

CYLINDER HEAD

CYLINDER HEAD



CYLINDER HEAD IS A IMPORTANT
PART OF COMBUSTION CHAMBER

TYPE of Cyl. Head :-1) Conventional

2) 251 Plus

POPULATION :- 16 NOS



Description

- ❖ Cylinder Head are made of special alloy cast iron casting.
- ❖ It is subjected to high shock stress and flame temperature at lower face which forms combustion chamber.
- ❖ Water cooling passage are cored with separate passage for high pressure injection line.
- ❖ Individual water jumper from Cylinder Block to each cylinder head, conduct water from Cylinder Block to water cooling passage in cylinder Head.
- ❖ Cooling water discharged from each head is carried to water outlet header by individual elbow connection.



Description

- ❖ Cored passages permit admission of scavenging air and exhaust gases.
- ❖ Metal-to-metal joints with lap type form the gas seal between the cylinder head and cylinder liners.
 - *Note : No gasket is reburied between cylinder head and liner.
- ❖ Space provided for holding fuel injection nozzle valve and valve seat insert.
- ❖ Recessed to cylinder Block by 7 stud.



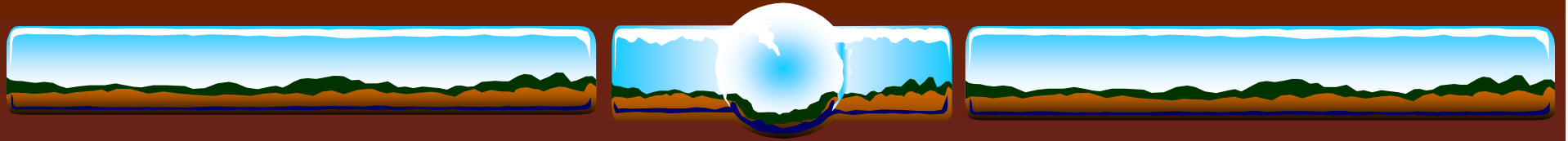
Description

- ❖ Valve lever bracket assembly, consisting of bracket and two valve liner mounted on valve liner shaft, is opposite to cylinder head along with equalizing yokes.

- ❖ **Material :**

- 1. Chemical Composition(%)**

Total carbon	:	3.00-3.40
Silicon	:	1.8-2.2
Sulpher	:	0.12 max
Phosphorus	:	0.15 max
Manganese	:	0.6-0.90
Chromium	:	0.20-0.40
Nickel	:	1.00 (min.)
Molybdenum	:	0.35-0.45



2. Physical Properties :

Hardness : 197-235 BHN

Note : The casting shall be stress relieved and cleanses

❖ Types of cylinder heads :-

1. Conventional Head-
 - (i) Both inlet and outlet valves at 45°
 - (ii) Inserts are made of waltite

2. Modified Head -
 - (i) inlet valves are at 30°
 - (ii) exhaust valves are at 45°
 - (iii) Inserts are made of waltite/stellite

* The modification in the inlet valve is made for better scavenging.



CONVENTIONAL CYLINDER HEAD



STUD
GROOVE

NOZZLE
SLEEVE

CHAMBER

VALVE

CONVENTIONAL CYLINDER

HEAD

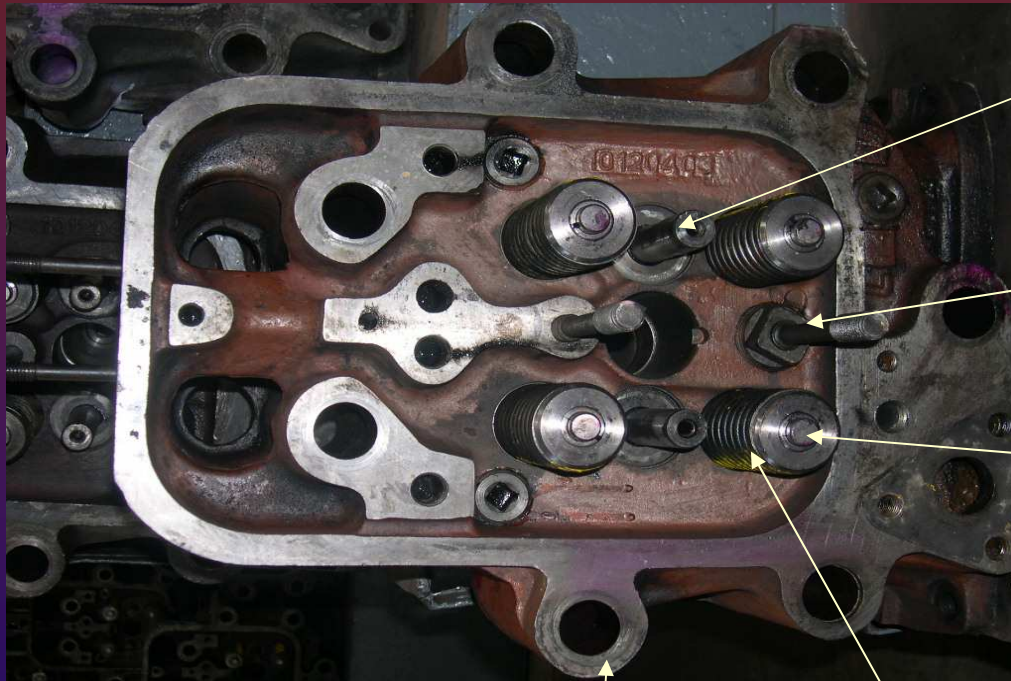
BRASS
SLEEVE



VALVE
SEAT
INSERT

VALVE
GUIDE

CYLINDER HEAD



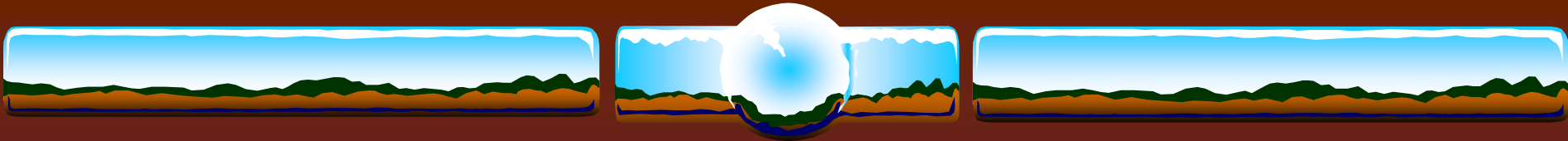
YOKE GUID

INJECTOR
RET. CLAMP
STUD

VALVE LOCK

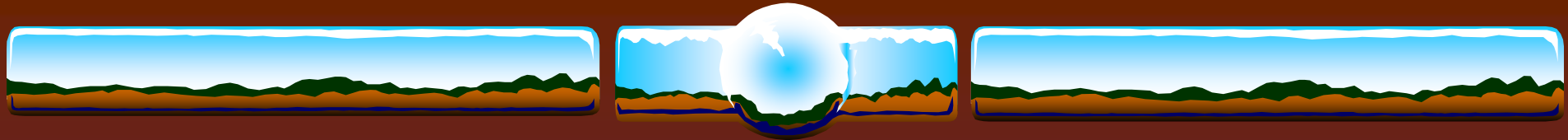
VALVE SPRING

STUD GROOVE



VALVES





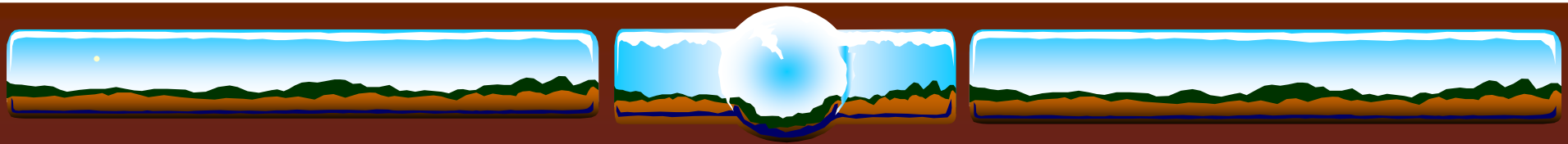
AIR & EXHAUST VALVE

Valve :

- Each Cylinder has 2 inlet and exhaust valve of 2.85” diameter
- Valves stem of alloy steel
- valve head of stainless steel*

Welded together into a composite unit.

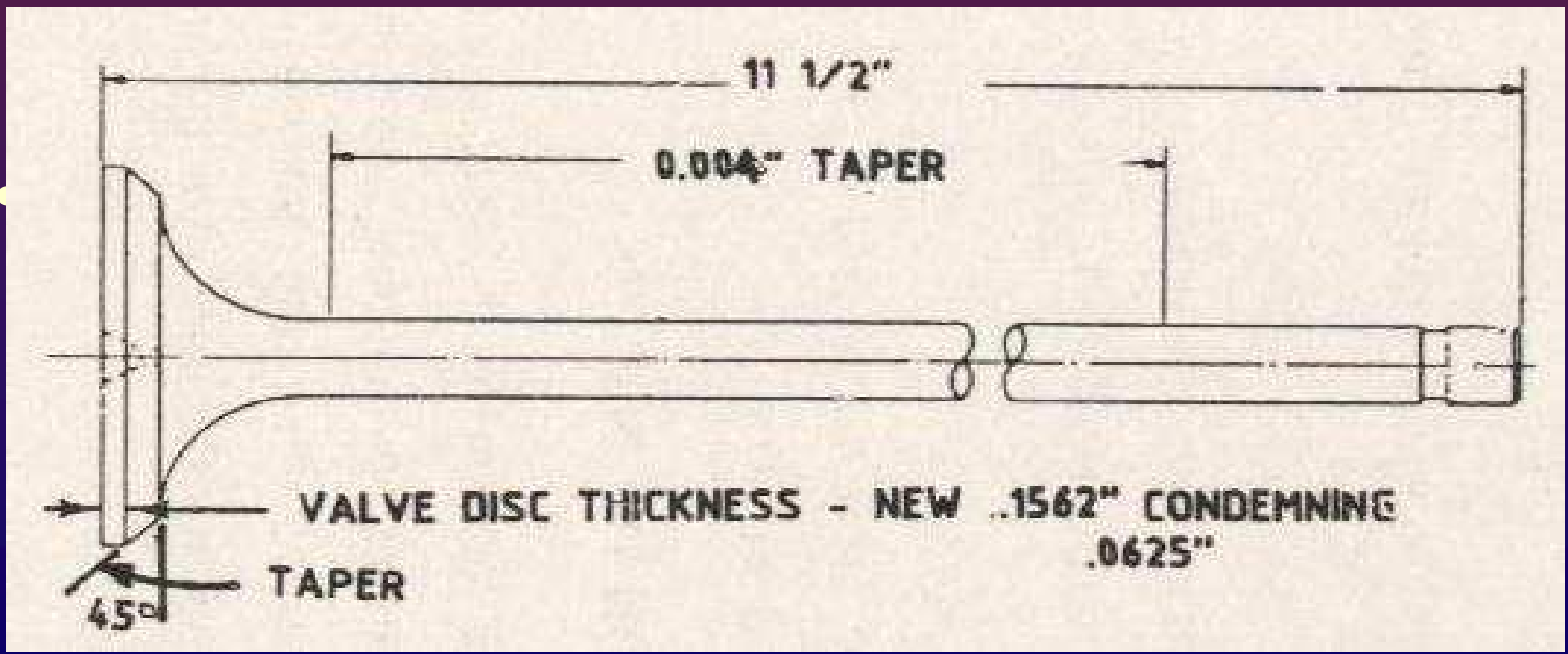
*Valve head material being Austenitic stainless steel has high resistance and is capable of hardening to resist deformation due to continuance pounding action.



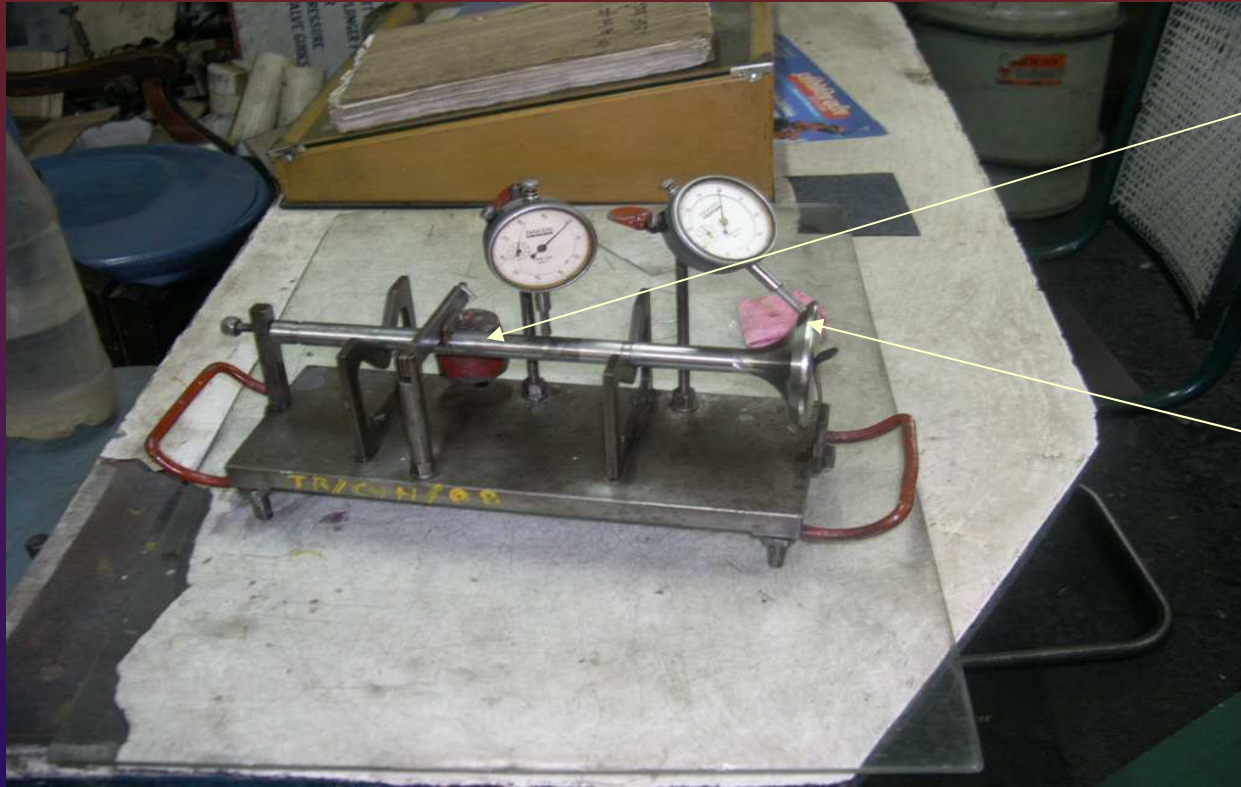
Note : Valve showing cracks to be scrapped.

Valves should also be scrapped when disc thickness 0.0625"

(New thickness-0.1562" | 5/32")



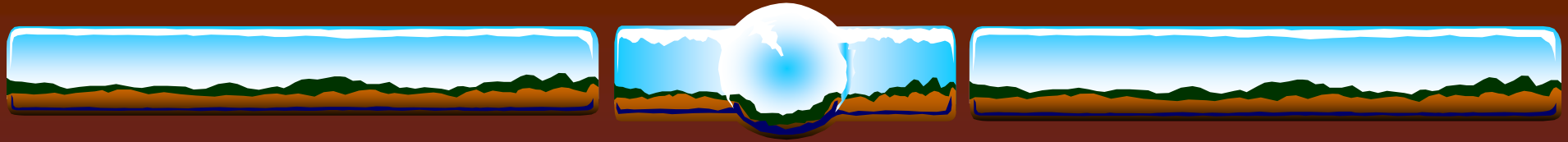
VALVE BENDNESS & RUN OUT



BEND NESS

RUN OUT

VALVE BENDNESS & RUN OUT
SHOULD NOT EXCEED-.002"



INLET VALVE -30 Degree



30 DEGREE
VALVE



EXHAUST VALVE- 45 DEGREE (INCONEL)

45 DEGREE
VALVE



VALVES GRINDING



VALVE SEAT INSERT

Cylinder Head uses valve seat inserts with snap rings-

- ❖ **Stellite material for VSI**

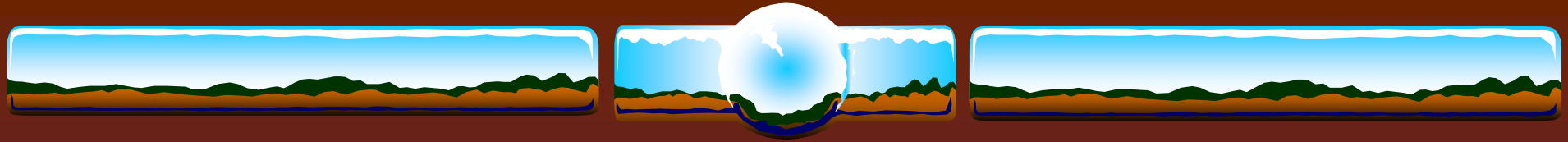
Cobalt	52%	Tungsten	11%
Carbon	2.5%	Others	4%
Chromium	30%		

Hardness: Rockwell 50(min) at room temp

- ❖ **Weltite material for VSI:**

Carbon	0.48 -0.58 %	Chromium	20 -22 %
Nickel	3.25-4.50 %	Nitrogen	0.38-0.50
Phosphorus	0.03 % max	Manganese	8- 10%
Silicon	0.25% max	Sulphur	0.09%

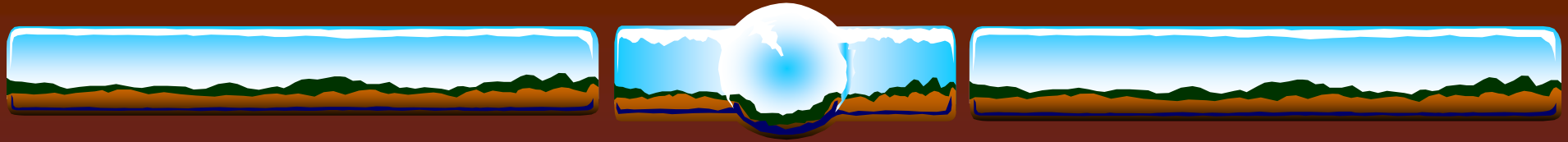
Hardness: Rockwell 32-38 at room temp.



VALVE SEAT INSERT-30 DEGREE
WELTITE (FOR INLET)
FOR CONVENTIONAL HEAD



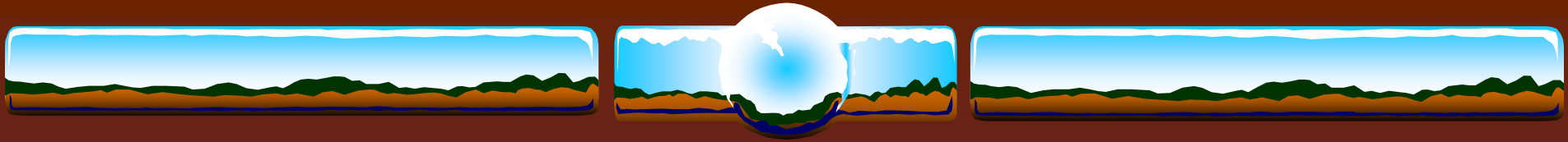
VALVE SEAT
INSERT-30
DEGREE
WELTITE
(FOR INLET)



VALVE SEAT INSERT-45 DEGREE
STELLITE (FOR EXHAUST)
FOR CONVENTIONAL HEAD

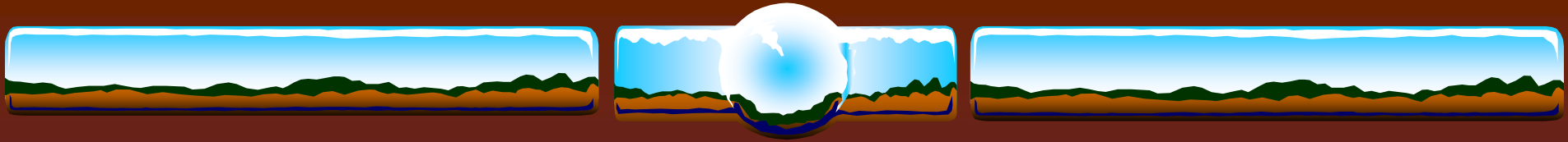


VALVE SEAT
INSERT-45
WITH SNAP
RING



Valve seat insert grinding-

- If necessary to remove valve seat insert, use valve seat extractor tool.
- After removal Check bore diameter ,If bore within standard dimension and snap ring groove is in good condition, new standard valve seat insert fitted.
- Interference between Valve seat insert to housing **0.0015” to 0.0035”(stellite), 0.003” to 0.005”(weltite)**

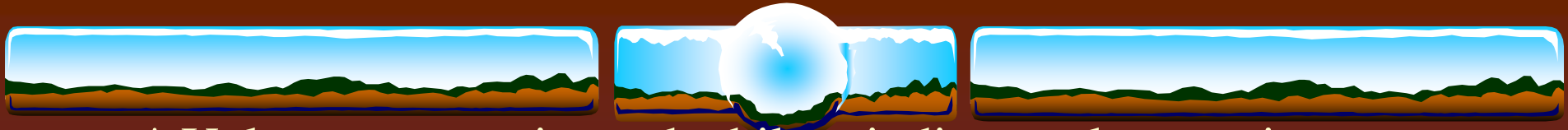


Valve Seat Insert

To provide interference fit , inserts are frozen in ice and cyl head is heated to bring about a temperature differential of 250° F and the Insert is therefore, pressed into

Grind- valve Seat insert

- Use dial indicator to check thickness
- Dress stone frequently at 45°/30° to eliminate formation of glass on stone
- Weight of grinders should only pressured executed on in seat during grinding*



* Unless extreme is used while grinding , valve seat inserts cracking may result major cause is either use of improper stones or application of too much pressure on driver when grinding the seat.

Valve Seat insert- Run out :

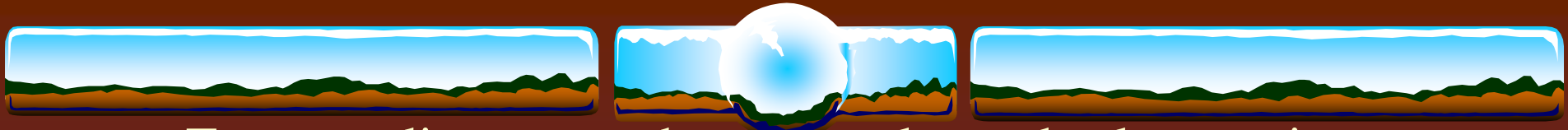
- Concentricity with valve guide bore should be on follows(0.002”)
- Check surface of valve seat insert with Dy penetrate for cracks
- Check thickness ,valve seat insert-3/32”(min)

INSERT GRINDING



EXHAUST
44.5 DEGREE

INLET
29.5 DEGREE

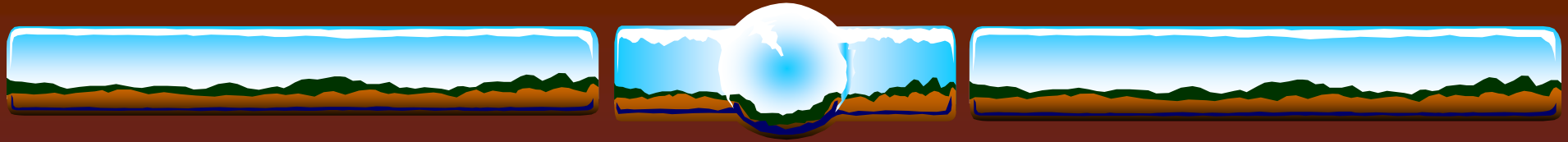


-To ensure line contact between valve and valve seat insert,

- Exhaust valve is ground to angle of 45°
- Insert are ground an angle of 44.5°
- Inlet valves are ground to an angle of 30°
- Insert are ground at 29.5° .

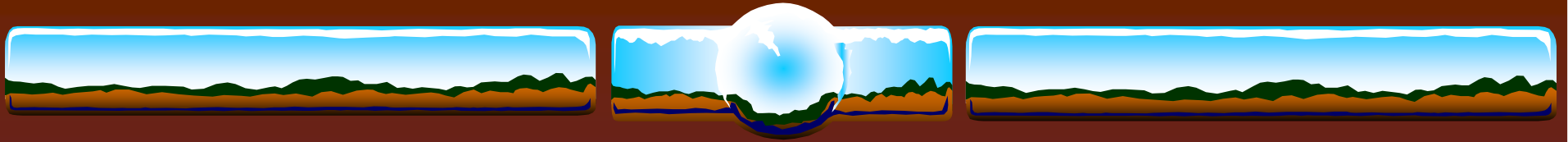
* To check valve with seat, blue valve, insert valve guide and bounce against valve seat.

Fine blue line must show around entire conference on large diameter of seat contacting area compression seal



VALVE SPRING





VALVE SPRINGS

- In order for a valve spring to give satisfactory service-
- spring load must not be less than 118 pounds at a spring height-

- Free height - 4.8125” (122mm)

- Compressed height -3.8125” (96.8mm)

SPRING PAIRING



COMPRESSED
HEIGHT

PAIRING OF SPRING TO BE DONE
AS FOLLOWS

HEIGHT

COLOUR

1. > 96.8 TO 98.4 MM

GREEN

2. > 98.4 TO 100 MM

YELLOW

3. > 100 TO 101-6 MM

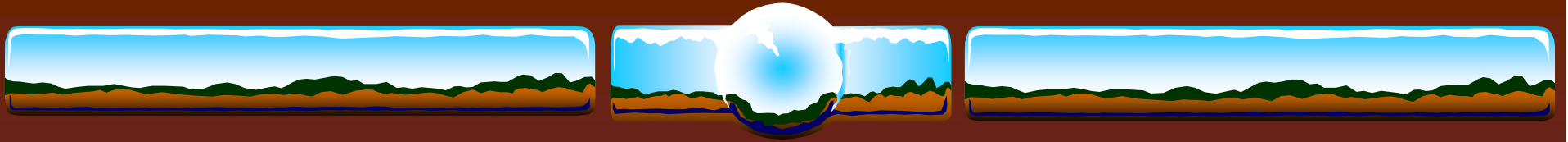
WHITE

FREE HEIGHT OF SPRING = 122
MM



MAINTENANCE

- ❖ Cylinder heads are repaired and overhauled in M-24 and above schedule and also for out of course repairs such as:
 - ❖ Less blow by from head.
 - ❖ Water coming from fuel return pipe.
 - ❖ Yoke guide broken.
 - ❖ Water coming from water jacket sleeve.
 - ❖ Injector not firing due to improper seating with injector sleeve.
 - ❖ Compression seat leaking.
 - ❖ Insert crack & broken.



Disassembly :

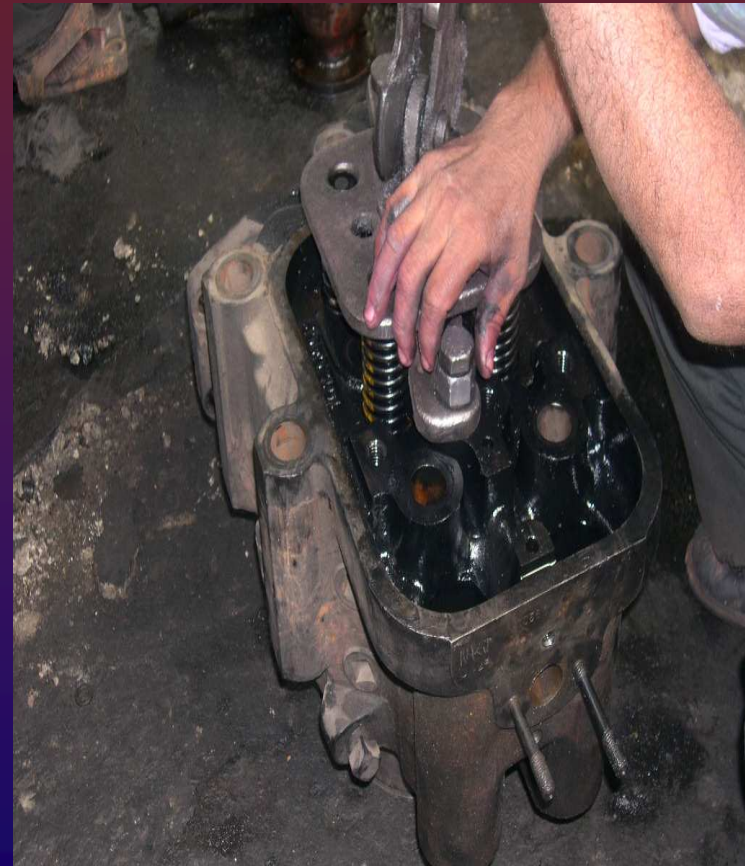
Removal from Engine :

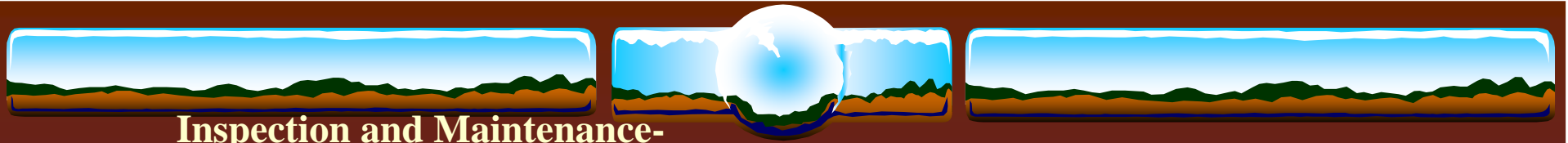
1. Drain Engine water
2. Remove cyl head cover.
3. Remove valve assembly from Cylinder Head
4. Left push rod
5. Disconnect air inlet and elbow
6. Disconnect and remove fuel oil drain line
7. Disconnect and remove lube oil supply line to valve operating mechanism
8. Disconnect and remove high pressure fuel line and nozzle
9. Remove water jumper and water outlet elbow
10. Remove cylinder head nuts and left head using lifter.



CYLINDER HEAD DISMANTLING

PUT THE CYLINDER HEAD ON WOODEN BLOCK AND REMOVE VALVES, LOCKS AND SPRINGS USING VALVE SPRING DEPRESSER. KEEP ALL THE COMPONENTS AT PROPER PLACE.





Inspection and Maintenance-

- Clean cylinder head

- ❖ **RDP- TESTING**

- **Application of Valve Guiders :-**

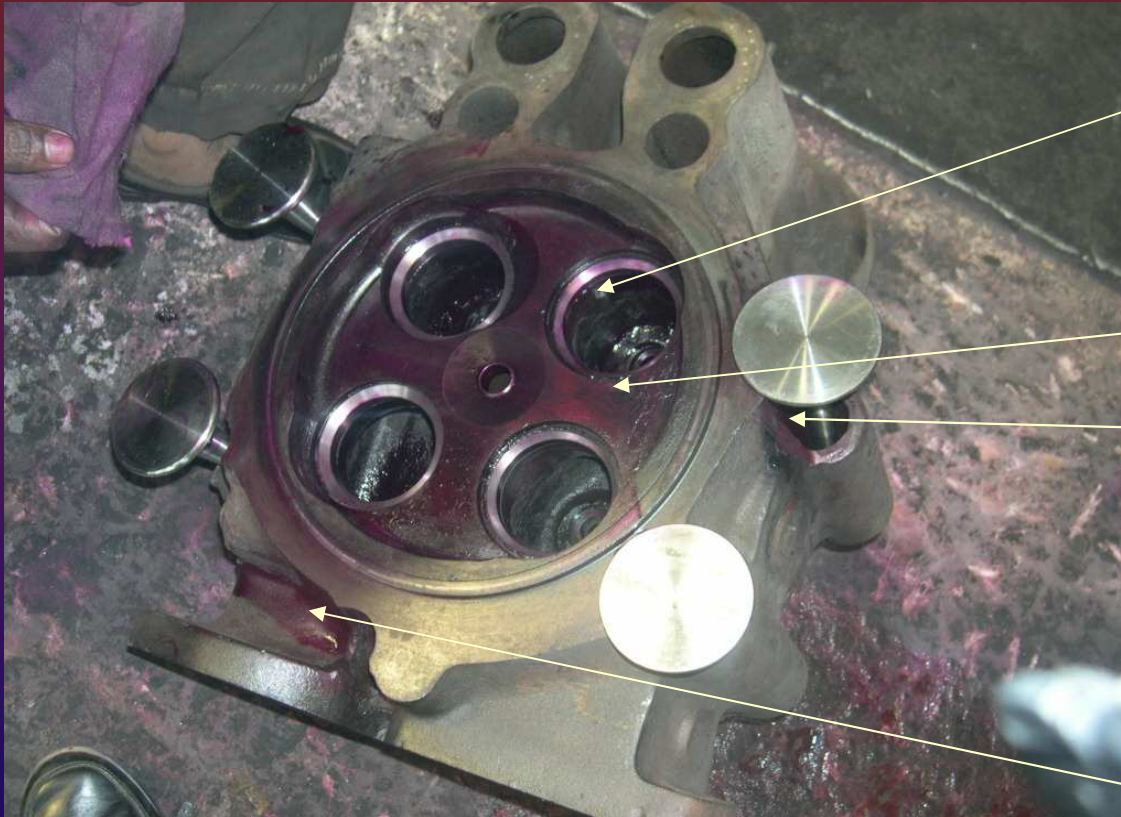
Valve guide can be removed by pressing or driving them out from bottom of head Removal is necessary when guider are worn or damages

- **Press in new valve guide with inserting tool-**

Valve guide to housing interference - 0.0008” to 0.0018”.

Valve Guide : Projected height –2.25”

RDP- TESTING



INSERT

CHAMBER

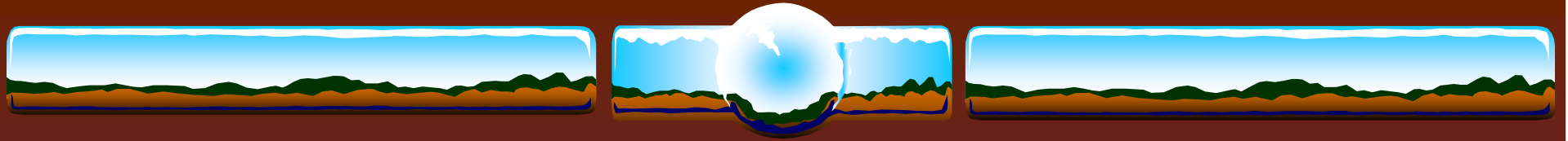
NO.03
STUD
GROOVE

NO.01 STUD
GROOVE

VALVE GUIDE CHANGING



ALL
FOUR
NOS
TO BE
CHANGED
IN M-24
AND ABOVE
SCHEDULE



- **Hydraulic Test :-**

Conduct Hydraulic Test for leaks at 70 psi and
190° F water Temperature

Cylinder head in following areas for leaks-

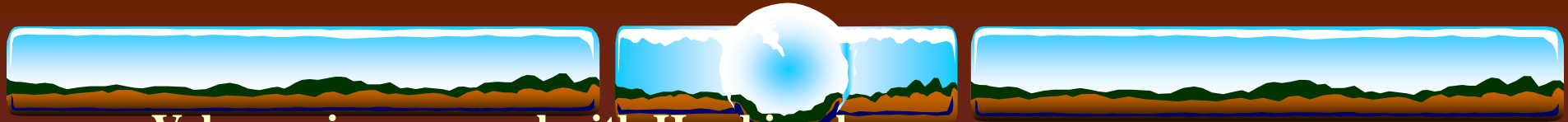
- . **Injector nozzle sleeve. .**
- . **Bridge of inserts**
- . **Water jacket sleeve.**
- . **All dummies.**
- . **All stud holes and etc.**

(Note : Cylinder Head to be scrapped of leakage exit)

HYDRAULIC TESTING

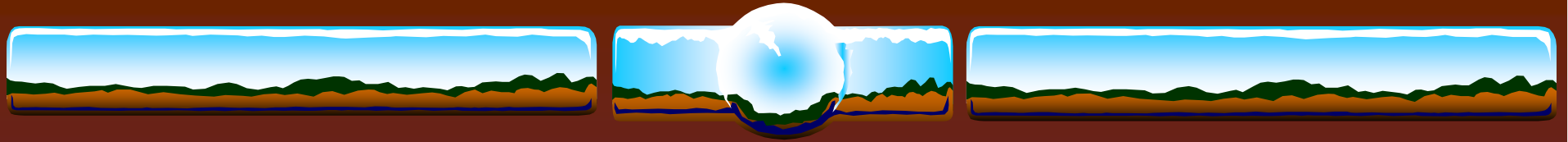


PRESSURE
OF
WATER:-70
PSI
TEMPE.
:-87 DEGREE
CENT.



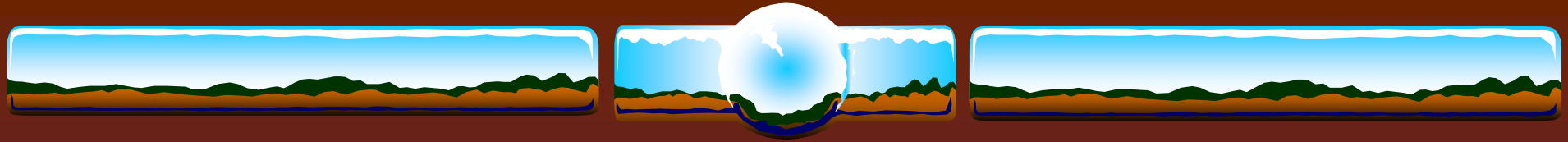
Valve spring removal with Head in place

- ❖ In case it is desirable to replace a valve spring with nut removing Cylinder Head, the piston of Cylinder valve should be brought TDC
Remove valve lever assly
- ❖ Equalizing Yoke Guide
- ❖ Two Equalizing Yoke guide are pressed into Cylinder Heads.
- ❖ Clearance between yoke and guide between excess or of yoke guide becomes bent.(Clearance yoke to yoke guide.0020”-.0035”)



- **Nozzle Hole sleeve**

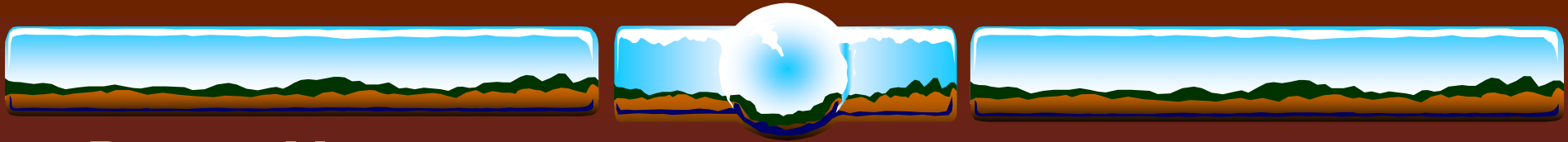
- _Sleeve applied with tide in the nozzle hole of each cylinder head to provide on water jacket for nozzle cooling and to furnish a seat for the nozzle.
- Clean nozzle hole with Cylinder Head nozzle hole clearing
- If water leak should occur between sleeve and head, old sleeve must be first replace with sleeve extractor and head water tested before applying new sleeve.



NOZZLE SLEAVE



NOZZLE
SLEAVE
PROVIDED
FOR
INJECTOR
SUPPORT.

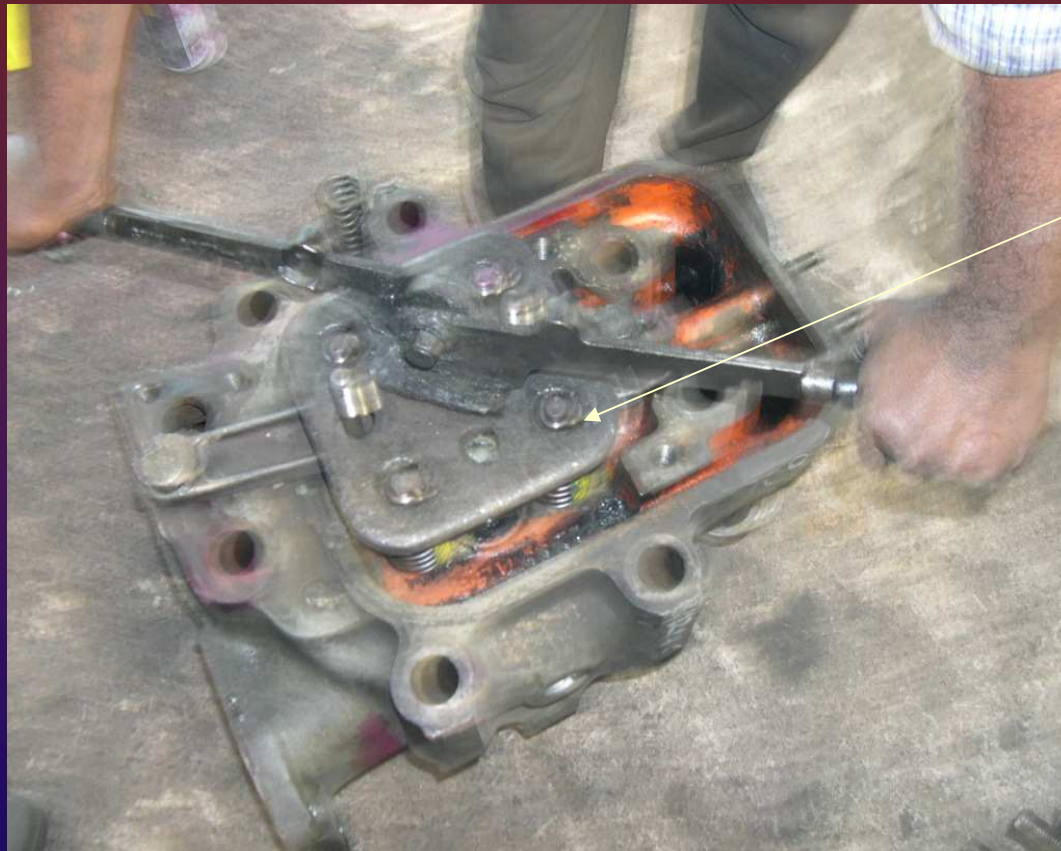


Reassembly

Nozzle Hole Sleeve

1. Enter sleeve in nozzle hole tapping at down until sleeve bottom firmly in head
2. Insert holding device and tighten nut until nozzle sleeve is held firmly in position in lower seat.
3. Using nozzle hole sleeve tube expander hole in upper portion of sleeve.
4. Hydraulics cylinder head at 70 psi with hot / cold water

CYLINDER HEAD ASSEMBLING



VALVE SEAT
SPRING
DEPRESSOR

Blow by Test:

Test Bench blow by test conducted on bench to ensure sealing effect of Cylinder Head.



INCOMING
PRESSURE
70 PSI

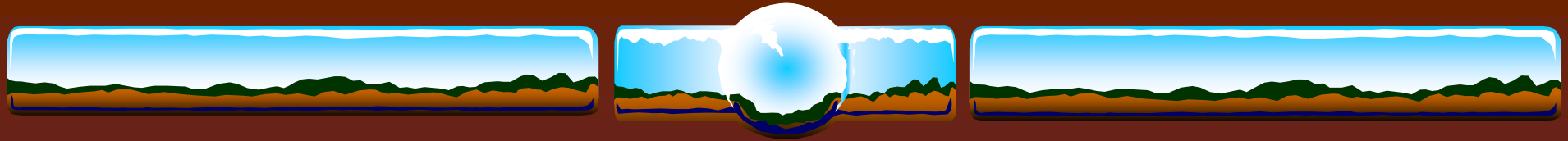
HOLDING TIME
MIN.-40 SECOND

CYLINDER
HEAD

YOKE GUIDE ULTRASONIC TESTING

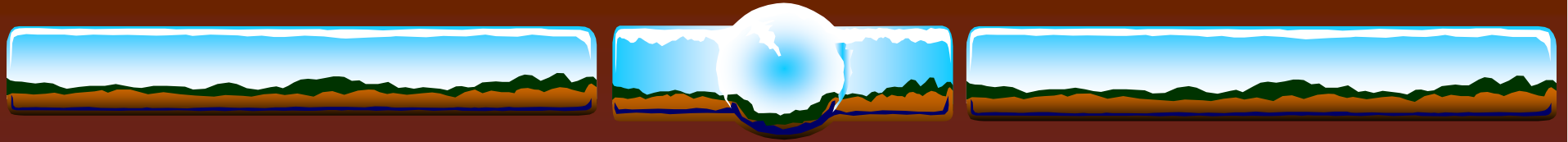
- ❖ AFTER ■
ULTRASONIC
TESTING OF YOKE
GUIDE ,CYLINDER
HEADS TO BE
GIVEN READY FOR
FITMENT.





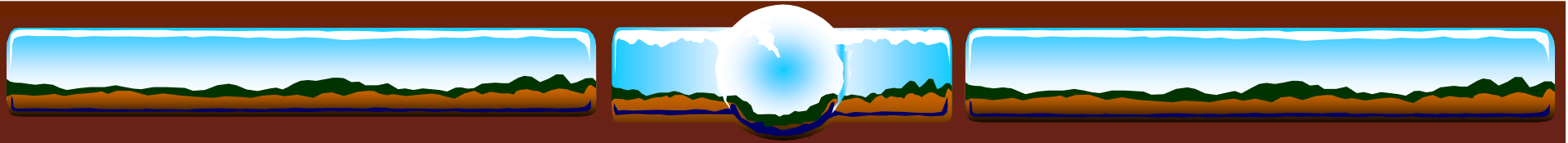
- Cylinder head to liner joint having metal-to-metal ,seating area must be in good condition.
- Check these surfaces by lapped using lapping ring (if necessary)
- Seating surface must be smooth and in one plane
- Using bluing, a continuous blue mark not less than 1/16” wide under must show throughout the circumference.





Installation of Engine :

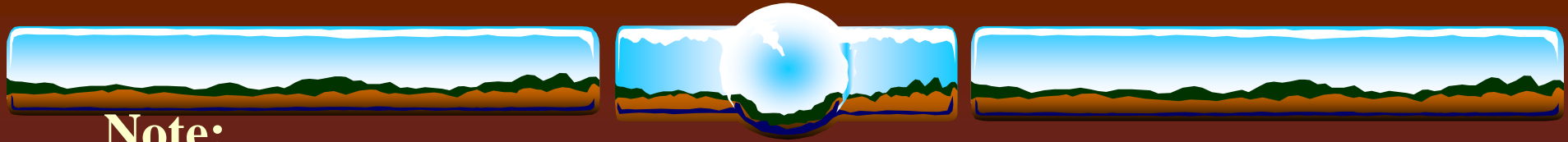
1. Clean compression seal joint faces of Cylinder Head and liner before installing Cylinder Head.
2. Insert grommets in push rod holes in Cylinder Block (if removed)
3. Set head in place and along with straight edge. Sequence head straight edge assemble. Proper alignment of bolt holes in air and exhaust elbow
4. Apply light coating of graphite grass to the thread of all stud. Install all nuts and hand tighten



5. Repeat tightening sequence. Final torque of 550 ft pond should not exceeded.

6 Connect Air inlet and Exhaust Elbows

7. Apply water inlet elbow. Gasket are used at top and bottom.



Note:

All cap screw to be tightened evenly.

9. Apply lube oil supply line to valve operating mechanism

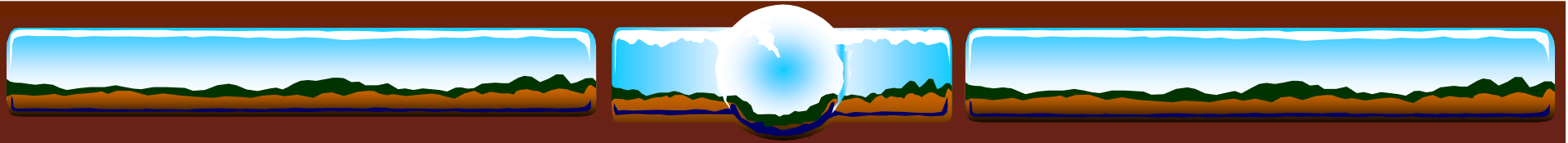
10. Apply water outlet elbow

11. Apply fuel injection nozzle and holder assembly.

Note : Ensure that pin in nozzle holder is in aligning slot in Cylinder Head.

12. Apply nozzle retaining clamp so that centre of clamp bearing surface is directly over center line of nozzle holder. Tighten clamp nut had type

13. Apply fuel injection pipe to nozzle holder using snobbier valve at pump



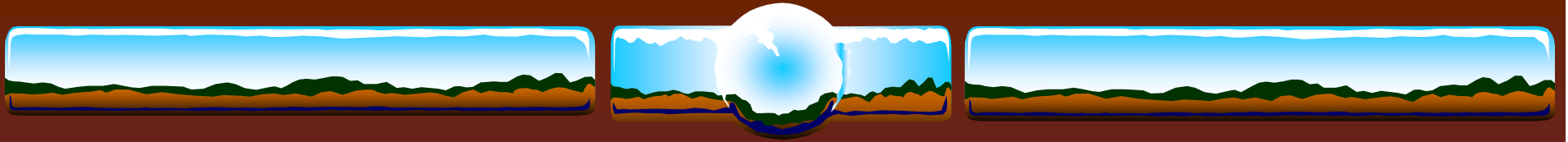
Note: Make sure that mating surface between pipe and nozzle are absolutely clear and properly aligned.

14. Apply push rod and valve lever mechanism.



ALCO 251+ Cylinder Head

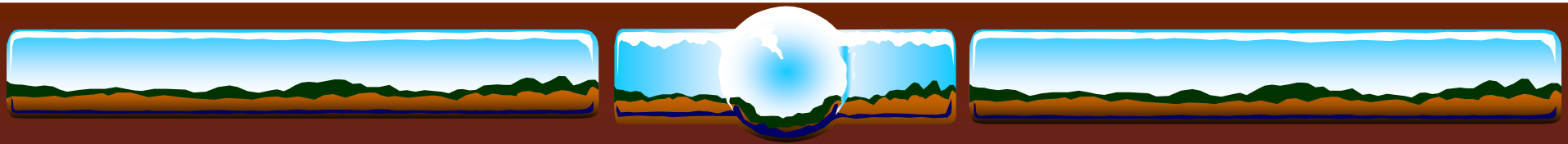
- ALCO 251+ are latest generation cylinder heads provided on operated engines with following features.
- Fire deck the clear reduced for better heat transmission.
- Middle deck modified by increasing No. of ribs (supports) to increase its mechanical strength
- Note : Water flow pattern improved after modification of middle deck eliminating water stagnation at covers inside cylinder Head.
- Water holding capacity increased by increasing number of cores
(14 instead 11)
- Use of frost core instead of threaded plug for arresting tendency of leaking
- Made lighter by 8 Kg (Al spacer is used to make good gap between grommet and cylinder Head)



- **Benefits :**

Better heat dissipation

Reduces by reducing crack and eliminating sagging effect of fire deck area.



251-PLUS CYLINDER HEAD



PUSH ROD
HOUSING

WATER JUMPER
PIPE HOLE

FROST
PLUG

251-PLUS CYLINDER HEAD

- WEIGHT-08 KG LESSER THAN CONV. CHD
- FROST PLUG IN PLACE OF THREADED DUMMIES
- INSERT SNAP RING ELIMINATED
- ADDITION PUSH ROD HOUSING
- ANNULAR COMBUSTION CHAMBER,
- IMPROVED CASTING

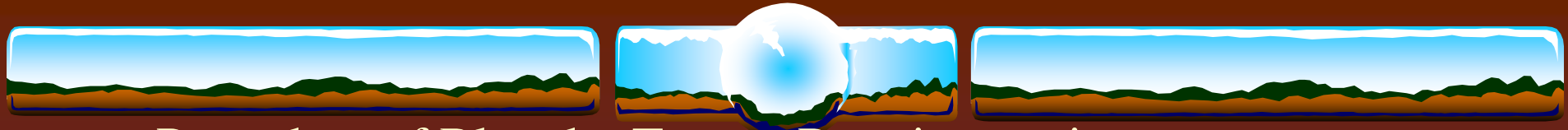


VALVE SEAT INSERT-30 DEGREE

WELTITE (FOR INLET) FOR 251
PLUS CYLINDER HEAD



VALVE
SEAT
INSERT
WITHOUT
SNAP RING



Procedure of Blow by Test on Running engine-

- Engine to attain normal operating temperature (65° C)
- Stop engine after attaining normal operating temp.
- Bring piston corresponding cylinder at TDC in

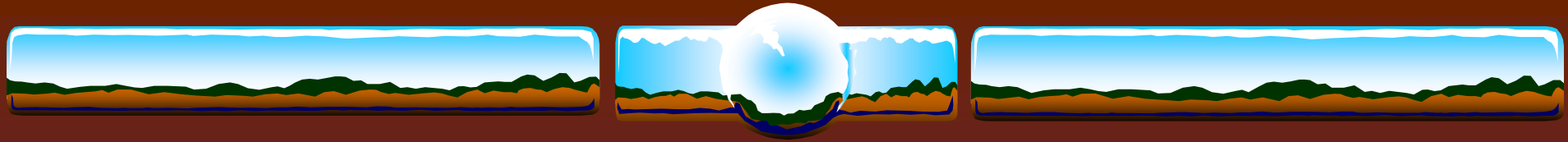
Compression stroke

- Fit blow-by gadget consists of compressed air line with the provision of pressed gauge and stop cock removing decompression plug

Charge combustion chamber with compressed air

Cut off air supply at 70 psi through stop lock and record time when it comes to zero

Note :7-10 secs blow by time is ok. If less check



- To check leakage, charge continuously at 70 psi.
- Leaking through T&C indicate defect in Cylinder Head.
- Leakage through sump indicate defect in piston and liner.

Tell Tale check

- Tell tale hole in Cylinder Head tells about the condition of Cylinder Heads in running condition as per following :

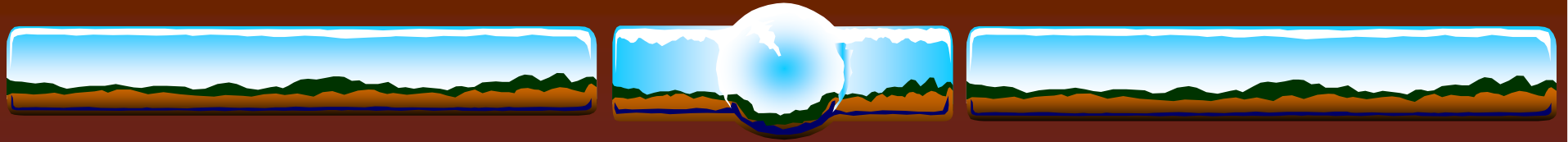
No Leakage : Ok

Fuel : Upto 2 drop/min if more, nozzle leak off rate is high

Fuel : Nozzle seat defective

Water Leakage : Nozzle sleeve ricketing

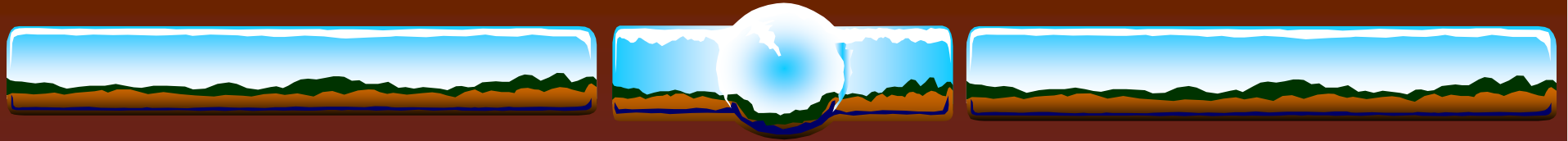
Lube oil Leakage : Rubber ring on nozzle ring damaged



CYLINDER HEAD

❖ MAIN REASONS OF CYLINDER HEAD FAILURE:-

- ❖ 1. BODY CRACK.
- ❖ 2. NOZZLE SLEEVE CRACK.
- ❖ 3. LESS BLOW BYE.
- ❖ 4. INSERT DROP/CRACK.
- ❖ 5. VALVE DROP/VALVE BROKEN etc.



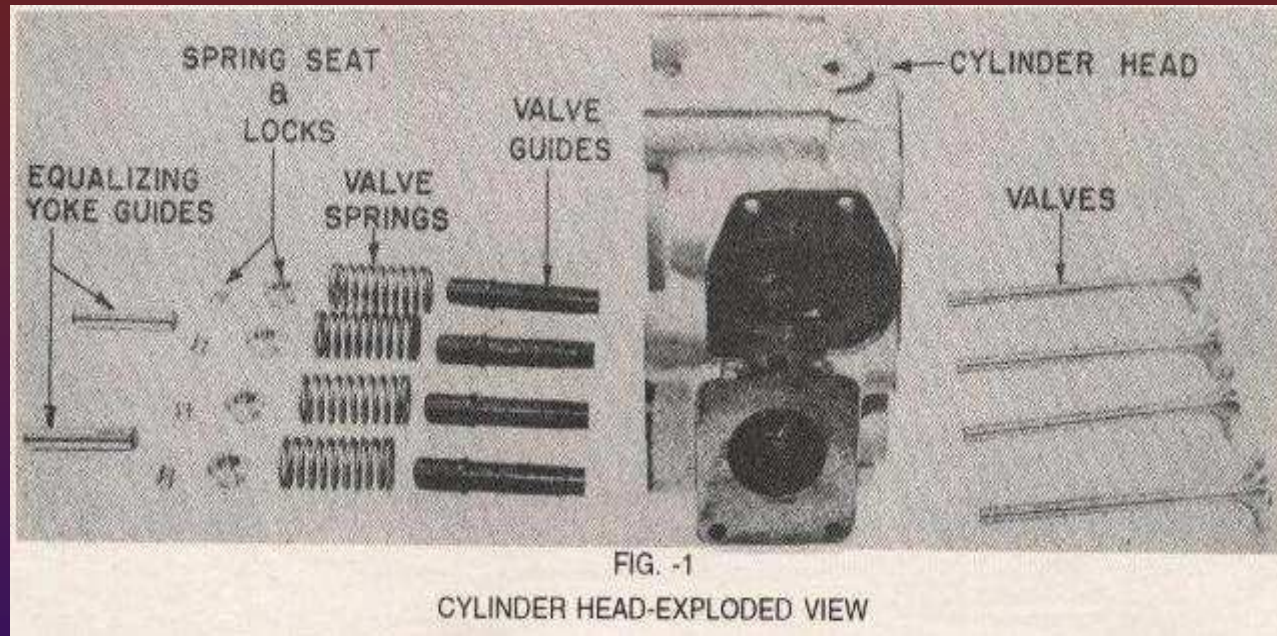
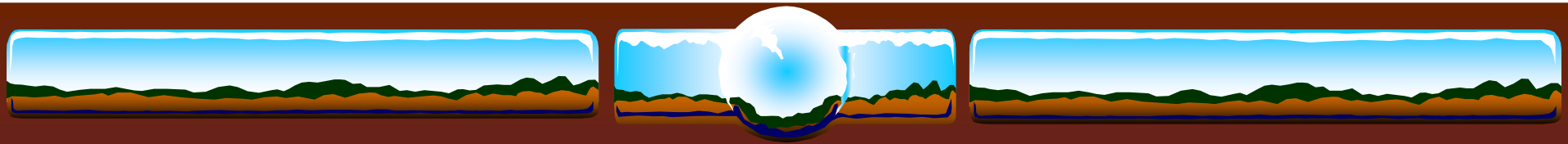
REASONS OF CYL.HEAD CRACK

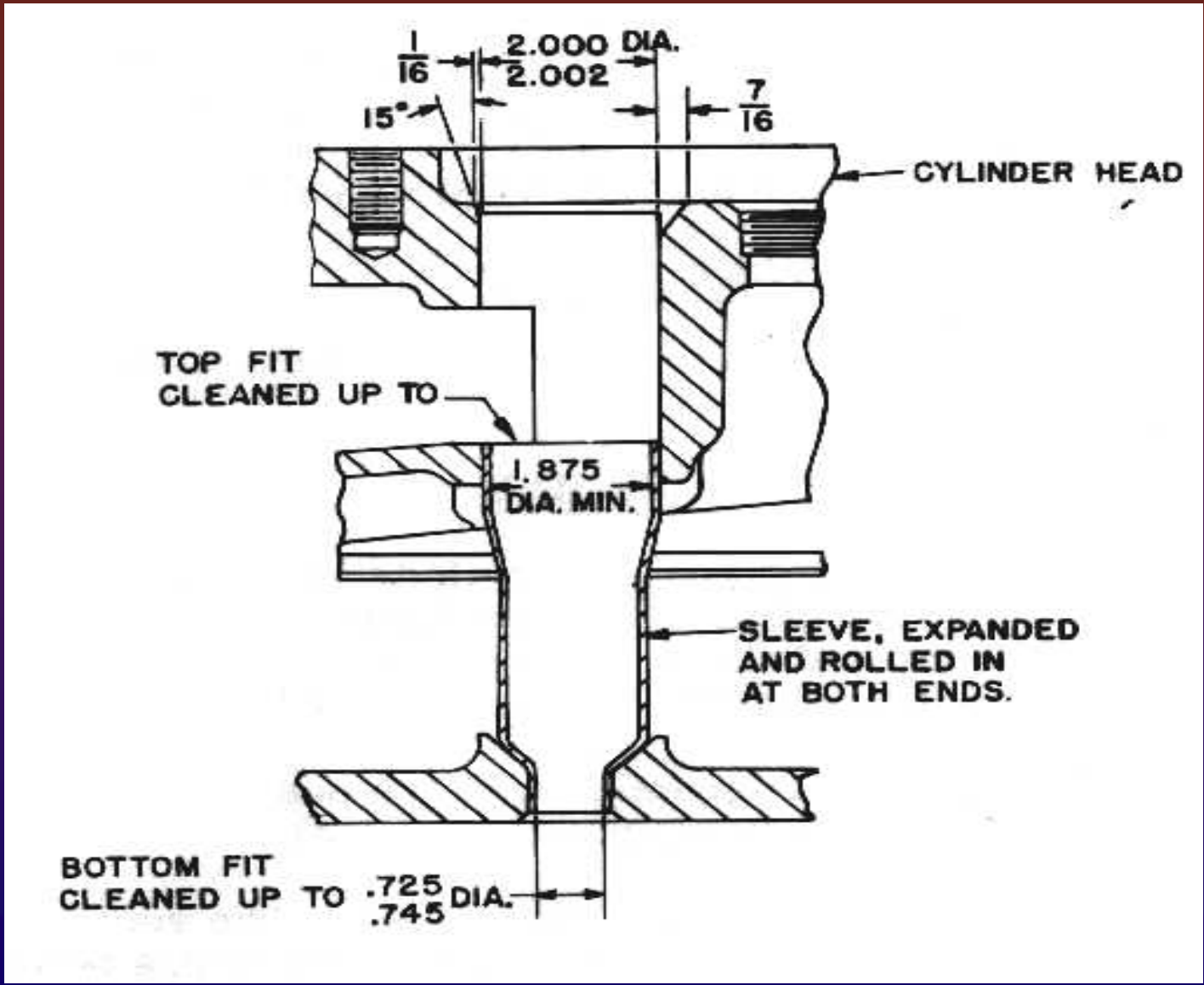
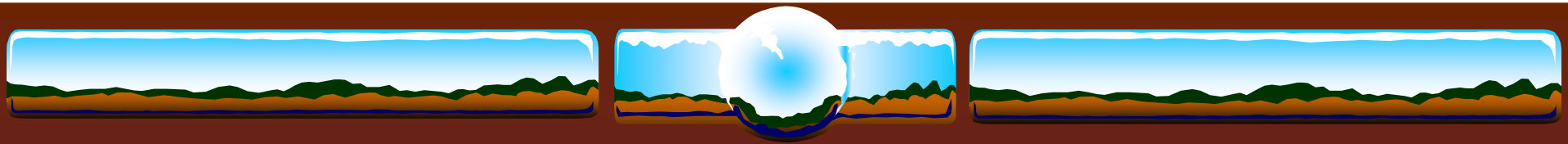
- ❖ **EXCESSIVE THERMAL LOADING.**
- ❖ **UNEVEN TIGHTENING OF HEAD.**
- ❖ **UNEVEN OR INADEQUATE TENSILE STRENGTH OF BLOCK STUD.**
- ❖ **SCALE FORMATION IN THE CORE PASSAGES OF CYLINDER HEAD.**
- ❖ **OVER TIGHTENING OF NOZZLE SLEEVE RETAINING CLAMP.**
- ❖ **MANUFACTURING DEFECTS.**
- ❖ **EXCESSIVE PEAK FIRING PRESSURE..**
- ❖ **OVER AGED CYLINDER HEAD.**

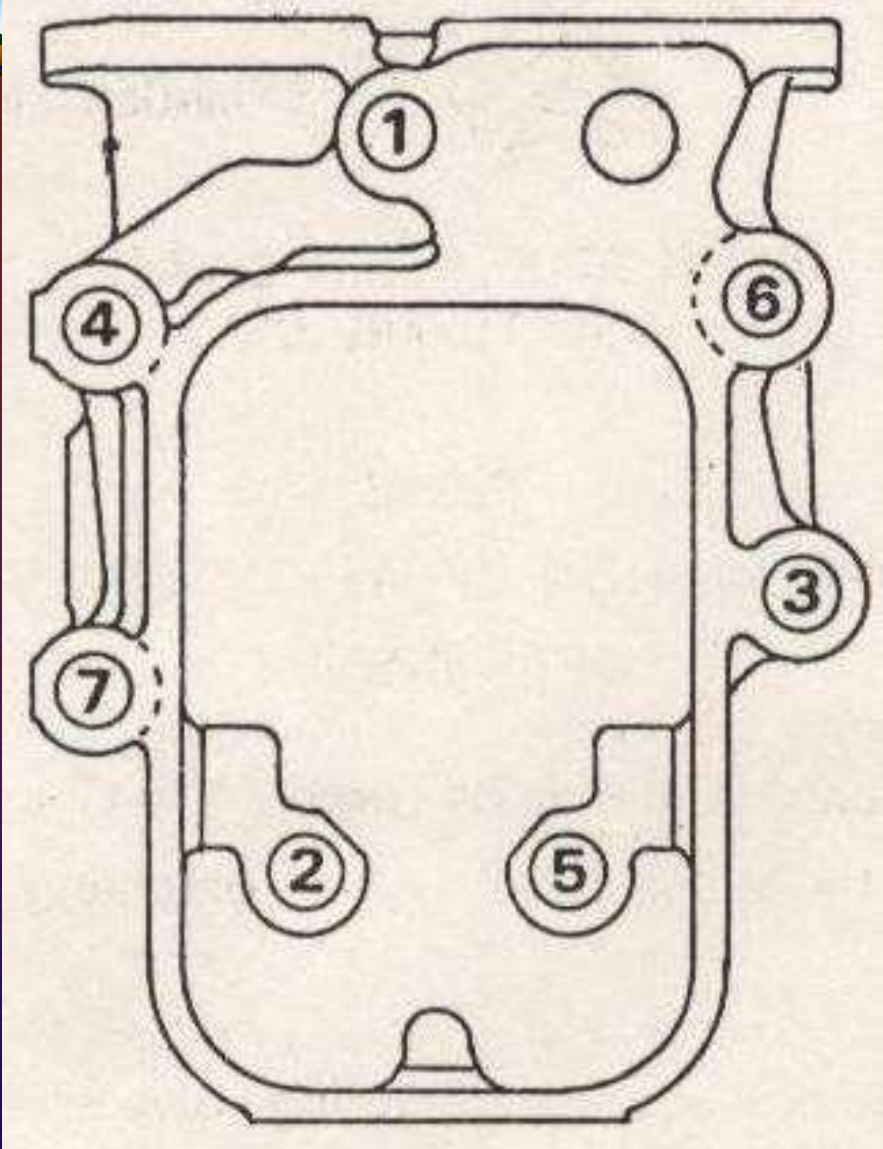


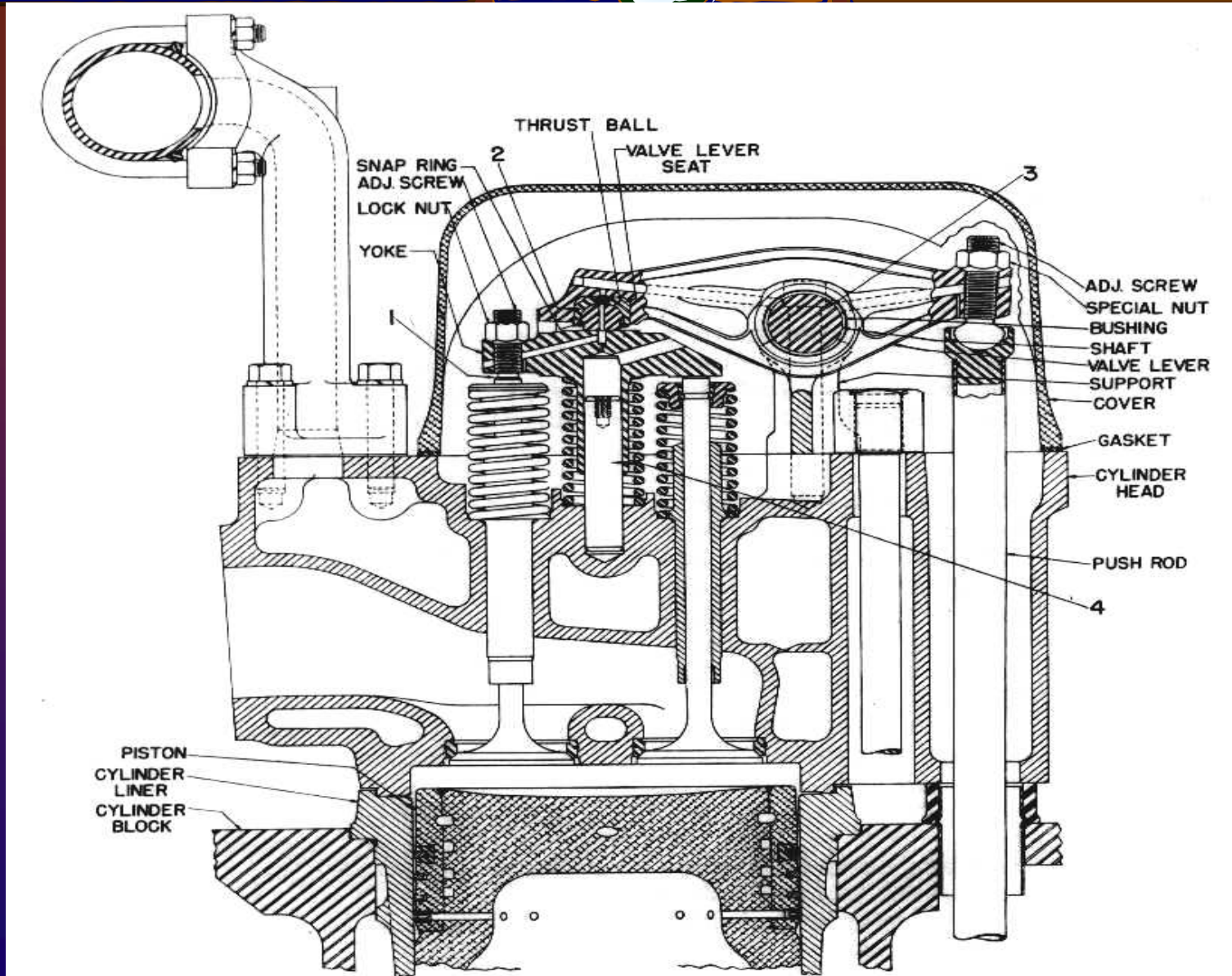
FAILURE ANALYSIS

PROBLEMS	CAUSES OF FAILURES
Oil leakage in exhaust elbow	Oil leakage between valve and guide -Eccentricity -Excessive clearance
Water leakage	Thermal cracks during operation Water scales inside the body Water leakage from ferrule or nozzle sleeve
Exhaust gas leakage	Low compression ratio due to -Compression leak from face joint -Leakage between valves and VSI (can be checked by blow by test)
Defective studs	Wear due to high stress. Proper threading should be done or they are replaced.

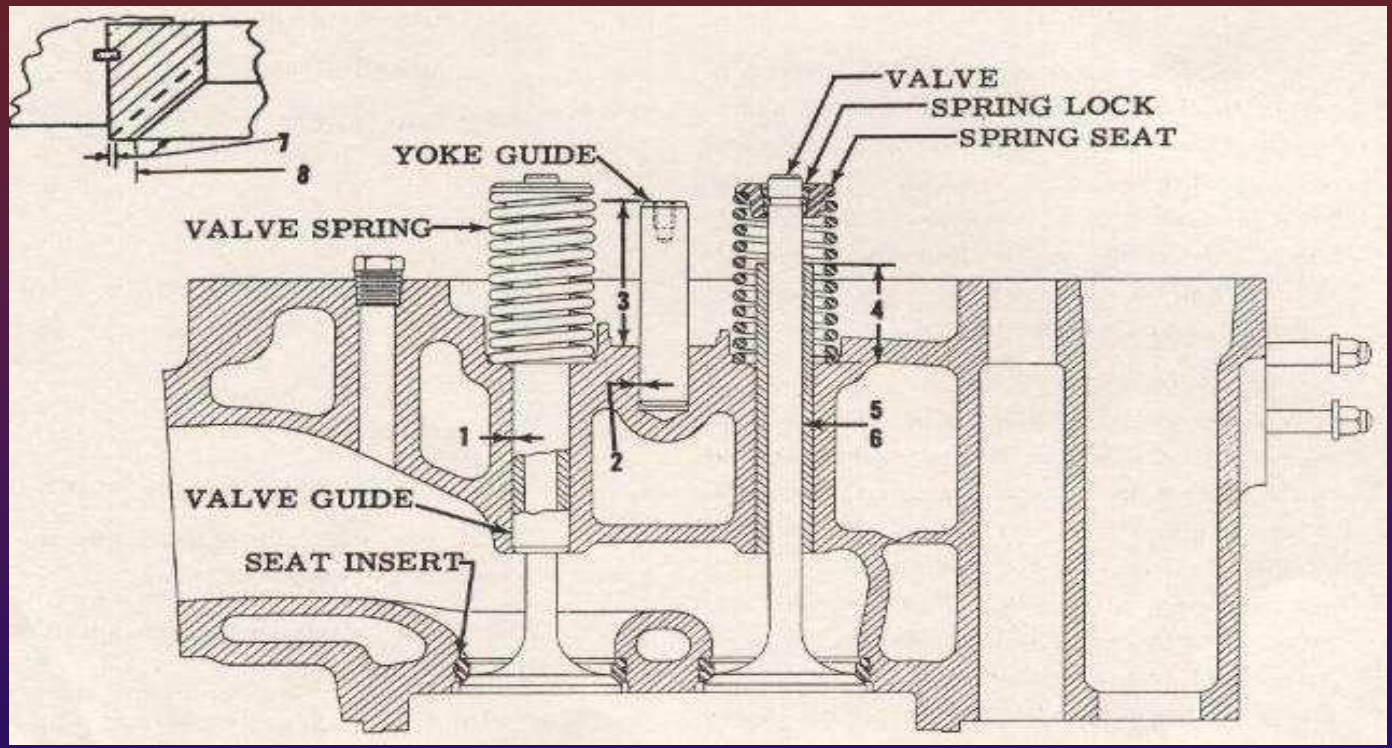
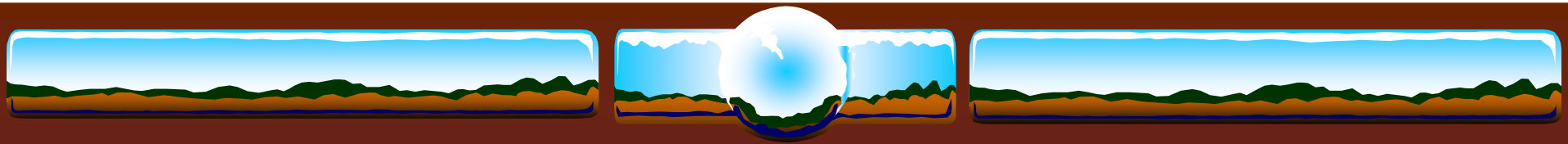


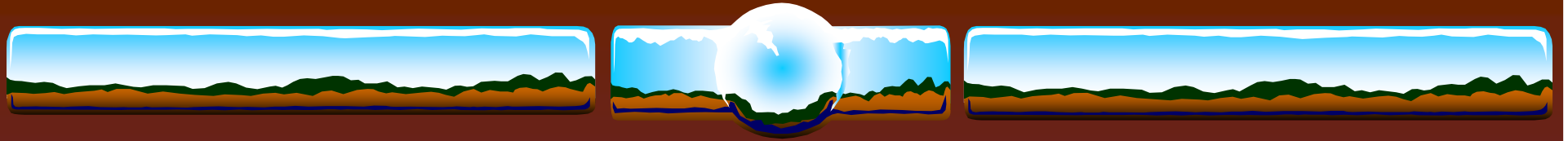






Various parts





THANK YOU