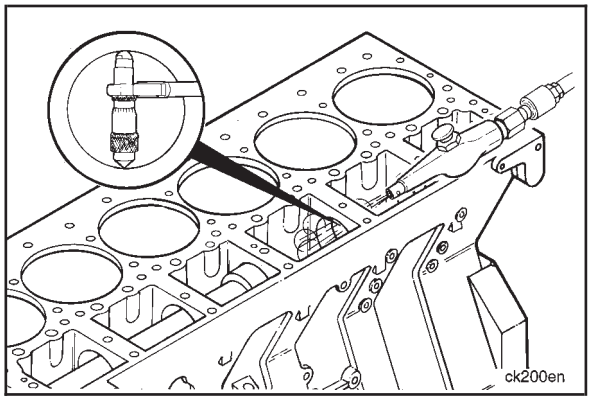
Remove the cutting tool holder.



Loosen the thumb screw.

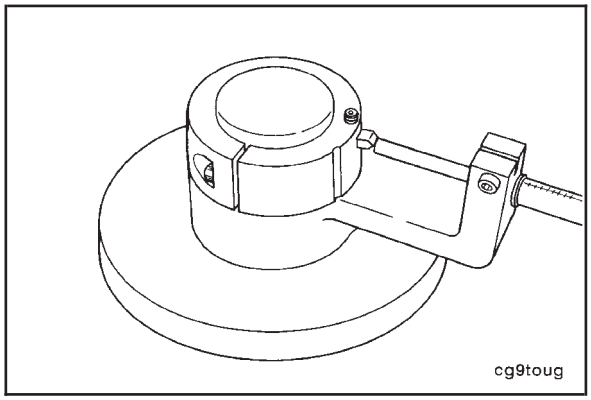
Move the directional lever on the drive unit to the "Open" position and back the boring bar out until there is enough clearance to measure the bore that was just cut.





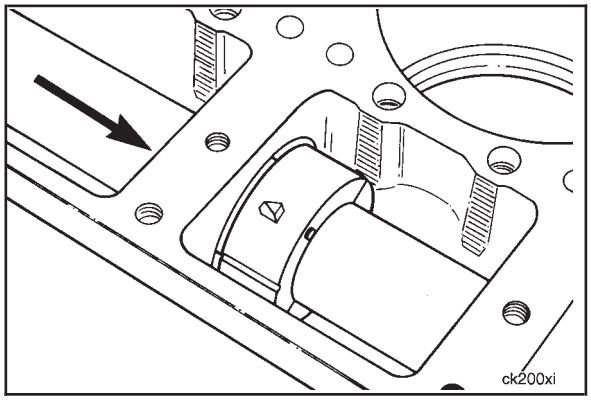
Clean the machining debris from the camshaft bore.

Measure the camshaft bore inside diameter. compare the measurement with the diameter the cutter was set.



Adjust the tool to the next desired size.

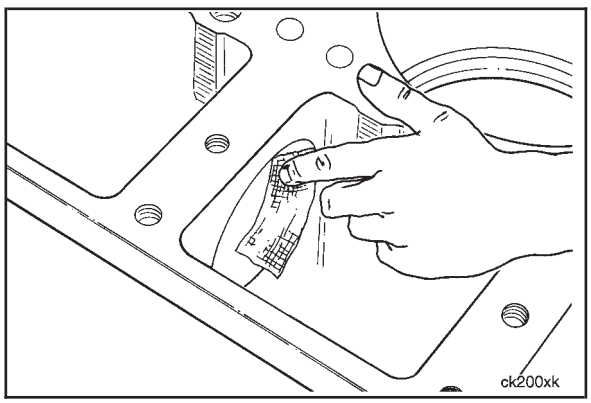
NOTE: Do **not** enlarge the camshaft bore by more than a maximum of 1.40 mm [0.055 inch] per cut. Do **not** remove more than 25 mm [0.010 inch] on the final cut.



Repeat the boring procedure until the proper hole size is reached.

NOTE: The final hole size **must** allow a 0.08 mm to 0.13 mm [0.003 to 0.005 inch] press fit for the salvage sleeve and camshaft bushing assembly.

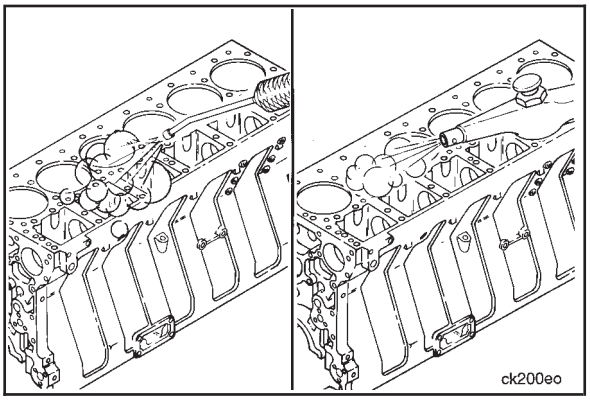
NOTE: When enlarging the bore to 78.74 mm [3.100 inch] or greater, it is necessary to install the cutter, Part No. 3376239.



Remove the burrs from the edges of the camshaft bore.

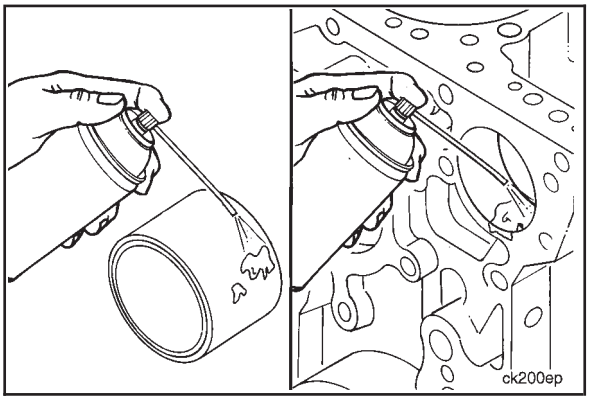
Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use steam to clean the cylinder block. Remove all machining debris. Dry with compressed air.

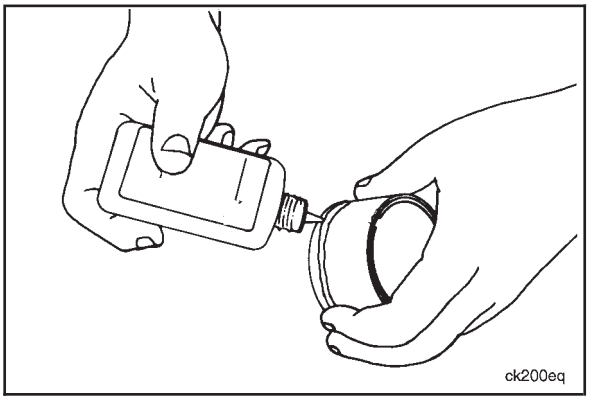


Camshaft Bushing Assembly and Salvage Sleeve — Installation

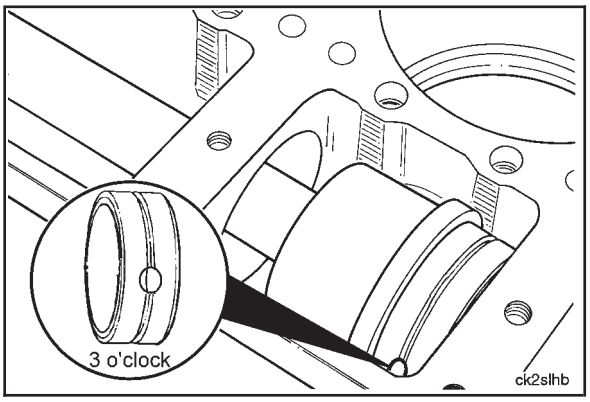
Use a spray cleaner to clean the outside diameter of the sleeve and bushing assembly and the cylinder block camshaft bore.

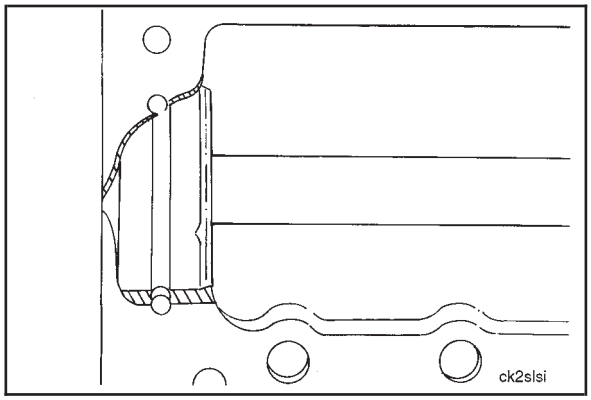


Apply a light coating of sealing compound, Part No. 3375068, to the outside diameter of the sleeve, bushing assembly and the inside diameter of the camshaft bore.

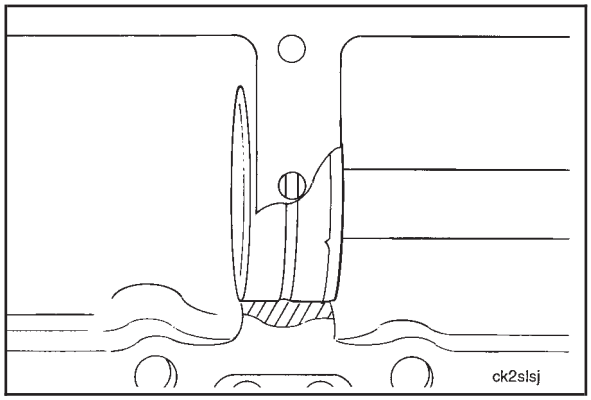


Use driver, Part No. 3377239, to drive the sleeve and bushing assembly into the cylinder block.

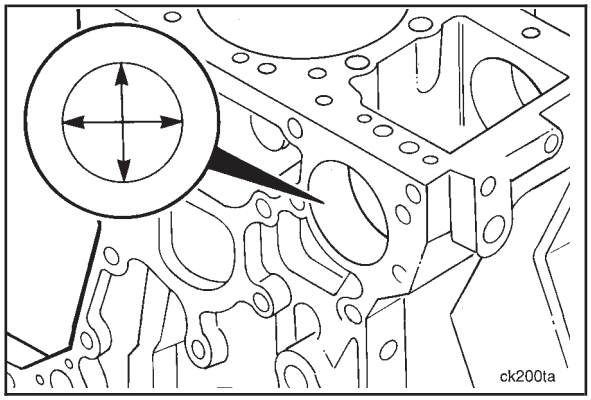




On camshaft bores No. 1 and No. 7, the oil groove on the outside diameter of the salvage sleeve **must** be visible in both oil drillings.

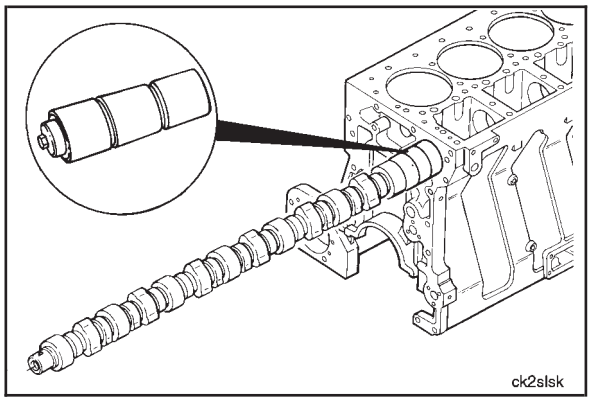


On camshaft bores No. 2 through No. 6, the oil groove **must** be directly under the cam follower stud hole.



Measure the inside diameter of the camshaft bushings.

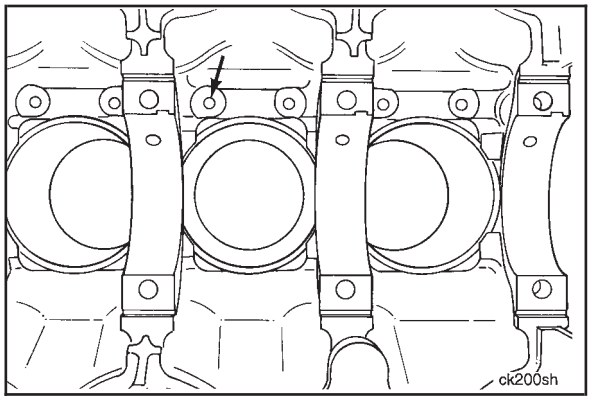
Camshaft Bushing I.D. (Bushing Installed)		
mm		**in**
72.078	MIN	2.8377
72.170	MAX	2.8413



Inspect the camshaft bore alignment by installing a camshaft of known good quality.

Specifications — Camshaft Bore Repair

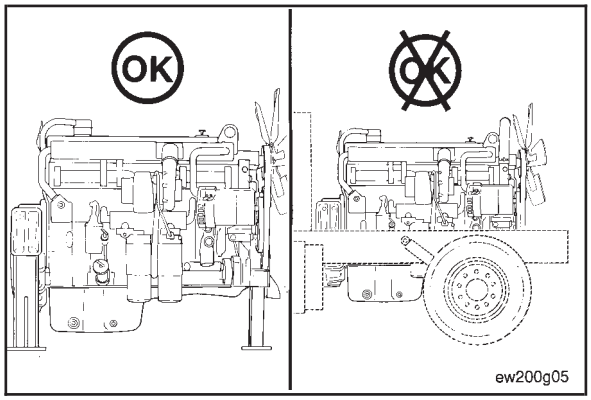
Measurement	mm	inch
Maximum Crack Depth on Original Bore	2.54	0.100
Cylinder Block Camshaft Bore I.D.	76.987 to 77.040	3.0310 to 3.0331
Surface Finish	2 µM	80 µ inch
Press Fit — Block to Bushing Sleeve Assembly	0.08 to 0.13	0.003 to 0.005
Bushing I.D. — Installed	72,078 to 72.170	2.8377 to 2.8413
Maximum Diameter Increase — Per Cut (Except for Final Cut)	1.40	0.055
Maximum Diameter Increase — Final Cut	0.25	0.010



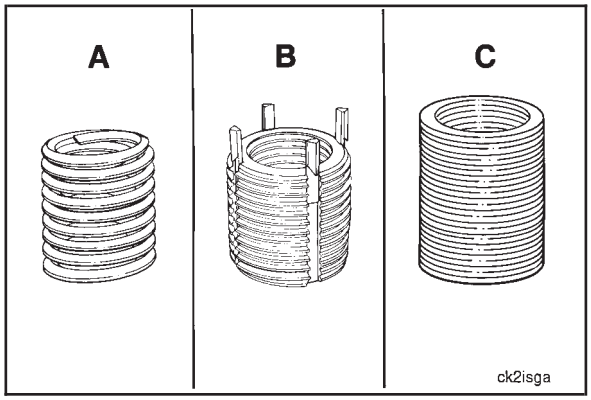
Piston Cooling Nozzle Thread Repair

General Information

This procedure describes the method for repairing the piston cooling nozzle capscrew threaded hole. All capscrew holes can be repaired.



NOTE: This repair procedure **must** be performed with the engine out-of-chassis. Repair in chassis will leave debris in the main oil rifle drilling.

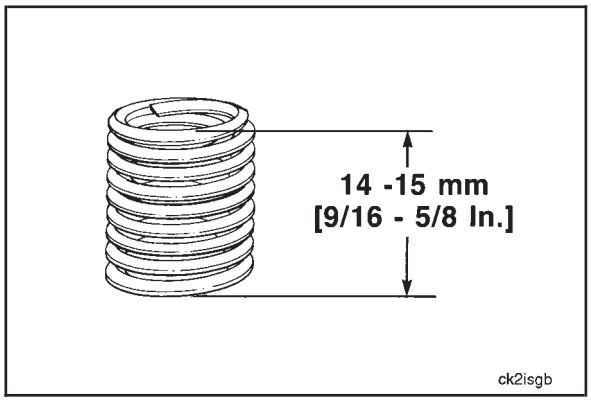


The accompanying illustration indicates the three types of thread inserts which can be used for this repair.

(A) Coiled Insert

(B) Keylock Thread

(C) Metric Open End



The tread insert **must** be 14 to 15 mm [9/16 to 5/8 inch] long. Refer to the following part numbers:

Coiled Thread Inserts
- Helicoil Part No. — 1084-10CN-0150
- Perma-Thread Part No. — 206M-10C-0150

Keylock Thread Inserts
- Tridair Part No. — KNM10 x 1.5F
- Microdot Part No. — KM9900-100

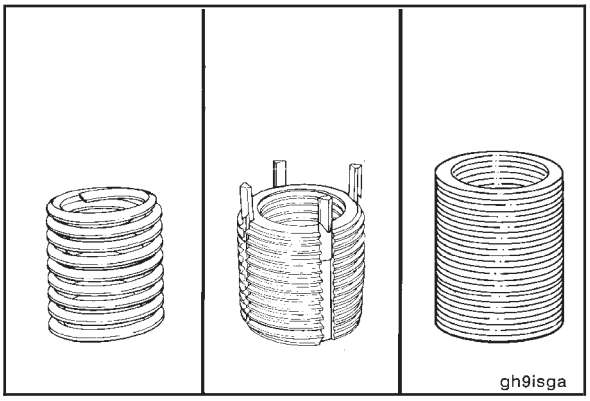
Open End Thread Inserts
- Cummins Part No. — 3376707

Refer to the following procedures in General Repairs — Group 00 for specific instructions.

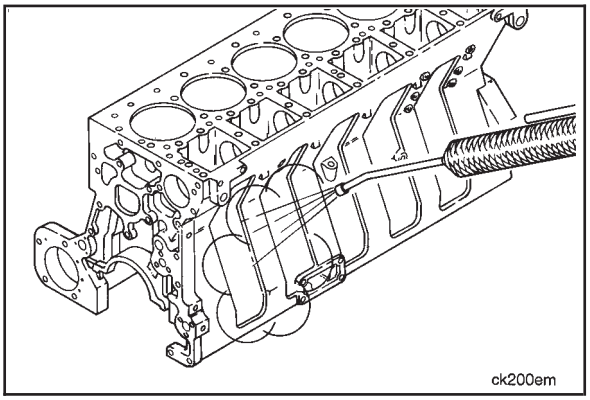
Coiled Thread Inserts

Keylock Thread Inserts

Metric Open End Thread Repair Inserts



After performing the repair, the cylinder block **must** be thoroughly cleaned to remove any debris from the main oil rifle.



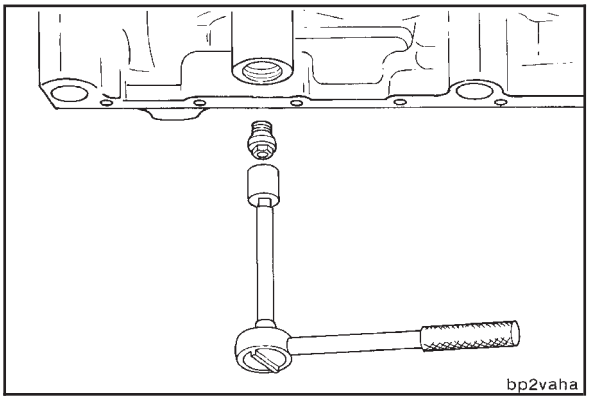
Viscosity Sensor

General Information

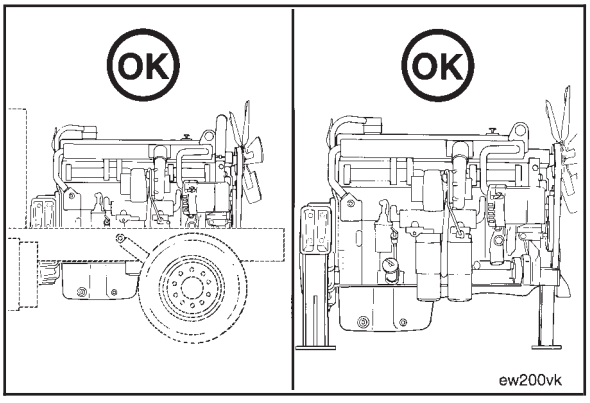
This procedure outlines the necessary information for tapping cylinder blocks that do **not** have threads for a viscosity sensor.

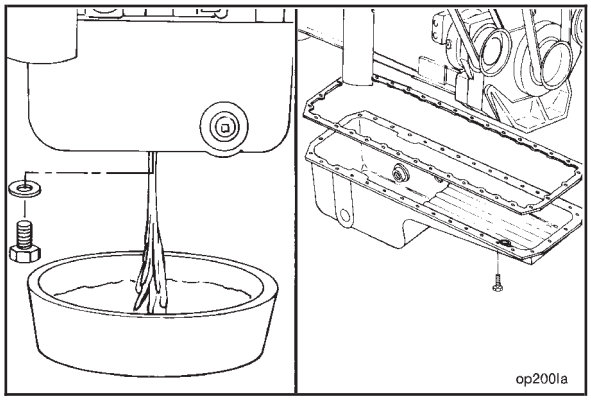
The viscosity sensor used in this procedure, Part No. 3899509, has M9 x 1.0 threads and is designed for use in blocks that never have had a viscosity sensor. Viscosity sensor, Part No. 3899509, is **not** a production used part.

NOTE: Production viscosity sensor, Part No. 3069728, has M10 x 1.5 threads. Refer to Section 0 "Thread Repair" for the correct procedure to repair threads for this viscosity sensor.



This repair procedure can be performed with the engine either in or out of the chassis.





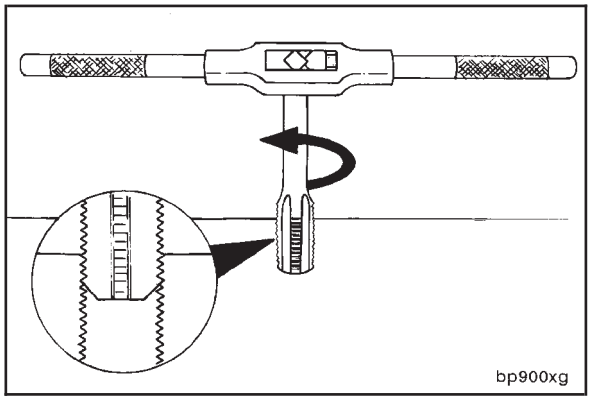
Initial Preparation

Drain the lubricating oil. Remove the following components:

- Oil pan
- Main oil pressure regulator

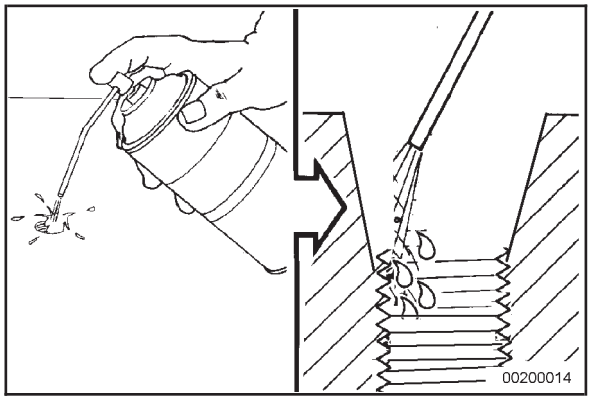
Refer to the following Troubleshooting and Repair Manual for the correct procedure:

- Bulletin No. 3810246 — Internal damper L10 engines,
- Bulletin No. 3810439 — External damper L10 engines,
- Bulletin No. 3666074 — M11 engines.

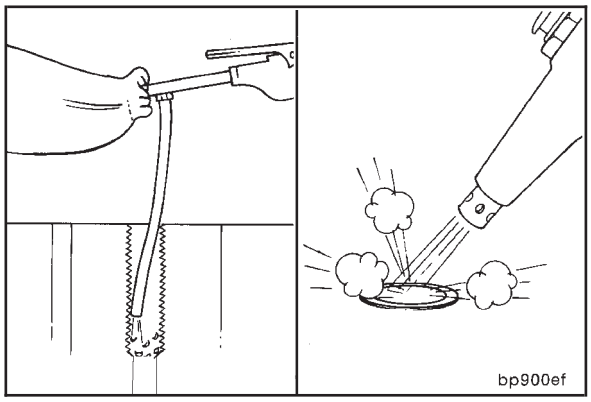


NOTE: Apply a small amount of grease to the cutting end of the tap to help catch some of the metal chips.

Use a M9 x 1.00 tap to cut threads into the cylinder block. Turn the tap approximately six revolutions or until the tap bottoms out.

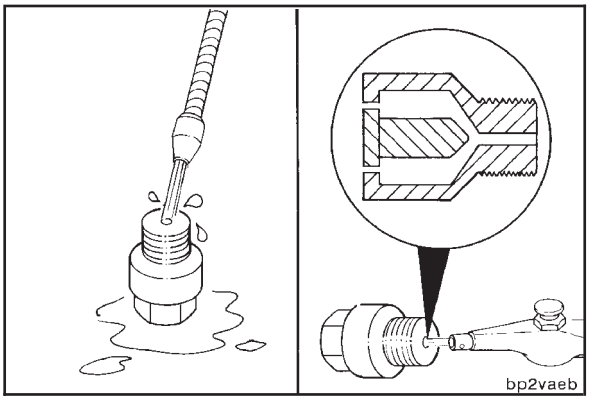


Use a spray cleaner to remove the oil film and clean the newly cut threads.



Use chip removal unit, Part No. ST-1272-11, to remove any debris from the hole.

Use a spray cleaner and compressed air to remove any debris or oil from the viscosity sensor.

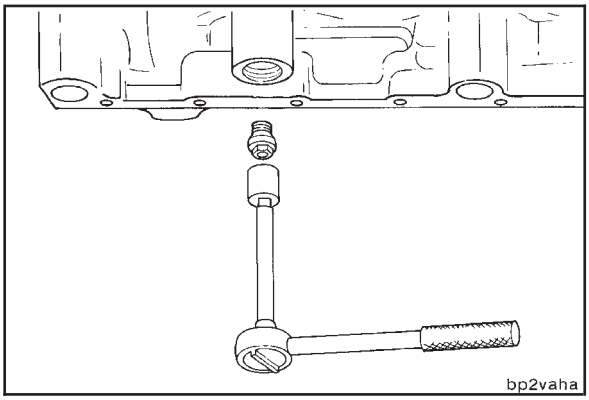


Viscosity Sensor Installation

Apply Loctite #242 to the threads of the viscosity sensor, Part No. 3899509.

Install the viscosity sensor in the cylinder block using a socket and wratchet extension. Do **NOT** over torque the sensor.

Torque Value: 1 N•m [10 in-lb]



NOTE: Main oil pressure regulator, Part No. 3068979, **must** be used when a viscosity sensor is used.

Install the following components:

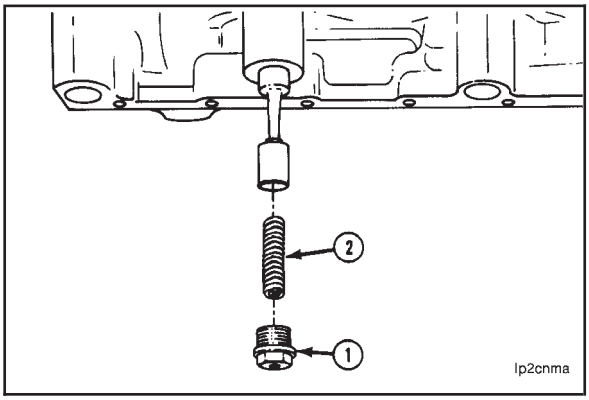
- Main oil pressure regulator, Part No. 3068979
- Oil pan

Refer to following Troubleshooting and Repair Manuals for the correct procedure:

Bulletin No. 3810246 — Internal damper L10 engines,

Bulletin No. 3810439 — External damper L10 engines,

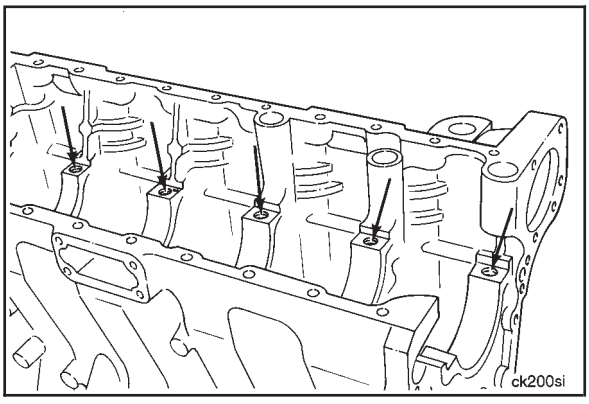
Bulletin No. 3666074 — M11 engines.

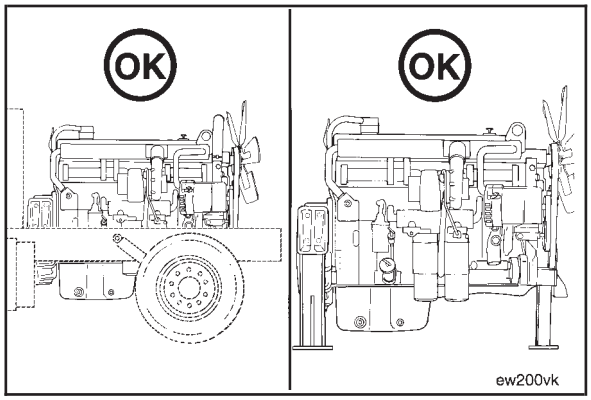


Main Bearing Capscrew Thread Repair

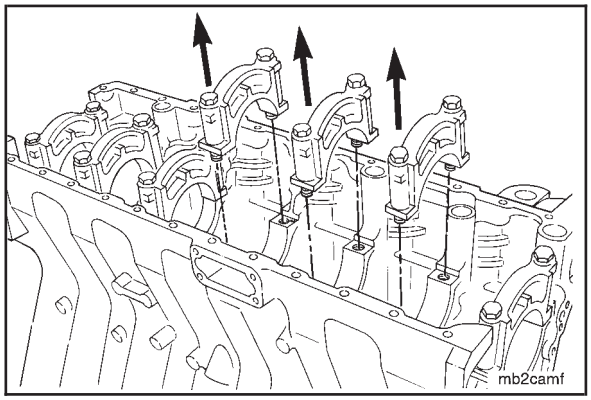
General Information

This procedure describes the method for repairing damaged main bearing capscrew threads. All main bearing capscrew threads can be repaired.





This thread repair procedure can be performed with the engine either in or out of the chassis.

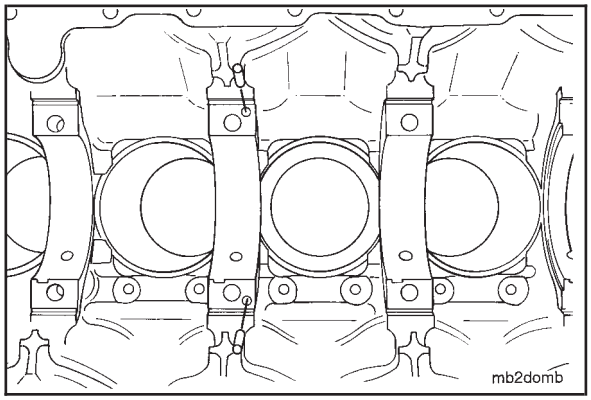


Repair Procedure

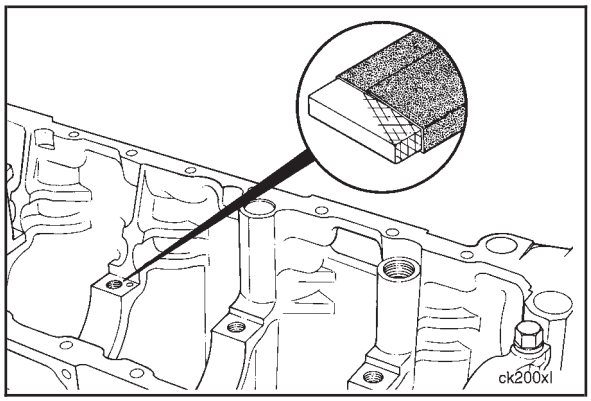
Remove the main bearing cap from the capscrew hole to be repaired.

Remove the next two main bearing caps in either the forward or rear direction.

Example: if No. 4 hole is to be repaired, remove either No. 5 and No. 6 main bearing caps, or remove No. 2 and No. 3 main bearing caps.



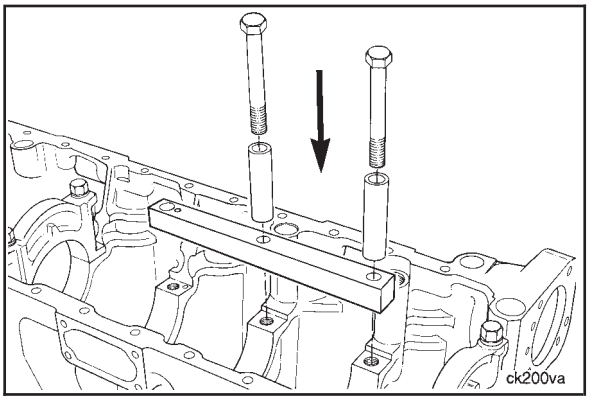
The dowel **must** be removed if the No. 4 main bearing cap is removed, either to salvage the hole or to use the joint face as a locator.



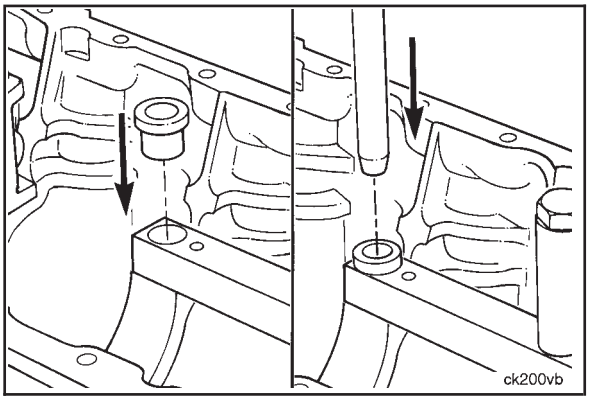
Use a flat mill file wrapped with emery cloth to remove any burrs from the joint face.

Install the alignment fixture, Part No. 3377231, using main bearing capscrews, washers and the two stud adapters, Part No. ST-1472-14.

Hand tighten the capscrews.

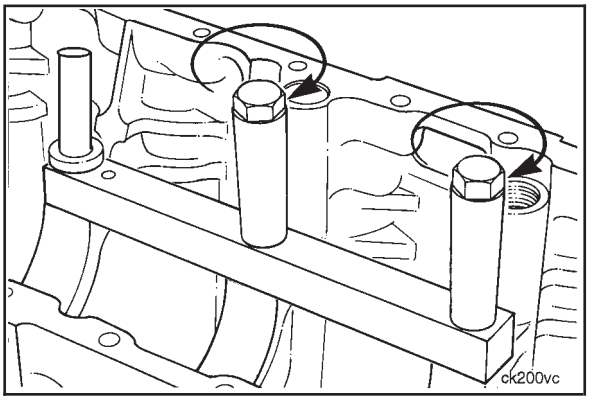


Install the bushing, Part No. 3377233, in the alignment fixture and use the locator pin, Part No. ST-1272-5, to center the fixture over the capscrew hole to be salvaged.



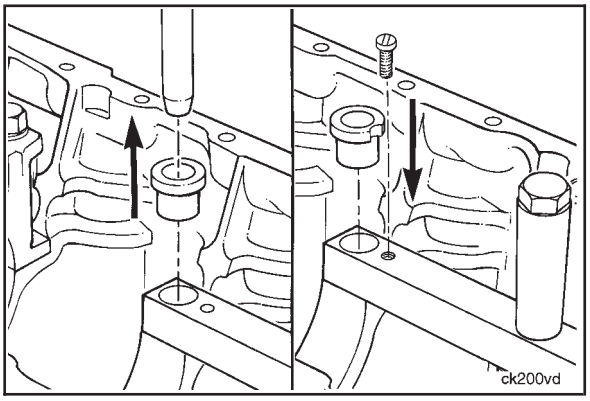
Tighten the capscrews.

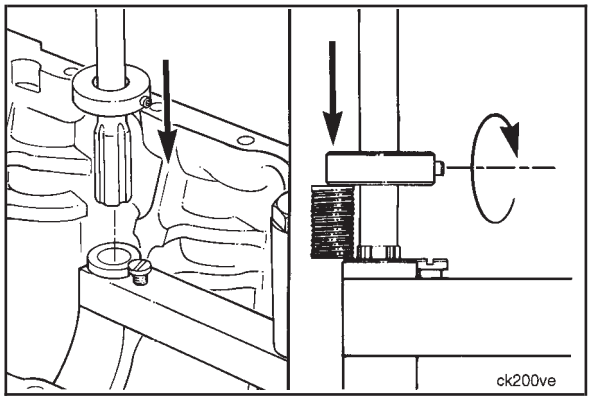
Torque Value: 65 N•m [50 ft-lb]



Remove the locator pin and the bushing, Part No. 3377233.

Install the guide bushing, Part No. 3377232, and tighten the lock screw.



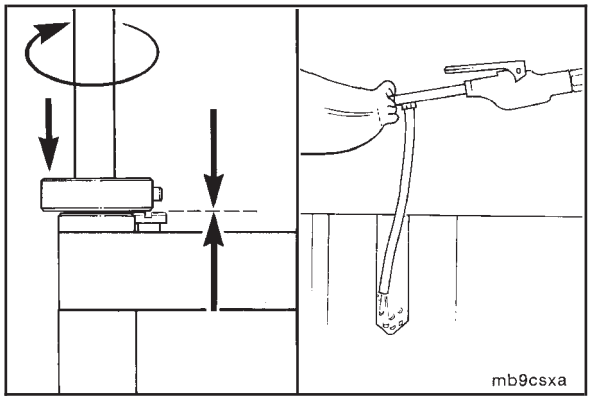


Install the reamer in the guide bushing until it contacts the cylinder block.

Place the thread insert to be installed between the guide bushing and the stop collar.

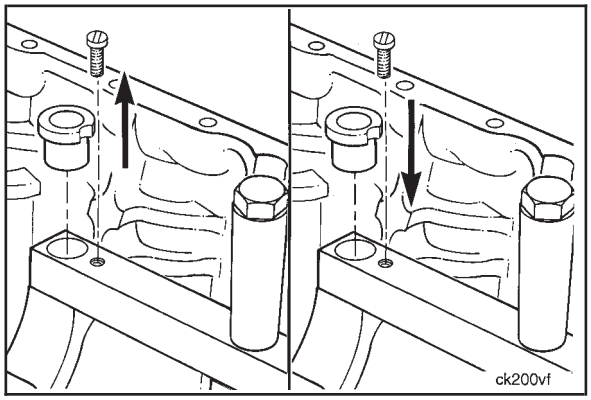
Move the stop collar until it contacts the thread insert and tighten the collar set screw.

NOTE: This will set the reamer depth.



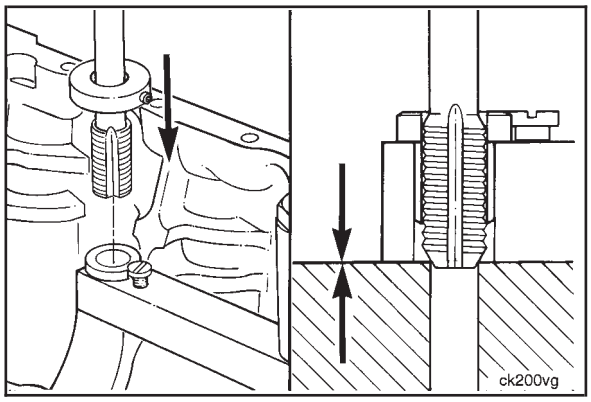
Use cutting oil. Ream the hole until the stop collar contacts the guide bushing.

Use chip removal unit, Part No. ST-1272-11, to remove the reamer chips and debris from the capscrew holes.



Remove the bushing, Part No. 3377232, from the fixture.

Install bushing, Part No. 3377233, into the fixture.

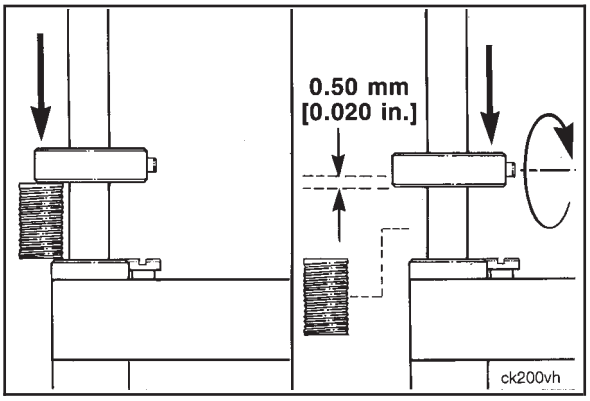


Install the tap, Part No. 3376997, into the bushing until it makes contact with the cylinder block.

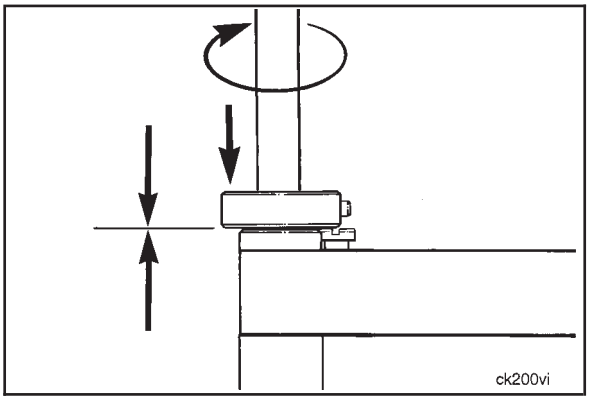
Place the thread insert between the guide bushing and the collar on the tap.

Remove the insert and move the collar an additional 0.05 mm [0.020 inch] towards the cylinder block and tighten the collar set screw.

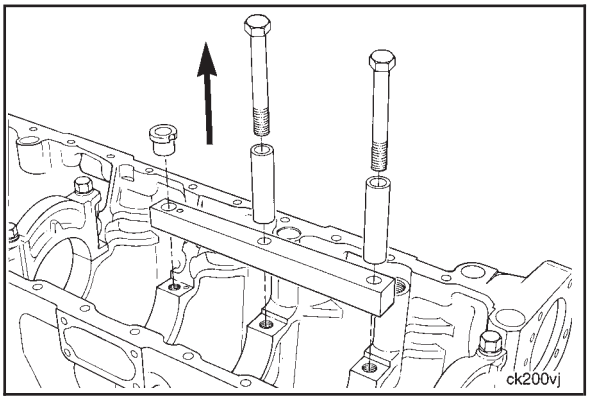
NOTE: This will set the tap depth.



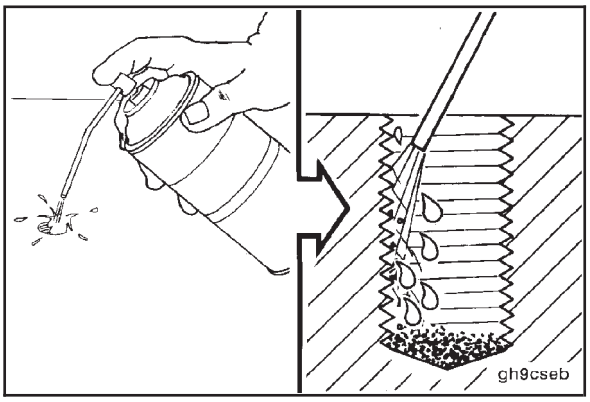
Use cutting oil. Tap the hole until the stop collar contacts the guide bushing.

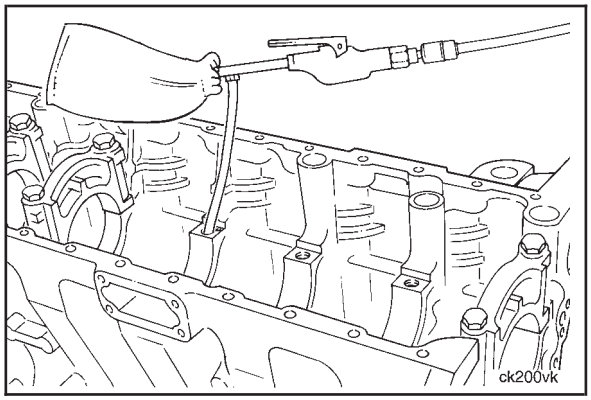


Remove the alignment fixture from the cylinder block.

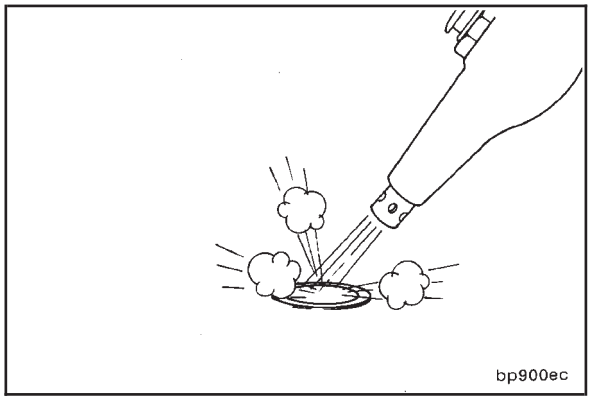


Use a spray cleaner to flush the newly cut threads.



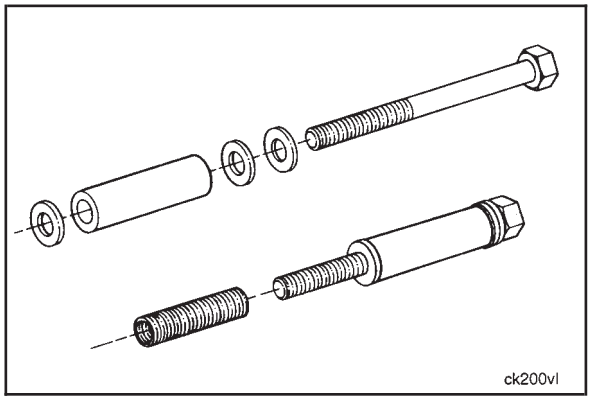


Use chip removal unit, Part No. ST-1272-11, to remove any debris from the capscrew hole.



Warning: When using compressed air to clean the capscrew holes, wear safety glasses or a face shield to protect the eyes. Personal injury can result.

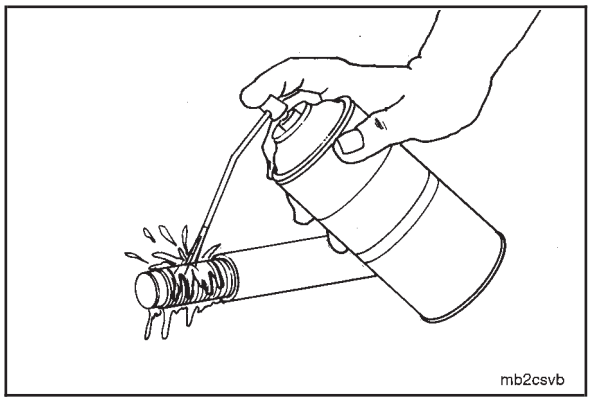
Dry the new threads with compressed air.



Install three main bearing capscrew washers and stud adapter, Part No. ST-1272-14, on the main bearing capscrew as shown.

Install the insert on the capscrew until it makes contact with the end washer.

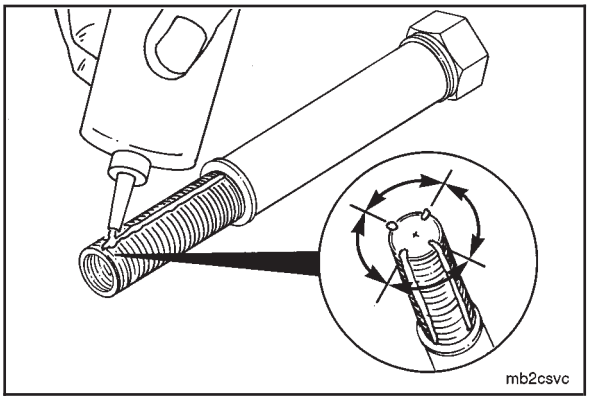
NOTE: The capscrew **must not** protrude from the end of the insert.



Use a spray cleaner to remove the preservative coating from the outside diameter of the insert.

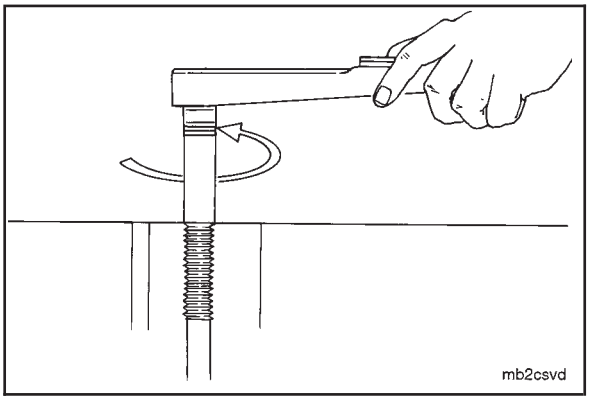
Apply four beads of sealant, Part No. 3375068, to the outside diameter of the thread insert.

NOTE: The beads of sealant **must** be approximately 0.08 mm [1/32 inch] wide and spaced 90 degrees from each other and **must** run the full length of the insert.



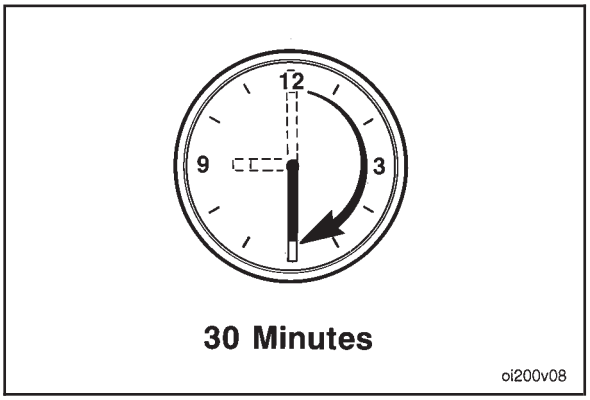
Install the thread insert in the capscrew hole.

Torque Value: 65 N•m [50 ft-lb]

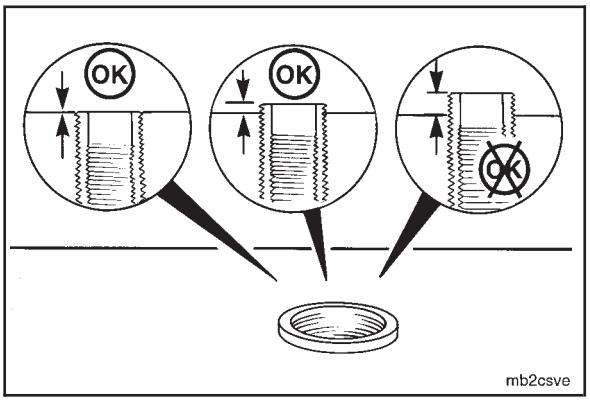


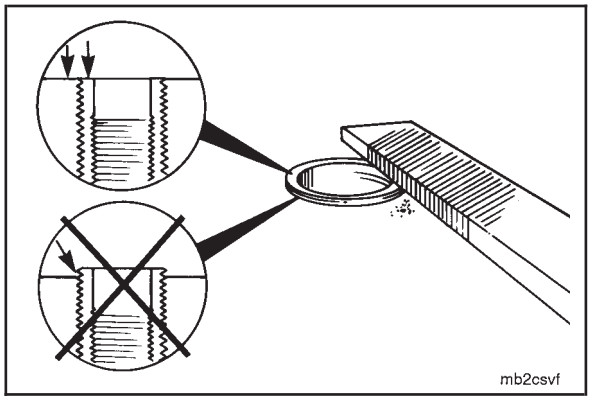
Allow the sealant to cure for 30 minutes.

Remove the capscrew, washers and adapters.



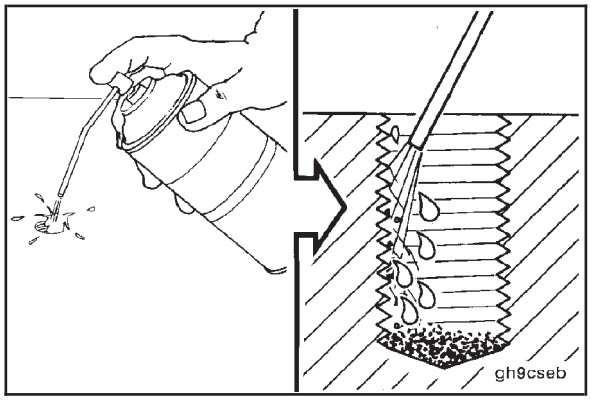
NOTE: The installed insert **must** protrude 0.00 to 0.50 mm [0.000 to 0.020 inch] from the cylinder block. If the insert protrudes more than 0.75 mm [0.030 inch] remove the insert and ream and tap the capscrew hole deeper as required.



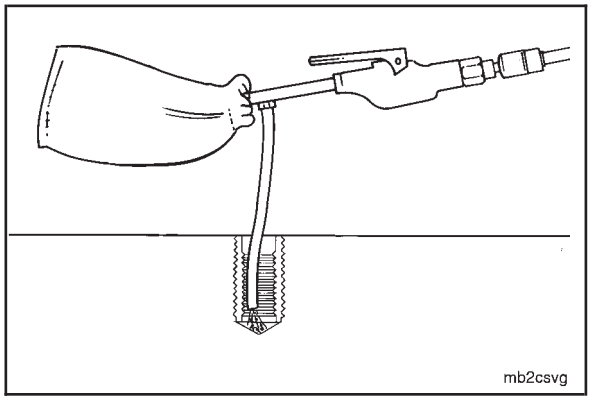


File or machine the top of the thread insert flush with the joint face of the main bearing cap.

NOTE: Care **must** be taken to insure the joint face of the cylinder block is **not** damaged.



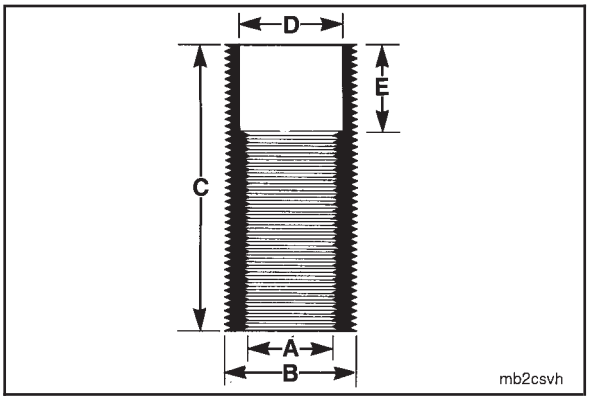
Use a spray cleaner to flush the inside diameter of the thread insert.

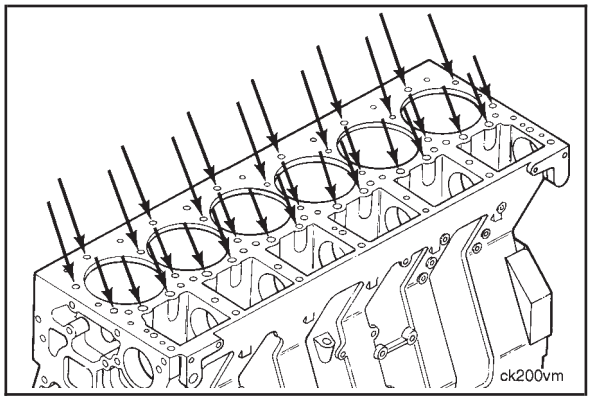


Use chip removal unit, Part No. ST-1272-11, to remove any debris from the capscrew hole.

Specifications — Main Bearing Capscrew Thread Repair

Part No. 3376281 Thread Insert				
Measurement	**Ref.**	**mm**		**inch**
Internal Threads	A	M14-1.5x6H		
External Threads	B	M18-1.5x6G		
Overall Length	C	62.75	MIN	2.470
		63.25	MAX	2.490
Counterbore Diameter	D	14.87	MIN	0.587
		15.13	MAX	0.595
Counterbore Depth	E	33.60	MIN	1.323
		34.40	MAX	1.354
Part No. 3377234 Reamer O.D.		16.50		0.650
Part No. 3376997 Tap-Thread Size		M18-1.5		

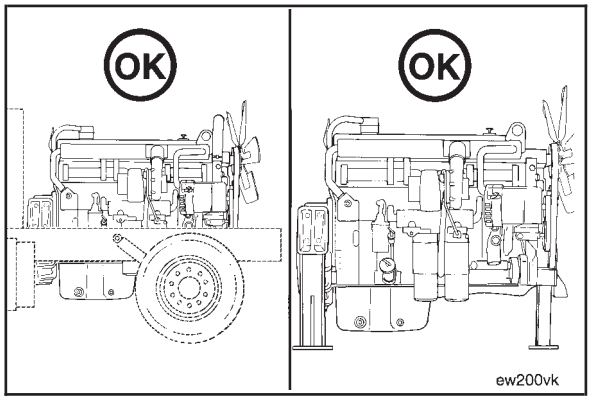




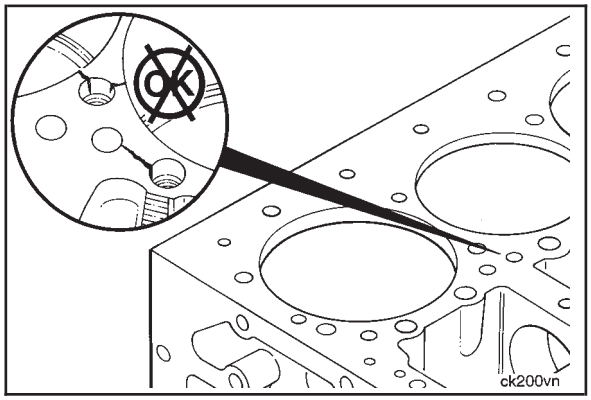
Cylinder Head Capscrew Thread Repair

General Information

This procedure describes the method for repairing damaged cylinder head capscrew threads. Any number of cylinder head capscrew threads can be repaired on the cylinder block.

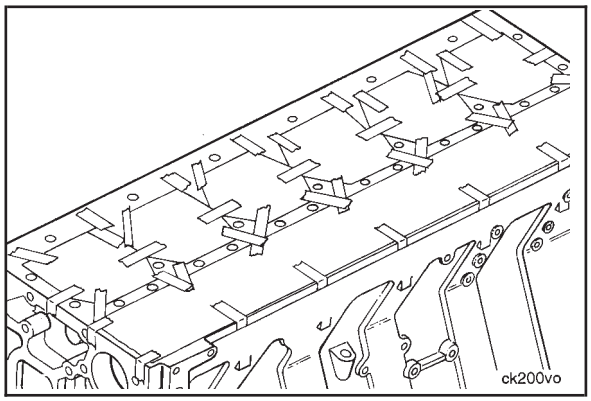


This repair can be performed with the engine either in or out of the chassis.



NOTE: This procedure **cannot** be used to repair cracks that extend from the capscrew holes into water passages.

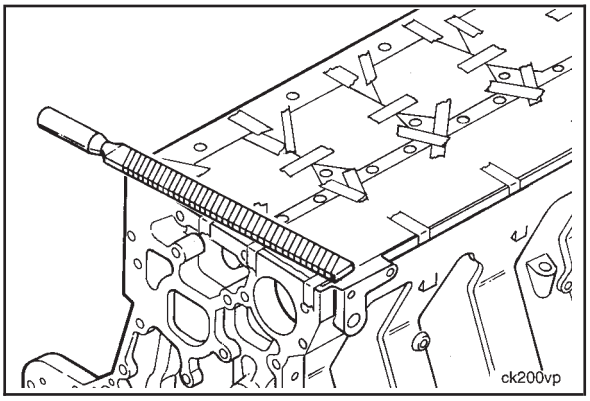
NOTE: Thread inserts **cannot** be used to repair the top deck for cracks that run into cylinder head capscrew holes.



Repair Procedure

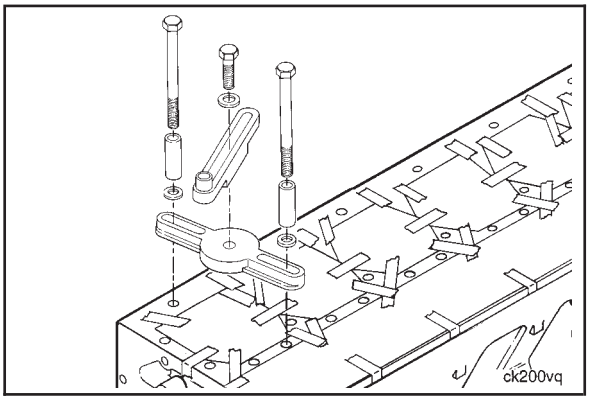
Cover the camshaft and cylinder liner bores to prevent contamination with machining chips and debris.

Use a flat mill file to remove any burrs from the capscrew hole to be repaired and from the capscrew holes that will be used to clamp the base plate assembly to the cylinder block.

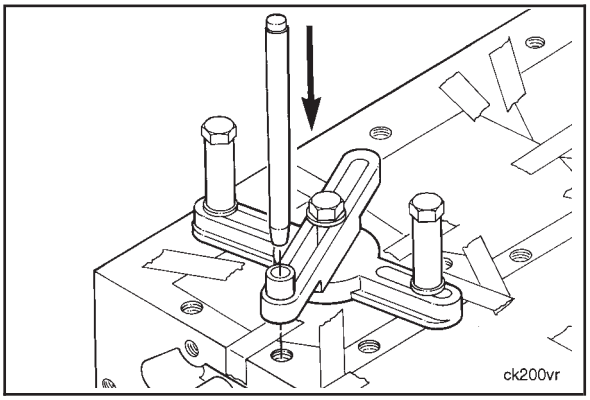


Install the base plate and drill jig assembly using the cylinder head capscrews, washers and stud adapters, Part No. ST-1272-14.

Torque Value: 65 N•m [50 ft-lb]



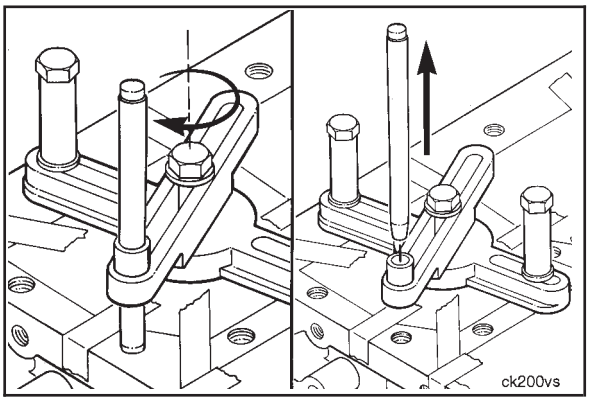
Use locator pin, Part No. ST-1272-5, to center the drill jig over the capscrew hole to be repaired.

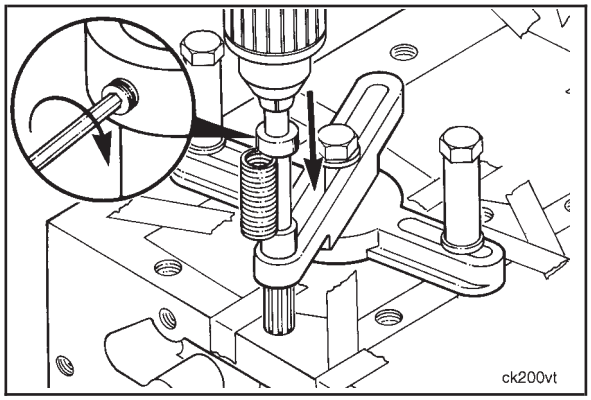


Tighten the drill jig to the base plate.

Torque Value: 45 N•m [35 ft-lb]

Remove the locator pin.



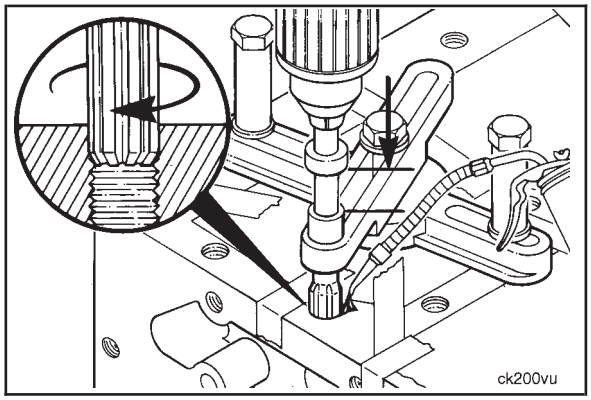


Install the reamer, Part No. 3377205, into the drill jig until it contacts the cylinder block.

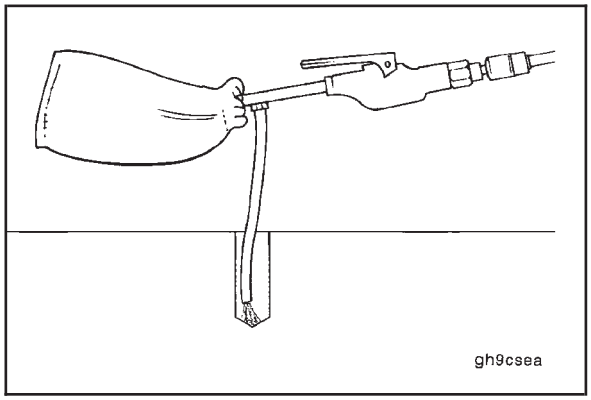
Place the thread insert to be installed between the drill jig and the stop collar.

Move the stop collar down until it contacts the thread insert and tighten the stop collar set screw.

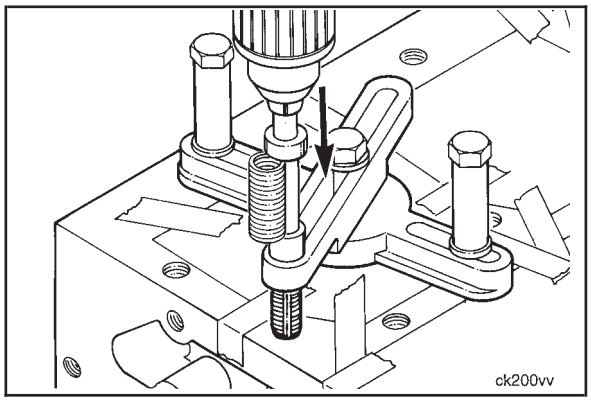
NOTE: This will set the reamer depth.



Use cutting oil. Ream the hole until the stop collar contacts the drill jig.



Use chip removing unit, Part No. ST-1272-11, to remove the reamer chips and debris from the capscrew hole.



Install the tap, Part No. 3379997, into the drill jig until it contacts the cylinder block.

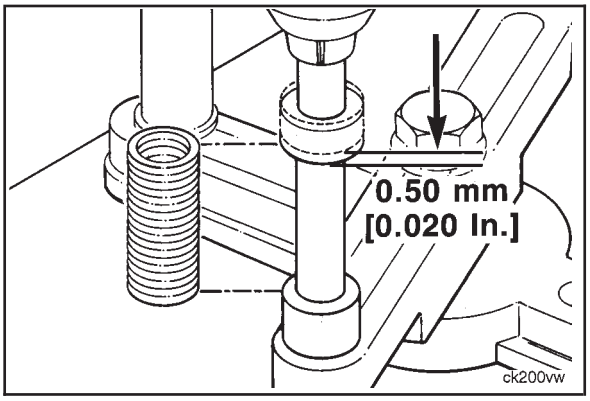
Place the thread insert to be installed between the drill jig and the stop collar.

Move the stop collar down until it contacts the thread insert.

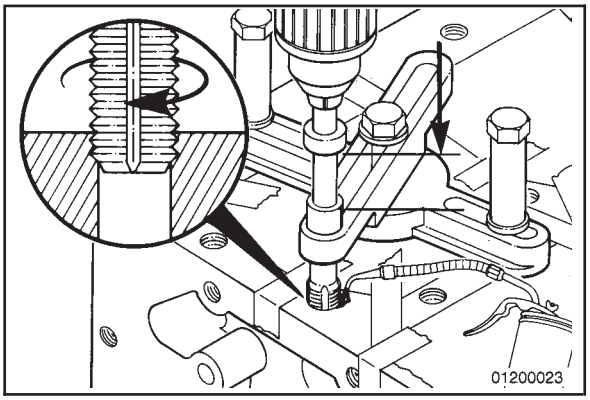
Remove the thread insert.

Move the stop collar down an additional 0.50 mm [0.020 inch] and lock the set screw.

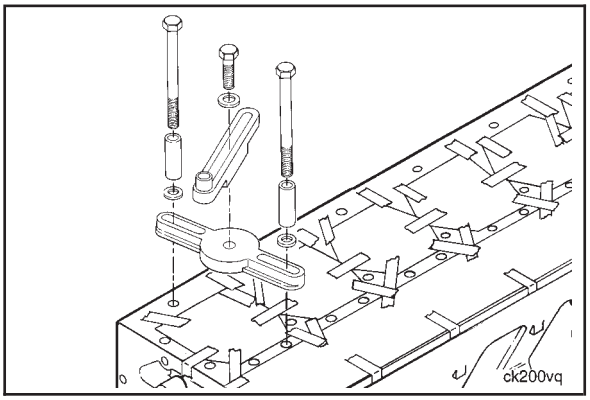
NOTE: This will set the tap depth.



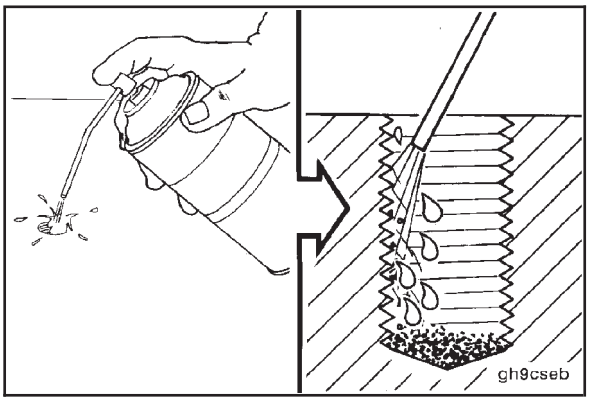
Use cutting oil. Tap the hole until the stop collar contacts the drill jig.

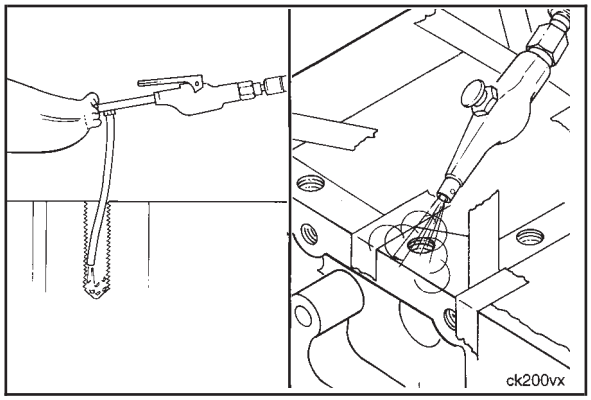


Remove the tap, drill jig and base plate from the cylinder block.



Use a spray cleaner to flush the newly cut threads.

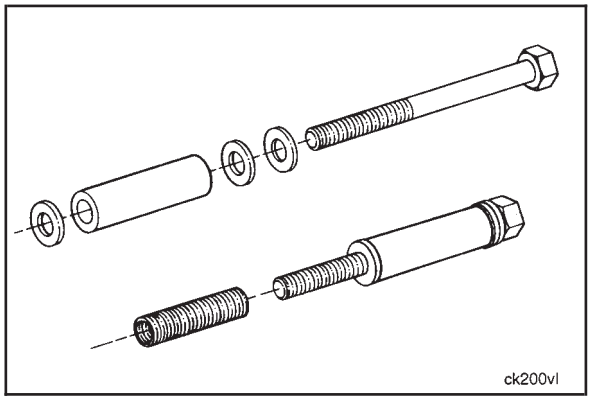




Use chip removal unit, Part No. ST-1272-11, to remove the debris from the hole.

Warning: When using compressed air to clean the capscrew holes, wear glasses or a face shield to protect the eyes. Personal injury can result.

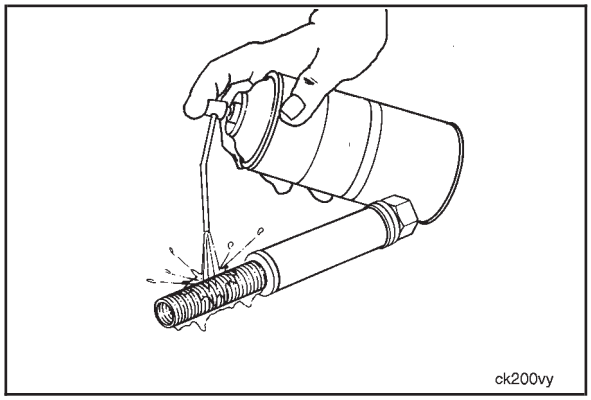
Dry the new threads with compressed air.



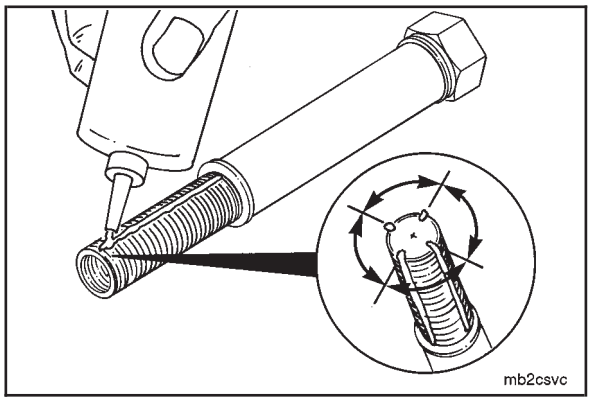
Install three cylinder head washers and the stud adapter, Part No. ST-1272-14, on the capscrew as shown.

Install the thread insert until it makes contact with the end washer.

NOTE: The capscrew **must not** protrude from the end of the thread insert.



Use a spray cleaner to remove the preservative coating from the outside diameter of the thread insert.

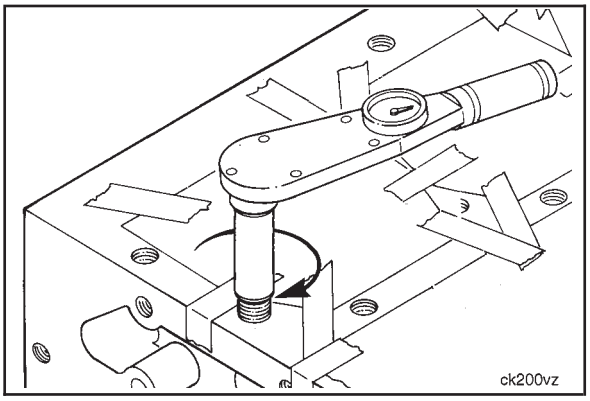


Apply four beads of sealant, Part No. 3375068, to the outside diameter of the thread insert.

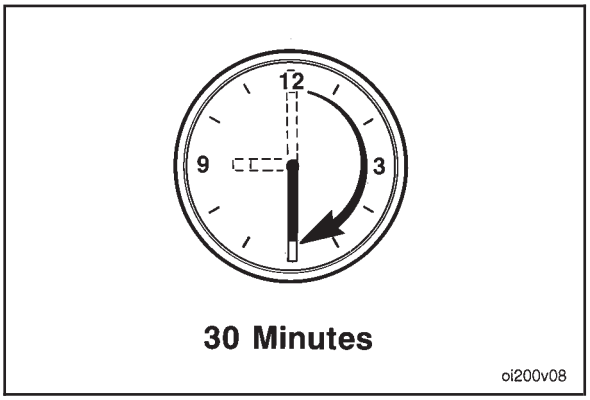
NOTE: The beads of sealant **must** be approximately 0.8 mm [1/32 inch] wide and 90 degrees apart and **must** run the full length of the thread insert.

Install the thread insert.

Torque Value: 65 N•m [50 ft-lb]

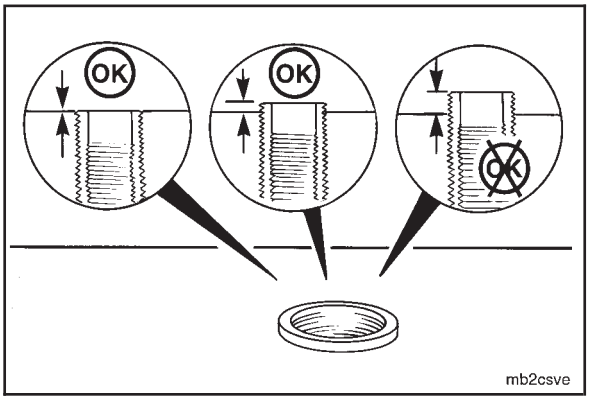


Allow the sealant to cure for 30 minutes and remove the capscrew, washers and adapters.



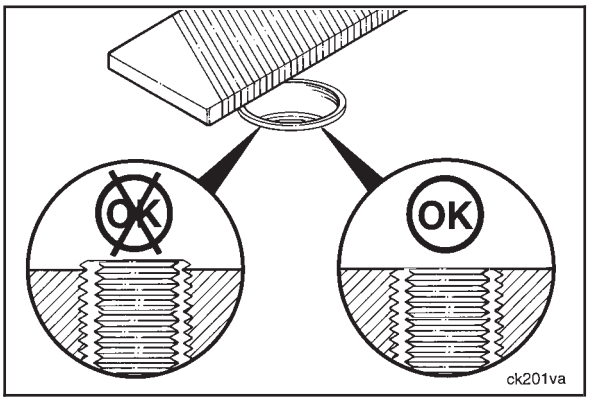
NOTE: The installed thread insert **must** protrude 0.00 to 0.50 mm [0.000 to 0.020 inch] from the cylinder block.

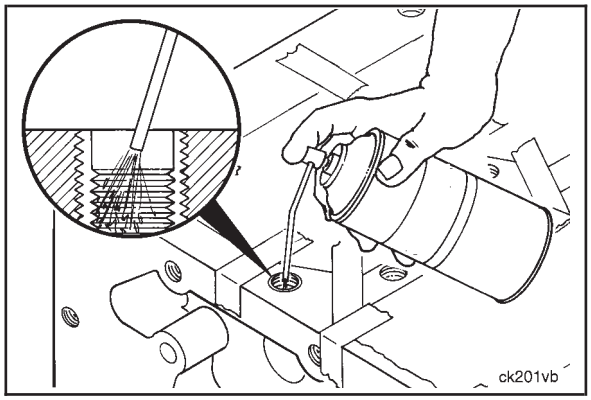
If the thread insert protrudes more than 0.76 mm [0.030 inch] remove the insert and ream and tap the capscrew hole deeper as required.



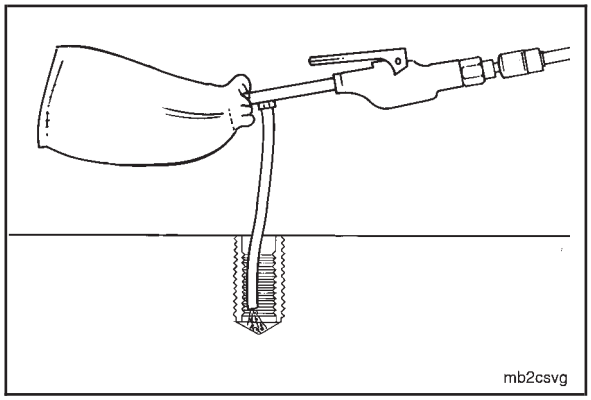
File or machine the top of the thread insert flush with the cylinder block top deck surface.

Make sure the cylinder block top deck surface is **not** damaged.

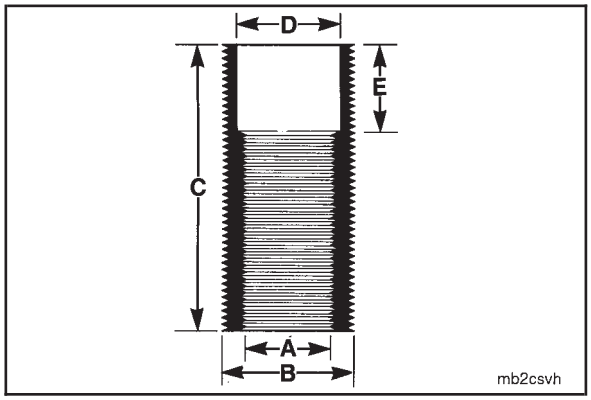




Use a spray cleaner to flush the inside diameter of the thread insert.



Use chip removal unit, Part No. ST-1272-11, to remove the debris from the hole.



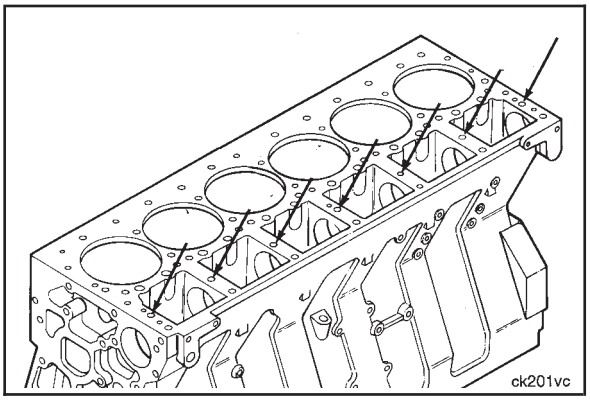
Specifications — Cylinder Head Capscrew Thread Repair

Part No. 3376282 — Thread Insert				
Measurement	**Ref.**	**mm**		**in**
Internal Threads	A	M14x1.5x6H		
External Threads	B	M18x1.5x6G		
Overall Length	C	42.75	MIN	1.683
		43.25	MAX	1.703
Counterbore Diameter	D	14.87	MIN	0.585
		15.13	MAX	0.595
Counterbore Depth	E	13.25	MIN	0.522
		13.75	MAX	0.541
Part No. 3377205 Reamer O.D.		16.50		0.650
Part No. 33776997 Tap-Thread Size		M18x1.5		
Reamed Depth		Thread Insert Length		

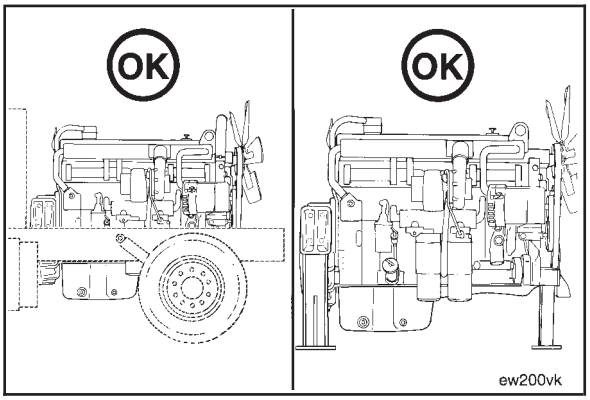
Cam Follower Stud Thread Repair

General Information

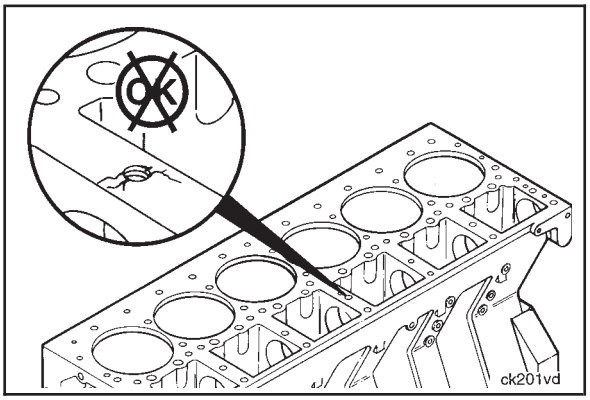
This procedure describes the method for repairing damaged cam follower stud hole threads. Any number of stud hole threads can be repaired on the cylinder block.



This repair can be performed with the engine either in or out of the chassis.



NOTE: This procedure **cannot** be used to repair cracks that extend from the stud hole.

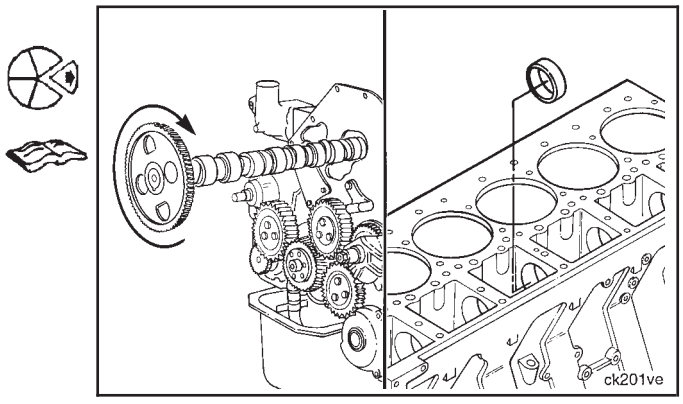


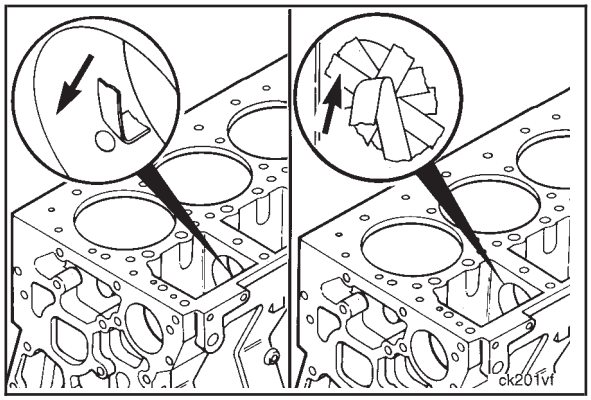
Repair Procedure

Remove the camshaft.

Remove the camshaft bushing that corresponds to the stud hole needing repair. Refer to the following Shop Manuals for the correct procedure:

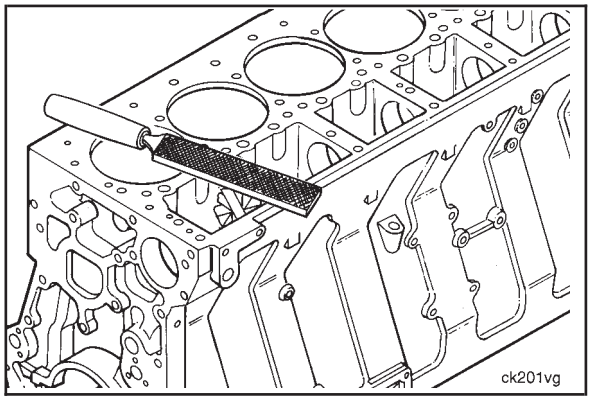
- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



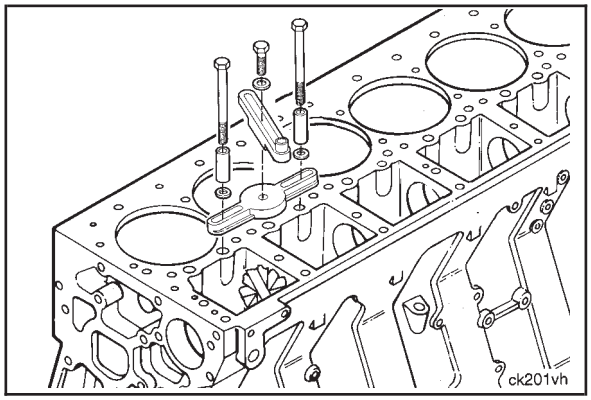


Use masking tape to cover the oil drillings in the camshaft bore.

Cover the sides on the camshaft bore to prevent debris from falling into the engine.

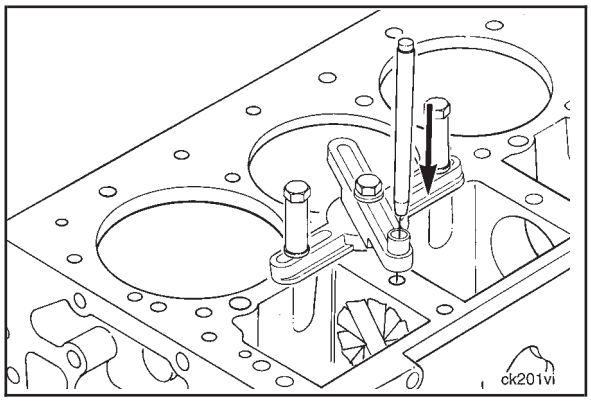


Use a flat mill file to remove any burrs from the top of the stud hole.



Install the base plate and drill jig assembly using cylinder head capscrews, washers and stud adapters, Part No. ST-1272-14.

Torque Value: 65 N•m [50 ft-lb]

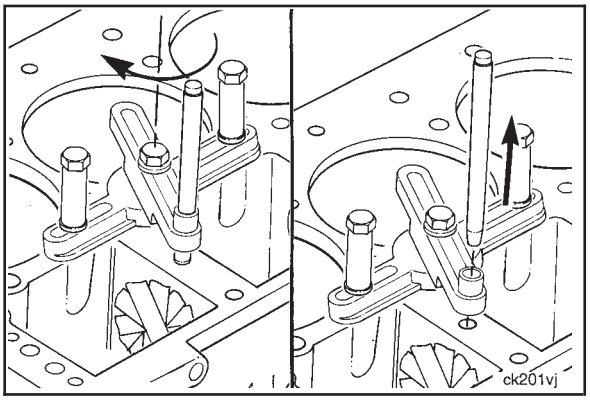


Use thread-insert-locating pin, Part No. 3377208, to center the drill jig over the cam follower stud hole to be repaired.

Tighten the drill jig to the base plate.

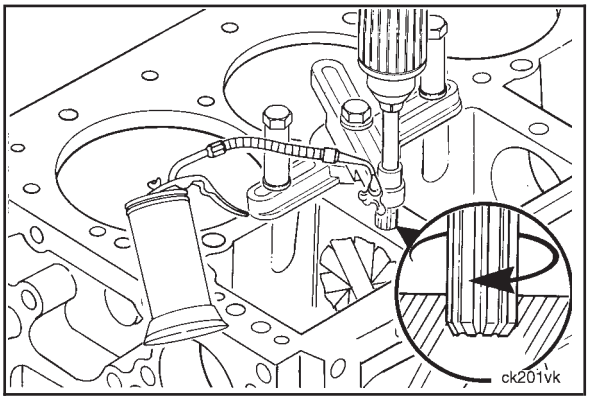
Torque Value: 45 N•m [35 ft-lb]

Remove the locator pin.

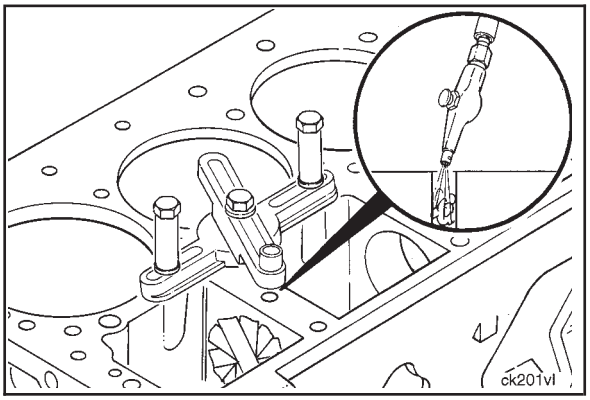


Use cutting oil and a 12.7 mm [0.50 inch] diameter drill or reamer to enlarge the stud hole.

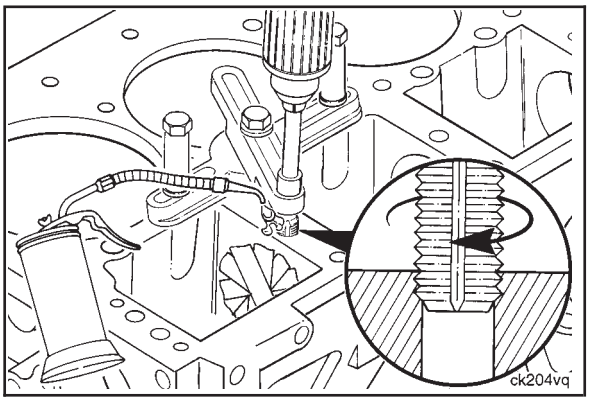
Drill or ream all the way through the camshaft bore.

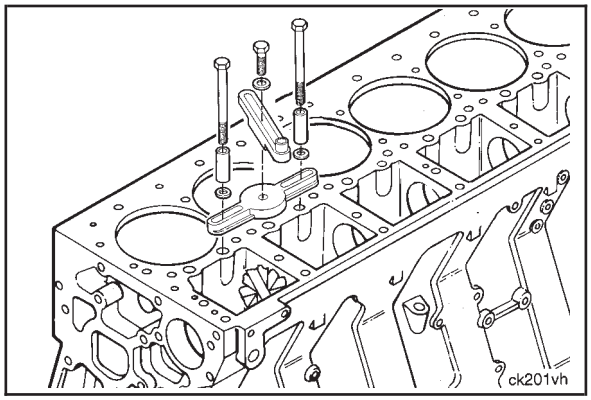


Use chip removing unit, Part No. ST-1272-11, to remove the debris from the stud hole and camshaft bore.

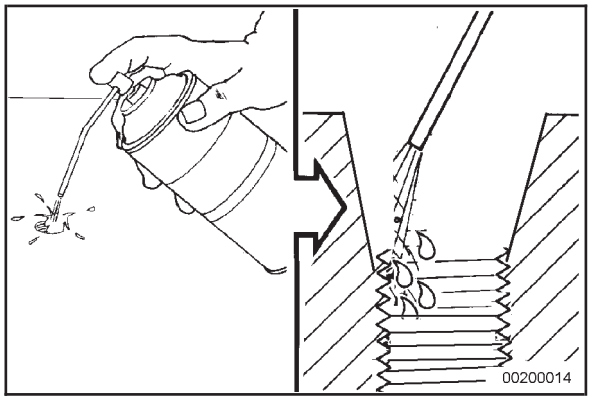


Use cutting oil and thread salvage tap (M14 x 1.50), Part No. 3376995. Tap the hole through to the camshaft bore.

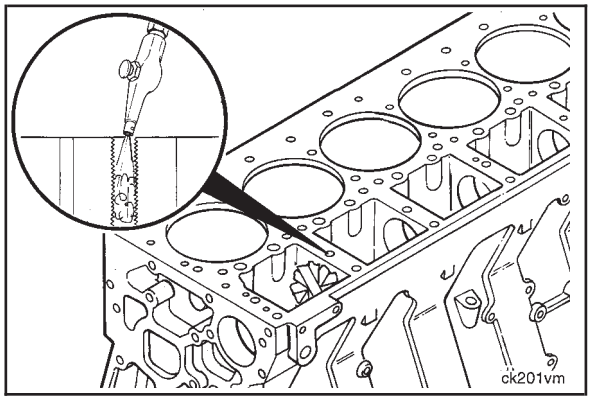




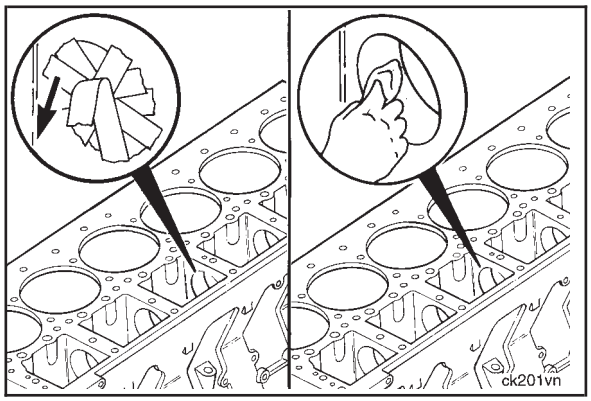
Remove the tap, drilling jig and base plate from the cylinder block.



Use a spray cleaner to flush the newly cut threads.

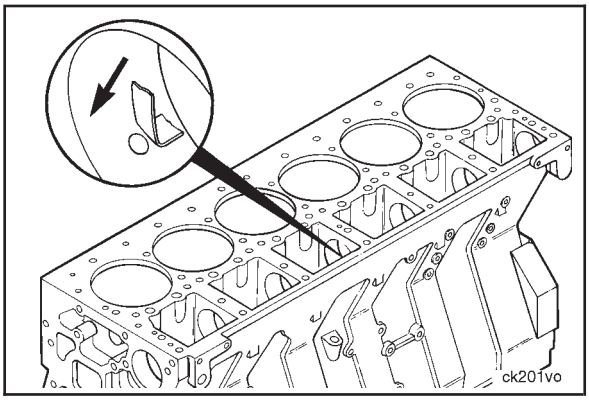


Use chip removal unit, Part No. ST-1272-11, to remove any debris from the stud hole and camshaft bore.



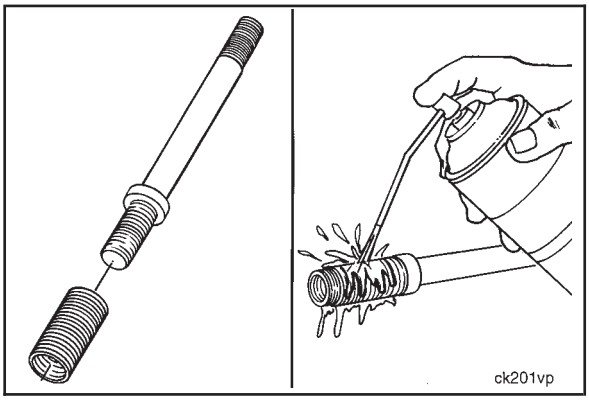
Remove the tape and clean any debris from the camshaft bore.

Remove the tape in the camshaft bore that is covering the oil drillings.



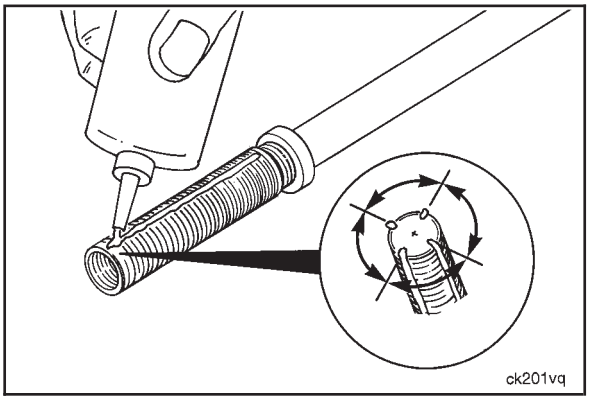
Install the thread insert, Part No. 3376706, on a cam follower stud.

Use a spray cleaner to clean the outside diameter of the thread insert.



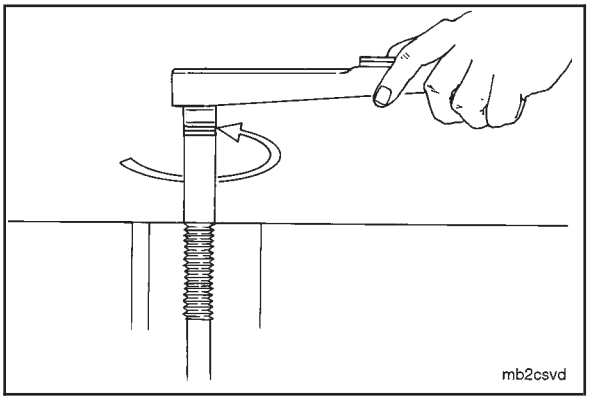
Apply four evenly spaced beads of sealant, Part No. 3375068, to the thread insert.

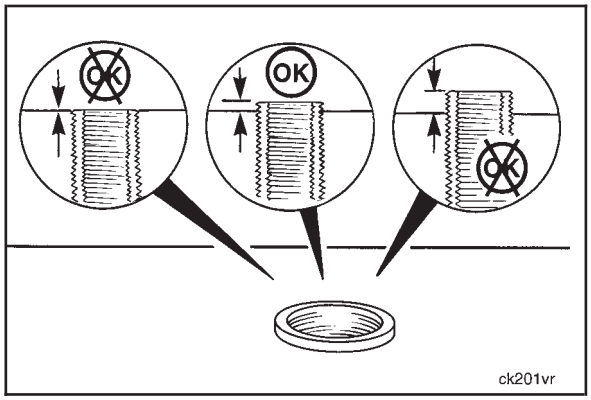
NOTE: The beads should be approximately 0.8 mm [1/32 inch] wide and run the full length of the thread insert.



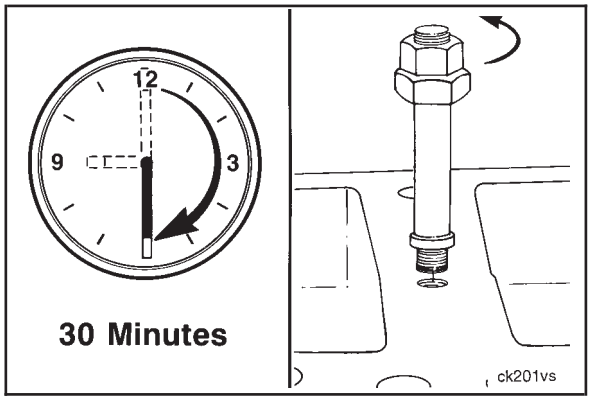
Install the thread insert.

Torque Value: 65 N•m [50 ft-lb]



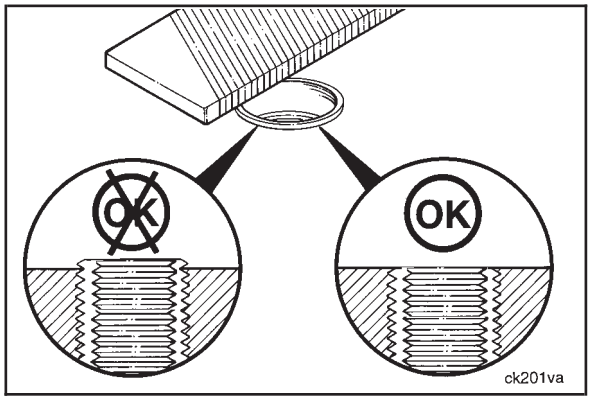


NOTE: Correct installation of the thread insert will allow 0.00 to 0.25 mm [0.000 to 0.010 inch] of the insert to protrude from the cylinder block.



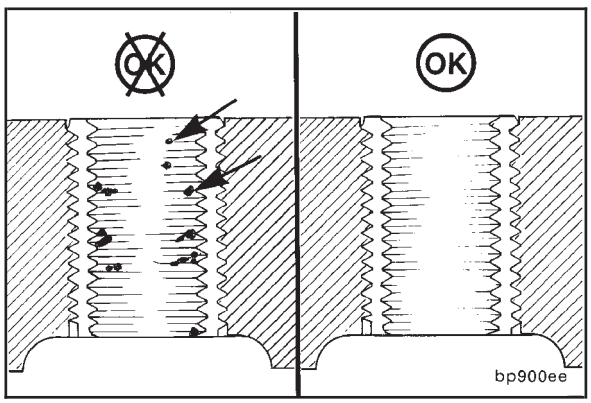
Allow the sealant to cure for 30 minutes.

Remove the cam follower stud.



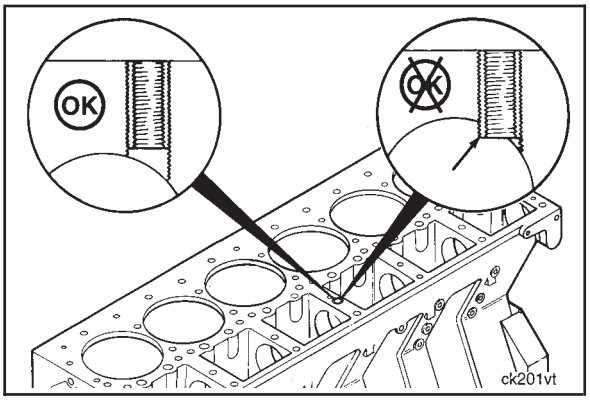
File or machine the top of the thread insert until it is flush with the cylinder block.

NOTE: Make sure the cylinder block top deck is **not** damaged.



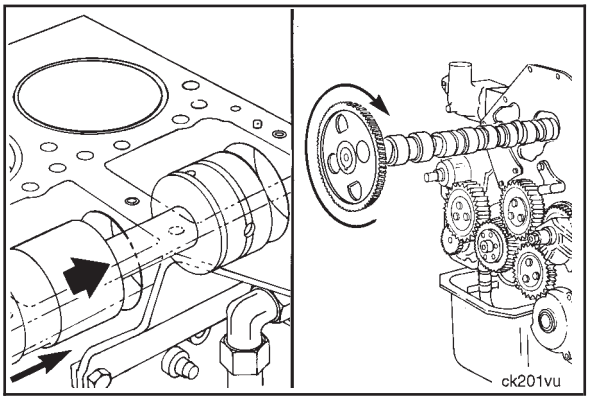
Clean any debris from the inside diameter of the thread insert.

Inspect the inside diameter of the camshaft bore. The insert **must not** protrude into the bore.



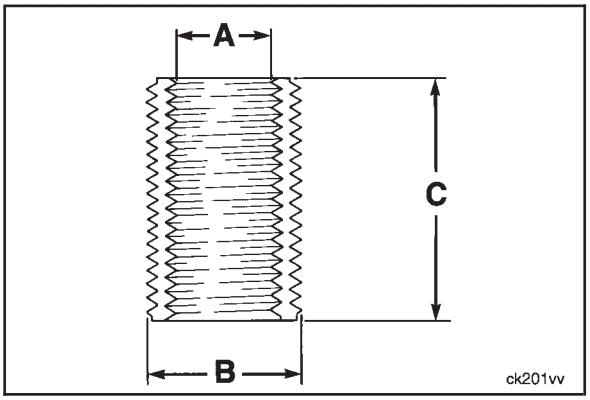
Install the camshaft bushing, camshaft and reassemble the engine. Refer to the following Shop Manuals for the correct procedure:

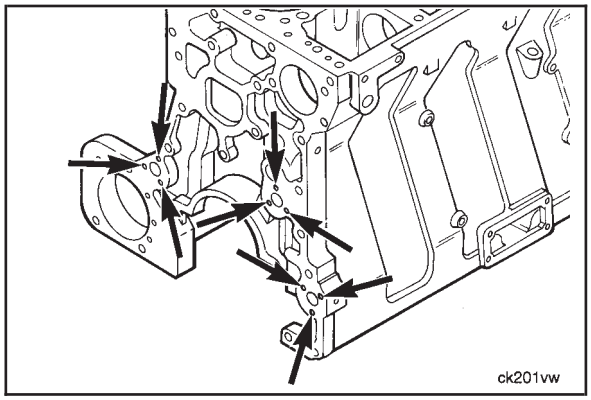
- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



Specifications — Cam Follower Stud Repair

Part No. 3376706 Thread Insert				
Measurement	**Ref.**	**mm**		**inch**
Internal Treads	A	M10x1.5		
External Treads	B	M14x1.5		
Overall Length	C	12.25 12.75	MIN MAX	0.482 0.502

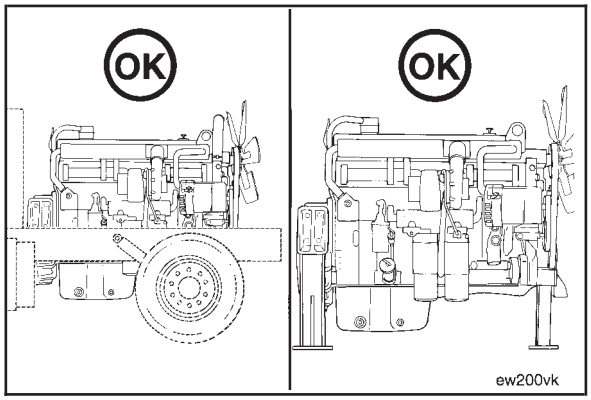




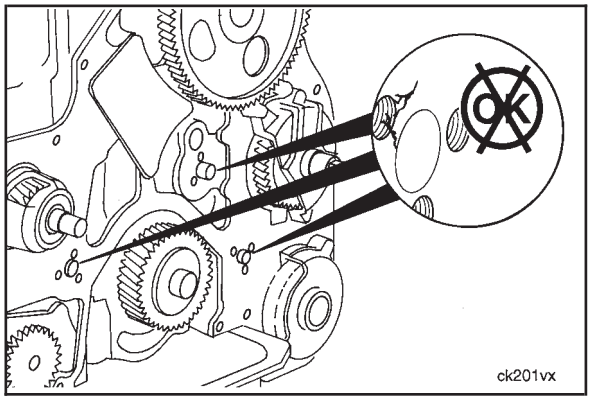
Idler Gear Capscrew Thread Repair

General Information

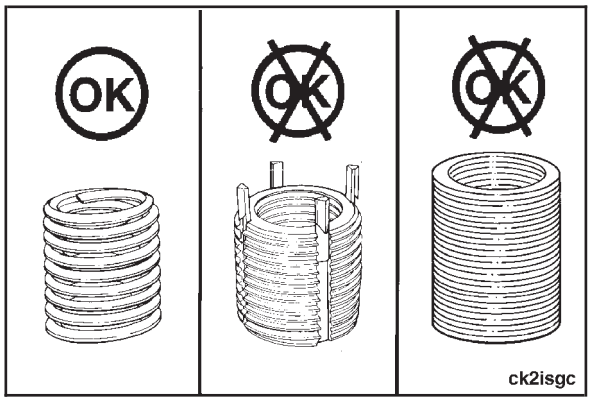
This procedure describes the method for repairing damaged idler gear capscrew hole threads. Any number of idler gear capscrew threads can be repaired on the cylinder block.



This repair procedure can be performed with the engine either in or out of the chassis.



NOTE: This procedure **cannot** be used to repair cracks that extend from the idler gear capscrew hole.

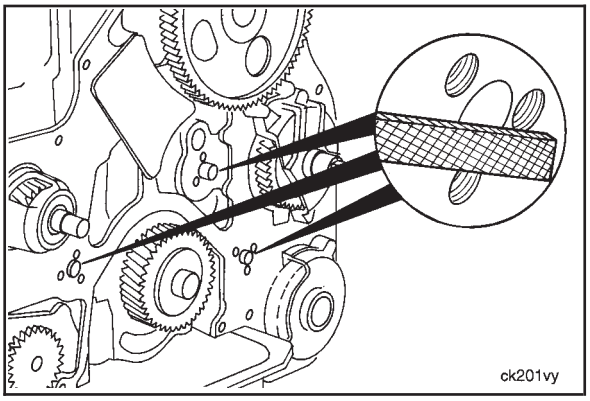


When performing this repair, only coiled thread inserts can be used.

NOTE: Other type thread inserts require removing too much material thickness.

Repair Procedure

Use a flat mill file to remove any burrs from the edge of the capscrew hole.

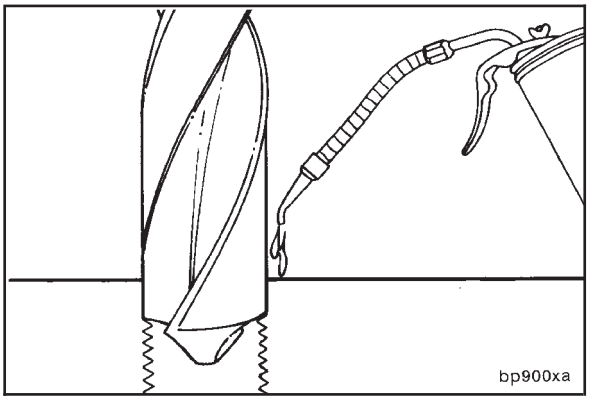


Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

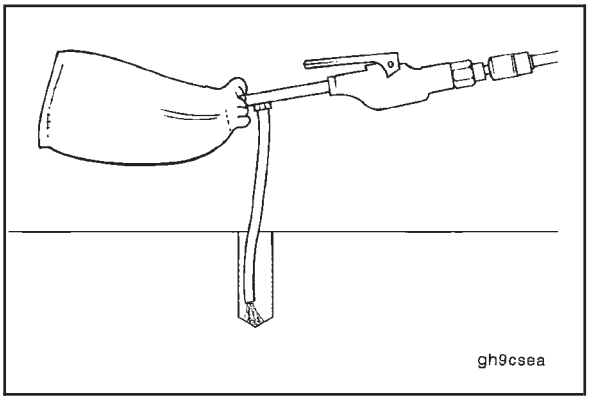
Use a 10.5 mm [13/32 inch] drill and cutting oil to enlarge the capscrew hole.

Drill to the bottom of the capscrew hole.

NOTE: Keep the drill as perpendicular to the cylinder block as possible.

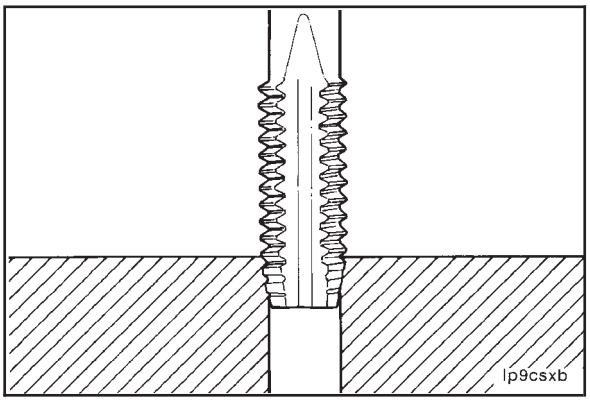


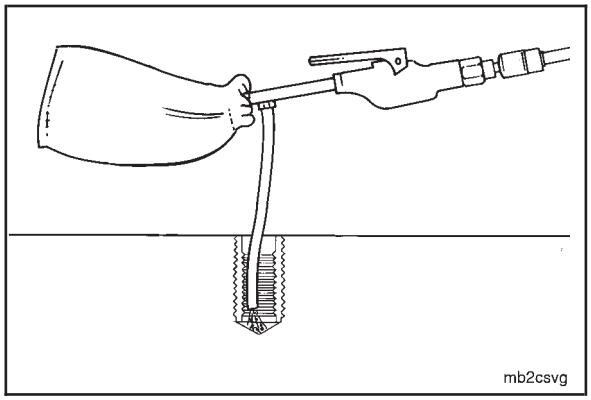
Use chip removal unit, Part No. ST-1272-11, to clean any debris from the capscrew hole.



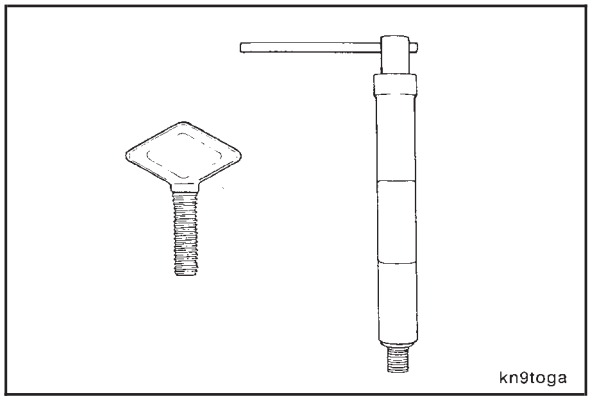
Use cutting oil. Use one of the following taps to cut new threads in the capscrew hole:

- Helicoil Part No. 2043-10
- Perma-Thread Part No. 5043-100CB5





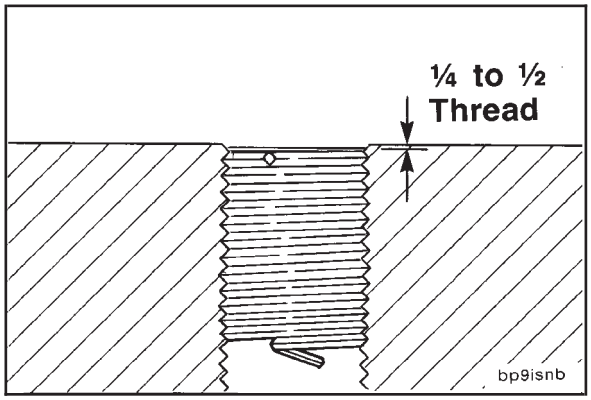
Use chip removal unit, Part No. ST-1272-11, to remove any debris from the capscrew.



NOTE: Use the installation tool, such as standard tool or prewinder tool, that suits your specific thread insert and space limitations.

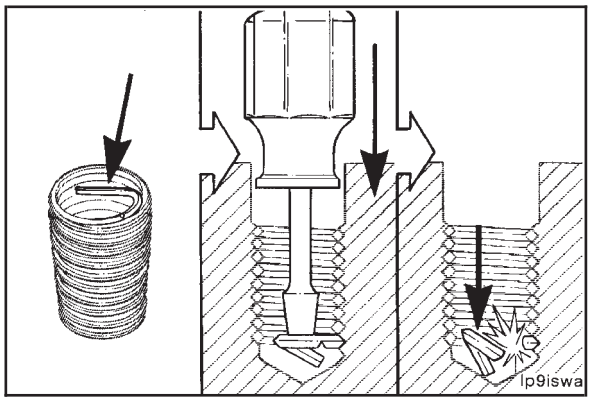
Install one of the following thread inserts on the installation tool.

- Helicoil Part No. — 1084-10CN-0200
- Perma-Thread Part No. — 206 M-10C-0200



Install the thread insert into the capscrew hole.

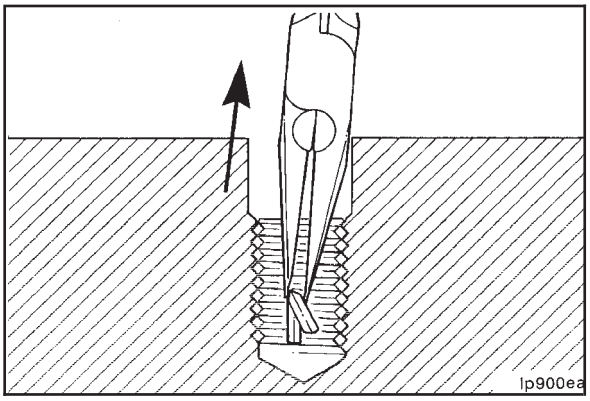
NOTE: The top of the thread insert **must** be 1/4 to 1/2 of a thread below the surface of the cylinder block.



Break the installation tang off of the thread insert.

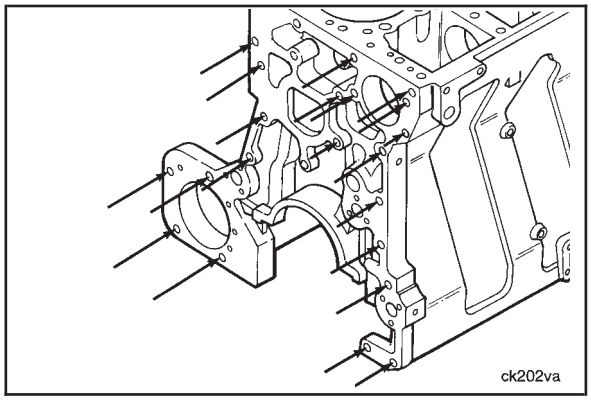
NOTE: Position a punch or screwdriver near the free end of the installation tang and strike the tool. The installation tang will break off.

Remove the installation tang from the repaired capscrew hole.



Specification — Idler Gear Capscrew Thread Repair

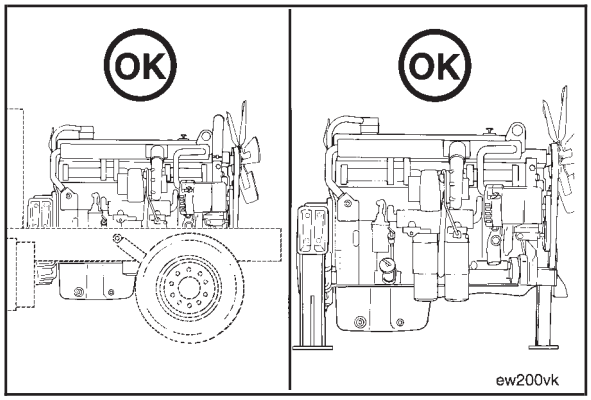
Measurement	mm	inch	
Drill Diameter	10.5	13/32	
Tap-Major Diameter	12.3	31/64	Helicoil Part No. 2093-10 Perma-Thread Part No. 5043-10CBS
Thread Insert Length	20	25/32	Helicoil Part No. 0184-10CN-0200 Perma-Thread Part No. 206M-10C0200



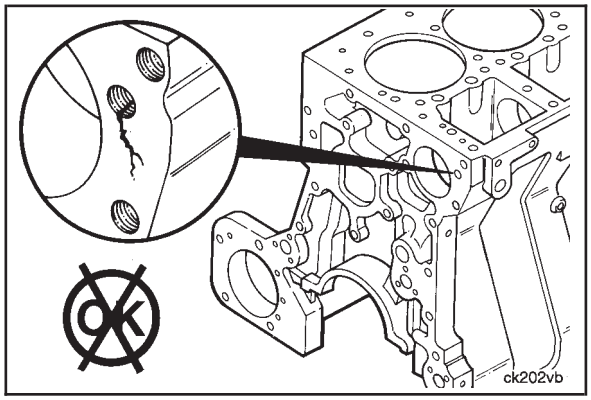
Gear Plate and Gear Cover Mounting Capscrew Thread Repair

General Information

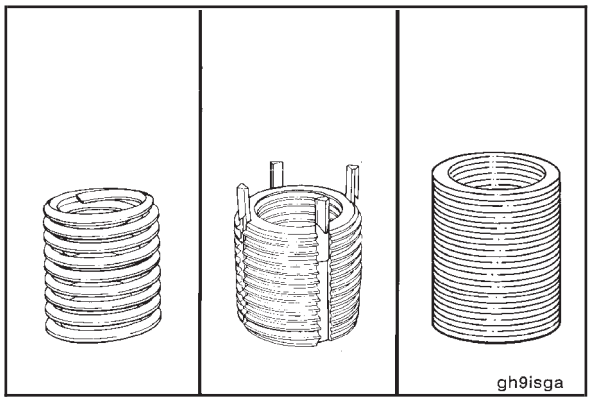
This procedure describes the method for repairing damaged gear plate mounting capscrew threads in the front of the cylinder block. Any number of capscrew threads can be repaired on the cylinder block.



This repair can be performed with the engine either in or out of the chassis.



NOTE: This procedure **cannot** be used to repair cracks that extend from the capscrew hole.



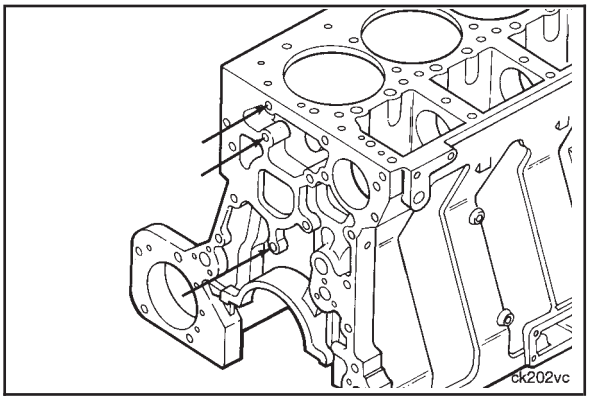
Coiled thread inserts, keylock inserts and open end threaded inserts can be used for this repair.

For these three holes, one of the following **must** be used:

Coiled Thread — 15 mm long
- Helicoil Part No. — 1084-10CN-0150
- Perma-Thread Part No. — 206M-10C-0150

Keylock Thread Insert — 14 mm long
- Tridair Keensert Part No. — KNM10X1.5F
- Microdot K-Sert Part No. — KM9900-100

Open End Insert — 14 mm long
- Cummins Part No. — 3376707

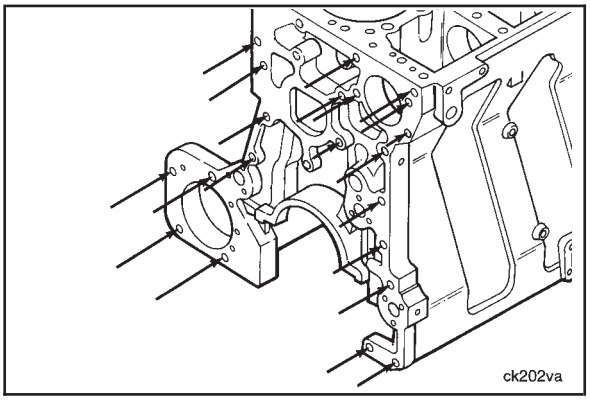


For the rest of the holes, one of the following inserts can be used:

Coiled Threads — 20 mm long
- Heilcoil Part No. — 1084-10CN-0200
- Perma-Thread Part No. — 206M-10C-0200

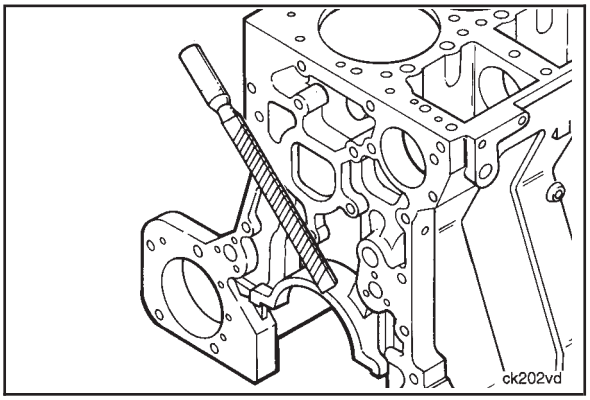
Keylock Thread Insert — 14 mm long
- Tridair Keensert Part No.- KNM10X1.50
- Microdot K-Sert Part No. — KM9900-100

Open End Thread Insert — 20 mm long
- Cummins Part No. — 3376610



Repair Procedure

Use a flat mill file to remove any burrs from the edge of the capscrew hole.



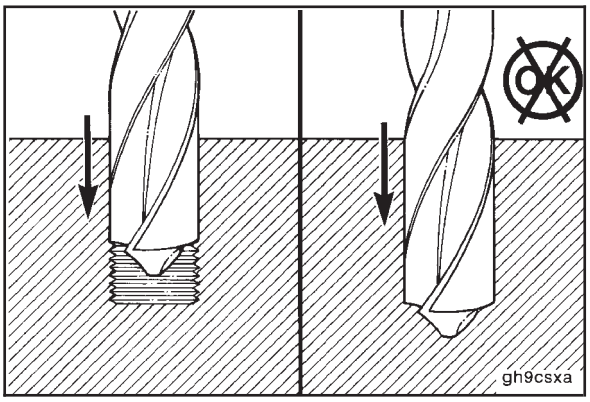
Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

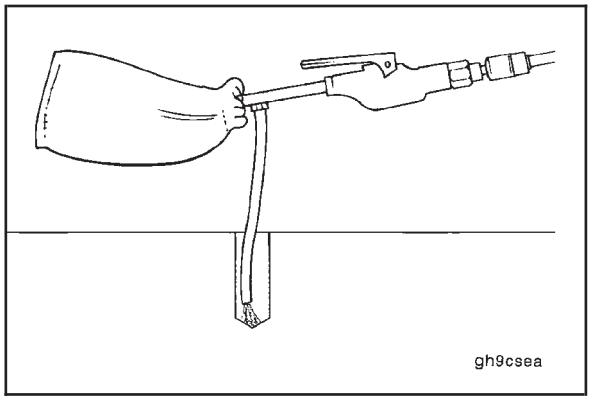
Caution: Do not drill into or through the bottom of the capscrew hole. Doing so can cause coolant leakage which will result in engine damage.

Use a drill and cutting oil to enlarge the capscrew hole. Refer to the end of this procedure for drill sizes.

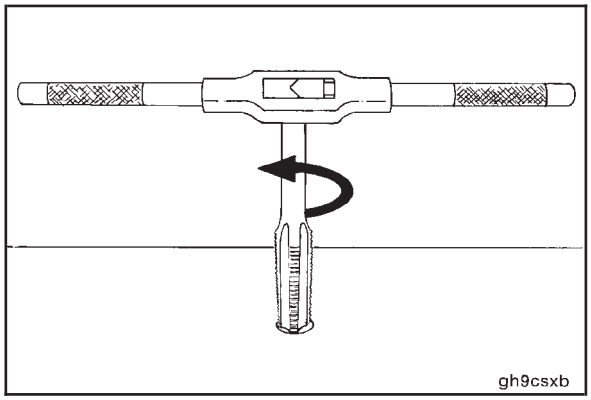
Drill to the bottom of the capscrew hole.

NOTE: Keep the drill as perpendicular to the cylinder block as possible.

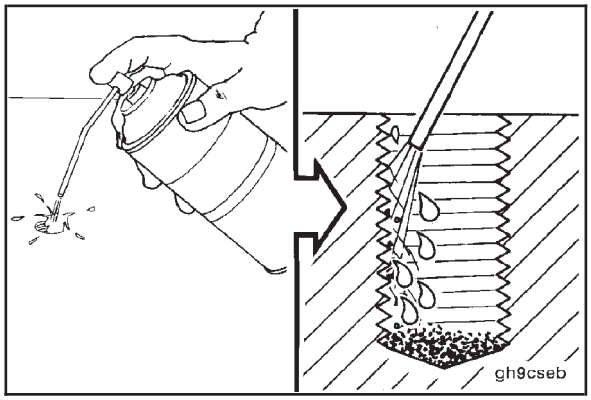




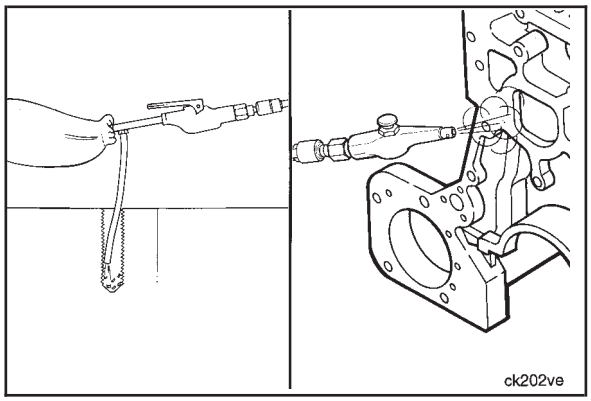
Use chip removal unit, Part No. ST-1272-11, to remove the debris from the hole.



Use cutting oil. Tap new threads in the capscrew hole. Refer to the end of this procedure for tap sizes.



Use a spray cleaner to flush the newly cut threads.

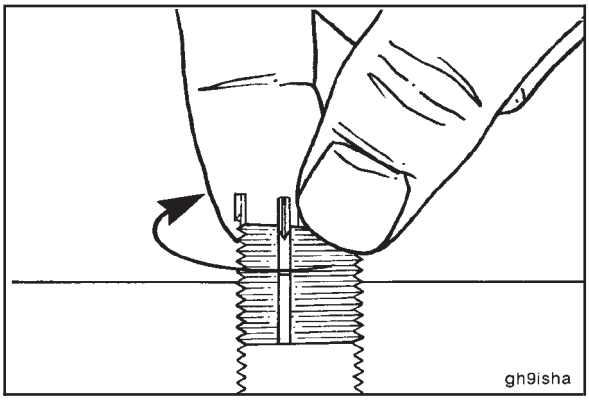


Use chip removal unit, Part No. ST-1272-11, to remove the debris from the capscrew hole.

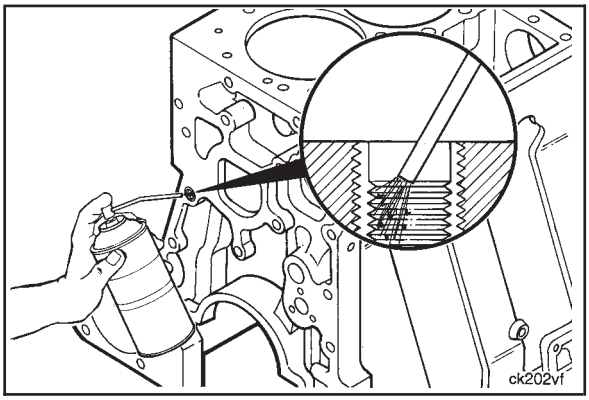
Warning: When using compressed air to clean the capscrew holes, wear safety glasses or a face shield to protect the eyes. Serious personal injury can result.

Dry the new threads with compressed air.

Install the thread insert. Refer to the Gear Plate and Gear Cover Mounting Capscrew Thread Repair — General Information for recommended inserts.



Use a spray cleaner to clean the inside diameter of the thread insert.



Specifications — Gear Plate and Gear Cover Mounting Capscrew Thread Repair

Drill Diameter

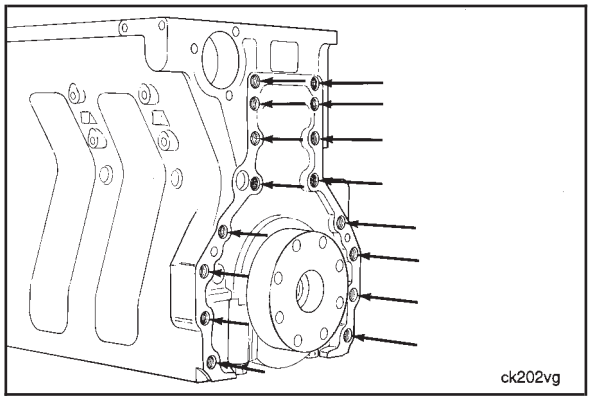
- Helicoil — 10.5 mm
- Keylock and Open End Inserts — 12.8 mm

Tap Information

- Coiled Threads
- Helicoil Part No. — 2093-10

Keylock and Open End Inserts

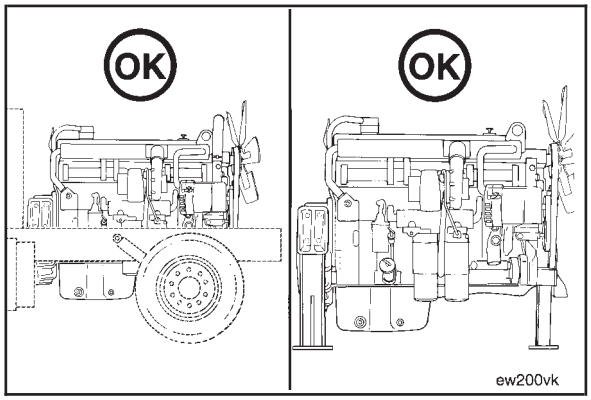
- Thread Size — M14X1.5



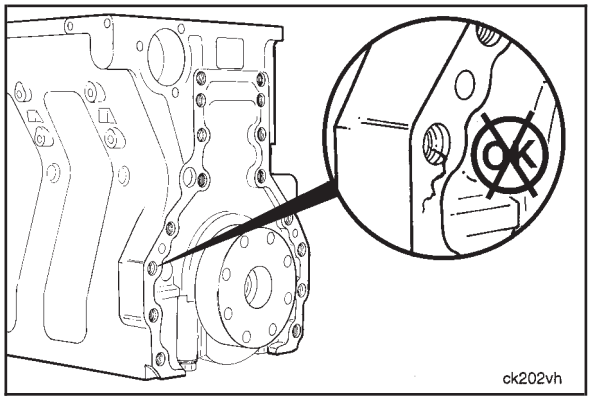
Flywheel Housing Mounting Capscrew Thread Repair

General Information

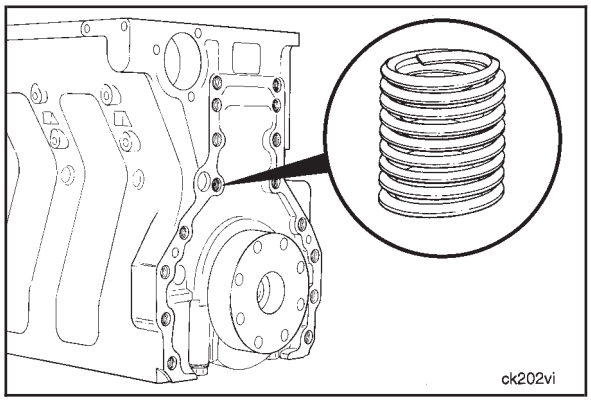
This procedure describes the method for repairing damaged flywheel housing mounting capscrew hole threads. Any number of the threads can be repaired on the cylinder block.



This repair procedure can be performed with the engine either in or out of the chassis.



NOTE: This procedure **cannot** be used to repair cracks that extend from the capscrew hole.



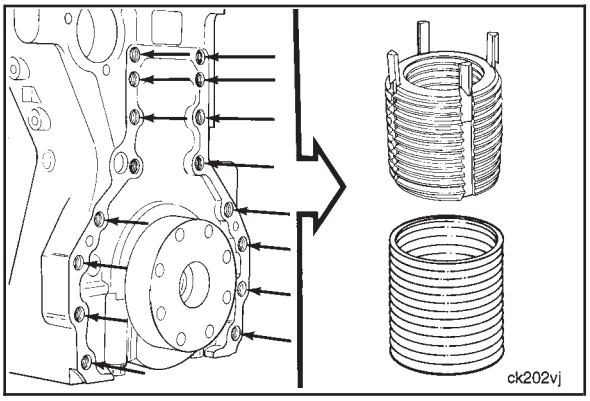
Repair Procedure

NOTE: Use only a coiled thread insert to repair the capscrew hole closest to the oil rifle. Other types of thread inserts require more space and **must not** be used in this location.

Remove the oil rifle cup plug when repairing the hole closest to the oil rifle.

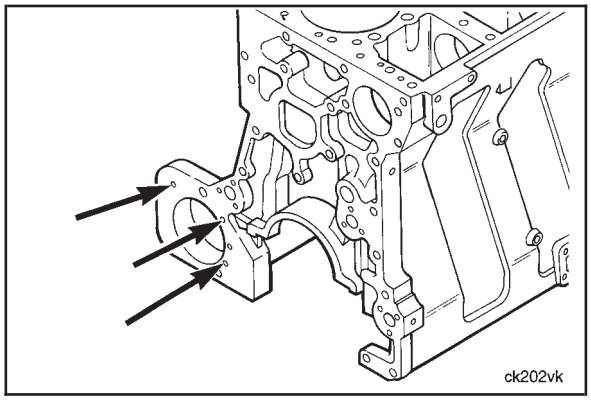
NOTE: Removing the cup plug is necessary to allow inspection to be sure the wall of the oil rifle is **not** pierced during the repair procedure.

Keylock or open end thread inserts can be used on the other flywheel housing mounting capscrew holes. Refer to Group 0 for thread insert installation procedures.



Specifications — Flywheel Housing Mounting Capscrew Thread Repair

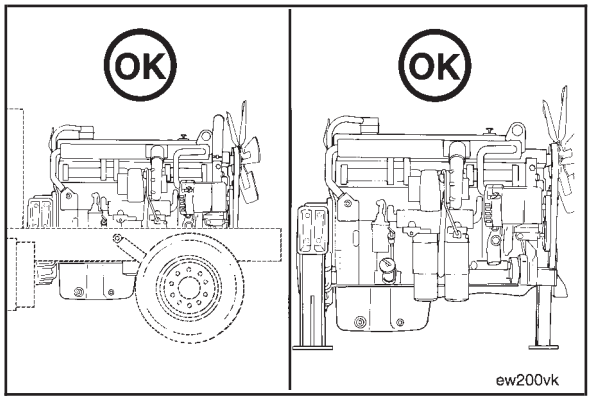
Thread Size M16 x 2.0		
mm		in
26.0	MIN	1.00
32.0	MAX	1.25



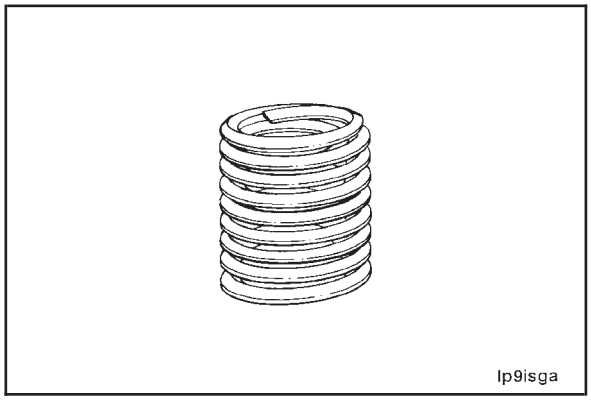
Lubricating Oil Pump Mounting Capscrew Thread Repair

General Information

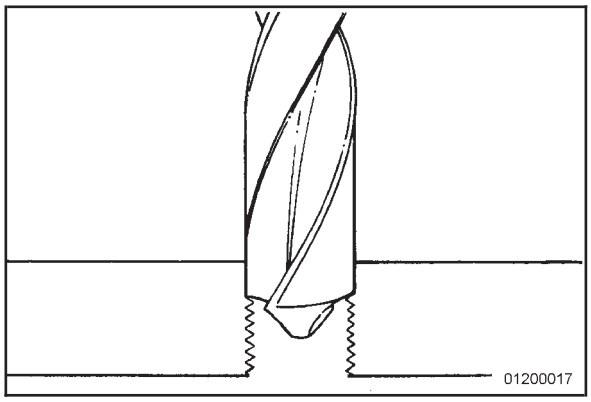
This repair procedure describes the method for repairing damaged lubricating oil pump mounting capscrew hole threads. Any number of the threads can be repaired.



This repair procedure can be performed with the engine either in or out of the chassis.



NOTE: Only coiled thread inserts can be used for this repair. Other types of thread inserts require removing too much material from the lubricating oil pump mounting flange and **cannot** be used in this location.



Repair Procedure

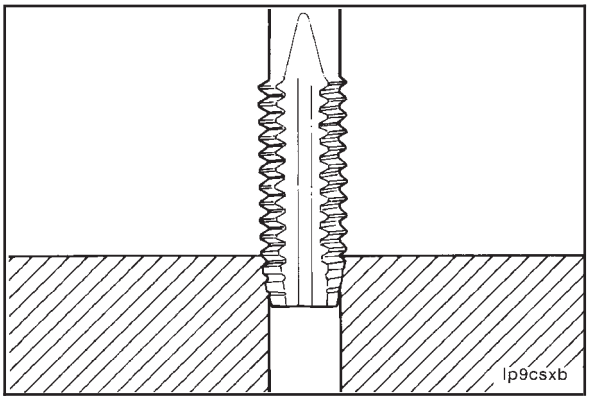
Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

Drill the capscrew hole using a cutting oil and an 8.4 mm [21/64 inch] drill bit.

Drill all the way through the lubricating oil pump mounting flange.

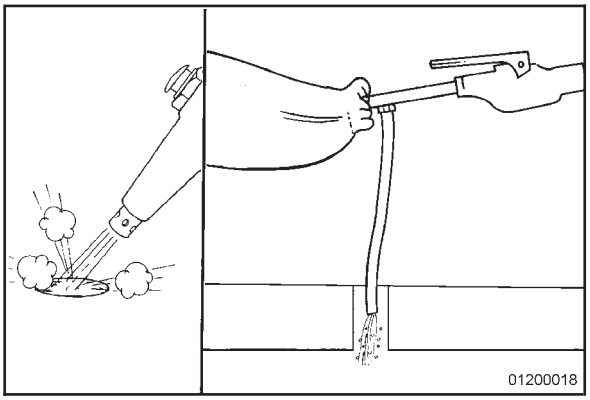
Use cutting oil and a special tap listed below to thread the capscrew hole.

- Perma-Thread Part No. — 5043-090CPS
- Helicoil Part No. — 2087-8



Caution: Do not use compressed air to clean the capscrew holes. Debris will be blown into the engine.

Use chip removal unit, Part No. ST-1272-11, to remove the debris from the capscrew hole.

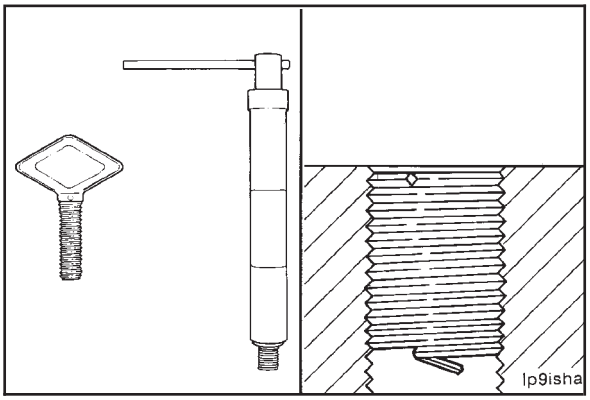


Use the coiled thread insert installation tool to install the insert.

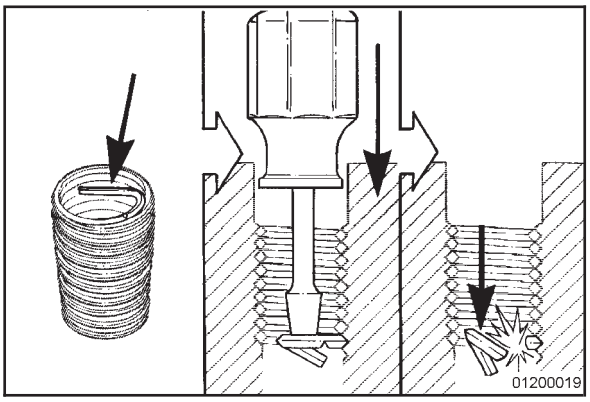
NOTE: The insert **must** be one-fourth to one-half of a thread below the lubricating oil pump mounting surface.

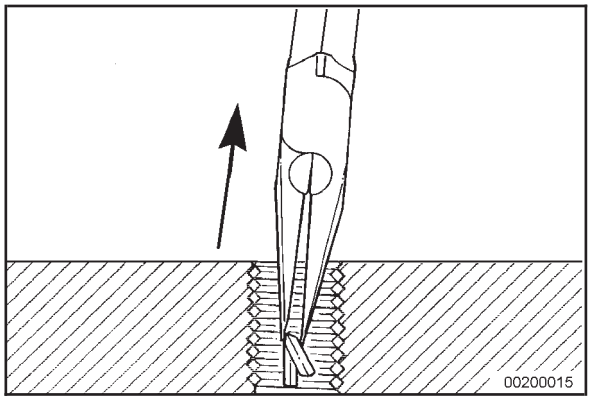
Use one of the following thread inserts:

- Perma-Thread Part No. — 206M-8C-0080
- Helicoil Part No. — 1084-8CN-0080

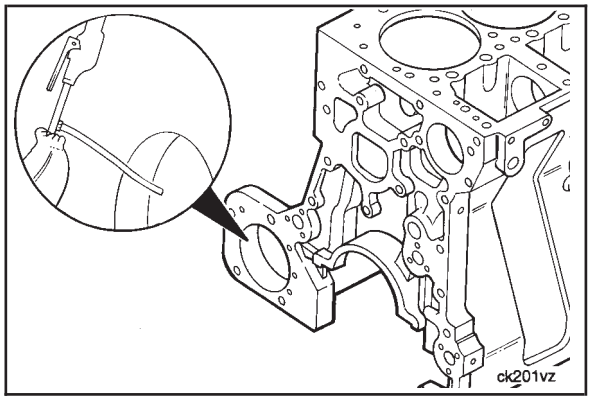


Use a screw driver or punch and a hammer to break the installation tang off of the insert.





Remove the broken off tang from the lubricating oil pump bore.



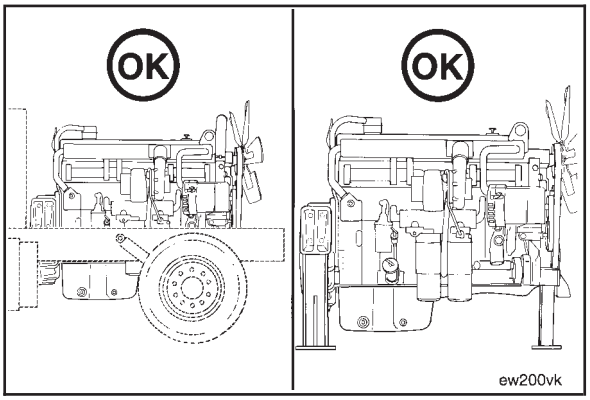
Clean the debris from the lubricating oil pump bore.

Cylinder Block Idler Shaft Ring Dowel Bore Repair

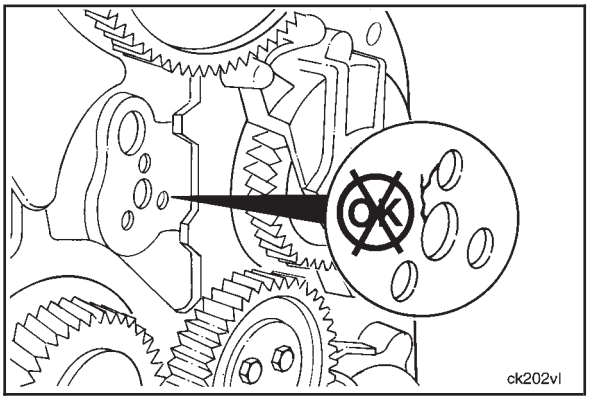
General Information

This procedure describes the method for repairing the idler shaft ring dowel bore(s) in the cylinder block. Idler shaft ring dowel bore repair consists of reaming the bore and installing an oversize ring dowel to locate the idler shaft.

This repair procedure can be performed with the engine either in or out of the chassis.



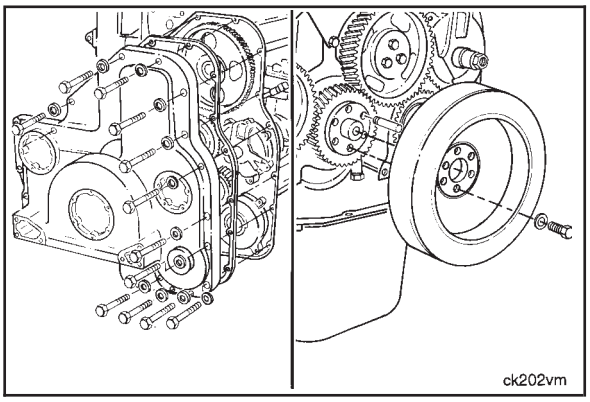
NOTE: This repair procedure **cannot** be used to repair cracks that extend from the ring dowel bore into the idler gear shaft mounting capscrew holes.

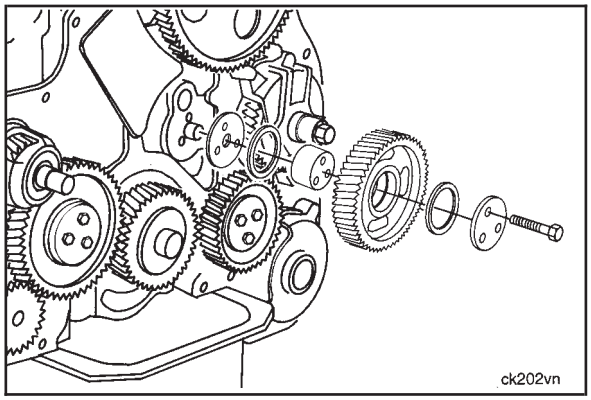


Repair Procedure

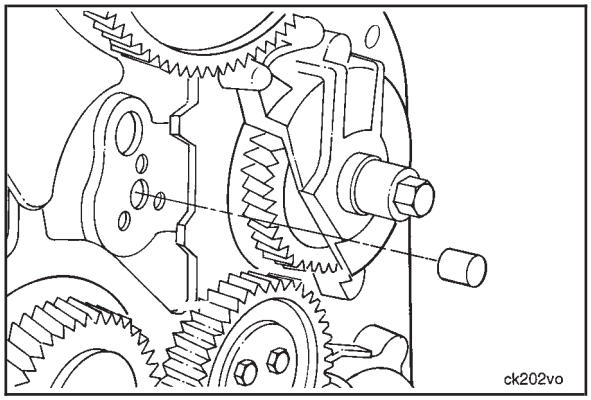
Remove the components and parts to gain access to the gear train of the engine. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.

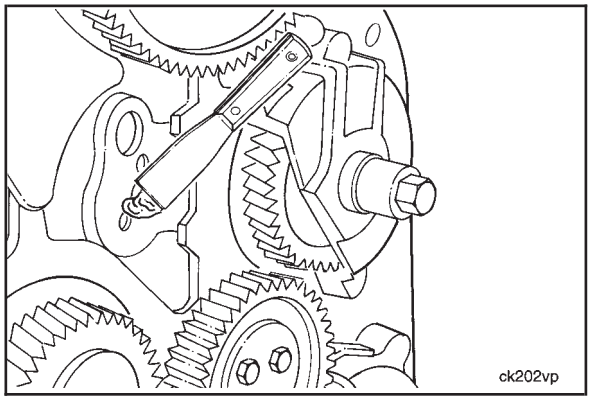




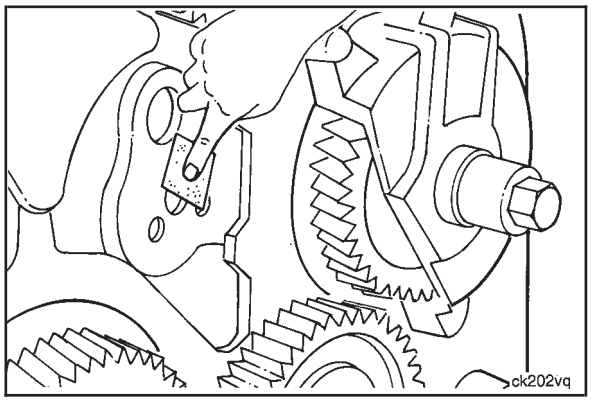
Remove the idler gear and shaft from the ring dowel bore to be repaired.



Use puller kit, Part No. 3375784, to remove the ring dowel.



Use thick bearing grease to plug the oil drilling inside the ring dowel bore.

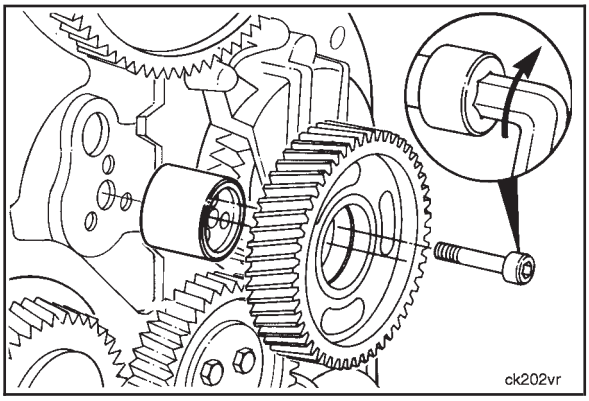


Use an Arkansas Hone or crocus cloth to remove burrs from the face of the cylinder block at the idler ring dowel bore.

NOTE: Do **not** allow debris to enter the oil passage in the ring dowel bore.

Install the reamer guide, Part No. 3823063, and idler gear using three capscrews, Part No. 3823071.

NOTE: Use the hex key wrench to snug tighten the capscrews. The reamer guide will be adjusted while measuring the idler gear backlash before final tightening.

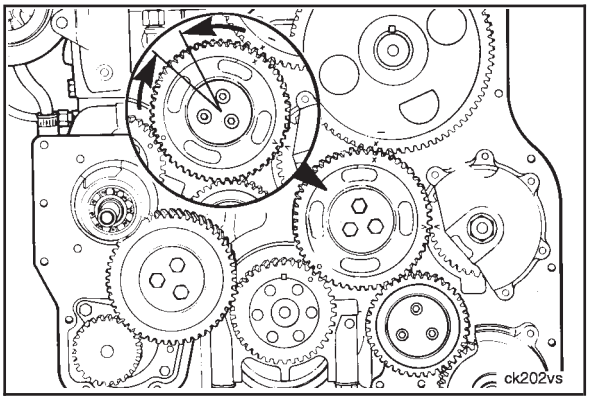


Use a dial indicator gauge with a magnetic base to measure the idler gear backlash.

Place the contact tip of the indicator gauge against a tooth on the idler gear.

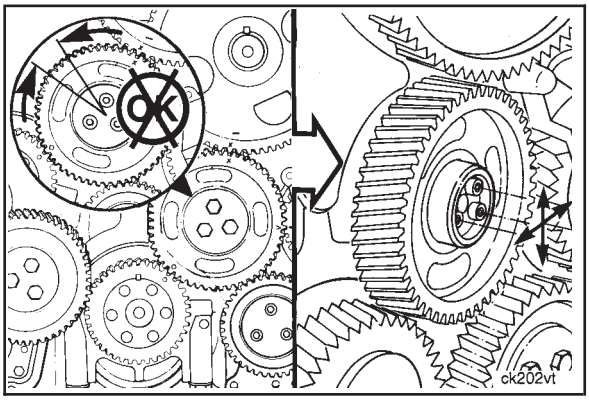
NOTE: Do **not** allow the mating gears to move while measuring the idler gear backlash.

Measure and record the amount of gear backlash between the idler gear and each mating gear.

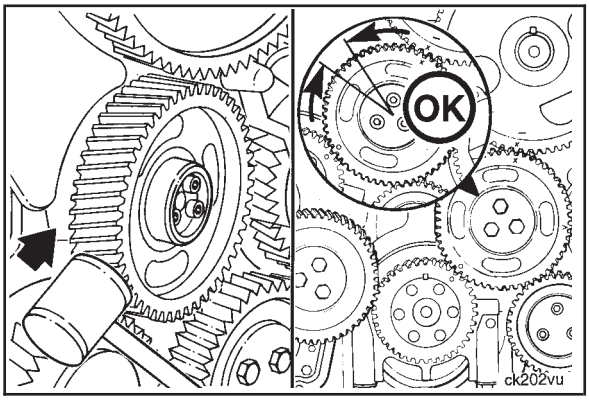


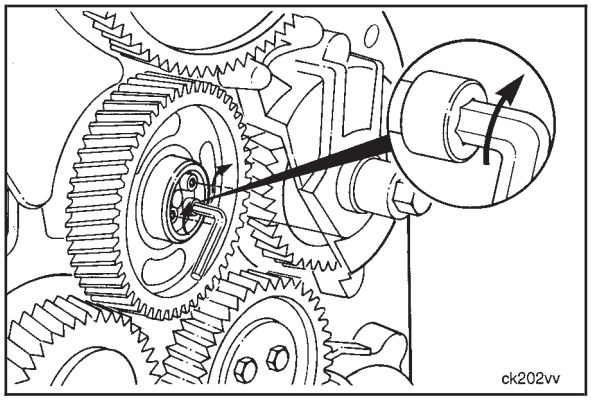
Idler Gear Backlash		
mm		**in**
0.08	MIN	0.003
0.38	MAX	0.015

NOTE: If the idler gear backlash for each mating gear is **not** within the limits specified, the reamer guide **must** be adjusted.

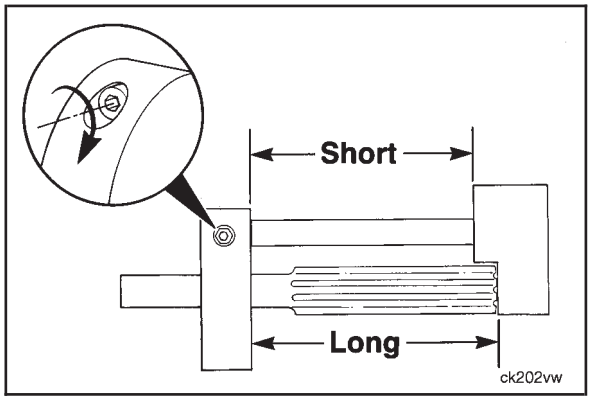


Adjust the reamer guide by tapping the idler gear with a soft hammer until the reamer guide has moved enough to provide the specified gear backlash between the idler gear and each mating gear.





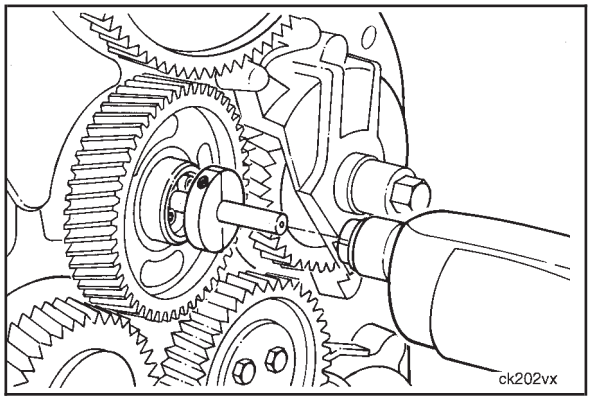
Use the hex key wrench to tighten the three capscrews.



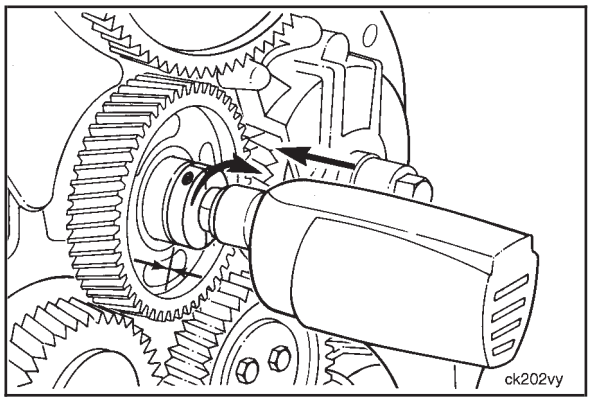
Use depth set gauge, Part No. 3823067, to set the depth stop collar, Part No. 3823068, on the rough reamer, Part No. 3823065.

Tighten the capscrew to secure the depth stop collar.

NOTE: When repairing the camshaft idler gear ring dowel bore, use the short side of the depth set gauge. The long side of the gauge **must** be used when repairing the hydraulic or lubricating oil pump idler ring dowel bores.



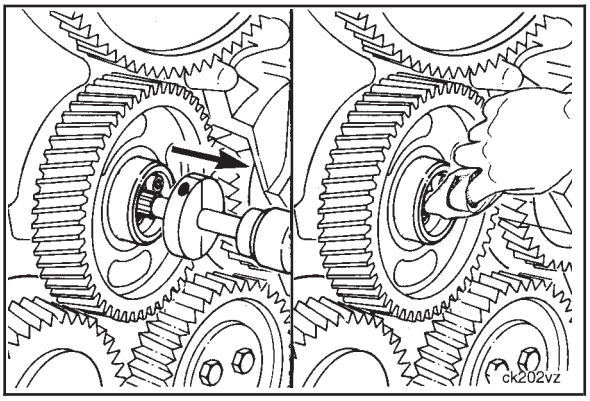
Install the rough reamer assembly in a heavy duty 3/4 inch 450 RPM drill motor.



Use cutting oil. Ream the idler shaft ring dowel bore until the depth stop collar contacts the reamer guide.

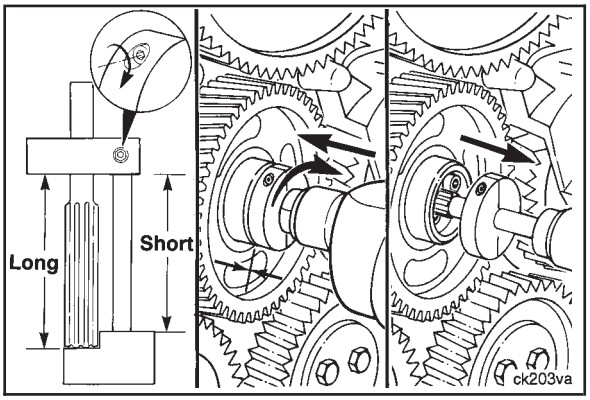
Remove the reamer assembly and wipe the debris from the bore. Do **not** allow any debris to enter the oil passage.

Remove the depth stop collar from the rough reamer.

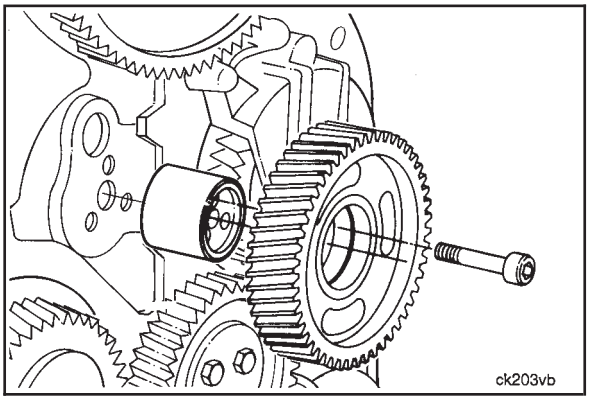


Install the depth stop collar on the finish reamer, Part No. 3823066. Use the depth set gauge to set the depth stop collar.

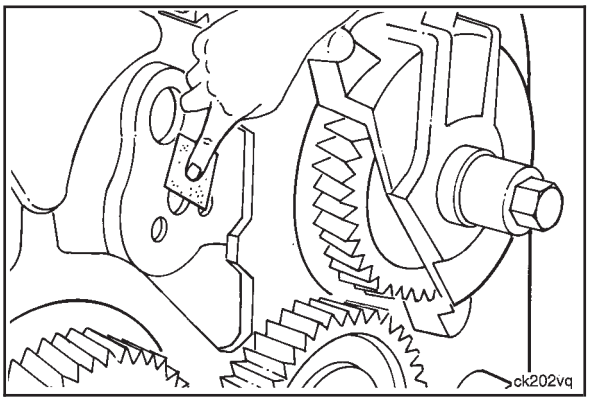
Install the finish reamer assembly in the drill motor. Use cutting oil. Ream the ring dowel bore until the depth stop collar contacts the reamer guide. Remove the reamer assembly.

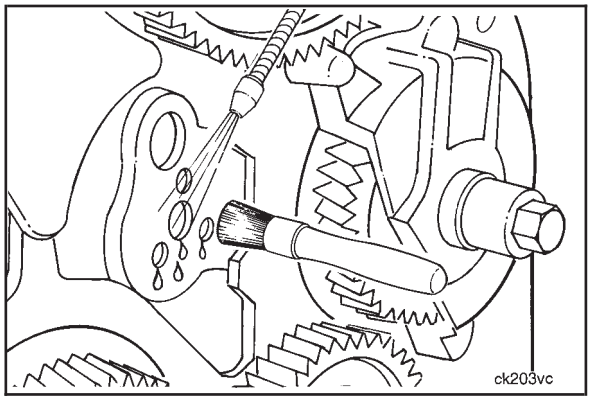


Remove the reamer guide and the idler gear.

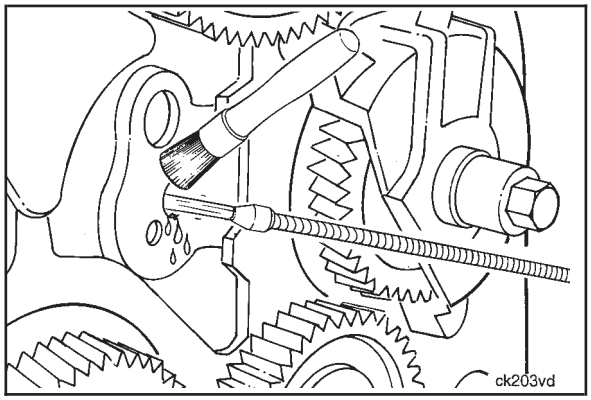


Use an Arkansas Hone or crocus cloth to remove burrs and sharp edges from the ring dowel bore.

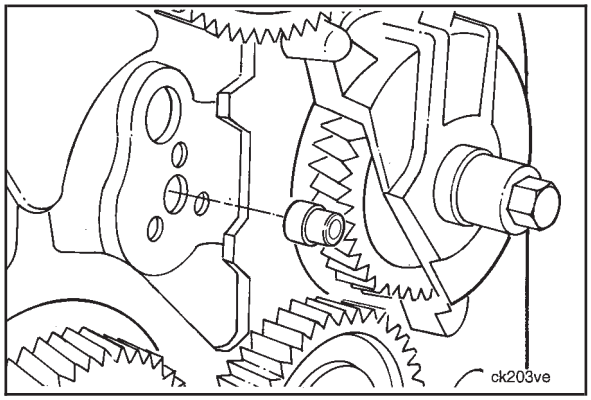




Thoroughly clean the face of the cylinder block. Remove all chips and debris from the ring dowel bore.



Clean the grease from the ring dowel bore and oil drilling.

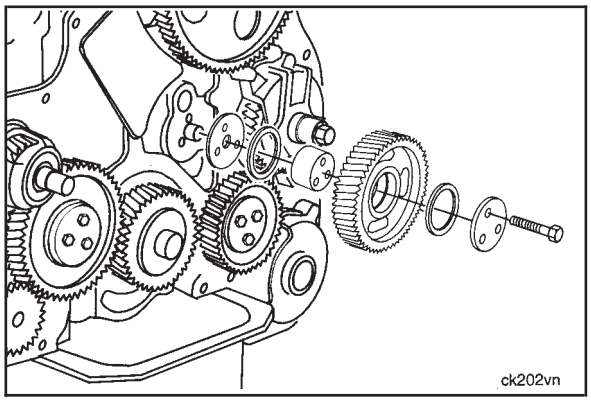


NOTE: The larger outside diameter of the new ring dowel **must** go into the bore in the cylinder block.

Use a soft hammer to drive the new ring dowel into the ring dowel bore until the larger outside diameter of the ring dowel is flush with the cylinder block.

Use ring dowel, Part No. 3823070, in the hydraulic or lubricating oil pump idler shaft bores.

Use ring dowel, Part No. 3823069, in the camshaft idler shaft bore.



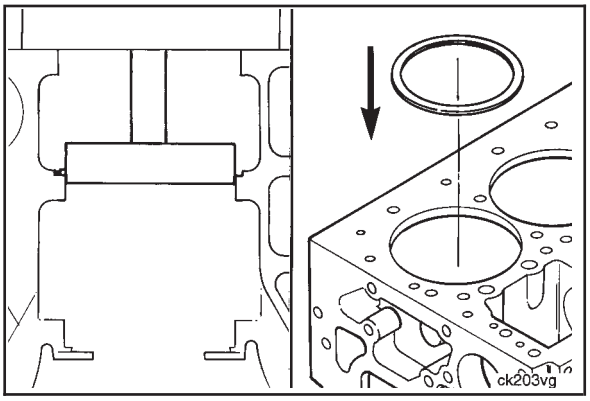
Install the idler shaft and idler gear assembly. Assemble the engine. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.

Cylinder Liner Counterbore Machining (Manual Cutting Tool)

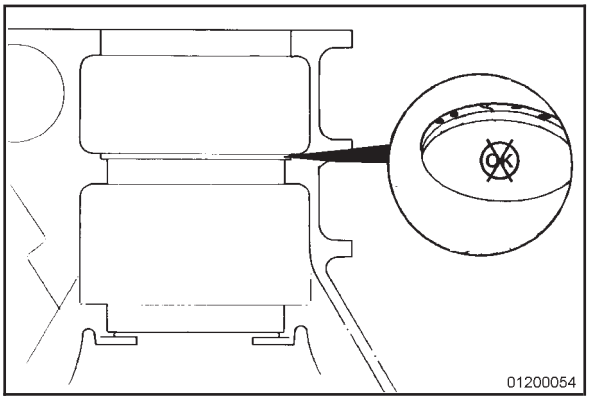
General Information

This repair procedure describes the method for machining the cylinder liner counterbore ledge using counterbore ledge cutter, Part No. 3823558. This tool is normally used to do light cleanup cuts.

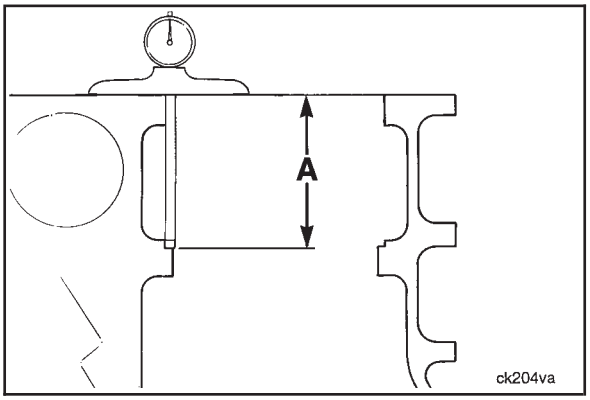


Visually inspect the counterbore seating area for pits or damage. If damage is seen, the counterbore **must** be cut to remove the pits or damage.

NOTE: The maximum cut depth recommended by Cummins Engine Company, Inc. is 3.8 mm [0.125 in].

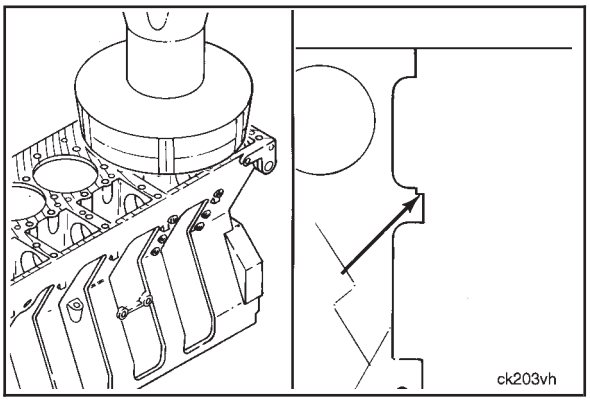


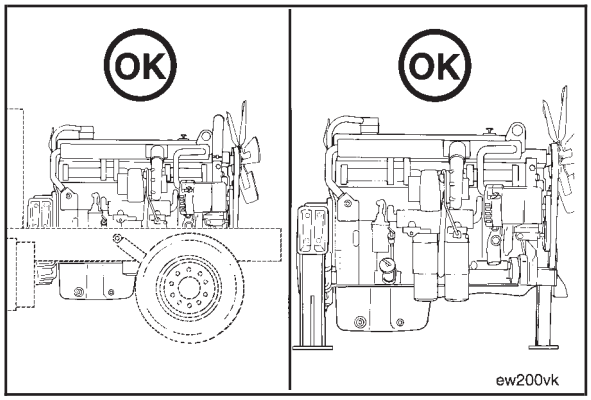
The maximum counterbore depth dimension ″A″ after any counterbore cut is 103.17 mm [4.062 in].



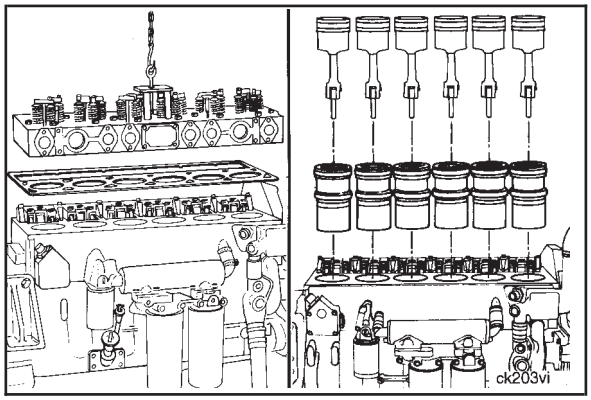
This repair is required for one of the following reasons:

- The cylinder block has been resurfaced.
- Fretting or wear is present on the cylinder liner counterbore ledge.





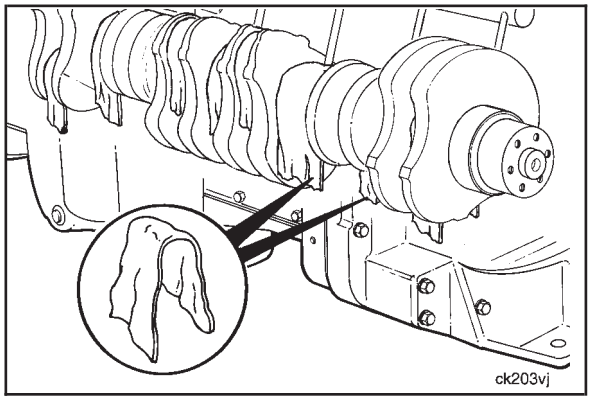
This repair procedure can be performed with the engine either in or out of the chassis.



Repair Procedure

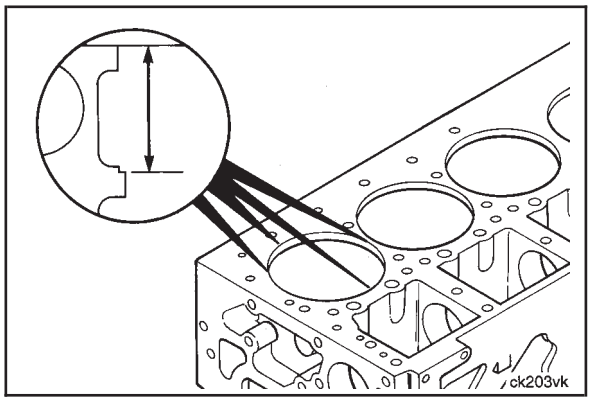
Remove the cylinder head, piston, and cylinder liner from the cylinder to have the counterbore ledge machined. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



If this procedure is to be performed with the engine in the chassis, use a shop towel to cover the crankshaft journal to prevent machining debris from entering the oil hole.

Cover the top deck of the cylinder block to prevent dirt and debris from entering the block.



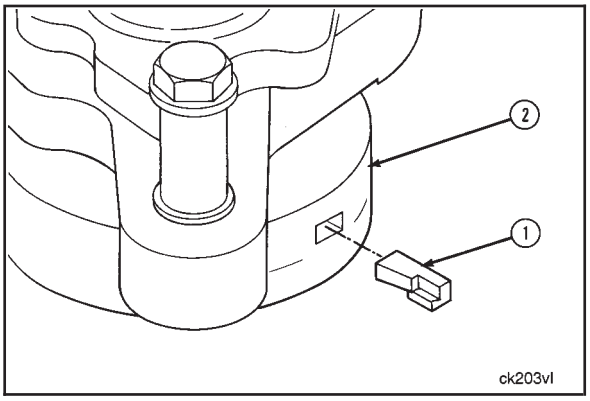
Measure the counterbore ledge depth in four places 90 degrees apart.

Record the location and depth of each measurement. The difference between the highest and lowest measurement is the amount that **must** be removed for cleanup. Combinations of shims can be used to obtain the desired liner protrusion after machining the counterbore ledge.

NOTE: The maximum cut depth recommended by Cummins Engine Company, Inc. is 3.8 mm [0.125 inch].

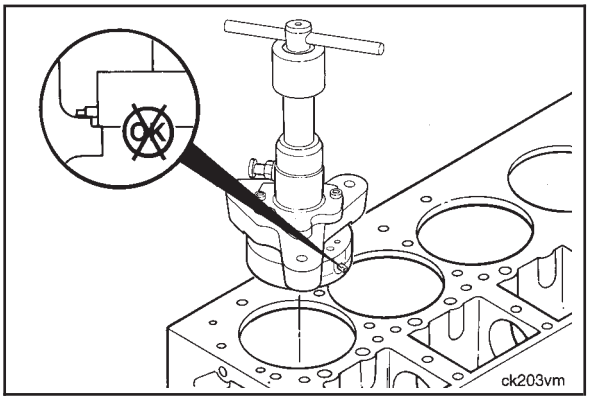
Install the tool bit (1) in the cutter plate (2).

NOTE: The tool bit **must** be installed so the cutting edge is on the lower right hand side when looking at the tool bit from centerline of the cutter plate.

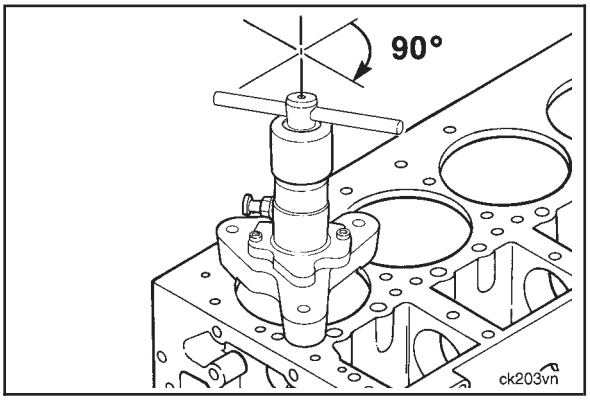


Install the tool and lower the cutter plate slowly until it rests on the counter bore ledge.

NOTE: The tool bit **must not** protrude from the outside diameter of the cutter plate.



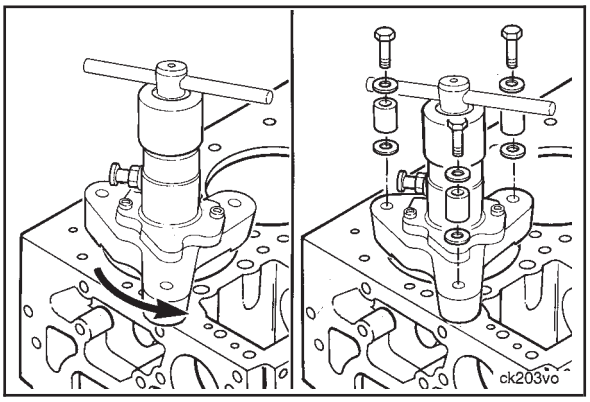
Slowly rotate the handle approximately 90 degrees to center the tool on the counterbore ledge.

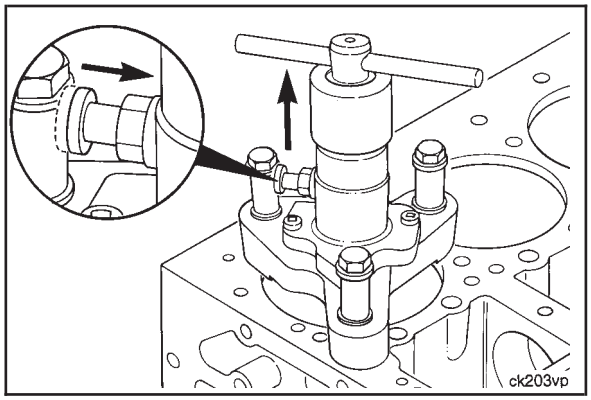


Rotate the adapter plate until the mounting holes align with the cylinder head capscrew holes.

Install three short cylinder head capscrews, spacers and washers.

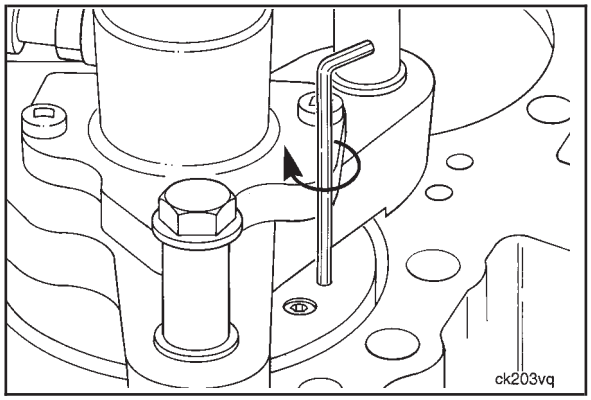
Torque Value: Step 1 - 35 N•m [25 ft-lb]
2 - 65 N•m [50 ft-lb]



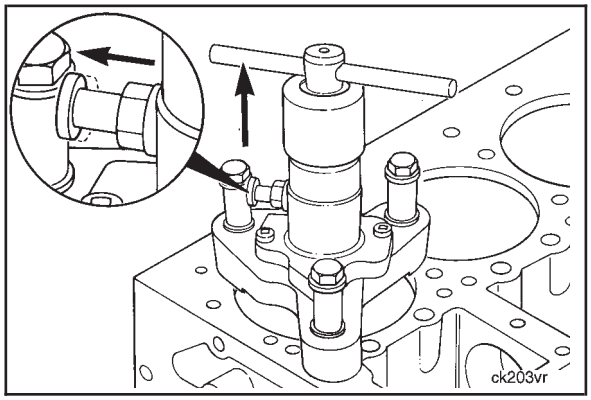


Caution: Be sure the detent plunger is engaged before releasing the handle. If the cutter plate falls quickly, damage to the cylinder block or tool can result.

Use the handle and lift the cutter plate until the detent plunger clicks.

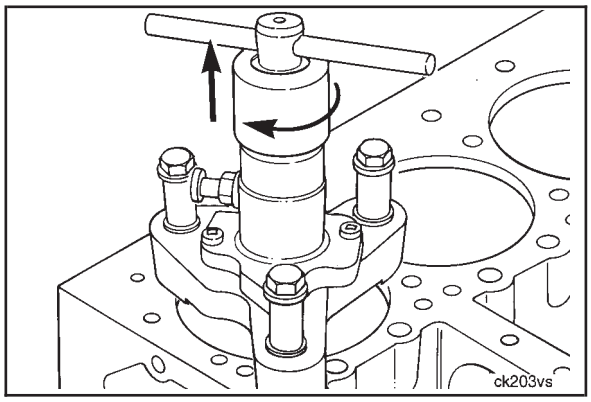


Use the 4.0 mm [5/32 inch] allen wrench supplied with the kit and turn the tool bit adjustment screw until the tool bit protrudes from the cutter plate.



Pull the detent pin out and lower the cutter plate until the tool bit rests on the counterbore ledge.

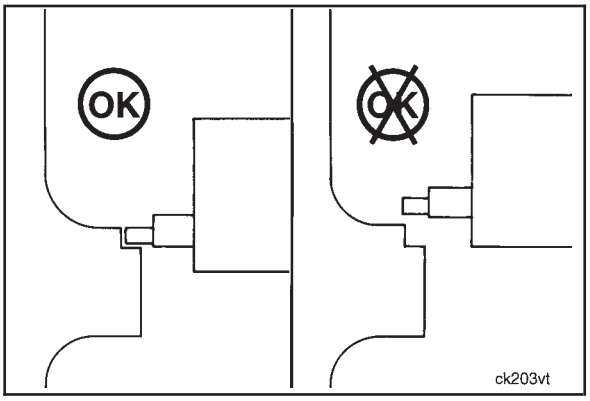
NOTE: Prevent the cutter plate from falling quickly by applying upward force to the tool handle.



Apply just enough upward pressure on the handle to remove pressure from the tool kit.

Screw the stop collar down so it will support the weight of the cutter plate.

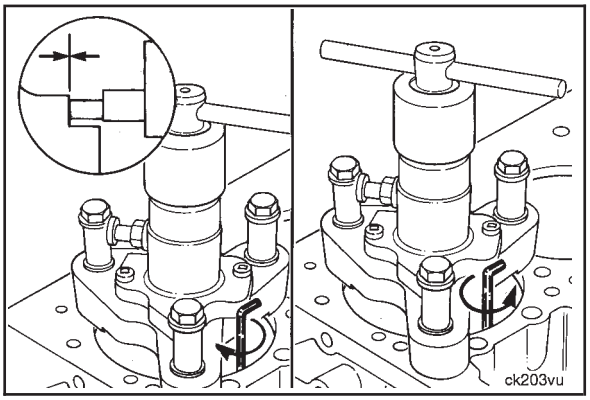
NOTE: Do **not** raise the cutter plate enough to allow the tool bit to be above the small shoulder located above the counterbore ledge.



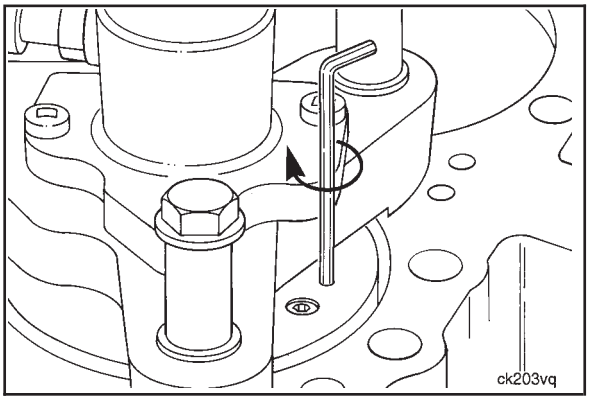
Turn the tool bit adjustment screw until the tool bit contacts the outer wall of the counterbore ledge.

Back the screw off slightly to relieve any pressure between the outer wall and the tool bit.

NOTE: The gap between the tool bit and outer wall **must** be 0.00 to 0.025 mm [0.000 to 0.010 inch].

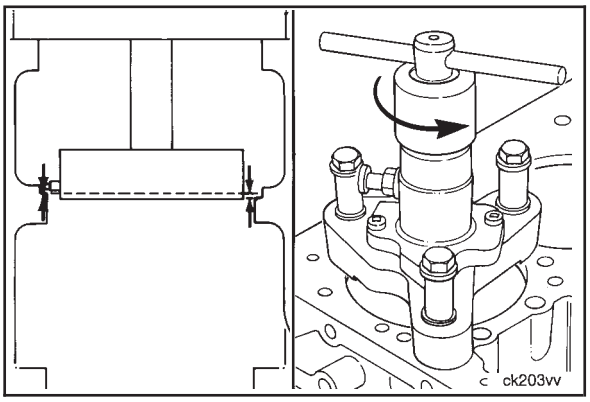


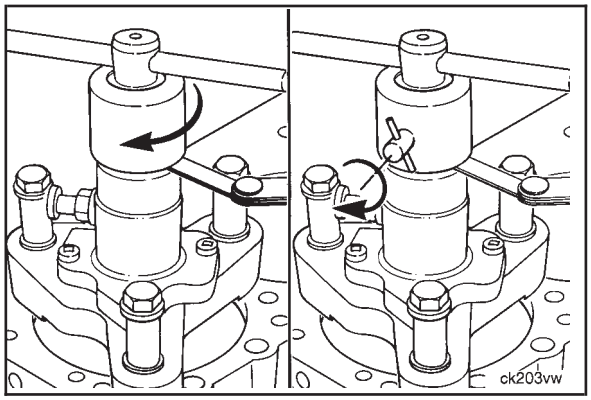
Tighten the set screw to lock the tool bit in place.



Locate the tool bit above the shallow portion of the counterbore ledge in the cylinder liner bore.

Loosen the stop collar until the tool bit rests on the counterbore ledge.



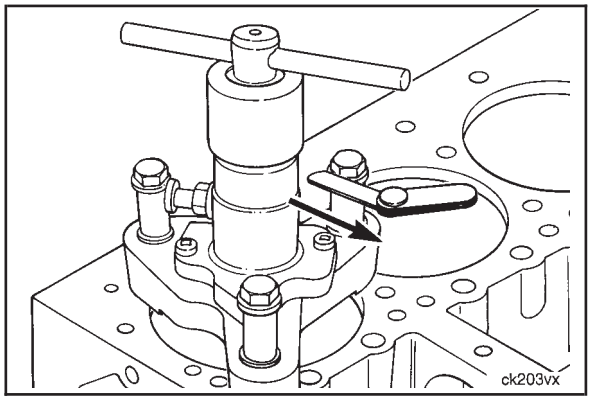


Install 0.08 mm [0.003 inch] feeler gauge under the stop collar.

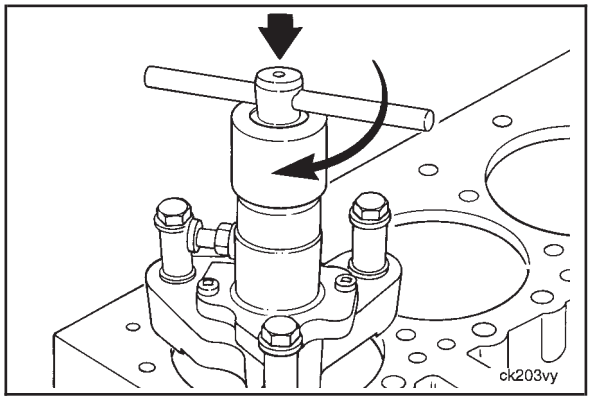
Tighten the stop collar until drag exists between the feeler gauge and stop collar.

Tighten the collar screw.

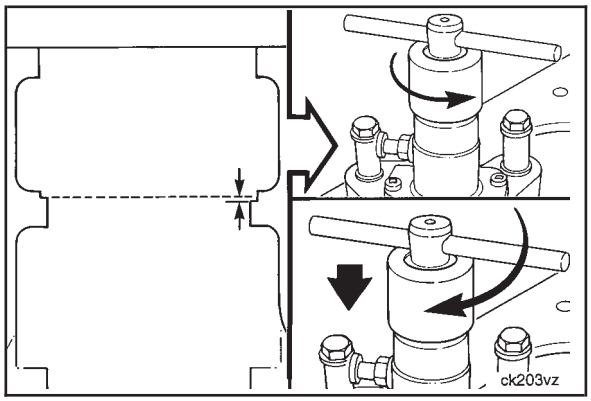
NOTE: If less than 0.08 mm [0.003 inch] is needed to clean up the ledge, use the appropriate feeler gauge.



Remove the feeler gauge.



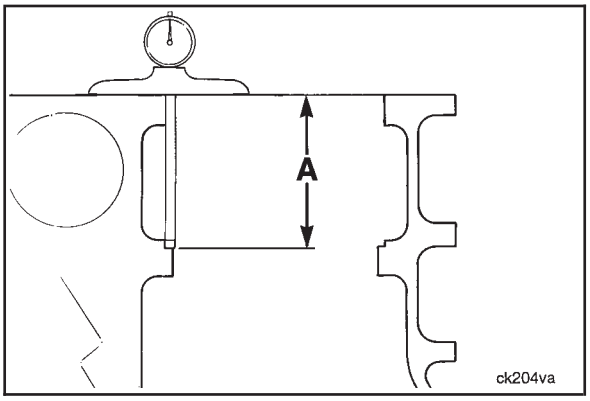
Apply downward pressure on the tool handle and rotate the handle until no more metal is being removed from the counterbore ledge.



If 0.08 mm [0.003 inch] was **not** enough to clean up the ledge, repeat the cutting procedure until the counterbore depth is equal at all locations.

Remove the cutting tool.

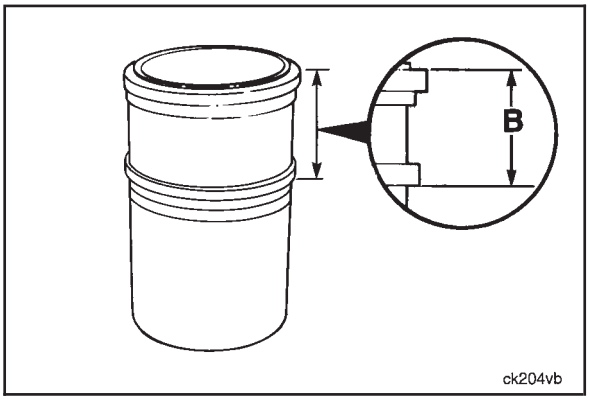
Measure and record the counterbore depth. This is dimension "A".



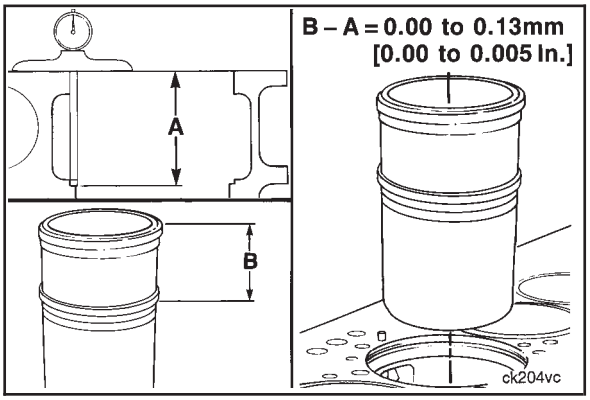
Obtain the cylinder liner to be installed and measure the distance from the flange to the top of the liner.

Flange to Top of Cylinder Liner-Height-Dimension "B"

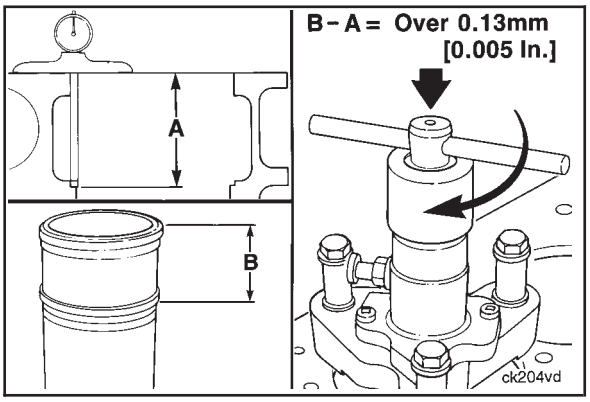
mm		in
100.00	MIN	3.937
100.05	MAX	3.939

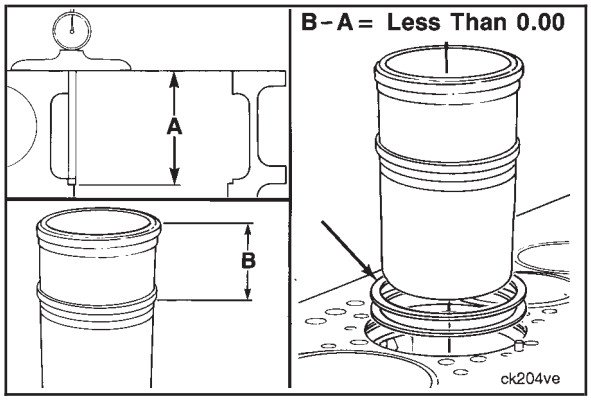


If dimension 'B' minus dimension 'A' is 0.00 to 0.13 mm [0.000 to 0.005 inch], install the cylinder liner in the cylinder block.

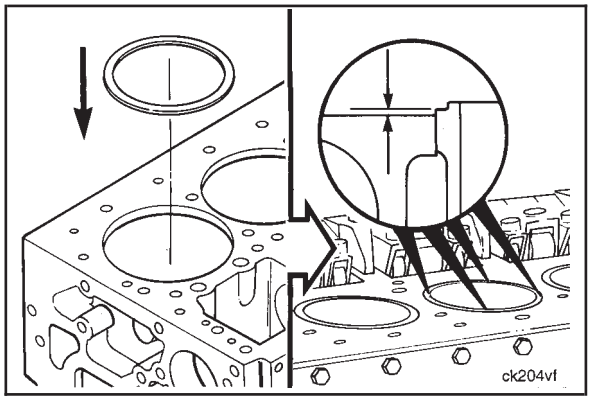


If dimension 'B' minus dimension 'A' is more than 0.13 mm [0.005 inch], the counterbore is **not** deep enough. Repeat the procedure until dimension 'B' minus dimension 'A' is 0.00 to 0.13 mm [0.000 to 0.005 inch].

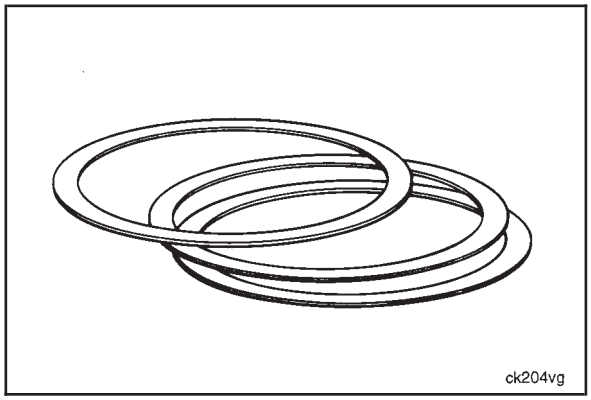




If dimension 'A' is more than dimension 'B', the cylinder liner **must** be shimmed.



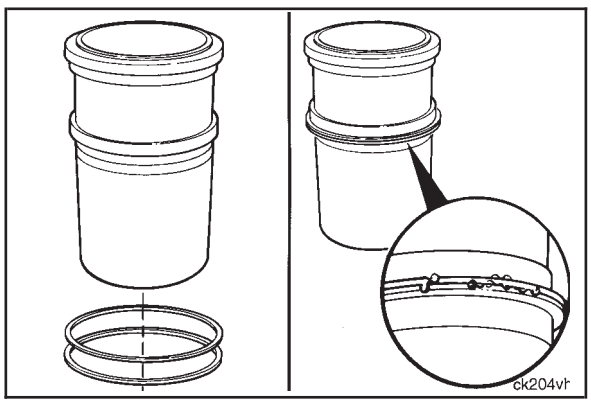
Calculate the shim height required to obtain 0.00 to 0.13 mm [0.000 to 0.005 inch] cylinder liner protrusion.



Select the shims necessary to obtain this height.

NOTE: Shims are available in the following thicknesses. Any combination of shims can be used.

Part No.	mm	inch
3032623	0.127	0.005
3034663	0.203	0.008
3899556	0.508	0.020
3899557	0.762	0.030
3899558	1.106	0.040
3899559	1.270	0.050

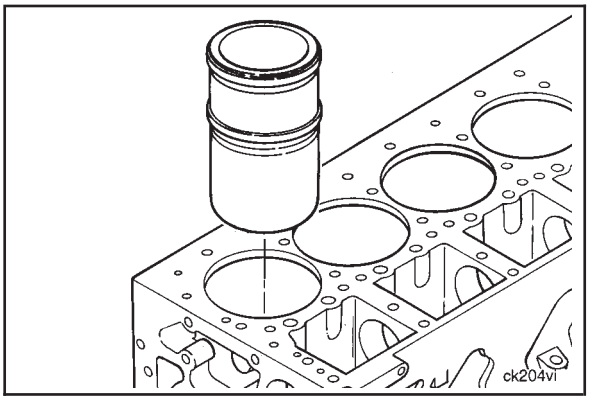


Install the shims on the cylinder liner.

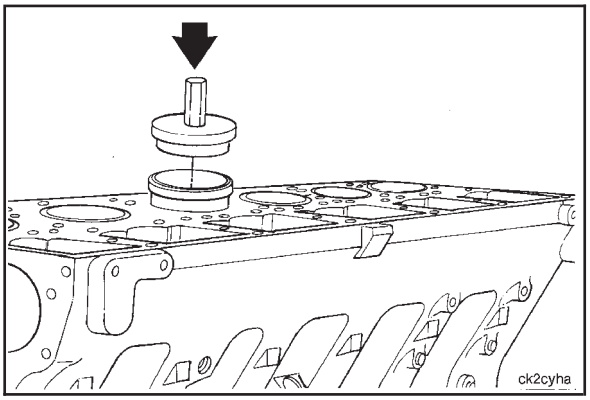
NOTE: The shims **must** be centered on the liner flange. A thick grease can be used to hold the shims in place.

Install the cylinder liner in the cylinder block.

NOTE: If the liner has been shimmed, be very careful **not** to disturb the shims.

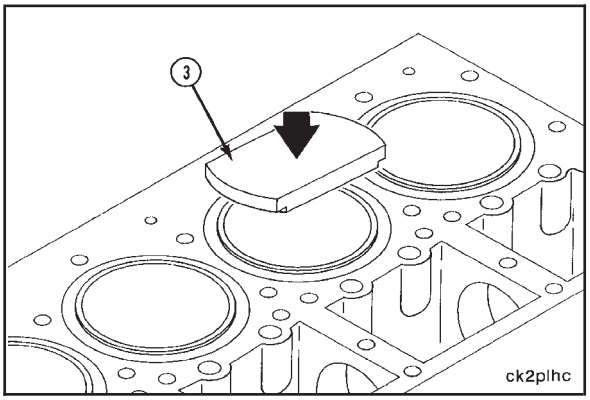


Use cylinder liner driver, Part No. 3376056, to drive the cylinder liner into the cylinder block.

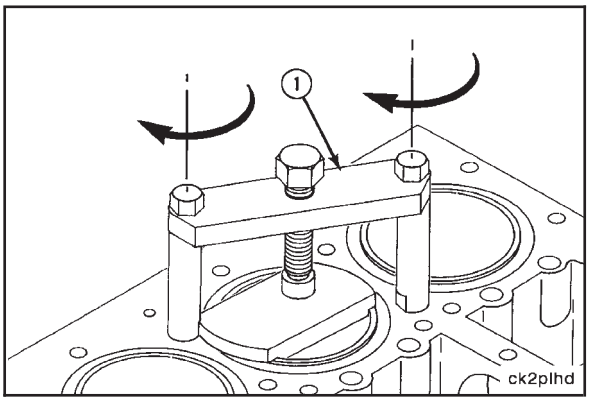


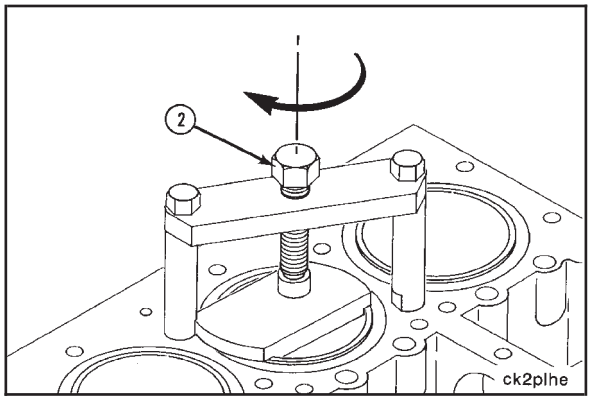
Use the cylinder liner clamping tool, Part No. 3824272, to seat the liner in the cylinder block bore.

Place the force plate (3) across the top of the liner with the step inside the liner bore.



Put the installation tool bridge (1) across the liner and install the two cylinder head capscrews finger tight to hold the bridge down. Rotate the force plate until the areas where the protrusion measurements will be taken are exposed.



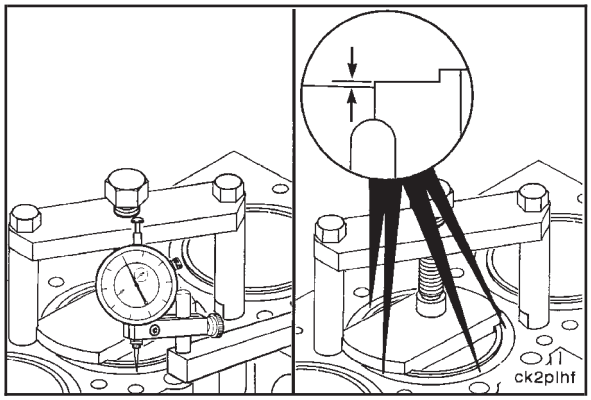


Caution: Do not use an impact wrench to tighten the liner force plate screw. Excessive torque will cause damage to the liner installation tool.

Tighten the forcing screw (2).

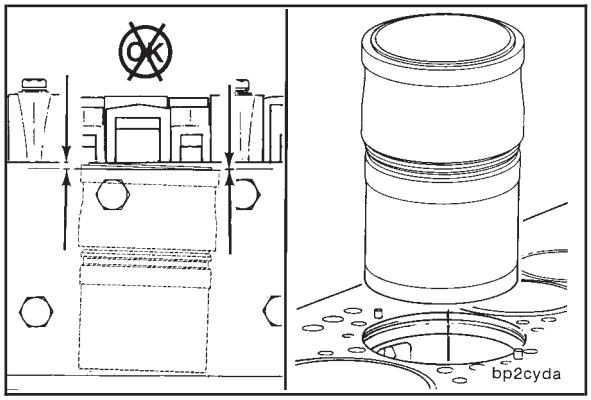
Torque Value: 136 N•m [100 ft-lb]

Check for the correct protrusion.

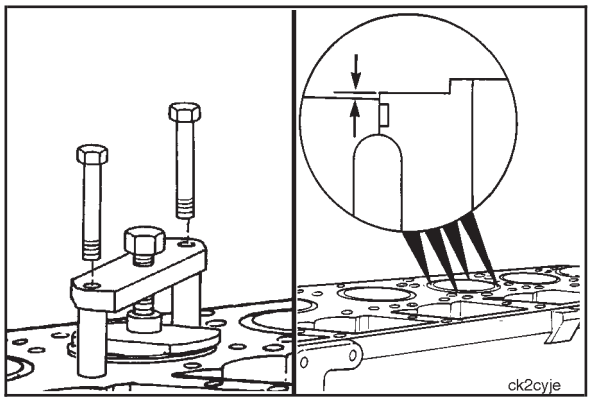


Measure the cylinder liner protrusion at four points 90 degrees apart.

Cylinder Liner Protrusion		
mm		in
0.00	MIN	0.000
0.13	MAX	0.005

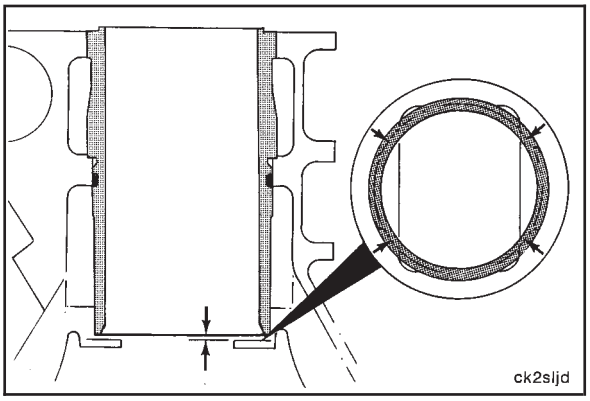


NOTE: If the liner protrusion varies more than 0.03 mm [0.001 inch] for 180 degrees, remove the cylinder liner and check for debris or damaged shims.

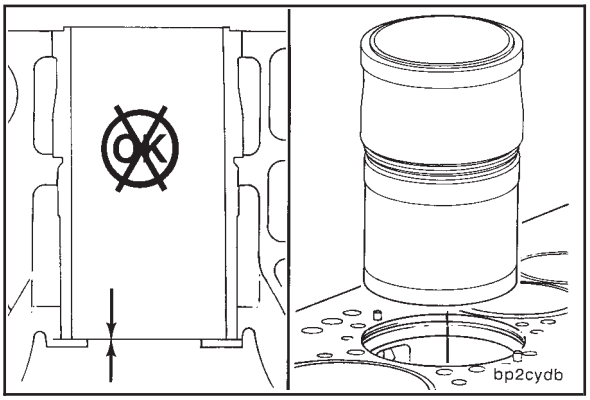


Repeat the procedure until the liner protrusion is within specifications.

Use a feeler gauge to measure the cylinder liner to cylinder block clearance at the four block casting points. The clearance **must** be a minimum of 0.25 mm [0.010 inch].

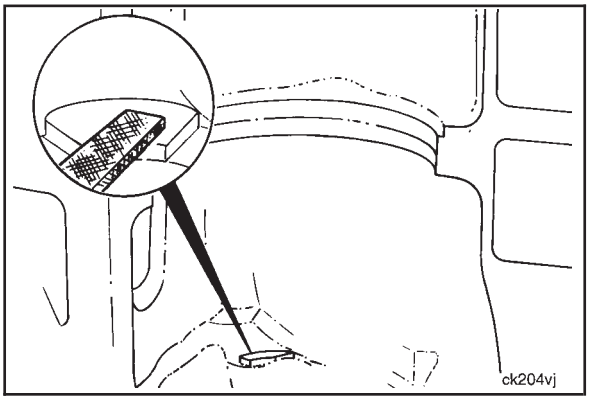


If the clearance is less than 0.25 mm [0.010 inch], remove the liner.

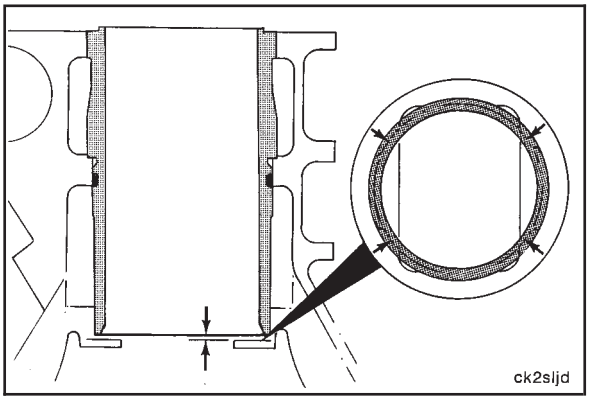


Use a file or grinding wheel to remove metal from the four cylinder block casting points.

NOTE: Care **must** be taken to remove only enough material to obtain clearance.



Install the cylinder liner and measure the liner protrusion and the liner to cylinder block casting point clearance again.



Specifications — Cylinder Liner Counterbore Machining

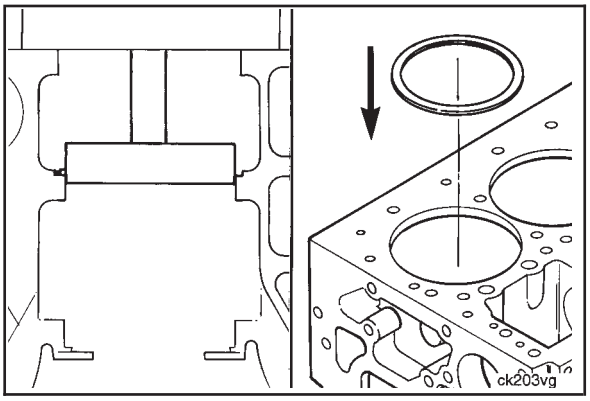
Measurement	mm		Inch
Original counterbore depth	99.930	MIN	3.9343
	100.000	MAX	3.9370
Cylinder Liner Height — Flange to Top Surface	100.000	MIN	3.9370
	100.050	MAX	3.9390
Cylinder Liner Protrusion	0.00	MIN	0.000
	0.13	MAX	0.005

Liner Shims		
Part No.	**Description**	**Thickness**
3032623	Shim, Liner (Existing)	0.127 mm [0.005 inch]
3034663	Shim, Liner (Existing)	0.203 mm [0.008 inch]
3899556	Shim, Liner (New)	0.508 mm [0.020 inch]
3899557	Shim, Liner (New)	0.762 mm [0.030 inch]
3899558	Shim, Liner (New)	1.106 mm [0.040 inch]
3899559	Shim, Liner (New)	1.270 mm [0.050 inch]

Cylinder Liner Counterbore Machining (Electric Cutting Tool)

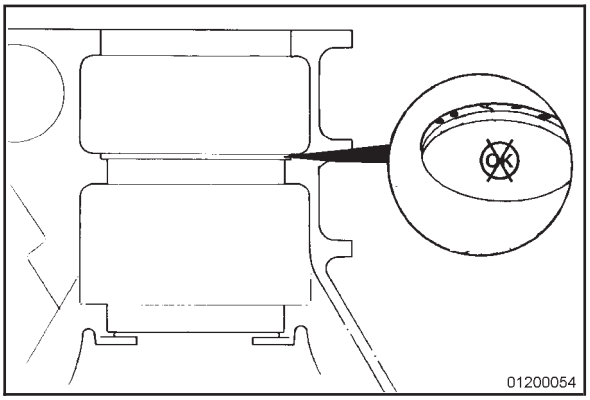
General Information

This repair procedure describes the method for machining the cylinder liner counterbore ledge using counterbore cutter kit, Part No. 3824789 and the basic machine, Part No. 3823352, which is a part of counterbore tool kit, Part No. 3823325.

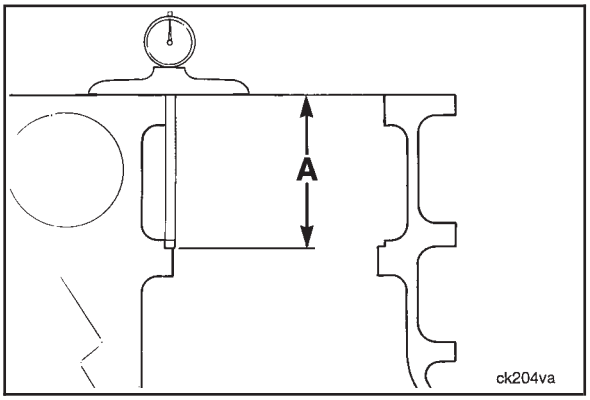


Visually inspect the counterbore seating area for pits or damage. If damage is seen, the counterbore **must** be cut to remove the pits or damage.

NOTE: The maximum cut depth recommended by Cummins Engine Company, Inc. is 3.8 mm [0.125 in].

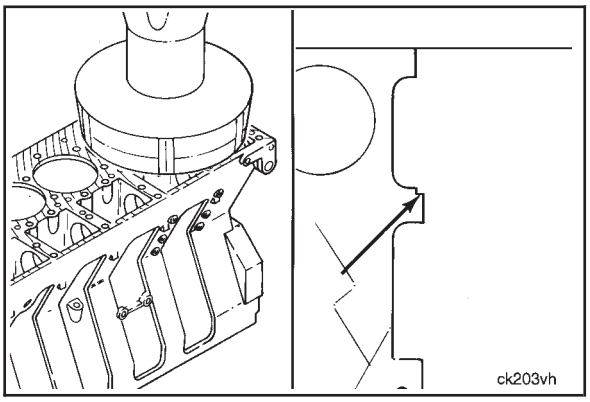


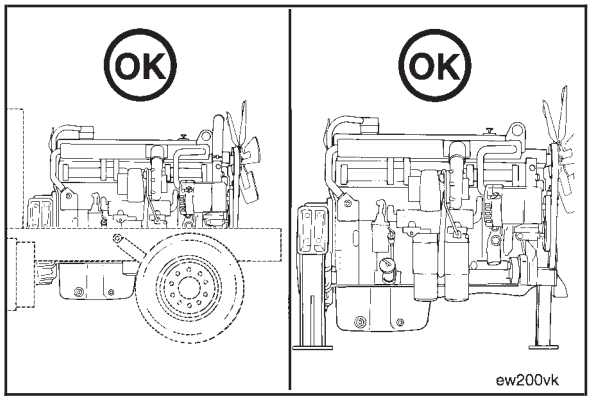
The maximum counterbore depth dimension ″A″ after any counterbore cut is 103.17 mm [4.062 in].



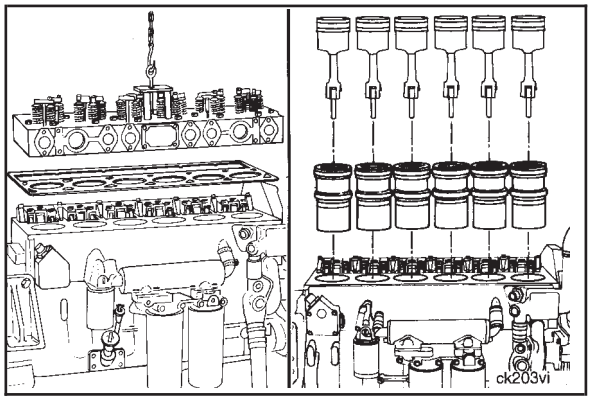
This repair is required for one of the following reasons:

- The cylinder block has been resurfaced,
- Fretting or wear is present on the cylinder liner counterbore ledge.





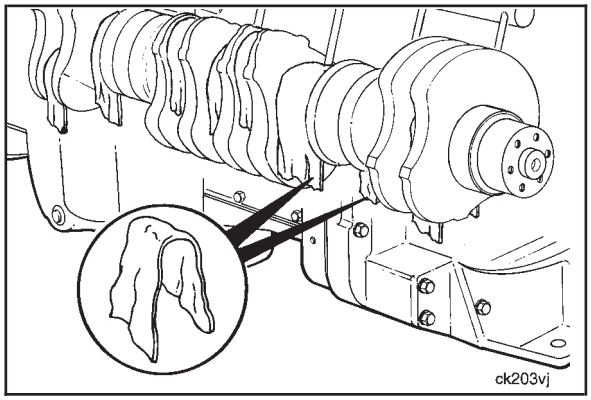
This repair procedure can be performed with the engine either in or out of the chassis.



Repair Procedure

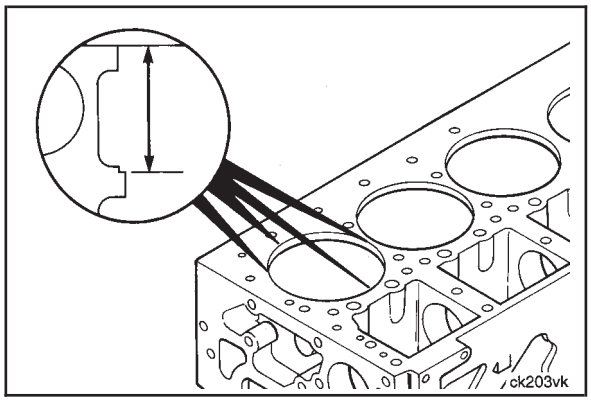
Remove the cylinder head, piston, and cylinder liner from the cylinder to have the counterbore ledge machined. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 Engines,
- Bulletin No. 3810476 — External Damper L10 Engines
- Bulletin No. 3666075 — M11 Engines



If this procedure is to be performed with the engine in the chassis, use a shop towel to cover the crankshaft journal to prevent machining debris from entering the oil hole.

Cover the top deck of the cylinder block to prevent dirt and debris from entering the block.



Measure the counterbore ledge depth in four places 90 degrees apart.

Using a depth vernier, measure the pit depth in the visually deepest area. Record the location and depth of each measurement.

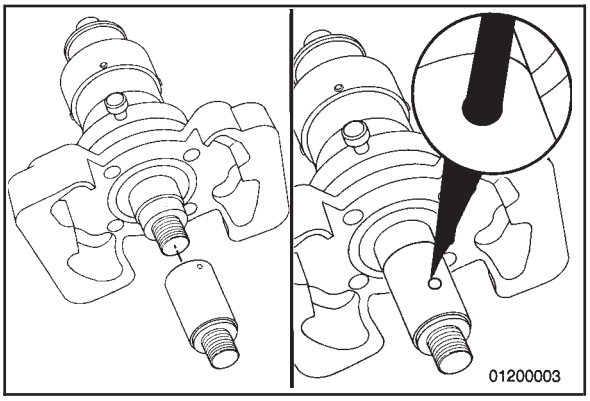
The difference between the highest and lowest measurement is the amount that **must** be removed for cleanup. Combinations of shims can be used to obtain the desired liner protrusion after machining the counterbore ledge.

NOTE: The maximum cut depth recommended by Cummins Engine Company, Inc. is 3.18 mm [0.125 inch].

Tool Preparation

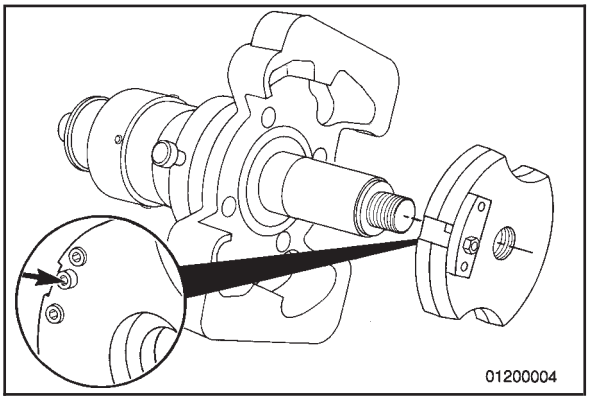
Install extension, Part No. 3824790, on the shaft of drive unit, Part No. 3823352.

Insert a rod in the 1/2 inch diameter hole in the side of the extension. Tighten the extension onto the drive unit with the rod.



NOTE: Be sure the cutter bit adjusting screw (reference the bubble in the accompanying graphic) is facing the towards the drive unit.

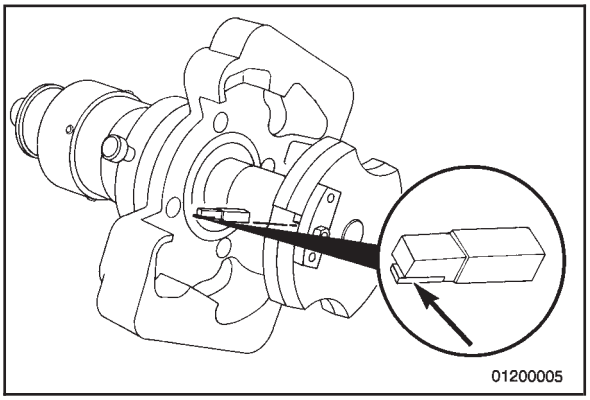
Install the cutter plate, Part No. 3823569, onto the extension. Tighten the cutter plate to the extension by hand.



Caution: Position the cutter bit completely into the plate during drive unit installation to prevent damage to the cutting tool edge.

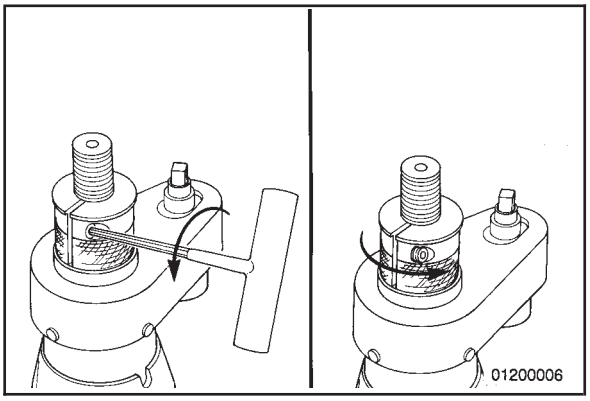
Install the cutter bit, Part No. 3823570, into the cutter plate. Turn the cutter bit positioning screw **counterclockwise** to **install** the bit.

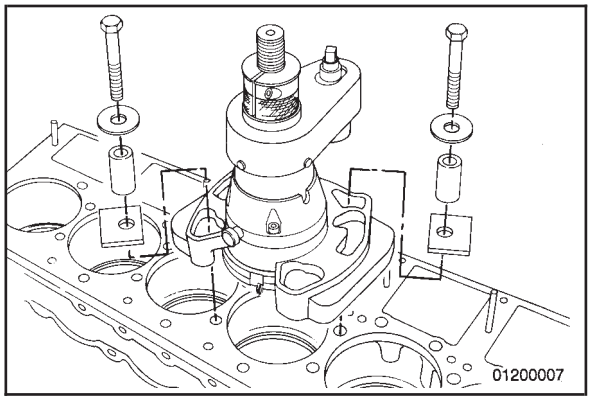
NOTE: Do **not** use any type of lubricant to install the bit. The bit movement is accomplished by means of an o-ring and the adjusting screw. If lubricant is used, the o-ring will **not** make the needed contact to move the cutter bit in and out of the cutter plate.



Loosen the set screw on the stop-ring of the drive unit.

Turn the stop-ring **counterclockwise** several turns to raise the cutter plate for correct tool installation into the cylinder block bore.





Tool Installation

Set the counterbore machining tool on the top of the cylinder block bore to be machined.

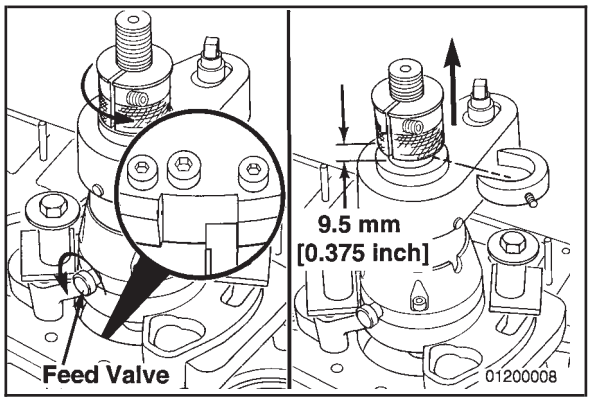
Lower the cutter plate all the way down into the bore. Shift the assembly from side to side to center the tool in the bore.

Install the two capscrews, spacers, and washers.

NOTE: Be sure to keep the drive unit square on the cylinder block so the cutter bit adjusting screw can be accessed. Cylinder head mounting capscrews can be used to secure the drive unit.

Alternately and evenly torque the mounting screws.

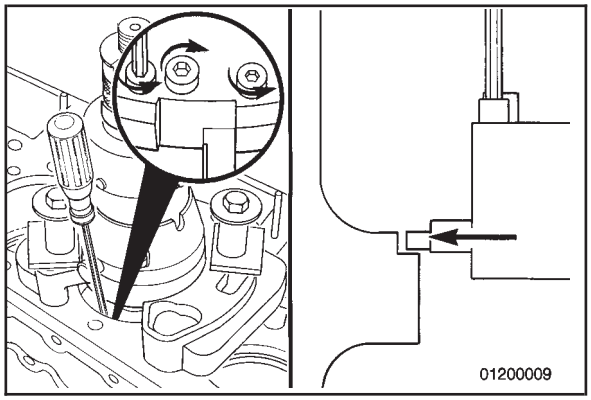
Torque Value: 68 N•m [50 ft-lb]



Rotate the cutter plate by hand so the cutter bit adjusting screw and clamping screws can be accessed from the exhaust side of the cylinder block.

Open the feed valve.

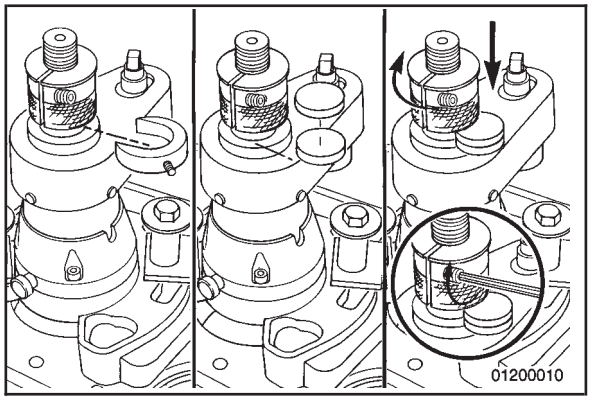
Lift the cutter assembly to approximately 9.5 mm [0.375 inch] and install depth set collar, Part No. 3823608, between the stop-ring and the dot-ring face.



Loosen the two cutter bit clamping screws.

Rotate the cutter bit positioning screw, **clockwise** to extend the bit, and position the end of the cutter bit near the middle of the counterbore ledge surface.

Snut tight the two cutter bit clamping screws.

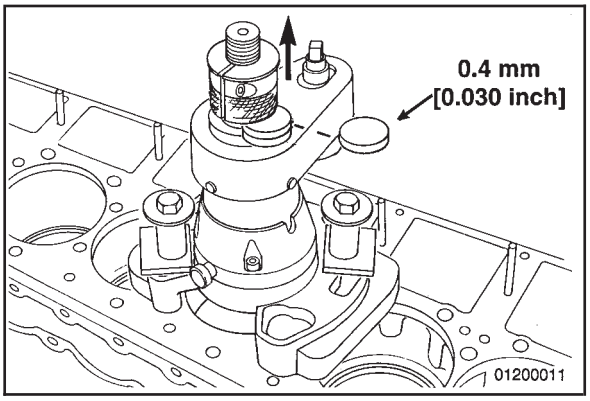


Remove the depth set collar from under the stop-ring and allow the cutter bit to rest on the counterbore ledge.

Obtain a shim(s) with the thickness equal to the depth of counterbore cut desired. Raise the stop-ring by turning it **counterclockwise** until there is enough clearance to insert the shims between the stop-ring and the dot-ring face. Place the shim(s) between the stop-ring and the dot-ring face.

Turn the stop-ring **clockwise** until it just contacts the shim(s). Tighten the stop-ring clamping screw.

Raise the cutter assembly by hand and add 0.4 mm [0.030 inch] to the previously determined shim thickness to allow proper positioning of the cutter bit.

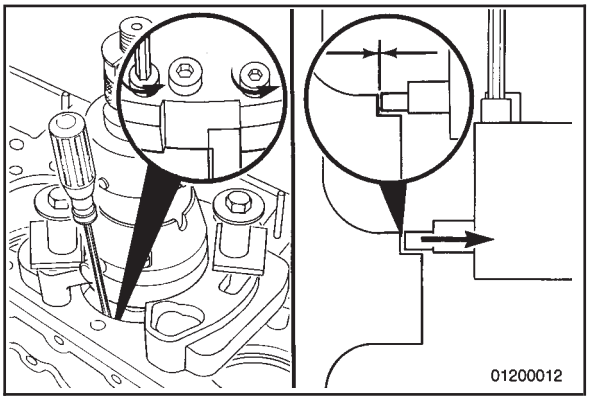


Caution: If the cutter bit engages the side wall above the ledge during the cut, chatter will be present on the side wall surface.

Loosen the tool bit clamping screws and move the cutter bit out to the wall of the counterbore.

Retract the cutter bit approximately 0.05 to 0.25 mm [0.002 to 0.010 inch].

Tighten the cutter bit clamping screws evenly.



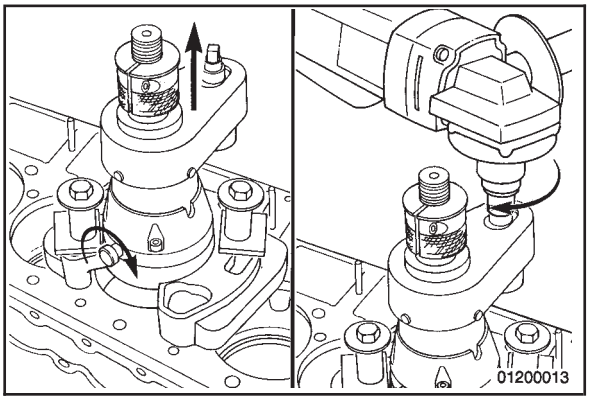
Warning: When operating a cutting or drilling tool, wear goggles or a face shield to protect the eyes. Personal injury can result.

Lift the cutter assembly to its highest position and close the feed valve.

Install your right angle drill with swivel adapter to the tool driver.

Begin the cut.

Do **not** stop the cut until the drill motor has sped up for several seconds.

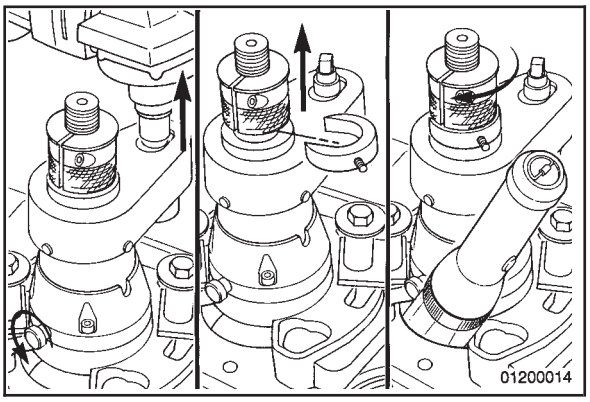


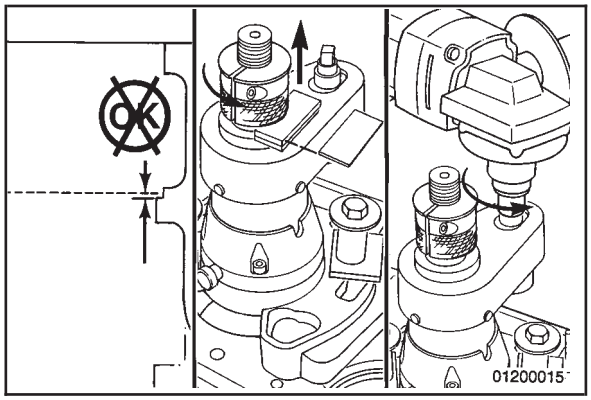
NOTE: Do **NOT** remove the drive unit from the cylinder block until the cut has been satisfactorily completed and inspected.

Remove the right angle drill and unlock the feed valve.

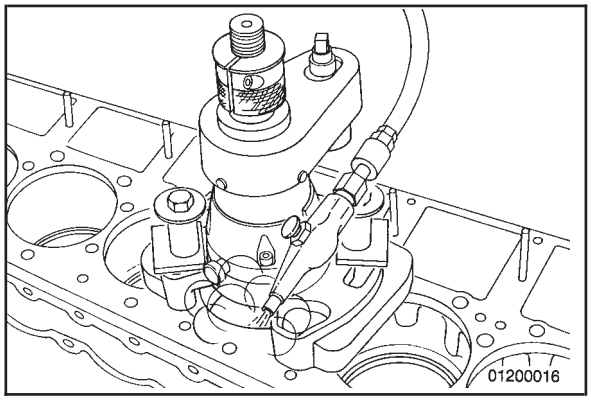
Lift the cutter assembly and install depth set collar, Part No. 3823608, between the stop-ring and the dot-ring.

Inspect the entire cut surface by using a flashlight and rotating the drive unit by hand.





If the cut is **not** to the desired depth, repeat the process by shimming to the desired cut depth and making a new cut. Do **not** reposition the cutter bit.

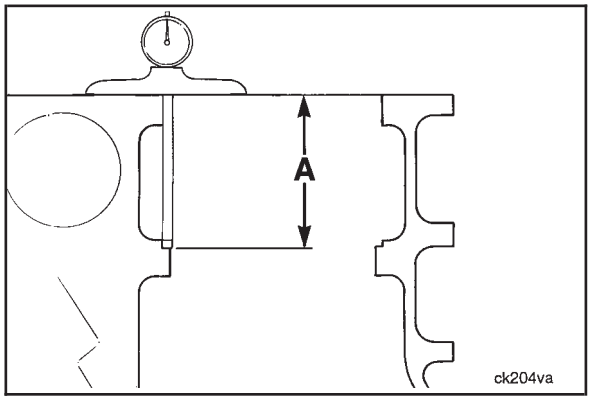


Warning: When using compressed air, wear goggles or a face shield to protect the eyes. Personal injury can result.

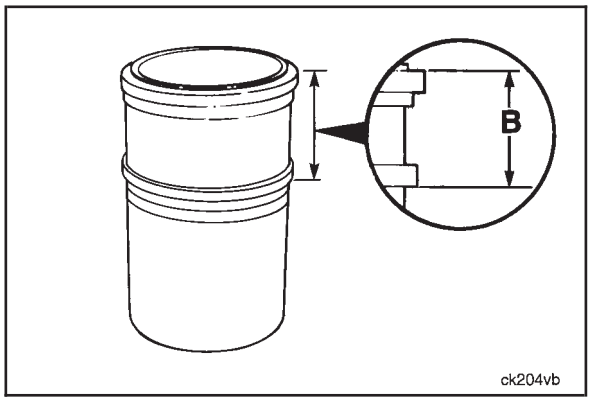
When the cut is satisfactory, use compressed air to remove debris from the cutter bit. This allows the cutter bit to retract smoothly.

Retract the cutter bit into the cutter plate before removing the drive unit.

Remove the capscrews and the drive unit from the cylinder bore.



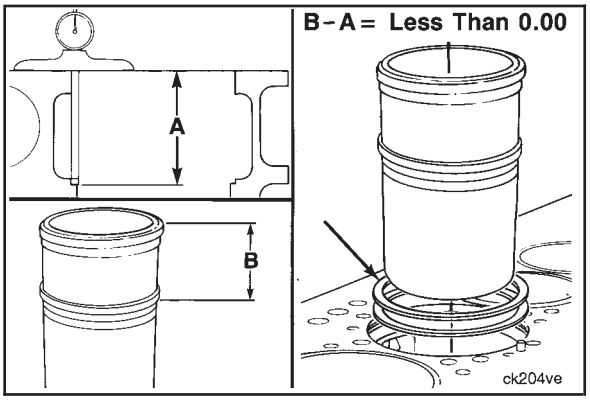
Measure and record the counterbore depth. This is dimension "A".



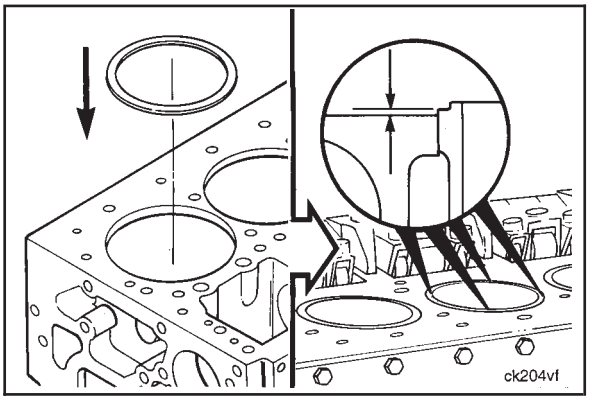
Obtain the cylinder liner to be installed and measure the distance from the flange to the top of the liner.

Flange to Top of Cylinder Liner-Height-Dimension "B"		
mm		in
100.00	MIN	3.937
100.05	MAX	3.939

If dimension 'A' is more than dimension 'B', the cylinder liner **must** be shimmed.



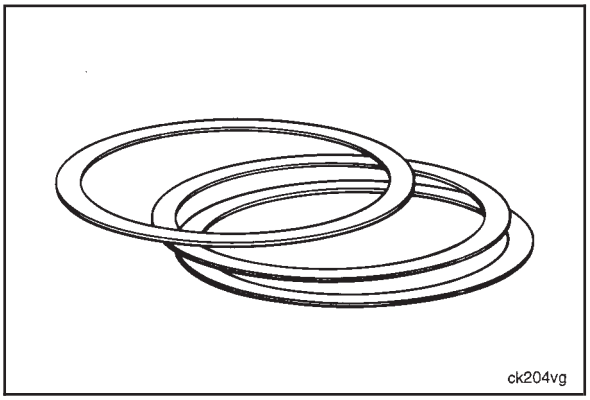
Calculate the shim height required to obtain 0.00 to 0.13 mm [0.000 to 0.005 inch] cylinder liner protrusion.



Select the shims necessary to obtain this height.

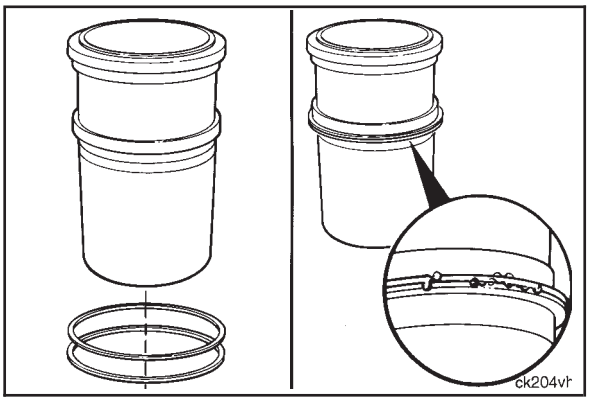
NOTE: Shims are available in the following thicknesses. Any combination of shims can be used.

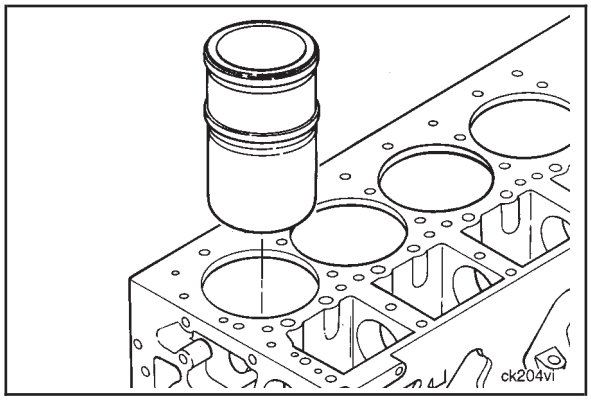
Part No.	mm	inch
3032623	0.127	0.005
3034663	0.203	0.008
3899556	0.508	0.020
3899557	0.762	0.030
3899558	1.106	0.040
3899559	1.270	0.050



Install the shims on the cylinder liner.

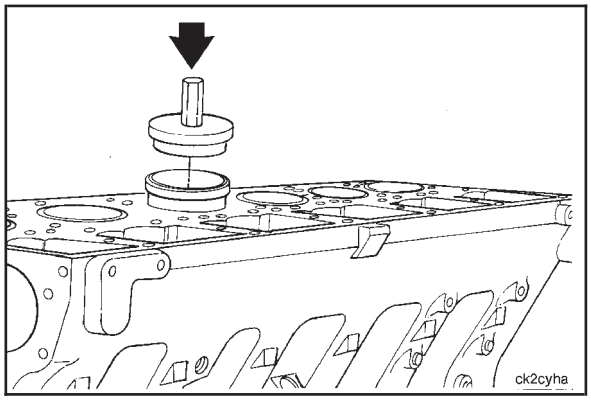
NOTE: The shims **must** be centered on the liner flange. A thick grease can be used to hold the shims in place.



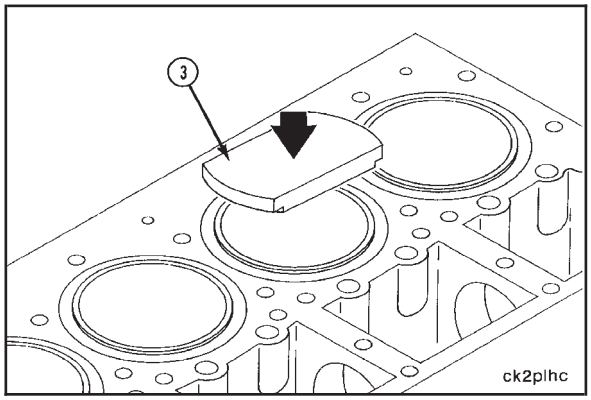


Install the cylinder liner in the cylinder block.

NOTE: If the liner has been shimmed, be very careful **not** to disturb the shims.

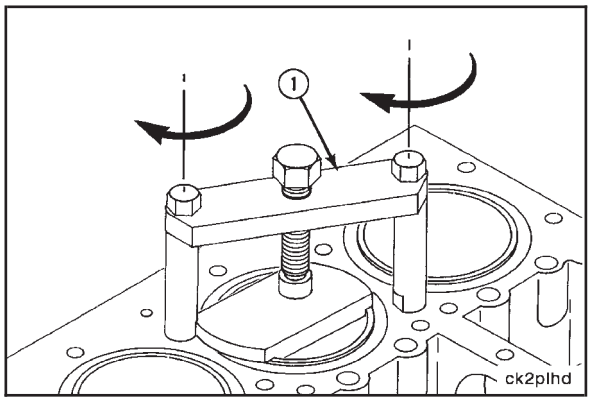


Use cylinder liner driver, Part No. 3376056, to drive the cylinder liner into the cylinder block.



Use the cylinder liner clamping tool, Part No. 3824272, to seat the liner in the cylinder block bore.

Place the force plate (3) across the top of the liner with the step inside the liner bore.



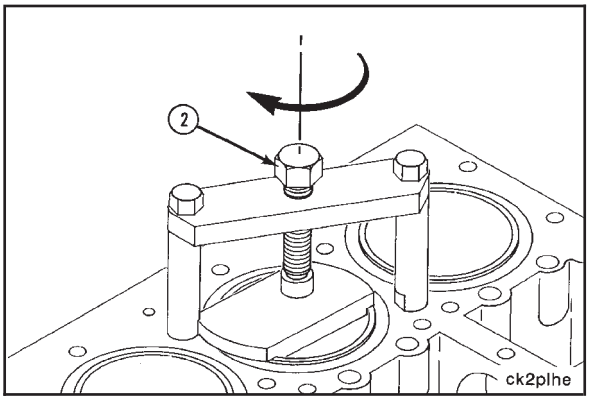
Put the installation tool bridge (1) across the liner and install the two cylinder head capscrews finger tight to hold the bridge down. Rotate the force plate until the areas where the protrusion measurements will be taken are exposed.

Caution: Do not use an impact wrench to tighten the liner force plate screw. Excessive torque will cause damage to the liner installation tool.

Tighten the forcing screw (2).

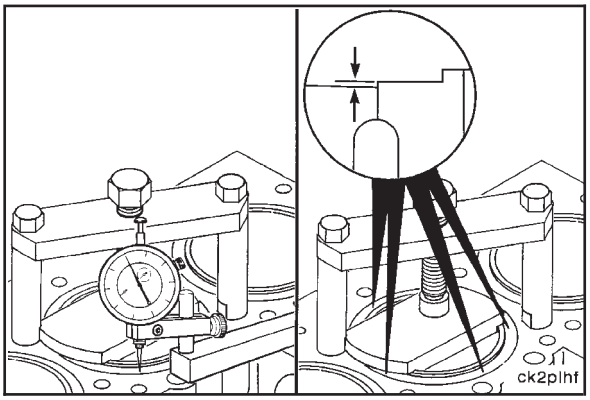
Torque Value: 136 N•m [100 ft-lb]

Check for the correct protrusion.

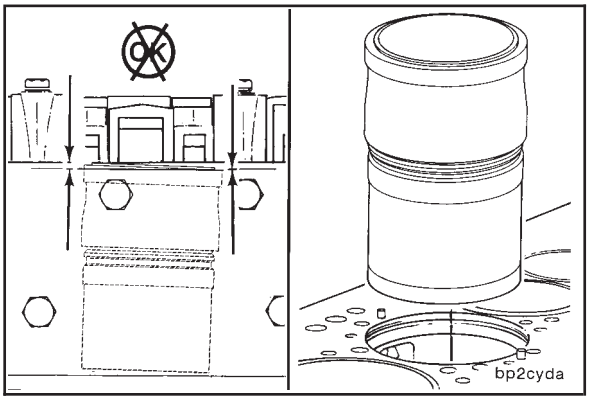


Measure the cylinder liner protrusion at four points 90 degrees apart.

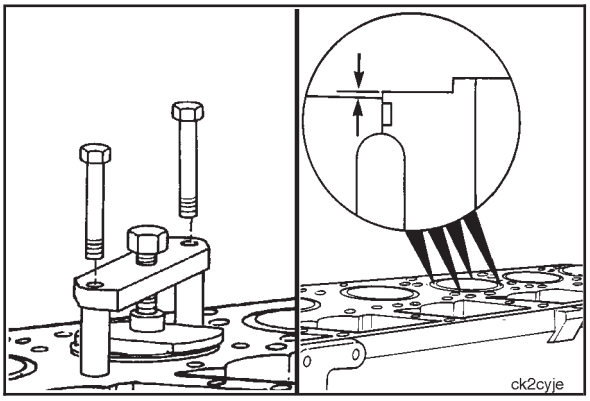
Cylinder Liner Protrusion		
mm		in
0.00	MIN	0.000
0.13	MAX	0.005

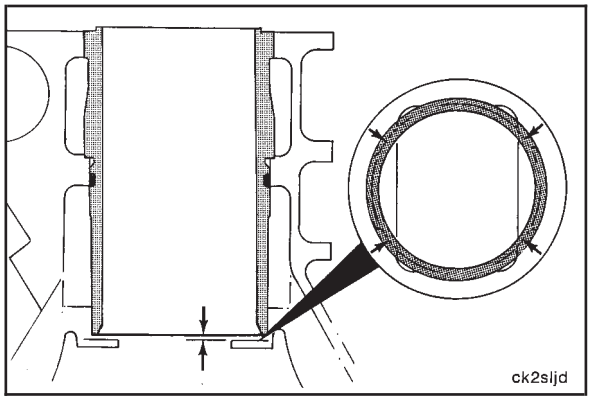


NOTE: If the liner protrusion varies more than 0.03 mm [0.001 inch] for 180 degrees, remove the cylinder liner and check for debris or damaged shims.

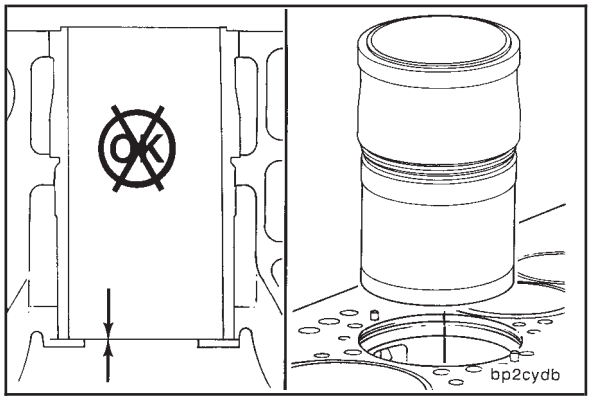


Repeat the procedure until the liner protrusion is within specifications.

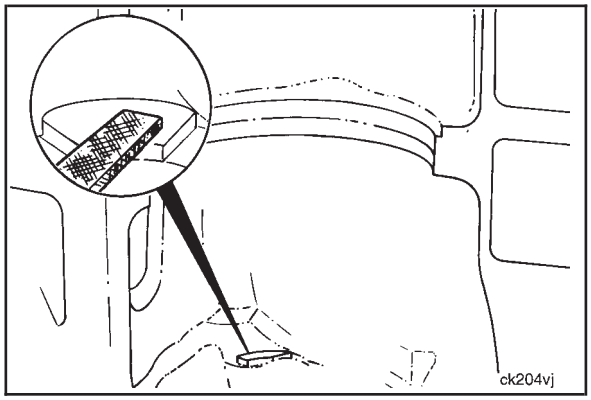




Use a feeler gauge to measure the cylinder liner to cylinder block clearance at the four block casting points. The clearance **must** be a minimum of 0.25 mm [0.010 inch].

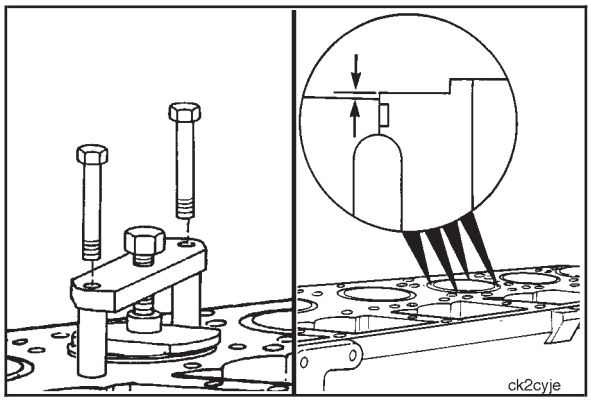


If the clearance is less than 0.25 mm [0.010 inch], remove the liner.



Use a file or grinding wheel to remove metal from the four cylinder block casting points.

NOTE: Care **must** be taken to remove only enough material to obtain clearance.

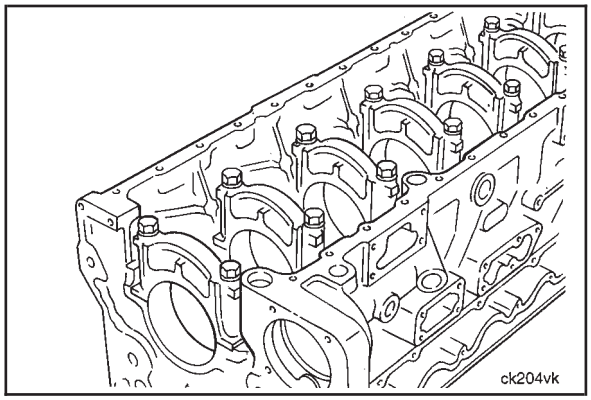


Install the cylinder liner and measure the liner protrusion and the liner to cylinder block casting point clearance again.

Specifications — Cylinder Liner Counterbore Machining

Measurement	mm		Inch
Original counterbore depth	99.930 100.000	MIN MAX	3.9343 3.9370
Cylinder Liner Height — Flange to Top Surface	100.000 100.050	MIN MAX	3.9370 3.9390
Cylinder Liner Protrusion	0.00 0.13	MIN MAX	0.000 0.005

Liner Shims		
Part No.	**Description**	**Thickness**
3032623	Shim, Liner (Existing)	0.127 mm [0.005 inch]
3034663	Shim, Liner (Existing)	0.203 mm [0.008 inch]
3899556	Shim, Liner (New)	0.508 mm [0.020 inch]
3899557	Shim, Liner (New)	0.762 mm [0.030 inch]
3899558	Shim, Liner (New)	1.106 mm [0.040 inch]
3899559	Shim, Liner (New)	1.270 mm [0.050 inch]



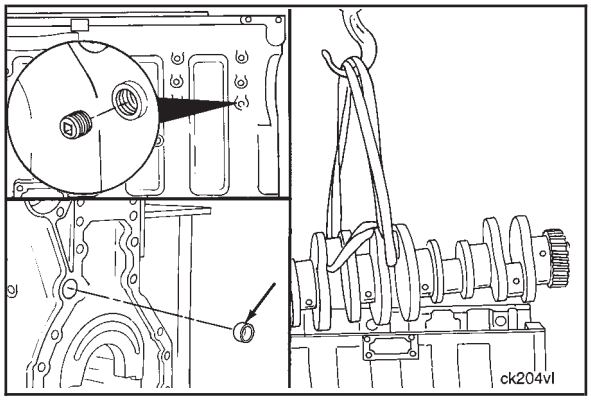
Main Bearing Bore Repair

General Information

This procedure describes the method for repairing damaged main bearing bores.

The repair can be performed out of chassis only with the cylinder block resting on the cylinder head surface.

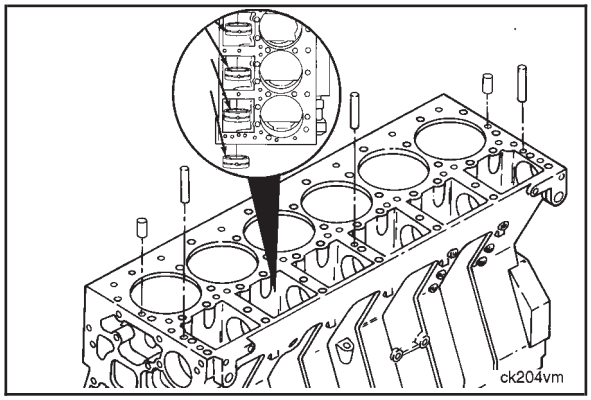
NOTE: The cylinder block **must not** be mounted on an engine stand as bore distortion will result.



Initial Preparation and Inspection

Disassemble the engine. Remove all pipe plugs, cup plugs, main bearings caps, and the crankshaft. Refer to the following Shop Manuals for the correct procedure:

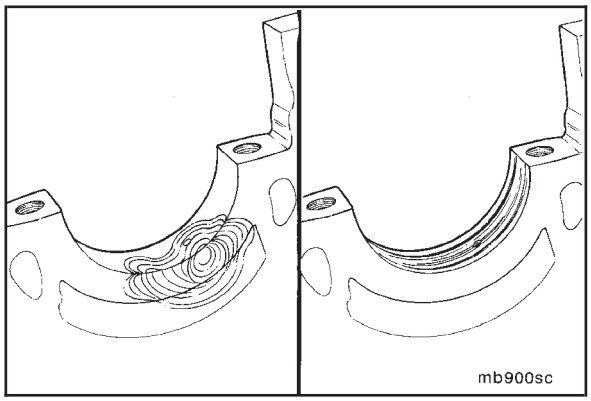
- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



Remove the cam follower studs.

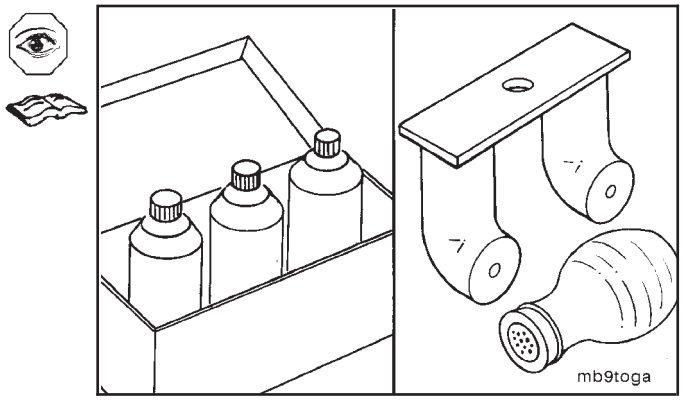
Remove the camshaft bushings.

Remove the dowels from the top deck of the cylinder block.



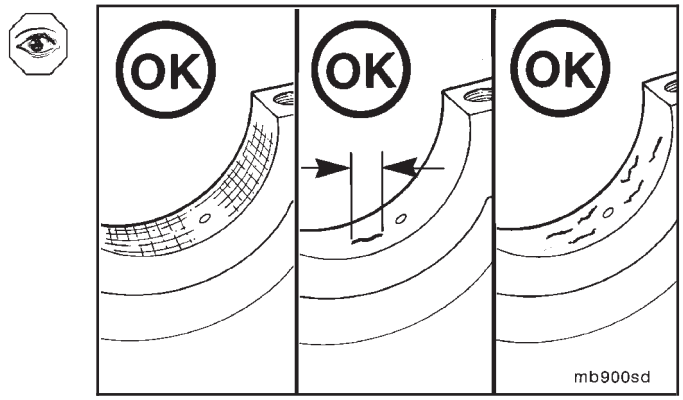
Visually inspect the main bearing saddles for discoloration.

If discoloration exists, inspect the bearing saddles for cracks. Refer to Group 0, Liquid Penetrant Inspection, for crack checking details.



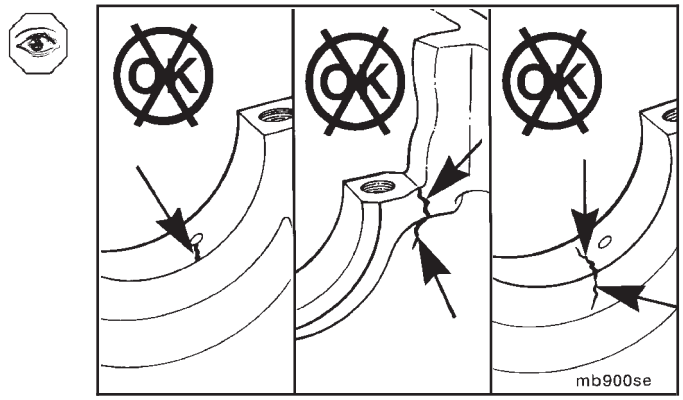
Acceptable cracks in the bearing saddles are as follows:

- Heat checks in the bore area
- Porosity pockets less than 2.28 mm [0.090 inch] diameter
- Circumferential cracks no longer than 19.05 mm [0.750 inch]
- Up to six circumferential cracks 9.52 mm [0.375 inch] and shorter



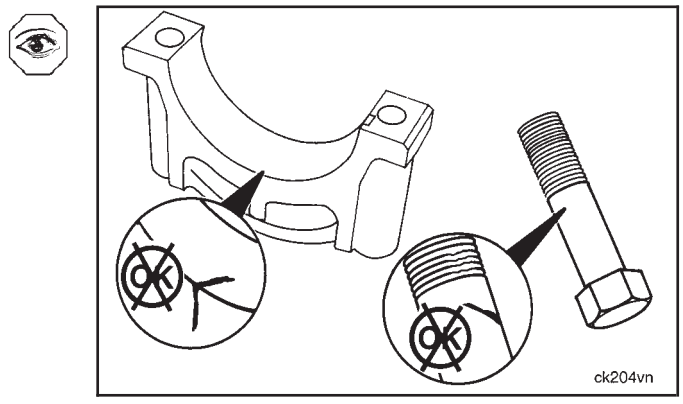
Non-acceptable cracks in the bearing saddles are as follows:

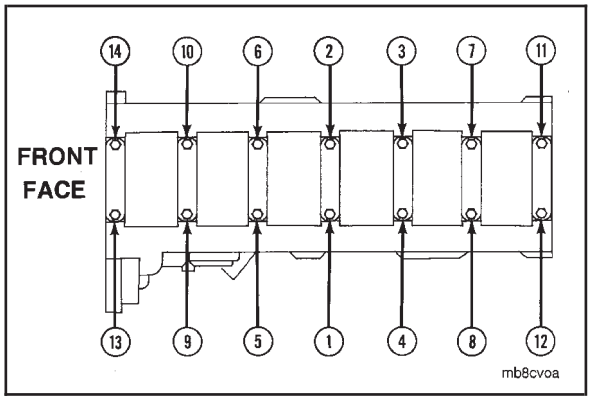
- Cracks entering the oil hole
- Cracks in the radii of the structural webs
- Cracks which break over the side of the main bearing bore saddle



Inspect the main bearing caps if reuse is being considered.

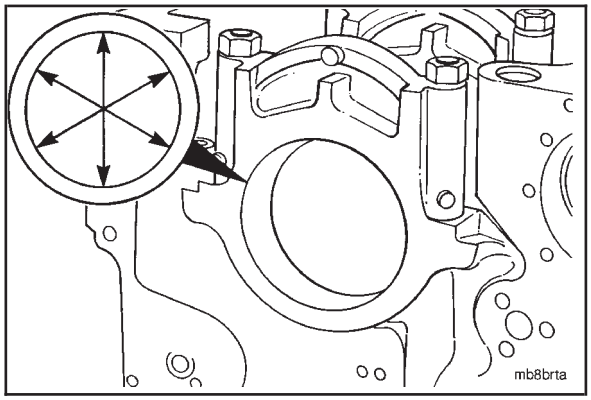
NOTE: A press fit between the main bearing cap and cylinder block **must** exist.





Install the main bearing caps.

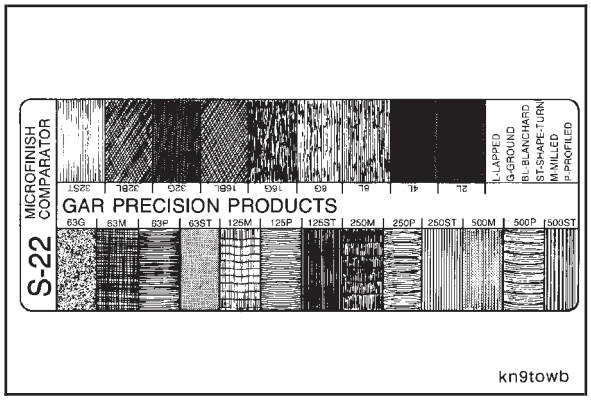
Torque Value: Step 1 - 70 N•m [50 ft-lb]
2 - 140 N•m [105 ft-lb]
3 - 210 N•m [155 ft-lb]
4 - Loosen
5 - 70 N•m [50 ft-lb]
6 - 140 N•m [105 ft-lb]
7 - 210 N•m [155 ft-lb]



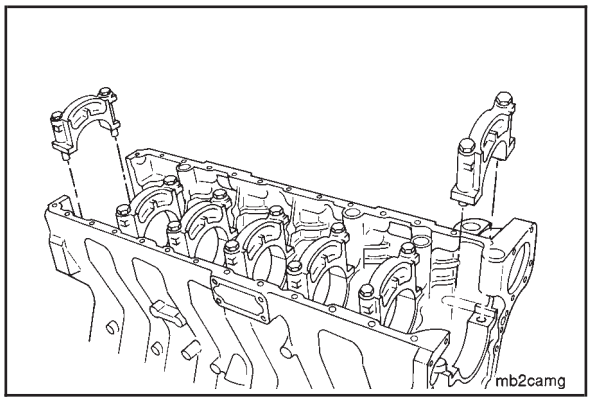
Measure the main bearing bores. Measure the inside diameter of the bore in four locations.

Main Bearing Bore I.D.		
mm		**in**
121.990	MIN	4.8028
122.025	MAX	4.8041

If any main bearing bore is out of round by more than 0.05 mm [0.002 inch], it **must** be repaired.



Visually inspect the surface finish on all main bearing saddles using a surface finish comparator. The surface finish **must** be 2 µM [80 µ inch] or less.



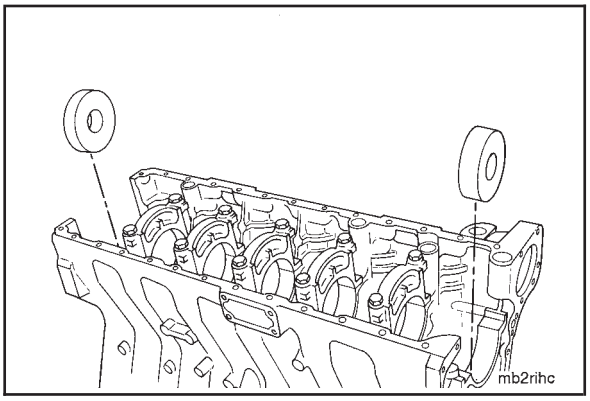
Main Bearing Bore Alignment — Inspection

Select one undamaged main bearing bore near each end of the cylinder block (preferably No. 1 and No. 7). Remove the two main bearings caps.

NOTE: If main bearing bores No. 1 and No. 7 are damaged, use the next two undamaged bores.

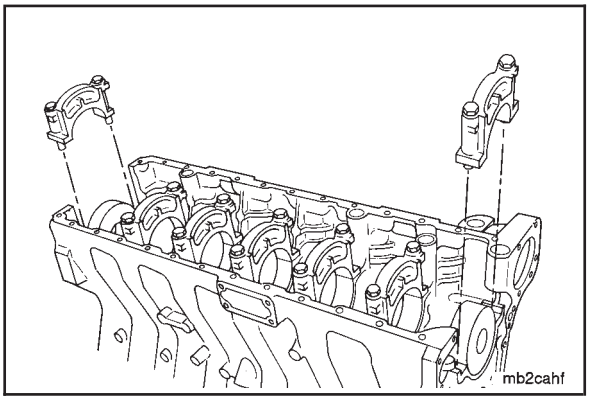
Install a centering ring, Part No. 3376781, in each of the two main bearing bore saddles.

NOTE: Tap on the top of each centering ring with a plastic hammer to seat the centering rings.

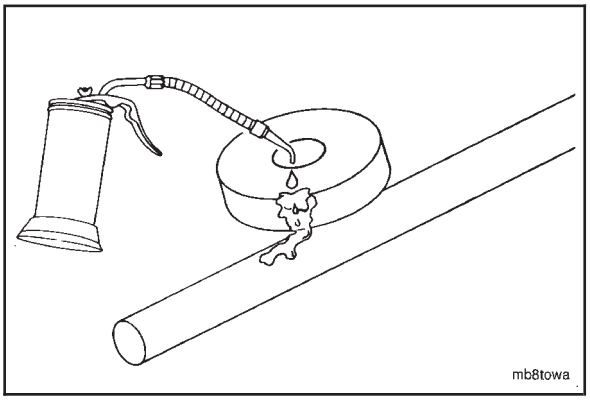


Install the two main bearing caps.

Torque Value: Step 1 - 70 N•m [50 ft-lb]
2 - 140 N•m [105 ft-lb]
3 - 210 N•m [155 ft-lb]
4 - Loosen
5 - 70 N•m [50 ft-lb]
6 - 140 N•m [105 ft-lb]
7 - 210 N•m [155 ft-lb]



Use clean 15W-40 oil to lubricate the inside diameter of the centering rings and the outside diameter of checking bar, Part No. ST-1177-16.

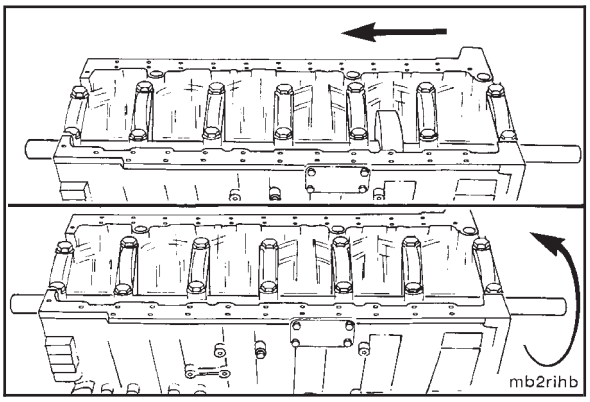


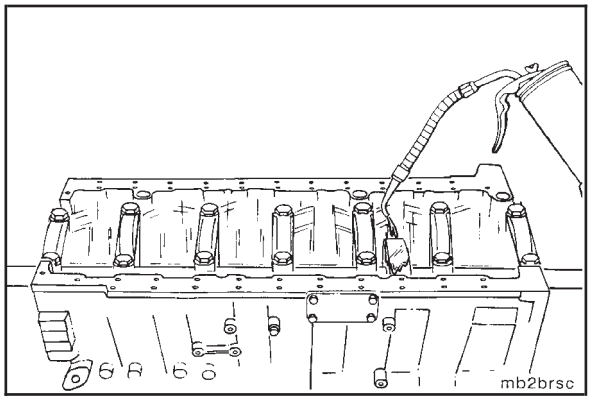
Slide the checking bar through one of the centering rings.

Install checking ring, Part No. 3376811, on the checking bar.

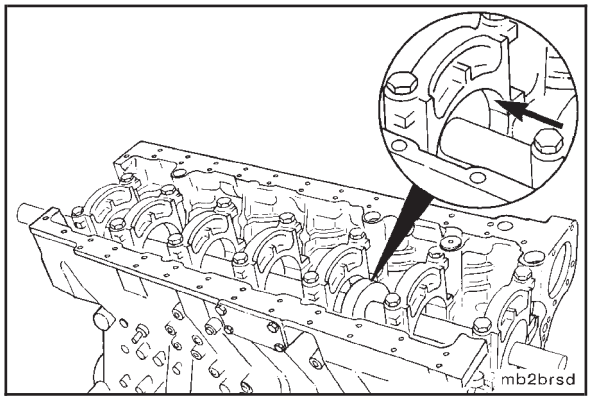
Slide the checking bar through the other centering ring.

Inspect the checking bar for freedom of rotation.



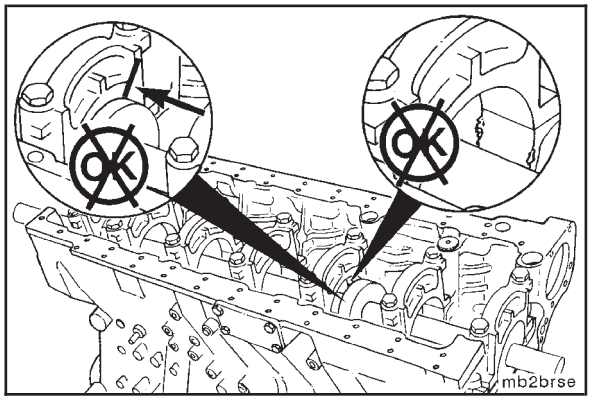


Use clean 15W-40 oil to lubricate the outside diameter of the checking ring.

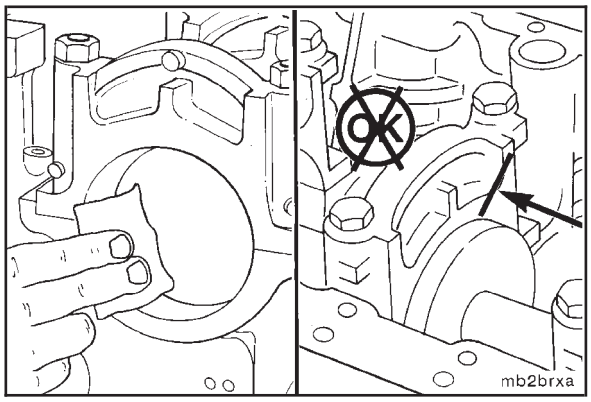


Push the checking ring through the bores to be inspected using light finger pressure on each side of the checking ring.

NOTE: The checking ring **must** pass through each bore with slight resistance.

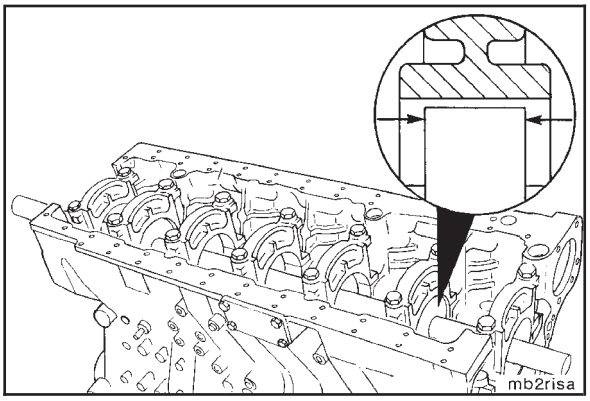


If the checking ring will **not** go through the bore, visually inspect the bore for burrs and other obstructions.



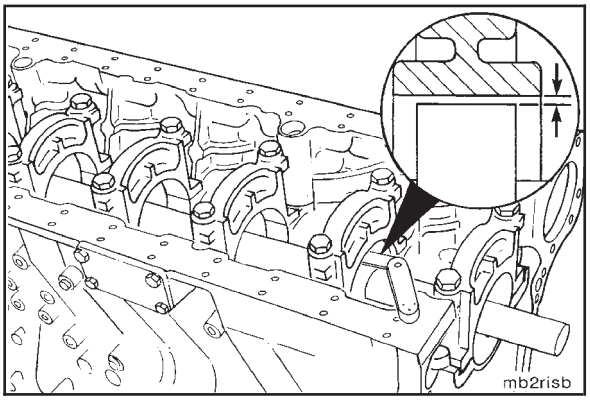
After removing any burrs, if the checking ring will **not** go through the bore, mark the bore for repair.

If centering ring will pass through the bore without any resistance, center the checking ring in the bore.



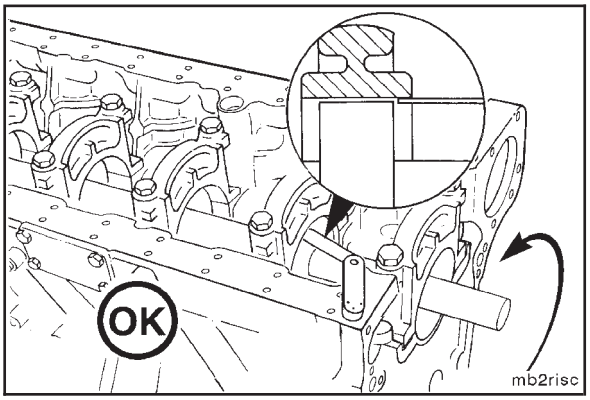
Use a 0.08 mm [0.003 inch] feeler gauge that is **not** more than 12.7 mm [0.500 inch] wide. Insert the feeler gauge between the checking ring and the cylinder block.

Rotate the feeler gauge completely around both sides of the checking ring.

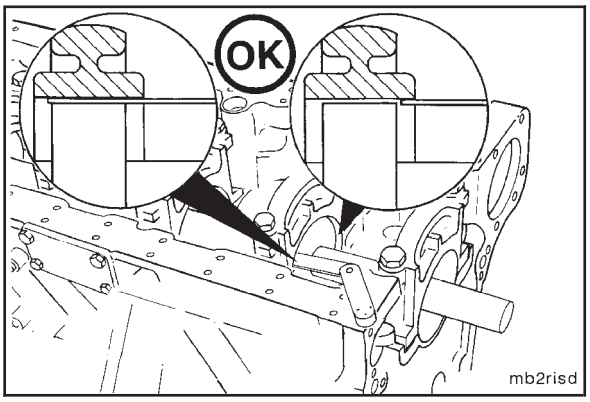


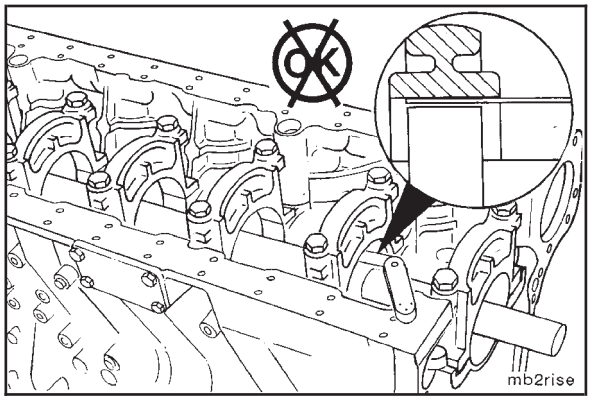
Evaluate the main bearing bore alignment inspection as follows:

- If the feeler gauge will **not** go in the bore at any point and the checking bar rotates freely, the main bearing bore is acceptable.

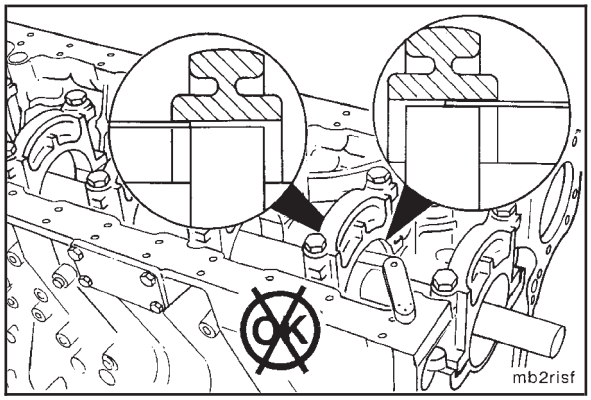


- If the feeler gauge will enter the bore at one point on one side of the checking ring, but will **not** enter the bore 180 degrees from that point on the same side, and the checking bar rotates freely, there is a slight misalignment, but the main bearing bore is acceptable.

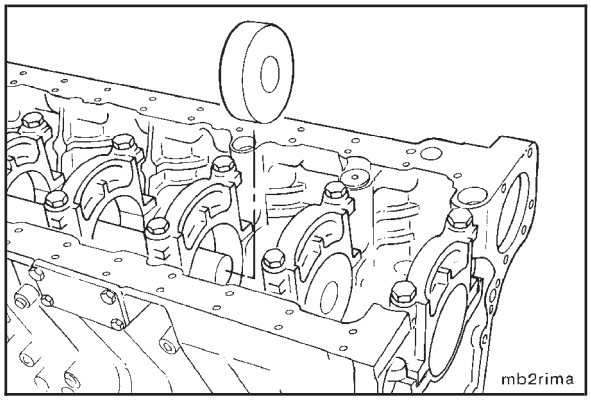




- If the feeler gauge is loose in the bore, the bore is oversize and **not** acceptable. Mark the main bearing bore to be repaired.

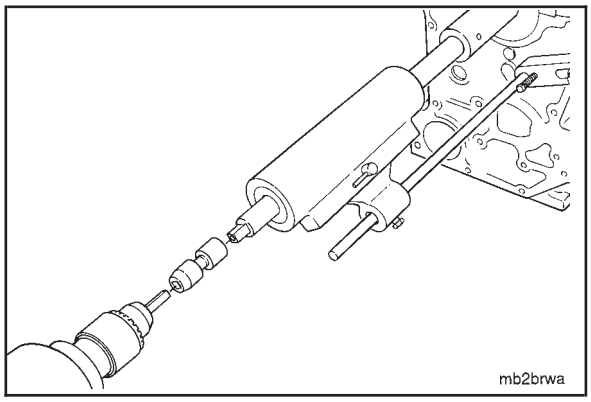


- If the feeler gauge will enter the bore all the way around on one side of the checking ring, but will **not** enter the bore on the other side, the bore is tapered and **not** acceptable. Mark the main bearing bore to be repaired.



Remove the checking ring.

NOTE: Leave the centering rings and checking bar in place if any bores are to be repaired.

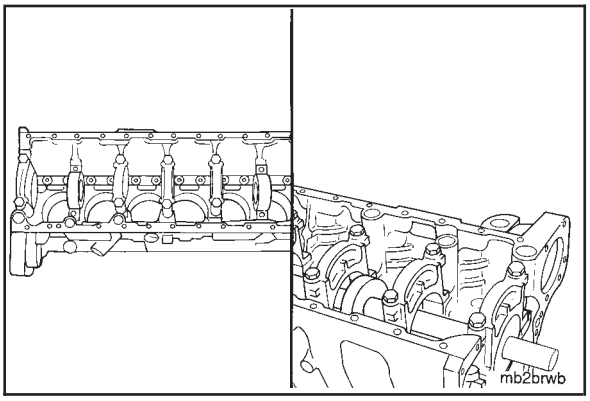


Main Bearing Bore Tool — Installation

The drive unit **must** be installed on the end of the cylinder block farthest from the bore to be repaired.

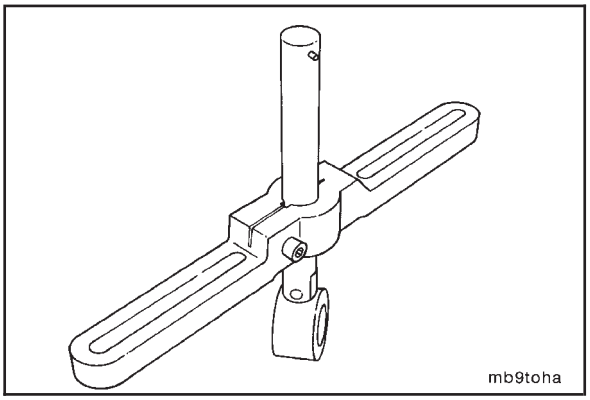
Example: The drive unit **must** be installed on the front face of the cylinder block for No.'s 4, 5, 6, and 7 bores, and on the rear face of the cylinder block for No.'s 1, 2, and 3 bores.

If the centering rings and checking bar are **not** installed, refer to Main Bearing Bore Alignment — Inspection.



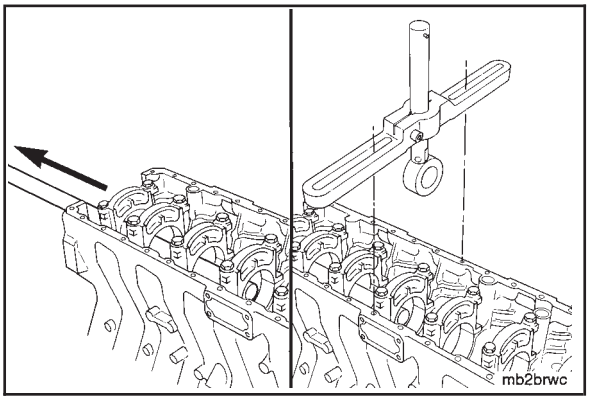
Install the bearing bar, Part No. ST-1177-22, in the bore bar bridgy, Part No. ST-1177-18.

NOTE: When installing, align the notch in the bore bar bridge with the dowel in the bearing bar.



Slide the checking bar out and install the bearing bar and bridge assembly on the side of the bore to be repaired that is opposite the drive unit.

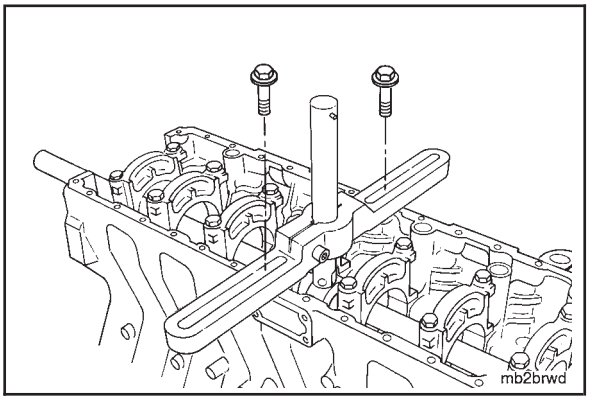
Example: If No. 5 bore is being repaired, the drive unit is installed on the front of the cylinder block. Therefore, install the bearing bar and bridge assembly between No. 5 and No. 6 bores.

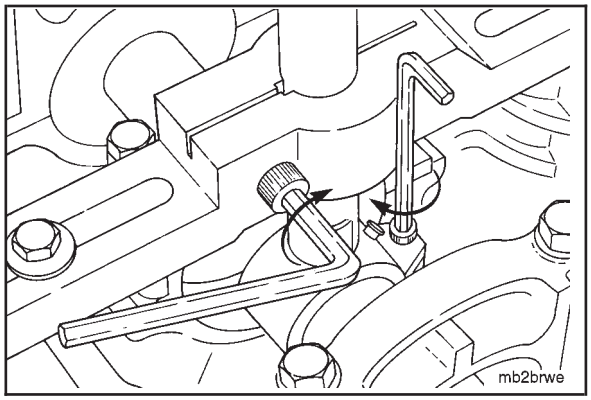


Install the bridge on the pan rail using two M10 x 60 capscrews.

Torque Value: 45 N•m [35 ft-lb]

NOTE: Leave enough room between the bearing bar and the bore being repaired to allow the tool bit to come through the bore.

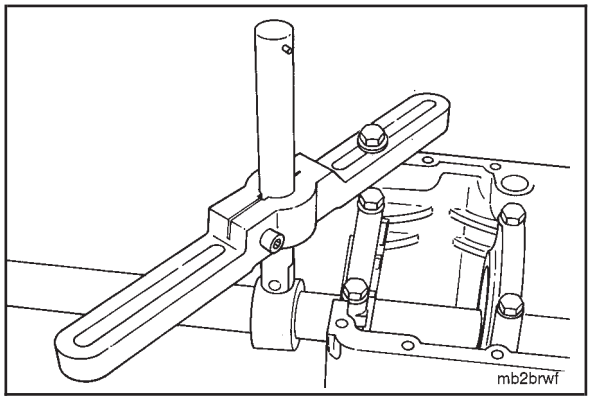




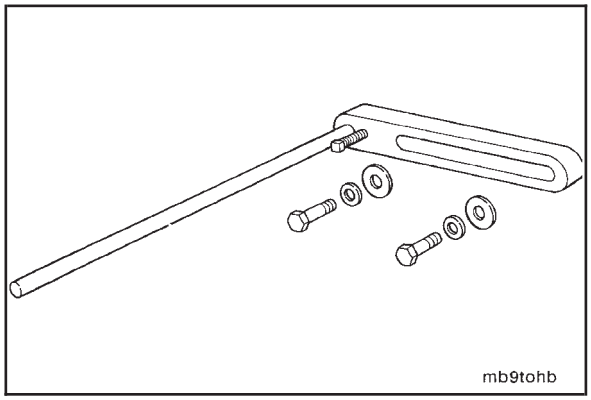
Tighten the socket head capscrew on the bridge to lock the bearing bar in place.

Tighten the socket head capscrew on the bearing bar.

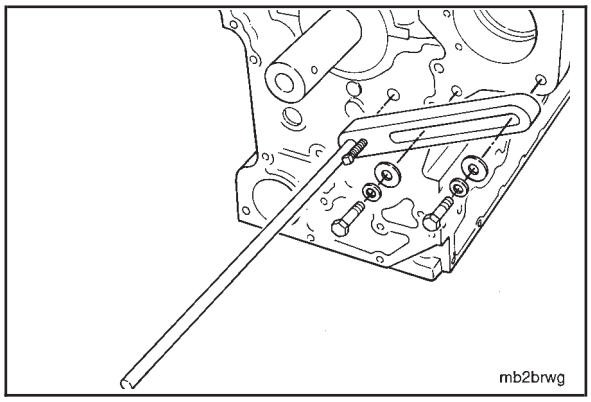
NOTE: The checking bar will bind if the bearing bar capscrew is tightened too tight.



If No. 1 or No. 7 bore is being repaired, it will be necessary to install the bridge at an angle external to the cylinder block using only one capscrew.



Install the torsion bar, Part No. ST-1177-33, in the torsion bar bracket, Part No. ST-1177-34.



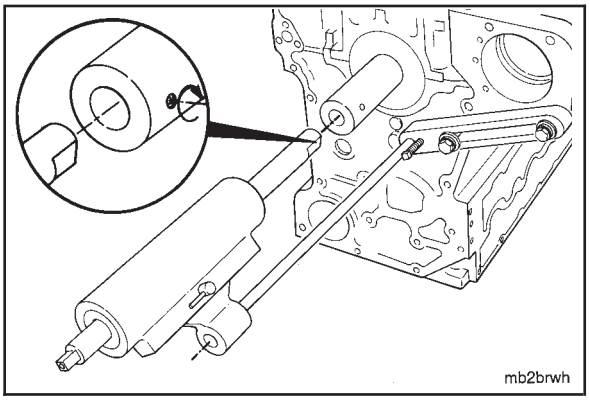
Install the torsion bar and bracket assembly on the cylinder block.

NOTE: Use a gear cover capscrew if the mounting is to the front or a flywheel housing capscrew if the mounting is to the rear of the cylinder block.

Install the drive unit, Part No. ST-1177-17, on the boring bar while guiding it onto the torsion bar.

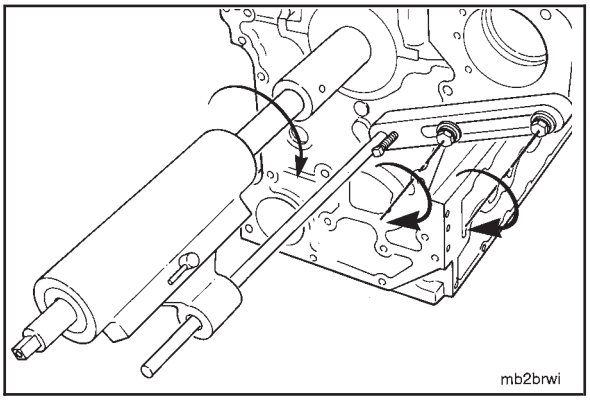
Align the flat on the drive unit shaft with the set screw on the checking bar.

Tighten the set screw.



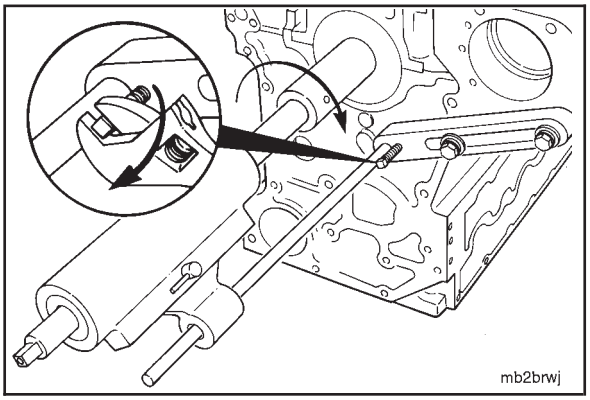
Tighten the capscrews holding the torsion bar bracket to the cylinder block.

Rotate the checking bar by hand while tightening the capscrew to make sure it doesn't bind.



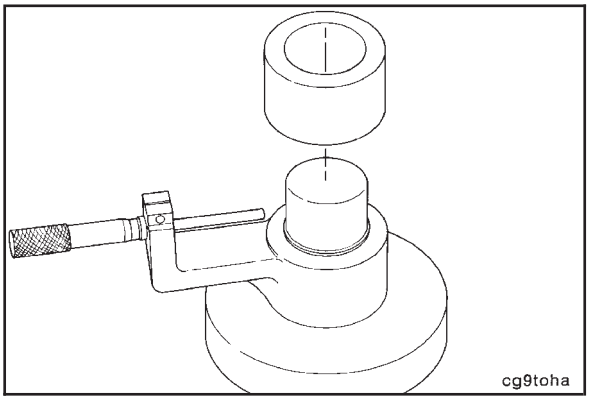
Snug tighten the square headed screw.

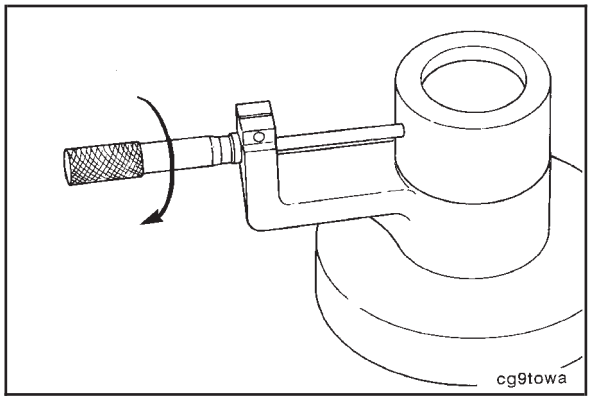
NOTE: Inspect the checking bar again to make sure it is **not** in a bind.



Main Bearing Bore Cutting Tool — Setting Cutter

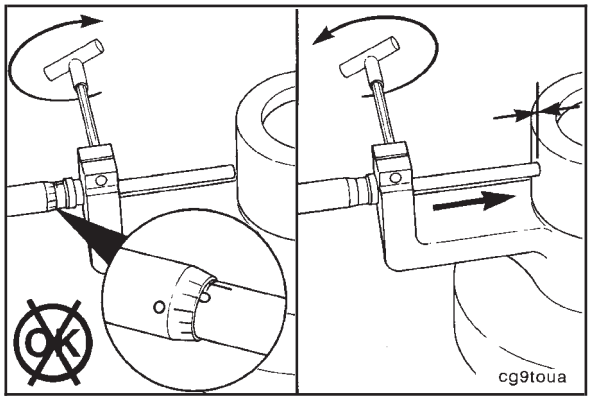
Install the micrometer setting ring, Part No. 3376355, in the micrometer base assembly, Part No. ST-1177-5111.





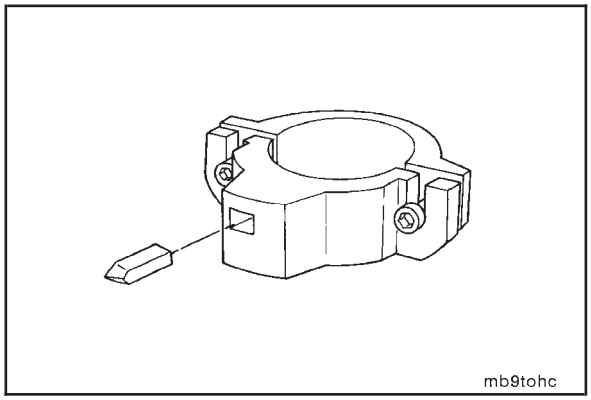
Adjust the micrometer thimble in until light contact is made with the setting ring.

NOTE: The micrometer **must** be recalibrated if it does **not** indicate 76.2 mm [3.00 inch].



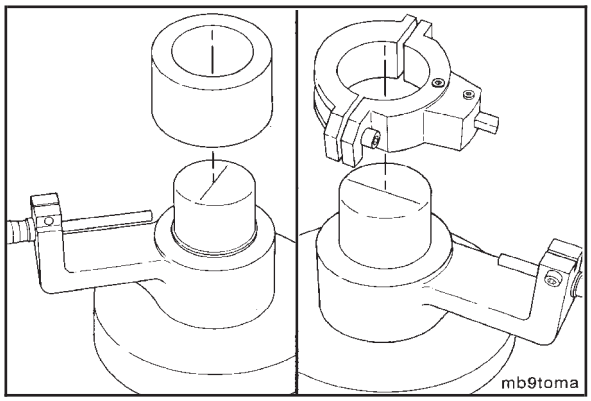
If recalibration is necessary:

- Loosen the socket head capscrew holding the thimble. Set the micrometer to "0".
- Move the micrometer in the holder until light contact is made with the setting ring and tighten the capscrew.



Install cutter tool, Part No. ST-1177-2, in the cutter tool holder, Part No. ST-1177-28.

NOTE: Orient the cuter tool as shown for clockwise rotation.

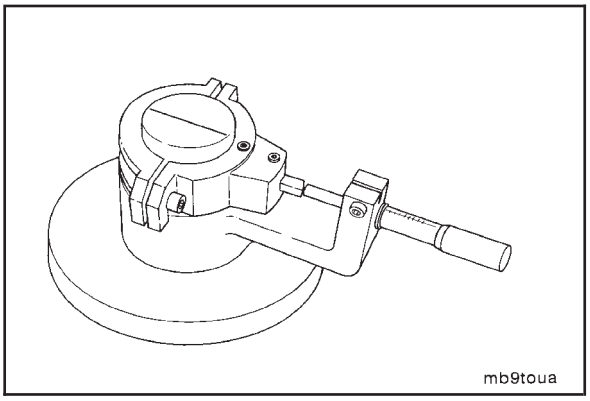


Remove the setting ring from the micrometer base assembly and install the cutter tool and tool holder assembly.

NOTE: The set screws in the holder **must** be facing up.

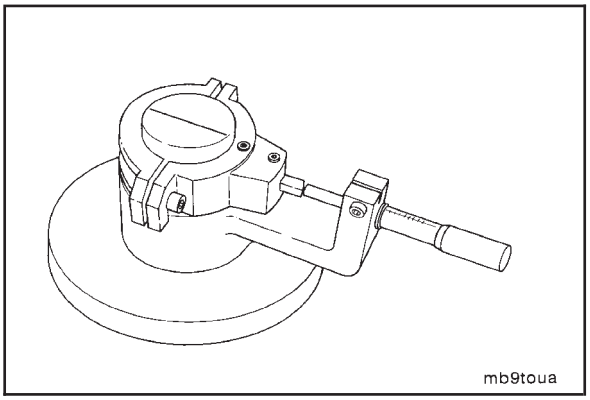
Align the centerline of the cutter tool with the line on the micrometer base assembly.

Tighten the socket head capscrews to lock the cutter holder to the micrometer.

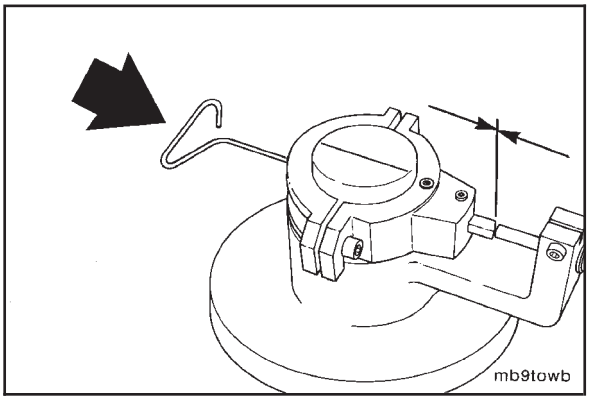


NOTE: The desired hole size is the size measured in the first part of this procedure plus no more than 0.76 mm [0.030 inch]. If machining the last cut, enlarge the diameter by 0.25 mm [0.010 inch] maximum.

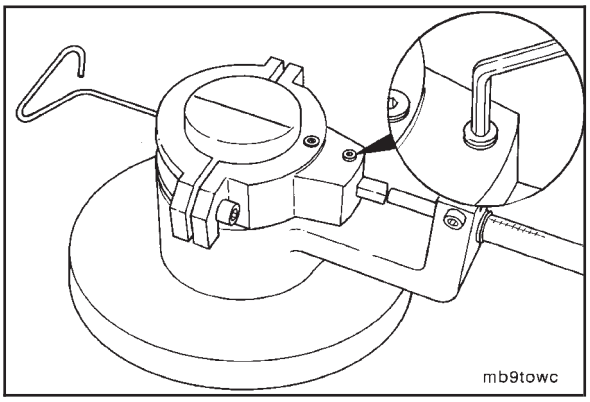
Set the micrometer to the desired hole size.

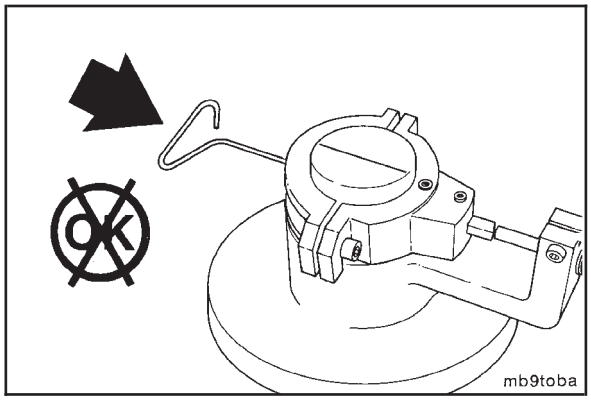


Push the cutting tool forward with the wire provided until it makes light contact with the micrometer shaft.

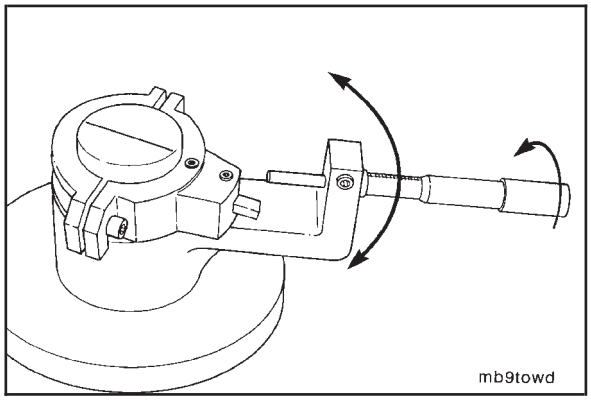


Tighten the set screw to lock the cutter tool in place.

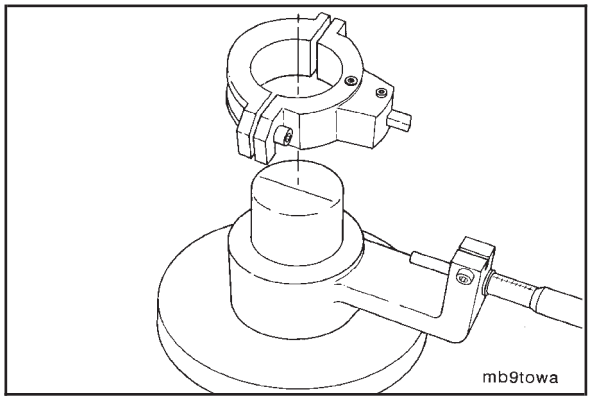




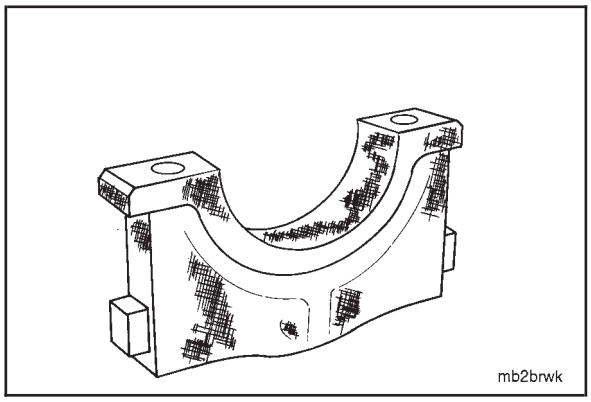
Caution: Care must be taken when pushing the cutting tool against the micrometer shaft. The carbide tip of the cutting tool is extremely brittle and can chip if excessive force is used.



Verify the size by backing off the thimble slightly and moving it forward gradually while swinging the micrometer back and forth gently until light contact is made with the cutter tool.



Swing the micrometer away from the cutter tool and remove the cutter holder from the micrometer base assembly.



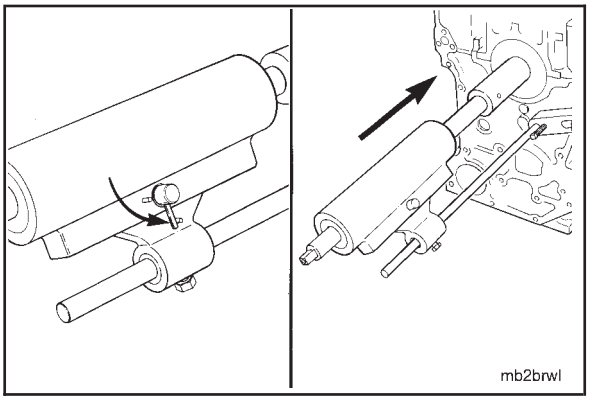
Main Bearing Bore — Machining

NOTE: This machining operation will destroy the main bearing cap. If it is intended to reuse the original cap, an unserviceable cap **must** be installed on the cylinder block. If the original cap is destroyed, service caps are available.

Remove the dowels before installing a non-original cap on No. 4 main bearing bore.

Move the directional valve lever to the "Open" position.

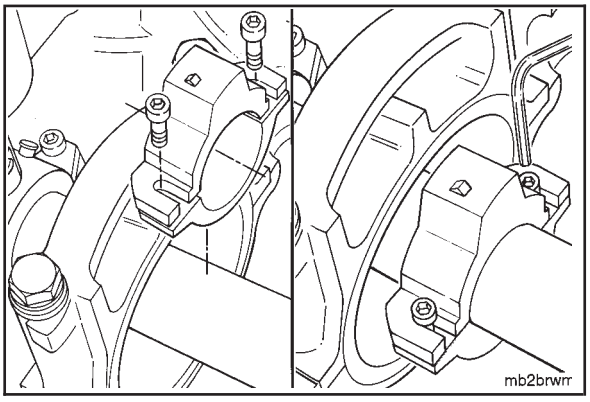
Hold the drive unit and pull the drive shaft through the drive unit.



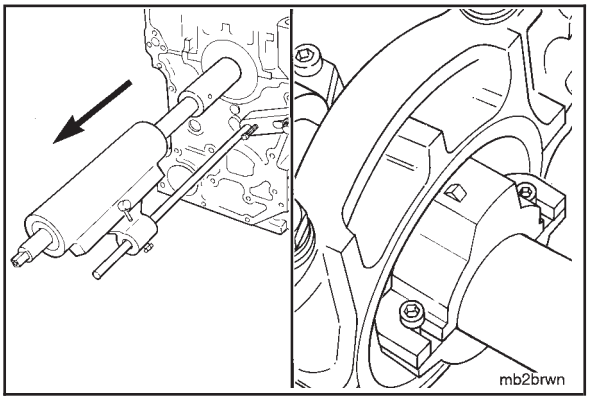
Install the cutter tool on the drive unit side of the bore to be repaired.

NOTE: Orient the cutter so the point is on the leading side when rotating the cutter **clockwise**.

Tighten the socket head capscrews.

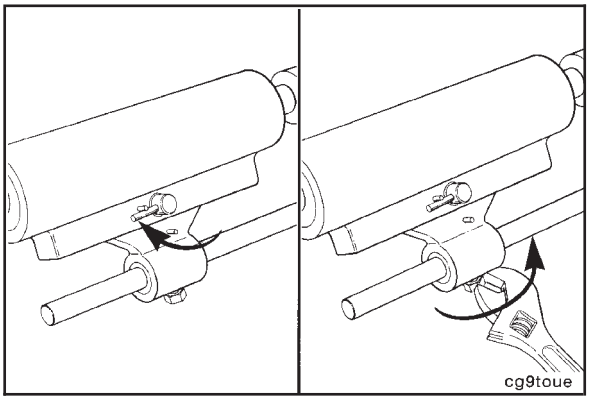


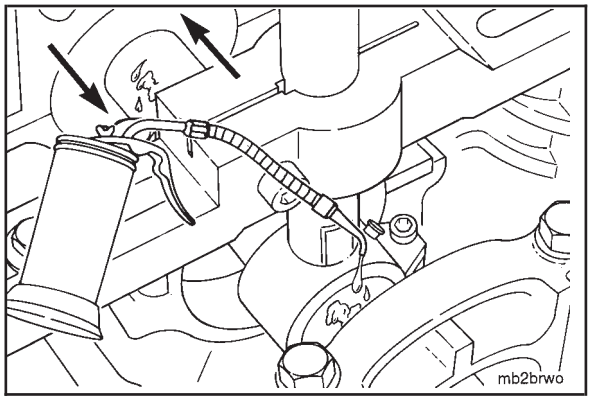
Push the drive shaft through the drive unit so the tool is approximately 3.2 mm [0.125 inch] from the bore to be cut.



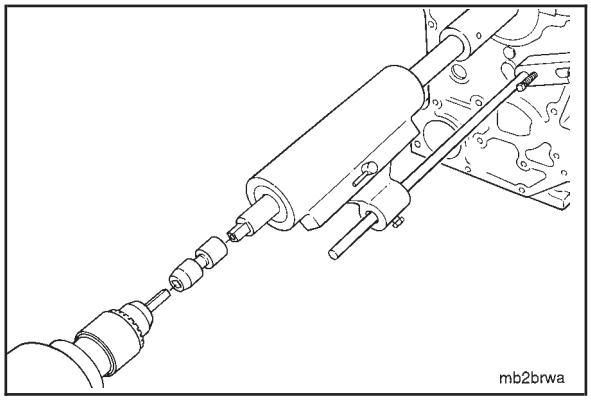
Turn the directional valve lever on the drive unit to the "Closed" position.

Tighten the thumb screw on the drive unit to lock it to the torsion bar.



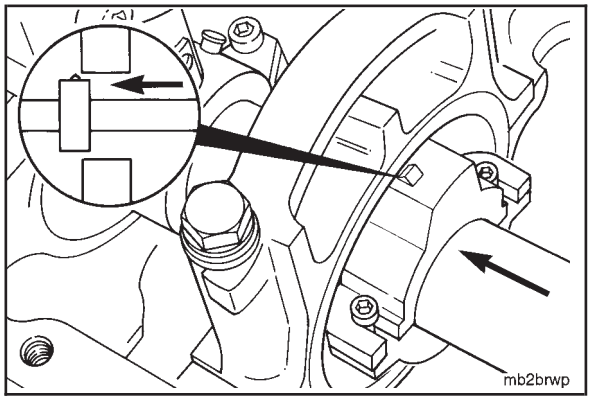


Use clean 15W-40 oil to lubricate the boring bar, centering rings and bearing bar.



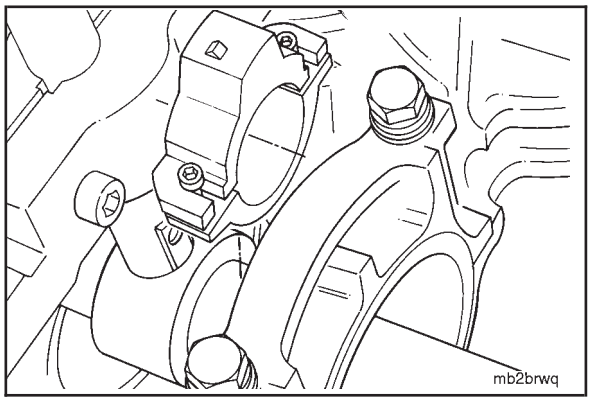
Install the swivel joint, Part No. ST-1177-27, into the chuck of a heavy duty 1/2 inch right hand, 450 to 500 RPM drill.

Attach the swivel joint to the drive unit.



Cut the main bearing bore completely through.

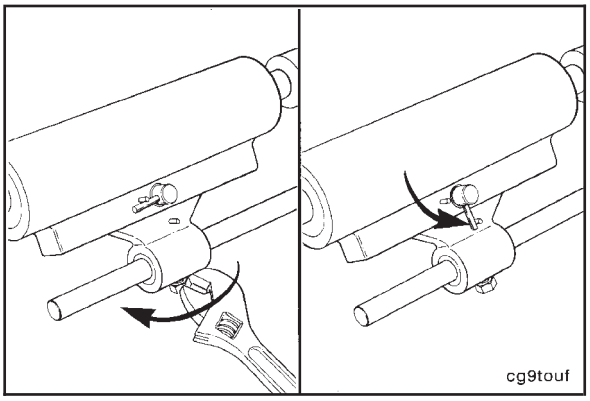
NOTE: Use cutting oil. Do **not** force the cut. Allow the drive unit to control the feed speed.



Remove the cutting tool holder.

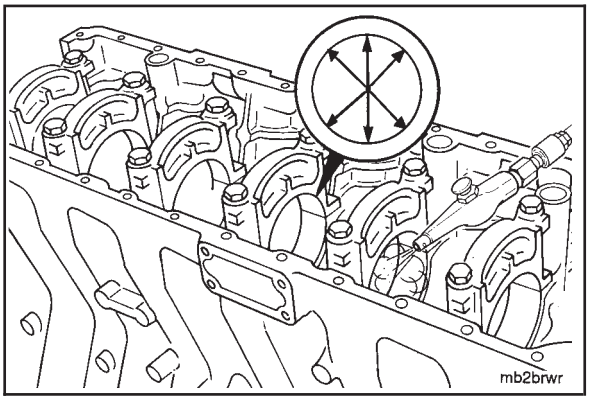
Loosen the thumb screw on the drive unit

Turn the directional lever to the "Open" position and back out the checking bar until there is enough clearance to measure the bore.



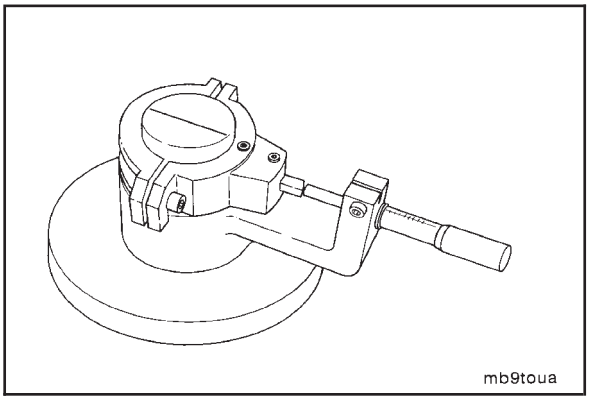
Clean the shavings and debris from the bore. Measure the bore to see if the desired bore size was obtained.

NOTE: The bore size **must** be equal to the micrometer setting. If **not**, some allowance on each cut will be necessary.

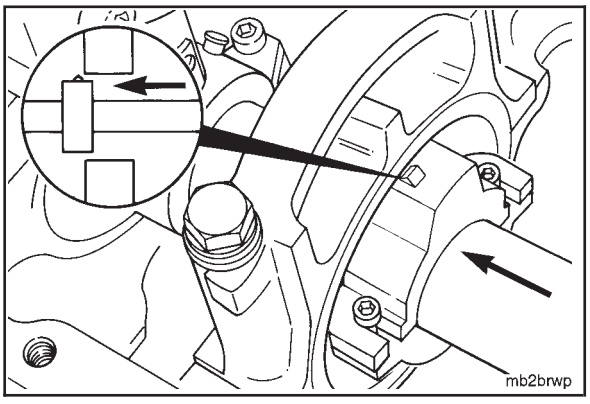


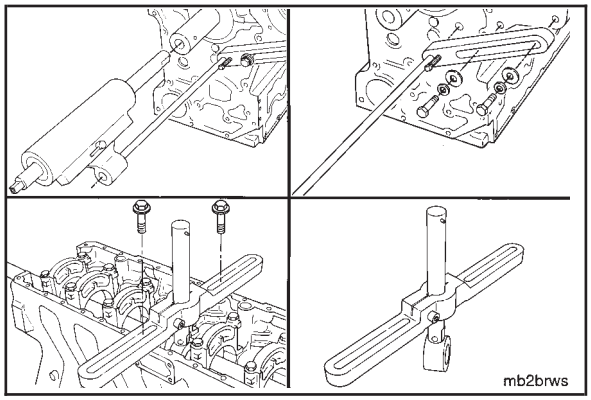
Adjust the cutting tool to the next desired size. Refer to Setting the Cutter.

NOTE: The diameter **must not** be bored more than 0.76 mm [0.030 inch] per cut and only 0.25 mm [0.010 inch] on the final cut.

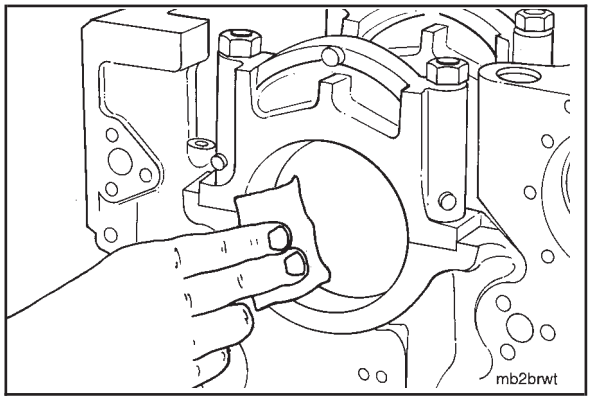


Use cutting oil and repeat the boring procedure until the inside diameter of the bore is 124.51 to 124.61 mm [4.902 to 4.906 inch].

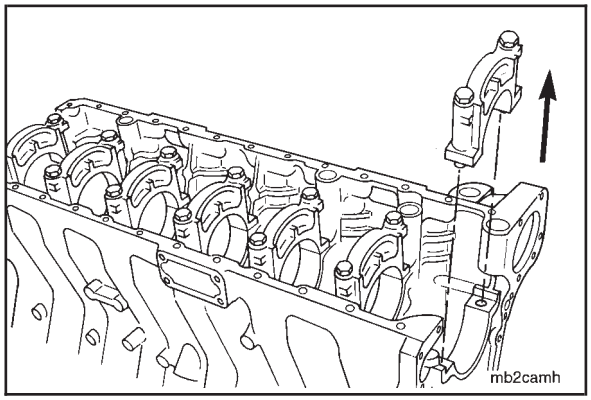




Remove the cutting tool assembly.

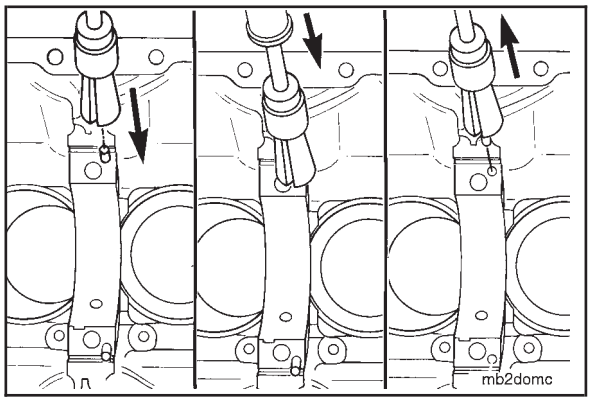


Use emery cloth to remove the burrs from the edges of the bore.



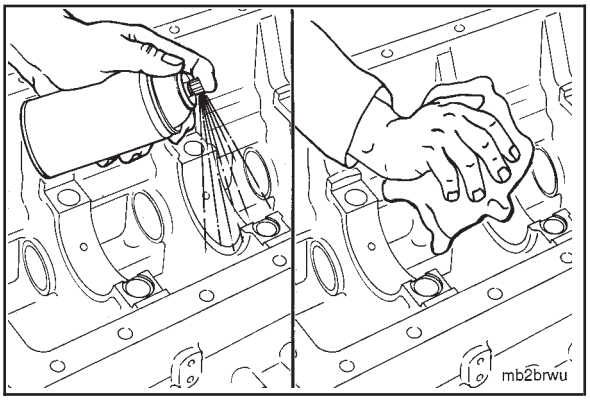
Main Bearing Bore Repair Sleeve — Installation

Remove and discard the main bearing cap from the bore just machined.

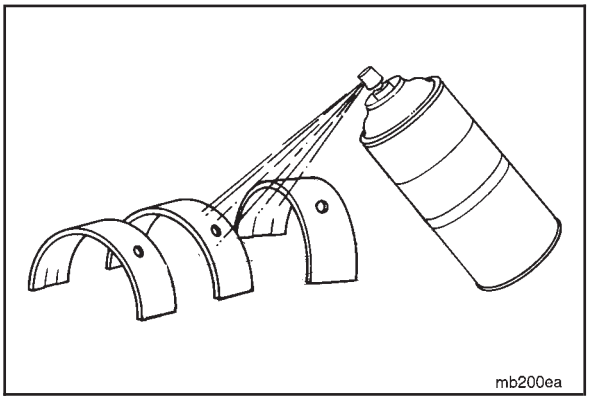


Remove the dowels if No. 4 main bearing bore is being repaired.

Clean the main bearing saddle area with a spray cleaner. Allow two minutes for excess cleaner to evaporate.

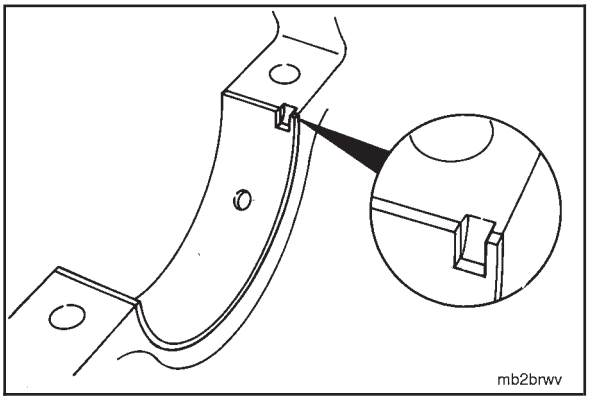


Clean the outside diameter of the repair sleeve, Part No. 3822491, to be installed with a spray cleaner.

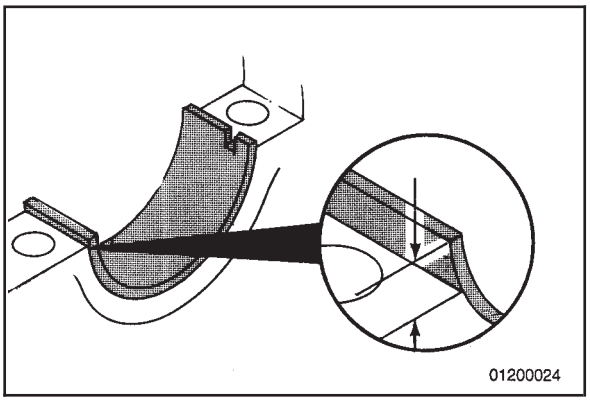


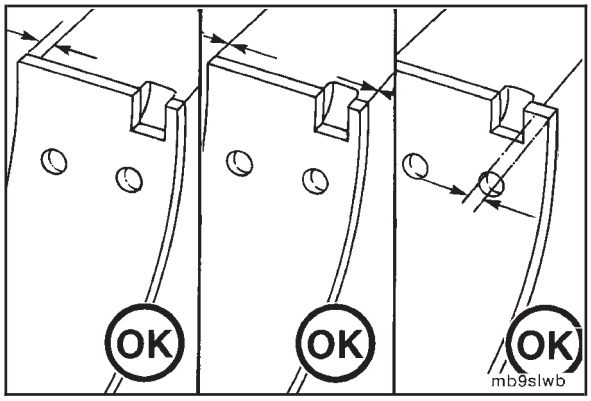
Install the sleeve in the main bearing saddle.

NOTE: Align the main bearing locking tang slot in the repair sleeve with the locking tang slot in the cylinder block.



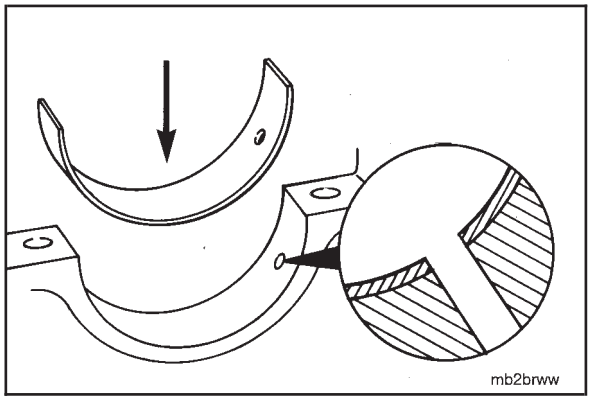
NOTE: The ends of the repair sleeve will protrude approximately 1.6 mm [0.062 inch] above the joint face of the cylinder block.





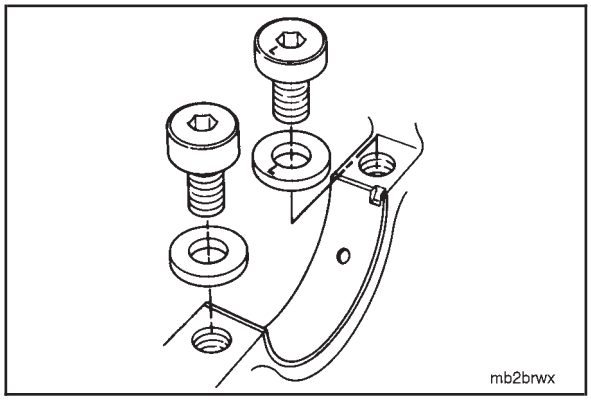
Visually inspect the side to side position of the repair sleeve.

NOTE: In most cases the sleeve will be flush with the side walls, but a variation of 0.38 mm [0.015 inch] from flush is acceptable.



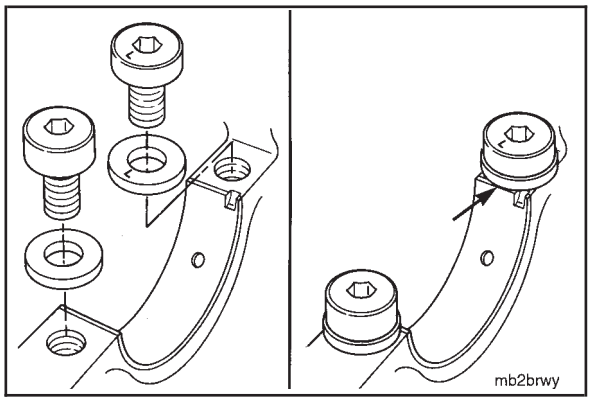
Visually inspect the position of the oil supply passage.

NOTE: A 2.4 mm [0.094 inch] diameter rod **must** pass through the repair sleeve and into the oil passage in the cylinder block.



Install the washers, Part No. 3822494 and Part No. 3822493, using bolts, Part No. 3822492.

NOTE: The washer marked "L" **must** be installed on the tang side of the main bearing bore.

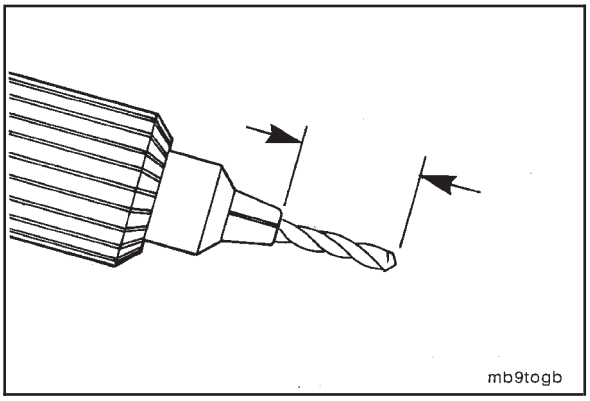


Install the washers so the edge of the repair sleeve is being held down by the washers.

Torque Value: 55 N•m [40 ft-lb]

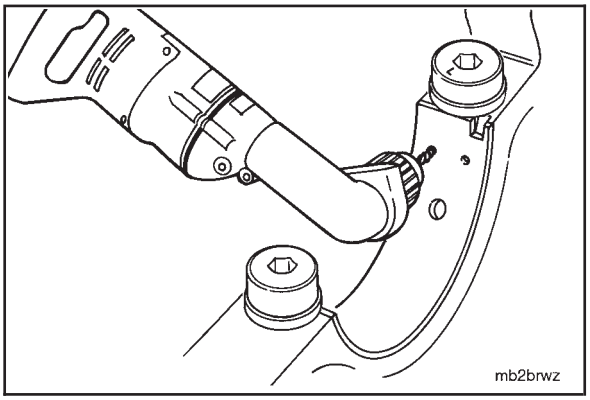
Install drill bit, Part No. 3377437, in a 90 degree drill motor.

NOTE: 5.84 to 6.35 mm [0.230 to 0.250 inch] of the drill bit **must** protrude from the chuck jaws.



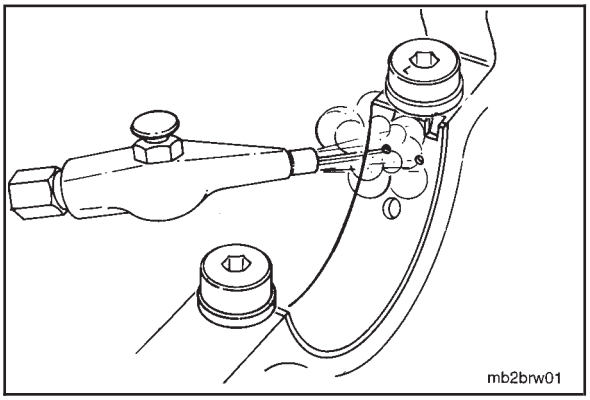
Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

Use cutting oil. Drill the cylinder block in four locations using the holes in the repair sleeve as a guide.

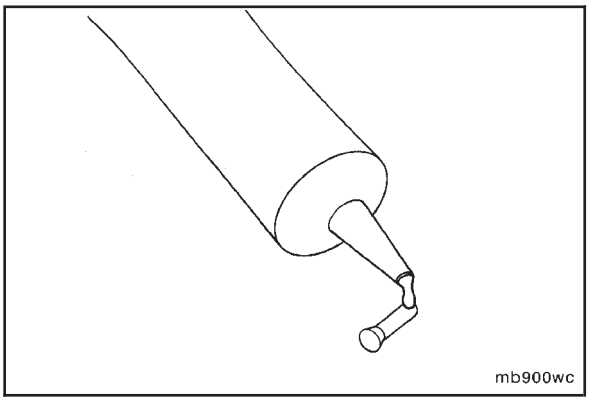


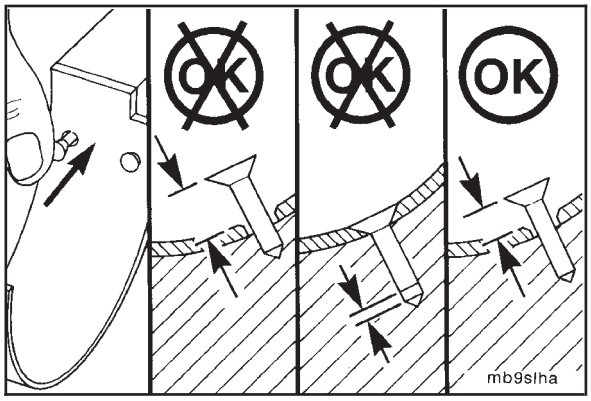
Warning: When using compressed air to clean capscrew holes, wear goggles or a face shield to protect the eyes. Personal injury can result.

Used compressed air to clean the debris from the holes.



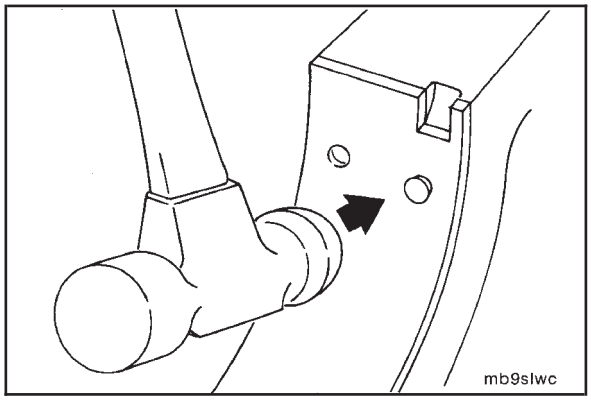
Apply a thin coating of sealant, Part No. 3375068 or equivalent, on the tip and body of four retaining rivets, Part No. 3376426.



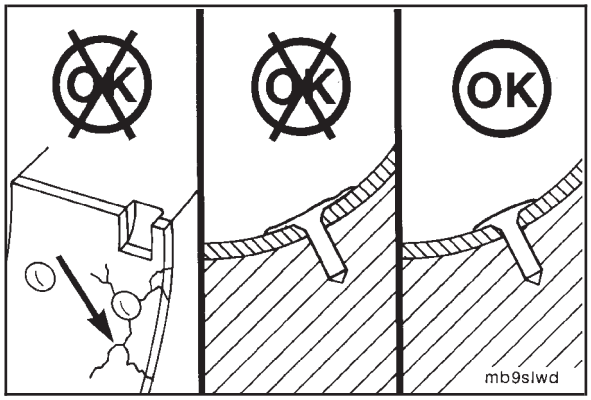


Install the rivets into the holes.

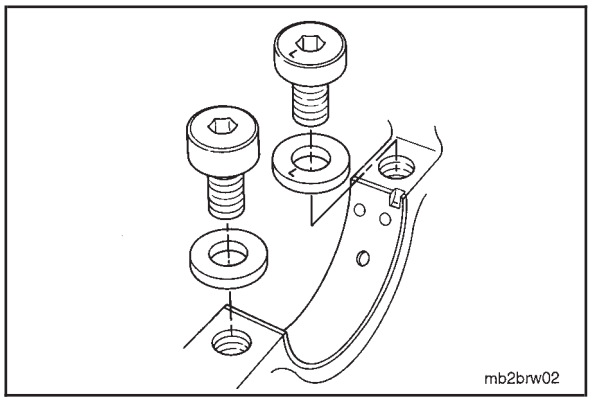
NOTE: The rivets will protrude approximately 2.54 mm [0.100 inch] if drilled and installed correctly.



Peen the rivets to the repair sleeve.

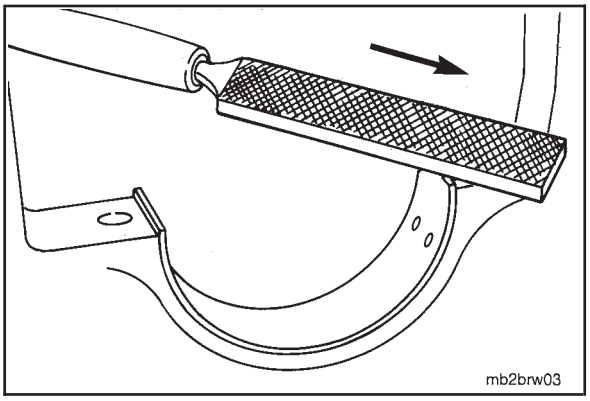


NOTE: Fully peen the rivets. Care **must** be taken **not** to damage the repair sleeve.

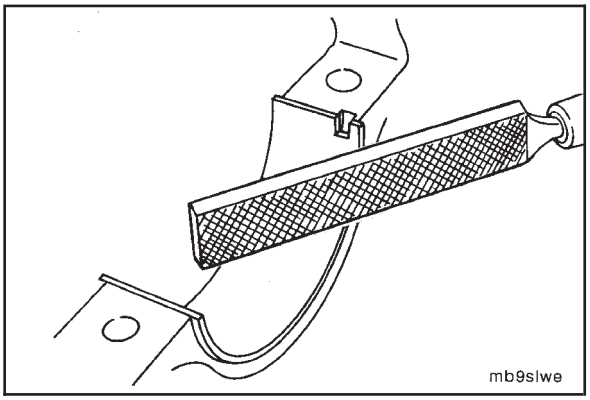


Remove the retaining washers and capscrews.

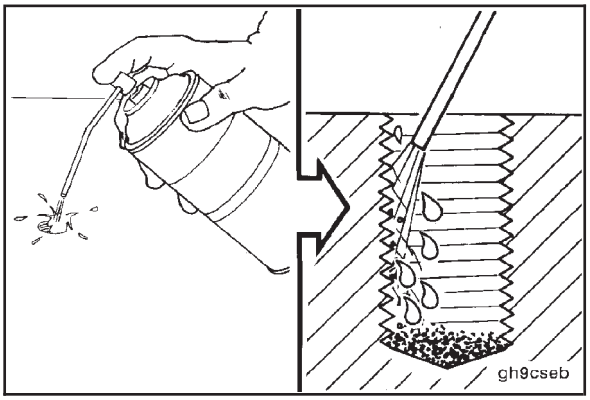
Use a flat mill file to file the ends of the repair sleeve until they are flush with the joint face of the cylinder block.



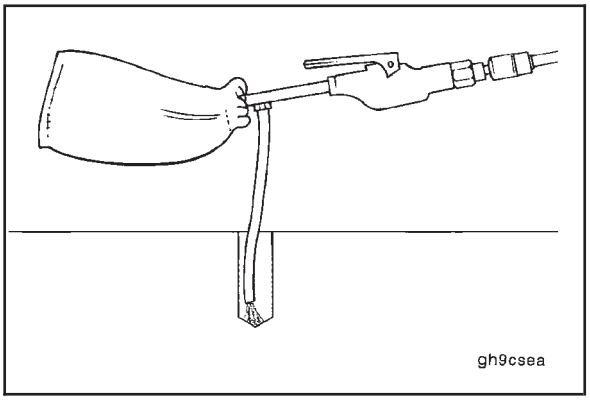
File the edge(s) of the repair sleeve until they are flush with the sides of the main bearing bore.

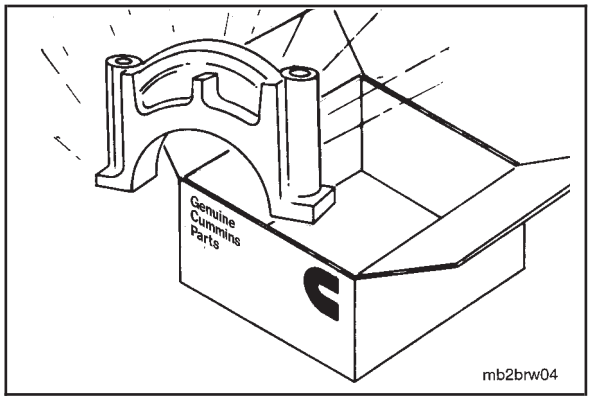


Use a spray cleaner to flush and clean the main bearing capscrew holes.



Use chip removal unit, Part No. ST-1272-11, to remove the debris and excess cleaner from the capscrew holes.



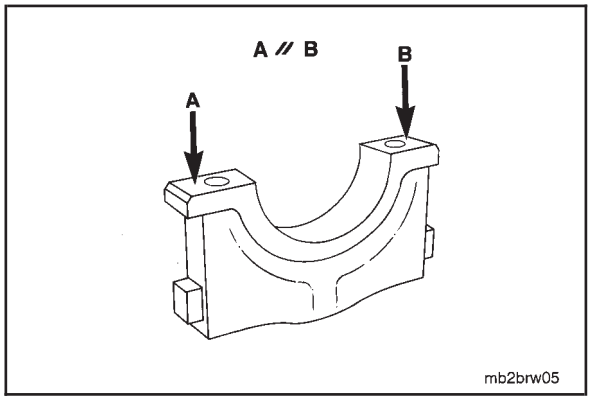


Main Bearing Cap — Installation

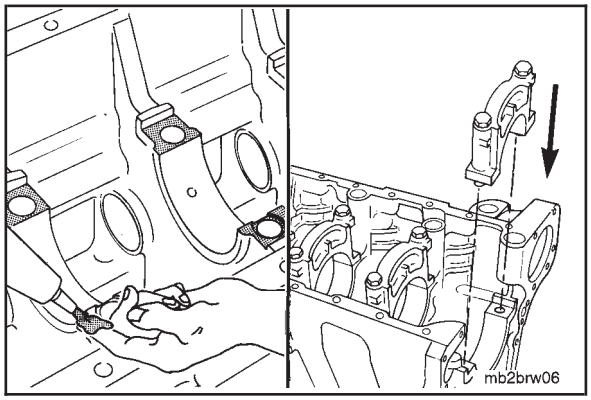
Either a new replacement semi-finished main bearing cap or the original cap that has had the parting face machined can be installed.

If the original cap has been damaged, it can be made reusable by machining the parting face of the cap.

NOTE: Typical machining will remove about 0.25 mm [0.010 inch] from the parting face.



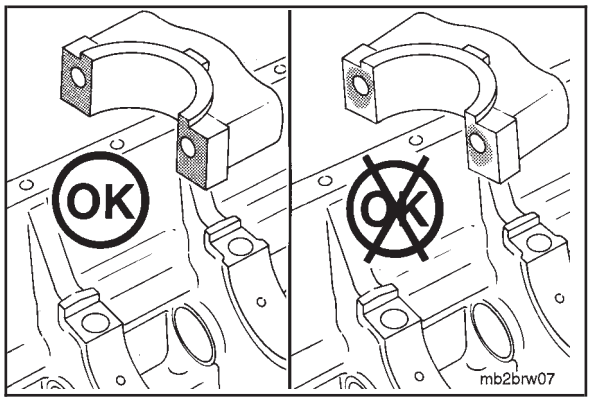
When machining the parting face of a cap, it is very important the faces are machined parallel to each other and perpendicular to the sides of the cap. After machining, the cap **must** fit squarely on the joint face of the cylinder block.



To check for squareness, apply a light coat of bluing compound to the cylinder block joint face.

Install the main bearing cap.

Torque Value: 135 N•m [100 ft-lb]



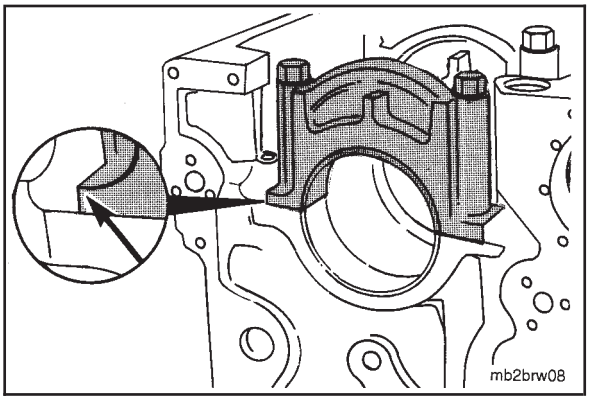
Remove the retaining capscrews and the main bearing cap.

NOTE: A bluing transfer of less than 80 percent is **not** acceptable.

Remove the bluing from the joint faces and the main bearing bore.

Install the main bearing cap.

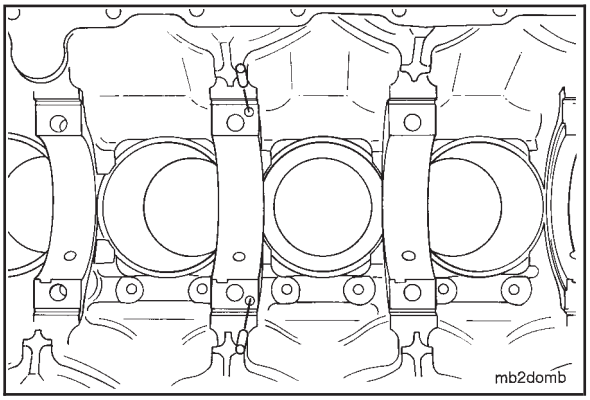
NOTE: Make sure a press fit exists between cap and the cylinder block.



Main Bearing Bore Dowel Holes — Redrilling

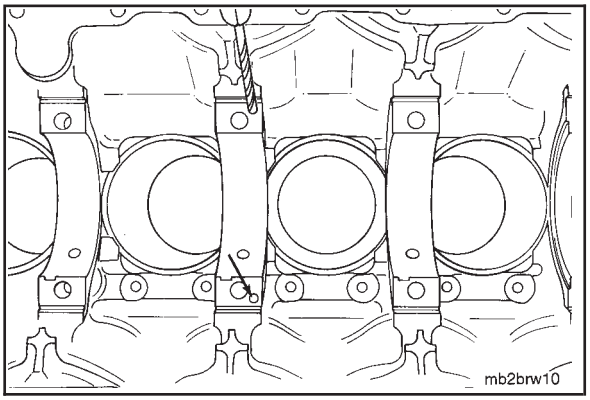
NOTE: If a replacement cap is installed on the No. 4 main bearing bore, it is necessary to relocate the dowel holes. The thrust bearing surfaces also **must** be machined after replacing the dowels.

Remove the dowels from the cylinder block.



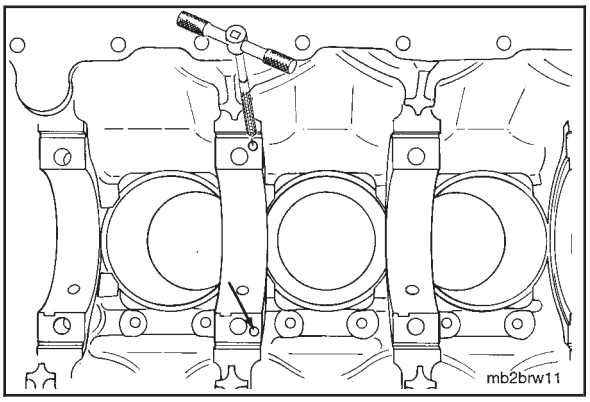
Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

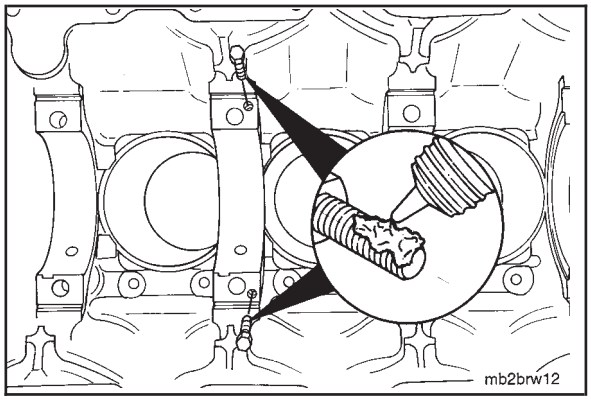
Use a 6.63 mm [0.261 inch] diameter drill bit and cutting oil to drill the dowel holes out.



Use a 5/16-18 bottoming tap and cutting oil to tap threads in the dowel holes.

NOTE: The tap depth **must** be 7.9 to 9.7 mm [0.31 to 0.38 inch].

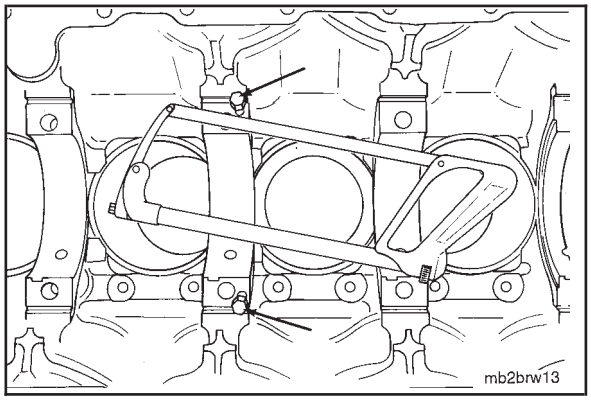




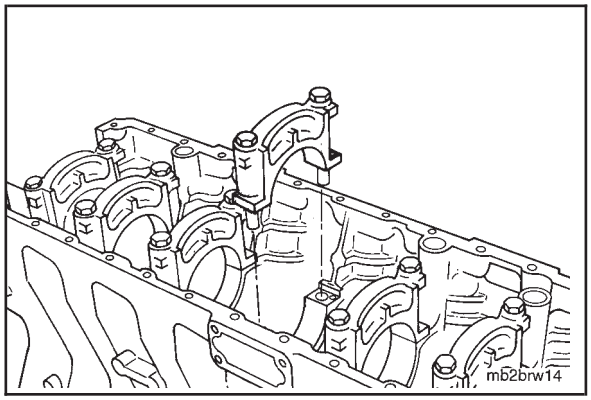
Apply sealant, Part No. 3375068 or equivalent, to the threads of a 5/16-18 grade 5 capscrew.

Install the capscrew in the threaded hole.

Torque Value: 20 N•M [15 ft-lb]



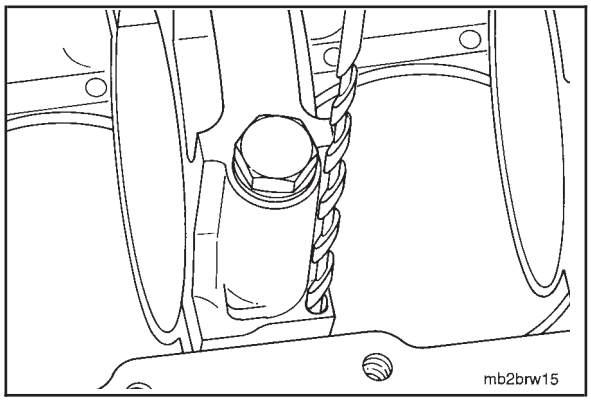
Cut the capscrew off. Use a flat mill file to file the capscrew flush with the cylinder block.



Install the replacement main bearing cap. Center the cap over the cylinder block web.

Install the main bearing capscrews.

Torque Value: 135 N•m [100 ft-lb]

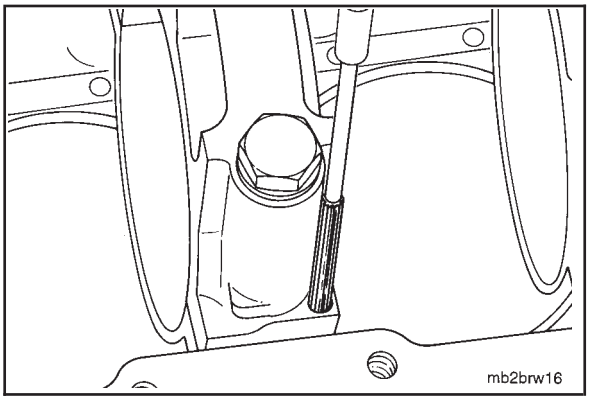


Warning: To avoid possible eye damage, always wear protective goggles when drilling metal.

Use cutting oil. Drill two 15/64 inch diameter holes in the cylinder block using the holes in the cap as a guide.

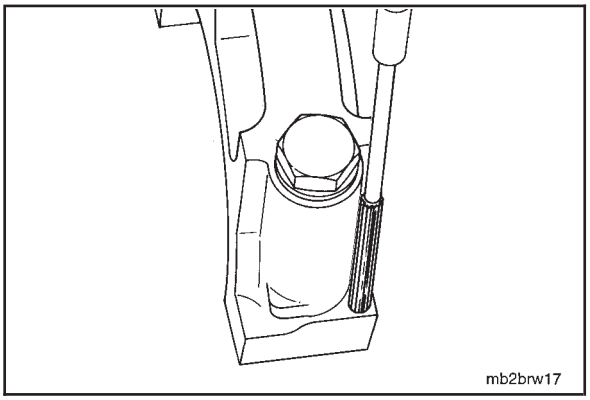
Use a 0.250 inch reamer and cutting oil to ream the holes in the cap and cylinder block.

NOTE: The reamer depth in the cylinder block **must** be 5.59 to 6.40 mm [0.220 to 0.252 inch].



Use a 0.252 inch reamer to ream the holes in the cap.

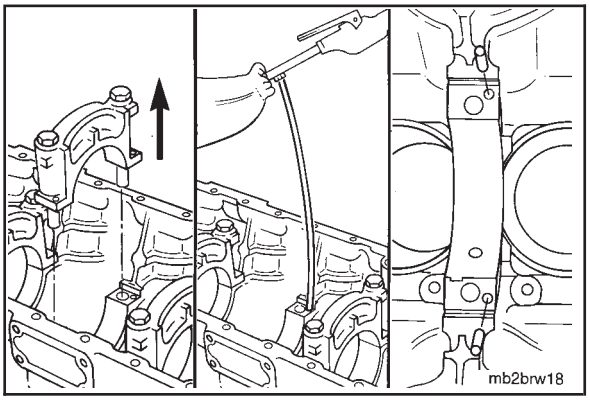
NOTE: Do **not** ream more than 0.99 mm [0.039 inch] into the cylinder block.



Remove the main bearing cap.

Use chip removal unit, Part No. ST-1272-11, to remove any debris from the dowel pin holes.

Install a new dowel pin, Part No. 148555, in each hole of the cylinder block.

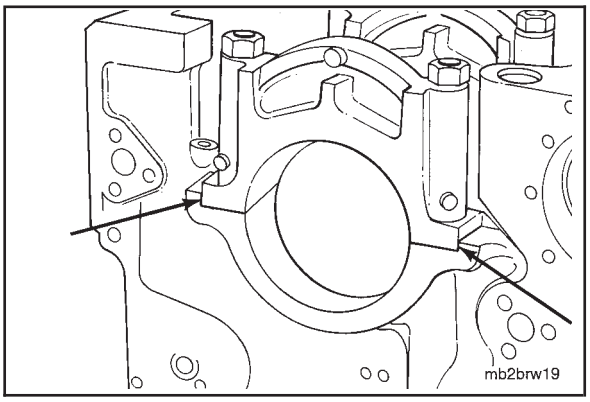


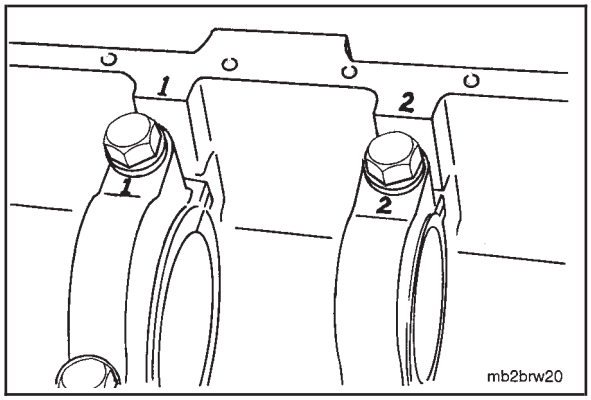
Repair Sleeve and Replacement Cap - Machining

Install the main bearing cap.

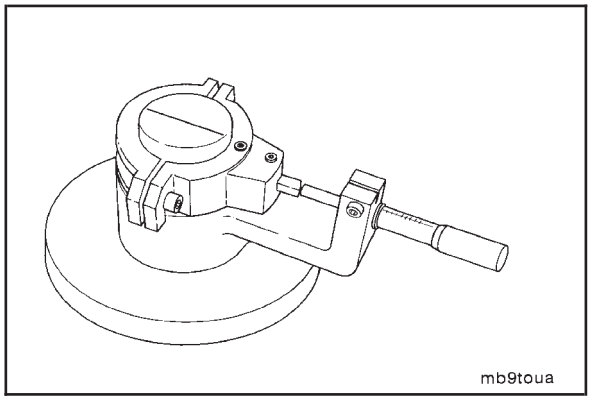
NOTE: Make sure a press fit between the cylinder block and main bearing cap is present.

Torque Value: Step 1 - 70 N•m [50 ft-lb]
2 - 140 N•m [105 ft-lb]
3 - 210 N•m [155 ft-lb]
4 - Loosen
5 - 70 N•m [50 ft-lb]
6 - 140 N•m [105 ft-lb]
7 - 210 N•m [155 ft-lb]



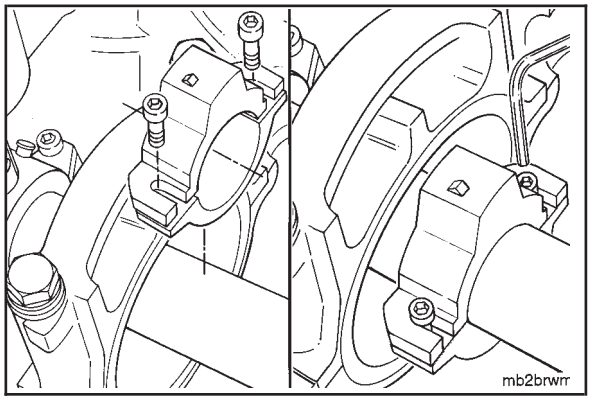


Mark the cap to identify its position if a replacement cap is being used.

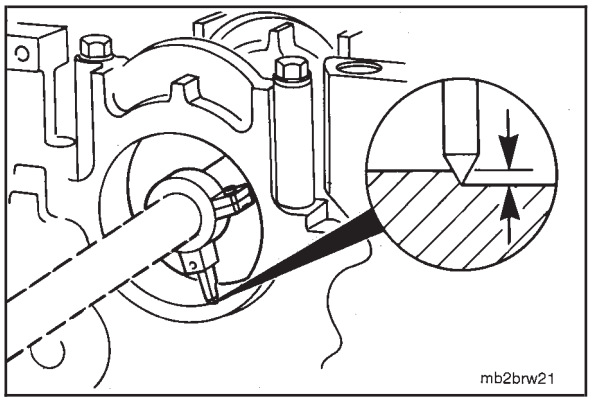


Set the cutter tool. Refer to Setting the Cutter.

NOTE: The inside diameter of the main bearing bore can be enlarged a maximum of 0.76 mm [0.030 inch] per cut.



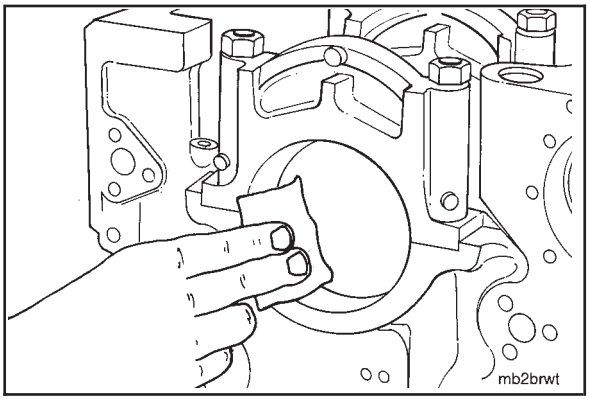
Install the tool on the cylinder block. Refer to Install the Main Bearing Bore Tool.



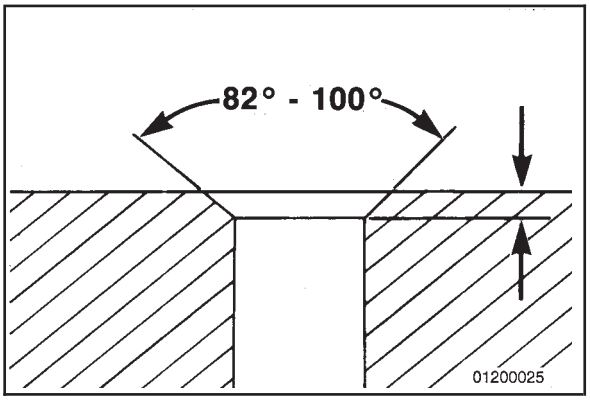
NOTE: The maximum amount of material to remove per cut is 0.76 mm [0.030 inch]. Do **not** remove more than 0.25 mm [0.010 inch] of material on the final cut.

Enlarge the main bearing bore to 121.990 to 122.010 mm [4.8020 to 4.8035 inch]. Refer to Machining the Main Bearing Bore.

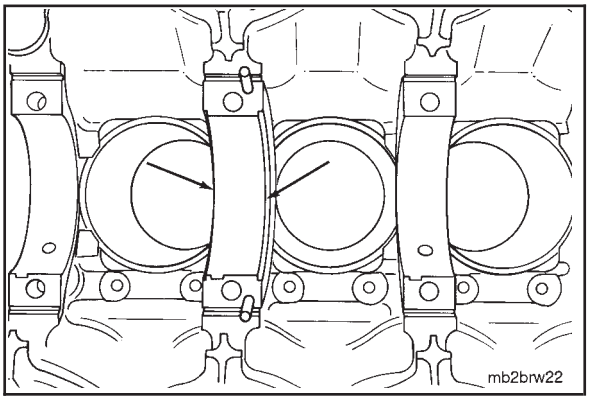
Use emery cloth to remove any burrs from the main bearing bore.



Use a drill bit and cutting oil to chamfer the oil supply hole in the repair sleeve.



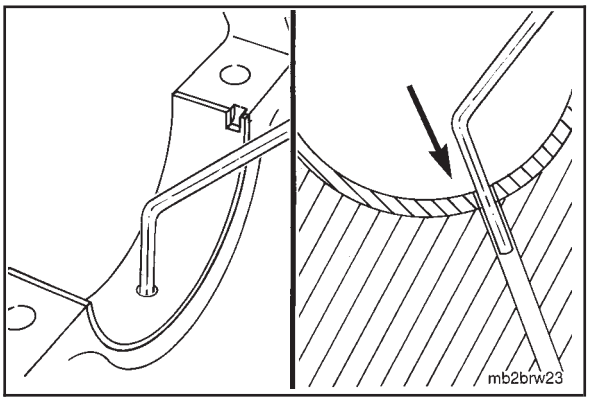
If the No. 4 main bearing bore has been repaired and a replacement cap has been installed, it will be necessary to cut the crankshaft thrust face surfaces. Refer to Cylinder Block Crankshaft Thrust Surface Machining .

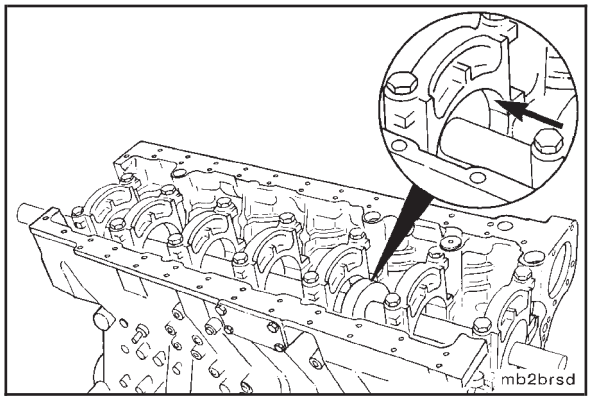


Final Inspection

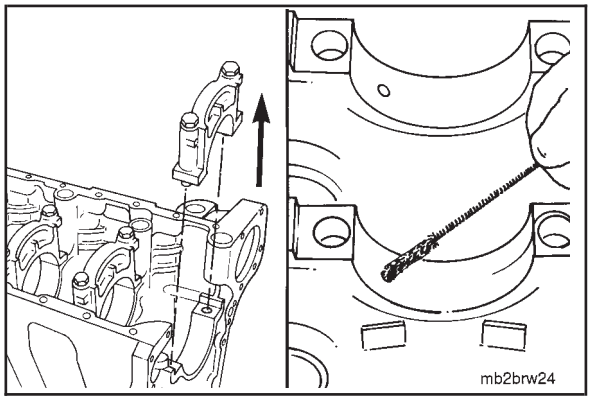
Inspect the oil supply passage to make sure it is aligned correctly.

NOTE: A 4.8 mm [3/16 inch] outside diameter rod **must** pass through the oil passage.



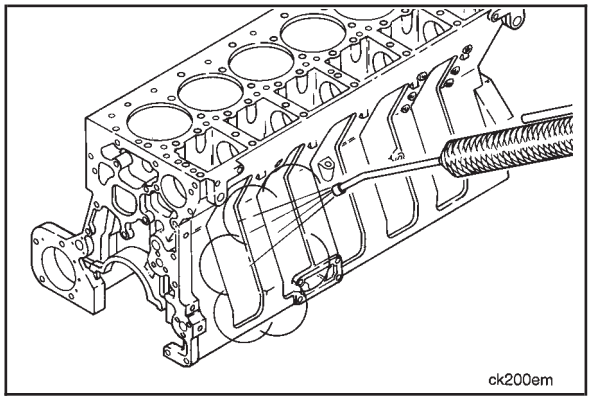


Inspect the main bearing bore alignment. Refer to Main Bearing Bore Alignment — Inspection.



Remove the main bearing caps.

Use a bristle brush to clean the oil drillings.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

Use steam to clean the cylinder block and dry with compressed air.

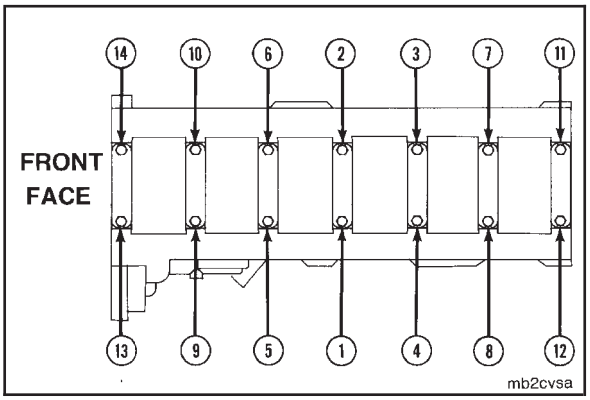
NOTE: Make sure to blow out all oil drillings, pipe plug bores, and capscrew threads.

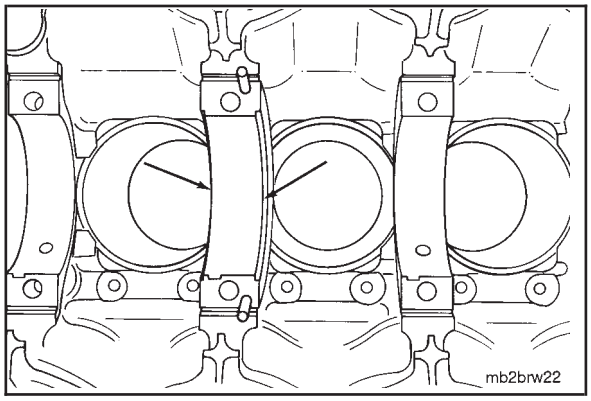
Specifications — Main Bearing Bore Repair

Measurement	mm		Inch
Main Bearing Bore I.D.	121.990 122.010	MIN MAX	4.8028 4.8035
Main Bearing Bore I.D. (Cut for Repair Sleeve)	124.51 124.61	MIN MAX	4.902 4.906
I.D. Enlargement — Per Cut	0.76	MAX	0.030
I.D. Enlargement — Final Cut	0.25	MAX	0.010
Surface Finish	2u m	MIN	80u in

Main Bearing Capscrew Torque:

Torque Value: Step 1 - 70 N•m [50 ft-lb]
2 - 140 N•m [105 ft-lb]
3 - 210 N•m [155 ft-lb]
4 - Loosen
5 - 70 N•m [50 ft-lb]
6 - 140 N•m [105 ft-lb]
7 - 210 N•m [155 ft-lb]



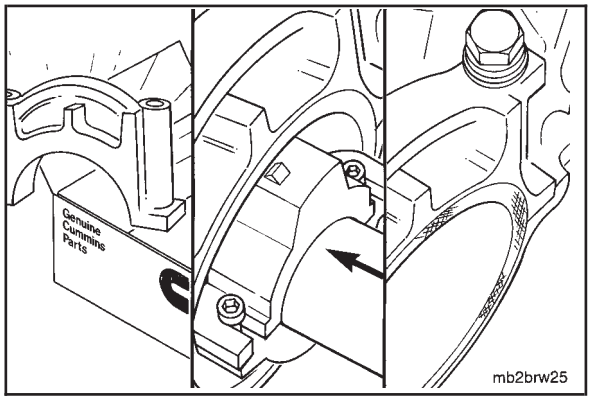


Cylinder Block Crankshaft Thrust Surface Machining

General Information

This procedure describes the method for machining the thrust surfaces on an L10 or M11 cylinder block. The thrust surfaces are located at No. 4 main bearing saddle.

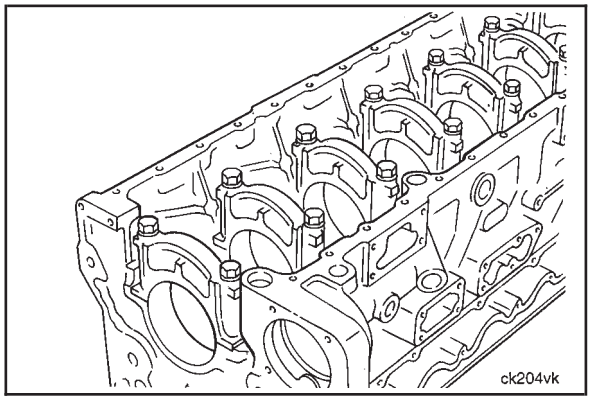
NOTE: When the No. 4 main bearing cap is replaced, the dowel pins **must** be replaced before performing this procedure. Refer to Main Bearing Bore Dowel Holes - Redrill.



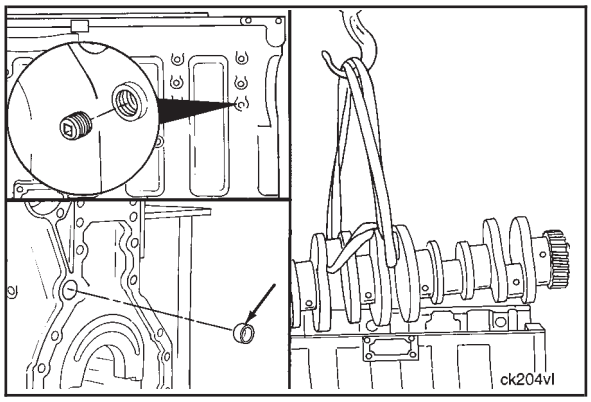
This operation is usually performed for one of the following reasons:

- No. 4 main bearing cap has been replaced or machined.
- No. 4 main bearing bore has been repaired.
- Thrust bearings have spun.

NOTE: There **must** be an original unmarred spot on either the front or rear thrust face surface to use as a reference point. In most cases, either the front or rear thrust surface is undamaged.



The repair **must** be performed with the engine out of chassis. The cylinder block **must** be resting on the cylinder head deck surface. Cylinder block distortion will result if the engine is mounted on an engine stand.



Initial Preparation and Inspection

Remove the pipe plugs and cup plugs from the cylinder block.

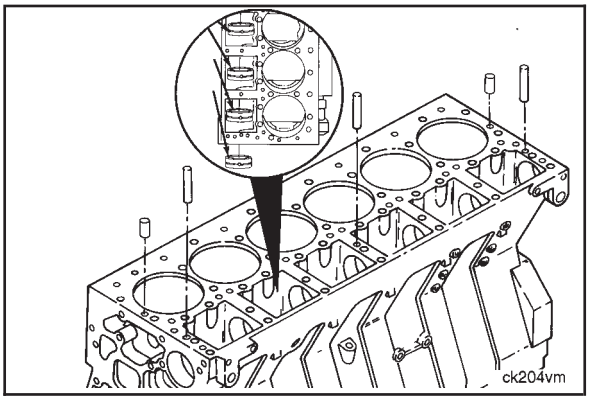
Remove the crankshaft.

Remove the cam follower studs.

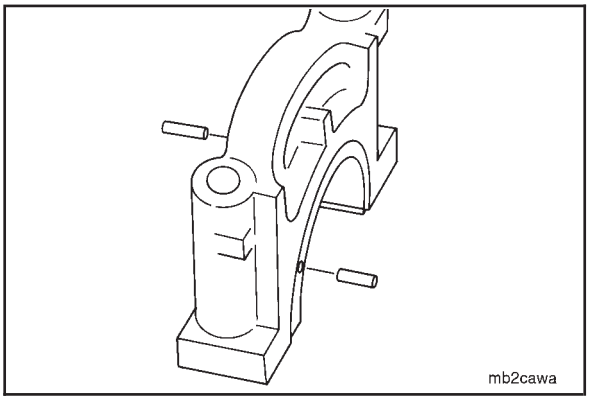
Remove the camshaft bushings.

Remove the dowel pins from the cylinder block top deck surface. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



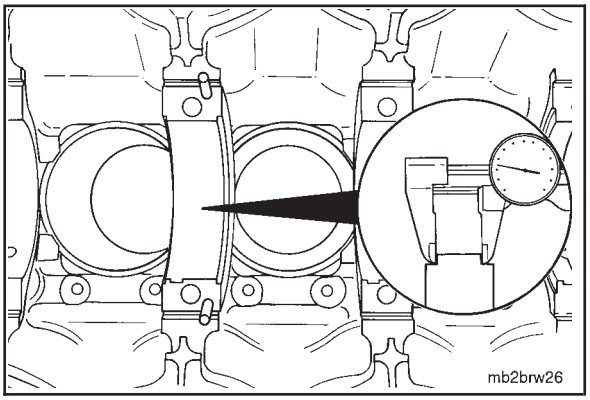
Remove the split pins from both sides of the No. 4 main bearing cap if the original cap is being used.



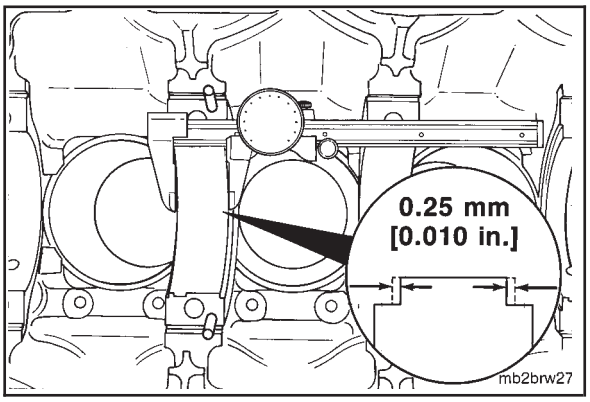
Measure the width of the cylinder block between the front and rear thrust bearing surfaces.

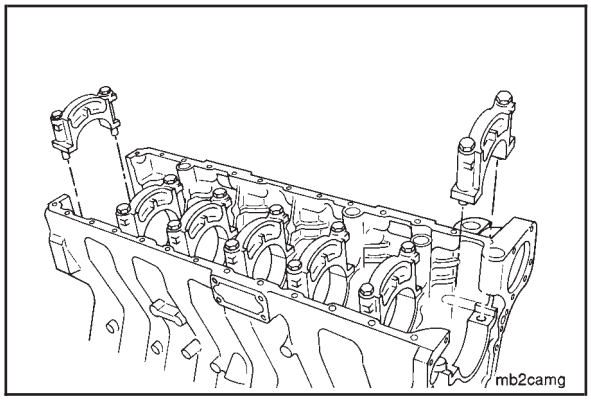
Cylinder Block Thrust Bearing Surface Width		
mm		in
39.95	MIN	1.573
40.05	MAX	1.577

NOTE: One original undamaged thrust bearing surface point is required as a reference point for this measurement.



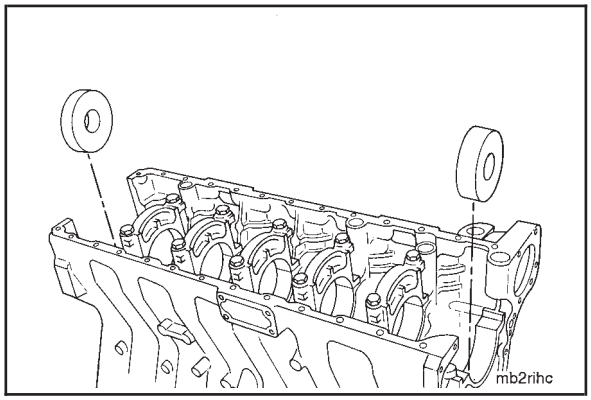
Currently, only 0.25 mm [0.010 inch] oversize thrust bearings are available. Therefore, 0.25 mm [0.010 inch] can be removed from each thrust face assuming that a crankshaft with a standard No. 4 thrust bearing journal width is used with this cylinder block.





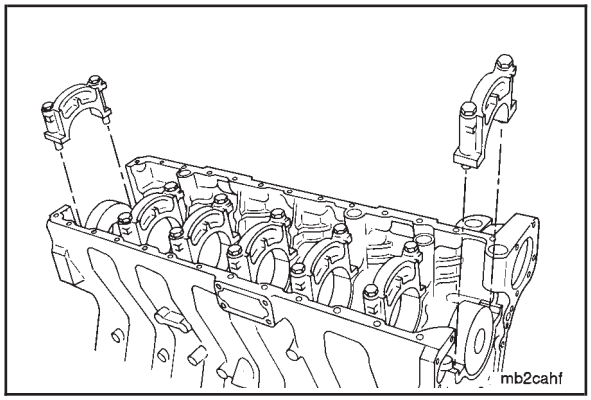
Crankshaft Thrust Surface Cutting Tool - Installation

Remove No. 1 and No. 7 main bearing caps.



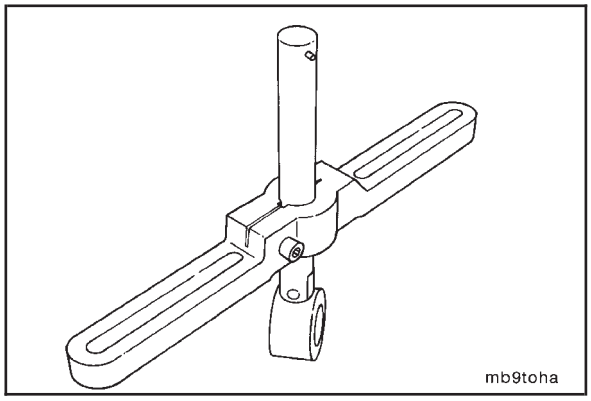
Install a centering ring, Part No.3376781, in each main bearing bore saddle.

Tap on the top of each centering ring with a plastic hammer to seat the centering rings in the bearing saddles.



Install the main bearing caps.

Torque Value: Step 1 - 70 N•m [50 ft-lb]
2 - 140 N•m [105 ft-lb]
3 - 210 N•m [155 ft-lb]
4 - Loosen
5 - 70 N•m [50 ft-lb]
6 - 140 N•m [105 ft-lb]
7 - 210 N•m [155 ft-lb]

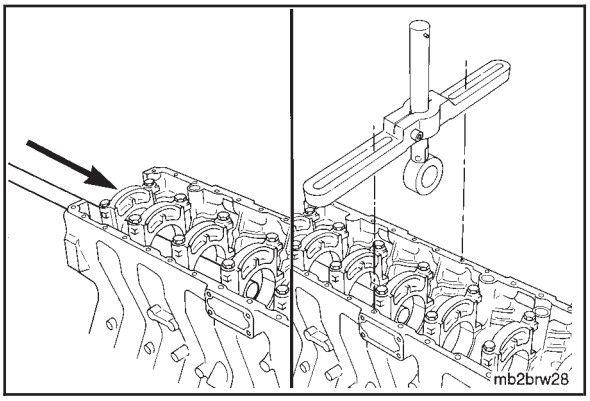


Install bearing bar, Part No. ST-1177-22, in bridge, Part No. ST-1177-18.

NOTE: Align the notch in the bore bar bridge with the dowel in the bearing bar.

Install the boring bar, Part No. ST-1177-16, through one centering ring, the bearing bar and the other centering ring.

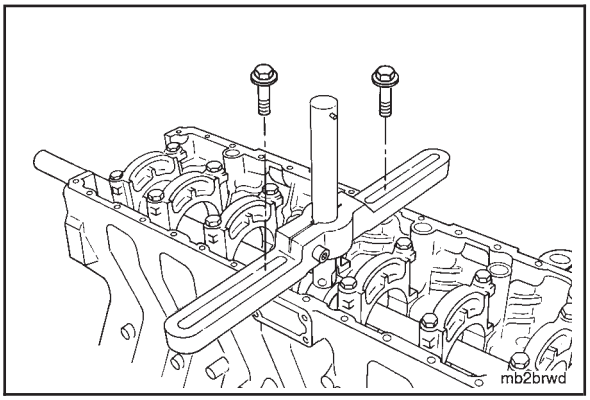
NOTE: The bearing bar **must** be located between No. 3 and No. 4 main bearing journals if cutting the rear thrust face, and between No. 4 and No. 5 main bearing journals if cutting the front thrust face.



Install two M10 x 60 capscrews in the bridge to lock it to the oil pan rail.

Torque Value: 45 N•m [35 ft-lb]

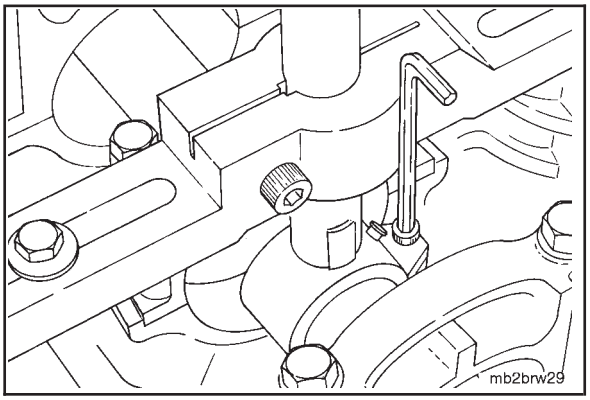
Tighten the socket head capscrew to lock the bearing bar to the bridge.



Tighten the socket head capscrew on the bearing bar.

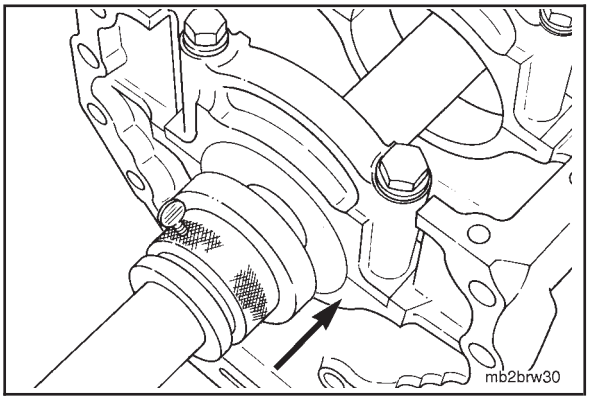
NOTE: Do **not** tighten so much as to bind the boring bar.

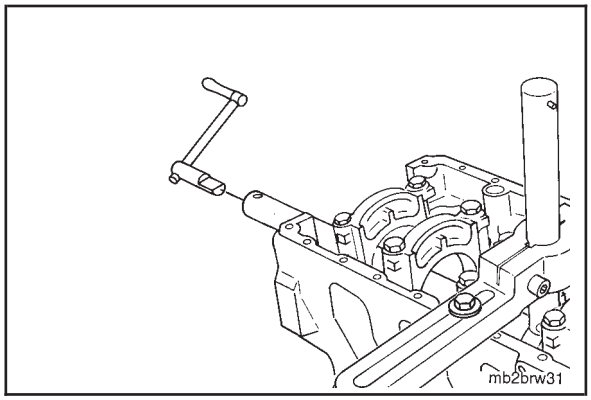
Turn the boring bar by hand to make sure it rotates freely.



Install the depth set collar onto the boring bar rear block face if machining the front thrust surface. Do **not** tighten the set screw at this time.

NOTE: The depth set collar **must** be installed on the front face if machining the rear thrust surface.

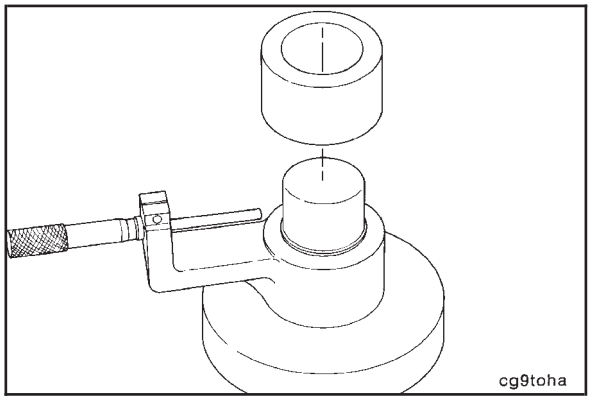




Install the crank handle.

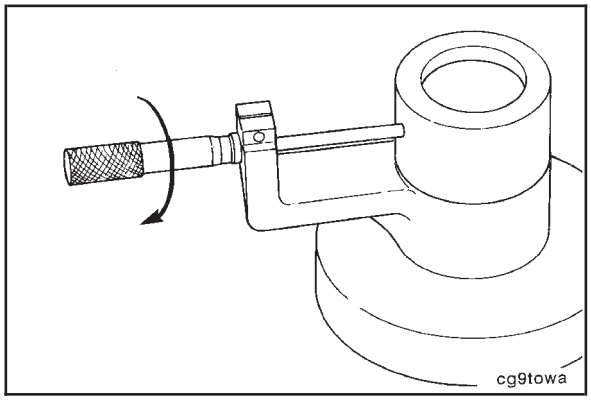
NOTE: align the flat on the crank handle with the set screw in the boring bar.

Tighten the set screw.



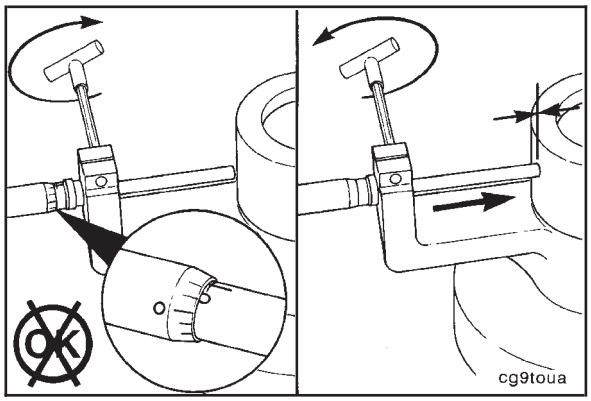
Crankshaft Thrust Surface Cutting Tool - Setting Cutter

Install the micrometer setting ring, Part No. 3376355, in the micrometer base assembly, Part No. ST-1177-5111.



Adjust the micrometer thimble in until light contact is made with the setting ring.

NOTE: The micrometer **must** be recalibrated if it does **not** indicate 76.2 mm [3.00 inch].

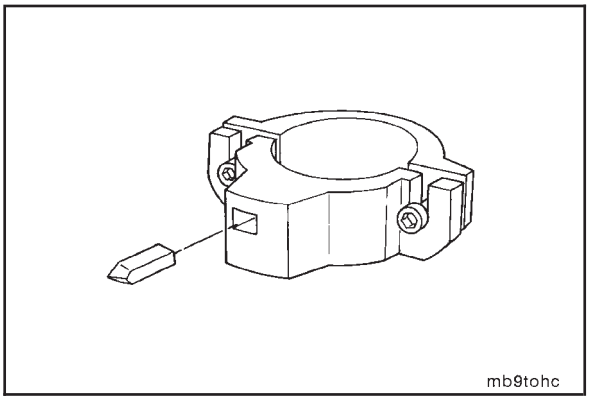


If recalibration is necessary:

- Loosen the socket head capscrew holding the thimble. Set the micrometer to "0".
- Move the micrometer in the holder until light contact is made with the setting ring and tighten the capscrew.

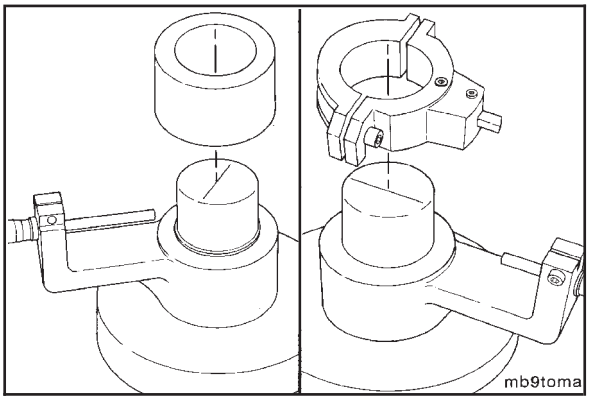
Install cutter tool, Part No. 3376202, in the cutter holder, Part No. 3375053.

NOTE: Position the cutter tool as shown with the cutting face at the holder center line. This will set the cutter tool for a clockwise cranking direction of the crank handle.



Remove the setting ring from the micrometer base assembly and install the cutter tool and holder assembly.

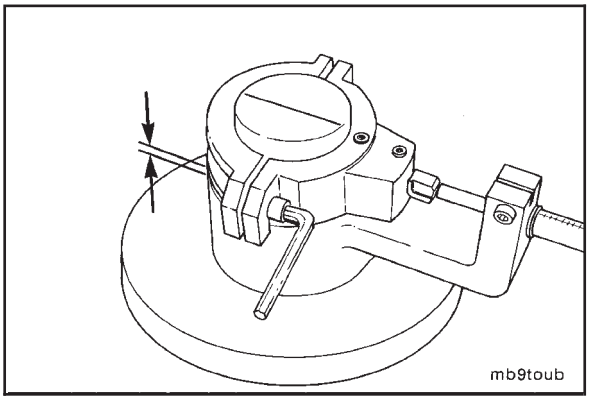
NOTE: The set screw in the holder and the cutting face of the cutter tool **must** be facing up.



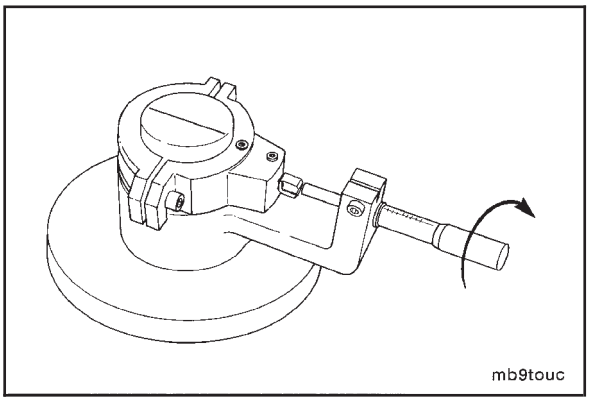
Align the centerline of the cutter tool with the line on the micrometer base assembly.

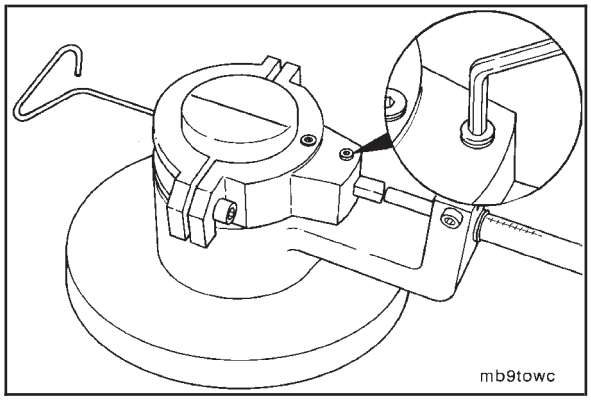
Raise the holder approximately 1.6 mm [0.063 inch] to allow the wire to fit into the square hole in the micrometer base assembly.

Tighten the socket head capscrews to lock the cutter holder to the micrometer.



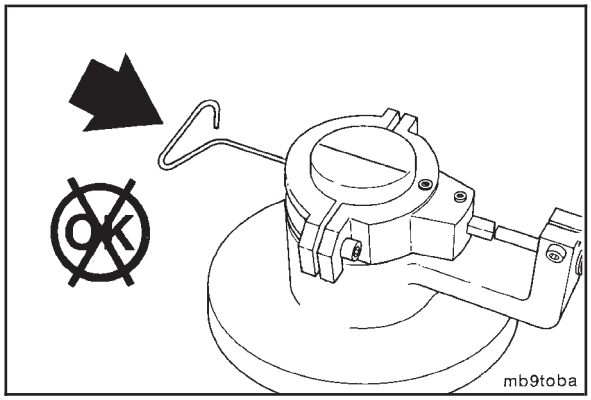
Set the micrometer to 141.91 mm [5.587 inch].



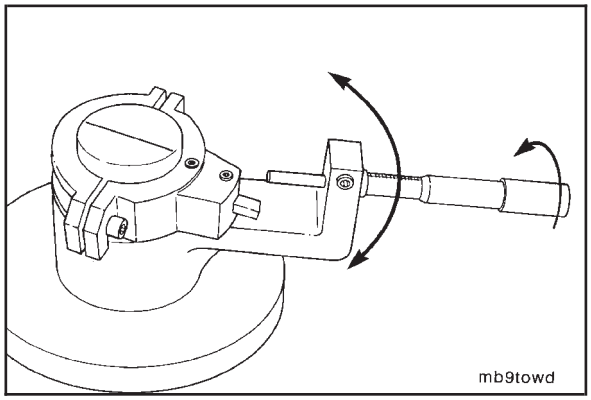


Push the cutter tool forward with the wire provided until it makes light contact with the micrometer shaft.

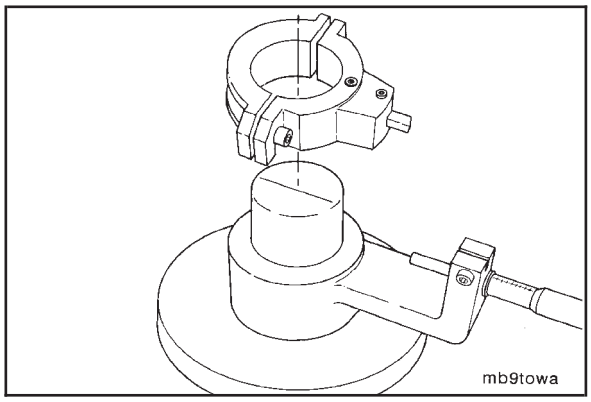
Tighten the set screw to lock the cutter tool in place.



Caution: Care must be taken when pushing the cutter tool against the micrometer shaft. The carbide tip of the cutter tool is extremely brittle and can chip if excessive force is used.



Verify the size by backing off the thimble slightly and then moving it forward gradually while swinging the micrometer back and forth gently until light contact is made with the cutter tool.

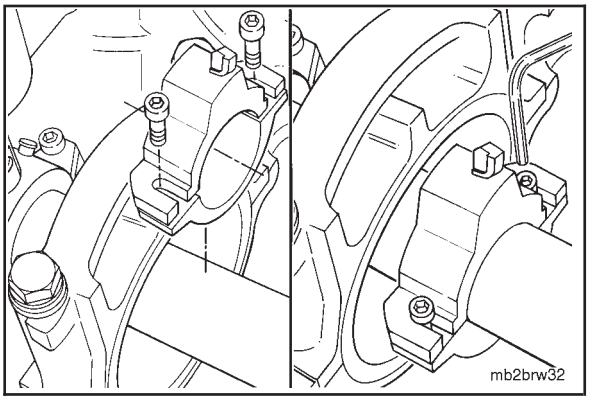


Swing the micrometer away from the cutter tool and remove the cutter holder from the micrometer base assembly.

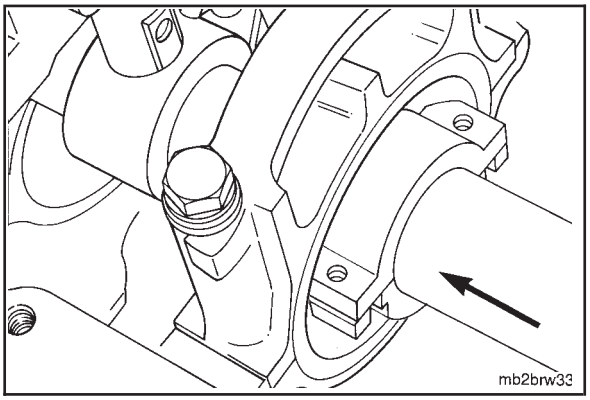
Crankshaft Thrust Face — Machining

Install the cutter tool and holder assembly onto the boring bar. Tighten the socket head capscrews.

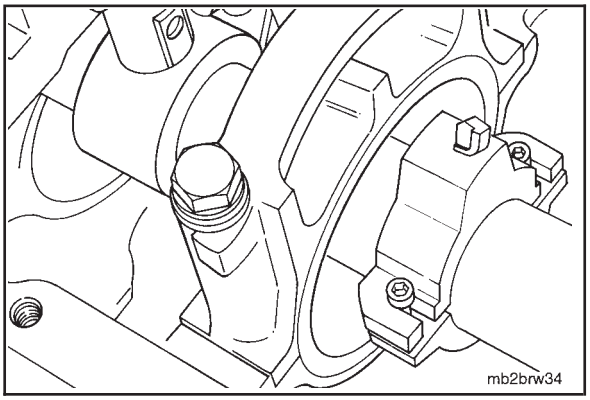
NOTE: The tool **must** be positioned for **clockwise** crank handle rotation.



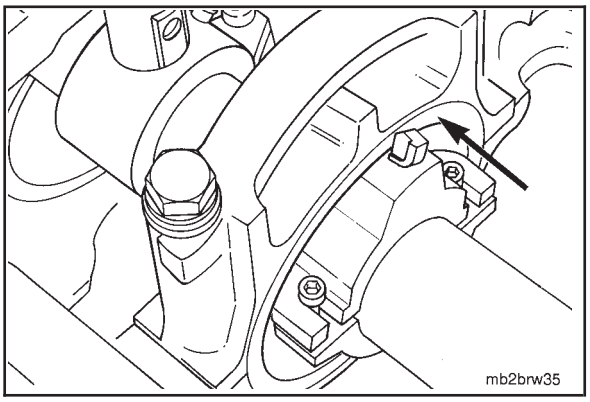
Verify the diameter setting of the cutter tool by locating it in the downward position and pushing it into the thrust surface on the cylinder block. It **must** fit in the recess in the block for the thrust bearings.

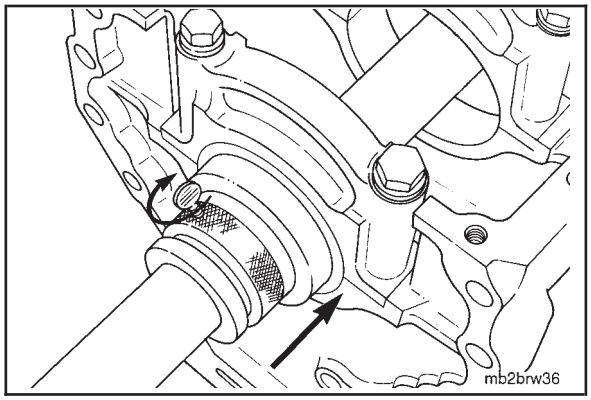


Pull the tool back away from the thrust surface and position it in the 12 o'clock position.



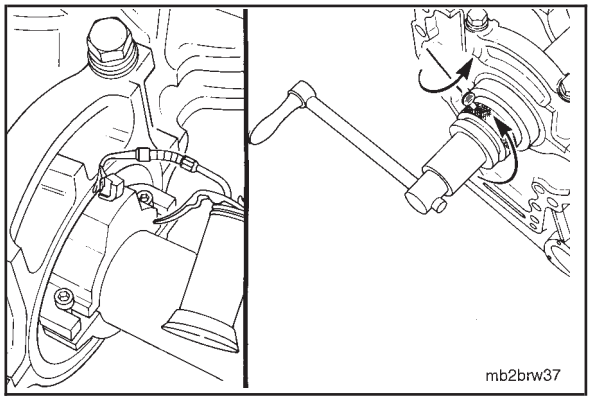
Push the cutter tool back in until it makes light contact with the main bearing cap.





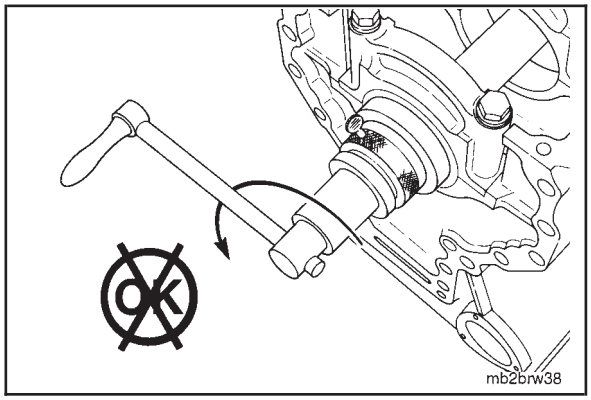
Push the depth set collar against the centering ring and tighten the set screw.

Tighten the thumb screw on the depth set collar.

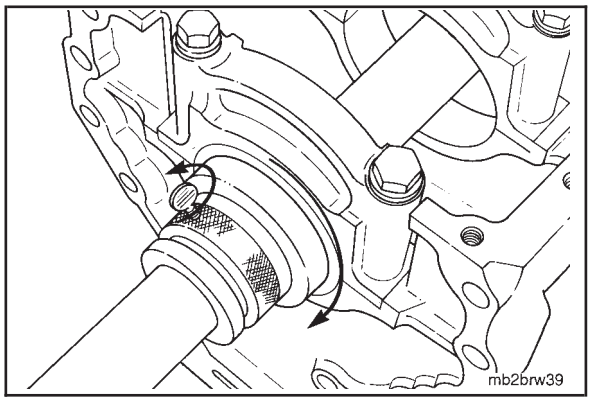


Use cutting oil while rotating the crank handle in a **clockwise** direction. Rotate the crank handle until no more material is being removed from the cylinder block and main bearing cap.

NOTE: If the crank handle is too difficult to turn, loosen the thumb screw on the depth set collar and rotate the collar **counterclockwise.**



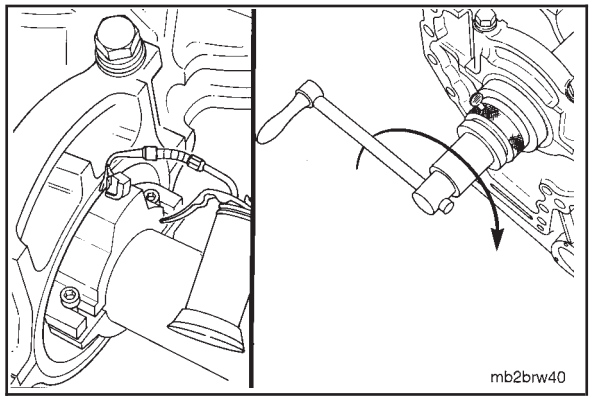
Caution: Do not rotate the crank handle counterclockwise as damage to the cutter will result.



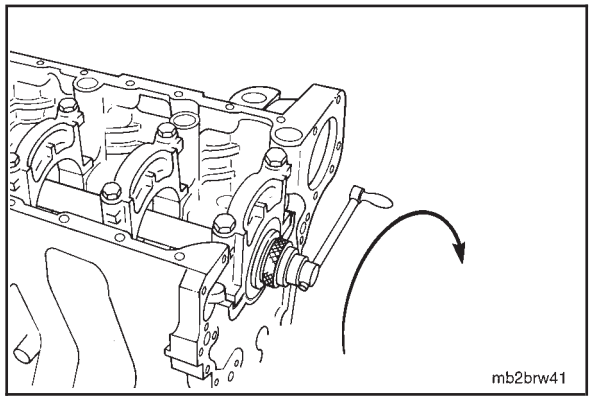
Loosen the thumb screw and turn the depth set collar one notch.

NOTE: One notch equals 0.03 mm [0.001 inch].

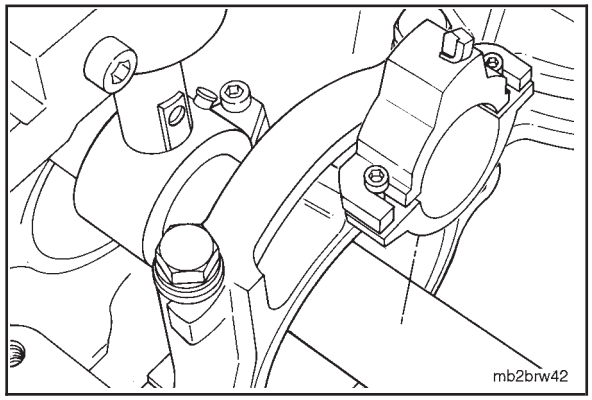
Use cutting oil while turning the crank handle **clockwise** until no more metal is being removed from the main bearing cap and cylinder block.



Repeat the procedure until the cylinder block and main bearing cap have been fully machined and until the specified thickness is achieved.

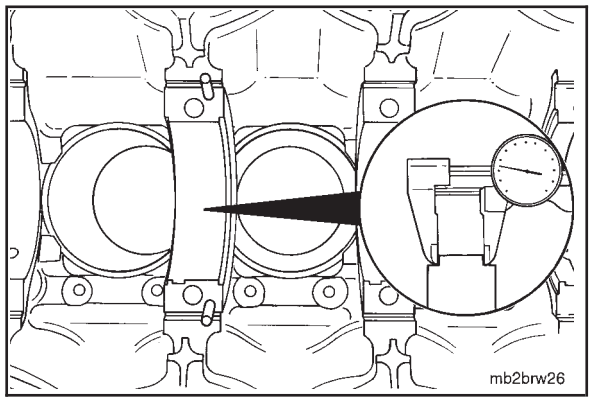


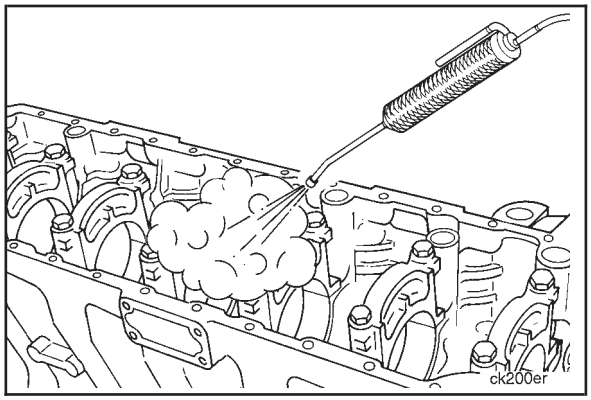
Remove the tool assembly from the cylinder block.



Final Inspection

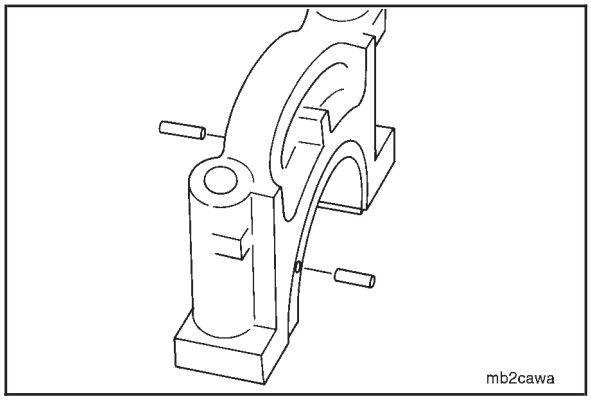
Measure the thickness of the cylinder block and main bearing cap between the front and rear thrust surface. Refer to Specifications — Cylinder Block Crankshaft Thrust Surface Machining.



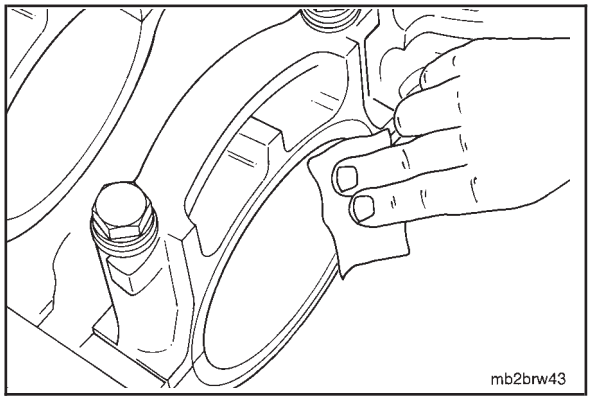


Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

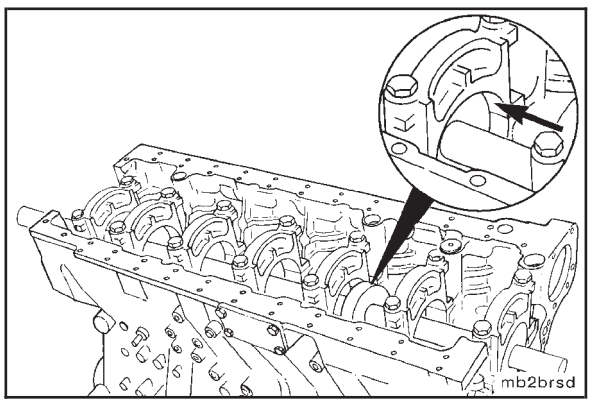
Use steam to clean the cylinder block and dry with compressed air.



Install the thrust bearing locating pins in the main bearing cap.



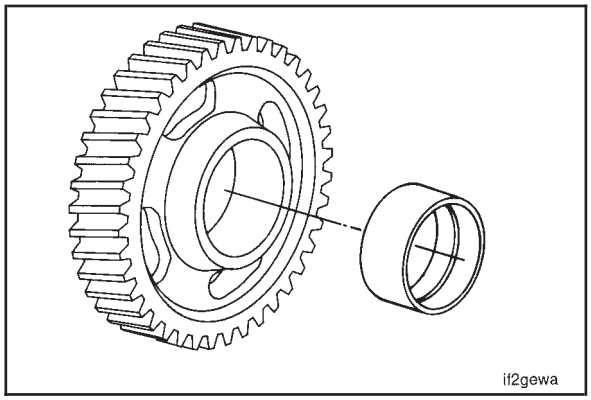
Use emery cloth to remove any burrs from the cylinder block and main bearing cap.



Inspect the main bearing bore alignment. Refer to Main Bearing Bore Alignment — Inspection.

Specifications — Cylinder Block Crankshaft Thrust Surface Machining

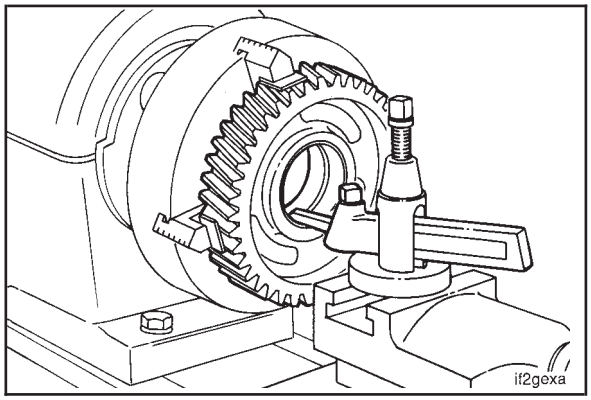
Measurement	mm		in
Original Cylinder Block Thickness	39.95 40.05	MIN MAX	1.573 1.577
Cylinder Block Thickness (One Thrust Surface Machined)	39.70 39.80	MIN MAX	1.563 1.567
Cylinder Block Thickness (Both Thrust Surfaces Machined)	39.44 39.54	MIN MAX	1.553 1.557
Micrometer Set — Diameter	141.91	MAX	5.587



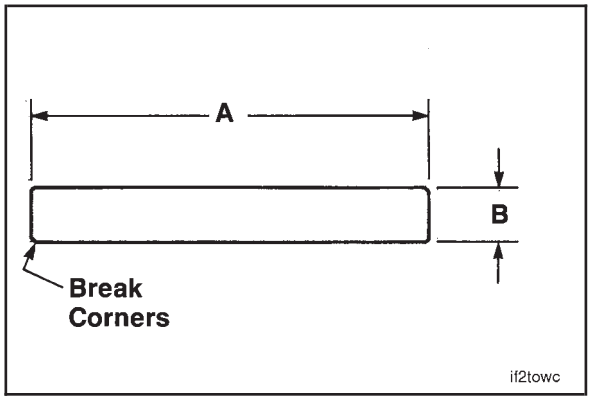
Idler Gear Bushing Repair

General Information

This procedure is **not** recommended in North America and Europe because it is more cost effective to replace the complete gear assembly in these areas. Use the following procedure only if it is significantly more cost effective compared to replacing the complete gear assembly.



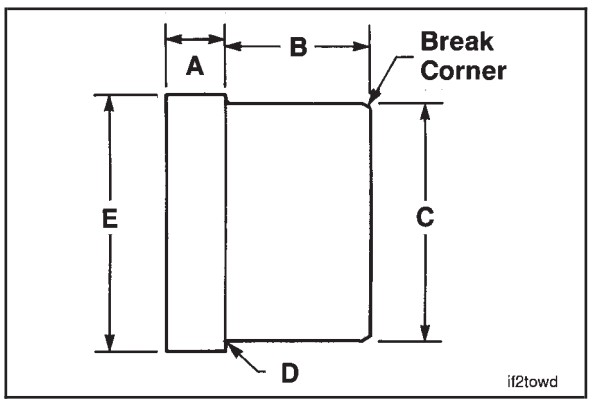
The bushing is machined to exact specifications after it is installed in the idler gear. This procedure describes specific machining steps, however, any alternative method can be used if the specifications listed in the back of this procedure are met.



The following tools **must** be fabricated to complete this repair:

- Measuring pin fabricated to the dimensions shown (four pins required). A No. 6 Drill Blank can be used.

Measuring Pin Dimensions			
Dim	mm		in
A	38.0	MIN	1.50
	42.0	MAX	1.65
B	5.171	MIN	0.2036
	5.197	MAX	0.2046

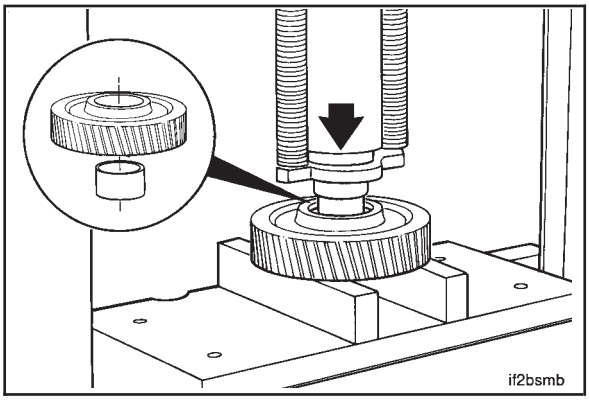


- Bushing driver fabricated to the dimensions shown.

Bushing Driver Dimensions			
Dim	mm		in
A	14.0	MIN	0.55
	16.0	MAX	0.63
B	35.0	MIN	1.38
	37.0	MAX	1.46
C	59.3	MIN	2.33
	59.4	MAX	2.34
D	0.4	MAX	0.02
E	64.5	MIN	2.54
	64.7	MAX	2.55

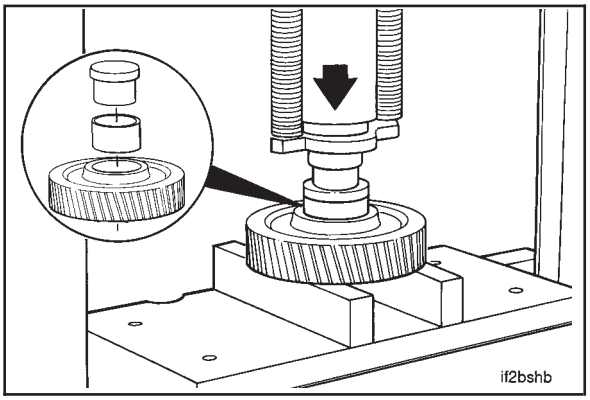
Repair Procedure

Use a hydraulic press and the bushing driver to remove the worn bushing from the gear.

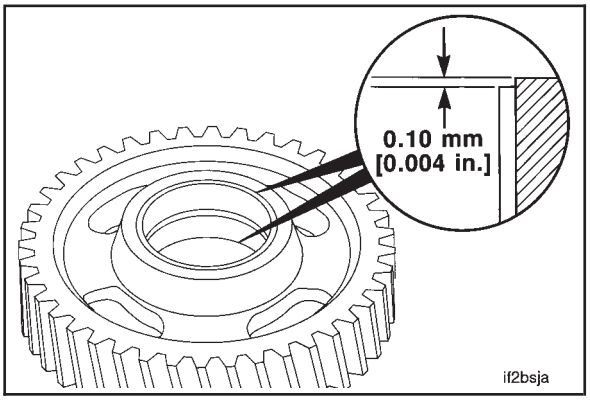


Use a hydraulic press and the bushing driver to install the new bushing in the gear.

Idler Gear	Gear Part No.	Bushing Part No.
Camshaft	3084447 3027423 3038985	3026188
Water Pump	3027219 3084448 3038987	3026189
Hydraulic Pump	3027217 3038995 3045855	3026189 3026189 3026188



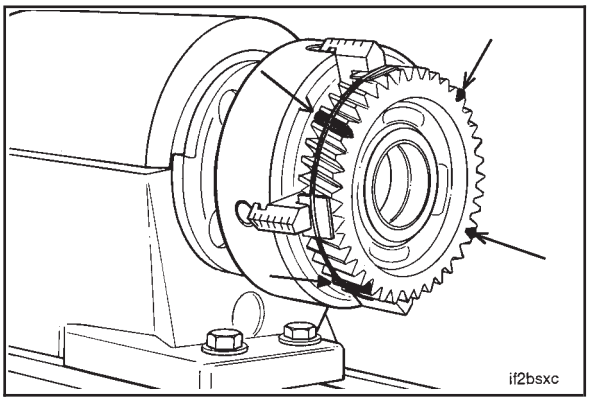
The bushing **must** be installed 0.10 mm [0.004 inch] below
the two thrust surfaces of the gear.

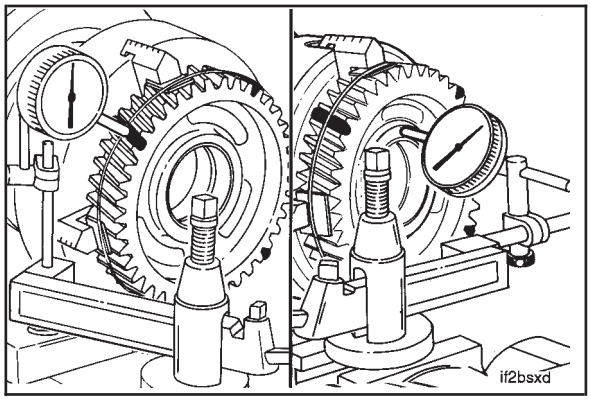


Caution: Use aluminum or copper pads between the lathe chuck jaws and the gear to prevent damage to teeth of the gear.

Install the gear in a lathe with a four jaw chuck. Install the four measuring pins equally spaced as shown in the teeth of the gear.

Use a rubber band or wire to hold the pins in place.

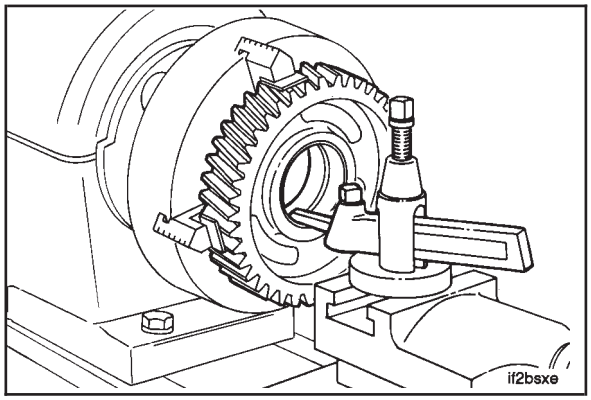




Use a dial indicator to correctly position the gear in the lathe chuck. the measuring pin outside diameters **must** be concentric within 0.05 mm [0.002 inch].

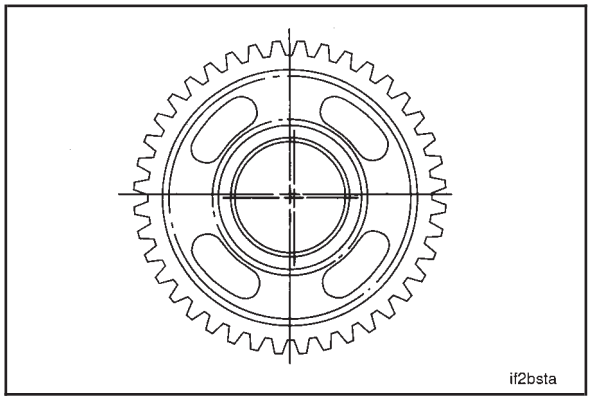
NOTE: The gear thrust surface face runout **must** be less than 0.05 mm [0.002 inch].

Remove the measuring pins after the gear is positioned to correct specifications.



Operate the lathe at a high speed with a slow feed to maintain a surface finish of 0.8 µM [32.00 µ inch].

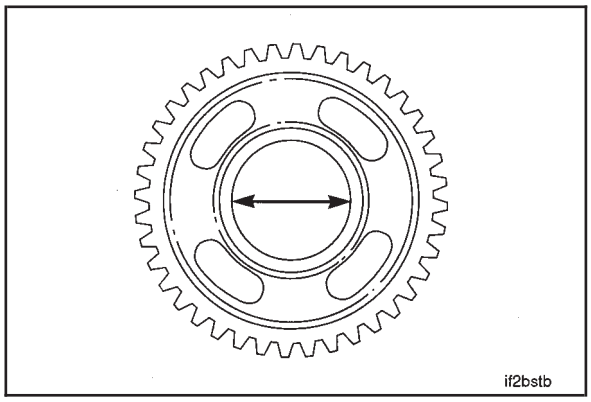
Use cutting oil. Machine the inside diameter of the bushing to 60.045 to 60.069 mm [2.3640 to 2.3649 inch].



Specifications — Idler Gear Bushing Repair

Concentricity between pitch diameter and bushing bore.

Bushing Bore Concentricity		
mm		**in**
0.05	MAX	0.002

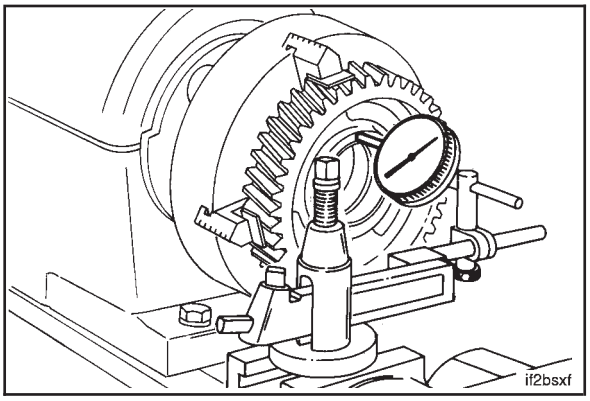


Gear bore inside diameter.

Gear Bore I.D.		
mm		**in**
64.987	MIN	2.5585
65.013	MAX	2.5596

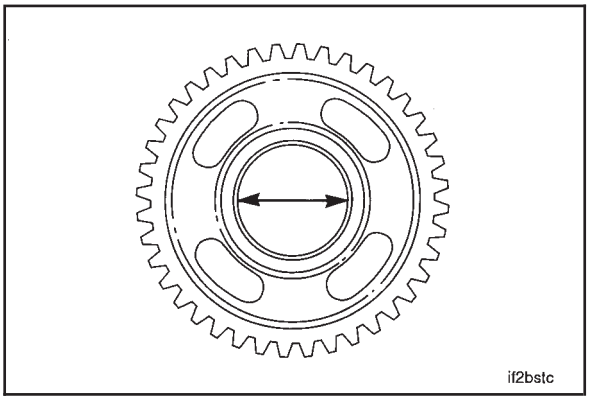
Thrust surface face runout.

Face Runout		
mm		in
0.05	MAX	0.002

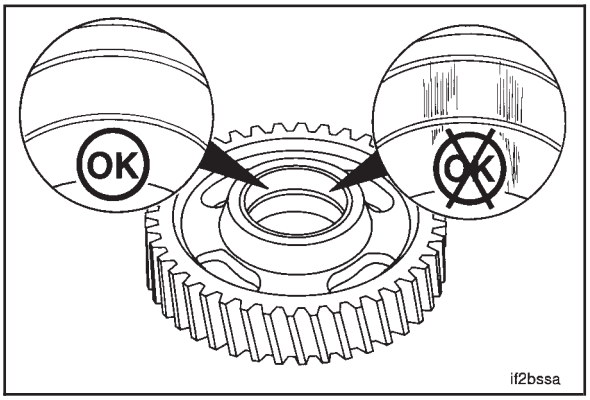


Bushing inside diameter after machining.

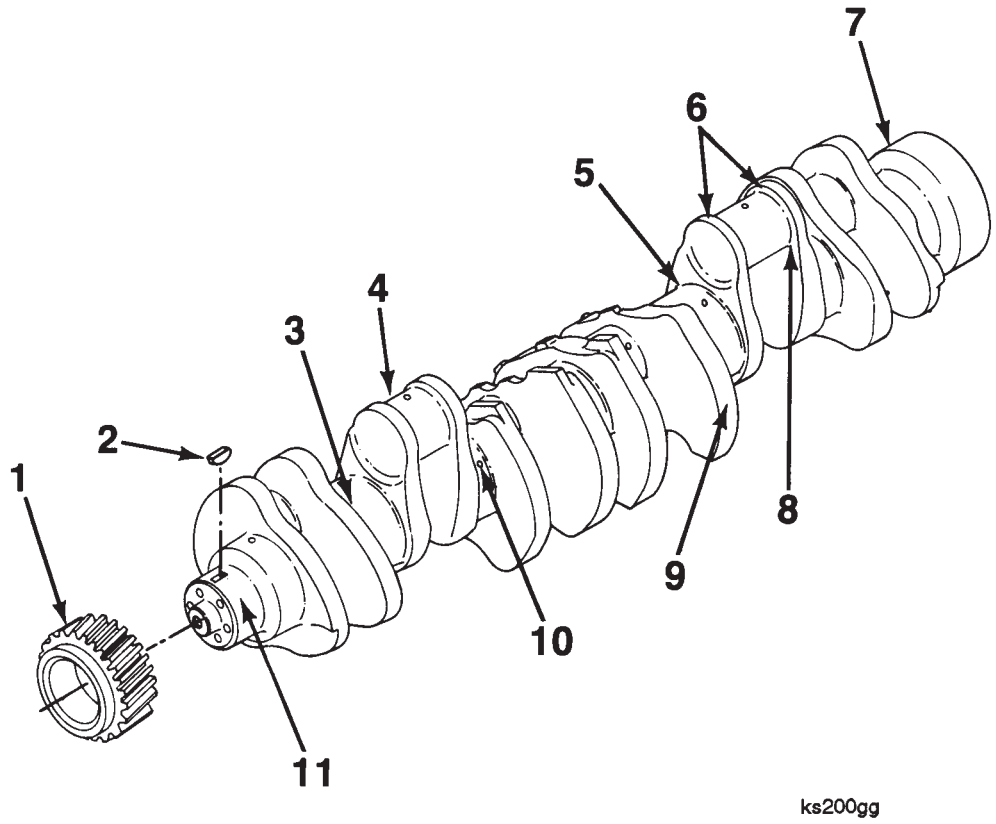
Bushing I.D.		
mm		in
60.045	MIN	2.3640
60.069	MAX	2.3649



Bushing Surface Finish	
micro-meter	micro-inch
0.8	32.00



Crankshaft — Exploded View



Ref. No.	Description	Ref. No.	Description
1	Crankshaft Gear	7	Rear Oil Seal Flange Diameter
2	Woodruff Key	8	Bearing Fillet Sidewall
3	Main Bearing Journal	9	Counterweight Area
4	Connecting Rod Bearing Journal	10	Oil Drillings
5	Bearing Journal Fillets	11	Gear Journal Diameter
6	Crankshaft Webs		

Crankshaft Inspection and Reconditioning

General Information

NOTE: This repair procedure can be a warrantable practice, but requires prior approval by the warranty department.

Reliability Statement

The following procedure describes the process and process specifications for reconditioning Cummins L10 and M11 crankshafts. The specifications and reuse criteria provide the maximum allowable reconditioning tolerances.

Deviation from these specifications can result in poor reliability or premature failure. Any crankshaft that does **not** meet the guidelines in this procedure **must not** be returned to service.

Successful reconditioning of crankshafts is dependent upon these essential factors:

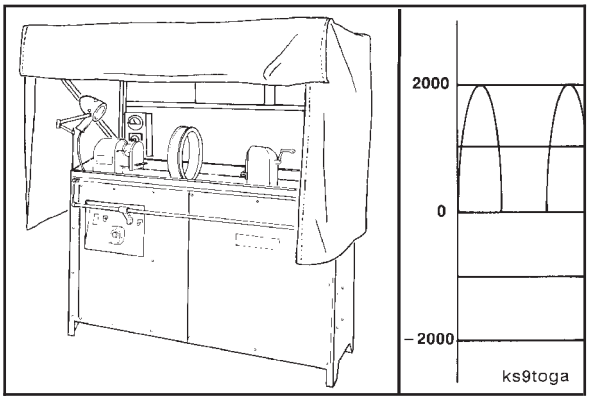
- Adequate equipment in a good state of repair
- Properly trained and conscientious personnel
- Thorough inspection prior to and after reconditioning
- Adherence to reconditioning specifications and tolerance limits

Equipment

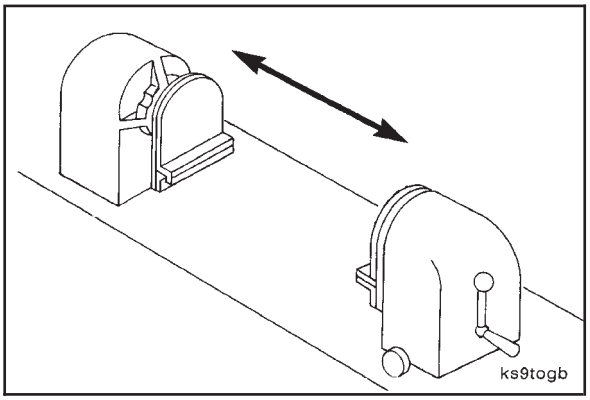
The following list of special equipment is considered necessary for reconditioning Cummins crankshafts:

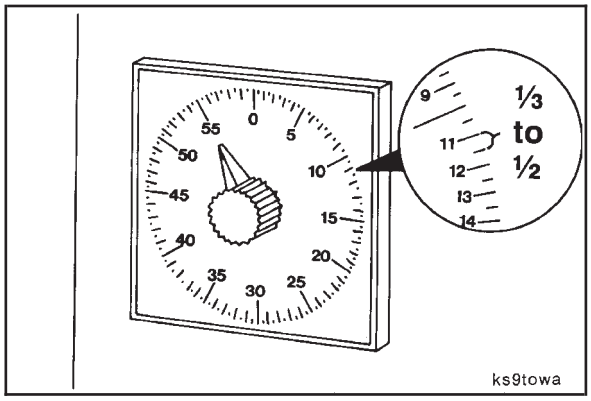
Fluorescent "Wet" Magnetic Particle Inspection Equipment

- To inspect for surface and subsurface discontinuities.
- **Must** be capable of 2,000 amperes direct current, half wave rectified, continuous operation for either a head shot or a coil shot.

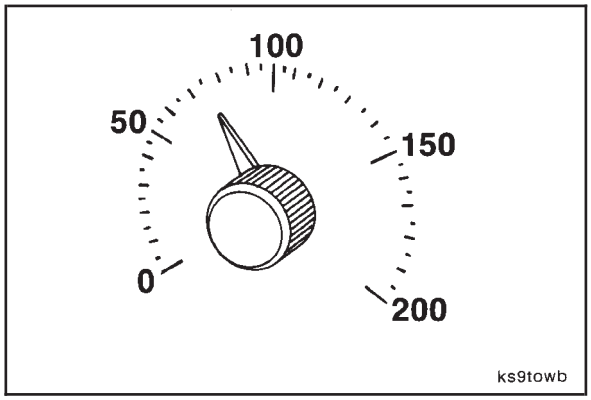


- The distance between the head stock and tail stock is adjustable.
- It **must** be large enough to accept an L10 or M11 crankshaft which is 1066.5 mm [41.99 inch] long.

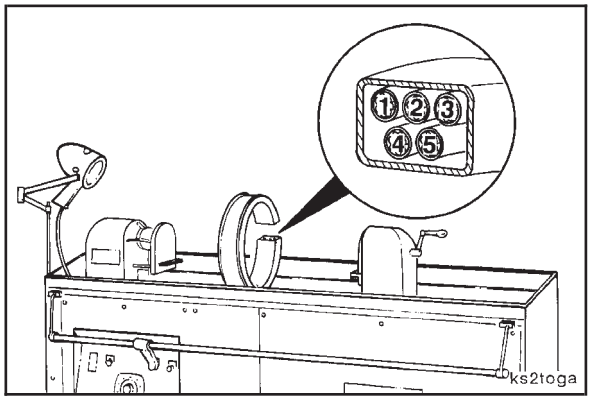




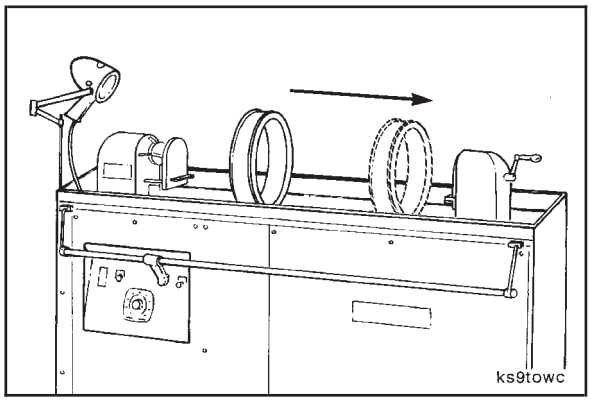
- The timer **must** be capable of controlling the duration of current flow. Typically a timer is set to control current flow from 1/3 to 1/2 second impulses.



- The current control **must** be capable of varying the current in increments of 200 amperes or less.

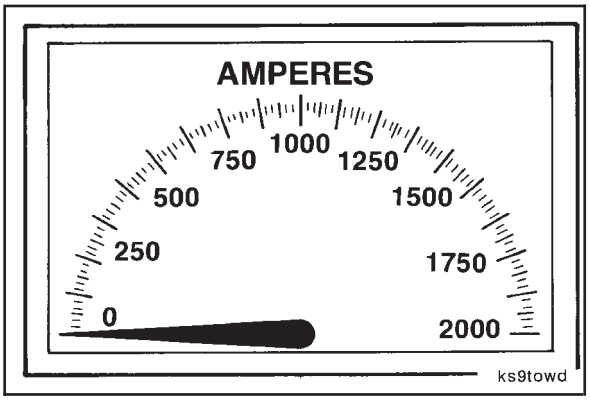


- The magnetizing unit **must** have a magnetizing coil attachment for making circumferential crack inspections (coil shot). A 514.5 mm [20.250 inch] inside diameter coil with 5 to 6 loops of cable is recommended.

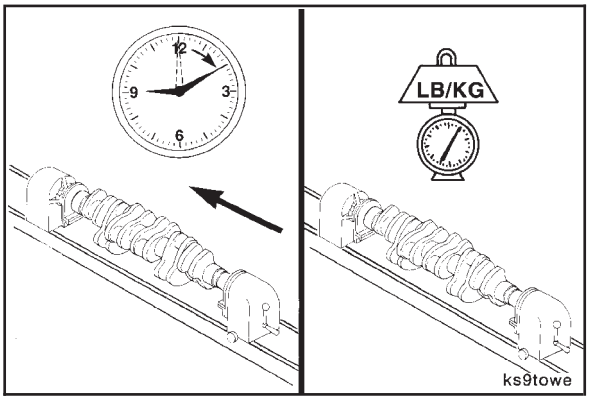


- The location of the magnetizing coil **must** be adjustable throughout the working length of the machine.

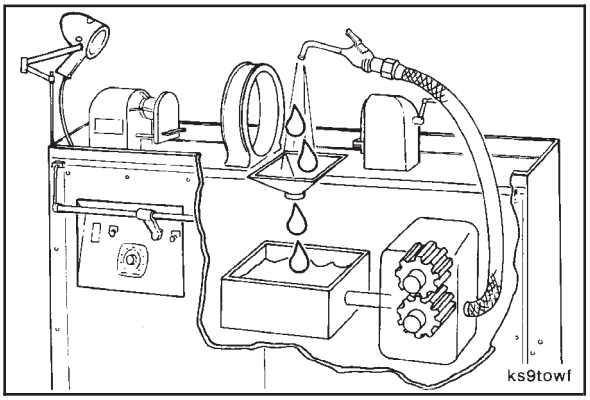
- The magnetizing unit **must** have an ammeter for current measurement while using either a head or coil shot.



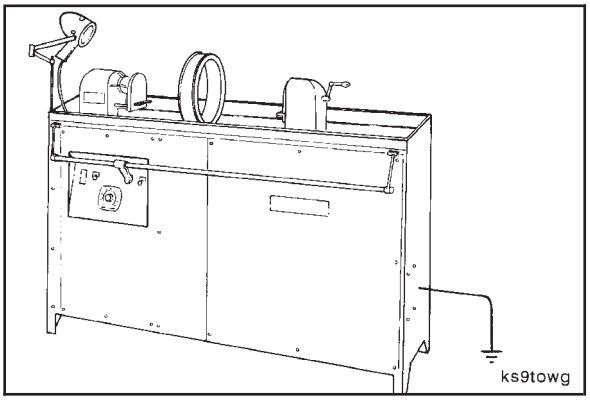
- The clamping speed and pressure **must** be adjustable. The pressure **must** be sufficient to maintain good electrical contact between the machine and the crankshaft.

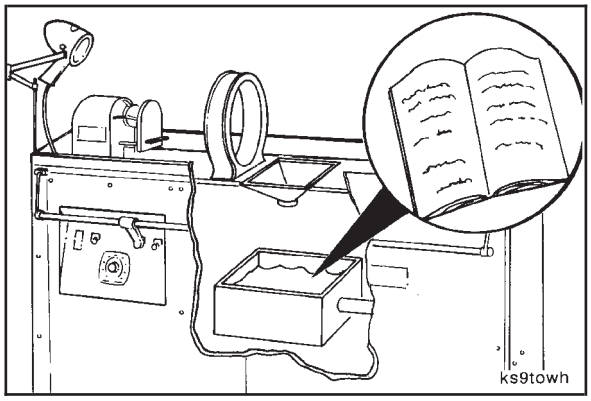


- The magnetizing unit **must** have a pump to agitate and circulate the magnetic particle solution (bath).



- The magnetizing unit **must** be adequately grounded. Refer to the manufacturer's instructions for installing the magnetizing unit.

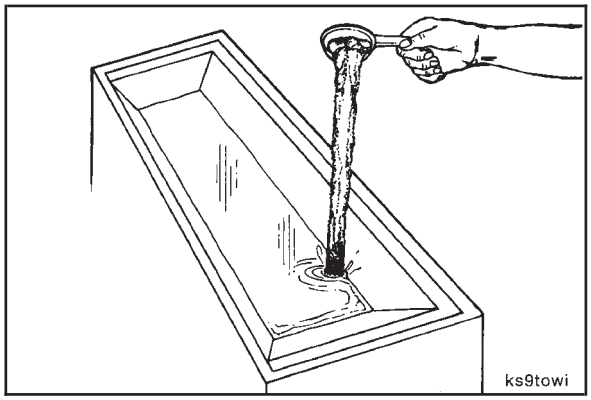




Material Particle Solution (Bath)

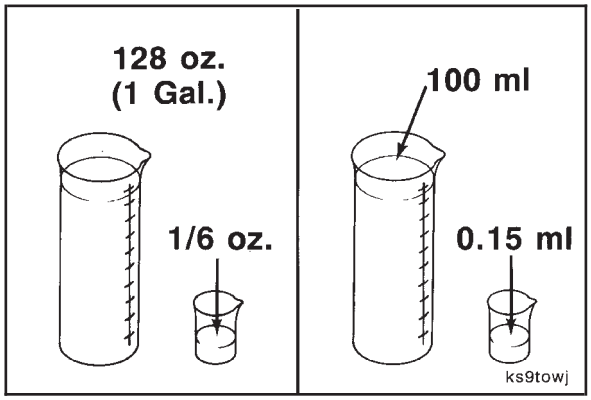
The liquid carrier for the flourescent magnetic particles **must** have the following properties:

- Viscosity (ASTM D-445) — Kinematic at 38°C [100°F], 3 centistokes maximum.
- Flash Point (ASTM D-93) 76°C [200°F] minimum.
- Initial Boiling Point (ASTM D-86) 199°C [390°F] minimum.
- End Point (ASTM D-86) 250°C [500°F] maximum.
- Color (ASTM D-156) Saybolt Plus 25.
- Sulfur (ASTM D-130) Low available **must** pass copper test.
- Florescence — none under black light.

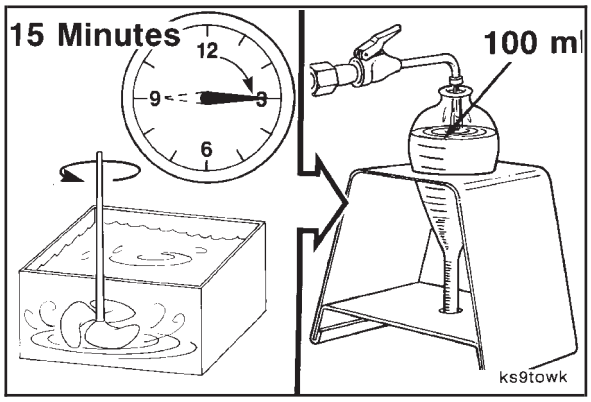


The powder to be mixed with the liquid carrier is fine ferromagnetic particles coated with flourescent dye.

The suspension of the flourescent particles in the carrier solution is referred to as the "bath".



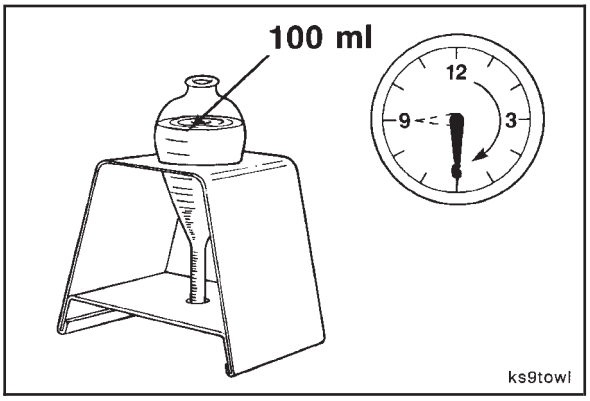
The concentration of most powders is 1/6 fluid ounce to one gallon of bath by volume (0.15 to 100 milliliters of bath). Follow the recommended concentration levels as specified by the equipment and powder manufacturer.



The bath strength or concentration is inspected by using an ASTM-D96 centrifuge tube graduated in 0.1 milliliters. This is known as a goetz tube.

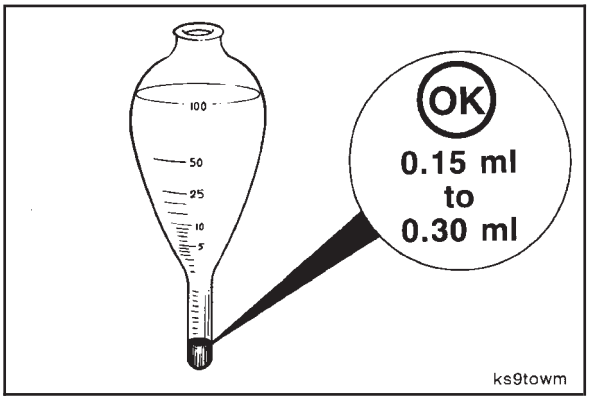
Thoroughly agitate the bath solution for 15 minutes. Fill the Goetz tube with 100 milliliters of bath solution.

Install the goetz tube in a vertical holder and allow it to stand for 30 minutes in a vibration free environment.



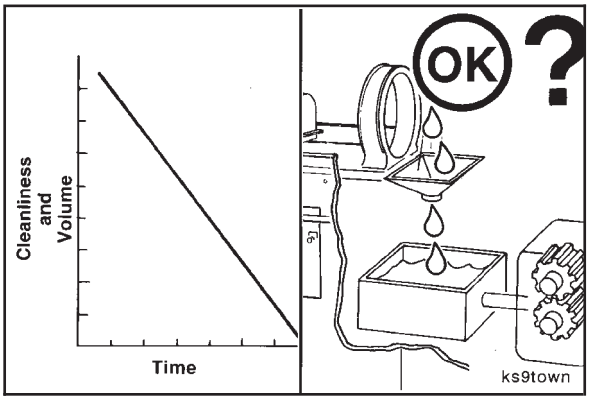
The volume of solid material that settles out after 30 minutes is indicated on the graduated cylindrical part of the tube.

NOTE: The reading **must** be between 0.15 and 0.30 ml for a properly prepared bath.



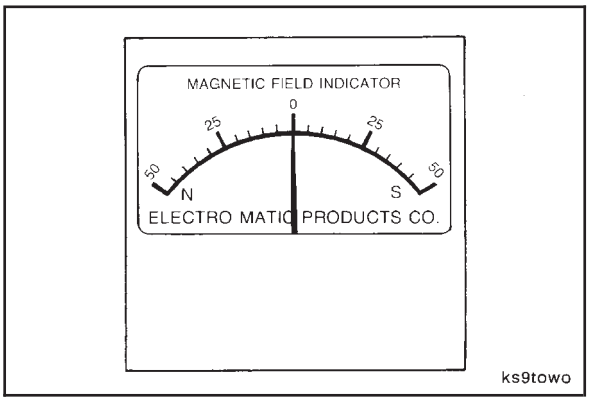
A correctly prepared bath **must** also be maintained. The maintenance requirements of a bath are related to the cleanliness of the parts being inspected and the volume of work to pass through the bath.

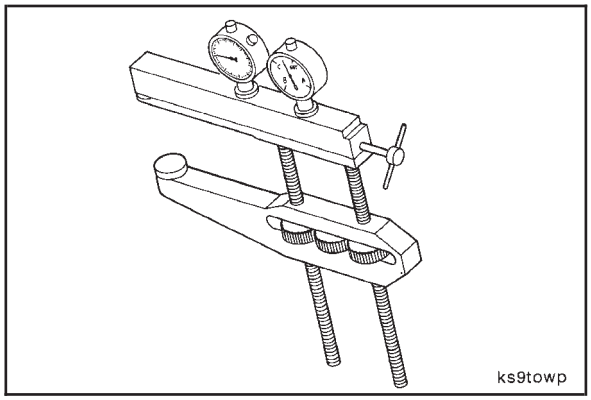
NOTE: If the magnetizing equipment is in constant use, the bath strength **must** be inspected every 8 hours. If the equipment is **not** in constant use, the bath strength **must** be inspected before each crankshaft is inspected.



Gauss Gauge

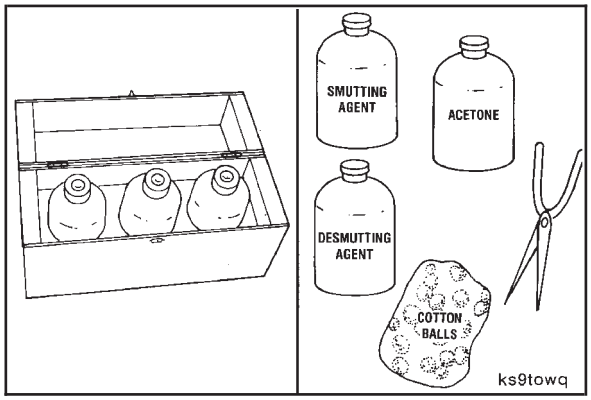
- For determining the residual magnetism, and to ensure crankshafts have been properly demagnetized after magnetic particle inspection.





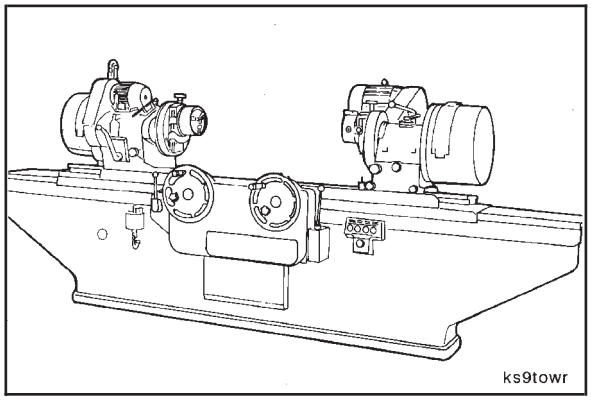
Portable Hardness Tester

- To check main bearing and crank pin journal hardness.



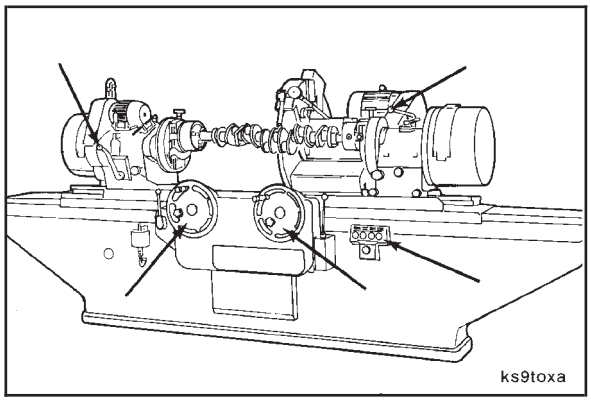
Nital Etching Capability

- To inspect for grinder burn.



Crankshaft Lathe with Necessary Attachments

- For polishing, checking runout and re-centering the crankshaft.

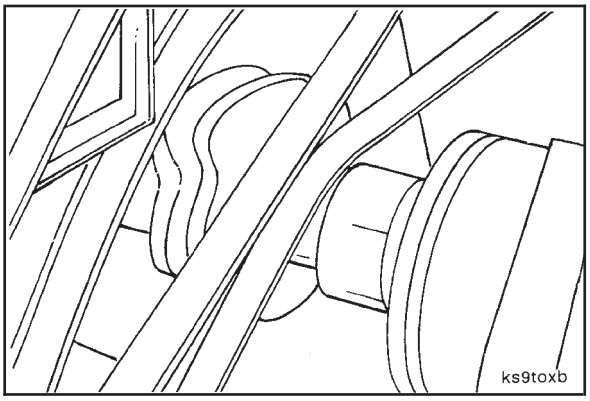


Crankshaft Grinding Machine

- With adequate grinding wheel width capacity, wheel dressers, coolant, coolant filters and temperature control.

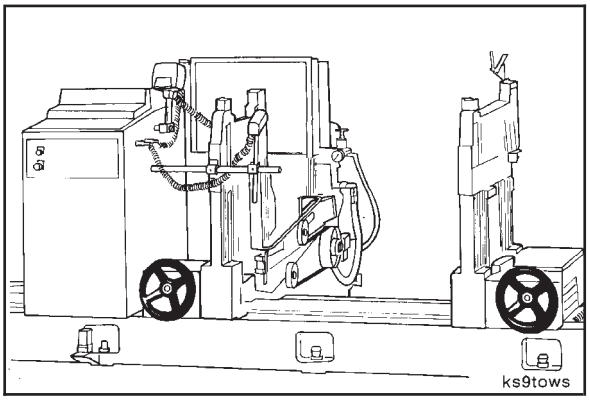
Crankshaft Polishing Equipment

- For improving the surface finish.



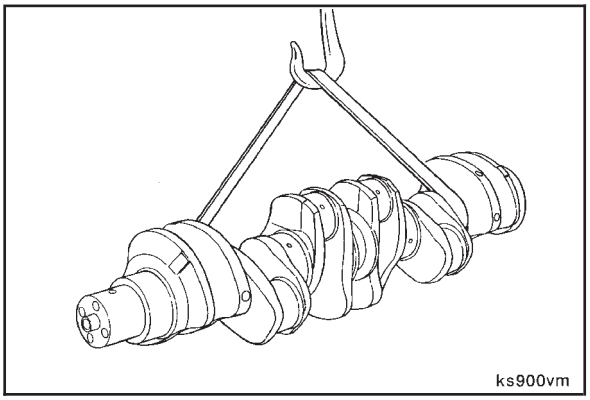
Balancing Machine

- To inspect and balance the crankshaft after grinding.



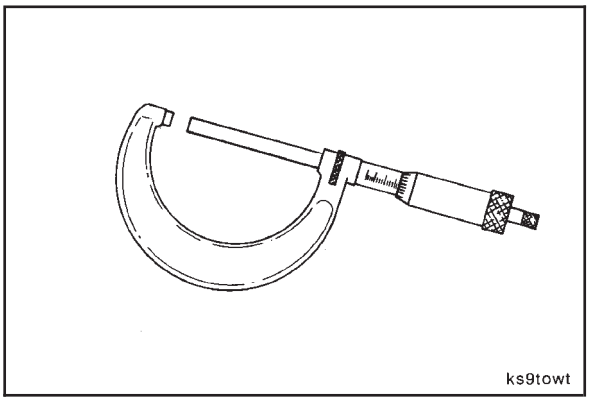
Lifting and Handling Equipment

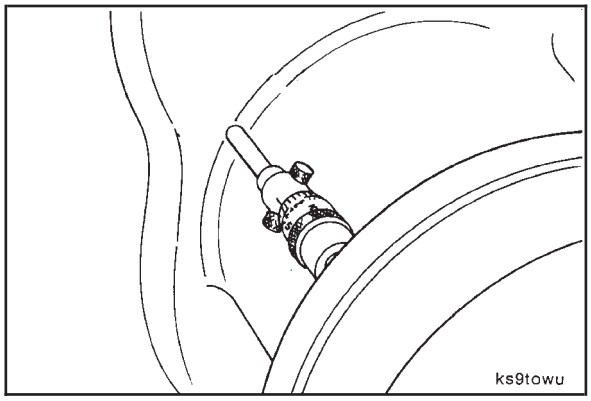
- For lifting and transferring the crankshaft through the various reconditioning processes.



Outside Micrometers

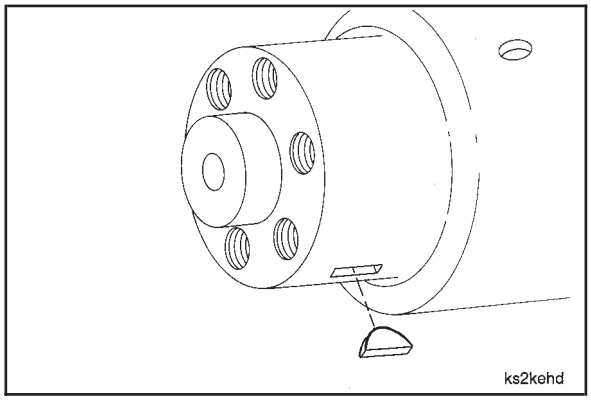
- For measuring the bearing journal outside diameters.





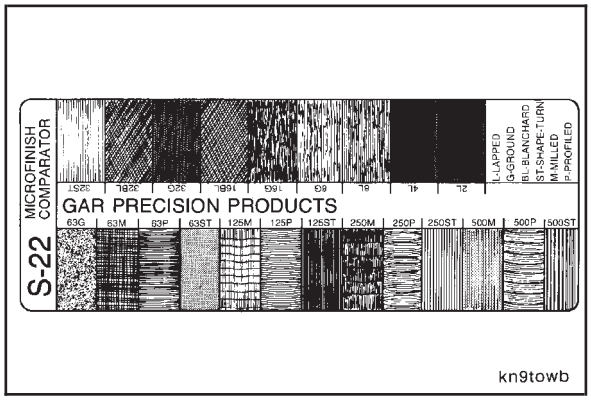
Inside Micrometers

- For measuring thrust surface widths and thicknesses.



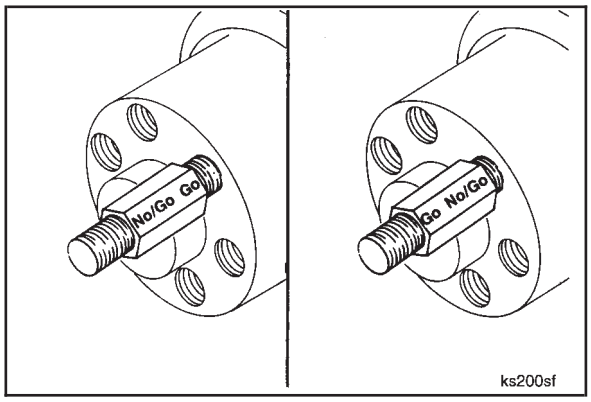
Width or Thickness Gauges

- To inspect keyway width.



Profilometer or Comparator Block

- To check surface finish specifications.

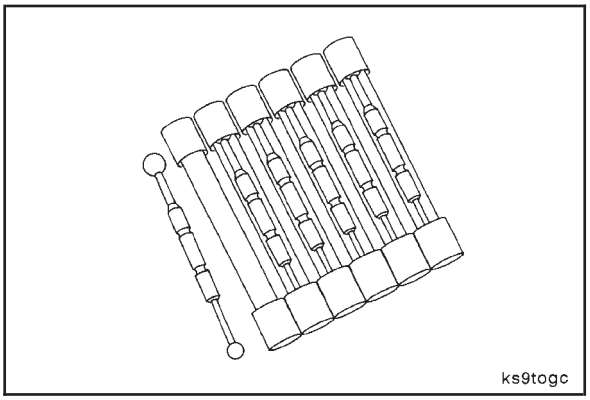


GO NO-GO Thread Gauges

- To determine the condition of the vibration damper and flywheel mounting capscrew hole threads in the crankshaft.

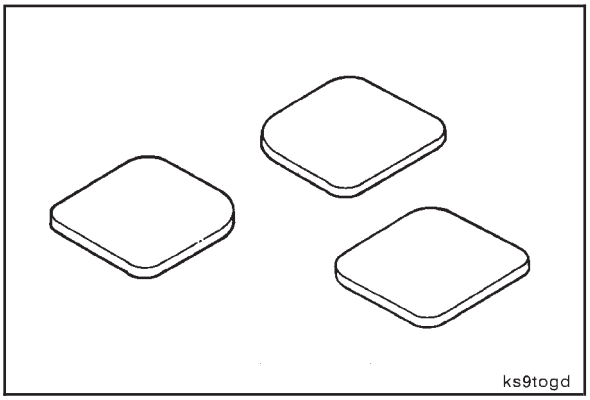
Radius Ball Gauges

- For measuring fillet radii.



Flat Radius Gauges

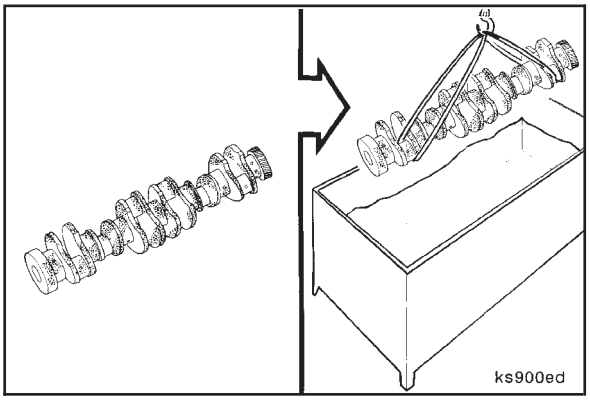
- For inspecting radii dressed on the grinding wheel.



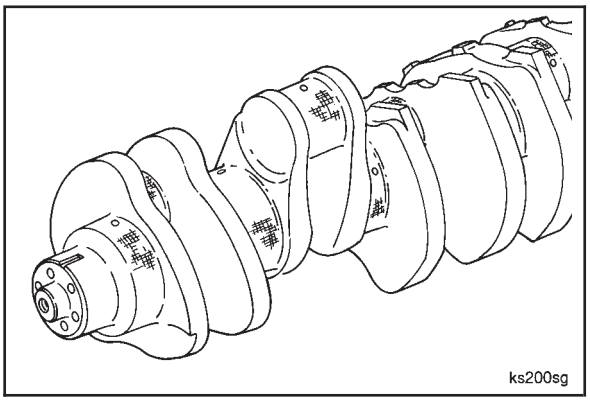
Crankshaft Inspection

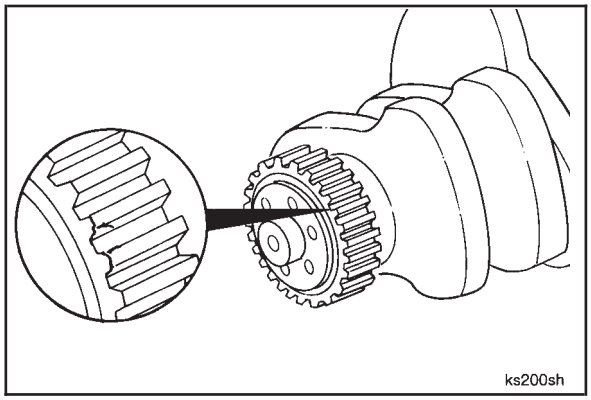
Basic Condition — Inspection

Remove any rust by immersing the crankshaft in a commercial rust stripper.



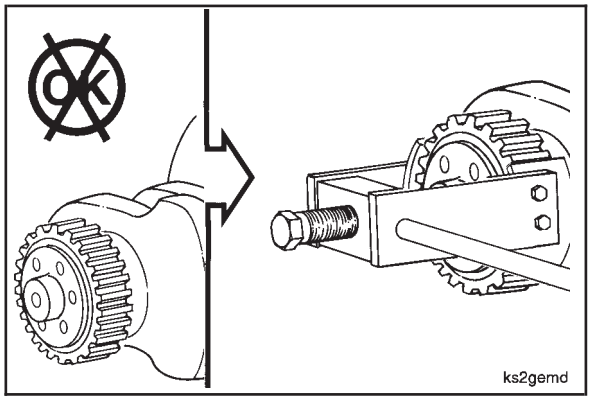
Remove all bearing material from failed journals.



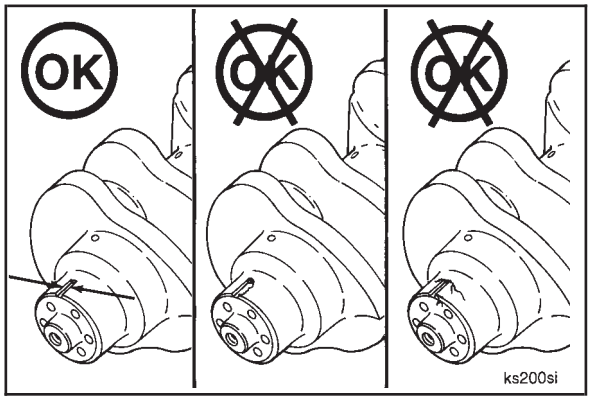


Visually inspect the crankshaft gear for cracks, chips, burrs or any damage that would make it unusable.

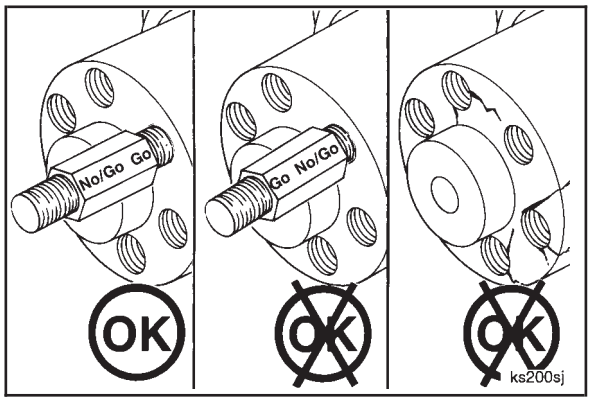
NOTE: If no damage exists, do **not** remove the gear.



If the crankshaft gear is damaged, use gear puller set, Part No. 3375074, to remove the gear.



Visually inspect the keyway for damage.



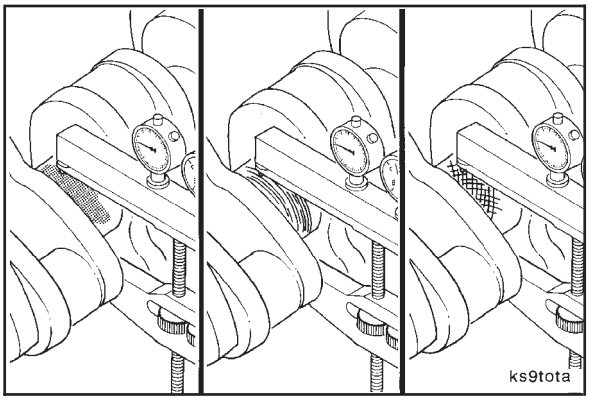
Inspect all threaded holes for cracking, damage or oversize condition. Refer to Crankshaft Thread — Repair if the threads are damaged.

- Threads on the vibration damper mounting face of a six hole crankshaft are M12 X 1.25.
- Threads on the vibration damper mounting face of a five hole crankshaft are M14 X 1.50.
- Threads on the flywheel mounting face are M14 X 1.50.

Journal Hardness — Inspection

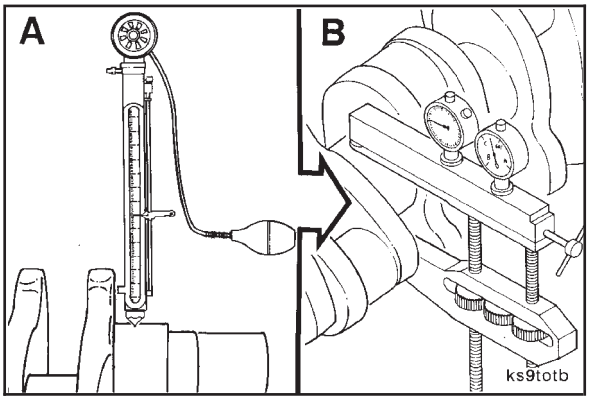
A journal hardness test is required if the journal shows any type of distress.

NOTE: A new crankshaft will have a Rockwell C hardness of 45 to 50. For regrind purposes, a minimum Rc Hardness of 43 **must** be maintained.



Crankshaft journal hardness can be inspected by using a sclerescope or a portable Rockwell C hardness tester.

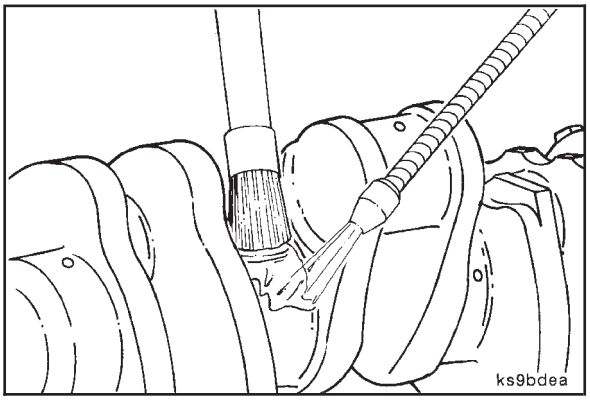
NOTE: The Rockwell C hardness tester is much more accurate than the sclerescope and is recommended for journal hardness inspection.



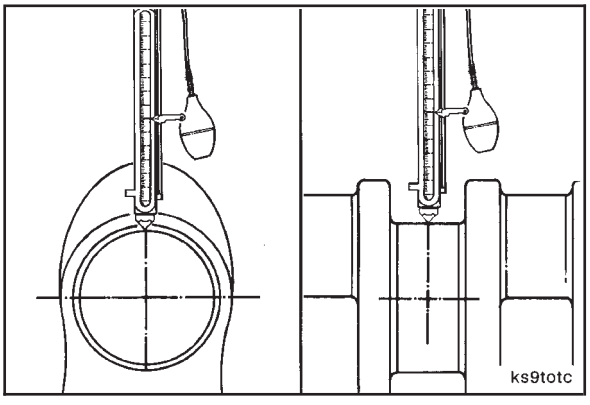
Sclerescope — Inspection

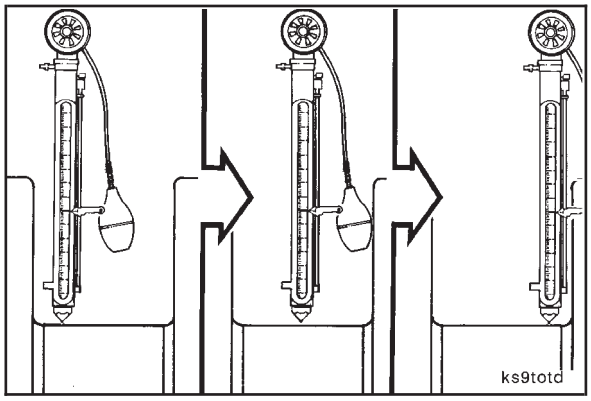
Thoroughly clean the crankshaft journal surface to be inspected to remove any foreign material.

NOTE: Correct hardness measurements **cannot** be obtained from surfaces that are **not** properly prepared for inspection.

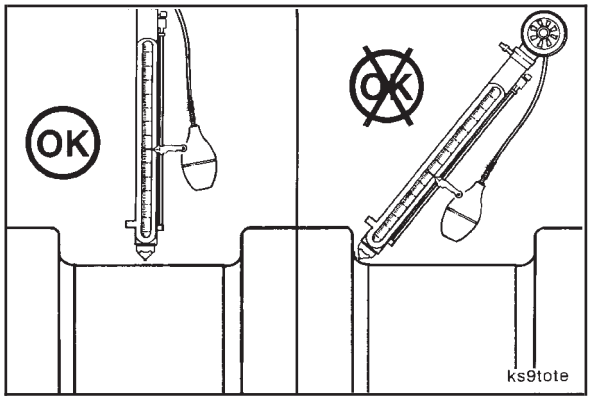


Hold the instrument against the surface to be inspected. Position the instrument so it is vertical and perpendicular.

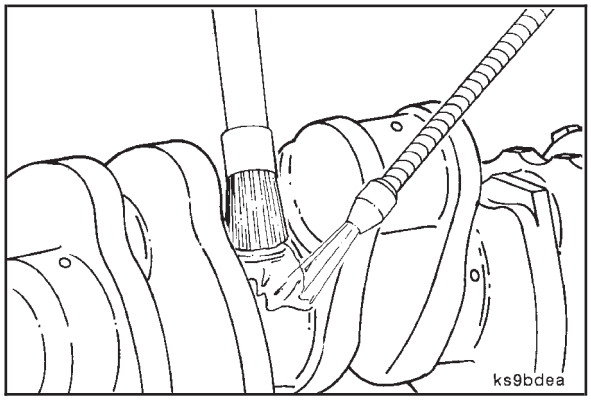




Make several measurements at slightly different locations until a consistent measurement is obtained.



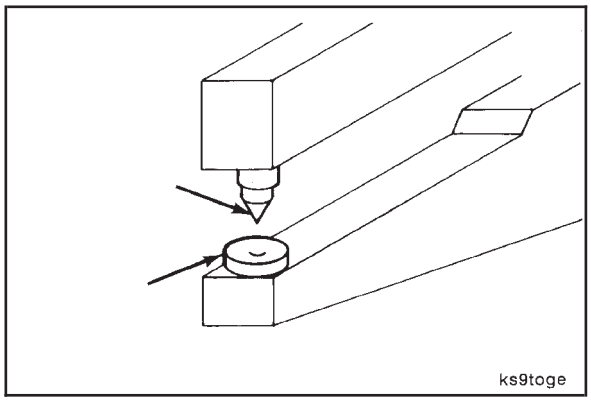
A hardness inspection of the fillet areas **cannot** be conveniently made with the sclerescope hardness tester. A hardness inspection of the adjacent journal will give a good indication of the fillet hardness.



Portable Rockwell Hardness Tester — Inspection

Thoroughly clean the crankshaft journal surface to be inspected to remove any foreign material.

NOTE: Correct hardness measurements **cannot** be obtained from surfaces that are **not** properly prepared for inspection.

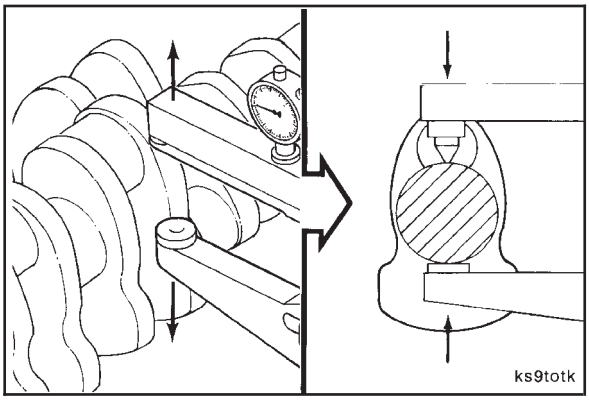


The sharp diamond contact on the upper arm is known as the indentor.

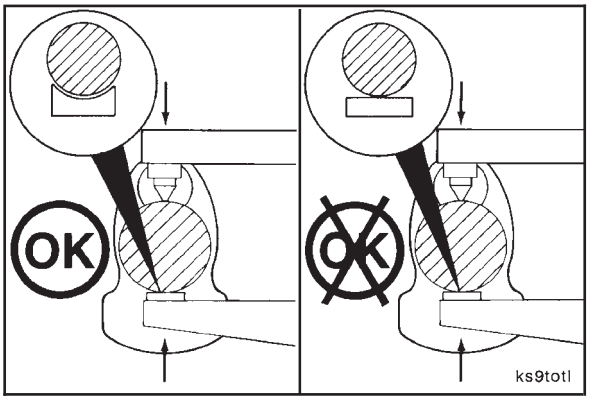
The bottom arm of the tester holds a concave rest known as the anvil.

Open the arms of the tester until they fit over the crankshaft journal.

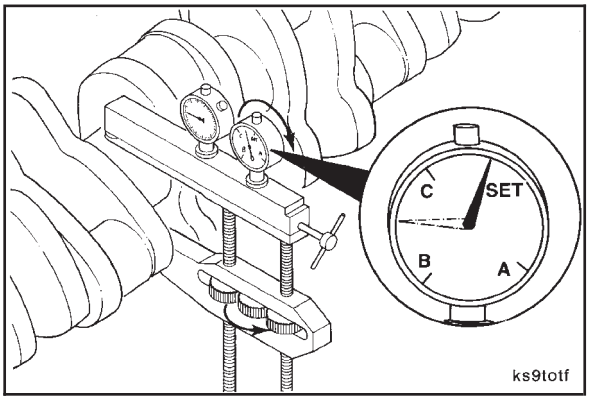
Tighten the arms of the tester until the indentor and anvil contact the surface of the crankshaft journal.



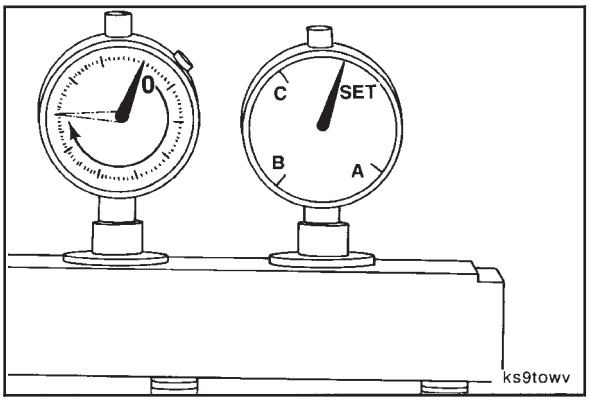
NOTE: The anvil of the tester **must** fit firmly and tightly against the bottom surface of the crankshaft journal in order to obtain correct hardness readings.

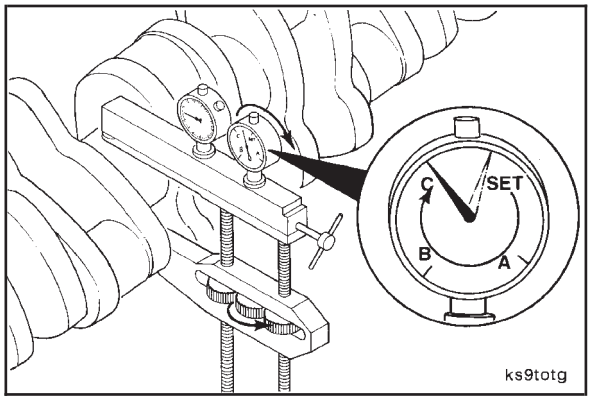


Increase the load on the indentor until the hand in the calibration indicator moves to the "Set" position.

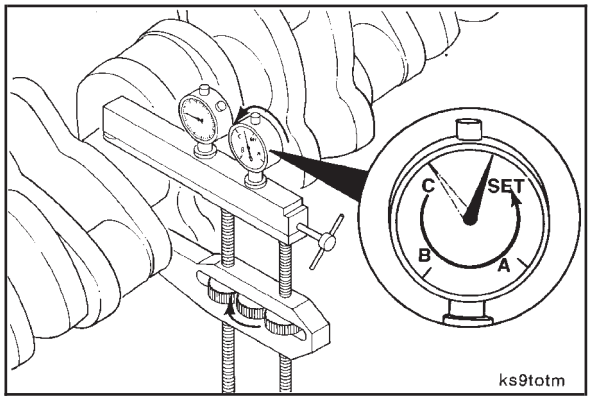


Zero ("0") the hardness reading indicator.

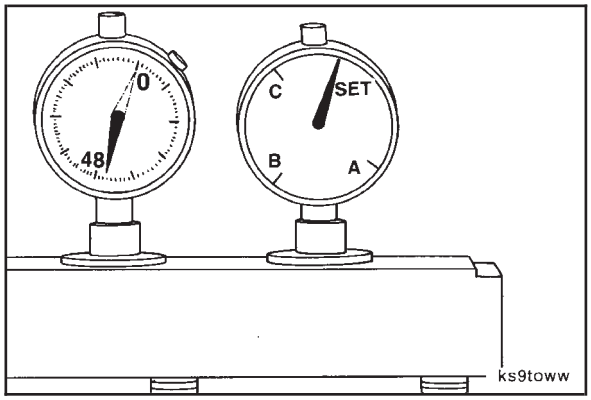




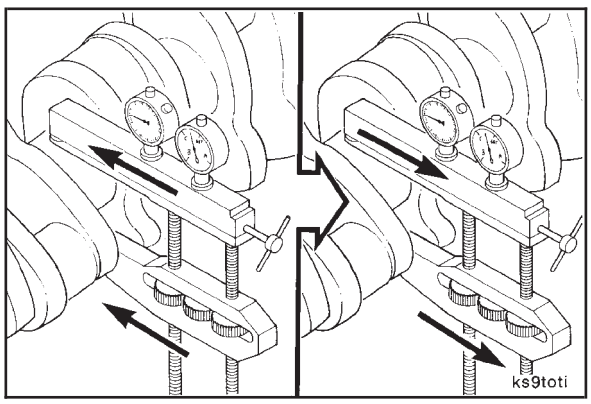
Increase the load on the indicator until the hand in the calibration indicator moves to the "C" position.



Relax the load on the indentor until the hand on the calibration indicator returns to "Set".

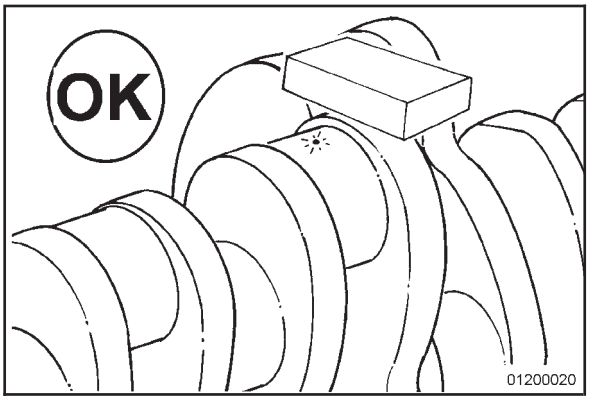


NOTE: The hardness indicator will indicate the Rockwell C hardness of the journal surface.

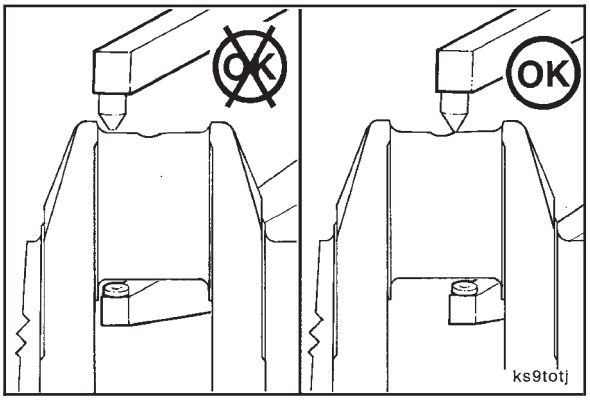


Continue to relax tension on the instrument until the tester can be removed from the crankshaft journal.

The small impression left in the journal surface is acceptable. It does **not** need to be removed before the crankshaft is returned to service.

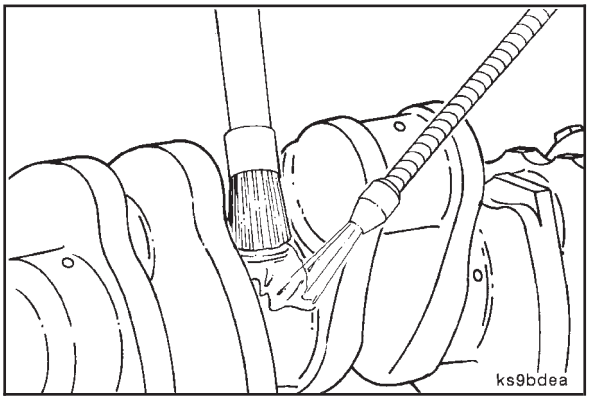


A hardness inspection of the fillet areas **cannot** be conveniently made with this hardness checker. A hardness inspection of the adjacent journal will give a good indication of the fillet hardness.



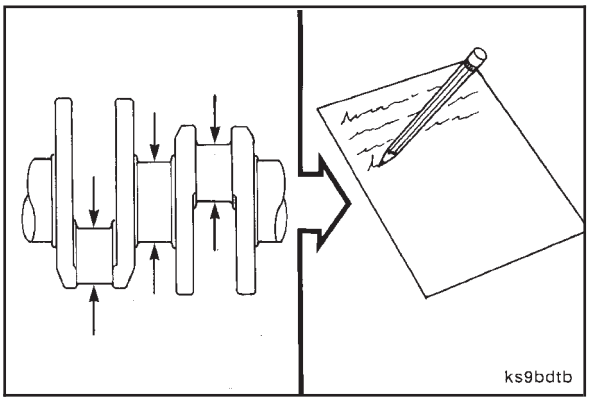
Determine the Crankshaft Journal Undersize Requirements

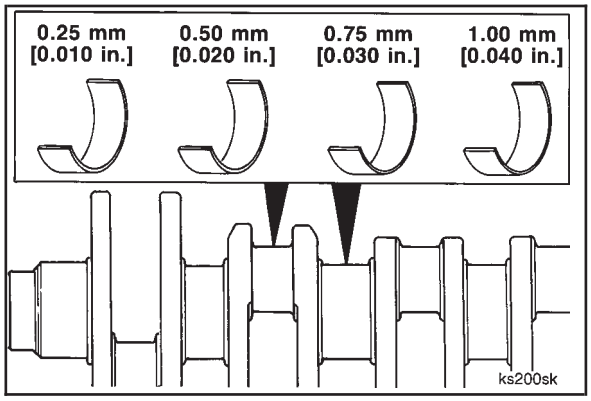
Thoroughly clean the crankshaft journal surface to remove any foreign material.



Measure the outside diameter of each connecting rod and main bearing journal. Record the measurement on a crankshaft data sheet.

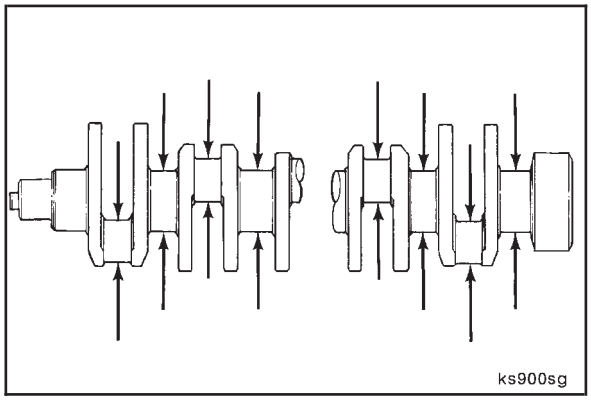
Crankshaft Connecting Rod Journal O.D. (Std.)		
mm		in
78.987	MIN	3.1097
79.013	MAX	3.1107
Crankshaft Main Bearing Journal O.D. (Std.)		
mm		in
114.015	MIN	4.4888
114.055	MAX	4.4904



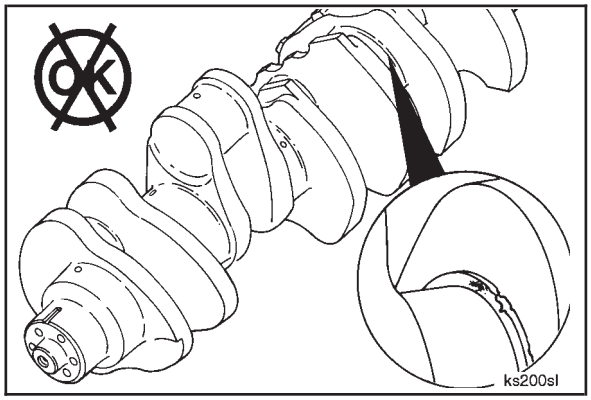


NOTE: Bearings are available for both connecting rod and main bearing journals to accommodate 0.25 mm [0.010 inch], 0.50 mm [0.020 inch], 0.75 mm [0.030 inch] and 1.00 mm [0.040 inch] undersize bearing journals.

Refer to the specifications at the end of this procedure for bearing journal diameter tolerances.



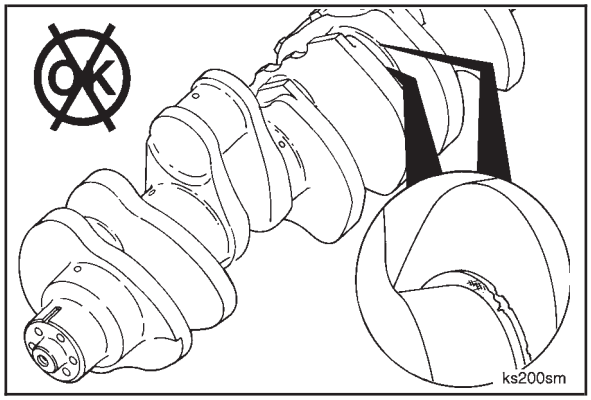
NOTE: It is **not** required that the main and rod bearing journals be the same undersize; however, all main bearing journals **must** be the same undersize, and all connecting rod bearing journals **must** be the same undersize.



Crankshaft Thrust Bearing Surface — Inspection

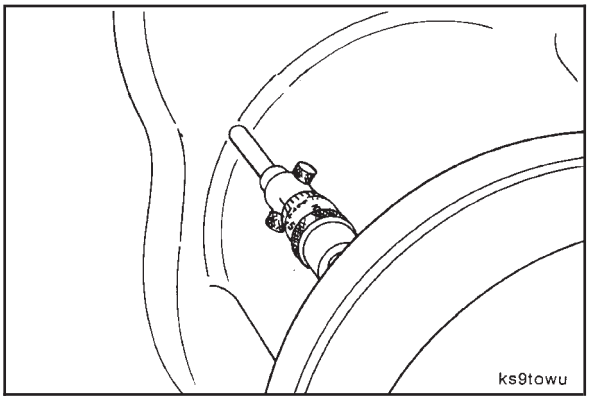
Visually inspect the crankshaft thrust bearing surfaces for damage.

NOTE: If any damage is visible, the thrust bearing surface(s) **must** be machined.



NOTE: To measure the thrust bearing surface width, at least one thrust bearing surface **must** be undamaged. If both bearing surfaces are damaged, and there is no accurate reference point for measurement, the crankshaft **must** be scrapped.

Measure the thrust bearing surface width.

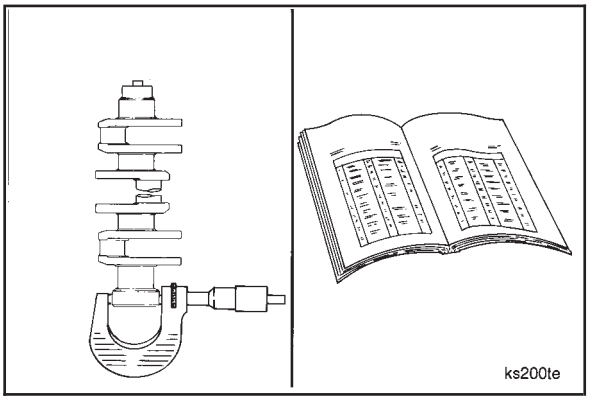


Crankshaft Thrust Bearing Surface Width (Std.)		
mm		in
49.975	MIN	1.9675
50.100	MAX	1.9724

Currently only 0.25 mm [0.010 inch] oversize thrust bearings are available. Therefore 0.25 mm [0.010 inch] can be removed from each thrust face, assuming that a cylinder block with a standard No. 4 thrust bearing journal width is used with this crankshaft.

Front or Rear Crankshaft Oil Seal Flange — Inspection

Measure the front and rear oil seal flange outside diameter.

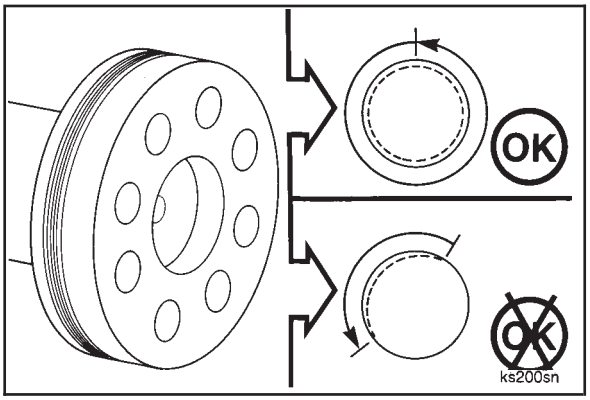


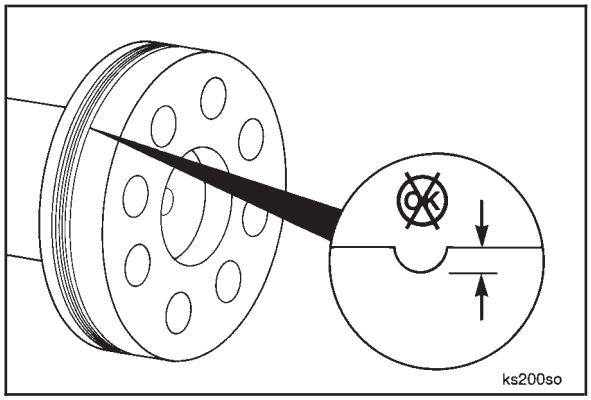
Crankshaft Front Oil Seal Flange O.D. (Std)		
mm		in
84.970	MIN	3.3453
85.000	MAX	3.3465

Crankshaft Rear Oil Seal Flange O.D. (Std.)		
mm		in
164.965	MIN	6.4947
165.035	MAX	6.4974

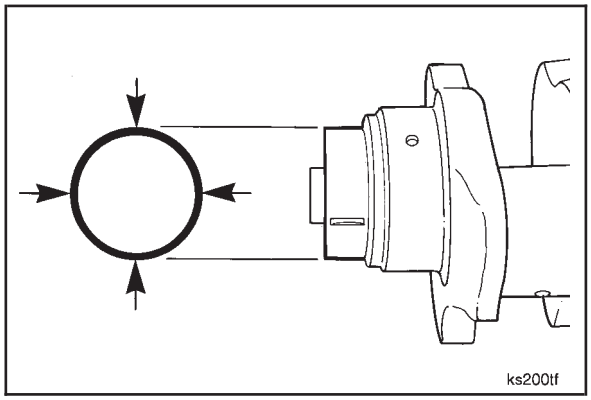
NOTE: The front crankshaft oil seal on internal damper model L10 engines rests on the crankshaft adapter, **not** the crankshaft itself.

NOTE: Visually inspect the oil seal contact area on the front and rear crankshaft oil seal flange. The marks caused by the oil seal touching the crankshaft **must** be the same all the way around the shaft. If they are **not**, the seal area diameter is **not** concentric with the crankshaft centerline and the oil seal flange **must** be repaired.





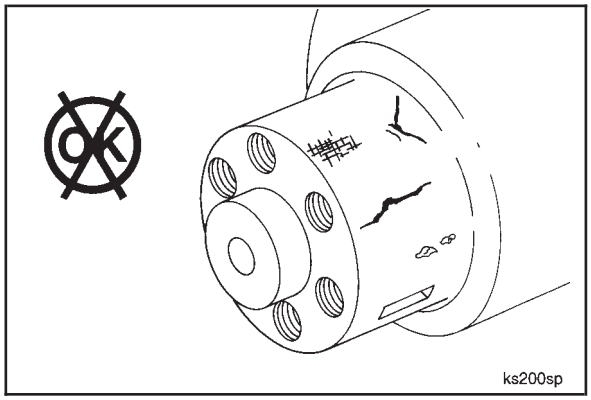
NOTE: The oil seal contact area **must not** be grooved more than 0.25 mm [0.010 inch] deep on the outside diameter of the crankshaft flange. If the groove is deeper than specified, a wear sleeve **must** be installed or the crankshaft oil seal flange **must** be repaired.



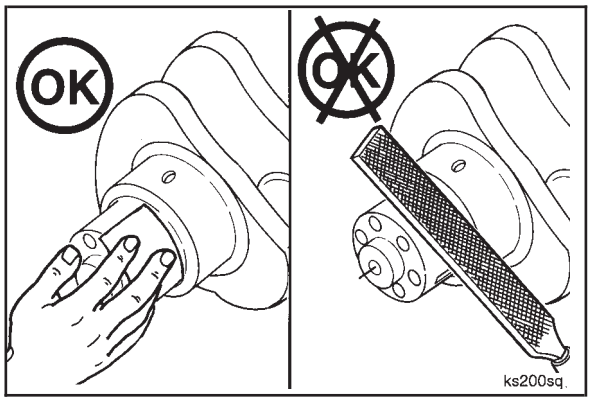
Crankshaft Gear Journal Diameter — Inspection

Measure the crankshaft gear journal outside diameter if the crankshaft gear has been removed.

Crankshaft Gear Journal O.D. (Std.)		
mm		in
85.975	MIN	3.3848
86.000	MAX	3.3858



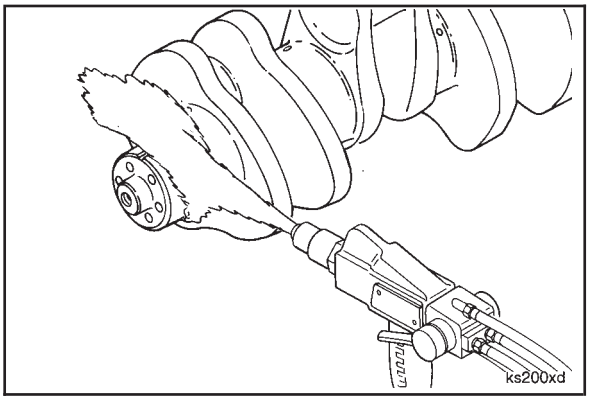
Visually inspect the gear journal diameter for cracks, fretting or any type of flaw.



Use emery paper to remove any minor flaws from the gear journal.

NOTE: When removing flaws, the gear journal outside diameter specifications **must** be maintained.

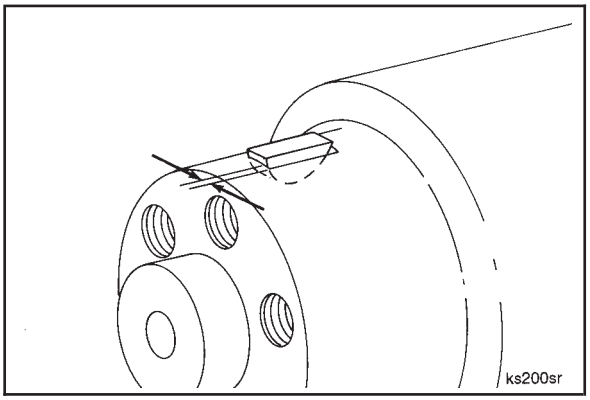
A worn gear journal outside diameter can be restored by chrome plating or building up the outside diameter with metal spray.



Crankshaft Gear Keyway — Inspection

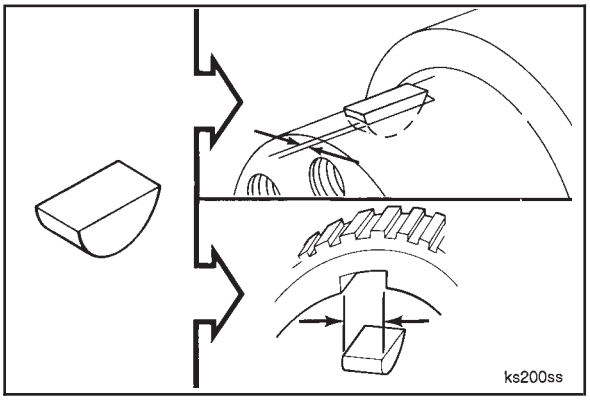
When installing a crankshaft gear key, there **must** be no more than 0.07 mm [0.003 inch] clearance between the key and the keyway slot.

Keyway Slot Width (Std.)		
mm		in
4.732	MIN	0.1863
4.851	MAX	0.1910



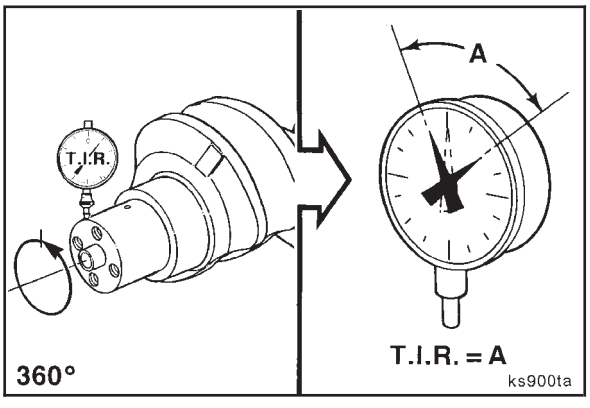
If the keyway slot is worn, a special key can be fabricated.

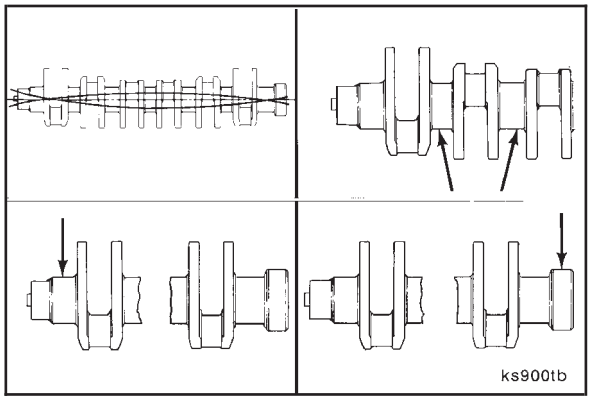
NOTE: The key **must** have the standard width on the top and have a 0.05 mm [0.002 inch] interference fit in the keyway slot. The key center **must** align with the No. 1 rod connecting bearing journal at top dead center.



Crankshaft Bend and Alignment — Inspection

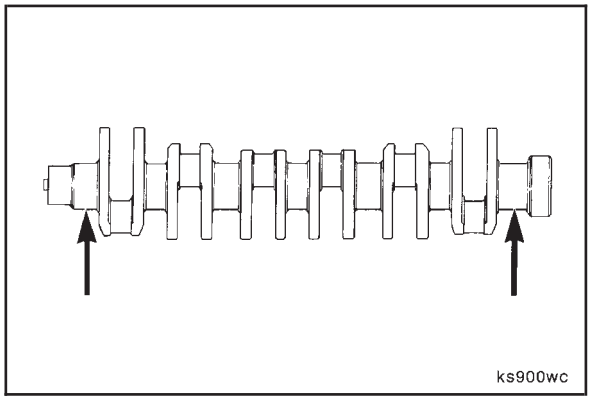
The crankshaft alignment limits are based on total indicator runout (TIR). Runout is measured as the crankshaft is turned one revolution while recording the total movement of the dial indicator.





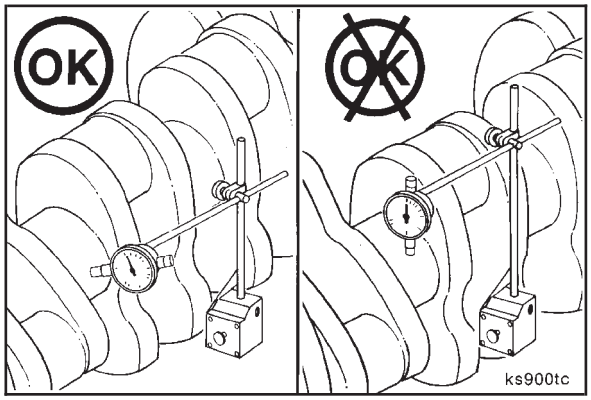
When measuring the crankshaft alignment, four measurements **must** be taken:

- Full Length Alignment
- Bearing to Bearing Alignment
- Gear Journal Diameter Runout
- Rear Oil Seal Flange Diameter Runout



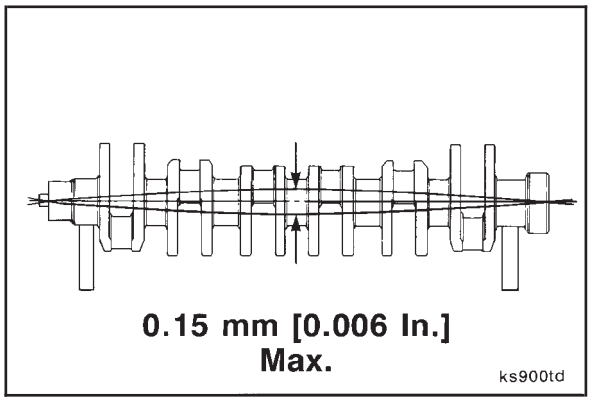
Measure the full length alignment as follows:

Support the crankshaft on No. 1 and No. 7 main bearing journals.



Caution: Measuring from the top of the main bearing journal will cause inaccurate alignment measurements due to crankshaft bend.

- The dial indicator **must** be set up so the indicator is located on the side of the No. 4 main bearing journal.



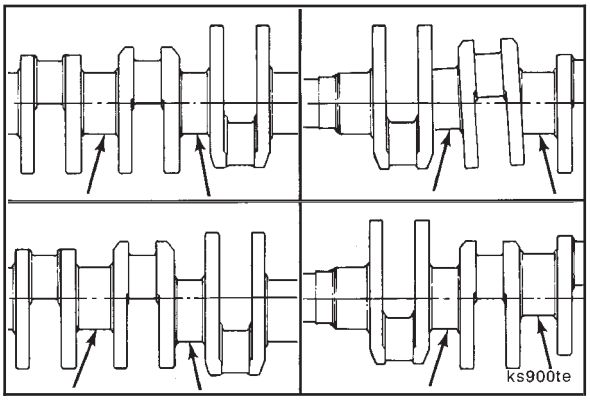
- Rotate the crankshaft one complete revolution and record the TIR.

The maximum TIR allowed is 0.15 mm [0.006 inch].

NOTE: If the TIR is **not** within specifications and **cannot** be repaired by grinding, the crankshaft **must** be scrapped. L10 and M11 crankshafts are fully fillet hardened and **cannot** be straightened.

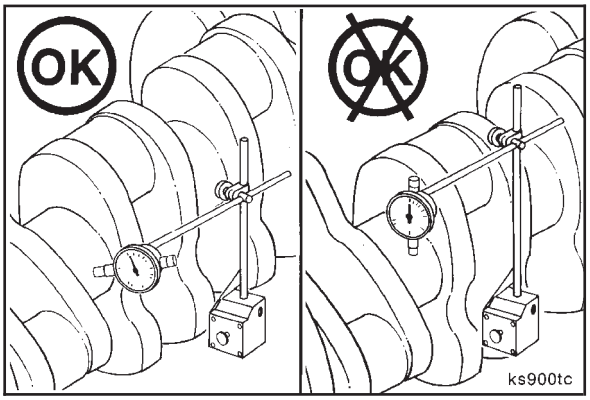
Measure the bearing to bearing alignment as follows:

- With the crankshaft supported on No. 1 and No. 7 main bearing journals, measure the TIR of the other main bearing journals.



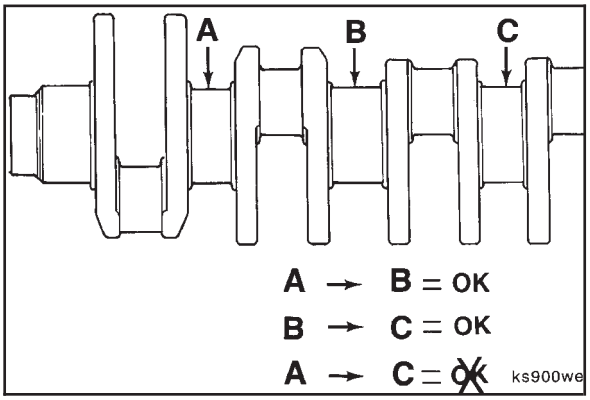
Caution: Measuring from the top of the main bearing journal will cause inaccurate alignment measurements due to crankshaft bend.

- The dial indicator **must** be set up so the indicator is located on the side of the bearing journal being measured.

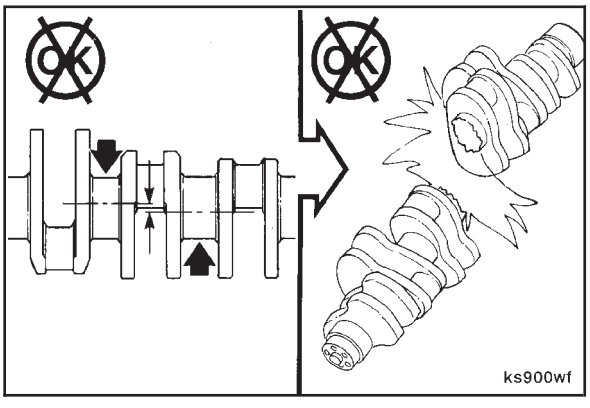


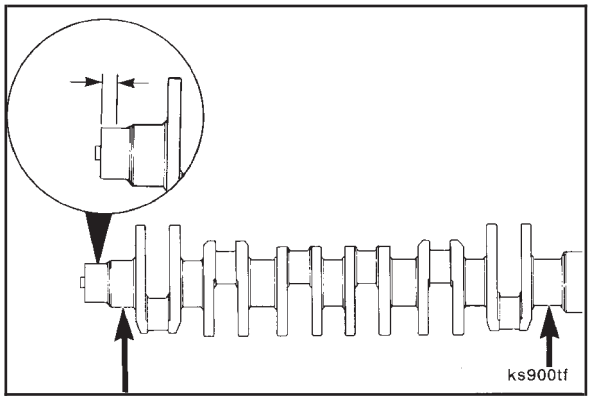
Rotate the crankshaft one complete revolution and record the TIR for each main bearing journal.

Compare the TIR of each journal with the adjacent journal. The TIR of each journal **must** be within 0.05 mm [0.002 inch] of the adjacent journals.



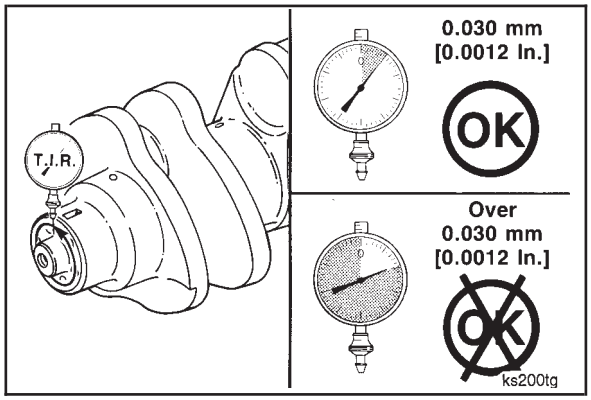
If the alignment between adjacent journals is **not** within specifications and **cannot** be repaired by grinding, the crankshaft **must** be scrapped. L10 and M11 crankshafts are fully fillet hardened and **cannot** be straightened.





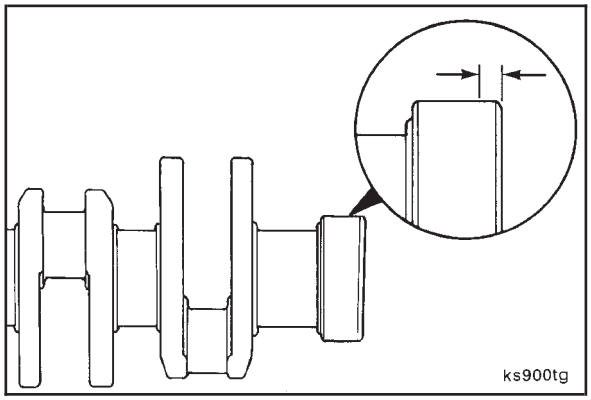
Measure the crankshaft gear journal diameter runout as follows:

- With the crankshaft supported on the No. 1 and No. 7 main bearing journals, install a dial indicator within 6.4 mm [0.250 inch] from the front end of the gear journal.



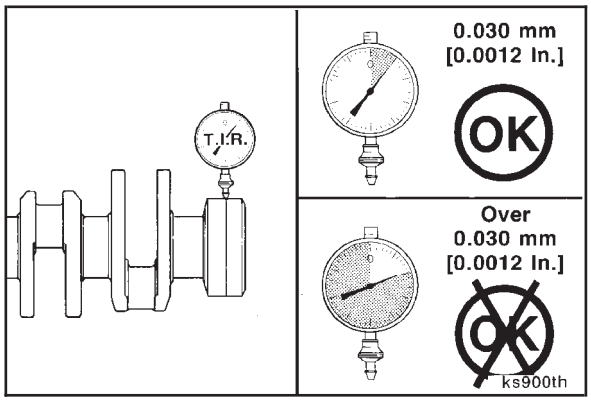
- Rotate the crankshaft one complete revolution and record the TIR.

NOTE: The maximum TIR is 0.030 mm [0.0012 inch].



Measure the crankshaft rear oil seal flange diameter runout as follows:

- With the crankshaft supported on the No. 1 and No. 7 main bearing journals, position a dial indicator within 6.4 mm [0.250 inch] from the rear of the oil seal flange diameter.

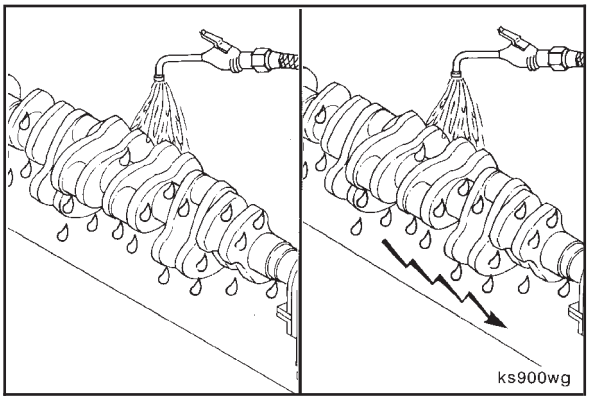


- Rotate the crankshaft one complete revolution and record the TIR.

NOTE: The maximum TIR allowed on the rear oil seal flange diameter is 0.030 mm [0.0012 inch].

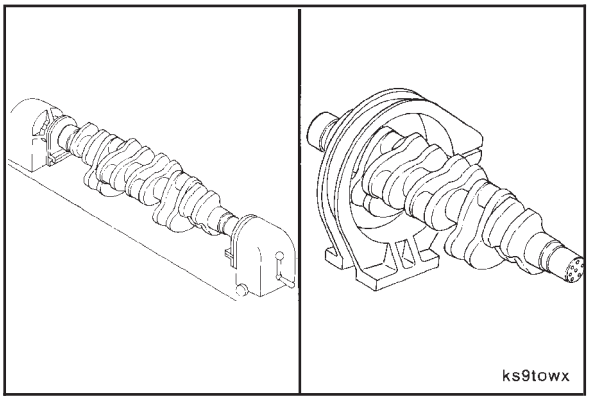
Crankshaft Magnetic Crack Inspection — Continuous Method

The crankshaft **must** be inspected using the magnetic particle "continuous method" in which the magnetic particle bath solution is applied before and during flow of the magnetic current through the crankshaft.



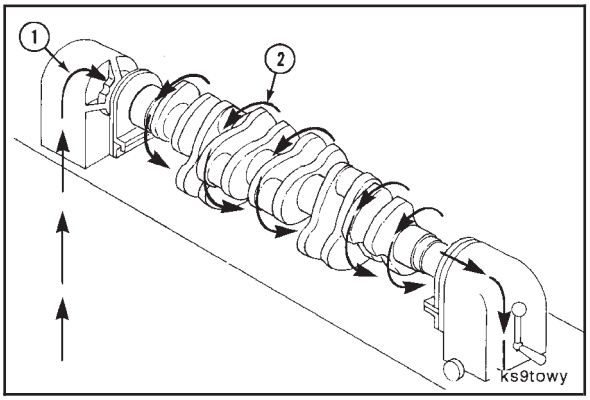
Two separate magnetization methods are required to detect both longitudinal and circumferential defects.

- Head Shot Method
- Coil Shot Method



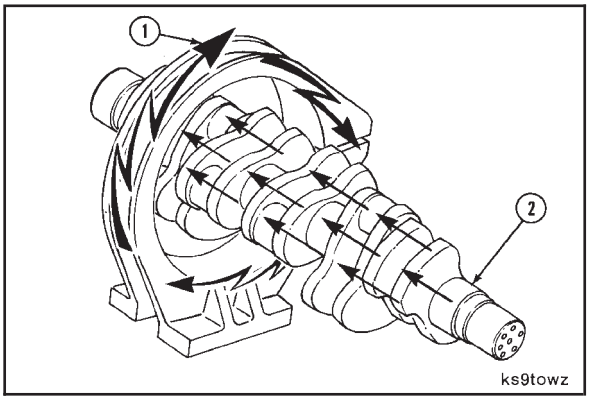
Head Shot Method

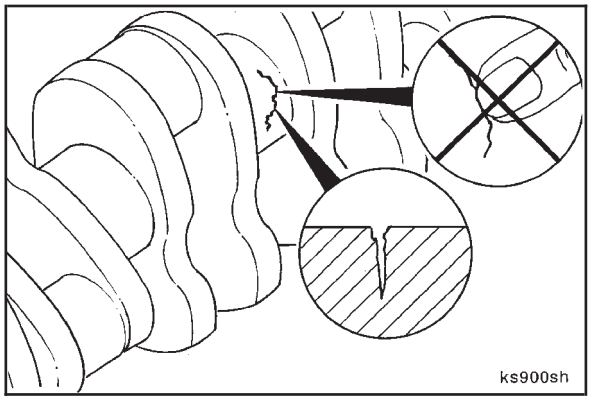
The Head Shot Method passes the magnetizing current (1) longitudinally through the crankshaft. The head shot produces a circular magnetic field (2) which is most effective in detecting longitudinal defects in the crankshaft.



Coil Shot Method

The Coil Shot Method passes the magnetizing current (1) through a coil centered around the crankshaft axis. The coil shot produces a longitudinal magnetic field (2) which is most effective in detecting circumferential defects.



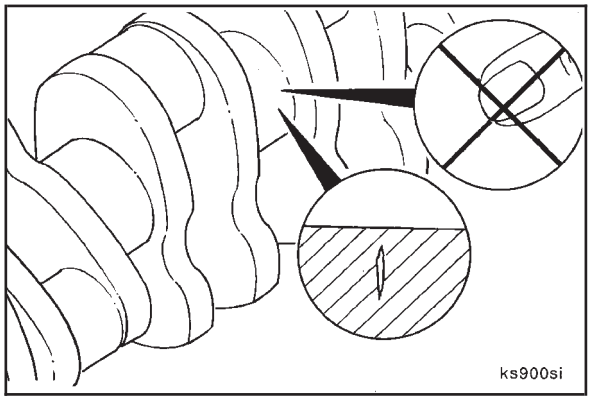


Magnetic Inspection — Limits of Acceptability

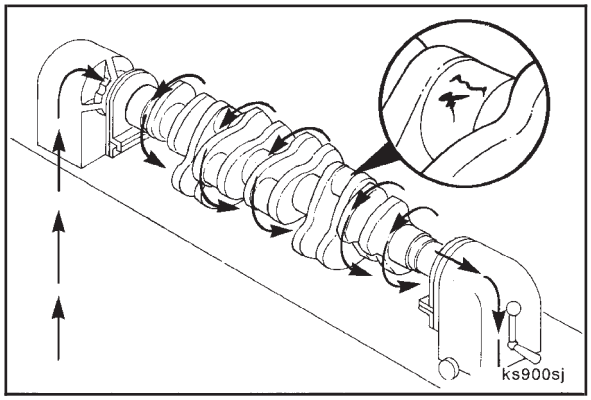
Definitions of Indications

Definitions of indications are as follows:

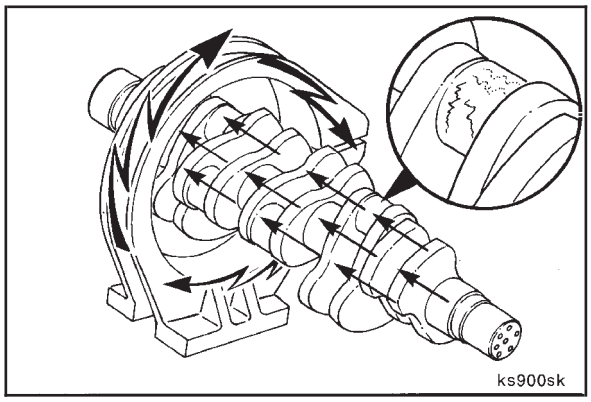
- Open Indication — An indication is open if, when wiped clean of magnetic particle bath, it can be seen with the naked eye in a well lighted area. Many times an open indication can be felt with a fingernail.



- Subsurface Indications — An indication is subsurface if, when wiped clean of magnetic particle bath, it **cannot** be seen with the naked eye in a well lighted area. Subsurface indications are often "voids" or "non-metallic inclusions" which are present in the raw material.

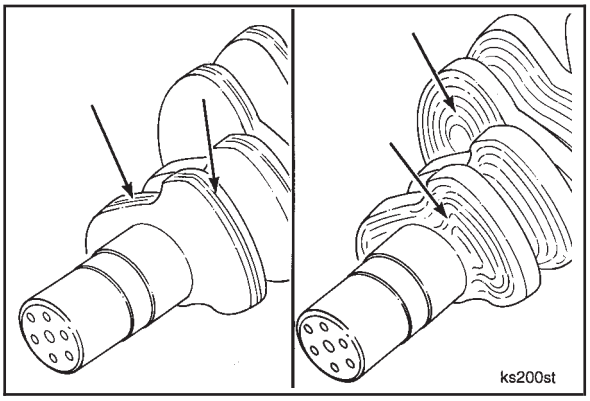


- Longitudinal Indications — An indication of a defect which is brought out with a head shot and lies parallel to the axis of the crankshaft, or at an angle less than 45 degrees to the axis of the crankshaft.



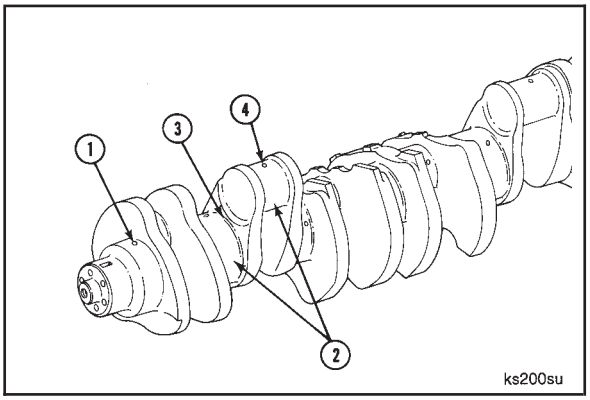
- Circumferential Indication — An indication of a defect which is brought out with a coil shot. These indications are located more than 45 degrees from the longitudinal axis of the crankshaft.

NOTE: Do **not** mistake forging trim lines or flow lines for relevant indications. These indications can exist in large quantities because they are non-relevant indications.

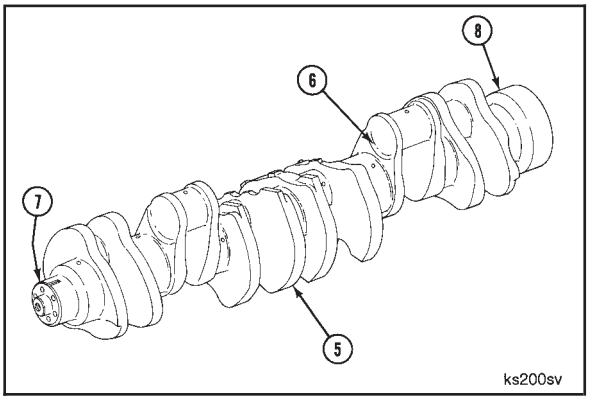


Acceptability of indications vary depending on their location on the crankshaft. The different areas to be inspected are:

1. Fillets
2. Connecting Rod and Main Bearing Journals
3. Bearing Fillet Sidewalls
4. Oil Drillings



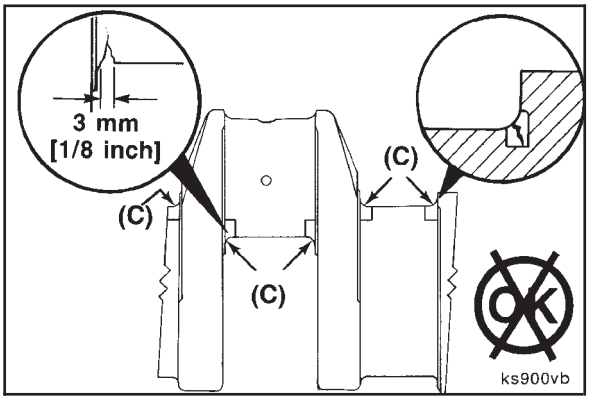
5. Counterweight Area
6. Crankshaft Webs
7. Gear Journal Diameter
8. Rear Oil Seal Flange Diameter

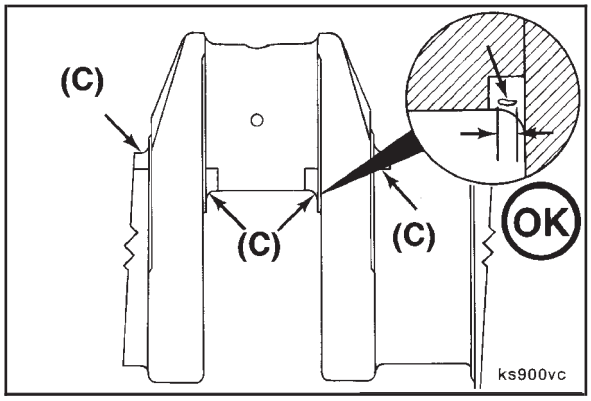


Crankshaft Journal Fillets

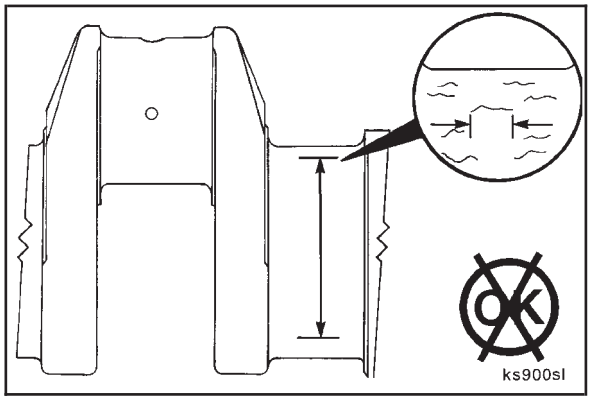
All fillets on L10 and M11 crankshafts are hardened. Open indications or subsurface indications larger than 1.50 mm [0.0625 inch] are **not** acceptable in the fillets or the critical areas (C).

NOTE: The critical area extends from the fillet side wall tangency to 3 mm [0.125 inch] beyond the fillet journal tangency on both the connecting rod and main bearing journal fillets.



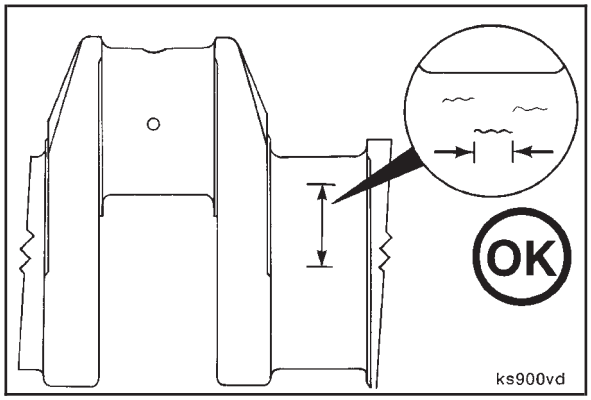


Subsurface indications smaller than 1.50 mm [0.0625 inch] in the fillets and critical areas (C) are acceptable.



Connecting Rod and Main Bearing Journals

Open indications in the longitudinal direction beyond the individual maximum length or the total cumulative length of open longitudinal indications on any one connecting rod or main bearing journal as indicated in the following tables are **not** acceptable.

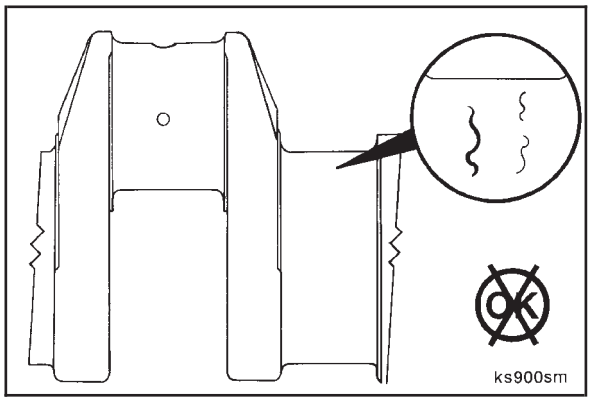


Rod Bearing Journal

Total Cumulative Length		Individual Length		
mm	in	mm		in
44.50	1.750	12.75	MAX	.500

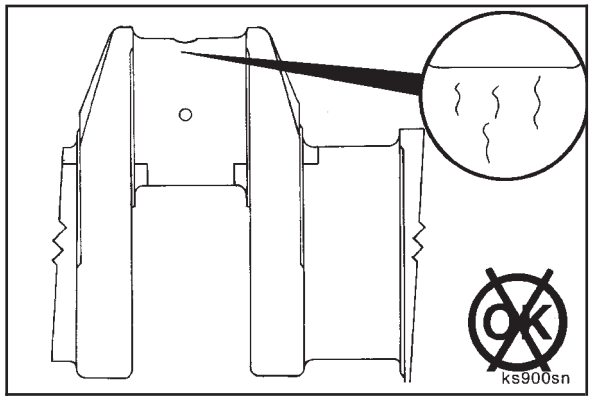
Main Bearing Journal

Total Cumulative Length		Individual Length		
mm	in	mm		in
63.50	2.500	15.896	MAX	0.625

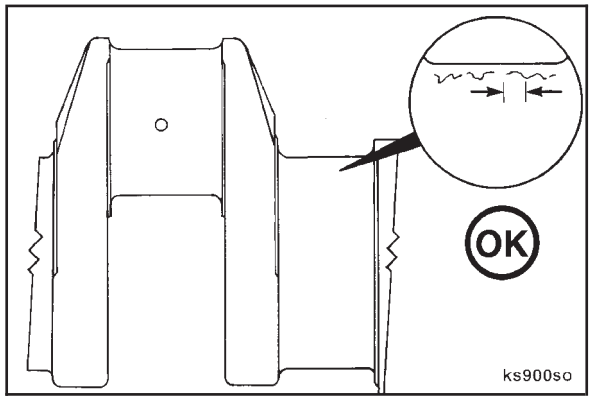


Open indications in the circumferential direction in the connecting rod or main bearing journals are **not** acceptable.

Subsurface circumferential indications on connecting rod journals are **not** acceptable.



Subsurface indications no longer than 28.50 mm [1.125 inch] are acceptable in the main bearing journals.

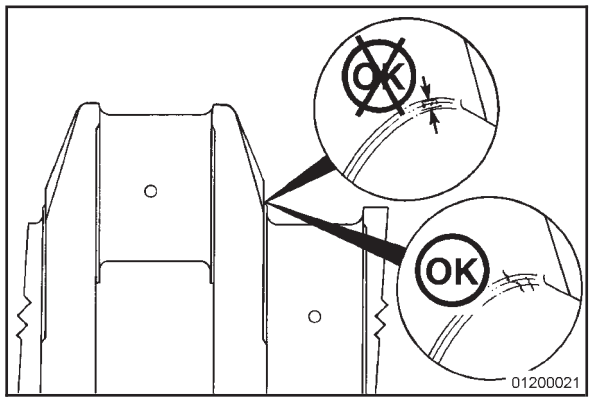


Bearing Fillet Sidewalls

Circumferential indications of any kind are **not** acceptable.

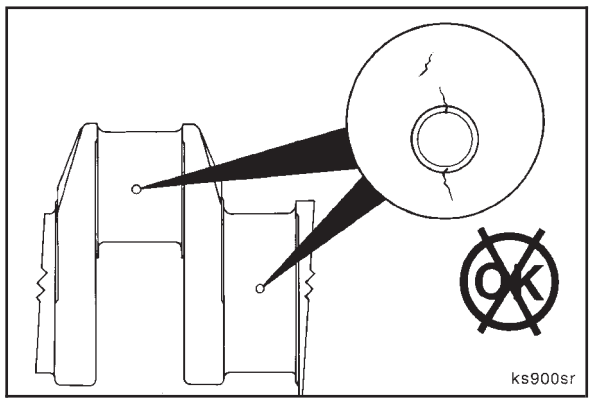
Open longitudinal indications no longer 4.750 mm [0.1875 inch] in or entering the fillet are acceptable.

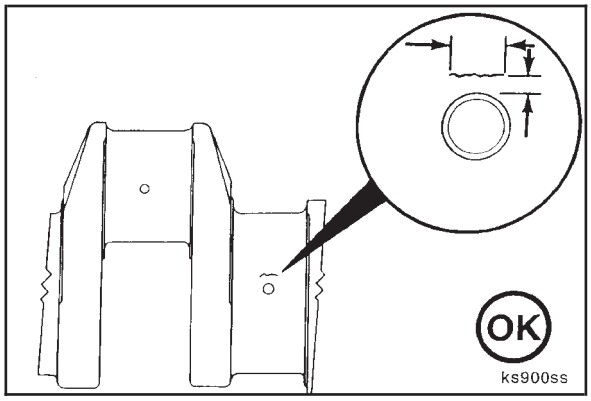
Subsurface longitudinal indications no longer than 6.50 mm [0.250 inch] are acceptable.



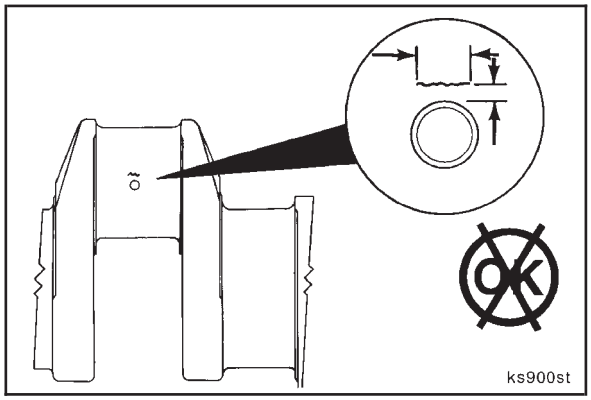
Oil Drillings

Open or subsurface indications entering the oil hole or chamfer are **not** acceptable.

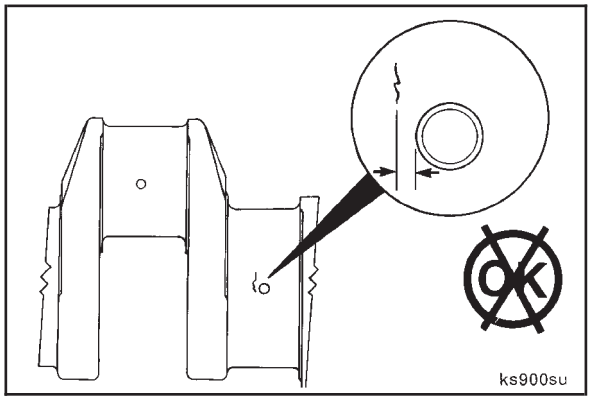




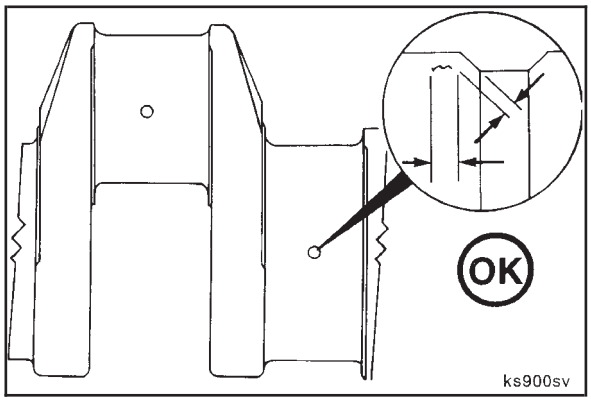
Open indications in the longitudinal direction up to 12.50 mm [0.500 inch] long but **not** closer than 3 mm [0.125 inch] to the oil hole chamfer are acceptable.



Open indications in the longitudinal direction closer than 3 mm [0.125 inch] to the oil hole chamfer are **not** acceptable.

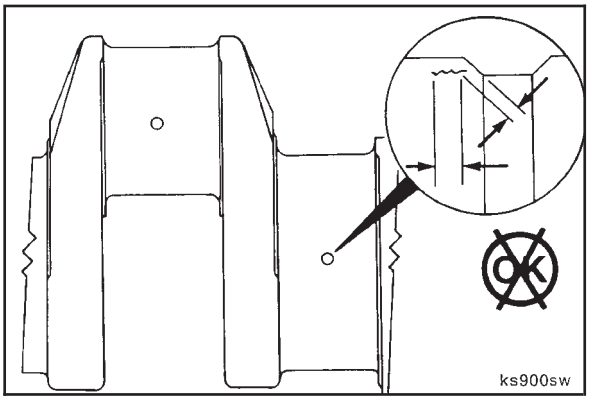


Open indications in the circumferential direction on the connecting rod or main bearing journals are **not** acceptable.

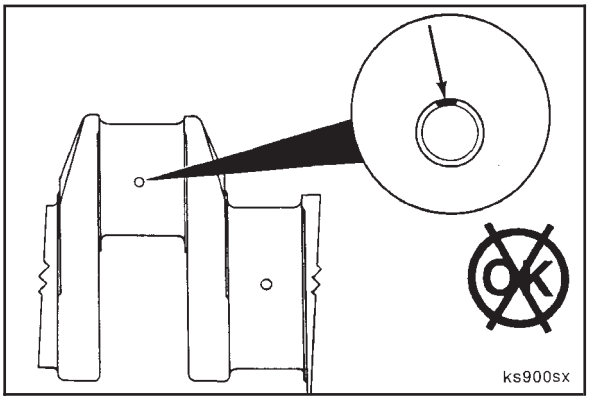


Subsurface indications in the longitudinal direction **not** closer than 3 mm [0.125 inch] to the oil hole chamfer and **not** more than 12.50 mm [0.500 inch] long are acceptable.

Subsurface indications in the longitudinal direction closer than 3 mm [0.125 inch] to the oil hole chamfer or subsurface circumferential indications are **not** acceptable.

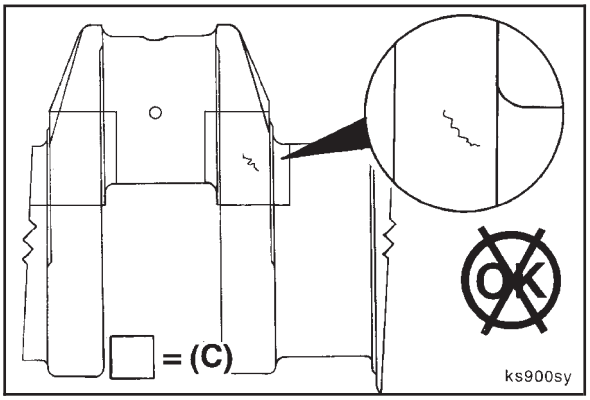


Any indication in the connecting rod bearing journal oil drilling entrance chamfer is **not** acceptable.



Crankshaft Webs

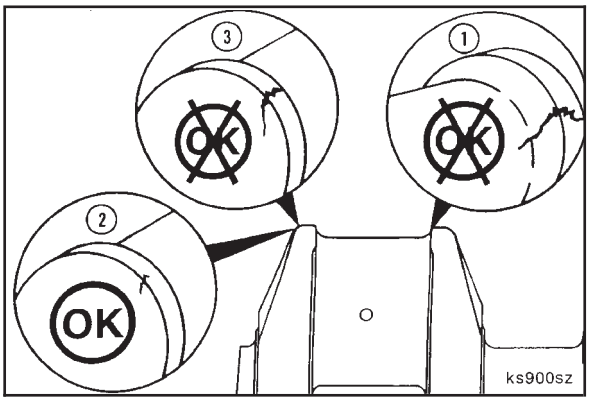
Open or subsurface indications in the crank web overlap critical area (C) are **not** acceptable.

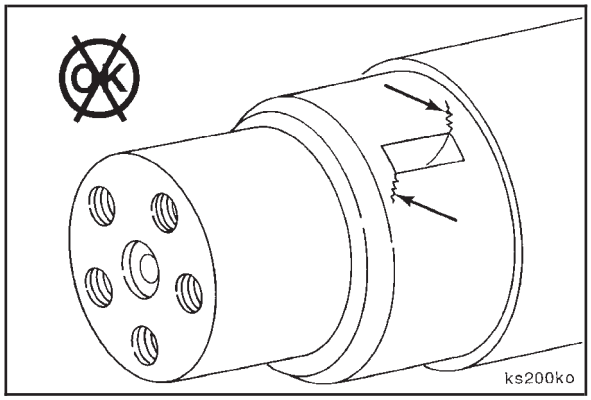


Indications that extend into the rod journal fillet are **not** acceptable.

Subsurface indications that extend out to the cast surface are acceptable.

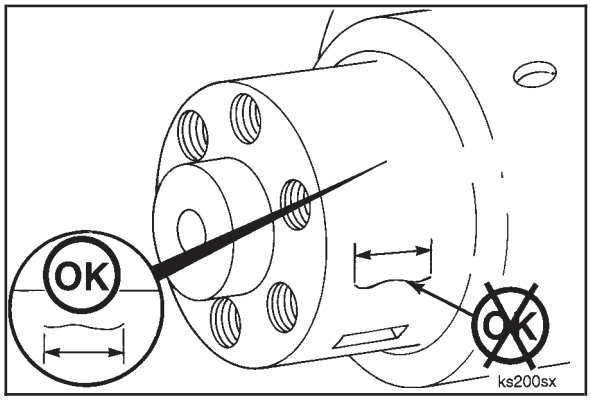
Open indications are **not** acceptable.





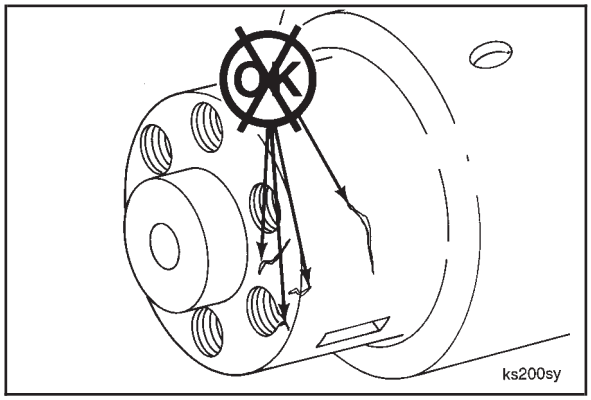
Crankshaft Gear Journal Diameter

Open indications on the gear journal diameter that enter the crankshaft keyway are **not** acceptable.



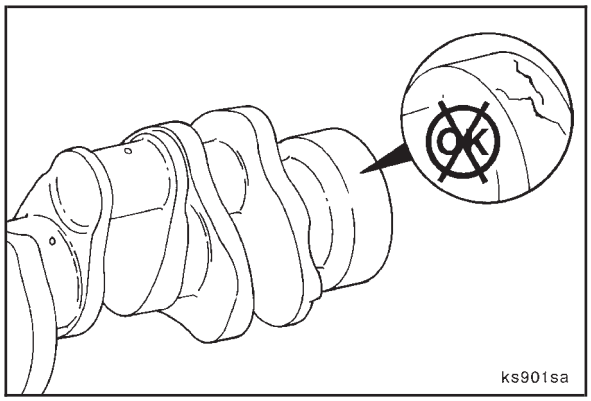
Subsurface indications in the longitudinal direction no longer than 50 mm [2 inch] are acceptable.

Open indications longer than 1.50 mm [0.0625 inch] are **not** acceptable.



An open indication or any kind of indication in the circumferential direction is **not** acceptable.

An open indication or any kind of indication that extends over the face of the crankshaft or extends into the damper mounting capscrew holes is **not** acceptable.

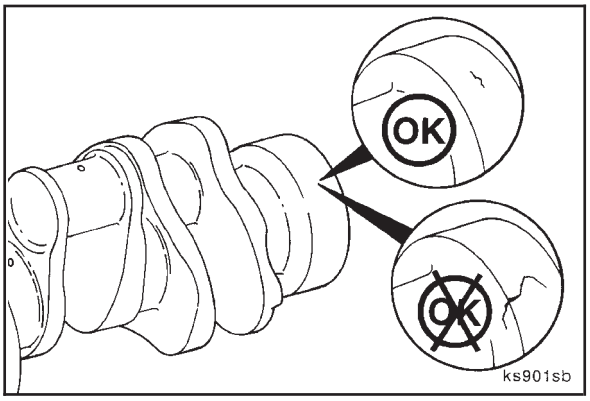


Rear Oil Seal Flange Diameter

Open indications are **not** acceptable.

Circumferential indications are **not** acceptable.

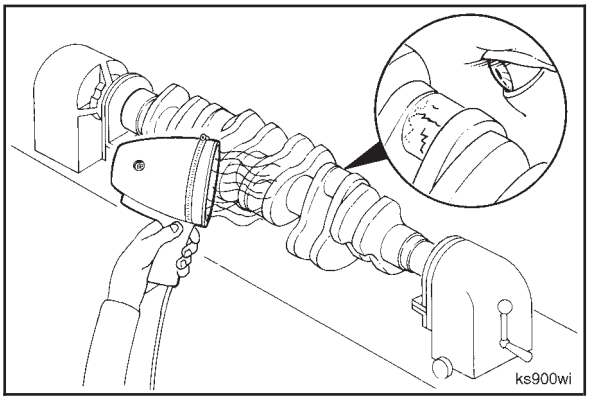
Subsurface indications no longer than 1.50 mm [0.0625 inch] are acceptable as long as the indication does **not** extend across the oil seal diameter chamfer.



Inspection Method

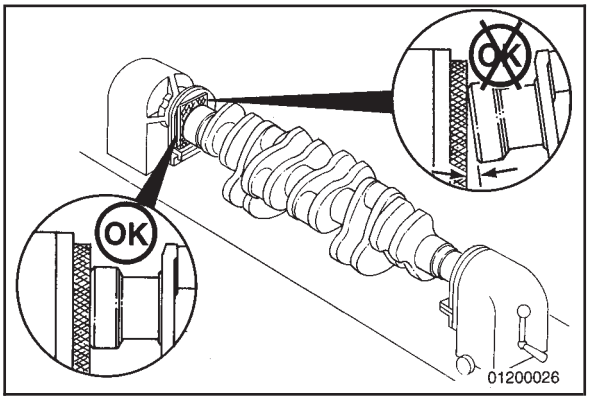
Use a 3600 angstrom (Å) ultraviolet light (black light). Inspect the crankshaft for defects in a covered booth that restricts the entry of white light.

Refer to "Crankshaft Magnetic Inspection — Limits of Acceptability" to determine if the crankshaft is acceptable for reuse.



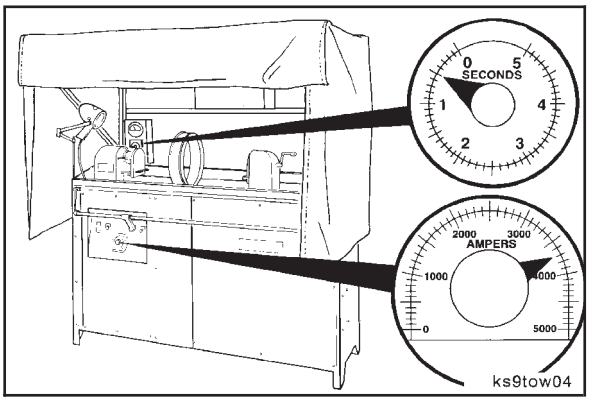
Crankshaft Longitudinal Defects (Head Shot) - Inspection

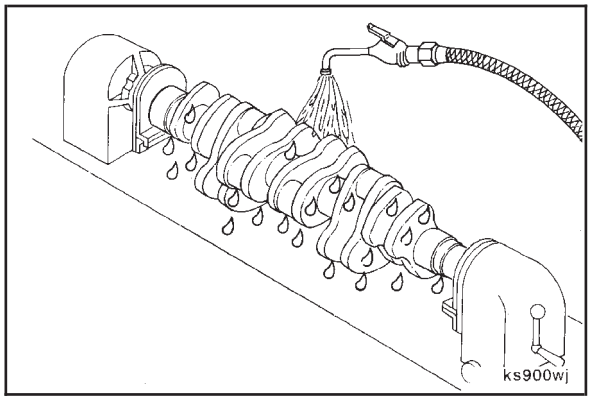
Make sure the crankshaft is tightly clamped with sufficient contact to prevent arcing.



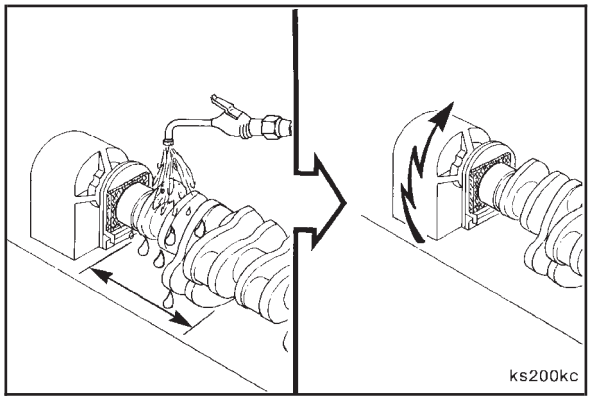
Set the timer to 1/2 second duration.

Set the amperage control to 3800 amperes D.C. or rectified A.C.





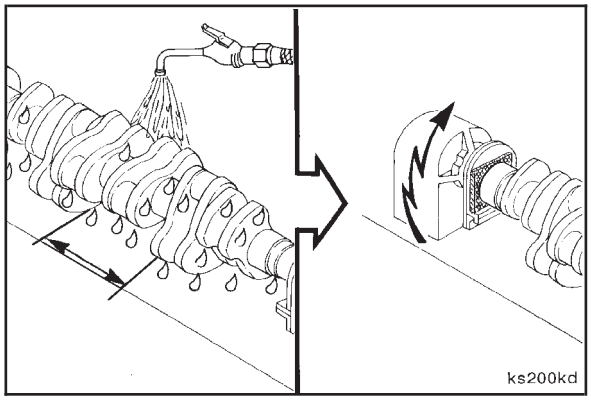
Wet the entire crankshaft with the bath solution **before** applying a magnetizing current.



A minimum of three successive head shots are required for each section of the crankshaft. Flow the bath solution over the first one-third length of the crankshaft, and apply three head shots of current.

NOTE: Turn off the flow of bath solution before the third head shot of current is completed to prevent washing the metal particles from the crankshaft.

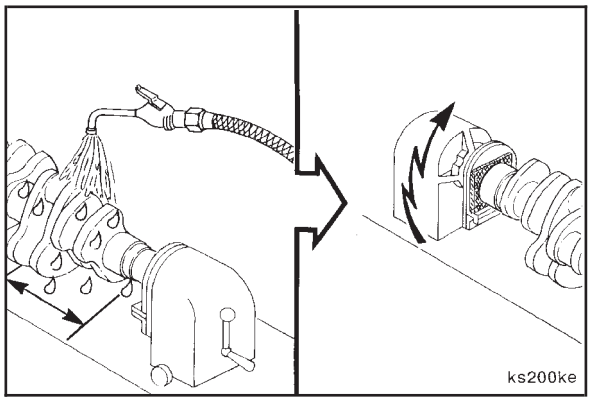
Inspect the first one-third section of the crankshaft.



Flow the bath solution over the second one-third length of the crankshaft, and apply three head shots of magnetizing current.

NOTE: Turn off the flow of bath solution before the third head shot of current is completed to prevent washing the metal particles from the crankshaft.

Inspect the second one-third section of the crankshaft.



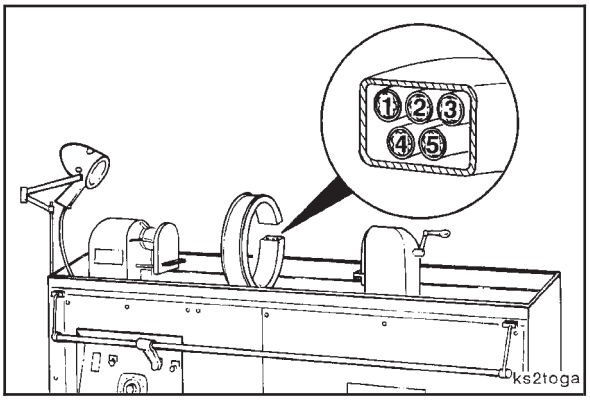
Flow the bath solution over the last one-third length of the crankshaft, and apply three head shots of magnetizing current.

NOTE: Turn off the flow of bath solution before the third head shot of current is completed to prevent washing the metal particles from the crankshaft.

Inspect the last one-third section of the crankshaft.

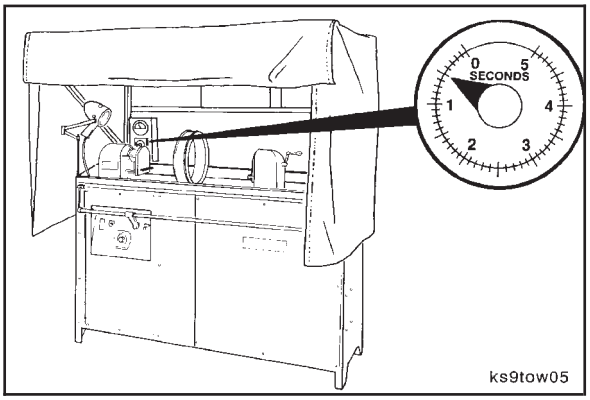
Crankshaft Circumferential Defects (Coil Shot) — Inspection

Use a coil with five turns of wire through the coil.

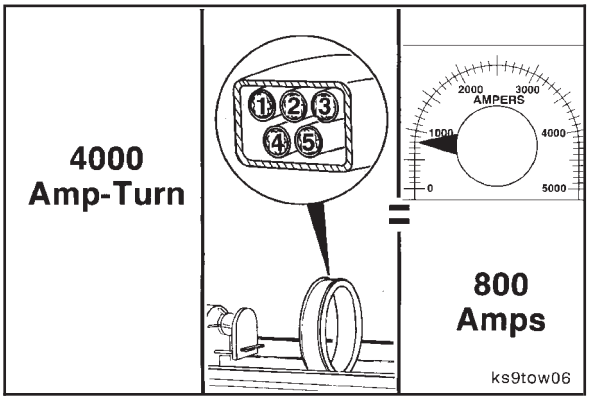


Set the timer to 1/2 second duration.

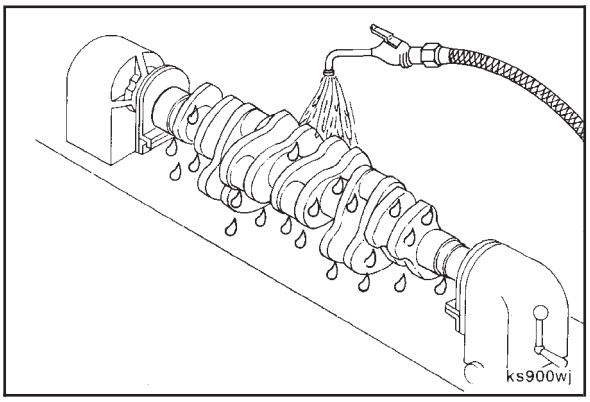
Set the amperage control to achieve 3600 to 4000 amp-turns current.

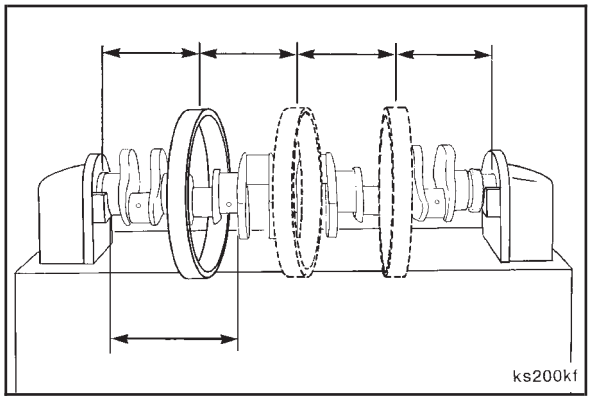


Ampere-turn is the amperage flowing through the coil multiplied by the number of turns in the coil. To determine the amp setting, divide the amp-turns by the number of coil windings.



Wet the entire crankshaft with bath solution before applying a magnetizing current.



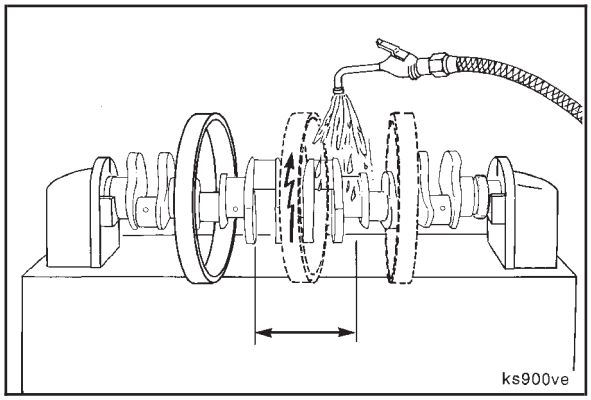


A minimum of three successive coil shots are required for each 18 inch length of the crankshaft.

Flow the bath solution over the first 18 inch length of the crankshaft, and apply three coil shots of magnetizing current.

NOTE: Turn off the flow of bath solution before the third coil shot of current is completed to prevent washing the metal particles from the crankshaft.

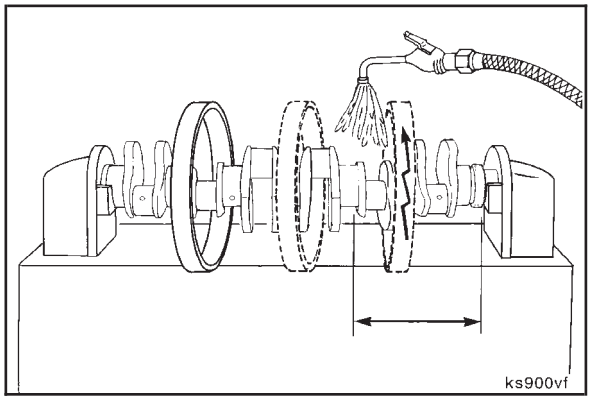
Inspect the first 18 inch length of the crankshaft.



Flow the bath solution over the second 18 inch length of the crankshaft, and apply three coil shots of magnetizing current.

NOTE: Turn off the flow of bath solution before the third coil shot of current is completed to prevent washing the metal particles from the crankshaft.

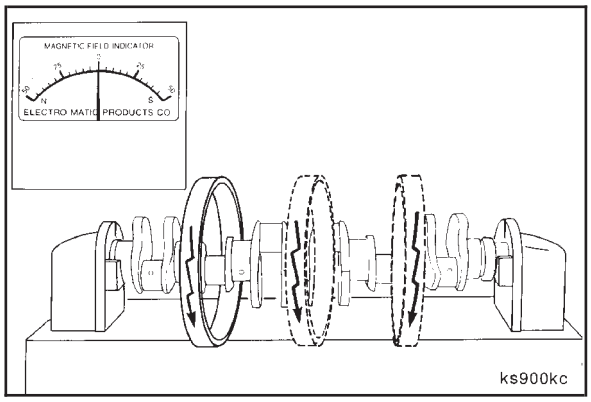
Inspect the second 18 inch length of the crankshaft.



Flow the bath solution over the last 18 inch length of the crankshaft, and apply three coil shots of magnetizing current.

NOTE: Turn off the flow of bath solution before the third coil shot of current is completed to prevent washing the metal particles from the crankshaft.

Inspect the last 18 inch length of the crankshaft.



Crankshaft De-Magnetization

Caution: All magnetism must be removed from the crankshaft completely. The crankshaft must be cleaned thoroughly. Small metal particles will cause engine damage.

Remove all magnetism from the crankshaft.

The maximum residual magnetic field on any pin or main bearing journal is 8 gauss as indicated on the magnetic field indicator gauss meter.

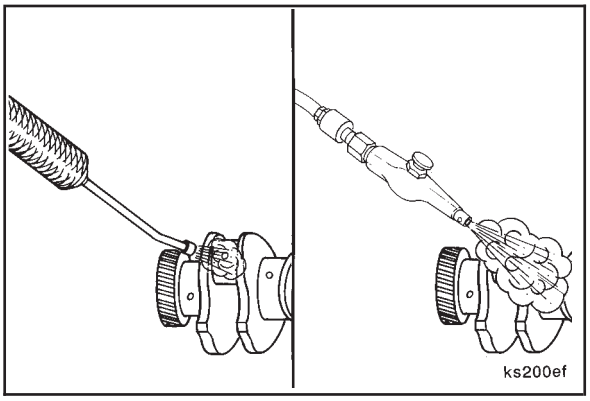
NOTE: It can be necessary to use reverse D.C.-30 point step down equipment or equivalent to remove the magnetism.

Crankshaft — Cleaning

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

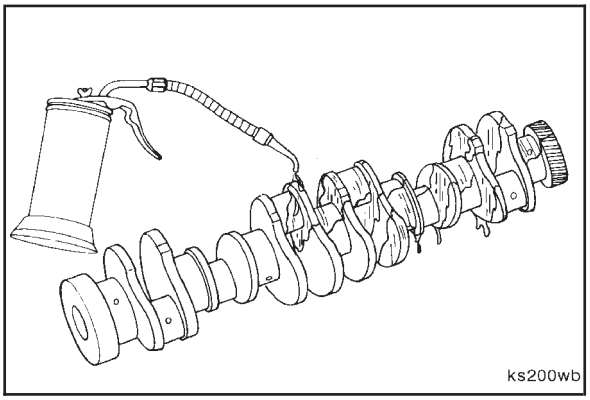
Use steam to clean the crankshaft and oil drillings.

Dry with compressed air.



Use a light preservative oil to lubricate the crankshaft to prevent rust.

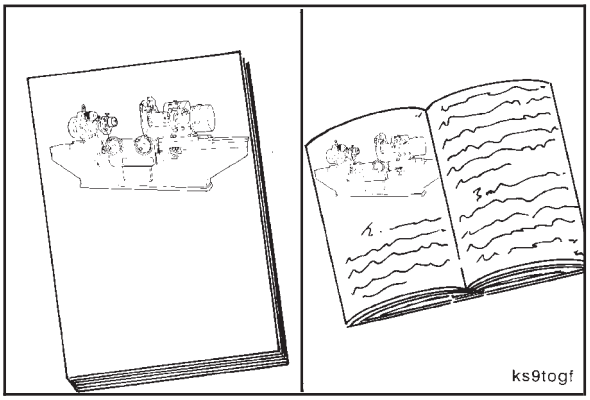
NOTE: Use a light preservative oil if the crankshaft is **not** going to be used immediately. Protect the part with a plastic cover to prevent dirt from sticking to the oil.



Grinding Machine and Wheels

Different makes of machines have different types of controls and characteristics. Each machine can vary in operation, setup, or grinding operation.

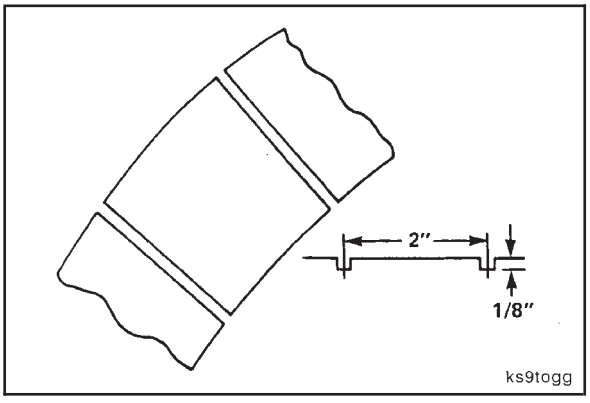
Follow the crankshaft grinding machine supplier's instructions on operations and care of the machine.

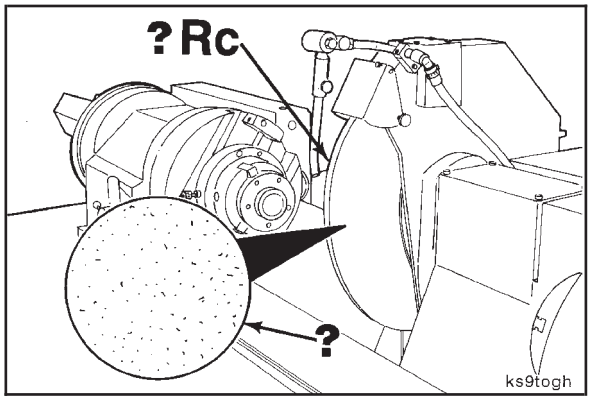


The grinding machine and grinding wheel **must** have the following characteristics:

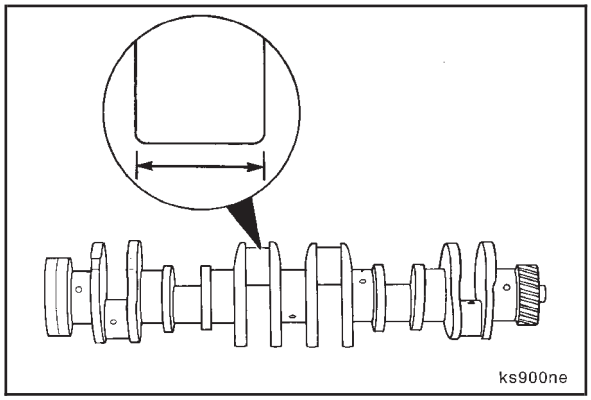
- Use a grooved grinding wheel. Each side wall of the wheel **must** have radial grooves approximately 3.2 mm [0.125 inch] deep by 76 mm [3 inch]. Grooves **must** be spaced approximately 51 mm [2 inch] apart.

NOTE: These grooves serve as an exit for debris and help reduce grinding temperatures.

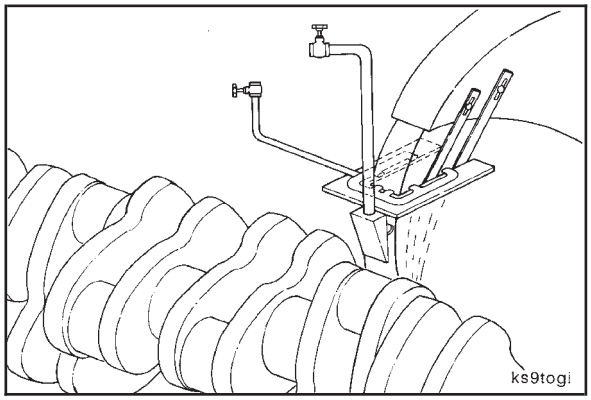




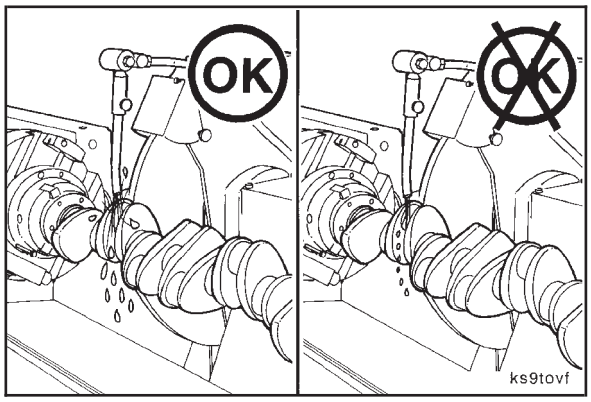
- The grinding wheel **must** have adequate hardness and acceptable bonding media. 6A-60K6-V22 is a description of a wheel that has been used successfully.



- The wheel for grinding connecting rod bearing journals **must** have a width of 53.130 to 53.168 mm [2.0917 to 2.0932 inch].

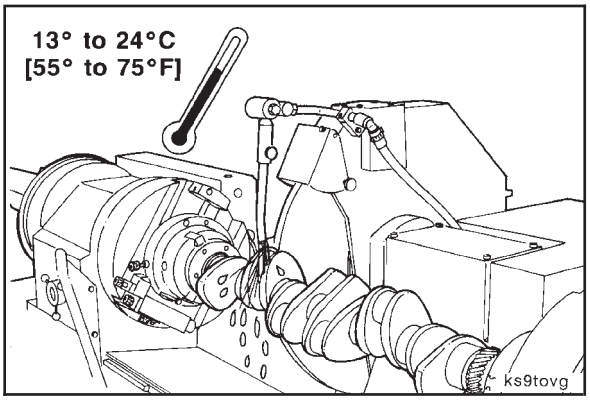


- The wheel guard **must** have an efficient air baffle and side washer equipment. Air baffles and side washers help direct the air and coolant being pumped to the wheel.



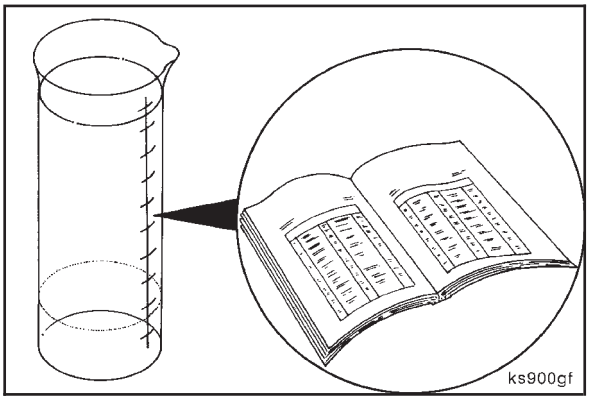
- Machine coolant volume flow **must** be sufficient to supply the manifold and main jet portions of the grinder.

- Coolant temperature **must** be controlled to 13 to 24°C [55 to 75°F].

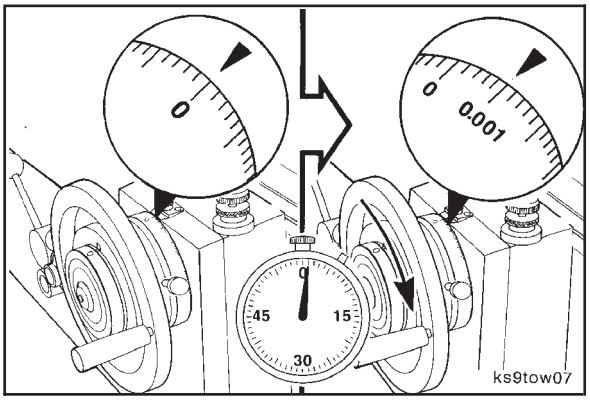


- Coolant mix concentration **must** be controlled.

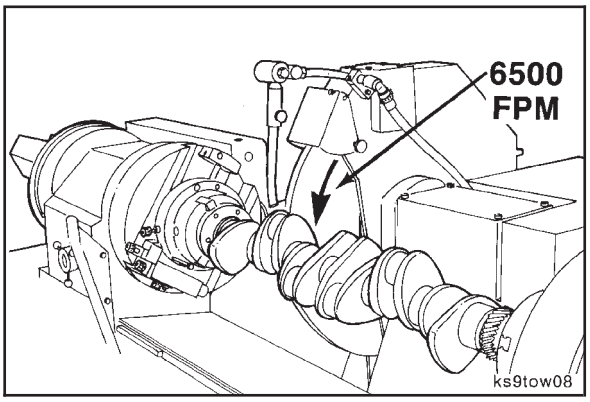
NOTE: Refer to the specific manufacturer's concentration recommendations as reference. Most coolant mixtures have a water to coolant ration of 35:1.

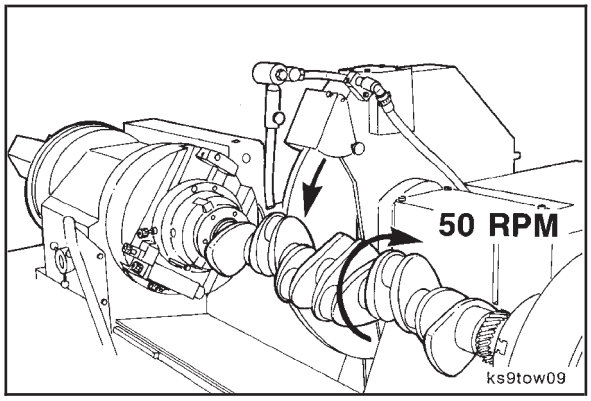


- When feeding the grinding wheel into the connecting rod thrust walls, do **not** exceed a feed rate of 0.03 mm [0.001 inch] per second.

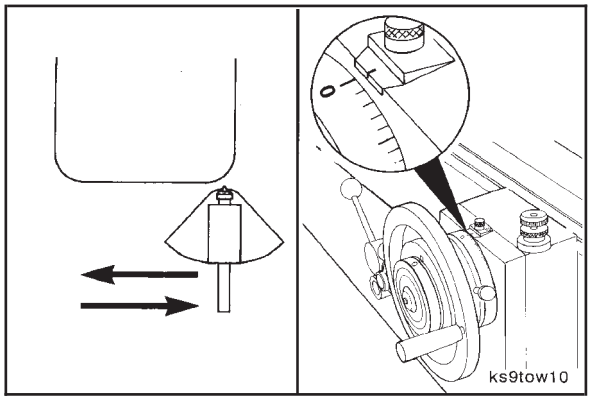


- The velocity of the wheel outside diameter will be approximately 1980 meters [6500 feet] per minute.



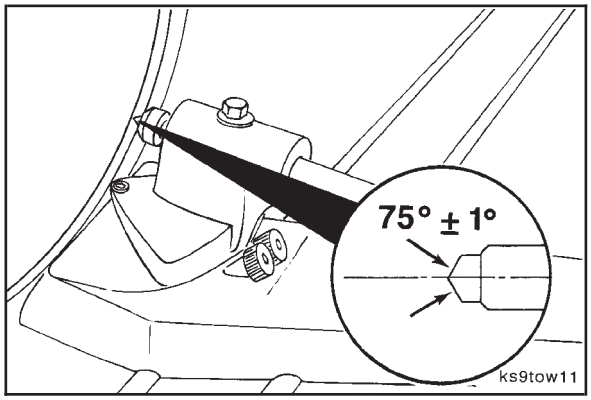


- The crankshaft **must** rotate in the opposite direction the grinding wheel is turning.
- The crankshaft **must** rotate at a speed of 50 RPM.



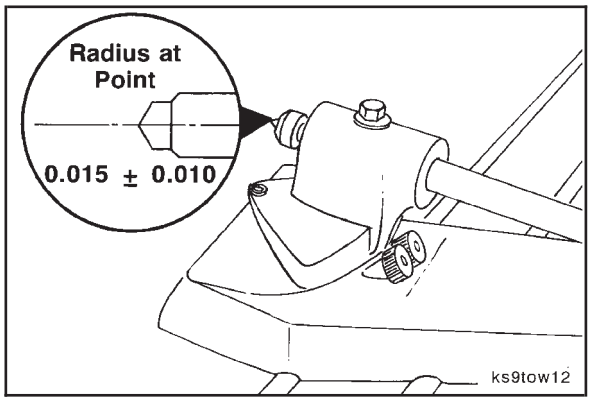
Grinding Wheel Dressing General Information

Caution: It is extremely important to dress the radii of the grinding wheel so they are tangent and smoothly blended with the sides and face of the wheel. Failure to properly dress the radii can result in a stress riser that will lead to crankshaft failure.



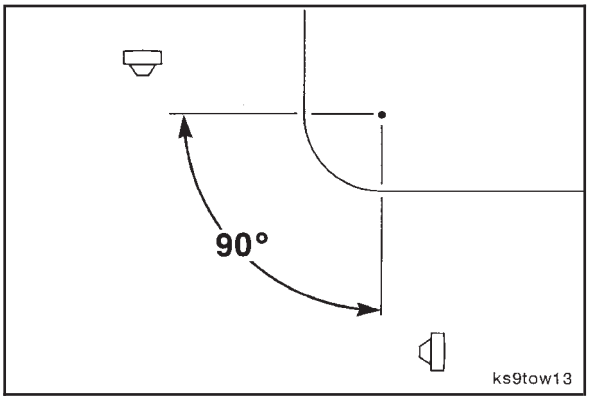
The wheel dressing tool **must** have the following characteristics:

- The wheel dresser **must** use a lapped industrial diamond. The diamond **must** be lapped into a cone with a 75 degree included angle.

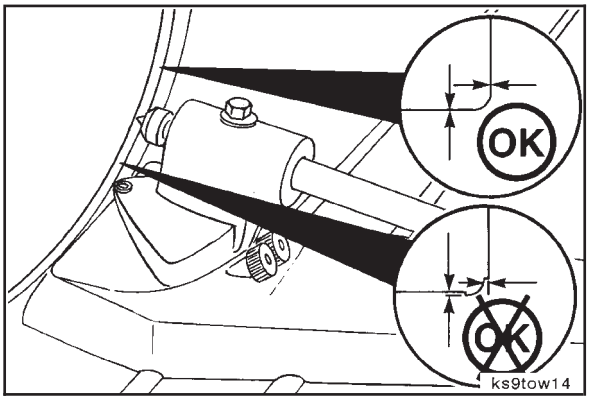


- The point radius of the diamond tool **must** be 0.38 ± 0.25 mm [0.015 ± 0.010 inch].
- The point of the cone **must** be on the same centerline as the shank.

- The dressing tool **must** have manual stops to limit the travel of the diamond dressing tool. The manual stops **must** establish a 90 degree arc.



- The diamond dresser **must** be on radial line from the pivot center of dressing device so that the radius generated on the grinding wheel will be tangent to the side and face of the grinding wheel.

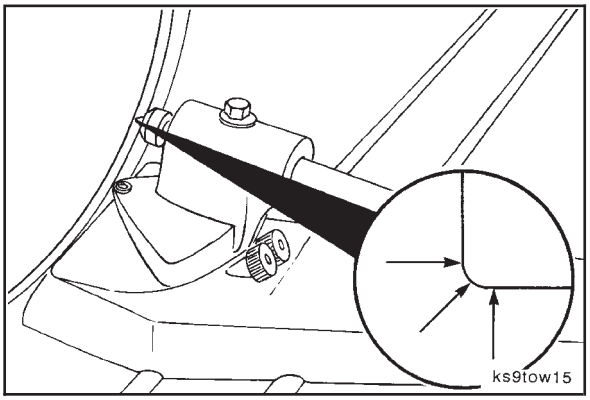


Grinding Wheel Dressing Procedure

Adjust the position of the diamond tip so it cuts the specified radius on the edges of the grinding wheel.

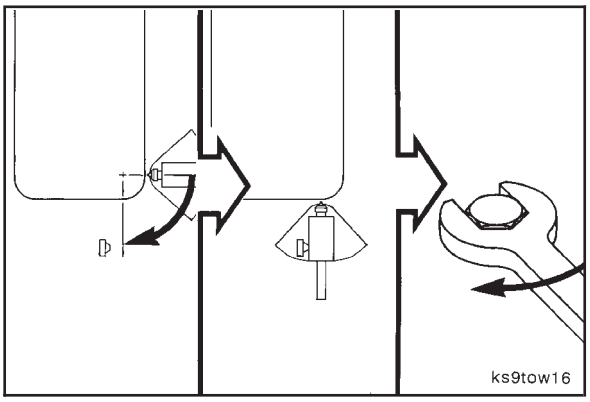
The radius specifications are as follows:

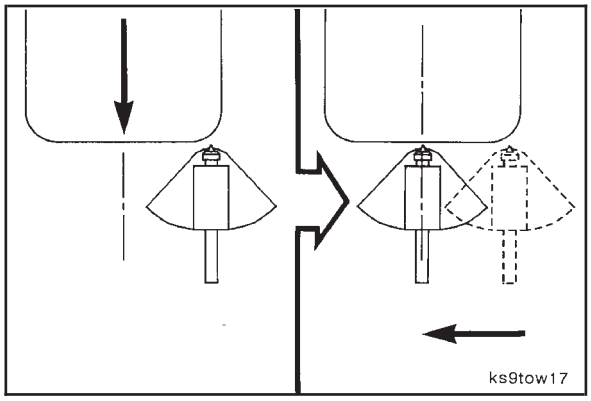
- Main Bearing Journals — 5.75 to 6.25 mm [0.226 to 0.246 inch]
- Connecting Rod Bearing Journals 4.75 to 5.25 mm [0.187 to 0.207 inch]



Turn the grinding wheel dressing tool so it is against the mechanical stop and perpendicular to the face of the grinding wheel.

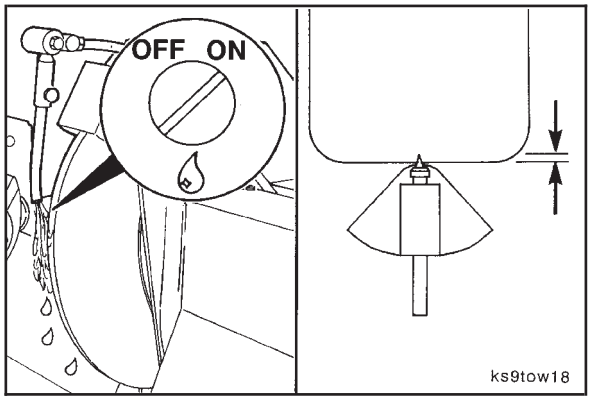
Lock the dressing tool in position.





Move the grinding wheel close to the diamond tip of the dressing tool.

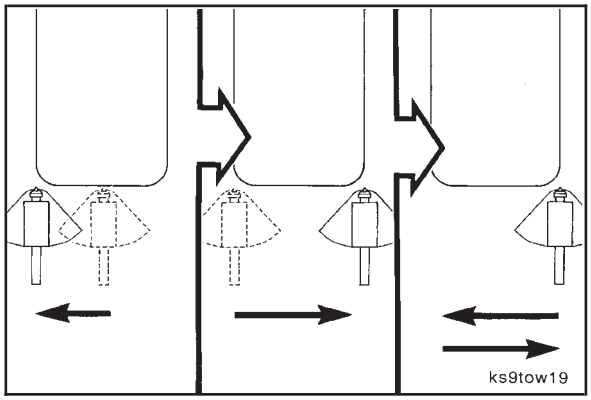
Position the wheel so its center is lined up with the diamond tip of the dressing tool.



Turn the grinding machine "ON".

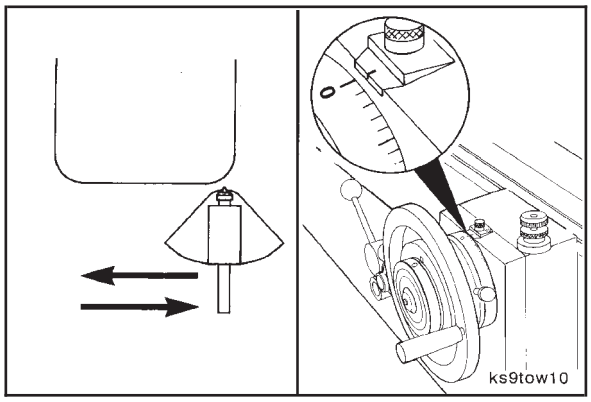
Turn the coolant supply "ON".

Move the wheel into the diamond tip of the dressing tool 0.03 to 0.08 mm [0.001 to 0.003 inch] deep.



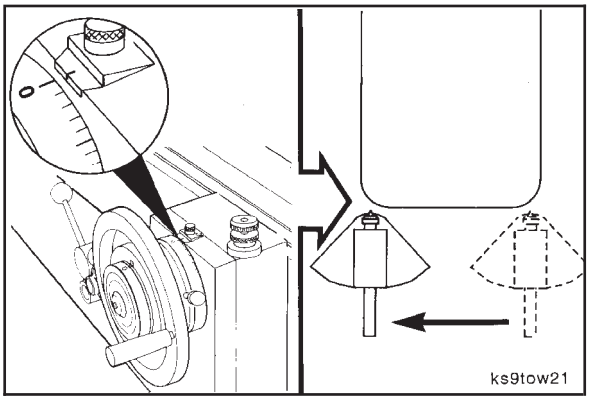
Traverse the wheel back and forth across the diamond tip to dress the face of the wheel.

NOTE: When traversing the wheel across the diamond tip, do it at a medium speed. A feed rate which is too slow will produce a wheel surface which is too smooth and can cause grinder burn. A feed rate which is too fast will **not** provide an evenly dressed surface.

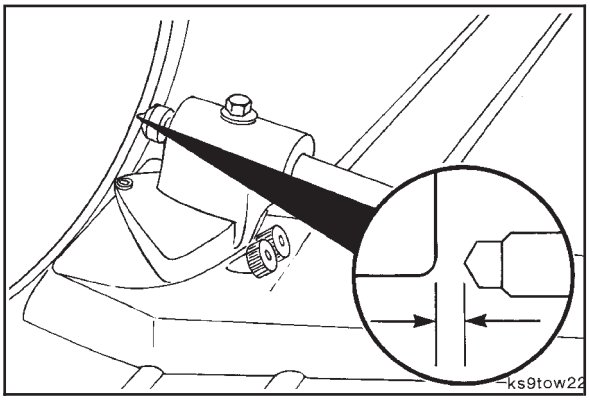


Repeat the procedure until the full face of the grinding wheel is cut on each pass.

Move the depth indicator to "0". Make a final single pass across the face of the wheel. This is commonly called the "spark out" pass.

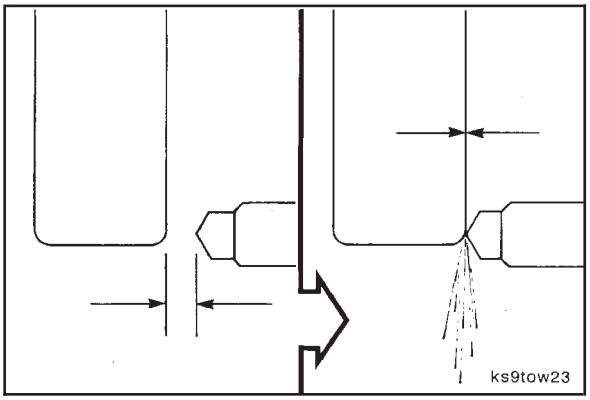


Back the wheel away from the diamond tip 0.08 to 0.13 mm [0.003 to 0.005 inch].



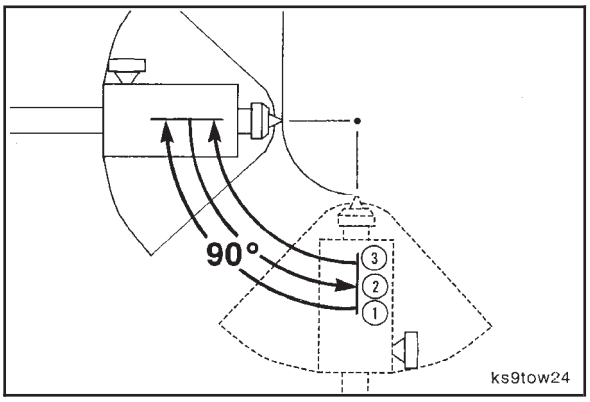
Position the dressing tool against the side mechanical stop.

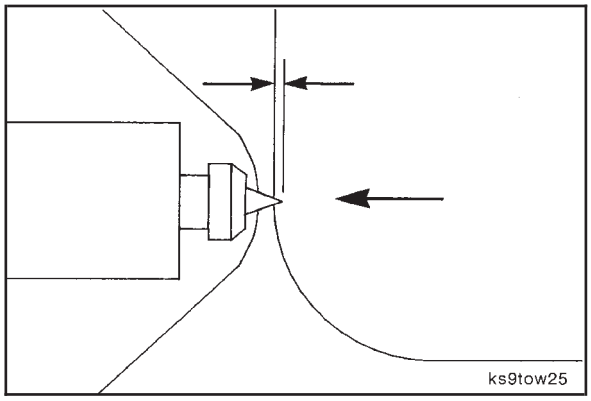
Feed the wheel over until it just touches the diamond tip of the dressing tool.



Oscillate the dressing tool from stop to stop until no more material is being removed from the grinding wheel radius.

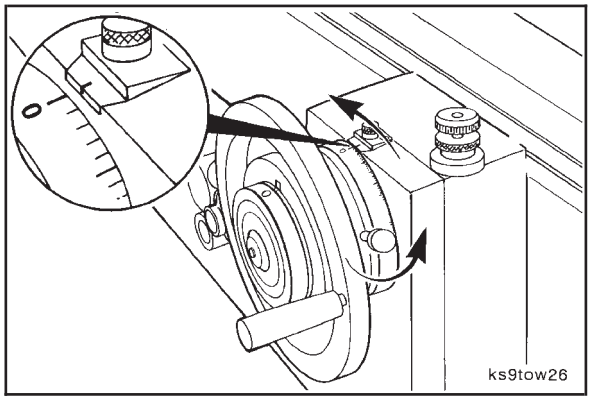
Position the dressing tool against the stop that places the diamond tip on the face of the wheel.





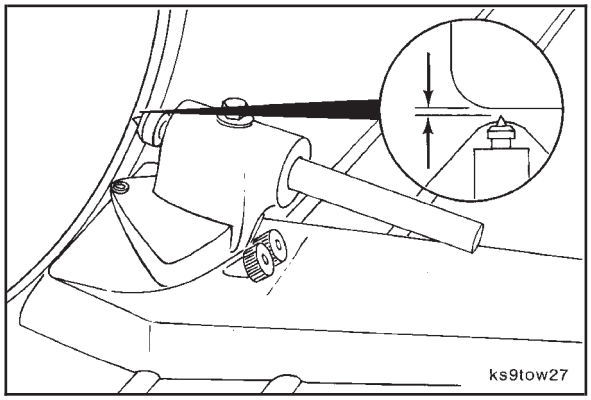
Move the grinding wheel towards the diamond tip 0.01 mm [0.0005 inch].

Repeat the oscillating procedure.

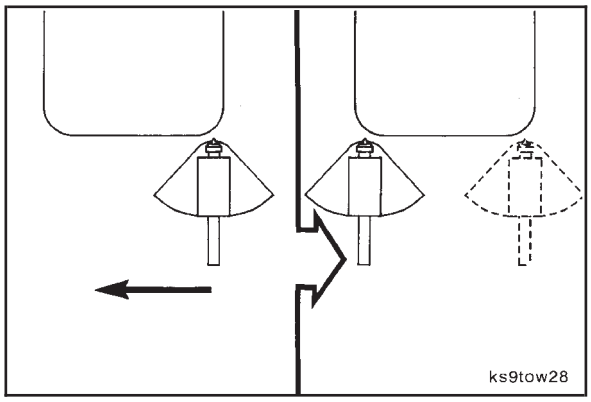


Repeat the oscillating procedure until the depth indicator reaches the "0" set point.

At this point the radius will be tangent to the face and side of the wheel.



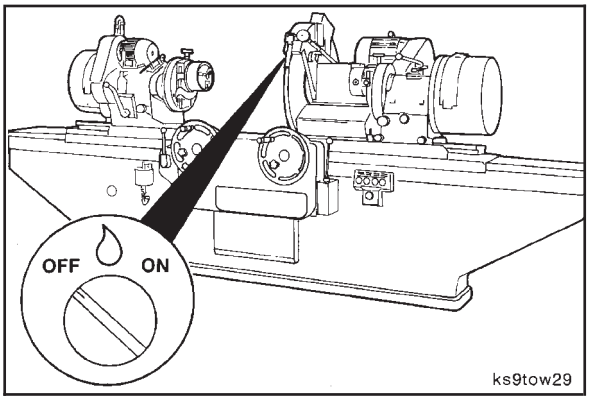
Move the grinding wheel away from the diamond tip.



Traverse the wheel so the other side of the wheel can have the radius formed.

Repeat the oscillation procedure to form the other radius.

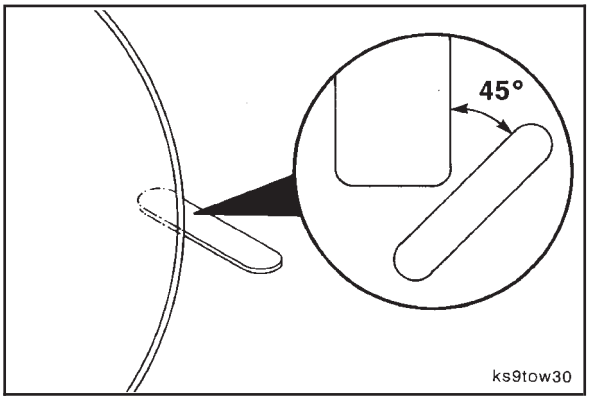
Turn the machine coolant supply "OFF".



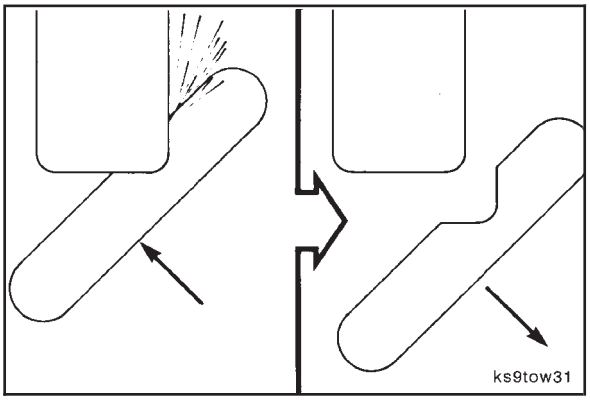
Radius Size — Inspection

Select a piece of soft wood to be ground to inspect the radius size.

Position the wood at a 45 degree angle to the grinding wheel face.



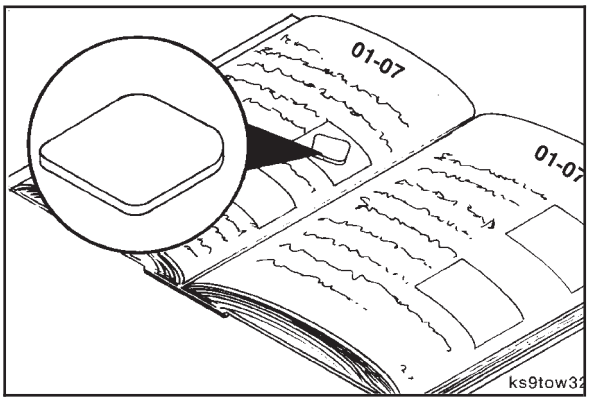
Push the wood into the grinding wheel. Allow the grinding wheel to cut a full form radius on in the wood.

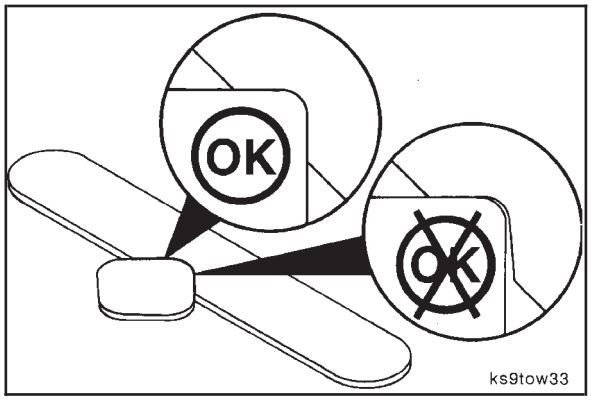


Select a flat gauge block with the specified radius size.

The radius specifications are as follows:

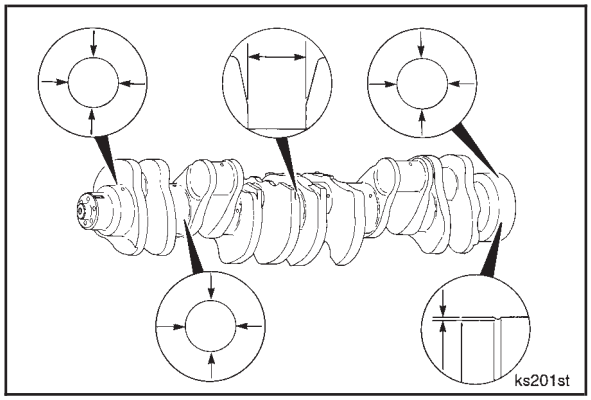
- Main Bearing Journals — 6.00 to 6.50 mm [0.236 to 0.256 inch]
- Connecting Rod Bearing Journals — 4.75 to 5.25 mm [0.187 to 0.207 inch]





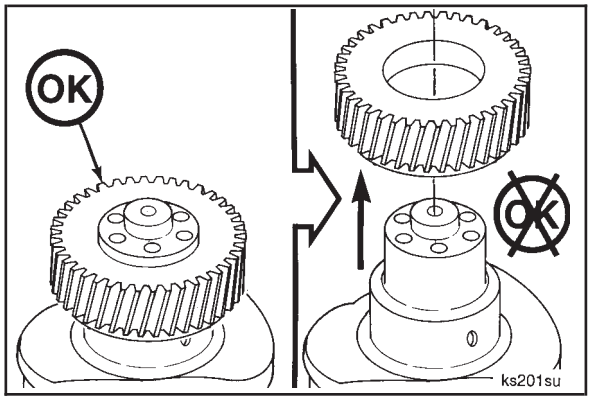
Compare the cut radius in the wood to the gauge block. The gauge block **must** completely fill the cut radius in the wood.

NOTE: If clearance exists, the radius has been mis-cut and the grinding wheel **must** be reformed.



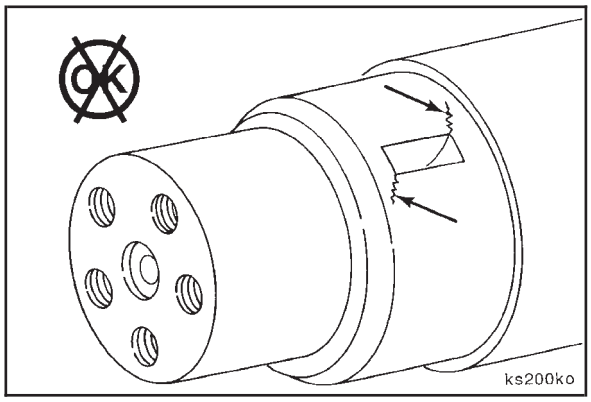
Crankshaft Reconditioning Process

The dimensional tolerances and specifications limits are based on requirements for long term reliability. Deviation from the tolerances and specification limits can result in premature crankshaft failure or wear out.



Gear Journal Outside Diameter — Inspection

If the crankshaft gear is in good condition, do **not** remove it. The crankshaft can be reground with the gear installed.

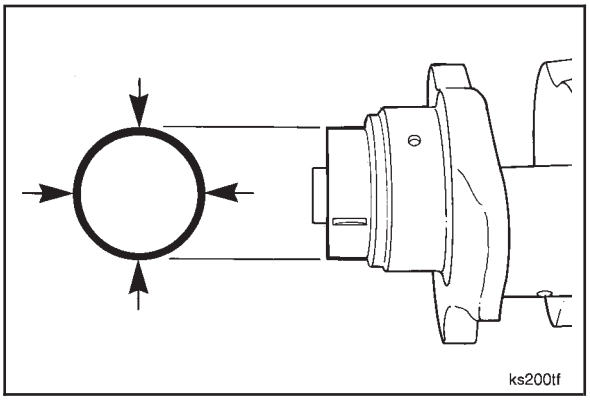


If the crankshaft gear has been removed, clean and visually inspect the gear journal outside diameter for damage.

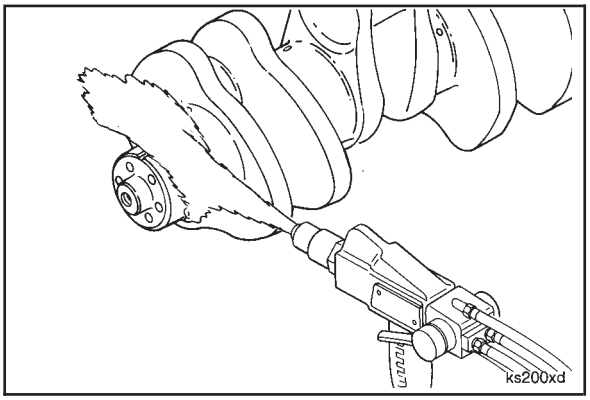
Open indications that enter the crankshaft keyway are **not** acceptable.

Measure the gear journal outside diameter.

Crankshaft Gear Journal O.D. (STD)		
mm		in
85.975	MIN	3.3848
86.000	MAX	3.3858

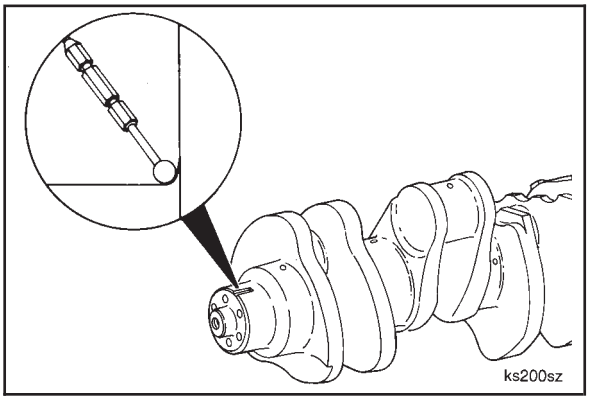


If the gear journal outside diameter is damaged or worn below the minimum specifications, it can be repaired by building it up with chrome plating or spray metal and regrinding to specifications.



When regrinding, the fillet radius between the gear journal outside diameter and the No. 1 main bearing journal **must** be:

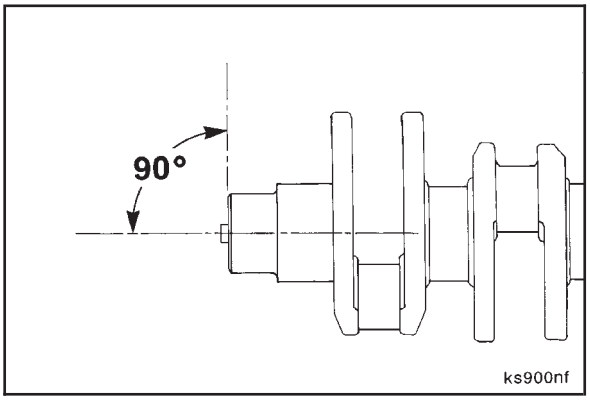
Fillet Radius		
mm		in
5.75	MIN	0.226
6.25	MAX	0.246

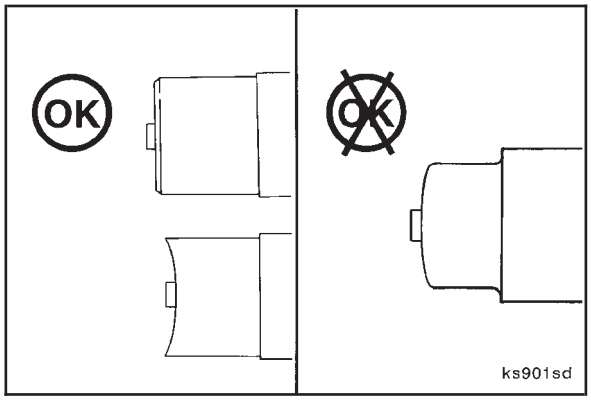


Vibration Damper Mounting Surface — Inspection

The vibration damper mounting surface **must** be inspected for excessive run out.

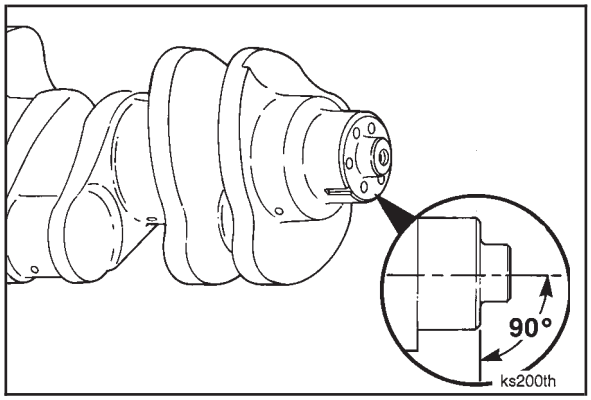
The face run out **must not** exceed 0.030 mm [0.0012 inch] when measured 37.5 mm [1.48 inch] from the crankshaft centerline.



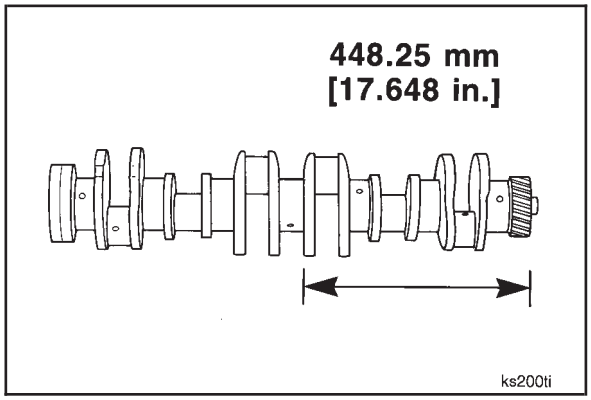


Inspect the flatness of the vibration damper mounting surface.

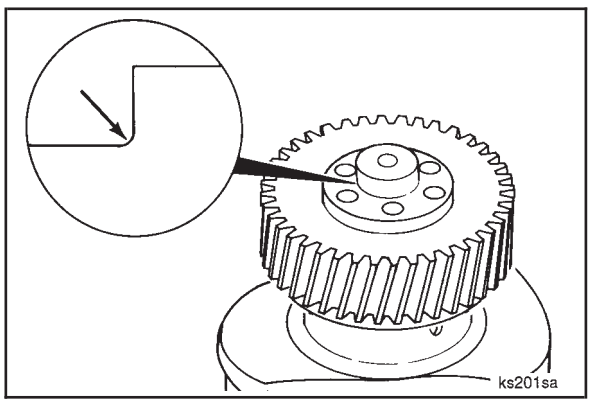
- A flat or concave surface is acceptable.
- A convex surface is **not** acceptable.



The perpendicularity of the vibration damper mounting surface can be corrected by machining the damper mounting face of the crankshaft.



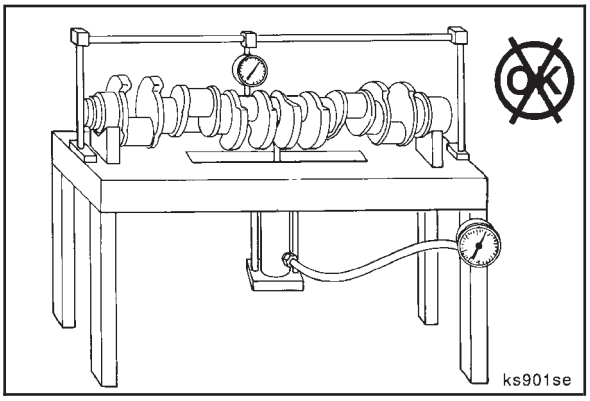
When re-facing the vibration damper mounting surface, a minimum distance of 448.25 mm [17.648 inch] **must** be maintained from the front of the No. 4 main bearing (No. 4 thrust surface) to the vibration damper mounting surface.



The radius between the vibration damper pilot and the vibration damper mounting surface **must** be a maximum of 3.0 mm [0.12 inch].

Cold Straightening

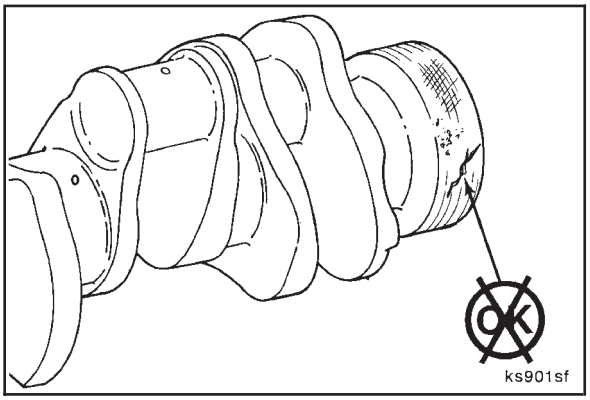
L10 and M11 crankshafts **cannot** be cold straightened because they are fully fillet hardened. If any bend or misalignment **cannot** be corrected by machining, the crankshaft **must** be scrapped.



Front or Rear Oil Seal Flange — Repair

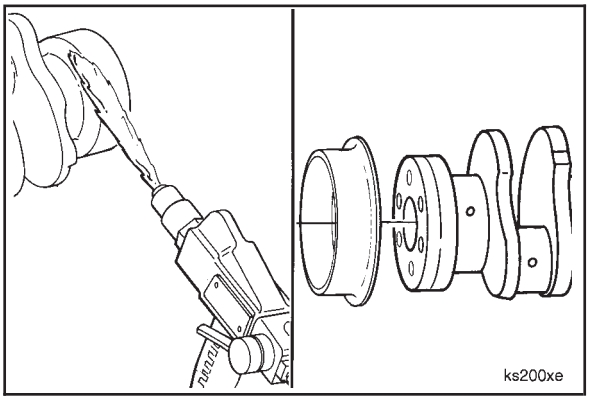
Refer to ″Front or Rear Crankshaft Oil Seal Flange - Inspection″ for seal flange inspection instructions.

NOTE: On internal damper model L10 engines, the front crankshaft oil seal rests on the crankshaft adapter, **not** the crankshaft.



If the front or rear oil seal flange requires repair, two repair methods can be used:

1. Chroming or filling the area to be repaired with spray metal
2. Installing a wear sleeve

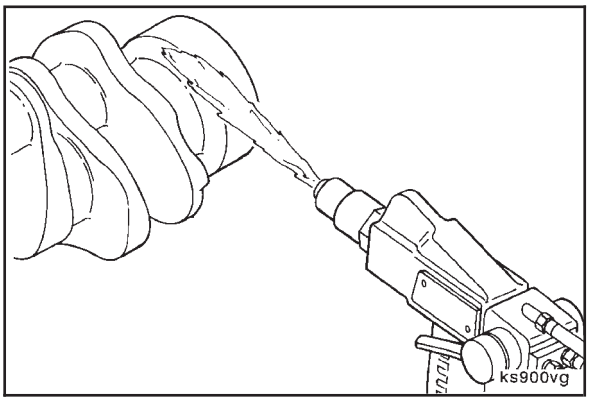


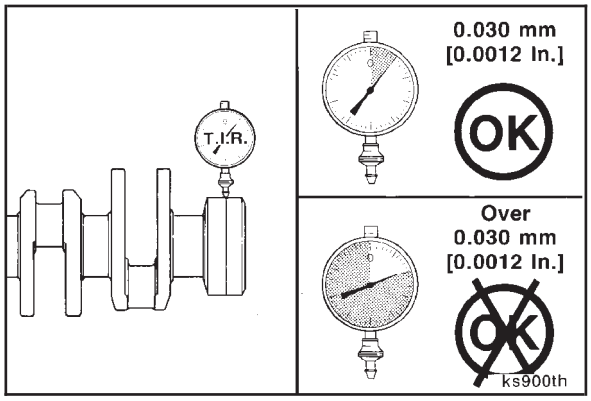
1. Chroming or Spray Metal Method

Eroded or undersize front or rear oil seal flange outside diameters can be repaired by chroming or building up the flange area with spray metal.

NOTE: After chroming or installing the spray metal, the oil seal flange **must** be reground to the standard size.

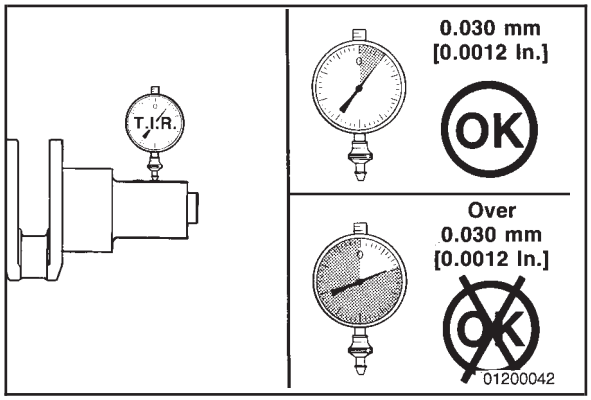
Crankshaft Oil Seal Flange O.D.			
	mm		in
Front Flange	84.970	MIN	3.3453
	85.000	MAX	3.3465
Rear Flange	164.965	MIN	6.4947
	165.035	MAX	6.4974





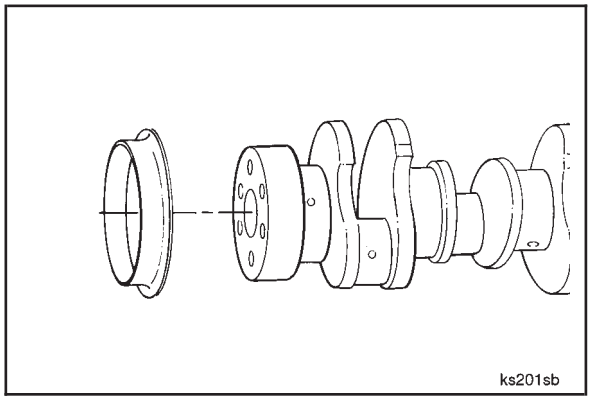
After grinding, inspect the run out of the rear oil seal flange.

The maximum allowable TIR is 0.030 mm [0.0012 inch].



Inspect the run out of the front oil seal flange.

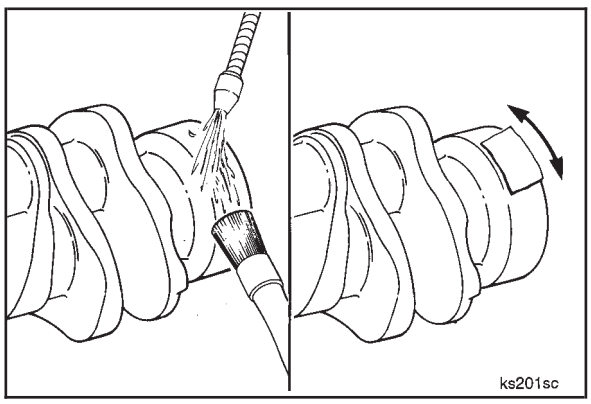
The maximum allowable TIR is 0.030 mm [0.0012 inch].



2. Wear Sleeve Method

If the front or rear oil seal flange requires repair, an ultra thin wear sleeve can be installed. Installation of a wear sleeve usually does **not** require machining of the crankshaft.

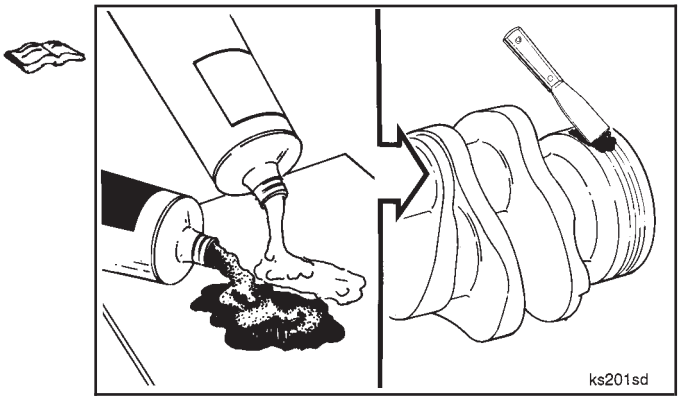
Crankshaft Wear Sleeve	
Crankshaft Flange	**Part No.**
Rear	3819774
Front Adapter (Internal Damper)	3820917
Front Crankshaft (External Damper)	3820918



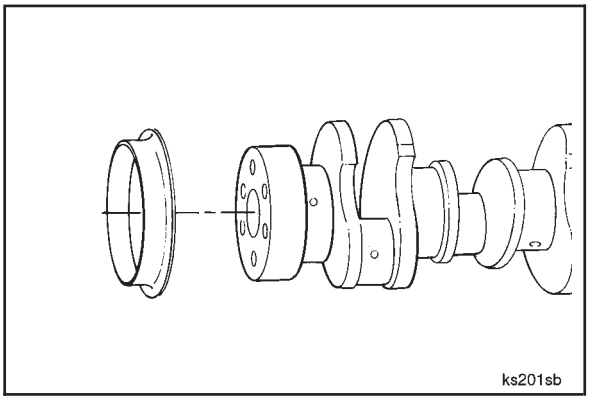
The following procedure can be used when installing a wear sleeve:

- Clean the oil seal surface of the flange thoroughly
- Use emery paper to remove any burrs or rough spots from sealing surface

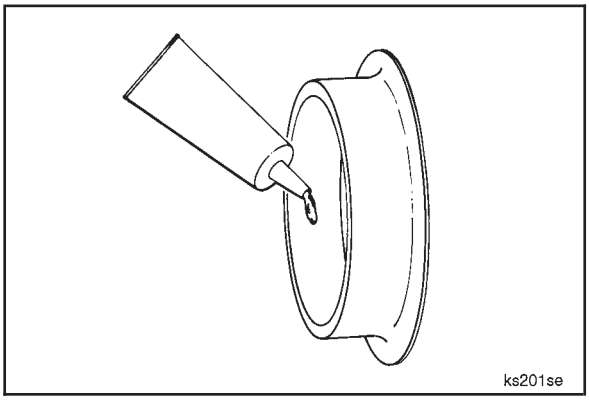
- If the crankshaft flange is deeply scored, fill the grooved area with epoxy metal filler before installing the wear sleeve. Refer to Group 0 for guidelines on use of epoxy metal filler.



- Remove excess filler material from the crankshaft surface
- Install the repair sleeve before the filler material hardens

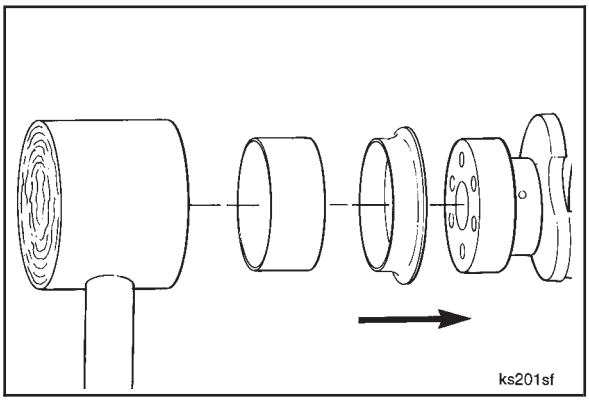


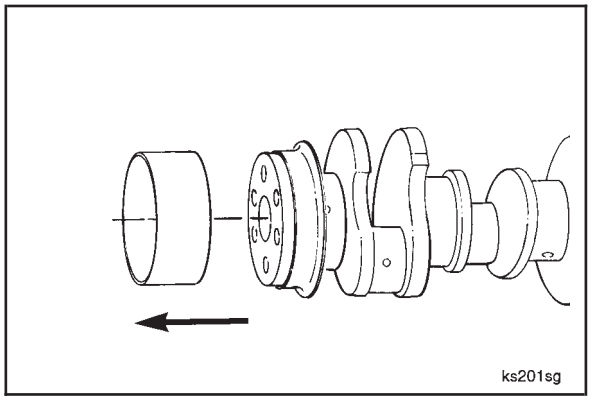
If the crankshaft does **not** require filling, apply a light layer of non-hardening sealant to the inner surface of the repair sleeve. Sealant, Part No. 3375068 or equivalent, can be used.



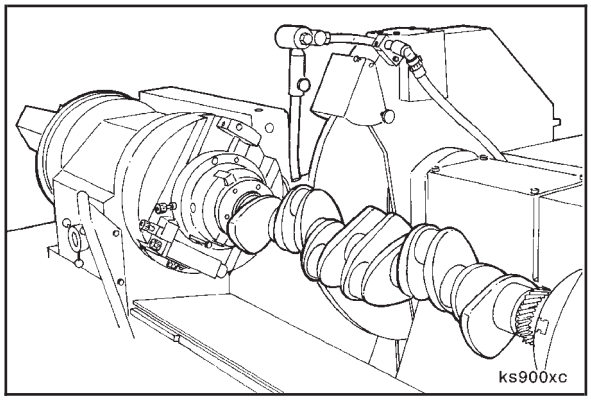
Use a wood block or large face mallet to drive the wear sleeve into position.

NOTE: The installation tool provided with the wear sleeve will insure proper wear sleeve depth by bottoming out on the face of the crankshaft flange.





Remove the installation tool.

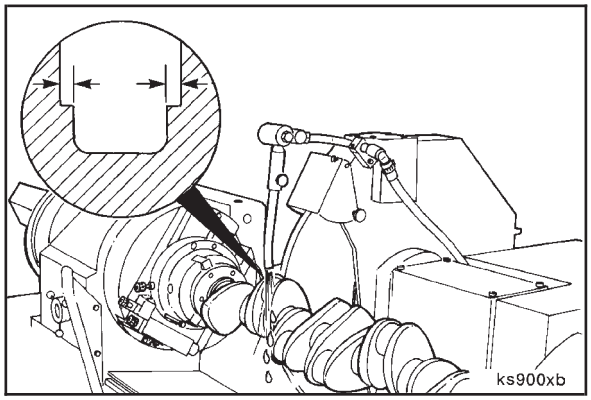


Grinding the Connecting Rod Bearing Journals

Grinding Wheel Width

A wheel width of 53.130 to 53.168 mm [2.0917 to 2.0932 inch] is recommended for grinding the connecting rod bearing journals.

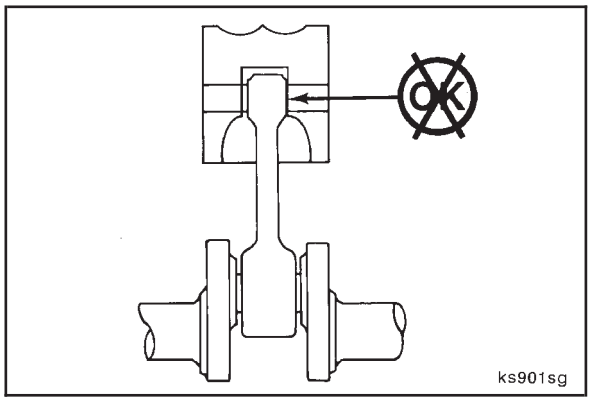
NOTE: This width wheel will allow the rod bearing journals to be ground in one plunge. It will also keep the journal narrow enough to prevent excessive side clearance and keep the connecting rod from bossing in the piston.



One plunge is desirable when grinding rod bearing journals because it eliminates the possibility of a stress riser that can be formed when dual plunging a rod bearing journal.

The grinding wheel **must** be centered on the rod journal so equal stock is reamed from each side.

NOTE: A stress riser, no matter how small, on the rod bearing journal can cause crankshaft failure.



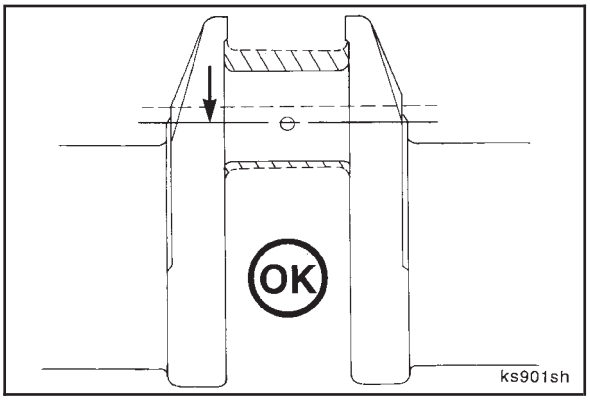
Using a grinding wheel wider than specified can cause problems also:

- Excessive rod bearing journal width will allow the connecting rod to boss in the piston instead of on the rod journal sidewall.
- A connecting rod which bosses against the piston can cause excessive oil consumption and uneven rod bearing wear.

Off Stroking

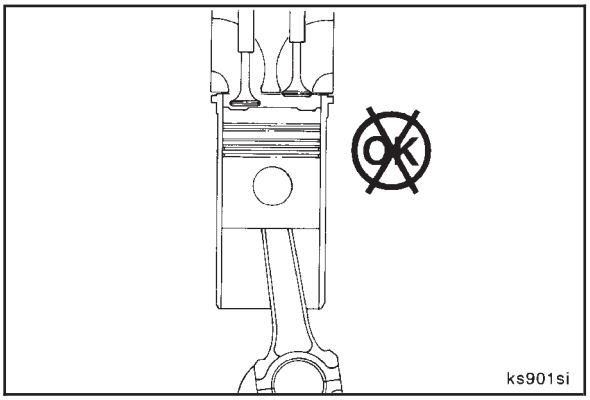
Rod bearing journals can be damaged on one side more than the other. The amount of grinding on such journals can be reduced by "off stroking" the throw of the crankshaft.

NOTE: Off stroking is the method of grinding the crankshaft that changes the centerline of the rod bearing journal. The crankshaft can be off stroked in the negative direction only. The negative direction shortens the stroke of the crankshaft. The off stroking limit is 0.25 mm [0.010 inch}.



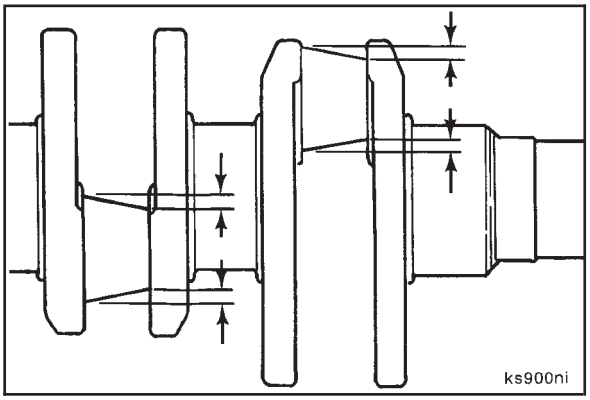
Caution: Off stroking the crankshaft in the positive direction can cause piston to valve interference or excessive cylinder pressures which can lead to premature failures.

Off stroking is **not** permitted on a crankshaft used in any marine agency certified engine.

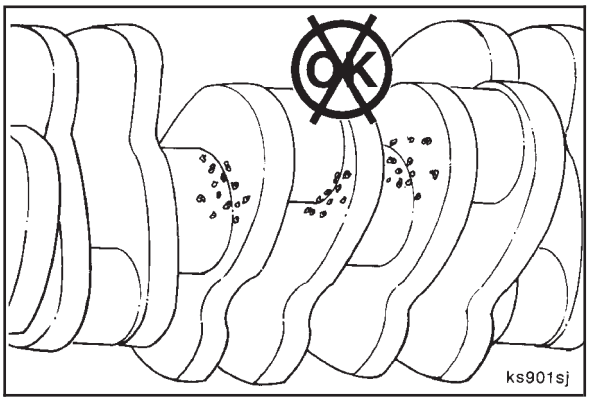


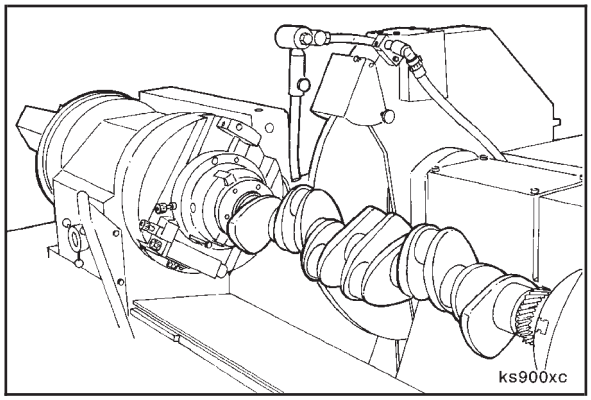
Connecting Rod Bearing Journal Contour Characteristics

When grinding rod bearing journals, the taper **must not** exceed 0.007 mm [0.0003 inch] across the width of the bearing journal.



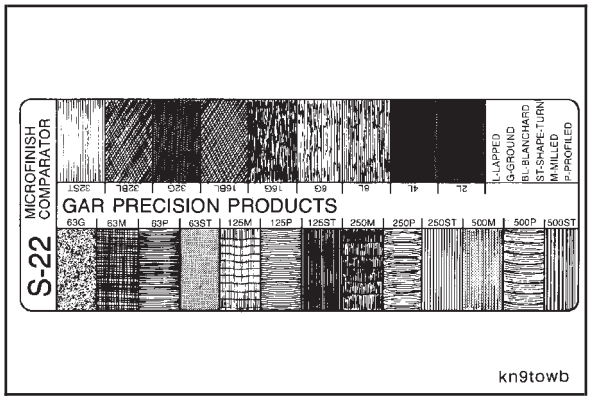
Surface imperfections, nicks or tool marks in or near the fillet area are **not** acceptable. The surface finish of the fillet areas **must** be at least 0.8 µM [32 µ inch].



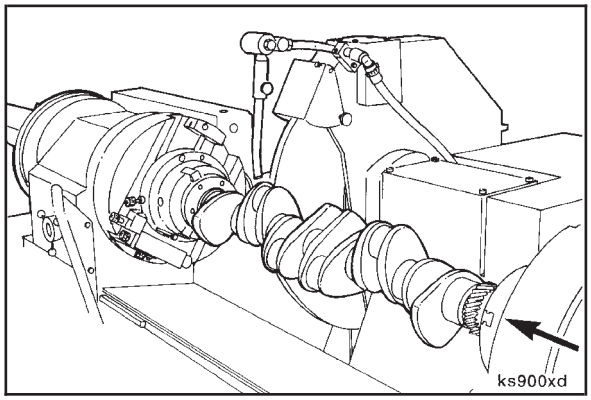


To help achieve the required surface finish and contour characteristics, it is recommended that bearing journals be ground in one set-up.

NOTE: If possible, do **not** dress the grinding wheel during the grinding process. However, it is best to dress the grinding wheel as opposed to trying to complete the grinding process with a wheel that is "loaded" with grinding debris.



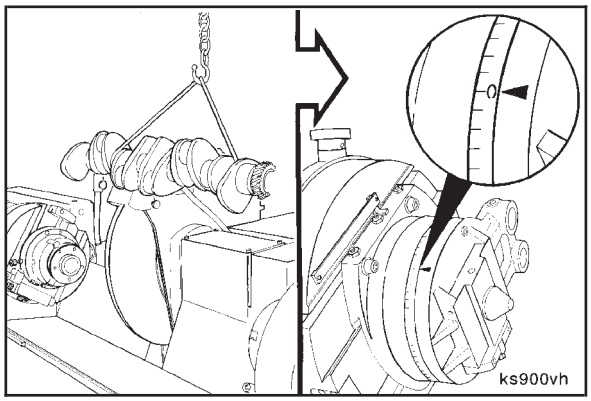
The surface finish of the rod bearing journal **must** be 0.4 µM [16 µ inch] or better.



Grinding Procedure

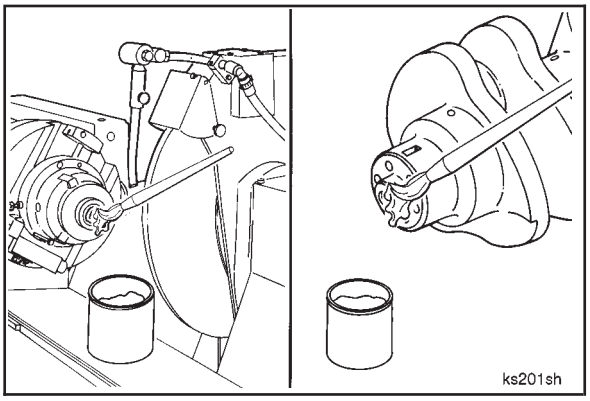
Move the tail stock on the grinding machine to accommodate the crankshaft.

NOTE: The total length of the crankshaft is 1066.5 mm [41.99 inch].



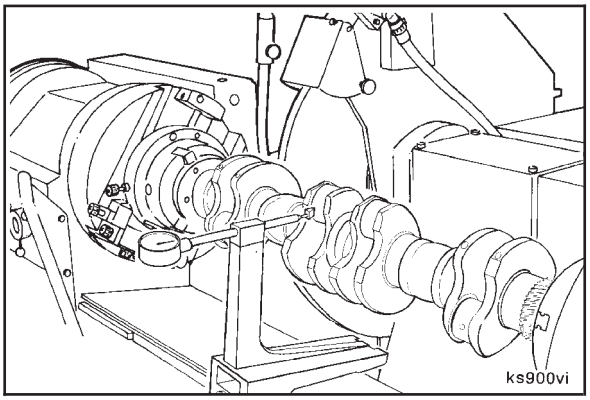
Locate and lock both throw heads at the "0" index mark.

Lubricate the crankshaft grinding machine centers and the centers on the crankshaft with clean heavy duty grease or lubricant.

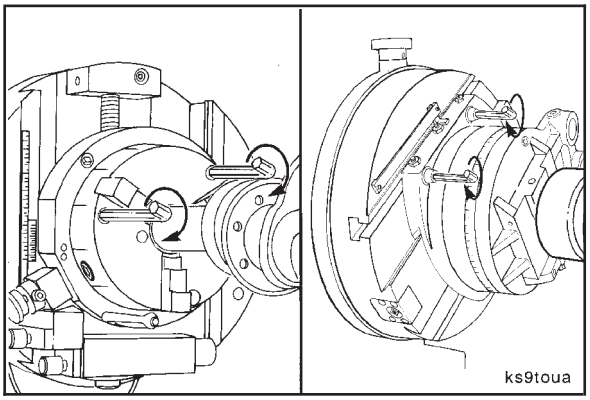


Install the crankshaft in the grinding machine. Position the crankshaft so the No. 3 and No. 4 rod bearing journals are at top center.

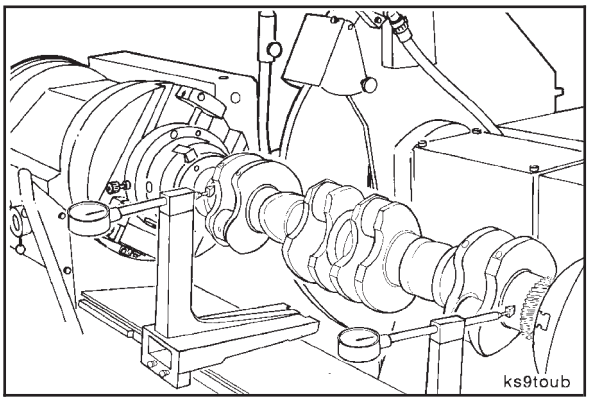
NOTE: Use a v-block type indicator to insure the crankshaft is located properly.

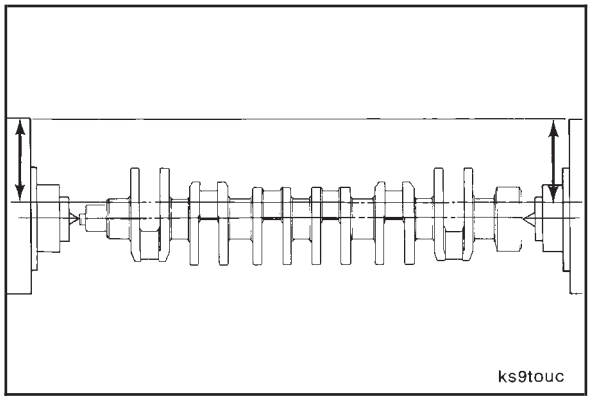


Tighten the chuck jaws on the throw head to hold the crankshaft in position.



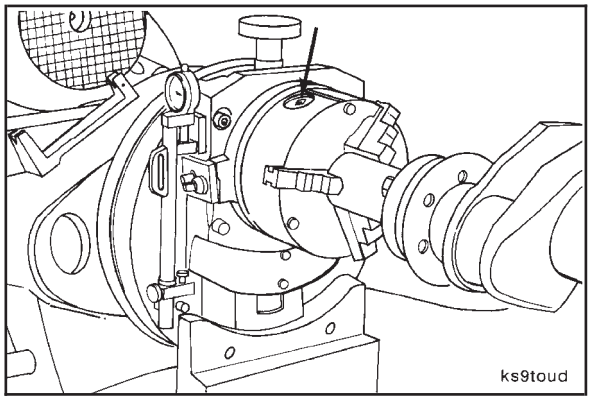
Rotate the crankshaft at approximately 50 RPM with dial indicators on No. 1 and No. 7 main bearing journals to make sure the crankshaft is aligned properly.





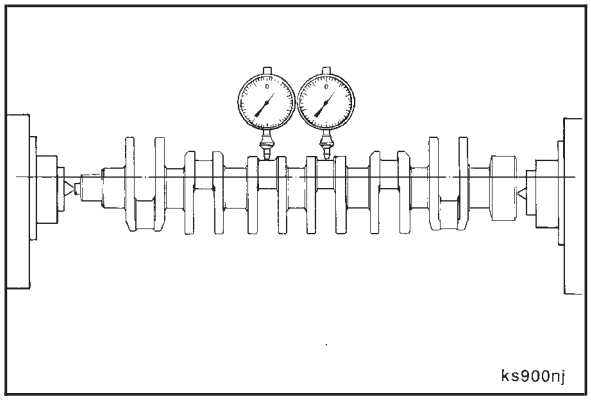
Adjust the throw heads down 67.935 to 68.065 mm [2.6746 to 2.6797 inch]. This is the throw of the crankshaft.

NOTE: Adjusting the throw heads down will align the center of No. 3 and No. 4 rod bearing journals with the centerline of the grinding machine. It is important that both heads be moved the same amount to maintain the correct parallelism and taper during the grinding process.

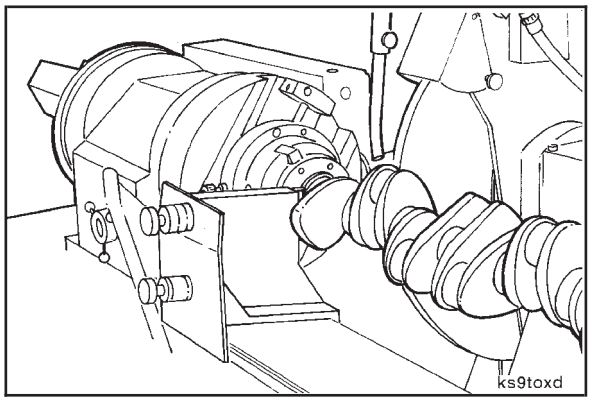


The geometric center of the crankshaft will now be off-center in the machine making counterbalancing necessary.

NOTE: This is normally accomplished by adjustable counterweights on the grinding machine.



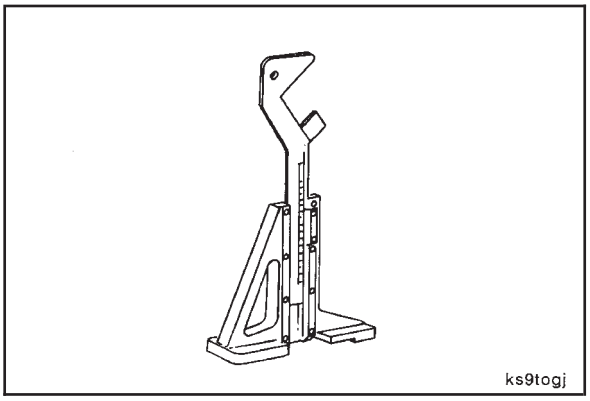
Measure the run-out on the connecting rod bearing journals. The TIR **must** be within 0.03 mm [0.001 inch].



Install a steady rest on the journals to stabilize the crankshaft during grinding.

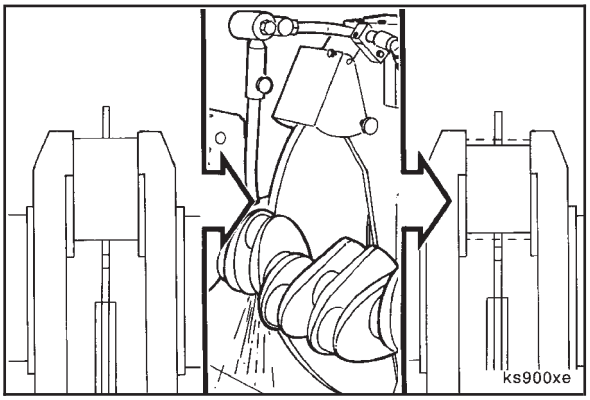
Adjust the size indicating gauge to the specified rod bearing journal diameter.

NOTE: The size indicating gauge is commonly known as an Arnold Gauge.

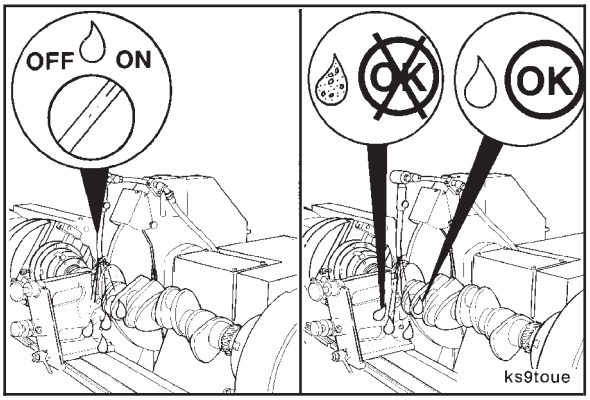


Install the size indicating gauge around the rod bearing journal to be ground.

NOTE: The size indicating gauge will allow the operator to monitor the amount of material being removed from the rod bearing journal during the grinding operation.

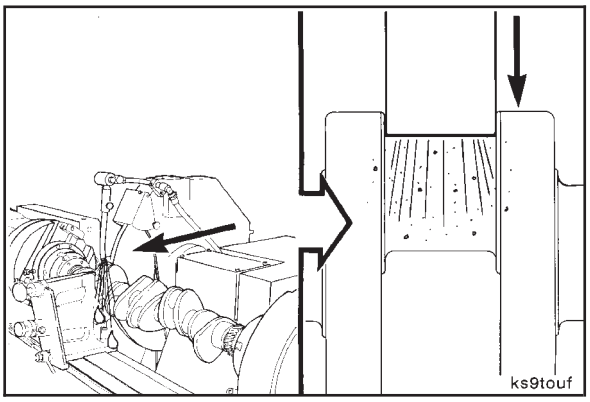


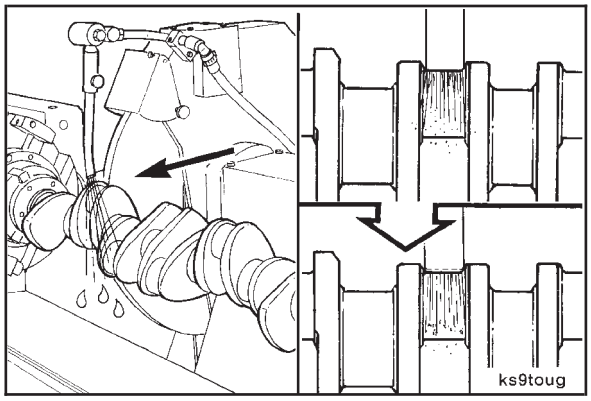
Turn the coolant "ON". Adjust the coolant flow to minimize the amount of air trapped in the liquid. A smooth continuous flow is preferred.



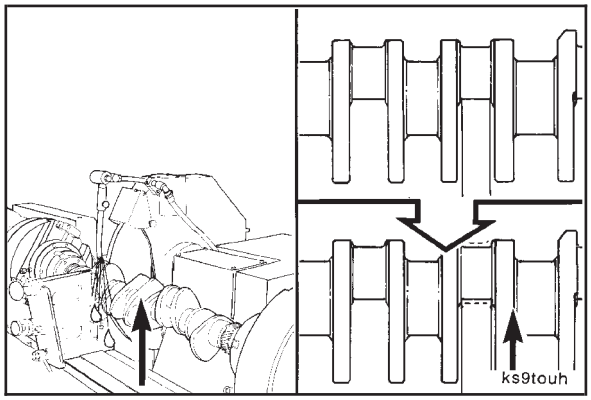
Very carefully bring the grinding wheel towards the rod bearing journal.

NOTE: Keep the grinding wheel centered so that it starts to spark on both sides of the rod bearing journal at the same time.

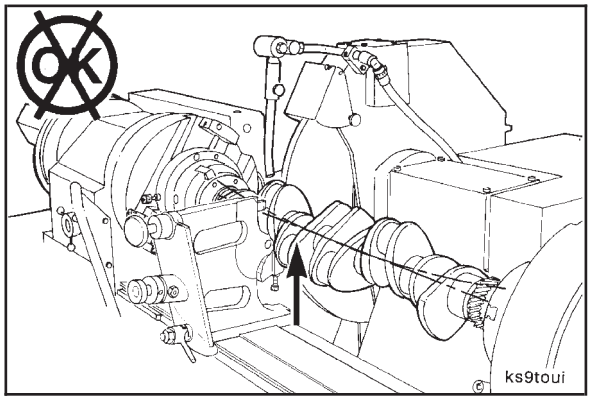




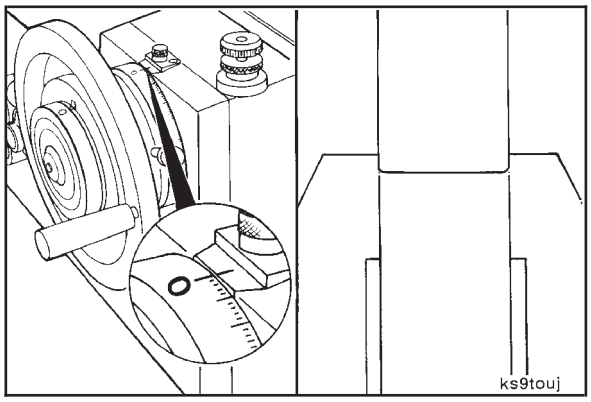
Slowly feed the grinding wheel in until the desired amount of material has been removed.



As the bearing journal size decreases, adjust the steady rest to keep light pressure on the journal.



Caution: Do not apply enough pressure to bow the crankshaft.

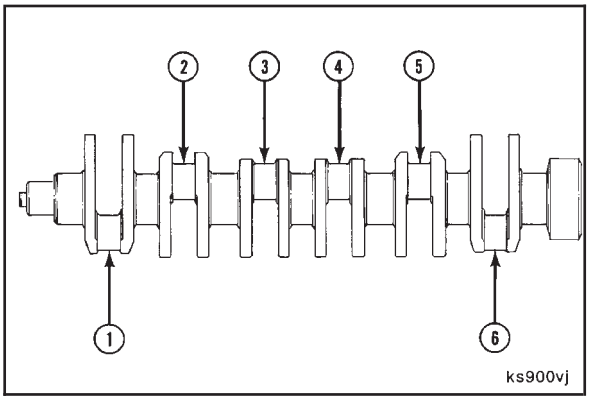


As the wheel reaches the "0" mark on the feed indicator, and no more material is to be removed, let the wheel idle or "spark out".

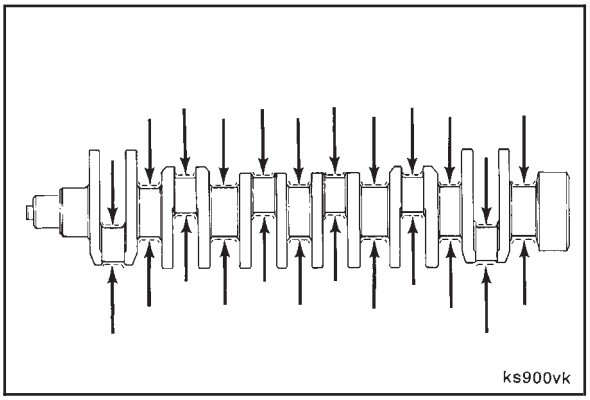
NOTE: The "spark out" grind improves the surface finish and prevents grinder burn damage.

Repeat the procedure until all connecting rod bearing journals have been correctly sized.

NOTE: When continuing through the grinding procedure, grind journals No. 3 and No.4 first, No. 2 and No. 5 second and No. 1 and No. 6 last.



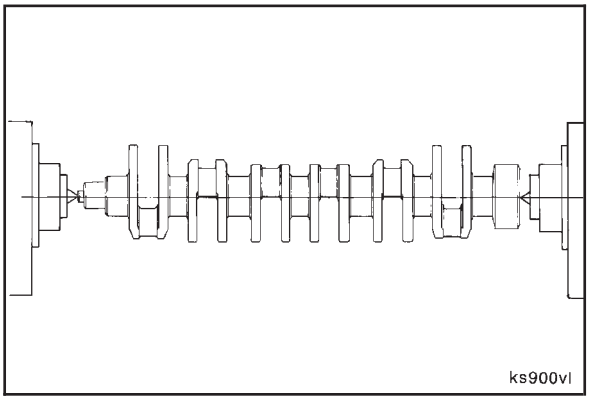
All connecting rod bearing journals **must** be ground to the same standard undersize. However, it is **not** necessary to grind the rod bearing journals to the same undersize as the main bearing journals are ground.



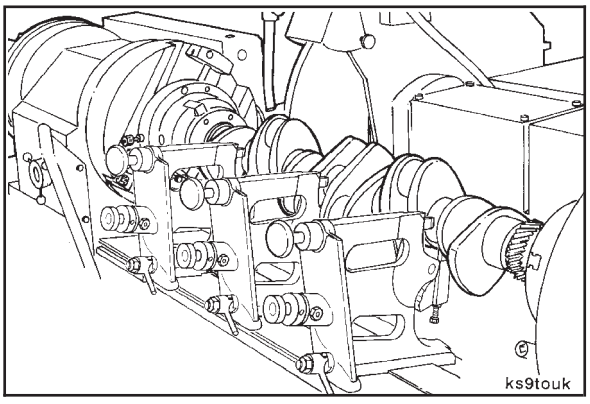
Grinding the Main Bearing Journals

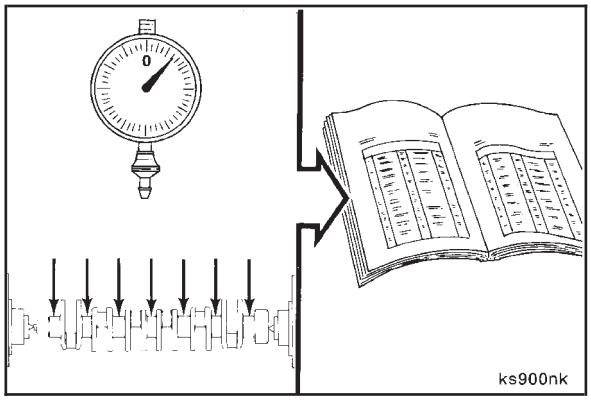
Align the crankshaft centerline with the grinding machine centerline.

Return the adjustable counterweights to the "0" position.



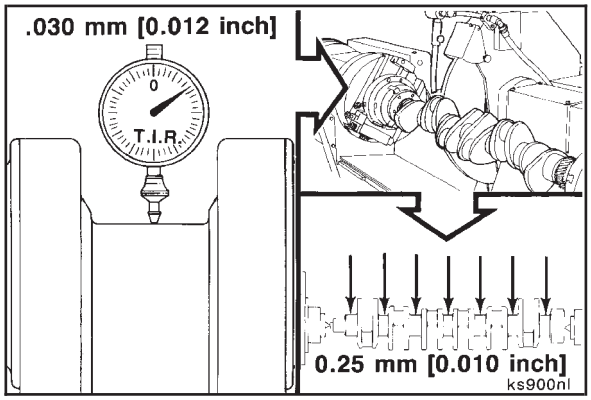
Install steady rests on No. 2, No. 4 and No. 6 main bearing journals.





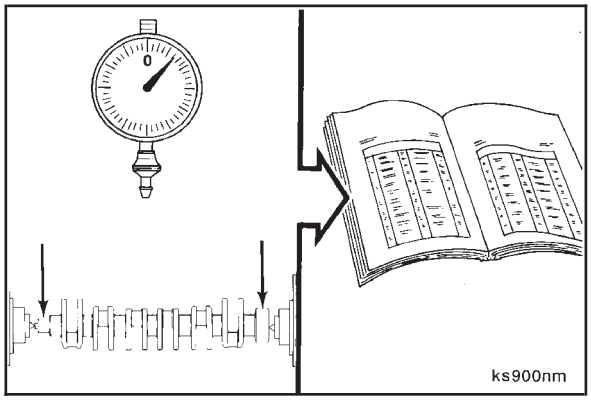
Measure the run-out at each main bearing journal.

NOTE: The main bearing journal with the most TIR will determine the undersize required for the main bearing journals.



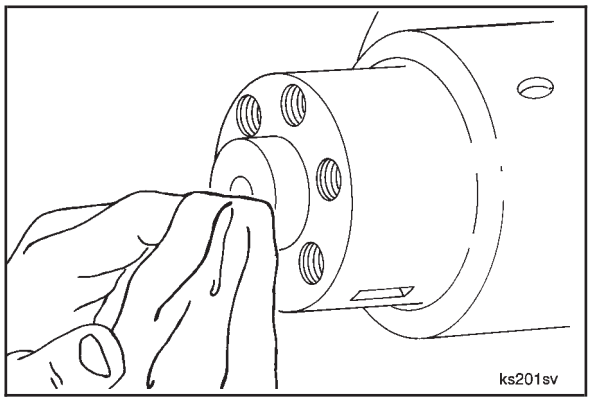
Divide the TIR of the main bearing journal with the most run-out by two to establish the minimum amount the main bearing journals **must** be ground undersize. The main bearing journals **must** then be ground to fit the next undersize bearing.

Example: TIR = 0.30 mm [0.012 inch] divided by 2 = 0.15 mm [0.006 inch]. The next main bearing size is 0.25 mm [0.010 inch] undersize. Grind all of the main bearing journals to 0.25 mm [0.010 inch] undersize.



Measure the run-out of the rear oil seal flange and the crankshaft gear journal.

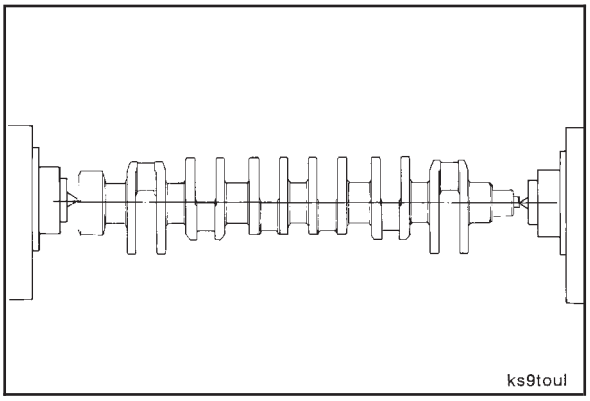
- Gear Journal Run-out = 0.03 mm [0.0012 inch] maximum
- Rear Seal Flange Run-out = 0.03 mm [0.0012 inch] maximum



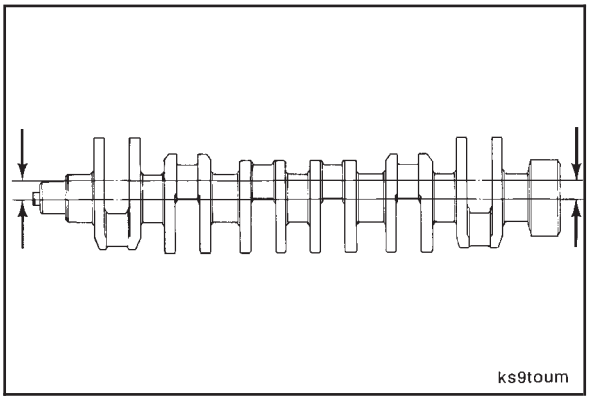
If the TIR is more than specified, the following can help to relocate the crankshaft properly:

Remove raised material from the crankshaft centers by cleaning and polishing.

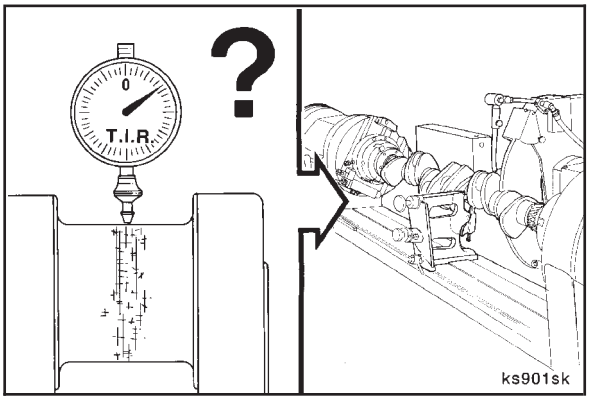
Move the head stock and tail stock of the grinding machine alternately and evenly to relocate the centerline of the crankshaft.



If the rod bearing journals have already been ground, the main bearing journals **must** stay parallel to them.



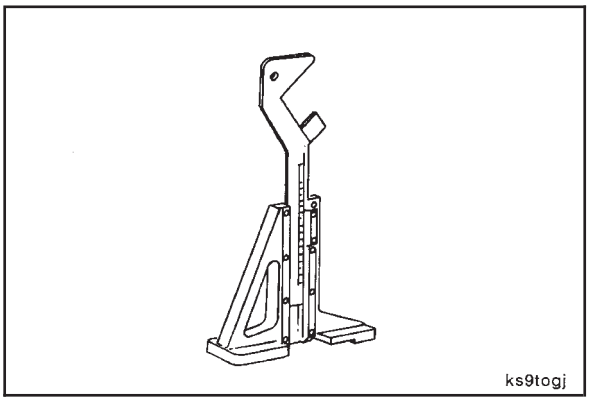
If a main bearing journal is damaged and there is question as to what undersize is necessary, grind it first to a rough size to determine the undersize requirements.

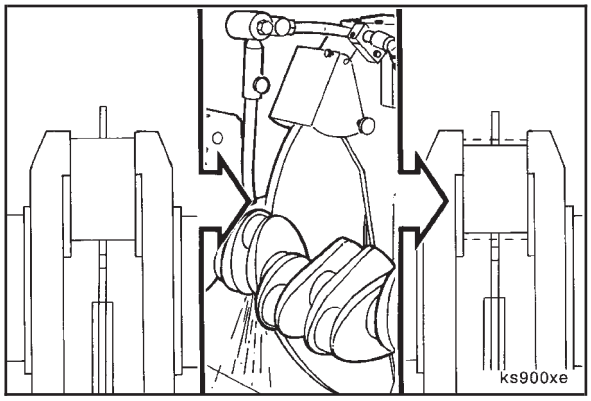


Adjust the size indicating gauge to the specified main bering journal size.

NOTE: The size indicating gauge is commonly known as an Arnold Gauge.

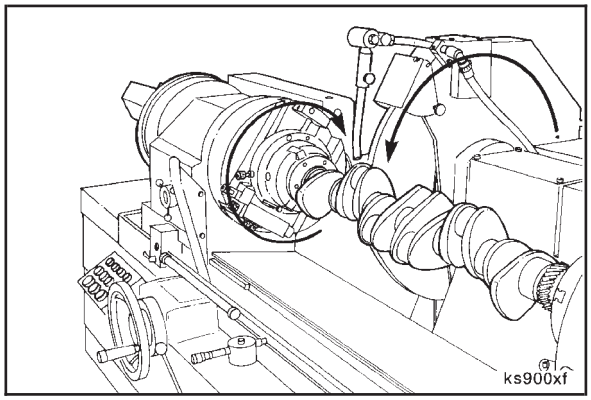
Refer to the specifications section at the end of this procedure for undersize main bearing journal diameters.



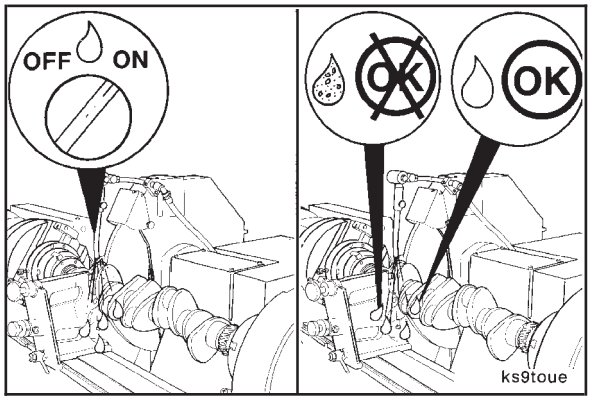


Install the size indicating gauge around the main bearing journal to be ground.

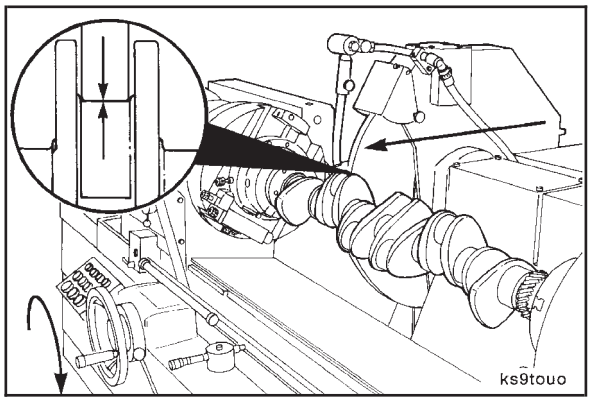
NOTE: Grind the bearing journals supported by the steady rests first.



Start the crankshaft rotating and start the grinding wheel.

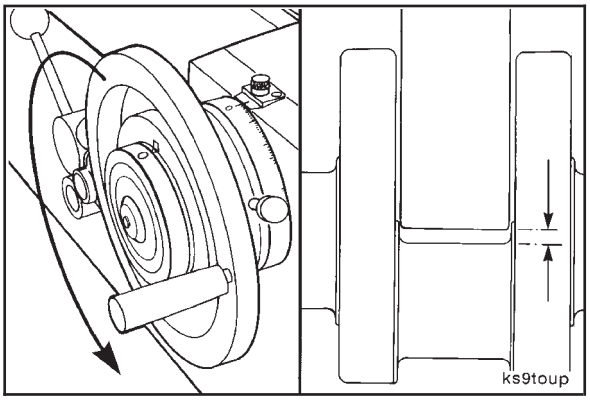


Turn the coolant "ON". Adjust the coolant flow to minimize the amount of air trapped in the liquid. A smooth continuous flow is preferred.

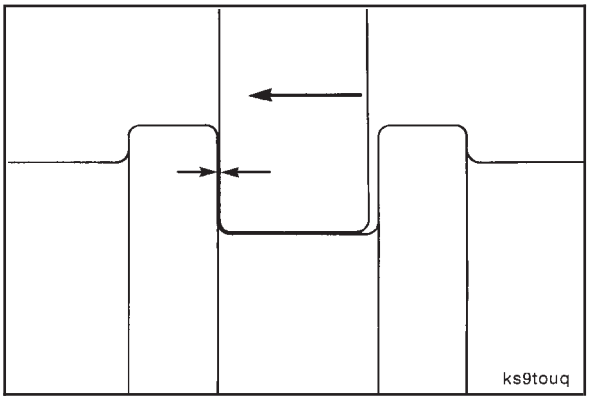


Move the grinding wheel into the main bearing journal until it just touches the surface of the journal.

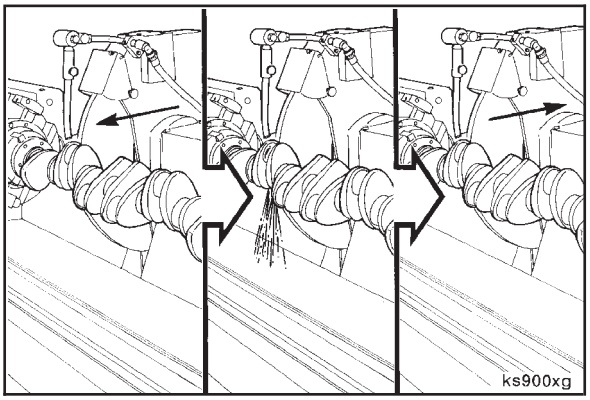
Move the grinding wheel away from the journal approximately 1.27 mm [0.050 inch].



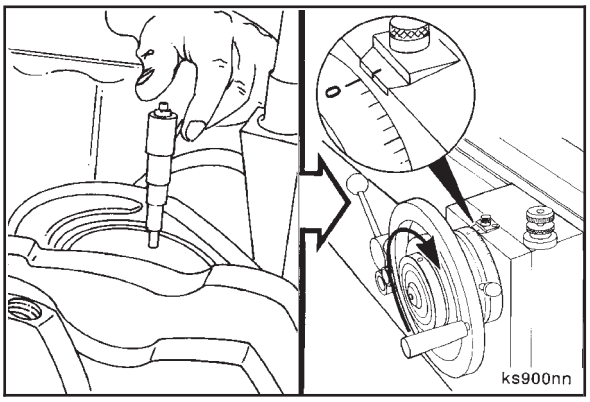
Traverse the grinding wheel to one side of the bearing journal until the wheel just touches the sidewall of the journal. Allow the grinding wheel to remove any out-of-roundness.

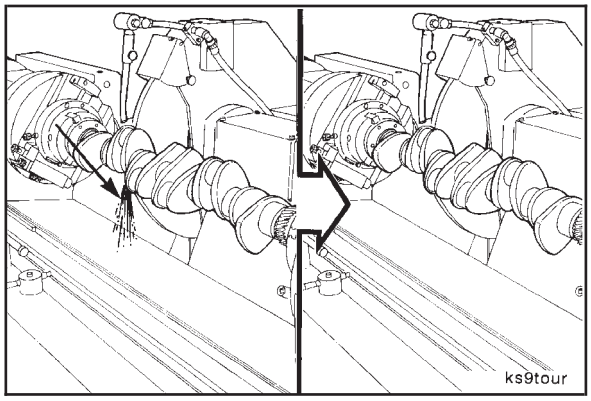


Slowly feed the grinding wheel into the journal. As soon as the wheel touches all the way around the journal, back the wheel out.

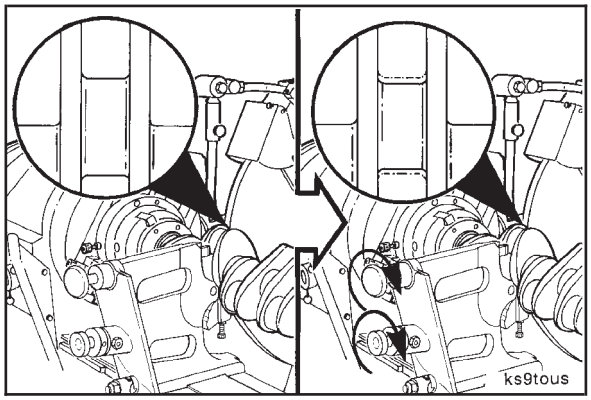


Use micrometers to measure the bearing journal diameter to determine how much material **must** be removed. Set the feed indicator for the amount to be removed.

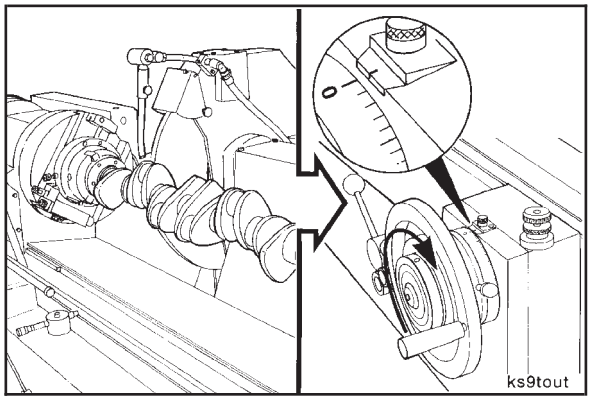




Slowly feed the grinding wheel into the bearing journal. When the specified depth is achieved, allow the grinding wheel to spark out.

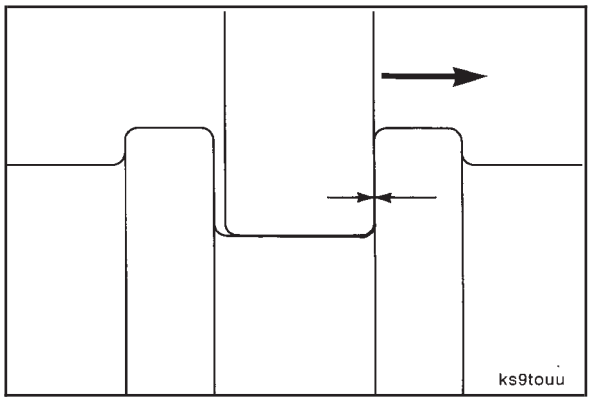


When feeding the grinding wheel in, adjust the steady rest to keep light pressure on the bearing journal.



Set the feed indicator to "0".

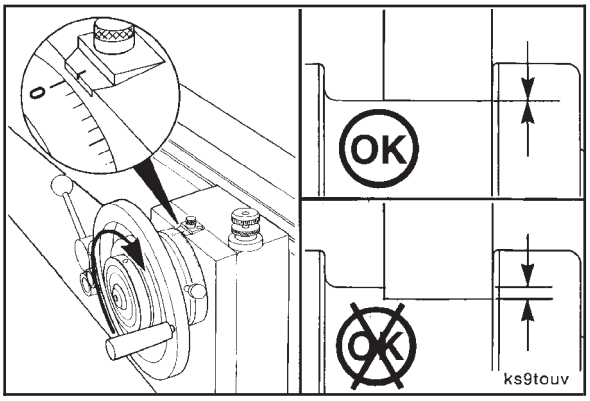
Back the grinding wheel out.



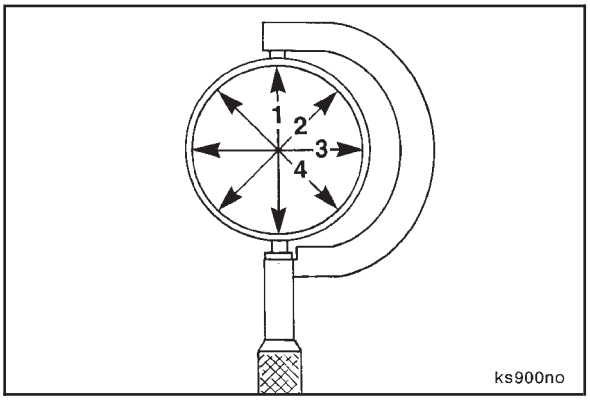
Traverse the grinding wheel over to the other side of the bearing journal until the wheel just touches the sidewall. Allow the grinding wheel to remove any out-of-roundness.

Feed the grinding wheel in slowly and grind down until the "0" mark is again reached on the feed indicator. Back the grinding wheel out.

NOTE: This will match the previous cut on the other side of the bearing journal.

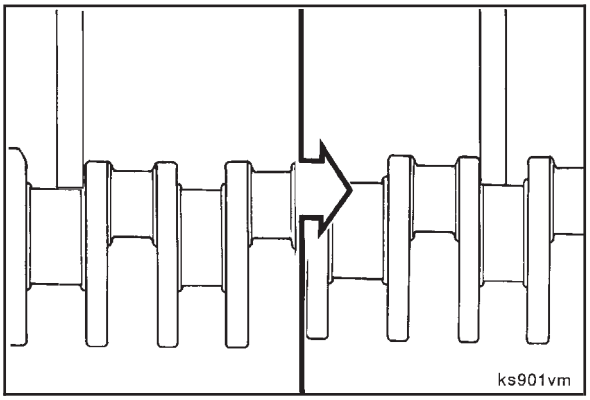


Measure the bearing journal outside diameter with a micrometer to assure the proper sizing of the journal.



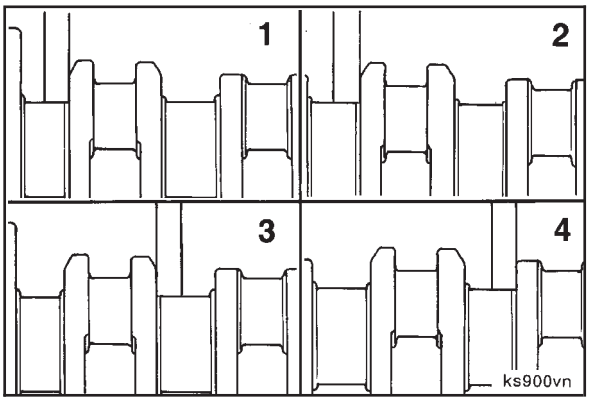
If the first cut was made on the right side of the bearing journal, cut the left side first on the next journal.

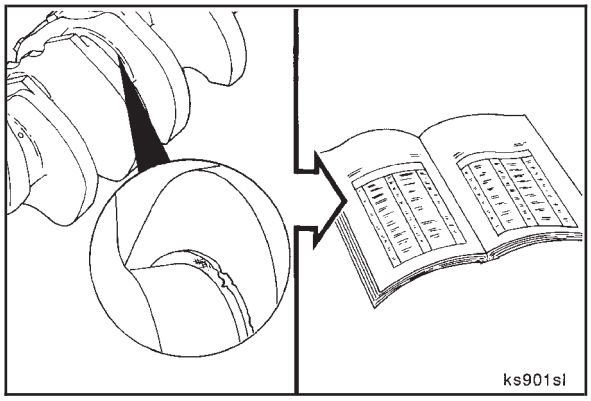
NOTE: This method assures even breakdown of the grinding wheel.



Repeat this procedure on the remaining main bearing journals.

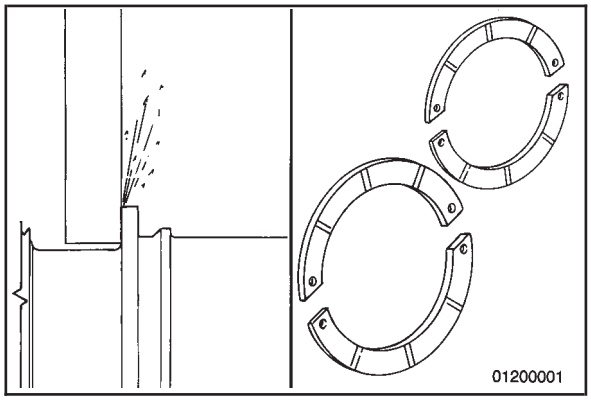
NOTE: All of the main bearing journals **must** be ground to the same undersize.





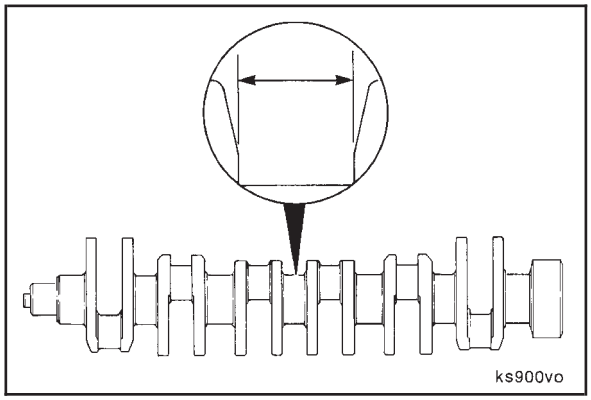
Crankshaft Thrust Bearing Surface Repair

Inspect the thrust surfaces to determine if they require repairing. Refer to Crankshaft Thrust Bearing Surface Inspection.



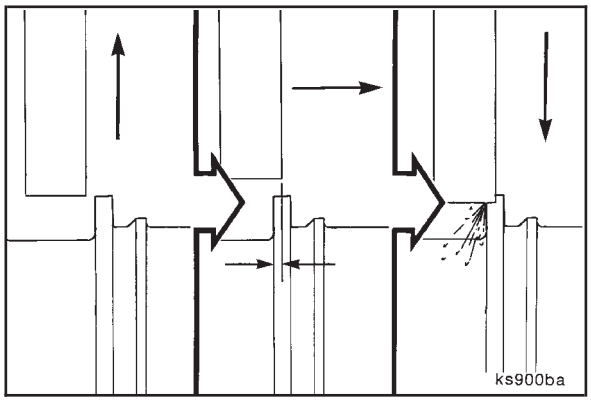
If repairing the thrust surface is required, 0.25 mm [0.010 inch] oversize thrust bearings are available.

NOTE: Currently only 0.25 mm [0.010 inch] oversize thrust bearings are available. Therefore, 0.25 mm [0.010 inch] can be removed from each thrust face, assuming that a cylinder block with a standard No. 4 thrust bearing journal width is used with this crankshaft.



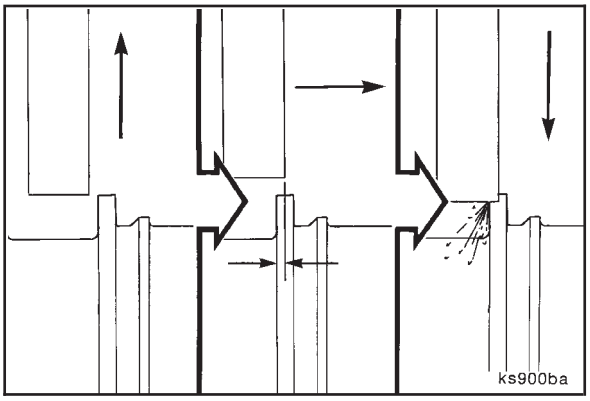
Use an undamaged thrust surface as a reference point when measuring the crankshaft to determine the required oversize.

If a reference point from one of the thrust surfaces **cannot** be found because of severe damage, the crankshaft **must** be scrapped.

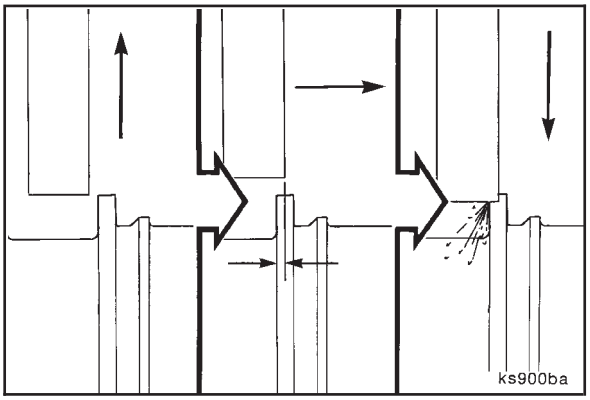


Caution: Do not traverse the grinding into the thrust surface to be ground. this will cause the side of the grinding wheel to break down.

Back out the wheel until it clears the thrust surface. Traverse the wheel over the necessary amount to make the desired cut. Leave 0.05 mm [0.002 inch] for the final cut.

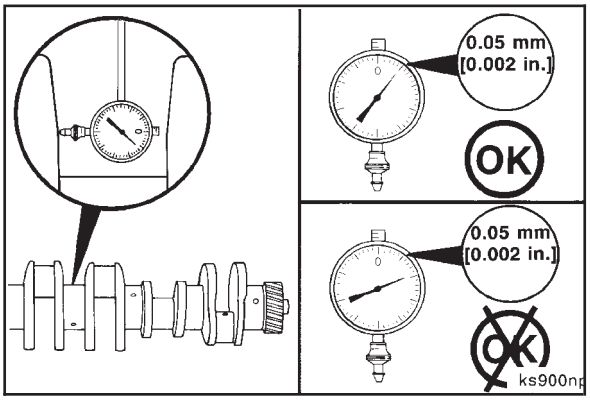


Back out the wheel and traverse over 0.05 mm [0.002 inch] to make the final cut. Slowly feed the wheel in making the final cut, and allow the wheel to spark out at the journal.



Inspect the squareness of the thrust surface by measuring the face runout at the outer edge.

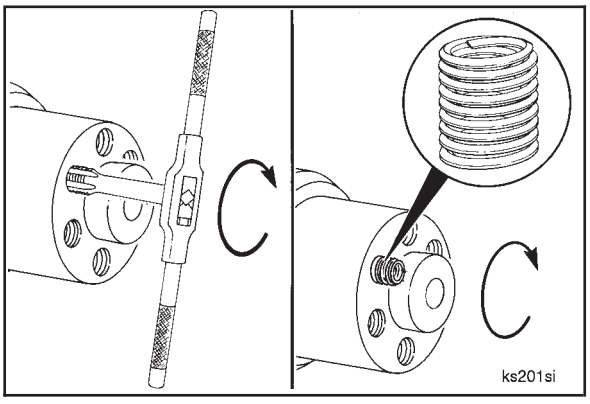
NOTE: The maximum face runout **must not** be more than 0.05 mm [0.002 inch].

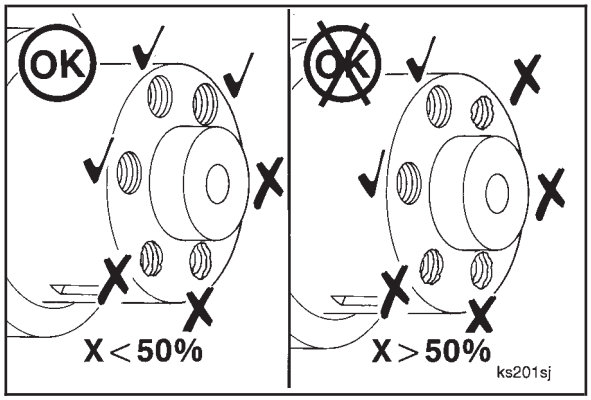


Crankshaft Thread — Repair

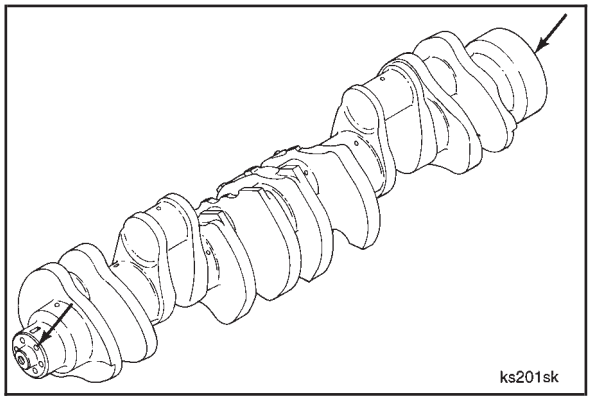
All of the internal threads on the crankshaft **must** be inspected. Chase any threads that are mutilated.

NOTE: Threads that **cannot** be cleaned up by chasing, can be repaired using thread inserts.





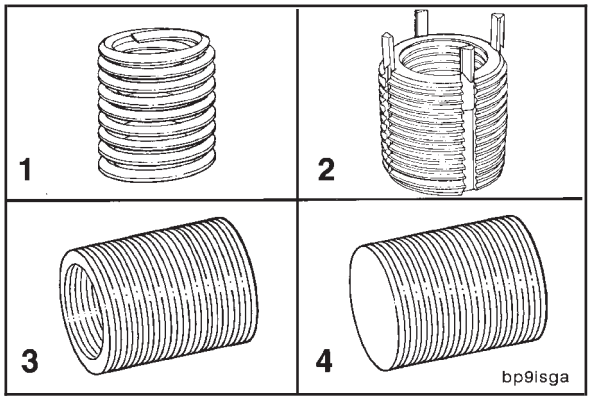
A maximum of 50 percent of the threaded capscrew holes per crankshaft end can be repaired.



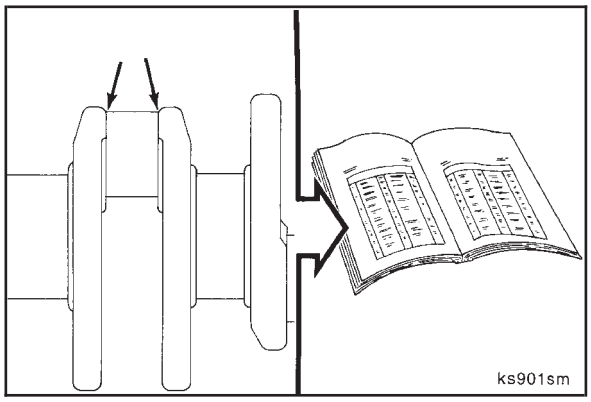
Capscrew threads in the front of a six hole crankshaft are M12 x 1.25 and are 44.5 mm [1.752 inch] deep.

Capscrew threads in the front of a five hole crankshaft are M14 x 1.50 and are 43.0 mm [1.6983 inch] deep.

Capscrew threads in the rear of the crankshaft are M14 x 1.50 and are 24.6 mm [0.969 inch] deep.



Any kind of thread insert can be used to repair these capscrew holes. Refer to Group 00 for specific thread repair instructions.



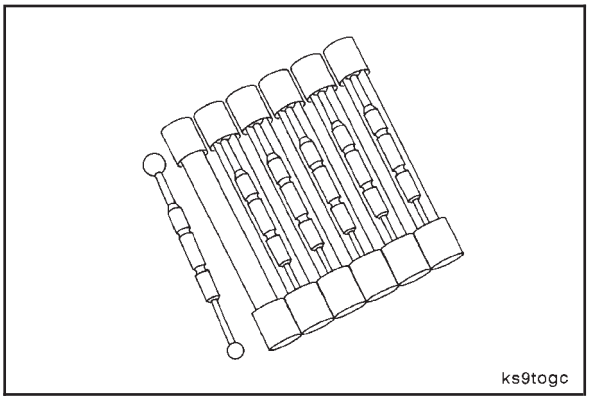
Processing After Grinding

Fillet Size and Blend — Inspection

It is essential that a fillet size and blend inspection be made on every reground crankshaft. The specifications are:

- Main Bearing Journals Fillets — 5.75 to 6.25 mm [0.226 to 0.246 inch]
- Rod Bearing Journal Fillets — 4.75 to 5.25 mm [0.187 to 0.207 inch]
- Gear Journal Radius — 5.75 to 6.25 mm [0.226 to 0.246 inch]

Fillet ball gauges can be used to inspect journal fillet size and blend. Ball gauges for L10 and M11 crankshafts are included in fillet ball gauge kit, Part No. 3375240.

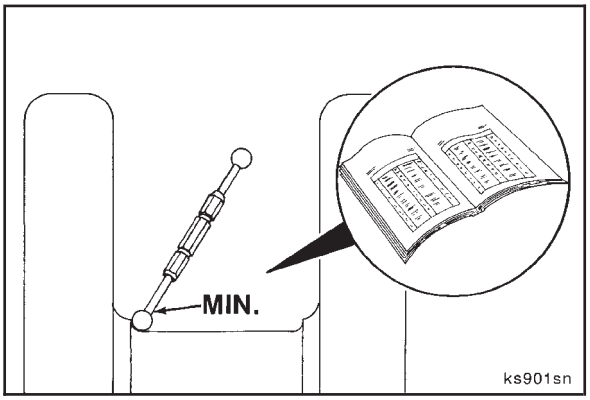


Procedures for inspecting the fillet size and blend are as follows:

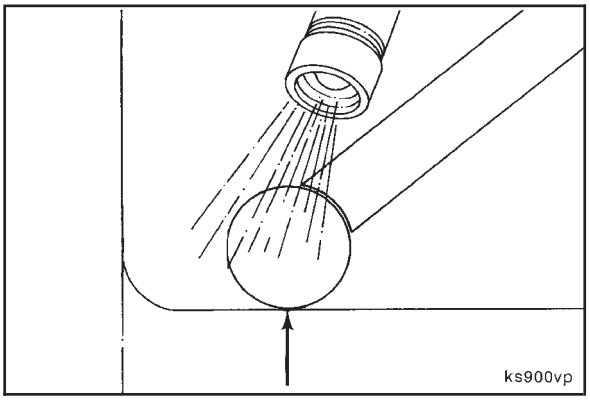
Select a ball gauge for the minimum specified bearing journal radius

Use ball gauge, Part No. 3376602, 5.75 mm [0.226 inch] for main bearing journals

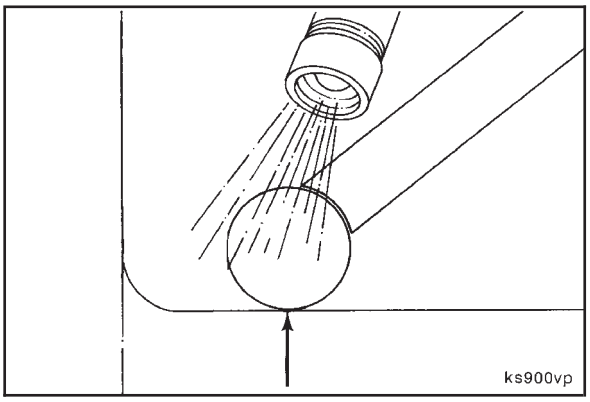
Use ball gauge, Part No. 3376603, 4.75 mm [0.187 inch] for rod bearing journals

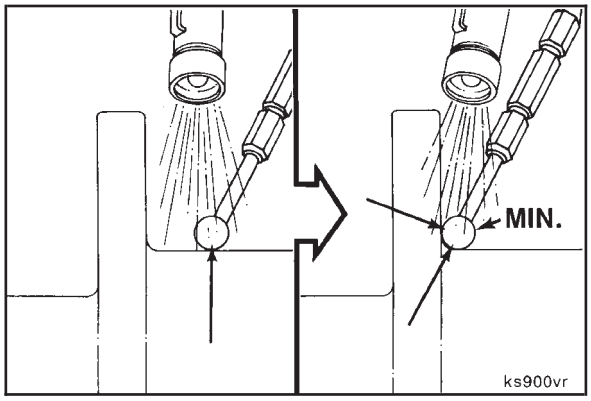


Place the ball on the bearing journal near, but **not** in the fillet. Direct the light from behind the ball.

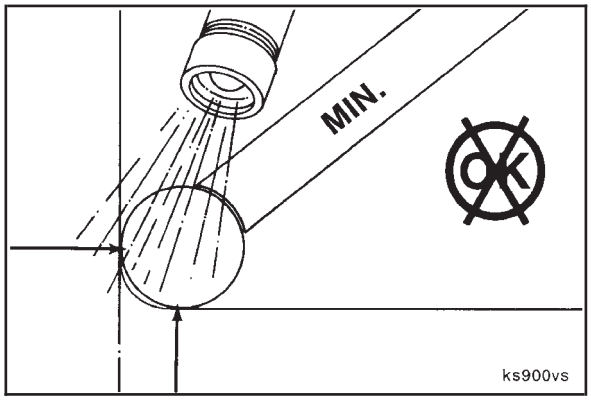


Correct positioning of the ball gauge and the light source will create one dark spot at the point of contact between the ball gauge and the journal surface.

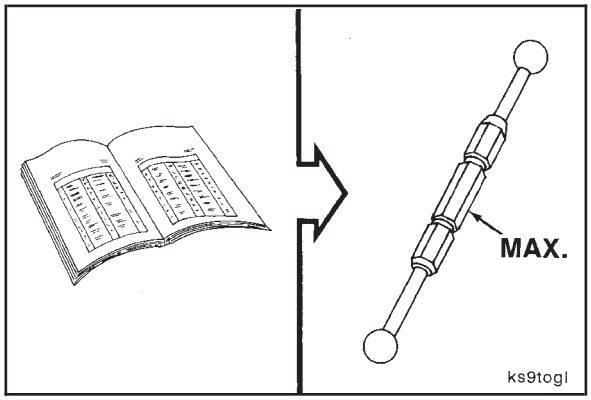




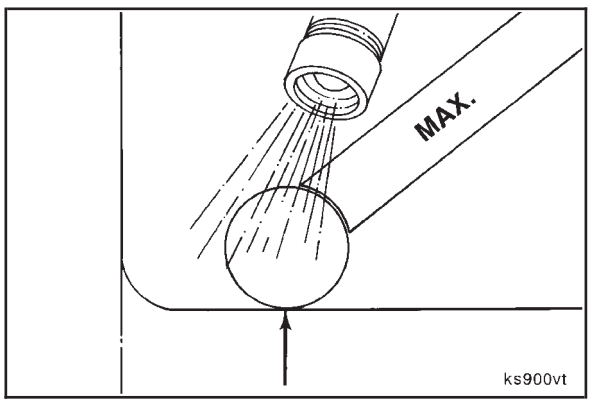
Move the ball gauge towards the fillet. As this is done, the contact point will move around the ball and up the fillet as the ball contacts the thrust wall.



If the radius is properly blended, there will never be more than one contact point. If two contact points exist, the radius is too small and is out of specifications.



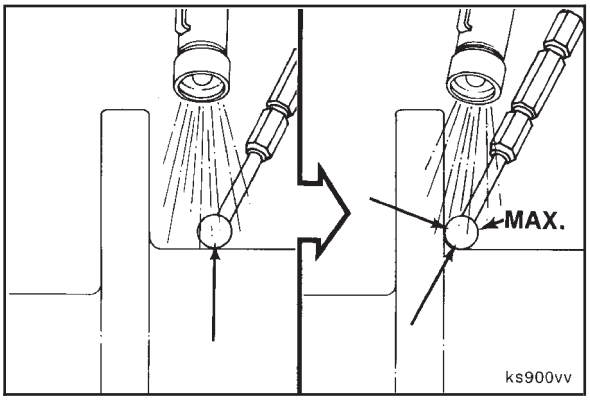
Select the ball gauge for the maximum specified journal fillet radius.



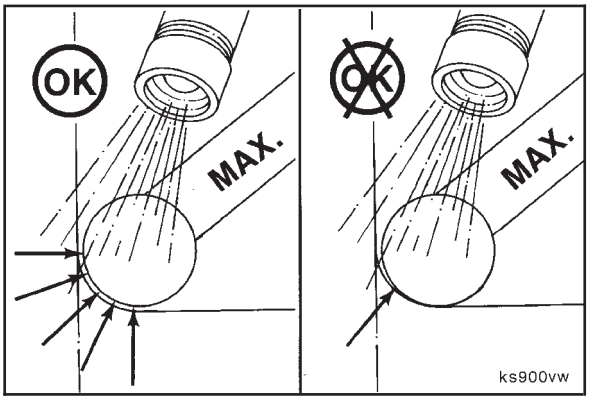
NOTE: Correct positioning of the ball gauge and the light source will create one dark spot at the point of contact between the ball gauge and the journal surface.

Place the ball on the bearing journal surface near the fillet radius. Direct the light from behind the ball.

Move the ball gauge toward the fillet. When the ball gauge is located in the fillet, two points of contact will be apparent if the radius is in specifications.



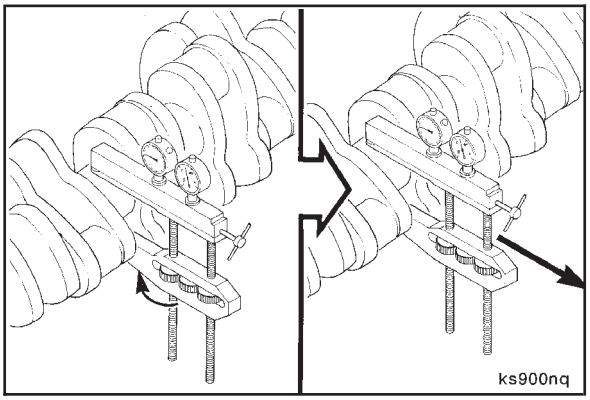
If the gauge touches at only one point, the radius is too large and is out of specifications.



Crankshaft Journal Hardness — Inspection

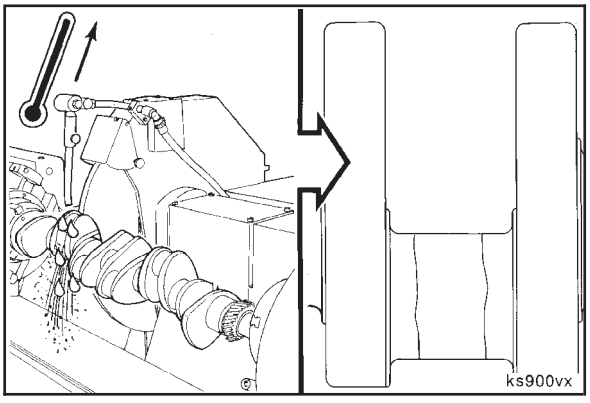
After grinding a crankshaft, it will be necessary to inspect the bearing journal hardness. Refer to Crankshaft - Inspection for instructions.

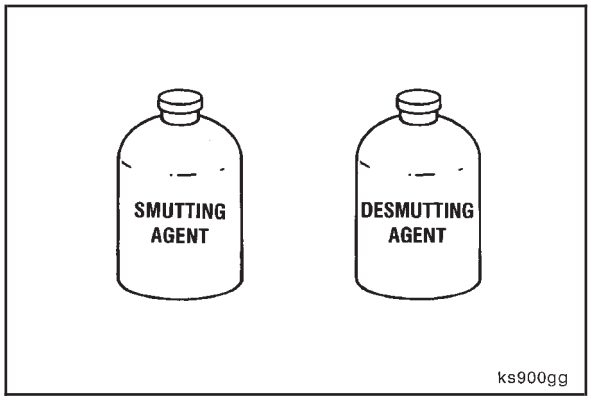
The minimum hardness **must** be 43 Rc.



Crankshaft Journal Grinder Burn Damage — Inspection

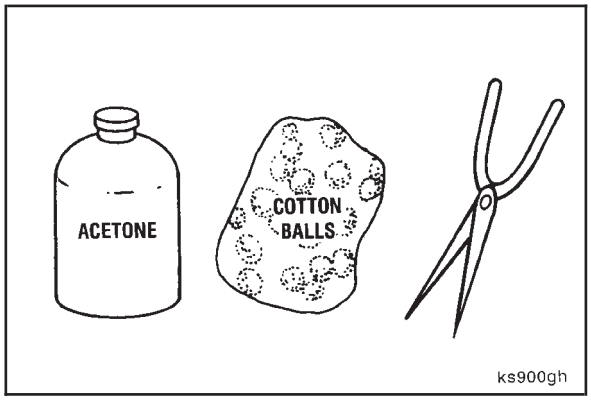
Grinder burn is deterioration of the metal caused by overheating during the grinding process. Usually grinder burn is shallow, but can cause a stress riser which will lead to crankshaft breakage.



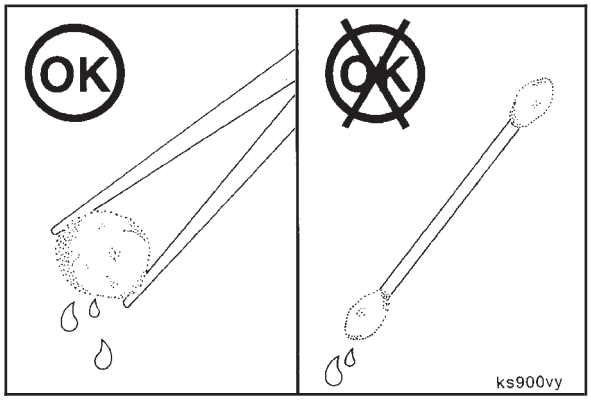


The following items are needed to etch check a crankshaft for grinder burn. The items are included in crankshaft etching kit, Part No. ST-1195.

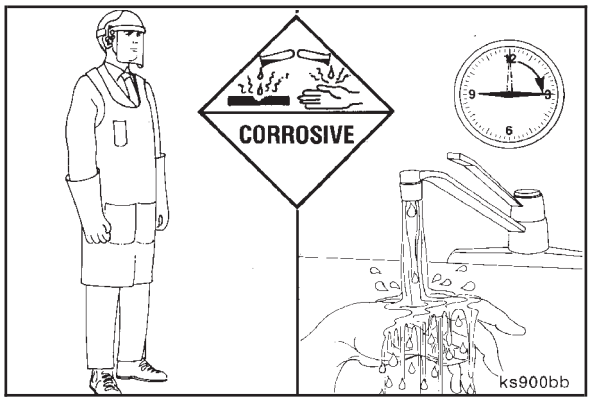
- Eight ounces of 4 percent solution of nitric acid in water. This is known as a smutting agent.
- Eight ounces of 2 percent solution of hydrochloric acid in acetone. This is known as a desumtting agent.



- Eight ounces of acetone
- One package of cotton balls
- One pair of stainless steel tongs for handling the cotton balls.



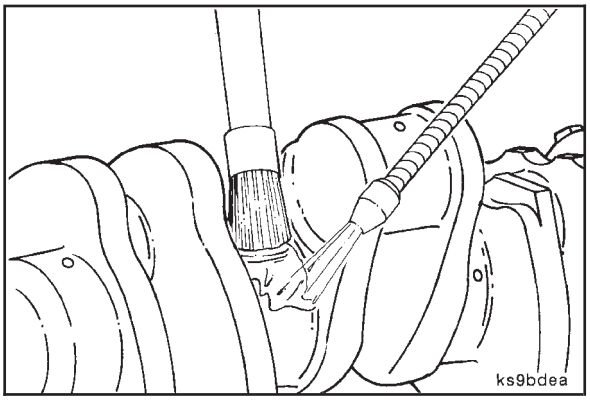
NOTE: The use of ordinary cotton swabs instead of cotton balls and tongs is **not** recommended. Small swabs will **not** carry a sufficient amount of the etching solution to fully develop the burn patterns, and are **not** strong enough for the scrubbing required during the inspection process.



Caution: Chemicals used during the etching process are irritating to the skin. When performing the etch check, wear a full face mask, rubber gloves and an apron. In the event of skin contact, flush the affected area with water for 15 minutes. In the event of eye contact, flush with water and obtain medical assistance immediately.

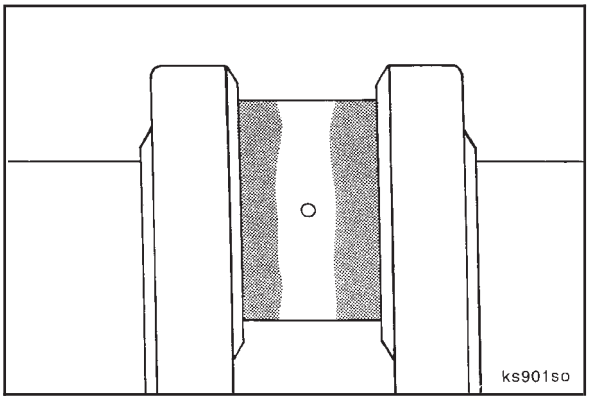
The procedure for etching a crankshaft for grinder burn follows:

- Thoroughly clean the crankshaft to remove oil, grease and debris.

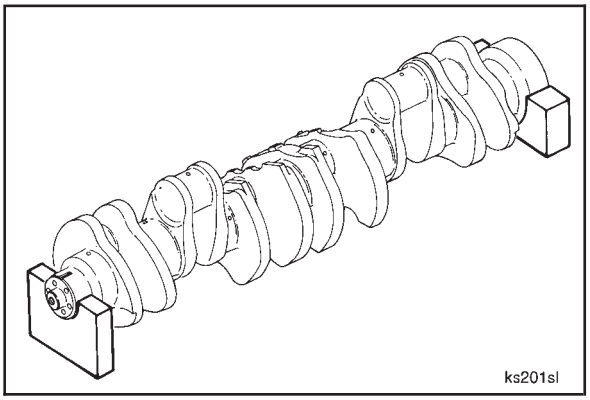


NOTE: Oil or grease can show as a false indication of burn during the etch check.

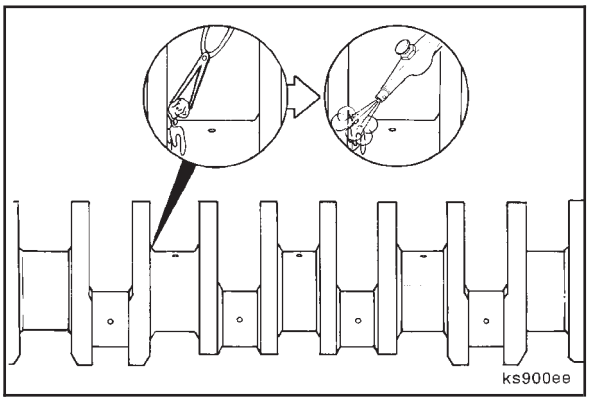
- Inspect the fillet areas closely as they are the most likely places to find grinder burn.



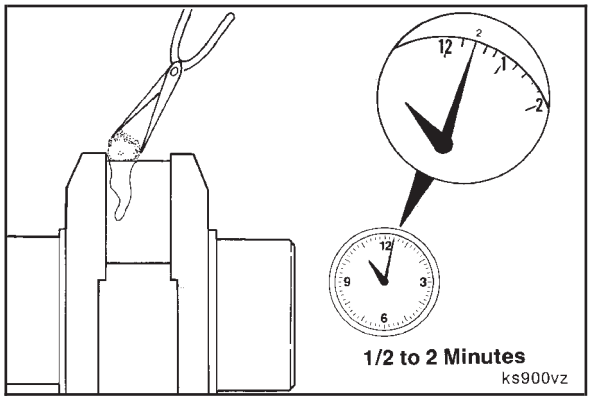
- Support the crankshaft with wooden v-blocks to allow the crankshaft to be rotated.



- Clean the area to be inspected with acetone. Apply the acetone using tongs and clean cotton balls. Dry with compressed air.

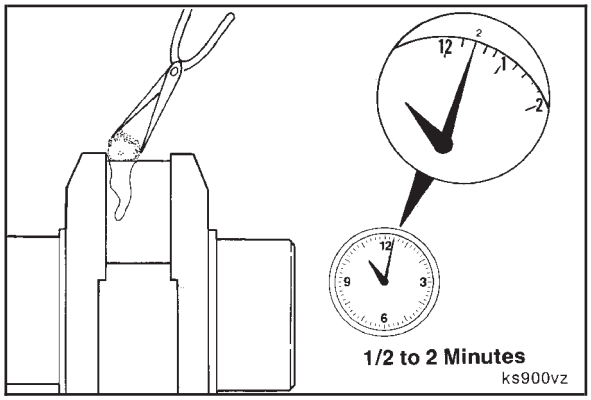


NOTE: Be sure to use clean cotton balls when applying the cleaners or etching chemicals. Do **not** reuse the cotton balls.

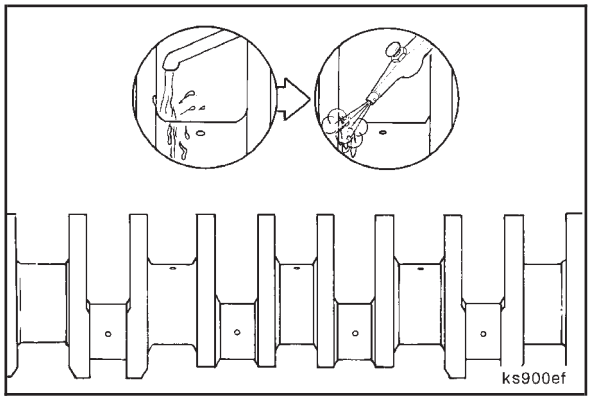


- Swab the area to be inspected with 4 percent solution of nitric acid in water.
- If inspecting a fillet, be sure to apply the nitric acid solution on the fillet sidewall.

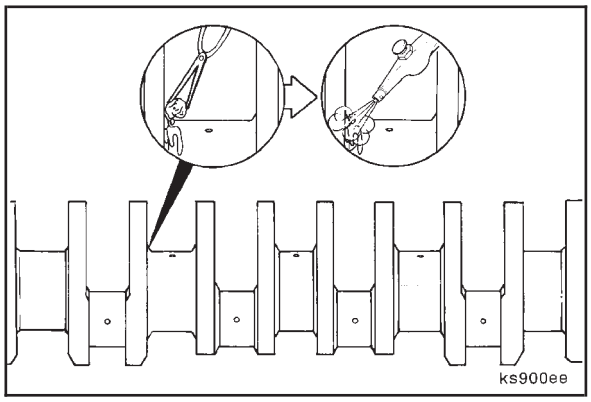
NOTE: Use a large ball of cotton and chemical tongs to apply generous amounts of the nitric acid solution.



- Swab vigorously for 30 seconds to two minutes. The surface **must** turn a uniform dark gray or black in color.

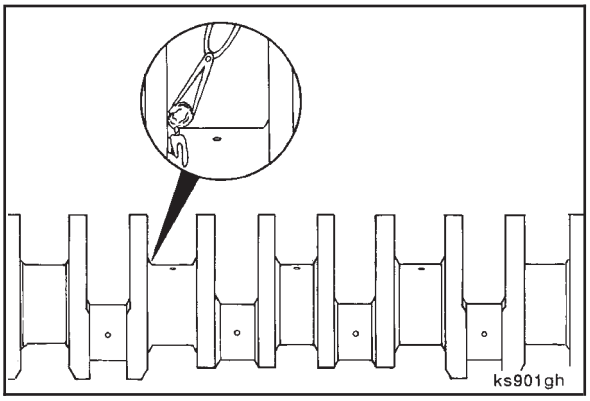


- Rinse with hot water and dry with compressed air.

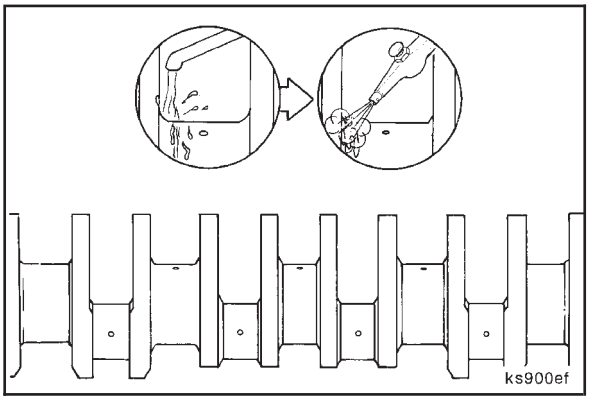


- Swab with acetone using clean cotton balls. Dry with compressed air.

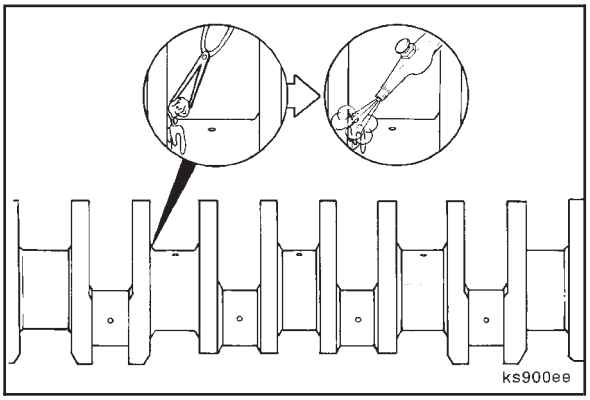
- Swab the area for 15 seconds to one minute with 2 percent hydrochloric acid in acetone using clean cotton balls.



- Rinse with hot water and dry with compressed air.

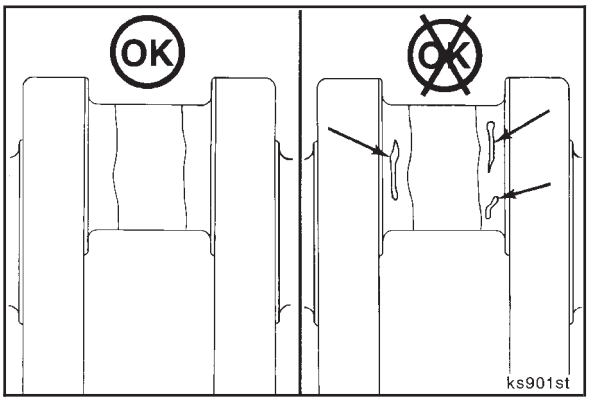


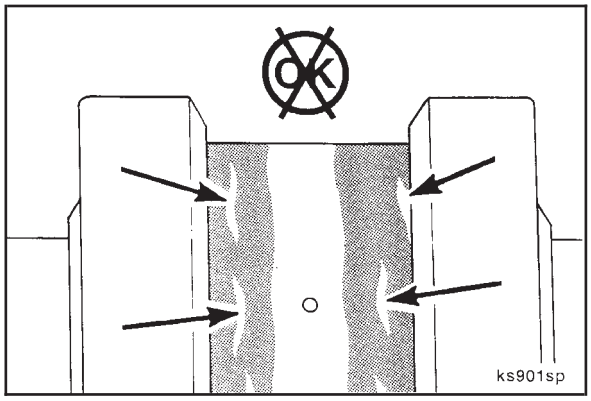
- Swab with acetone using clean cotton balls and dry with compressed air.



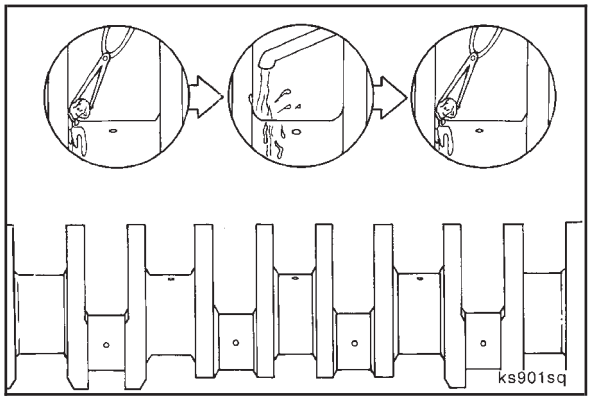
- Inspect the area for grinder burn.

A uniform gray color with no color irregularities indicates no grinder burn. Any streaks or darker spots in the light gray background is evidence of grinder burn damage and is **not** acceptable.





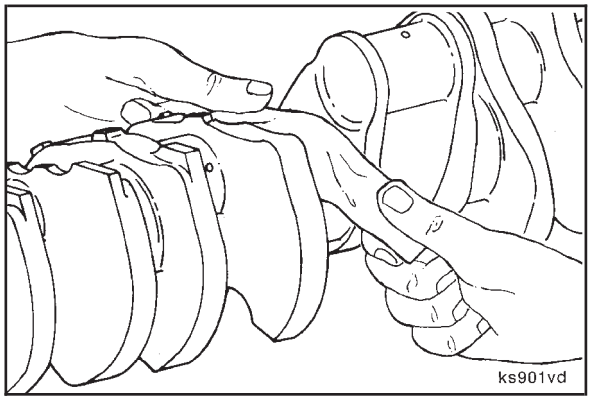
Streaks or areas lighter than the gray background are evidence of rehardening as a result of excessive heat generated in the grinding process. Rehardening is **not** acceptable.



In cases of questionable patterns, polish out the etching discoloration and repeat the procedure.

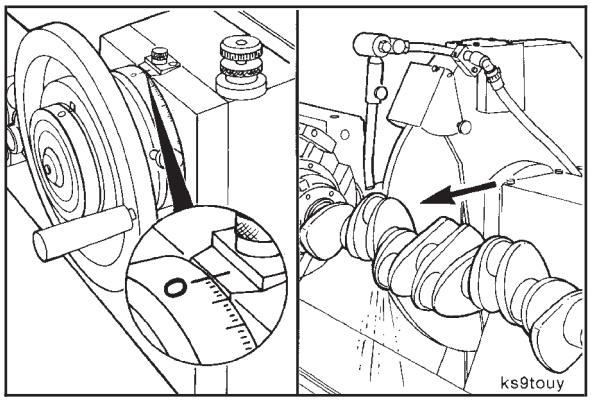
NOTE: Use 400 grit emery cloth when polishing. Clean the crankshaft journal before repeating the procedure.

When inspecting for grinder burn or rehardening, be sure to inspect the bearing journal, fillet and sidewall.



On acceptable crankshafts, polish out the etch coloration using 400 grit emery cloth.

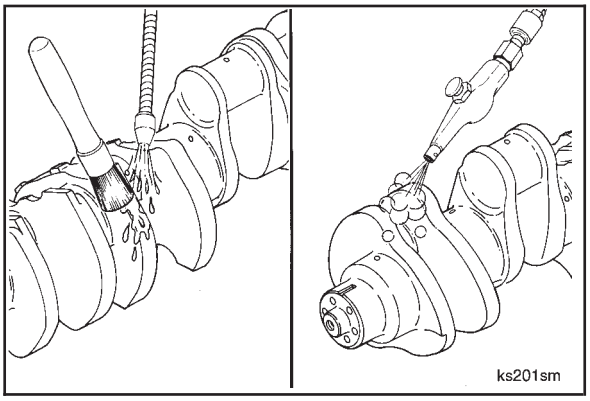
- Clean the crankshaft thoroughly.



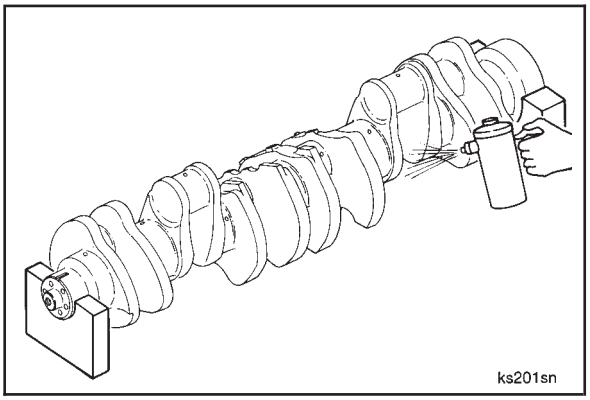
Some crankshafts that have grinder burn damage can be repaired by grinding the journals to the next standard undersize.

NOTE: After grinding the crankshaft to the next standard undersize, the crankshaft **must** be inspected for grinder burn again.

- Thoroughly clean the crankshaft and dry with compressed air.

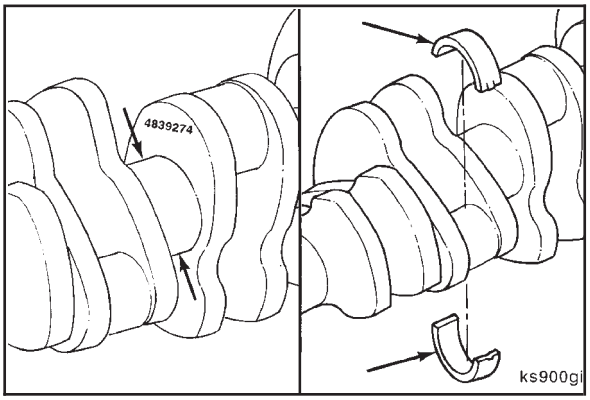


- Treat the entire crankshaft with a preservative type oil to prevent rusting.



Crankshaft Size — Identification

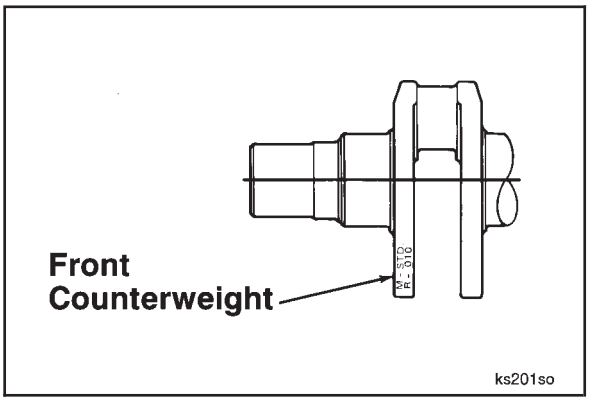
All reconditioned crankshafts **must** be properly stamped to identify the crankshaft journal and thrust surface size, and to prevent the use of wrong size bearings.

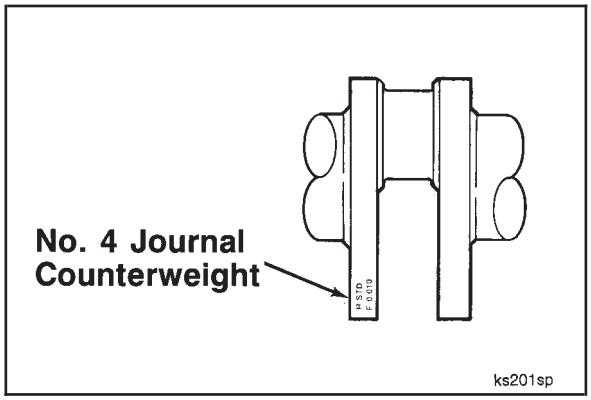


Crankshafts that have had the journals ground **must** be stamped with 3.2 mm [0.125 inch] characters on the number one crankshaft counterweight.

Stamp a "M" to identify the main bearing journal size and a "R" to identify the rod bearing journal size. For example:

- M — Std.
- R — 0.010

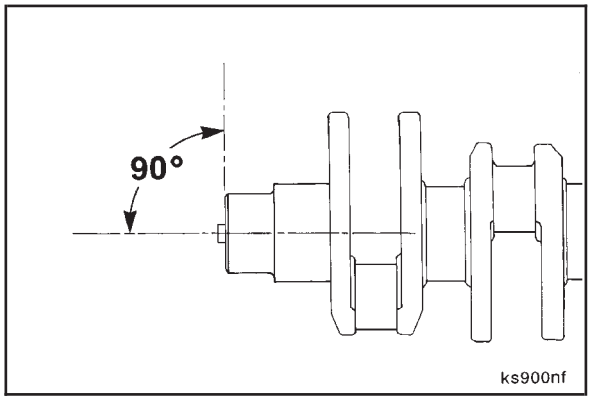




The thrust bearing oversize **must** be stamped on the crankshaft counterweight adjacent to the front thrust surface (No. 4 main bearing journal).

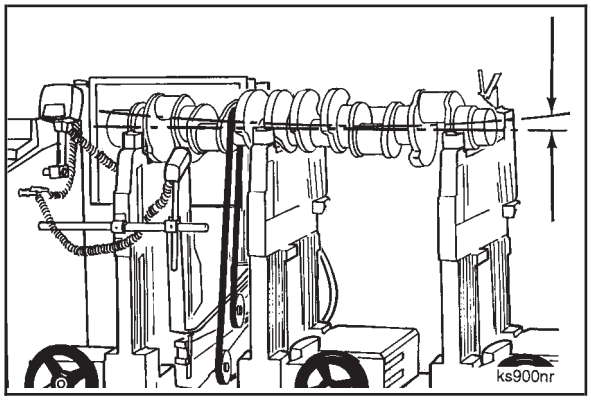
Stamp a "F" to indicate the amount of material removed from the front thrust surface and a "R" for the rear thrust surface. For example:

- F — 0.10
- R — Std.

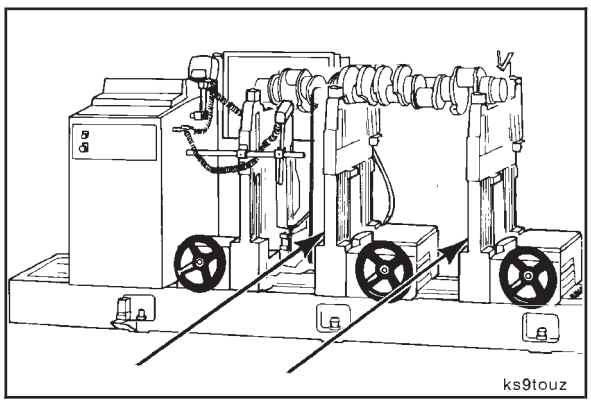


Crankshaft — Balancing

Reconditioning can vary the weight distribution and dynamic balance of the crankshaft. Perform a dynamic balance inspection after reconditioning. The L10 and M11 crankshafts **must** be balanced to 72 gram-centimeter [1 inch-ounce].



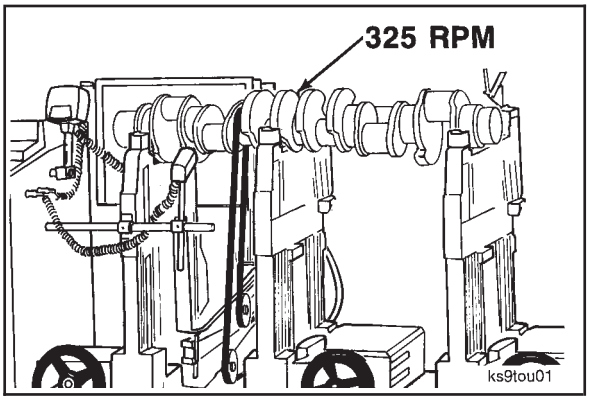
Accurate balancing requires that the crankshaft alignment be held within 0.05 mm [0.002 inch] during the balancing operation.



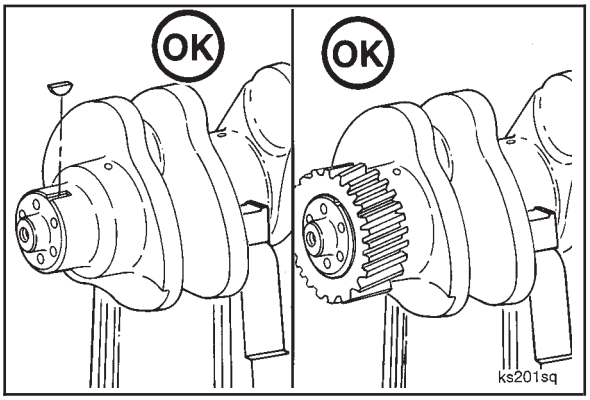
The crankshaft **must** be supported at No. 1, No. 4 and No. 7 main bearing journals during the balancing operation.

The crankshaft rotation speed **must not** exceed 325 RPM during balancing.

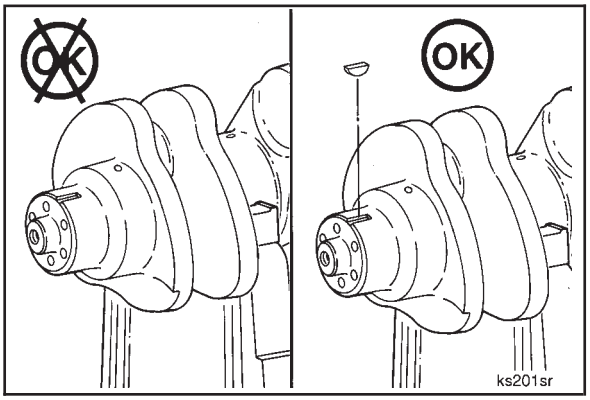
NOTE: Excessive speeds will cause the crankshaft to whip, resulting in incorrect balance indications.



The crankshaft can be balanced with or without the crankshaft gear installed.

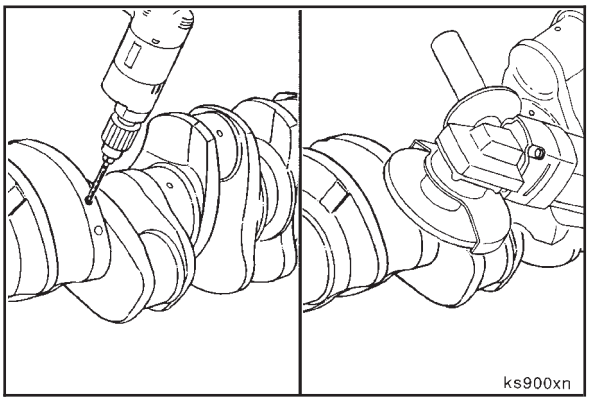


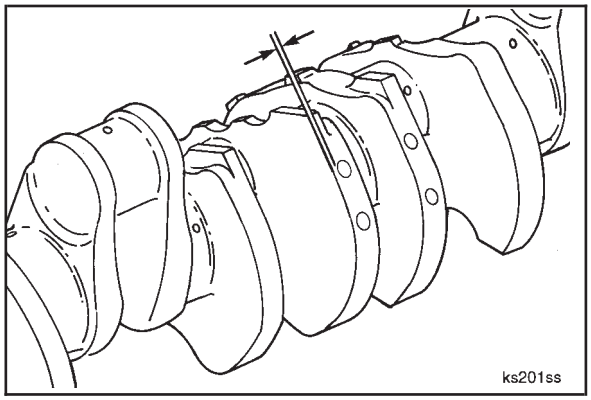
When balancing the crankshaft without the gear, compensation **must** be made for the gear keyway slot.



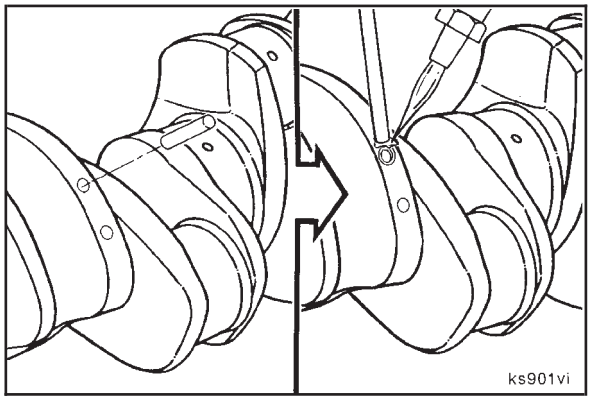
Balance corrections can be performed by drilling holes in the counterweight or "snag drilling" on the perimeter of the counterweights.

Do **not** grind excessive amounts of material from any one counterweight. Remove no more than 57 grams [2 ounces] of weight per counterweight.

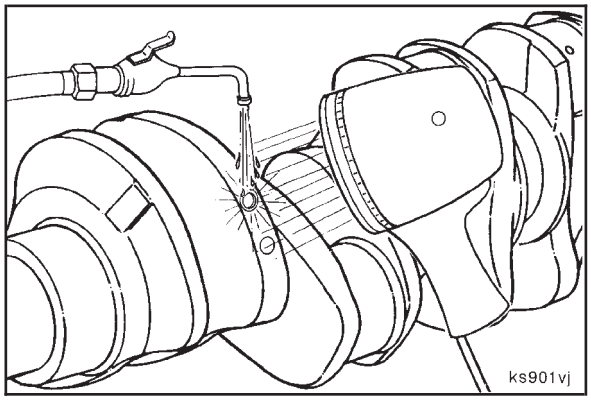




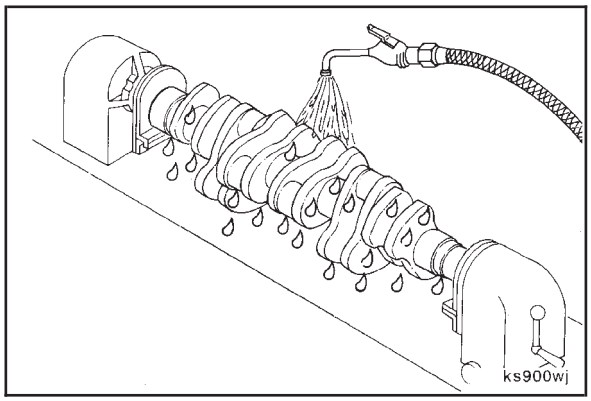
When drilling the crankshaft counterweight, maintain a minimum of 3.2 mm [0.125 inch] wall thickness between any balance hole and the sidewall of the counterweight.



Where excessive amounts of metal have been removed, balance can be obtained by adding weight. Lead can be tapped in an existing balance hole and secured by welding a steel cup plug in the hole over the lead.



All welds **must** be inspected using magnetic particle inspection. No cracks or indications are permitted.



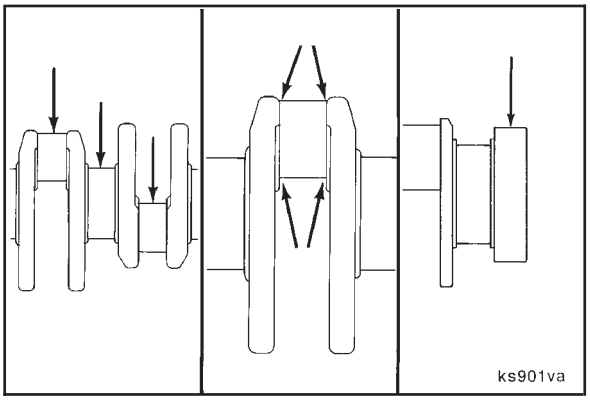
Crankshaft Magnetic Crack — Inspection

After grinding, the crankshaft **must** be inspected for cracks using magnetic particle inspection. Refer to Crankshaft Magnetic Crack Inspection — Continuous Method for instructions and inspection standards.

Crankshaft — Polishing

After grinding, the surfaces that require polishing are:

- Bearing Journals
- Fillets
- Rear Oil Seal Flange

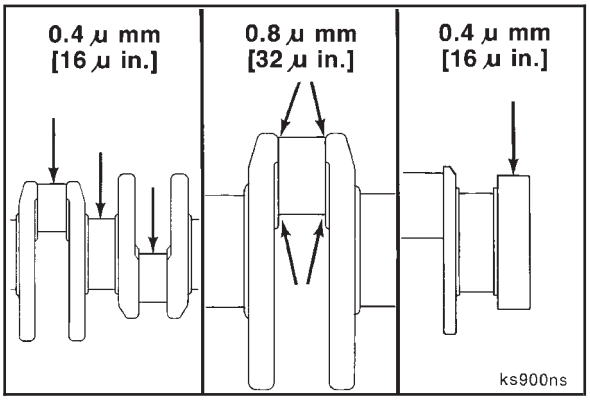


The surface finish requirements are:

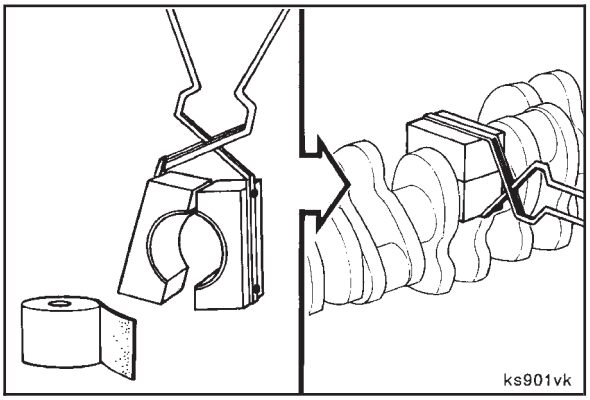
0.4 µM [16 µ inch] on bearing journals and thrust surface

0.8 µM [32 µ inch] on journal fillets

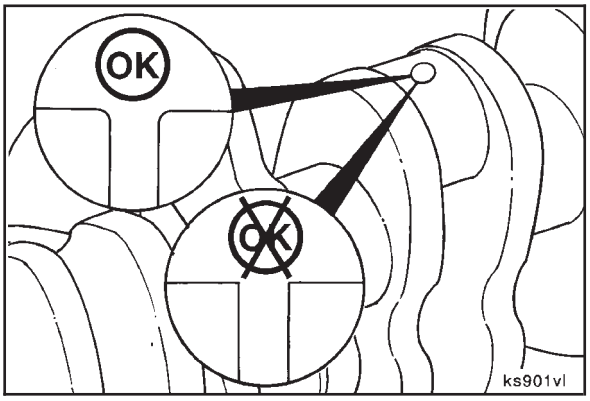
0.4 µM [16 µ inch] on rear seal flange

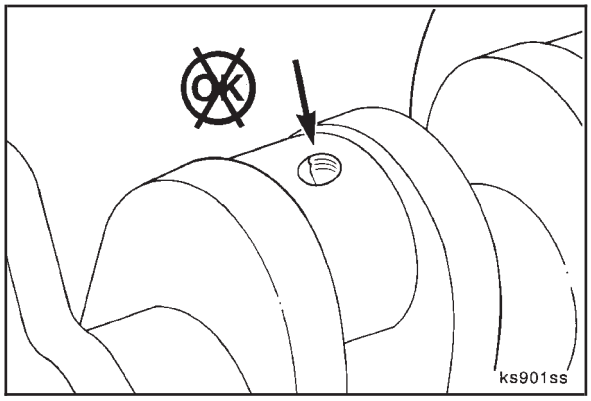


Encompassing fixtures that provide full journal contact are recommended for journal and fillet polishing. The type of fixtures improve contour as well as surface finish.

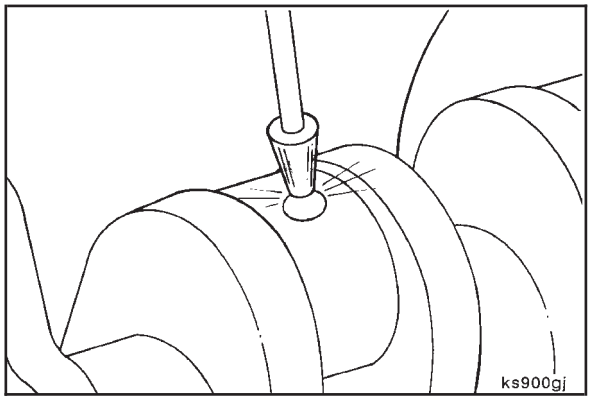


It is especially important to polish the intersection of oil hole cross drillings and the journal diameters.

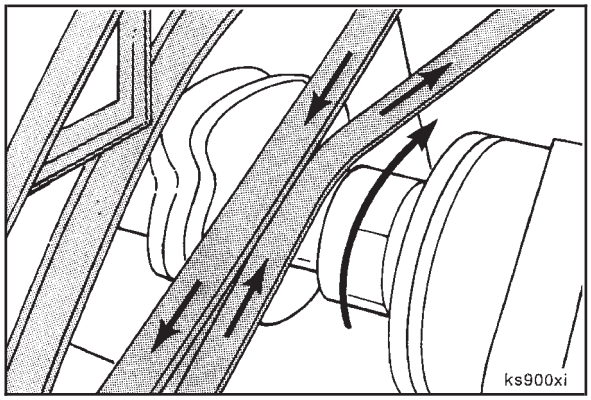




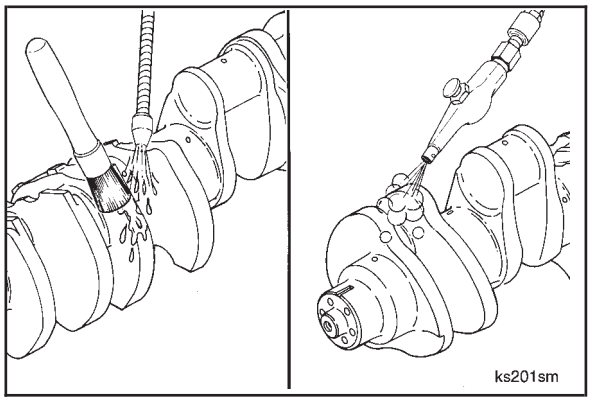
No cracks or tool marks are acceptable in the blended area of the oil hole cross drillings and the journal diameters.



A small hand grinder can be used to remove any marks inside the oil hole.

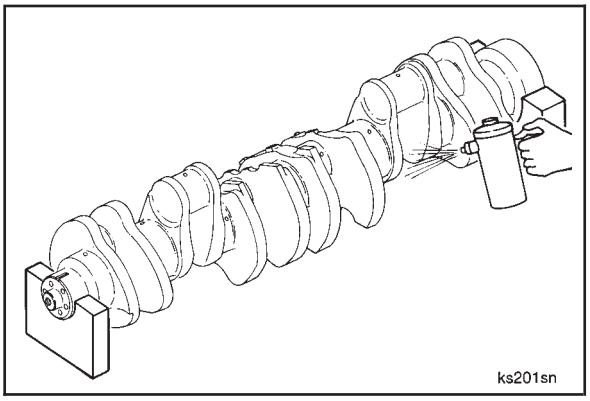


If a belt type polisher is used, a 400 grit polishing cloth belt **must** be used. The crankshaft **must** be rotated in the same direction it will turn in the engine with the polishing cloth pulling away from the direction of crankshaft rotation.



Thoroughly clean the crankshaft and dry with compressed air.

Coat the entire crankshaft with a preservative oil that will prevent rusting.



Specifications — Crankshaft Repair

Main Bearing Journal O.D.	mm		inch
Standard Journal Size	114.015	MIN	4.4888
	114.055	MAX	4.4904
0.25 mm [0.010 inch] Undersize	113.765	MIN	4.4789
	113.805	MAX	4.4805
0.50 mm [0.020 inch] Undersize	113.515	MIN	4.4691
	113.555	MAX	4.4707
0.75 mm [0.030 inch] Undersize	113.265	MIN	4.4593
	113.305	MAX	4.4608
1.00 mm [0.040 inch] Undersize	113.015	MIN	4.4494
	113.055	MAX	4.4510
Connecting Rod Bearing Journal O.D.			
Standard Journal Size	78.987	MIN	3.1097
	79.013	MAX	3.1107
0.25 mm [0.010 inch] Undersize	78.737	MIN	3.0999
	78.763	MAX	3.1009
0.50 mm [0.020 inch] Undersize	78.487	MIN	3.0900
	78.513	MAX	3.0911
0.75 mm [0.030 inch] Undersize	78.237	MIN	3.0802
	78.263	MAX	3.0812
1.00 mm [0.040 inch] Undersize	77.987	MIN	3.0704
	78.013	MAX	3.0714
No. 4 Main Bearing Journal (Thrust Surface) Width — Standard Size	49.975	MIN	1.9675
	50.100	MAX	1.9724
0.25 mm [0.010 inch] Oversize (One Thrust Surface)	50.225	MIN	1.9774
	50.350	MAX	1.9823
0.50 mm [0.020 inch] Oversize (Both Thrust Surfaces)	50.475	MIN	1.9872
	50.600	MAX	1.9921
Gear Journal O.D.	85.975	MIN	3.3848
	86.000	MAX	3.3858
Gear Journal diameter Runout	0.030	MAX	0.0012
Gear Journal Fillet Radius	5.75	MIN	0.226
	6.25	MAX	0.246
Crankshaft Gear Runout — Installed (Measured on Measuring Pin O.D.)	0.08	MAX	0.003
Crankshaft Gear Measuring Pin O.D.	5.18		0.204
Crankshaft Gear Keyway Width	4.732	MIN	0.1863
	4.851	MAX	0.1910
Vibration Damper Mounting Face Runout	0.030	MAX	0.0012
Rear Oil Seal Flange O.D.	164.965	MIN	6.4947
	165.035	MAX	6.4974
Front Oil Seal Flange O.D.	84.970	MIN	3.3453
	85.000	MAX	3.3465
Rear Oil Seal Flange Diameter Runout	0.030	MAX	0.0012
Front Oil Seal Flange Diameter Runout	0.030	MAX	0.0012
Flywheel Mounting Face Runout	0.030	MAX	0.0012

Crankshaft Repair — Specifications (Continued)

	mm		in
Crankshaft Length	1066.5		41.99
Crankshaft Full Length Alignment	0.15	MAX	0.006
Crankshaft Journal to Journal Alignment	0.05	MAX	0.002
No. 4 Main Bearing Thrust Surface Runout	0.05	MAX	0.002
Crankshaft Throw - L10	67.935	MIN	2.6746
	68.065	MAX	2.6797
Crankshaft Throw - M11	73.435	MIN	2.8911
	73.565	MAX	2.8963
Permissible Variation Among Throws	0.13	MAX	0.005
Off Stroking Limit (Under Only)	0.25	MAX	0.010
Crankshaft Throw Index Limits (Horizontal Deviation — Front to Rear)	0.46	MAX	0.018
Distance from Vibration Damper Face to Front Thrust Bearing Surface			
Internal	502.75	MIN	19.774
External	529.75	MIN	20.856
Vibration Damper Pilot Radius	3.0	MAX	0.12
Vibration Damper Pilot O.D.			
6-Hole Internal Damper (L10)	35.02	MIN	1.3787
	35.05	MAX	1.3799
5-Hole Internal Damper (L10	32.02	MIN	1.2606
	32.05	MAX	1.2618
External Damper (L10/M11)	32.01	MIN	1.2602
	32.04	MAX	1.2614

Surface Finish Specifications			
Bearing Journals	0.4 µM	MIN	16 µ in
Thrust Surfaces	0.4 µM	Min	16 µ in
Fillets	0.8 µM	MIN	32 µ in
Rear Oil seal Surface	0.4 µM	MIN	16 µ in
Rockwell Hardness	43 Rc	MIN	
Grinding Wheel Width (Rod Bearing Journals)	53.130	MIN	2.0917
	53.168	MAX	2.0932
Crankshaft Balance (per end)	72 g cm	MAX	1 oz in
Connecting rod Bearing Journal Fillet Radius	4.75	MIN	0.187
	5.25	MAX	0.207
Main Bearing Journal Fillet Radius	5.75	MIN	0.226
	6.25	MAX	0.246

Amperage for Magnetic Inspection	
Head Shot	1200 Amps
Coil Shot	3600 to 4000 Ampere Turns
Vibration Damper Mounting Capscrew Threads	M12 x 1.25
6-Hole Crankshaft	M12 x 1.25
5-Hole Crankshaft	M14 x 1.50
Flywheel Mounting Capscrew Threads	M14 x 1.50
Wear Sleeve Part No.	3819774 Rear Seal Repair Kit 3820918 Front Crank Seal (External)

NOTES

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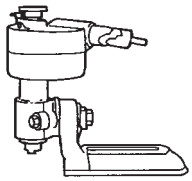
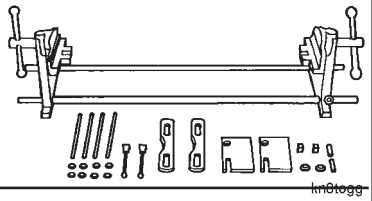
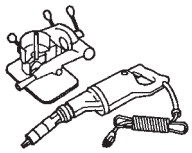
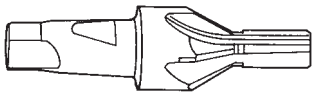
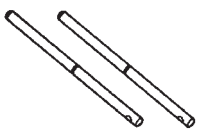
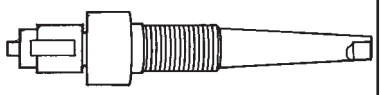
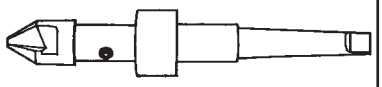
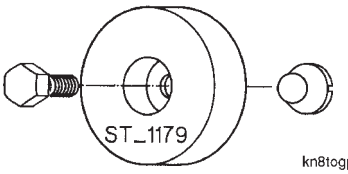
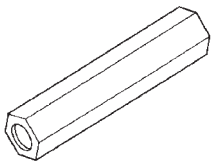
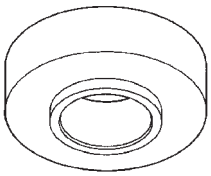
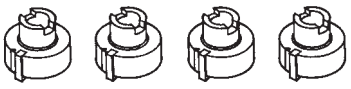
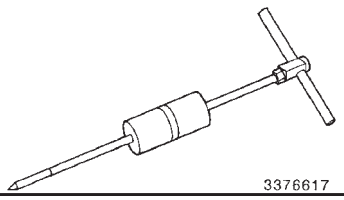
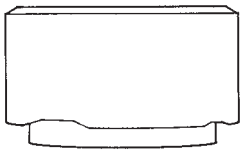
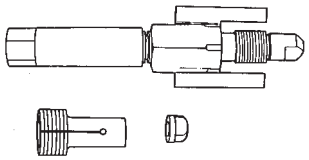
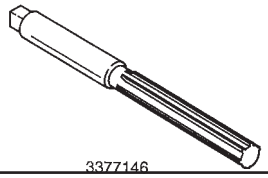
Service Tools — Cylinder Head

The following special tools are recommended to perform procedures in Group 02. The use of these tools is shown in the appropriate procedure. These tools can be purchased from your local Cummins Authorized Repair Location.

Tool No.	Tool Description	Tool Illustration
ST-257	**Valve Seat Insert Tool** Cut valve seat counterbores for oversize valve seat inserts. Used with valve guide set, Part No. ST-804, and valve seat insert cutter, Part No. 3376595.	 kn8togo
ST-583	**Head Holding Fixture** Hold and revolve the cylinder head during repair and assembly.	 kn8togg
ST-685	**Valve Seat Grinding Machine** Grind the valve seats in the cylinder head. Used with valve guide arbor set, Part No. ST-804 and valve seat grinding wheel, Part No. 3376077.	 kn8togi
ST-788	**Bead Cutting Tool** Used with holder, Part No. ST-884-1 and pilot, Part No. ST-884-6, to cut the injector sleeve bead seat.	 ST-788
ST-804	**Valve Guide Arbor Set** Used with valve seat insert tool, Part No. ST-257, and valve seat grinding machine, Part No. ST-685. ST-804-1 Arbor (3/8 in + 0.006 in) ST-804-2 Arbor (3/8 in + 0.007 in)	 kn8togj
ST-880	**Injector Sleeve Expander** Roll and seal the upper portion of the injector sleeve in the cylinder head.	 kn8togl

Tool No.	Tool Description	Tool Illustration
ST-884-3	**Injector Seat Cutter** Used with pilot, Part No. ST-379-2	 kn8togm
ST-1179	**Injector Sleeve Holding Tool** Hold the injector sleeve in place when rolling the upper portion of the sleeve and testing the cylinder head.	 kn8togp
ST-1227	**Injector Sleeve Driver** Install the injector sleeve into the cylinder head.	 kn8togq
3823947	**Valve Guide Driver** Used to install valve guides requiring valve seals to the proper assembled height in the cylinder head.	 3376061
3376105	**Valve Seat Driver Mandrel** Used with the adapter sleeve and seat driver in the valve seat insert tool, Part No. ST-257.	 3376105
3376146	**Valve Seat Extractor** Used with slide hammer assembly, Part No. 3376617, to remove the valve seat inserts from the cylinder head.	 3376146
3376595	**Valve Seat Insert Bore Cutter Kit** This kit contains 0.25 mm [0.010 in], 0.50 mm [0.020 in], 0.75 mm [0.030 in], and 1.00 mm [0.040 in] oversize valve seat insert bore cutters.	 3376595
3376617	**Slide Hammer Assembly** Used with the valve seat extractor and sleeve puller to remove the valve seat inserts and injector sleeves from the cylinder head.	 3376617

Tool No.	Tool Description	Tool Illustration
3376965	**Staking Tool** Used with staking tool driver, Part No. ST-1122, to install the valve seat insert in the cylinder head.	 3376965
3377079	**Injector Sleeve Puller** Used to remove the injector sleeves from the cylinder head. This tool is designed for use with an air impact wrench.	 3377079
3377145	**Oversize Valve Guide Reamer** Ream the valve guide bore in the cylinder head for oversize valve guides.	 3377145
3377146	**Valve Guide Reamer** Used to ream the inside diameter of the new valve guide.	 3377146
3823495	**Gauge Block** Used to measure the injector protrusion and valve recess in the cylinder head.	3823495-h

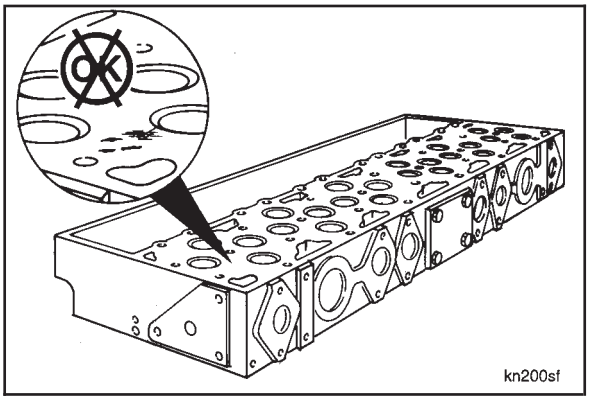
Cylinder Head Resurfacing

General Information

This repair procedure describes the method for resurfacing the combustion face of the cylinder head.

Cylinder head resurfacing can be required if the cylinder head combustion face surface is:

- warped,
- grooved,
- pitted.

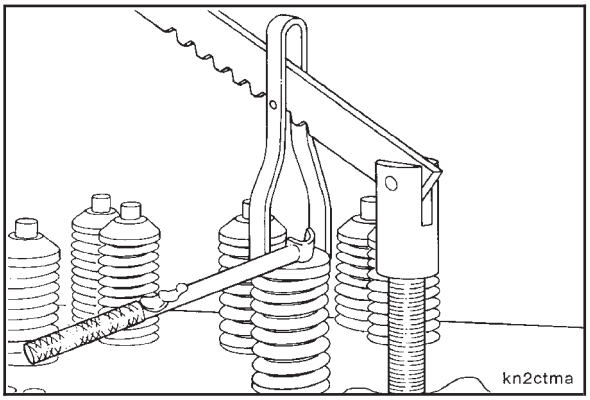


The cylinder head **must** be removed from the engine and completely disassembled to perform this repair. Refer to the following Shop Manuals for the correct procedure:

Bulletin No. 3379347 — Internal Damper L10 engines,

Bulletin No. 3810476 — External Damper L10 engines,

Bulletin No. 3666075 — M11 engines.

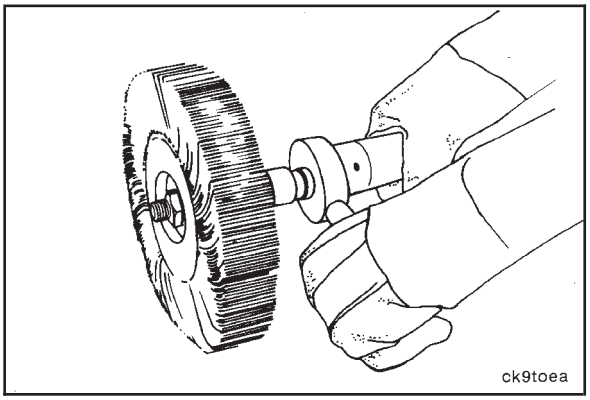


Initial Preparation and Inspection

Warning: To avoid possible eye damage, always wear protective eye goggles when using a flapwheel or when drilling metal.

Remove all dirt, debris, and rust from the combustion face of the cylinder head.

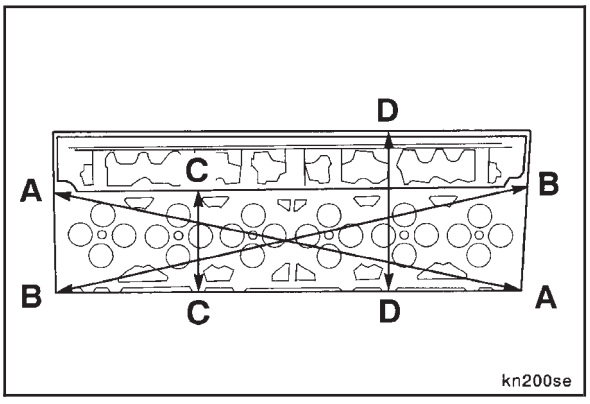
NOTE: A flap wheel or rotating disk of Scotch-Brite® can be used for this.



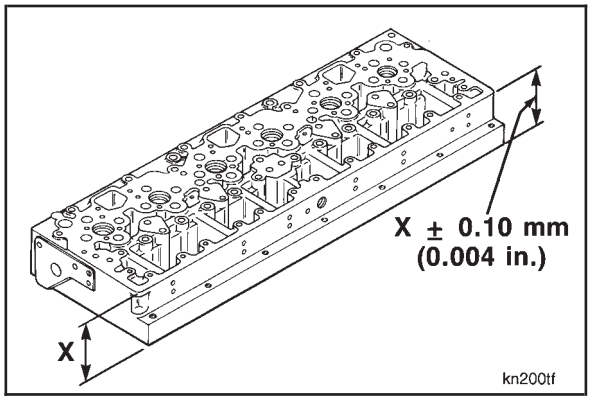
Measure the flatness of the cylinder head gasket surface as follows:

- AA and BB (corner to corner),
- CC (across combustion face),
- DD (across entire head surface).

NOTE: Dimensions CC and DD **must** be checked from front to rear of the cylinder head.

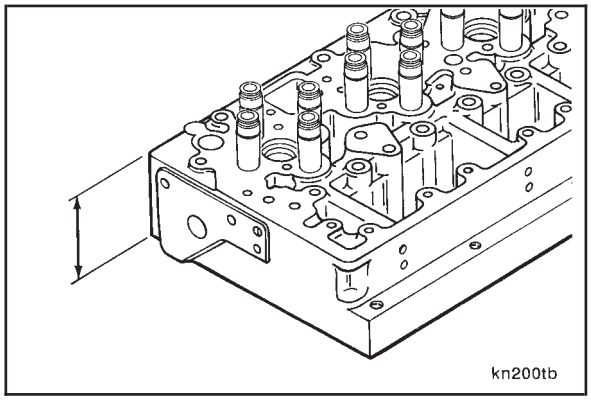


Cylinder Head Flatness			
	mm		in
AA and BB	0.200	MAX	0.008
CC	0.076	MAX	0.003
DD	0.127	MAX	0.005



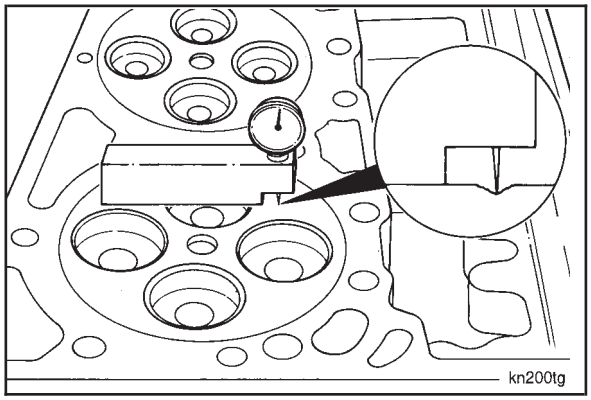
Measure the parallelism between the combustion surface and the top surface of the cylinder head.

Cylinder Head Parallelism		
mm		in
0.10	MAX	0.004



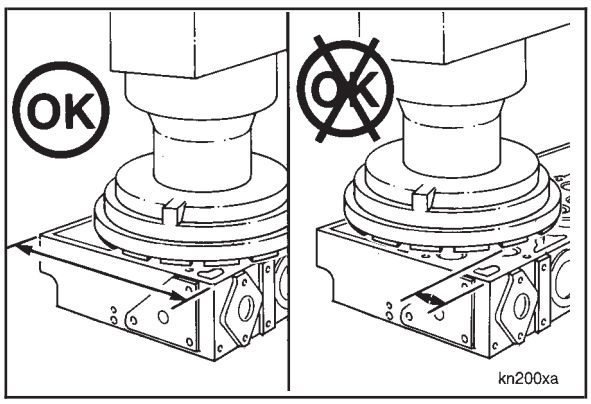
Measure the thickness of the cylinder head.

Cylinder Head Thickness (New)		
mm		in
99.75	MIN	3.927
100.25	MAX	3.947



Measure the depth of any grooves or pits in the cylinder head.

NOTE: If the cylinder head thickness minus the depth of grooves or pits is less than 99.24 mm [3.907 inch], the cylinder head **cannot** be resurfaced.



Cylinder Head Combustion Face — Machining

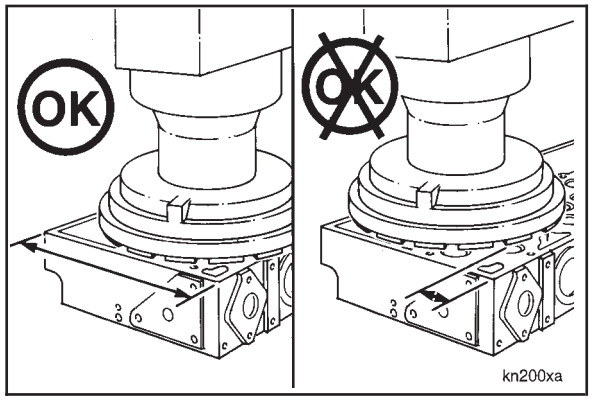
A milling machine or grinder can be used to resurface the combustion face of the cylinder head.

NOTE: The grinding wheel or cutter **must** have a 317.5 mm [12.5 inch] diameter to fully cover the combustion surface of the cylinder head.

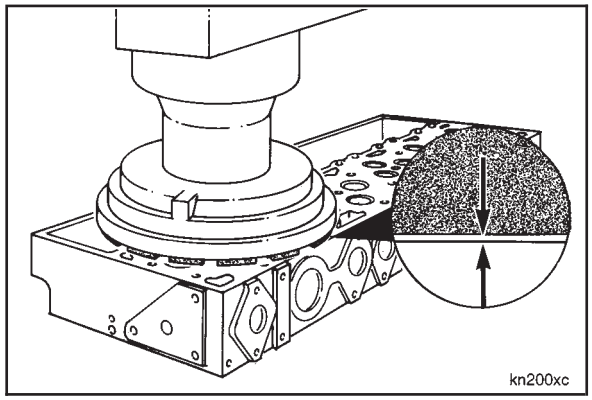
Install the cylinder head on the milling machine or grinder. Reference points can either be:

- the top surface of the cylinder head,
- four locations on the combustion face close to the corners if the cylinder head is **not** warped.

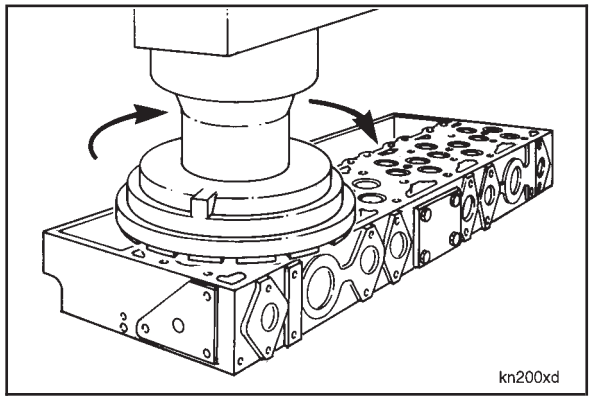
NOTE: Parallelism with the top surface **must** be within 0.010 mm [0.004 inch]. Follow the tool manufacturer's instructions for installing the cylinder head.



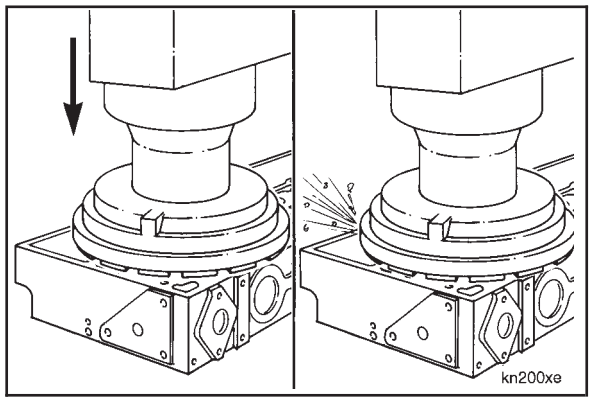
Adjust the machine so there is approximately 0.79 mm [1/32 inch] clearance between the grinding wheel or cutter and the cylinder head.

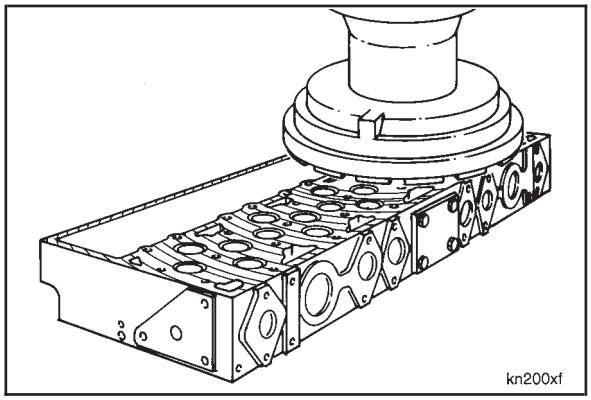


Manually turn the grinding wheel or cutter to be sure it is **not** touching the cylinder head.

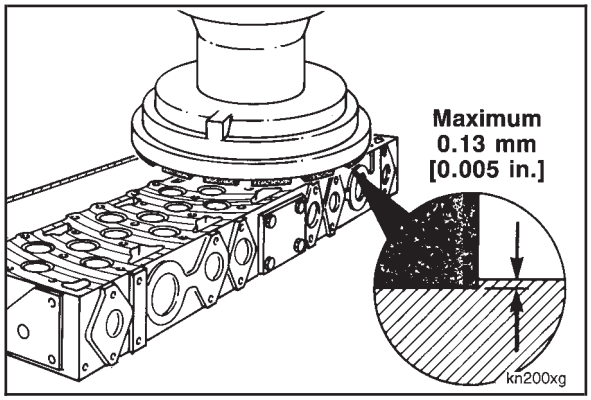


Turn the milling machine or cutter "ON" and slowly lower the grinding wheel or cutter until it just touches the cylinder head combustion face.



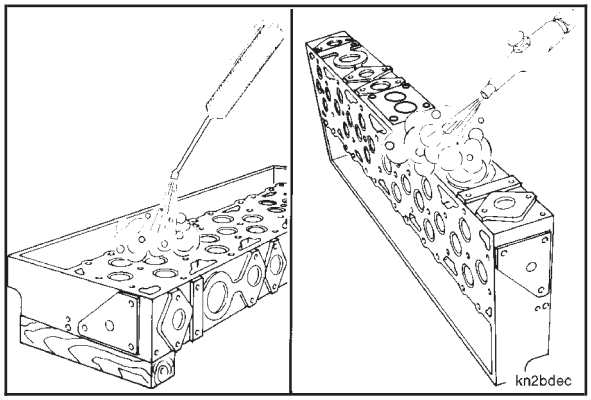


Manually move the grinding wheel or cutter slowly across the full length of the cylinder head to be sure the contact is **not** excessive.



Machine the cylinder head combustion surface. The maximum material removed **must not** be more than 0.13 mm [0.005 inch] per cut.

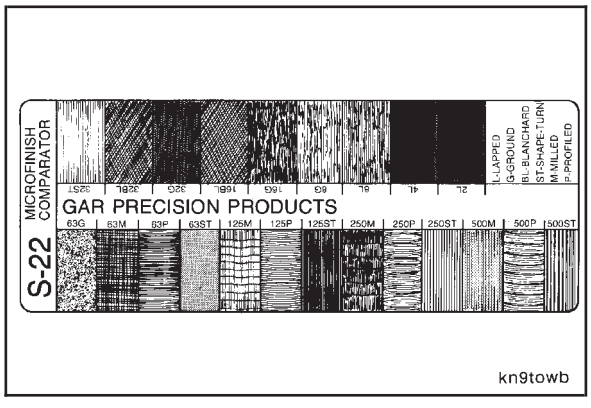
NOTE: The minimum cylinder head thickness after machining is 99.24 mm [3.907 inch].



Final Inspection

Warning: When using a steam cleaner, wear protective clothing, and safety glasses or a face shield. Hot steam can cause serious personal injury.

Steam clean the cylinder head to remove any machining debris. Dry with compressed air.

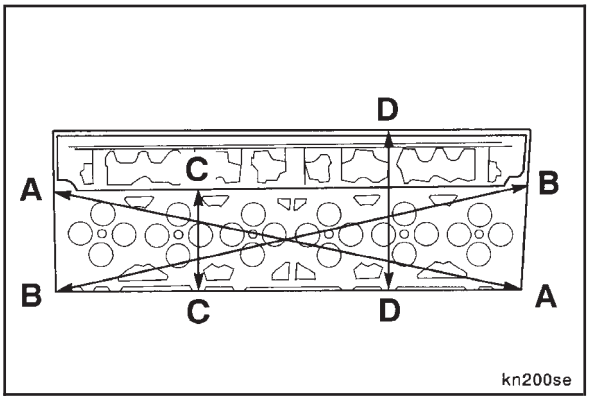


Use a surface finish comparator to inspect the surface finish of the combustion face. It **must** be 3.2 µM [125 µ inch] or less.

Measure the flatness of the cylinder head gasket surface as follows:

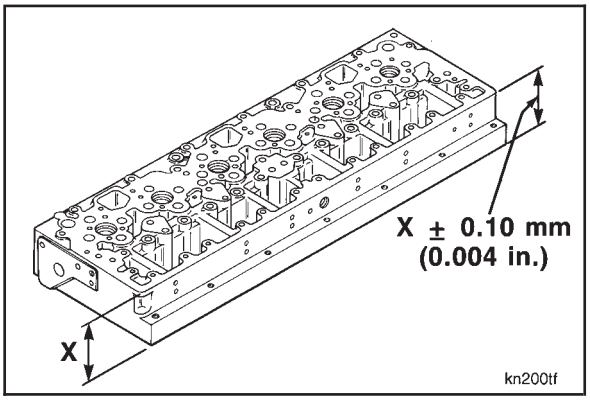
- AA and BB (corner to corner),
- CC (across combustion face),
- DD (across entire head surface).

NOTE: Dimensions CC and DD **must** be checked from front to rear of the cylinder head.



Cylinder Head Flatness			
	mm		in
AA and BB	0.200	MAX	0.008
CC	0.076	MAX	0.003
DD	0.127	MAX	0.005

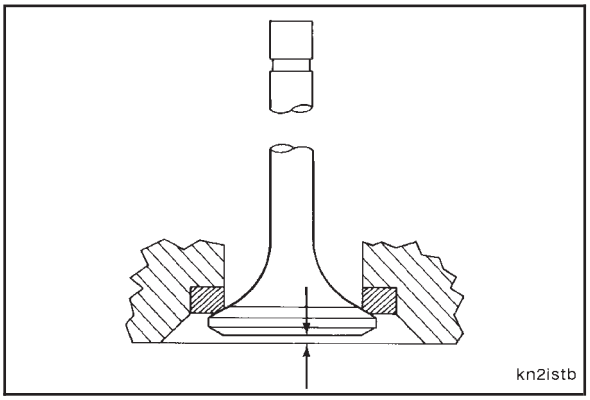
Measure the parallelism between the combustion surface and the top surface of the cylinder head.



Cylinder Head Parallelism		
mm		in
0.10	MAX	0.004

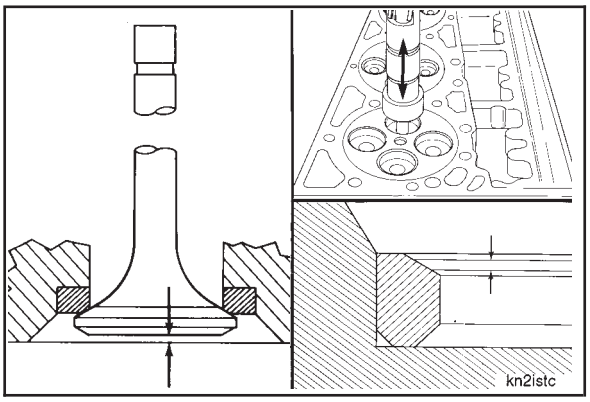
Install a new or reconditioned valve in each of the valve guides. Hold the valves firmly against the valve seats.

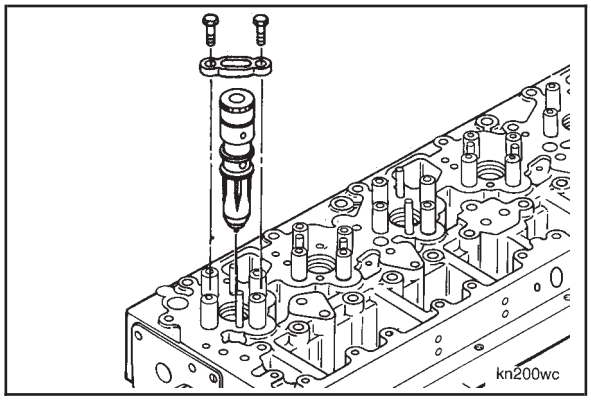
Use gauge block, Part No. 3823495, to measure the valve recess in the cylinder head.



Valve Recess			
	mm		in
Engines built before 1988	0.04	MIN	0.002
	0.46	MAX	0.018
Engines built after 1988	0.76	MIN	0.030
	1.17	MAX	0.046

If the valve recession in the cylinder head is **not** within the specifications, the valve seats **must** be ground or replaced. Refer to Valve Seats — Grinding, or Oversize Valve Seat Inserts - Installation.





Install an injector without the o-rings into each injector bore in the cylinder head. The following table is for fixed time engine injectors.

Fixed Time Injector Hold Down with M10 x 1.50 Capscrews

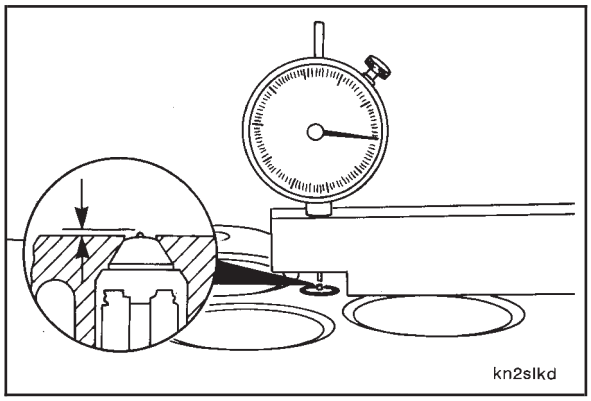
Torque Value: Step 1 - 6 N•m [55 in-lb]
2 - 12 N•m [110 in-lb]
3 - 19 N•m [165 in-lb]

Fixed Time Injector Hold Down with M8 x 1.25 Capscrews

Torque Value: Step 1 - 5 N•m [45 in-lb]
2 - 10 N•m [90 in-lb]
3 - 15 N•m [130 in-lb]

STC and CELECT™ Injector Hold Down

Torque Value: 75 N•m [55 in-lb]



Turn the cylinder head over and use gauge block, Part No. 3823495, to measure the injector tip protrusion.

Injector Tip Protrusion		
mm		**in**
2.29	MIN	0.090
2.54	MAX	0.100

NOTE: If the tip protrusion is **not** within the specifications, the injector sleeve **must** be replaced. Refer to Injector Sleeves - Replacement.

Specifications — Cylinder Head Resurfacing

Cylinder Head Flatness:

Cylinder Head Flatness			
	mm		in
AA and BB	0.200	MAX	0.008
CC	0.076	MAX	0.003
DD	0.127	MAX	0.005

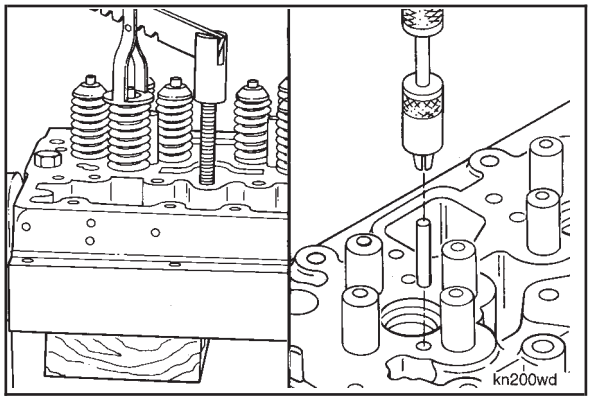
Cylinder Head Parallelism		
mm		in
0.10	MAX	0.004

Cylinder Head Thickness			
	mm		in
Before Machining	99.75	MIN	3.927
	100.25	MAX	3.947
After Machining	99.24	MIN	3.907

Cylinder Head Combustion Face			
	mm		in
Allowable Material Removed Per Cut	0.13	MAX	0.005
Surface Finish	3.2 micron	MIN	1.25 micron

Valve Recess			
	mm		in
Engine built before 1988	0.04	MIN	0.002
	0.46	MAX	0.018
Engines built after 1988	0.76	MIN	0.030
	1.17	MAX	0.046

Injector Tip Protrusion		
mm		in
2.29	MIN	0.090
2.54	MAX	0.100



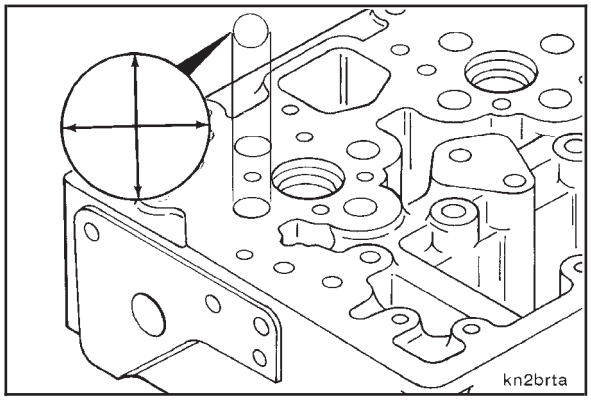
Oversize Valve Guides — Installation

General Information

This procedure describes the method for machining the valve guide bore in the cylinder head and installing oversize valve guides.

The cylinder head **must** be removed from the engine and completely disassembled to perform this repair. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.

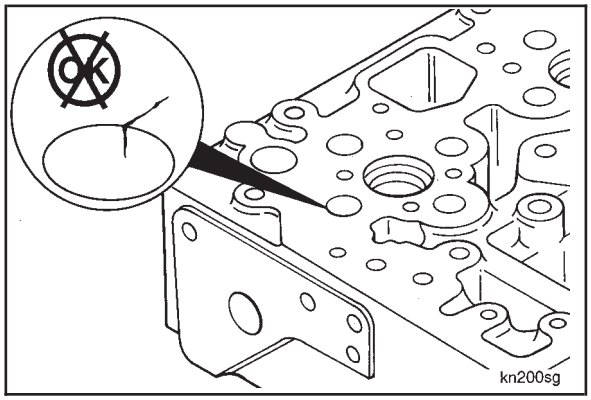


Initial Preparation and Inspection

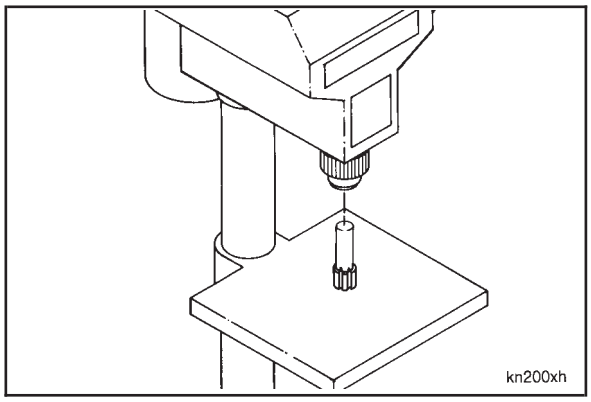
Measure the inside diameter of the valve guide bore in the cylinder head.

Valve Guide Bore I.D. (Std)		
mm		**in**
16.480	MIN	0.6488
16.500	MAX	0.6496

NOTE: If the valve guide bore measures more than 17.023 mm [0.6702 inch], the cylinder head **cannot** be repaired.



Inspect the cylinder head for cracks extending from the valve guide bore. Any cracks that **cannot** be machined out are unacceptable.



Valve Guide Bore — Machining

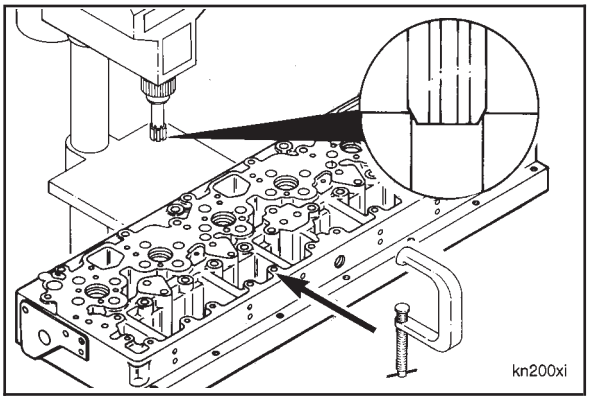
Install reamer, Part No. 3377145, in a drill press.

Install the cylinder head on the table of the drill press.

Locate the valve guide bore to be machined under the reamer.

NOTE: Use the taper on the end of the reamer as a pilot when centering the reamer in the bore.

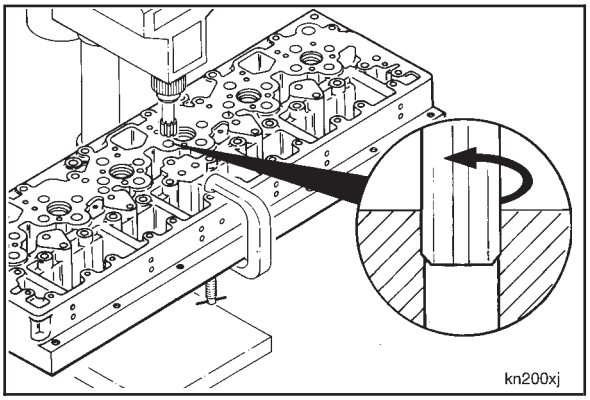
Clamp the cylinder head to the drill press table.



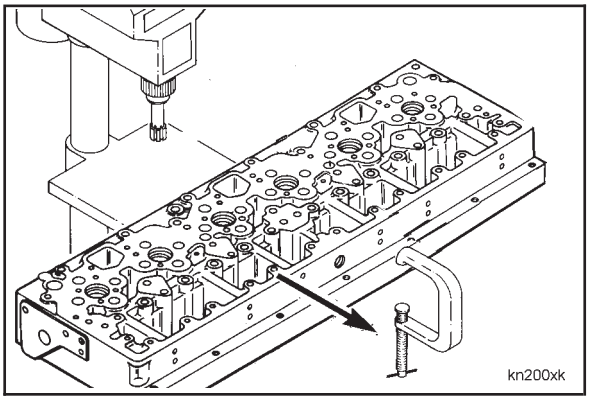
Use cutting oil and ream the bore completely through.

Clean the debris from the bore.

Inspect the bore to make sure all damage to the bore has been removed.



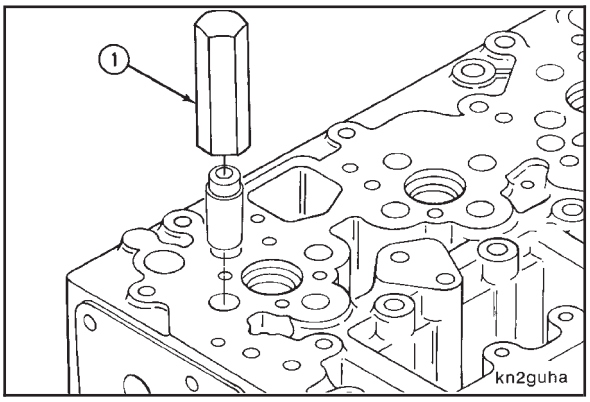
Remove the cylinder head from the drill press.

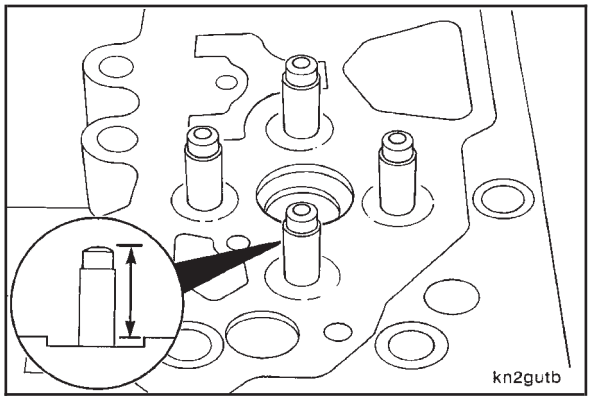


Oversize Valve Guide — Installation

NOTE: Valve guide driver, Part No. 3823947, is for used for installing valve guides that require a valve seal.

Use valve guide driver (1), Part No. 3823947, to install the new oversize valve guides.



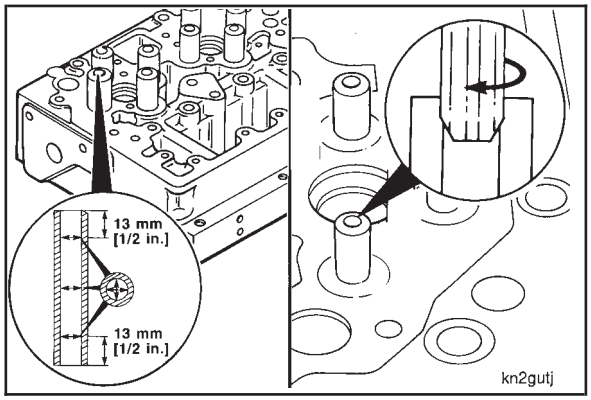


Measure the height of the valve guide from the top of the cylinder head deck to the top of the valve guide.

NOTE: The measurements given in the table below are for valve guides which require a valve seal.

Valve Guide Height (Installed)		
mm		**in**
27.15	MIN	1.069
27.65	MAX	1.089

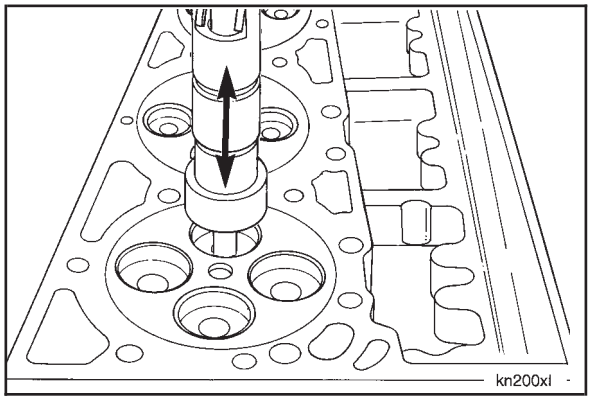
NOTE: The height **must** be measured from the cylinder head top deck, **not** from the bottom of the valve spring guide bore.



Measure the inside diameter of the valve guide in locations 13 mm [1/2 inch] from each end and at the center of the valve guide as shown.

NOTE: If the valve guide inside diameter is less than the minimum specified, use reamer, Part No. 3376146, to ream the inside diameter of the valve guide.

Valve Guide I.D. (Installed)		
mm		**in**
9.670	MIN	0.3807
9.695	MAX	0.3817



NOTE: After installing the oversize valve guide, it is necessary to grind the valve seats. Refer to Valve Seats — Grinding.

Specifications — Oversize Valve Guide

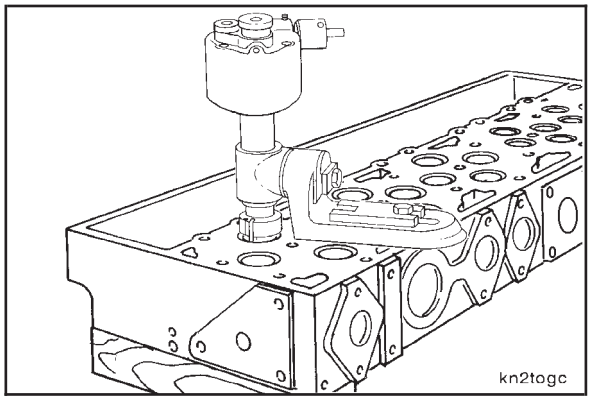
Valve Guide O.D.			
	mm		in
Standard Guide	16.513	MIN	0.6501
	16.526	MAX	0.6506
Oversize Guide	17.036	MIN	0.6707
	17.049	MAX	0.6712

Cylinder Head Valve Guide Bore I.D.			
	mm		in
Standard Bore	16.480	MIN	0.6488
	16.500	MAX	0.6496
Oversize Bore	17.003	MIN	0.6694
	17.023	MAX	0.6702

Valve Guide I.D. (Installed)		
mm		in
9.670	MIN	0.3807
9.695	MAX	0.3817

NOTE: The valve guide height values listed in the table below are for valve guides which require a valve guide seal.

Valve Guide Height (Installed)		
mm		in
27.15	MIN	1.069
27.65	MAX	1.089



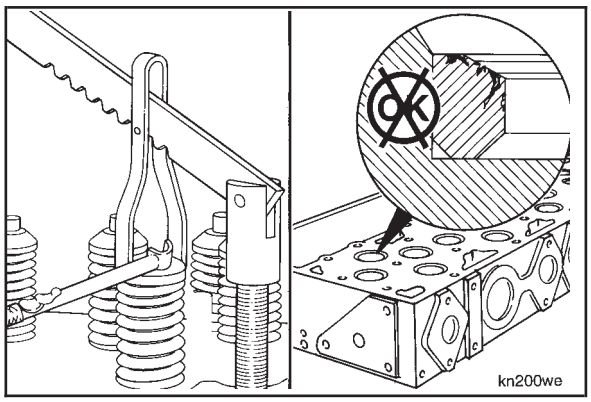
Oversize Valve Seat Inserts — Installation

General Information

This repair procedure describes the method for machining the cylinder head valve seat insert bore and installing oversize valve seat inserts.

NOTE: To perform this repair, it is necessary to have a good usable valve guide installed in the cylinder head. The valve guide is required to pilot the arbor and align the cutting machine. Refer to the following Shop Manuals for the correct procedures:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.

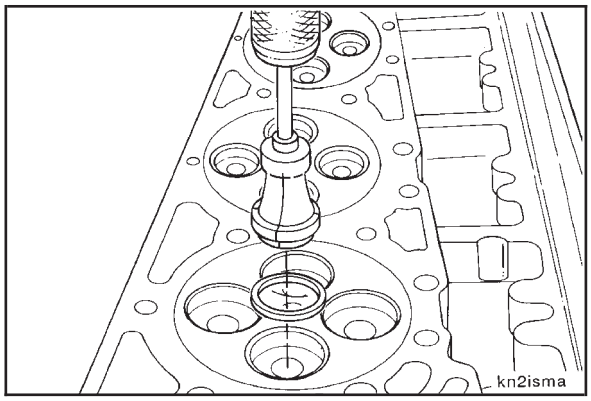


Initial Inspection

Remove all the valves from the cylinder head.

Inspect the cylinder head for damaged or loose valve seat inserts.

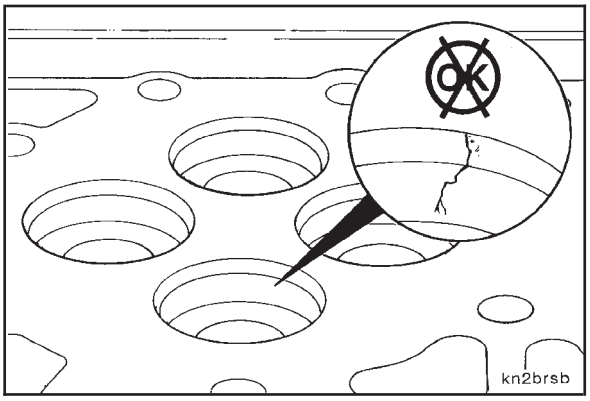
NOTE: Damaged or loose valve seat inserts **must** be replaced.



Remove the valve seat inserts that **must** be replaced with the valve seat insert extractor, Part No. 3376146, and slide hammer assembly, Part No. 3376617.

Inspect the cylinder head for cracks in the valve seat insert bores.

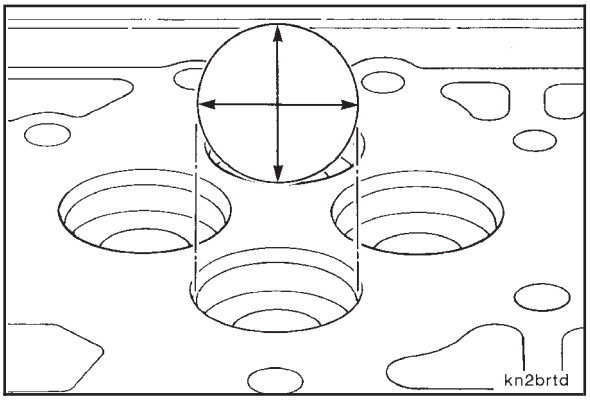
NOTE: Any cracks that **cannot** be machined out are **not** acceptable.



Measure the inside diameter of the valve seat insert bore in the cylinder head.

Valve Seat Insert Bore I.D. (Std.)		
mm		in
45.905	MIN	1.8073
45.935	MAX	1.8085

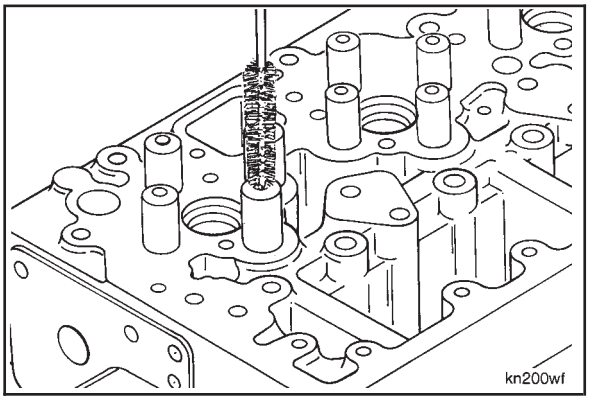
NOTE: If the inside diameter of the valve seat insert bore is worn beyond the specifications, the bore **must** be machined to accept an oversize insert.



Valve Seat Insert Bore — Machining

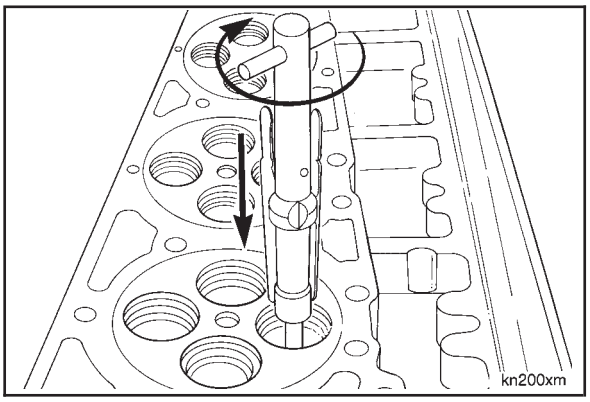
Clean the inside diameter of the valve guide.

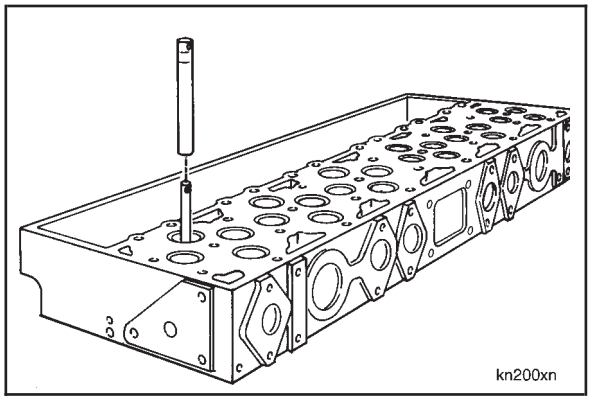
NOTE: A clean valve guide is required for successful machining.



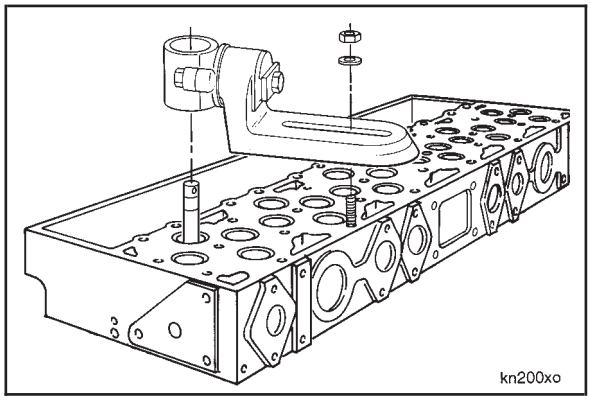
Install the arbor, Part No. ST-804-1 or Part No. ST-804-2, in the valve guide using the arbor puller, Part No. ST-685-5.

NOTE: Turn the arbor puller handle while pressing down to seat the arbor in the guide.



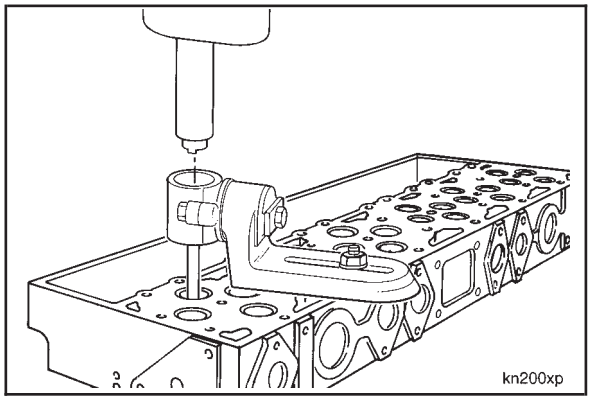


Install the adapter sleeve from valve seat insert tool kit, Part No. ST-257, over the arbor.



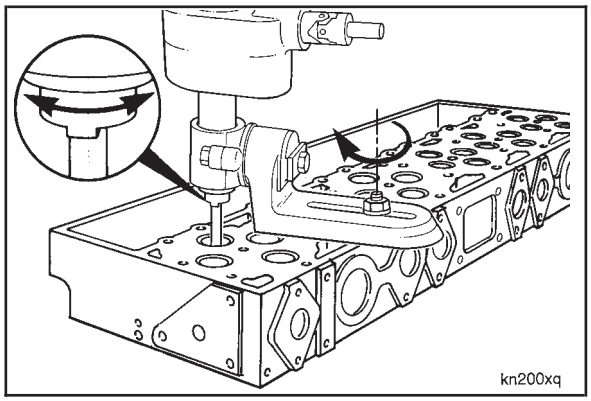
Install the base assembly and gear case swivel on the cylinder head.

NOTE: Clamp the base assembly loosely to the cylinder head using a M14 x 152 or 1/2 x 6 capscrew, washer, and nut.



Install the seat cutter drive shaft into the gear case and over the arbor.

NOTE: This will align the base assembly.



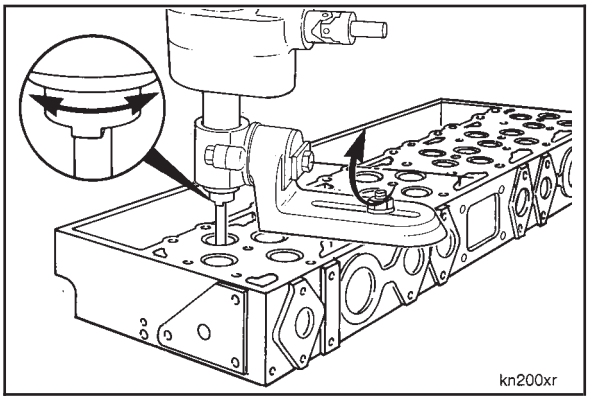
Position the base assembly and the gear case swivel so the seat cutter drive shaft turns freely.

NOTE: While tightening the capscrew, turn the seat cutter drive shaft to make sure it turns freely.

Tighten the base assembly to the cylinder head.

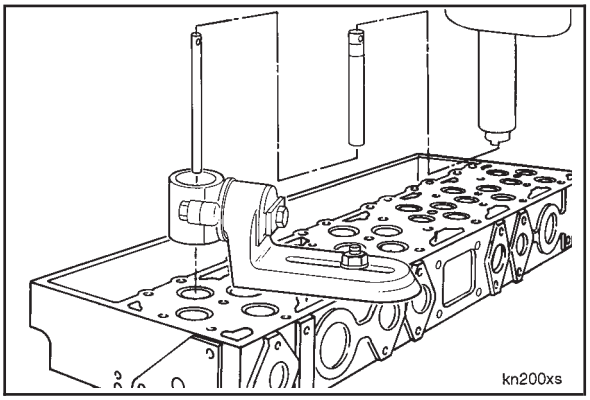
Tighten the capscrew that locks the gear case swivel to the base assembly.

NOTE: While tightening the capscrew, turn the seat cutter drive shaft to make sure it turns freely.



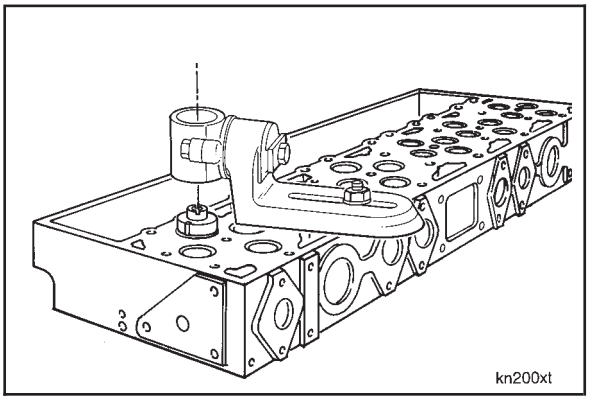
Remove the seat cutter drive shaft.

Remove the adapter and the arbor from the valve guide.



Install the oversize valve seat insert cutter over the bore to be machined.

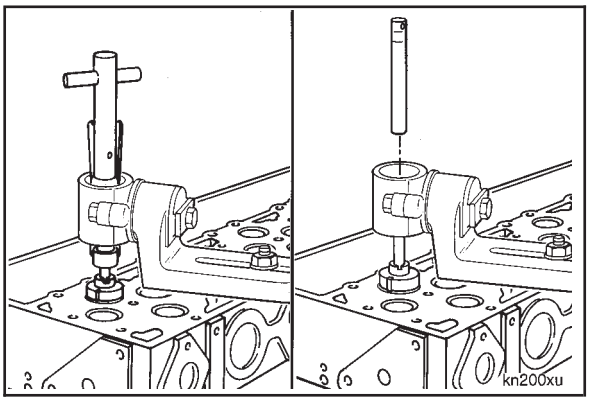
NOTE: Refer to Specifications — Oversize Valve Seat Insert at the end of this repair procedure for the oversize valve seat cutters.

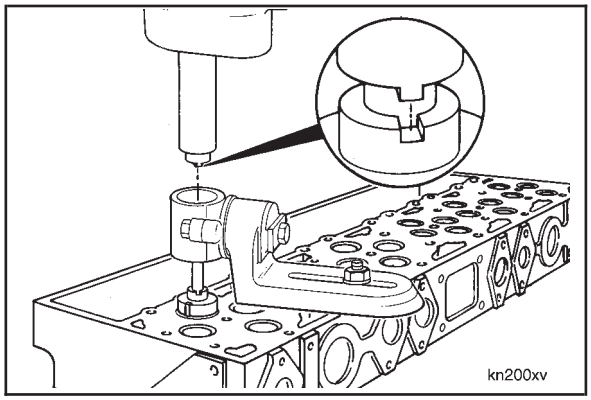


Install the arbor through the valve seat insert cutter and into the valve guide.

NOTE: Use the arbor puller to turn the arbor while pressing down to seat the arbor in the guide.

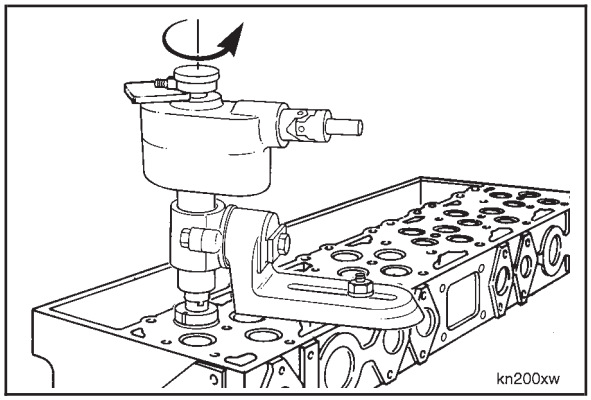
Install the adapter over the arbor and into the center of the valve seat insert cutter.



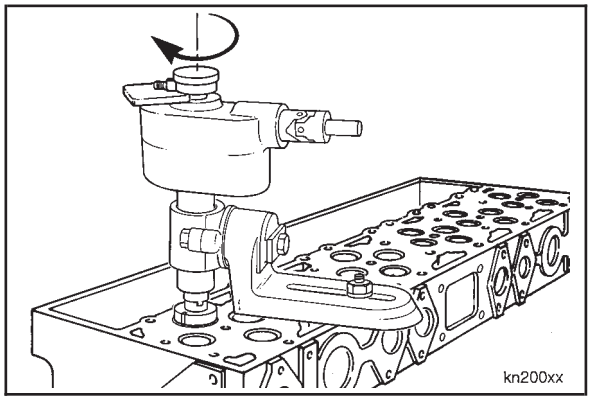


Insert the gear case assembly into the gear case swivel.

Press downward until the driving tangs of the gear case assembly engage with the driving tangs of the valve seat insert cutter.

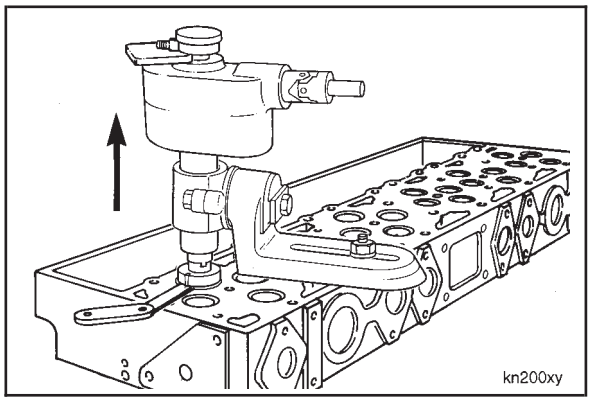


Rotate the knurled handwheel **counterclockwise** until the oversize valve seat insert to be installed and 4.52 mm [0.178 inch] gauge block will slip in between the knurled handwheel and the machined surface of the gear case assembly.



Rotate the knurled handle **clockwise** until the oversize valve seat insert and the gauge block are lightly clamped.

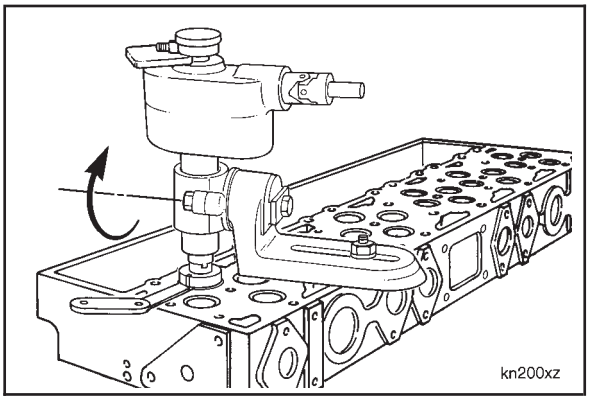
NOTE: This procedure will set the correct machining depth.



Set the vertical location of the gear case assembly by raising the assembly so the bottom edge of the cutter is 0.75 mm [0.030 inch] above the combustion surface of the cylinder head.

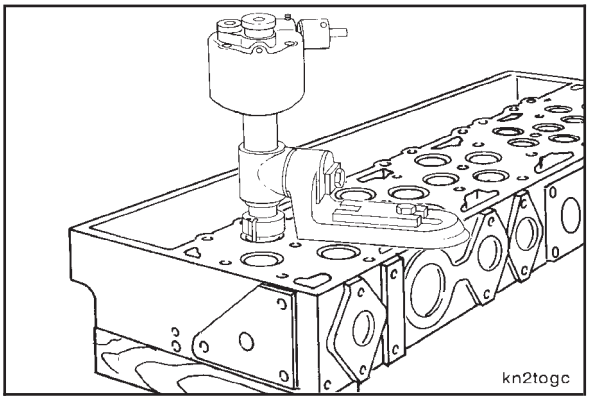
NOTE: A feeler gauge can be used for this. Be sure the feeler gauge is **not** bowed when setting the height.

Tighten the gear case swivel capscrew.



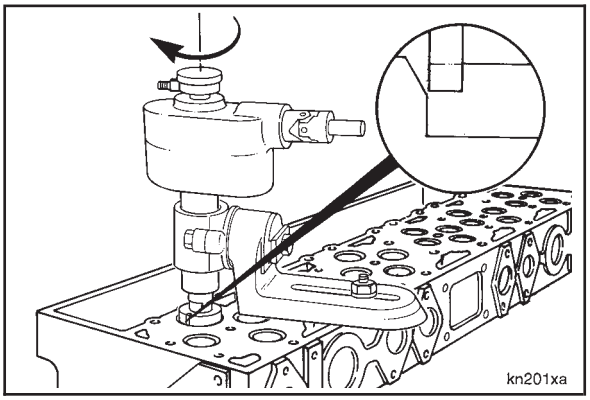
Remove the feeler gauge.

Remove the oversize valve seat insert and the gauge block.

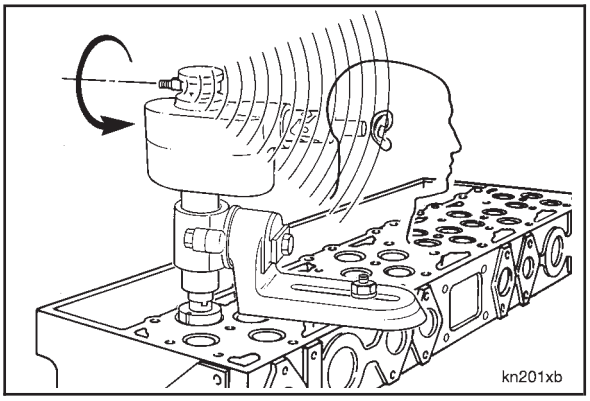


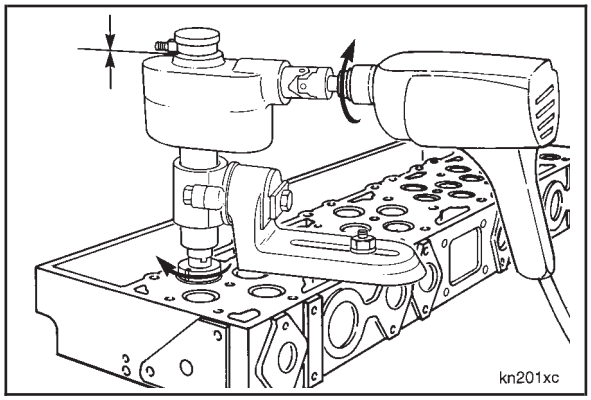
Turn the knurled handle **clockwise** to move the cutter down to the cylinder head until the cutter almost touches the insert bore.

NOTE: Be sure the driving tangs are engaged.



Engage the automatic down feed by rotating the small knurled handwheel **clockwise** until a click is heard.

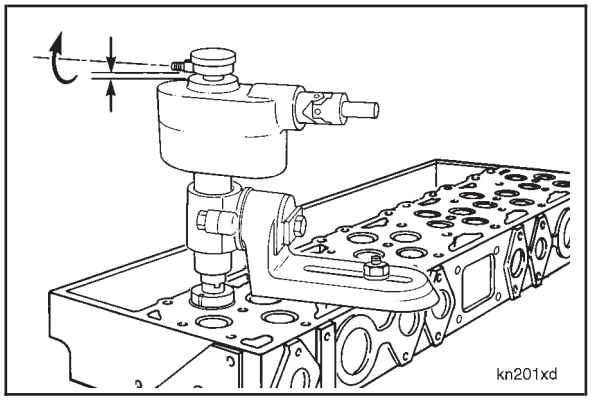




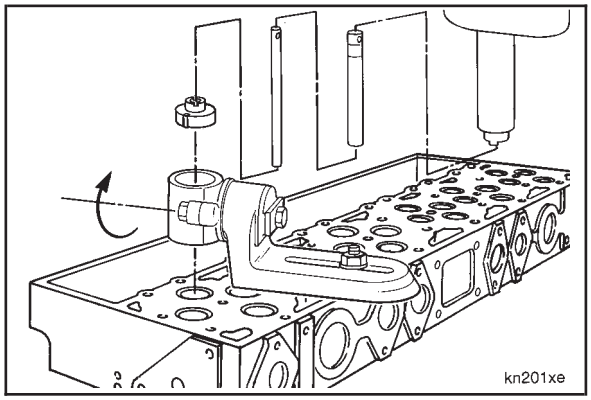
Connect the drill motor to the driver shank.

Turn the drill motor "ON" and use cutting oil while machining the bore.

NOTE: Machine the bore until the feed depth knob is against the gear case. Let the cutter turn two or three more revolutions to make sure the counterbore surface is even.

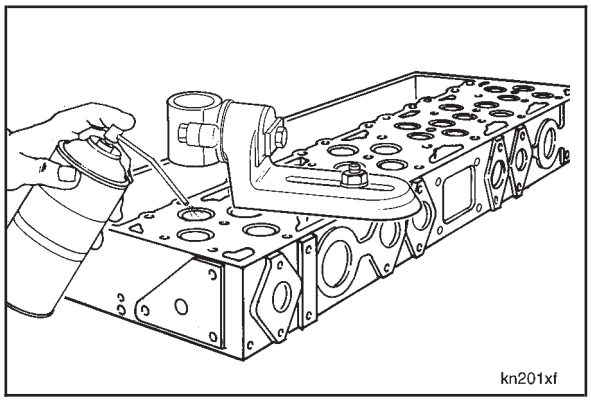


NOTE: If the feed engagement knob disengages before the knob is against the gear case, turn the knob by hand to complete the cut.



Loosen the swivel capscrew and remove the gear case assembly, arbor, and cutter.

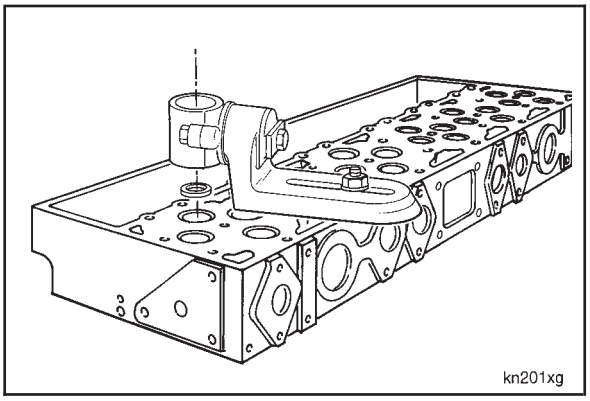
NOTE: Do **not** remove the base assembly and gear case swivel casting.



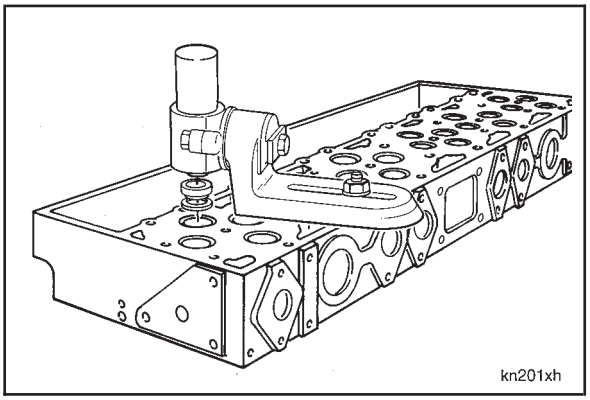
Use a spray cleaner to clean the valve seat insert bore. Remove all machining debris.

Oversize Valve Seat Insert — Installation

Install the oversize valve seat insert over the inert bore in the cylinder head.

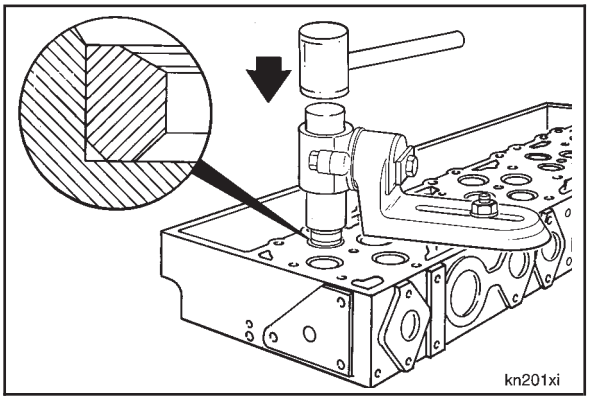


Install the valve seat driver, Part No. 3376105, and the seat driver shaft from valve seat insert tool, Part No. ST-257, through the gear case swivel until the assembly rests on the valve seat insert.

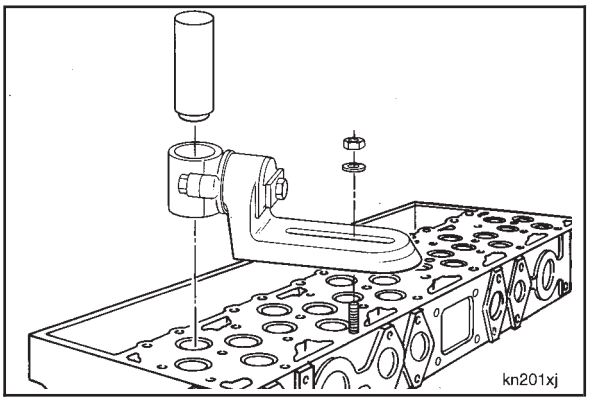


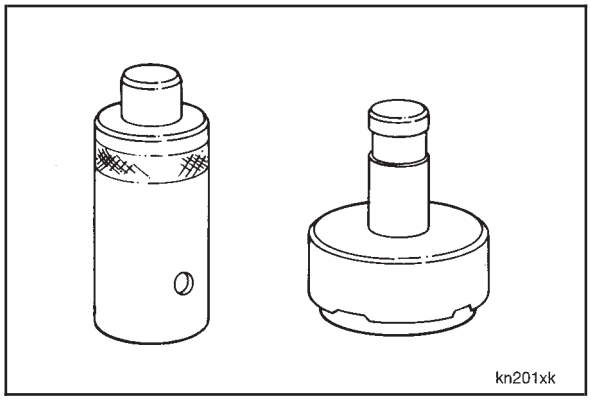
Use a hammer to drive the valve seat insert into the cylinder head.

NOTE: A distinctly different sound will be evident when the valve seat insert contacts the insert bore.

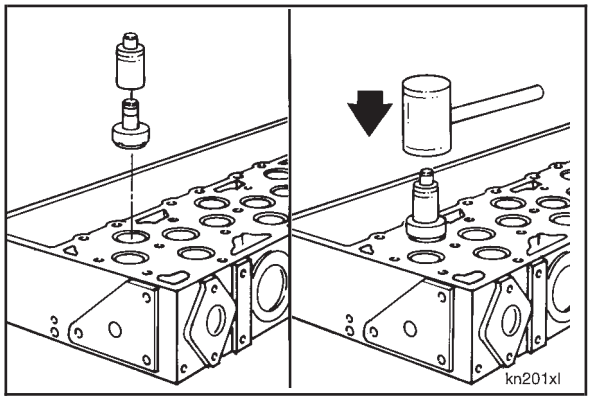


Remove the driver, base assembly, and gear case swivel from the cylinder head.



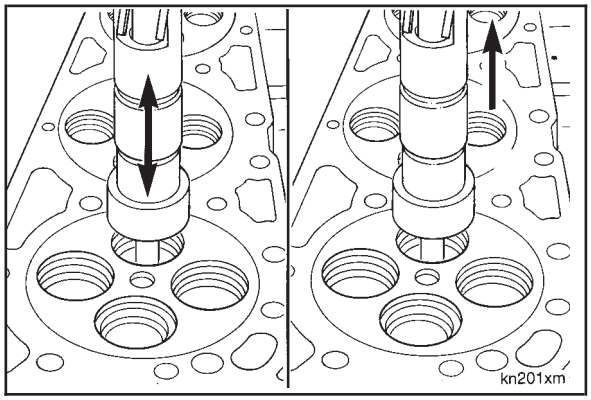


Install staking tool and pilot, Part No. 3376965, into the staking tool driver, Part No. ST-1122.



Install the staking tool and driver assembly into the insert.

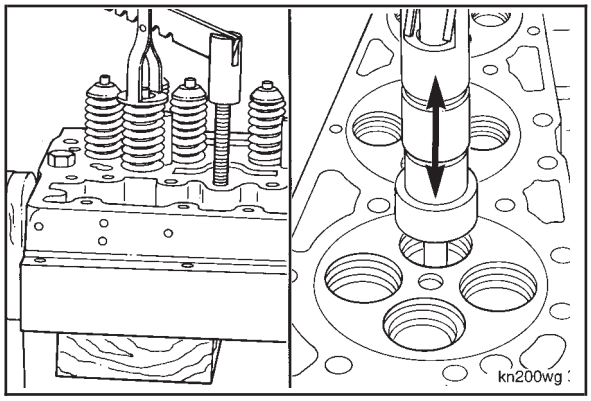
Strike the driver with a hammer to stake the insert in the cylinder head.



Grind the valve seat insert. Refer to Valve Seats — Grinding.

Specifications — Oversize Valve Seat Inserts

Valve Seat Inserts					
Valve Insert Part No.	Valve Seat Insert Cutter Part No.	Cylinder Head Valve Insert Bore Depth Nominal	Cylinder Head Valve Insert Bore Diameter Nominal	Valve Insert O.D. Oversize	Valve Insert Thickness Oversize
3027060 STD		8.45 mm	45.920 mm	STD mm	STD mm
		0.343 in	1.8079 in	STD in	STD in
3028071	3376596	8.75 mm	46.170 mm	0.25 mm	STD mm
		0.344 in	1.8177 in	0.010 in	STD in
3028072	3376597	8.88 mm	46.420 mm	0.50 mm	0.13 mm
		0.350 in	1.8276 in	0.020 in	0.005 in
3028073	3376598	9.00 mm	46.670 mm	0.75 mm	0.25 mm
		0.354 in	1.8374 in	0.030 in	0.010 in
3028074	3376599	9.13 mm	46.920 mm	1.00 mm	0.38 mm
		0.359 in	1.8472 in	0.040 in	0.015 in



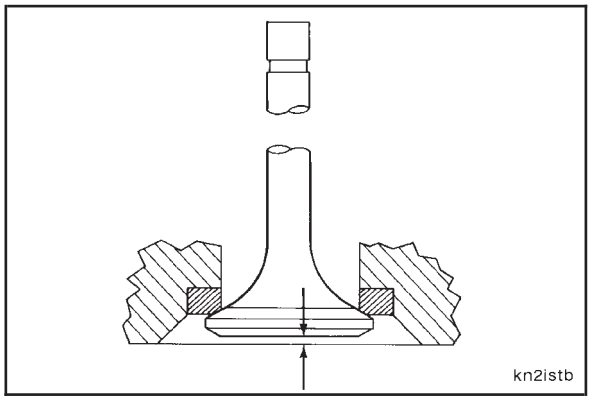
Valve Seats — Grinding

General Information

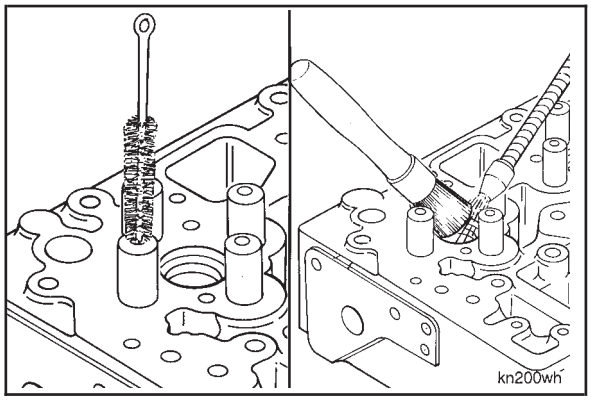
This repair procedure describes the method for grinding the valve seats. Valve seat grinding can be required to clean up the old valve seats or new valve seat inserts that have been installed.

The cylinder head **must** be removed from the engine and the valves and injectors removed to perform this repair. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



NOTE: When performing this repair procedure, the valve guides for the seats being ground **must** be clean and within specifications. Refer to Oversize Valve Guides — Installation for the valve guide inside diameter specifications. Valve guides that are **not** clean, or are worn beyond the specified limits, will cause improper arbor alignment.

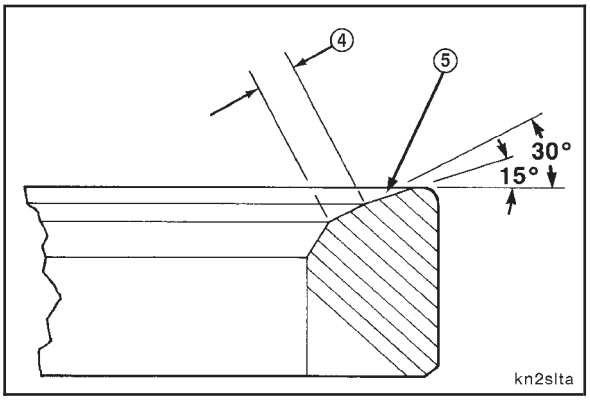


Initial Inspection

Clean the inside diameter of the valve guides and the valve seat inserts to remove any carbon deposits.

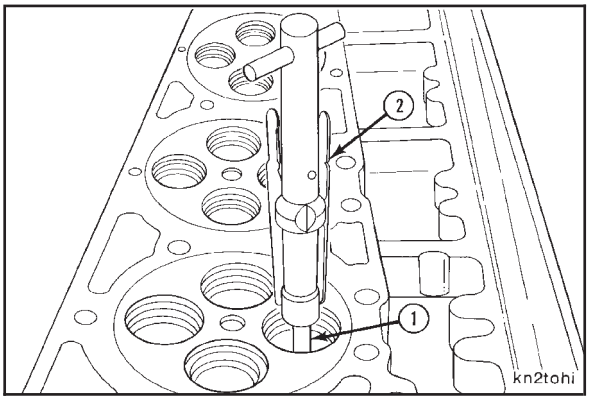
Measure the width of the valve seat area on the valve seat insert.

NOTE: If the seat width is wider than 2.69 mm [0.106 inch], the valve seat **must** be ground.



Install the valve guide arbor, Part No. ST-804-1 or Part No. ST-804-2, in the valve guide bore with the arbor puller, Part No. ST-685-5.

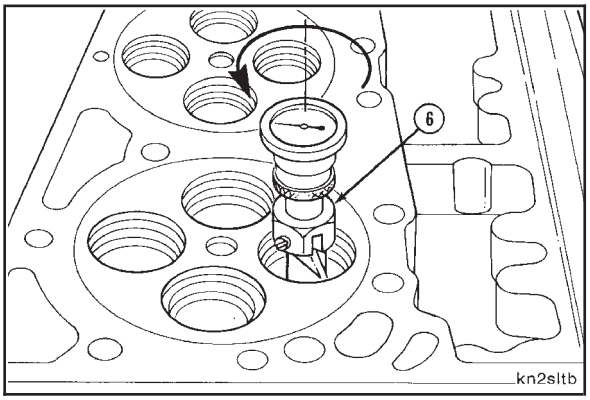
NOTE: Use the arbor puller to rotate the arbor in the valve guide bore to make sure the arbor is installed correctly.



Install the eccentrimeter gauge, Part No. ST-685-4, on the arbor.

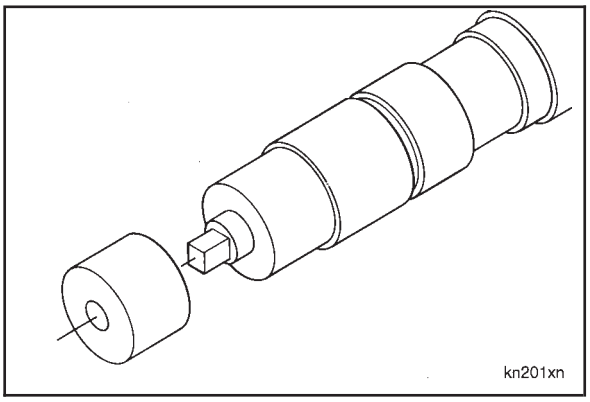
Rotate the eccentrimeter gauge 360 degrees to measure the valve seat to valve guide concentricity.

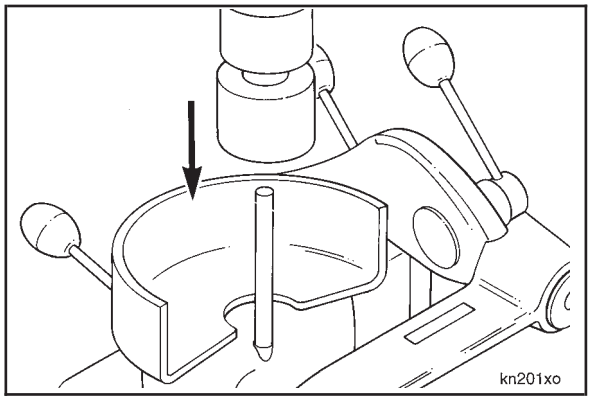
NOTE: If the valve seat runout is more than 0.05 mm [0.002 inch] maximum, the valve seat insert **must** be replaced.



Grinder Wheel — Dressing

Install a grinder wheel, Part No. 3376077, on the drive unit, Part No. ST-685-2.

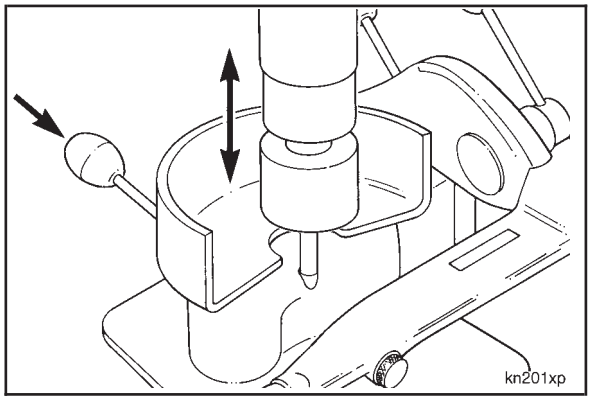




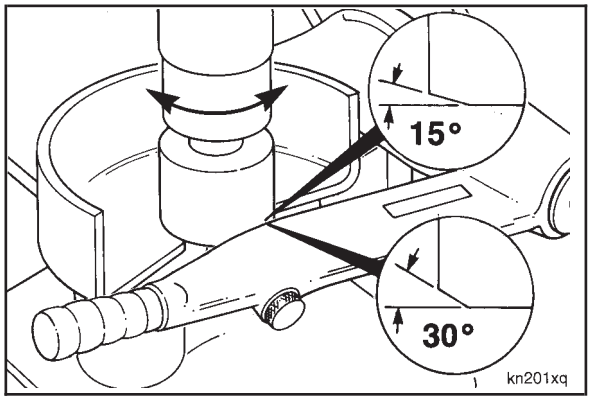
Lower the drive unit and grinder wheel onto the arbor in the wheel dresser fixture, Part No. ST-685-3.

Set the wheel dresser to dress the grinder wheel to the required angle.

- Set the wheel dresser to a 30 degree angle for valve seats.
- Set the wheel dresser to a 15 degree angle to narrow the valve seat width.



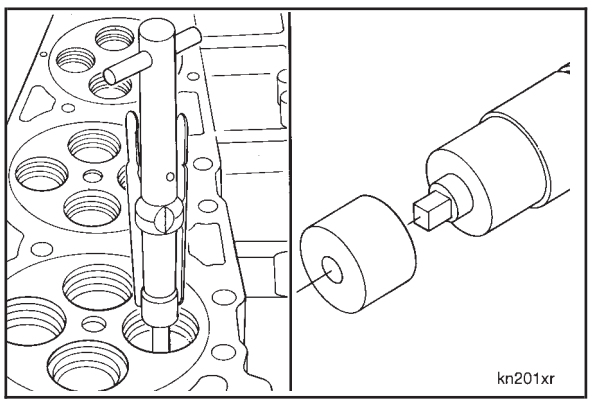
Raise or lower the arbor in the fixture to place the grinder wheel in the proper location with respect to the diamond tip of the wheel dresser.



Caution: Do not force the diamond tip into the grinder wheel as damage to the diamond tip or grinder wheel can result.

NOTE: When making a 15 degree angle cut, feed the diamond tip quickly across the grinder wheel. On a 30 degree angle cut, feed the diamond tip across the grinder wheel at a medium speed. Continue making light cuts with the diamond tip until the grinder wheel is entirely trued up.

Turn the motor "ON" and feed the diamond tip to the grinder wheel to make a very light cut.



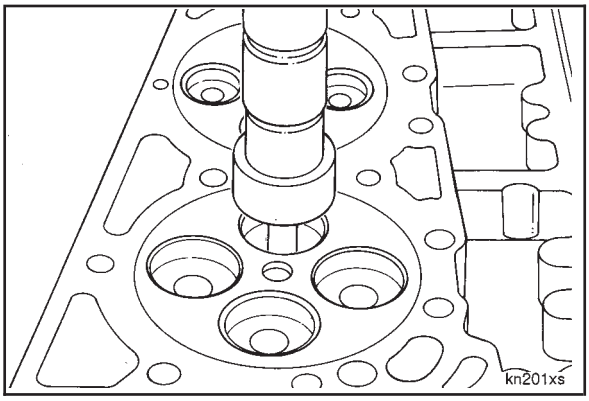
Valve Seat Insert — Grinding

Install the arbor in the valve guide if **not** previously installed.

Install the grinding wheel on the drive unit (30 degrees for seat angle, 15 degrees for reducing seat angle width).

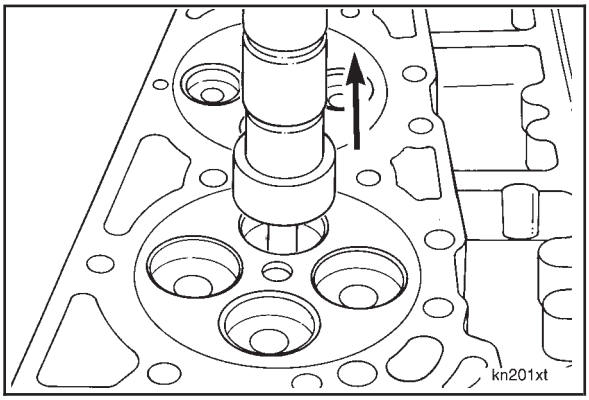
Install the drive unit and grinder wheel assembly on the arbor.

NOTE: Do **not** let the grinder wheel touch the valve seat insert. The grinder wheel **must not** be making contact with the seat when the drive unit is turned on.



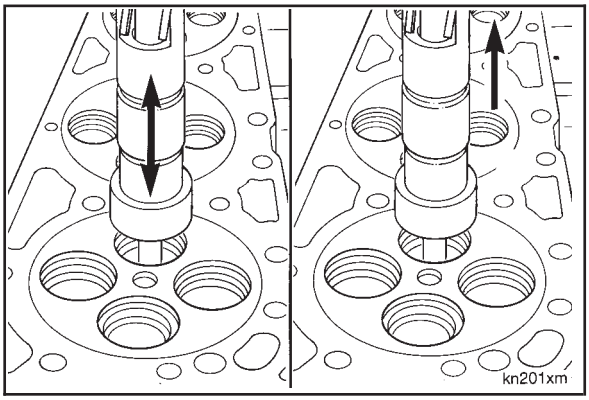
Turn the drive unit "ON" and use and up-and-down movement of approximately 13 mm [1/2 inch] travel and light pressure to grind the insert.

NOTE: Oscillating up-and-down with a light pressure will allow the drive unit to maintain maximum speed, and keep the grinding wheel and seat free of cutting and grinding wheel particles.



NOTE: Keep the drive unit as straight as possible on the arbor to prevent any side loading while grinding the valve seat.

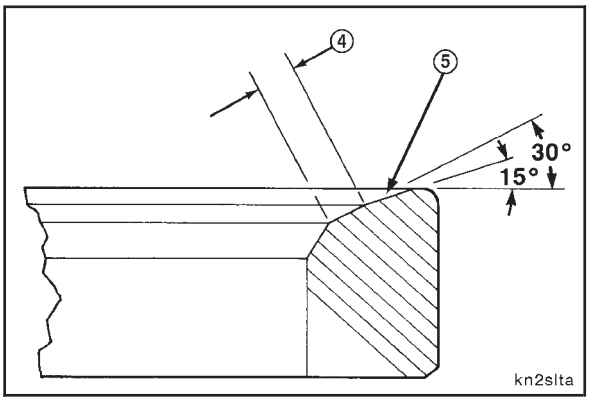
Remove the grinder unit from the arbor.

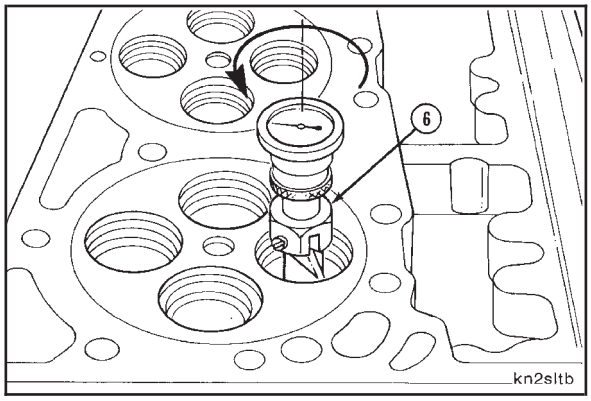


Measure the width of the seating face.

NOTE: If the width of the seating face is greater than 2.69 mm [0.106 inch], it will be necessary to grind the top part of the seat with a 15 degree angle to narrow the seat width.

Repeat the procedure using a 15 degree angle grinding wheel if a 15 degree cut is required.

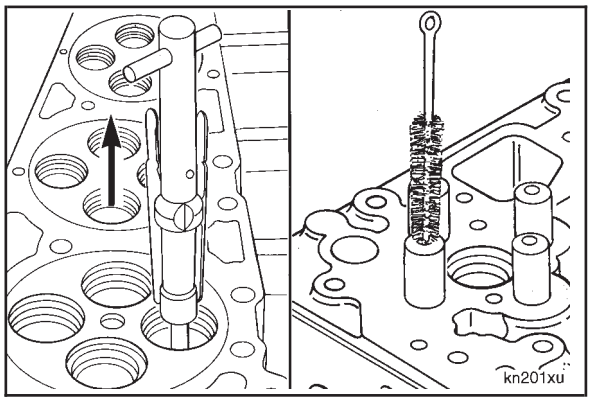




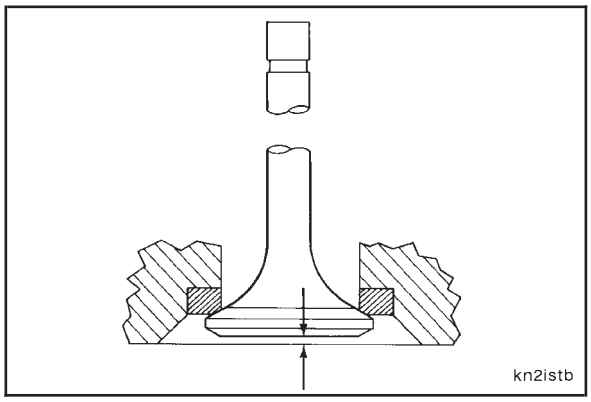
Final Inspection

Install the eccentrimeter gauge, Part No. ST-685-4, on the arbor and measure the valve seat to valve guide concentricity.

Rotate the eccentrimeter gauge 360 degrees. The valve seat alignment **must** be within 0.05 mm [0.002 inch].



Remove the valve guide arbor and clean the inside diameter of the valve guide.



Install a new or reconditioned valve in the valve guide.

Use gauge block, Part No. 3376220, to measure the valve recess in the cylinder head.

	Valve Recess		
	mm		in
Engines Built Before 1988	0.04 0.46	MIN MAX	0.002 0.018
Engines Built After 1988	0.76 1.17	MIN MAX	0.030 0.046

NOTE: If the valve recess is **not** within the specifications given, the valve seat **must** be reground or replaced.

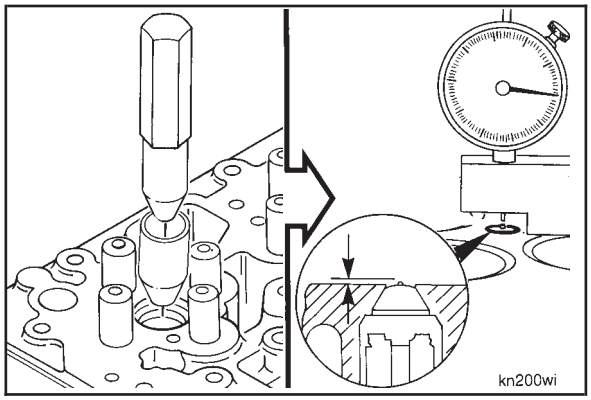
Specifications — Valve Seat Insert

Valve Seat Alignment (Valve Seat to Valve Guide Concentricity)		
mm		**in**
0.05	MAX	0.002

Valve Seat Area Width		
mm		**in**
1.63	MIN	0.064
2.69	MAX	0.106

Valve Recess in Cylinder Head			
	mm		**in**
Engines Built Before 1988	0.04	MIN	0.002
	0.46	MAX	0.018
Engines Built After 1988	0.76	MIN	0.030
	1.17	MAX	0.046

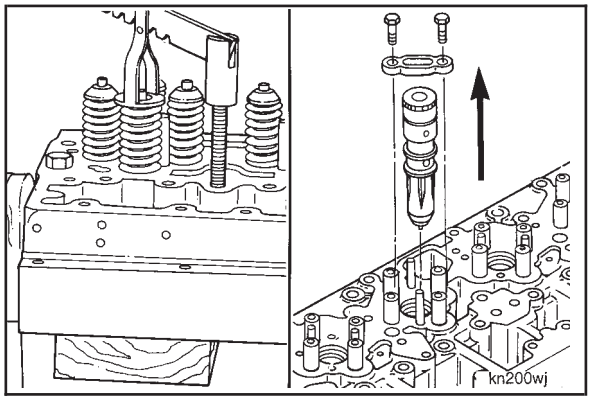
Valve Seat Angle — 29° 30 Minutes to 30° 30 Minutes



Injector Sleeve — Replacement

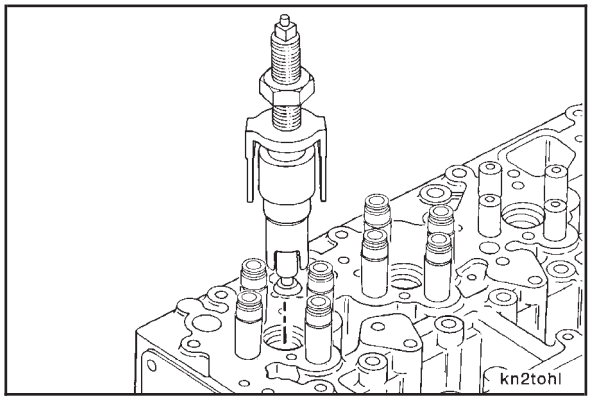
General Information

This repair procedure describes the method for replacing the injector sleeves. The injector sleeves **must** be replaced and the injector seats cut to properly control the injector tip protrusion. Damaged injector sleeves and o-rings can also cause coolant leaks.



The cylinder head **must** be removed from the engine, and the valves and injectors removed to perform this repair. Refer to the following Shop Manuals for the correct procedure:

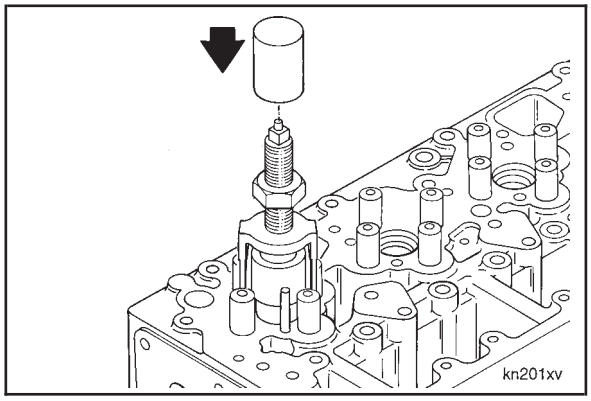
- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



Injector Sleeves — Removal

Use the injector sleeve puller, Part No. 3376616, to remove the injector sleeves from the cylinder head.

Install the puller into the injector sleeve with the legs of the bridge against the cylinder.



Install the driver, Part No. ST-1244-8, against the large nut on the puller, as shown.

Hit the driver with a mallet to push the forming collar into the injector sleeve.

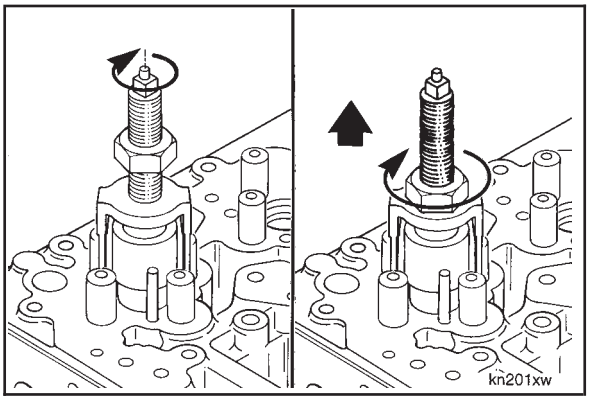
Remove the driver from the puller.

Tighten the small nut.

Torque Value: 65 N•m [50 ft-lb]

Turn the large nut **clockwise** to pull the injector sleeve from the cylinder head.

Loosen the nuts and remove the old injector sleeve from the puller.



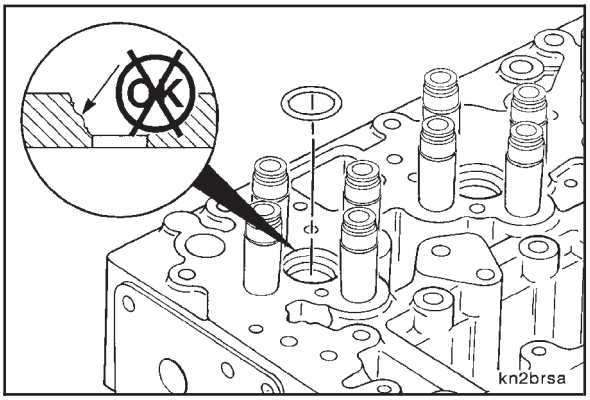
Initial Inspection

Remove the injector sleeve o-ring from the injector bore.

Use solvent to clean the injector bore. Dry with compressed air.

NOTE: If the bead in the cylinder head is **not** smooth, the injector bore **must** be repaired.

Visually inspect the injector seat surface in the bottom of the injector bore.

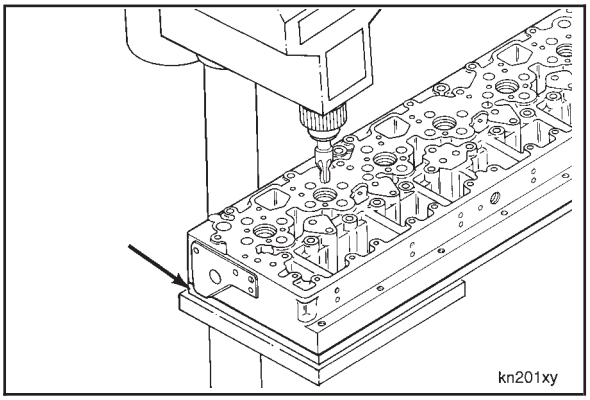


Injector Sleeve Bead Seat — Repair

Use the bead cutting tool, Part No. ST-788, holder, Part No. ST-884-1, and pilot, Part No. ST-884-6, to cut the injector sleeve bead seat.

Install the bead seat cutter assembly and the cylinder head in a drill press.

NOTE: When cutting the bead seat, the end of the cutter **must** protrude into a 12.7 mm [1/2 inch] pilot. The pilot **must** be centered below the spindle between cylinder head and the drill press table.

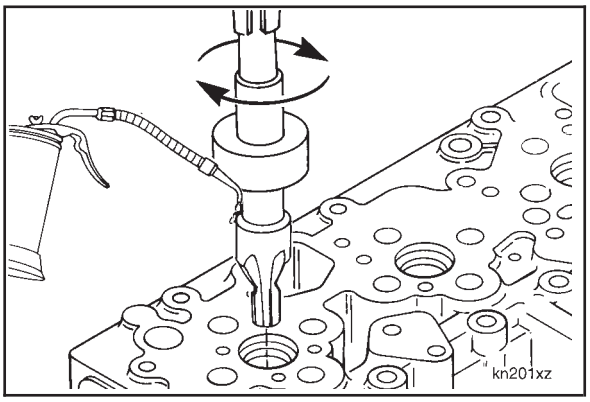


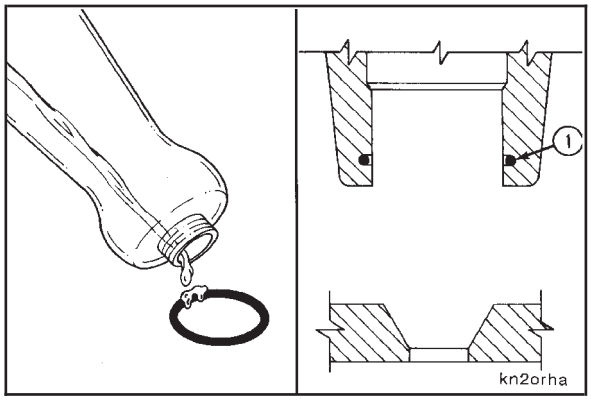
Use cutting oil to lubricate the cutter head.

Set the drill press speed at 75 RPM and carefully machine the bead seat.

NOTE: Do **not** cut more than 0.25 mm [0.010 inch] from the bead seat. Allow the cutter to dwell for approximately 10 seconds to make sure the seat and grooves are smooth and clean.

Clean the metal particles from the injector sleeve bore and fuel passages.

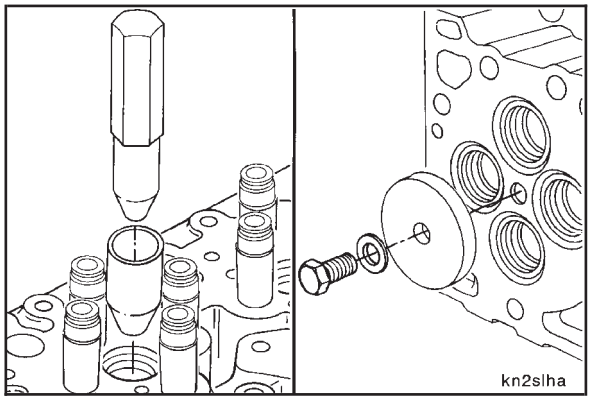




Injector Sleeves — Installation

Use vegetable oil to lubricate the injector sleeve o-rings.

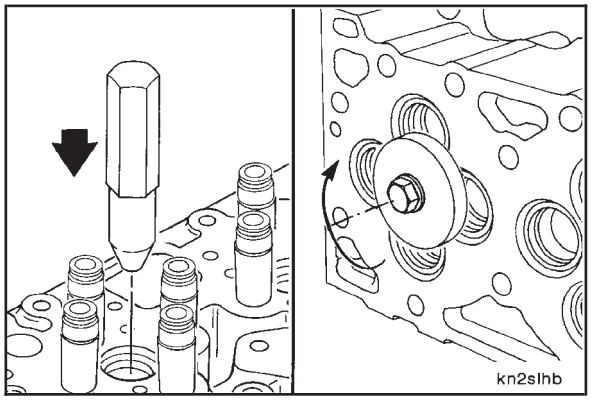
Install the o-ring (1) in the groove of the injector sleeve bore.



Use the injector sleeve driver, Part No. ST-1227, to install the injector sleeve into the cylinder head. Remove the sleeve driver.

Install the injector sleeve holding tool, Part No. ST-1179, in the injector sleeve.

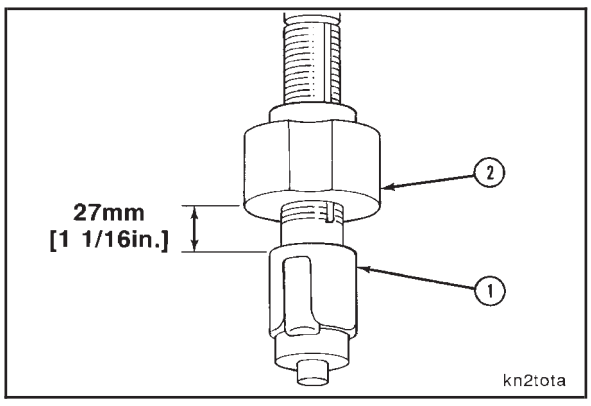
Torque Value: 50 N•m [38 ft-lb]



Use a brass drift to seat the sleeve in the bore.

Remove the driver and tighten the injector sleeve holding tool capscrew again.

Torque Value: 50 N•m [38 ft-lb]



Use the injector sleeve expander, Part No. ST-880, to expand the upper section of the injector sleeve.

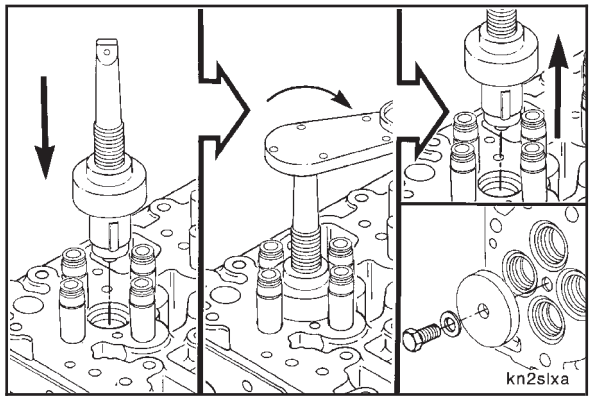
Adjust the expander roller edge and collar to the clearance specified.

Clearance: 27 mm [1-1/16 inch]

Install the expander into the injector sleeve and turn the mandrel with an inch pound torque wrench.

Torque Value: 9 N•m [75 in-lb]

Remove the expander and holding tool from the injector sleeve.



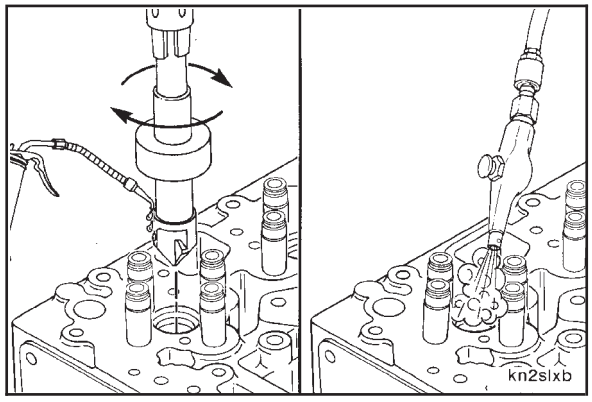
Use the pilot, Part No. ST-379-2, holder, Part No. ST-884-1, and injector seat cutter, Part No. ST-884-3, to cut the injector seat.

Install the injector sleeve cutter and the cylinder head in a drill press.

Use cutting oil to lubricate the cutter head.

Carefully machine the injector sleeve until the sealing area is smooth.

Clean the metal particles from the injector sleeve bore and fuel passages.



Caution: Support the cylinder head in the head holding fixture, Part No. ST-583, to prevent damage to the injector tip that protrudes from the combustion face.

Install the injector into the cylinder head without the o-rings.

Fixed Time Injector Hold Down with M10 x 1.50 Capscrews

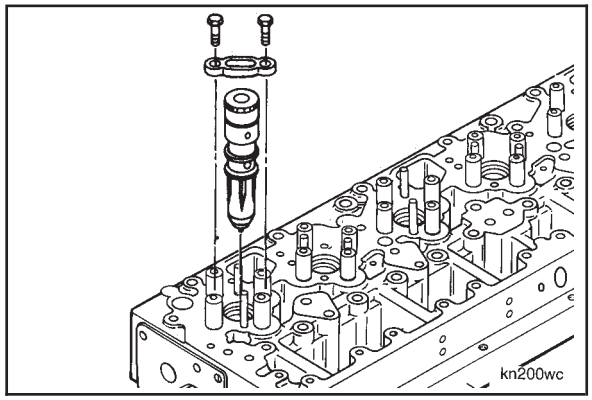
Torque Value: Step 1 - 6 N•m [55 in-lb]
2 - 12 N•m [110 in-lb]
3 - 19 N•m [165 in-lb]

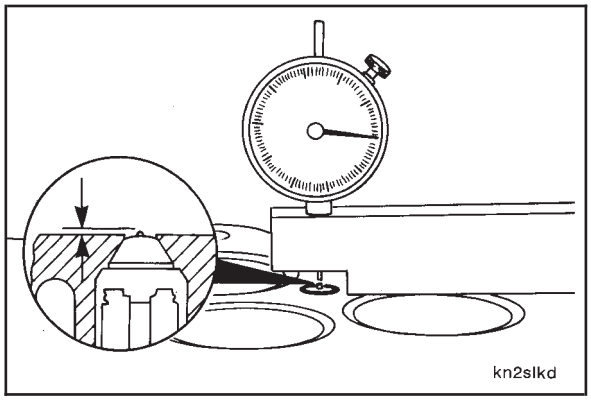
Fixed Time Injector Hold Down with M8 x 1.25 Capscrews

Torque Value: Step 1 - 5 N•m [45 in-lb]
2 - 10 N•m [90 in-lb]
3 - 15 N•m [130 in-lb]

STC and CELECT™ Injector Hold Down with M10 x 1.50

Torque Value: 75 N•m [55 in-lb]

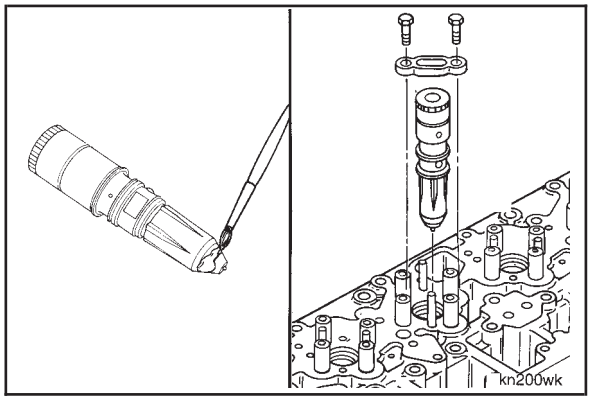




Turn the cylinder head over and use gauge block, Part No. 3823495, to measure the injector tip protrusion.

Injector Tip Protrusion		
mm		**in**
2.28	MIN	0.090
2.54	MAX	0.100

NOTE: If the injector tip protrusion does **not** meet the specifications given, the injector sleeve **must** be machined again.



Remove the injectors and apply a bluing compound to the outside diameter of the injector at the injector seat area.

Install the injectors into the cylinder head without the o-rings.

Fixed Time Injector Hold Down with M10 x 1.50 Capscrews

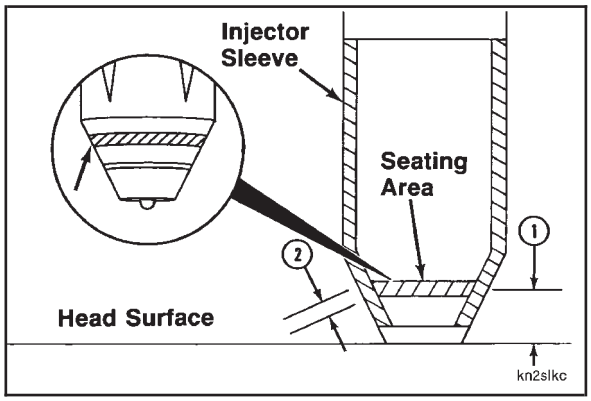
Torque Value: Step 1 - 6 N•m [55 in-lb]
2 - 12 N•m [110 in-lb]
3 - 19 N•m [165 in-lb]

Fixed Time Injector Hold Down with M8 x 1.25 Capscrews

Torque Value: Step 1 - 5 N•m [45 in-lb]
2 - 10 N•m [90 in-lb]
3 - 15 N•m [130 in-lb]

STC and CELECT™ Injector Hold Down with M10 x 1.50

Torque Value: 75 N•m [55 in-lb]



The bluing pattern of the injector seating area **must** be approximately 13 mm [0.50 inch] from the cylinder head surface.

The injector bore seating width **must** be a minimum of 1.52 mm [0.050 inch].

NOTE: Inspect the cylinder head for leaks after the new injector sleeves have been installed. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.

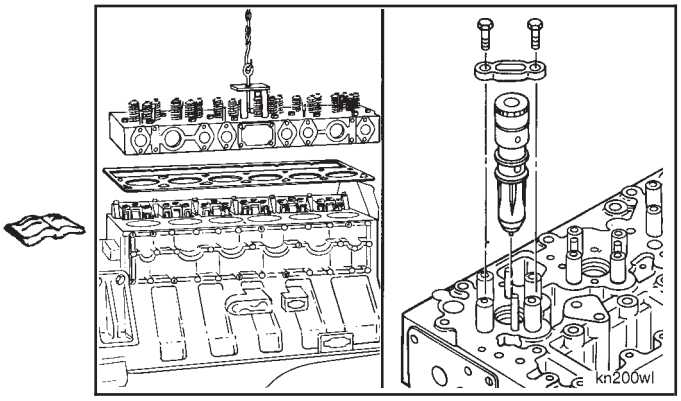
Exhaust Manifold Mounting Surface Refacing

General Information

This repair procedure describes the method for resurfacing the exhaust manifold mounting surface of the cylinder head.

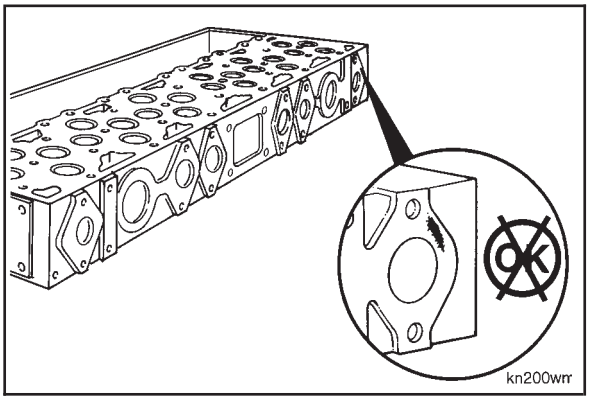
The cylinder head **must** be removed from the engine and completely disassembled to perform this repair. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.



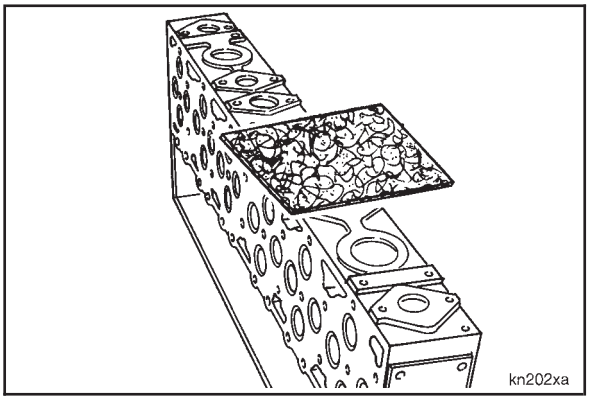
This procedure allows for 1.59 mm [1/16 inch] of material to be removed from the exhaust manifold mounting surface.

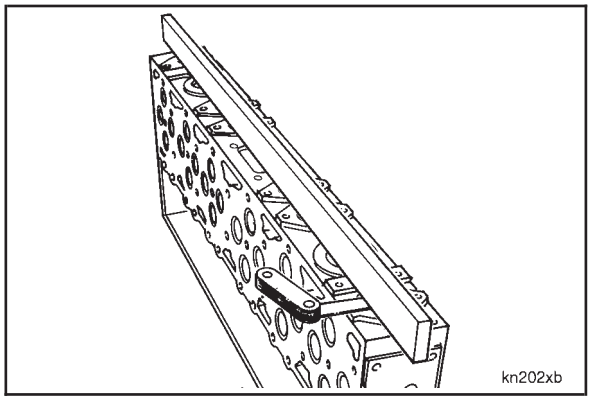
NOTE: If grooves or pits are deeper than 1.59 mm [1/16 inch], the mounting surface **cannot** be cleaned up by machining.



Initial Inspection

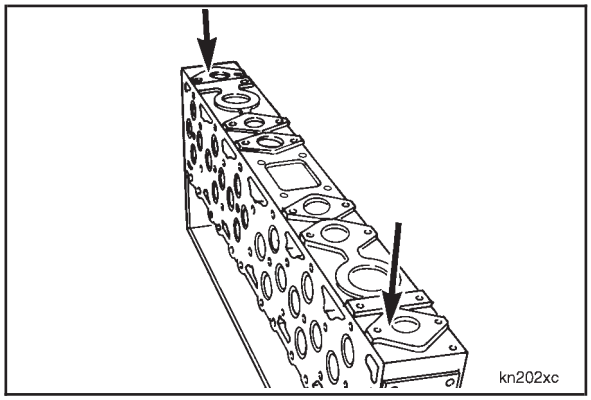
Use Scotch-Brite® to remove the dirt, debris, and rust from the exhaust manifold mounting face.





Use a straight edge and a feeler gauge to measure the flatness of the exhaust manifold mounting surface.

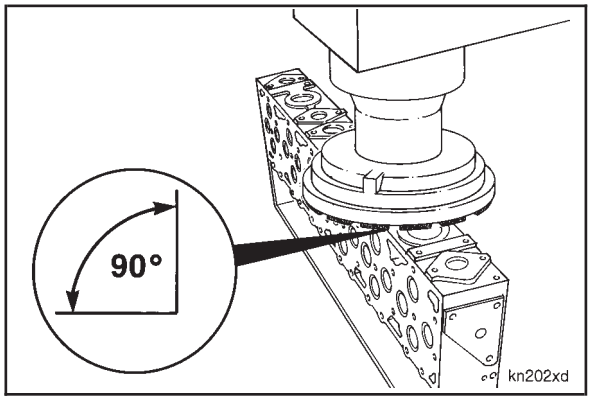
NOTE: If the exhaust manifold mounting surface of the cylinder head is **not** flat within a maximum of 0.15 mm [0.006 inch], the mounting surface **must** be machined.



Exhaust Manifold Mounting Surface - Machining

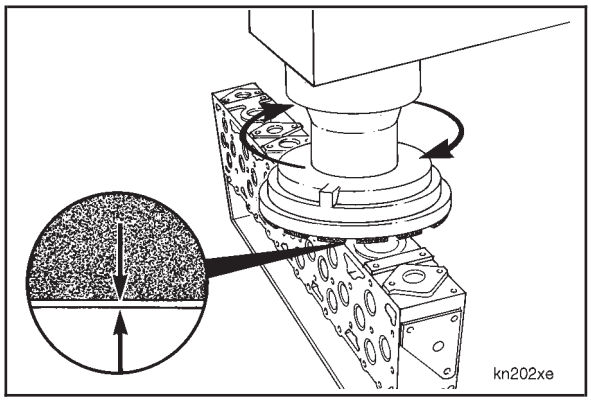
NOTE: Align the cylinder head lengthwise using two undamaged points that are as far apart as possible on the exhaust manifold mounting face.

Install the cylinder head on the resurfacing machine.



NOTE: The cutting tool **must** be perpendicular within 0.05 mm per 25.4 mm [0.002 inch per 1.00 inch].

Inspect the perpendicularity of the cutting tool with either the top or bottom surface of the cylinder head.



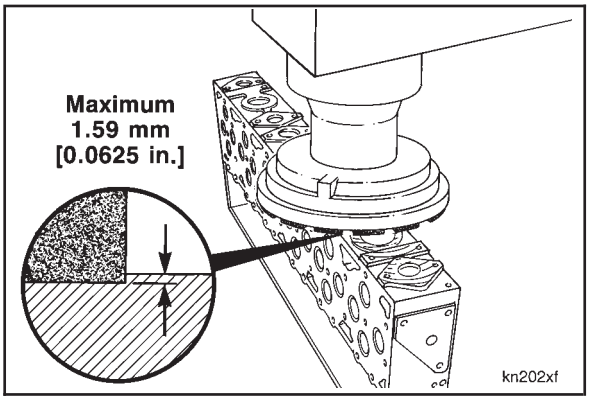
Inspect the full length alignment of the cylinder head.

1. Move the cutting tool down to within 0.79 mm [1/32 inch] of the exhaust manifold mounting surface.
2. Rotate the cutting tool by hand while moving the tool the full length of the cylinder head.

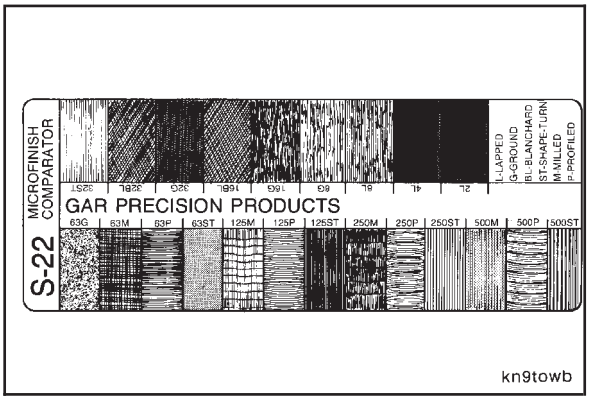
Machine the exhaust manifold mounting surface. It is acceptable to machine only the exhaust manifold mounting surface and **not** the cover plate (cup plug) mounting surface.

NOTE: Do **not** remove more than 1.59 mm [0.0625 inch] from the cylinder head.

Follow the tool manufacturer's instructions for operating the resurfacing machine.



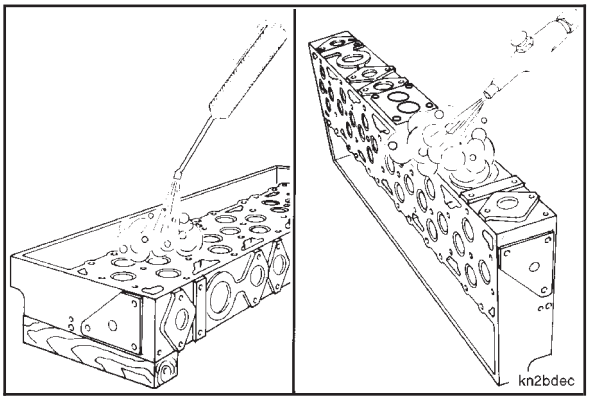
Use a surface compartor to inspect the finish of the exhaust manifold mounting surface. A surface finish of 3.2 µM [125 µM inch] **must** be maintained.



Final Inspection

Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

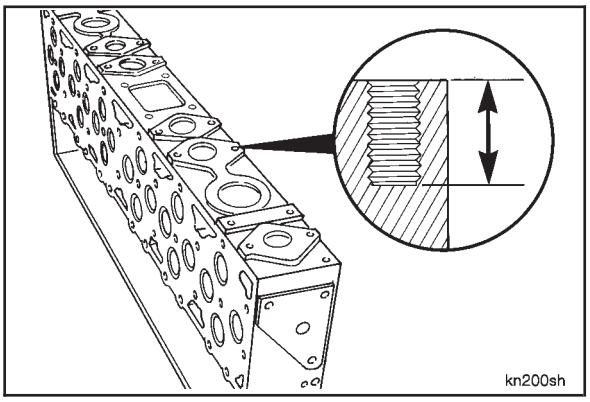
Steam clean the cylinder head to remove the machining debris. Dry with compressed air.

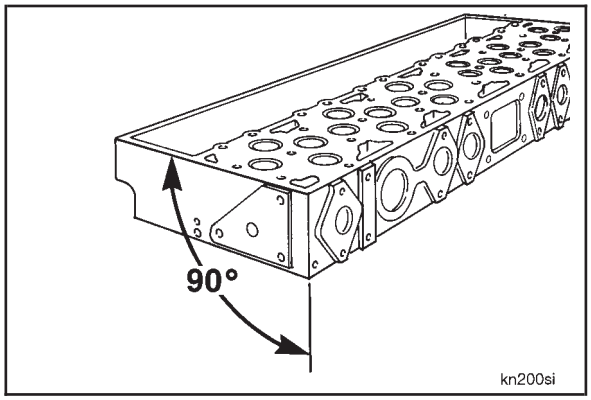


Caution: Insufficient thread depth will cause capscrew and cylinder head damage when installing the exhaust manifold.

NOTE: If the thread depth is **less** than 19 mm [3/4 inch], the capscrew hole **must** be repaired. Refer to Exhaust Manifold Capscrew Threaded Hole Repair.

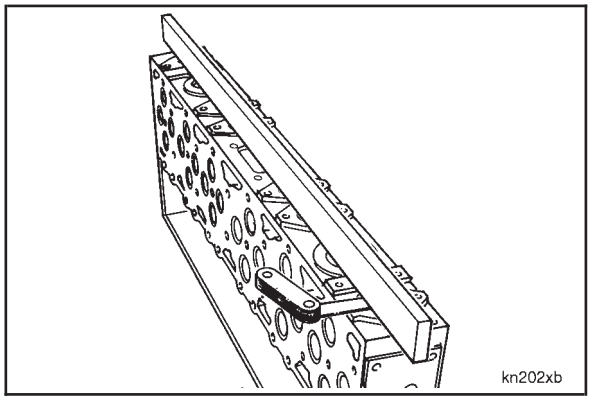
Measure the depth of the exhaust manifold capscrew mounting holes using a M10 x 1.50 capscrew.





NOTE: The surfaces **must** be perpendicular within 005 mm per 25.4 mm [0.002 inch per one inch].

Measure the perpendicularity between the exhaust manifold mounting surface and the combustion face of the cylinder head.



NOTE: The mounting surface **must** be flat within 0.15 mm [0.006 inch] for the full length of the cylinder head.

Use a straight edge and a feeler gauge to measure the flatness of the exhaust manifold mounting surface.

Specifications — Exhaust Manifold Mounting Surface

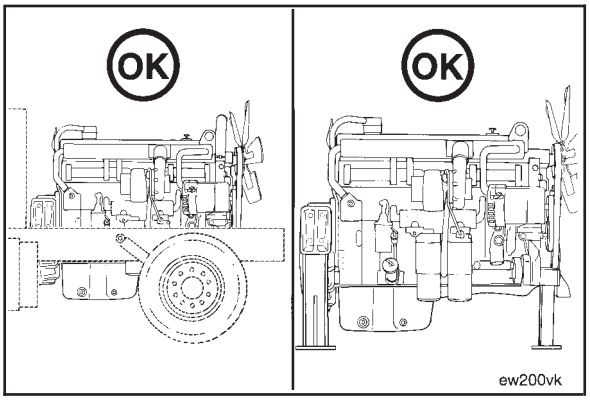
Location and Measurement	mm		in
Amount of Material Removed	1.59	MAX	0.0625
Surface Finish	3.2 µM	MIN	125 µ inch
Perpendicularity with Combustion Face	0.05 per 25.4	MAX	0.002 per 1.0
Flatness (Full Length of Cylinder Head)	0.15	MAX	0.006
Capscrew Hold (Thread Depth)	19.0	MIN	3/4

Exhaust Manifold Capscrew Threaded Hole Repair

General Information

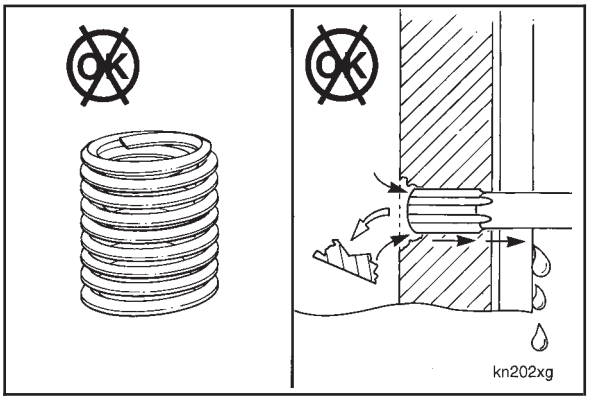
This repair procedure describes the method for repairing the exhaust manifold capscrew holes in the cylinder head.

This repair procedure can be performed with the engine either in or out of the chassis.



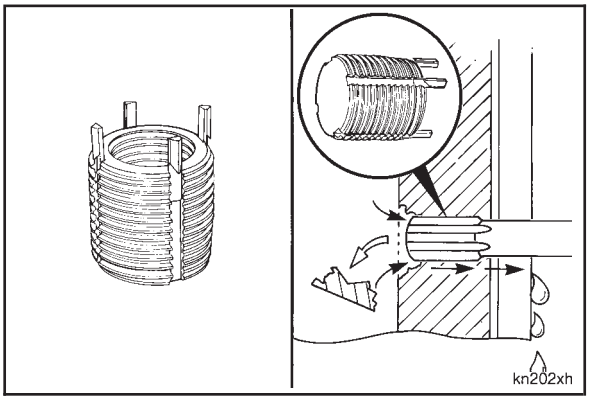
Special instructions for repairing the capscrew threads are required because of the following:

- coiled thread inserts **must not** be used because the exhaust manifold is mounted with self locking capscrews,
- it is possible to pierce the wall of the threaded hole and expose the capscrew to coolant.



NOTE: Use only keylock closed end thread inserts if the capscrew hole being repaired has had the wall pierced.

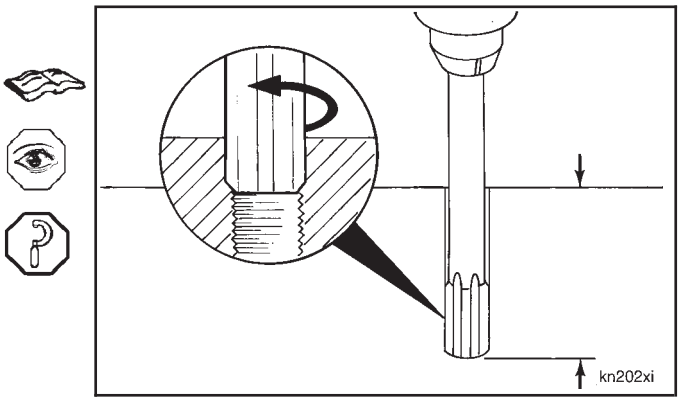
Use only keylock closed end, or open end, thread inserts for this repair.

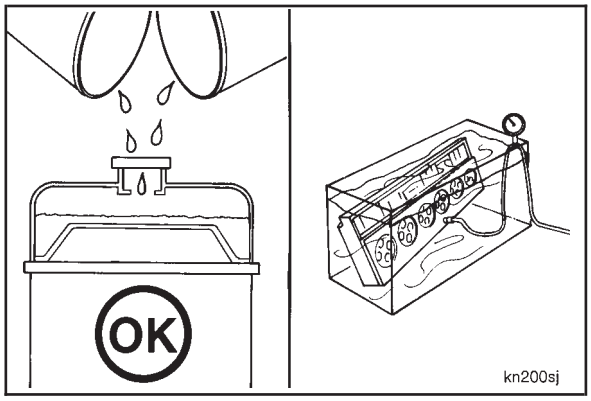


Repair Procedure

Follow the repair procedure for the type of insert being installed. Refer to General Repairs — Group 00.

NOTE: If keylock open end inserts are being used, care **must** be taken when drilling or reaming the hole. The depth **must** be 19 to 20 mm [0.75 to 0.79 inch]. Drilling too deep will expose the capscrew hole to the coolant in the cylinder head.





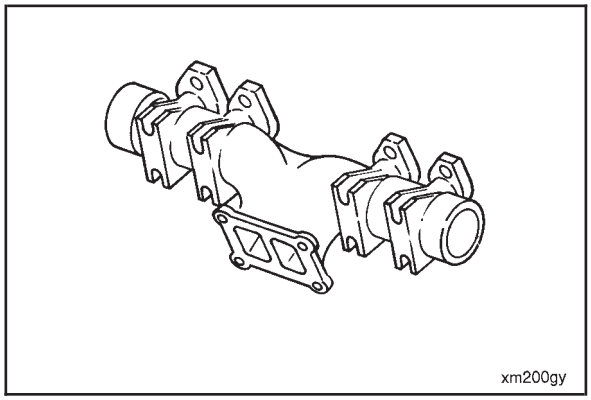
NOTE: If the repair is being performed with the engine in the chassis, pressurize the cooling system to perform the test. If the repair is being performed with the engine out of chassis, it will be necessary to pressure test the cylinder head. Refer to the following Shop Manuals for the correct procedure:

- Bulletin No. 3379347 — Internal Damper L10 engines,
- Bulletin No. 3810476 — External Damper L10 engines,
- Bulletin No. 3666075 — M11 engines.

Inspect the cylinder head for coolant leaks after repairing the capscrew hole.

The following insert can be used:

- Tridair Keenserts — Part No. KNM 10X1.5F

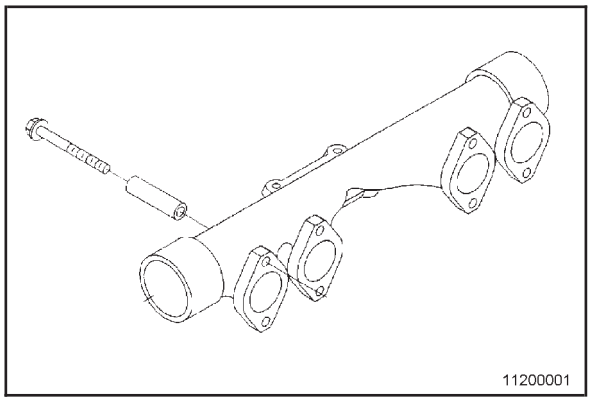


Exhaust Manifold Repair

General Information

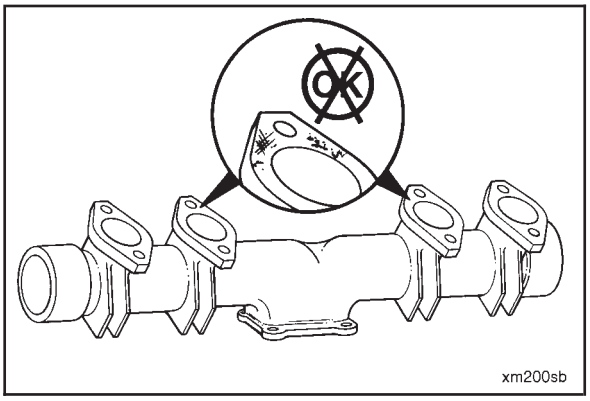
This procedure describes a method for repairing the center section of the exhaust manifold. If thermal cycling has caused the manifold center section to warp or shrink, the manifold can be repaired by enlarging the eight capscrew mounting holes.

NOTE: The art shown here is of an older L10 model manifold.



The art shown in this frame is a M11 manifold. The repair procedure is the same for the older (L10) and newer (M11) models.

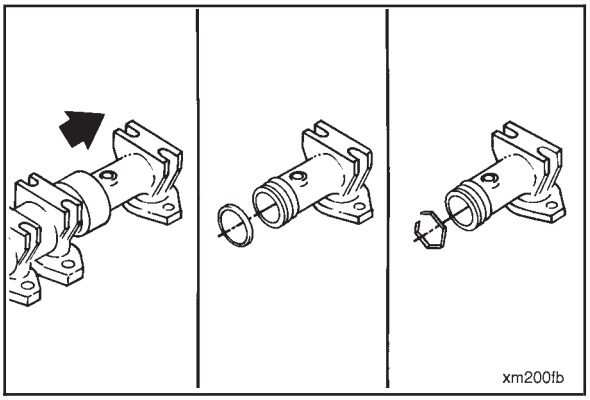
The mounting surface of the exhaust manifold will require resurfacing if the surface has deteriorated or is deformed from warping.



Initial Preparation and Inspection

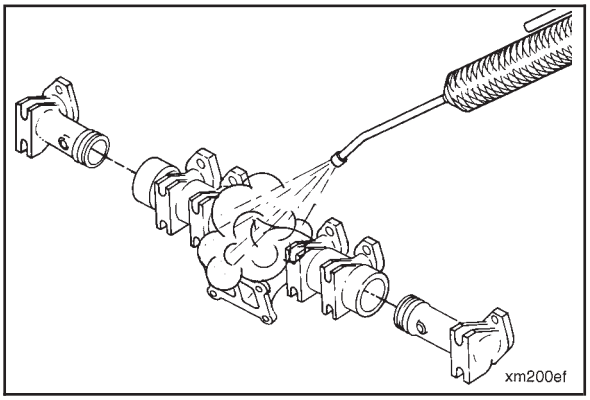
Use a mallet to remove the two end sections from the center section.

Remove the seal ring and seal ring expander (if equipped) from both end sections.



Warning: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam can cause serious personal injury.

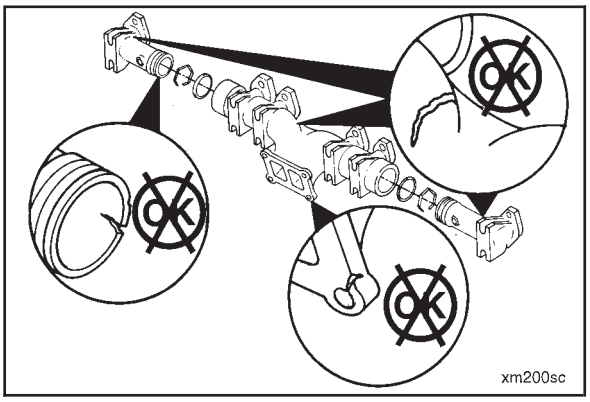
Use steam to clean the manifold sections. Dry with compressed air.

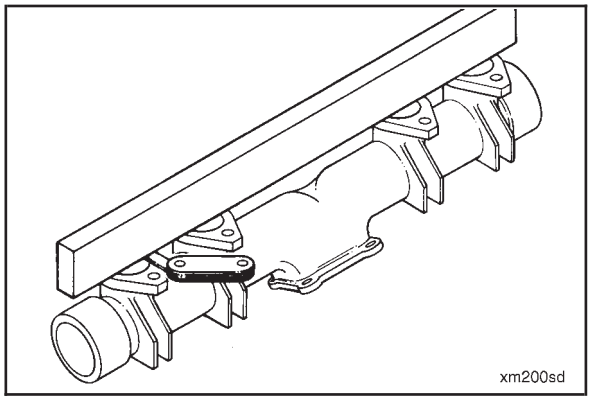


Visually inspect the manifold sections for cracks or damaged threads in the turbocharger mounting flange.

Visually inspect the sealing connection surfaces for damage.

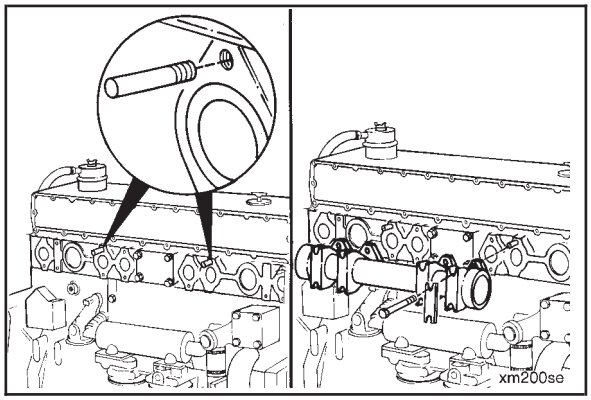
NOTE: Parts that are cracked or damaged **must** be replaced.





Use a straight edge and a feeler gauge to measure the flatness of the mounting surfaces of the exhaust manifold center section.

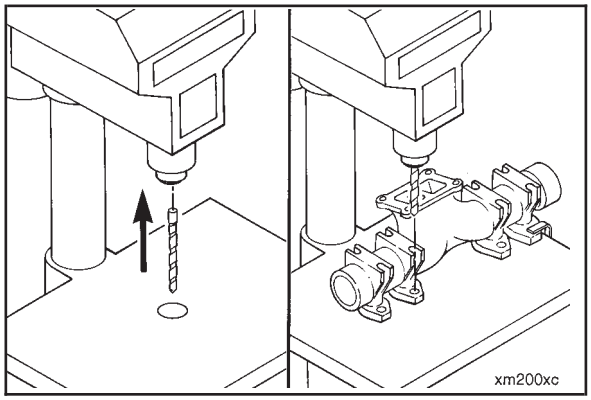
NOTE: If the mounting surfaces of the center section are **not** flat within a maximum of 0.25 mm [0.010 inch], the mounting surfaces **must** be machined.



Inspect the manifold center section for shrinkage.

1. Install two guide pins, Part No. 3376488, into the cylinder head.
2. Do **not** install exhaust manifold gaskets.
3. Install the exhaust manifold center section onto the guide pins.
4. Install the six capscrews.

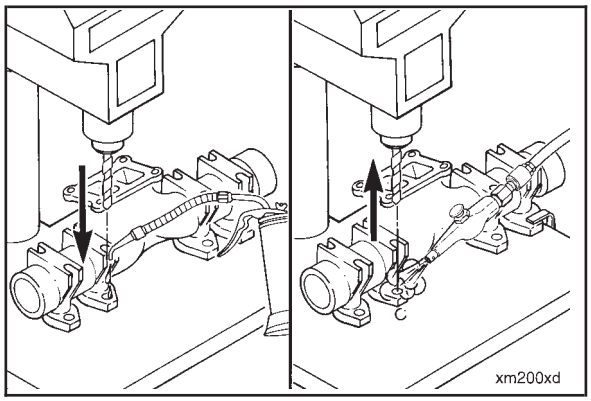
NOTE: If the center section will **not** go over the guide pins, or the capscrews will **not** align properly due to the shrinkage, the center section **must** be repaired.



Repair Procedure

Install a 14 mm [9/16 inch] diameter drill bit in a drill press.

Locate the capscrew hole under the drill bit. Clamp the center section to the drill press table.



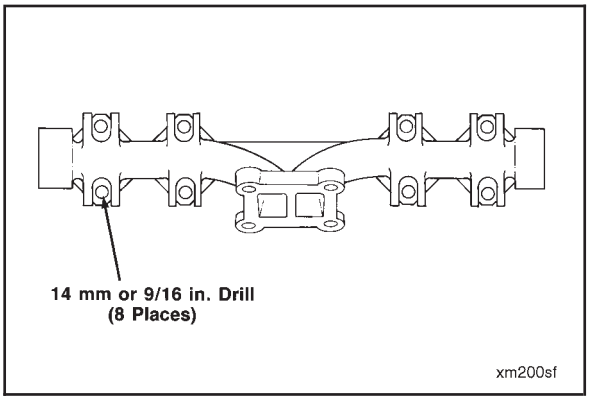
Use cutting oil and drill the capscrew hole completely through.

Clean the debris from the hole.

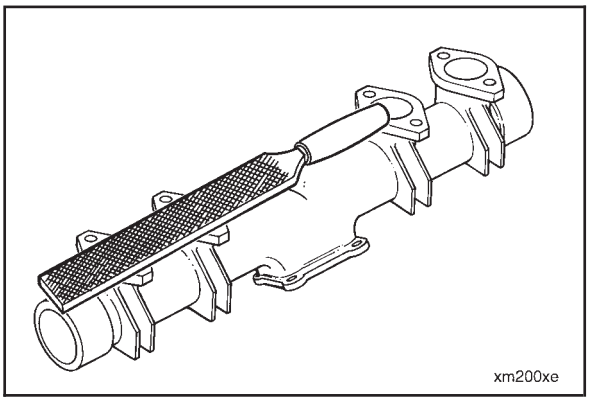
Remove the center section from the drill press.

Locate the next capscrew hole under the drill bit.

Repeat the procedure for each of the eight capscrew holes.



Use a flat mill file to remove any burrs from the capscrew holes on the mounting surface of the center section.

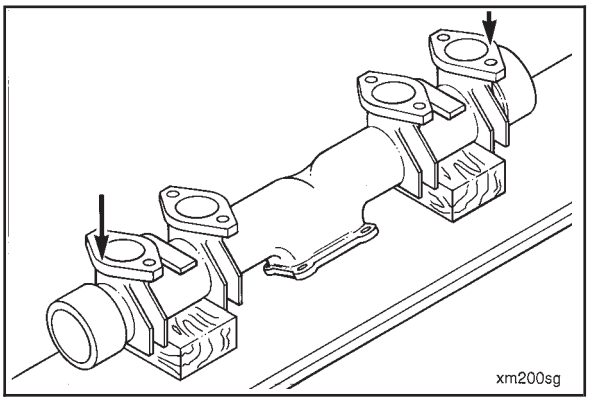


Center Section Mounting Surfaces - Machining

NOTE: Use blocks under the manifold. Align the center section lengthwise using two undamaged points that are as far apart as possible on the mounting surface.

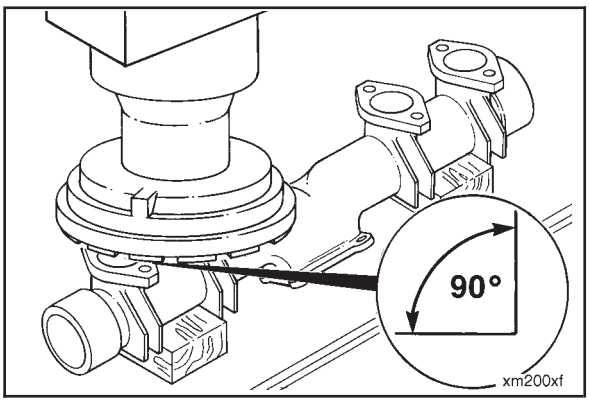
Install the center section on the resurfacing machine.

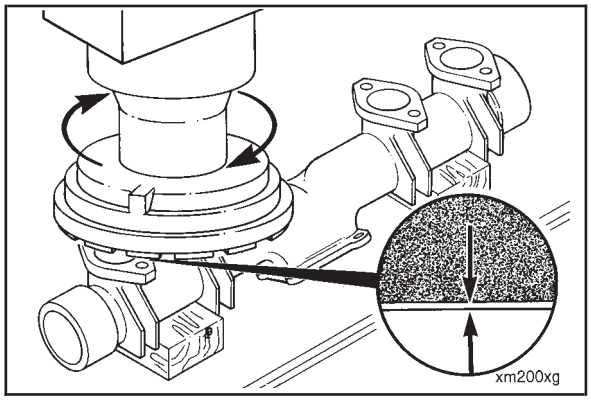
Clamp the manifold center section to the resurfacing machine table.



Inspect the perpendicularity of the cutting tool with the mounting surface of the manifold center section.

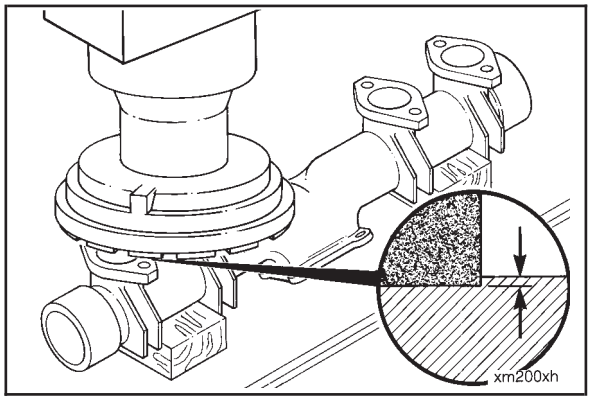
NOTE: The cutting tool **must** be perpendicular within 0.05 mm per 25.4 mm [0.002 inch per 1.00 inch].





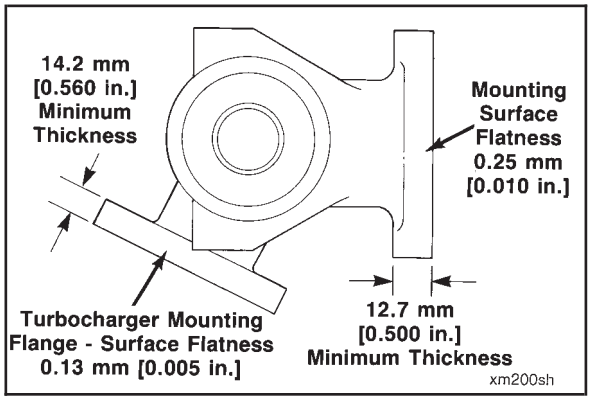
Inspect the full length alignment of the manifold center section.

1. Move the cutting tool down within 0.79 mm [1.32 inch] of the mounting surface.
2. Rotate the cutting tool by hand while moving the tool the full length of the manifold center section.



NOTE: If more than 0.51 mm [0.020 inch] of material is removed from the mounting surface, an equivalent amount of material **must** be removed from the mounting surface of the exhaust manifold end sections to ensure adequate sealing between the sections.

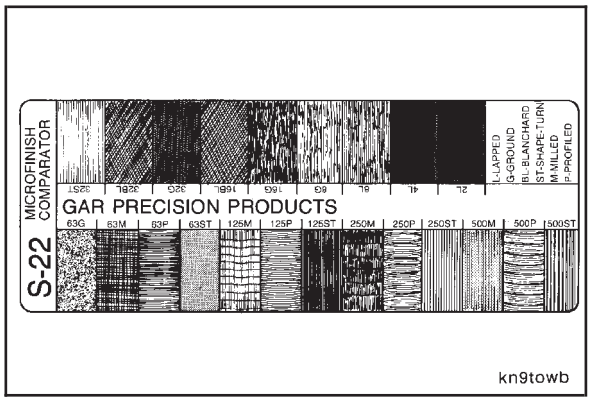
Machine the center section mounting surface. Follow the tool manufacturer's instructions for operating the resurfacing machine.



NOTE: Follow the same repair procedure if the turbocharger mounting flange requires machining.

The following specifications **must** be maintained while machining the manifold mounting surfaces:

- exhaust manifold mounting flange minimum thickness - 12.7 mm [0.500 inch],
- turbocharger mounting flange minimum thickness - 14.2 mm [0.560 inch],
- exhaust manifold mounting flange flatness — 0.25 mm [0.010 inch],
- turbocharger mounting flange flatness — 0.13 mm [0.005 inch].



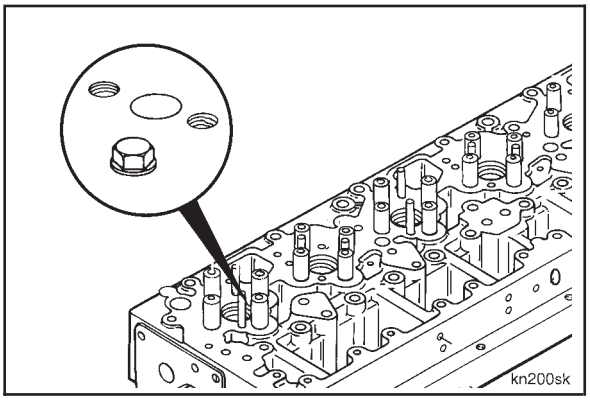
Use a surface comparator to inspect the finish of the exhaust manifold mounting surfaces. A surface finish of 3.2 µm [125 µ inch] **must** be maintained.

NOTE: If the center section mounting capscrew holes have been enlarged, it will be necessary to inspect the threads in the cylinder head. Refer to Exhaust Manifold Capscrew Threaded Hole Repair.

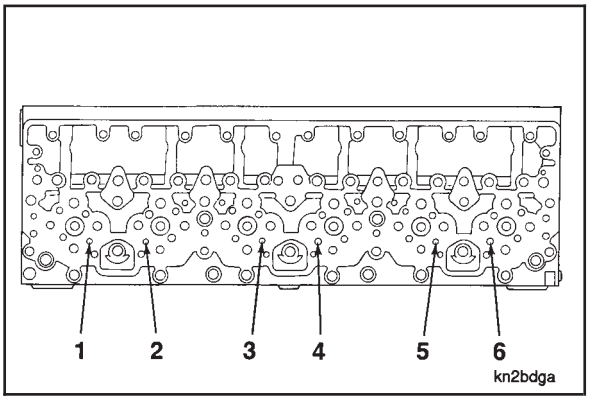
Injector Hold Down Capscrew Threaded Hole Repair

General Information

This repair procedure describes the method for repairing the injector hold down capscrew holes in the cylinder head.

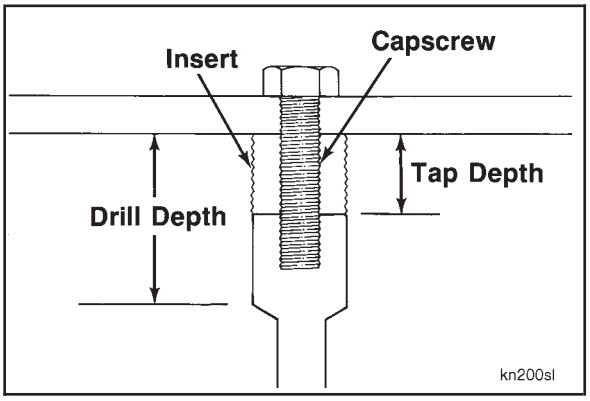


Only the holes on the exhaust side of the injector hold down (1, 2, 3, 4, 5, and 6) can be repaired with this procedure.



NOTE: This drill or ream depth is required to provide adequate clearance for the capscrew even though the thread insert will **not** extend that deep into the cylinder head.

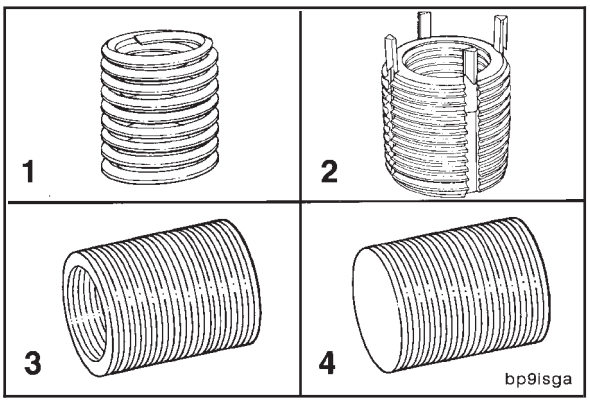
Special instructions are required for these capscrew holes because the drill or ream depth **must** be 10 to 21 mm [0.75 to 0.83 inch].

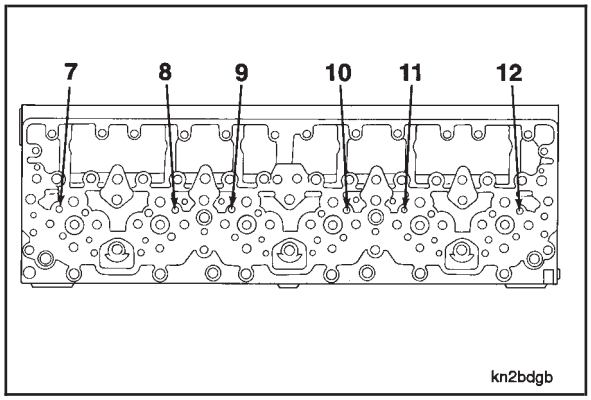


Any type of thread insert can be used. The following length inserts can be used:

- Coiled Thread — 16 mm long,
- Keylock — 12 mm long,
- Open End — 18 mm long,
- Closed End — 18 mm long.

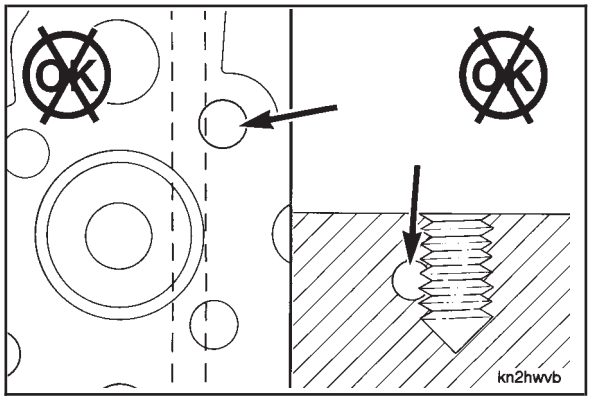
NOTE: The tap depth **must** correspond to the insert length. Refer to General Repairs — Group 00 for specific instructions and drill diameters.





The holes on the fuel pump side of the injector hold down (7, 8, 9, 10, 11, and 12) **cannot** be repaired with this procedure.

Due to the close proximity of the fuel gallery cross drillings, these hold down holes **cannot** be repaired. If these holes are damaged beyond use, the cylinder head **must** be replaced.



Any attempt to repair the holes would result in penetration of the fuel gallery because of the larger diameter and depth required to repair the holes. As a result, fuel would leak into the lube oil system.

NOTES

Section L - Service Literature

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Additional Service Literature L-2

Service Literature Ordering Location L-3

Additional Service Literature

The following publications can be purchased by filling in and mailing the Literature Order Form:

BULLETIN NO.	TITLE OF PUBLICATION
3377710	[1]Service Products Catalog
3379133	Control Parts List
3810303	Parts Reuse Guidelines
3666083	M11 Standard Repair Times
3810387	Analysis and Prevention of Bearing Failures
3810388	Overhead Reuse Guidelines, L10 Series Engines
3666084	Troubleshooting and Repair Manual, CELECT™ System
3379347	L10 Shop Manual, Internal Damper Models
3810476	L10 Shop Manual, External Damper Models
3810246	L10 Troubleshooting and Repair Manual, Internal Damper Models
3810439	L10 Troubleshooting and Repair Manual, External Damper Models
3810328	L10 Standard Repair Times
3666074	M11 Troubleshooting and Repair Manual
3666075	M11 Shop Manual
3666076	M11 Specifications Manual
3810490	Shop and Installation Manual, Rear Engine Power Takeoff

[1] This publication is available only from Service Products Company, Inc. Refer to the Service Literature Ordering Locations on the following page.

Service Literature Ordering Location

Region	Ordering Location
United States and Canada	Cummins Distributors or Contact 1-800-DIESELS (1-800-343-7357)
U.K., Europe, Mid-East, Africa, and Eastern European Countries	Cummins Engine Co., Ltd. Royal Oak Way South Daventry Northants, NN11 5NU, England
South and Central America (excluding Brazil and Mexico)	Cummins Americas, Inc. 16085 N.W. 52nd Avenue Hialeah, FL 33104
Brazil and Mexico	Cummins Engine Co., Inc. International Parts Order Dept., MC 40931 Box 3005 Columbus, IN 47202-3005
Far East (excluding Australia and New Zealand)	Cummins Diesel Sales Corp. Literature Center 8 Tanjong Penjuru Jurong Industrial Estate Singapore
Australia and New Zealand	Cummins Diesel Australia Maroondah Highway, P.O.B. 139 Ringwood 3134 Victoria, Australia

Obtain current price information from your local Cummins Distributor or (for U.S.A. and Canada) by calling Cummins Toll Free Number 1-800-DIESELS (1-800-343-7357).

Literature Order Form

Use this form for prompt handling of your literature order.

Item	Bulletin Number	Title of Publication	Quantity	U.S. Price Each	Amount
1				$	$
2					
3					
4					
5					
6					
				Order Total	$

Contact your Cummins distributor for prices and availability.

For problems with literature orders, contact 1-800-DIESELS (1-800-343-7357) (for U.S.A. and Canada).

Prices subject to change without notice.

Please cut on dotted line

Literature Order Form

Use this form for prompt handling of your literature order.

Item	Bulletin Number	Title of Publication	Quantity	U.S. Price Each	Amount
1				$	$
2					
3					
4					
5					
6					
				Order Total	$

Contact your Cummins distributor for prices and availability.

For problems with literature orders, contact 1-800-DIESELS (1-800-343-7357) (for U.S.A. and Canada).

Prices subject to change without notice.

Mail the Literature Order Form along with your ship-to address to your nearest Cummins distributor.

FROM:

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

SHIP TO: (Name and address where literature is to be shipped)

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

Please cut on dotted line

Mail the Literature Order Form along with your ship-to address to your nearest Cummins distributor.

FROM:

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

SHIP TO: (Name and address where literature is to be shipped)

Name: _____

Street Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

Section M - Component Manufacturers

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Component Manufacturers' Addresses

NOTE: The following list contains addresses and telephone numbers of suppliers of accessories used on Cummins engines. Suppliers can be contacted directly for any specifications **not** covered in this manual.

Air Compressors

Bendix Heavy Vehicles Systems
Div. of Allied Automotive
901 Cleveland Street
Elyria, OH 44036
Telephone: (216) 329-9000

Holset Engineering Co., Inc.
1320 Kemper Meadow Drive
Suite 500
Cincinnati, OH 45240
Telephone: (513) 825-9600

Midland-Grau
Heavy Duty Systems
Heavy Duty Group Headquarters
10930 N. Pamona Avenue
Kansas City, MO 64153
Telephone: (816) 891-2470

Air Cylinders

Bendix Ltd.
Douglas Road
Kingswood
Bristol
England
Telephone: 0272-671881

Catching Engineering
1733 North 25th Avenue
Melrose Park, IL 60160
Telephone: (708) 344-2334

TEC - Hackett Inc.
8909 Rawles Avenue
Indianapolis, IN 46219
Telephone: (317) 895-3670

Air Heaters

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Kim Hotstart Co.
P.O. Box 11245
Spokane, WA 99211-0245
Telephone: (509) 534-6171

Air Starting Motors

Ingersoll Rand
Chorley New Road
Horwich
Bolton
Lancashire
England
BL6 6JN
Telephone: 0204-65544

Ingersoll-Rand Engine
Starting Systems
888 Industrial Drive
Elmhurst, IL 60126
Telephone: (708) 530-3875

StartMaster
Air Starting Systems
A Division of Sycon Corporation
9595 Cheney Avenue
P. O. Box 491
Marion, OH 43302
Telephone: (614) 382-5771

Alternators

Robert Bosch Ltd.
P.O. Box 98
Broadwater Park
North Orbital Road
Denham
Uxbridge
Middlesex UD9 5HG
England
Telephone: 0895-833633

Butec Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: 0744-21663

C.A.V. Electrical Equipment
P.O. Box 36
Warple Way
London
W3 7SS
England
Telephone: 01-743-3111

A.C. Delco Components Group
Civic Offices
Central Milton Keynes
MK9 3EL
England
Telephone: 0908-66001

C. E. Niehoff & Co.
2021 Lee Street
Evanston, IL 60202
Telephone: (708) 866-6030

Delco-Remy America
2401 Columbus Avenue
P.O. Box 2439
Anderson, IN 46018
Telephone: (317) 646-3528

Leece-Neville Corp.
400 Main Street
Arcade, NY 14009
Telephone: (716) 492-1700

Auxiliary Brakes

The Jacobs Manufacturing Company
Vehicle Equipment Division
22 East Dudley Town Road
Bloomfield, CT 06002
Telephone: (203) 243-1441

Belts

Dayco Rubber U.K.
Sheffield Street
Stockport
Cheshire
SK4 1RV
England
Telephone: 061-432-5163

T.B.A. Belting Ltd.
P.O. Box 77
Wigan
Lancashire
WN2 4XQ
England
Telephone: 0942-59221

Dayco Mfg.
Belt Technical Center
1955 Enterprize
Rochester Hills, MI 48309
Telephone: (810) 853-8300

Gates Rubber Company
900 S. Broadway
Denver, CO 80217

Goodyear Tire and
Rubber Company
Industrial Products Div.
2601 Fortune Circle East
Indianapolis, IN 46241
Telephone: (317) 898-4170

Catalytic Convertors

Donaldson Company, Inc.
1400 West 94th Street
P.O. Box 1299
Minneapolis, MN 55440
Telephone: (612) 887-3835

Nelson Division
Exhaust and Filtration Systems
1801 U.S. Highway 51 P.O. Box 428
Stoughton, WI 53589
Telephone: (608) 873-4200

Walker Manufacturing
3901 Willis Road
P.O. Box 157
Grass Lake, MI 49240
Telephone: (517) 522-5500

Clutches

Twin Disc International S.A.
Chaussee de Namur
Nivelles
Belguim
Telephone: 067-224941

Twin Disc Incorporated
1328 Racine Street
Racine, WI 53403
Telephone: (414) 634-1981

Coolant Heaters

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Drive Plates

Detroit Diesel Allison
Division of General Motors
Corporation
P.O. Box 894
Indianapolis, IN 46206-0894
Telephone: (317) 242-5000

Electric Starting Motors

Butec Electrics
Cleveland Road
Leyland
PR5 1XB
England
Telephone: 0744-21663

C.A.V. Electrical Equipment
P.O. Box 36
Warple Way
London
W3 7SS
England
Telephone: 01-743-3111

A.C. Delco Components Group
Civic Offices
Central Milton Keynes
MK9 3EL
England
Telephone: 0908-66001

Delco-Remy America
2401 Columbus Avenue
P.O. Box 2439
Anderson, IN 46018
Telephone: (317) 646-3528

Leece-Neville Corp.
400 Main Street
Arcade, NY 14009
Telephone: (716) 492-1700

Nippondenso Inc.
2477 Denso Drive
P.O. Box 5133
Southfield, MI 48086
Telephone: (313) 350-7500

Engine Protection Controls

The Nason Company
2810 Blue Ridge Blvd.
West Union, SC 29696
Telephone: (803) 638-9521

Teddington Industrial Equipment
Windmill Road
Sunburn on Thames
Middlesex
TW16 7HF
England
Telephone: 09327-85500

Fan Clutches

Holset Engineering Co. Ltd.
P.O. Box A9
Turnbridge
Huddersfield, West Yorkshire
England HD6 7RD
Telephone: 0484-22244

Horton Industries, Inc.
P.O. Box 9455
Minneapolis, MN 55440
Telephone: (612) 378-6410

Rockford Clutch Company
1200 Windsor Road
P.O. Box 2908
Rockford, IL 61132-2908
Telephone: (815) 633-7460

Fans

Truflo Ltd.
Westwood Road
Birmingham
B6 7JF
England
Telephone: 021-557-4101

Hayes-Albion Corporation
Jackson Manufacturing Plant
1999 Wildwood Avenue
Jackson, MI 49202
Telephone: (517) 782-9421

Engineered Cooling Systems, Inc.
201 W. Carmel Drive
Carmel, IN 46032
Telephone: (317) 846-3438

Brookside Corporation
P.O. Box 30
McCordsville, IN 46055
Telephone: (317) 335-2014

TCF Aerovent Company
9100 Purdue Rd., Suite 101
Indianapolis, IN 46268-1190
Telephone: (317) 872-0030

Kysor-Cadillac
1100 Wright Street
Cadillac, MI 49601
Telephone: (616) 775-4681

Schwitzer
6040 West 62nd Street
P.O. Box 80-B
Indianapolis, IN 46206
Telephone: (317) 328-3010

Filters

Fleetguard International Corp.
Cavalry Hill Industrial Park
Weedon
Northampton NN7 4TD
England
Telephone: 0327-41313

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Flexplates

Corrugated Packing and Sheet Metal
Hamsterley
Newcastle Upon Tyne
England
Telephone: 0207-560-505

Allison Transmission
Division of General Motors Corporation
P.O. Box 894
Indianapolis, IN 46206-0894
Telephone: (317) 242-5000

Midwest Mfg. Co.
29500 Southfield Road, Suite 122
Southfield, MI 48076
Telephone: (313) 642-5355

Wohlert Corporation
708 East Grand River Avenue
P.O. Box 20217
Lansing, MI 48901
Telephone: (517) 485-3750

Fuel Warmers

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Gauges

A.I.S.
Dyffon Industrial Estate
Ystrad Mynach
Hengoed
Mid Glamorgan
CF8 7XD
England
Telephone: 0443-812791

Grasslin U.K. Ltd.
Vale Rise
Tonbridge
Kent
TN9 1TB
England
Telephone: 0732-359888

Icknield Instruments Ltd.
Jubilee Road
Letchworth
Herts
England
Telephone: 04626-5551

Superb Tool and Gauge Co.
21 Princip Street
Birmingham
B4 61E
England
Telephone: 021-359-4876

Kabi Electrical and Plastics
Cranborne Road
Potters Bar
Herts
EN6 3JP
England
Telephone: 0707-53444

Datcon Instruments
P.O. Box 128
East Petersburg, PA 17520
Telephone: (717) 569-5713

Rochester Gauges, Inc.
11616 Harry Hines Blvd.
P.O. Box 29242
Dallas, TX 75229
Telephone: (214) 241-2161

Governors

Woodward Governors Ltd.
P.O. Box 15
663/664 Ajax Avenue
Slough
Bucks
SL1 4DD
England
Telephone: 0753-26835

Woodward Governor Co.
P.O. Box 1519
Fort Collins, CO 80522
Telephone: (303) 482-5811
(800) 523-2831

Barber Colman Co.
1354 Clifford Avenue
Loves Park, IL 61132
Telephone: (815) 637-3000

United Technologies
Diesel Systems
1000 Jorie Blvd.
Suite 111
Oak Brook, IL 69521
Telephone: (312) 325-2020

Heat Sleeves

Bentley Harris Manufacturing Co.
100 Bentley Harris Way
Gordonville, TN 38563
Telephone: (313) 348-5779

Hydraulic and Power Steering Pumps

Hobourn Automotive
Temple Farm Works
Priory Road
Strood
Rochester
Kent, England
ME2 2BD
Telephone: 0634-71773

Honeywell Control Systems Ltd.
Honeywell House
Charles Square
Bracknell
Berks RG12 1EB
Telephone: 0344-4245

Sundstrand Hydratec Ltd.
Cheney Manor Trading Estate
Swindon
Wiltshire
SN2 2PZ
England
Telephone: 0793-30101

Sperry Vickers
P.O. Box 302
Troy, MI 48084
Telephone: (313) 280-3000

Z.F.
P.O. Box 1340
Grafvonsoden Strasse
5-9 D7070
Schwaebisch Gmuend
West Germany
Telephone: 7070-7171-31510

Oil Heaters

Fleetguard, Inc.
1200 Fleetguard Road
Cookeville, TN 38502
Telephone: (615) 526-9551

Kim Hotstart Co.
P.O. Box 11245
Spokane, WA 99211-0245
Telephone: (509) 534-6171

Torque Converters

Twin Disc International S.A.
Chaussee de Namur
Nivelles
Belgium
Telephone: 067-224941

Twin Disc Incorporated
1328 Racine Street
Racine, WI 53403-1758
Telephone: (414) 634-1981

Rockford Powertrain, Inc.
Off-Highway Systems
1200 Windsor Road
P.O. Box 2908
Rockford, IL 61132-2908
Telephone: (815) 633-7460

Modine Mfg. Co.
1500 DeKoven Avenue
Racine, WI 53401
Telephone: (414) 636-1640

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