WHAT YOU HAVE ALWAYS WANTED TO KNOW ABOUT SHOT PEENING

By

Cecilia D. Whinney
Assistant Marketing Manager
Empire Abrasive Equipment Corp.

ABSTRACT

Although controlled shot peening was developed in the automotive industry and has been used by the aerospace industry for some time, new applications for this process by the metal working industry have greatly expanded in recent years. The primary effects of shot peening are to prevent metal fatigue failures, eliminate porosity and also to form or change the shape of some parts. There are two types of equipment or systems used for peening: Air-blast and Airless or Centrifugal Wheel. Each have advantages and disadvantages of their own. Various basic questions about shot peening are answered as well as applications utilizing new automated air-blast systems presented.

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INTRODUCTION

Impact cleaning of various parts using such media as steel shot or glassbeads is an old, well-known process. However, something more happens than just cleaning to the surface of these metal parts. Improved fatigue life, elimination of stress corrosion, reduction in surface porosity as well as a change in shape of the part can also occur. These effects are the final result of a process which is commonly referred to as peening or shot peening. Hammer peening is thought to be one of the secrets of the superiority of the famous old Damascus swords.

In order to better familiarize those individuals involved with manufacturing and who are unaware of the merits of shot peening, basic questions will be answered as well as a discussion of various applications and types of peening equipment.

WHAT IS PEENING?

Peening or shot peening, as it is commonly referred to in the metal working industry, is a cold-working process performed under highly controlled conditions in which the part to be treated is bombarded by a stream of rounded media or shot.

WHAT ARE THE EFFECTS OF SHOT PEENING?

Usually metal fatigue failures begin as small cracks at the surface of the part and travel toward the core under cyclic loading, resulting in final failure. For a crack to be initiated, the surface must be under tensile stress which can be caused by either the applied operational load of the equipment or from a surface defect.

Shot peening prevents these failures by creating a surface which is in high compressive stress; therefore, an even higher tensile stress will be required in order to initiate a fatigue crack which could result in failure.

Shot peening can also be used to form or change the shape of some parts and also to eliminate porosity.

WHAT ARE SOME OF THE COMMON APPLICATIONS?

1. Coil and leaf springs are peened to improve their fatigue characteristics. In most cases spring life can be increased a minimum of 30 per cent and has often been increased as much as ten times by shot peening.

2. Torsion bars are peened in areas of highest stress.

3. Shafts and axles are peened to improve fatigue strength.

4. Gears should be peened at the root of the fillets which is an area of high stress.

5. Aluminum die-castings such as transmission housings are peened in order to reduce porosity and therefore, eliminate leakage of lubricant through the walls.

6. High strength steel parts should be peened after grinding, since grinding will induce residual tensile stress.

7. Steel parts being used under dynamic loads should be peened prior to plating. In this case, peening will act to prevent any cracks or imperfections in the chrome or nickel plating spreading into the parent part.

WHAT TYPES OF EQUIPMENT ARE USED FOR PEENING?

In peening, there are two methods for propelling shot. These methods are the airless or centrifugal wheel and the air-blast systems.

1. Airless or Wheel-Blast System: A metallic shot is propelled by a wheel against a part to be peened. The position and speed of the wheel are critical for successful peening. The airless system is especially suitable for production peening due to the high rate of shot flow which

can be economically achieved using this type of equipment.

Other advantages include the constant shot velocity and effectiveness which does not diminish up to a distance of 10 feet from wheel to work piece. Shot up to 1/16 inch in diameter can be projected at very high velocities by centrifugal wheels.

2. Air-Blast System: The most efficient Air-Blast system for peening is the direct pressure method as opposed to the suction-induction type. Direct pressure produces the highest shot velocity and is the only system that can peen deep holes by moving the shot through long lances and side-shooting nozzles.

In the direct pressure system, the peening shot must be contained in a pressure vessel so that it will drop by gravity through a metering orifice into the compressed air line. Depending on the peening application, this system can either be manual or automatic. In order to assure consistency of results, an automated system is recommended for peening.

Shot size, duration of the blast, distance of the nozzle from the part and blast pressure are all carefully controlled to give the desired result.

WHAT TYPE OF MEDIA IS USED FOR PEENING?

Most peening is done with cast-steel shot rather than cast-iron shot which has a low initial cost but is more brittle and breaks down rapidly. Cut wire conditioned to round balls is used for some very critical applications.

Glass beads are used for some peening applications where the sections are thin or where steel shot would leave iron contamination on the part.

Ideally, peening shot, whether it be metallic or glass should be perfectly round and of uniform size, hardness and density.

Basically the larger the shot, the greater the peening intensity. If the shot is too large, peening "craters" are intensified; also, crevices, angles and radii of the part may not be peened. Most peening applications require a steel shot with a hardness of 55-65 Rockwell C and 90 percent of the usable media within this range. If the shot is too hard, it fractures and becomes angular; too soft the shot mulls over and has "flat" spots. Both conditions are unsuitable for peening.

As the shot is used, it is reduced in diameter thereby affecting peening intensities. Therefore, a periodical evaluation of the media is required in order to assure consistency of results.

HOW IS PEENING MEASURED AND CONTROLLED?

Three parameters are used to control shot peening: intensity, saturation and coverage. Intensity is measured through the use of an Almen Strip which involves mounting a strip of spring steel of closely held dimensions on a holder. It is then placed in the same position that the part would be in during the peening process.

The strip is curved depending on the (1) shot size and hardness, (2) shot velocity and angle of the blast, (3) coverage. The curvature will be convex on the side of the strip peened. Intensity is therefore a measure of the height of the curved arc. Curvature is measured using an Almen gauge.

A series of test strips are peened with all conditions remaining constant except exposure time. When the deflection measured by the Almen gauge is not increased by more than 10 per cent, although peening time has been doubled, the part is said to have been "saturated".

Finally, the part is checked for coverage with a 10x magnifier. When the entire surface has been obliterated with peening "dimples", full coverage has been obtained. Most peening specifications usually require "200 per cent" coverage.

EXAMPLES OF AUTOMATED AIR-BLAST PEENING SYSTEMS

Various types of peening systems have recently been developed for the aerospace industry. These systems are presented in order to stress their versatility as well as ability to process a variety of parts in various shapes and sizes.

<u>Figure I</u>: A composite photograph illustrating a pressure-type, automated peening system for processing turbine blades to comply with military specifications.

Complete system includes a 36 inch Turntable, Dust Collector with large cloth filtering area, four nozzles and two blast stations. Of special interest is the unique, media reclaiming and classification system which separates round, peening shot from undersized, broken or "flattened" shot. System is designed to be used with S110 steel shot but will handle all shot sizes. With better media reclamation and classification, an 80 per cent savings in media costs can be realized.

Figure II: This system was designed for a special application: Peening the cooling holes on a jet engine's main drive shaft. The equipment is capable of peening the I.D. on (3) sets of cooling holes. (2) sets have a diameter of .203 inches and (1) set has a diameter of .103 inches.

A carbide probe is oscillated through the center of the holes during the peening operation to insure complete coverage throughout the specified areas.

Media used in this system is S110 steel shot.

Figure III: Direct Pressure System for peening a variety of jet engine parts such as air foils, stators, compressor blades, shrouds, hubs and blades. System is universally adjustable and can be used with either glassbeads or steel shot depending on the application.

Composite photograph illustrates equipment, nozzle orientation within the blast chamber as well as a sample part before and after peening.

CONCLUSION

As the demand for high performance from metal parts and components increases, shot peening will be called upon to achieve these objectives.

Available today are a variety of peening systems which can offer maximum versatility in their ability to process a variety of parts in various shapes and sizes.

It is important that those involved with the metalworking industry be aware of the many applications and effects of shot peening.

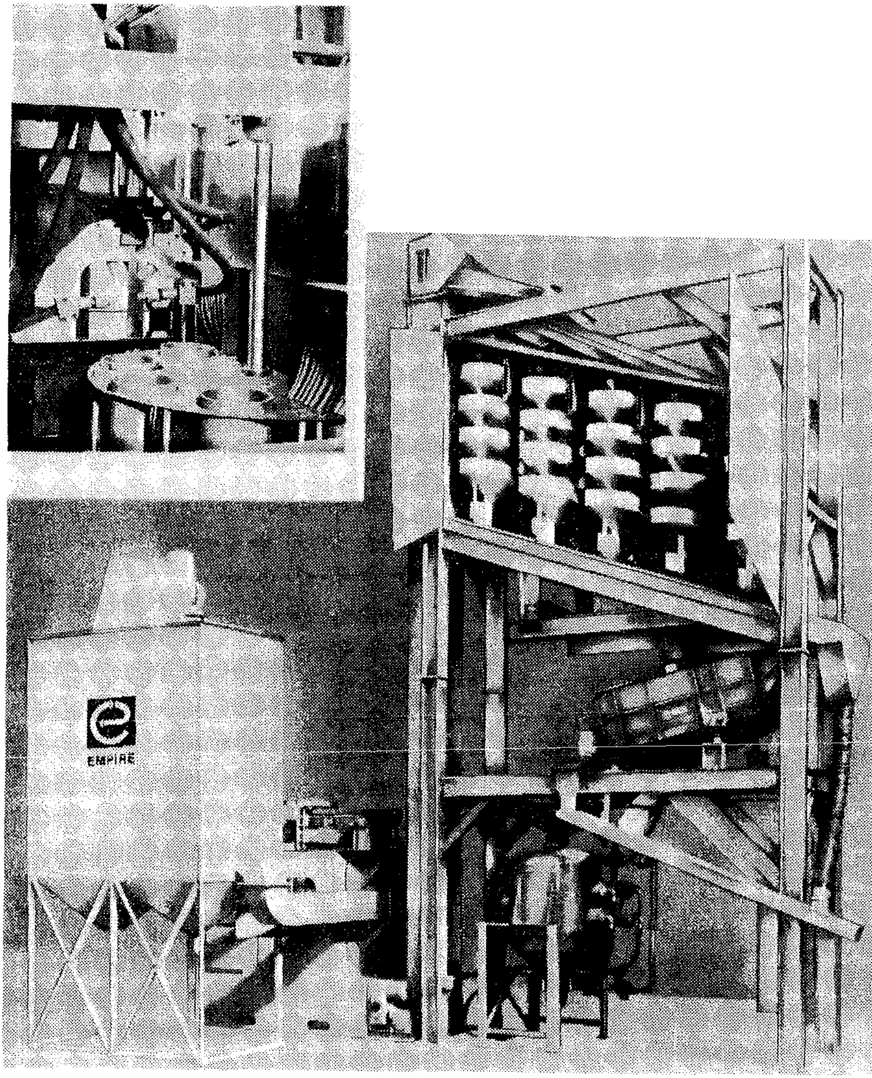

Figure 1
Pressure-type Automated Air-Blast Peening System with built-in Reclaimer and Classifier. Illustrated is the overall view of the system and inside view of the cabinet showing nozzle orientation.

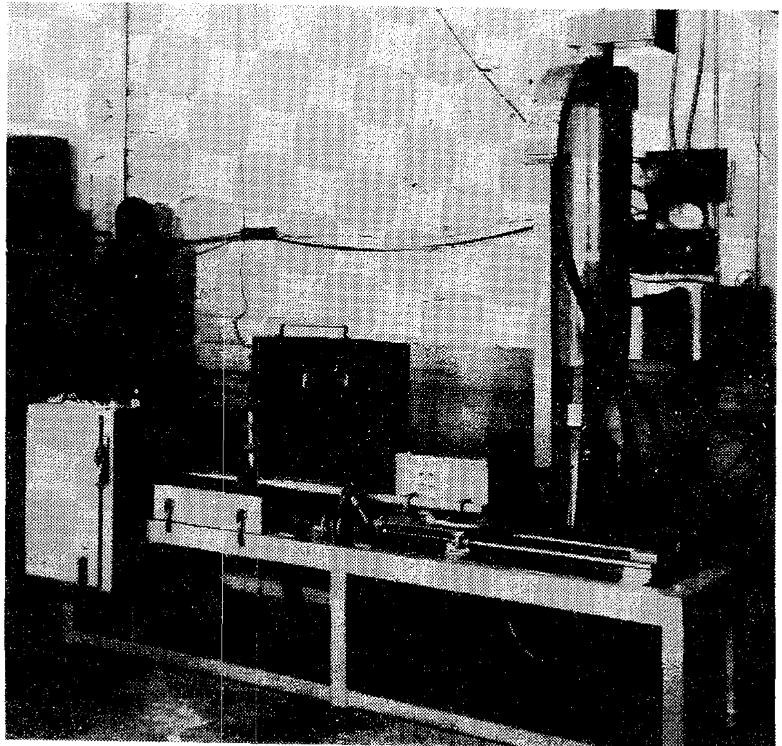

Figure 2
Direct-Pressure system for shot peening the cooling holes on a jet engine's main drive shaft.

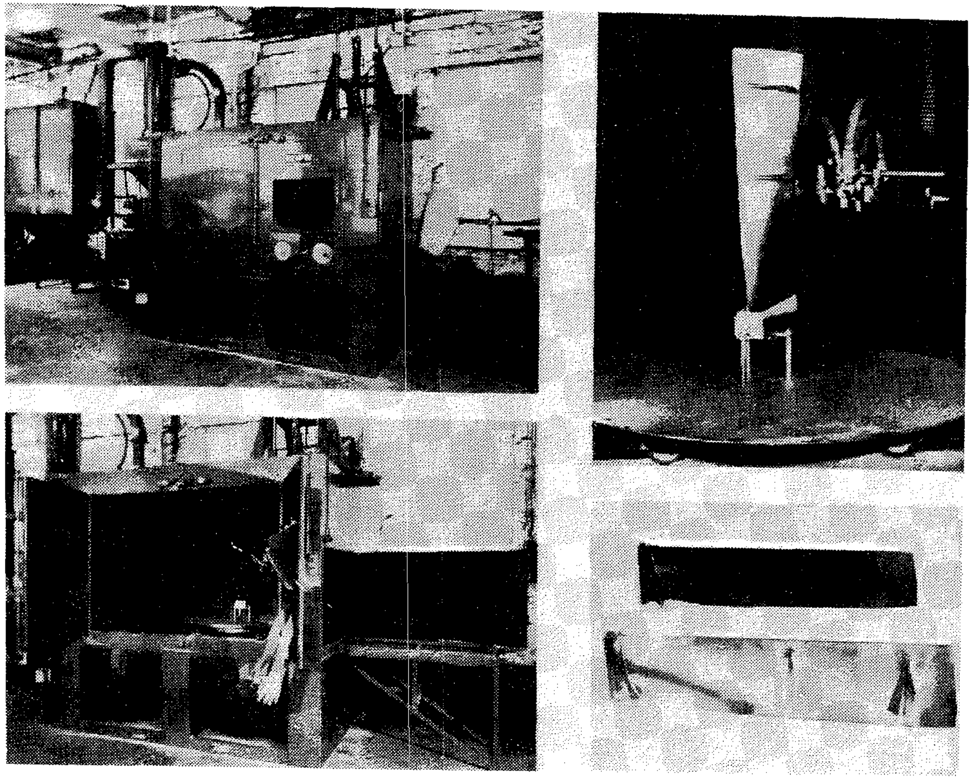

Figure 3
Direct-Pressure system for peening a variety of parts. Can use either glassbeads or steel shot.