1996155

Recent Developments in Shot Peening Machine

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Reprinted from the Proceedings of ICSP4

ABSTRACT

The shot peening process has been increasingly employed as one means of improving the endurance reliability of automotive parts.

While the effect of shot peening for springs has been widely known, a recent technological development is the powerful shot peening process called "hard shot peening", which is applied to parts of high hardness, such as transmission gears. This paper introduces a newly developed shot peening machine which is capable of performing reliable "hard shot peening' by monitoring the peening process with various sensors.

KEY WORDS

Shot peening machine, hard shot peening, gear.

INTRODUCTION

Increasing requirements for higher automobile engine power output and more compact transmissions require improved endurance reliability in transmission gears. As one means to cope with such requirements, shot peening has been widely employed on the gears for the great merit of improving gear strength at relatively low cost.

The "hard shot peening" process can give higher intensity to gears, compared with the conventional shot peening process. As a result, in recent years, "hard shot peening" has become the new shot peening process for gears, achieving a good result in the gear durability.

One of the most important factors in the shot peening process is maintaining a stable peening effect for workpiece. The conventional shot peening machines, however, are not provided with any monitoring system for the various factors which affect a peening effect. They can not control the peening effect. In order to solve this problem we have developed a practical hard shot peening machine which is equipped with various sensors to monitor the shot peening process and thereby attain the optimum intensity.

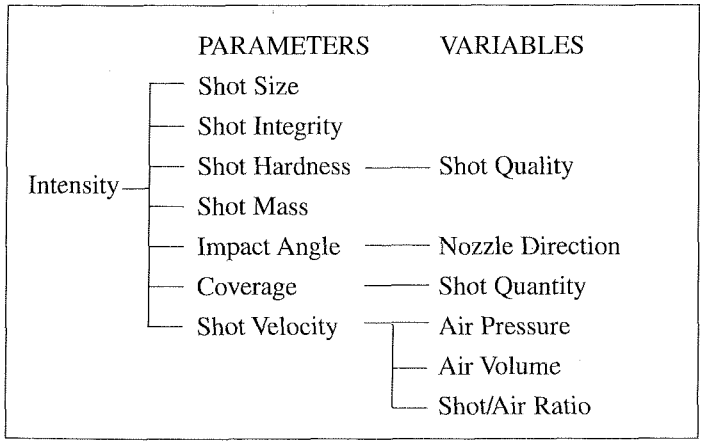

Figure 1. Parameter, variable flow chart

SHOT PEENING PROCESS MONITORING SYSTEM

The shot peening effect is affected by various factors as shown in Figure 1. Changing any one of these factors leads directly to a variation in the shot peening effect. In "hard shot peening" where high intensity must be maintained, it is critically important to restrict changes in these factors.

The new shot peening machine introduced here is equipped with a peening process monitoring system consisting of a monitor for each shot projecting condition, grain size of recycling shots, workpiece revolution speed and timing of replacing wearing parts. By monitoring these factors during shot peening operation, uniform shot peening can be achieved. Figure 2 shows an outline of the monitoring system.

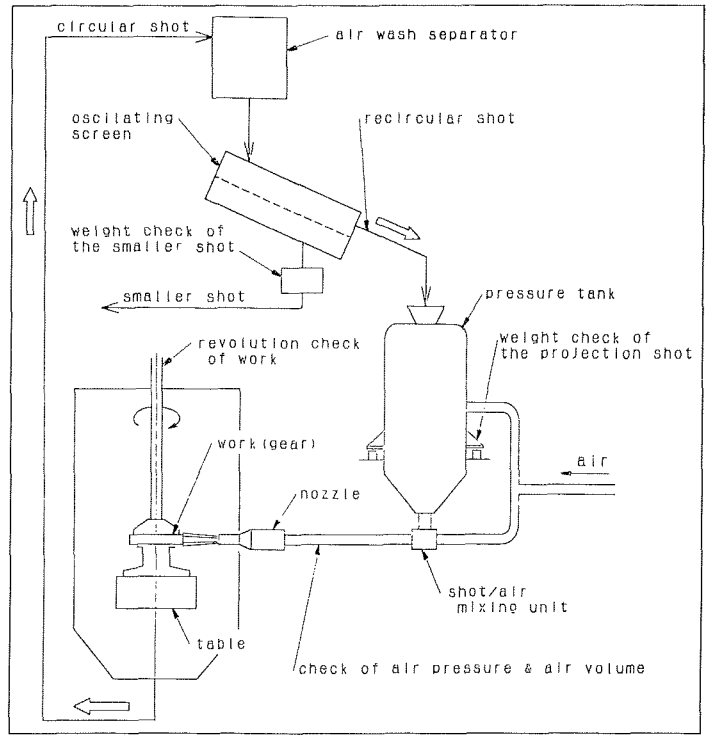

Figure 2. Outline of the monitoring system

SHOT PROJECTION MONITOR

As shown in Figure 3 (on next page), this monitor checks if shot projection has been performed at a constant shot/air ratio, while it confirms that air pressure, air volume, and shot projecting amount have been kept within a consistent range to stabilize the shot projection condition which affects intensity.

CONTROL OF CIRCULATING SHOT GRAIN SIZE

Variation in the grain size of the circulating shot naturally affects the intensity, even if shot projection conditions are kept constant. Usually, the initial shot charged into a shot peening machine is of standard grades in size, hardness, and grain size distribution, causing no problem in variation of intensity.

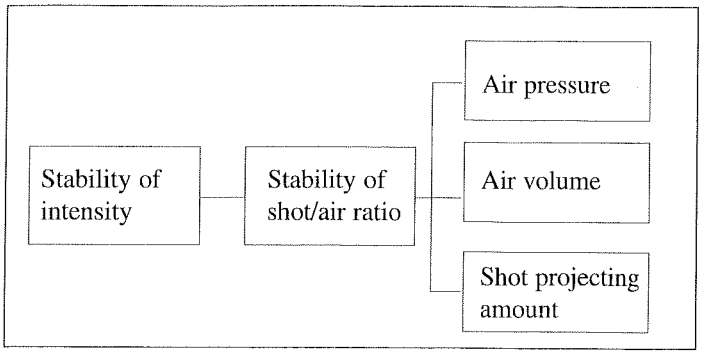

Figure 3. Flow of shot projection control

However, grain sizes of the circulating shot gradually become smaller during shot peening due to wear and cracking, and therefore new shot must be supplied to keep proper grain sizes in the circulating shot.

In "hard shot peening", where high-hardness shot is mostly used, the wear rate of the shot is relatively higher than in the conventional shot peening process. As a result, grain sizes of the circulating shot are more likely to become inconstant; therefore the shot separator plays a more important role in stabilizing grain size. As shown in Figure 2, our "hard shot peening machine" is equipped with both an air wash separator and a oscillating screen to classify the shot. It is also equipped with a device to check the separator's performance by measuring the shot separated by the separator.

REVOLUTION MONITOR OF WORKPIECE

In shot peening process of this machine, basically individual work is processed and the number of revolutions of the work is checked to keep the movement of the work secure during shot peening. This check is carried out while the work is clamped and rotating.

WEARING PARTS REPLACEMENT TIMING MONITOR

The shot peening machine issues a warning to replace wearing parts, such as the nozzle, by checking the variation in the air flow meter or counter for the number of peening operations. When the reading of either the air flow meter or counter reaches the preset limit, the parts are replaced.

GEAR SHOT PEENING MACHINE

Figure 4 and Figure 5 show the overview of an air nozzle type "hard shot peening" machine for gears and the layout of nozzles in the cabinet. The arc height and the distribution of the residual stress obtained with this machine are shown in Figure 6 and Figure 7. This machine is provided with a centralized monitoring system for the peening process as previously described.

CONCLUSION

While application of the shot peening process will be continued for the improvement of the durability of various parts, the stabilization of peening effect as well as improvements in peening effect, will be indispensable in making shot peening more popular. From this point of view, an ideal way of shot peening has been introduced in this paper. We hope that this paper contributes to the development of an advanced shot peening machine capable of achieving a more stabilized shot peening effect. ❍

REFERENCES

[1] Y. Kojima, "Carbonitriding and Hard Shot Peening for High-Strength Gears". Mazda Technical Report, No. 5. P. 165-173 (1987)

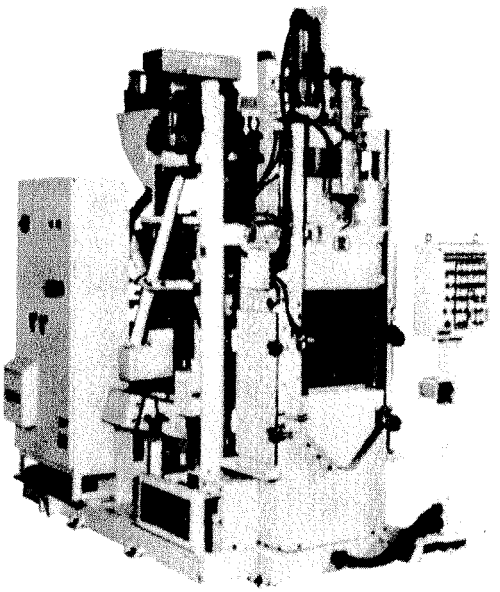

Figure 4. Overview of shot peening machine.
Applicable workpieces: Transmission gears, Drive gears
Intensity (Arc height): Max. 1 OmmA at coverage 300% (Full coverage x 3)
Shot size: SAE S230 or S280
Shot hardness: HRC53 or HRC60
Cycle time: 60 sec/cycle

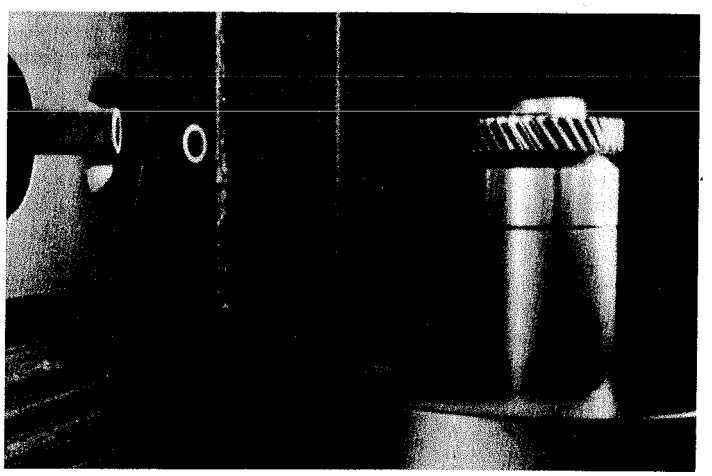

Figure 5. The layout of nozzles in cabinet

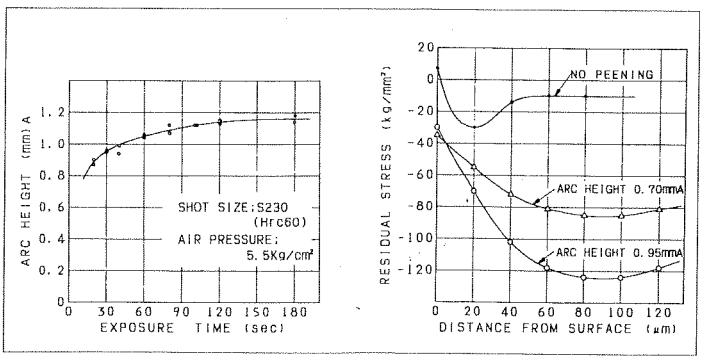

Figure 6. The relationship between exposure time and arc height.
Figure 7. Distributions of residual stresses.