WHY COMPRESSORS FAIL AND HOW TO MINIMIZE THE RISK OF REPEAT FAILURES

THE FACTS

- COMPRESSORS DO NOT WEAR OUT.
- MOST COMPRESSOR FAILURES OCCUR DUE TO A SYSTEM OR SYSTEM COMPONENT FAILURE.
- DID YOU KNOW THAT APPROXIMATELY 8 OUT OF 10 BURNOUTS ARE THE RESULT OF MECHANICAL FAILURE?
- CHANGING A COMPRESSOR IN A SYSTEM WITH A PROBLEM WILL ALMOST ALWAYS LEAD TO ANOTHER FAILURE.

TYPES OF FAILURES

- SLUGGING
- OVERHEATING
- LACK OF LUBRICATION
- LOSS OF OIL
- REFRIGERANT FLOODBACK
- FLOODED STARTS
- ELECTRIC MOTOR FAILURE

1. SLUGGING

Slugging is a term we use when significant quantities of liquid refrigerant, oil, or a combination of both are able to enter the cylinders of the compressor causing it to hydraulic.

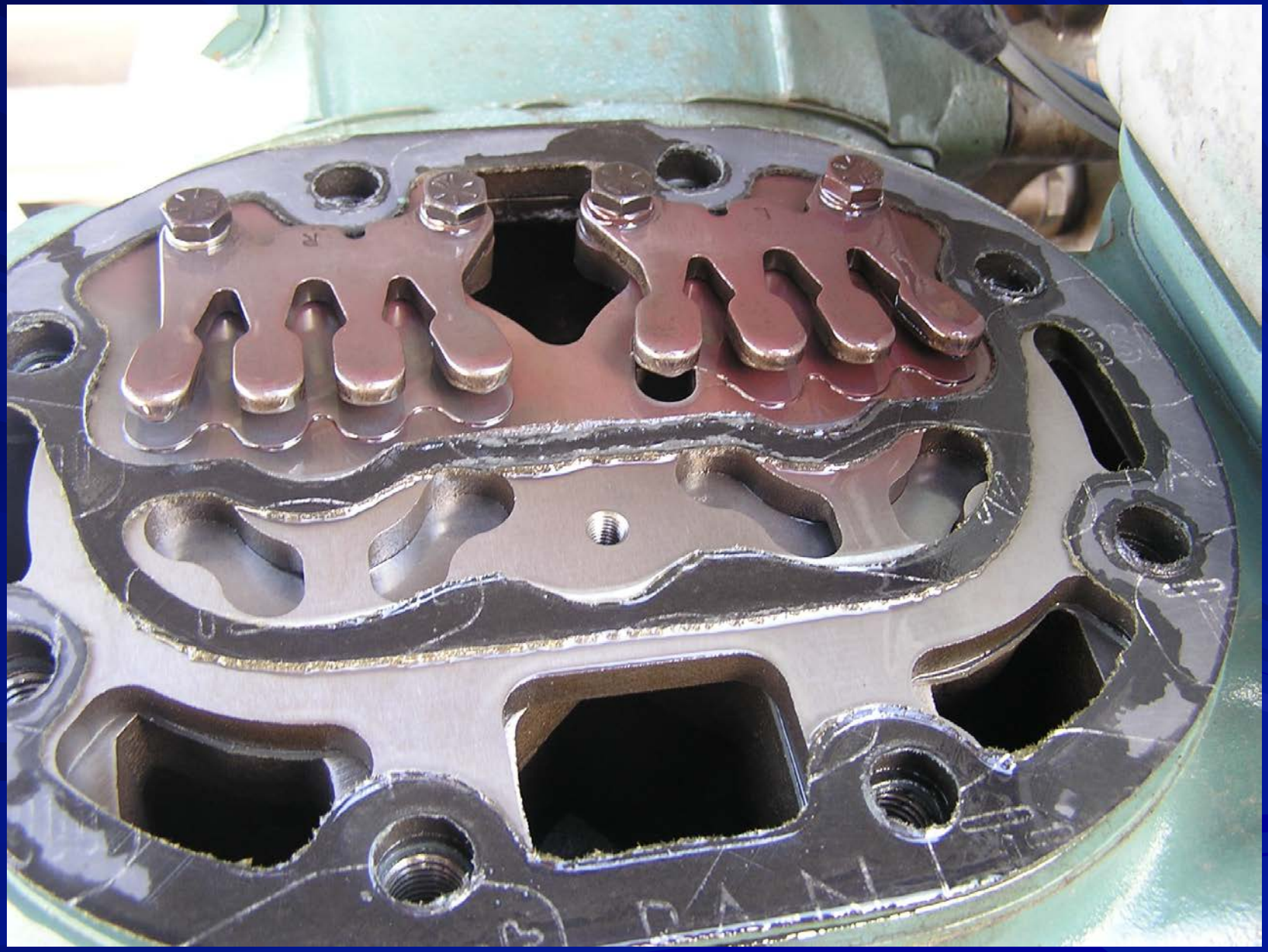
This can be due to extreme floodback or from a flooded start, where an explosion of refrigerant and/or oil which has mixed in the crankcase is forced into the cylinders when the compressor starts.

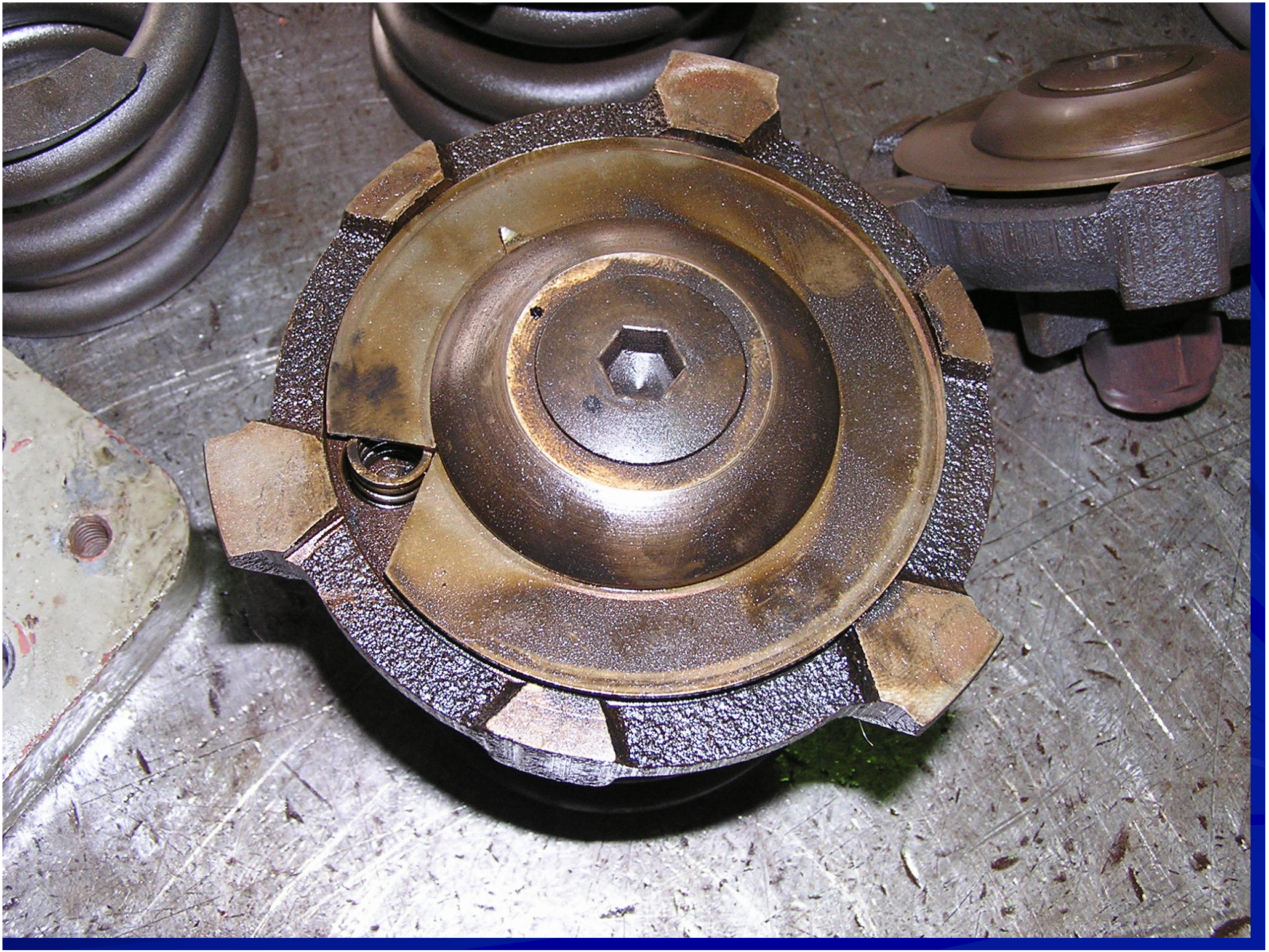
SLUGGING

If a technician is in the vicinity, it is characterised by anything from a gentle knocking to loud hammering and vibration, and can often be witnessed as foaming in the sight glass.

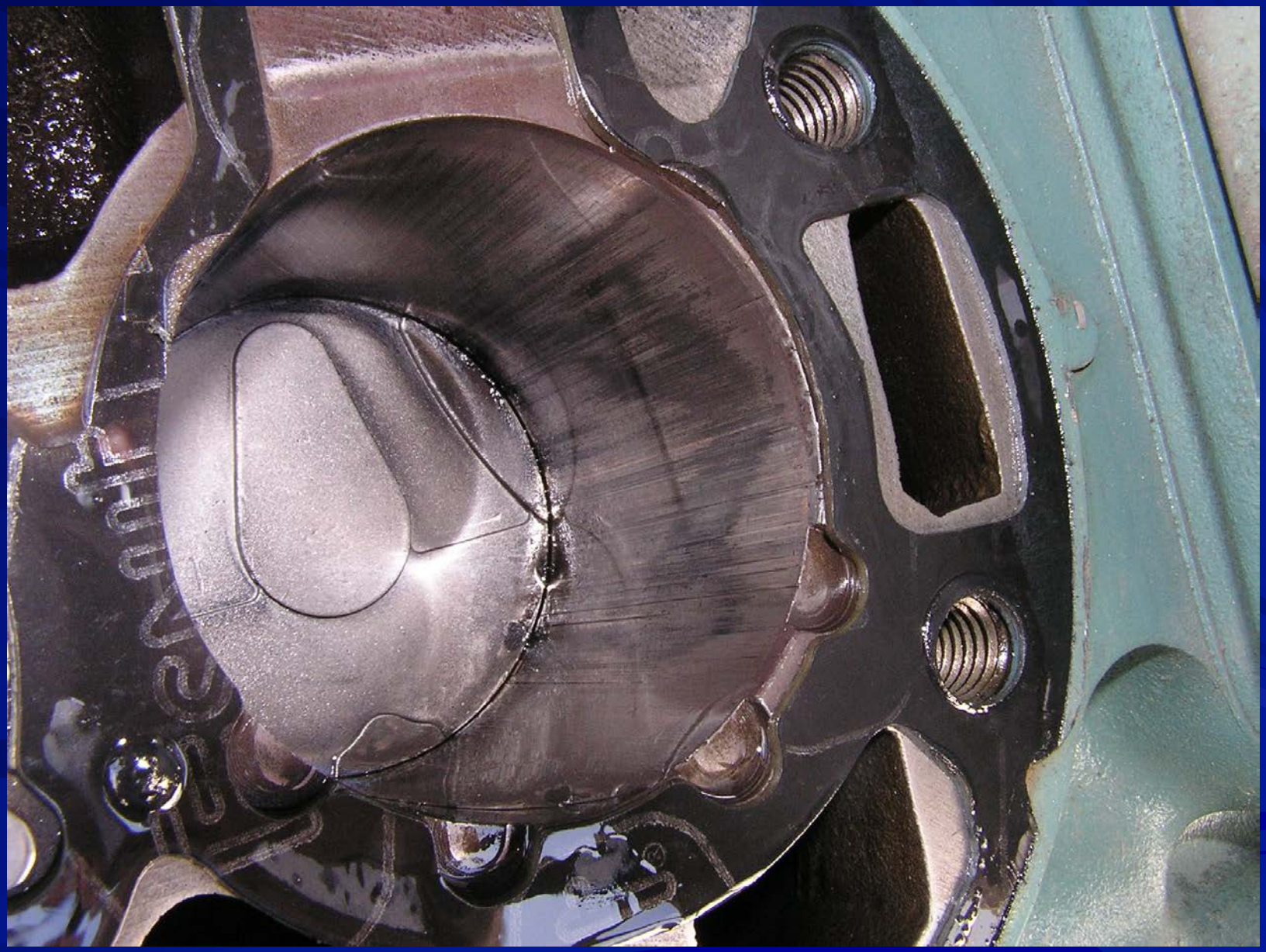
THE DAMAGE CAN BE SEEN AS . . .

BROKEN VALVE REEDS

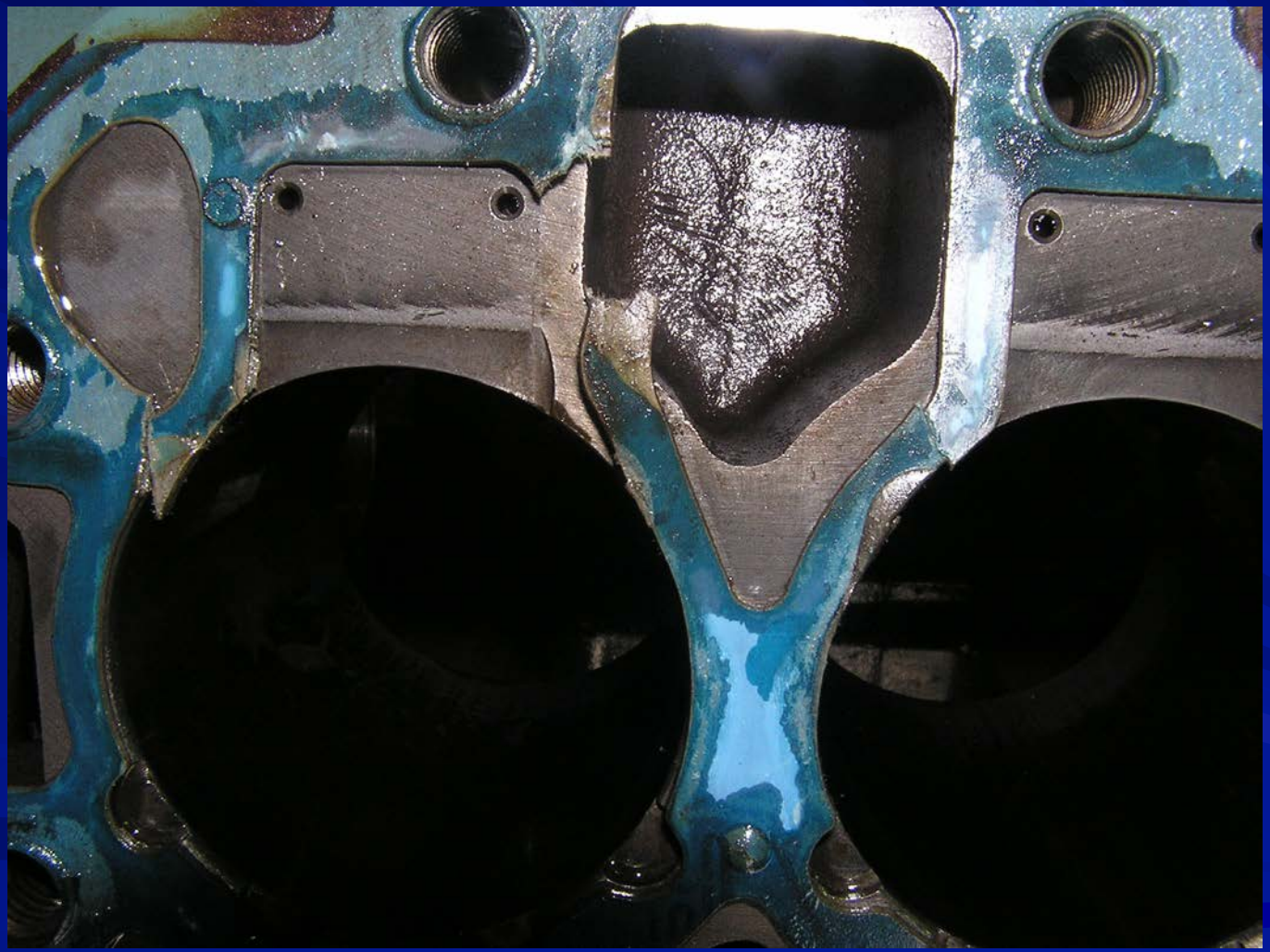


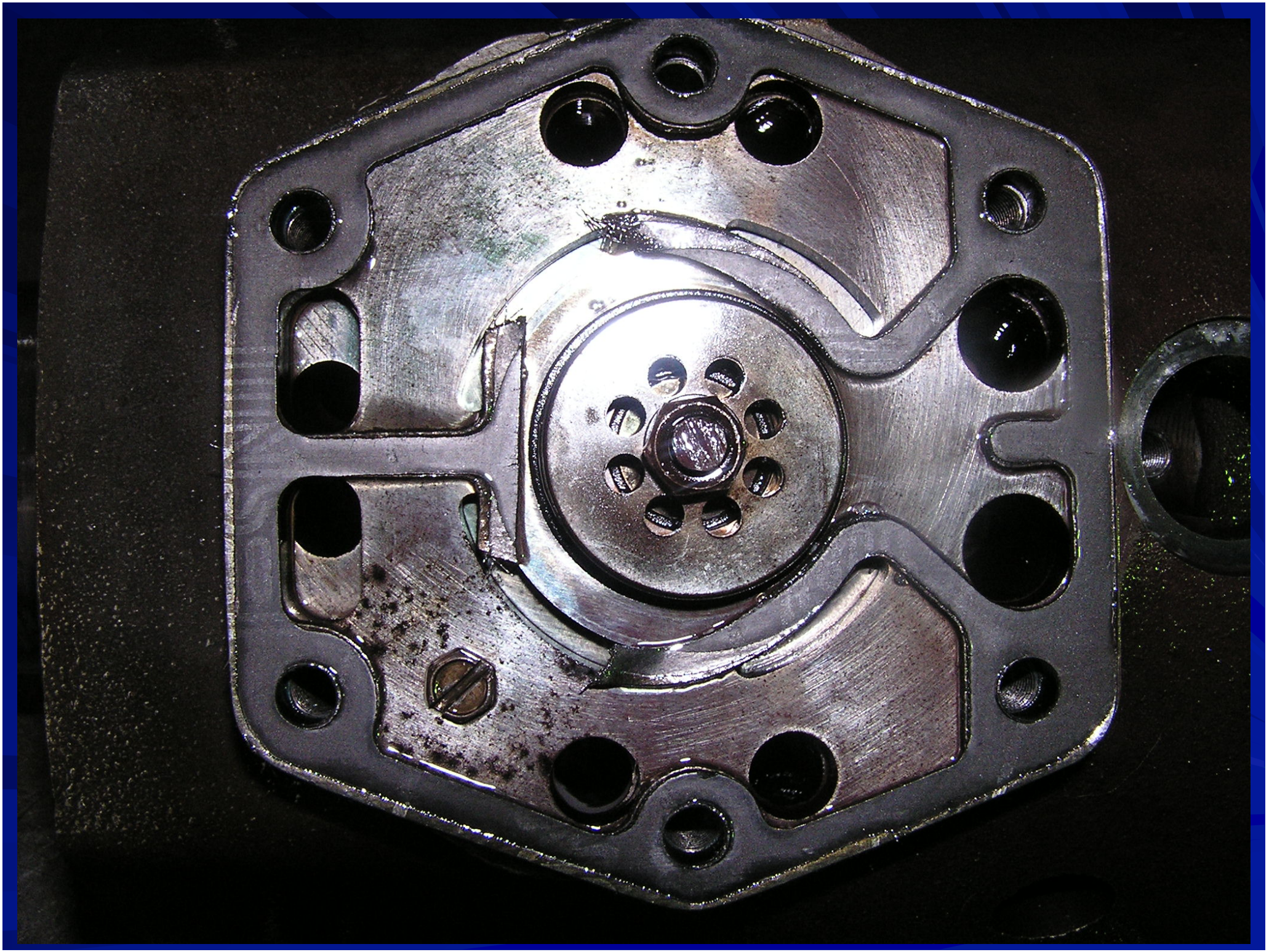


SCORED BORES

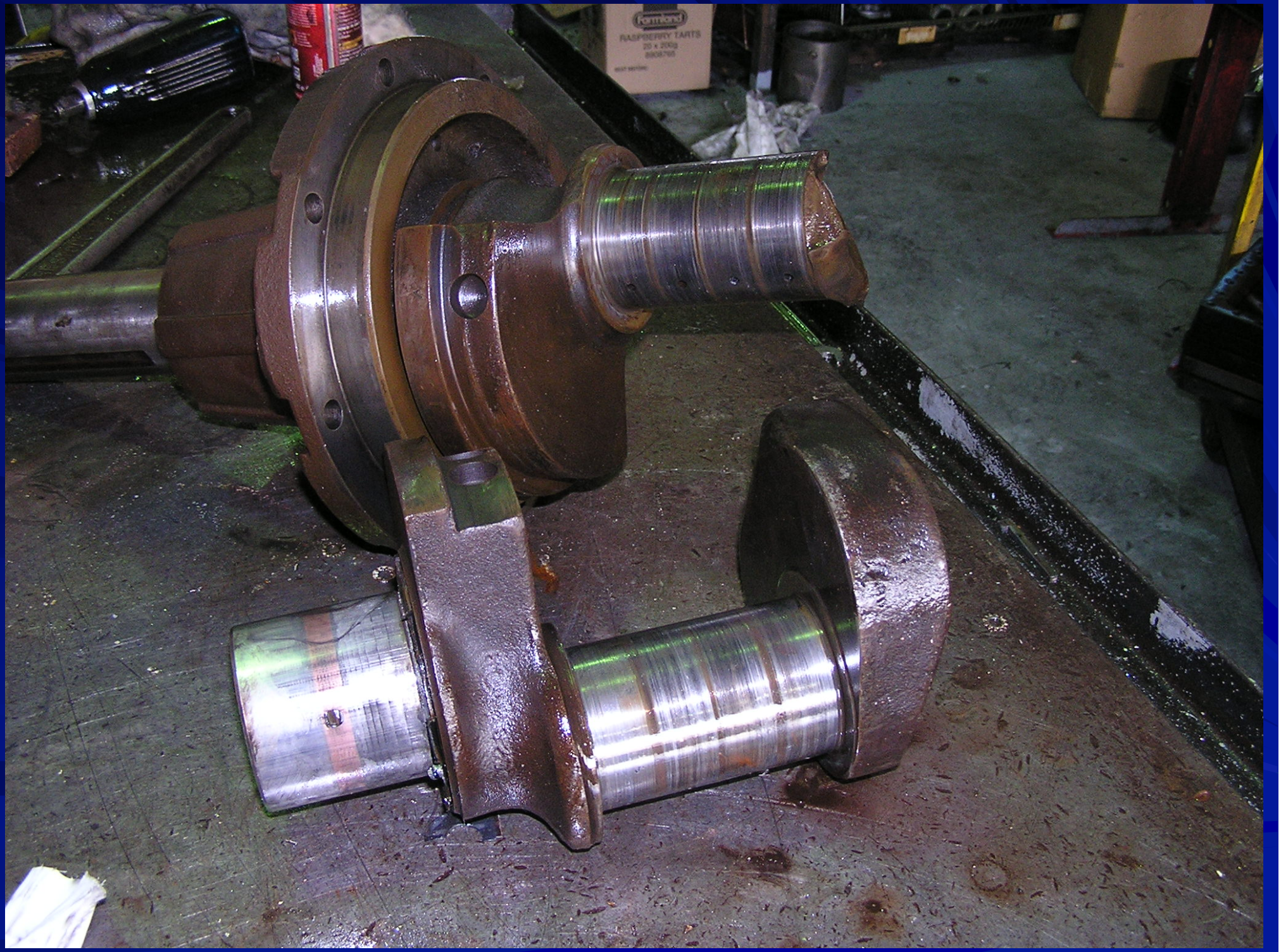


Blown Valve Plate Gaskets

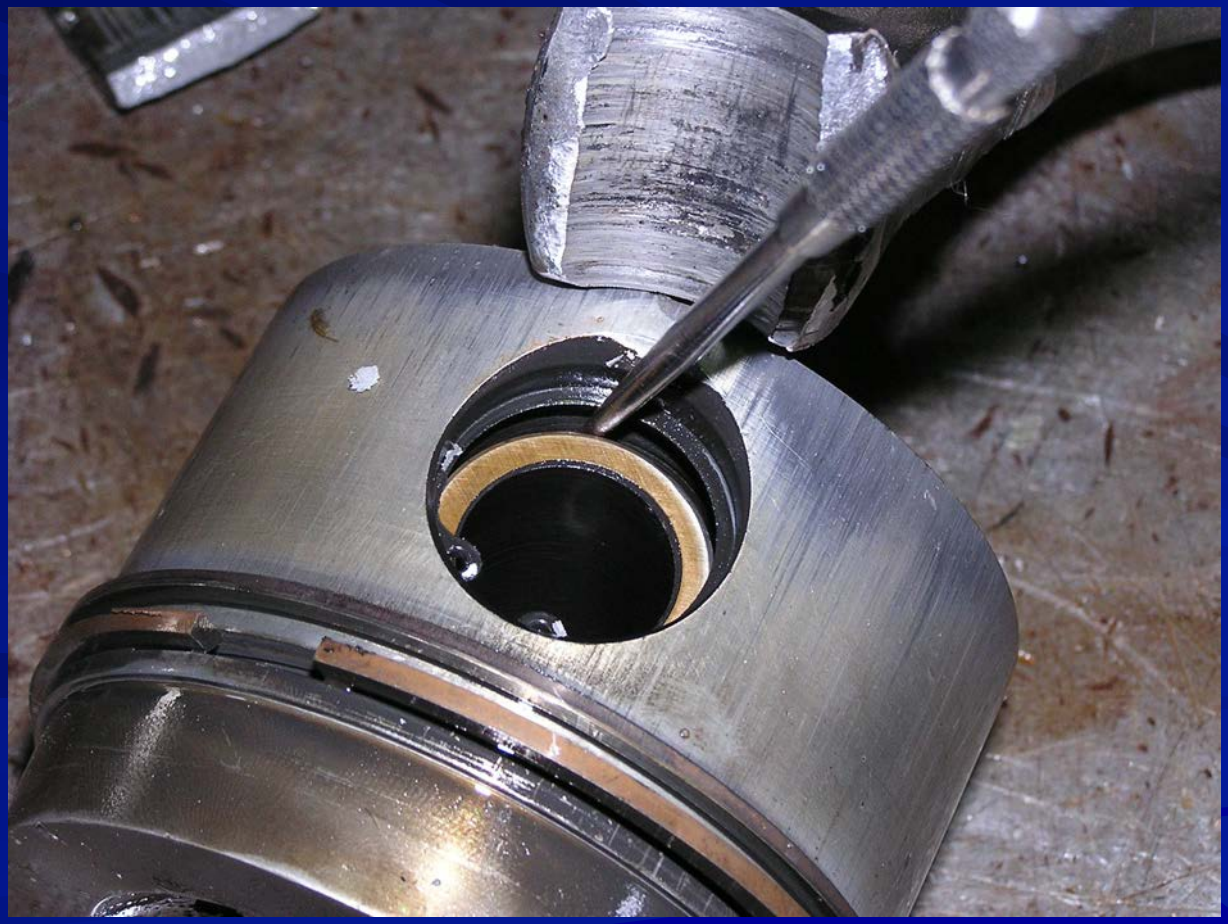


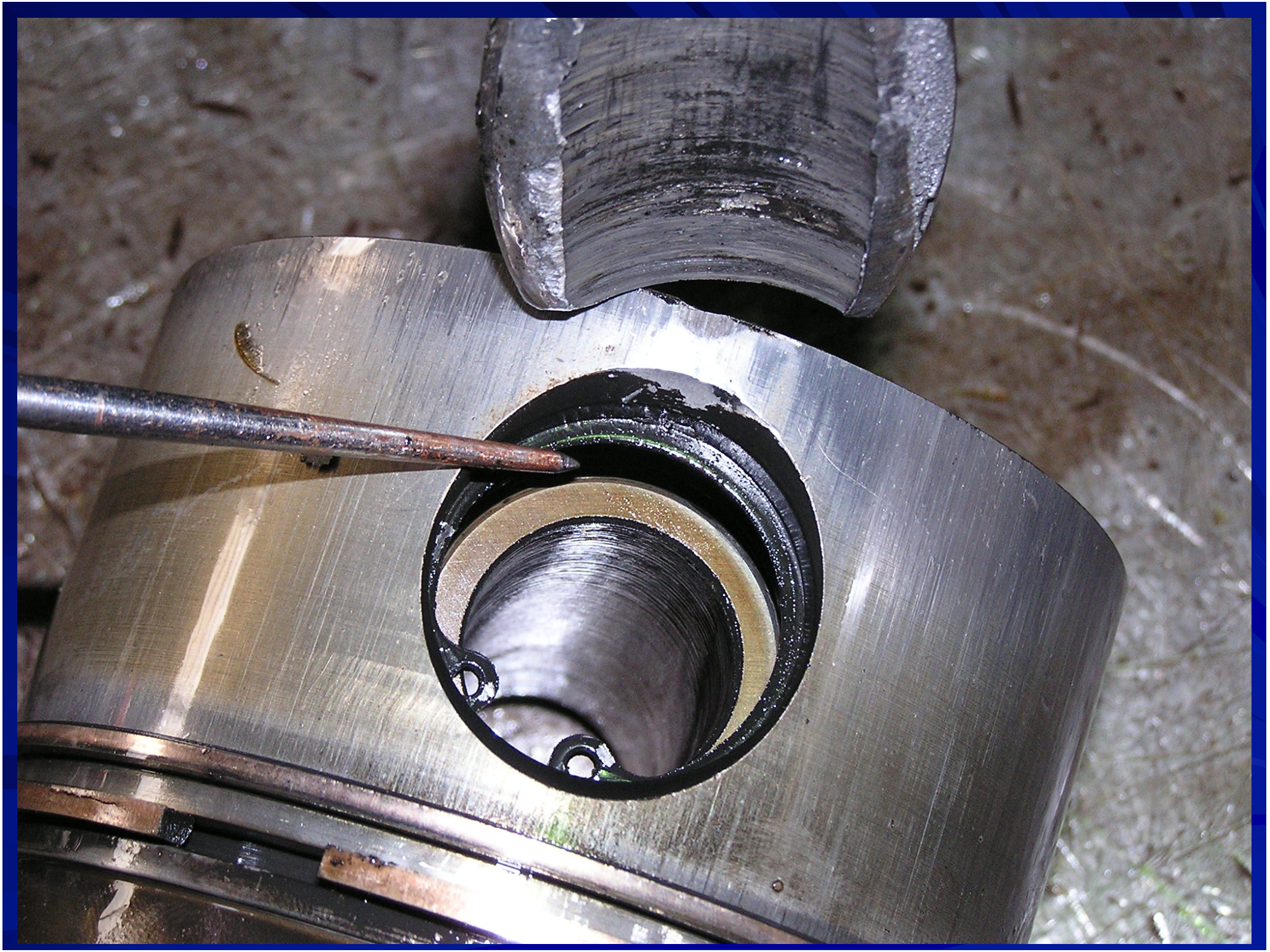


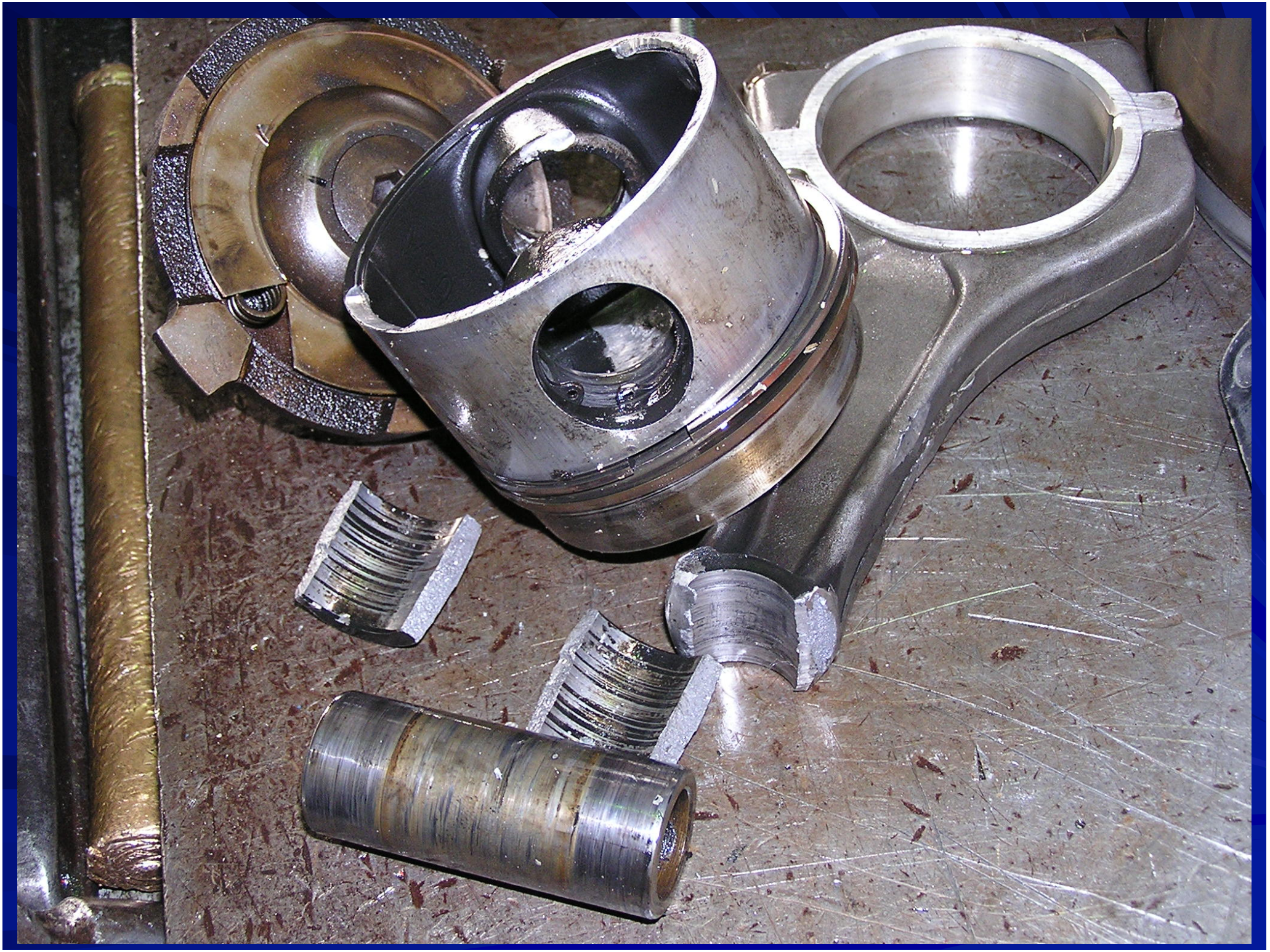
BROKEN CRANKSHAFT


fortinos
RASPBERRY TARTS

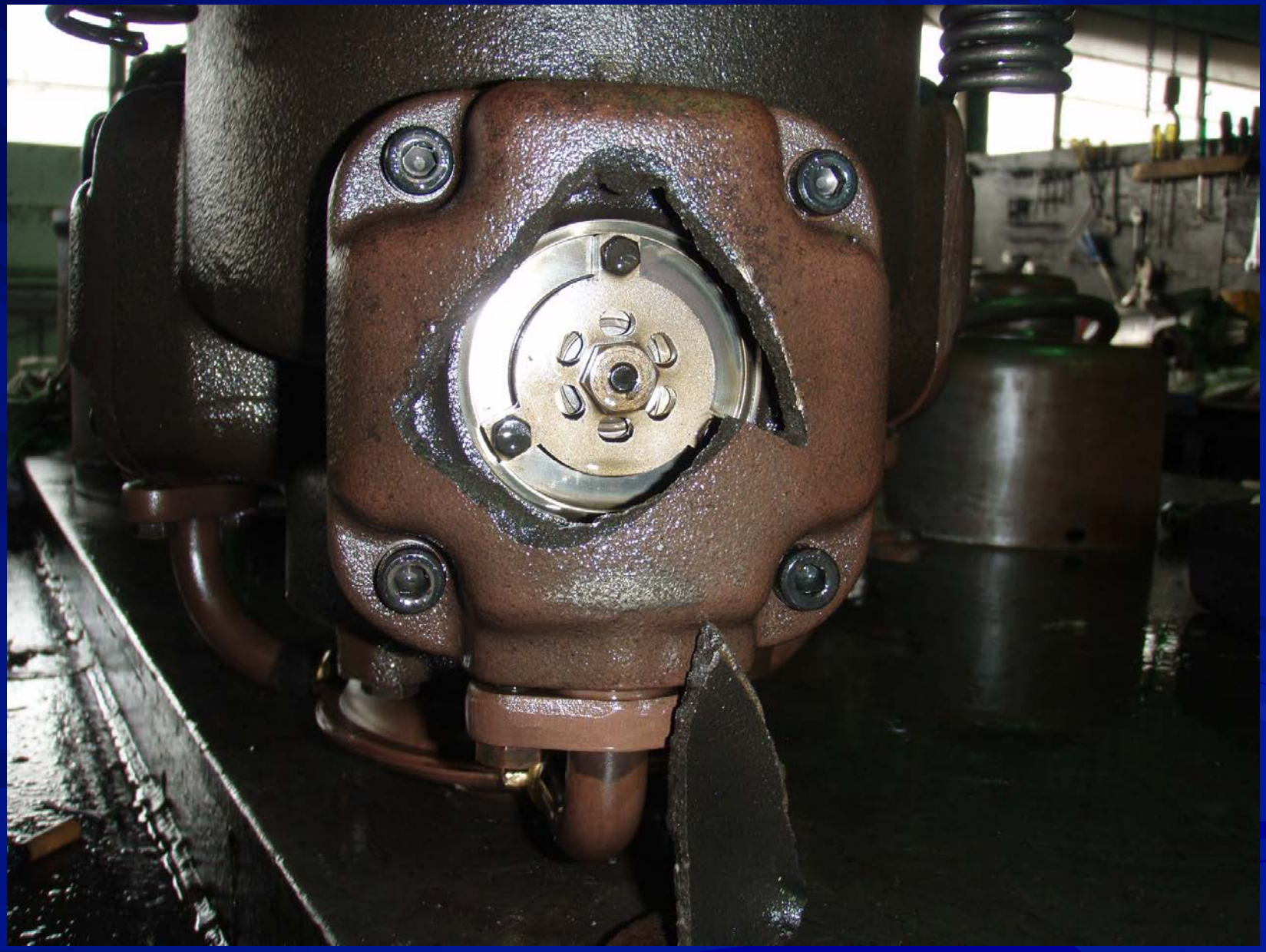
BROKEN DISCHARGE VALVES ALMOST ALWAYS RESULT IN PISTON/ROD LITTLE END DAMAGE







IN EXTREME CASES . . .



SLUGGING IS ONLY A SYMPTOM.

THE PROBLEM LIES WITHIN THE REFRIGERATION SYSTEM

THINGS TO CHECK

- Suction Superheat at the compressor. Check superheat 150mm from the compressor suction. 10 degrees is required for safe compressor operation, allowing for low load conditions (a common cause of slugging).

- Correct operation and sizing of the sump heater to avoid flooded starts

CAUSES OF LOW LOADS

- Blocked air flows
- Dirty evaporator coils
- Frosted evaporator coils
- Broken evaporator fan blade
- Loose evaporator fan belt
- Burned out evaporator fan motor
- Oil logged evaporator
- Incorrectly set or faulty expansion valve
- Overcharged system on Capillary Tube Systems
- Sudden or light load situations

FLOODED START THINGS TO CHECK

- Compressor located in low ambient conditions
- Evaporators warmer than the compressor (sun, heaters, defrost, etc)
- Long off cycles
- Insufficient sump heater
- Floodback causing too much refrigerant in the oil for the heaters to overcome

2. OVERHEATING

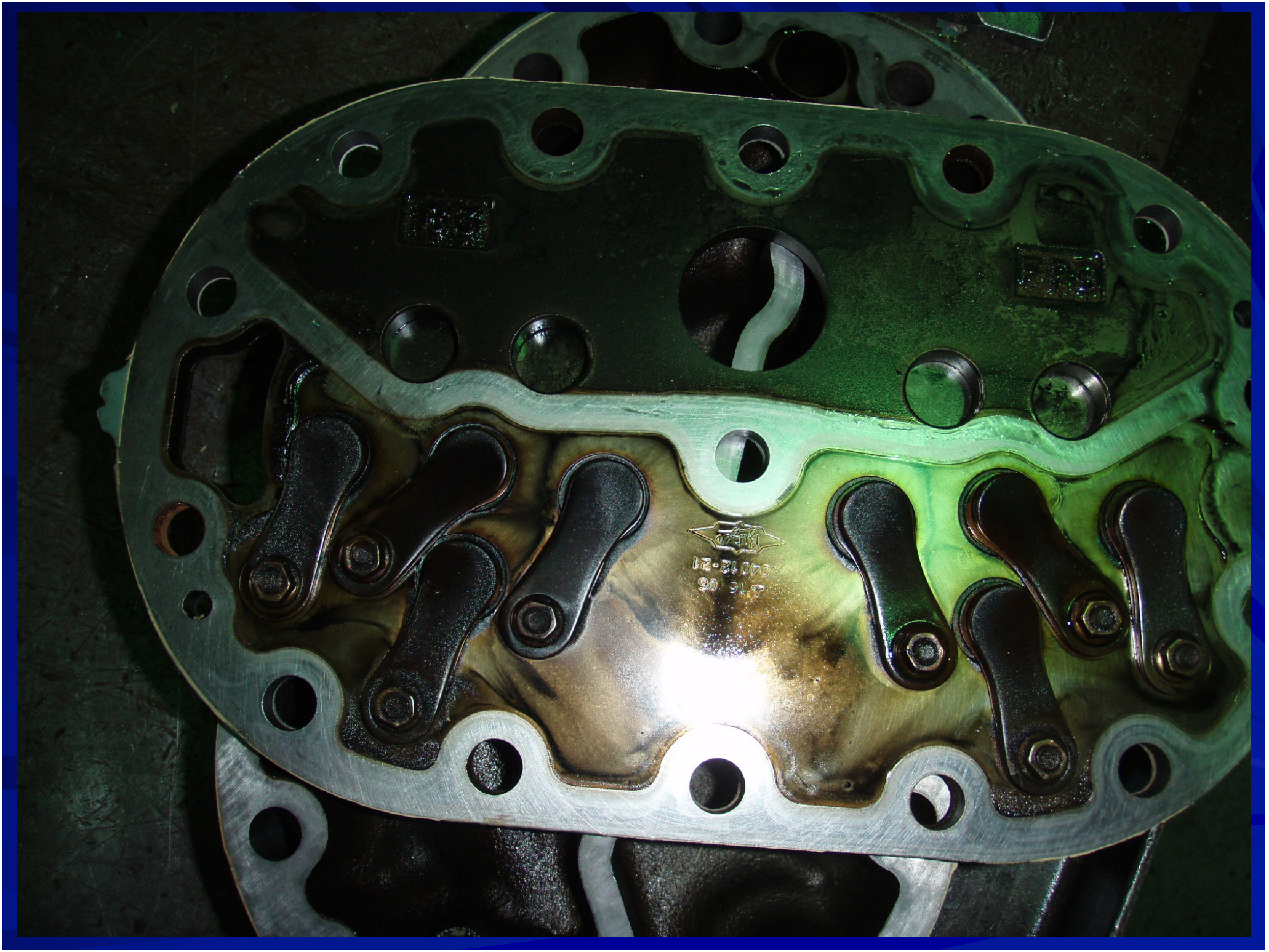
Overheating problems occur when the compressor is forced to operate at a temperature higher than design and causes the oil to break down chemically.

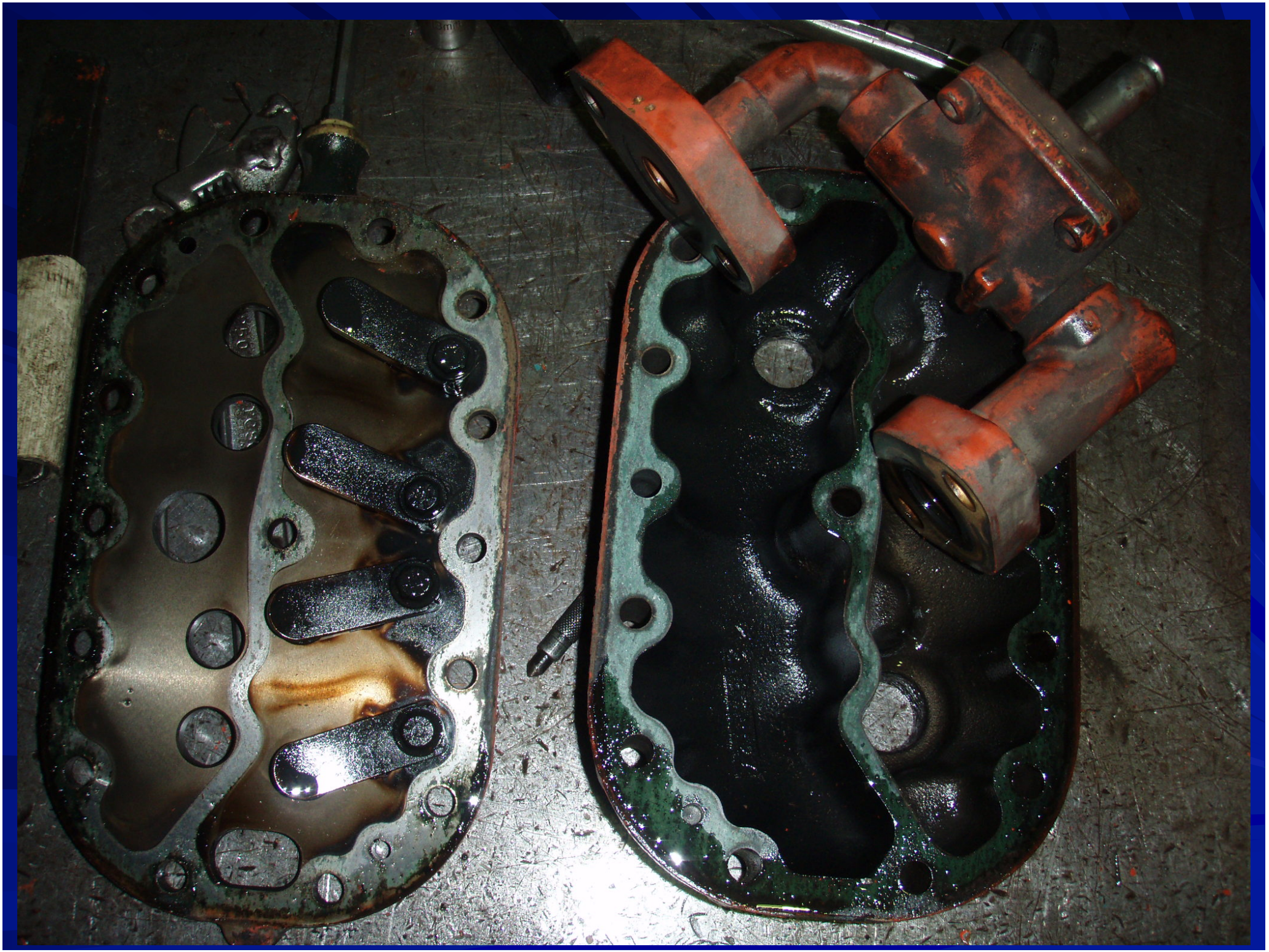
If severe enough, both oil and refrigerant may break down creating carbon and acids that can cause harm throughout the system.

THE DAMAGE CAN BE SEEN AS . . .

BURNED VALVE REEDS

CARBONISED VALVE PLATES





WORN CYLINDER BORES & RINGS

BURNT MOTOR WINDINGS

FINE METAL PARTICLES IN SUMP

Oil strainer blocked from carbon and fine metal particles.

DISCOLOURED COMPRESSOR HEADS

Occasionally you may find that the compressor oil drops while running, but returns relatively quickly during the off cycle. This is likely due to worn piston rings allowing ‘blow by’ of the discharge gases into the compressor sump. This pressurizes the sump above suction pressure, trapping the returning oil in the motor compartment. When the compressor shuts down, the pressures equalise and oil returns through the crank case oil check valve.

OVERHEATING IS ONLY A SYMPTOM.

THE PROBLEM LIES WITHIN THE REFRIGERATION SYSTEM

COMMON CAUSES OF OVERHEATING

- Low suction pressure
- High discharge pressure
- High compressor superheat
- Inadequate compressor cooling (cooling fans – liquid injection)
- Incorrect refrigerant
- Incorrect motor voltage
- Part start control failure
- Undersized compressor
- Blocked driers

COMMON CAUSES OF OVERHEATING

- Blocked suction strainer
- Blocked condenser
- Non condensibles
- Condenser fan motors
- Overcharged system
- Undersized condenser
- Faulty or inadequate suction line insulation

HOW TO SPOT AND SAVE THE COMPRESSOR

- Measure discharge pipe temperature 150mm from the service valve.
- Temperatures of 75-95 degrees centigrade are acceptable. If temperatures are higher than this and ambient conditions are not in the very high range, there is a problem.
- In any situation irrespective of ambient temperatures, a discharge temperature of 105 degrees is damaging the compressor

3. OIL DILUTION

Oil Dilution can be categorized as when -

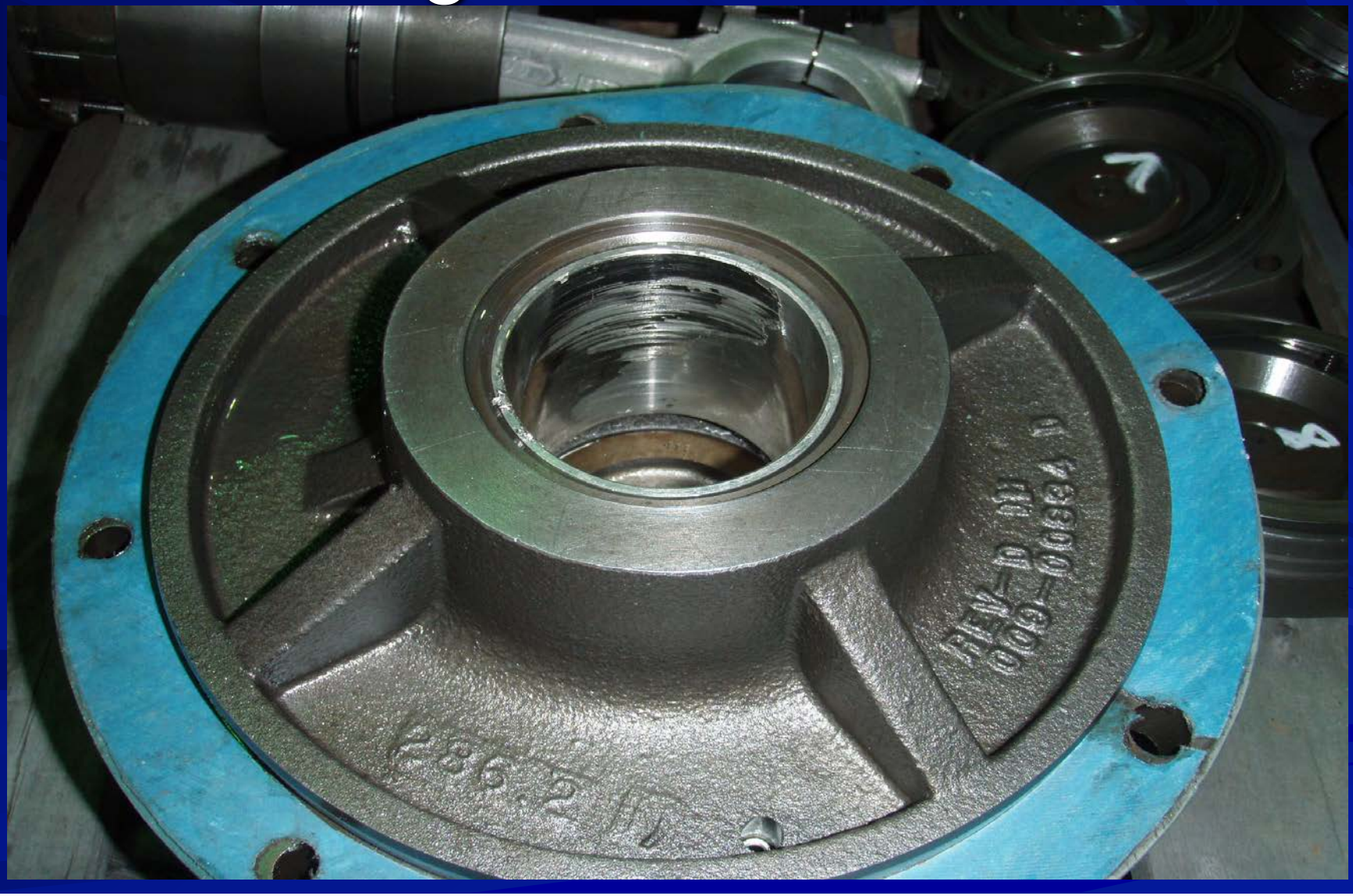
oil does reach the surfaces but is mixed with refrigerant and cannot lubricate properly.

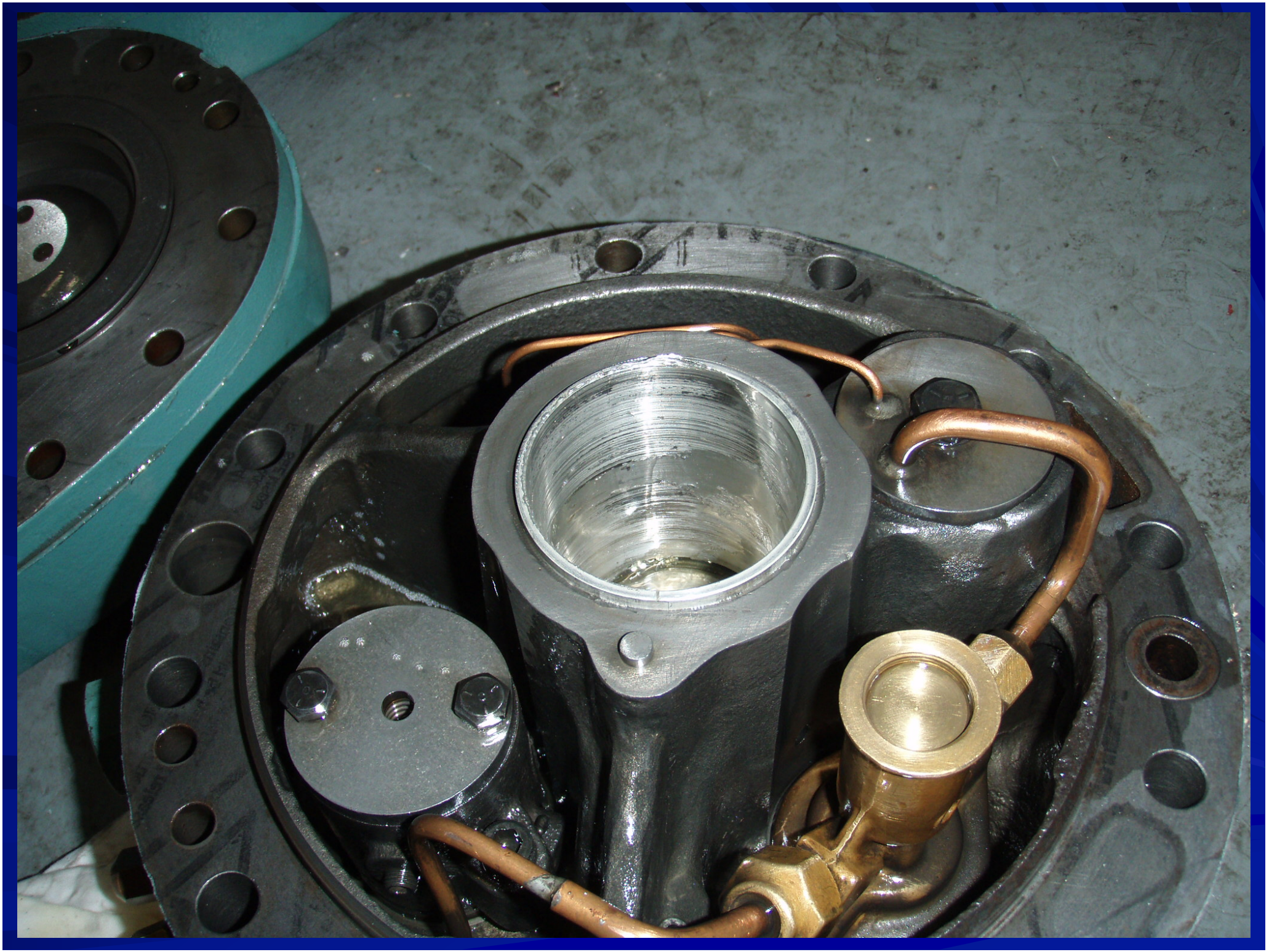
THE DAMAGE CAN BE SEEN AS . . .

Some or all con rods damaged or broken and the metal torn from the big end with no obvious signs of heat

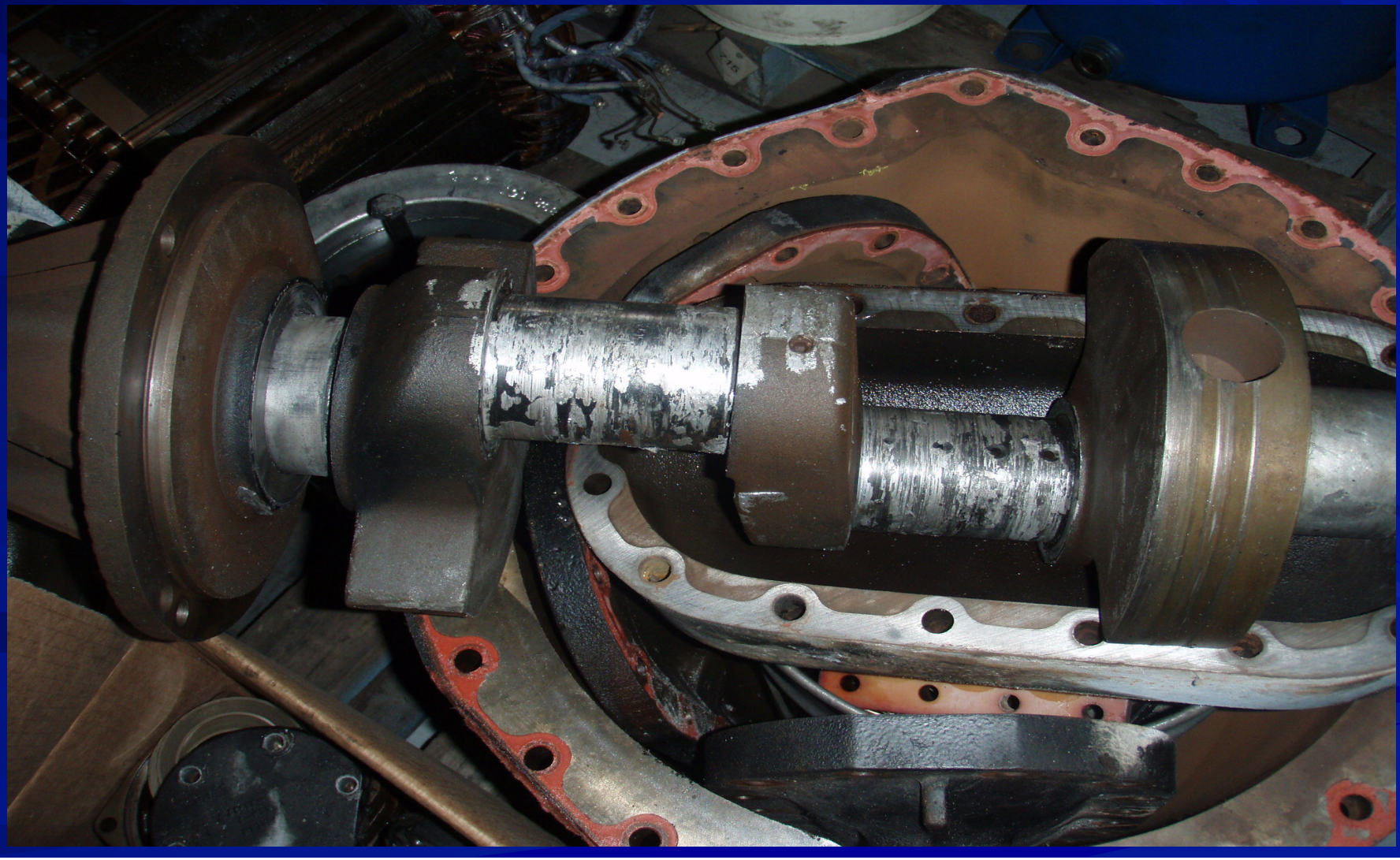

HOCKA RIDGE
QLD 4110.

Main bearings damaged and material torn from the bearing surface – again little heat





Crankshaft has bearing and or con rod material “built up” on the shaft with little scoring or sign of heat.



Oil pump gears scored and/or drive tang broken

OIL DILUTION

The reason for the metal smearing with little sign of heat is due to the refrigerants very high solvent abilities.

The refrigerant washes all traces of oil from the journal surfaces as well or better than petrol or other solvents could, leaving clean metal surfaces to run against each other.

This causes them to seize together very quickly and tear the surface of the softest metal, which is generally the con rods and/or bearings.

OIL DILUTION

The damage is often seen on bearing surfaces closest to the oil pump or oil feed and becomes progressively less damaged further away.

This is due to the refrigerant rich oil flashing off as it travels up the shaft as it encounters hot surfaces and gaps in the journals. As the refrigerant flashes off, the mixture becomes more oil than refrigerant and therefore more likely to lubricate the surfaces it touches.

The things to look for here are the same for flooded starts and floodback.

- Blocked air flows
- Dirty evaporator coils
- Frosted evaporator coils
- Broken evaporator fan motor
- Loose evaporator fan belt
- Burned out evaporator fan motor
- Oil logged evaporator
- Incorrectly set or faulty expansion valve
- Overcharged system on capillary tube systems

- Sudden or light load situations
- Compressor located in low ambient conditions
- Evaporators warmer than the compressor (sun, heaters, defrost, etc)
- Long off cycles
- Insufficient sump heater
- Floodback causing too much refrigerant in the oil for the heaters to overcome

4. LOSS OF OIL

Loss of oil is when oil leaves the compressor and either doesn't come back at all, or doesn't come back quickly enough to maintain lubrication and can generally be categorised into two causes. Little return or no return.

It is a simple equation – oil returning must equal oil leaving.

As oil is a vital form of heat removal for the bearing surfaces as well as a lubricating component, damage from loss of oil is generally seen by the scoring and overheating of the bearing surfaces.

Unlike oil dilution, there is generally oil left on the journals from a previous run enabling some lubrication for the crankshaft.

This reduces the tearing associated with dilution, but does not provide adequate flow to remove heat from the surfaces, or sufficient oil pressure to stop the surfaces rubbing hard into each other.

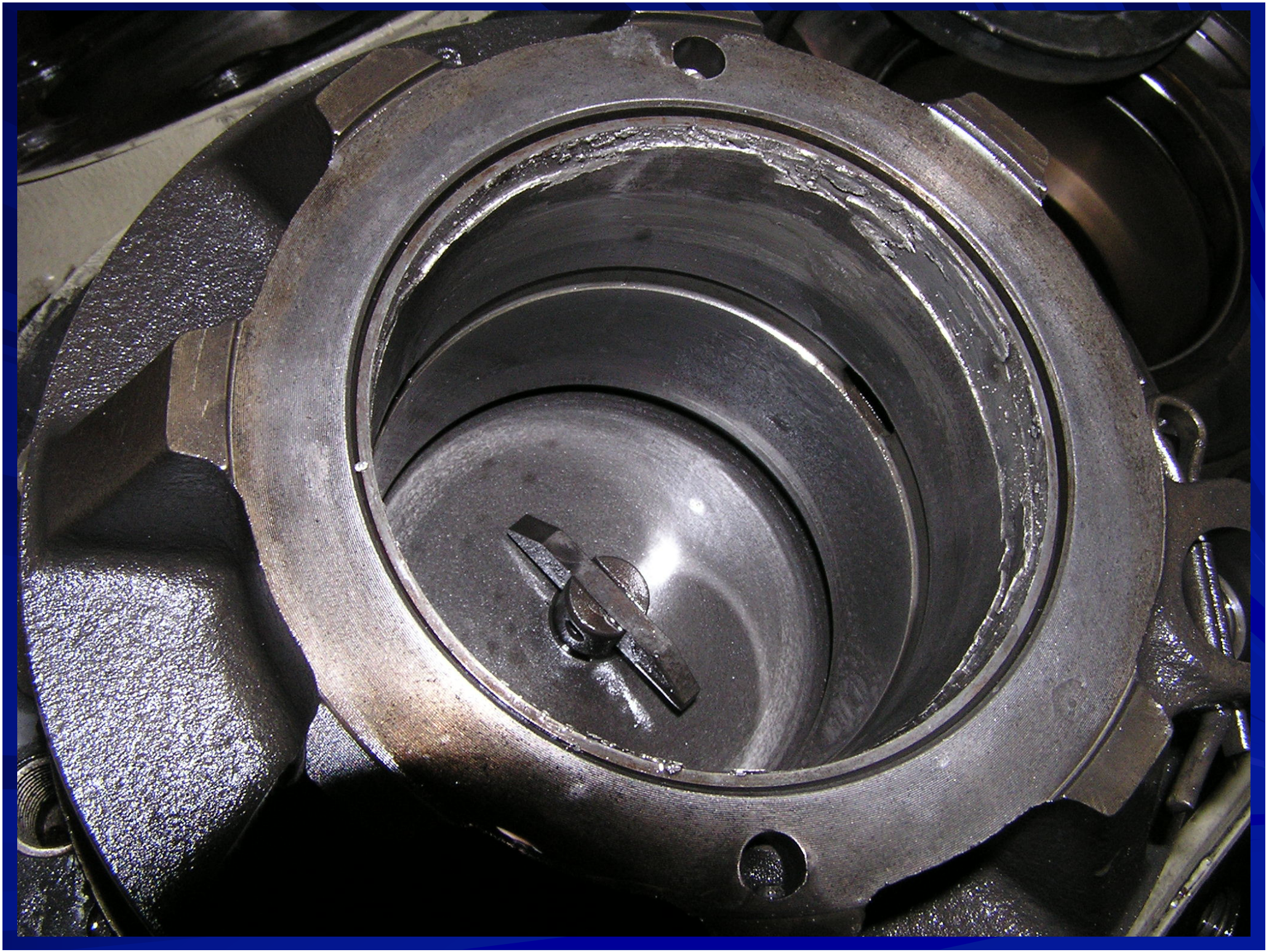
Therefore it is evidenced by crankshaft scoring and wear, con rods wearing to the point of seizing or breaking, and generally an underlying pattern of heat around these surfaces.

If caught early, the pattern of wear is generally more damage the further away from the oil pump or supply, and gradually less damage the closer to the oil source.

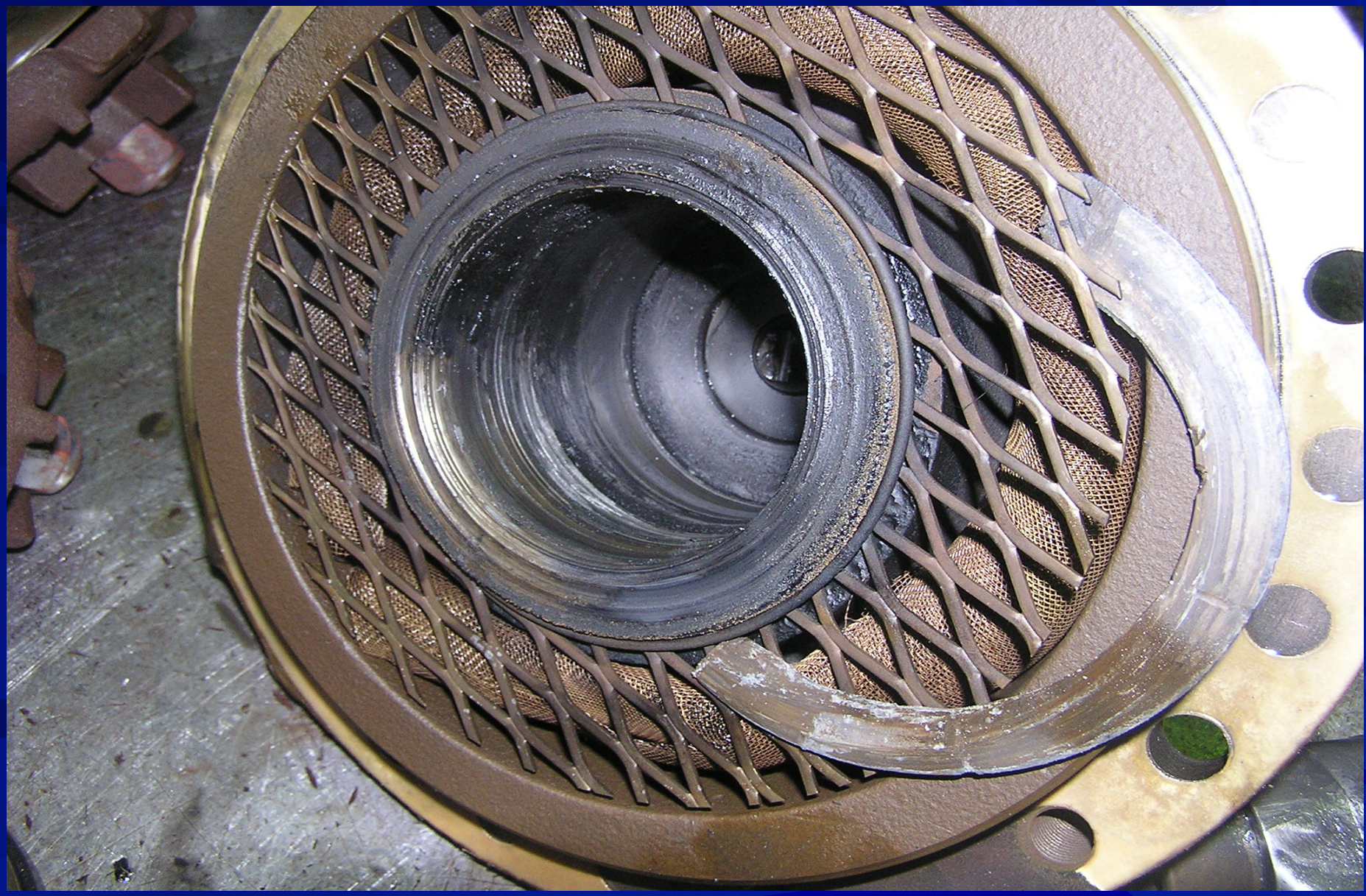
THE DAMAGE CAN BE SEEN AS . . .

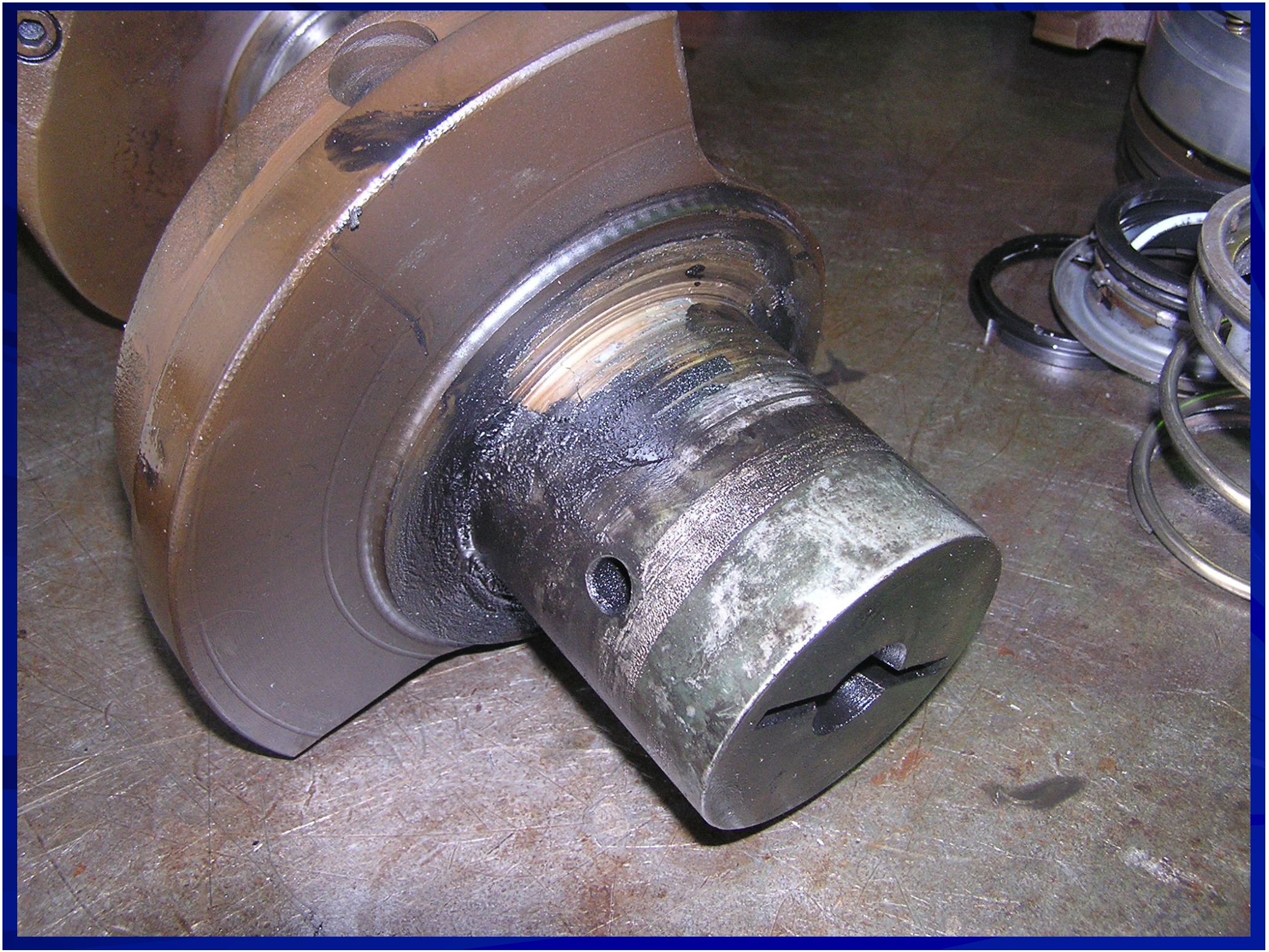
CONRODS BADLY WORN AND HEAT DAMAGED


C2095S

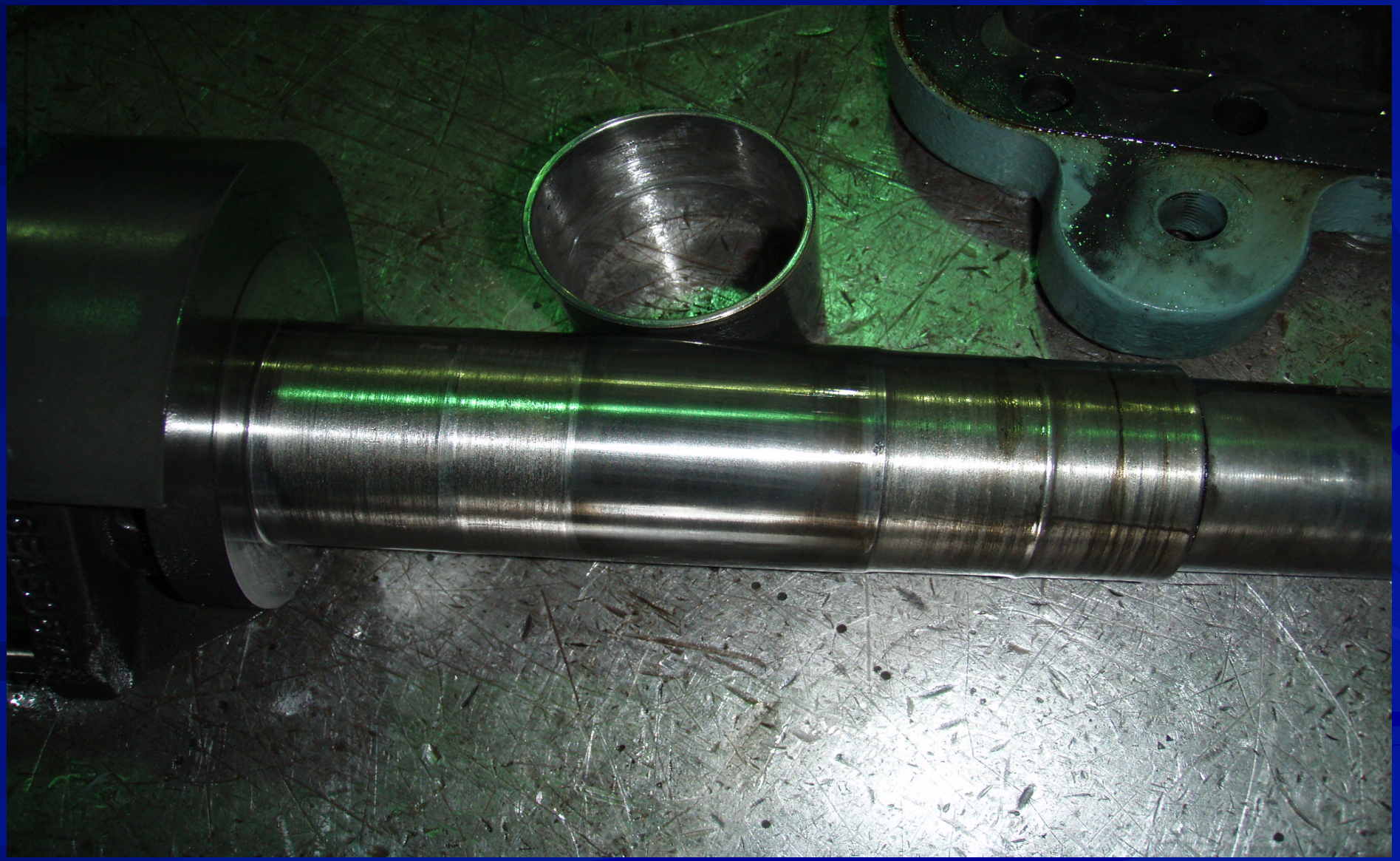


BEARING SURFACES WORN AND HEAT DAMAGED

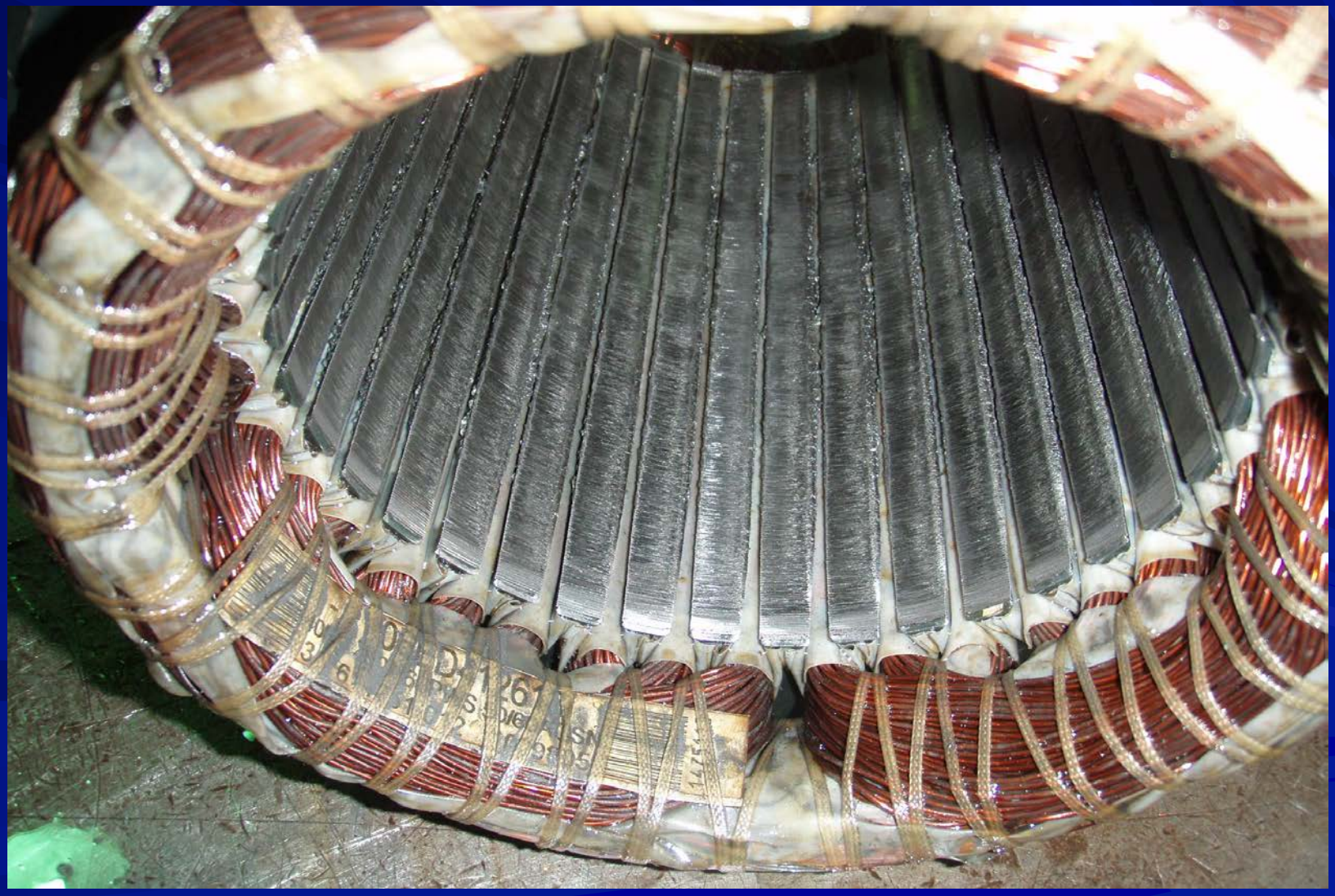




CRANKSHAFT JOURNALS WORN AND HEAT DISCOLOURED



ROTOR RUBBING (POLING) ON THE STATOR FROM BEARING FAILURE



SOME CAUSES OF LOSS OF OIL

- Flooded starts lifting the oil from the compressor
- Poor pipe sizing
- Poor oil traps
- Short cycling – the compressor doesn't run long enough to bring oil back
- Running unloaded for extended periods – the refrigerant velocity isn't adequate to stop oil logging
- Inadequate defrost – in low temp applications, increased velocity after defrost helps oil return.
- Loss of refrigerant charge

5. REFRIGERANT FLOODBACK

Refrigerant floodback, occurs when liquid refrigerant flows through the suction line into the compressor during the running cycle.

In a refrigerant cooled compressor the liquid refrigerant separates in the motor housing, flowing to the crankcase through the oil check valve where it will dilute the oil in the crankcase.

The oil pump will then pump the refrigerant rich oil mixture to the bearing journals resulting in mechanical failure.

CAUSES OF FLOODBACK

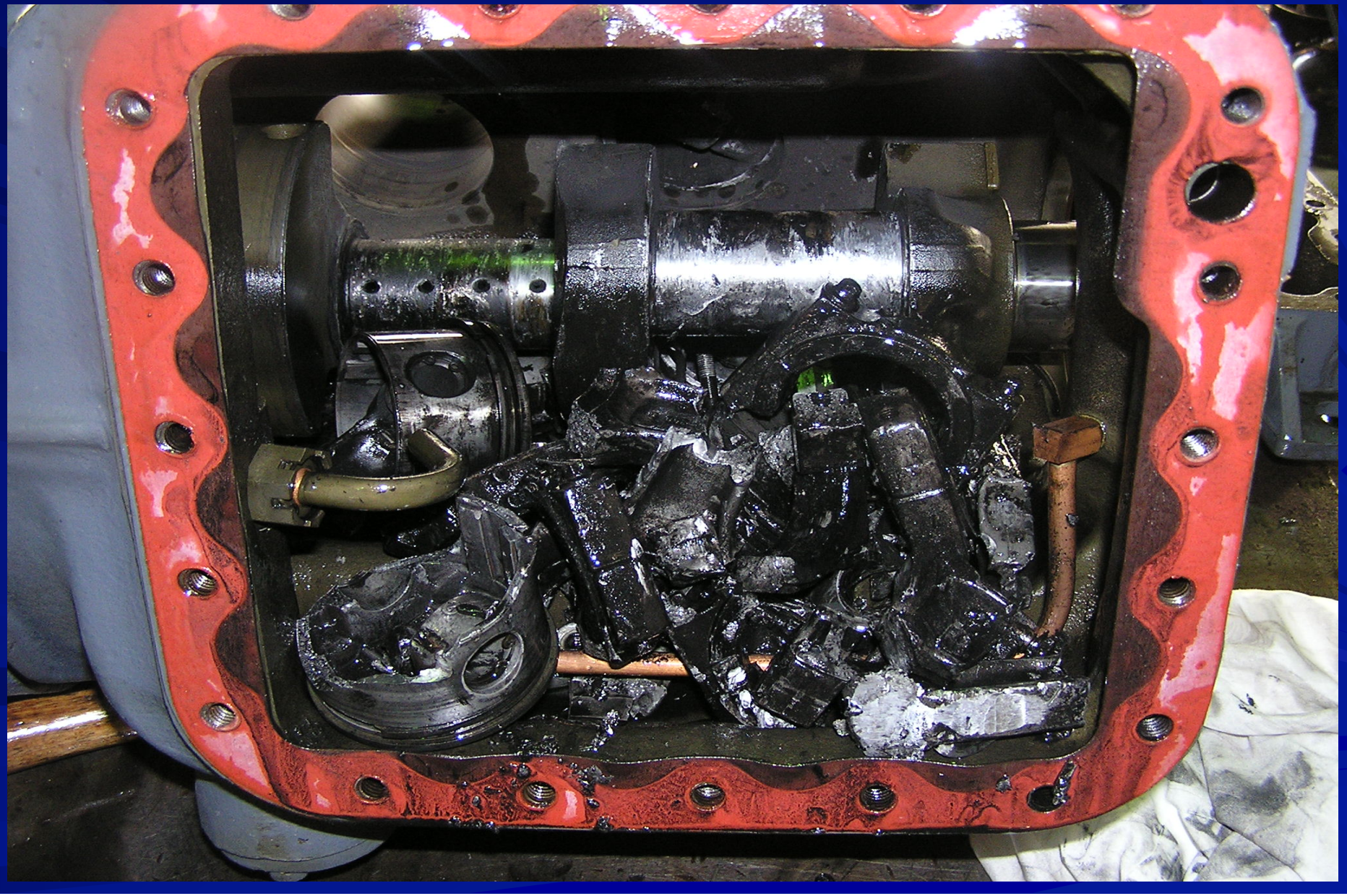
- Incorrectly set or faulty expansion valve
- Overcharge on capillary system
- Low evaporator loads
- Poor or uninsulated expansion valve bulb connection
- Plugged or disconnected EXV external equaliser line
- Sudden changes in load
- Improperly sized equipment
- Poor heat transfer
- Lack of air circulation
- Oil logged evaporator
- Liquid charging into suction

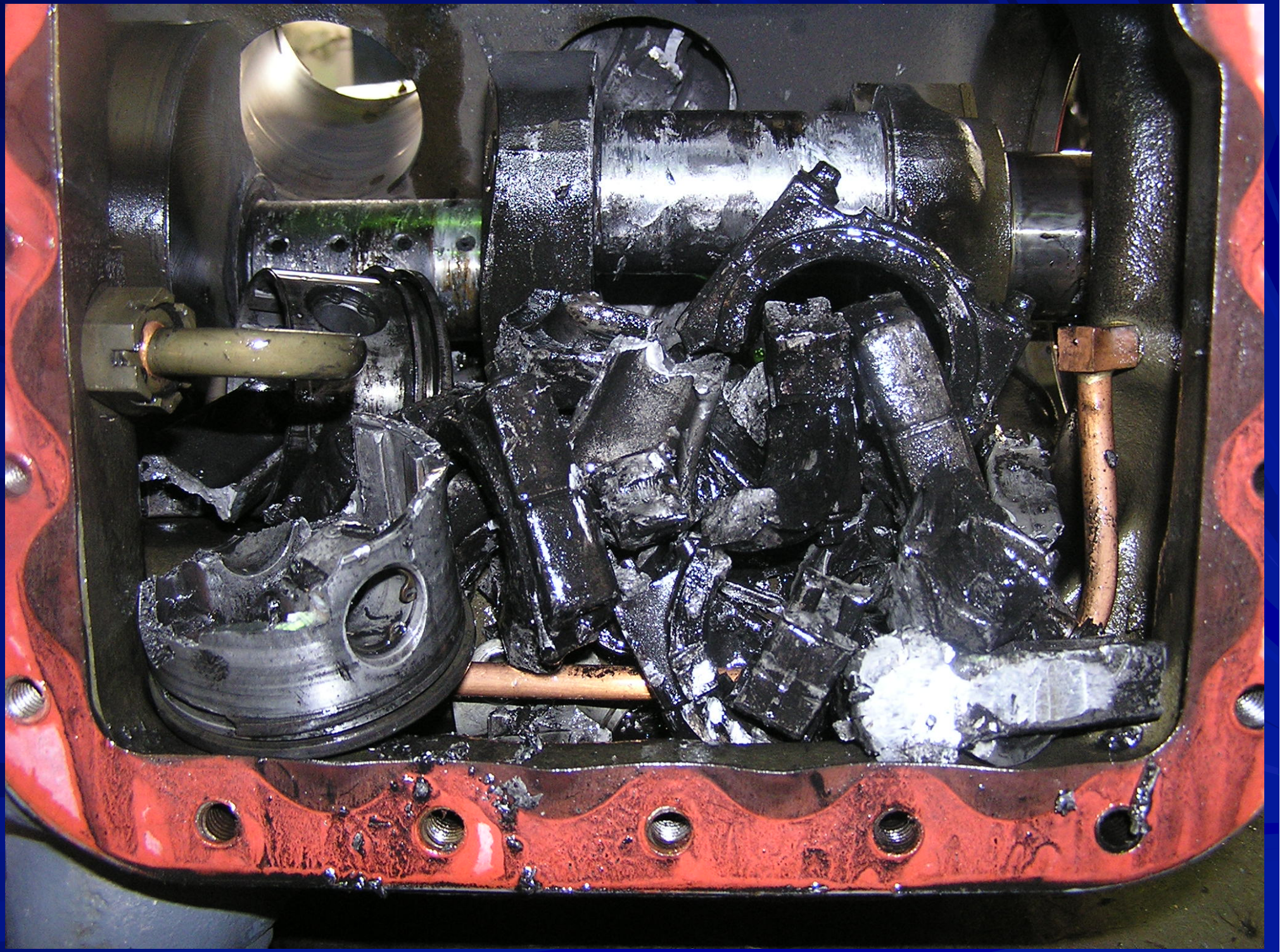
As floodback often occurs during low load periods, often at night or after defrost, the technician is often not on site to witness the problem.

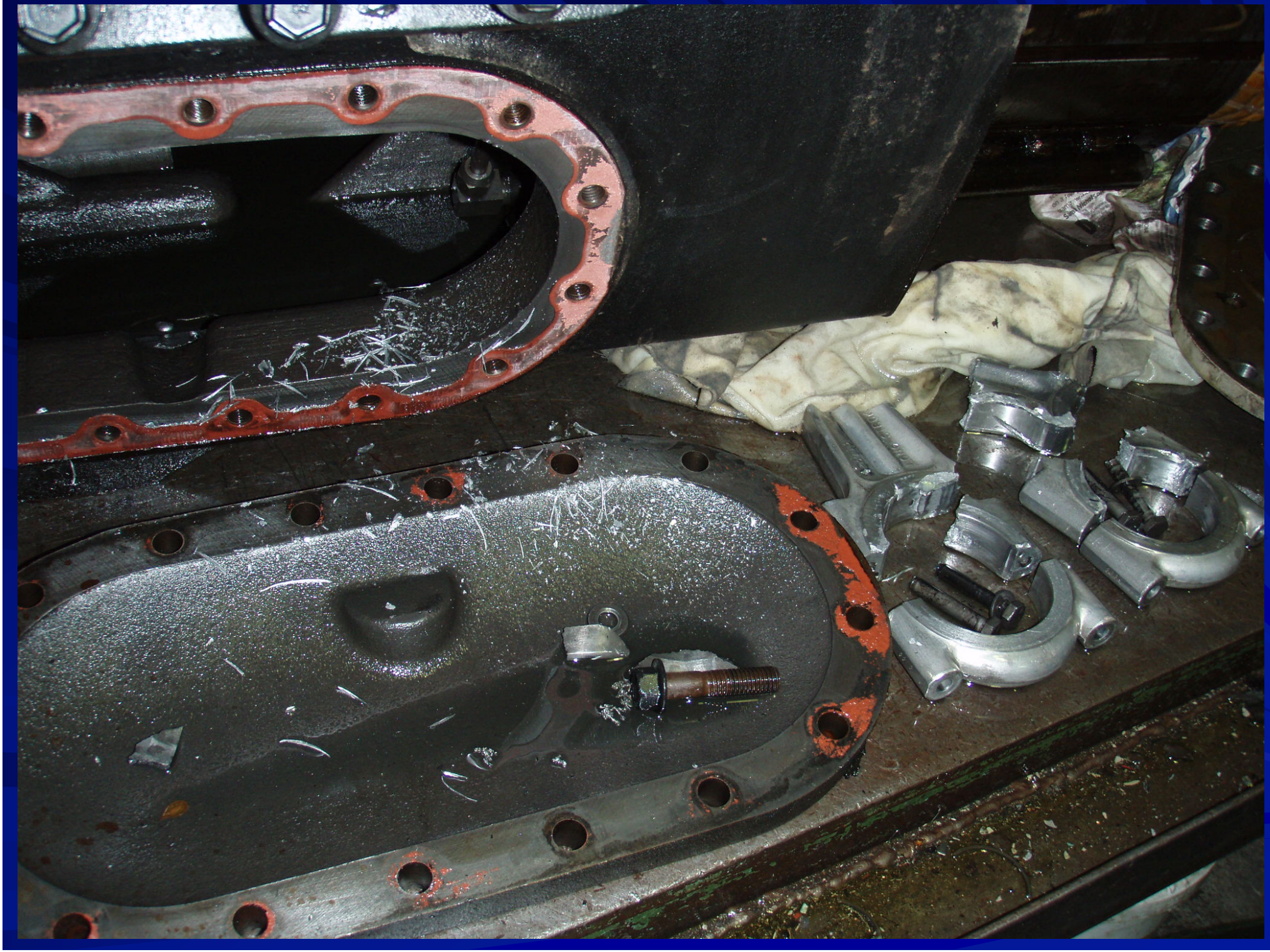
Setting a superheat of 10 degrees AT THE COMPRESSOR will significantly reduce the risk of failure due to floodback.

THE DAMAGE CAN BE SEEN AS . . .

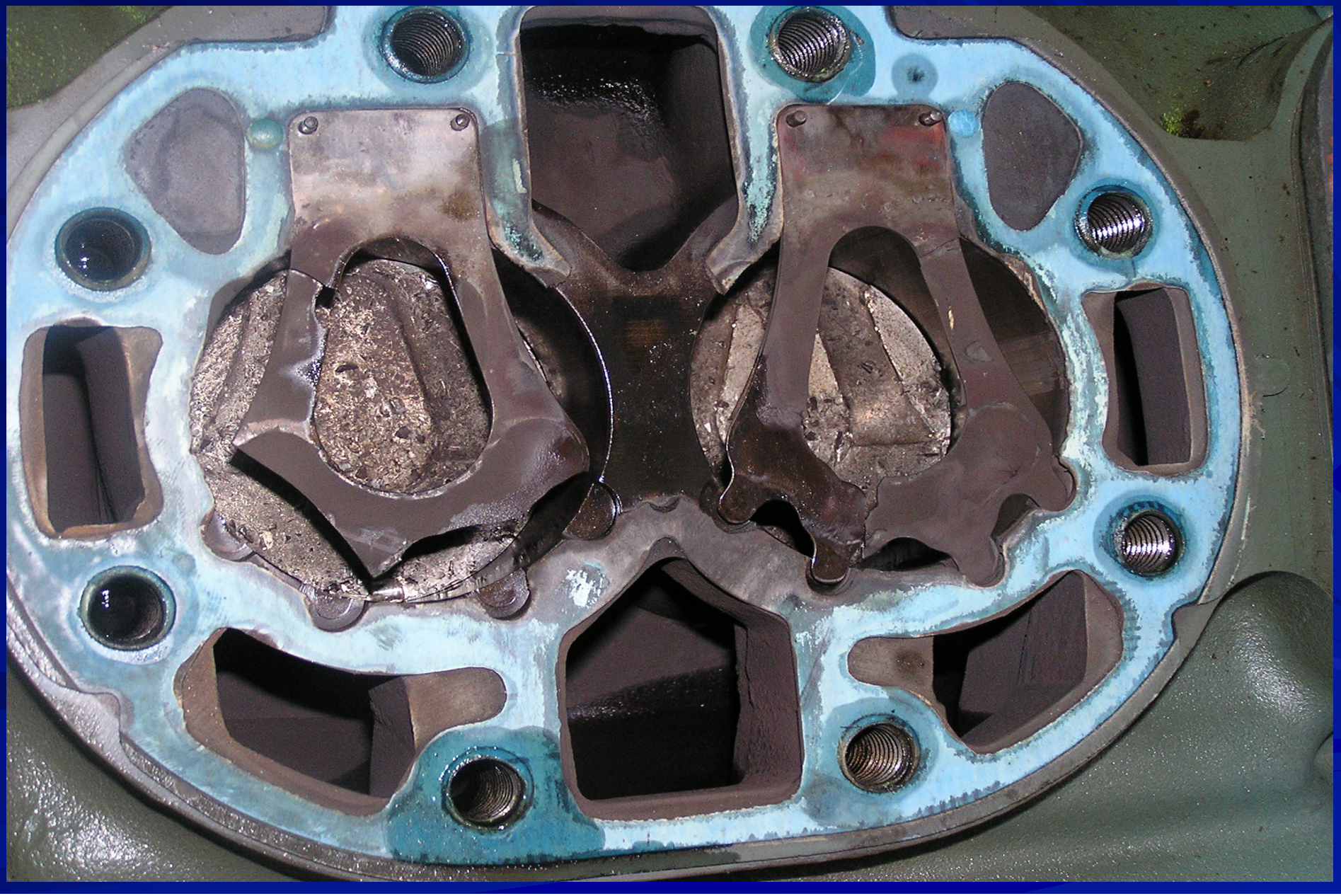
BROKEN CON RODS





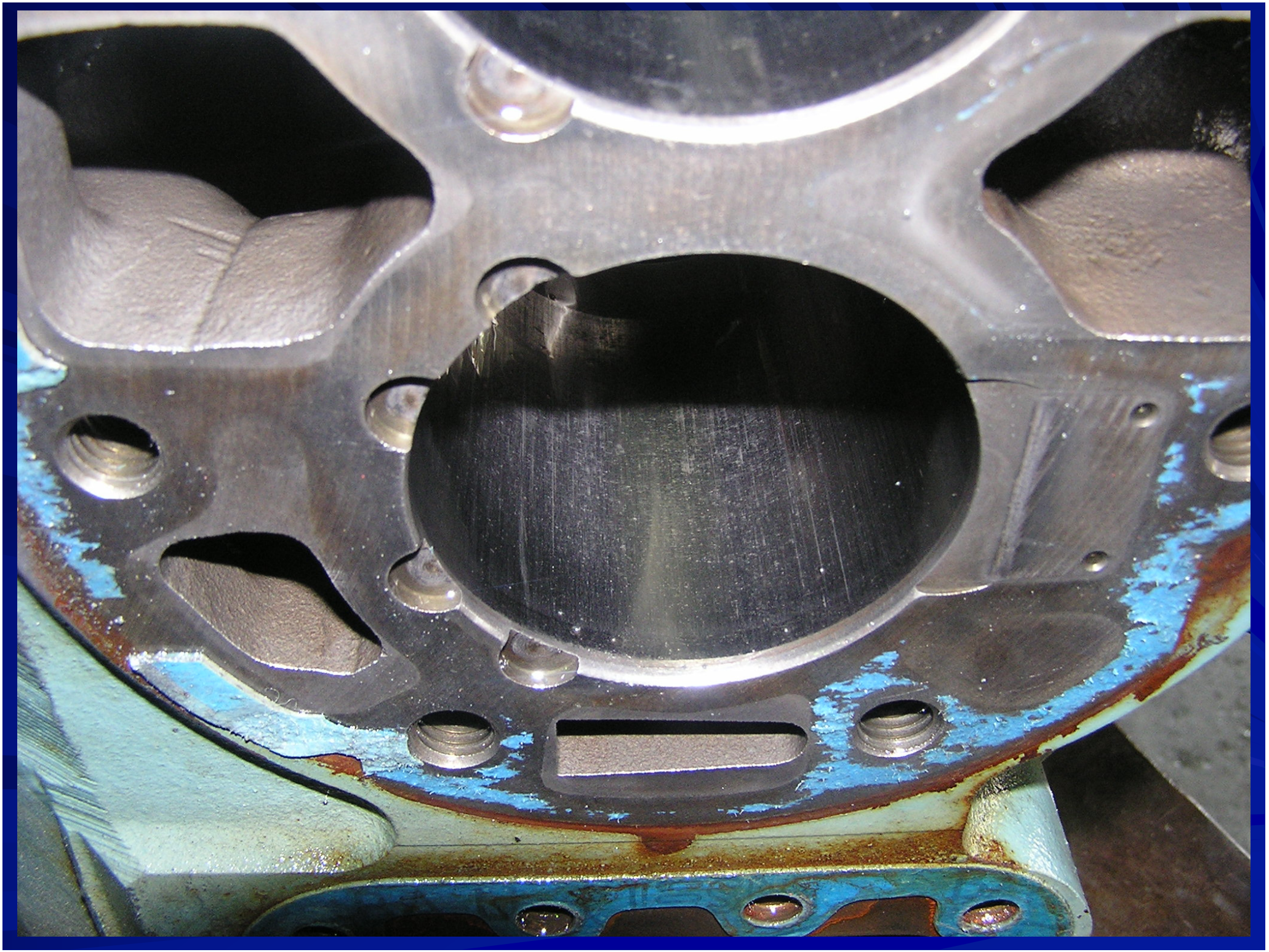


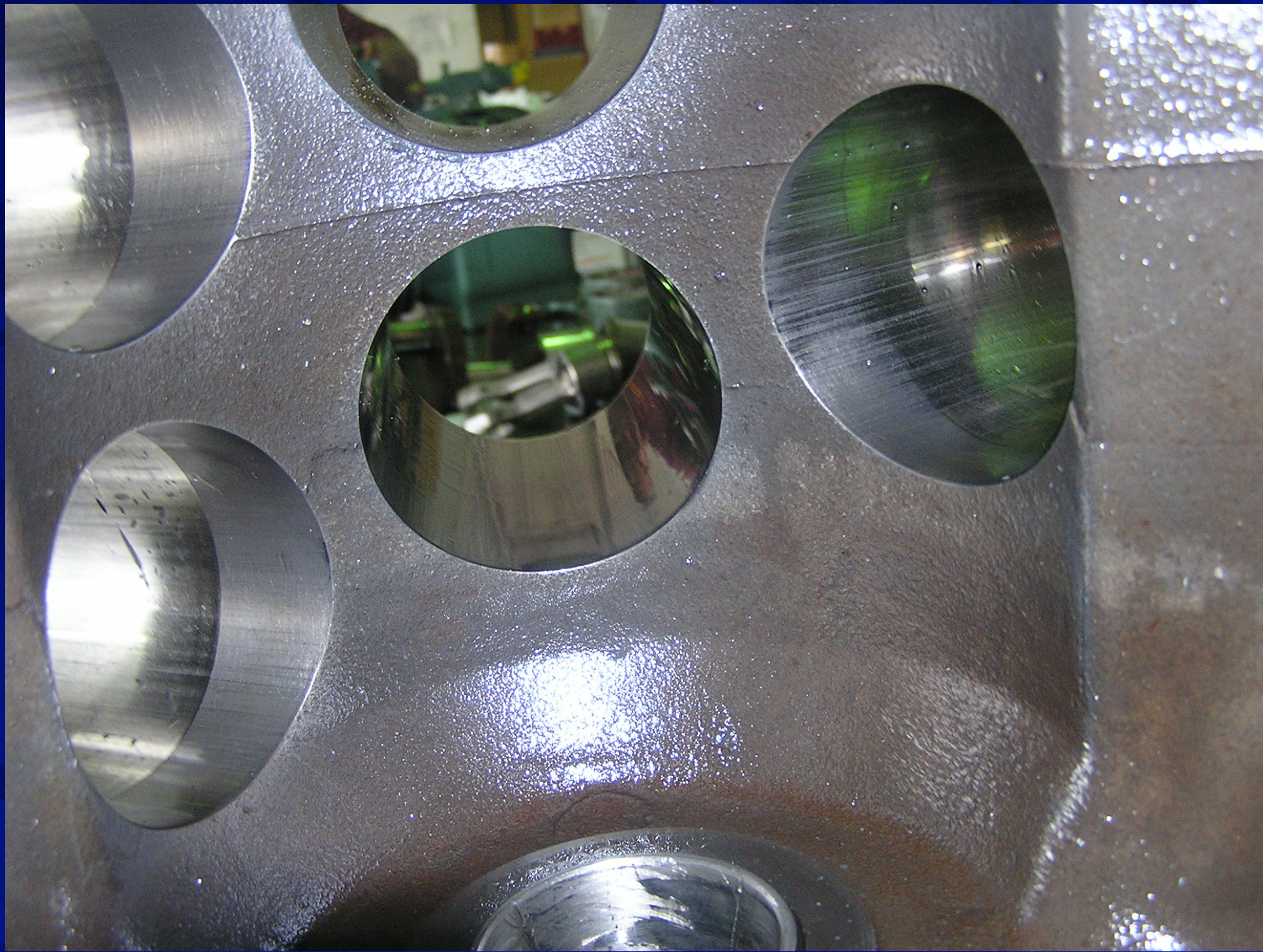
BROKEN VALVE REEDS



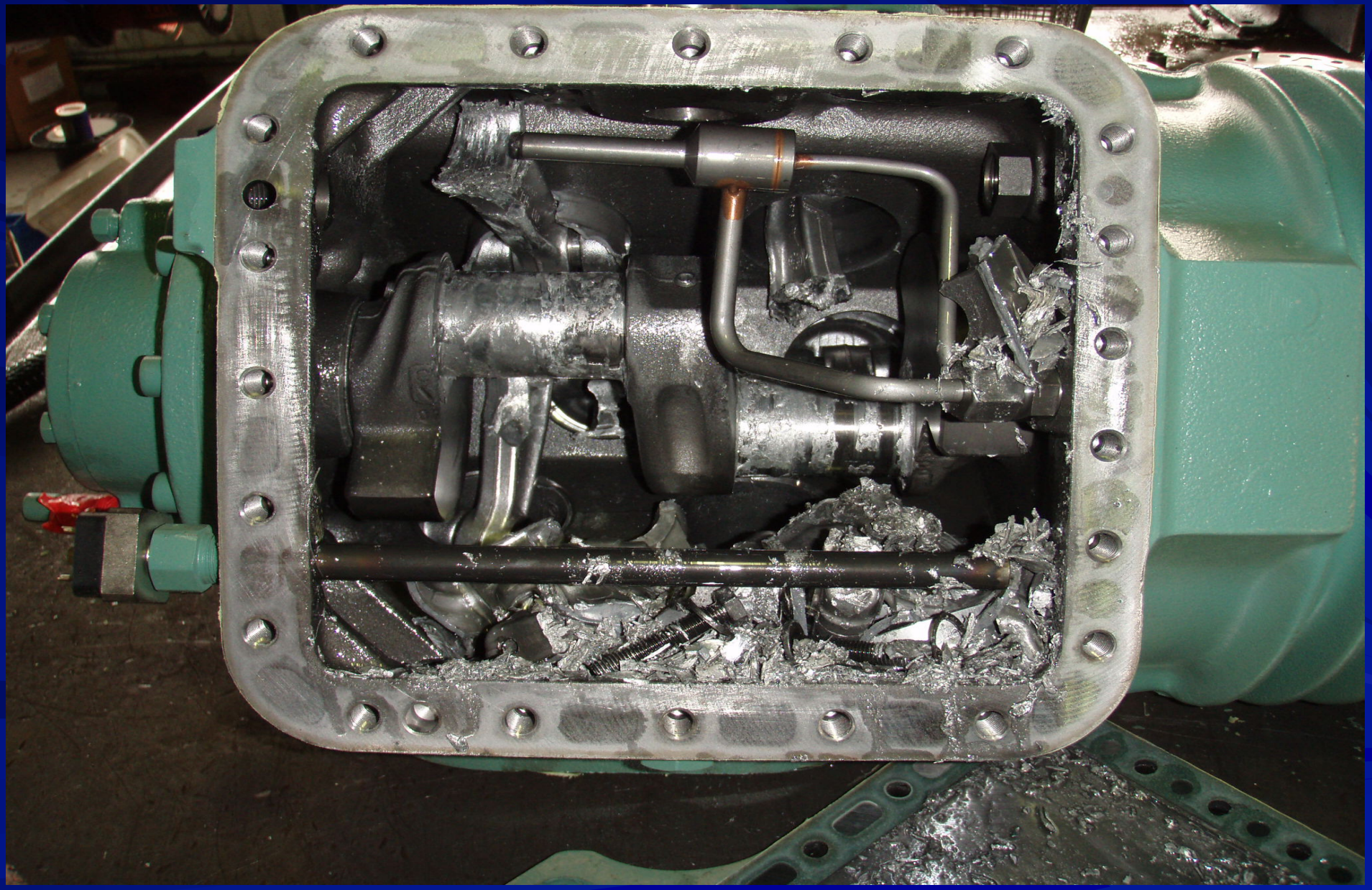
Heavily worn valve seats

SCORED BORES





METAL BUILD UP ON CRANK



6. FLOODED STARTS

Flooded starts occur when the compressor is started with enough refrigerant in the crankcase to dilute the oil and overcome the oils ability to lubricate properly.

The refrigerant enters the oil in the off cycle by a process called migration.

This occurs every time the compressor is not running and is normally not a problem, however, if the vapour pressure of the compressor oil is lower than the standing refrigerant pressure, excessive refrigerant will then flow to the compressor sump.

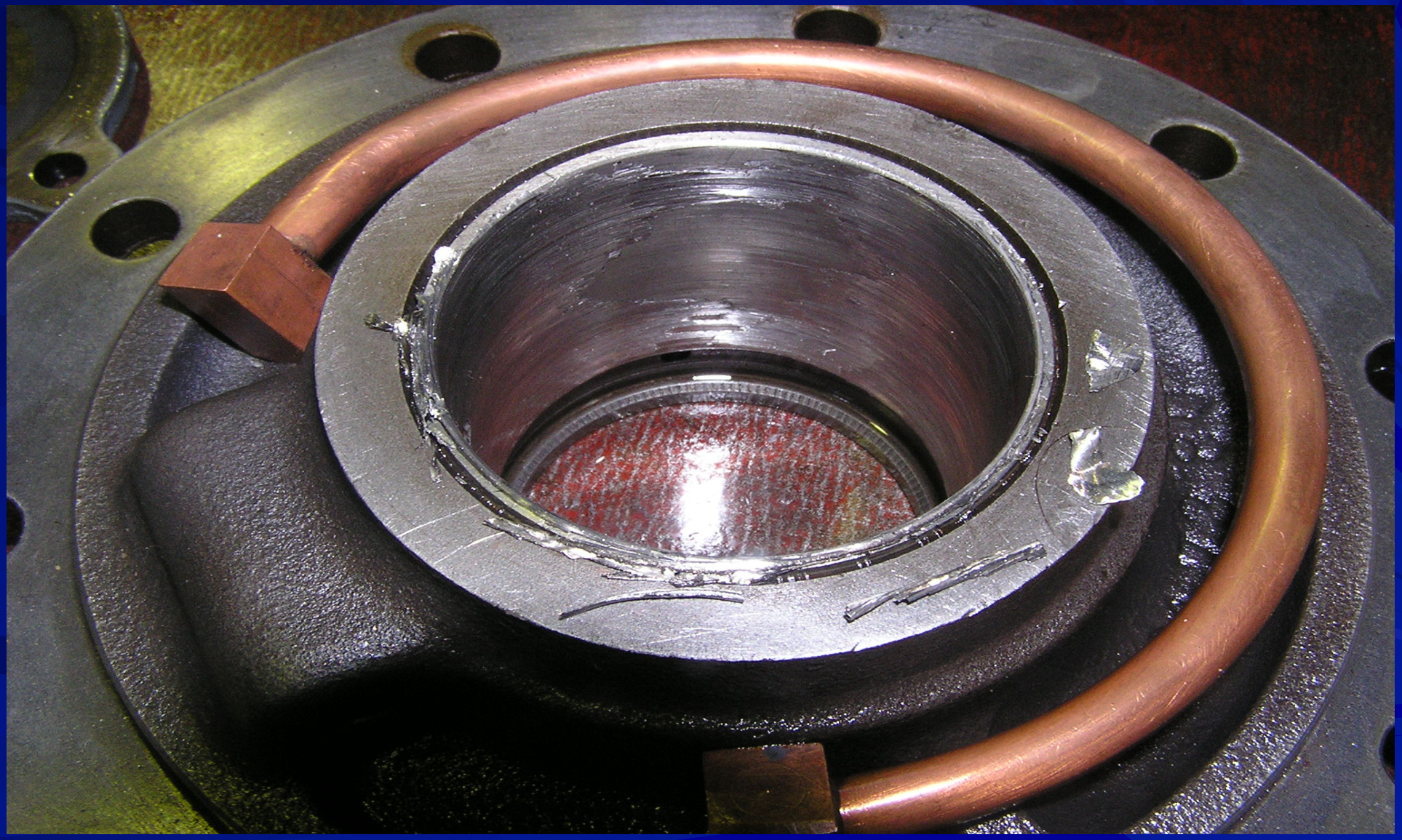
Sump heaters are fitted to reduce this risk, however, if the compressor has been flooding back, or the off cycle is particularly long, the heater may not be strong enough to heat the oil adequately.

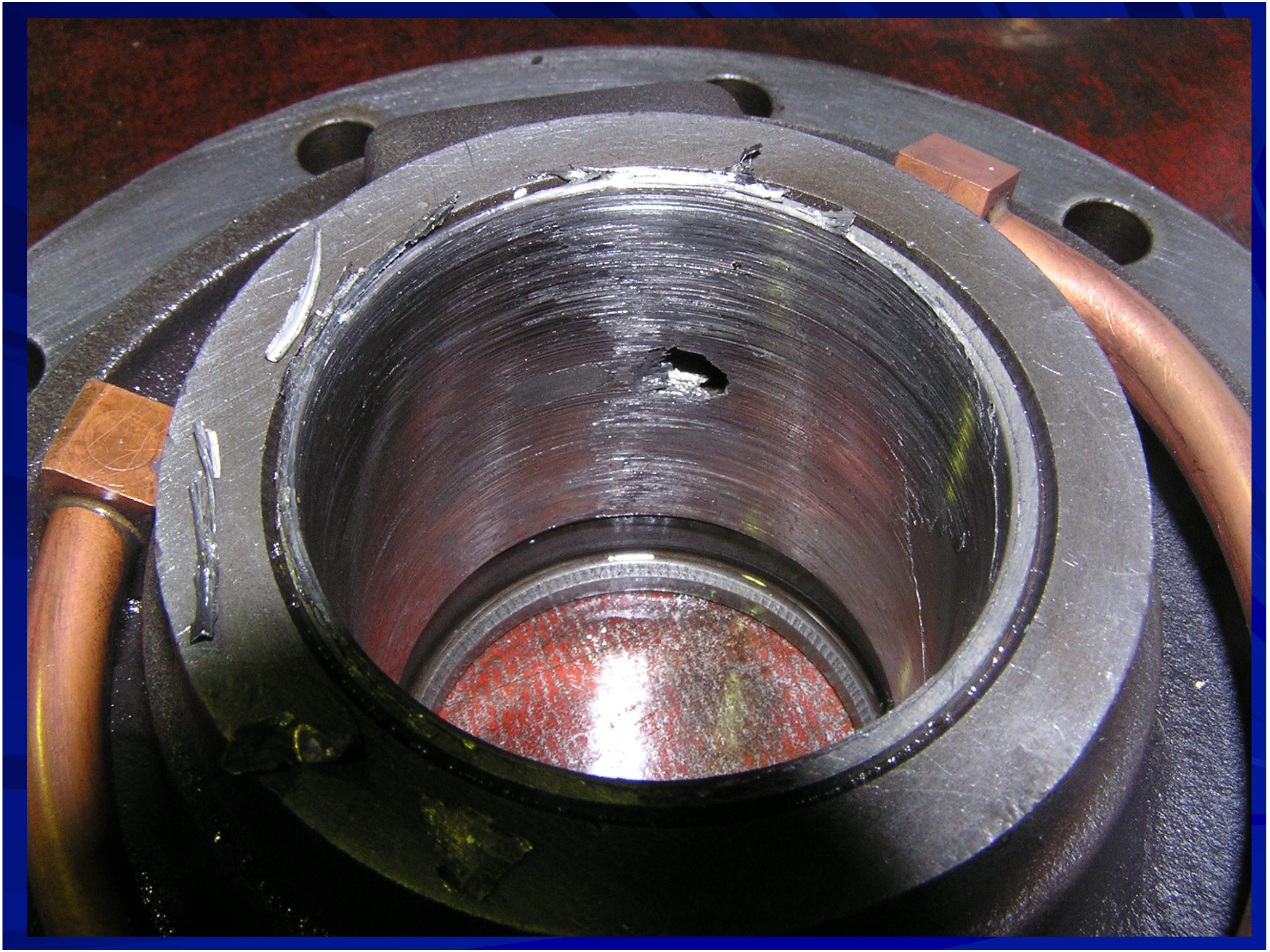
FACTORS THAT AFFECT THE RATE OF REFRIGERANT MIGRATION

- Length of off cycle
- Compressor ambient temperature – if lower than 5 degrees, sump heaters may not provide sufficient heat.
- Temperature/pressure difference between the refrigerant in the evaporator and the oil in the sump – eg, heater banks, electric defrost
- Excessive refrigerant charge
- Floodback
- Sump heater operation

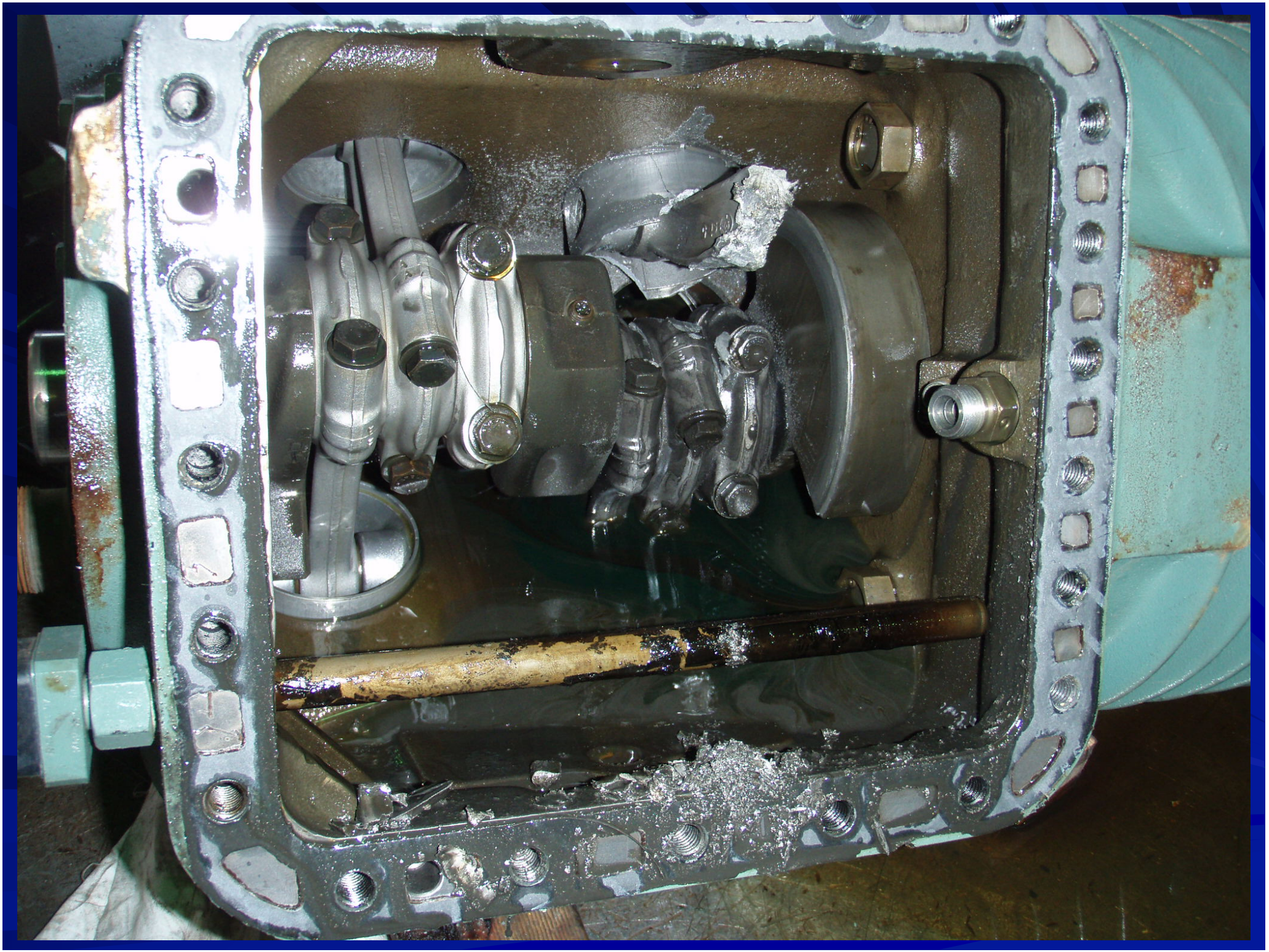
THE DAMAGE CAN BE SEEN AS . . .

MAIN BEARING DAMAGE – NO HEAT

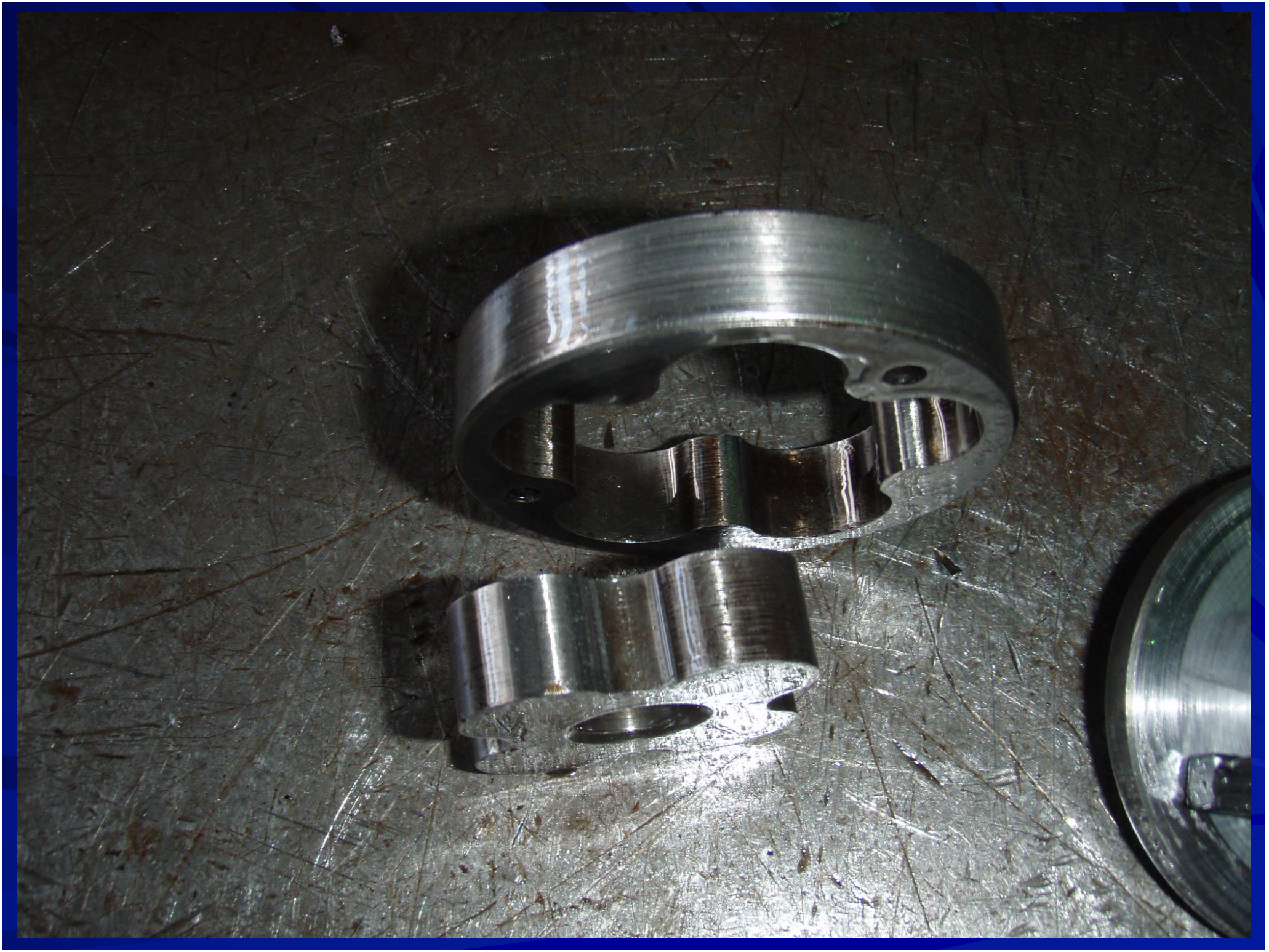




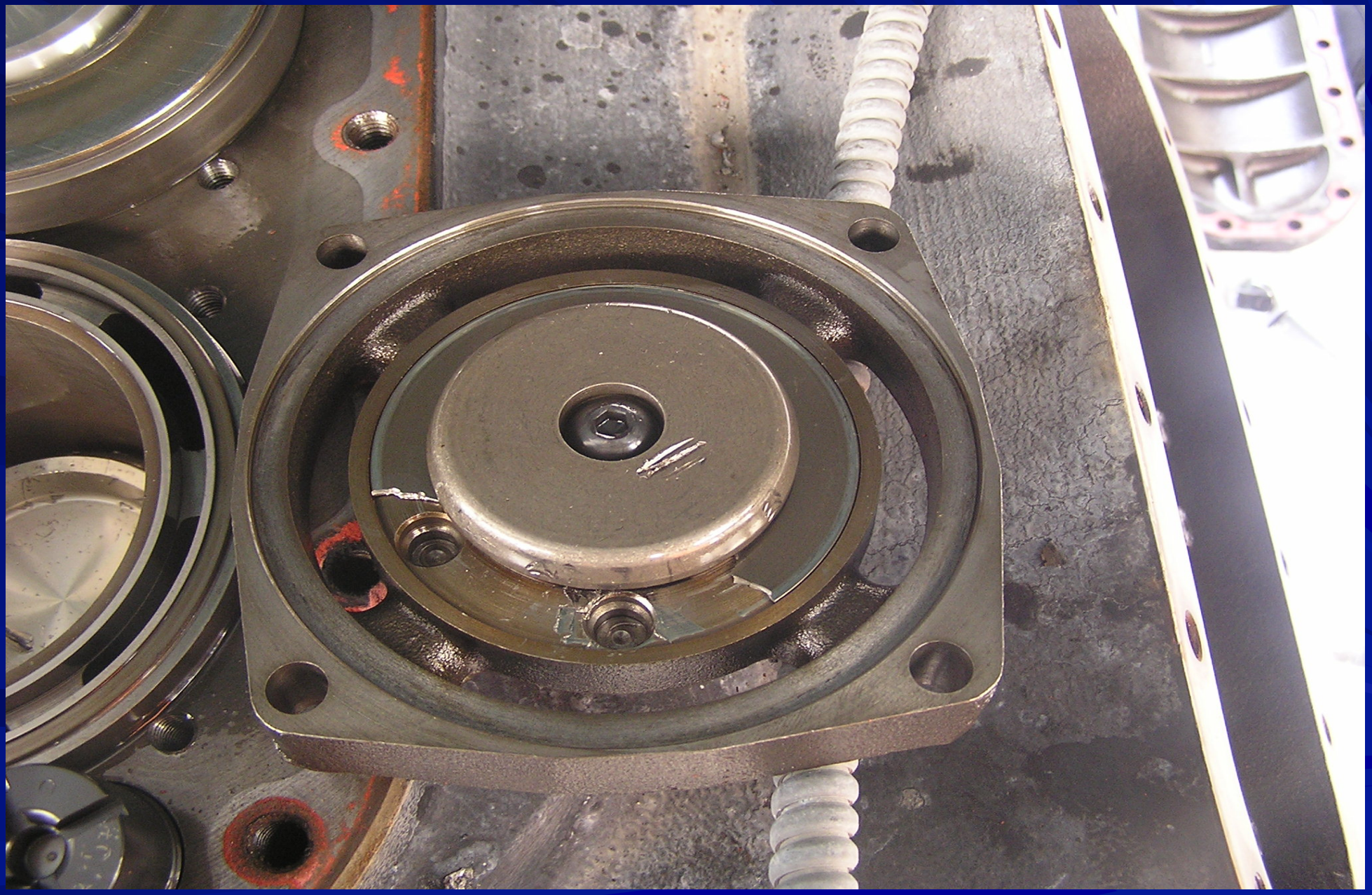
BROKEN CON RODS



SCORED OIL PUMP

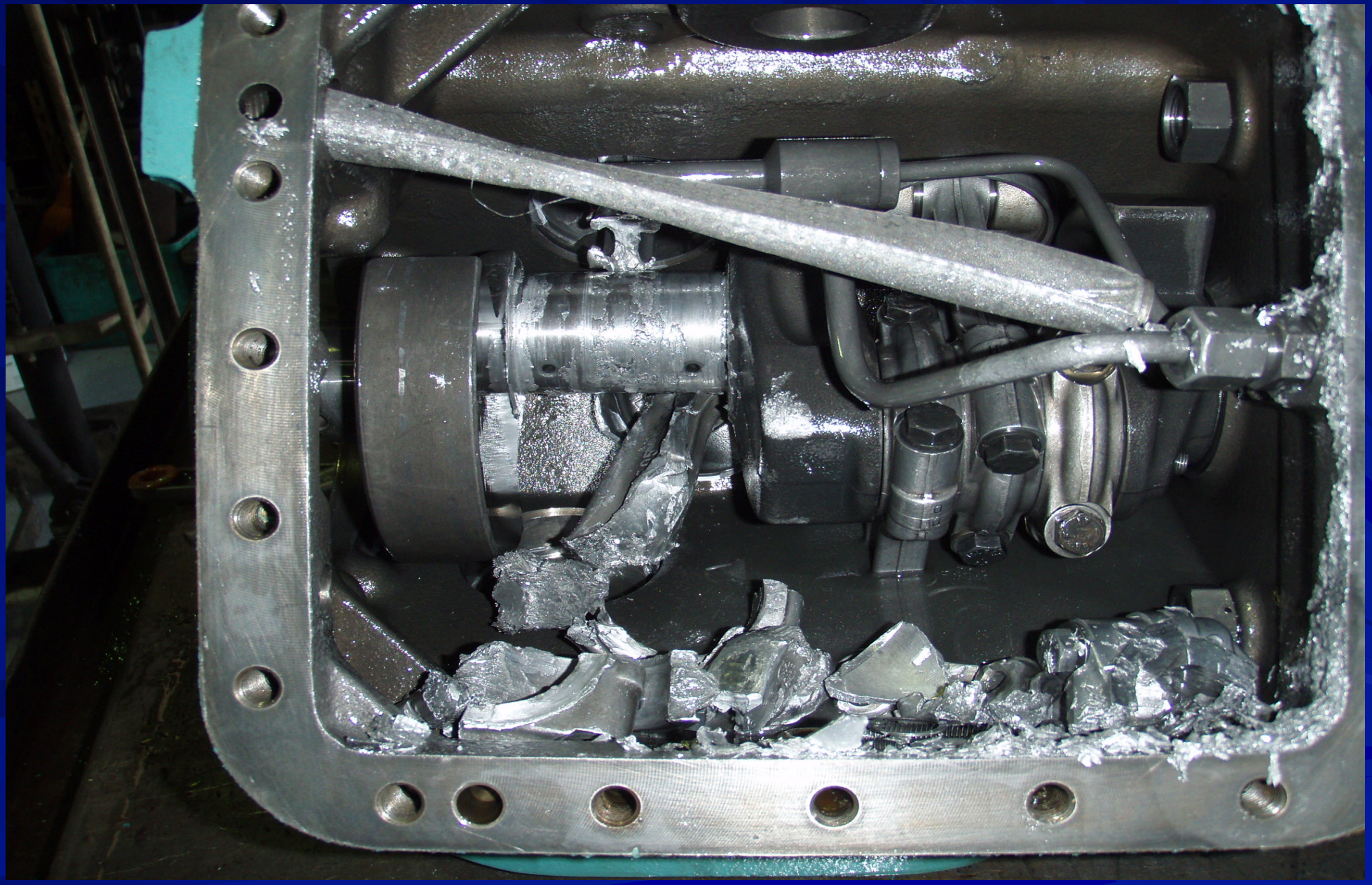


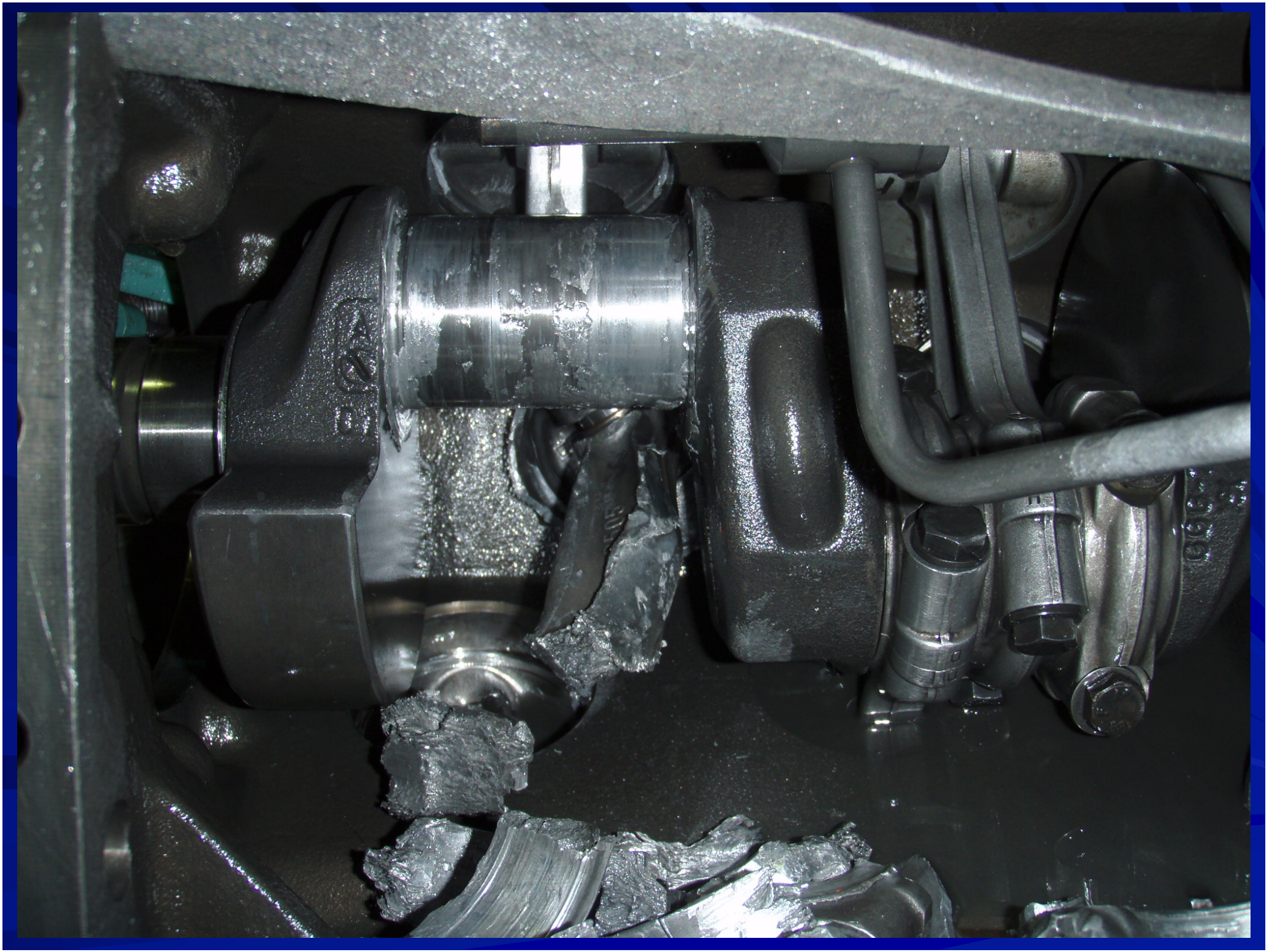
BROKEN VALVE REEDS

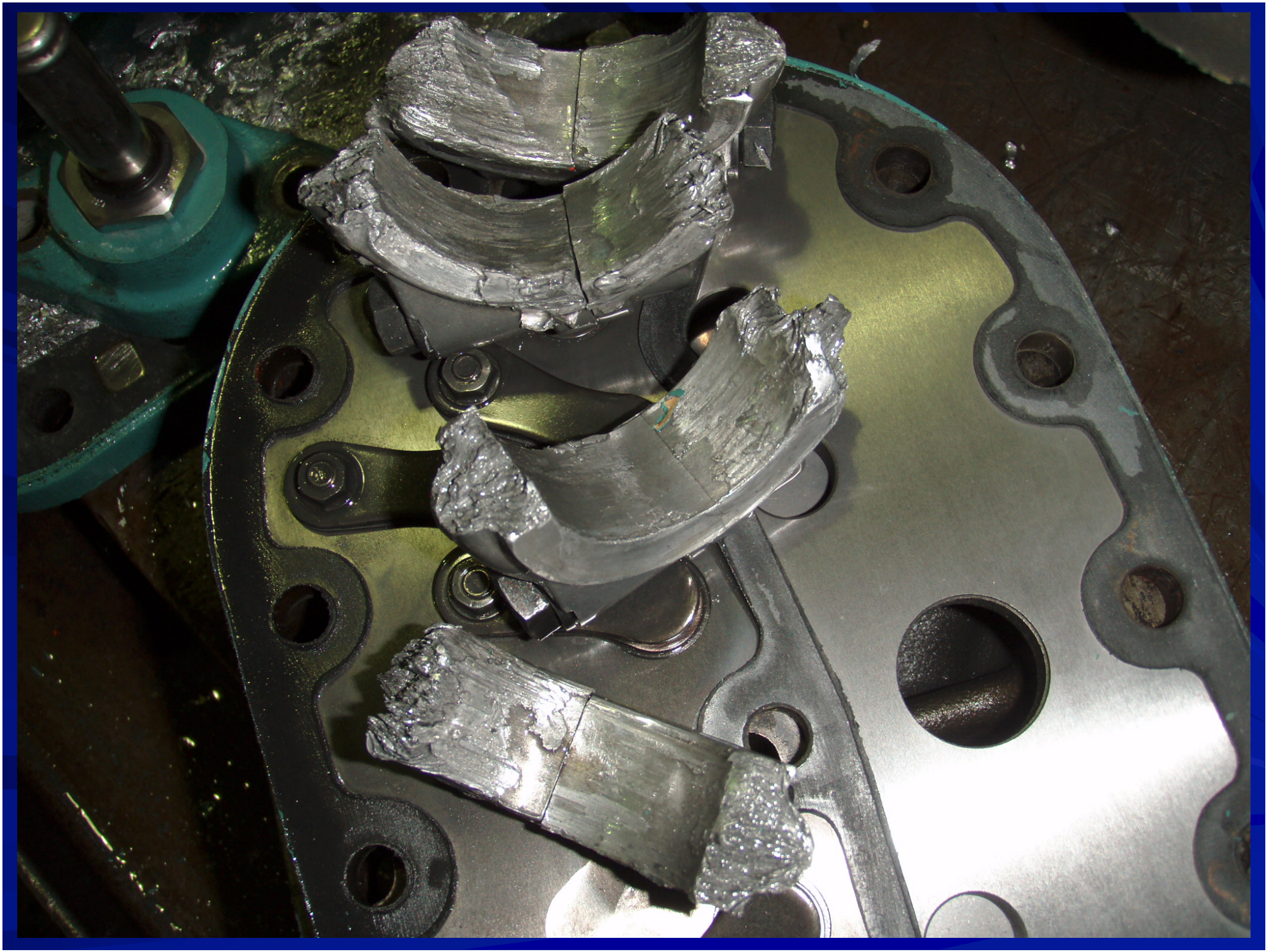


SCORED BORES

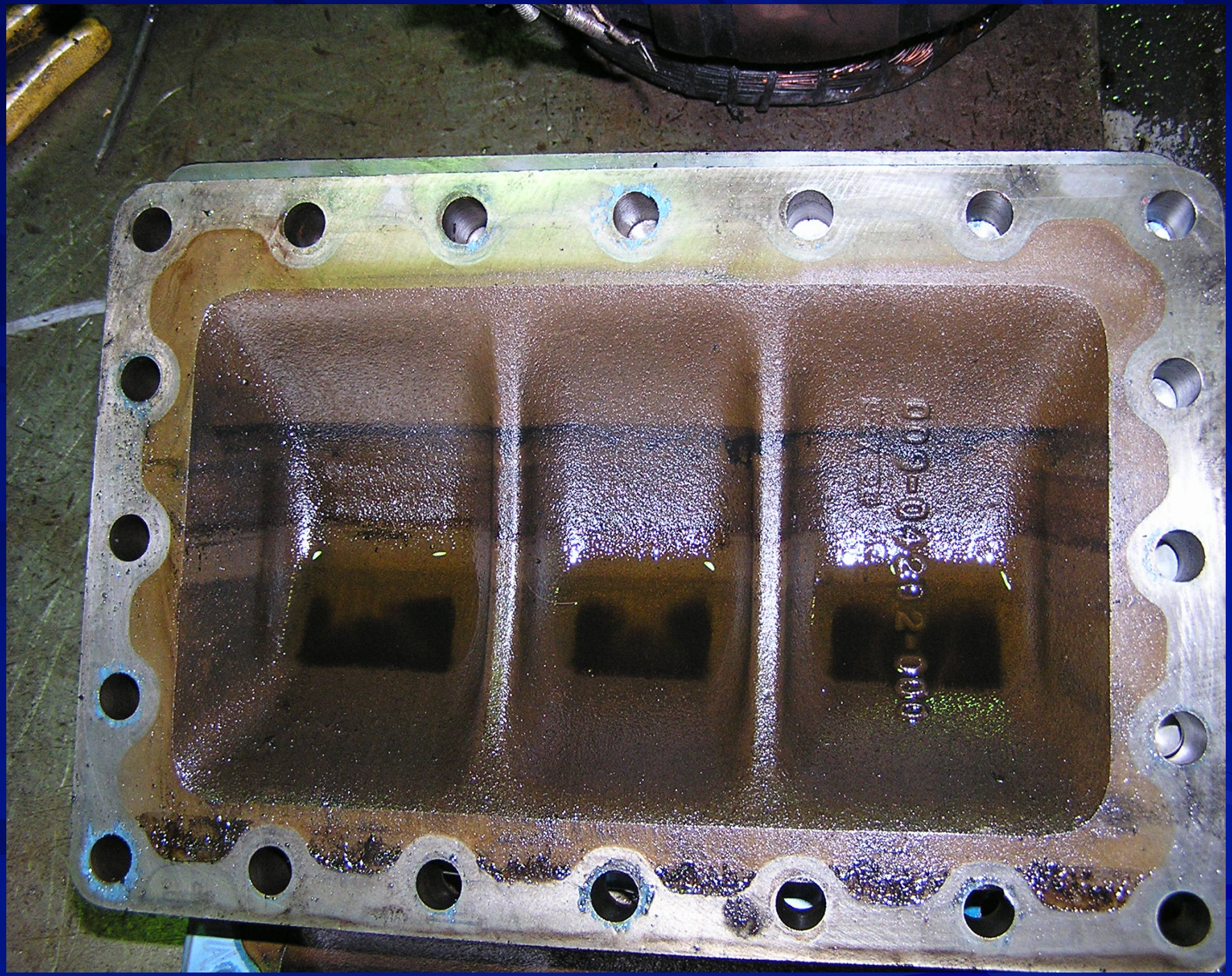
METAL BUILDUP ON CRANK

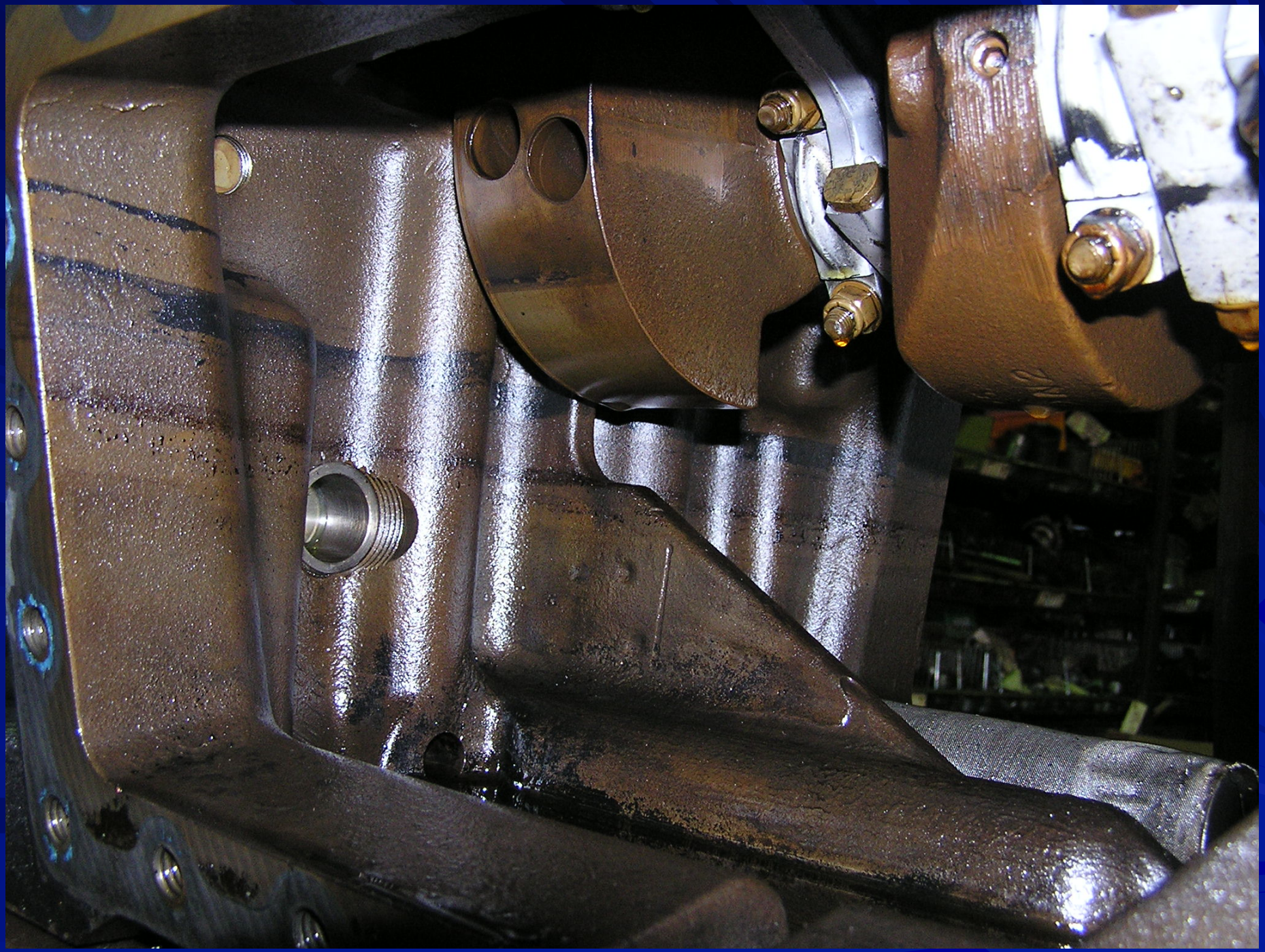


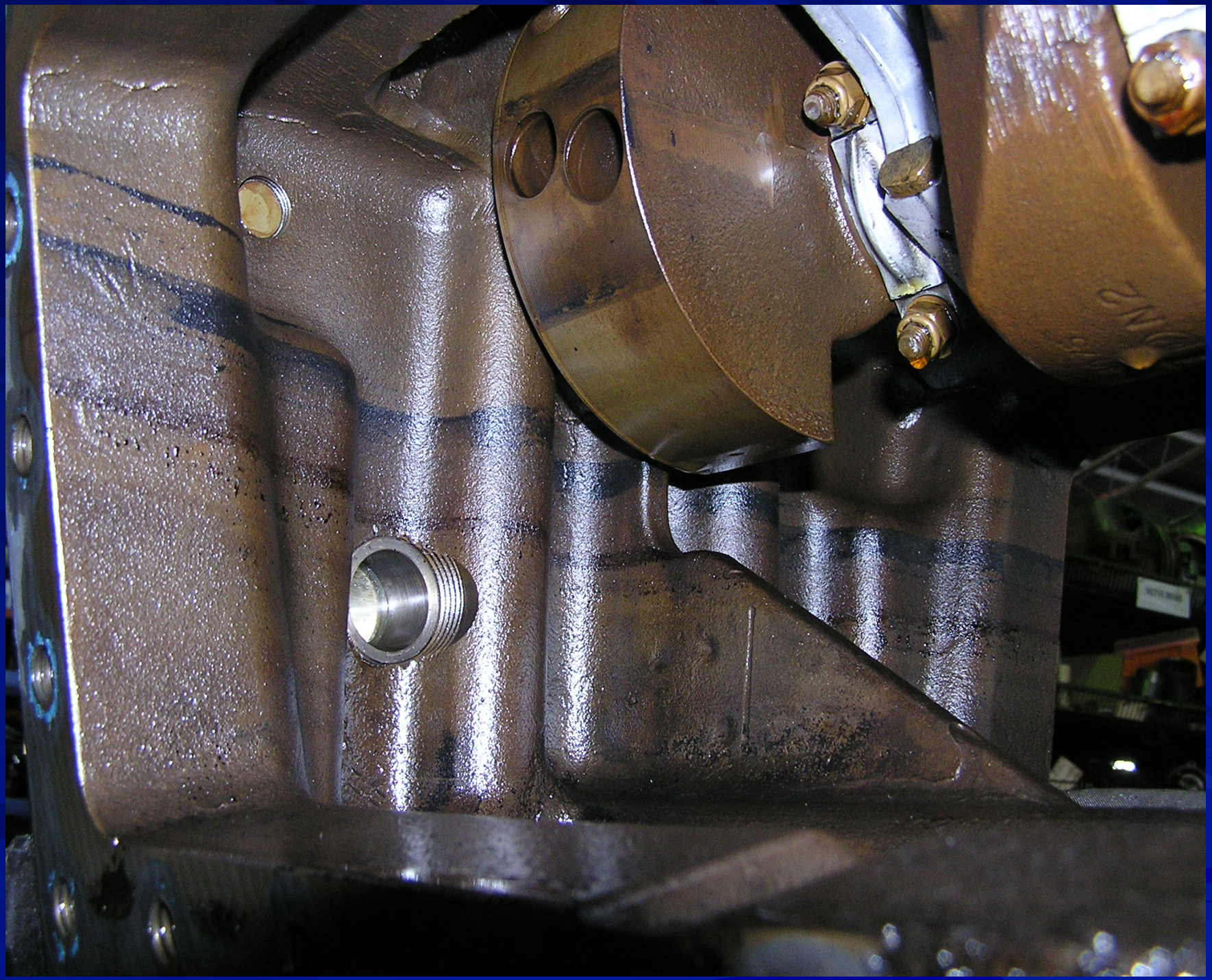




MULTIPLE OIL LEVELS







ELECTRIC MOTOR FAILURES

FULL BURN OUT

CAUSES

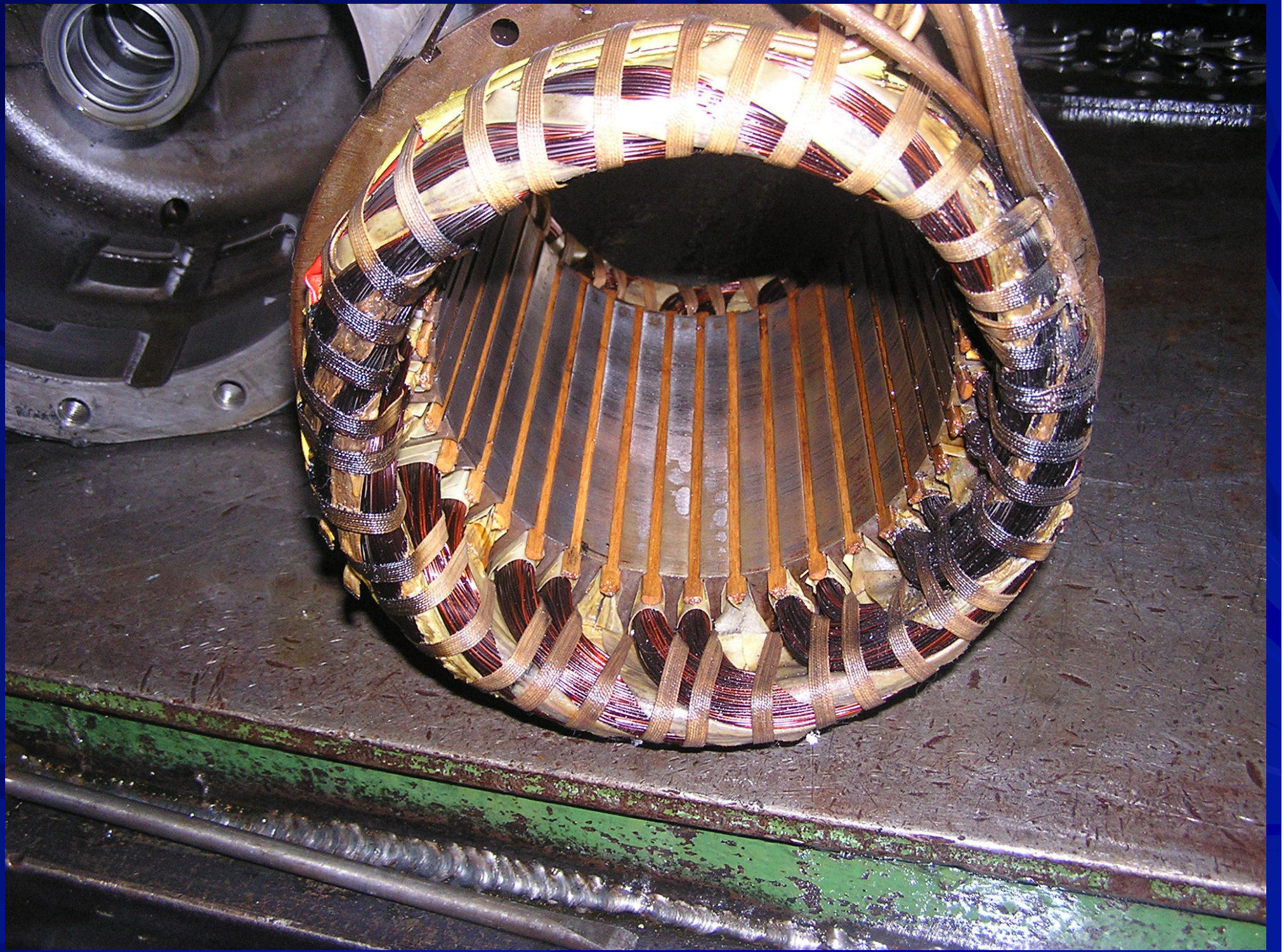
- Compressor seized or hydraulically locked.
- Poor sub cooling - reduced gas flow from short cycling, low gas charge or incorrect superheat.
- Low supply voltage resulting in high current and potential contactor damage.

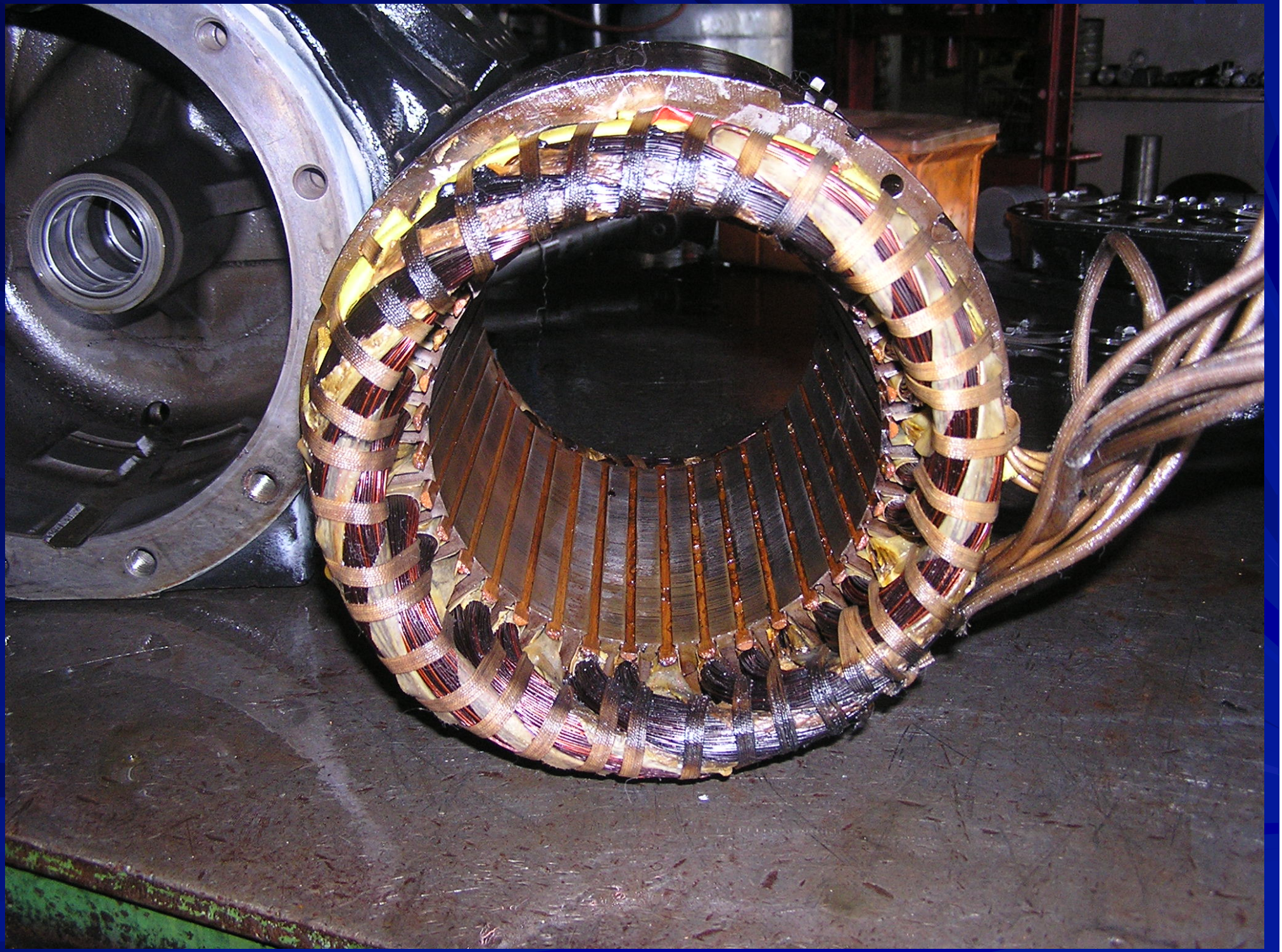
LOSS OF PHASE

CAUSES

- High resistance joint. This can be on the compressor terminal, contactor or supply circuit.
- Loss of phase before the compressor supply. Power failure, supply issues, fuses etc.
- Motor protection or contactor overload relay should shut down the supply, but doesn’t always happen as the high current can fuse the contact together.

PART START FAILURE





CAUSE

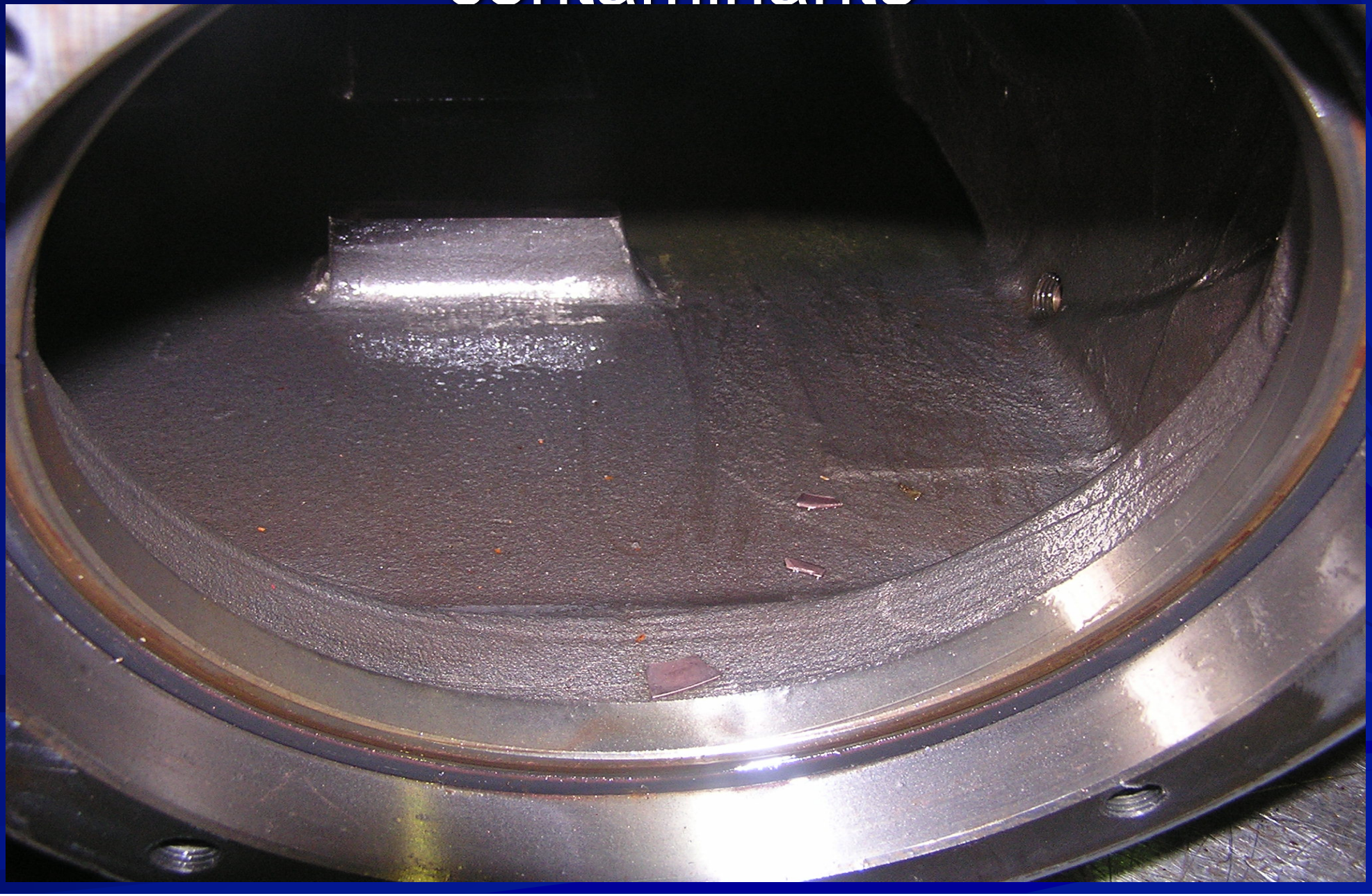
Usually when the second contactor fails to energise, or one contactor remains energised after unit calls for shutdown.

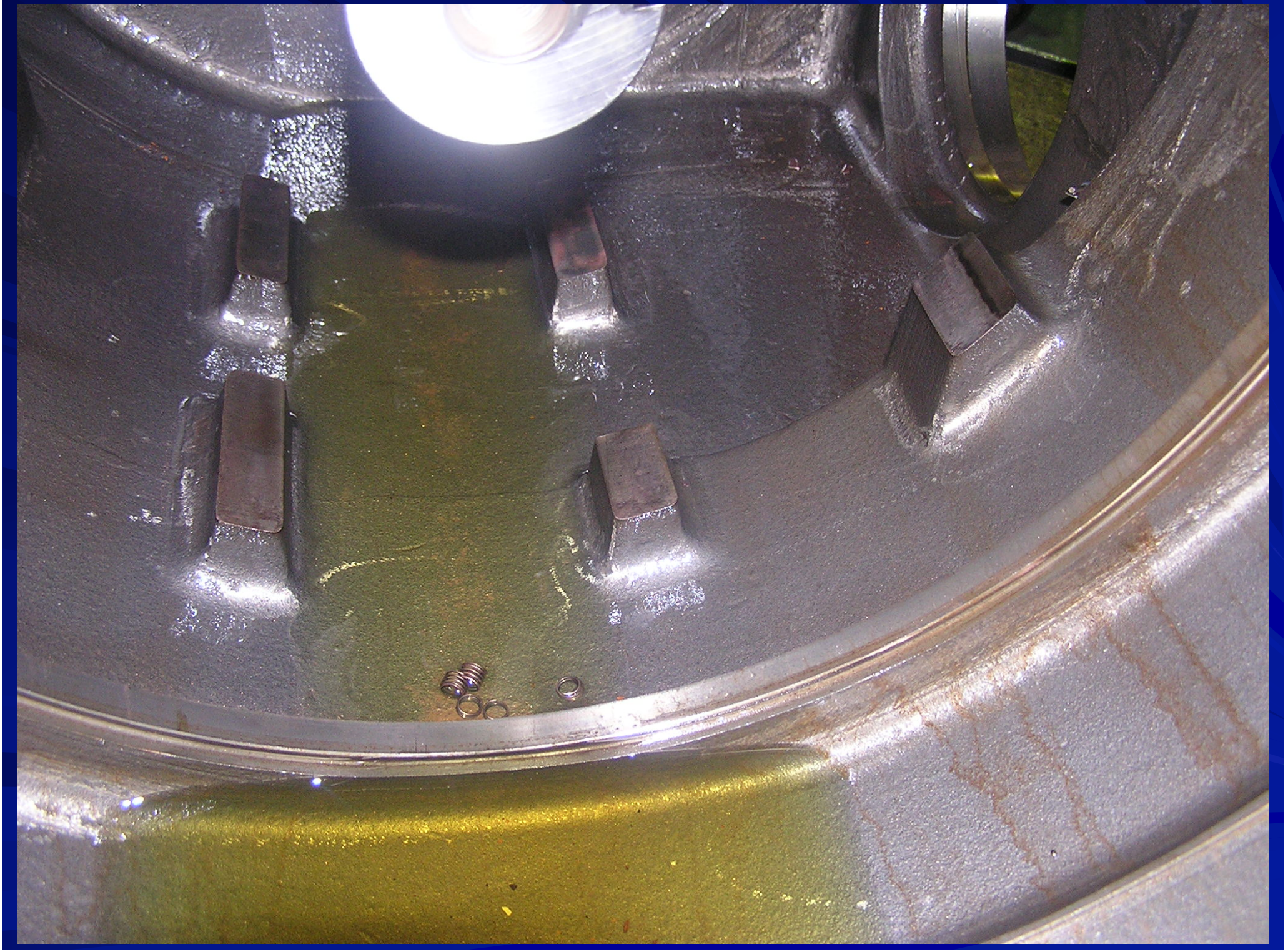
This will burn out a number of groups in the stator windings, but in a different pattern to a loss of phase.

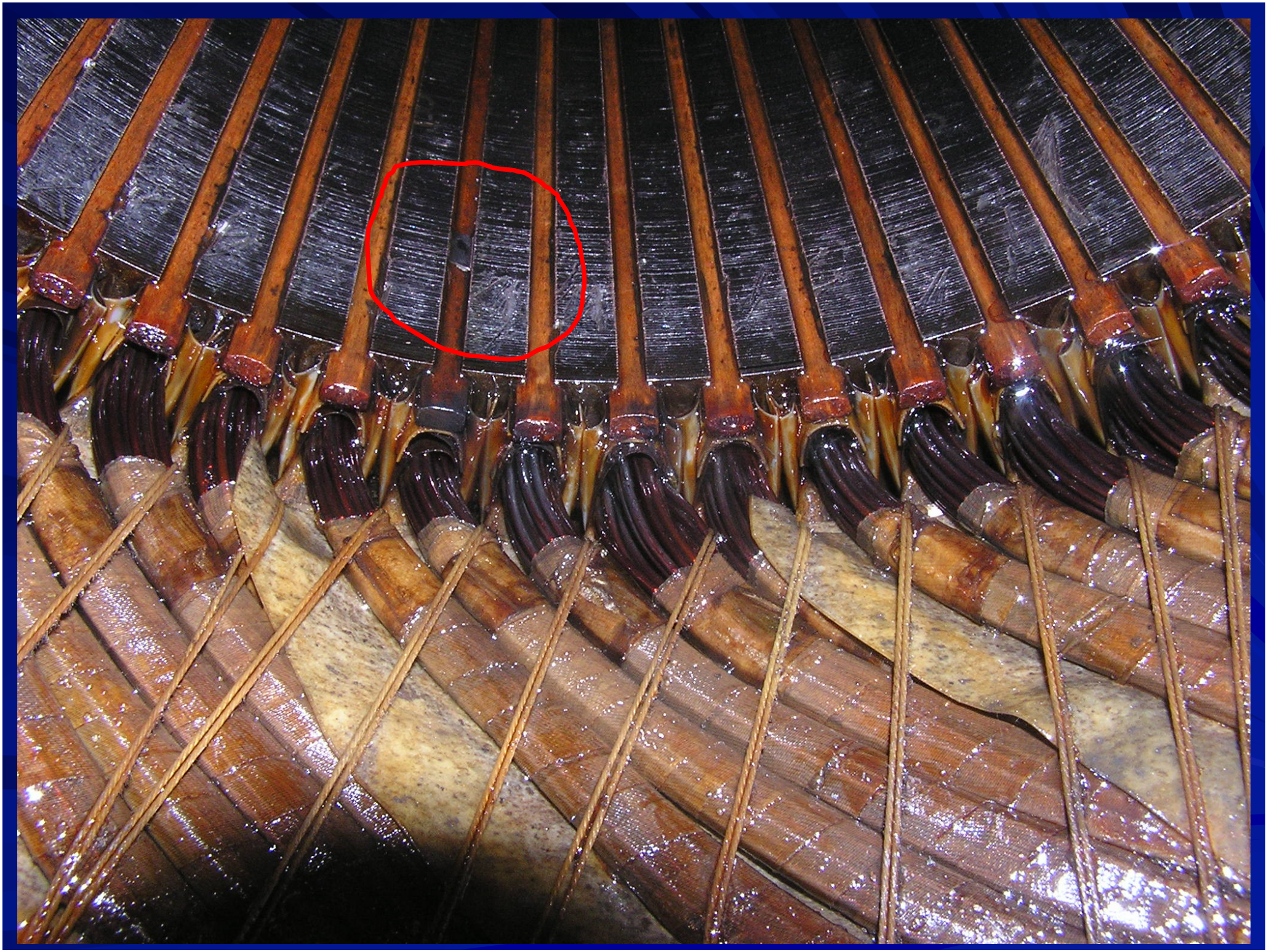
When the internal winding connection is known, the pattern and diagnosis is relatively simple.

SPOT BURNS

Commonly caused by system contaminants







SPOT BURNS

This is possibly the hardest electrical failure to diagnose as the fault or contaminant can be from a variety of areas and after causing a localised burn, is often destroyed in the process.

The causes are normally from a condition influencing a breakdown of the windings insulation system ie. metal ingress into the winding - rather than the insulation just breaking down.

CAUSES

- Contamination from a previous failure - debris from broken valve reeds or springs, worn internal compressor components settling on the winding causing abrasion.
- The compressor running into a vacuum.
- Compressor running out of its parameters stressing the stator.
- Voltage surge.

20 GOLDEN RULES TO CHANGING COMPRESSORS

Note: If you do not follow these basic rules while performing a compressor change **you could be responsible for the failure of the replacement compressor.**

- Purge system with nitrogen
- Install liquid line & or suction line burnout driers & contactors
- Check correct oil & oil charge is in compressor sight glass
- Install compressor.
- Test & energise crankcase heater.
- Evacuate system.
- Perform dry run start of the unit
- Check & record line voltage – at compressor terminals
- Charge system with correct refrigerant – **Do not bomb {liquid} charge suction or discharge line.**
- Check oil pressure {if available} & current draw – in that order- immediately after start up.

- Charge system to specified refrigerant charge while monitoring suction & discharge pressures & amperages.
- Measure superheat at compressor suction valve – 10 degrees.
- Measure temperature of discharge line – 150mm from compressor – 75 to 95 degrees.
- Measure air {water} on & off temperature at condenser & evaporator & compare with pressure temperature chart.
- Compressor sump temperature – below oil level if possible - 40 degrees.
- Check all other system accessories eg heat exchangers, oil separators, reversing valves.
- Watch unit run through full cycle & test integrity of all solenoid, TX valves, oil separators etc. during off cycle – temperature changes are a good indication of leakage.
- Listen to compressor re-start - re-check above readings.
- Watch, feel and listen.
- **Remember. Replacing a failed compressor in a system with a problem will often gain you nothing more than another failed compressor. Compressors rarely if ever wear out; it is up to you to find the cause.**

On behalf of Oliru Trading we would like to take this opportunity to thank you all for attending our training session.

Please do not hesitate to contact your nearest branch if you have any questions or require any assistance on site.

Perth: 0411 592 344

www.oliru.com.au

peter@oliru.com.au