6. **REPAIR TECHNOLOGY**

INTRODUCTION

Repair technology is a very wide field. This chapter, therefore, presents only selected examples of methods, materials and tools that are unfamiliar or untried by many people and which we believe can contribute to quicker or better repairs.

THERMAL SPRAYING OF METALS

As early as the beginning of the 1920s, people were trying to use metal spraying as an alternative to electrolytic surface coating, welding and shrink-fitting. At that time, insufficient knowledge of the fundamental principles of the method meant that the results were not particularly successful.

However, the technique has been continuously developed and nowadays thermal spraying is an indispensable surface coating method. Today, thermal spraying is no longer an alternative but a developed, self-contained method for renewing worn out or damaged machine components, or, for increasing protection against corrosion, wear and heat, and for conducting electric current or acting as an insulator. Thermal spraying is not a costly method in view of the excellent qualitative and quantitative results obtained.

PRINCIPLE - Briefly metal spraying works like this:
Metal (in wire or powder form) is fed into a spray gun in which a heat source (gas or electric current) melts it. Compressed air atomises the molten metal and directs it on to the workpiece with great force. Extremely small metal particles penetrate all the irregularities of the workpiece and adhere well. Atomic adhesion, a certain amount of diffusion and partial welding are the contributing factors that guarantee reliable adhesion between the spray coating and the workpiece.

METHODS - There are many different methods for thermal spraying on the market. One company (Elektro Metallisering AB) uses the terms FLAME SPRAYING and ARC SPRAYING. The heat source for FLAME SPRAYING is gas. the ejection force is provided by compressed air. This method is also known as gas spraying. In ARC SPRAYING the heat source is electric current. Here too, it is compressed air that directs the molten metal towards the workpiece. This method is sometimes referred to as electric spraying. The two methods are regarded as complementary. The conditions of each individual case determine which method is appropriate.

Another company (Castolin) has developed its own methods, which go by the names EUTALLOY, ROTOTEC, EUTALLOY-RW and ROTO LOY. EUTALLOY is a method for thermal spraying with melting-in. The burner is designed so that the alloy powder is drawn into the gas stream in the burner tube and passes out through the burner nozzle. The feed rate is controlled by means of a lever on the burner handle. Powder application and

melting takes place simultaneously. There are several sizes of burner. The powders are supplied in special plastic containers to be mounted directly on the burner. Eutalloy-Microfloy alloys are considered to have excellent properties, particularly resistance to wear, impact, heat, oxidation and corrosion. They are used both for welding-on new parts and for repairing worn or incorrectly machined parts.

ROTOTEC: Unlike the Eutalloy method, this method does not involve any melting-in of the applied powder. The bond to the base material is mechanical. The powder is applied with a special burner. It uses acetylene/oxygen and does not require compressed air. The temperature of the workpiece does not exceed 250^{o}C. The powders come in special containers for mounting directly on the burner. The powder is fed directly into the flame from outside. Coatings may be applied both to rotating parts and to flat surfaces.

EUTALLOY-RW: The equipment consists of a burner for powder application and a burner for melting-in. Unlike the Eutalloy method, the powder is fed directly into the flame without passing through the burner tube. The powders, which are sprayed on up to a given coating thickness and then melted in with the second burner, come in plastic containers. This method is now covered entirely by the new Roto Loy equipment.

The Roto Loy equipment covers both the Eutolloy-RW and Rototec methods. This means that both cold-sprayed and sintered coatings can be made. The system works on the injector principle for acetylene/oxygen, and the powder feed is controlled via a separate injector system. The fixing device for the powder module is rotatable and can be locked in any position, depending on whether the spraying is to be done horizontally, vertically, upward or downward.

Both rotating components and asymmetrical or flat work pieces can be coated, and the two angle-nozzles (45^{o} and 80^{o}) make it possible to coat workpieces internally. The equipment includes an air cleaner with hose, a melting-in burner for sintered coatings, a heat shield for the equipment, a support bracket and tools for the nozzles.

The Roto Loy equipment uses powder for additional material for melting-in and for "cold spraying" (See Figure 6-1 below).

Figure 6-1: **Thermal Spraying of a roll**

The following are typical examples from industry:-

1. A twin-blade variable-pitch propeller had severe wear on bearing seating on both blades. The bearing seating were to built up to their original dimensions. The bearing seating were arc-sprayed with aluminium bronze. The coating was made two millimeters thick. The work cost about Rs. 1500/-. Two new propeller blades would have cost about Rs. 1,25,000/- .

2. A pulp pump with a complex shape was worn, and was sprayed with acid-resistant steel and molybdenum. The work cost about Rs. 1500/-. To buy a new pump would have cost Rs. 1,20,000/- .

3. A shaft for a large generator with a diameter of 1080 mm was machined to 0.02 mm below the specified dimension. The shaft was rescued from scrapping by arc spraying. The bearing seating was 1 meter long and the shaft weighed 42 tonnes. The work of spraying cost Rs. 9,000/- . A new shaft would have cost Rs. 3,75,000/- and the delivery period for a new blank was about 1 year. The shaft was still perfectly working after 6 years' service.

BRUSH PLATING

Brush plating is an electrolytic method for metallising without dipping the component in a bath of electrolyte. Instead, the electrolyte is applied by "brushing" over the surface to be plated an anode wrapped in cotton wool and dipped in the electrolyte. The method is relatively quick and simple. No extensive masking is needed. Often the method can be used directly in-situ in the machine; this may save dismantling costs. It is frequently possible to plate directly to the tolerance dimension without subsequent machining.

The method of brush plating has long been known in the surface treatment sector. The electrolyte method was first used to touch up incomplete plating after electrolytic treatment in a bath. In the early 1950s electrolytes were produced with such a high deposition rate that the brush plating technique became a practical possibility (See Figure 6-2 below).

Figure 6-2: Brush Plating

The equipment is fairly easy to transport and consists of

- a special rectifier, 0-50 V, 30-1000 A
- working tools: anodes with holder
- pretreatment electrolytes
- metal electrolytes
- various accessories

Since the equipment is easy to transport, repairs and surface treatment can be done on site, avoiding time consuming and costly transport of the equipment to be treated.

Specially designed rectifiers are used for power supply. The working tools consist of graphite anodes of various shapes and sizes with holders. There must be one anode for each electrolyte; they are wrapped in an absorbent material such as cotton wool or polypropylene wool and tubular gauze sheath. The workpiece is connected to the negative pole of the rectifier and the anode holder to the positive pole. (With reversed polarity it is possible to etch, i.e. to remove metal by the same technique as for plating.)

By relatively simple masking, the surfaces adjacent to the surface to be treated are covered. Ordinary electrical tape or protective tape may be used, covering a few centimeters on all sides of the area to be plated. On plating, the anode is dipped in the electrolyte or the electrolyte is pumped to the anode, which "brushed" over the surface. The contact between the anode and the workpiece closes an electric circuit, and metal ions are deposited from the electrolyte on the surface with which the anode is in contact. No pressure or heat is required. Brush plating is possible on most electrically conducting materials, including chromium, aluminium and cast iron.

The adhesion of brush-plated coatings is good, 200-400N/mm^2, which is equivalent to hard-chromed coatings, and is sufficient to enable the plating to be turned, ground, milled and polished.

The deposition rate is 5-50 times faster for brush plating than for bath electroplating. This is due, among other things, to the very much higher metal concentration in brush plating and the fact that the voltage and current for deposition are higher for brush plating.

The Table 6-1 gives an idea of the usefulness of the brush-plating method.

THE METALOCK METHOD

With the metalock method, repairs can be made without heating. By drilling out a pattern to fit a specially designed locking piece (the Metalock), a very strong repair can be made to cracked machine foundations, gear casings etc.

The principle is illustrated in the diagram Figure-6-3 below, which is supplied by Granges Metalock, Sweden.

Field of application	Metallic electrolyte	Deposition rate s/ m	max thickness in mm	Hardness H_v 0.2 kg
The repair of tools and machine parts with, e.g.: - tolerance faults - wear - scoring - corrosion - impact damage, etc.	Cobalt Semi Bright Copper Alkaline Heavy Build Copper High Speed Acid Nickel High Speed Tungsten 'D' Nickel Extra Heavy Build	13 5 0.5 5 24 4	0.15 0.5 more than 1 0.5 0.1 more than 1	600 250 300 610 700 460
As wear protection	Cobalt Tungsten Nickel Tungsten 'D'	16 24	0.025 0.1	750-800 700
As corrosion protection	Gold Cadmium LHE Nickel Low Stress Tin/Indium 70/30 Zinc Alkaline	3 2 24 4 5	0.05 more than 1 0.125 more than 1 0.5	150 40 350 1 70
Noble Metals	Gold 24 carat Hard gold 23.5 carat Palladium Platinum Rhodium Silver Heavy Build	3 3 16 16 24 5	0.05 0.05 0.125 0.0125 0.005 0.5	150 170 150 200 500 60

Table 6-1: FIELDS OF APPLICATION FOR BRUSH PLATING

Figure-6-3: Princple of Metalock Method