THE NEWEST SHOT PEENING TECHNOLOGY FOR AIRCRAFT COMPONENTS

M. Hiraga (1), W. Hisada (1), M. Shimada (1), T. Sakurai (1)

(1) SINTOBRATOR, LTD. Nagoya, Japan

ABSTRACT

The highest quality and reliability are essentially required particularly in aircraft engines and airframe components for securing safe flights where the failure of a single component part can lead to a serious disaster. In recent years, extreme reliability is demanded for shot peening as a key process in the aircraft parts manufacturing. Under these circumstances, the demand of manufacturers of these important aircraft components for peening machines and equipment capable to achieve the highest peening quality is quite severe.

In 1998, the company (shortened as SB) where the authors of this paper belong, developed the shot peening machines capable to monitor and record the treatment conditions stipulated in AMS2432B of SAE standard, and since then, this type of machines using magnetic shot have been introduced to a number of manufacturers of aircraft components. In the same period of time, there was quite a strong demand in the market for the equipment using non-magnetic shot, but left unsatisfied due to such technical problem of difficulty in monitoring blasting rate.

With this background, SB started to develop the shot flow sensor capable to detect flow rate of both magnetic and non-magnetic shot, and the development was completed successfully. The new flow sensor enabled SB to develop the machine capable to monitor and record the treatment conditions of Glass Peening using glass beads and ceramic media.

The following descriptions introduce the basic schematic of shot peening machine with monitoring system, practical case example as well as the capability performance of shot flow rate sensor.

LIST OF CONTENTS

1. Shot Peening machine with Monitoring System

Shot peening is the treatment process to blast out numerous pieces of fine shot with accelerated speed, making the shot particles collide with the surface of metallic target work at a high speed. The collision of shot covers the surface of metallic target work with countless number of dents, the surface hardness is increased, a higher compressive stress is imparted to the surface zone, and it improves fatigue strength. The evaluation of this treatment is assessed by the arc height value and coverage result of Almen test specimen processed under the same conditions as the actual work against the result of destructive test of the actual work. Therefore, the key is whether the treatment was performed under the correct conditions or not. This section explains the peening equipment using magnetic shot.

1-1) Determining Factors in Shot Peening Machine

For stabilizing and maintaining the quality of shot peening, it is essential to monitor and control the multiple determining factors. The factors are as follows.

Items	Factors
Shot particles	Material, hardness, shape, size
Blasting nozzle	Distance between nozzle point and work surface, angle, moving speed, shot flow, blasting air pressure
Work to be peened	Movement, speed

・ The material and hardness of steel shot are generally stabilized by the quality control during the manufacturing process of shot makers (including SB), but the diameter will become smaller due to wear, and shape will become irregular due to breakage during peening treatment. Even if the round shot is used, it will become irregular when broken. Accordingly, the devices mentioned below will become necessary.

① Sifter to regulate the size of shot. (Sifter with netting to separate oversize and undersize)

② In case of using round shot, shape sorting machine.

・ The effect of shot flow blasted from the nozzle and the blasting air pressure is significant. It is important to have a device for constant monitoring and controlling.

・ What is required for nozzle, in case of stationary type, is the toughness. However, if it is mobile, the controlled reproducibility by using servo-motor or other controller will be essential in addition to toughness.

・ In case the work is also moving, the controlled reproducibility of motion by using servo-motor or similar precision controller will be indispensable.

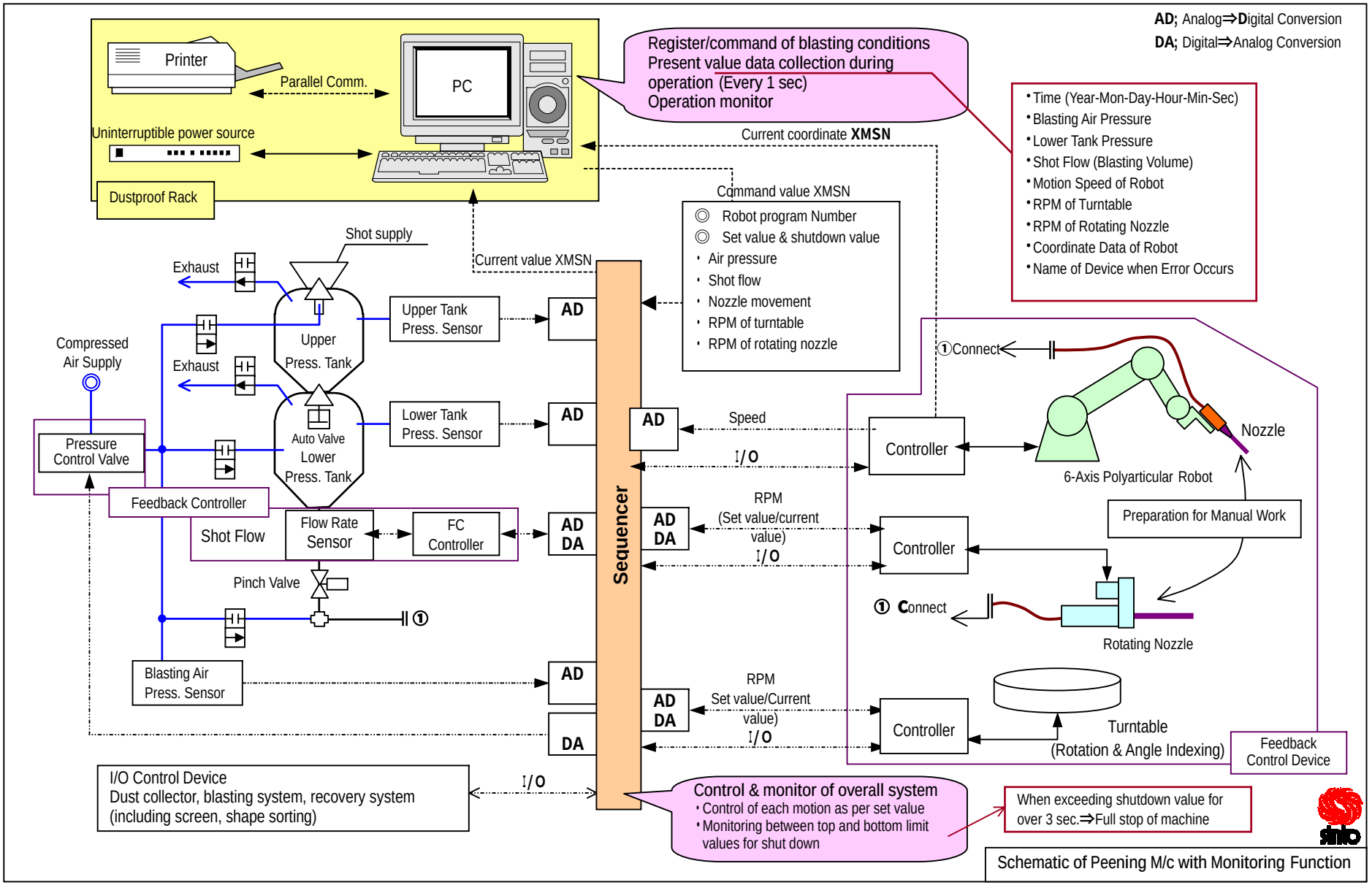
・ High accuracy and the control system within the tolerable range of process will be imperative for the highly determining factors.

1-2) Basic Construction of Peening Machine

There is a limit for human control of the whole machine. However, human control is also needed. The SB peening machine incorporates human-controlled type monitor. The basic construction is shown in “Schematic of Peening Machine with Monitoring System”. The control of equipment is effected by Sequencer through the controllers of each device, and PC functions as monitoring device and performance data collector only.

1-3) Practical Case Example

The practical case example of peening treatment of disc part is shown in “Practical Case Example”.

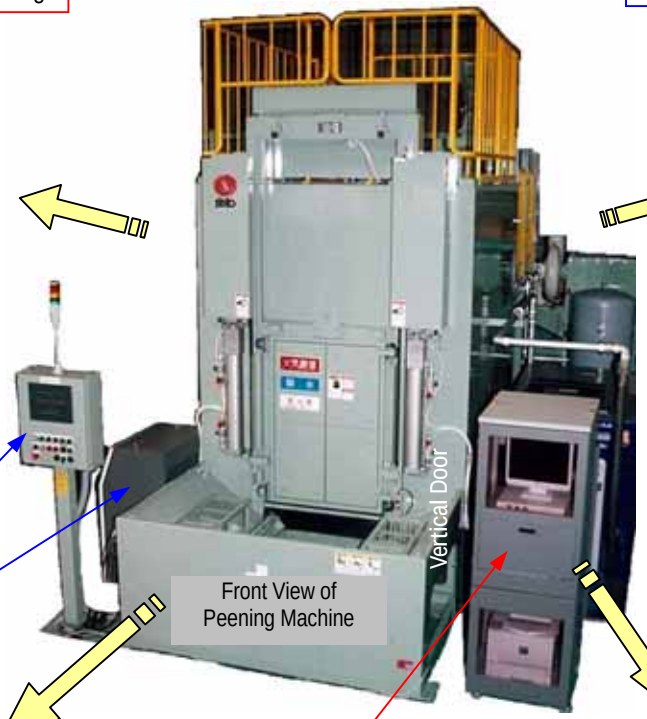

AD; Analog⇒Digital Conversion
DA; Digital⇒Analog Conversion
Printer
Parallel Comm.
PC
Uninterruptible power source
Dustproof Rack
Register/command of blasting conditions
Present value data collection during operation (Every 1 sec)
Operation monitor
Current coordinate XMSN
• Time (Year-Mon-Day-Hour-Min-Sec)
• Blasting Air Pressure
• Lower Tank Pressure
• Shot Flow (Blasting Volume)
• Motion Speed of Robot
• RPM of Turntable
• RPM of Rotating Nozzle
• Coordinate Data of Robot
• Name of Device when Error Occurs
Command value XMSN
◎ Robot program Number
◎ Set value & shutdown value
• Air pressure
• Shot flow
• Nozzle movement
• RPM of turntable
• RPM of rotating nozzle
Shot supply
Current value XMSN
Exhaust
Exhaust
Compressed Air Supply
Upper Press. Tank
Auto Valve
Lower Press. Tank
Upper Tank Press. Sensor
Lower Tank Press. Sensor
Pressure Control Valve
Feedback Controller
Shot Flow
Flow Rate Sensor
FC Controller
Pinch Valve
Blasting Air Press. Sensor
AD
DA
Sequencer
Speed
I/O
RPM (Set value/current value)
RPM Set value/Current value)
Controller
①Connect
Nozzle
6-Axis Polyarticular Robot
Preparation for Manual Work
① Connect
Rotating Nozzle
Turntable (Rotation & Angle Indexing)
Feedback Control Device
I/O Control Device
Dust collector, blasting system, recovery system
(including screen, shape sorting)
Control & monitor of overall system
• Control of each motion as per set value
• Monitoring between top and bottom limit values for shut down
When exceeding shutdown value for over 3 sec.⇒Full stop of machine
Schematic of Peening M/c with Monitoring Function

Robot for Nozzle Handling

Self-Traveling Turntable

Operation Panel

Robot Controller



Front View of Peening Machine

Monitor (PC)

Switching over 2 types of abrasives (shot)

Changeover Valve

Screen
(to cut upper and lower limit)

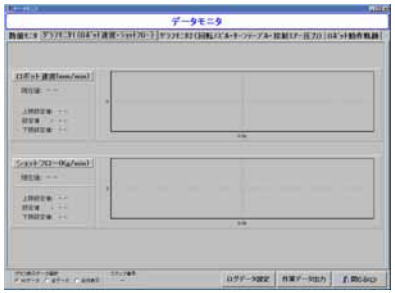
Shot storage hopper

Pressure Tank

Pressure Tank

Flow Rate Sensor

Flow Rate Sensor



Work setting and removing
Photo shows the status when the door is opened and turntable is pushed out.

Practical Case Example

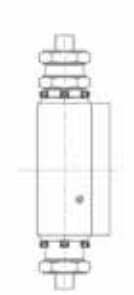
2. Flow Rate Sensor

The material of blasting media used for peening treatment diversifies to a wide range such as various metals, glass, ceramic, etc., and the selection is mainly depending on the required peening intensity to be imparted to the work surface. The monitoring system explained in the above section is capable to cope with magnetic shot, but the system can not possibly monitor the blasting flow rate (shot flow rate) of non-magnetic shot. For monitoring the flow rate of non-magnetic shot, it is necessary to have a different but suitable sensor. In this section, the flow rate sensor developed by SB is introduced.

The flow rate sensor is of electrical capacitance type, and consists of ① Indicator and ② Flow Sensor proper. The specification and capacity are stated below. The main feature is that the flow sensor is applicable for both magnetic or non-magnetic blasting media. The problem here is the fact that the sensing element is exposed to the abrasion of blasting media flow, and the intensity of abrasion varies greatly depending on the type of blasting media used.
For protecting the sensing element, alumina-based protector tube is adopted. This tube is easily replaceable when worn out.
The detecting accuracy is ± 5% FS when the protector tube is new. Periodical calibration is required.

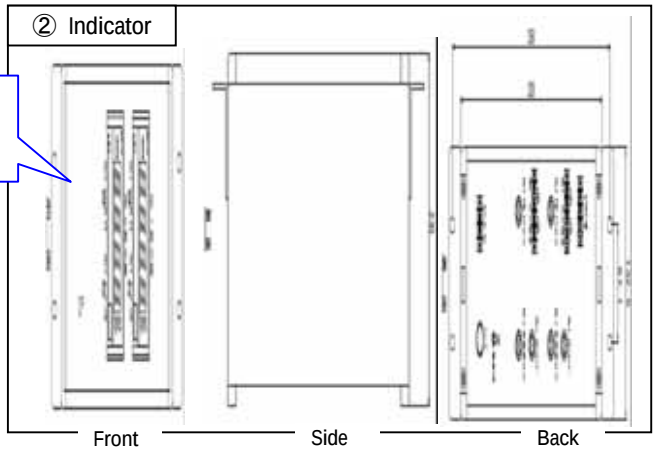
Type		BF-120-09	BF-120-15
Suitable Blasting Method		Suction System	Pressure System
Measuring Detecting Range		50 ~ 500 g/min	0.2 ~ 14 kg/min
Target Blasting Media	Size	About 20 μm ~ 0.5 mm	About 50 μm ~ 1.2 mm
	Material	Blasting media (metallic, ceramic, glass, etc.)	
	Property	Non-adhesive dry powdery material	

① Flow Rate Sensor



Blasting rate (kg/min) is displayed
Possible to connect 2 sensors
Individually displayed

② Indicator



Future Development Plan

- **Accuracy and durability for various powdery media.**
- **Development of media supply system in feedback control based on the data detected by sensor.**

End