Reclaiming Rotating Parts by Metal Spraying

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Machine parts on board wear out

There are hundreds of rotating parts in various types of machinery on board a ship. They suffer stress and strain in the forms of metal -to -metal friction, abrasion, corrosion or a number of other wear phenomena, singly or in a combination.

These phenomena all have one thing in common: They lower the performance of the machines concerned until periodic inspection establishes that the part has been worn down to sub-standard and must be replaced, or a breakdown may occur.

In both cases it is necessary to have replacement part available. If not, it may have far-reaching consequences.

Cost of replacement parts

Ordering spare parts and arranging for their delivery on board cost large amounts of money each year. In addition, it consumes time in follow up and administration.

The money invested in the spare parts stock means a reduction in operating profit. It is always a calculation of types and quantities of spares against the money bound up in them.

Purchasing replacement parts and discarding the worn ones may seem unavoidable. But a method for prolonging part-lifetime and thereby saving on replacement cost is available.

Reduce cost-Increase efficiency

As an alternative to carrying large stocks of spares and of scrapping worn parts, it is possible to reclaim them on board by using the Metal Spray processes.

In practically all cases this is a cheaper solution than purchasing new parts, and by on-board reconditioning it is possible to reduce the number of spares carried. This reduces operating expenses considerably.

The Metal Spraying makes it possible to impart desired qualities in the reconditioned part, such as corrosion resistance, low coefficient of friction a. o. making the part better suited for its function, and with a lifetime exceeding that of the original part. This means an increase in maintenance efficiency.

Example:

Cargo Pump

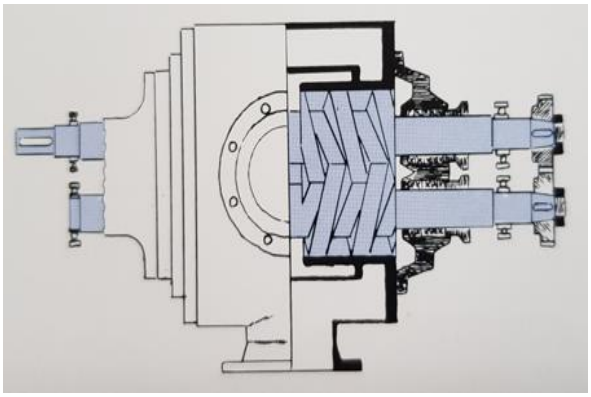
Worn shaft Ø 100mm (4”) must be replaced. No spare shafts available on board.

New part solution: Purchase of new set of shafts, min. USD 17.000, -.

Metal Spray solution: Reconditioning by cold spraying on board USD 200, -.

Savings USD 16.800, -.

The reconditioning operation may be done twice on this type of shaft doubling the savings



Metal Spraying processes

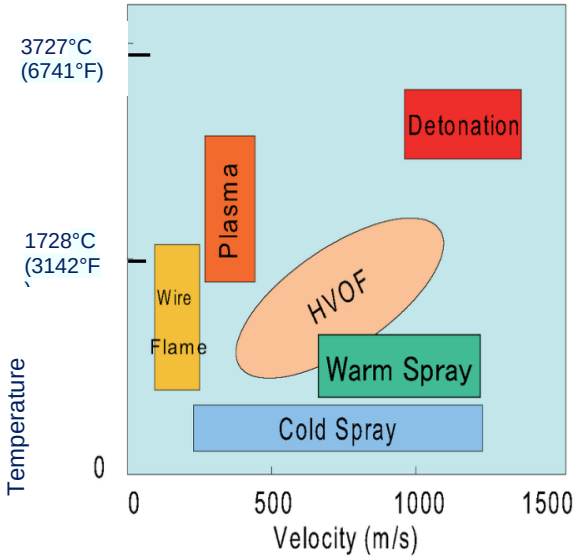
Metal Spraying is also known as Thermal spraying. Thermal spraying is actually the proper name. This is a coating processes in which melted (or heated) materials are sprayed onto a surface. The powder or wire is heated by a combustion flame or by an electrical arc. Coating materials available for thermal spraying include metals alloys, ceramics, plastics and composites. They are fed in powder or wire form, heated to a molten or semi molten state and accelerated towards the work piece in the form of micro meter-size particles. Coating quality is usually assessed by measuring its porosity, oxide content, macro and micro-hardness, bond strength and surface roughness. Generally, the coating quality increases with increasing particle velocities.

Thermal spraying can roughly be divided as follows:

By delivery system:
- Plasma spraying
- Detonation spraying
- Flame spraying
- Arc spraying (wire arc spraying)
- High velocity oxy-fuel coating spraying (HVOF)
- High velocity air fuel (HVAF)

By consumable:
- Powder
- Wire

By temperature range:
- Warm spraying
- Cold spraying



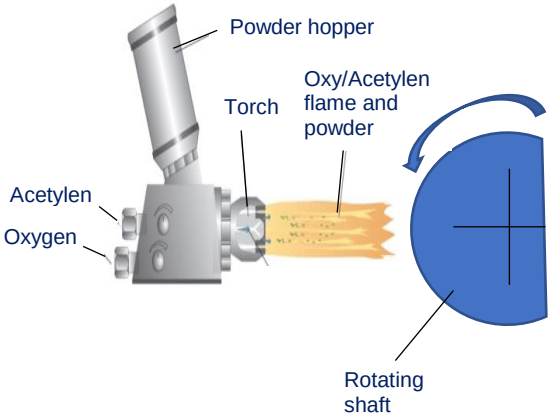
What process to use onboard

Equipment for metal spraying onboard need to be easy to operate and mount up, preferably using the late onboard. Likewise, it needs to run on an available energy source.

This will make Flame spraying using Oxy- Acetylene gas with consumable in Powder form the most attractive choice. The powder should likewise be a Could spraying powder. This will give virtually little or hardly no heat input to the base material avoiding deformation or warping of for example a shaft.

Cold Spraying powder using oxy-acetylene:

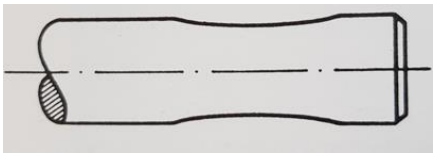
The process is based on powered micro alloys which are deposited on a worn area through an oxy acetylene flame. As the powder particles passes through the flame from the torch to the base material, they are heated up, and when they strike the colder base material an exothermic reaction takes place, releasing heat and micro -welding the particles to the base material.

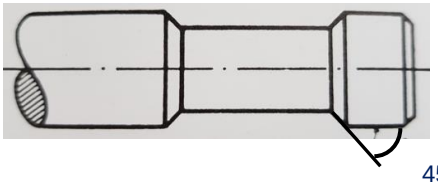


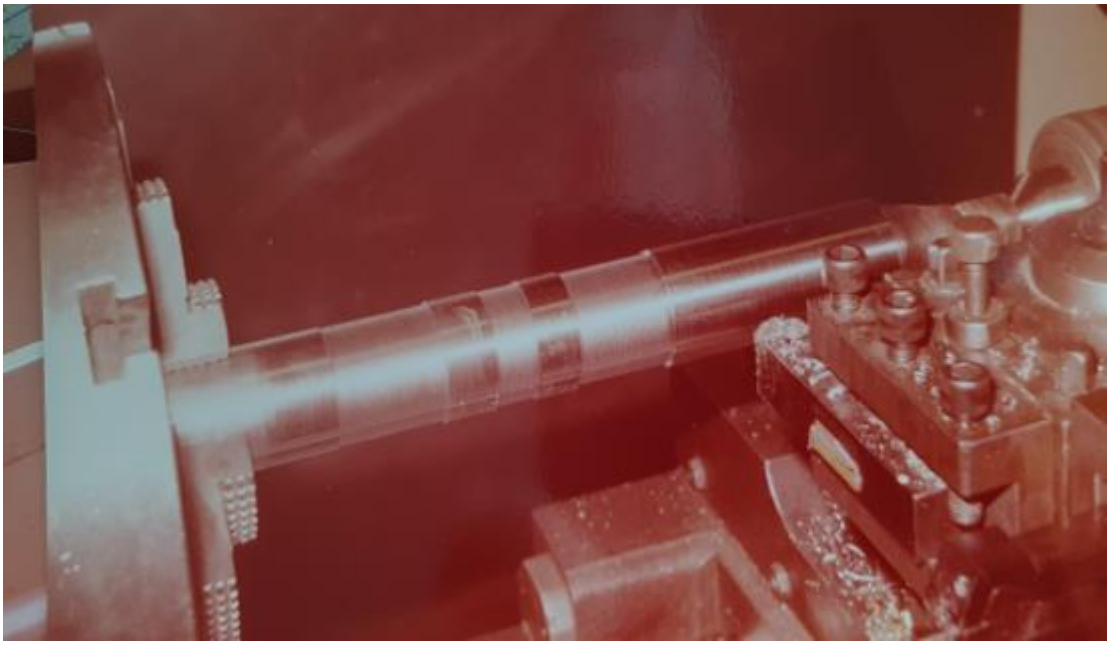
The process can be applied with equal success to all metals commonly found on board, such as steels, copper alloys, and aluminium alloys. The depositing is done at low temperatures, from 50 to 250°C (122 to 482°F) This prevents any distortion or deformation in the parts structure. The deposit obtained is dense and easily machinable. The process is easily learned and requires no expert welding technic or skills.

Cold spraying step by step:

Clean and degrease the whole part if a smaller item. If a large item, clean the area to be coated and the area immediately adjacent to it. Place the shaft in the late and undercut to the extent of the wear, but at least to 0,5mm (1/64”) That will be same as 1mm (3/64”) on the diameter. The worn section should be machined to obtain a 45° chamfer. Note that the coating dos not contribute to any significant strength to rebuild the part. Therefore, take care that the part is not undercut down to the point where the reminding diameter will no longer contribute to sufficient strength when put back into service. Undercut should extend at least 6-12mm (15/64-15/32”) beyond both ends of the worn area.

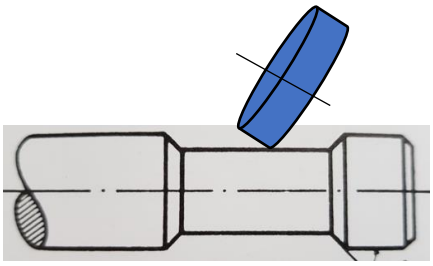




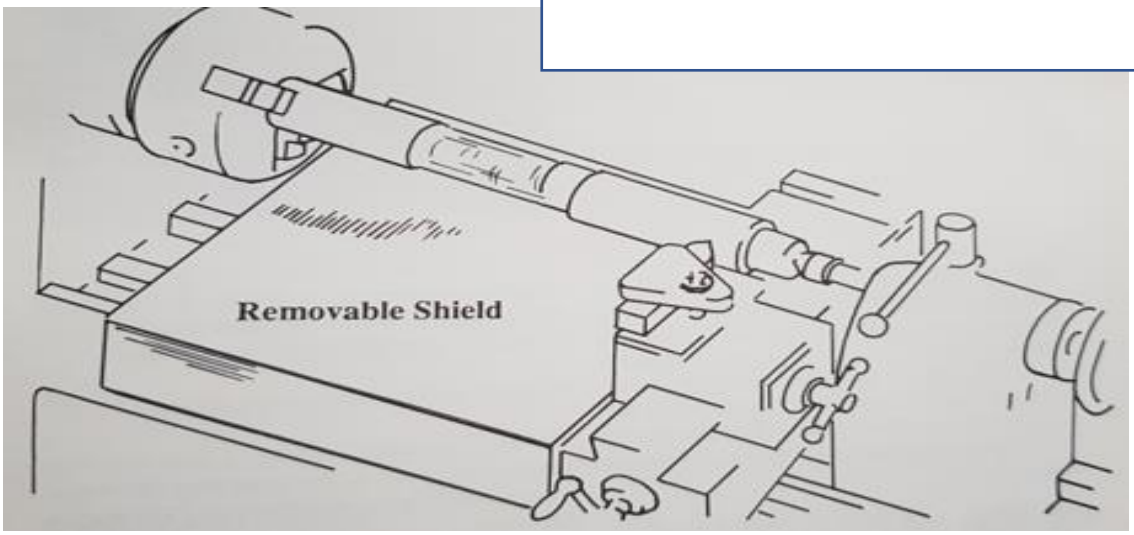


Under no circumstances should the preheat temperature exceed 90°C (194°F). Preheat with a neutral flame wile the workpiece is rotating in the lathe.
To make sure that no condensation may form on the workpiece it should be heated to slightly above ambient temperature. This must be done before roughening the surface to make sure that any oxides form by pre heating are removed from the prepared area by the subsequent grinding. Preheating to 50- 60°C (122 - 140°F) is sufficient.

To obtain a good surface for the spraying operation the machined area must be roughened. For this operation an angle grinder with a coarse, clean carborondum grinding disc should be used. Make sure to grind also the corners and the 45° shoulders at each end of the undercut. The finished surface should have a sandpaper appearance. Do not touch the prepared area after grinding.



Cover the lathe bed with a non -flammable material like a sheet steel plate. This will prevent hard powder particles entering into the lathe's bearings and machined surfaces. All other exposed sections should be coated with oil preventing the powder from sticking.

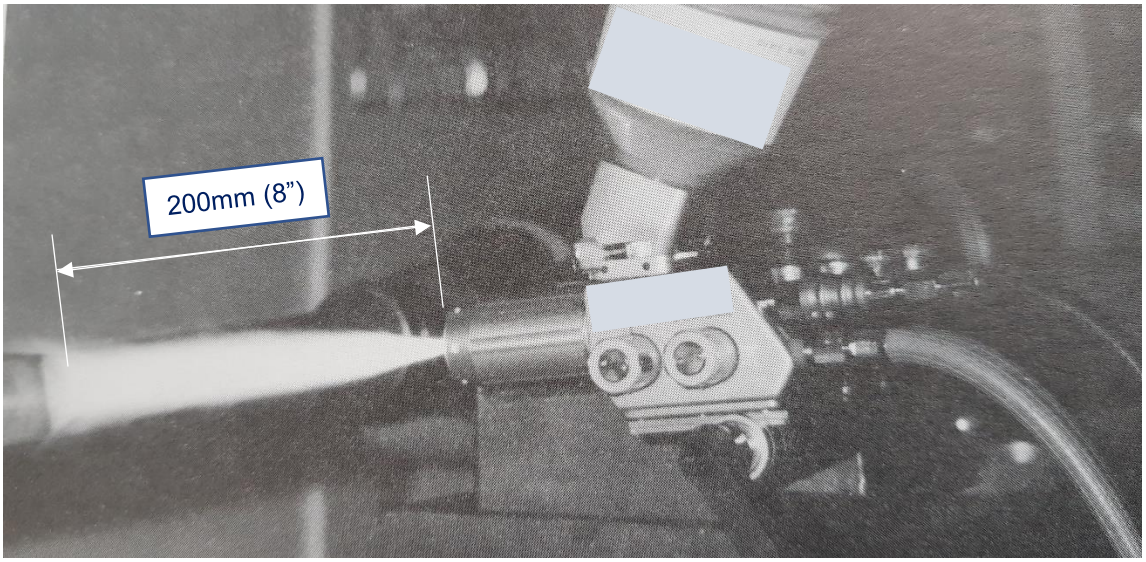


Spraying should be done immediately after the surface has been prepared. It is therefore recommended to:

Prepare the torch:

- Attach the correct powder module (keep powder flow valve closed). Type of powder informed separately.
- Adjust correct gas pressures. The setting depends on type of powder spraying equipment. Normally Oxygen: 2,5-5,5 bar, Acetylene: 0,5-0,6 bar. Some of the torches are also using compressed air to further increase the velocity speed of the powder. Air pressure will if this is the case be 0,5- 0,6 bar. Consult supplier for further information.

1) Set lathe to recommended work speed (surface speed 25-30m/min).
2) When spraying long workpieces, it is recommended to fit the torch to the tool post of the lathe with the toolholder bracket that is normally supplied with the torch. Set the automatic feed to 3-8mm per revolution.



Spraying distance should be approx. 200mm (8”) and the torch should be approx. 90° to the work piece centre line. Manual spraying may take place in a back and forth movement of the torch when the prepared length is less than 100mm (4”). For longer spraying distances it is preferable to make one continues pass from one end to the other, cut the supply of powder, and resume spraying again from the original starting point.

Set a pair of callipers to approximately 1 -3 mm (3/64-1/8”) over the finished diameter of the work piece (depending of workpiece diameter). During spraying it is necessary to ensure that sufficient powder has been deposited on the complete length of the work area. If it after spraying it is discovered that insufficient powder has been sprayed the complete coating must be removed and preparation must be done once again.

Spraying according to the above may now be done continually while the temperature of the workpiece is continuously watched. DO NOT OVERHEAT! Under no circumstances must the temperature exceed 250°C (482°F). For some powders the maximum temperature is down to 100°C (212°F).

Keep temperature input down by shutting of the powder supply and removing the flame from time to time during the process. Allow the workpiece to lose some of its heat rotating in the lathe. Check the temperature and interrupt the spraying for a minute or two if it is to high. Then proceed spraying, using shorter spraying periods and longer cooling periods to keep temperature down.

By adopting this technique, it is fully possible to work below 150- 200°C (302- 392°F) during the whole coating process, with correspondingly better result in the finished part.

When rebuilding is finished and sufficient excess thicknesses checked, close powder feed and gas valves. Allow the workpiece to cool down while turning in the lathe before the machining operation.

Finish machining of cylindrical parts using tungsten carbide tools

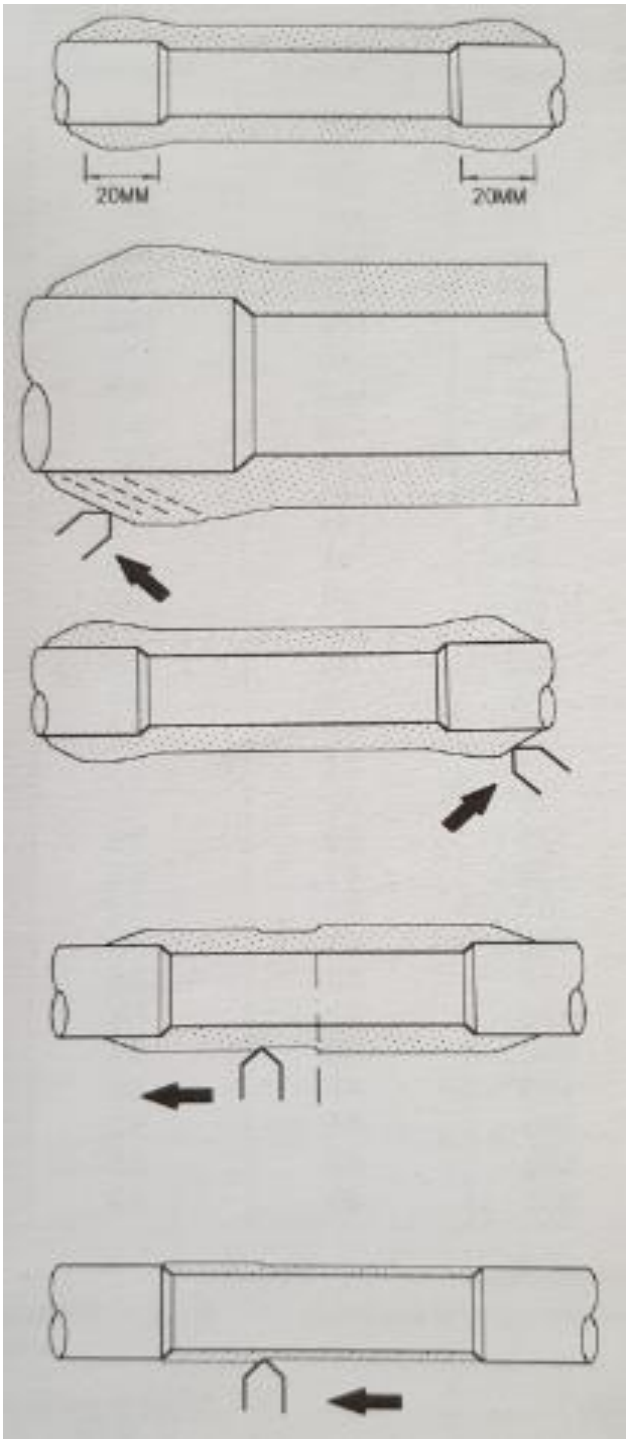
Rebuilt workpiece after spraying and ready for machining.

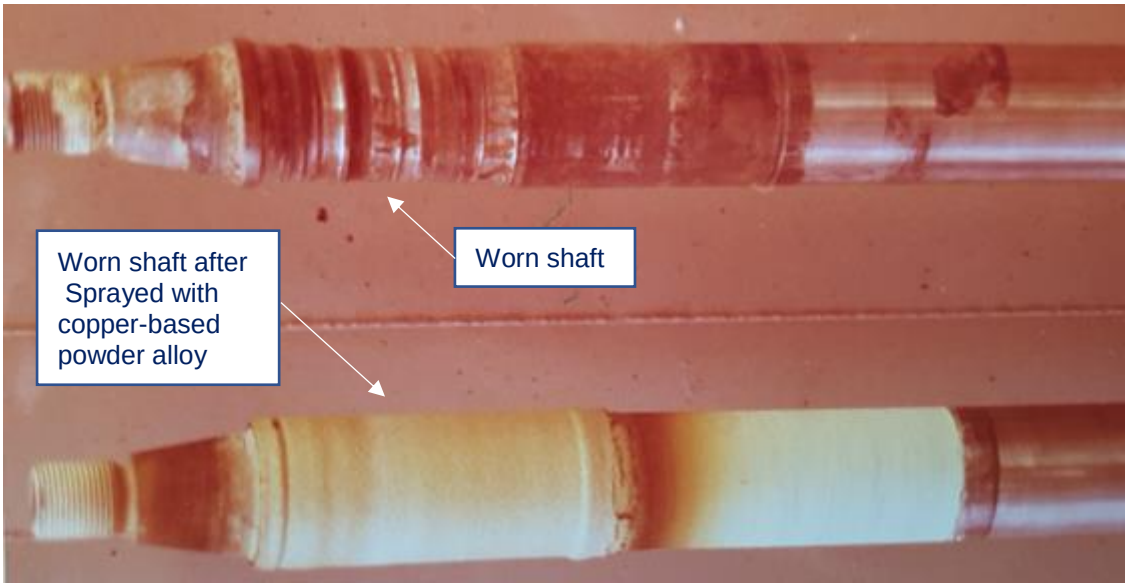
Removal of coating overlaying shoulder. Step -chamfer with 45° cutting tool held at 45° to workpiece and hand -feed as illustrated.

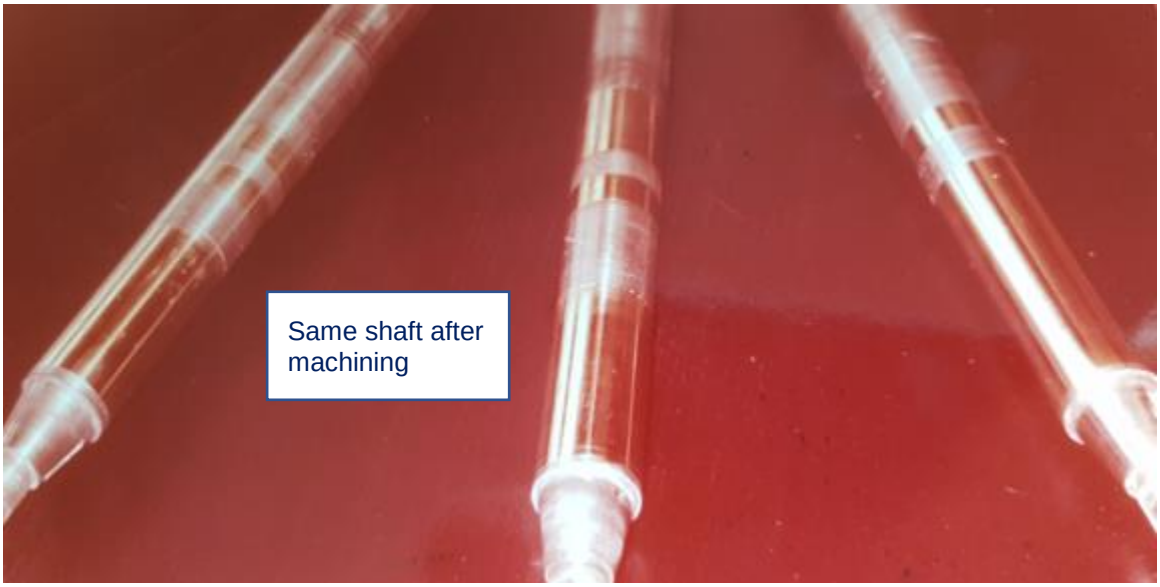
Repeat above step at opposite end.

Remaining high spots should be removed with tool square to workpiece, machining from centre of coating outwards to each end.

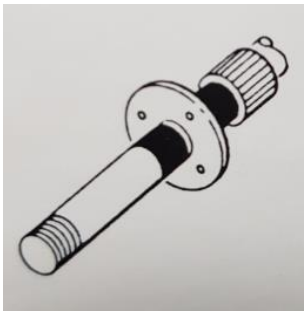
When coating is of uniform thickness, use full traverse and light infeed (max. 0.01mm on radius) to machine coating down to workpiece diameter, taking special care with minimum depth final cut.



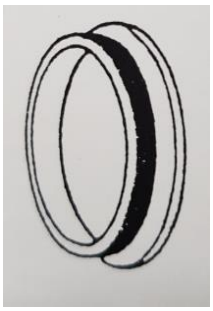

Worn shaft after
Sprayed with
copper-based
powder alloy
Worn shaft


Same shaft after
machining

Application areas onboard:



Gear box shaft

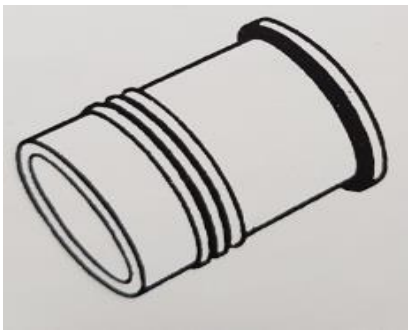


Wear ring

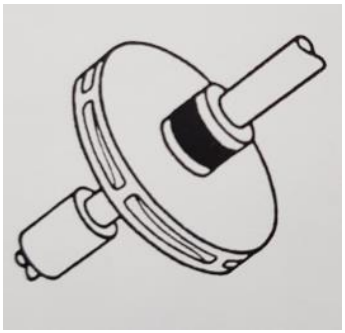
Sealing sleeve

Pump impeller

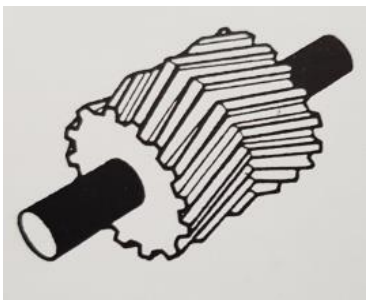
Shaft bearing area



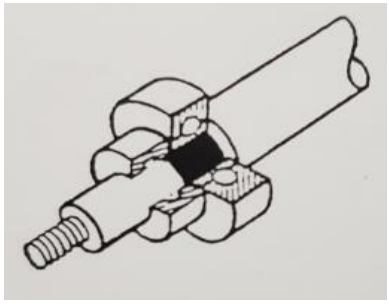
Sleeve



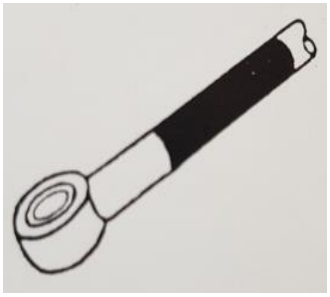
Pump shaft



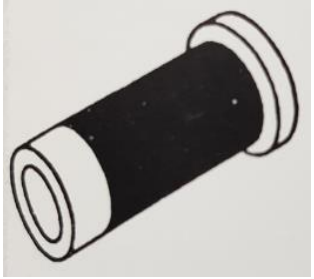
Reducer shaft



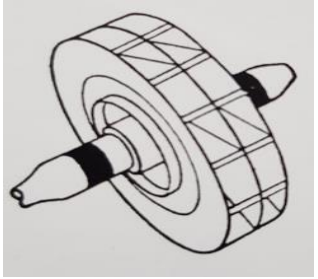
Shaft bearing surface



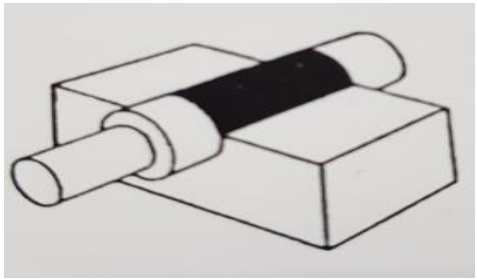
Hydraulic piston



Protecting sleeve



Fan shaft



Bearing wear in general

Flame spraying powders

Manufacturers of Cold spraying powders can deliver them as one step powders that are self-bounding powders that do not require a special bonding powder as a first step.

The two step powders require a bonding layer before the actual powder for rebuilding to required thickness.

For simplicity we do recommend a one step powder for use onboard.

The most common type of powders to choose between are:

Nickel base alloys (Ni 90%, Mo 5%, Al 5%)

This alloy has resistance against corrosion, particle abrasion and erosion. The deposit has very good gliding properties, even where metal to metal gliding occurs under high pressure. The alloy is machinable with all commonly used tools, and a very smooth surface is easily obtainable. Machine deposit with 90° tool bit 5° positive angle

Copper base alloys (Cu 90.2%, Al 9.7, C 0.1%)

This alloy produces a seawater resistant deposit providing low friction under both dry and lubricated conditions. This alloy is especially suited when metal to metal friction occurs as the gliding properties of the deposit prevents shearing between bearing surfaces. This is partly because of micro porosity in the spayed alloy where oil can penetrate and self-lubricate the bearing area when put back in action. Also, excellent where one requires extensive deposit thickness. Deposit of up to 5mm (13/64”) thickness on round parts can be actived. The alloy is machinable with all commonly used tools, and a very smooth surface is easily obtainable. Machine deposit with 90° tool bit 5° positive angle

Nickel, Chrome, Molybdenum Alloys (Ni 70%, Cr 9%, Mo 5%, Al 7%, B 2%, Si 2%, Fe 2%

, TiO2 3%)

This alloy produces as very hard deposit. With normal spraying procedure the hardness will be approximately 300HB. Best result will require grinding when machining to correct size. Recommended maximum layer thickness is approximately 2mm (5/64”) on cylindrical parts. The deposit is corrosion resistant and has excellent bonding and low shrinking factor reducing the danger of cracks considerably.

There are also zinc coat powders and a variety of plastic coat powders in different colours available from manufacturers of cold spraying powders.

Equipment and consumable suppliers:

There are a number of manufacturers/ suppliers of metal spraying equipment and consumables. Below is a list of some of them.

DURA-METAL	IBEDA	CASTOLIN EUTECTIC	METALLISATION UK	OERLICON METCO
Flamejet Powder Flame Spray Gun	Minisprayjet	CastDyn DS8000 kit	MK 74 Power Flame	5P-II Powder spray gun

Additional benefit of Metal Spraying:

No waiting time for spares.
No forwarding expenses.
Short downtime of equipment.
Reconditioning done by ship's crew.
No expenses for shoreside assistance.
Also consider this: The part in need of replacement is no longer available from the supplier. Then what to do?