

Highly Complex Green Parts in Excellent Quality

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Abstract

SMS Meer GmbH, formerly Mannesmann and today part of the SMS Group, has been building powder presses since the early 1950s. The patents developed here in this field have long since documented the pioneering work carried out for the PM industry. The paper focuses on the challenge of reconciling the contradictory demands in the production of highly complex and crack-free PM parts. The process employed with the patented Controlled Punch Adapter (CPA) [1] counters possible cracking reliably and directly at the source. In this way is it possible to develop new and highly complex parts to series production maturity in a minimum of time even without simulation of the press cycle [2]. The quality data achieved in the production series, almost 100% crack and micro crack-free green parts with optimum density distribution over all press levels is unrivalled and thus gives the user a clear lead over the competition.

Keywords: Controlled Punch Adapter (CPA), crack-free, best even density

1. Introduction

This paper describes advancements of CNC / CPA technology and even the combination of withdrawal- and counter pressure- process to fulfill the high quality demands of PM parts nowadays. The precisely controlled hydraulic press axis operating in a closed loop control circuit opened up new possibilities and functions such as powder transfer, continuous path control during compaction and individual movements of each press axis. This is to compensate punch deflection to produce parts crack free with very high even density distribution and allows the need of continuous monitoring of all relevant production data. The technology eliminates most all special machine and tool design and represents a process characterized by short set up times for PM parts with the quality impact that today's customer requires.

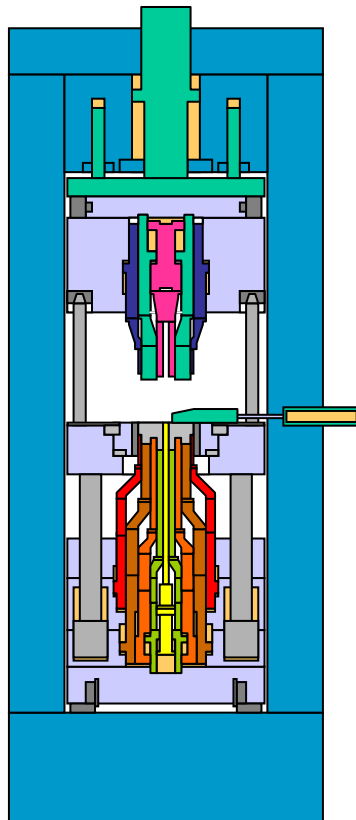


Fig. 1. HPM 350 E3 i

2. CNC Press to follow one of the most important rules of the PM Industry

The hydraulic CNC presses (Fig. 1) were equipped with up to 12 CNC controlled axes (ram movements) according customers request to allow the flexible production of an extremely broad range of shapes with just one press. All axes move in a closed loop control for speed and position, or force. The upper ram provides the reference value for all other axes and sets the speed ensuring that all systems reach the compaction position at the same time. This design follows one of the most important rules of PM Industry by practicing "Speed proportional compaction from filling height to compaction height individually for each ram". This procedure guarantees green compacts with highest even density distribution at a prime part rate very close to 100%. Another essential criterion for the production of high quality components is the meanwhile world wide delivered Controlled Punch Adapter technology. The patented CPA, which is a SMS Meer development, offers a huge variety of advantages.

Advantages:

- Best even density distribution even at critical areas like thin walls, corners etc.
- Excellent controlled powder transfer without any pre compaction
- Simultaneous compaction with the use of continuous path control
- No mechanical dead stops for the compaction position
- Force reduction from upper and / or lower side is possible
- Full compensation of deflection for each punch individually

- Combination of compaction methods – withdrawal and counter compaction

Other important advantages to follow the trends of powder metal industry demands:

- Permanent monitoring of forces even during compaction for all CNC controlled punch level
- Highest compaction forces at each press level
- Economical use of the press due to high repetition accuracy, high-speed production, quick adapter / tool change and easy handling

3. The above describe preconditions

The higher quality demands seen in the PM market could be described and divided in two main fields like technology and economical. With that presentation we like to focus more the technical ones. When we see the world wide range of PM parts we can consider that the part shapes coming more complex under following aspects:

- Bigger part dimension at shape in general
 - Need for higher compaction force
 - increase of weight
- Longer overall part length
- Extremely different section length
 - Short (1 mm); long (60 mm)
 - Design goes to longer top section drop length
- More section leveled parts
 - Up to 4 upper and 6 lower levels
- Very different punch section areas
 - E.g. no punch sections on opposite side
- More irregular parts shapes
 - Non-symmetrical vertical shape like Carrier
 - Non-symmetrical horizontal shape like (con rod)
- Higher Densities in all section
 - 7,0 → 7,3 g/cm³ means 50 % higher pressing force
- Much higher specific punch loads
 - Need an excellent compensation of punch 'deflection
 - Need of specific punch load monitoring to protect each punch
- Demand of higher part quality – smaller tolerances

Described aspects are shown detailed in the following parts schematics Fig 2-5:

Schematics of different part shapes

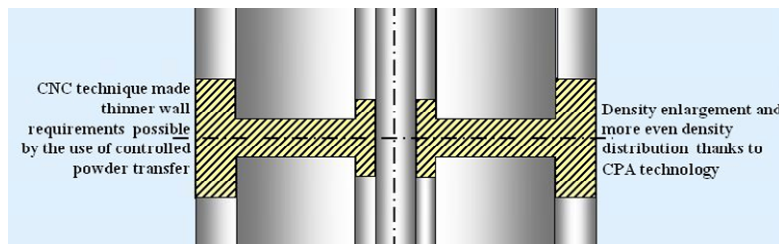


Fig. 2. Symmetrical parts.

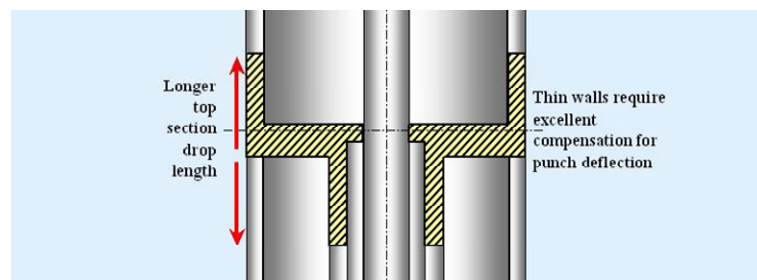


Fig. 3. Parts with extra rams for powder transfer only.

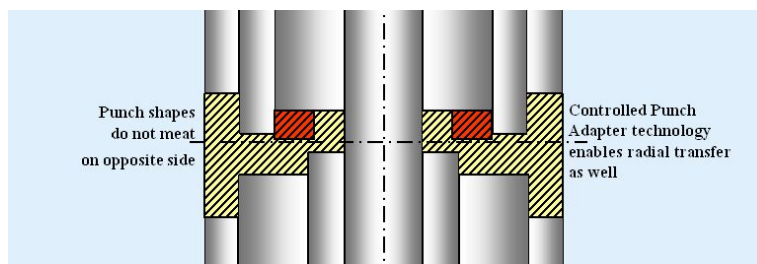


Fig. 4. Parts with radial transfer needed.

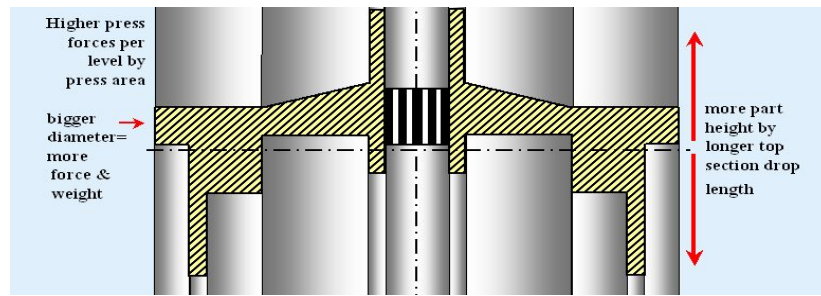


Fig. 5. Part size.

4. Examples of challenging parts SMS Meer customers can produce

	Tough and complex shape to realize with individually and extreme accurate force reduction of each punch only.
	Helical gear. Flank producible thanks to special proceeding of force depending torque enlargement
	Multiple thin walls require extreme accurate force reduction of each punch individually
	Carrier with long top section drop length needs longer ram travel and counter press procedure.

	Double sprocket by split die technology.
	Top flange 0,04" thin. Defects mainly avoided by force reduction from both sides possible
	Unsymmetrical part with long drop section. thanks to combination of compaction methods
	Thin punch areas possible by full compensation of deflection for each punch individually only

5. Summary

The durable increase of PM Industry to produce more complex parts in excellent quality generated solutions within the SMS Meer powder presses meeting highest receivables. Even at extremists demands in regard to press force, density, thinner wall thickness, verified segment length and continuous increasing press speed enlargements it was taken care producing green parts free of any kind of defects achieving prime parts output of nearly 100 %.

6. References

- [1] Pulverpresse mit etagenförmiger Grundplatte im Adapter, Deutsches Patentamt DE 42 27 640 A1, 1992
- [2] G.Hinzmann *Capability of Closed Loop Controlled CNC Compacting Presses.*