

Polishing Up on Finishing: Finishing Jewellery by Machine

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Introduction

The alternative title to this paper is “How to stay competitive through optimised surface finishing”. I am going to discuss modern mass finishing for the polishing of jewellery such as that produced by lost wax casting.

Modern machine-based finishing technology has been used by the engineering industry for decades. Its primary use is to deburr, descale, grind and polish work pieces by using a surface abrasive or polishing agent. Single barrel tumblers with hexagonal drums, vibrators and disc finishing machines have traditionally been used. As a result of abrasive friction between the media and work pieces, the surfaces and edges of the work pieces become processed. These machines were frequently found in the metalworking industries but only to a limited extent in the watch and jewellery industries.

Progress in recent years has provided new opportunities for a more efficient means of surface treatment using machines. The many advantages of using machines have helped revitalise the jewellery and watch industries. Machine polishing is increasingly replacing manual polishing. Today, increasing competitive pressure and market globalisation demand continued advances in finishing technology to produce a high quality polish reliably, consistently and cost-effectively.

There are now many polishing techniques and machines on the market that can provide quality polishing of your jewellery but only if used properly. There is no use in buying a machine without knowing how to use it and, where problems arise, without access to any technical support. That is where a good finishing machine company can help you.

Before discussing the different types of finishing machine, let us look at some of the important points involved in polishing.

Reflection of light from a surface

What is a polished surface? We may recall from our school lessons that when an incident beam of light strikes a surface, it is reflected at the same angle to that surface as the angle that the original incident beam makes to that surface. The light from the sun hits a surface in parallel beams, Figure 1. If it is flat and polished, that light is reflected in parallel beams and we see a polished surface, Figure 1a. However, if the surface is uneven – bumpy and scratched, then the parallel beams of incident light are reflected at different angles, Figure 1b, and only some reflected beams reach our eyes. We see it as a rough, unpolished surface.

Machine polishing using abrasive media

Abrasive media cut the surface and hence remove material in order to flatten and polish it. Removal of material just to flatten it is known as grinding and usually involves use of relatively coarse abrasive, often done wet. Polishing utilises finer, softer abrasives and may be done dry. There are many types of media and a variety of shapes and sizes. Common shapes of ceramic and plastic abrasive media are pyramid and cones. What is the difference?

A pyramid shape has a tendency to slide over the jewellery surface whereas a cone tends to roll over it. The sharp edges of the pyramid result in a higher pressure of these edges on the surface compared to that of the cone where the load is more widely distributed. Hence the pyramid will cut – or grind – more strongly than the cone and leave

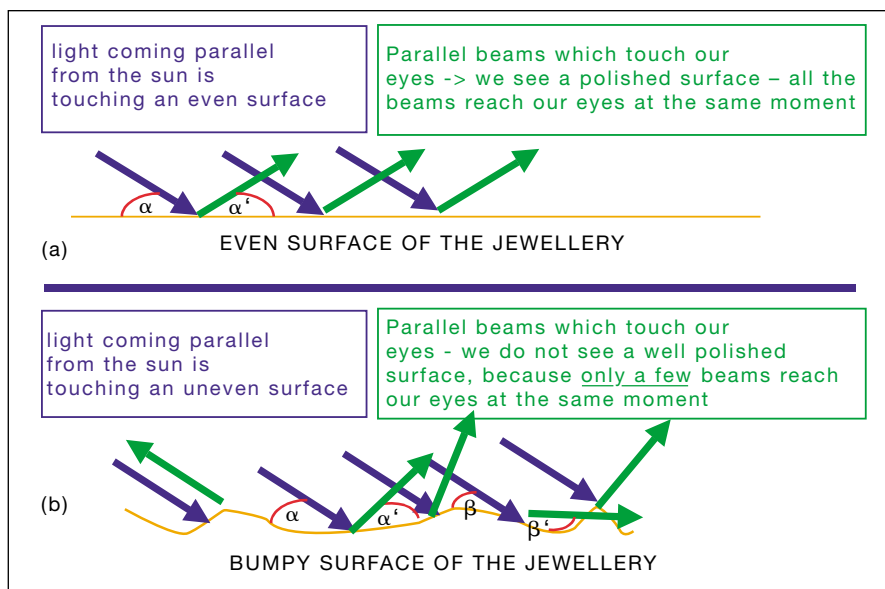


Figure 1 - Reflection of light from a surface (a) polished flat surface (b) unpolished surface

deeper grooves or scratches. With soft, large grained (or crystal) metals, the pyramid will tend to exaggerate the 'orange peel' effect that can develop on the surface. Cones, on the other hand, can work better on concave surfaces such as the inside of rings.

The shape of the surface being polished can influence the process. On a convex surface, Figure 2a, the media can flow with a high pressure on the surface, whereas on flat surfaces, Figure 2b, the pressure is less.

The media size is important. Smaller media can follow the more detailed finer contours of the surface, whereas large media will tend to flatten out the surface, losing detail, Figure 3. Small media also create more points of contact with the surface than large media but, because they are lighter, they do not cut so deeply and the depth of the scratches is less.

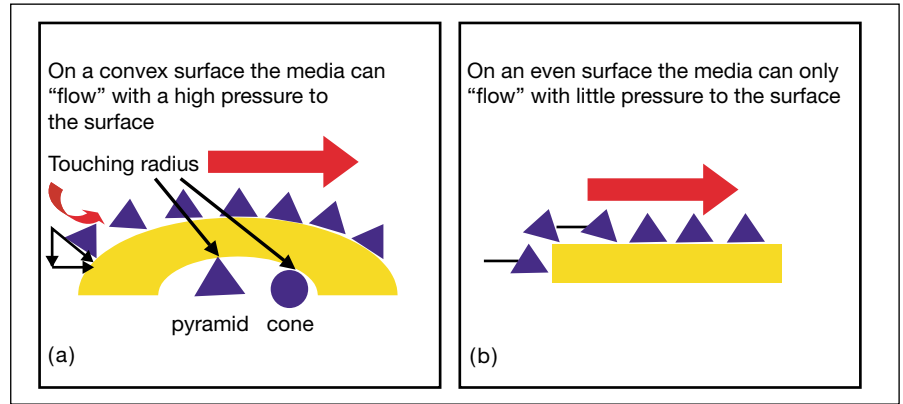


Figure 2 - Flow of media over the jewellery surface during finishing (a) convex surface (b) flat surface

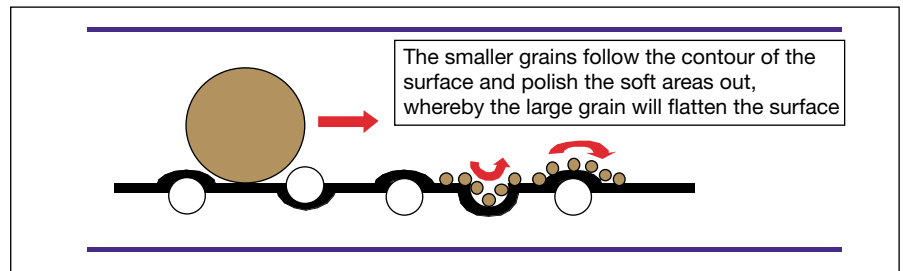


Figure 3 - Influence of media size on polishing (schematic)

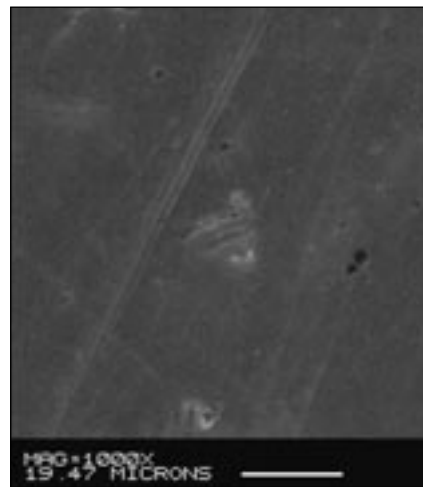


Figure 4 - Scanning electron micrograph of the surface during polishing showing marks left by media. Mag:1000 x

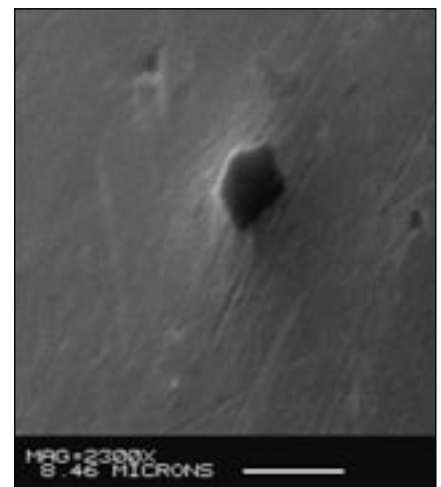


Figure 5 - Scanning electron micrograph of surface during polishing showing fragment of media embedded in surface. Mag: 2,300x

Figure 4 shows a high magnification view of a surface after polishing with abrasive media, taken in a scanning electron microscope (SEM). The scratches and marks left by the media can be readily seen. Sometimes, fragments of the media are hammered into micropores in the surface by the other media (chips). Figure 5 is taken in the SEM at even higher magnification. This is shown

schematically in Figure 6. These embedded fragments can be ripped out subsequently to leave small holes that eventually leaves an uneven surface, similar to 'orange peel'.

The grade of media selected will influence the finish obtained on the surface. Finer media will polish to a smoother surface. This is illustrated in Figure 7, which shows the surfaces of two rings, each polished with a

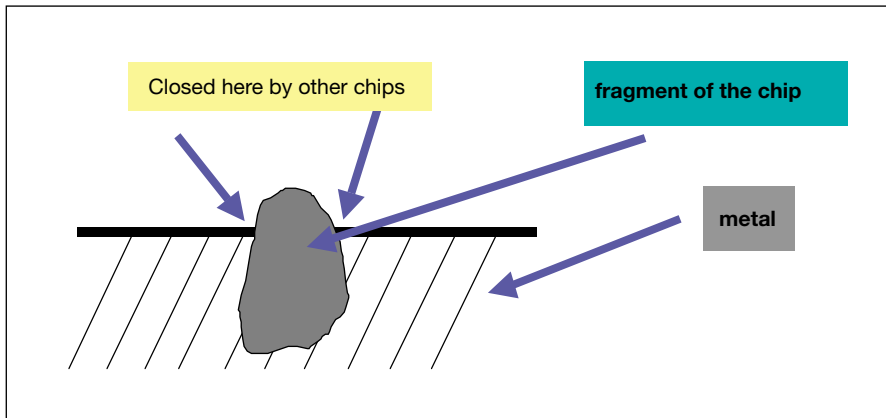


Figure 6 - Schematic: cross-section showing embedded media fragment

different grade of media for 5 hours.

Another aspect to be considered is the effect of the media on gem stones, if polishing gem-set jewellery, for example castings made with stones-in-place. In Figure 8, the effect of the polishing media grade and shape on gemstone damage is demonstrated. Figure 8a shows a Zircon stone after polishing 4.5 hours in a mixture of pyramids and cones with a fine grade of media in which surface damage is evident. Edge damage is seen, Figure 8b, when a coarser grade of cones is used, but use of cones of the finer grade results in virtually no damage, Figure 8c.

For final polishing to a high gloss, very fine abrasive compounds are often used in conjunction with soft media such as walnut shell and corn husk granules (grains).

Machine polishing using burnishing media

Use of steel or porcelain media can also give a polishing action through hammering of the surface. The high density and weight of the media impacts the surface, and mechanically smooths the surface by flow of the metal, Figure 9. The surface of the jewellery is also work hardened and some oxidation may occur. The surface will show a hammered effect if examined closely and it is not always possible to get a good polish, even if hand polishing afterwards. Burnishing is done wet.

Types of finishing machines

There are several types of machines on the market, some of which can be used for both grinding and polishing with abrasive media and for

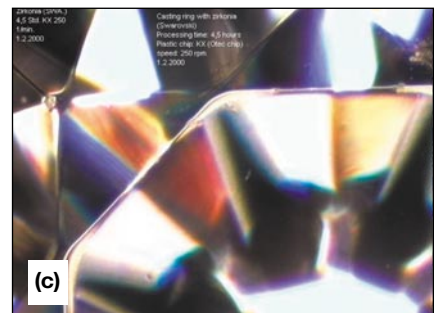
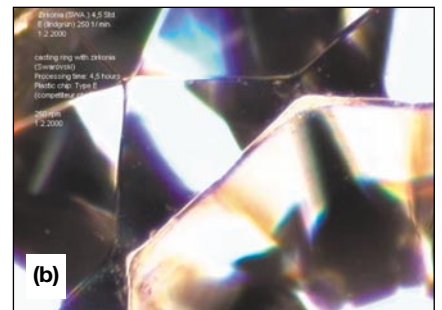
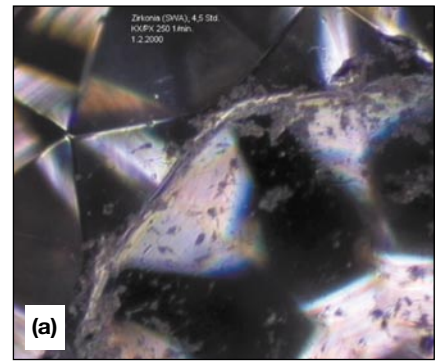


Figure 8 - Effect of abrasive media on Zircon gem stone damage after 4.5 hours processing (a) Surface damage from use of a mixture of pyramid and cone shaped plastic media (white grade) (b) Edge damage from use of green grade 'E' plastic cones (c) Lack of damage from use of white grade 'X' plastic cones

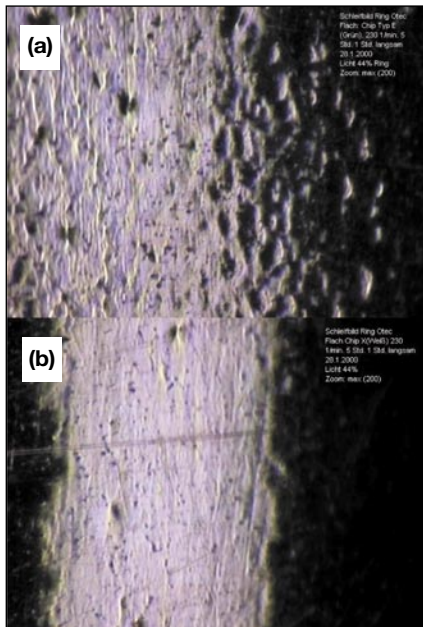


Figure 7 - Effect of media grade on quality of polished surface of silver rings after 5 hours

(a) Green grade 'E' chips: Surface still too bumpy and scratched, poor polished appearance. 200x. (b) White grade 'X' chips: Finer abrasive results in smoother surface and good polished appearance. 200x

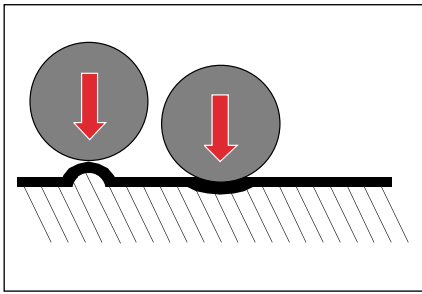


Figure 9 - Schematic: polishing by burnishing. Steel balls hammer surface flat

burnishing. Table 1 lists the various machine types with their attributes and comments on their applications. As can be seen, some types of machine are quite versatile whilst others have some limitations. For example, the magnetic needle polisher can only polish by burnishing, using steel media in the form of pins or needles. Figures 10 and 11 show typical Disc-finishing and Drag-finishing machines.

The mode of action for 3 of the commonly used types is shown in Figure 12. An advantage of the disc finishing machine is that the water is continually recirculated and this flushes out any debris or dirt that might otherwise cause damage during polishing. The different pressures and polishing actions influences the polishing and this can be seen in the nature of the scratches and marks they impart to the jewellery surface, Figure 13.

Disc-finishing machine

Recent developments in machine design with microgap, Figure 10,

Table 1. Types of Finishing machines and their attributes

Machine type	Grinding media	Polishing media	Advantages	Disadvantages	Work pieces
Single Barrel Tumbler	<ul style="list-style-type: none"> • Ceramic • Plastic 	<ul style="list-style-type: none"> • Wood • Walnut shell • Corn 	<ul style="list-style-type: none"> • Inexpensive 	<ul style="list-style-type: none"> • Long process time • Impact marks • Uncomfortable handling • Dirt in surface • Surface compression 	<ul style="list-style-type: none"> • All kinds of jewellery
Vibrator	<ul style="list-style-type: none"> • Ceramic • Plastic 	<ul style="list-style-type: none"> • Wood • Walnut shell • Corn • Porcelain • Steel balls 	<ul style="list-style-type: none"> • Inexpensive • Heavy pieces • Stamped pieces 	<ul style="list-style-type: none"> • Long process time • Low force on piece • Impact marks • Low smoothing effect • Dry processing not satisfactory 	<ul style="list-style-type: none"> • Small chains • Machine made chains
Centrifugal Tumbler	<ul style="list-style-type: none"> • Ceramic • Plastic 	<ul style="list-style-type: none"> • Wood • Walnut shell • Corn 	<ul style="list-style-type: none"> • Very aggressive • Short process time 	<ul style="list-style-type: none"> • Impact marks • Uncomfortable handling • Dirt in surface • Surface compression 	<ul style="list-style-type: none"> • All kinds of jewellery, but not too heavy
Disc Finisher	<ul style="list-style-type: none"> • Ceramic • Plastic 	<ul style="list-style-type: none"> • Walnut shell • Plastic • Porcelain 	<ul style="list-style-type: none"> • Very efficient • Short process time • 70% done by machine • Few working steps • Clean jewellery • Easy handling • Top quality surface 	<ul style="list-style-type: none"> • No heavy pieces (20 grammes max.) • No necklaces • No small chains 	<ul style="list-style-type: none"> • Most jewellery (few exceptions) • Watch cases • Industrial products
Magnetic Polisher	–	<ul style="list-style-type: none"> • Steel needles/pins 	<ul style="list-style-type: none"> • Shining surface • Short process time 	<ul style="list-style-type: none"> • Does not smooth • Impact marks • Pins can get stuck in piece • No high polish 	<ul style="list-style-type: none"> • Filigree jewellery • Inside of jewellery
Drag Finisher	<ul style="list-style-type: none"> • Walnut shell 	<ul style="list-style-type: none"> • Walnut shell 	<ul style="list-style-type: none"> • Can polish large & heavy pieces • No impact damage • Short process time • Easy handling • Top quality surface 	<ul style="list-style-type: none"> • No wet grinding or polishing 	<ul style="list-style-type: none"> • All kinds of jewellery, provided they can be fixed on racks



Figure 10 - Disc finishing machines



Figure 11 - Drag finishing machine (jewellery holder raised from container)

enable high gloss polishing, comparable to hand polishing, to be achieved by this technique. The disk-finisher (or centrifugal disc machine) comprises an open container with a rotating base. The walls of the container remain static in operation. When the media and jewellery are placed in the container, the movement of the rotating base creates a toroidal motion and enables grinding or polishing to occur.

Until recently, the gap between the rotating base and container in most machines was about 0.25-0.5 mm wide. This restricted processing of thin pieces and use of fine media particles. New, patented technology allows a much narrower gap of 0.05mm and enables use of very fine media such as walnut shell of small particle size without it falling into the gap. This in turn means a higher gloss can be achieved. Hard ceramic rings, which have high wear resistance, are used as the seals at the gap, conferring increased service life.

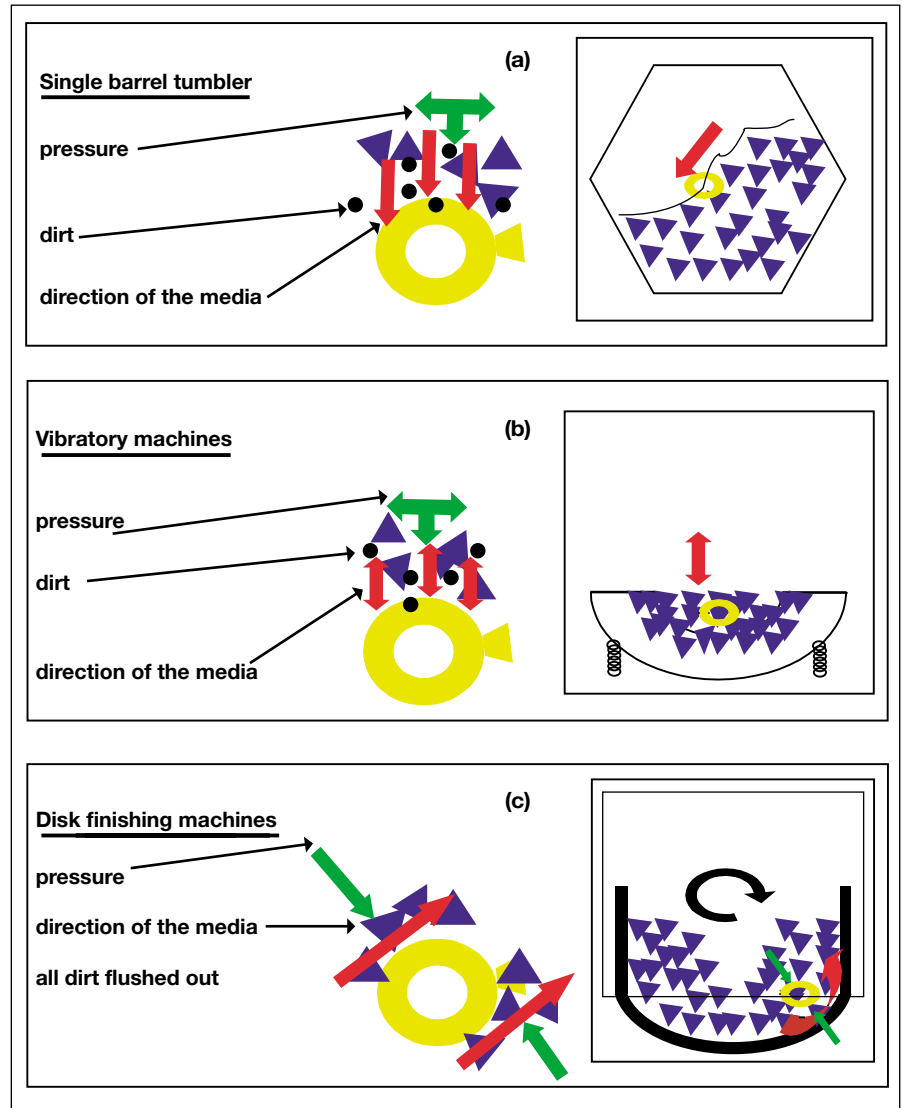


Figure 12 - Schematic: Polishing action of (a) Single barrel tumbler (b) Vibratory machine (c) Disc finishing machine

Drag-finishing machine

The introduction of drag finishing, Figure 11, was another important development; it is very different from the other finishing techniques. The work pieces are literally dragged through the media. Each piece to be polished is placed in a special holder on a rack so that it cannot come into contact with other pieces and get damaged. The work pieces are immersed in and dragged through the media, typically walnut shell. This produces high relative movement and hence more intensive processing, so reducing process times considerably.

This technique is especially advantageous for heavy items, which previously could only be machine

polished to a limited extent. Now they can be polished to a high gloss. The technique also allows polishing of internal surfaces and so it is particularly useful for rings and cuff-links as well as watch cases and other heavy items, provided they can be suspended or fixed in the holders.

Finishing of jewellery

For rough grinding of gold jewellery, ceramic abrasives in water, often with added compounds, can be used. The compound (1-3%)-water mixture helps with degreasing, and inhibiting corrosion as well as ensuring removal of abraded material from the surface.

For less intensive grinding and pre-polishing, plastic media are used, again in water. Plastic media tend to have a medium to fine abrasive effect and are used frequently for grinding and pre-polishing cast gold jewellery. The most commonly used plastic media are in the form of pyramids and cones, often as a 50/50 mixture. For grinding, typically one would start with the Otec red grade of cones and pyramids, grinding for 2-4 hours in a disc-finisher, followed by the white grade for 1-2 hours to get a finer surface. To get an even finer surface, a further stage of dry grinding is done for about 2 hours using coarse walnut shell granules with added fine abrasive powders. The jewellery and the container must be carefully cleaned between each stage to prevent carry-over of debris and coarser media particles. It helps the process if the rotational speed is reduced towards the end of each cycle. This can be done automatically on the Otec machines.

If a higher polish is required, then additional stages of dry or wet polishing can be done. For dry polishing, fine grained walnut shell granules are preferred. The amount of jewellery in the machine is reduced to minimise impact damage. Typical polishing time is 1-3 hours. For wet polishing, burnishing with porcelain balls or steel media is carried out. This can give a gloss finish, but close examination reveals a textured surface from the hammering action. This is typical of magnetic polishers using steel needles.

Optimised finishing by machine

A finishing machine achieves the best

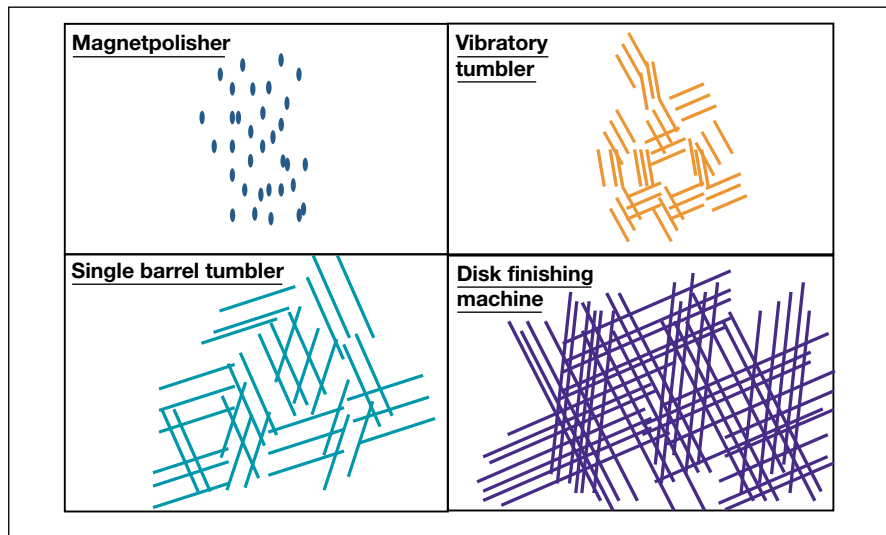


Figure 13 - Schematic: The nature of the marks and scratches imparted by various finishing techniques.

results if the jewellery design incorporates the following features:

- No flat surfaces
- No sharp edges
- No sharp corners
- Convex shapes are preferable

In reality, jewellery design is dictated by other considerations and often calls for sharp edges, flat surfaces, etc

Potential problems in finishing by machine that affect quality are:-

(a) Grinding

- Mixing of different media grades
- Too much or too little added compound
- Too much jewellery in the container
- Wrong processing speed
- Too short a processing time

(b) Dry polishing

- Too little or too much polishing paste
- Use of old polishing granules
- Processing speed too high (impact damage)
- Too much jewellery in the container
- Mix of big and small jewellery in container (similar size and shape preferable)

Concluding comments

The modern machine technologies are very effective in producing a high gloss finish to gold jewellery that is comparable to and more consistent than hand polishing. Requirements for obtaining a good polish include:

- Suitable finishing machine with

high specification (e.g. microgap on disc finishers)

- Optimal processing technology
- Suitable design of jewellery
- High quality of jewellery for finishing with no defects
- Machine operator skills

These require good technical support from a reliable finishing machine company. A good machine producer can help you optimise your finishing procedures for your range of jewellery and recommend the correct finishing machine for your production.

Editor's Comment: I recommend readers requiring more detailed information to 'The Handbook on Finishing', which is published by World Gold Council. It is a unique reference book on finishing technology that covers both basic principles, best practice and equipment choice. Details of this handbook were published in *Gold Technology*, No 25, April 1999. It may be purchased from World Gold Council, International Technology, 45 Pall Mall, London SW1Y 5JG, England. Fax: +44 20 7839 6561.