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BALLIZING – THE LATEST TECHNOLOGY IN HOLE FINISHING

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Abstract:- *The ballizing process consists of forcing an oversized ball of a hard material through a premachined hole in softer material.The interference between the ball and the hole causes the holeto expand such that its deformation is partly plastic and partly elastic. The elastic deformation of the hole is recovered due to elastic spring back whereas the plastic deformation results in a slight permanent increase in the hole diameter after ballizing. Ball burnishing or ballizing is a production process for improve the accuracy, surface finish, roundness, hardness and fatigue life of holes. This process is a mass production process for sizing and finishing holes. The sizing and finishing of holes depends upon the interference adopted for ballizing process.*

KeyWords: **Machining, Ballizing, Precision grinding, Aluminium oxide, Deburring.**

1. Introduction

One of the most difficult production machining problems which manufacturers face today involve machining of holes, particularly where precision, size roundness and finish is important. Because once the hole of larger diameter is made one cannot make it of smaller diameter. Cost of producing a surface increases as its quality i.e. as value of surface roughness decreases.

A large portion of holes require finishing after drilling, EDM or laser cutting. Size must be improved, surfaces smoothed, residual stresses eliminated, burrs removed, taper eliminated and special edge configurations produced. As a result, parts manufacturers perform secondary finishing operations such as boring, grinding, honing and abrasive flow machining to finish holes. Most of these finishing processes, however, require special equipment, some of which is relatively expensive and time consuming [1].

- The selection of the method by which a hole is to be finished will depend on a large number of variables ranging from the physical limitations imposed by the material and duties to be imposed on the surface, to the commercial consideration of output

2. Traditional Hole Finishing Methods

Some traditional methods which are used now-a-days for hole finishing are:-

1) Precision grinding
2) Honing
3) Super finishing
4) Diamond Turning and boring

2.1 Precision Grinding

Precision grinding is generally method of finishing steel. It uses abrasives, which are firmly attached to a rigid backing, such as a wheel. This method is used prior to polishing to remove large surface imperfections and is often the first operation in a finishing sequence.

Progressive grinding employs a series of wheels with decreasing grit sizes. It produces components with tolerances of between 0.005 mm of 0.025 mm and finishes in a range 0.2 to 0.3µm. But grinding requires a high degree of skill to repeat continuously a restricted grade of surface finish [4].

2.2 Honing

Honing after turning, boring, reaming or grinding can produce a surface finish of 2 to 4 micro inches Ra. Honing uses an aluminum oxide or silicon carbide abrasive and produces straight and round bores by correcting taper, out-of-roundness, or spirals produced by previous machining. Honing tool is given a slow reciprocating motion as it rotates having reciprocating motion. Honing also provides an accurate control of size.

Any metal can be honed including steels and carbides as well as non-metallic materials such as glass or ceramic. The hardness of the material does not limit the honing process; it only affects the rate at which stock can be removed. Honing produces a characteristic crosshatched finish, resulting in a stress-free surface, which improves sealing ability. The quality of the finish depends on the hardness of the material being machined, abrasion, speed, and, in some cases, the coolant. This process is used primarily to remove the grinding or tool marks left on surface by previous operation. Honing is a grinding process in it very little material is removed. Parts honed for finish remove only 0.0250 mm or less [4].

2.3 Super Finishing

Super finishing is an abrasion process for refining the outside diameter of cylindrical parts. It is similar in action and effect to honing, but it works on the outside diameter of a cylinder only. A very small amount of stock is removed, averaging from 0l.0001 to 0.0002 inch (0.003 to 0.005 mm) in diameter. Super finishing can produce surface finishes of 2 micro inches Ra, free from scratches exhibiting directional effect or pattern. Super finishing is often faster and more economical than other finishing methods that produce rougher finishes [4].

2.4 Diamond Turning and Boring

Light alloy, bronzes and tin alloys, bearing metal being turned using diamond tools with a geometric control of about 0.0125 mm or below and with surface roughness measurement of between 0.075 and 0.125µm. Use of diamond tools are expensive and uncertain because diamond tool is more or less confined to those materials which do not include hard / abrasive particles and which cut clearly with definite chip [4].

3. Concept of Ballizing Process

3.1 Need of Ballizing

Traditional hole finishing methods such; such as grinding, honing, turning, burnishing etc. are seen to be both time consuming and energy consuming when compared to simpler ballizing process.

Ballizing is a method of finishing an internal diameter by forcing a precision ground tungsten carbide ball through a slightly undersized, premachined hole, using a push rod. Ballizing, also known as ball broaching, is one of the simplest methods for improving hole finishes while also providing more consistent hole sizes. To finish holes, the user takes a hardened metal ball slightly larger than the existing drilled hole and forces it through the hole using a lubricant brushed in the hole to reduce friction, such as vitriol oil treatment. Fig. 3.1 shows the schematic diagram for ballizing process. Ballizing is for rapid finishing of holes, typically under 1" in diameter and more commonly under ¼" in diameter.

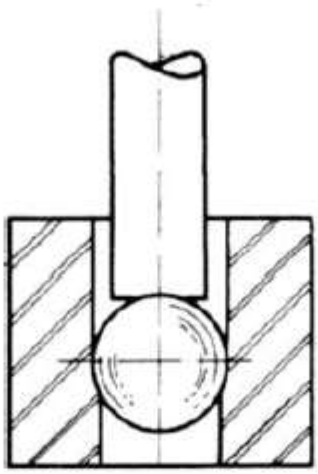

Fig. 3.1: Schematic arrangement of the ballizing process [5].

3.2 Mechanism of Ballizing

To understand ballizing, first look at the simple case of a hardened ball on a flat plate. If the ball is pressed directly into the plate, stresses develop in both objects around the area where they contact. As this normal force increases, both the ball and the plate's surface deform.

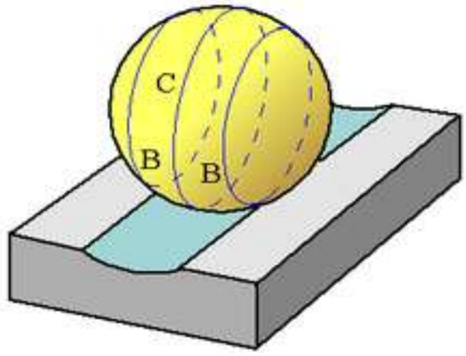

Fig. 3.2: Mechanism of ballizing [8].

The deformation caused by the hardened ball is different depending on the magnitude of the force pressing against it. If the force on it is small, when the force is released both the ball and plate's surface will return to their original, undeformed shape. In this case, the stresses in the plate are always less than the yield strength of the material, so the deformation is purely elastic. Since it was given that the flat plate is softer than the ball, the plate's surface will always deform more.

If a larger force is used, there will also be plastic deformation and the plate's surface will be permanently altered. A bowl-shaped indentation will be left behind, surrounded by a ring of raised material that was displaced by the ball.

Now consider what happens if the external force on the ball drags it across the plate. In this case, the force on the ball can be decomposed into two component forces: one normal to the plate's surface, pressing it in, and the other tangential, dragging it along. As the tangential component is increased, the ball will start to slide along the plate.

4. Applications

In addition to hole sizing and surface improvement, ballizing can also be used for a wide range of other purposes, many of which may be impossible or difficult to achieve by other methods. Example includes: work-hardening of metal close to the surface of the bore and, in case of powder-metal parts, local densification of the material; improvement of surface finish after plating or similar treatment; and finishing holes in such positions that the conventional methods are impractical, either due to tool overhang or inaccessibility [7].

Typical potential applications areas include machine tools and metal forming; aeronautical/aerospace industries;

instrumentation components; nozzles carburetor jets; fluid logic controls, valves etc; automotive industries; business machine components such as typewriters; and camera and optical component [7]. Following are some applications of ballizing process-

5. Advantages and Limitations

5.1 Advantages

- Low initial cost.
- Simple and inexpensive tooling.
- Low maintenance cost.
- Minimum operator training.
- It achieves close tolerance inside diameter.
- Enhances the fatigue life of the component.
- Production advantages.
    - High speed
    - High production rate
    - High accuracy
    - Excellent surface finish
    - Minimum set up time [7].

5.2 Limitations

- The balls of high precision and quality are costly to produce.
- The curved or crooked lengths of bore cannot be straightened.
- Very deep and blind holes are difficult ballize [7].

6. Concluding Remarks

Hole finishing by ballizing produces a hole rounder and closer in concentricity with the original machined hole and with better finish at lower cost. Ballizing is also cheaper than other techniques as there is no need to use and throw away a sleeve every time a hole is cold expanded. Generally, as the interference is increased, the surface quality improved up to an optimum point, after which the surface quality deteriorated. Since the ballizing process is a plastic deformation one, insufficient interference can cause elastic deformation only leading to bad quality for small interference. Large interference can cause distortion of the microprofile and excessive work hardening which leads to poor finish. Also the ballizing process leads to the increase in the hardness of the premachined holes. In addition to hole sizing and surface improvement, ballizing can also be used for a wide range of other purposes, many of which may be impossible or difficult to achieve by other methods.

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