SZ 2498 ENGINE

MAHINDRA INSTITUTE OF LEARNING EXCELLENCE

Mahindra institute of learning
excellence, Nasik

ABBREVATION USED

SZ 2498 Plus	**: Timing - Chain Drive**
SZ	**: Scorpio Zip**
2498	**: CC of engine**
TCI	**: Turbo charged intercool**

The SZ 2498 TCI engine is a 4-cylinder, in-line, overhead valve, water-cooled, direct injection engine.

Specification-SZ 2498

No. of cylinders	:	04
Bore	:	94mm
Stroke	:	90mm
Displacement	:	2498cc
Compression ratio	:	18.5 : 1
Power	:	105 HP at 3800 RPM
Torque	:	238 Nm at 1700 to 1900 RPM
Type of operation	:	Four stroke , Direct injection
Timing mechanism	:	Chain drive [Plus]
Cooling System	:	Pressurised
		Centrifugal water pump
Lubrication System	:	Force feed lubrication

Maintenance schedule

- **Change engine oil & filter [Maximile Premium oil -10K]**
  OR **Viscosity index 15W 40. If API CG4 grade oil then.**
  5000km ,10000km & then every 10,000km
- **Refill fresh coolant [Maximile Coolant]**
  Once in a year / After every 40,000 kms
- **Change primary fuel filter**
  10000km, 20000kms & then every 10000kms
- **Change secondary fuel filter**
  20000km, 40000kms & then every 20000kms
- **Remove drain plug & Clean fuel tank**
  After every 80,000Kms
- **Check & drain water from filter**
  Every 10,000 Kms
- **Adjust fan belt tension as per value**
  During PDI & every service

- **Clean air filter**

  Every 10000Kms / Service indicator shows red band
- **Change air cleaner cartridge**

  At every 40,000kms / Service indicator shows red band even after cleaning
- **Adjust tappet**

  5000Km[If required], 20000 Km & then every 20000Km
- **Check vacuum pipe, PCVS pipe, Oil hoses & LDA connection**

  PDI & then every 10,000 Km
- **Check Radiator coolant hose connection, Heater connection**

  PDI & then every 5000km.

Engine oil

Alternate oil : Oil confirming to API CG4 grade with Viscosity index 15W 40. If API CF4 grade oil used then oil change interval is after Every 5000Kms.

Engine Coolant

Maximile Coolant should be used for SZ 2600/ SZ 2600 Plus engine.

Note: No alternate coolant is available in the market. Used of any other coolant may deteriorate liner 'O' rings which may lead to coolant & oil mixing. This coolant is premixed with water. Total coolant capacity is 9.3 lit..

Sealant

RTV silicon sealant-Rhodoseal to be used

: Between ladder frame & block.

: Between Rear oil seal retainer & block.

All other places

: use Loctite 547

Rust cleaning solution [For Turbo charger mounting Nut, EGR pipe Nut etc.]

: WD 40

General construction

All engine internal parts remain same as SZ 2600 except crankshaft, connecting rod, FIP & nozzles

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2600	: CC of engine
TCI	: Turbo charged intercool

The model SZ 2600 TCI engine is a 4-cylinder, in-line, overhead valve, water-cooled, direct injection engine.

Specification-SZ 2600/SZ 2600 Plus

No. of cylinders	:	04
Bore	:	94mm
Stroke	:	94mm
Displacement	:	2609 cc
Compression ratio	:	18.5 : 1
Type of operation	:	Four stroke , Direct injection
Power	:	109bhp @ 3800rpm
Max Torque	:	26.00 Kg-m
Timing mechanism	:	Chain drive [Plus]
Cooling System	:	Pressurised
		Centrifugal water pump
Lubrication System	:	Force feed lubrication

Maintenance schedule

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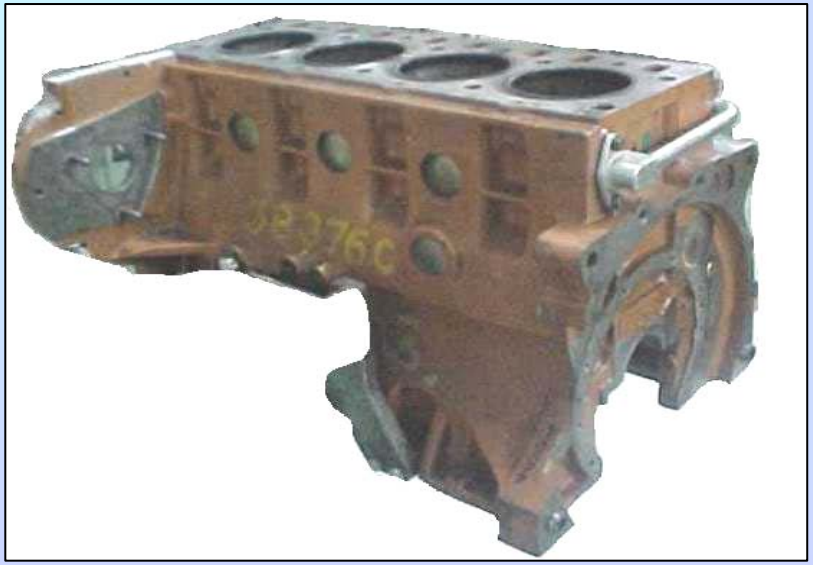
: WD 40

GENERAL CONSTRUCTION

Block

Replaceable wet type liner , Inline cylinder arrangement



Chain Drive [Orange colour]

Cylinder head

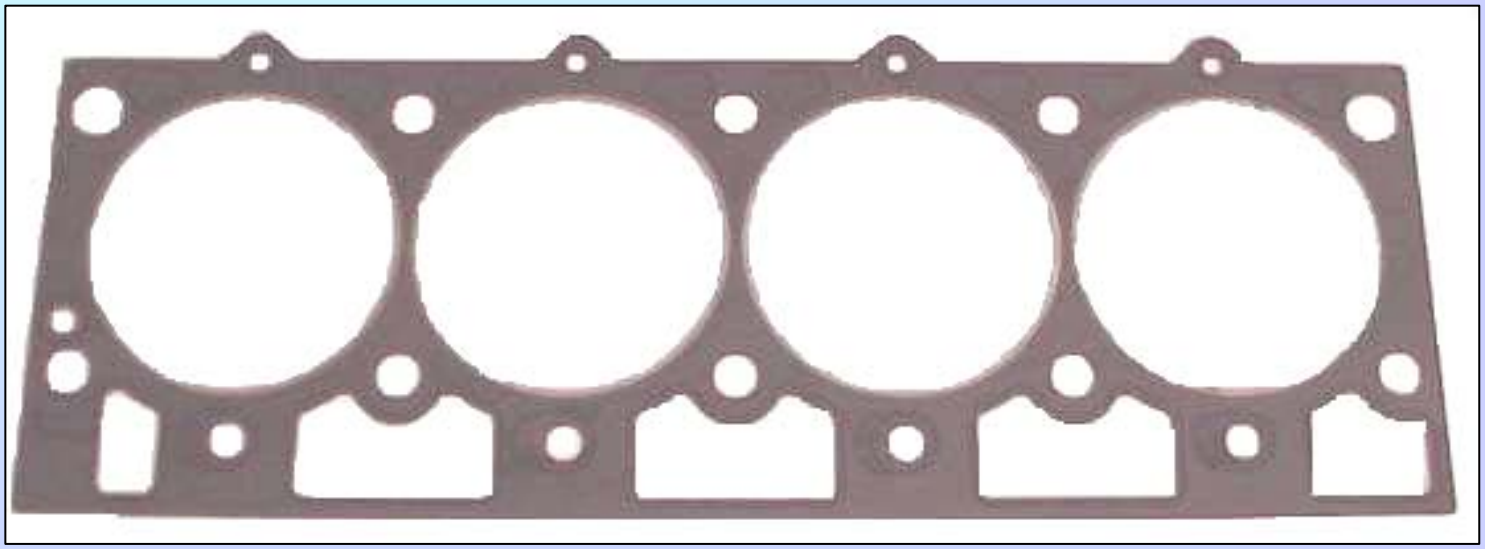
Height of cylinder head : **97.70mm to 98.30mm**

Min. cylinder head height: **97.40mm**

Cylinder head Gasket

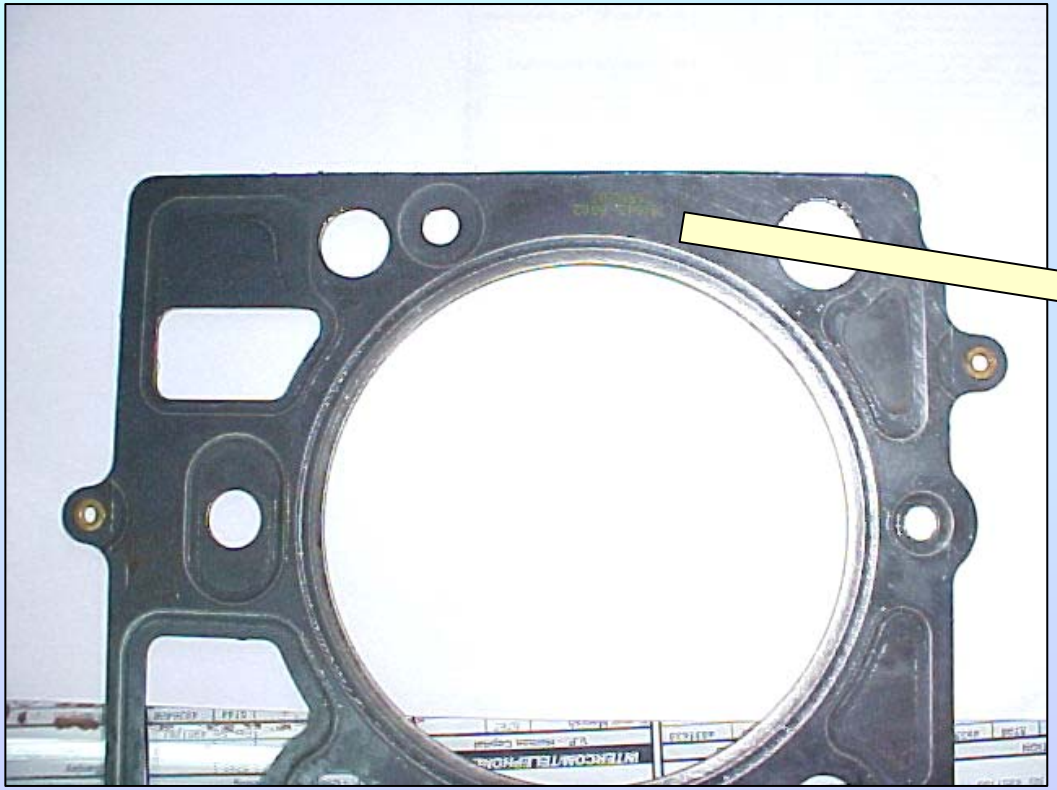
Type : Multilayer steel gasket

Gives uniform sealing on surface area.



Note : Do not use any oil or shellac on the cylinder head gasket or on block surface or on cylinder head surface.Do not reused the gasket even if it appears to be good.

Head gasket position : Assemble gasket with lettering facing upward.



Cylinder block warpage

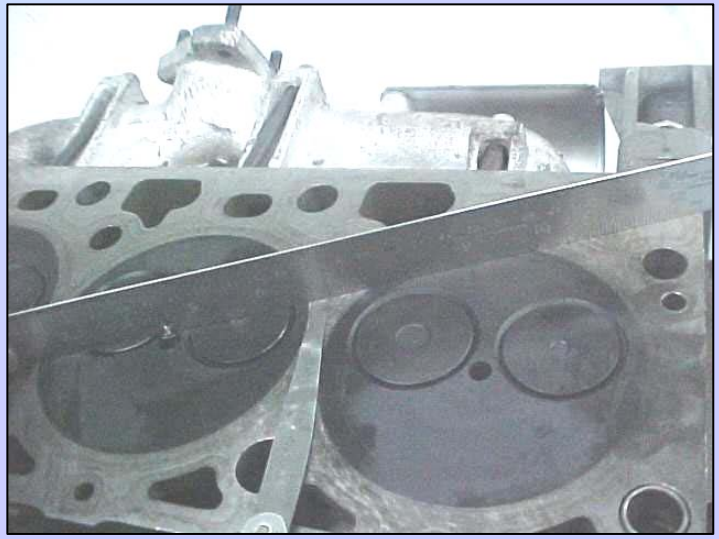
Standard limit : 0.07mm

Service limit : 0.10mm max.

Cylinder head warpage

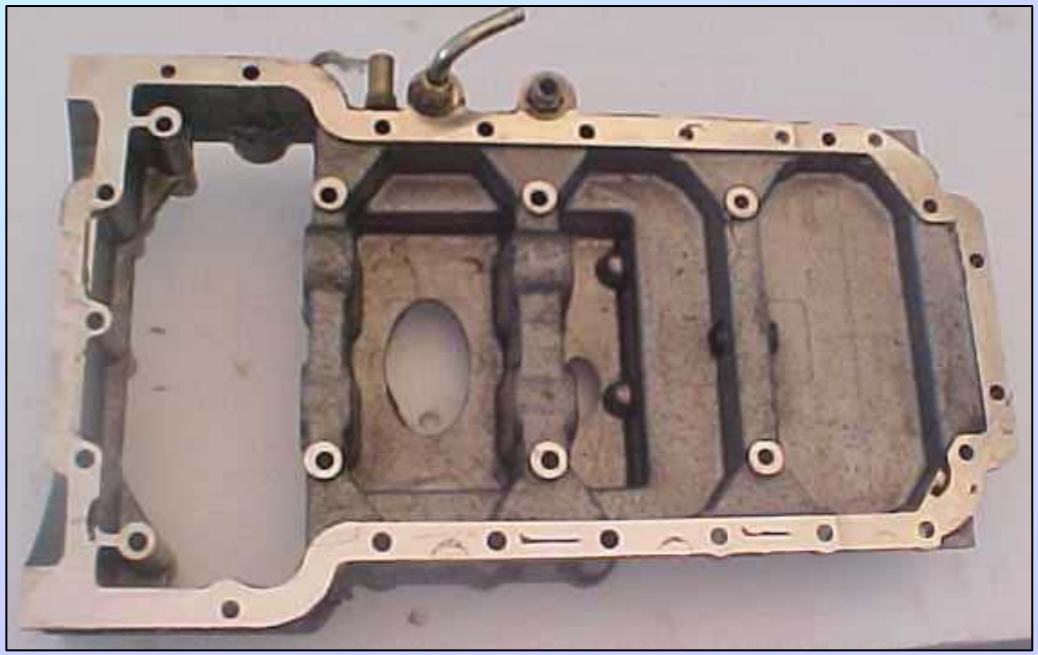
Standard limit : 0.05mm

Service limit : 0.10mm max.



Ladder frame

- **Support block from bottom side.**
- **Act as a barrier between rotating crankshaft & returning oil to control oil mist formation.**
- **Reduces engine noise & vibration.**

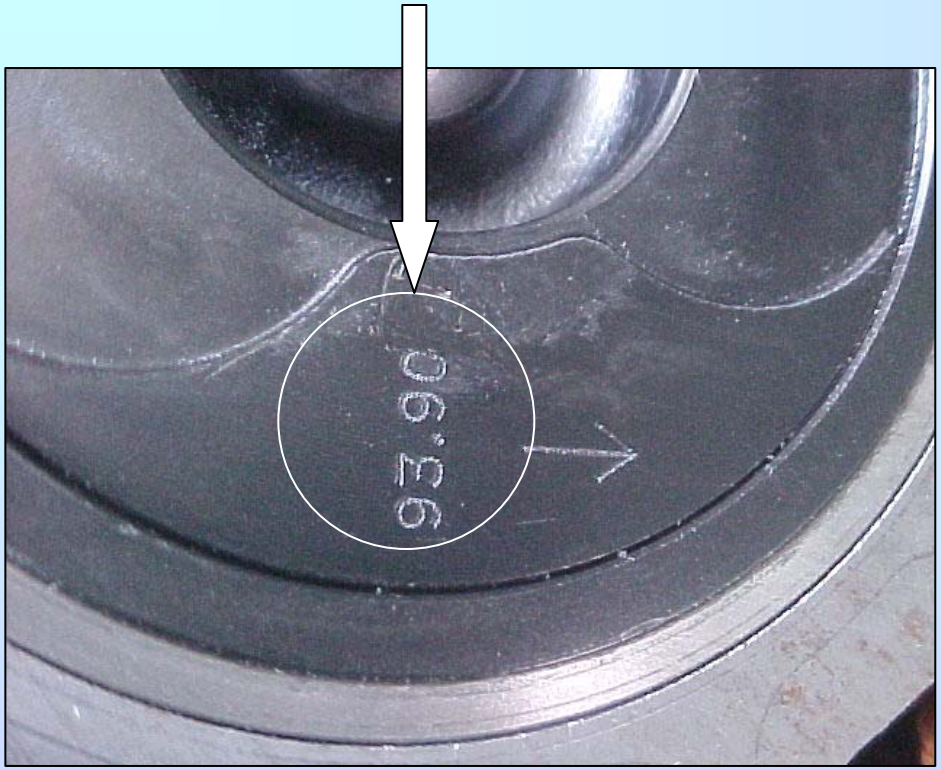


Piston

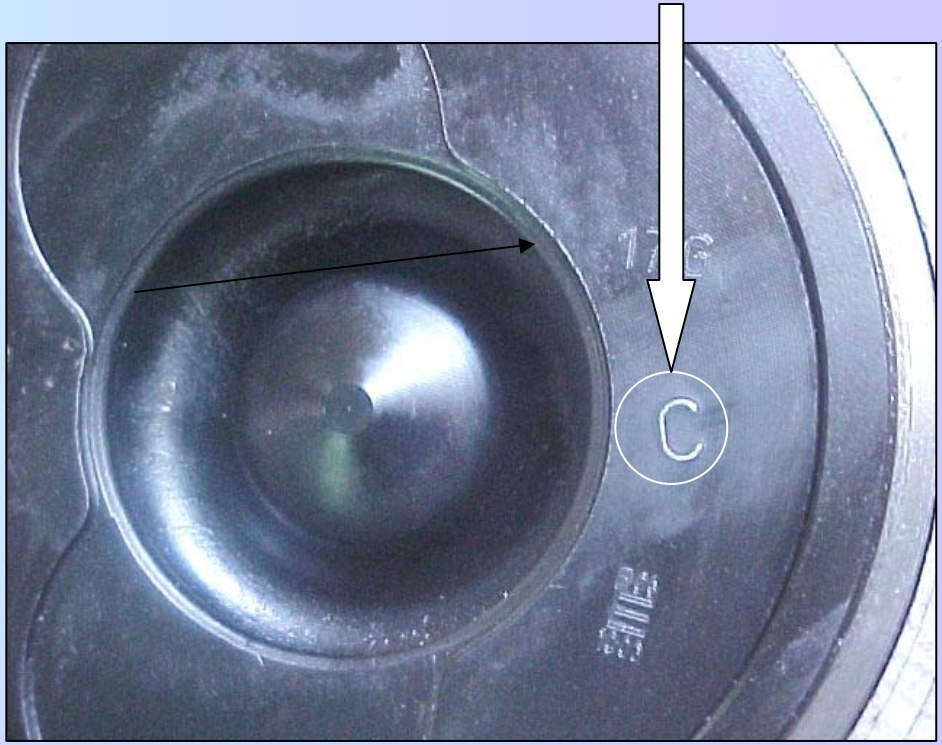
Piston : Re-entrant bowl type

Max weight difference allowed : +/- 5 gms

Diameter grading



Weight grading



Piston pin

Type : Full floating. Surface hardened & ground

Diameter : 32.00 mm

Piston rings

Top : **Keystoned shaped. [Top mark]**

Middle : **Oil Scrapper ring - Taper faced [Top mark]**

Bottom : **Conformable type oil ring**

Piston rings

Ring gap [Standard]

Top	:	0.35 to 0.55mm
		(14 to 22 Thou)
Middle	:	0.80 to 1.05mm
		(32 to 42 Thou)
Bottom	:	0.25 to 0.55mm
		(10 to 22 Thou)

Ring gap [Service limit]

Top	:	0.90mm (36 Thou)
Middle	:	1.50mm (60 Thou)
Botom	:	0.90mm (36 Thou)

Note : While fitting the piston rings ensure that the ring end gap are straggered in 180^0

Piston ring to piston groove clearance

		Standard limit	Service limit
Top	:	0.11 to 0.15mm	0.25mm
Middle	:	0.05 to 0.09mm	0.15mm
Botom	:	0.04 to 0.07mm	0.15mm

Liner

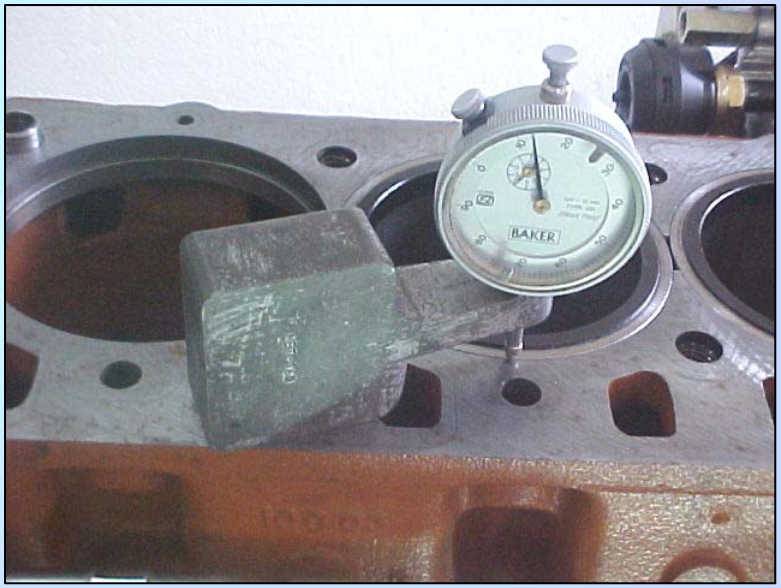
Liner : Replaceable wet type liner.

Coolant & oil jacket are separated by ‘O’ rings.

Both ‘O’ rings are same .

Viton base rubber is used.

Liner projection from block surface : 0.03mm to 0.09mm



Note : Check liner projection without ‘O’ rings.

Connecting rod

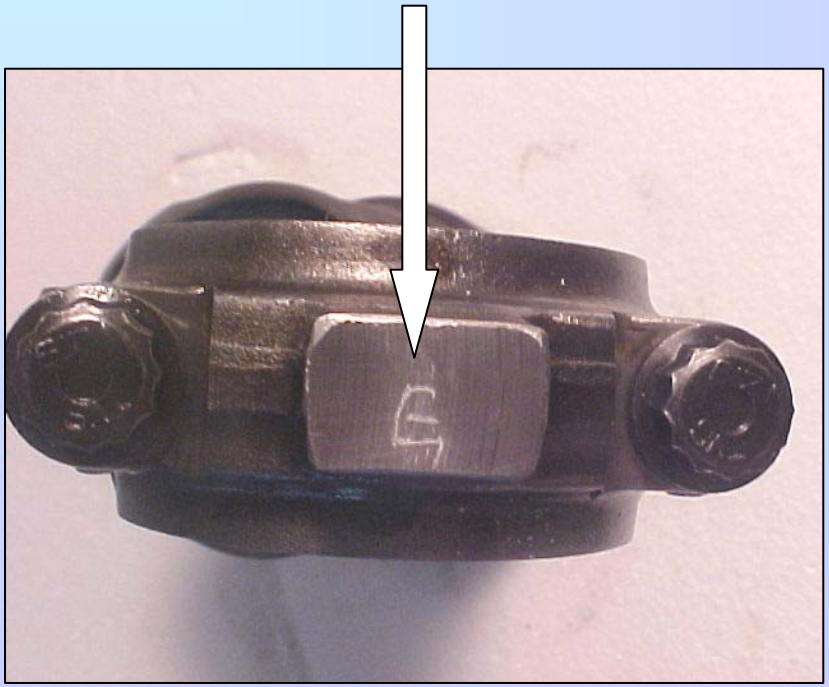
Identification No : **Punched on connecting rod cap viz. 1,2,3,4**
No. 1 start from Fan side.
Also help for cap positioning.

Identification number

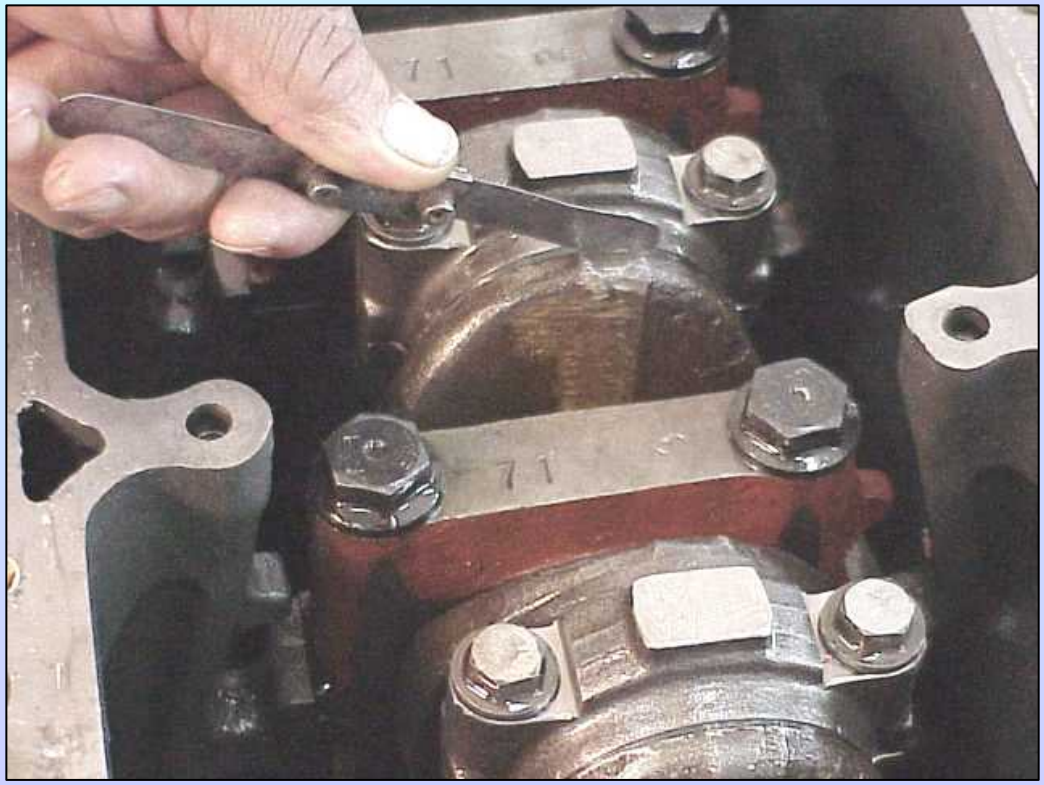
Weight grading mark : Punched on connecting rod cap viz. F, G H,I,……T,U.

Recommended for service replacement : Grade ‘M’

Weight grading mark



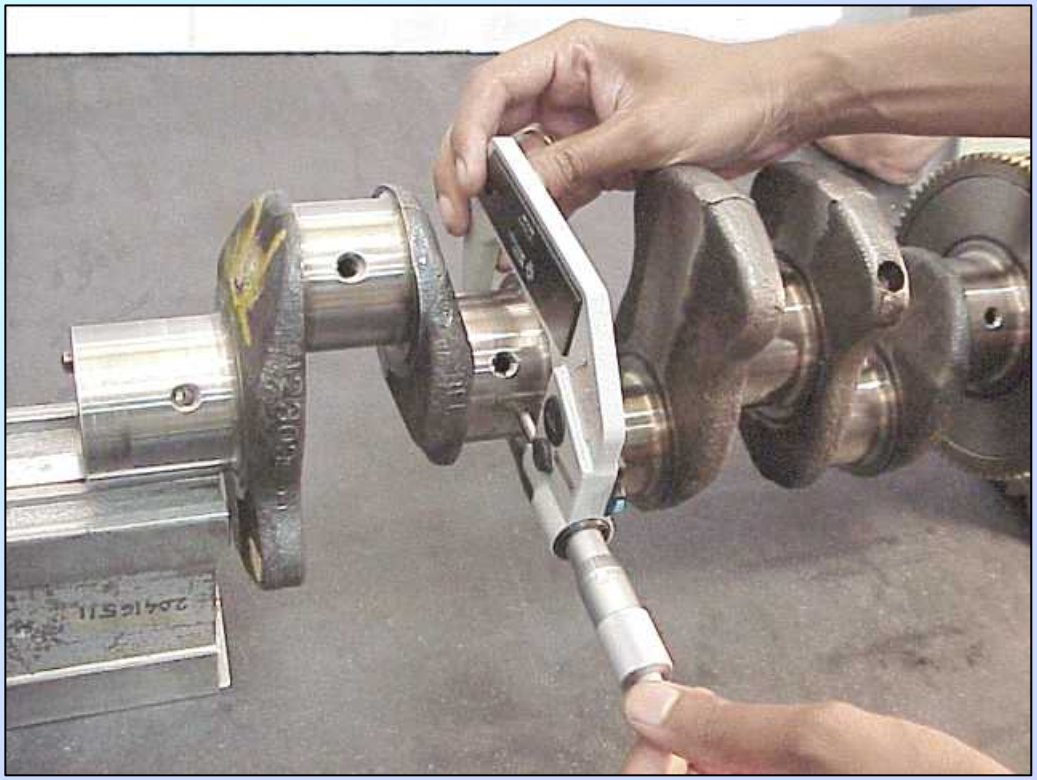
Connecting rod side play: 0.10mm to 0.30mm (4 to 12 thou)



Crank pin journal

Std size of crank pin journal	:	52.98 to 53.00mm
1st u/s 0.25 Crank pin journal	:	52.73 to 52.75mm
2nd u/s 0.50 Crank pin journal	:	52.48 to 52.50mm
3rd u/s 0.75 Crank pin journal	:	52.23 to 52.25mm

Crank shaft main journal

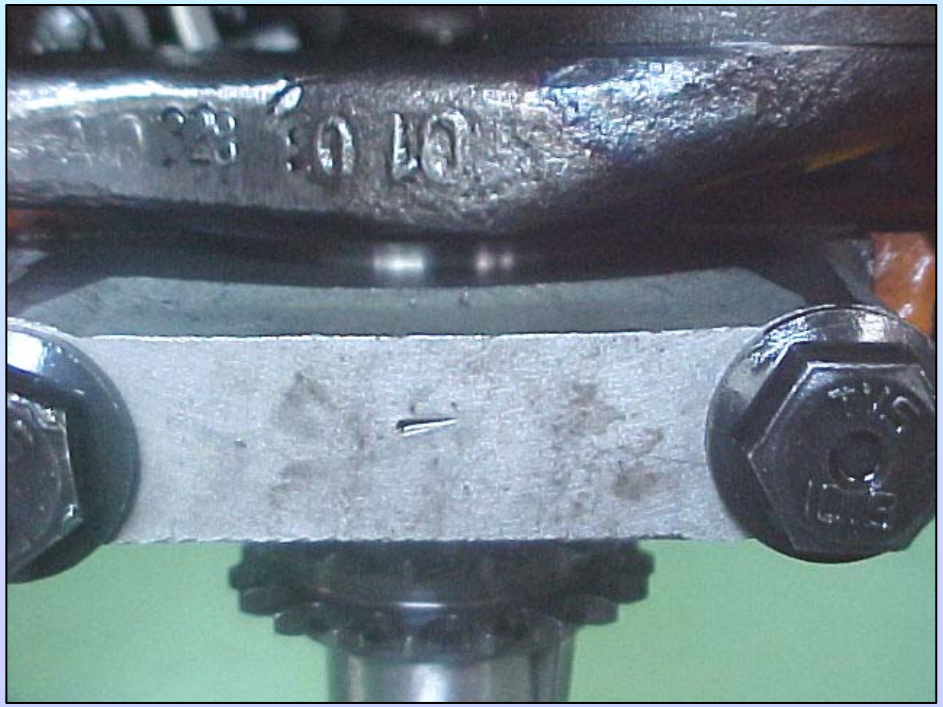


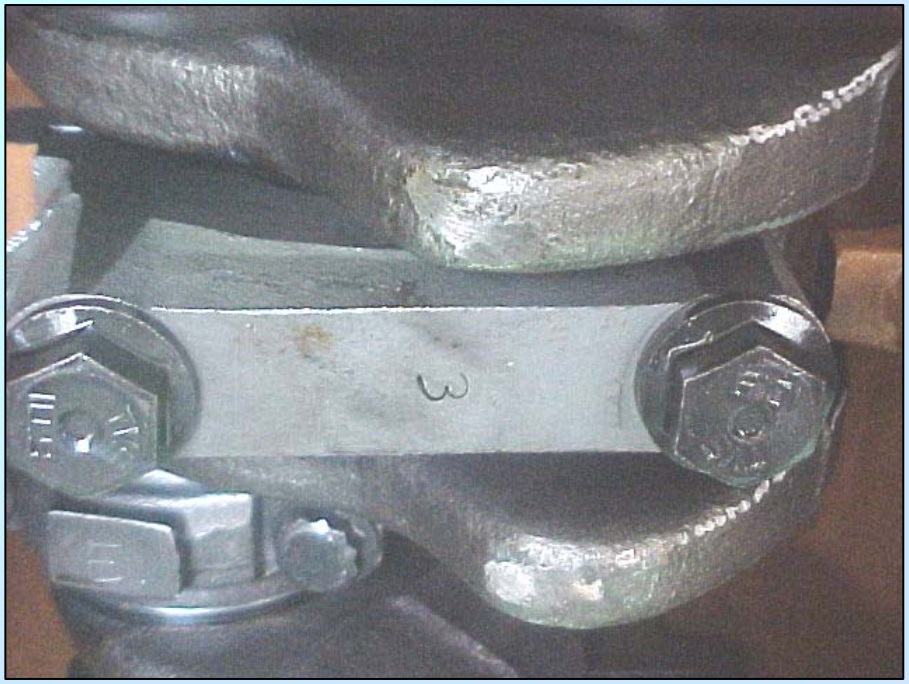
Std size of main journal	:	58.98 to 59.00mm
1st u/s 0.25 main journal	:	58.73 to 58.75mm
2nd u/s 0.50 main journal	:	58.48 to 58.50mm
3rd u/s 0.75 main journal	:	58.23 to 58.25mm

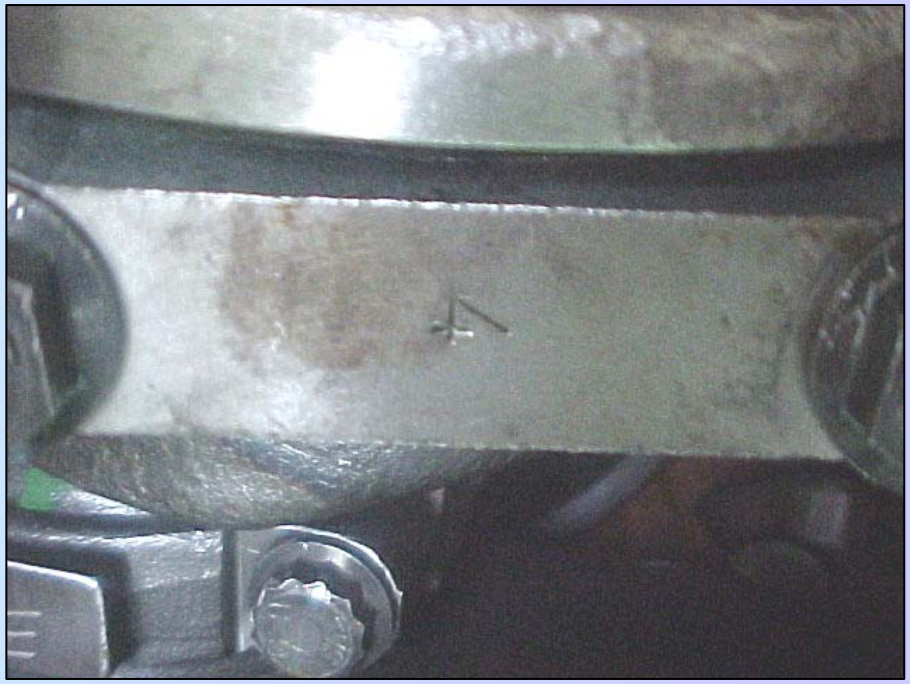
Main bearing Cap

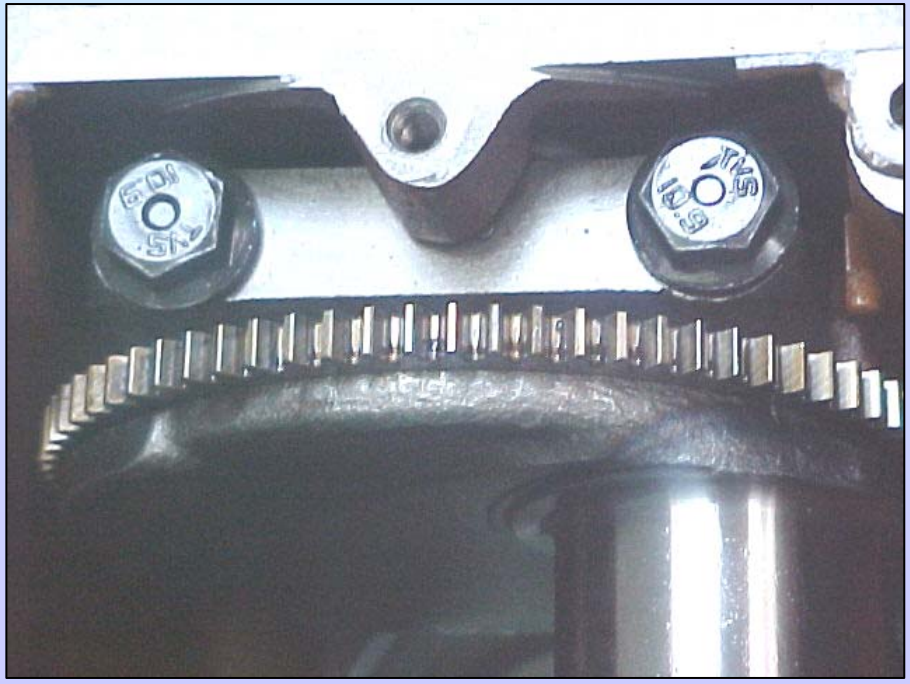
Identification mark i.e. 1 to 5 is punched on main bearing cap.

No 1 cap start from fan side.

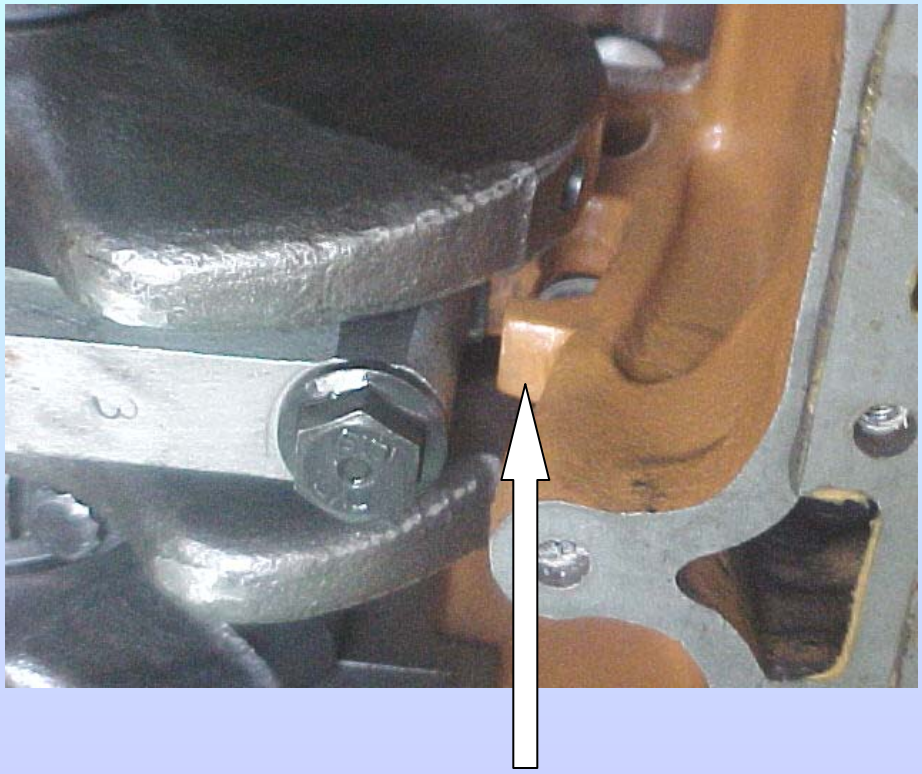




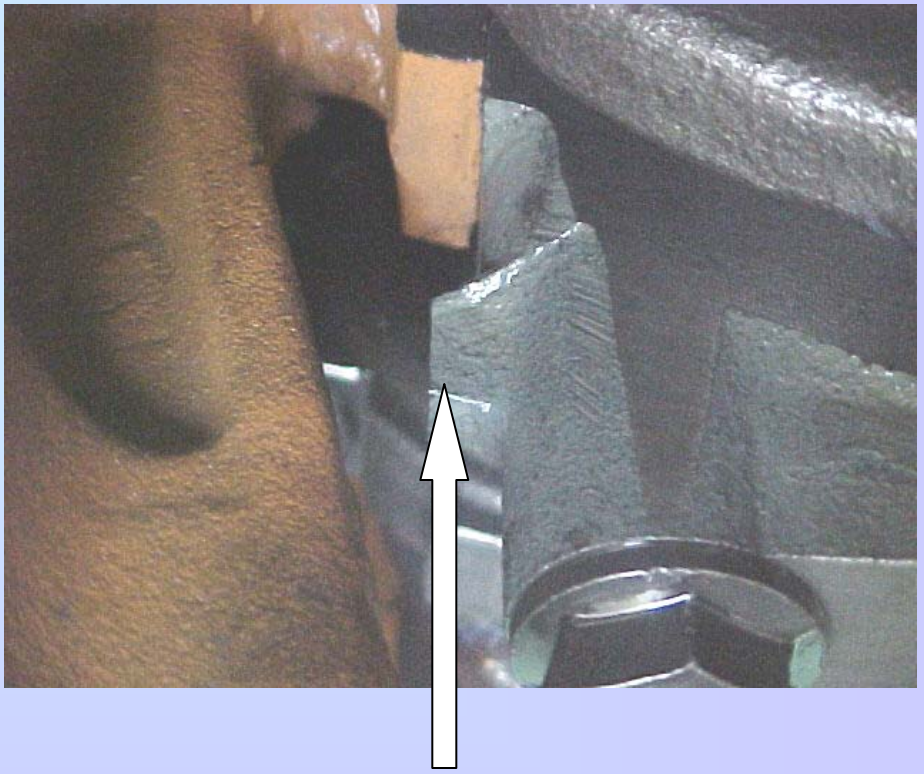




Main bearing cap position : Projection on block & Cap is provided to avoid wrong fitments of Main bearing cap.



Projection on block

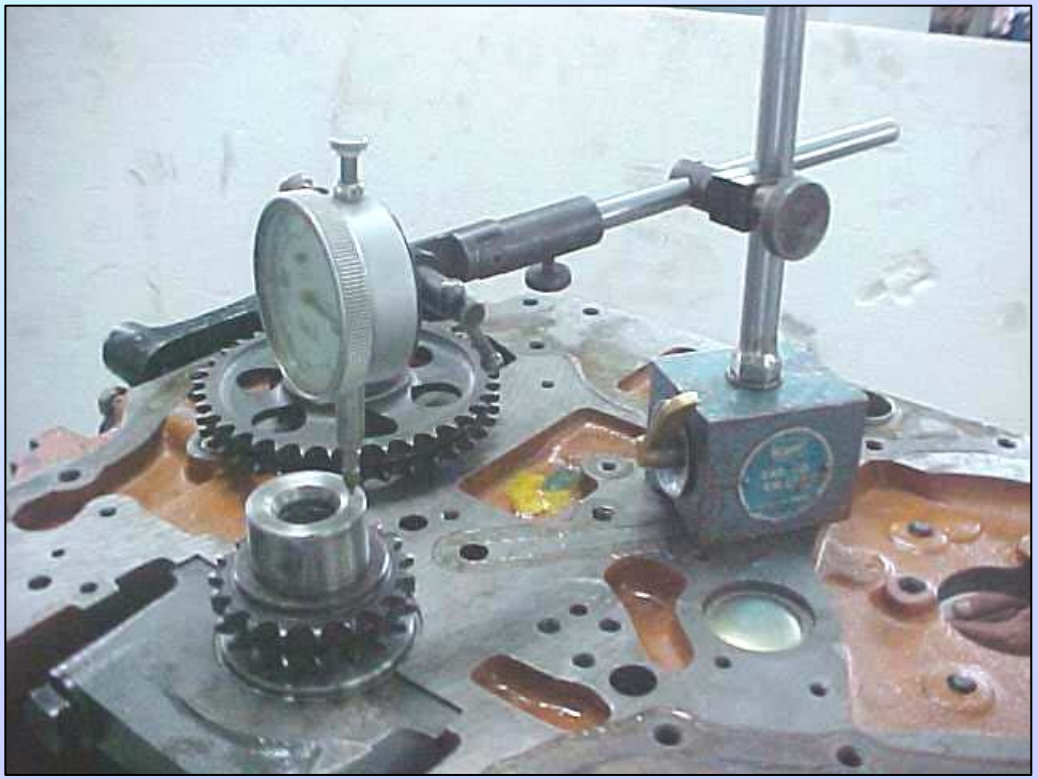


Projection on cap

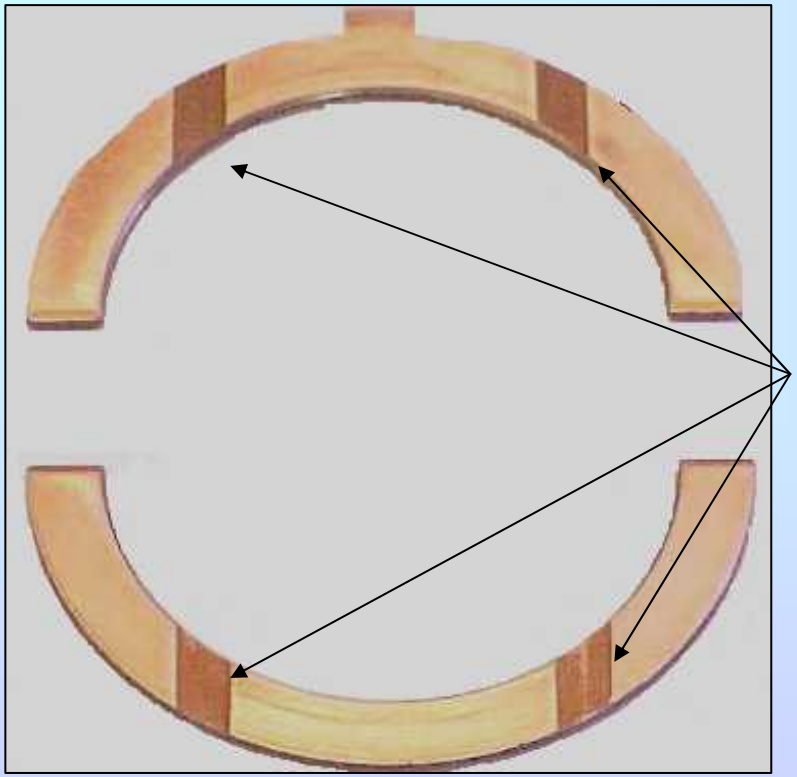
Crank shaft end float

Standard : 0.10 mm to 0.37 mm (4 to 15 thou)

Service limit : 0.50mm (20thou)



End float is adjusted by using thrust washer.
Thrust washer on cap have locating lips.

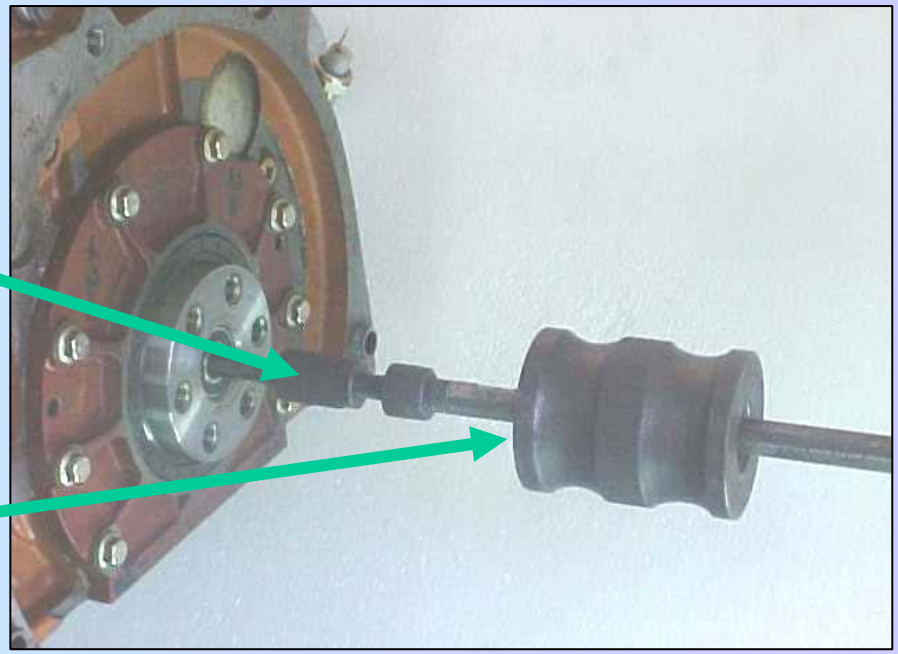


Oil grooves faces outer side

Crankshaft bearing removal

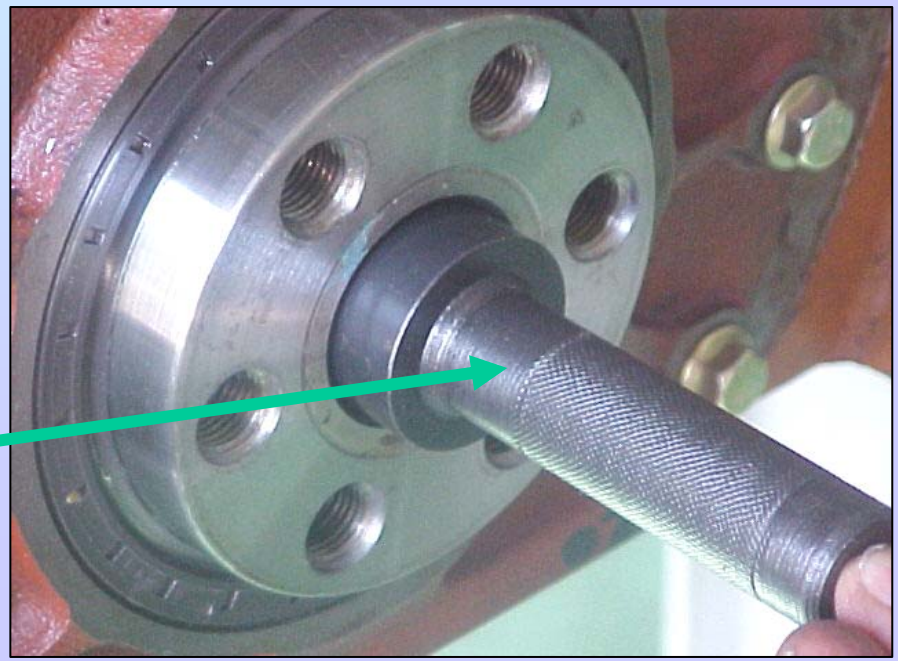
MST:543

MST:577

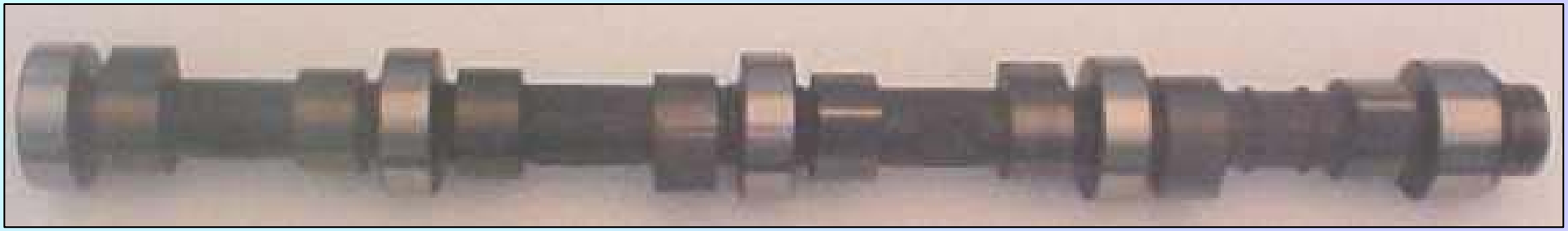


Crankshaft bearing pressing

MST:544



Cam shaft



Axial clearance of cam shaft

Standard : 0.10 to 0.30 mm

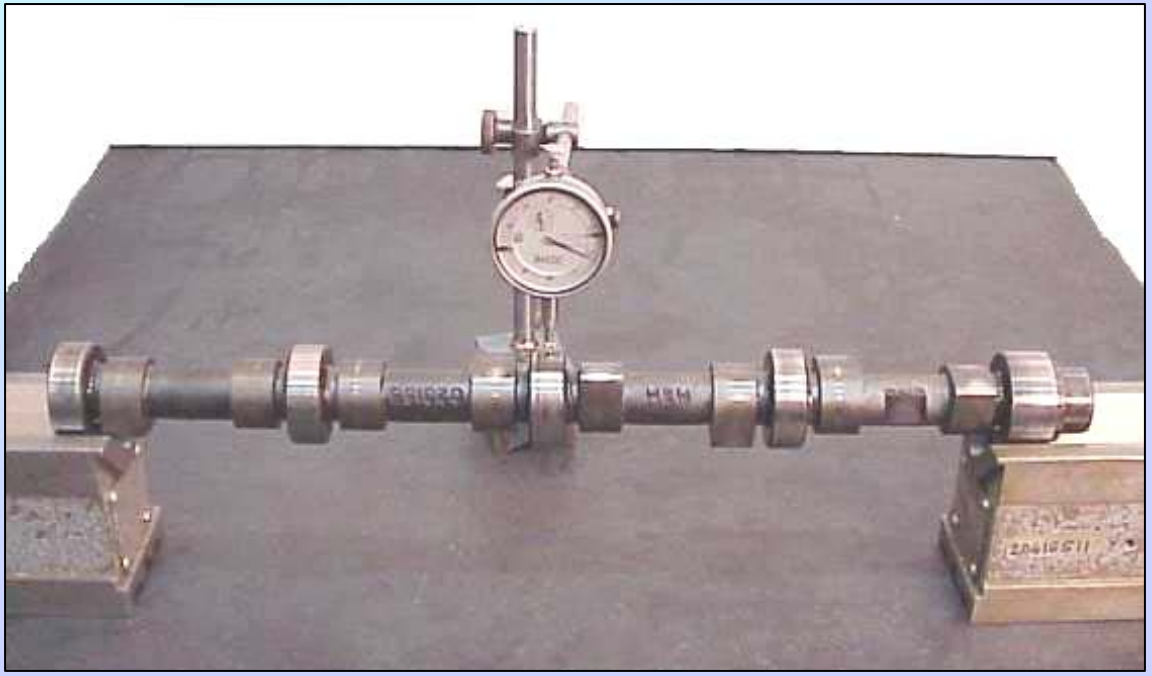
Service limit : 0.40 mm

Cam shaft bush to cam journal clearance

Standard : 0.02 to 0.075 mm

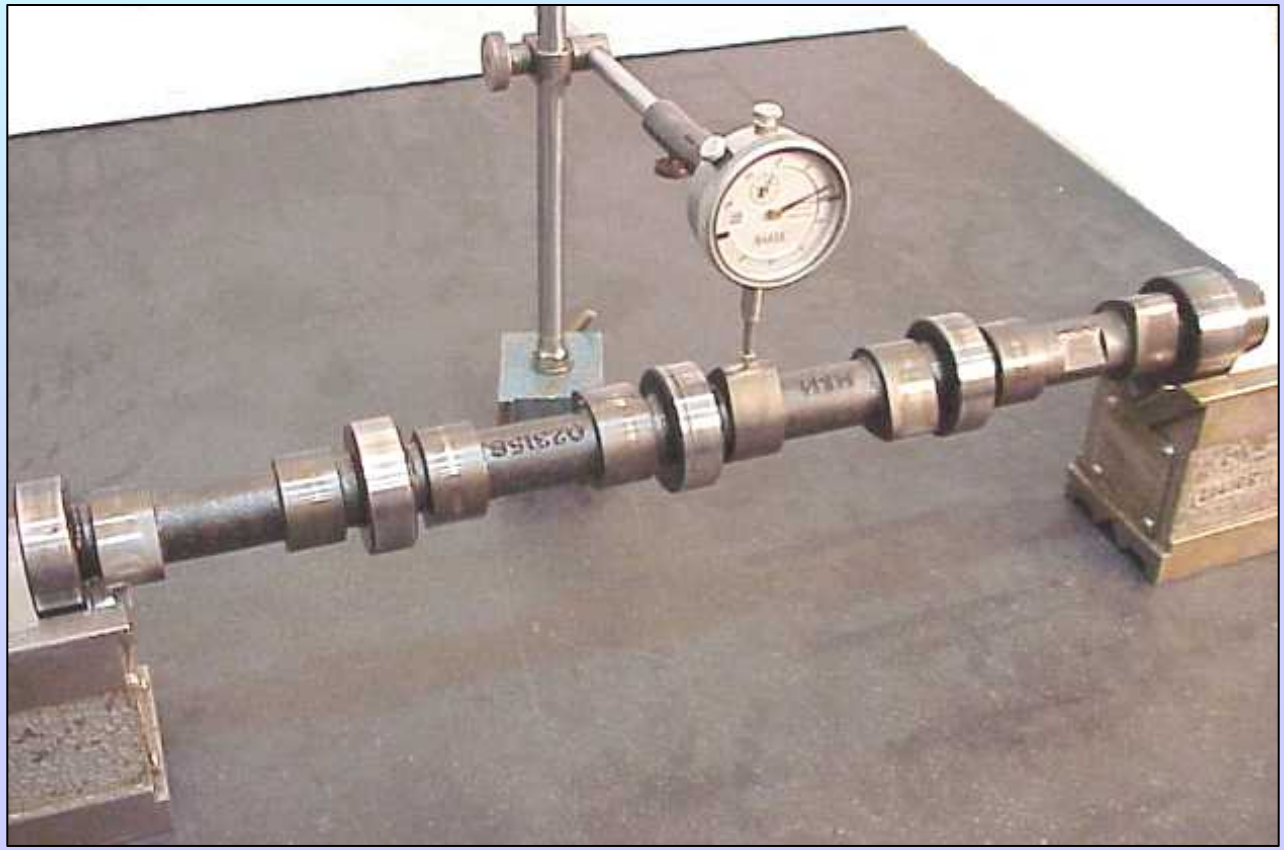
Service limit : 0.10 mm

Cam shaft runout : 0.01mm [max]



Camlobe lift

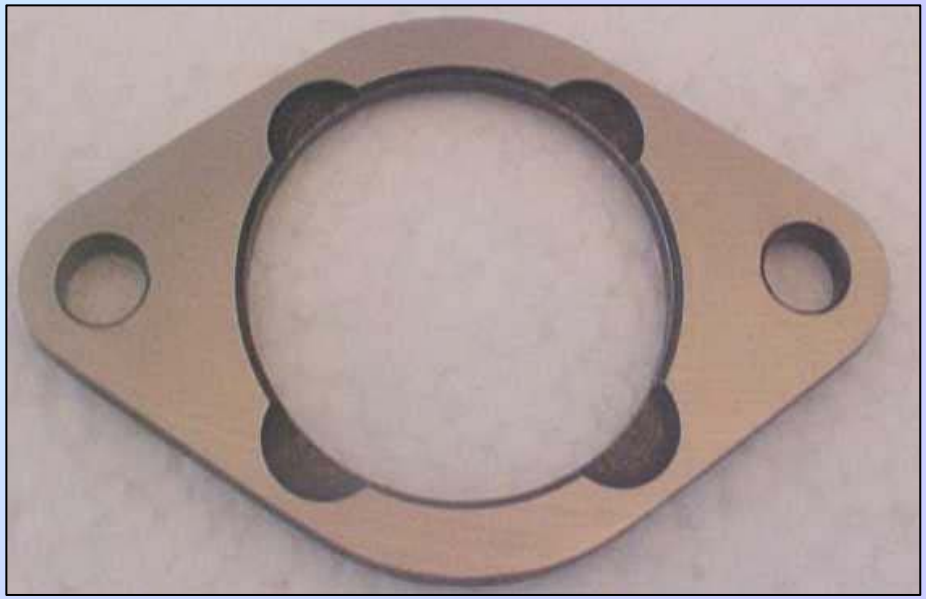
		Inlet	Exhaust
Standard	:	6.08 mm	6.91 mm
Service limit	:	5.58 mm	6.41 mm



Cam shaft thrust plate mounting

: While assembling the cam shaft thrust plate ensure that the vertical groove will face towards gear / sprocket.

Gear / Sprocket side



Cam bush side

Cam shaft identification

On chain drive cam shaft letter ‘CHAIN DRIVE’ in forged on cam shaft..

Tappets

Inner dia of tappet hole in crankcase : **24.48mm**

Tappet to tappet hole clearance

Standard limit : **0.075mm to 0.02mm**

Service limit : **0.10mm**

Flywheel

Flat ness

Standard limit : 0.05mm[max]

Service limit : 0.10mm[max]

Run out

Standard limit : 0.05mm

Service limit : 0.10mm

Valve,Guide & spring

Valve seat angle : $44^0 45'$ to 45^0

Valve stem OD [Inlet & exhaust valve]

: 6.95mm to 7.10mm

Clearance between valve & valve guide.

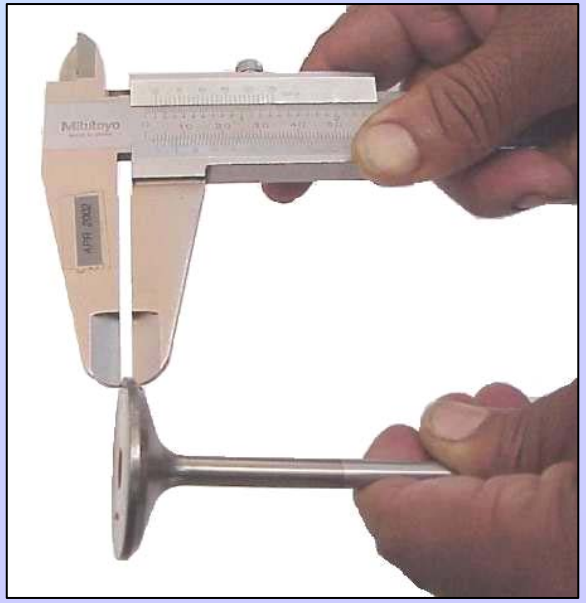
Inlet valve : 0.03mm to 0.07mm

Exhaust valve : 0.05mm to 0.09mm

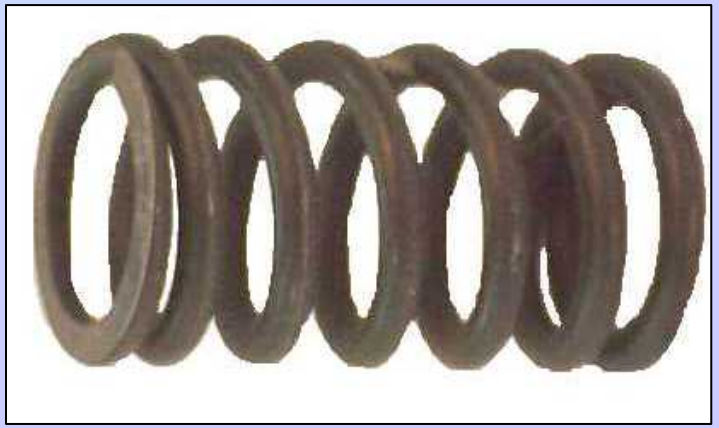
Thickness of valve head

Standard limit : 2.00mm

Service limit : 1.50mm



Valve & valve lock

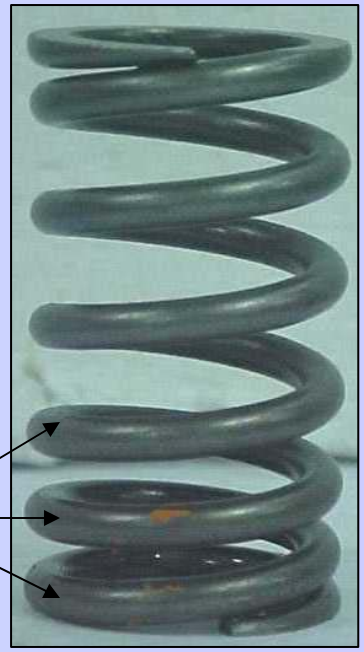


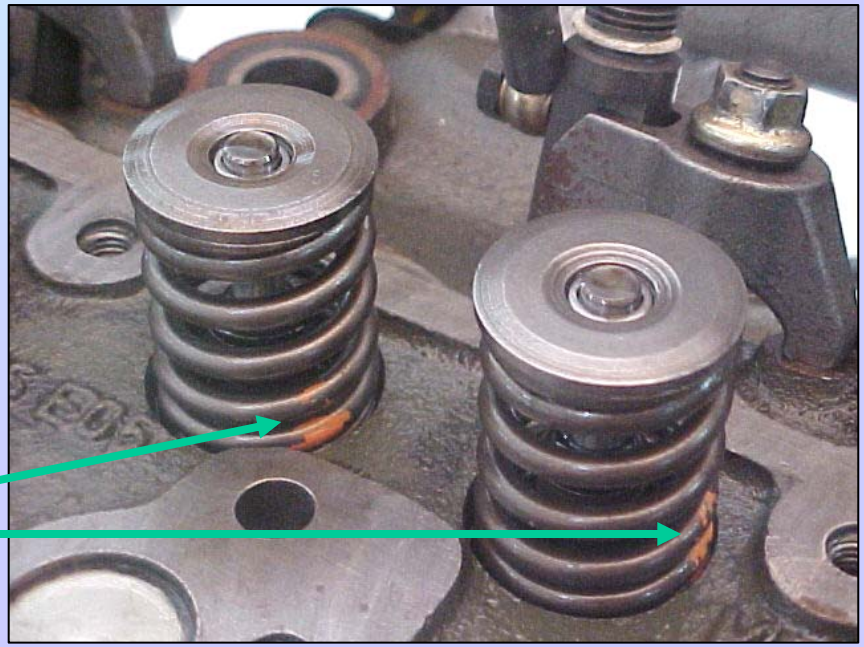
Valve spring free length

: 53.60mm [Standard limit]

50.60 mm[Service limit]

Valve spring is variable pitch spring. **While assembling ensure that the closer pitch should face towards head side.[Paint marking is given for identification]**



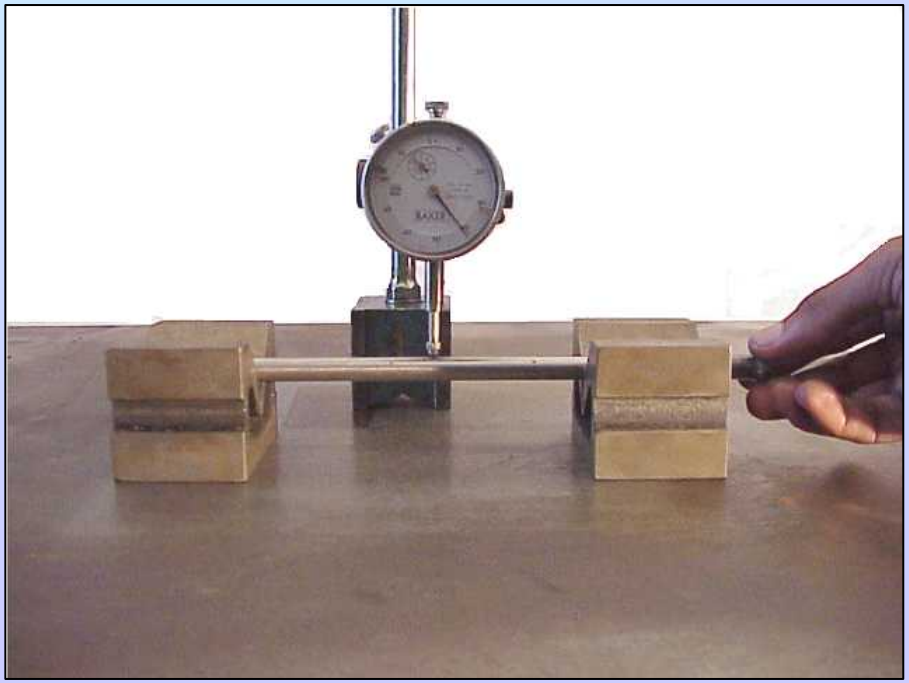


Push rod

Push rod bent

Standard limit : 0.25 mm[max.]

Service limit : 0.40 mm



Viscous fan drive

Uses fluid coupling, which drives the fan blade by means of silicon fluid.

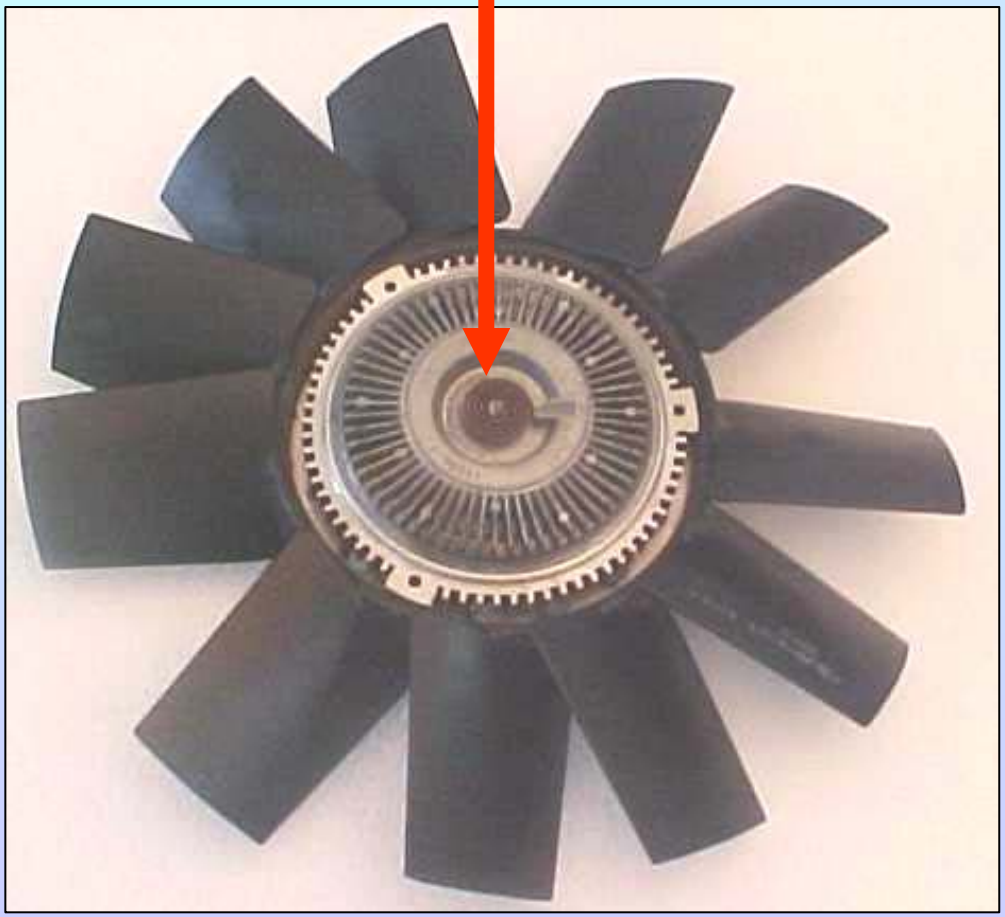
The fan drive has to be engaged only periodically,between 5 to 10% of the normal operating conditions.

Bi-metal coil senses the air temperature behind the radiator.

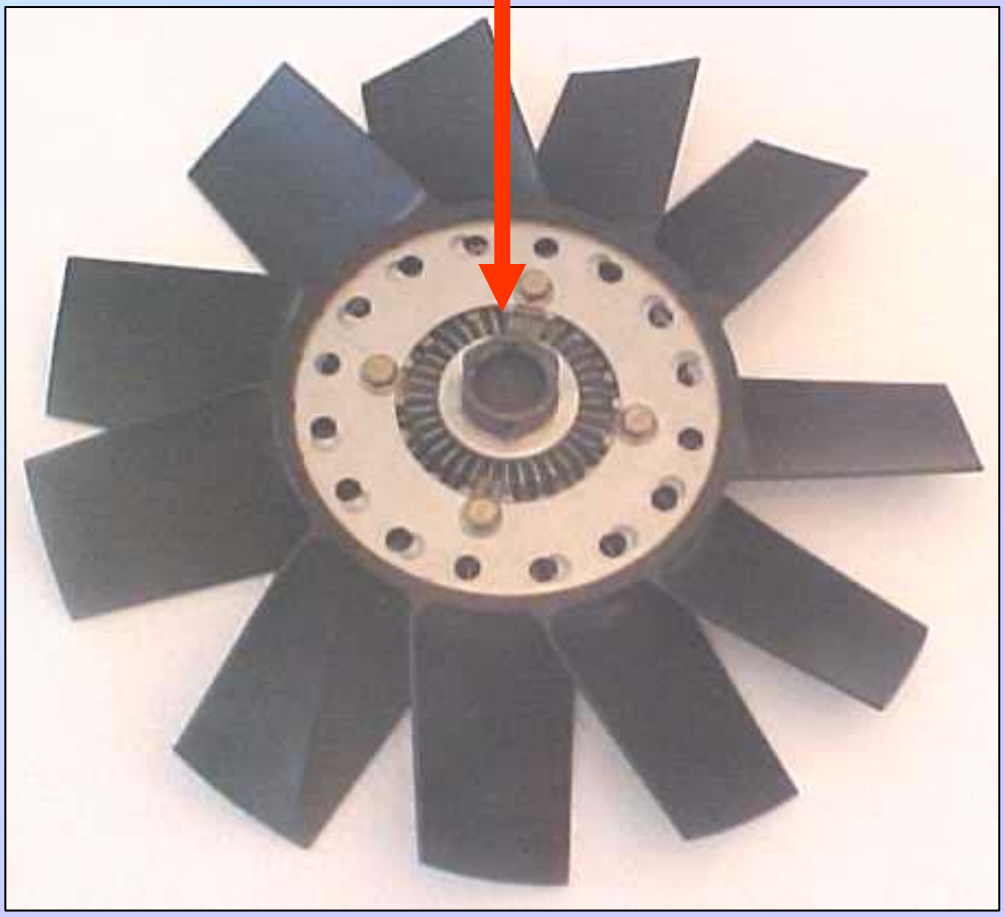
The VFD assembly should be kept in either vertical plane or in horizontal plane with bimetallic strip facing down.

Note : If store in horizontal position resting on the nut face then the silicon fluid will flow down to the bearing assembly & result in contamination of the bearing's lubricant.

Temperature sensor



Nut

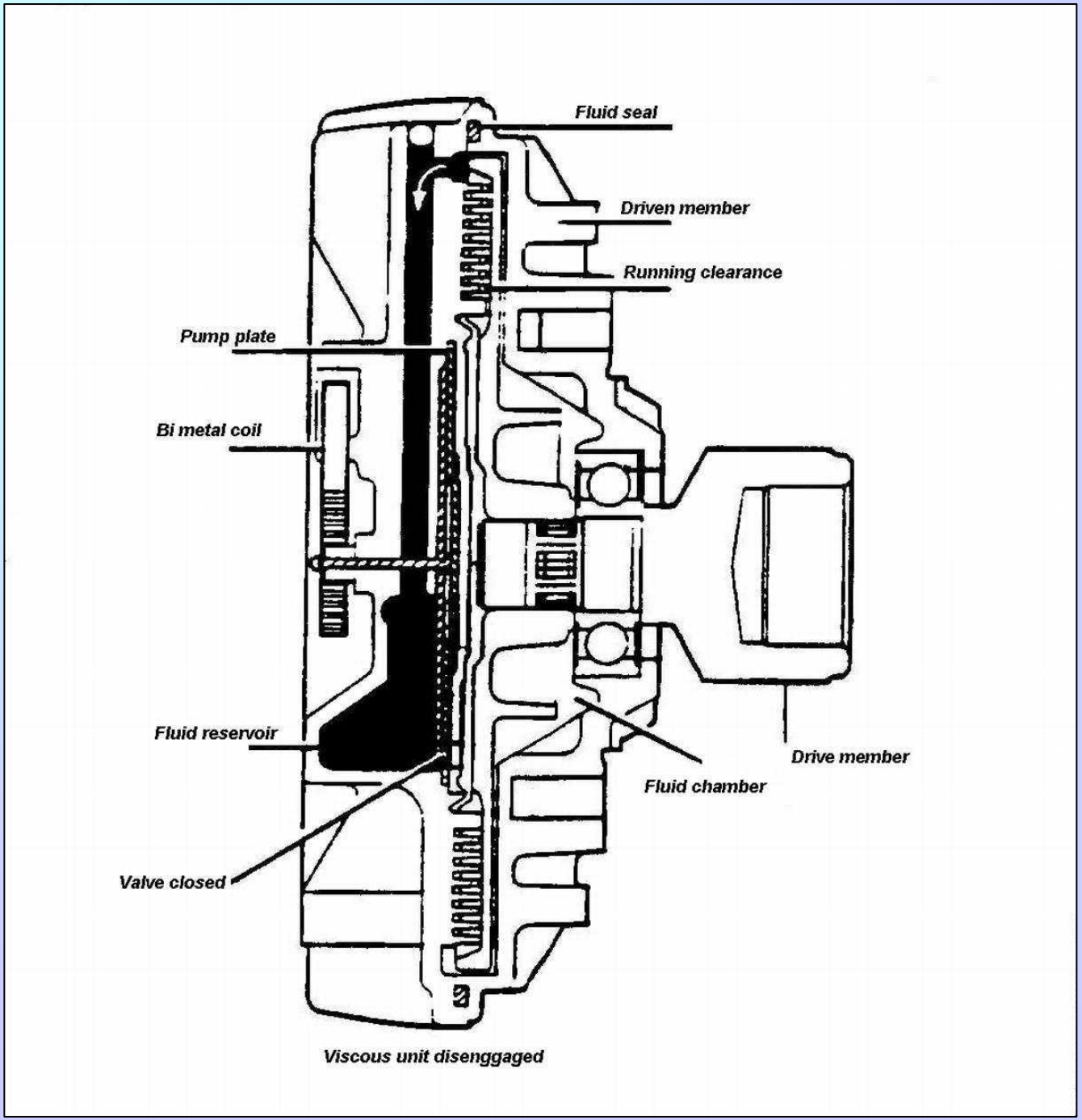


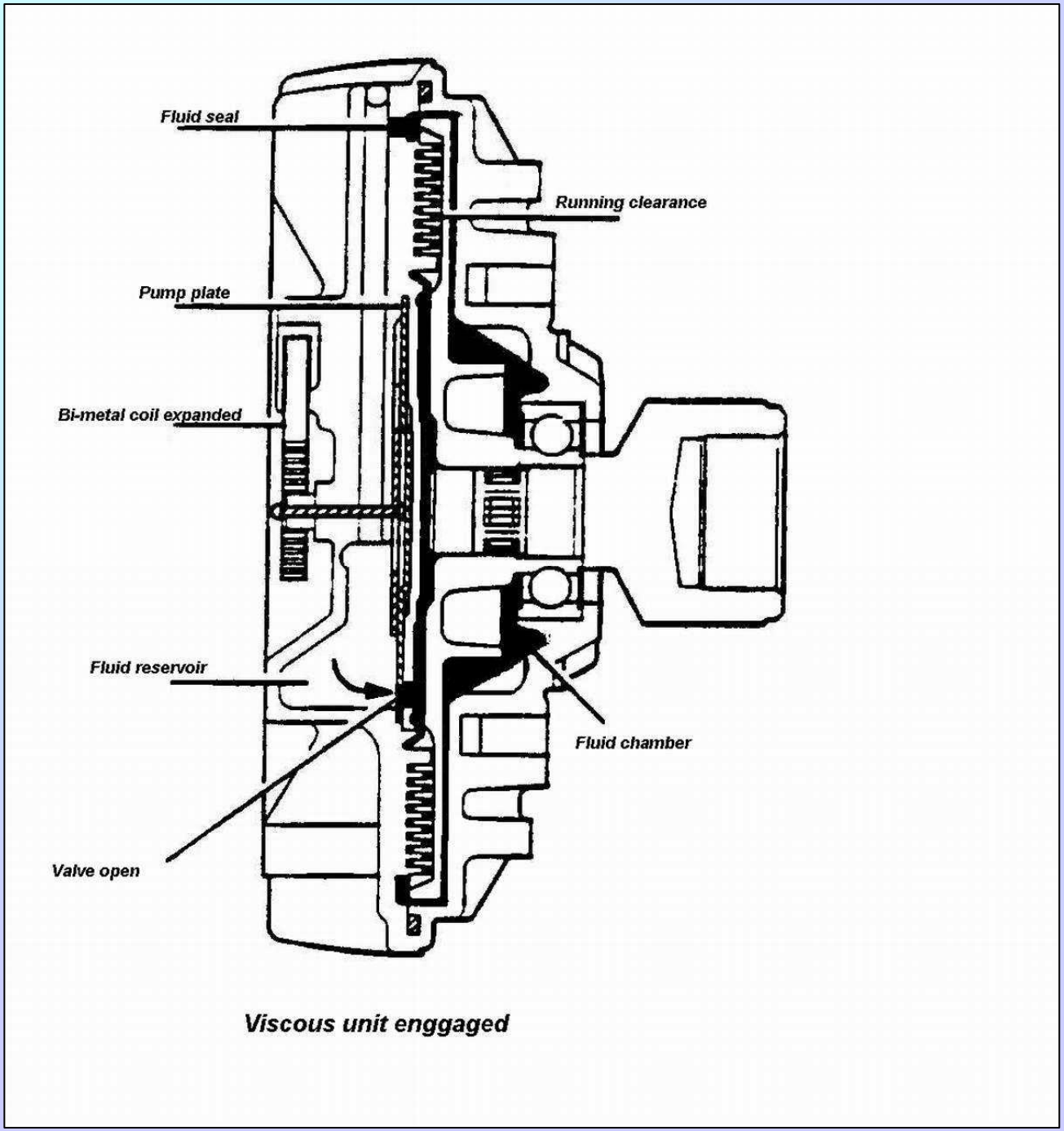
VFD Checking

To check if the VFD is operating itself or not. Let the engine temperature go near the red band. Stop the engine. The moment the engine is stopped the fan blade should also stop rotating. If the fan blade is still rotating then the VFD is not engaged.

To confirmed the VFD fan is engaged or not follow the below procedure.

:- When the temperature reaches to app. 105^0C [1-2 'O' Clock position of needle] , run the engine at around 1600 rpm. That time the fan pulley speed is appr. 2000 rpm. Check the fan speed by using non contact type tachometer. It should be around 1800 rpm.


Fluid seal
Driven member
Running clearance
Pump plate
Bi metal coil
Fluid reservoir
Drive member
Fluid chamber
Valve closed
Viscous unit disenggaged



Viscous unit enggaged

Oil filter

Ensure that the oil retaining seal is present inside the filter.

Oil retaining seal retained oil inside the filter even after engine is switch off.

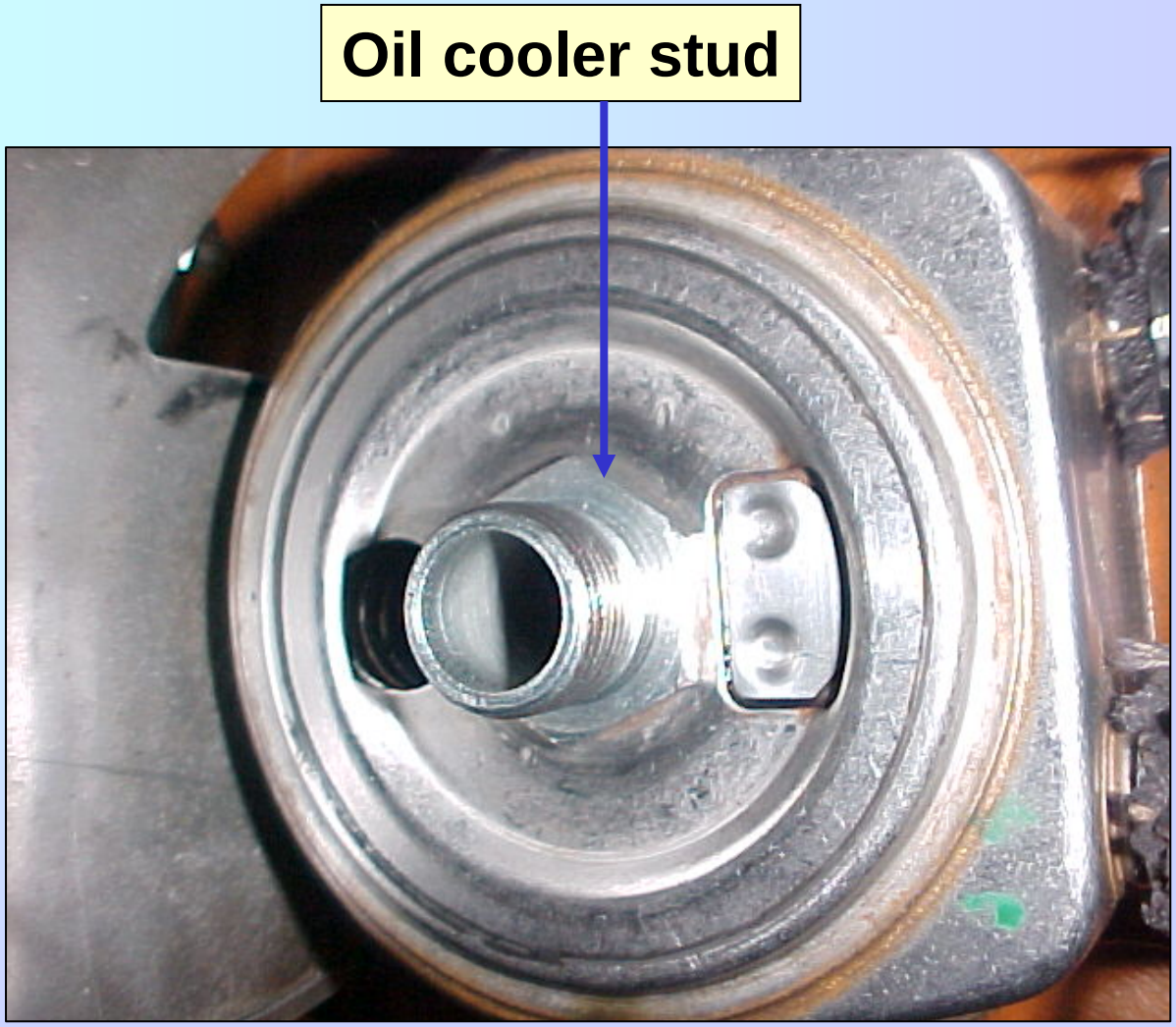
Oil cooler

Control the oil temperature.

Uses engine coolant as a cooling media for hot oil.

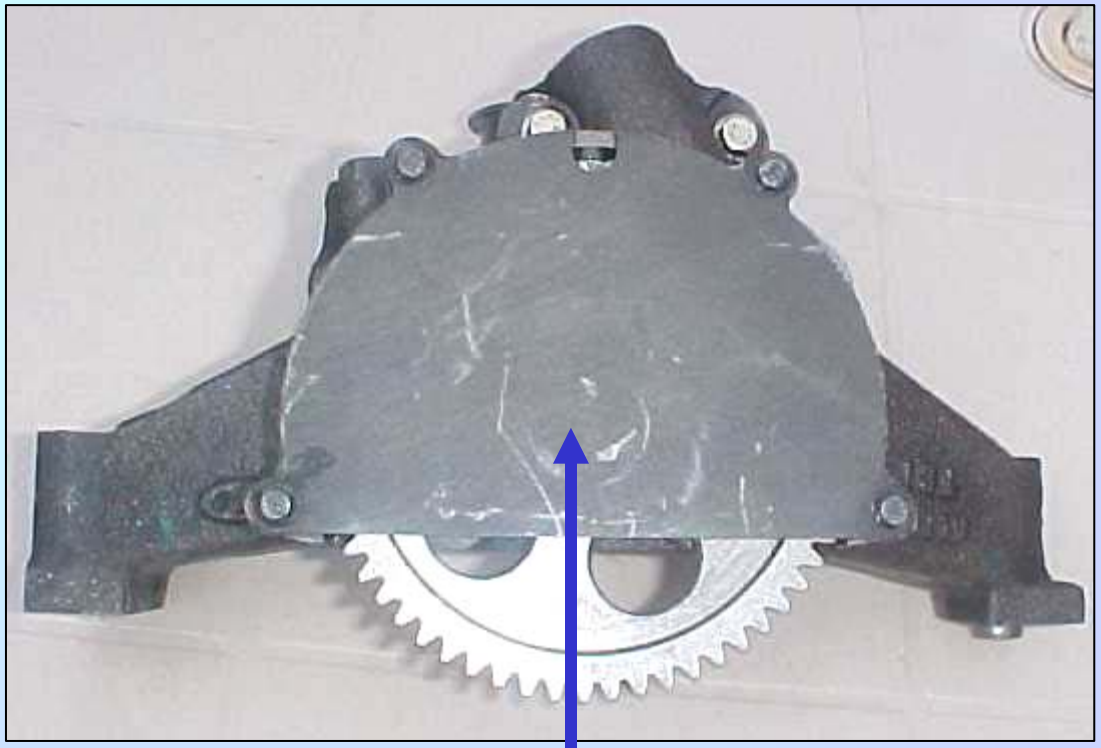
Oil cooler made by vacuum brazing process

Copper traces on surface



Torque oil cooler stud with 3.00Kg-m to avoid loosening of stud while removing the filter.

Oil pump

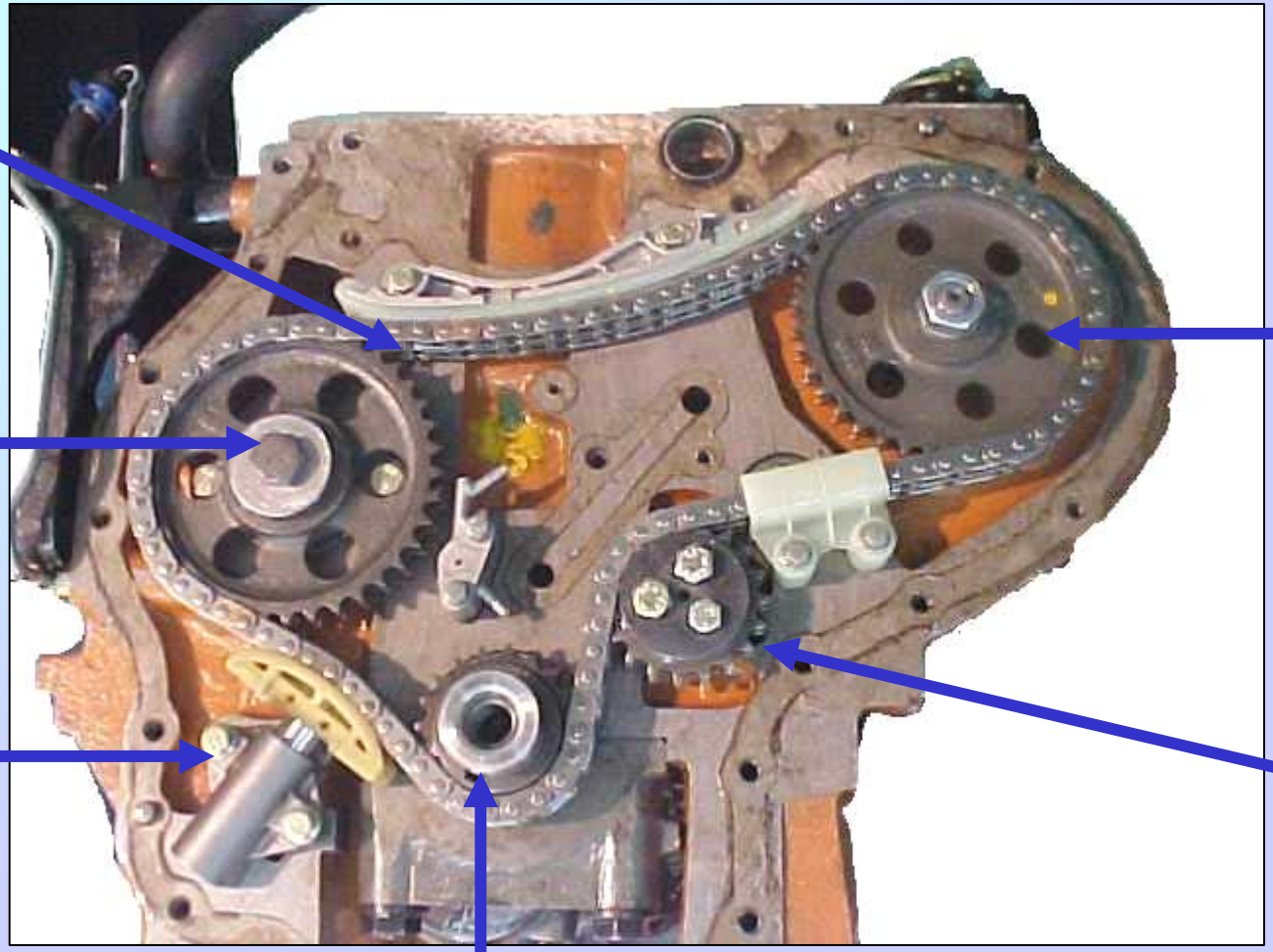


Black phosphating on cover plate on chain drive engine.

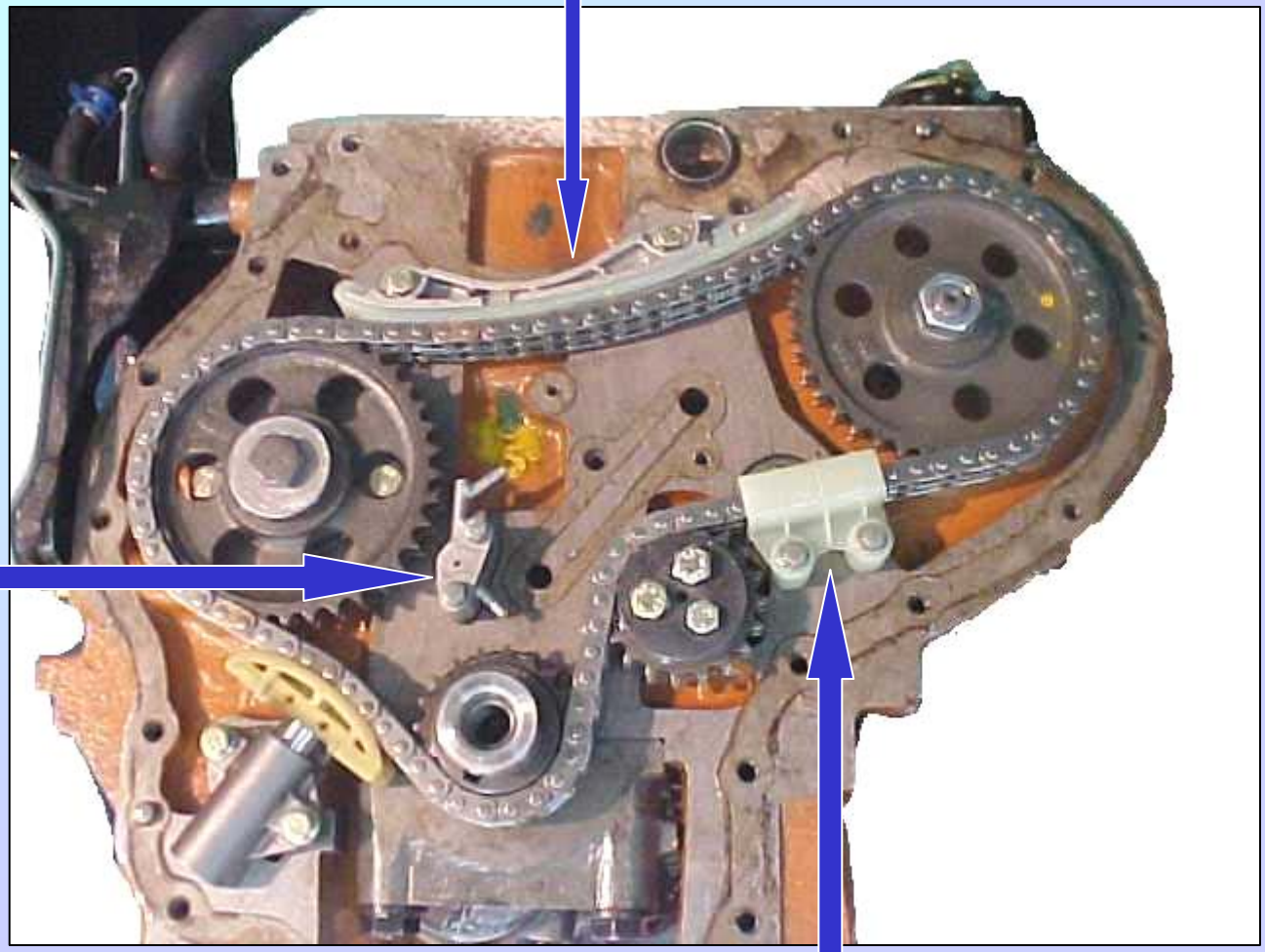
Note : Crank opening pressure of chain drive engine is 4.50bar

IMPORTANT ADJUSTMENTS & SETTING

Chain timing



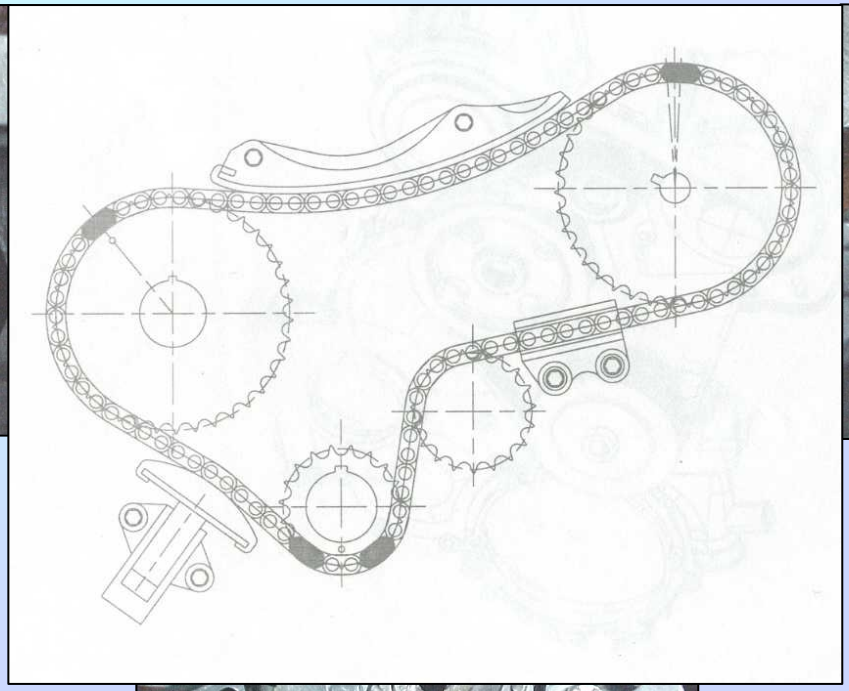
Guide- Cam sprocket to FIP

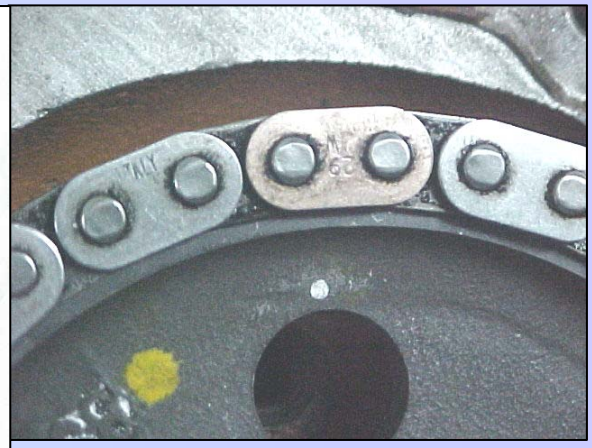


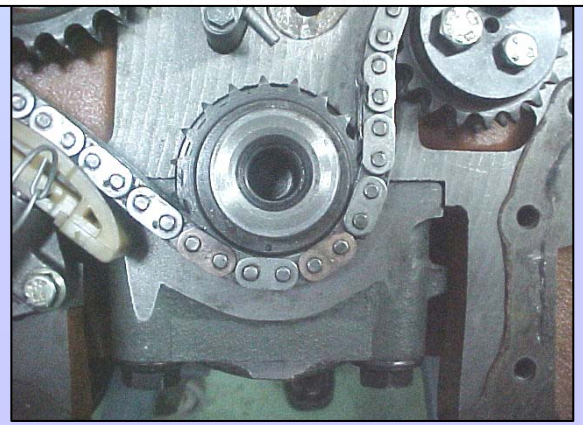
Oil jet

Guide- FIP sprocket to idler

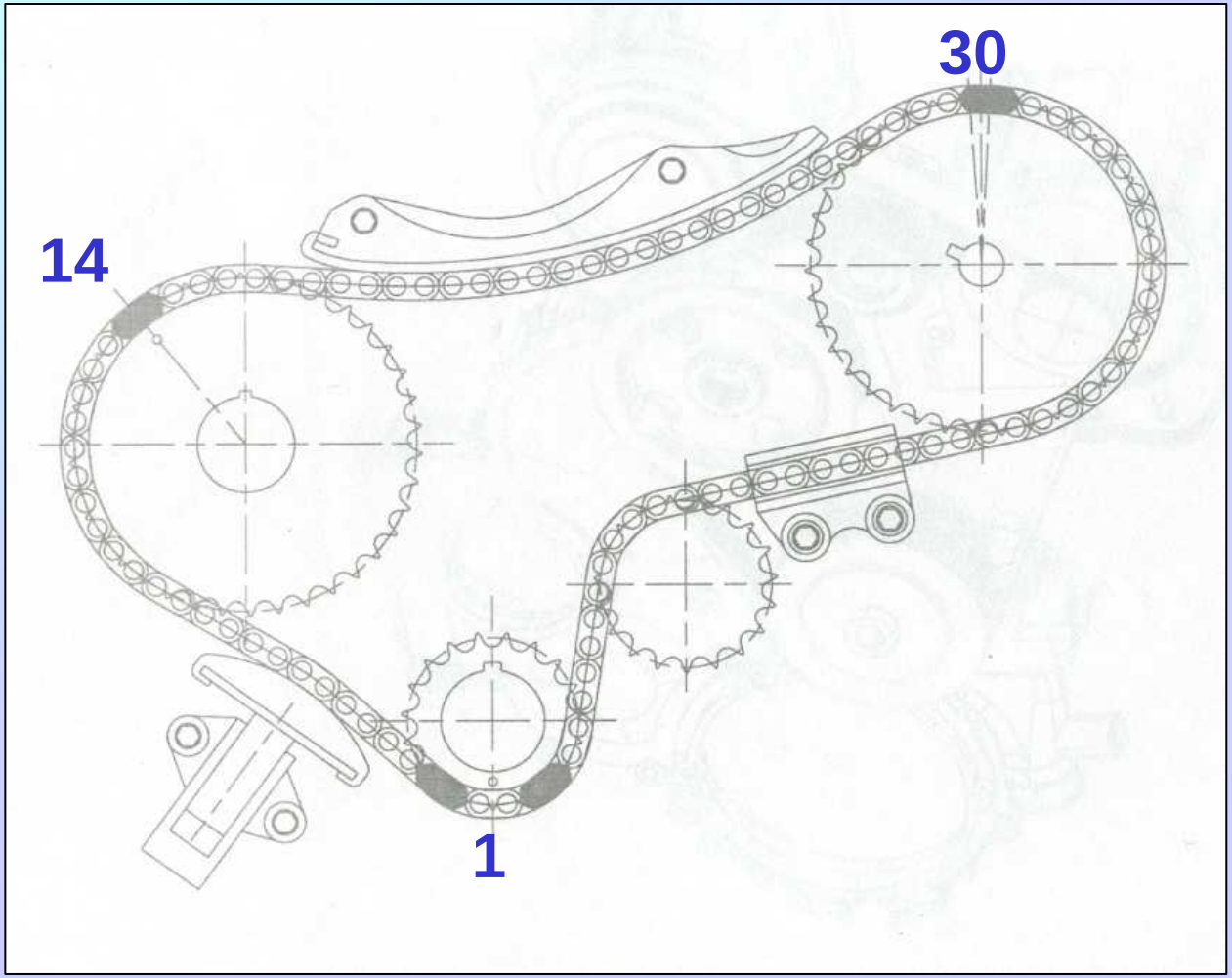
Match center link of two copper coated link with crank sprocket mark. Next copper coated link with cam shaft sprocket mark.Last copper coated link with FIP sprocket mark





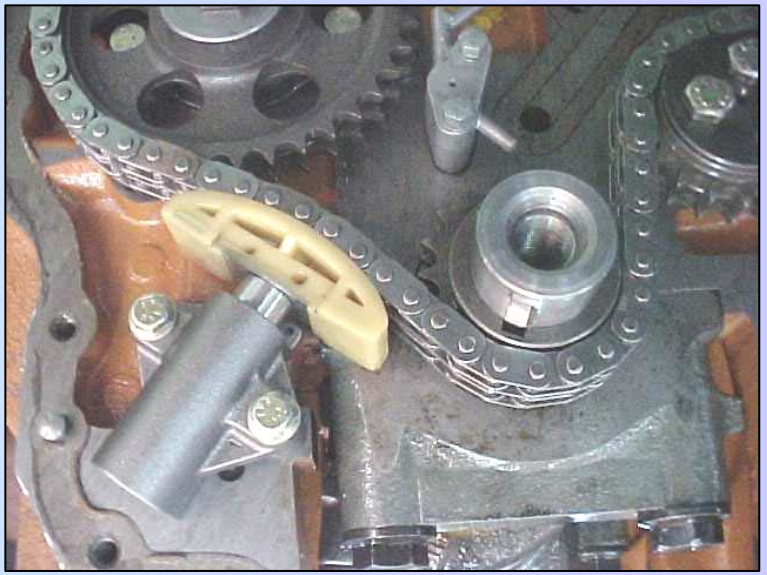


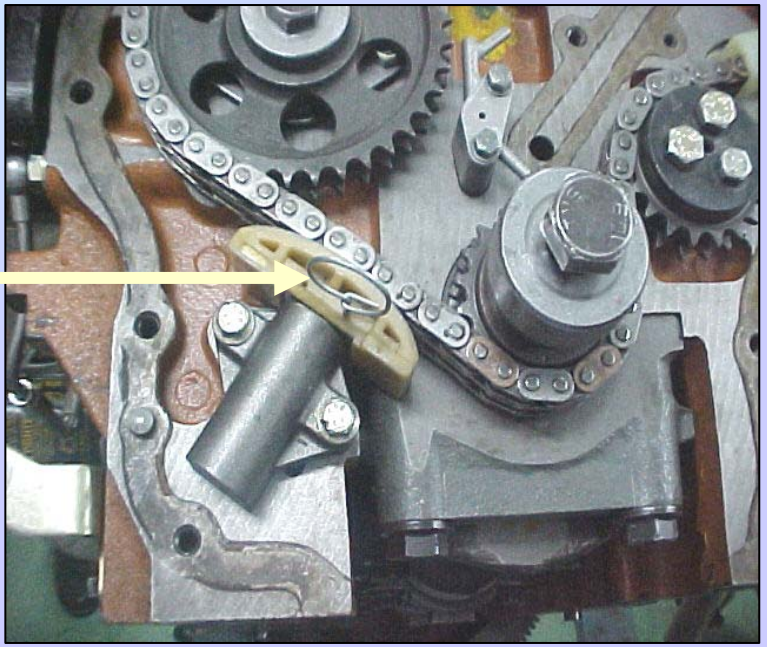
Match no 1 link with Crank sprocket mark
Match no 14 link with Cam sprocket mark
Match no 30 link with FIP sprocket mark



Chain tensioning

Chain tensioning : SZ 2600 Plus engine uses hydraulic chain tensioner hence doesn't required initial chain tensioning.

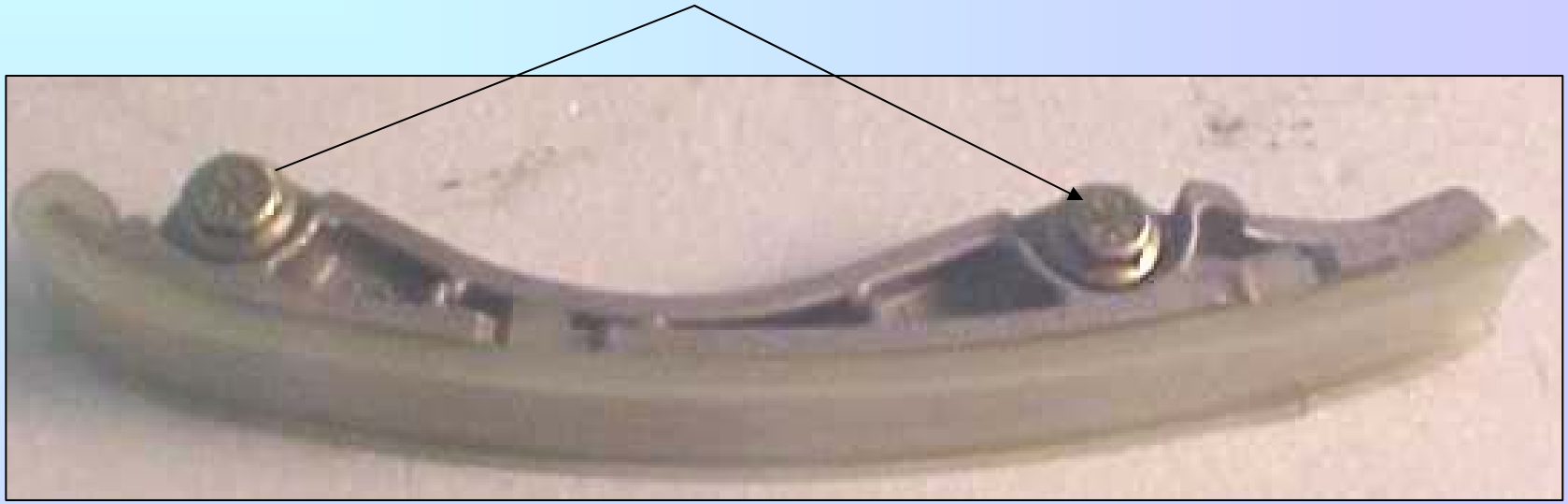




Note : Lock hydraulic chain tensioner, before removing.

Guide - Cam sprocket to FIP sprocket must be secured with a class of 10.9 bolt.

10.9 Class bolt [Part no-0310EC0110N]



Wear limits of chain guides

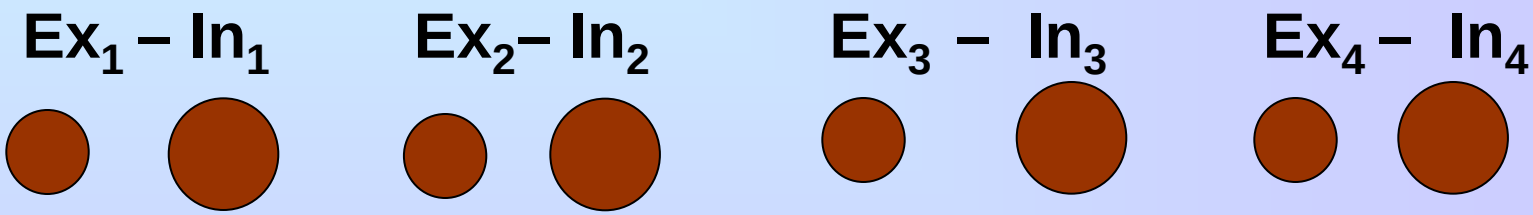
Hydraulic chain tensioner	**:**	**2.00mm**
Guide - Cam shaft to FIP sprocket	**:**	**1.50mm**
Guide - F I P to Idler sprocket	**:**	**1.00mm**

Tappet setting

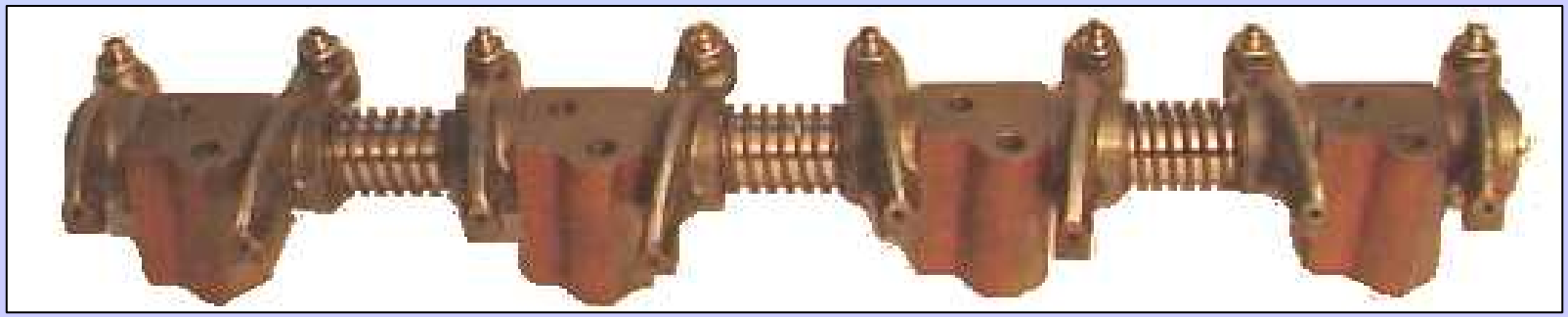
It is recommended to do the tappet setting in cold condition

Inlet : 0.30mm (12 Thou)
Exhaust : 0.45mm (18 Thou)

Valve layout :



FRONT



Procedure for tappet setting

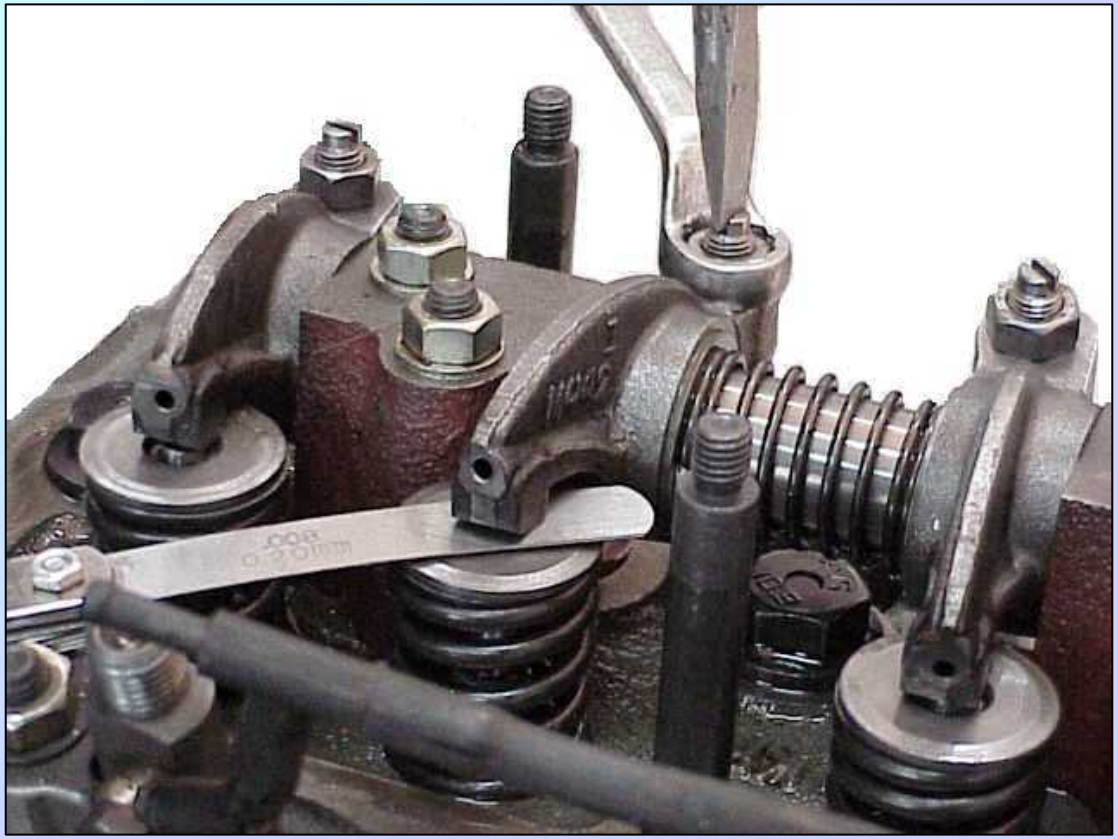
Bring no.1 piston at TDC. Ensure no 4 cylinder valve at rockering position.

Adjust the tappet clearance of No-1 cylinder valve as per given specifications.

Turn the engine further to 180 ^{0} in the dirction of engine rotation. Adjust tappet of No 3 cylinder valve as per given specification.

Follow the above procedure for cylinder No 4 & 2 by further rotating the engine by 180 $^{0.}$

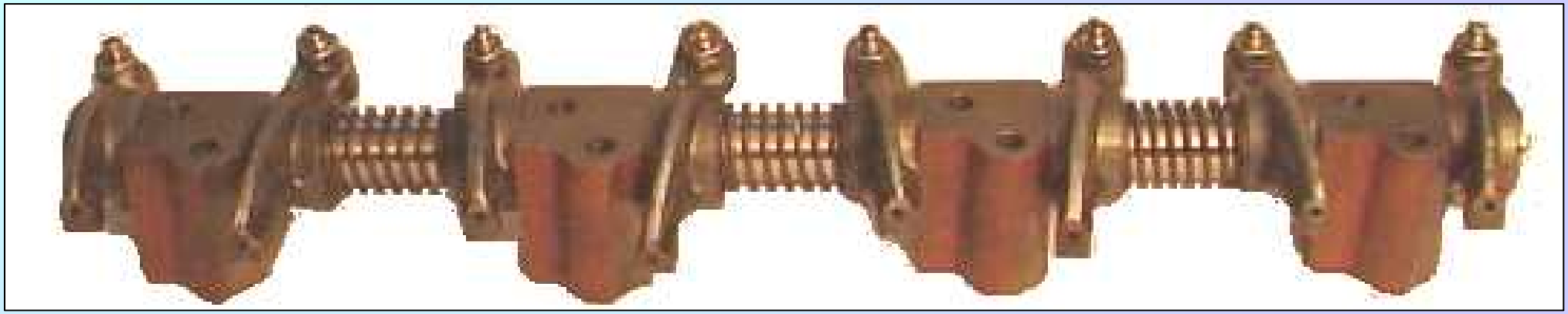
Tappet setting-cold condition



Inlet : 0.30mm (12 Thou)

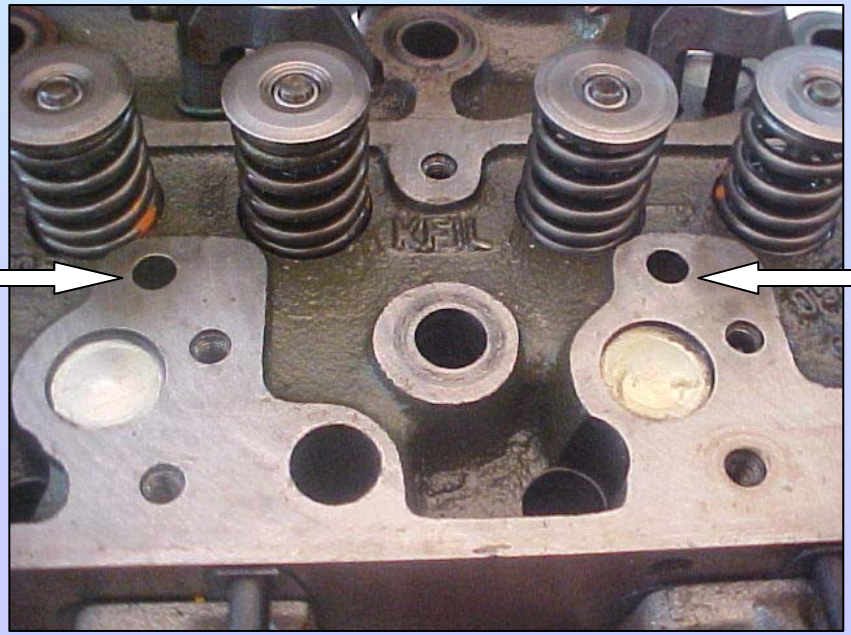
Exhaust : 0.45mm (18 Thou)

Rocker lubrication system



Holes are drilled to lubricate rocker arms below the rocker support 1 & 2.

Oil hole -2



Oil hole -1

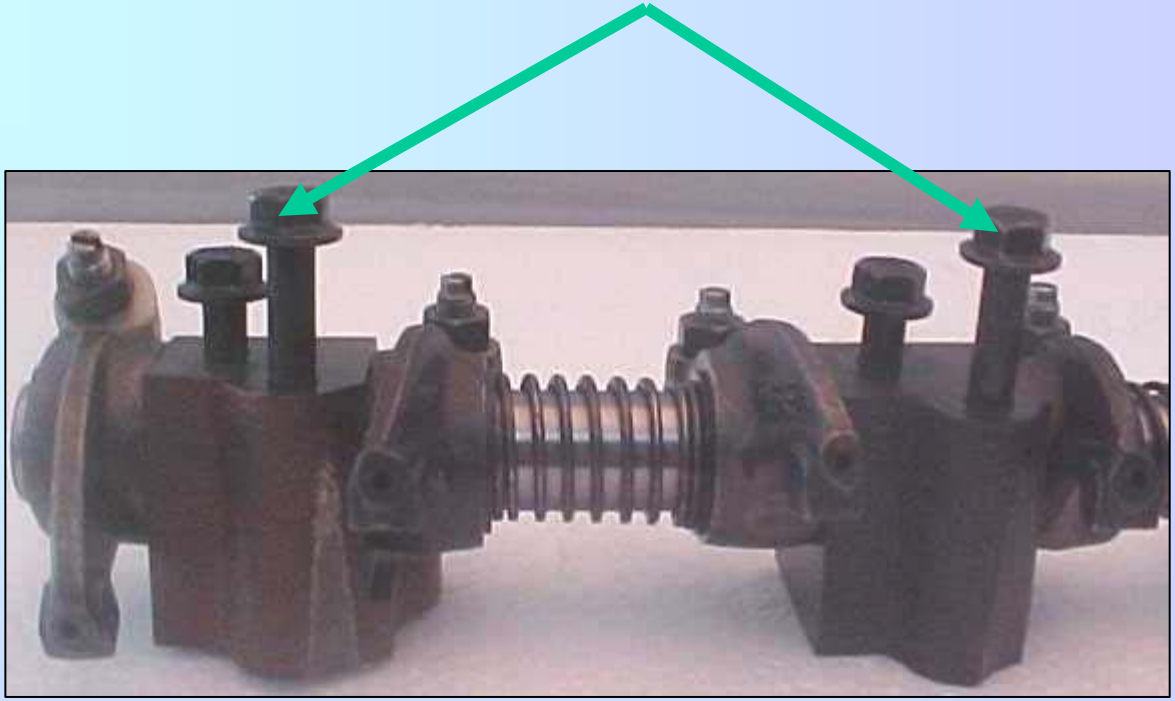
However to supply uniform oil pressure for all rocker arms, oil is taken from oil hole 2.

Oil hole -1 (From fan side) is blocked by means of flat rocker support .

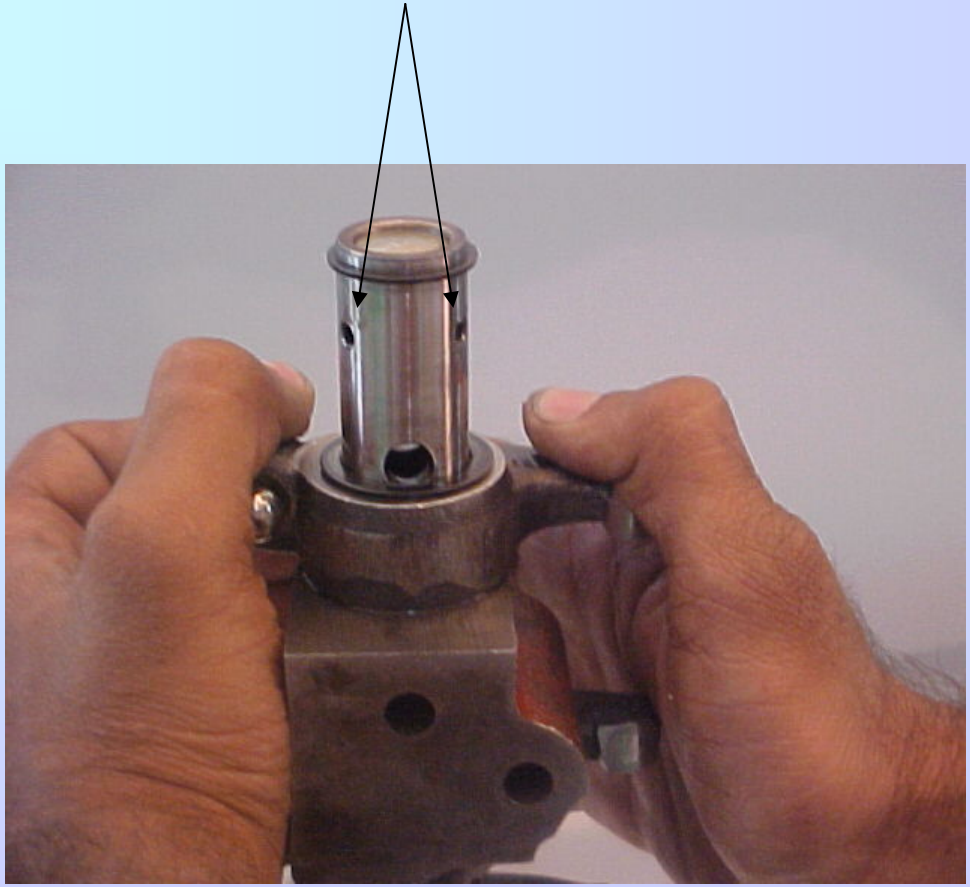
Oil support without slots

Note : Ensured that oil hole 1 is blocked by means of rocker support w/o slot. If slotted support is used for both one & two oil holes, oil pressure will drop significantly which will lead the failure of rocker shaft & rocker arms bush.

Rocker support bolt : Longer bolt are used to secured rocker support above oil holes.



While assembling the rocker shaft, ensure that lubricating holes will face towards head side.



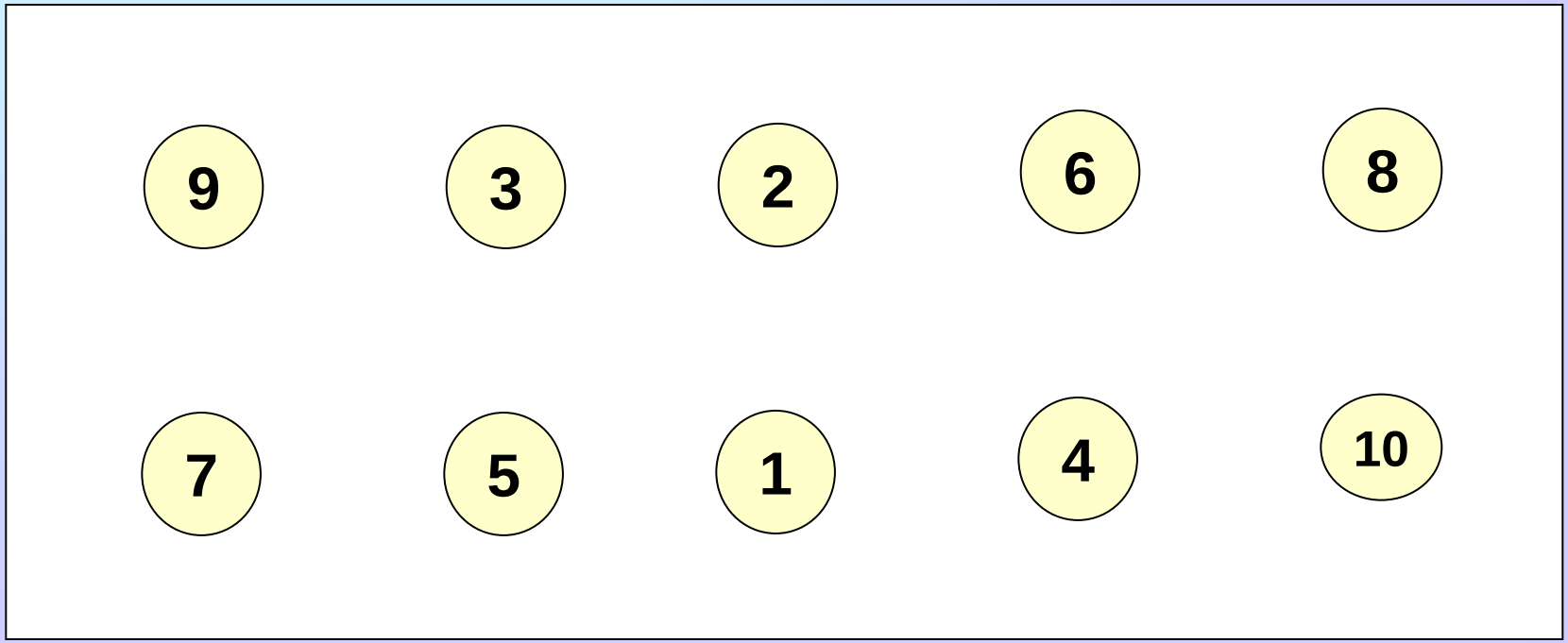
Cylinder head torquing

Step 1: Tighten each bolt in sequence to 9.00 Kg-m (65.00lbsft)

Step 2: Rotate each bolt in the same sequence further by 60^0.

Step 3: Rotate each bolt in the same sequence further by 60^0.

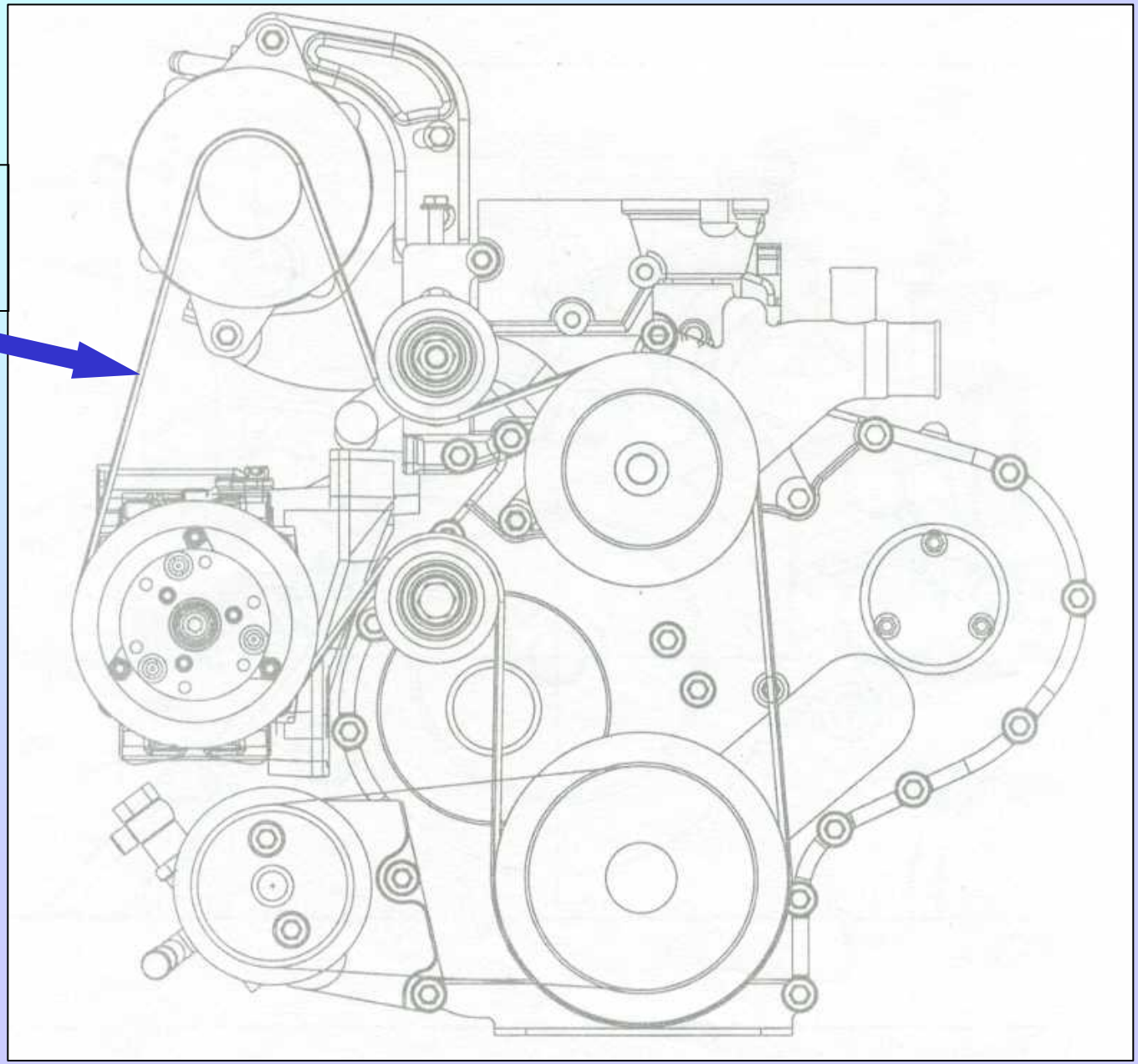
Tightening sequence



Note : While removing cylinder head , ensure that the bolts are loosen in reverse of tightening sequence.

Front end accessories drive-SZ 2600PLUS

Check frequency



Belt alignments / Belt replacements

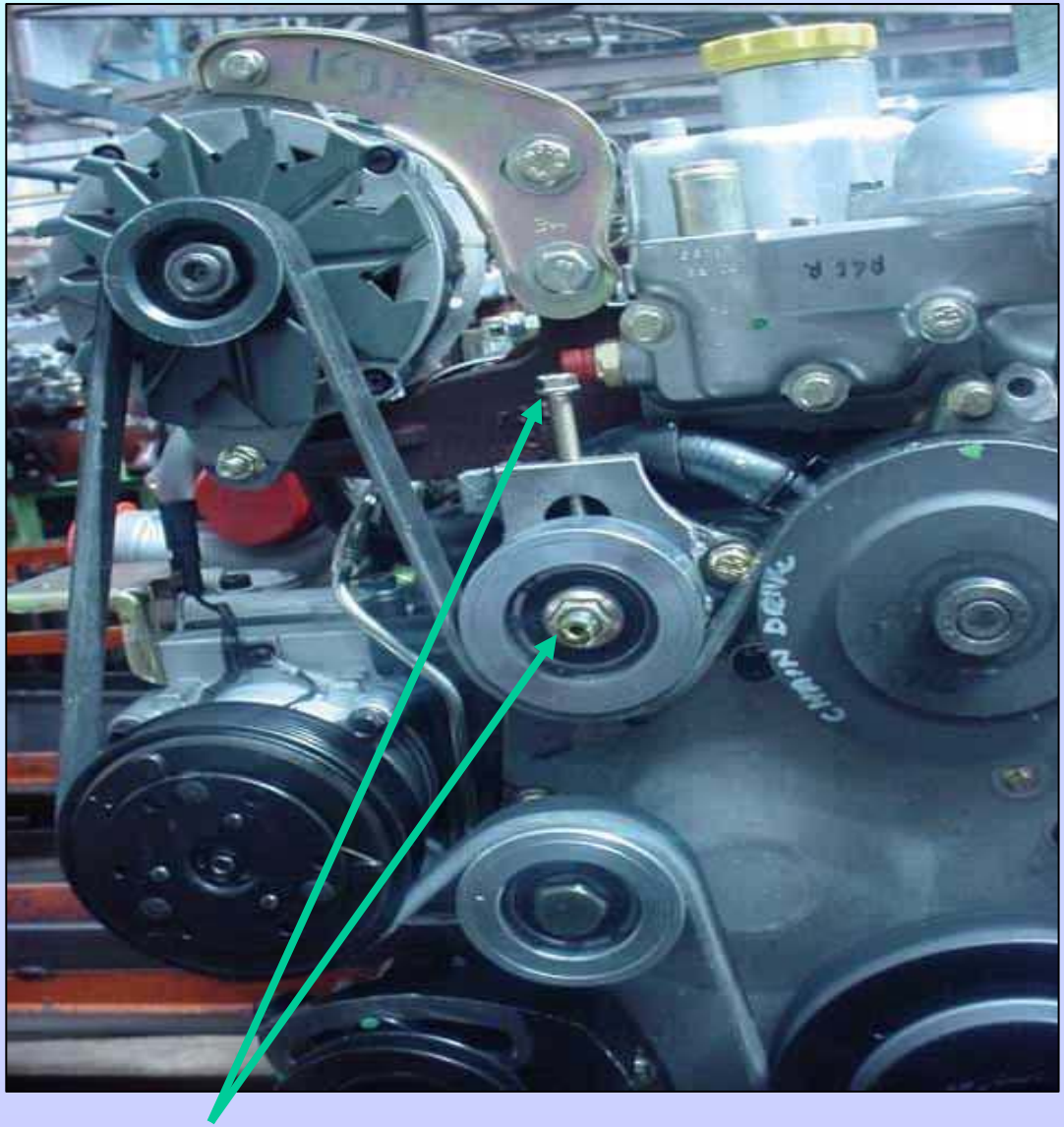
Loosen the tensioner pulley nut and release the belt tension by loosening tensioning bolt.

Remove the old belt.

Ensure integral bracket bolts tightness on the front cover (Torque 2.5 Kg-m)

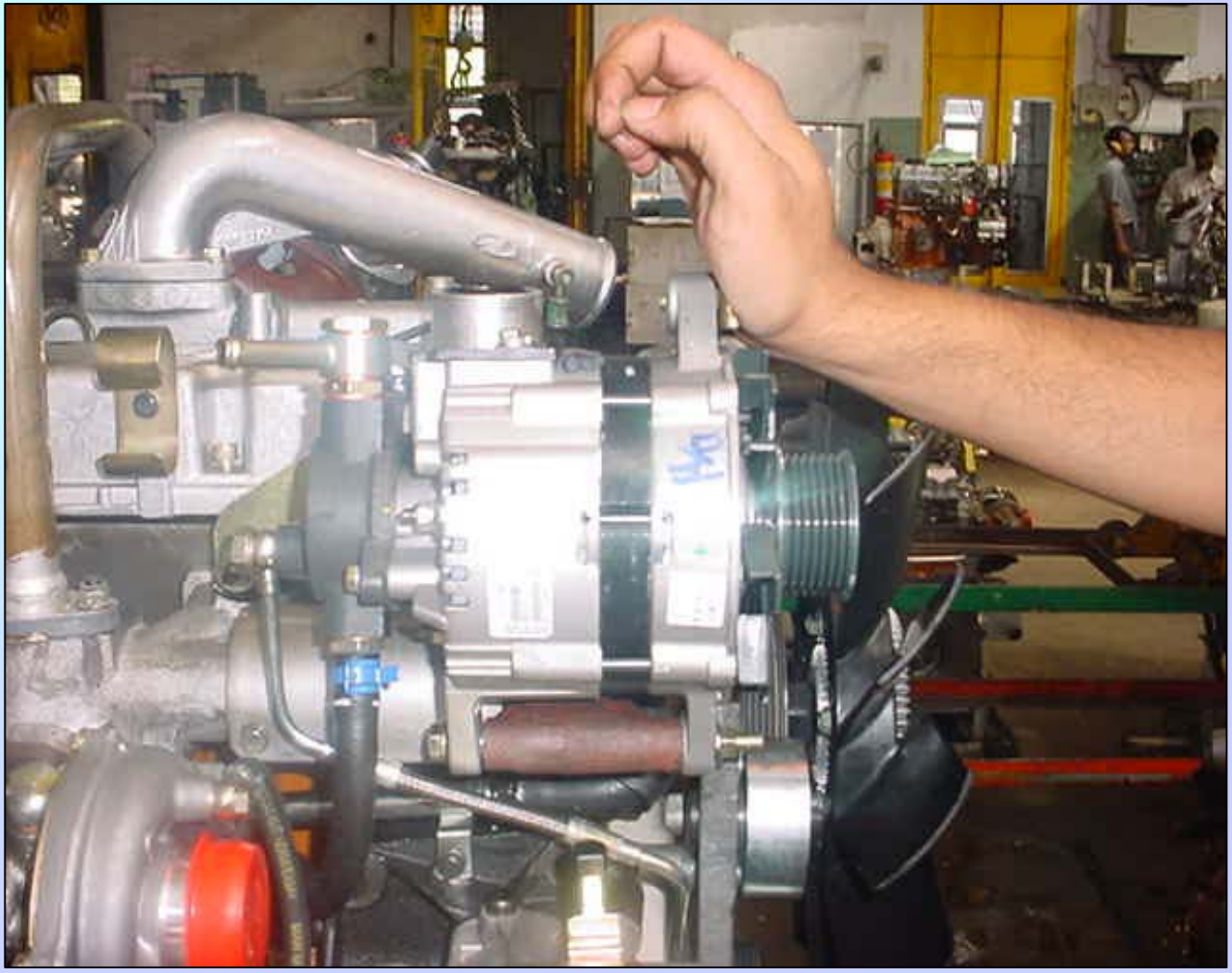
It is not necessary to loosen the alternator and brace mounting bolts.

Loosen alternator mounting bracket 2 bolts (mounting on cylinder head) & push the alternator along with bracket to the rear side. essentially the top portion of the alternator should move back. Tighten & torque (4.00 Kgm) alternator bracket mounting bolts on the cylinder head.



Loosen tensioner pulley nut & tensioner bolt to release belt tension

loosen the top & bottom mouting alternator mtg bolts on cylinder head



Push the top portion of alternator with bracket backward & tighten the alternator bracket mtg. bolts on cylinder head

Ensure tightness of alternator mounting bolt (2.5 Kg-m), Brace mounting bolt on alternator (2.5 Kg-m) & brace mounting 2 bolt (m10) on alternator bracket (3.5 Kg-m).

Hand tighten the tensioner pulley nut so that nut face is resting against bearing face.

Engage the belt on all pulleys correctly & push the belt towards the engine on the tensioner pulley. Tension the belt to 140 –145 Hz incase of old belt and 170+/-2 Hz if it is new belt,with the help of tensioning screw. Belt tension to be measured between span of alternator and compressor.

Tighten and torque the tensioner pulley nut.(3.5Kg-m)

If the belt is new, run the engine for few minutes and confirm the tension 140 - 145 Hz.

S.O.P for belt noise (continuously on the engine)

Spray some drops of water between tensioner pulley and belt.

On running the engine at idling rpm, if the noise disappears and again reoccurs, the alignment is said to be off. (Follow the above procedure for alignment)

On running the engine, if the noise continues or increased, the belt tension is low. tension to be reset to min. 140- 145 Hz.

If the noise still persists, reverse the direction of the belt on the pulleys. (Follow the above procedure from point. no. 1 & 7 onwards.) If the noise persists the belt needs to be replaced.

Belt tensioning [Gate/Clavis gauge] :

		Chain drive
New belt tension	:	170 +/- 2
Stabilised belt tension	:	140 + 5
Min belt tension	:	125

While fitting a new belt, set the tension as per new belt value.

Drive the vehicle for min 5 Kms, check the belt tension, if it is less than stabilised belt tension, reset it to stabilised belt tension.

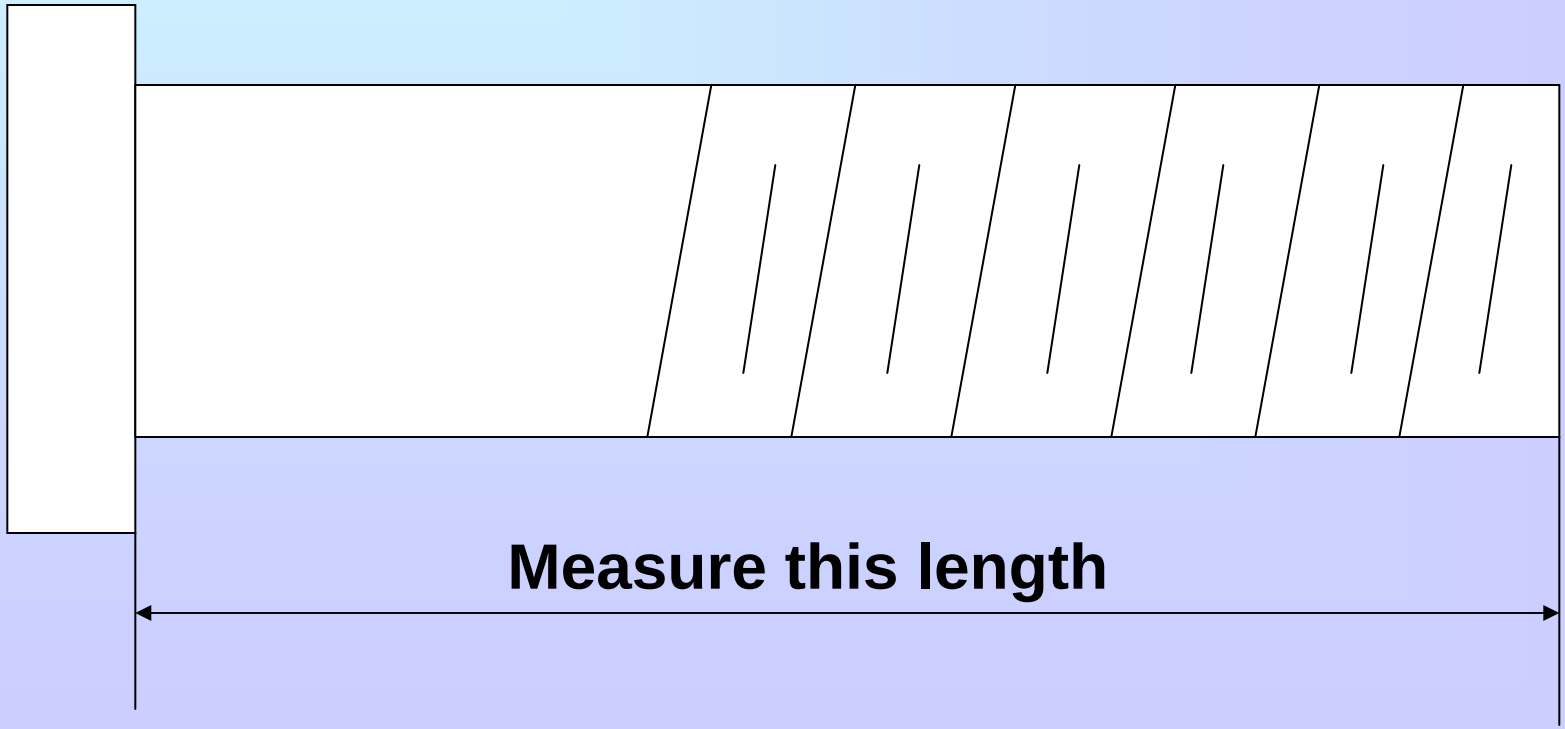
Belt should not be run less than minimum belt tension value.

Note : Poly 'V' belt is manufactured by using EPDM rubber , Belt must be protected from contact with oil.

Bolt acceptance criteria

It is possible that that bolt may get elongated when torque either by using angular torquing or by using torque wrench.

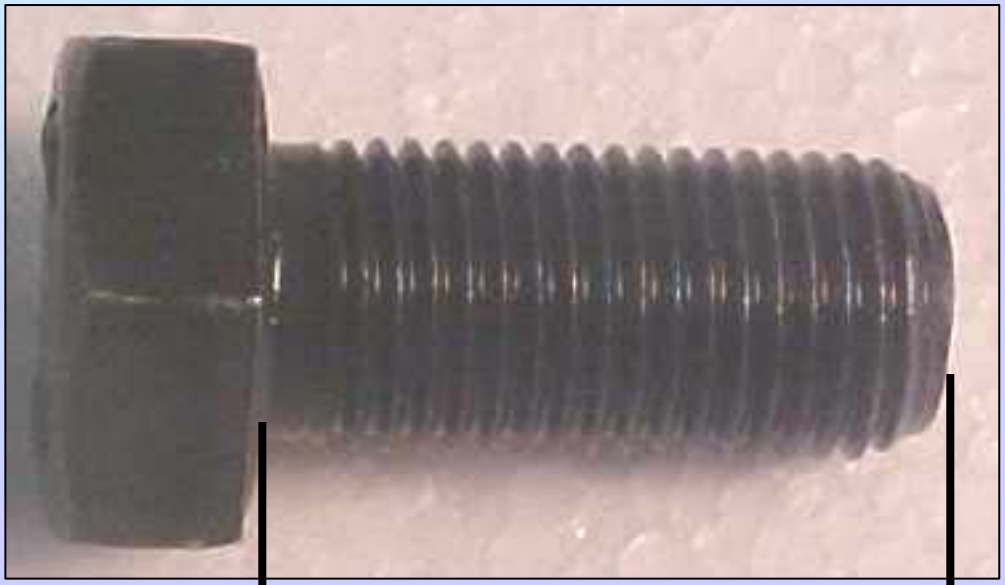
Measure the length, if it is within the limit the bolt can be reused



Cylinder head bolt :

135.40mm to 136.60mm

Flywheel bolt :



29.58mm to 30.42mm

Main bearing bolt :

Connecting rod bolt :

Replace all the time

Idling , Antistalling & FICD setting

Engine : **SZ 2600 / SZ 2600 Plus**

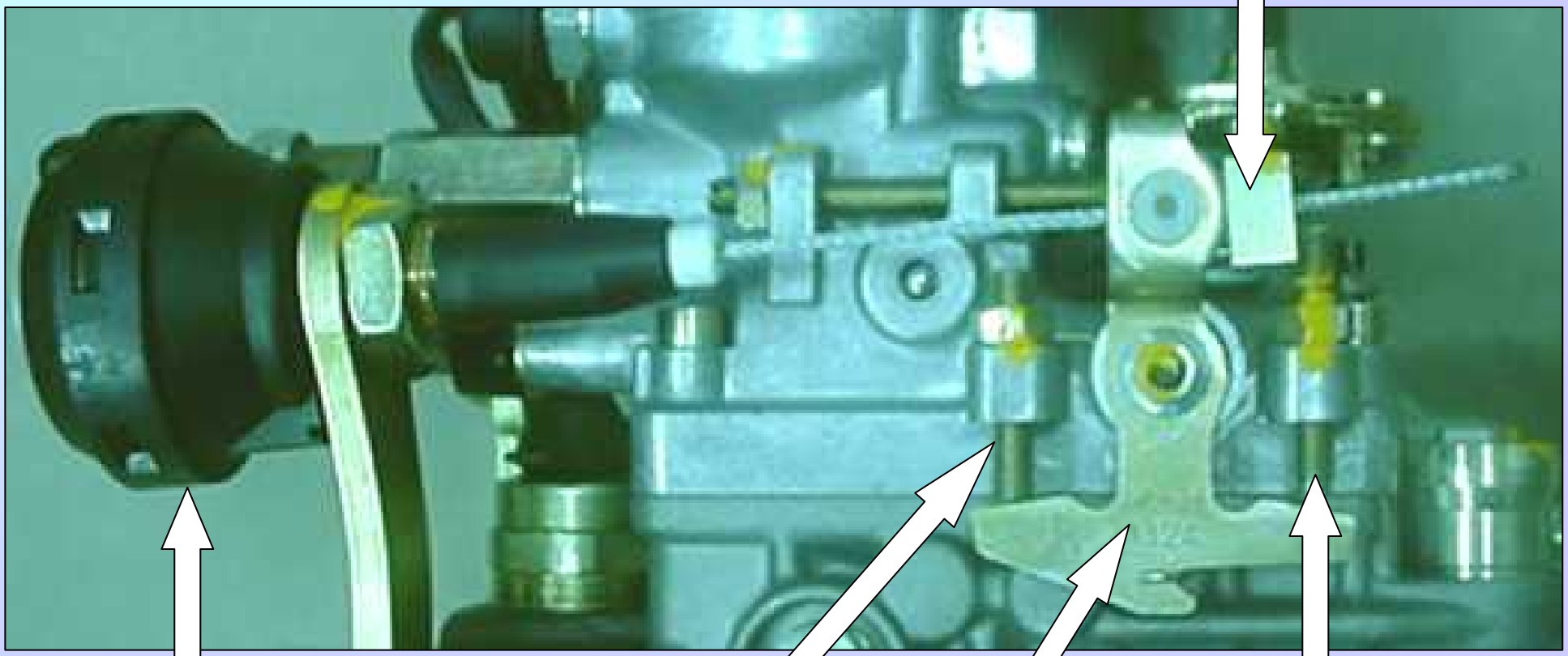
Fuel injection pumps

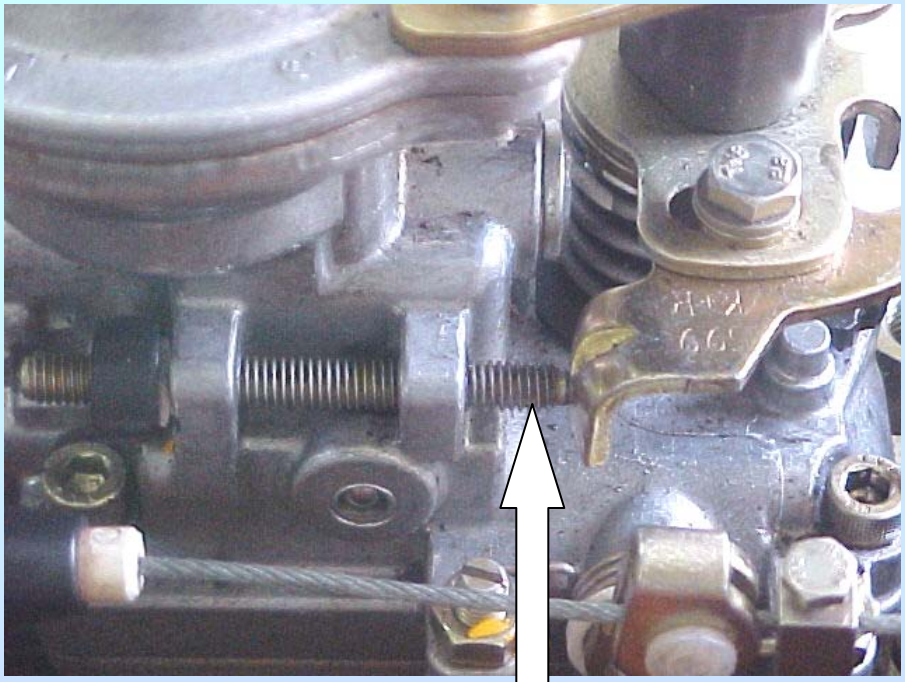
BSII : **0 460 414 223**

Idling Specification

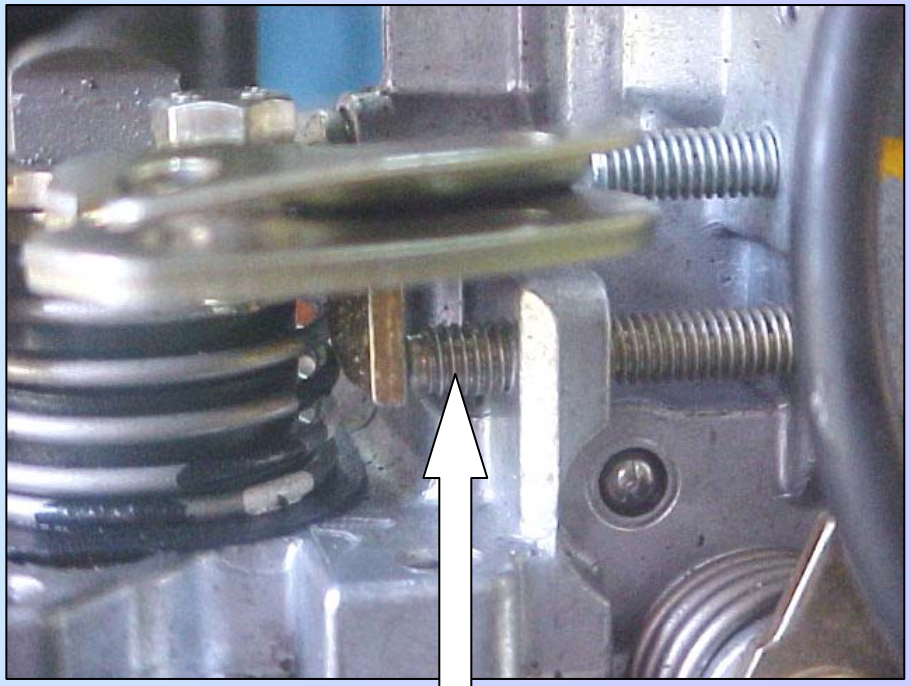
Normal Idling : **825 to 900 rpm**

Fast Idling on vehicle : **850 to 950 rpm (With AC load)**


Clamp
PLA unit
Idling screw
LFG lever
Fast idle screw



Antistalling screw



High idle screw

[Do not disturb this screw]

Procedure to adjust the Idling rpm on Vehicle

1] Observe / record idling rpm in as is condition.

2] Ensure LFG lever is resting on idling screw . Gap between LFG lever and clamp on cable to be approx. 1.0 to 1.5 mm. If LFG lever is resting on clamp, release the clamp and check for Idling rpm again.

- **If idling rpm is in spec. Set fast idling as defined in procedure 'B'**
- **If idling is not in spec. Adjust the idling by following method.**

3] Unscrew anti-stalling fully such a way that this has no effect on idling rpm and idling is controlled by normal idling screw.

4] Unscrew Fast idle screw to ensure it doesn't stop the movement of LFG lever.

5] Set the idling to 845 - 850 rpm approx. by adjusting idling screw.

Screw in : increases rpm , screw out : reduces rpm.

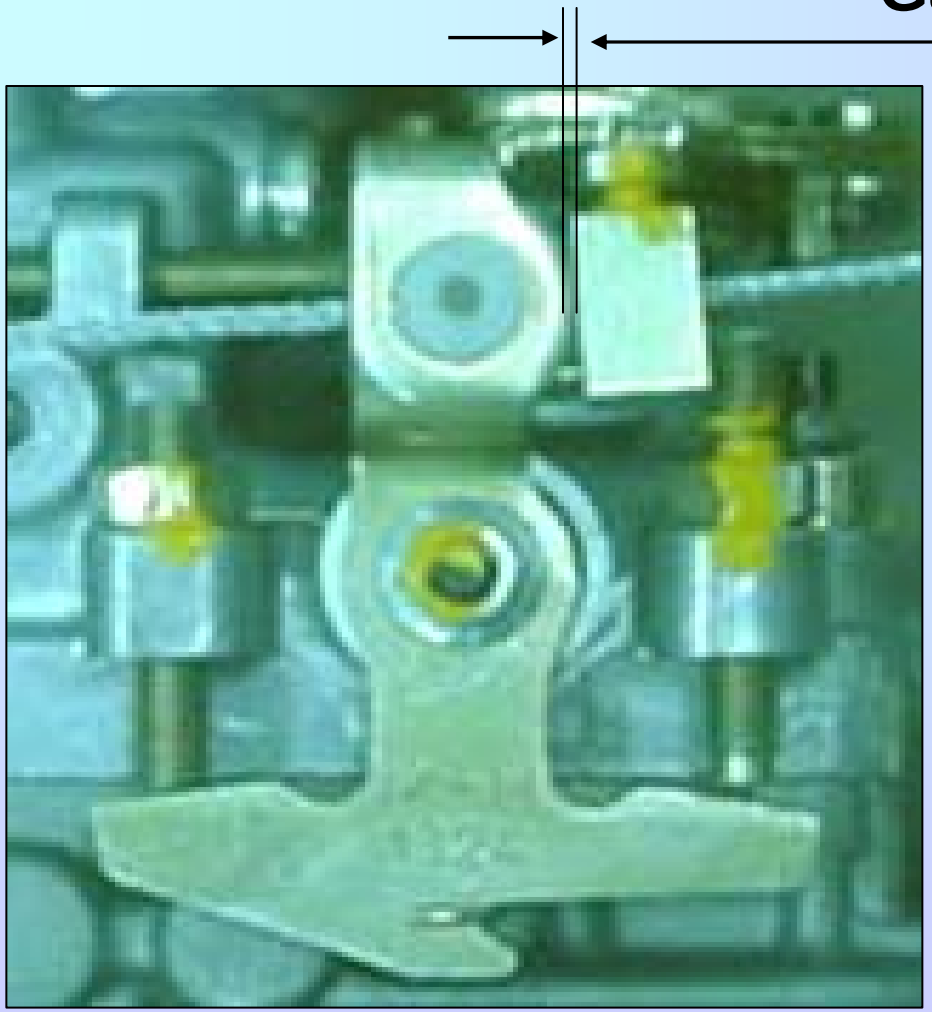
6] Re set the anti-stalling screw to get idling rpm of 855 - 860 approx..

Idling set with anti stalling should be slightly more then normal idling

7] To ensure anti stalling screw is in proper position. Set or ensure the gap between clamp and LFG screw , lock it at that position.

8] Set Fast Idling as explained in procedure ‘B’ .

Gap to be maintained



1.0 ± 0.5 mm

B] Setting Fast Idling rpm on the Vehicle.

1. Ensure Idling is with in the specification

2. Ensure gap is maintained between LFG lever and clamp

3. Switch on the AC. When AC is on vacuum supply will go to PLA unit which activates the LFG lever and pulls in lever so that it butts against fast idle screw . Ensure LFG lever is pulled.

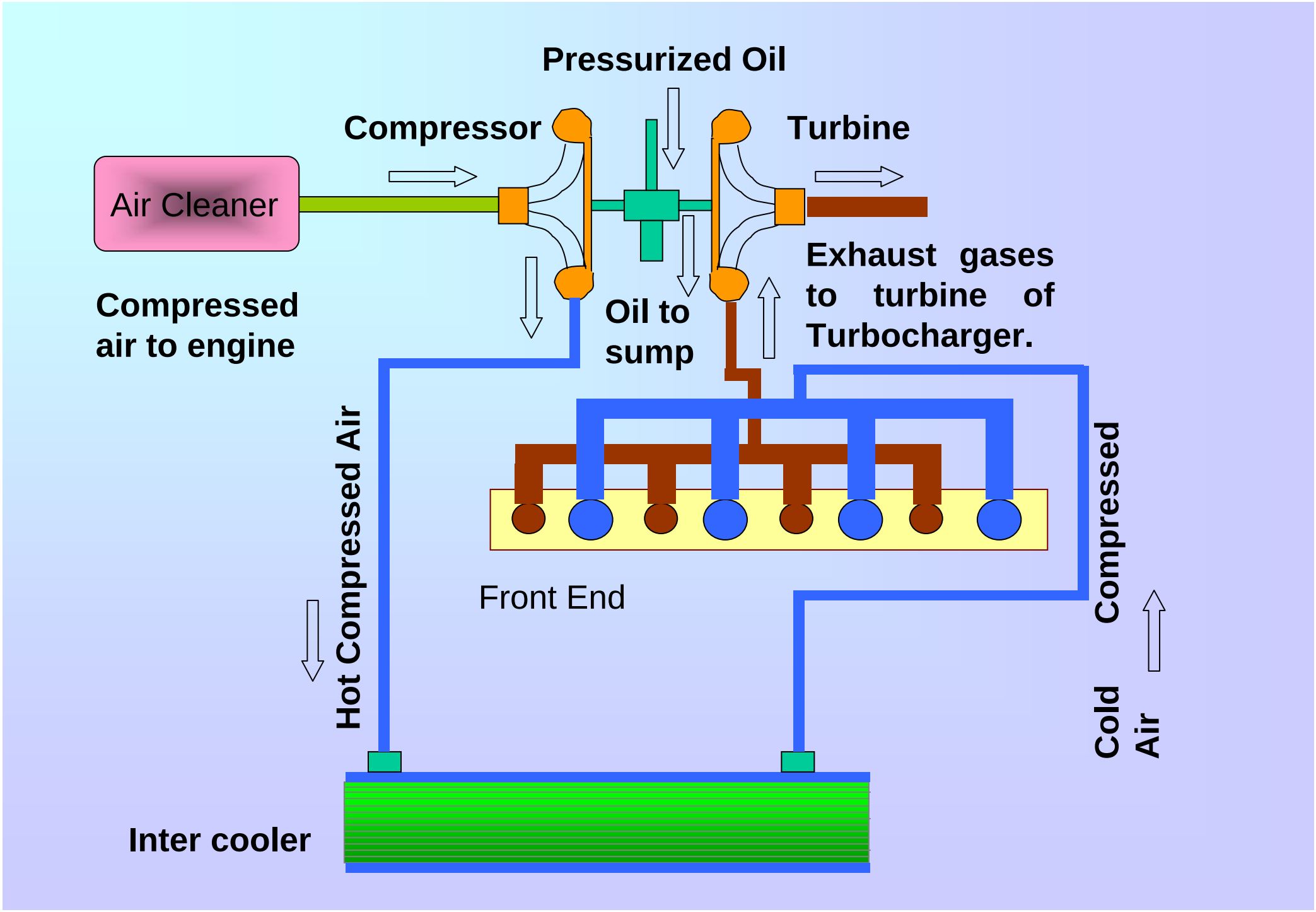
4. Measure engine rpm.

5. If rpm is out of specification adjust the fast idle screw to get required rpm.

   - Screw in : Decrease rpm , Screw out : Increase idling rpm
   - With AC on (load on engine) fast idle rpm should be between 850 - 950

5. Lock fast idle screw in that position.

Turbo charger


Pressurized Oil
Compressor
Turbine
Air Cleaner
Exhaust gases to turbine of Turbocharger.
Compressed air to engine
Oil to sump
Hot Compressed Air
Front End
Cold Compressed Air
Inter cooler

Principle of turbocharger

In exhaust gas turbo-charging, the exhaust gas energy which would normally be wasted , is used to drive a turbine. The turbine drives a compressor, which draws in combustion air and feeds this at a higher pressure to the engine.

Main advantages of the turbocharger are :

Lower fuel combustion.

Lower emissions.

Better torque characteristics.

Lower weight and smaller engine package.

Lower engine noise

Altitude compensation

Precautions for turbocharger

1. Use specified grade of engine oil & oil filter.
2. Regular cleaning / change of air filter element according to engine manufacturer's recommendations.
3. Check for oil pressure at engine idling condition.
4. Idle the engine for 60 seconds after starting the engine.
5. Idle the engine for 60 seconds before stopping the engine.
6. Periodic cleaning of crankcase breather is necessary to allow free flow of oil from turbocharger outlet.
7. Regularly check the oil feed and return pipes for leaks, air intake system pipes and hoses for leakage, blockage and exhaust piping for leakages, blockage.
8. Check the fuel injection system for proper functioning
9. Close all the turbocharger openings with protective plugs when not in use.

1. **Don’t run the engine with low oil pressure.**
2. **Don’t put the engine under full load immediately after starting.**
3. **Don’t switch off the engine in full load condition.**
4. **Don’t run the engine with leaky, restricted oil feed & drain pipes.**
5. **Don’t run the engine with blocked, punctured, aged, deformed hose / pipe connections from the air cleaner to the turbocharger and turbocharger to the inlet manifold.**
6. **Don’t run the engine with leaky connections, blocked, deformed connections to the turbocharger turbine inlet and from the turbine outlet.**
7. **Don’t tamper with the fuel injection system.**
8. **Don’t use actuator control rod for turbocharger. Do not tamper the actuator settings.**
9. **Don’t dismantle turbocharger contact TEL authorized service center.**

Exhaust gas recirculation

Emission control for BS2 diesel engines

Normal/Ideal combustion

Diesel($C_{10}H_{22}$) + Air(77% N_2, 23% O_2) ---> Co_2 + H_20 + N_2

Actual combustion

Diesel($C_{10}H_{22}$) + Air(77% N_2, 23% O_2) ---> Co_2 + H_20 + N_2 + O_2
+ Co + HC + No_x + PM

Components of diesel exhaust

Co - Colourless, poisonous gas

Hc - Colourless , poisonous gas

No_x - Brownish ,poisonous gas

PM - particulate matter, commonly called soot or smoke

Co_2 - Non-poisonous - Potential greenhouse gas related to global warming.

H_20 - Non-poisonous

Bharat stage 2 emission norms

Chassis Dynamometer Tests (Cycle : EEC + EUDC - 90 km/h)

All in g/km

	CO	HC+Nox	PM
RW >1700	1.50	1.20	0.17

RW [Reference Weight] = Curb weight + 200 Kgs

Tests are on Chassis Dynamometer

EUDC Cycle Speed is limited to 90 km/h instead of 120 km/h (in EEC)

Emission control technologies try to reduce these harmful exhaust gases by the following technologies :

1] In-cylinder combustion improvements

In-cylinder improvements aims to attack the problem at the source, i.e improve the quality of combustion inside the cylinder so that less of harmful pollutants are produced inside the cylinder. Some of the in-cylinder options are :

- **Modification to internal engine components**
- **Modifications to fuel injection system**
- **Exhaust gas recirculation (EGR) system**

2] Exhaust gas after treatment

Exhaust gas after treatment aims to reduce the pollutants after they are generated inside the engine but before it is released to the atmosphere. Some of the options are :

- **Catalyst in the exhaust**

Principles of No_x generation

No_x (Oxides of nitrogen) comprises of various types of oxides of nitrogen, clubbed together. These are no, No_2, No_3 etc.

Nitrogen is an inert gas and will not react with oxygen in normal conditions. However, under certain conditions, nitrogen starts to react with oxygen and forms oxides of nitrogen.

Conditions favoring formation of No_x

1. In-cylinder temperatures excessive of 1800^0c
2. Availability of excess free oxygen

Technologies for No_x control aims to reduce either one or both of the above factors inside the engine cylinder.

Principles of No_x control

No_x can be controlled either by arresting the formation,at source or by exhaust after treatment.

1] In-cylinder No_x control

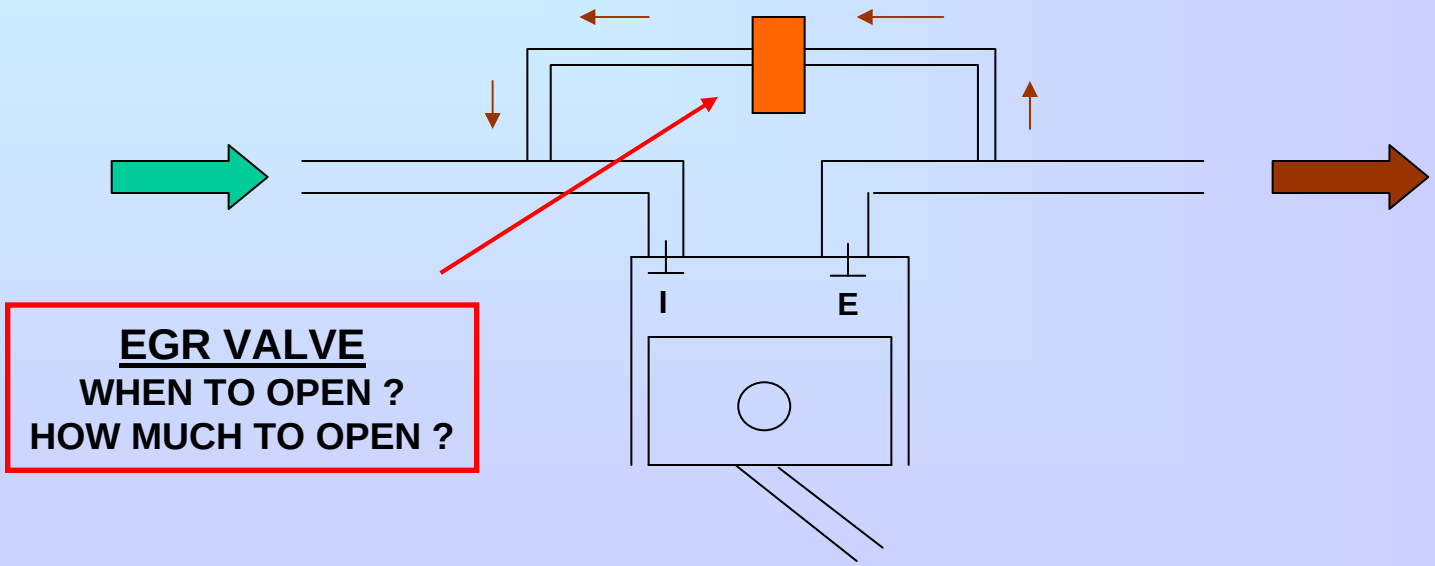
Formation of No_x can be controlled either by reducing the combustion temperatures or by reducing the availability of free oxygen. This is achieved by exhaust gas recirculation - egr,

2] Exhaust after treatment No_x control

Catalytic treatment of No_x requires a catalyst to reduce No_x to N_2. The available catalysts to reduce No_x to N_2 works on oxygen-free exhaust. There is no catalyst technology available, as of now, which can reduce No_x, in an oxygen-rich exhaust, as found in diesel exhaust.

Principles of exhaust gas recirculation (EGR)

EGR system recirculates part of the burnt exhaust back in to the intake system, to help in reducing the combustion temperatures as well as reducing the quantity of free oxygen.



EGR VALVE
WHEN TO OPEN ?
HOW MUCH TO OPEN ?

Reduction of combustion temperatures -

Exhaust gases are inert gases with a very high value of c_p i.e they do not take part in combustion but absorbs heat without increasing its temperature. This acts as a heat sink and reduces the overall combustion temperatures. (Point 1).

Reduction of free oxygen inside cylinder -

Exhaust gases occupy some space and reduce the equivalent amount of free oxygen (Point 2).

In order to meet Bharat stage II emission norms, the following modifications are done on the SZ 2600 engine

In-cylinder control

- **Modifications to fuel injection system**
- **Exhaust gas recirculation - Electronically controlled variable EGR.**

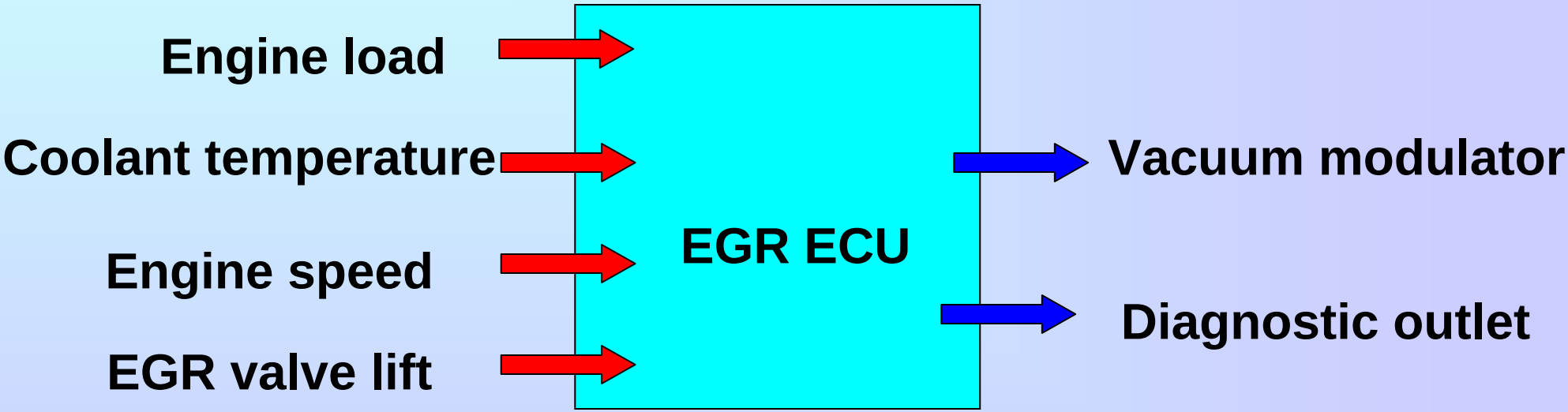
Fuel injection system modifications

1. Higher peak injection pressures
2. Injector nozzle - 6 holes
3. Cold running advance
4. FIP timing - 1.25 mm plunger lift at TDC.
5. FIP with throttle potentiometer

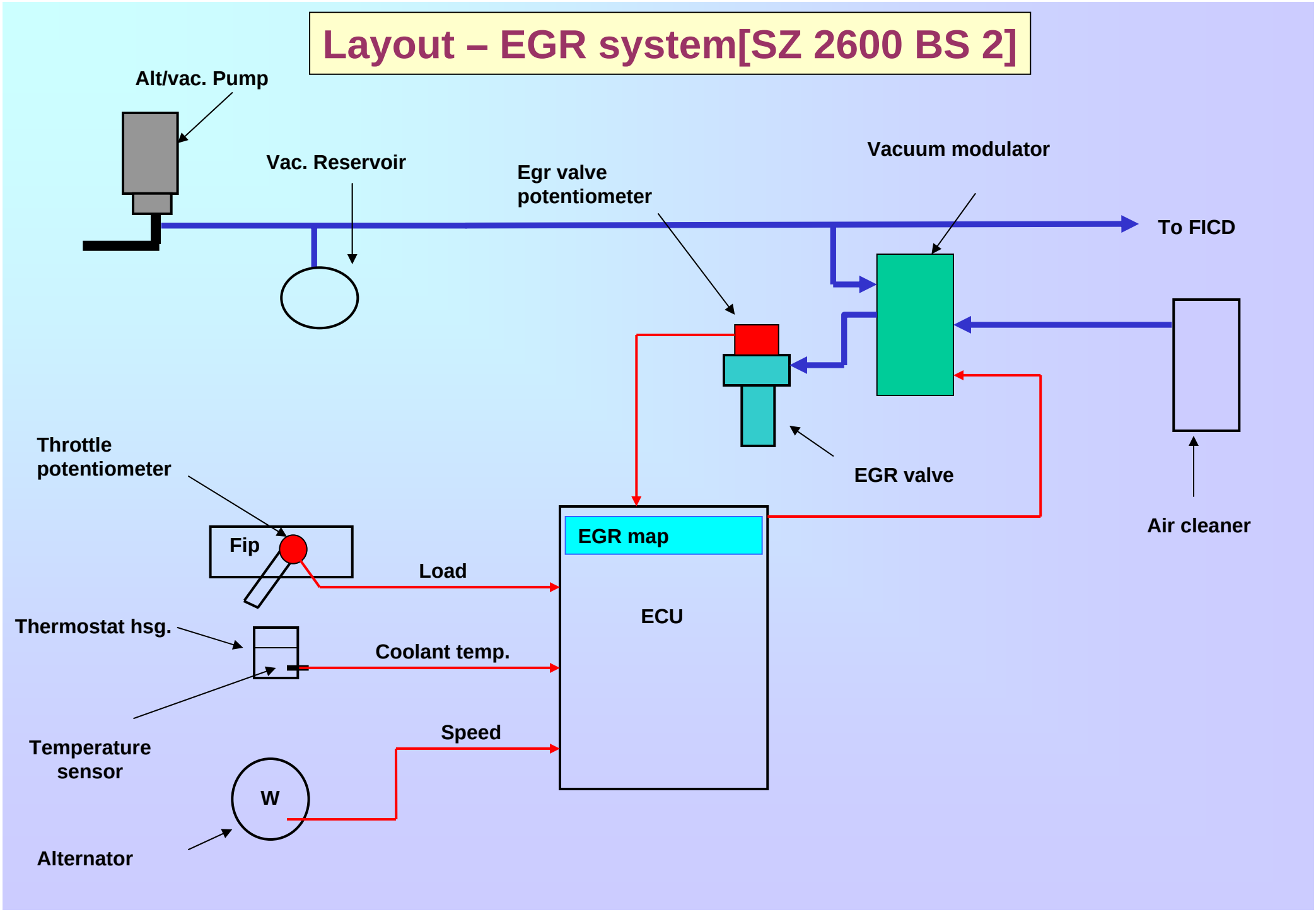
BS1 Vs BS2		MICO	DTVS
FIP TIMING (Plunger Lift at TDC, mm)			NOT APPLICABLE
	BS2	1.25	
NOOZLE OPENING PRESSURE (Bar)			
	BS2	250	
NO. OF HOLES IN NOZZLE			
	BS2	6 (VCO)	
PEAK INJECTION PRESSURE (Bar)			
	BS2	1200	

Exhaust gas recirculation - EGR

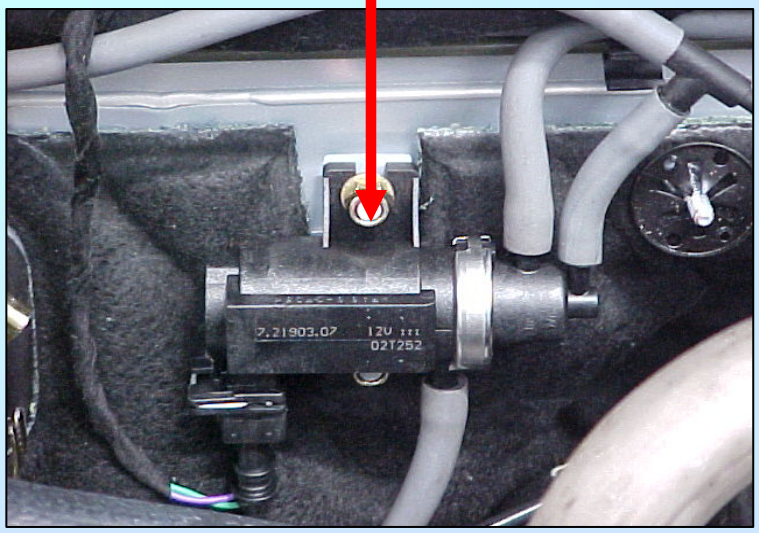
Electronically operated, pneumatically actuated variable EGR



Layout – EGR system[SZ 2600 BS 2]

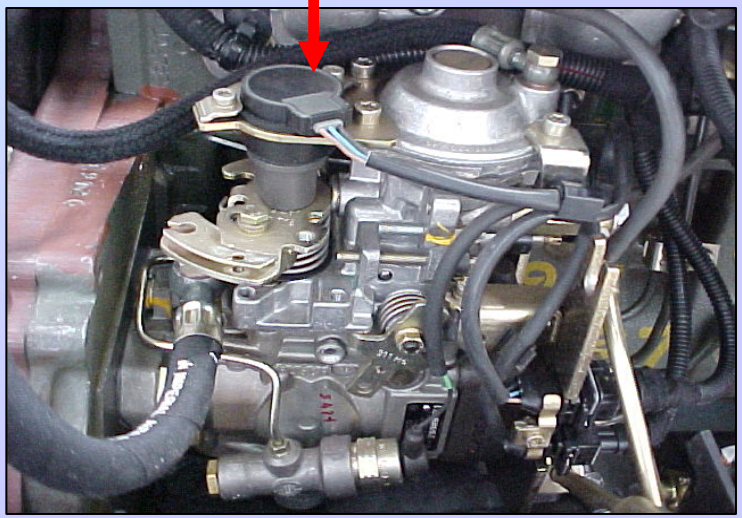


Vacuum Modulator

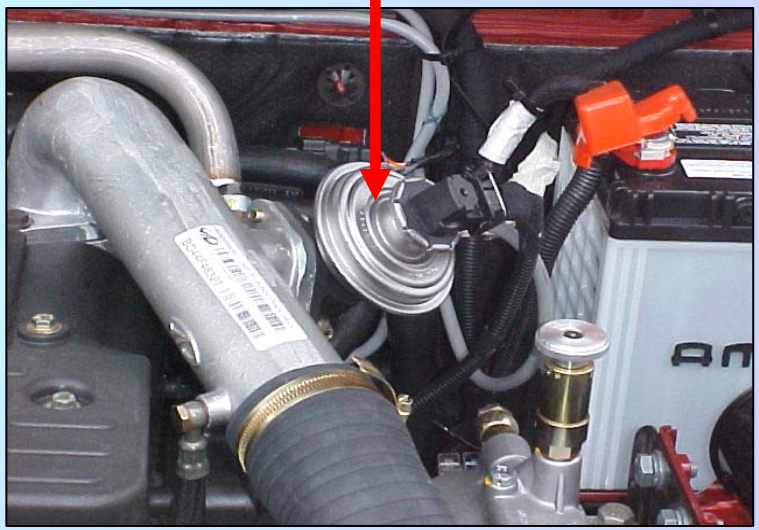


ECU

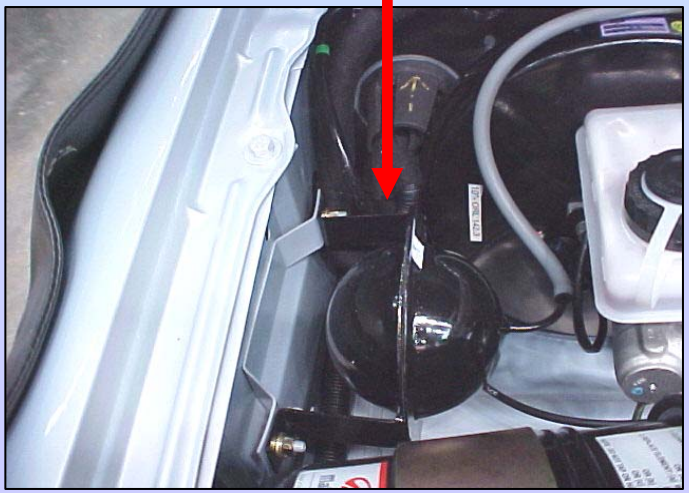
Throttle Potentiometer



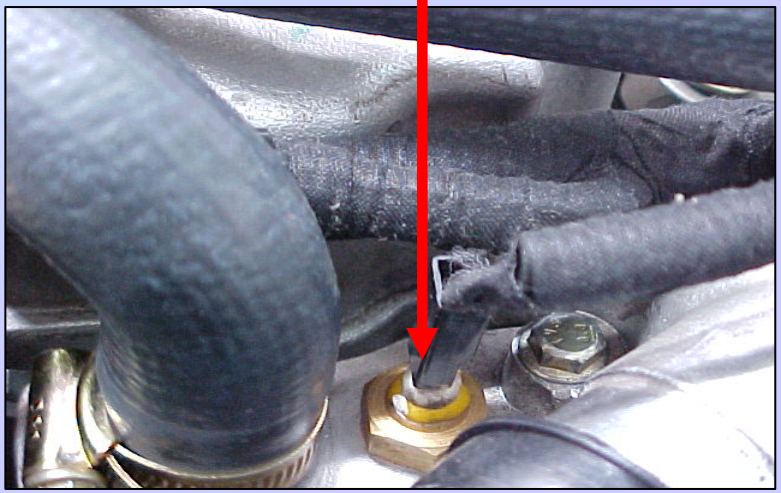
EGR valve (New)



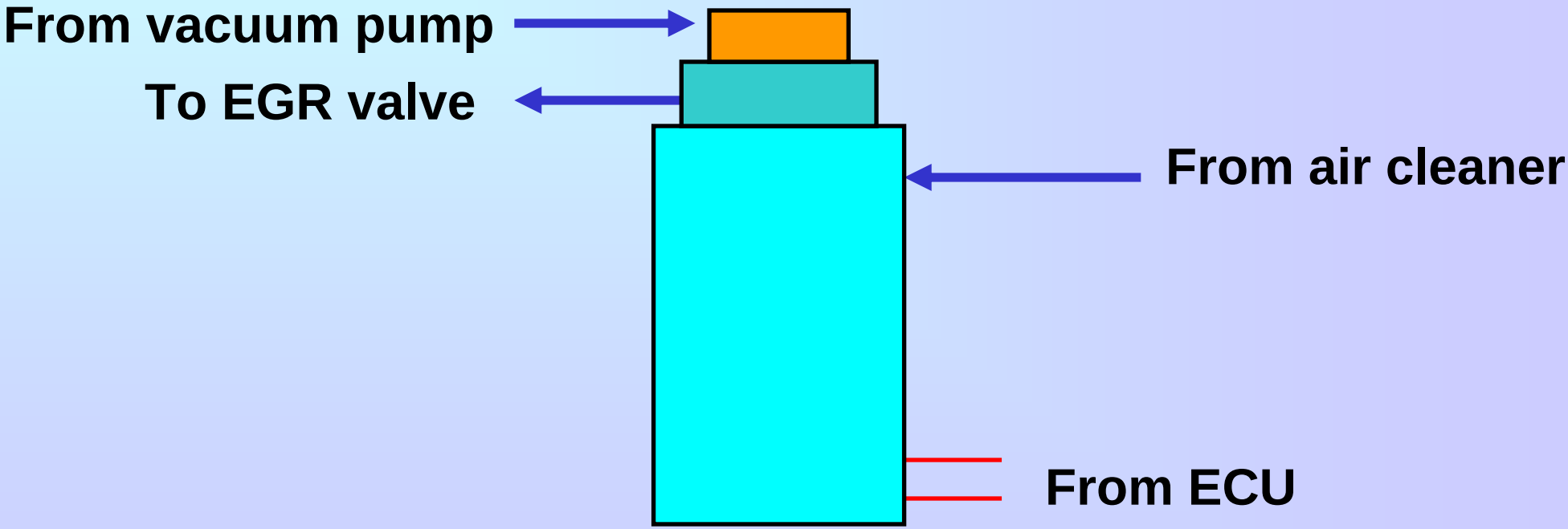
Vacuum reservoir



Temperature Sensor



Vacuum line connection at vacuum modulator



Controls & strategies

Accleration cut-off - The EGR valve will close when the vehicle is suddenly accelerated.

Overheating cut-off - The EGR valve will close if the coolant temperature reaches 95^0

Cold engine - The EGR will not work if the coolant temperature is less than 25^0.

Half EGR - Between 25^0 & 40^0 of coolant temperature, the EGR valve will open only 50% of the lift as specified in the EGR map.

Cold running advance - The cold running advance will be active up to 30^0 coolant temperature.

Diagnostic defect codes reading

Connect a 12V, 2W bulb to the diagnostic connector provided in the wiring harness.

Switch on the ignition

Wait for minimum 3 seconds

Start the engine and run at idle speed

Look for blink codes in the bulb

Observe the blink codes

Compare blink codes with decoding chart to identify the defective sensor/actuator.

Important - Using a bulb with higher rating will damage the ECU.

Defect code decoding chart

Sr No.	Parameter	Error type	Blink code
1	EGR ECU	No errors	Lamp on continuously
2	EGR ECU	No ECU supply / ECU defective	No blink
3	Throttle sensor	No Signal	On 2s / Off 2s
		Sensor not connected / Setting error	On 1s / Off 5s
4	Temperature sensor	Open / Short	On 5s / Off 1s
5	EGR Valve sensor	No Signal / Sensor not connected	(On 0.5s Off 0.5) x 2 cycles then Off 3s
		Valve not lifting	(On 0.5s Off 0.5) x 3 cycles then Off 3s
		Valve not closing	(On 0.5s Off 0.5) x continuously.

EGR Valve checking

Remove the EGR valve and check it for valve-sticking, deposition of carbon etc. If excess carbon deposits and sticky valve noticed then it should be cleaned with a suitable solvent, so that the correct valve seat is ensured.

After cleaning the valve blow air from the bottom side of the valve and check for any leakage.

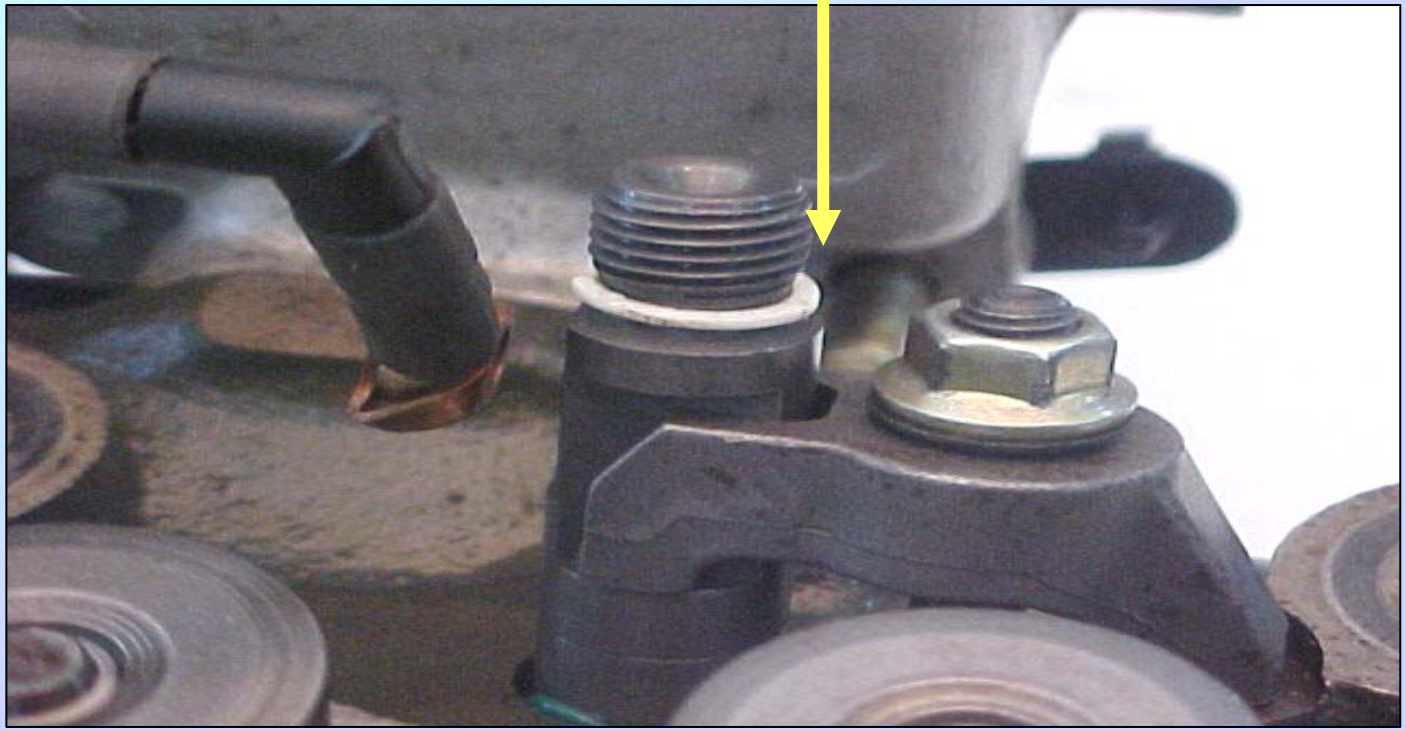
To check for the functioning of the EGR valve apply vacuum on the vacuum connection of the EGR valve. The lift of the valve at the required vacuum should be achieved.

FIE Details

	BS II
Static timing	1.25mm Plunger lift at TDC
LDA	Yes
Lock timing bolt	Yes
FICD	Yes
LFG	Yes
Potentiometer	Yes
Injector	
Identification	Milky white ring
Nozzle opening pressure	250 + 8 bar
Specification	6 X 0.203 X 150°
Nozzle holder	F 002 C70 **555**
Nozzle holder pressure	1200 bar

Identification of Nozzles of BSII

Milky white colour ring

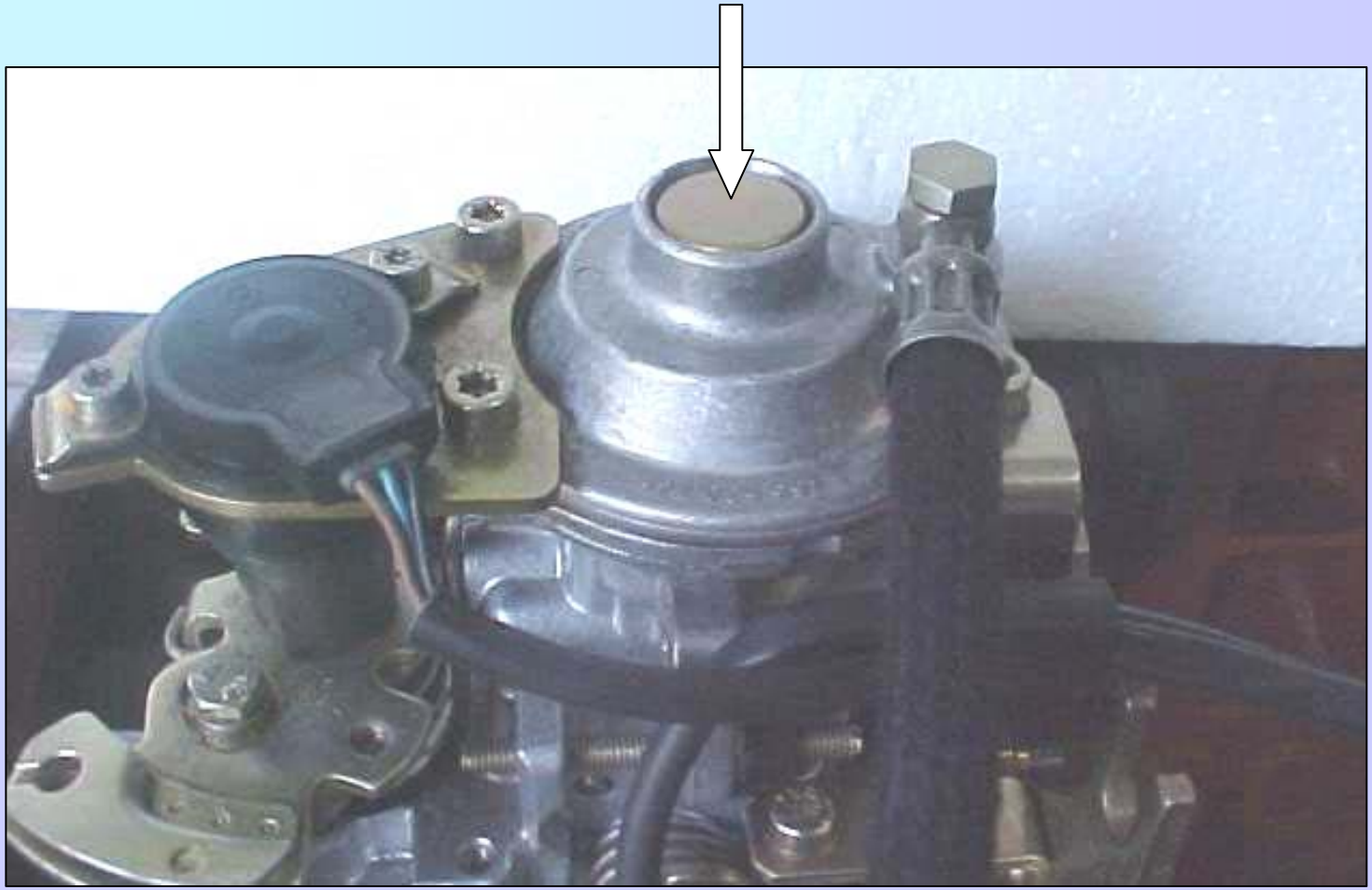


BS II Nozzle

Features in F I P

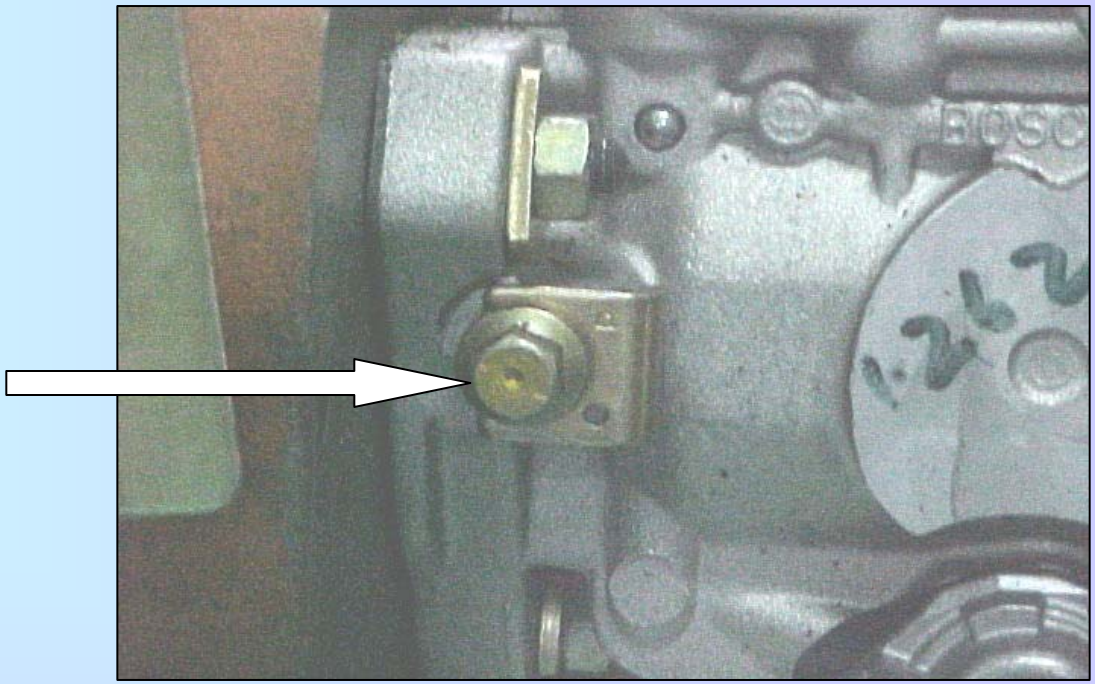
LDA :

Increases the fuelling according to the boost pressure developed by turbo charger.



Lock timing bolt [FBB] :

Ease in FIP timing.

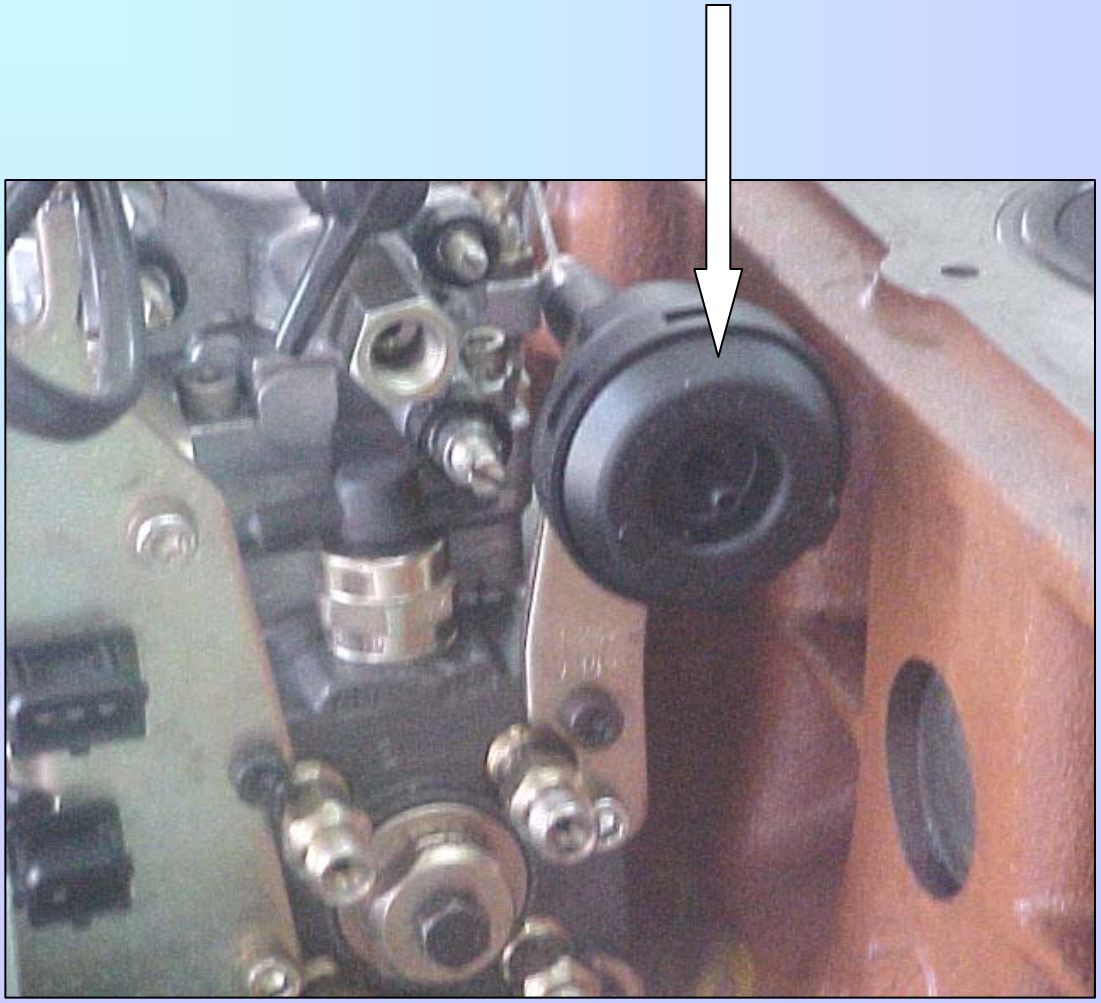


LFG:

Avoids the fuelling to become zero during gear changing.

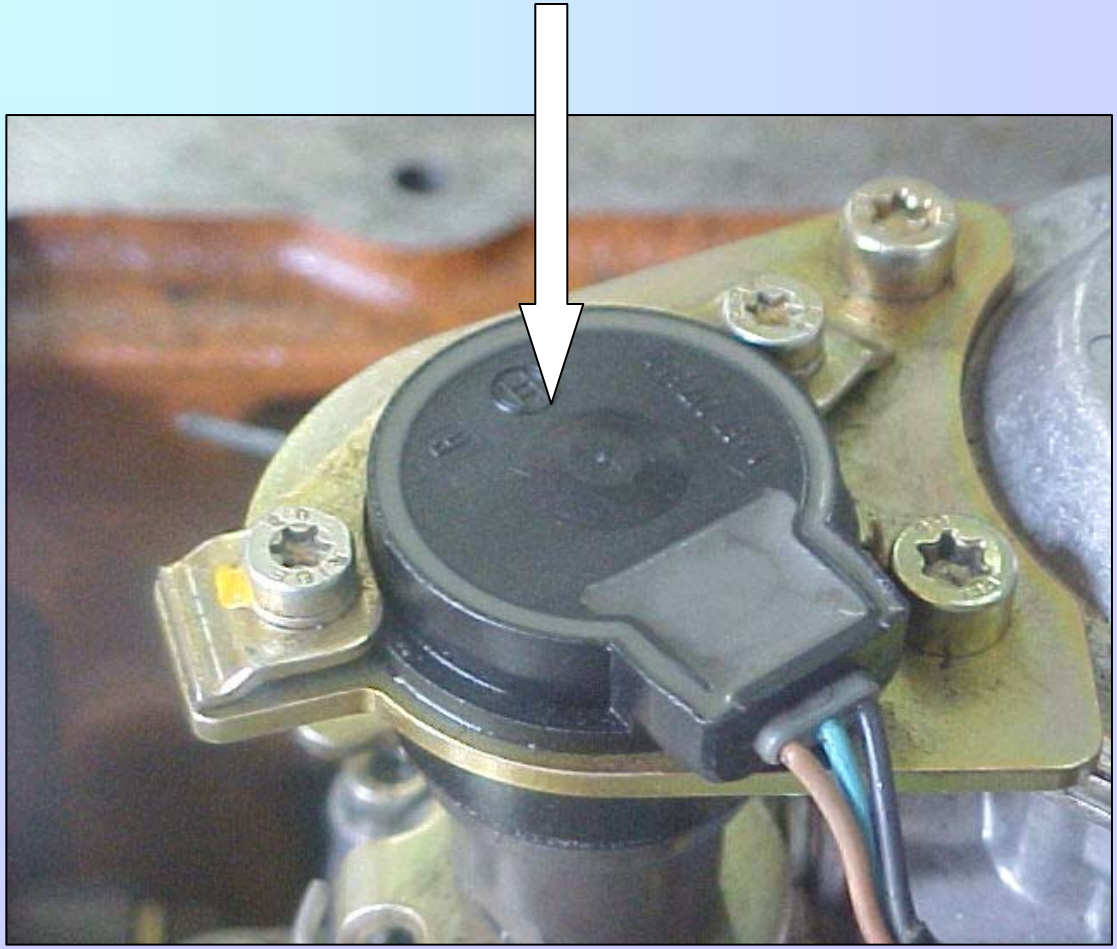
Fast idling control device [PLA] :

Controls the idling to the set band when AC is on.



Potentiometer [BS II FIP] :

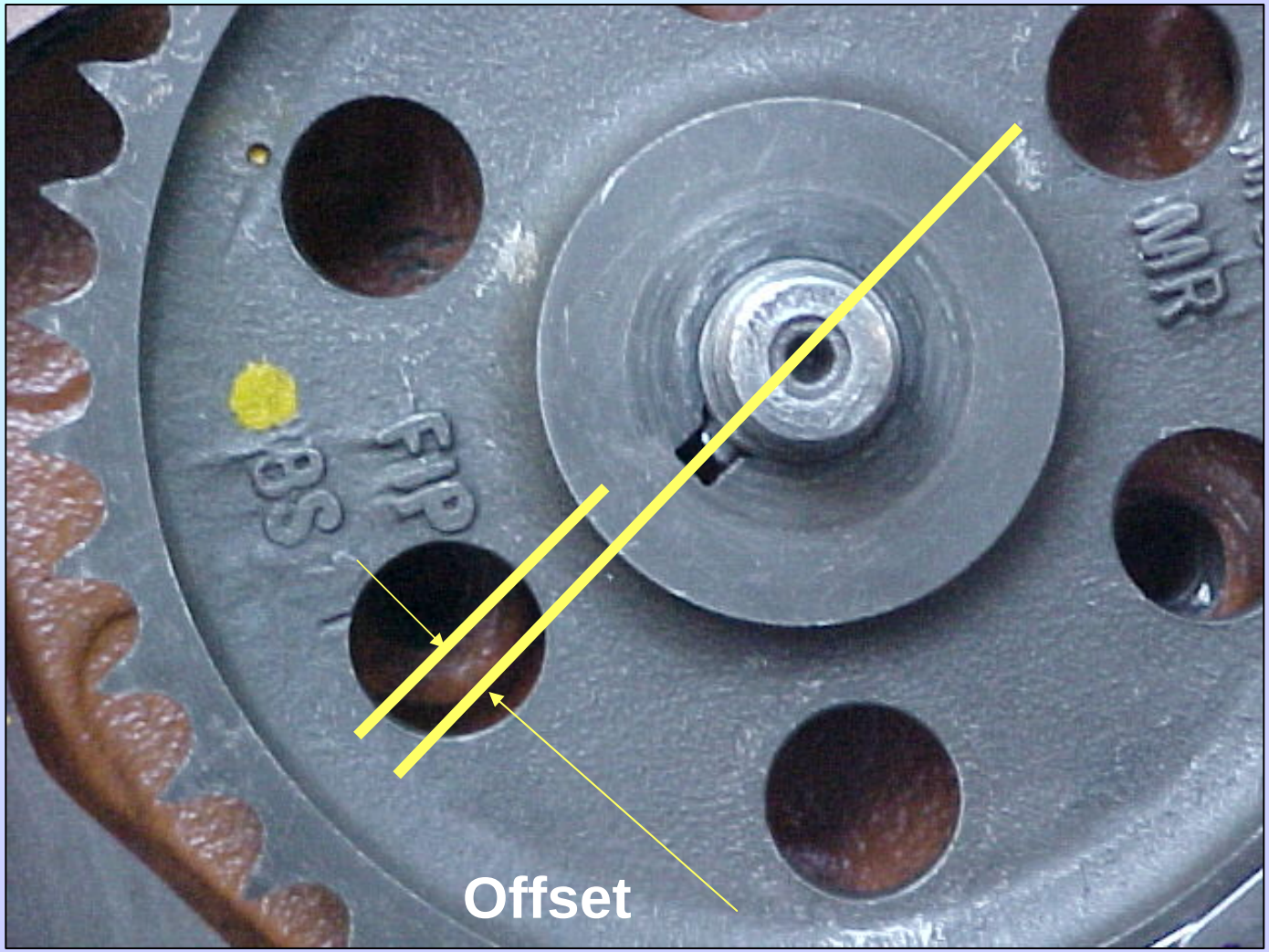
Gives input of engine load to the EGR ECU.



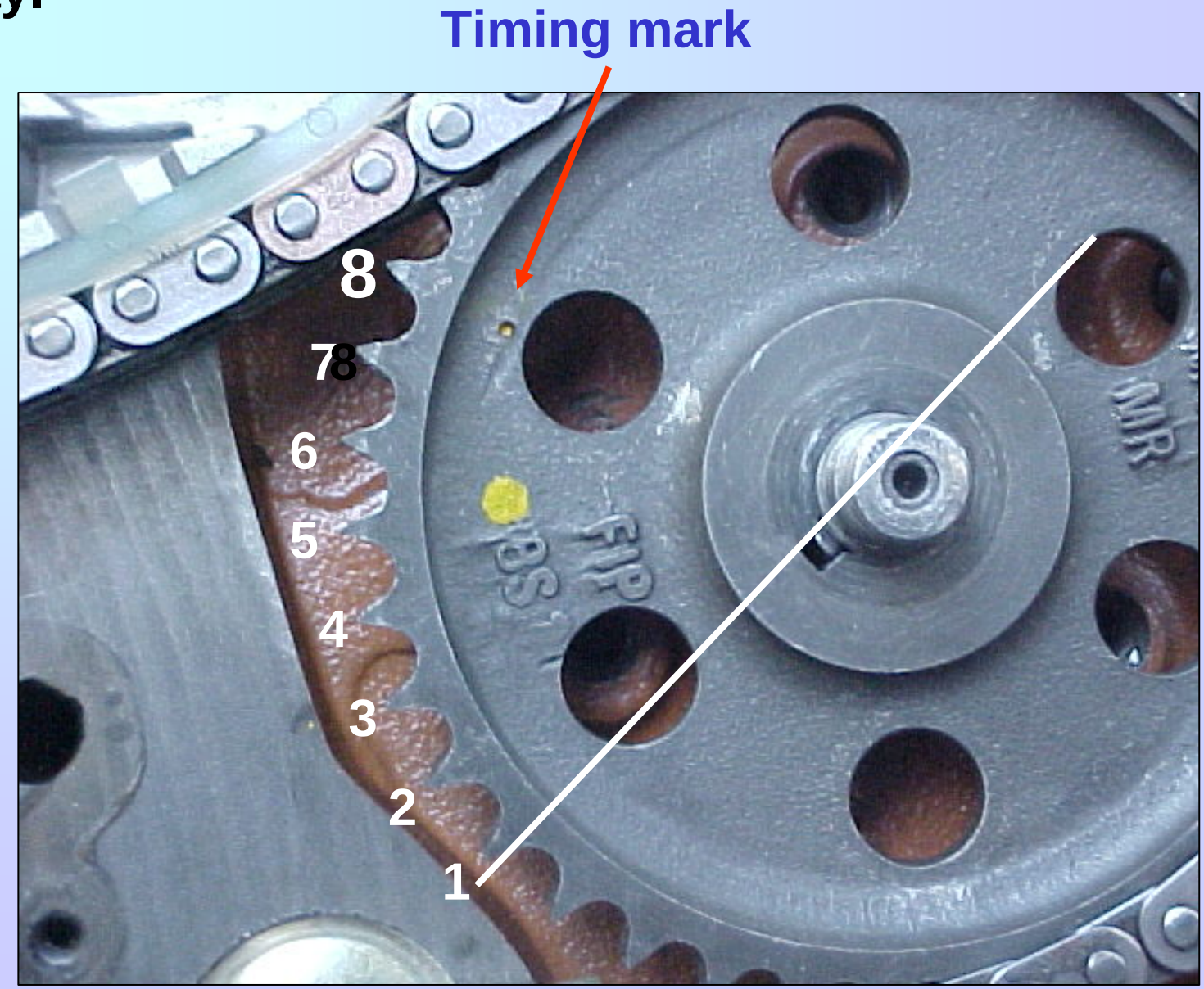
F. I. P. TIMING

[SZ 2600 Plus]

In BSII sprocket, Key ways is offset w.r.t. centre line of weight reducing hole.



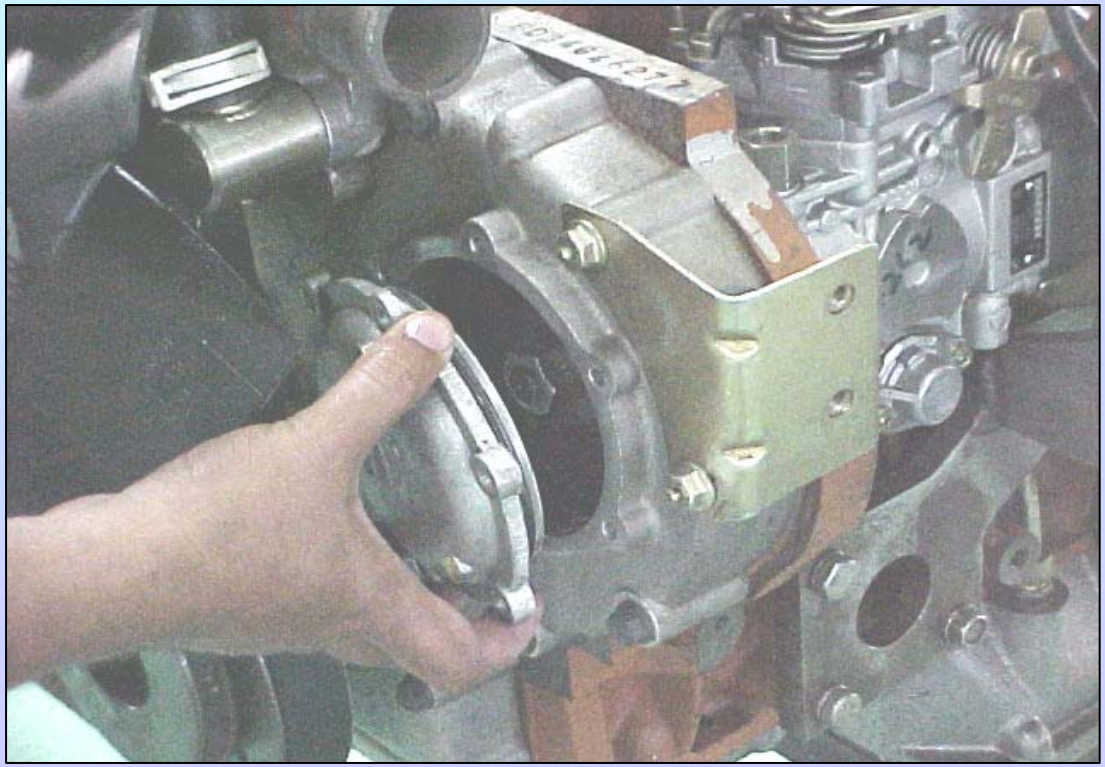
BS 2 Sprocket : Timing marks is on 8 th teeth clockwise from keyway.



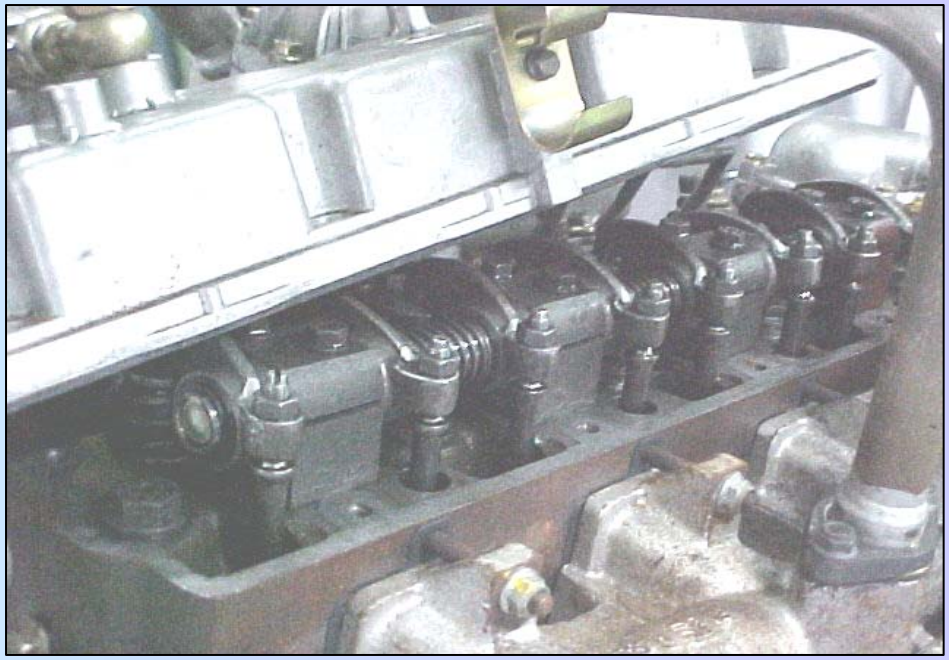
Procedure for FIP removal of SZ 2600 + engine

Remove viscous fan drive & shroud

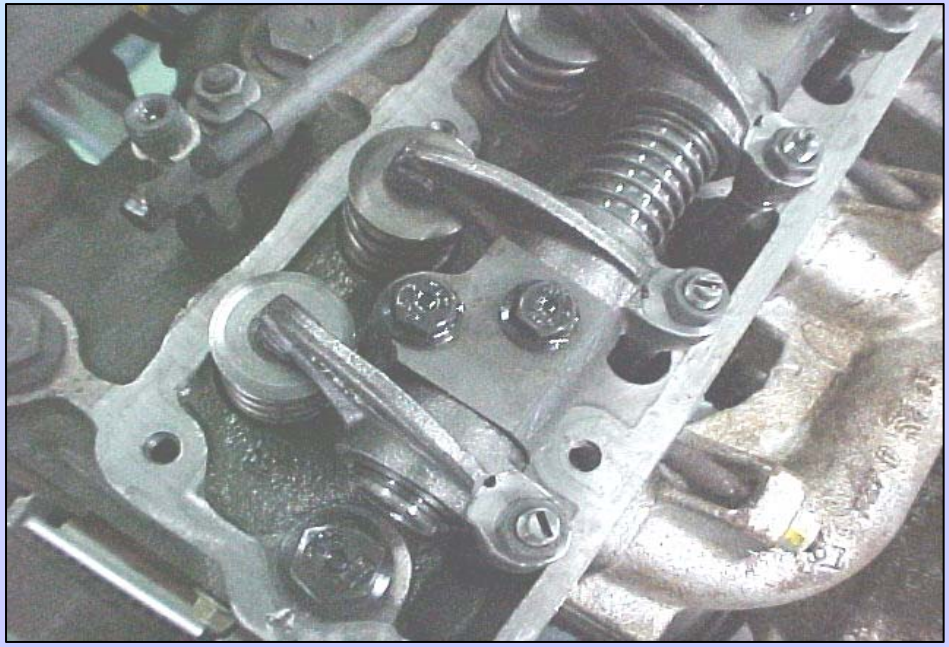
Remove FIP inspection window cover



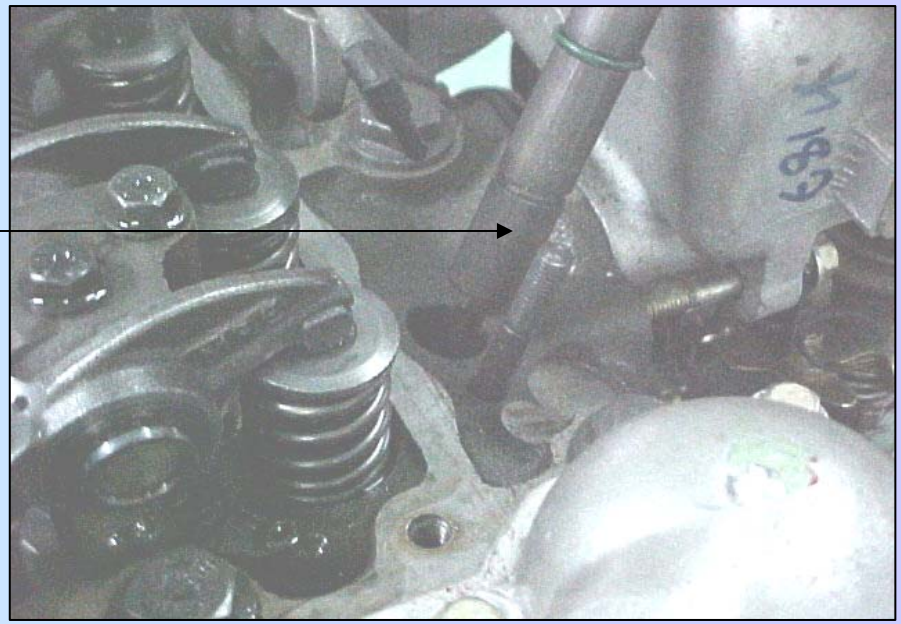
Remove R/A cover.



Bring no. 1 cylinder to compression stroke.

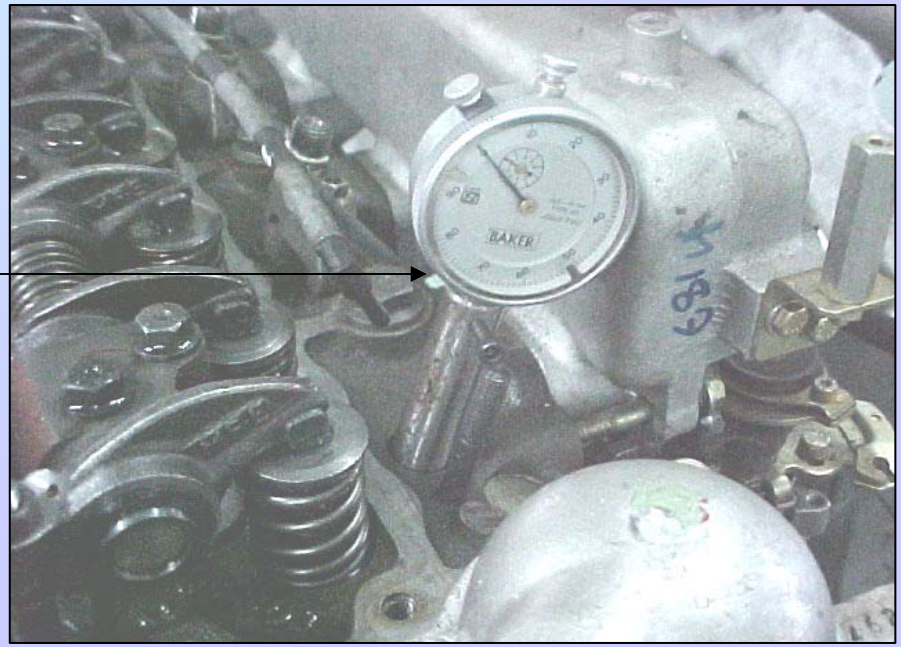


Remove all high pressure pipe.

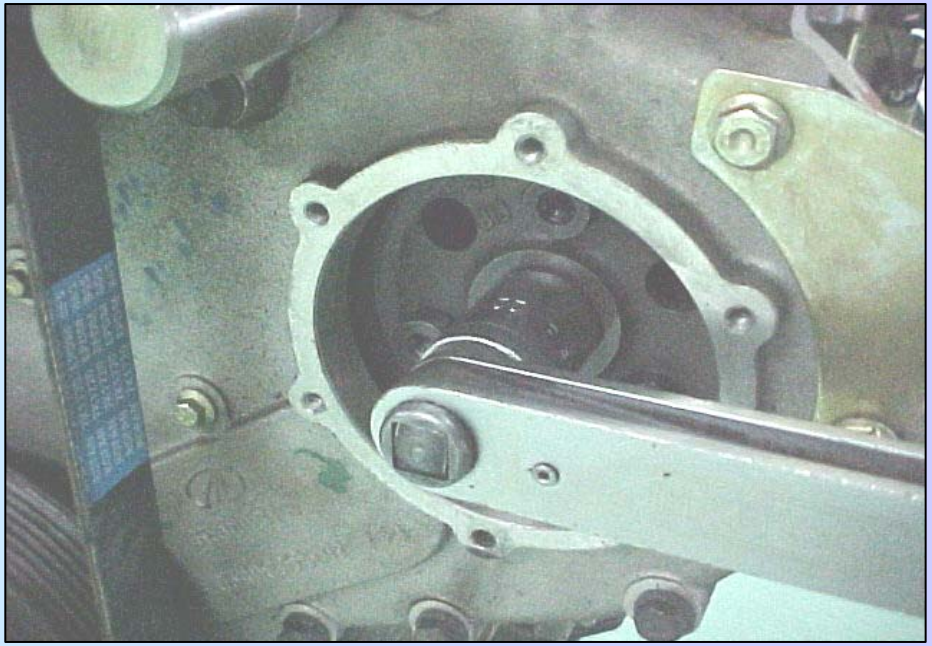


Remove first cylinder injector.

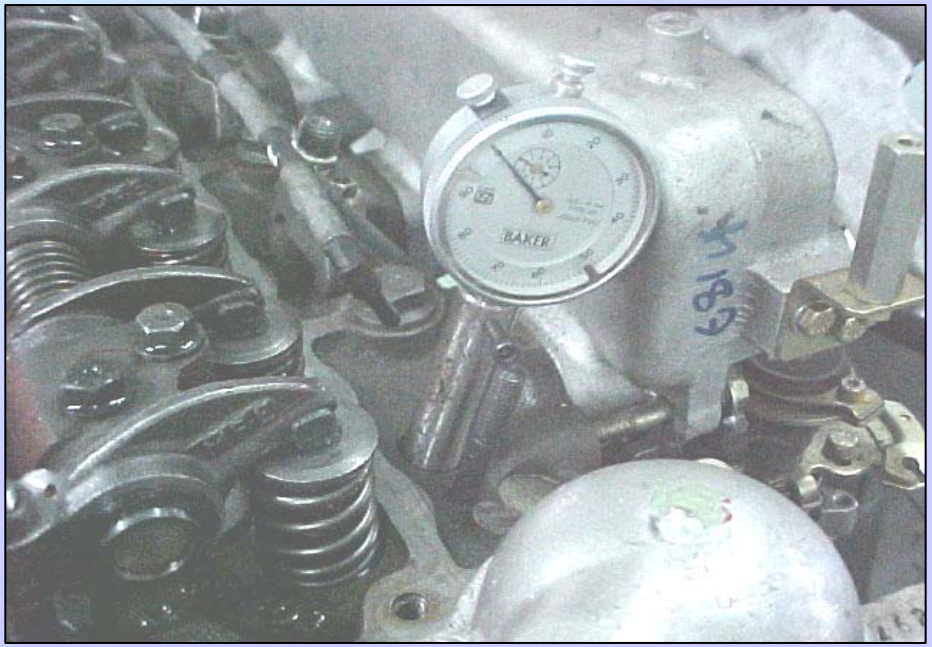
Put MST No. 0272 & dial gauge.



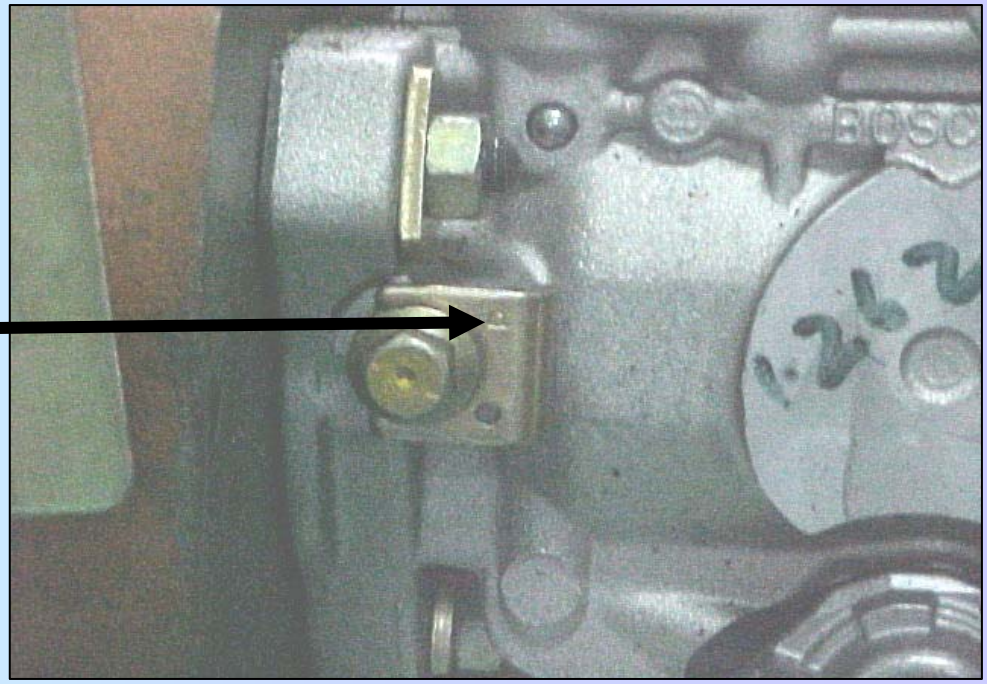
Loosen FIP sprocket lock nut & re-torque it to 2.5kg-m. (20 lbs.ft)



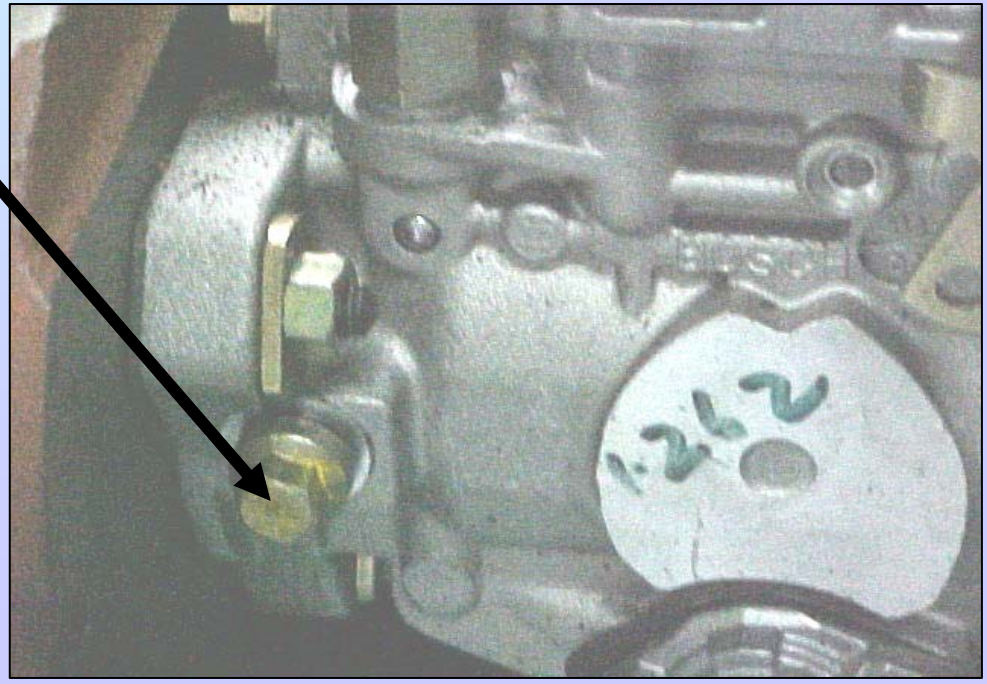
Bring no 1 piston exactly at TDC



remove lock plate.

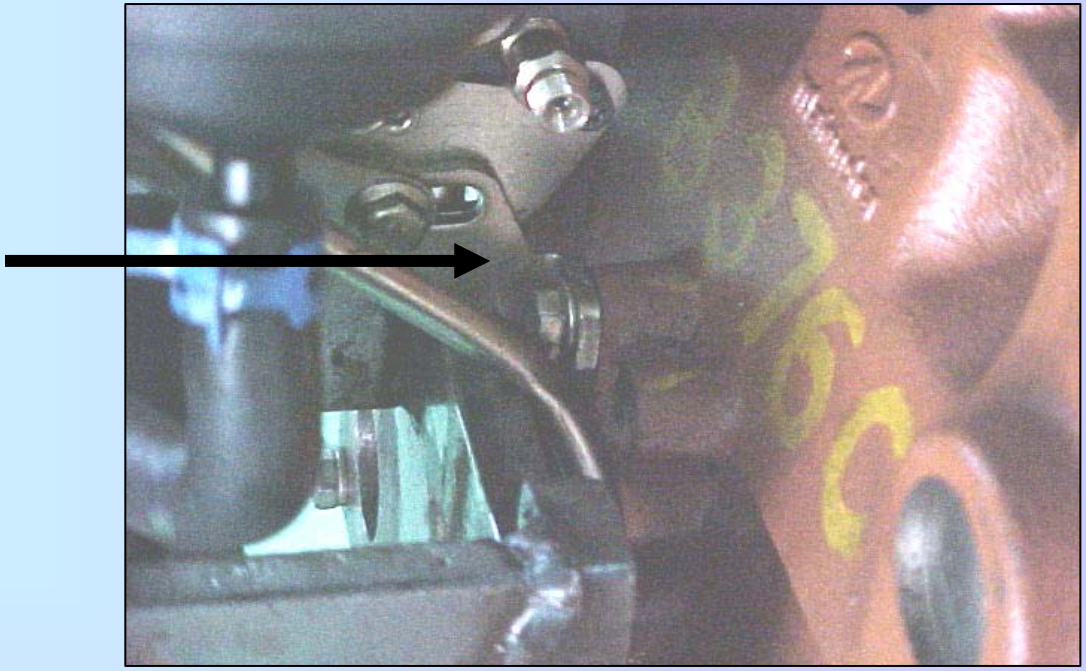


Torque lock screw to 1.5 kg-m

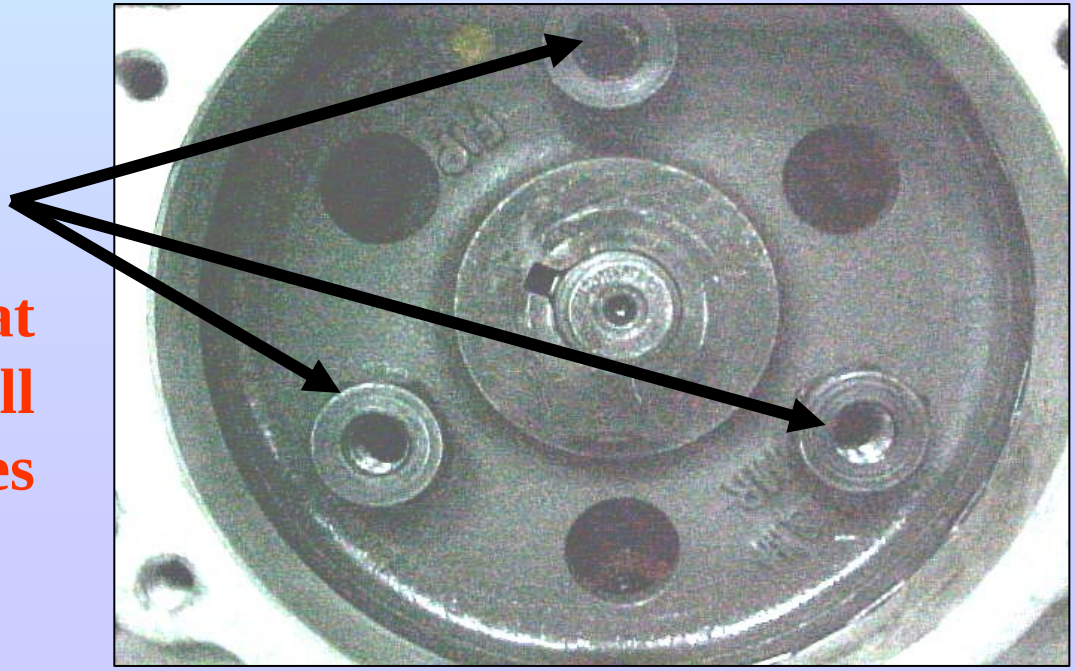


Note: At this point FIP shaft is locked. Even slight rotation of engine will damage FIP rotor shaft.

Remove FIP flange mounting nuts & rear mounting bracket

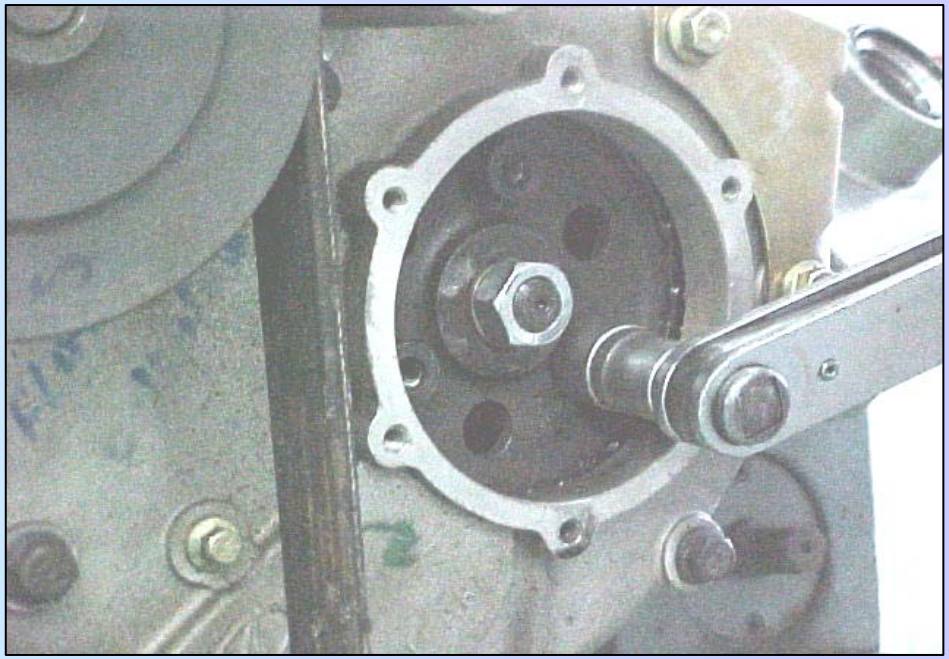


Place sprocket locking pins (three no.) of MST 0270 in sprocket relief holes.

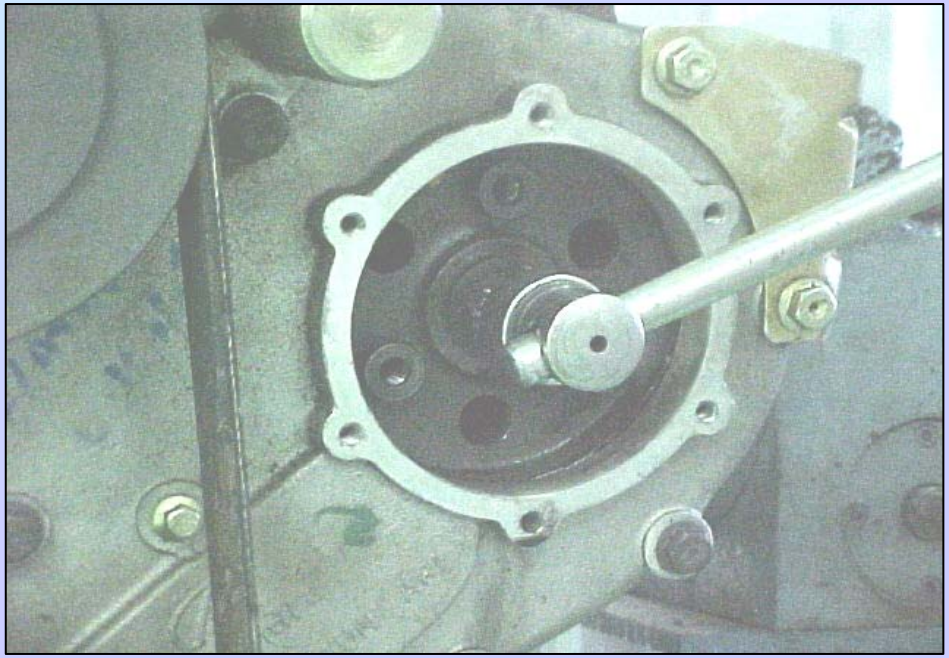


Note: If piston is not at TDC, threads on blocks will not align with the holes provided for locking pins.

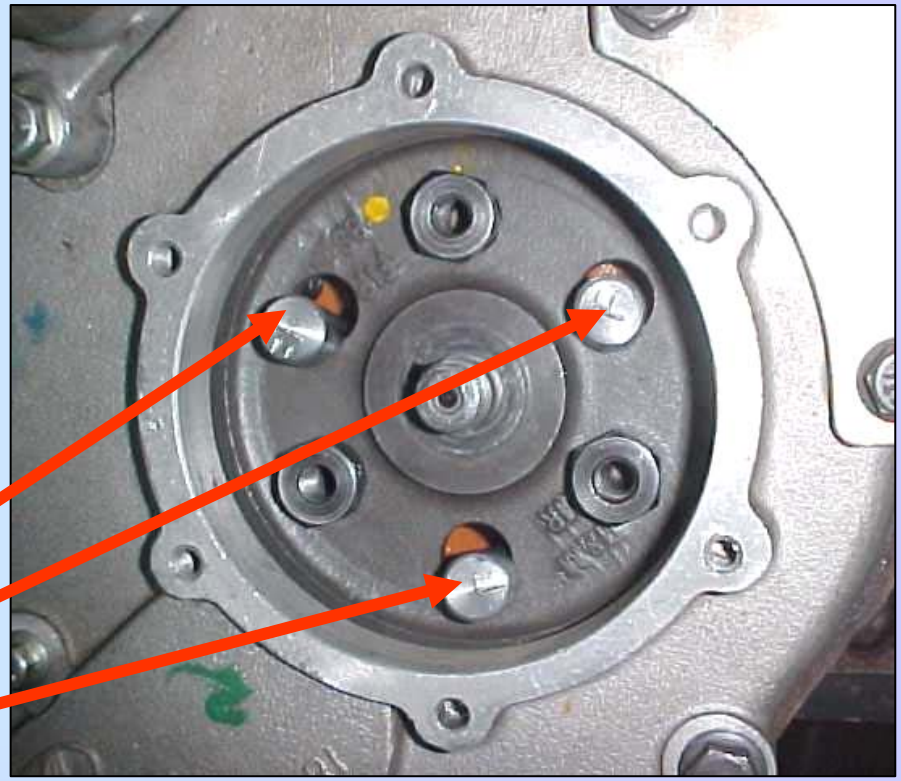
Torque them to 1.0-1.5 kg-m.



Remove FIP sprocket mounting nut & washer

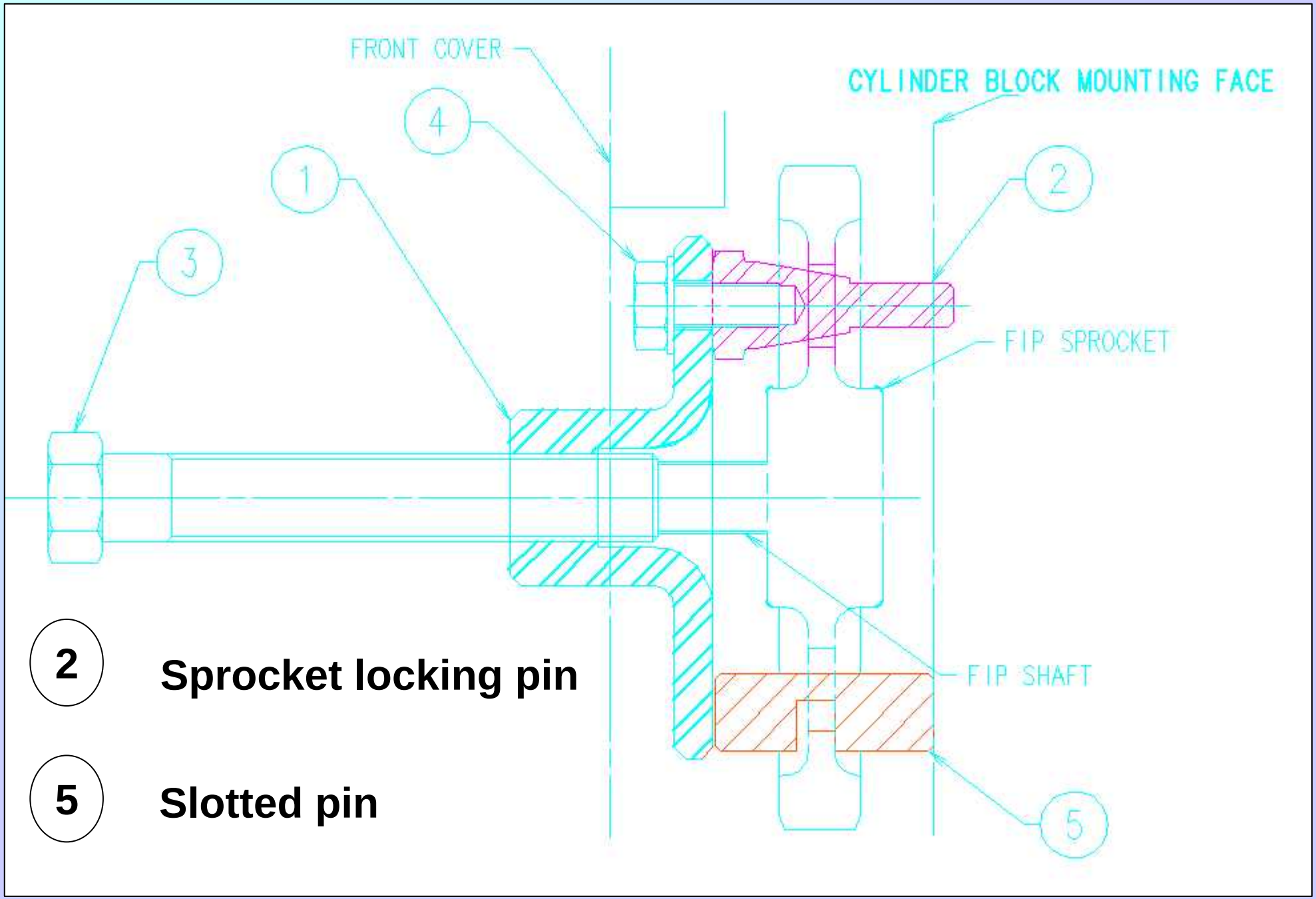


Put slotted pins. Ensure that the side with ‘F’ punched will face outside.



Letter ‘F’ punched should Face outside

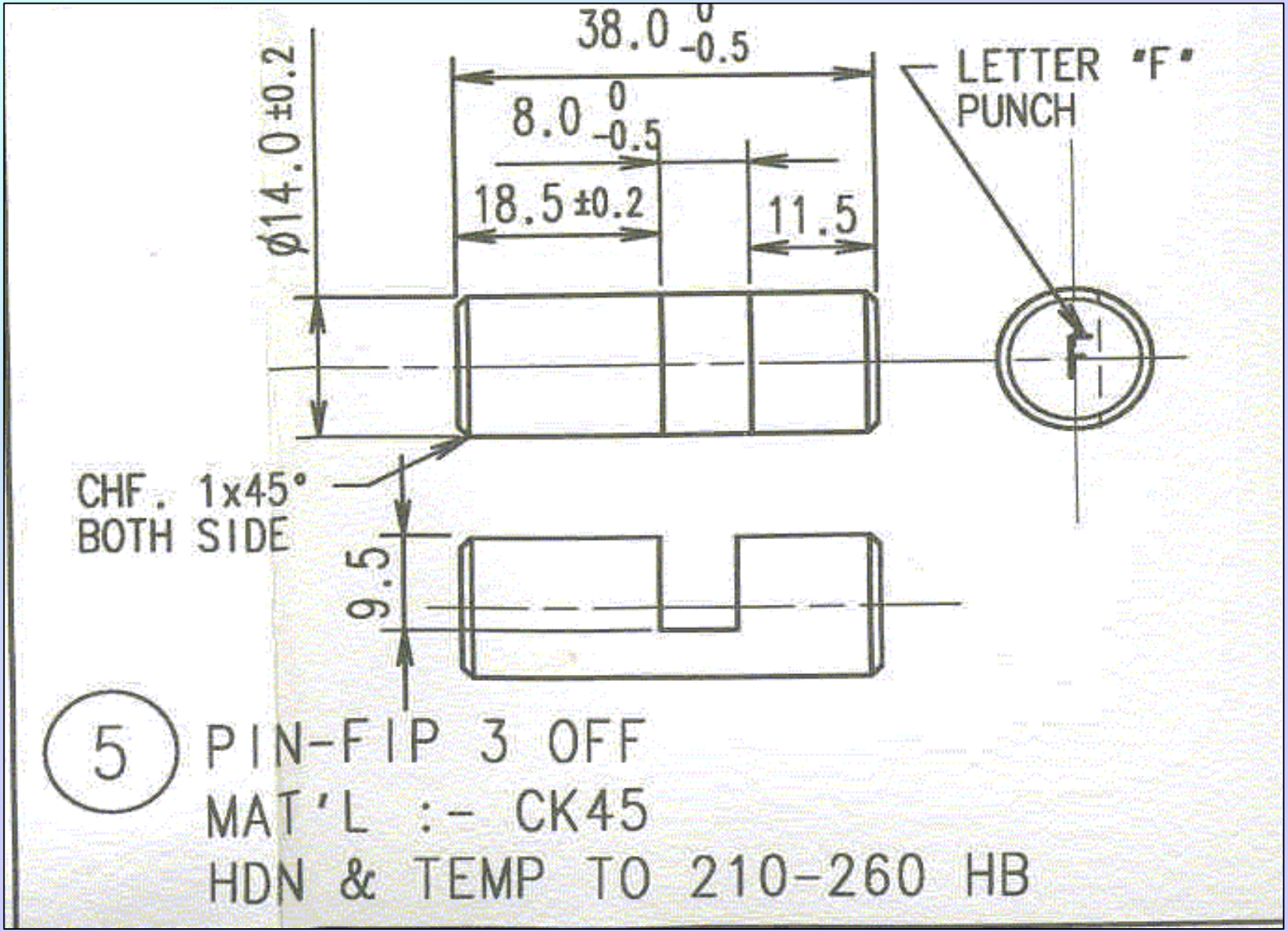
Note : Slide pins in the slot such that bottom portion of slot will butt against the back face of sprocket when FIP shaft is pushed away from sprocket



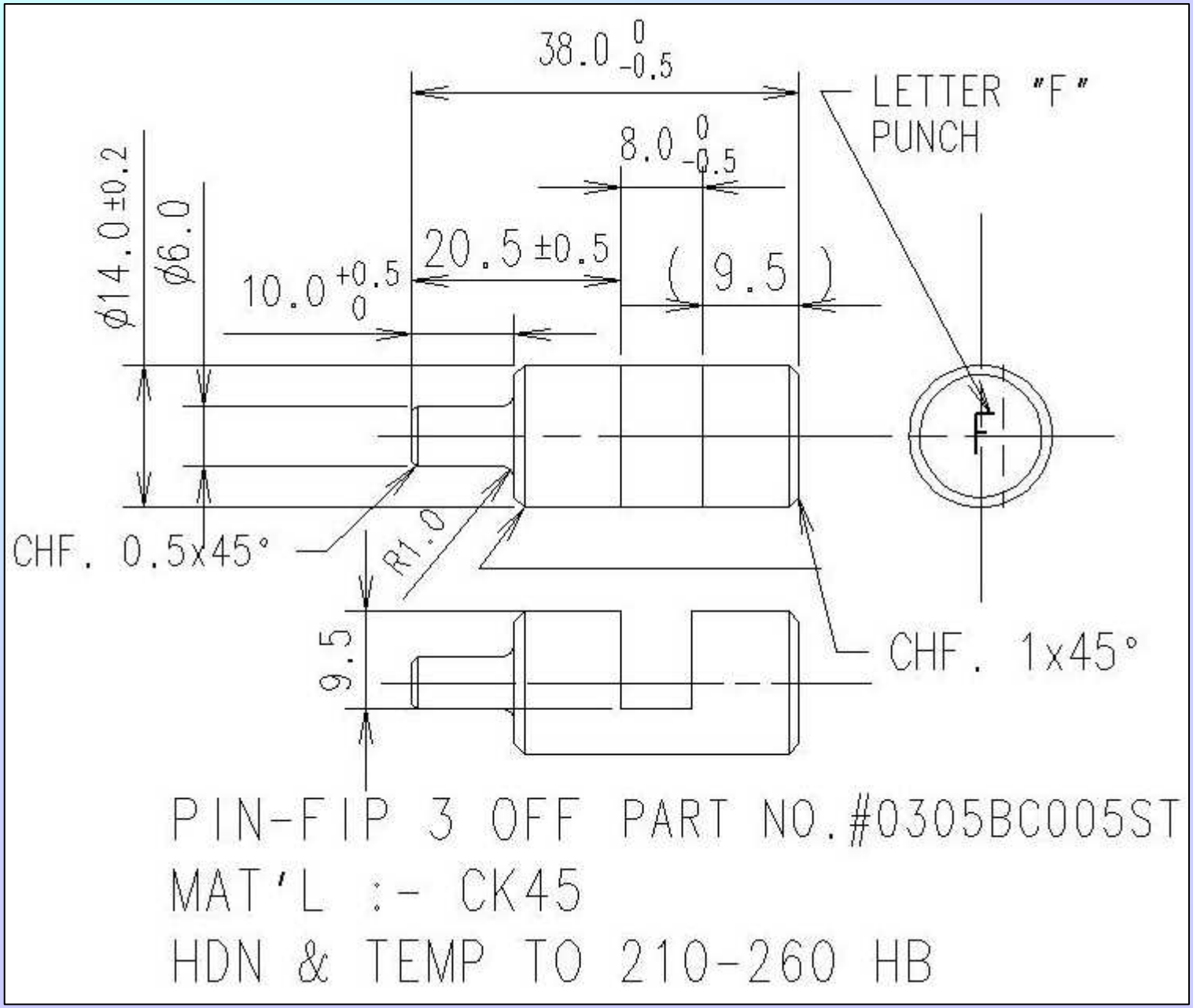
2 **Sprocket locking pin**

5 **Slotted pin**

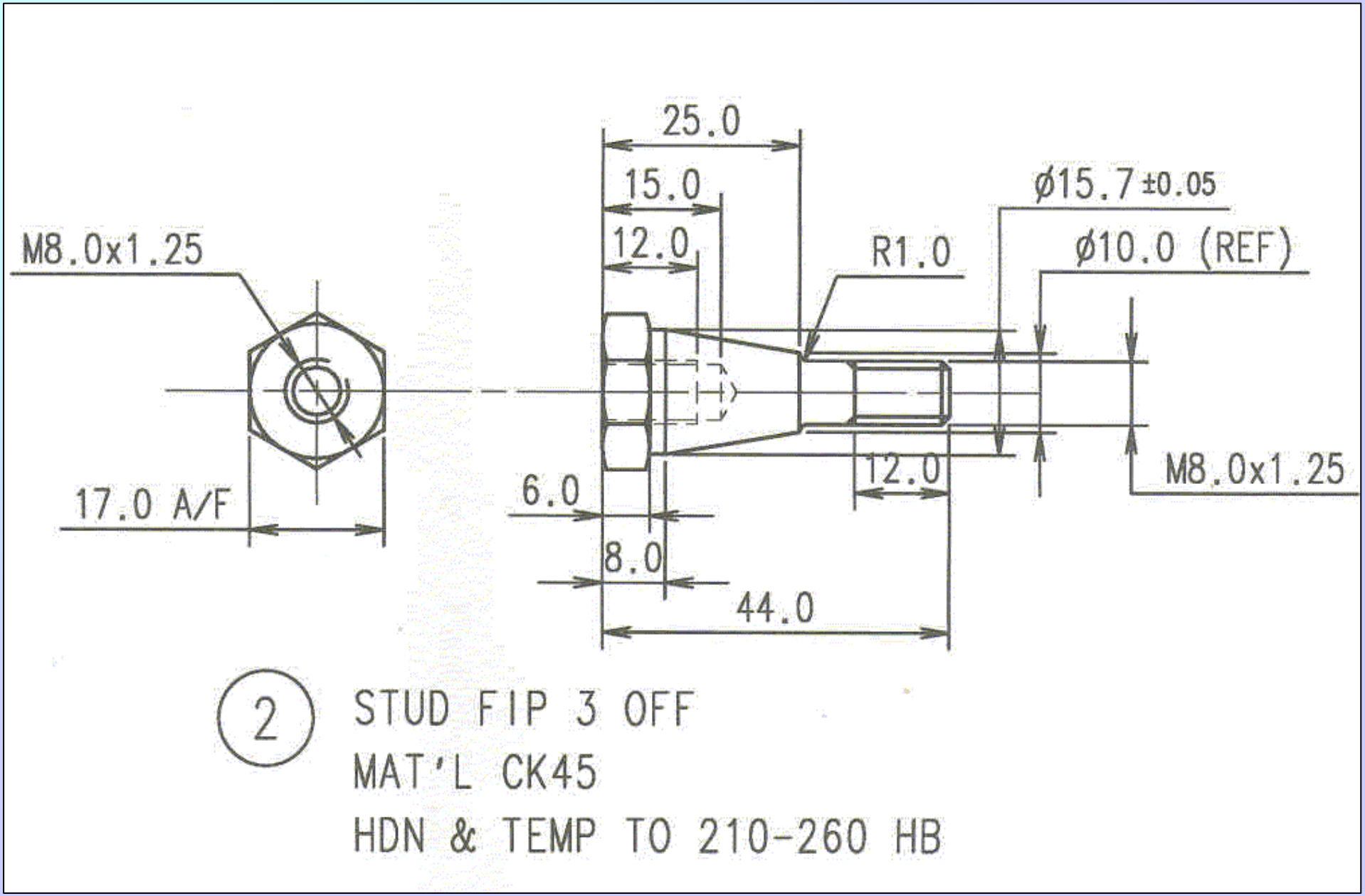
Slotted Pin Drawing



Slotted pin used for commonised cast block with CRDI

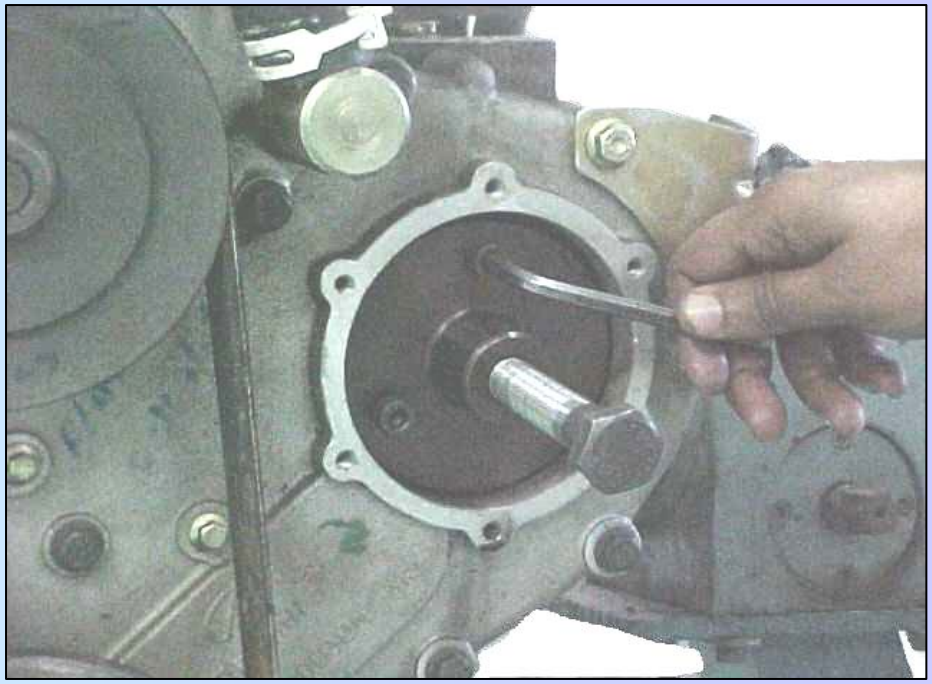


Locking Pin - FIP Sprocket

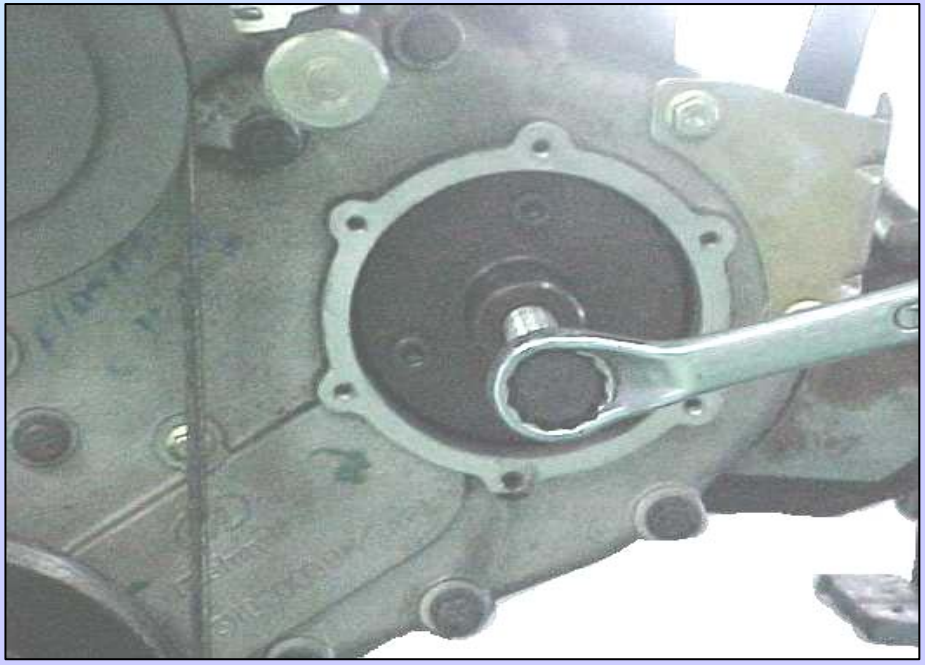


Assemble FIP pusher plate of MST 0270 with.

Ensure plate is butting properly on all the three pins.



Push FIP by tightening puller bolt



Note : Till the refitment of FIP is done, it is not possible to use MST 0270 on another vehicle.

Procedure for FIP fitment of SZ 2600 Plus engine

FIP is removed with following engine condition:

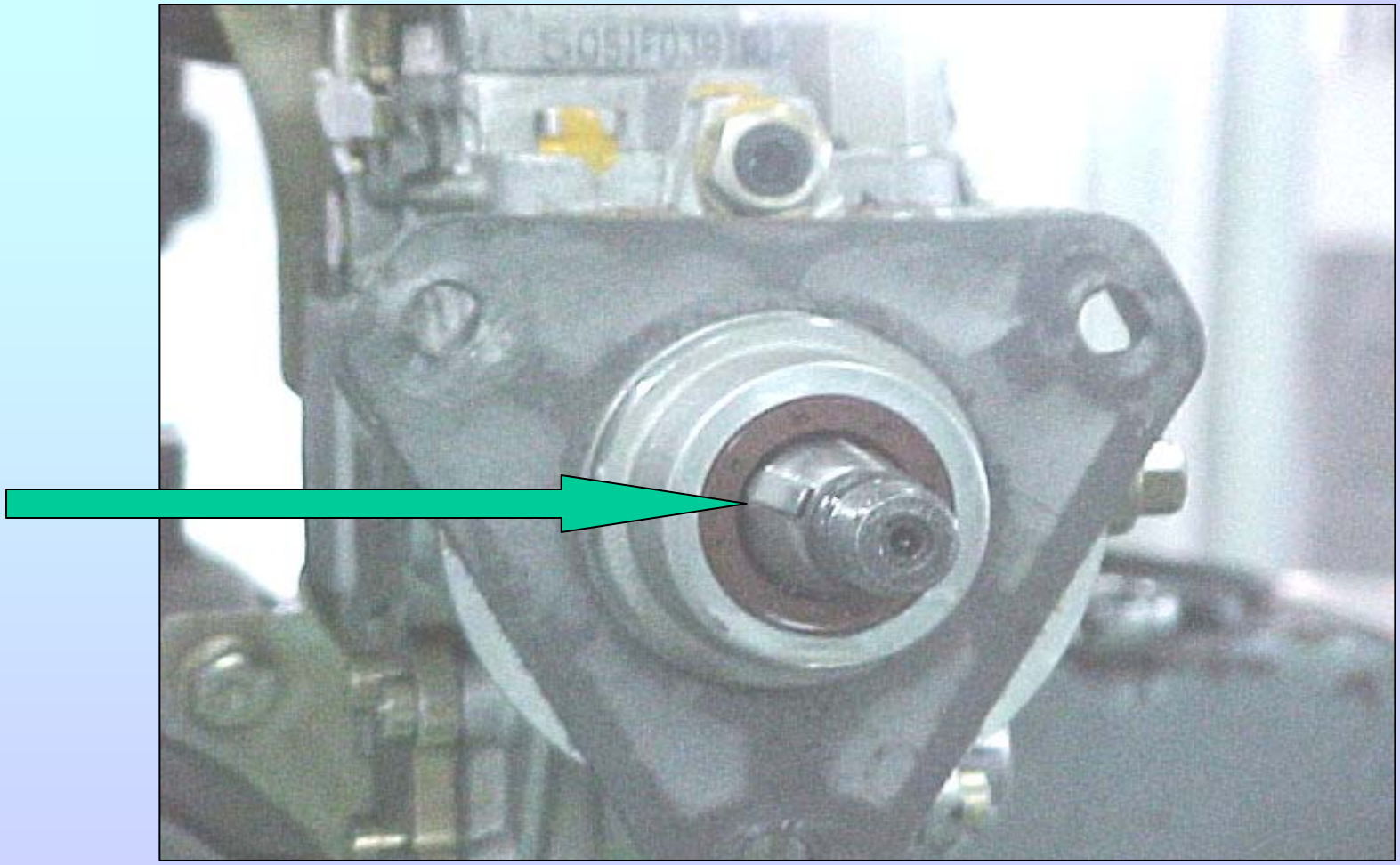
No 1 piston is TDC compression.

FIP sprocket is hold by locking pin.

FIP is locked with required plunger lift.

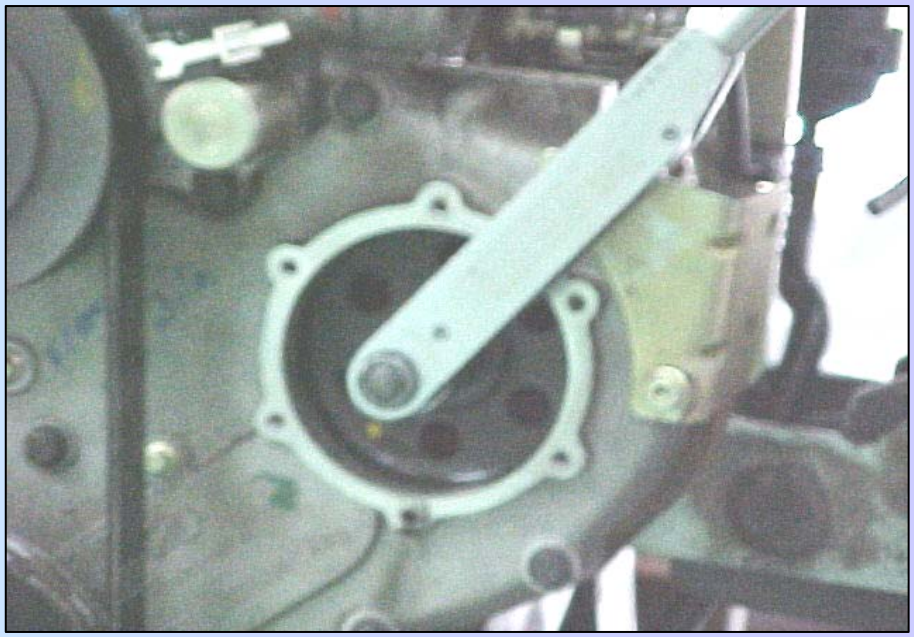
Note: FIP, if return from MICO dealer is also locked when it is injecting fuel in no. one cylinder & with required plunger lift. (1.25mm for BS II pump }

This can be ensured with key position of FIP.



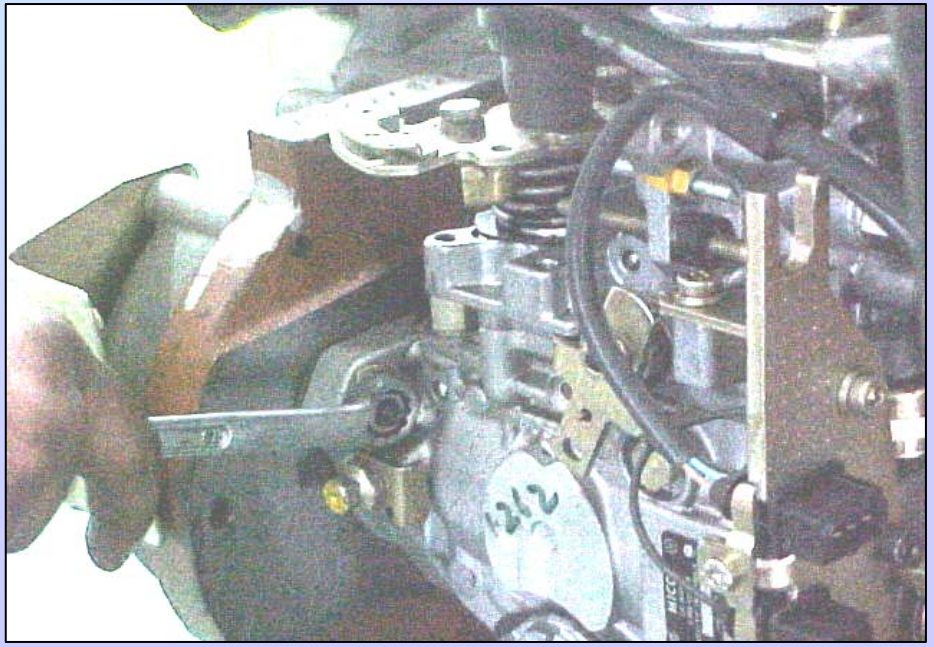
Key position of FIP when injecting into no 1 cylinder i.e. in-between 9 to 12 O' clock position.. this should match with key way position of FIP sprocket.

Put the locked FIP into fip sprocket.



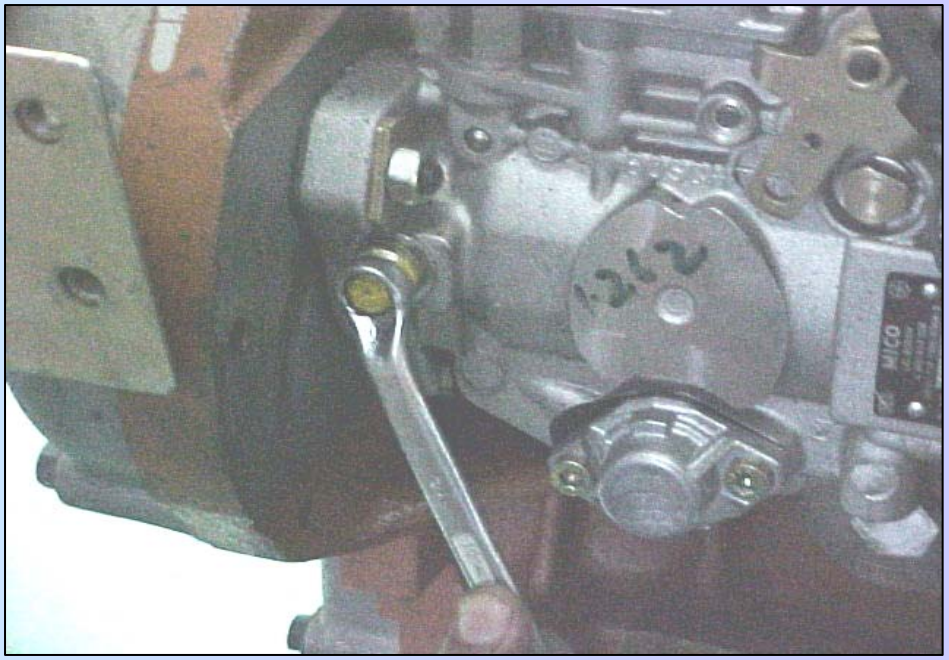
Assemble sprocket mounting nut & washer. Torque it to 2.5 kgm.

Remove sprocket locking pins & slotted pins

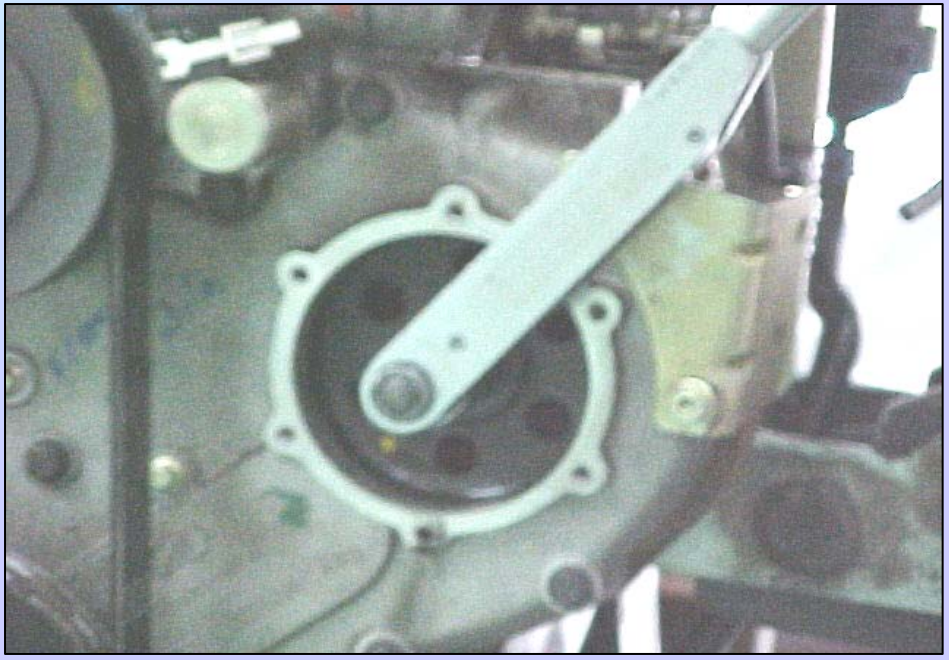


Assemble flange mounting nut & torque them to 3.5 kgm.

Put back the locking plate & tight locking screw.



Finally torque the sprocket mounting nut to 9.00 kgm.

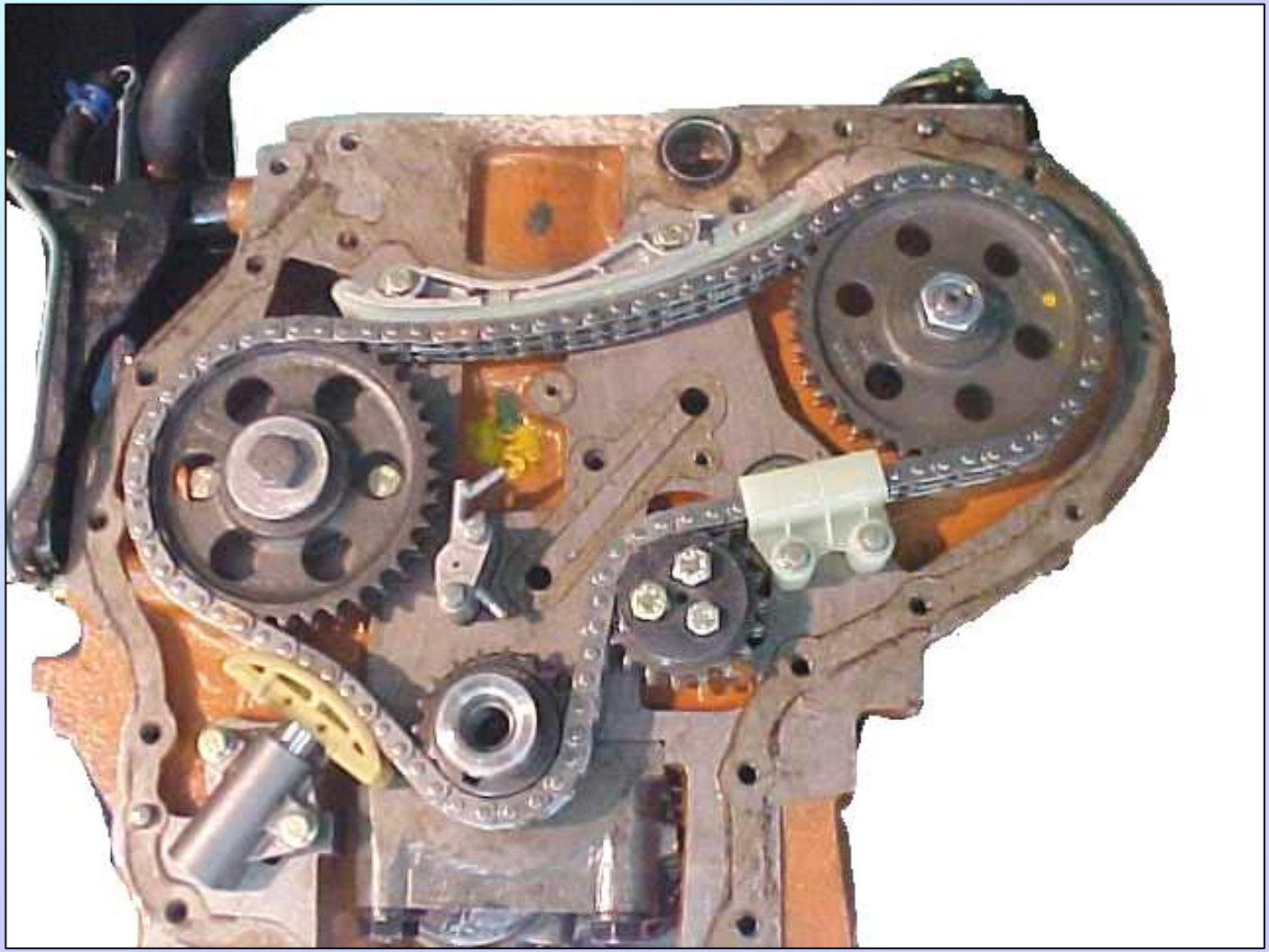


Note: it is advisable to check plunger lift by using dial gauge.
For BSII - 1.25 mm at TDC

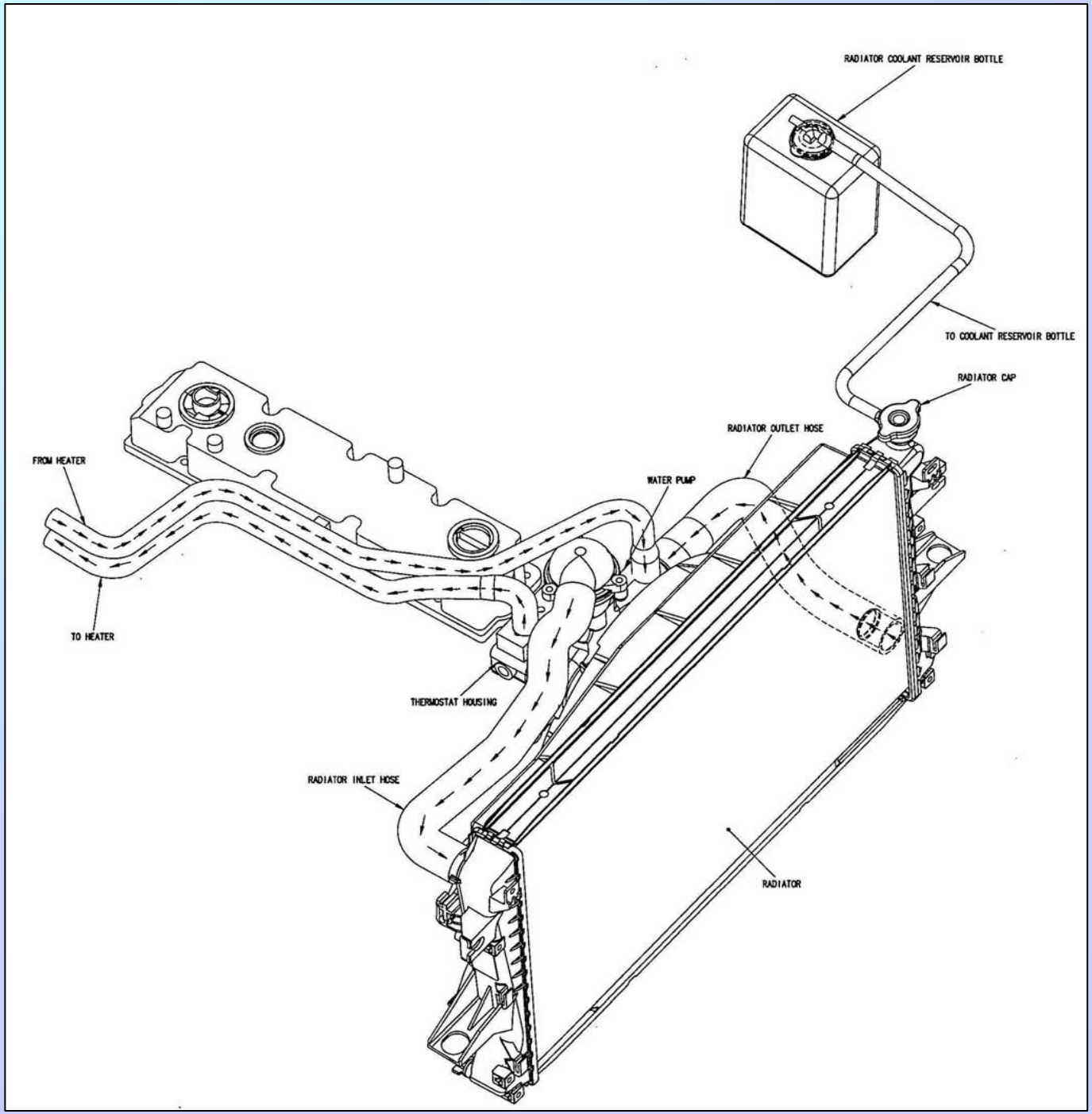
Complete the assembly

FIP removal & refitment w/o special tools

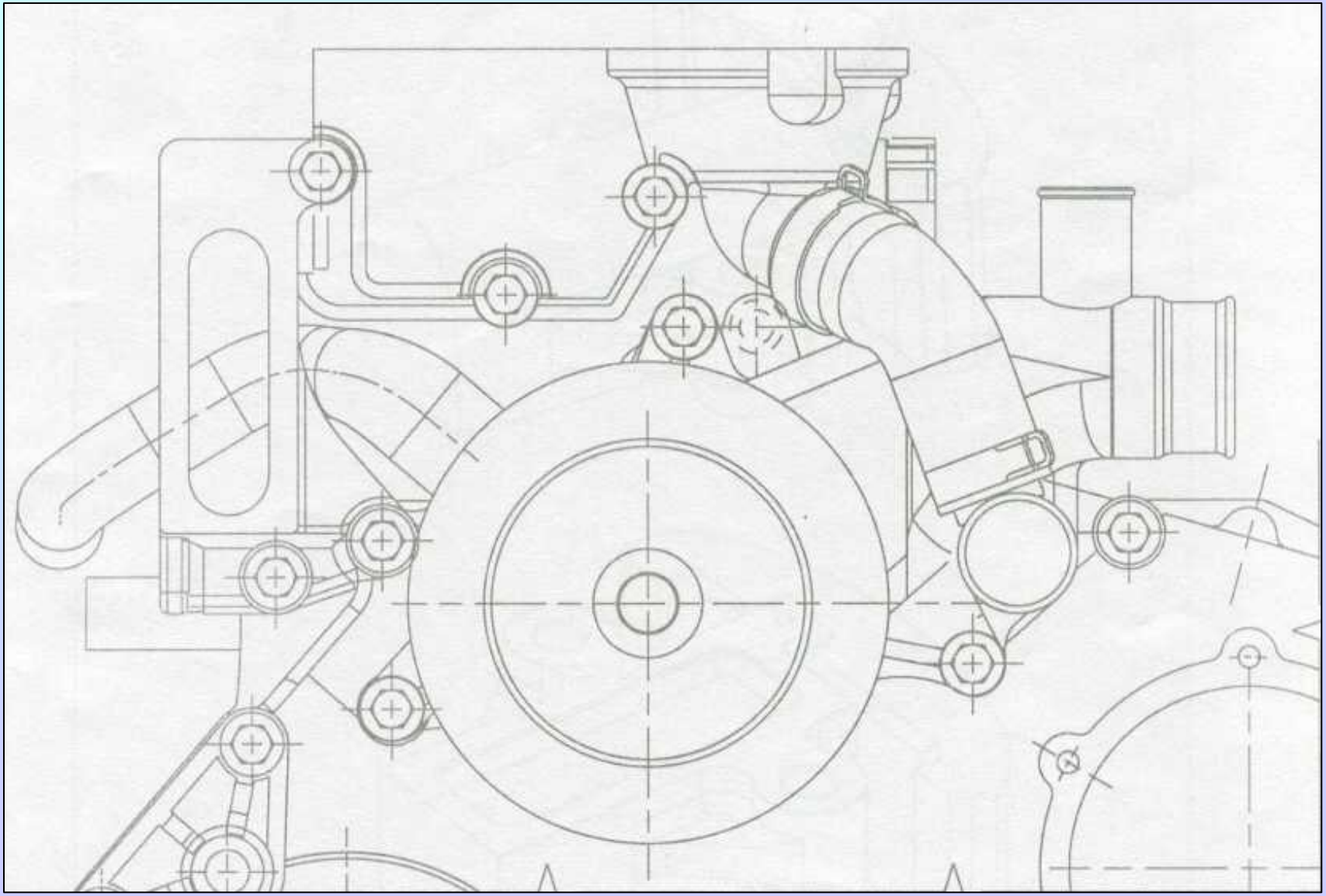
Without MST 270 & 272, if pump has to be removed ,remove timing cover & chain.

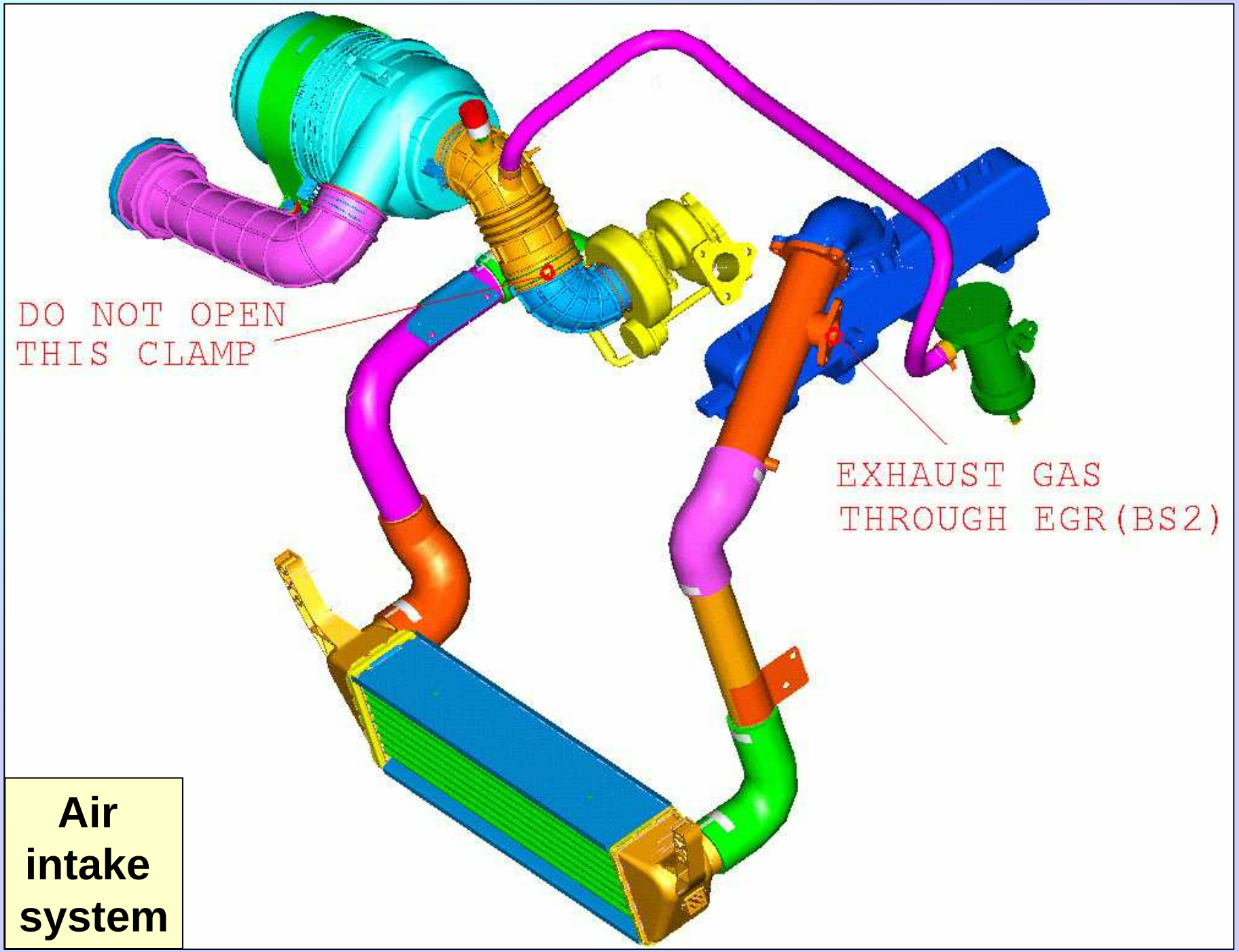


Cooling system

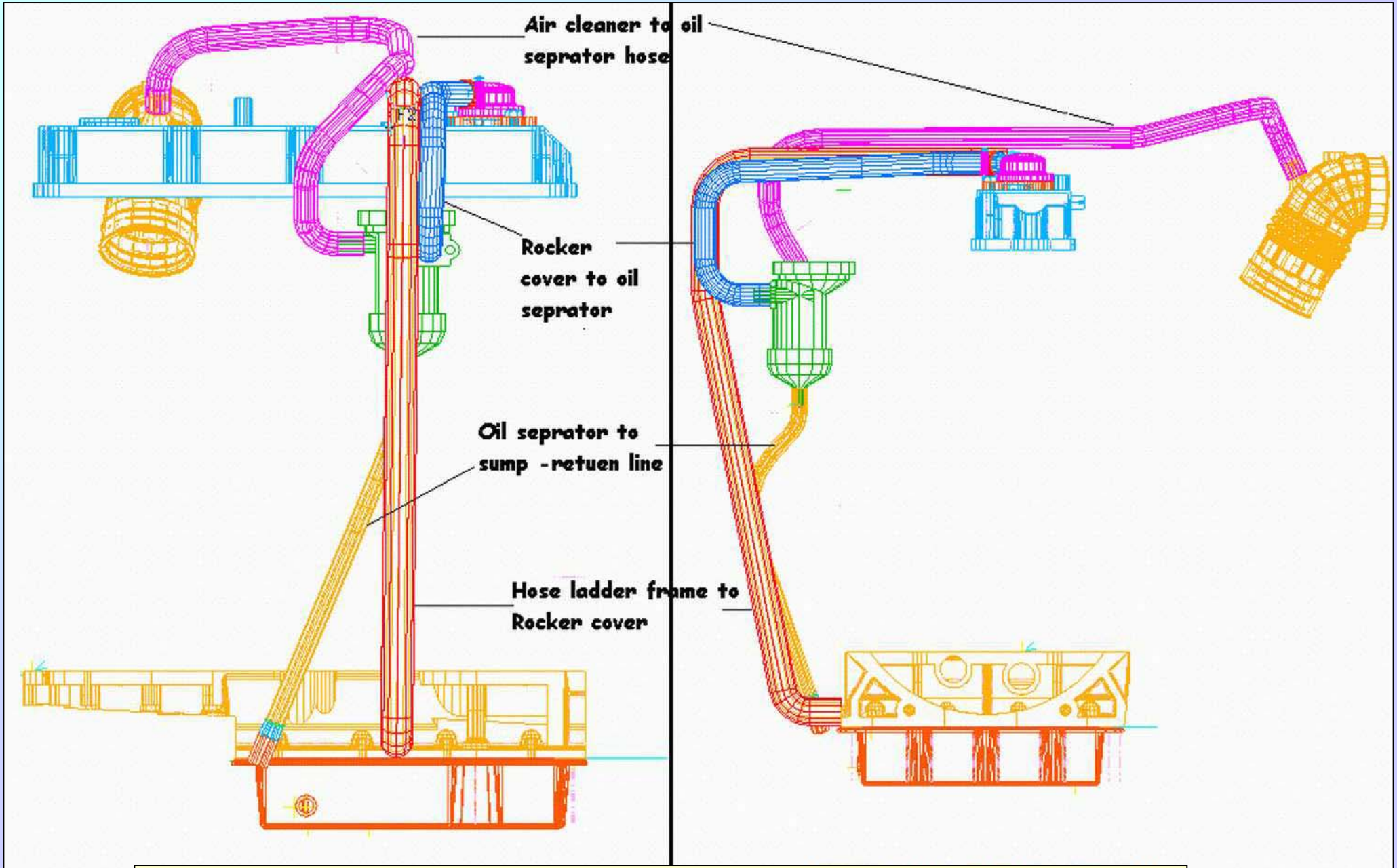


Water bypass system- SZ 2600 Plus



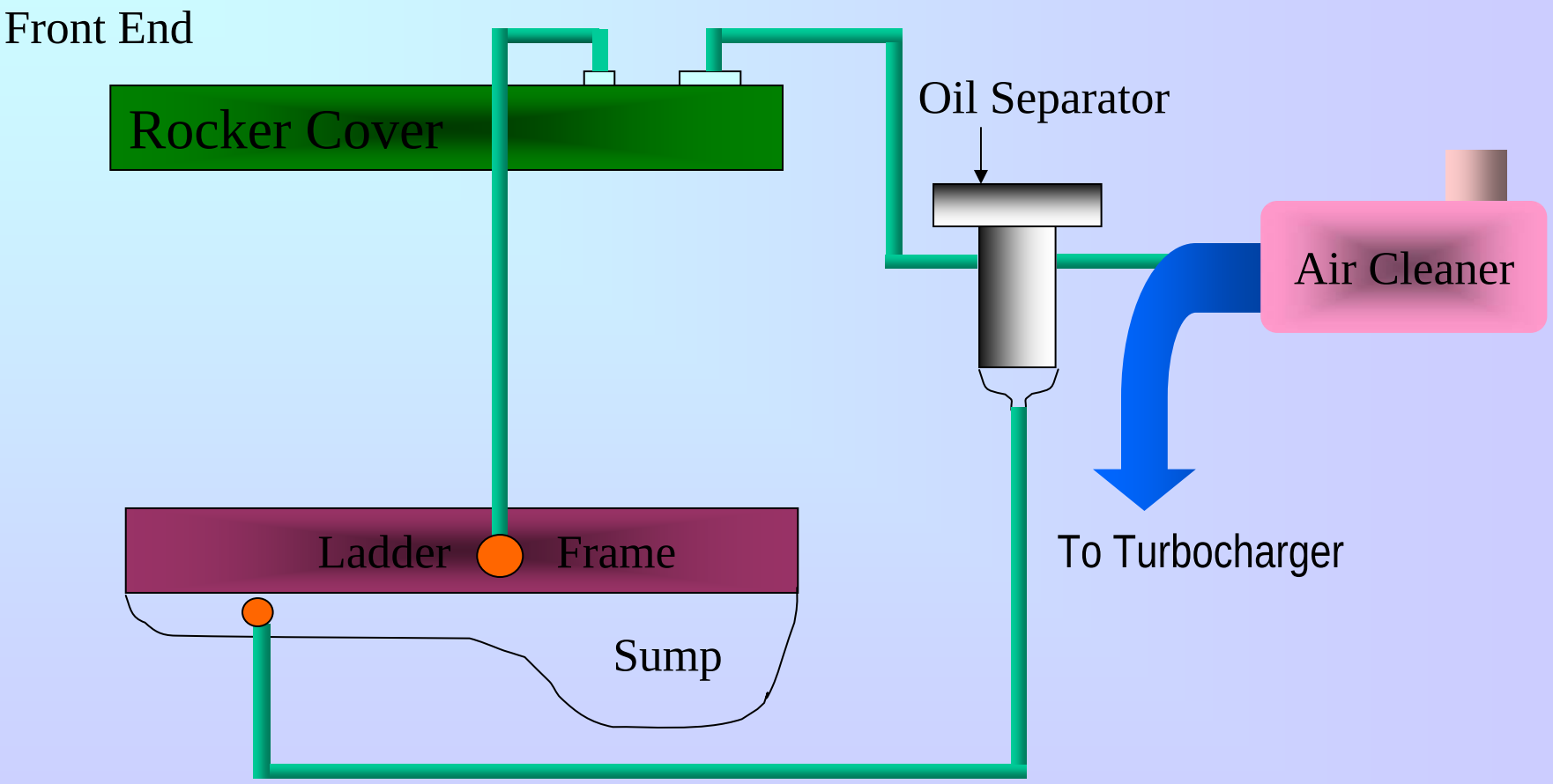


Air intake system



Positive crankcase ventilation system

POSITIVE CRANK CASE VENTILATION

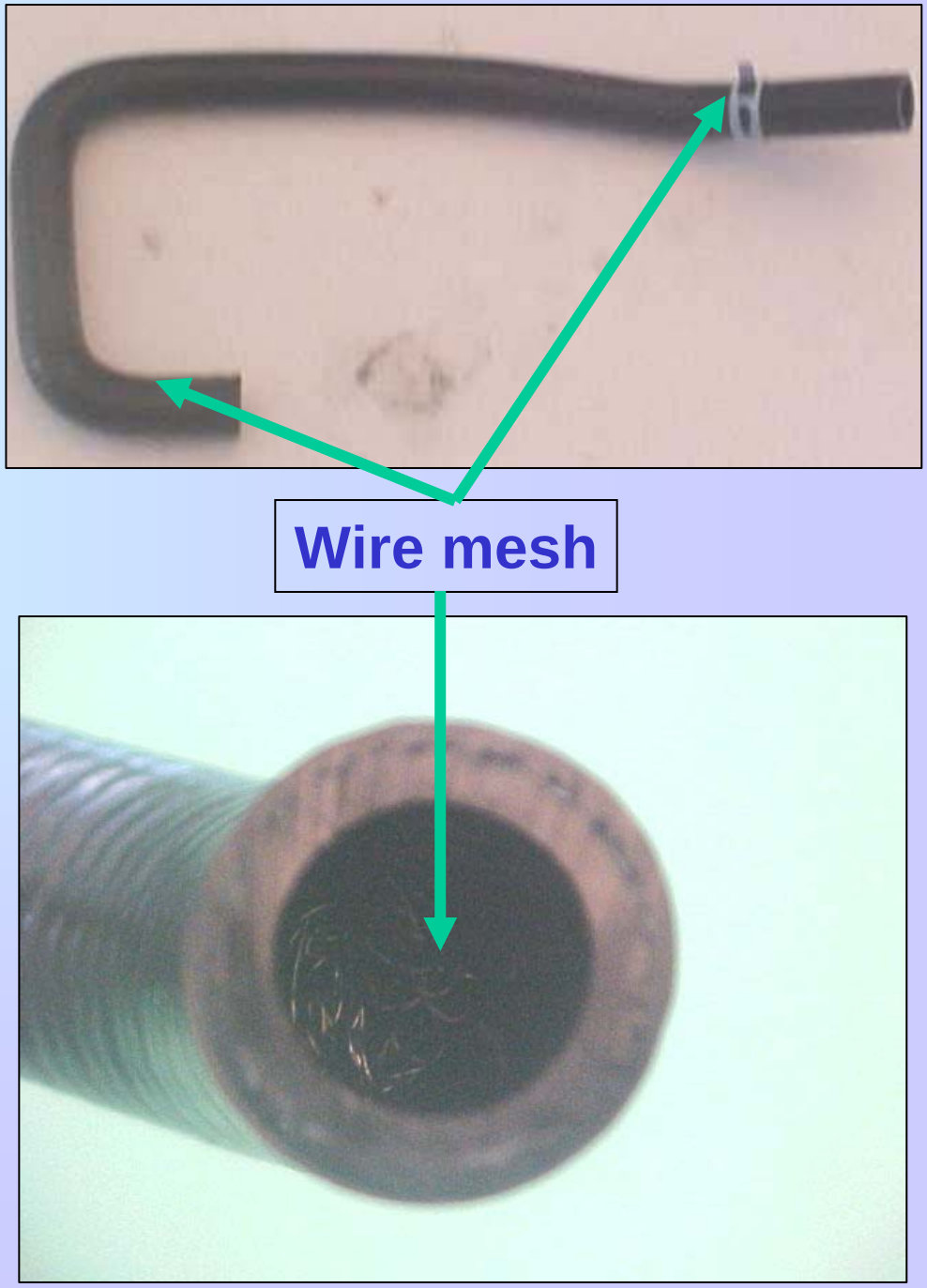


This hose connects the ladder frame assembly to rocker cover.

This hose balances the gas pressure in the rocker cover & sump.

This hose connect rocker cover to the oil separator.

It has a coarse mesh, at both ends which trap bigger particle & thus help to improve oil separator efficiency.

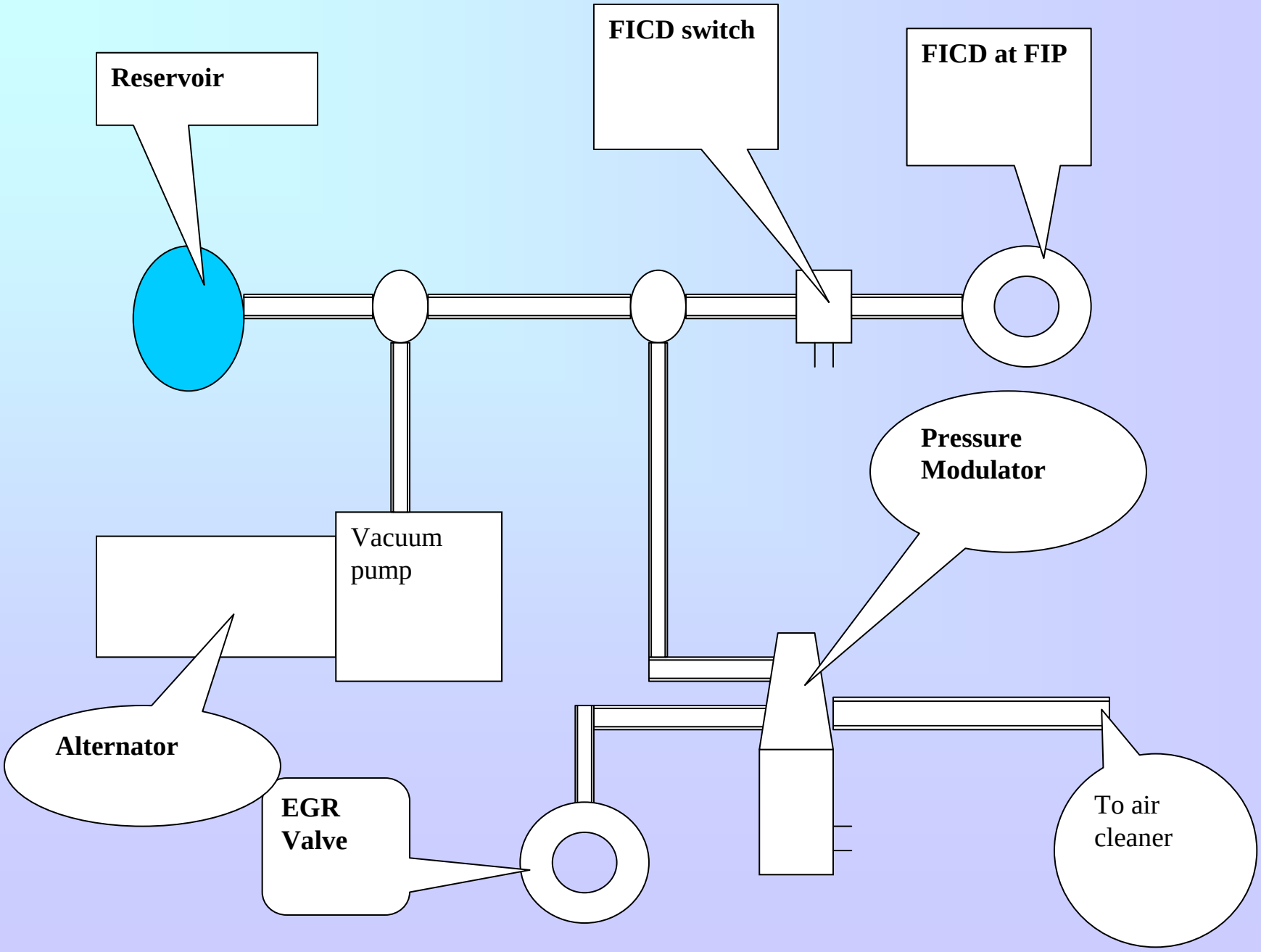


Oil separator separates oil particle & gas due to centrifugal action.

The vacuum after the air cleaner acts on to the top of diaphragm . The balance of the vacuum against the spring & the vapour pressure controls the amount of the oil going to the sump.

Oil return hose

Vacuum connection to EGR & FICD



Important clearances & dimension

Exhaust cam lobe lift	:	6.07
Inlet cam lobe lift	:	6.90
Valve stem & guide	:	0.03 to 0.07[inlet]
		0.05 to 0.09 [Exhaust]
Crank shaft & main bearing	:	0.02 to 0.07
Crank shaft run out	:	0.025mm [max]
Crank shaft end float	:	0.10 to 0.37
Connecting rod & crank pin	:	0.20 to 0.04
Connecting rod side clearance	:	0.10 to 0.30
Cam shaft bush & journal	:	0.02 to 0.07
Axial clearance of cam shaft	:	0.1 to 0.3

All dimension in ‘mm’ unless specified

Cylinder head height	:	97.70 to 98.30
Transverse deflection of head	:	0.05
Tappet setting - inlet	:	0.30
Tappet setting - exhaust	:	0.45
Nozzle opening pressure- MICO	:	250 + 8 bar

All dimension in ‘mm’ unless specified

Important torque

	Kg-m	lbs-ft
Cylinder head	: 9.00+ 60^{0+} 60^{0}	65.00+ 60^{0+} 60^{0}
Connecting rod bolts	: 4.50+90^{0}	30.00+ 90^{0}
Main bearing caps	: 17.00	125
Crank shaft pulley	: 9.00+ 90^{0+} 90^{0}	65.00+ 90^{0+} 90^{0}
Flywheel bolts	: 9.00+60^{0}	65.00+ 90^{0}
Cam shaft gear/sprocket bolt	: 11.00	80
Timing cover mounting bolt	: 2.50	20
F I P main shaft Nut	: 9.00	65

Important MST

		MST No
Piston ring compressor	:	168
(Common with XD 3P)		
Spanner for engine mounting nut	:	542
Extractor - Fly wheel bearing	:	543
Drift - Flywheel bearing	:	544
Wrench- Oil filter removal	:	545
Cylinder head bolt deep socket	:	588
Tool for removing FIP[Chain drive]	:	270
Flywheel lock[Chain drive]	:	271
TDC tool	:	272
Lock pin for chain tensioner	:	273
Sliding hammer [Use alongwith MST 543]	:	577

THANK YOU