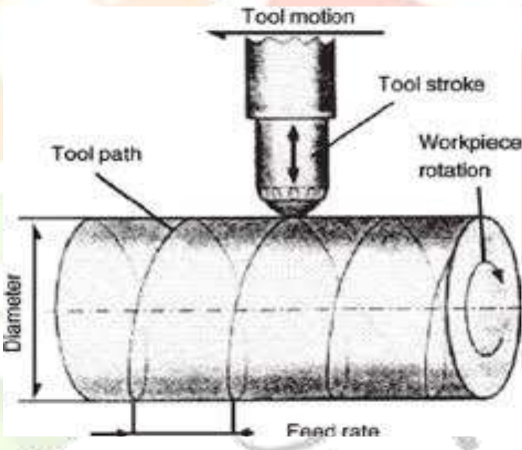
Design and Development of Ball Burnishing Tool

Kaustubh Dave[1], Rahul Panara [2], Parth V. Delvadiya [3]
[1, 2] Students of Department of Mechanical Engineering, V.V.P Engineering College, Rajkot, INDIA
[3] Faculty of Mechanical Engineering, V.V.P Engineering College, Rajkot, INDIA

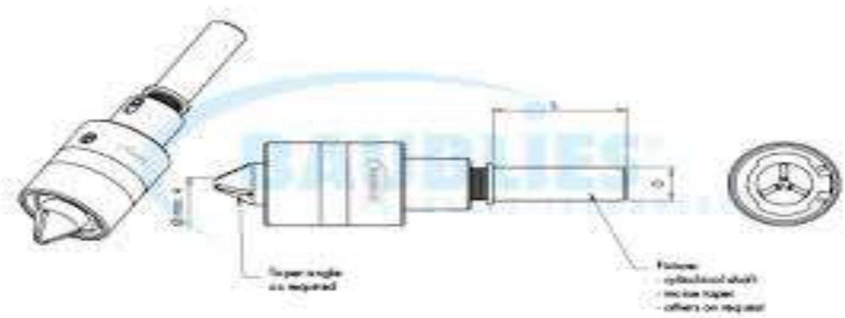
Abstract— Today's metal processing industries are often interested to induce compressive residual stresses in the several components which they will come across in fabrication processes daily. The conventional methods of finishing process viz. grinding, broaching used to improve the surface finish of the metallic components, but the burnishing process which is having same role to play in finishing process has many advantages associated with it fulfilling above said requirement successfully. This paper presents results of the study about design and developmental issues of Ball burnishing tool. This tool is used to perform burnishing process successfully by controlling different parameters. Index Terms— compressive stress; surface finish; ball burnishing tool

I. INTRODUCTION Burnishing is a post finishing operation, in which highly polished ball or roller burnishing tools are pressed against pre-machined surfaces to plastically deform peaks into valleys as shown in fig.1. Today it is becoming more beneficiary process among the conventional finishing operations in metal finishing processes in industries because of its many advantages. Inducing the compressive stresses in metal surface increases many properties associated with metal surface like surface finish, surface hardness, wear resistance, fatigue resistance, yield and tensile strength and corrosion resistance [1].

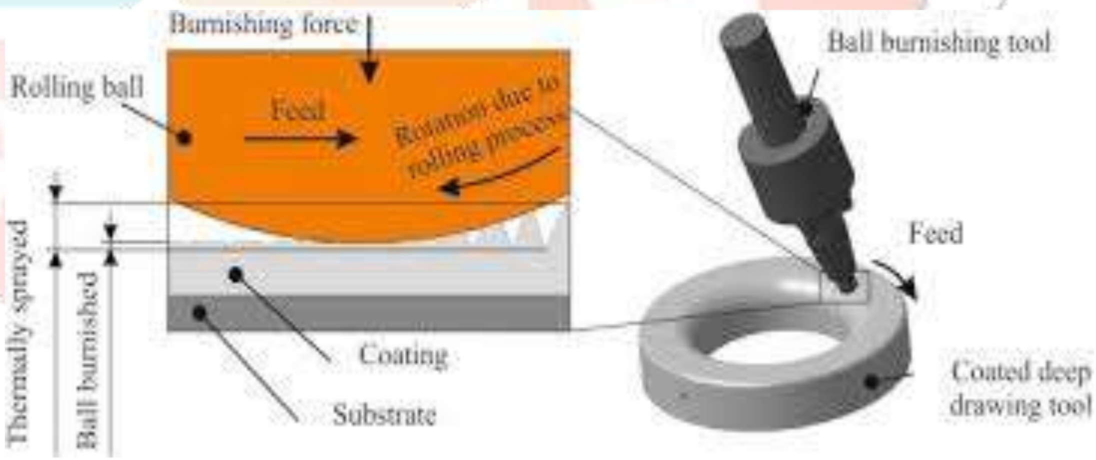


It is observed that the conventional machining methods such as turning and milling leave inherent irregularities on machined surfaces and it becomes necessary to very often resort to a series of finishing operations with high costs [3]. However, conventional finishing processes like grinding, honing and lapping are traditionally used finishing processes, but these methods essentially depend on chip removal to attain the desired surface finish, these machining chips may cause further surface abrasion and geometrical tolerance problems. Accordingly, burnishing process offers an attractive post-machining alternative due to its chip less and relatively simple operations [5]. Many researchers have done their works by developing different types of burnishing tools i.e. ball and roller burnishing and making them ready to use with conventional machine tools viz. Lathe and milling. A.M. Hassan et al. [1] Developed ball burnishing tool with different ball diameters and examined the effects of parameters on non-ferrous work piece materials like machining brass and Al-Cu alloy. Mieczyslaw Korzynski et al. [2] developed the centre less burnishing device to conduct burnishing process on long length work pieces smoothly. Effect of roller burnishing tool width and burnishing orientation was studied by N.S.M. El-Tayeb et al. [4] to find the effect of different parameters on tribological properties as well as on surface qualities [4]. Sliding contact with rolling contact type burnishing tool is developed and effect of burnishing force is investigated on surface roughness on PDS5 plastic injection mold steel [6].

II. MECHANICS OF BURNISHING [9] Figure 2. A ball plowing a trough through a flat plate To understand burnishing, let us consider the simple case of a hardened ball on a flat plate as shown in fig.2. 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. 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 (un-deformed) 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. If the external force on the ball drags it across the plate, 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. At the same time, the normal force will deform both objects, just as with the static situation. If the normal force is low, the ball will rub against the plate but not permanently alter its surface. The rubbing action will create friction and heat, but it will not leave a mark on the plate. However, as the normal force increases, eventually the stresses in the plate's surface will exceed its yield strength. When this happens the ball will plow through the surface and create a trough behind it. The plowing action of the ball is burnishing. Figure 3. Burnishing between two plates Burnishing also occurs on surfaces that conform to each other, such as between two flat plates.



I. III. DESIGN OF BURNISHING TOOL As it was decided to carry out the ball burnishing process in present work among two process of burnishing, the first and foremost



work is to design and develop the ball burnishing tool by selecting suitable materials, dimensions and proper design such that the process and the tool is simple, cheaper and requires minimum time consumption with minimum cost. The tool developed in this work can be used on convectional machine tools like lathe. Fig.4 shows the tool developed in this work to carry out ball burnishing process with interchangeable roller burnishing tool assembly. This option increases flexibility of the tool and allow us to carry out both the processes. Figure 4. Ball burnishing adapter with roller burnishing interchanging adapter type tool The burnishing tool designed in above said manner consists of parts namely ball holder, square casing, lock pins and threaded lock support and spring. The design of tool is made in consideration with the parameters to be selected and to be controlled in the work. The experimental work is planned to conduct mainly considering four different parameters and burnishing force is one among the parameters. So, the force is measured by means of spring deflections in the tool. The work piece material will be 60/40 Cu-Zn and the maximum force applied on the work piece during experiment is 30kgf.

II. A. Design of spring The spring used in this work is grounded type and commonly used in automobile applications. The design procedure for the spring is as follows; Maximum Burnishing force, F= 294 N Maximum Measurable deflection (d) = 21.38 mm Stiffness of the spring (K) = (F/d) = (294/21.38*10^-3) = 11760 N/m Available spring of stiffness (K1) = 13740 N/m

III. B. Design of ball adapter the ball adapter has made up of EN 8 material and it has sufficient strength to take the loads which are arises in machining of 60/40 Cu-Zn brass. This adapter will be inserted into the square casing and locked by means of the locking pin and simultaneously it is held by means of threaded nut at the end. The ball is with diameter 10 mm and is sufficiently hardened to develop the deformation in the soft material like 60/40 Cu-Zn Brass. The properties of EN-8, ball and 60/40 Cu-Zn are mentioned in Table.1. TABLE 1. PROPERTIES OF MATERIALS Material/ properties Tensile strength, MPa Hardness, BHN Brass rod, IS 319-2007 Gr 406.698 121 Ball (high chrome steel) 2240 710 EN 8 550 220

IV. C. Design of square casing: This is made of mild steel and has dimensions of 150 mm*25mm*25mm. This part holds the tool in the chuck of the lathe.

V. IV. APPLICATION OF BURNISHING TOOLS Burnishing tools are being used in sectors like Automobile, Aircraft, Defence, Spacecraft, Railways, Textile, Machine Tool, Motors and Pump Industry, Hydraulic and Pneumatic Farm Equipment, Home Appliances etc., and areas where close tolerance and superior surface finish is required.

VI. V. CONCLUSIONS The developed ball burnishing tool can be used successfully on 60/40 Cu-Zn Brass to study the effect of different burnishing parameters on the work piece. Fig. 6 shows the arrangement of ball burnishing tool inlathe. It is believed that the ball burnishing process will become interesting in case of hardness than roller burnishing. The parameters like speed, feed, force and number of passes has been selected and the effects of these parameters will be studied on surface roughness and hardness. The following advantages may result from the burnishing process 1. Mirror like surface finish 2. Dimensional Consistency / Repeatability 3. Single Pass Operation 4. Increase in Surface Hardness 5. Reduces the Reworks and Rejections

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