MONITORING OF SHOTPEENING PROCESSES BY HYBRID RECORDERS

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ABSTRACT

Computer controlled and monitored shot peening will become increasingly important, especially in the aerospace and automotive industries where verification is required to document that a specific shot peening process and operation has been performed on a critical part. New equipment can be designed to fulfill exacting specifications, wheras existing machinery can be extensively modified and modernized. In the latter, two major areas are identified. First, parameter conversion with signal conditioning is needed. Second, signal recording with display and hard-copy facility is required. These modifications are shown for a three axis air-driven peening machine having a single shot-delivery nozzle. Signals for pressure, for example, are easily obtainable. However, shot flow rate measurement requires use of special devices with monitoring and signal conditioning capability. Devices for obtaining displacement signals are examined. Capabilities of hybrid recorder are presented. Using a modern hybrid recorder all required standardized signals can be combined, programmed and the results printed out on a hard-copy which can be interpreted in real time, if required, in a readily understood format. Examples of printouts showing process irregularities are presented. Reasons for choice of hybrid recorder are
explored.

KEYWORDS

Hybrid, shot peening, programmable, computer control, recorder.

INTRODUCTION

One serious problem in shotpeening is the difficulty of verifying the quality and accuracy of peening on a processed part. Destructive methods are known, of course, but are not economical for industrial production. The common procedure is to work. out a process routine by using Almen strips, or peening actual parts for destructive testing. Once a process has been successfully established with all parameters quantified, the major task would then be to monitor all subsequent processes under real production conditions. The computer can be a fine instrument for this purpose. Data acquisition using personal computers supported by available software is possible, however practical experience shows that it is still a long way to go for getting an approvable record from a peening machine basically not equipped with such a feature. To overcome such time-consuming development and to reduce system complexity, another met hod could be considered. The following describes a monitoring method using latest recording techniques.

BASIC PRINCIPLE

A common and simple multipurpose air-operated peening machine has e.g. a combined X - Y nozzle traversing system. At least one or more nozzles direct and energize the peening media. As shown in Fig. 1 a minimum of 5 dynamic parameters need to be monitored. Each of the 5 functions have to be converted into a recorder readable signal. Together with the set logic and calibration, the recorder will follow the process and print out the documentation required as presented in Fig. 2.

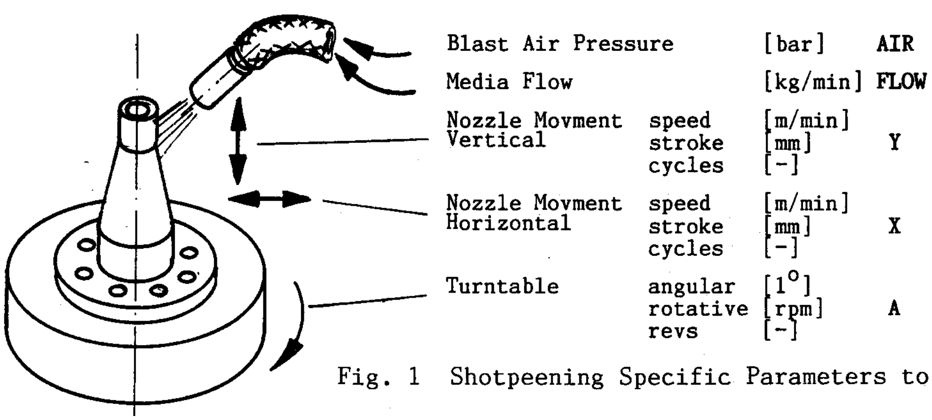


Fig. 1 Shotpeening Specific Parameters to be Monitored

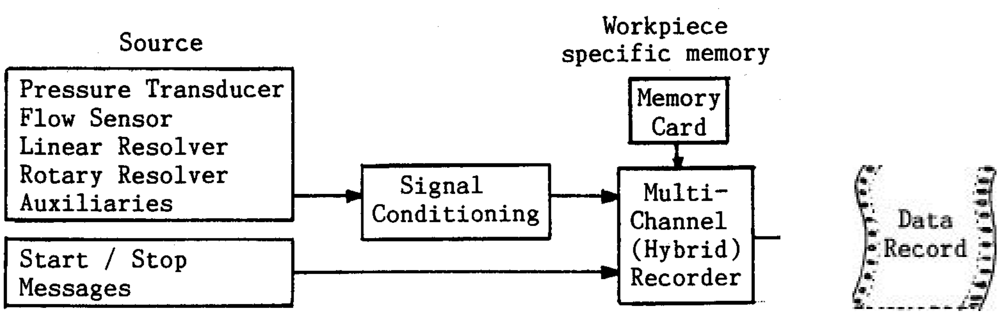


Fig. 2 Block Diagram of Monitoring System

PARAMETER CONVERSION AND SIGNAL CONDITIONING

Blast Air Pressure "Air"

A common pressure transducer can be used. A normal range is 0.8 to 8.0 bar with a signal output of e.g. 0.8 to 8.0 volts.

Media Flow "Shot"

Few flow sensors are suitable for peening and blasting application and a limited choice is available on the market. For the described installation a mechanical-electronic device of ANVIL DEVELOPMENTS has been successfully used. The monitor gives a standard current output equivalent to a shot flow of 0.50 to 12.00 kg/min with an accuracy better then 3% of the nominal value above 1.00 kg/min.

Linear Resolver "X ... Z"

To convert a linear motion into an analog electrical signal, the use of potentiometer devices is recommended. Depending on the design of the nozzle traversing mechanism a linear conductive plastic potentiometer, available up to 1000 mm travel, can be installed. If in combination with a feed rod, a geared rotative potentiometer can be even more simple. Connected to a voltage source, the signal goes directly to the recorder and the level represents the absolute position of the nozzle carrier.

Rotary Resolver "A ... C"

The turntable angular position must be readable by the recorder. An absolute encoder with an analog output or a coupled pair of potentiometers according Fig. 3 and 4 can be used. If the turntable is in a continuous rotation mode, the recorder shall receive pulses from an e.g. proximity switch. One revolution should transmit 1 pulse. This technique is required for speed higher than 5 rpm.

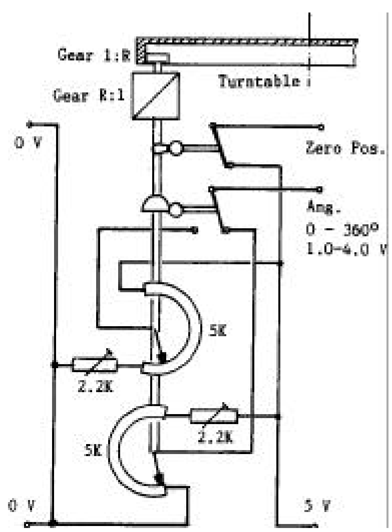


Fig. 3 Principle of a 360° Potentiometer Device

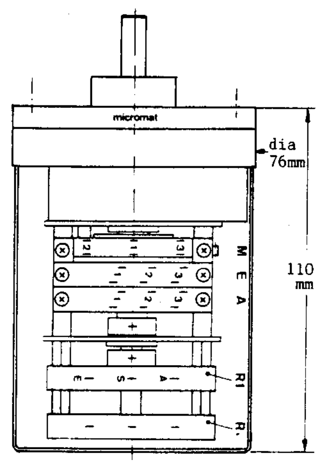


Fig. 4 Sectional View of a 360° Potentiometer Device

Auxiliary Feedback "R..."

Additional signals may be monitored, e.g. a nozzle rotator. In this case, the nozzle drive shaft must be coupled to a tachometer. Also strobe signals, depending on speed with a devider, are acceptable by the recorder. Additionally, machine transmitted time marks may be recorded to give a maximum of process information.

Error Messages

Signals of a constant level throughout the process can easily be alarm protected by the recorder. This applies mainly to all pressures and flow rates. Trouble indicator equipment is often part of the original machine. Signals from such devices can be coupled to the recorder to simplify trouble-shooting. The recorder has no means for switching functions due to any errors in the motion system. One exception may be the detection of overtravel. Shutdown facilities apply only to channels with constant input level.

RECORDER

A most simple 1-nozzle/3-axis peening machine requires at least 5 channels. However, in production, 4 and more nozzles are common and also additional axis and auxiliaries have to be recorded. Standard pen recorders offer 6 to 8 channels. For industrial shotpeening 10 and more instrumentation channels are required, thus giving a capacity of 4 nozzles, 4 axis and auxiliaries. Therefore the more universal multichannel hybrid recorder is superior. The relatively high speed of modern models with an all channel print out every 2 seconds is just about sufficient. A compulsary feature is the possibility to work with memory cards. Setting datas must be exchangable according the workpiece variation within a very short time. It also protects from faulty programming due to human error. For the herewith described installation, a YOKOGAWA HR2300 Model 37607/Math/Rem capable of 30 channels has been successfully used. Fig. 5.

PROGRAMMING

First of all, the recording width of 250 mm on the 342 mm chart used, is devided into columns. This prevents an overlapping of channels and presents a clearer and easier to understand record. It is recommended to use machine specific printed charts. If numerous jobs are entirely different, it may even be advisable to have specially printed charts for groups of similiar process procedures.

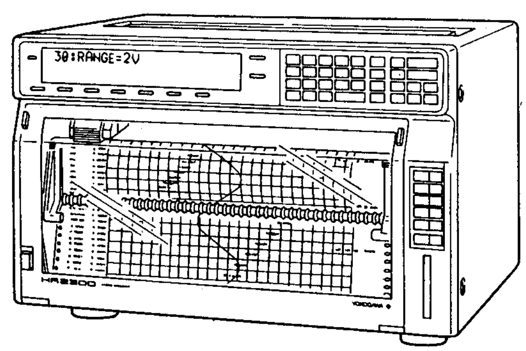


Fig. 5 A 30 Scans/s Hybrid Recorder

Header

This feature should be used extensively to give a maximum on information and explanation about the process and its affiliation with the workpiece.

Air Pressure and Shot Flow

The setpoint of those channels shall be in such a manner that the correct value will be marked on the particular space provided on the chart. Columns for this purpose can be spaced according the total number of signals to be monitored. The width of such a column can be 10 to 25 mm. E.g. zone setting is 15/30 mm for a shot flow of 2.90 to 4.10 kg/min. Thus the column accepts a spread of 1.20 kg/min. In this case a deviation of 0.10 kg/min will clearly show 1.3 mm on the paper.

Linear Movment

Expected max/min signals equivalent to max/min strokes shall be zoned between the two lines provided. Therfore a stroke of 40 mm on the machine may be compressed in a recording width of e.g. 30 mm on the paper. Even if a stroke is 500 mm, a 20 error gives 1.2 mm on the paper.

Rotative Movment

Such an axis may be a rotary table. In this case, two different modes are possible. It can act as a spindle and each full rotation shall print a mark on the paper. For this purpose a 10 mm column would be sufficient. However, if running as a true axis with increments down to 6 degrees (e.g. a disk with 60 slots), the column should be spread to 60 mm resulting in 1 mm offsets on the paper.

Auxiliaries

Space for monitoring nozzle rotators, time marks or other information is provided. Also message print facilities can be activated for such purposes.

EXAMPLE

A simple industrial peening job shall represent the monitoring technique described. A number of slots in a disk have to be peened with a rotating lance. Fig. 6 and 7.

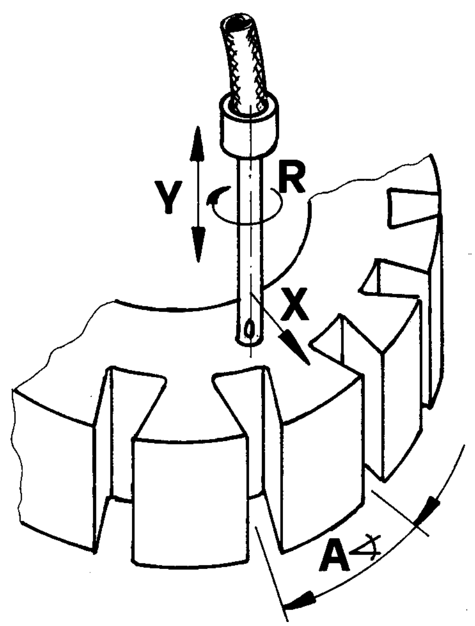


Fig. 6 Illustration of Job Example

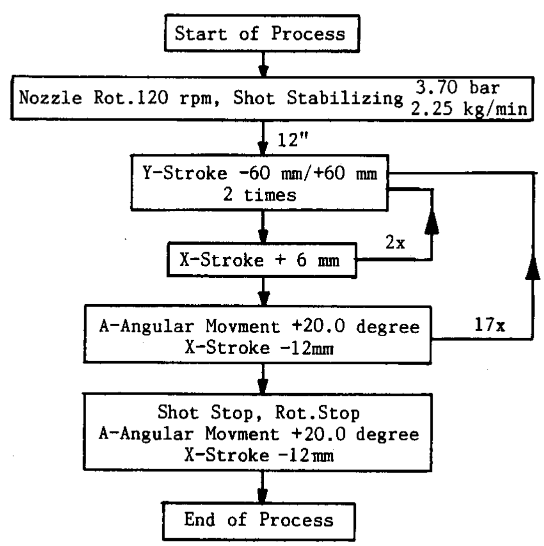
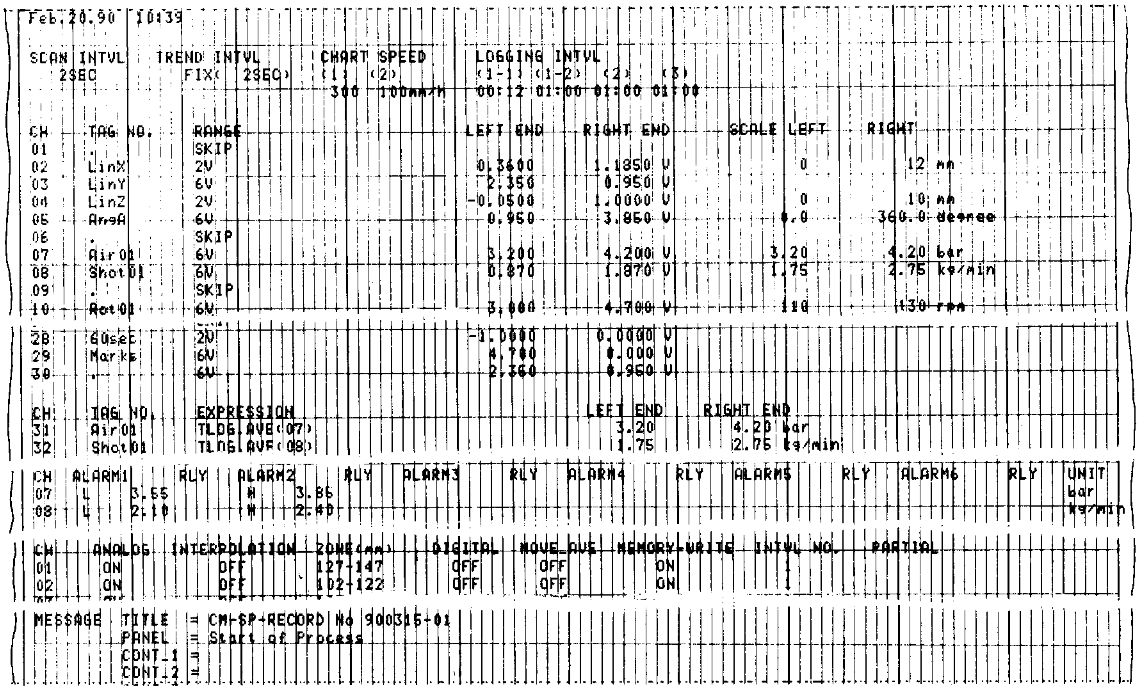


Fig. 7 Operational Diagram of Process

RECORDER SET

The set up of the recorder can be done together with working out of the process routine. The interactive display allows a simple programming. Table 1 is a partial printout of settings and gives an idea of the datas to be entered. This workpiece specific data will have to be stored on the memory card system provided in this recorder.



Feb.20.90 10:39

SCAN INTVL	TREND INTVL	CHART SPEED (1)	CHART SPEED (2)	LOGGING INTVL (1-1)	(1-2)	(2)	(3)
2SEC	FIX(2SEC)	300	100mm/h	00:12	01:00	01:00	01:00

CH	TAG NO.	RANGE	LEFT END	RIGHT END	SCALE LEFT	RIGHT
01	.	SKIP				
02	LinX	2V	0.3600	1.1850 V	0	12 mm
03	LinY	6V	2.350	0.950 V		
04	LinZ	2V	-0.0500	1.0000 V	0	10 mm
05	AngA	6V	0.950	3.850 V	0.0	360.0 degree
06	.	SKIP				
07	Air01	6V	3.200	4.200 V	3.20	4.20 bar
08	Shot01	6V	0.870	1.870 V	1.75	2.75 kg/min
09	.	SKIP				
10	Rot01	6V	3.000	4.700 V	110	130 rpm
28	60sec	2V	-1.0000	0.0000 V		
29	Marks	6V	4.700	0.000 V		
30	.	6V	2.360	0.950 V		

CH	TAG NO.	EXPRESSION	LEFT END	RIGHT END
31	Air01	TLOG.AVE(07)	3.20	4.20 bar
32	Shot01	TLOG.AVE(08)	1.75	2.75 kg/min

CH	ALARM1	RLY	ALARM2	RLY	ALARM3	RLY	ALARM4	RLY	ALARM5	RLY	ALARM6	RLY	UNIT
07	L 3.55		H 3.85										bar
08	L 2.10		H 2.40										kg/min

CH	ANALOG	INTERPOLATION	ZONE(mm)	DIGITAL	MOVE_AVE	MEMORY-WRITE	INTVL NO.	PARTIAL
01	ON	OFF	127-147	OFF	OFF	ON	1	
02	ON	OFF	102-122	OFF	OFF	ON	1	

MESSAGE TITLE = CM-SP-RECORD No 900315-01
PANEL = Start of Process
CONT_1 =
CONT_2 =

Tab. 1 Partial Printout of Settings. About 2/3 of Natural Size

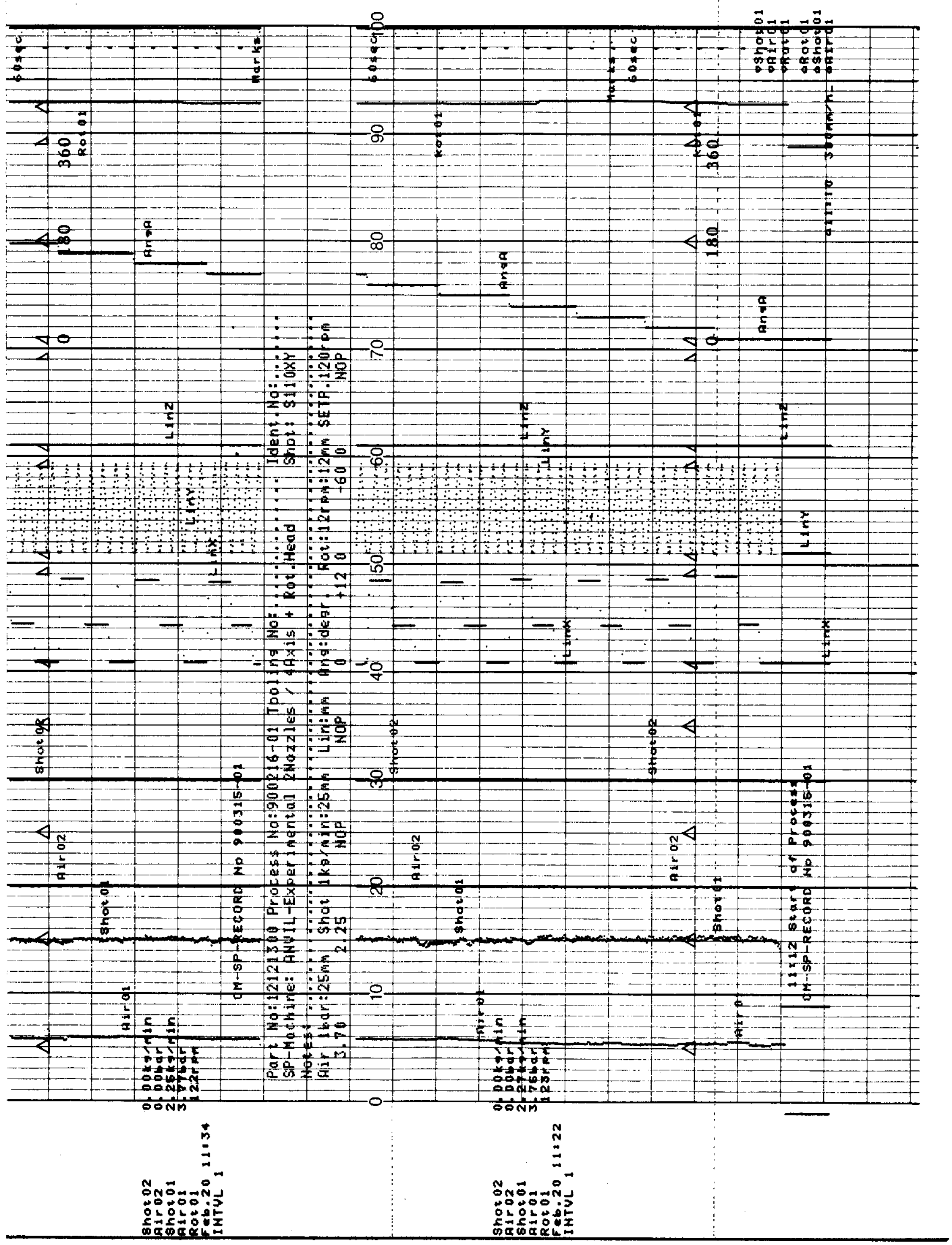
RESULT

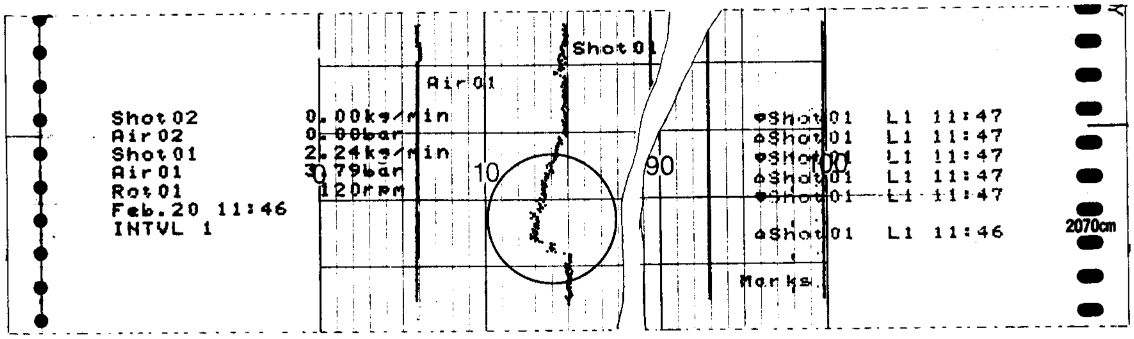
Table 2 shows a reduction print of a successfull peening job from process start to slot situated at 180 degrees of the disk described. The record gives a true and easy to read picture of the process dynamic. It gives the following informations:

- -Time, chart speed
- -Title: CM-SP-RECORD .....
- -Absolute starting position of all axis
- -Starting message with time of actual starting
- -Datas of all dynamic parameters: Air, Shot, Lin, Ang, Rot, ...
- -Time marks
- -Digital printout: Average over e.g. 12 minutes, time of this information
- -Header with various informations: Part No .,...., setpoints, scales
- -Alarms on various levels, also alarm outputs

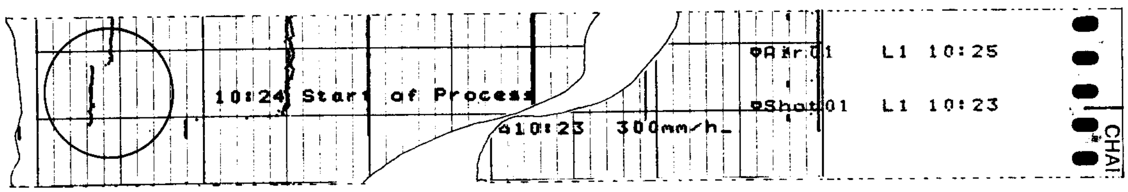
Table 3 is of about original size. It shows irregularities that could happen during a process. With the help of such printouts, faults can simply be traced and used as guides for further procedures. Also the memory card can store all recorded datas.

Tab. 2 Printout Example of a successfull Peening Job

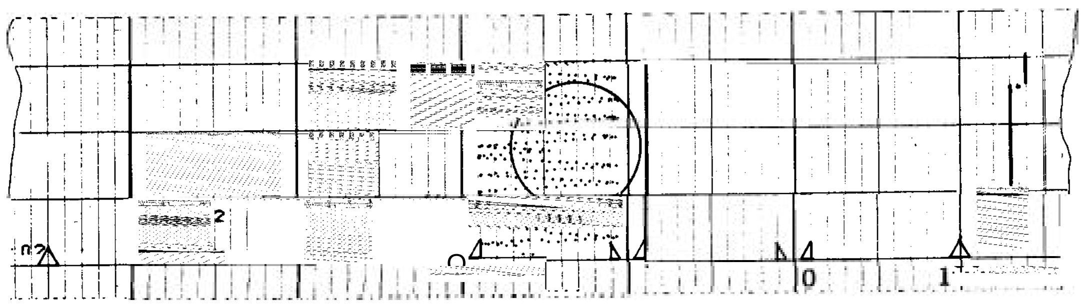




a) Low shot flow 25 mm ≙ 1 kg/min



b) Full airpressure delayed 25 mm ≙ 1 bar



c) Incomplete stroke at 240°

Tab. 3 Examples of Irregularities (a,b,c)

CONCLUSION

For certain applications the monitoring of shotpeening processes by hybrid recorders could be utilized for quality control. The outfit and its installation is comparably simple and inexpensive. The creation of the printout organization can be done by most anyone with a minimum of training on a particular recorder. The programming procedure has to be done only once and can be stored by using the memory card system.

The aim of this paper is to inform related engineers about the todays possibility using a modern hybrid recorder for monitoring peening or other blasting processes.