MODERN EQUIPMENT FOR CONTROLLED SHOT PEENING AND PEEN FORMING

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ABSTRACT

Modern peening equipment has been developed especially to fullfill claims of the aeronautical and space industry. Today other fields like the automobile industry need peening systems with peening conditions between a narrow range of tolerance too. To fullfill these conditions the development of all types of peening machines is continously going on.

Wet- and dry-peening-equipment working on a pressure- or injector-system need measuring and regulation prinziples to guarantee constant peening parameters as well as conditioning and maintenance of shot.

Solutions to fullfill this claims for different shot (steel, glass, ceramics) in a wide range of shot size (S70 to 8mm diameter) will be shown.

Especially a new developed peen forming machine, which will be able to form cylindrical and spherical parts from a flat sheet will be explained.

KEYWORDS

"CNC-Peening and CNC-Peen-Forming Installations"
Control of massflow, air pressure, nozzle path and velocity.
Continous and/or discontinous separation of shot in size and shape.
Wet and dry air-operated systems.

INTRODUCTION

In shot-peening and peen-forming technics pellets of glass, ceramic and metal alloys are used. Each material will be used economically in a limited range of reachable intensities in spite of the fatigue durability of the pellets. This is one viewpoint to choose a shot. Others are contamination problems, inclusions, surface structure and sometimes surface design. To reach the wanted intensities and to fullfill the other claims it is necessary to have the right acceleration system.
Especially parts which are of complex geometrie and which have areas with different intensities the air-blast-nozzle-type equipment has the best chance to produce and reproduce the local wanted energy.
There are three types of usual peening installations working with nozzles:

1 Wet-peening-system with acceleration by the injector method.

2 Dry-peening-direct-pressure-system.

3 Dry-peening-injector-system.

4 Dry-peening-gravitation-system with acceleration by the injector method.

Each type of installation has its own type of control of the peening parameters and a special industrial processing engineering of the shot conditioning and maintenance.
On the next pages some examples of realized peening installations will be explained.

WET-PEENING-EQUIPMENT

Fig. 1 showes a peening installation for the treatment of turbine blades and other parts of turbines in maintenance. It is built and constructed to fullfill the claims of the turbine manufacturer's specifications. The result is a fully CNC working wet-peening-system for glass beads and ceramic shot. The shot is forced metered and mixed with the preselected quantity of water, which takes the transport of the shot to the nozzles. The medium ratio mixture can be set from 20 to 40% of solids (Fig. 2). The absolute quantity depends on the number of working nozzles. This ratio of mixture can be changed during one peening operation without handling any shot.

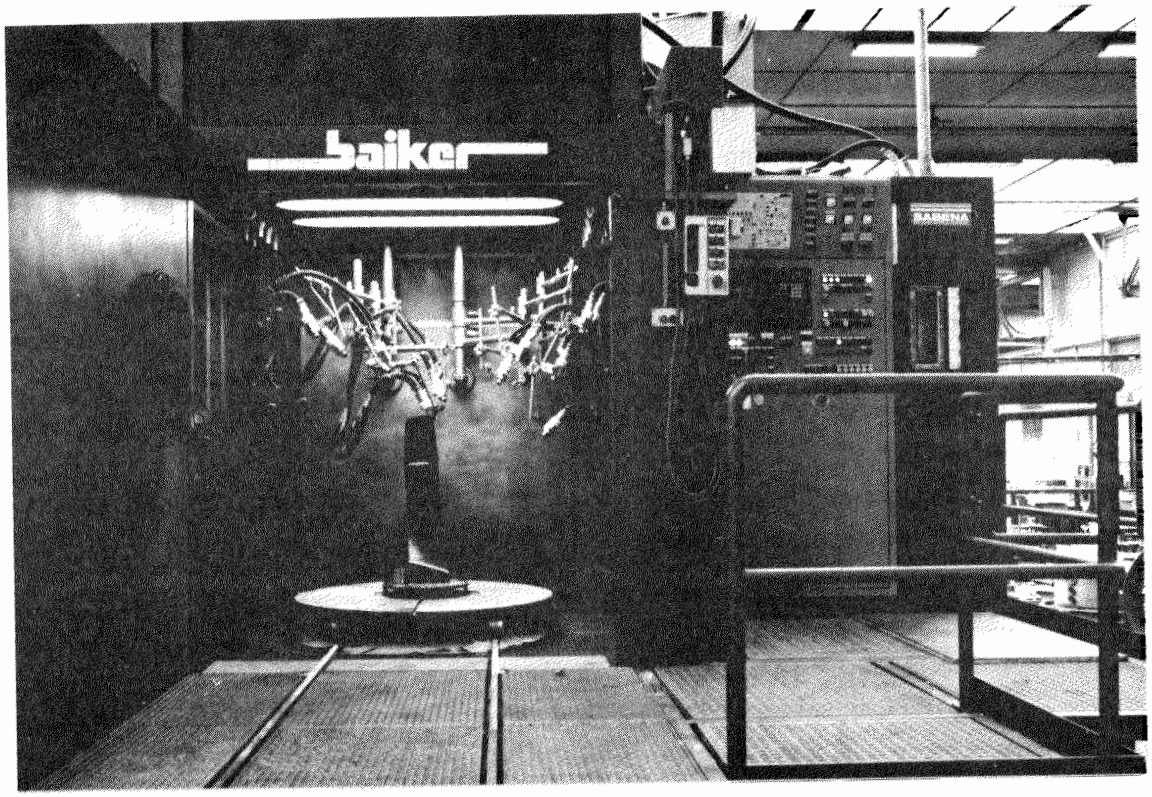

Fig. 1: Wet-Peening-Equipment (Sabena, Belgium 1989)

process technics:
- forced metering of glass beads or ceramic shot,
- centrifugal process pump,
- 6 pieces independent pressure systems,
- 6 sets of two pairs of nozzles.

movements:
- one x, y system for the nozzle fixture,
- one rotary table for the workpiece.

control technics:
- fully CNC.

monitoring:
- medium ratio mixture, air and medium pressure
- automated sampling device for visual examination.

shot conditioning:
- fully automatic adding of shot,
- recycling of conditioned shot by cyclone technics.

water treatment:
- conveyor type filtre for waste separation and water purification.

With the automated sampling device a visual examination of the mixture ratio is possible /2, 3, 4/./ The acceleration of the medium up to the working velocity starts in the nozzle. In this case 6 pieces of independent pressure systems are feeding one pair of nozzles, so each of the 6 pairs of nozzles can run the individually set velocity.

All nozzles are moving on one fixture in the x,y range. On the walkable ground of the chamber a rotary table moves the workpiece.

Reclaimed shot will be conditioned by cyclone technics and will be recycled. The broken shot and other waste will be separated on a conveyor type filtre. The purificated water will be returned to the process. Lost shot will be added automatically.

Latest of wet-peening-installations will have a closed loop control system with a special flow meter arrangement.

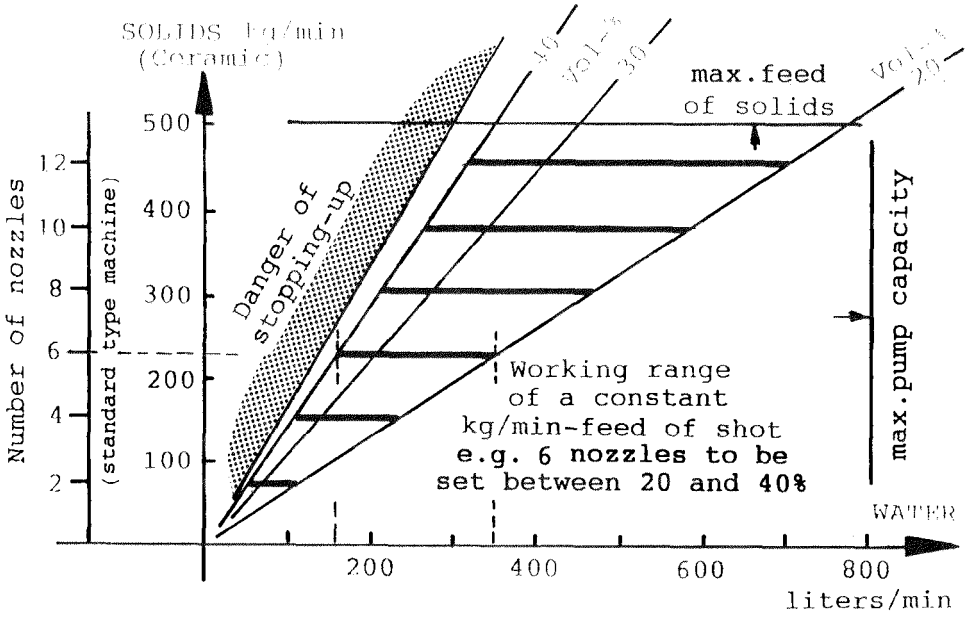

Fig. 2: Medium Process Characteristic

SPECIALIZED-PEENING-EQUIPMENT

One of the small type installations introduced in industry is the standard precision peening apparatus for one nozzle and different shot up to S330 (about 1 mm).

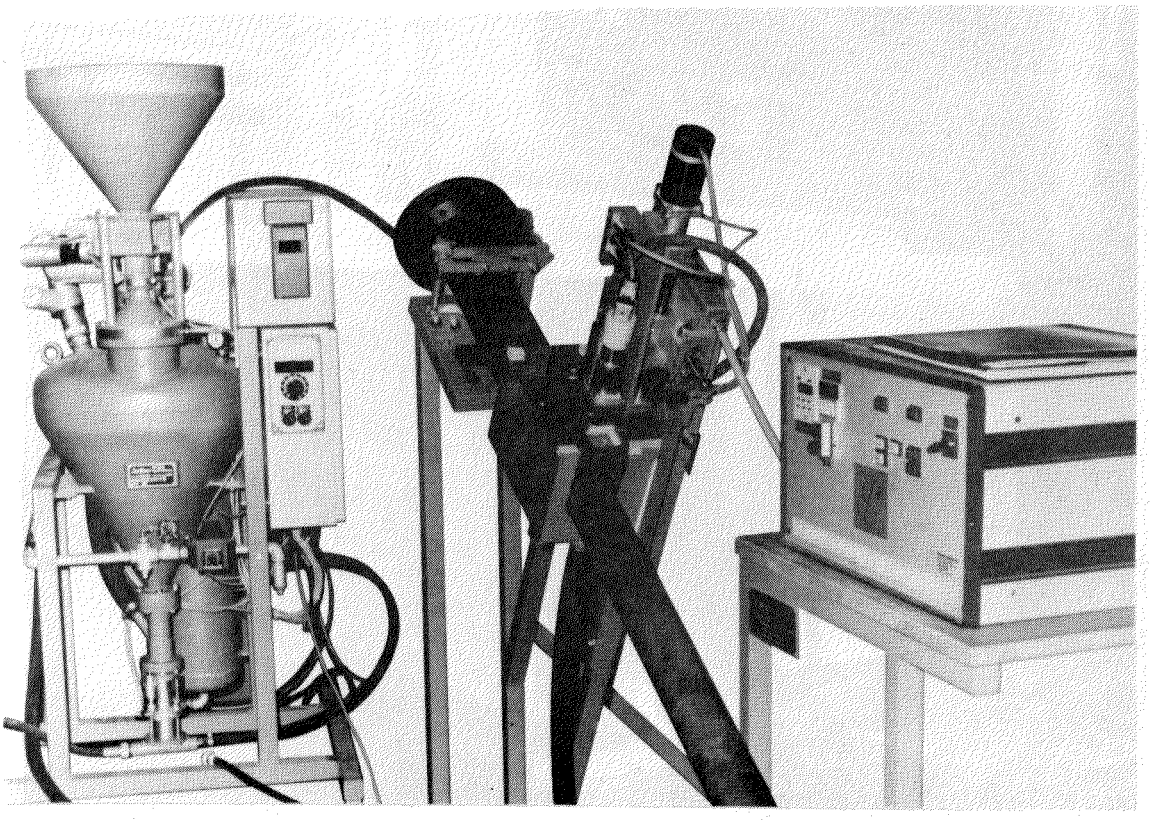

Fig. 3: Specialized-Peening-Equipment for "small-holes" of 2,6mm diameter and over (e.g. turbine maintenance)

process technics: - one discontinously working pressure-system with one nozzle.

movements: - one linear axis and nozzle rotation,
- workpiece manually adjusted.

control technics: - NC.

monitoring: - shot flow and air pressure.

auxiliary equipment: - fixtures for processing standard engine components.

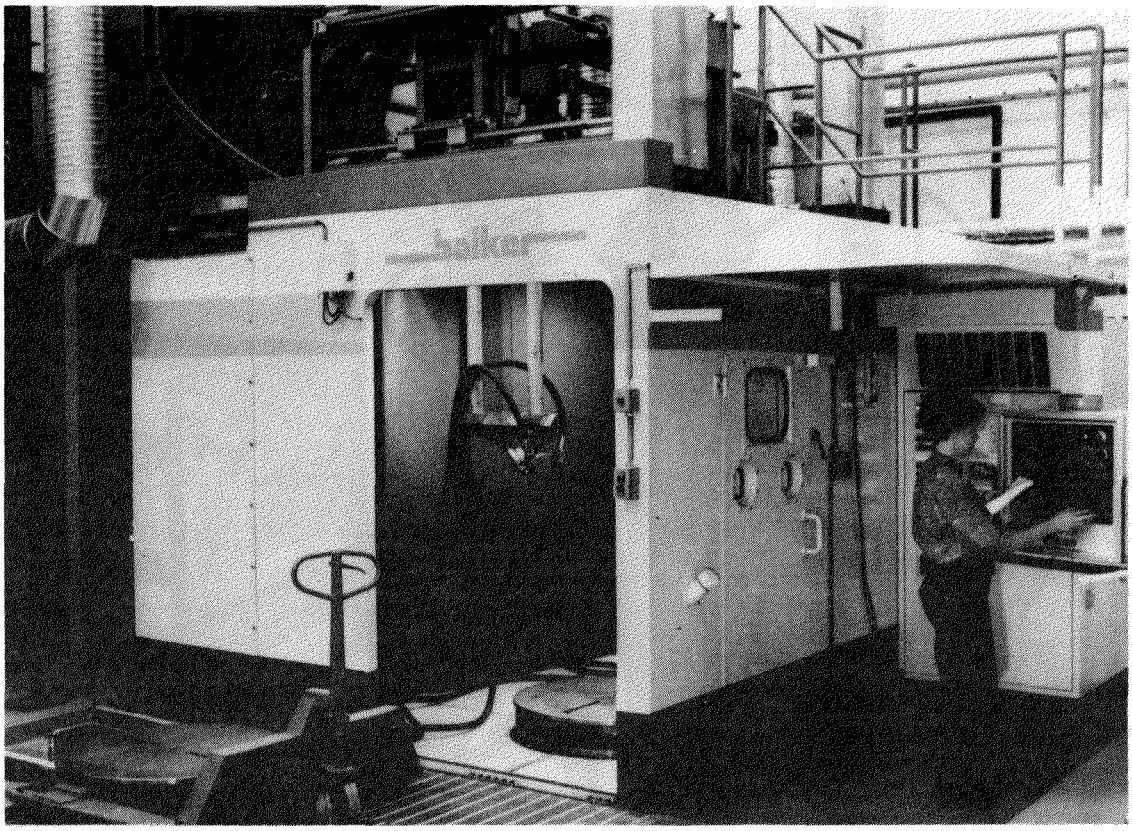

Fig. 4: Peening-Installation (Turbine manufacturer, 1990)

process technics:	- 2 independent continously working pressure-systems, - 8 nozzles totally, steel shot.
movements:	- two independent nozzle sets, - vertical and horizontal movement, - one rotary table with exchangeable pallets.
control technics:	- fully CNC.
monitoring:	- shot flow and air pressure, - closed loop control facilities.
shot conditioning:	- screening device for continous under- and oversize separation.
auxiliary equipment:	- storage silos with automated transferring of shot.

Combined with a moving unit with one longitudinal axis and rotating nozzle, it is possible to shot-peen with this equipment holes of about 2,6 mm (0,1 inch) in diameter and in minimum ten times of the diameter deep with equal intensity over the entire hole. Such holes can be peened to required specifications in less than 3 minutes with little quantity of shot. Main facts of the peening operations are uniform solidification in the entire hole and a soft gradiant in solidification and residual stresses in the surface of the shaft. For this a special system of nozzle and target has been developed /4/.

PEENING INSTALLATION

In comparison to the small peening equipment, dry-peening-installations are working normally continously with one or more pressure systems. The installation in Fig. 4 consists of two independent moving sets with 4 nozzles each and two independent pressure systems.
The moving ranges are vertical and horizontal (x,z and y,z) for the nozzle sets and a rotary table with exchangeable pallets in walkable ground hight moves the workpiece.
This machine is fully CNC-controlled and the peening parameter are subsidary under closed loop control.

PEEN-FORMING-INSTALLATION

Of quite another concept than the peening equipment shown before is the peen forming machine at the plant of Dornier in Munich (Fig. 5) to produce special parts for aircrafts (Airbus) and the Ariane program. This machine consists of three independent working shot supply systems (Fig.7) and two metering units, so that different shot sizes with different energy can work. Before returning to any main storage a continous working screening device separates the shot to be collected in the corresponding silo.
The 7-axis movement and the peening process are fully CNC-controlled. The peening can be PC- or panel programmed (Fig. 6) and is also teach-in supported.
The 5-axis nozzle moving unit shows Fig. 8, at the moment with laser installation for adjustment. Fig. 9 shows the installation in action forming a segment for the Ariane5.
The installation is completed with a storage and a classification system (Fig. 10 and 11).

All installations shown will fullfill all national safety standards.

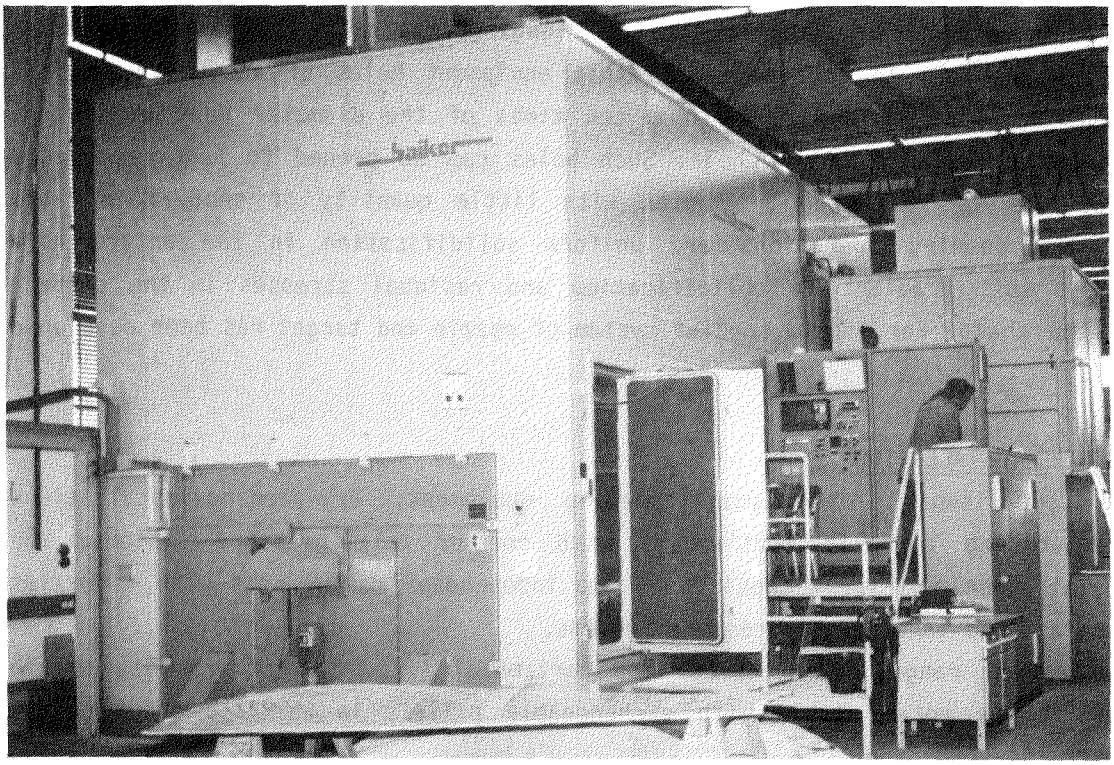

Fig. 5: Peen-Forming-Installation (Dornier Luftfahrt GmbH, 1990)

process technics:	- one continously working pressure-system with one nozzle for shot up to 4mm diameter, - two continously working gravitation-systems with one nozzle (injector acceleration) for steel shot up to 8mm diameter.
movements:	- 5-axis for the nozzle (3 linear and 2 rotative) - 2-axis for the workpiece (rotation, inclination).
control technics:	- fully CNC.
monitoring:	- flow of shot and air pressure, - closed loop control facilities.
ball observation and conditioning:	- screening device for the continous separation of shot , - device for discontinous classification of shot in shape and size.
auxiliary equipment:	- storage silos with automated transferring of shot.

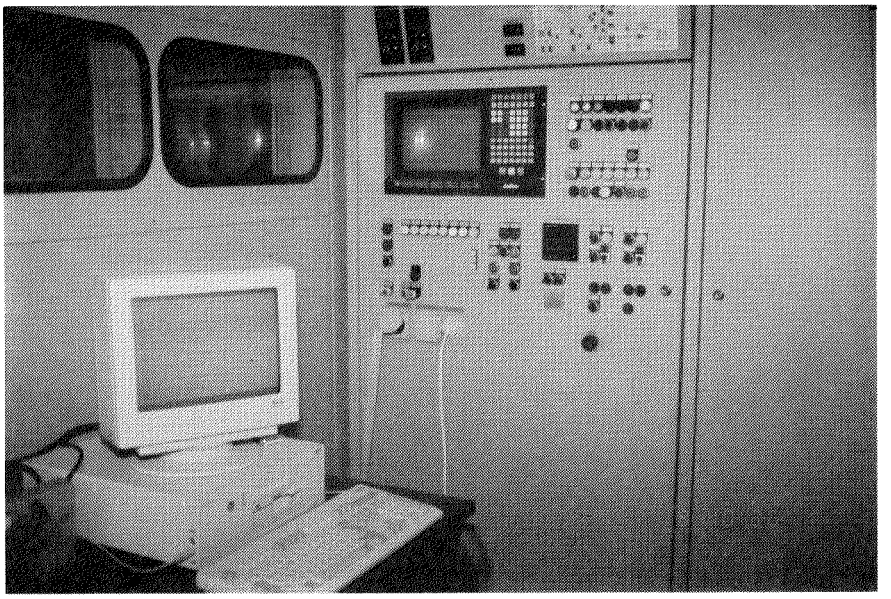

Fig. 6: PC, CNC-Units, Switch Board, Instrumentation for Mass Flow and Air Pressure

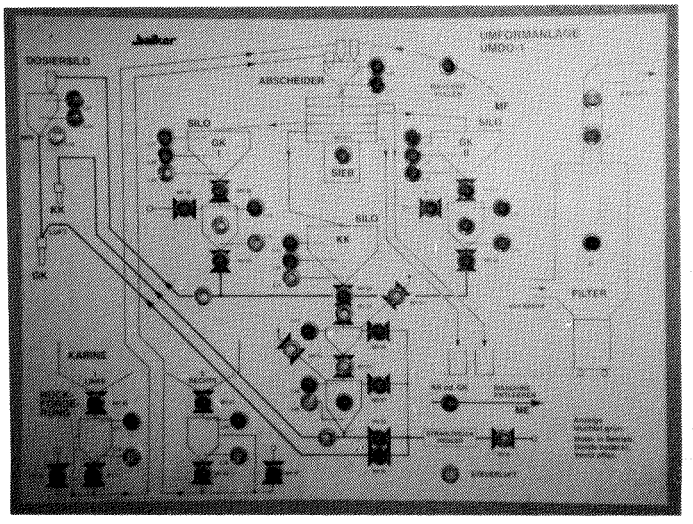

Fig. 7: Shot Flow Diagram

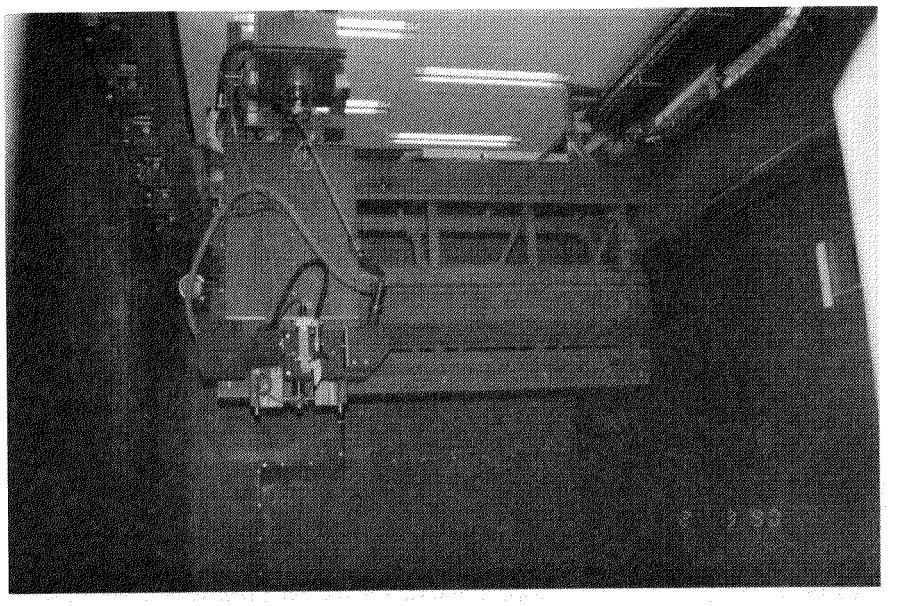

Fig. 8: Axis Unit with Laser Positioner in the Cabin

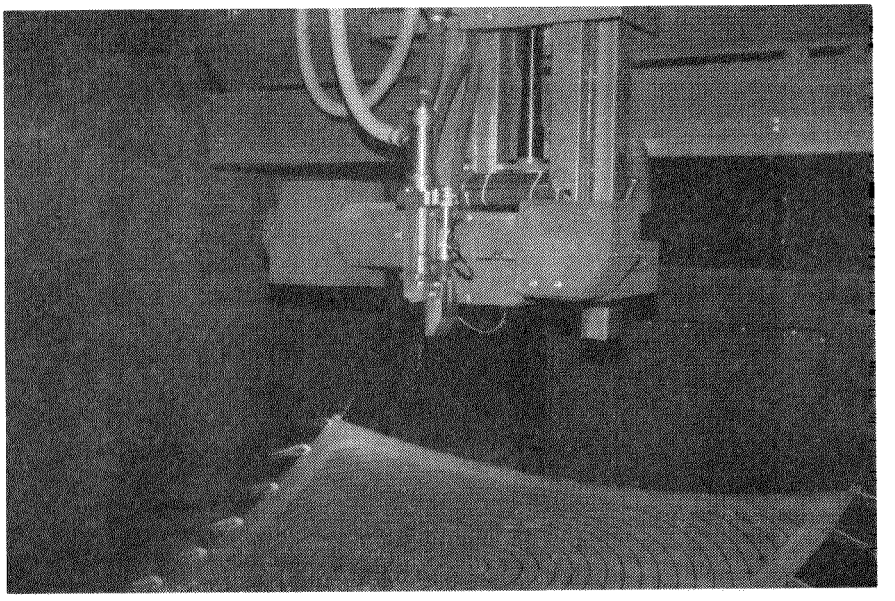

Fig. 9: Inclined Rotary Table with Workpiece during Peen-Forming-Operation

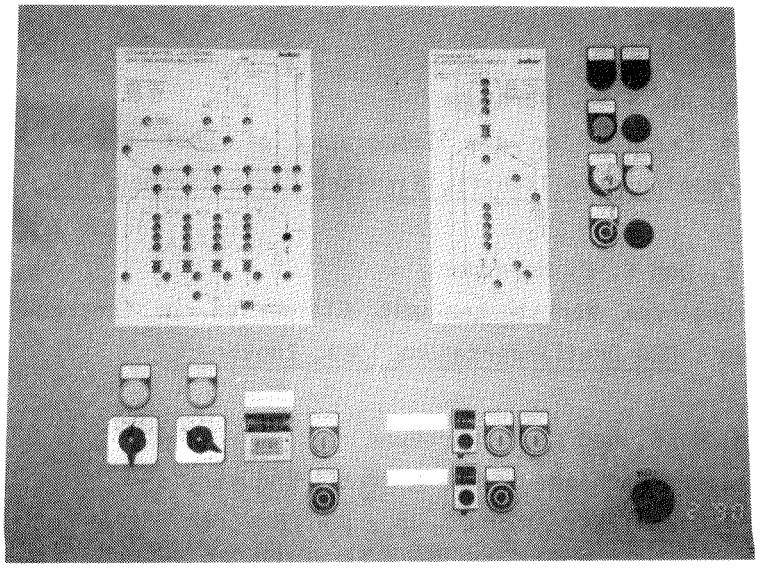

Fig. 10: Switch Board for Transferring Shot from Pressure Systems to Storage Silos or Classification Unit

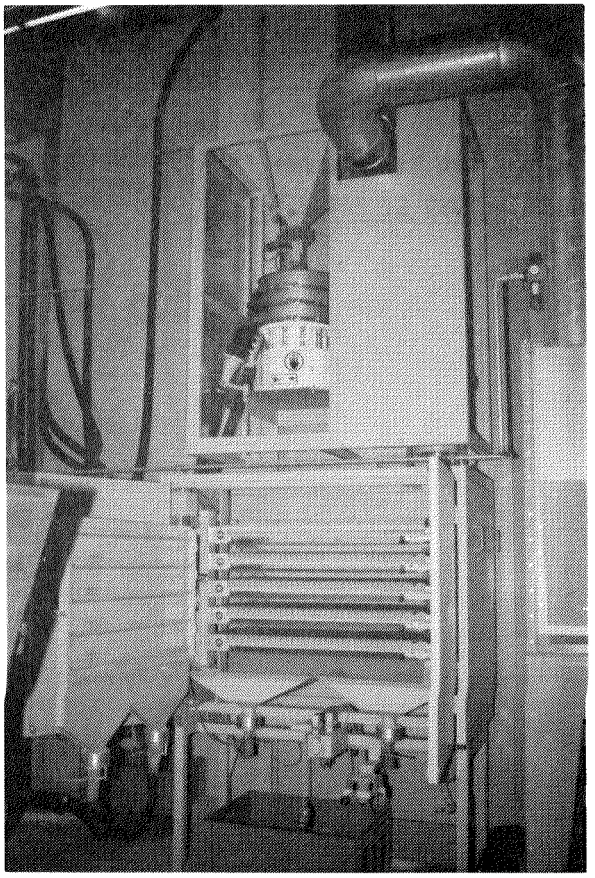

Fig. 11:
Classification Unit for Size and Shape of Round Steel Shot

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