

The  
**Diecasting**  
Society



Friday 27<sup>th</sup> April 2007

**NATIONAL TECHNICAL  
CONFERENCE**

# New Buhler & Schaufler die concepts for In-line and V-engine blocks

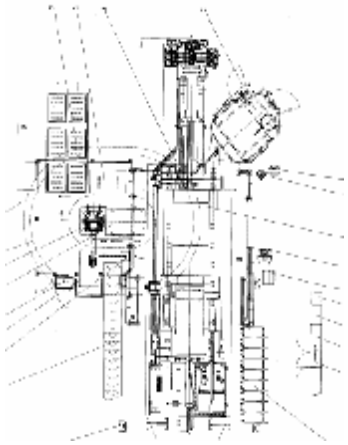


***Bühler  
Druckguss AG,  
CH – Uzwil***



***Schaufler Tooling  
GmbH & Co. KG,  
D - Laichingen***

# Buhler Diecasting portfolio



real-time shot control DCMs with locking forces from 2'600 kN to 42'000 kN

integrated casting cells or complete diecasting facilities

world-wide training and maintenance services

consultancy on most appropriate technology for each project, supported by virtual product development

achieving best match between process and project

prototype castings for development projects



# Schaufler Tooling portfolio

- Aluminum and Magnesium diecasting dies up to 50 tonne, for complex parts such as engine block, instrument panel, structural and body parts
- long term production programmes with very high volumes
- trial casting and small batch production
- innovations which address individual customer problems
- one stop service for engineering, die making and sampling



# Diecasting Center Laichingen

## **Buhler and Schaufler: joint venture since 2000**

development of innovative technology and processes

development and trial casting for large and complex castings

integrated optimisation – diecasting machine, process and die

## **one-stop-service for diecasters and product development engineers**

fully automated diecasting cell using

4,200 ton (metric) Buhler Evolution 420D

dual capability: Magnesium and Aluminum



# Joint experience

## DCL

trial castings

small batch production

casting of spare parts requirements

quality optimisation

optimisation of die and part design

development parts

special alloy prototypes

process development

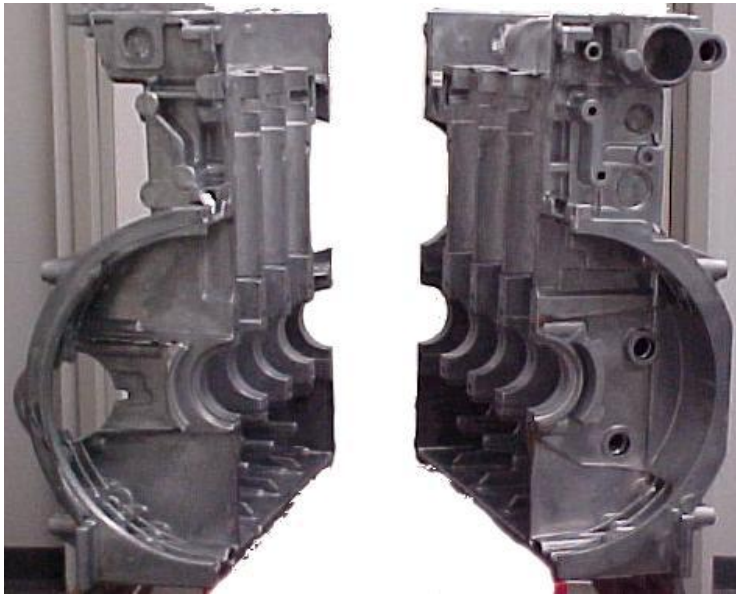


## Manufacture of engine block dies by Schaufler

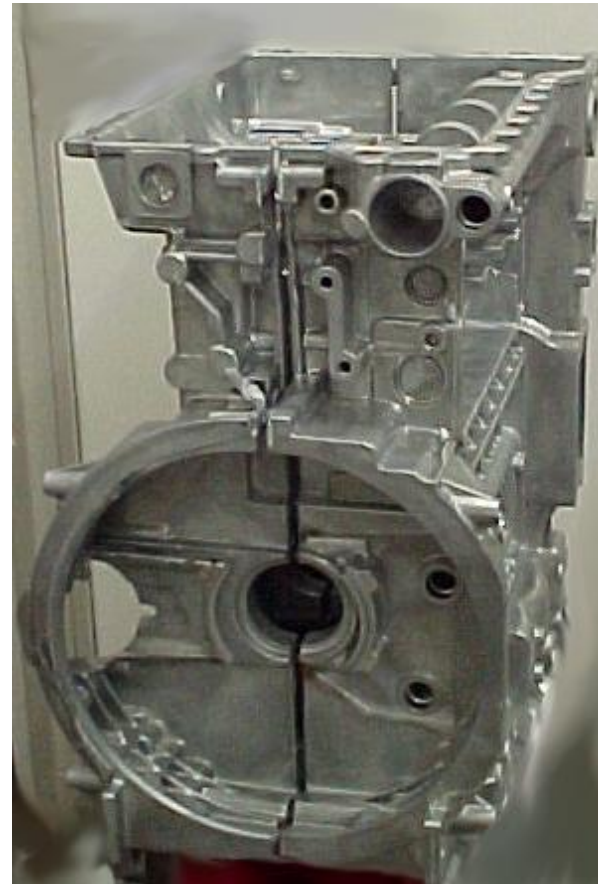
PSA	in-line 4 cyl	Volvo diesel	in-line 5 cyl
Smart diesel/petrol	in-line 3 cyl	Mitsubishi	in-line 3 cyl
Hatz	in-line 2 + 3 + 4 cyl	Mitsubishi	in-line 4 cyl
Mercedes-Benz	V 6 cyl		

in total over 30 dies

# Engine blocks produced on Buhler DCMs I



Hatz Diesel 2, 3 and 4 cyl variants



# Engine blocks produced on Buhler DCMs II

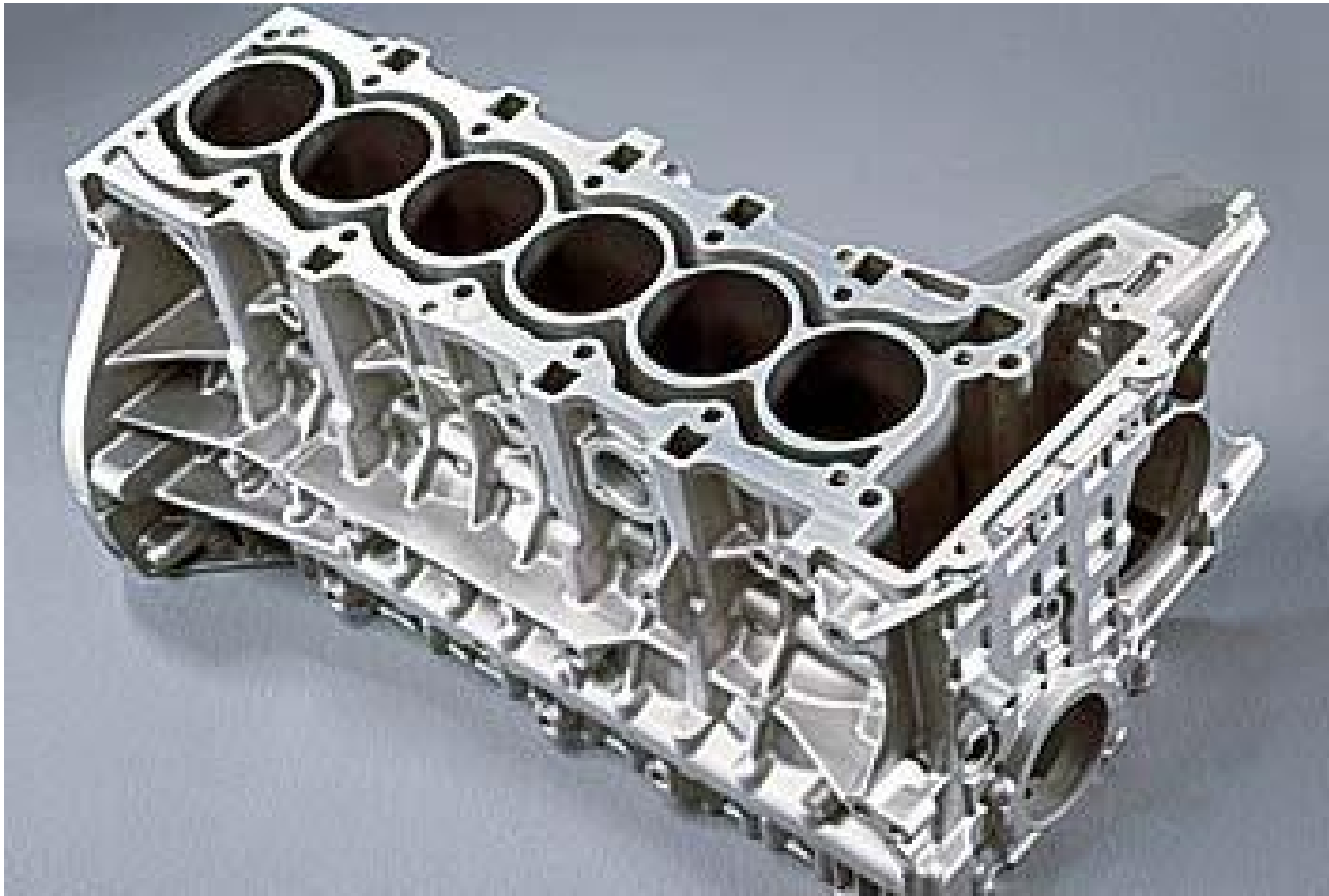


DC M271



MMC 3 cyl

## Engine blocks produced on Buhler DCMs III

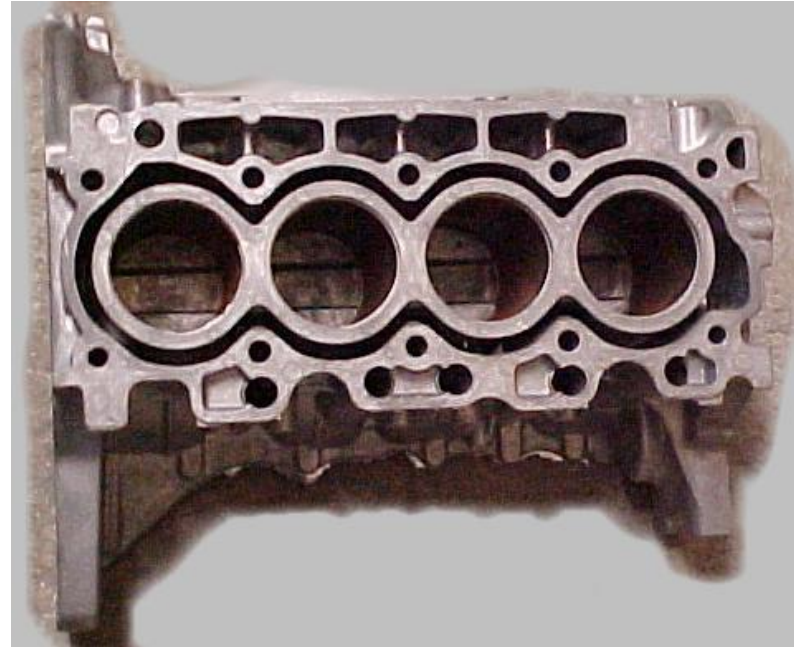


BMW I6 Magnesium

## Engine blocks produced on Buhler DCMs IV



Smart 3 cyl



Ford/PSA 4 cyl Diesel

# Diecaster + Toolmaker + Machine Maker



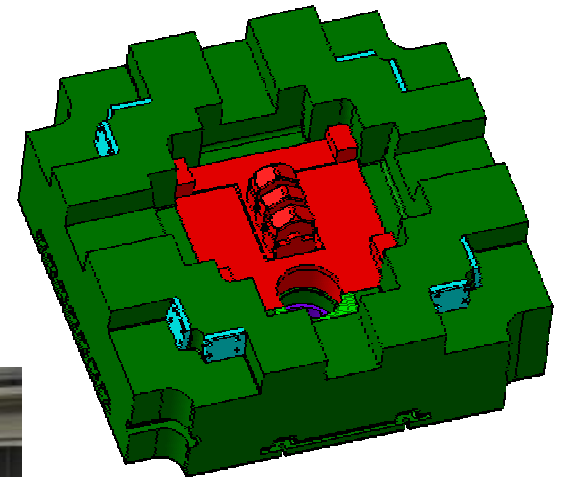
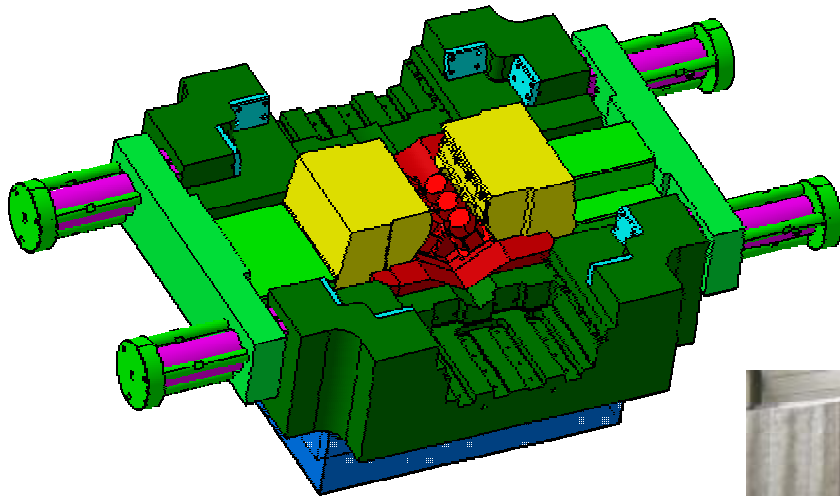
# The rationale for new die concepts

Buhler and Schaufler developed the new die and manufacturing concepts, based on their joint experience of looking at die, DCM and process as one system

**Main aim: to overcome the disadvantages of the conventional approach**

- long cycle times
- high wear rate of the water jacket inserts
- downtime for die maintenance
- build-up of flash around slides
- ejector pin breakage
- leakages
- poor temperature control
- relatively big and heavy dies
- high tooling cost

# Centering and locking system for engine block dies



detail: ejector die

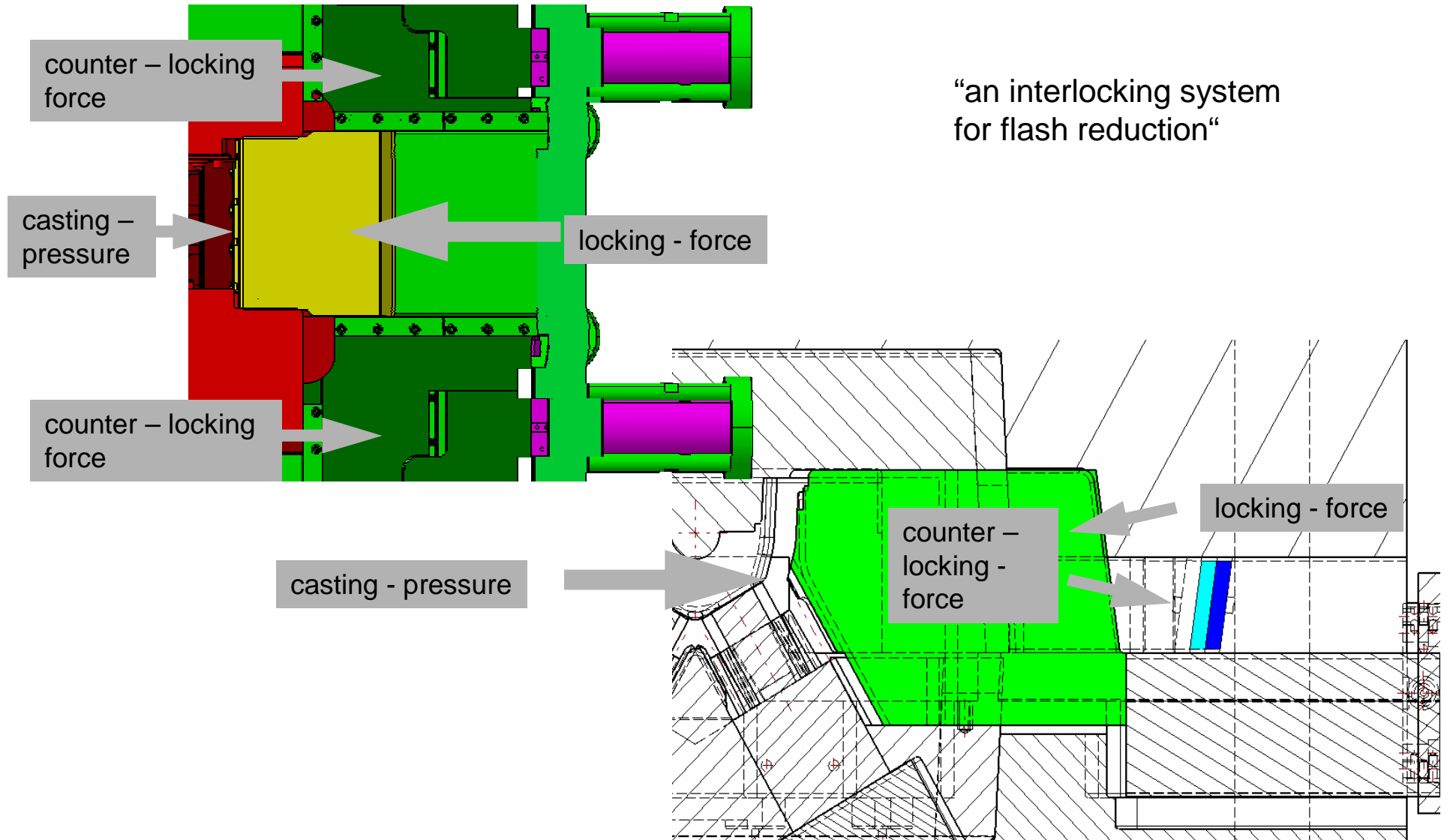


detail: cover die

no need for round or angular guide pins

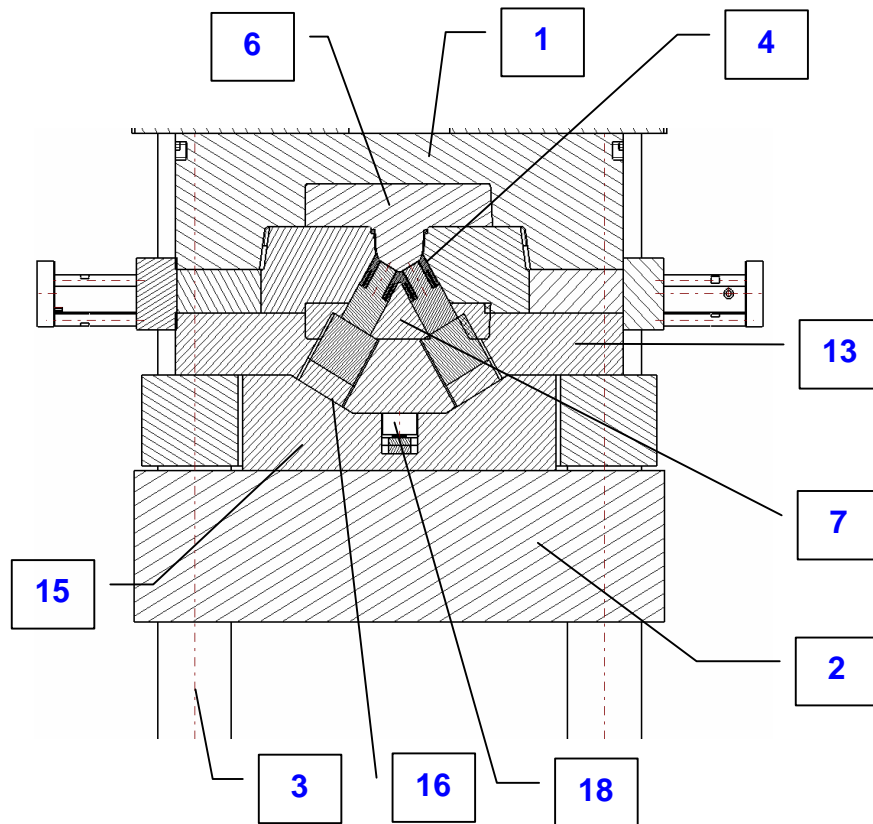
Patent applied for

# Centering and locking system applied to V6



# The new V-engine die and DCM concept I

die closed



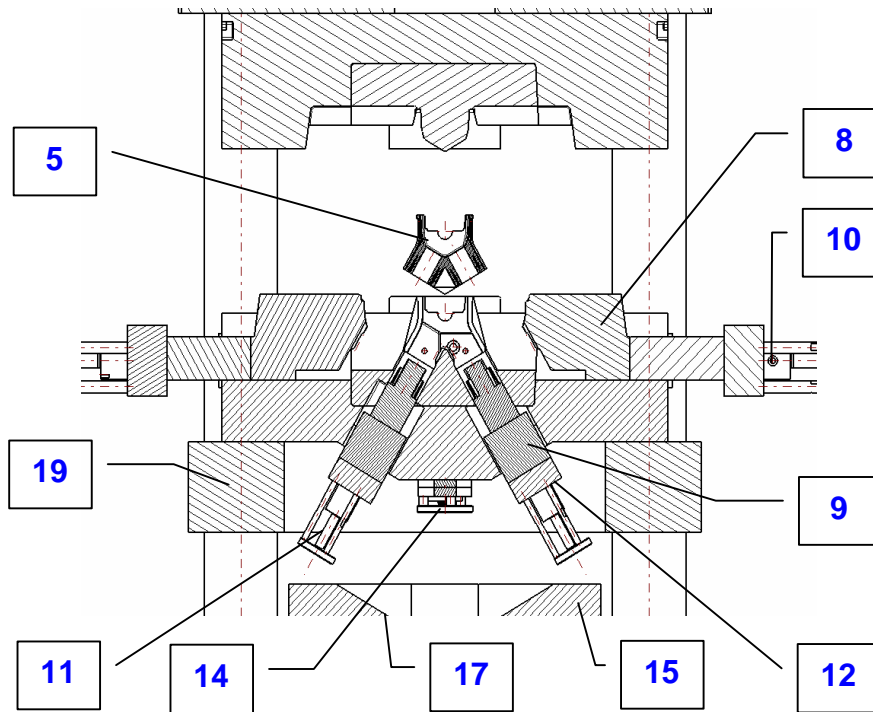
locking plate (15) is support and conduit for (locking) force

Description	
1	Holder block cover die
2	Machine platen ejector side
3	Tiebar
4	Cavity
5	V-engine block casting
6	Insert cover side
7	Insert ejector side
8	Slide
9	Bank slide
10	Hydraulic cylinder
11	Hydraulic cylinder bank slide
12	Cross bar (traverse)
13	Holder block ejector die
14	Hydraulic cylinder, die ejector unit
15	Locking plate
16	Locking surface bank slides
17	Locking surface, locking plate
18	Space for die ejector unit
19	Holder frame

Patent applied for

# The new V-engine die and DCM concept II

die open



locking plate (15) is fixed to machine platen ejector side

ejector die is fixed to holder frame (19)

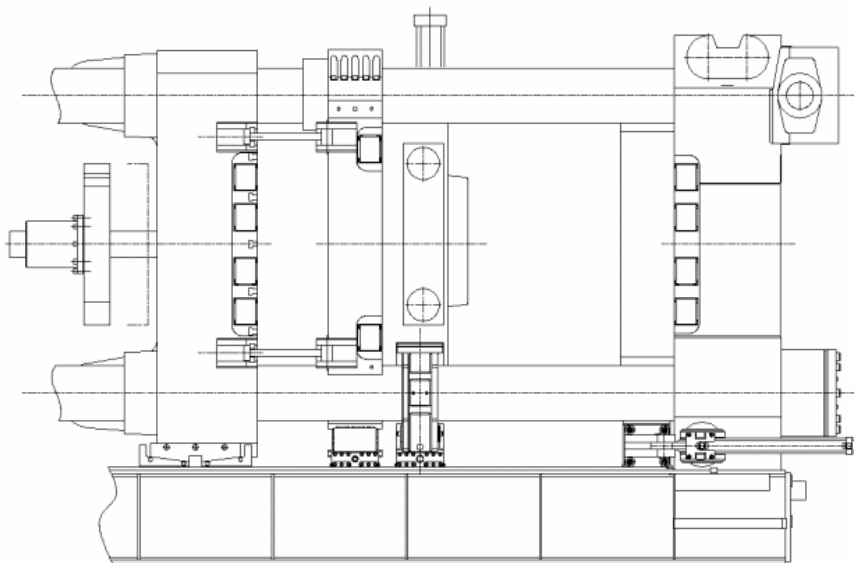
Description	
1	Holder block cover die
2	Machine plate ejector side
3	Tiebar
4	Cavity
5	V-engine block casting
6	Insert cover side
7	Insert ejector side
8	Slide
9	Bank slide
10	Hydraulic cylinder
11	Hydraulic cylinder bank slide
12	Cross bar (traverse)
13	Holder block ejector side
14	Hydraulic cylinder, die ejector unit
15	Locking plate
16	Locking surface, bank slide
17	Locking surface, locking plate
18	Space for die ejector unit
19	Holder frame

Patent applied for

# The new V-engine die and DCM concept III

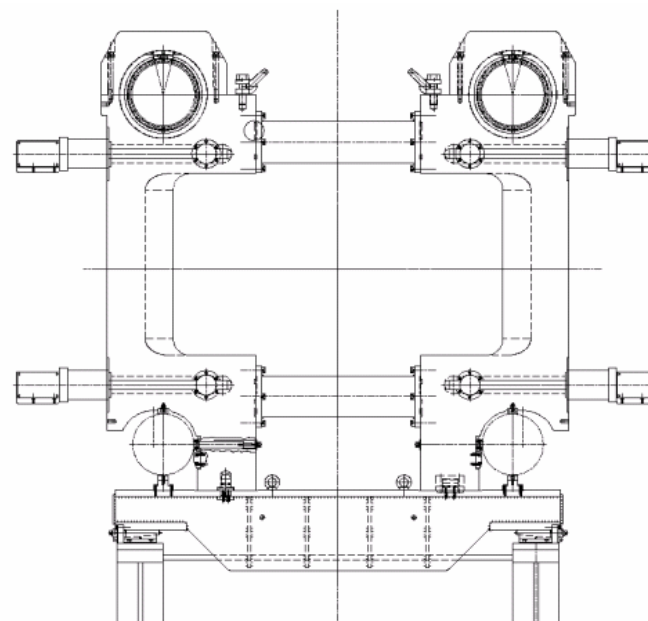
## Die support

- cover side hydraulically actuated
- integrated die centering
- simplified die set-up



## Holder frame

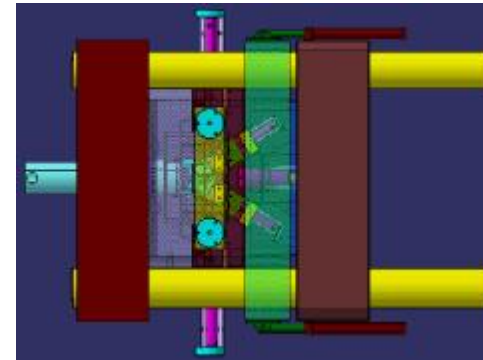
- quick clamping system
- utility supply
- can be dis-assembled / retro-fitted



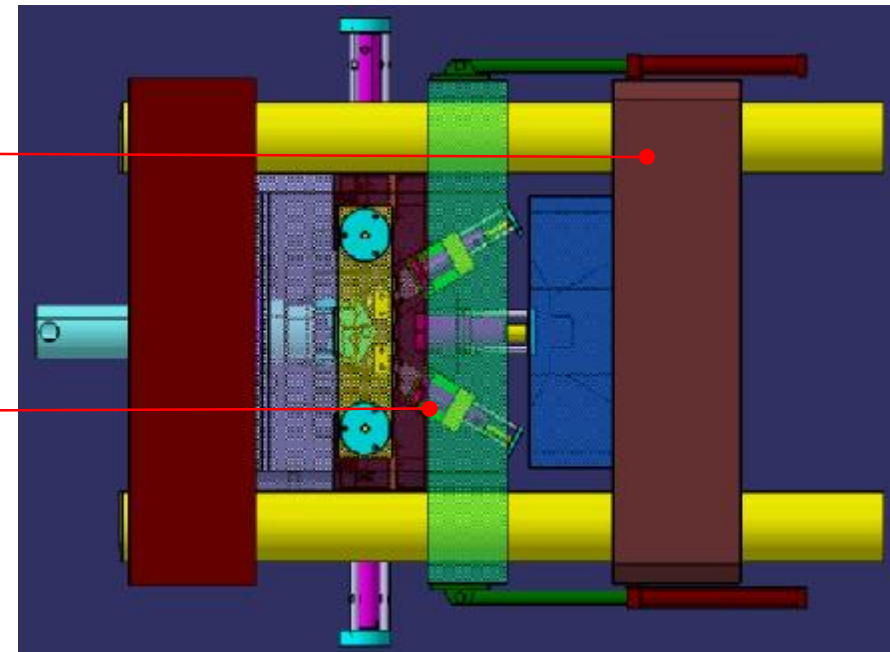
Patent applied for

# Operating sequence 01

- solidification time 1 dependent on part geometry
- pressure off injection cylinder
- machine platen ejector side opens by 300 mm – die stays closed
- bank slides move out
- air cooling starts



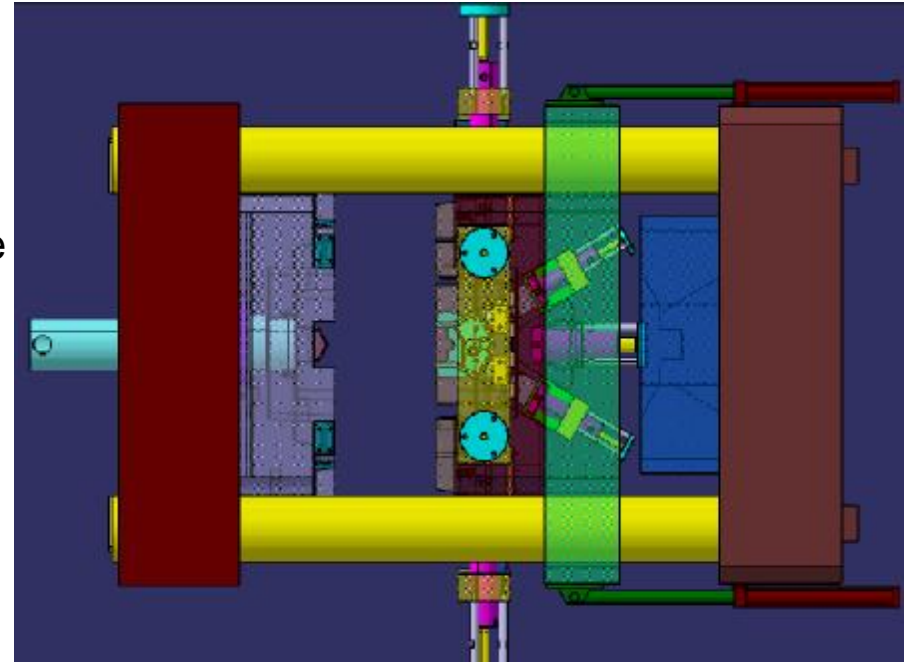
metal in cavity



Patent applied for

# Operating sequence 02

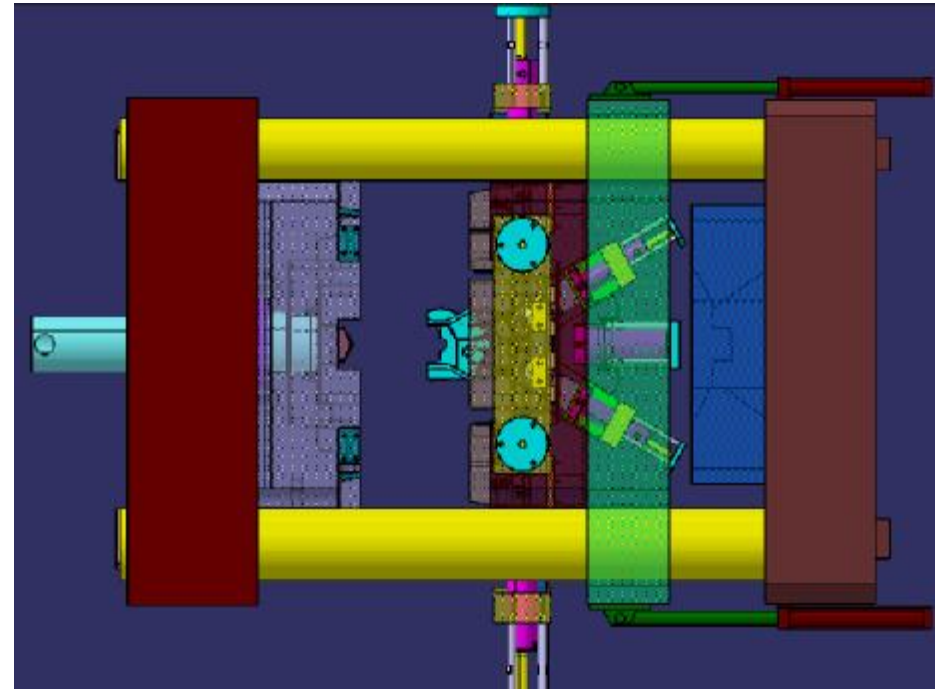
- solidification time 2 dependent on biscuit
- die opens – machine plate ejector side pulls holder frame with ejector die connected to it
- side slides move out simultaneously



Patent applied for

# Operating sequence 03

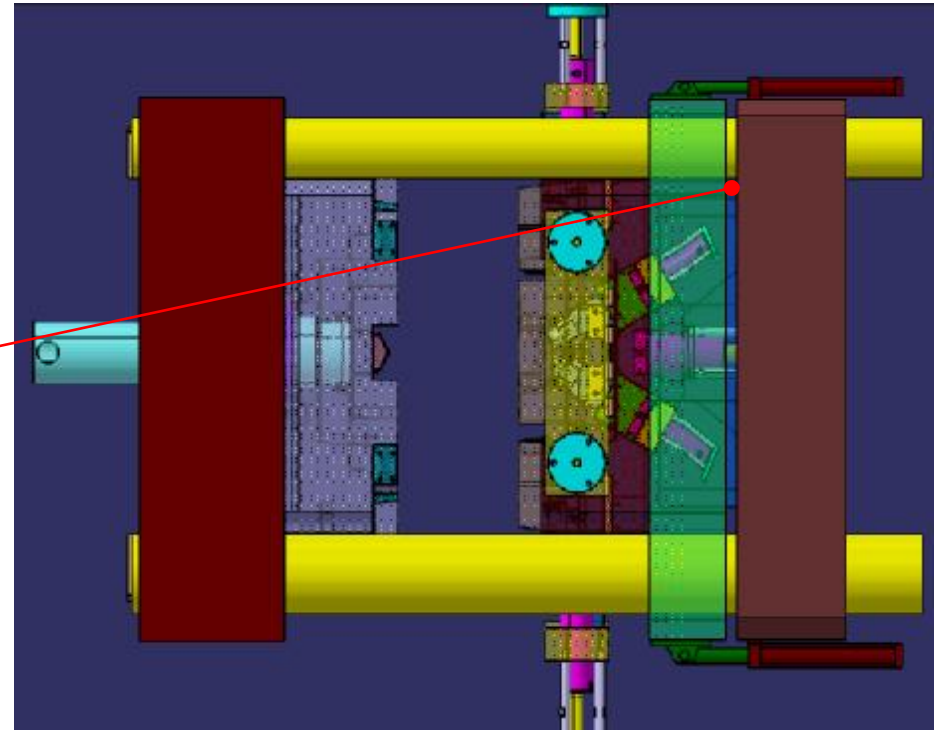
- robot moves in and grips casting
- top and bottom slides move out simultaneously
- ejectors move forward
- extraction of casting
- ejectors move back



Patent applied for

# Operating sequence 04

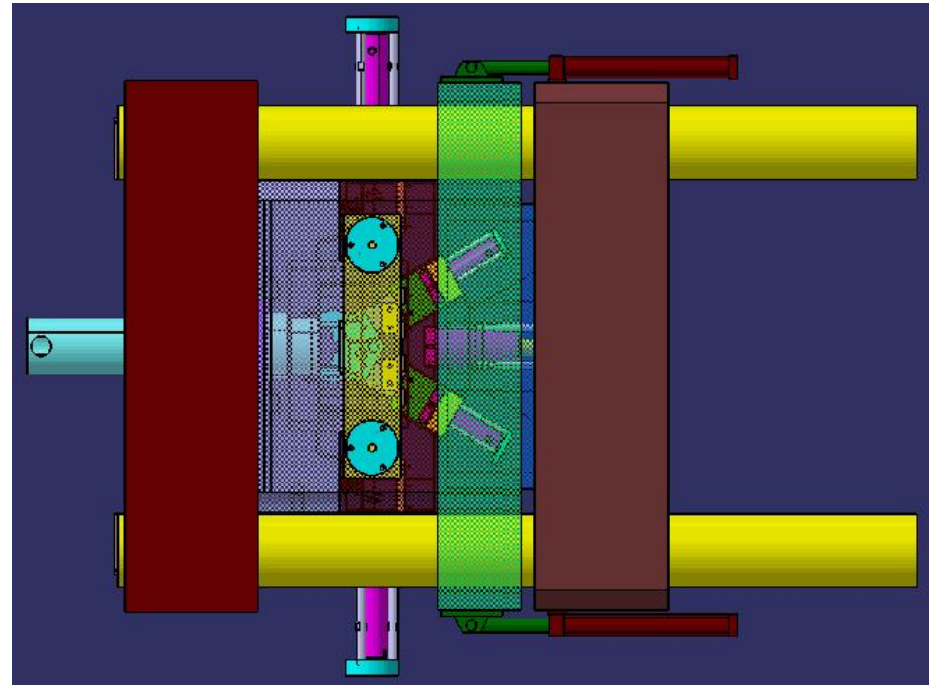
- bank slides move in
- spray cycle starts
- machine platen ejector side moves 300 mm (opening/closing stroke)
- spray and blast
- insert liners



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# Operating sequence 05

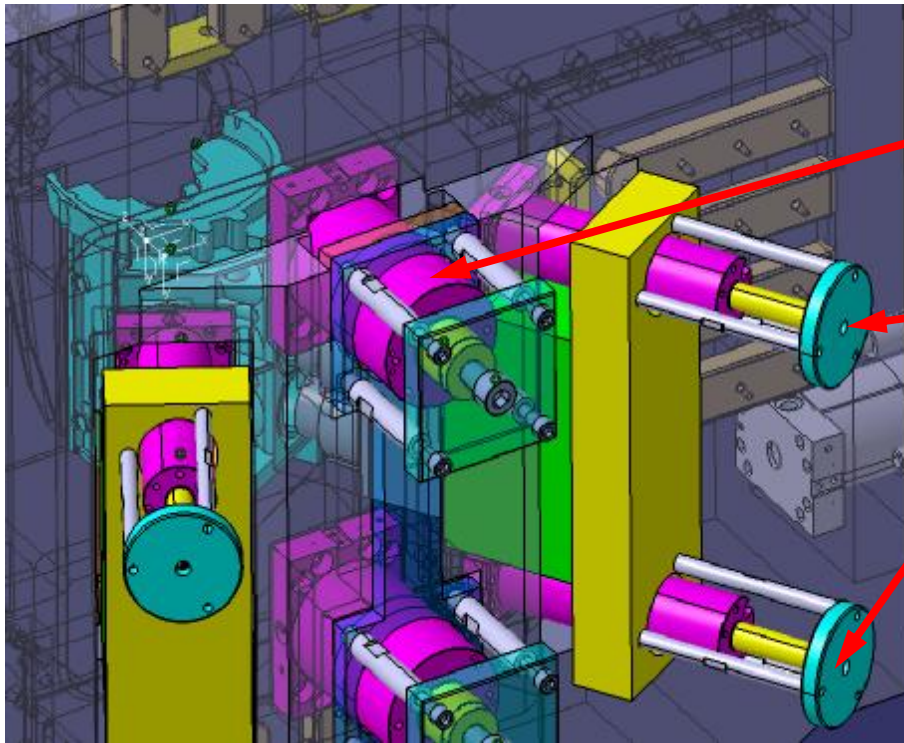
- slides move in
- close and lock die
- filling of shot sleeve
- metal injection



Patent applied for



# Replacement sequence of bank slide assembly II



die ejector unit

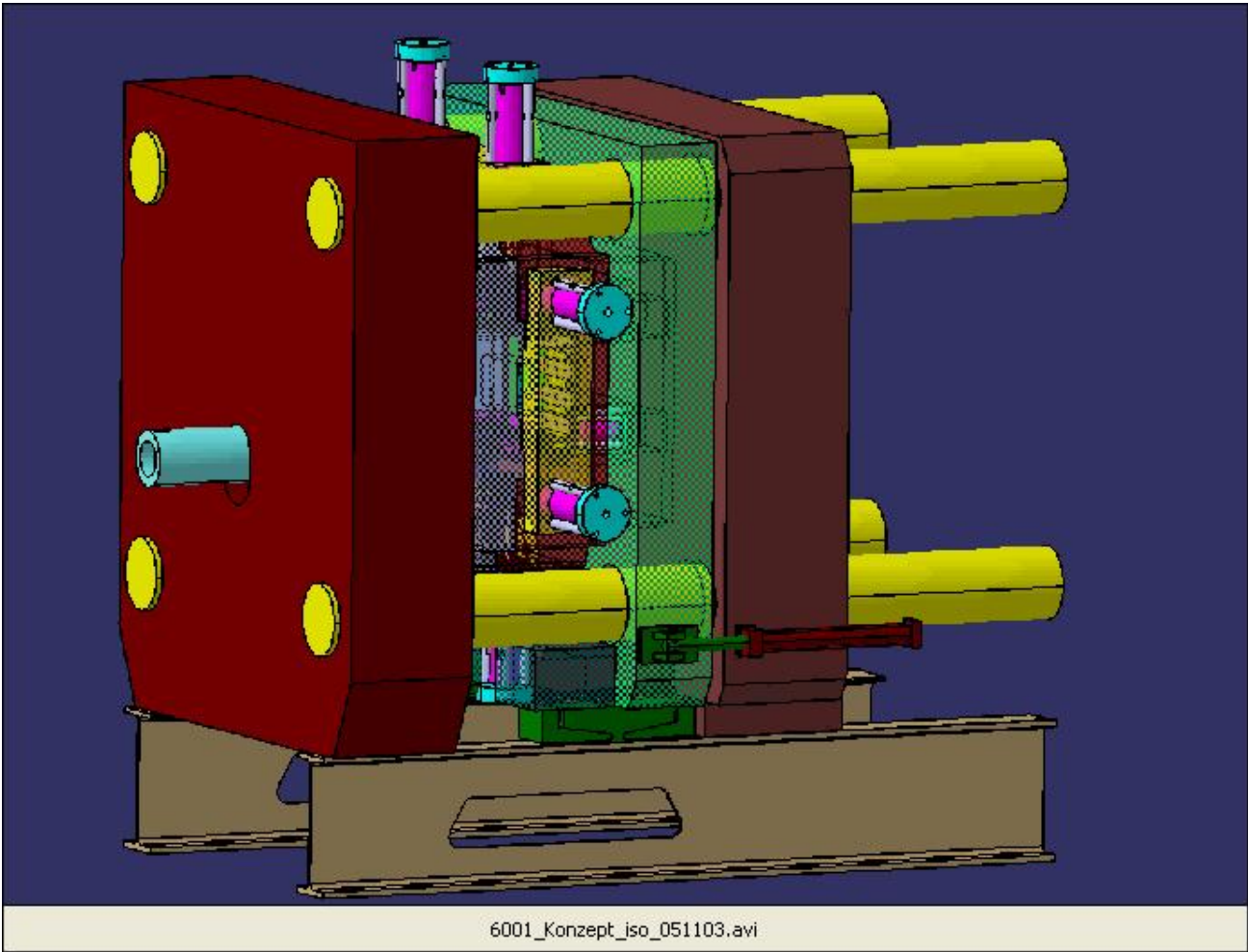
- release fasteners
- disconnect water
- remove slide with hoist

à die ejector unit stays in place

à no need to disconnect hydraulics

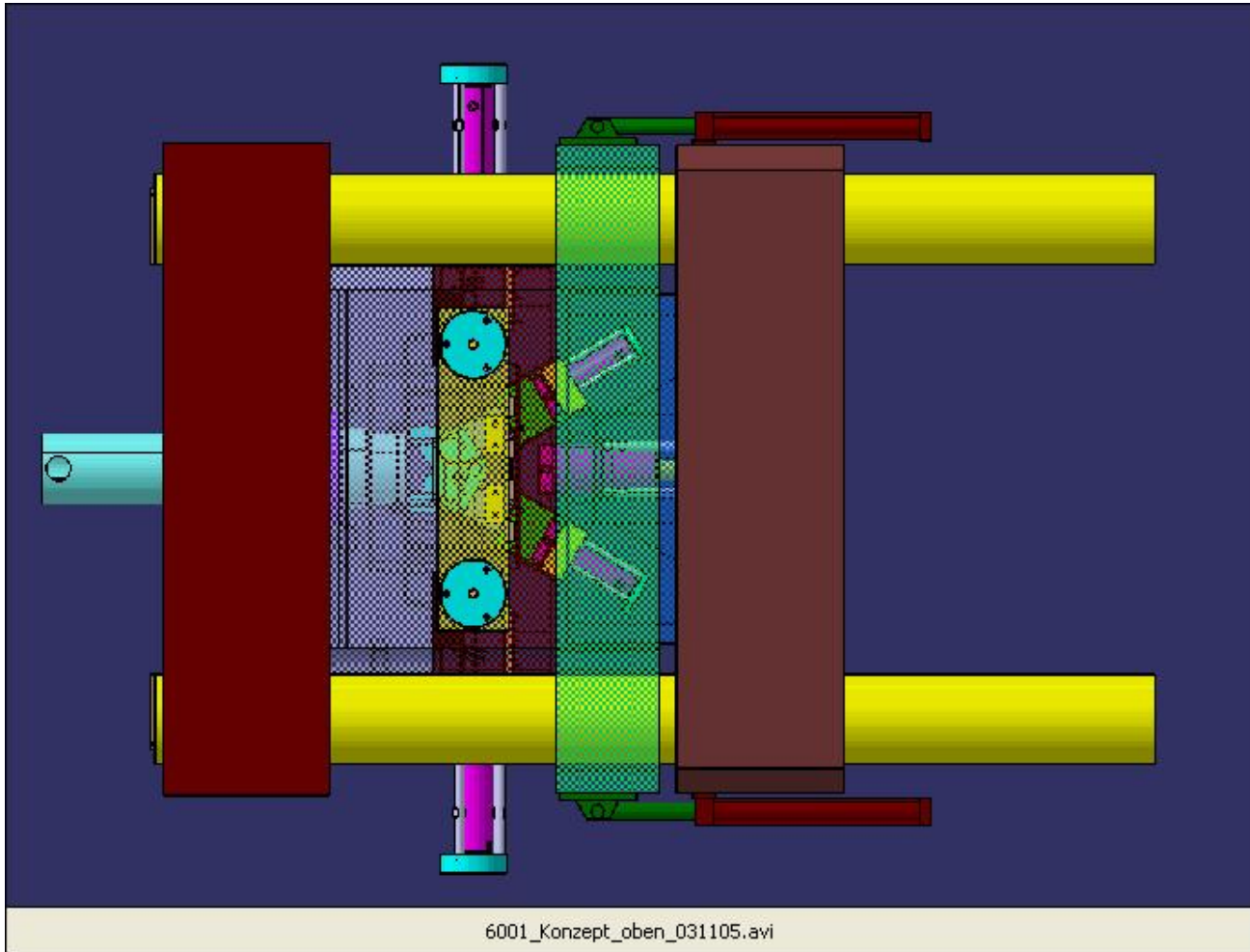
Patent applied for

# Movie - side view



Patent applied for

# Movie – top view



Patent applied for

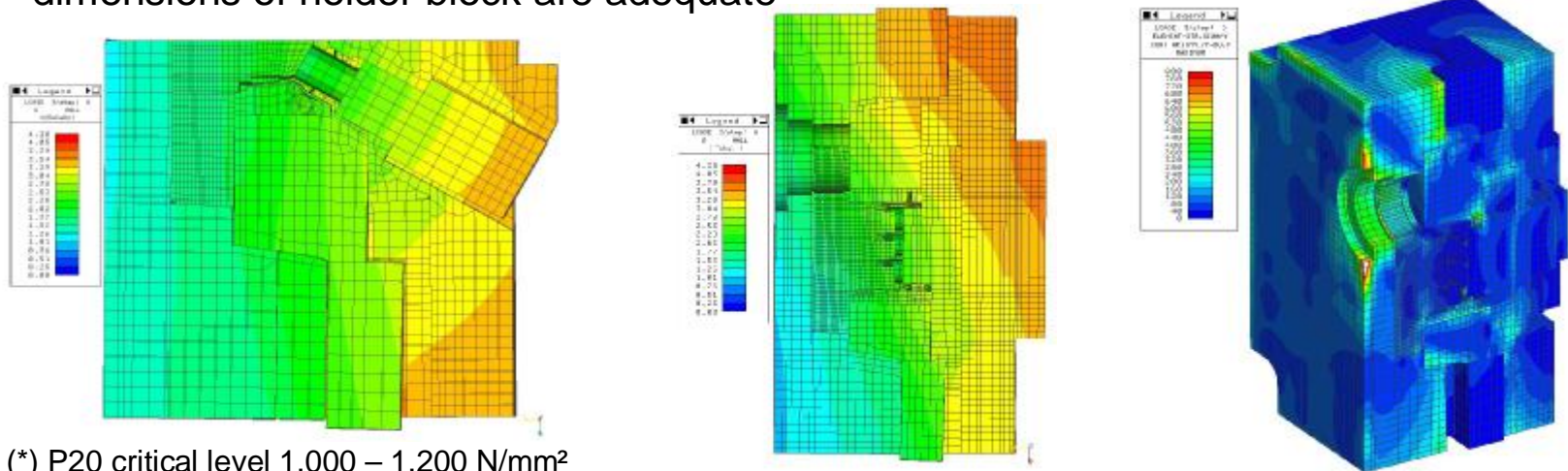
# FEA calculations

## Parameters

- DCM locking force: 3,200 tons (metric)
- cavity pressure range 800 - 1,000 bar (10,000 – 15,000 psi )
- machine platen distortion has been taken into account

## Results

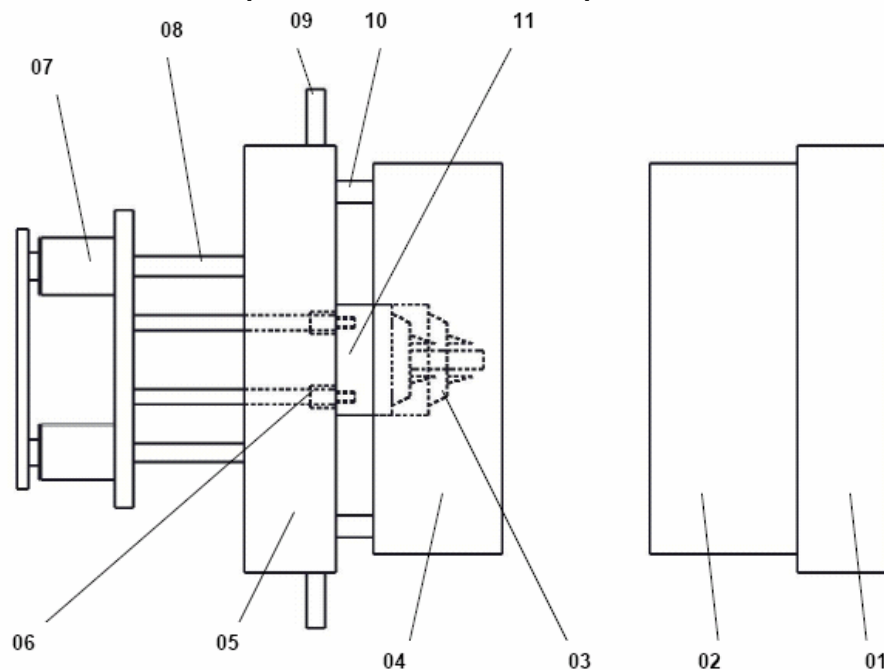
- influence of temperature is most significant in terms of stress and distortion
- displacement of top, bottom and side slides does not exceed 0.23 mm
- displacement of bank slides 0.10 mm
- stress values (von Mises) of slides, inserts and holder block: max. 600 N/mm<sup>2</sup> (\*)
- dimensions of holder block are adequate



# The new die concept for in-line engine blocks I

## Main features

- mobile insert incorporating water jacket, mandrels and core pins
- mobile insert fixed to DCM ejector unit
- guidance system is taken through machine platen (4 rods)
- part ejection without core pins
- die without ejector box, base/ejector plates (typically 350 mm)
- wear plate on machine platen

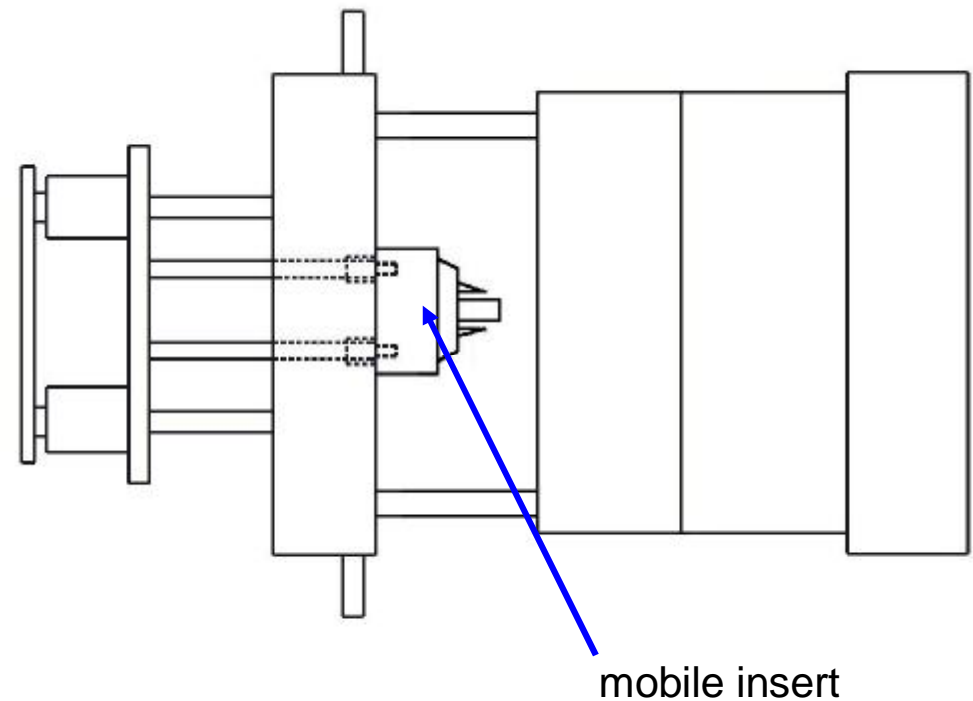


01	Machine platen cover side
02	Cover die
03	Space for opening/closing stroke of mobile insert
04	Ejector die
05	Machine platen ejector side
06	Connection ejector unit and mobile insert
07	Ejector unit
08	Connecting rod
09	Hydraulic quick clamping system
10	Locking bolt for quick clamping systems, two positions
11	Mobile insert

Patent applied for

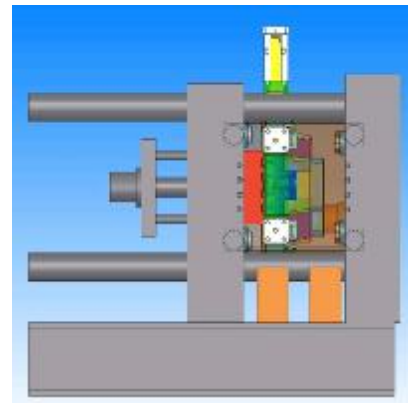
# Replacement sequence of mobile insert

- close die
- ejector moves back
- open machine platen ejector side
- attach mobile insert to crane
- open ejector lock
- move ejector forward
- replace mobile insert



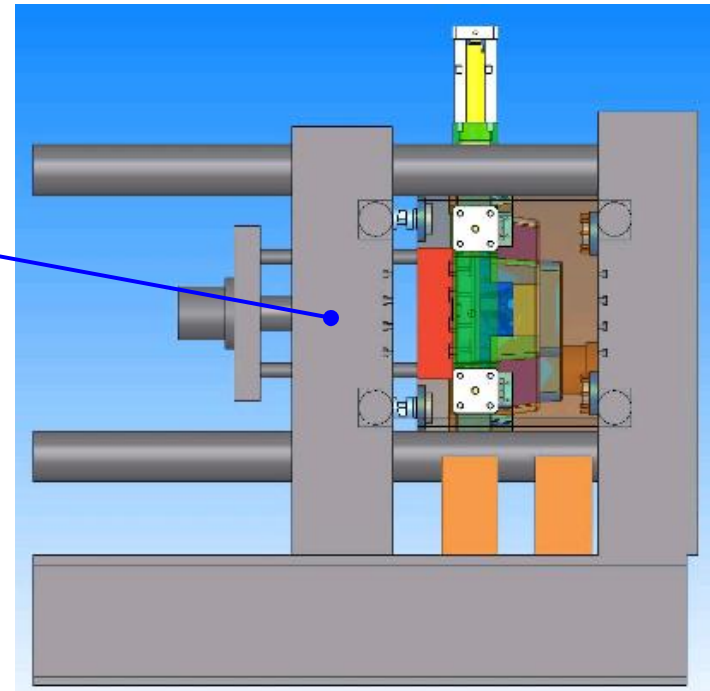
Patent applied for

# Operating sequence 01



metal in cavity

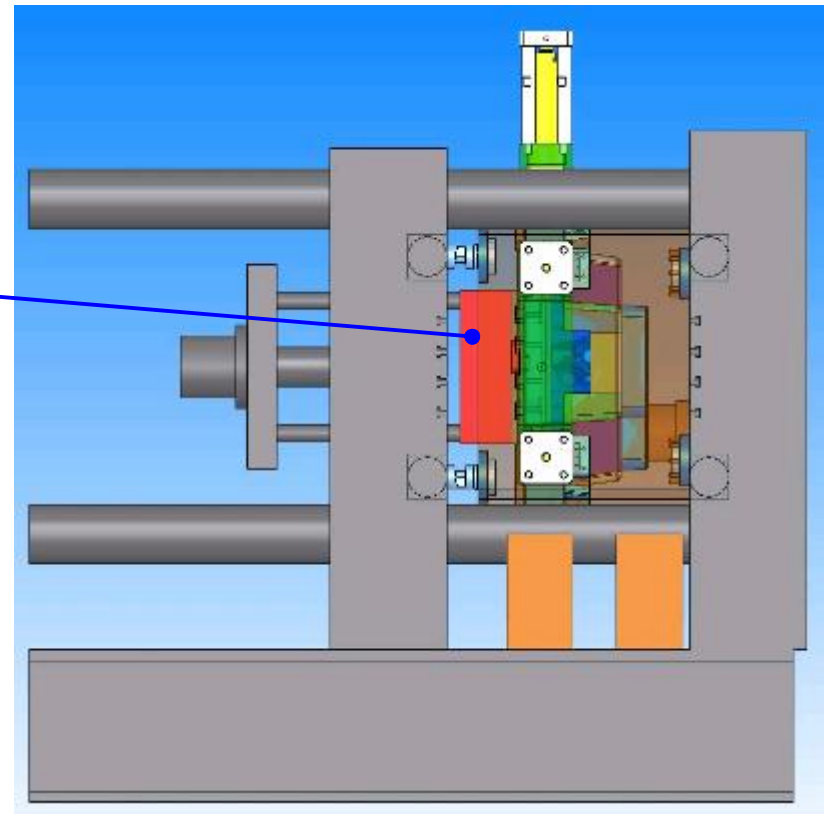
- solidification time 1
- pressure off injection cylinder
- release quick clamping system
- machine platen ejection side opens
- ejector front position signal
- fasten quick clamping system



Patent applied for

## Operating sequence 02

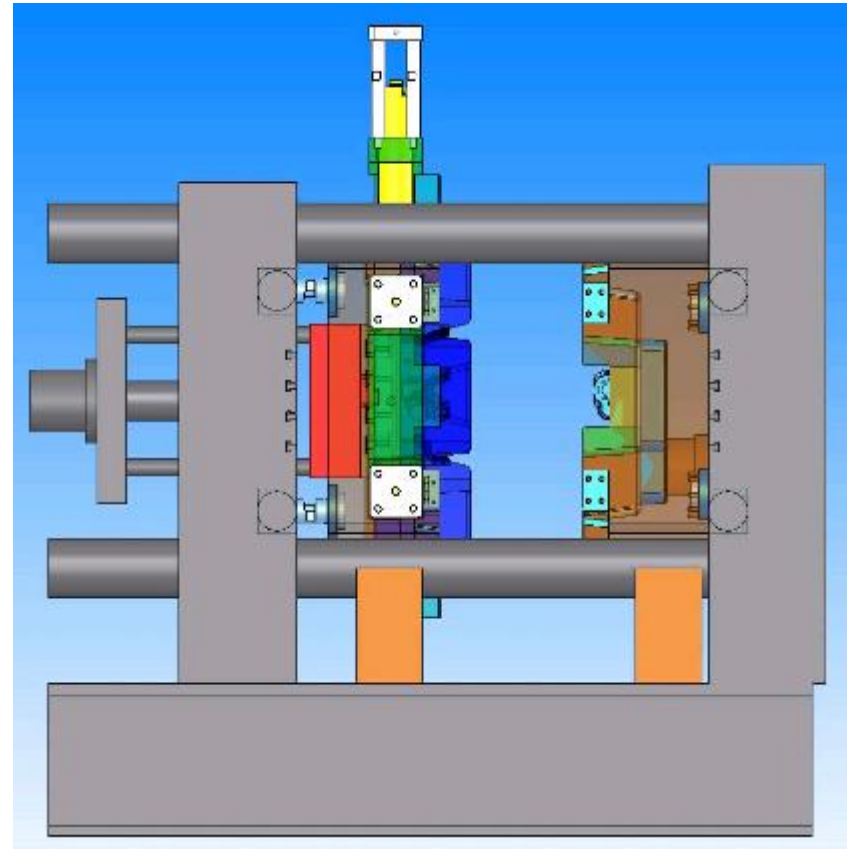
- ejector back position signal (stroke 1)
- mobile insert (water jacket insert and mandrels) moves back
- water jacket insert fully detached, mandrels still protrude approx. 50 mm into casting
- air cooling starts



Patent applied for

# Operating sequence 03

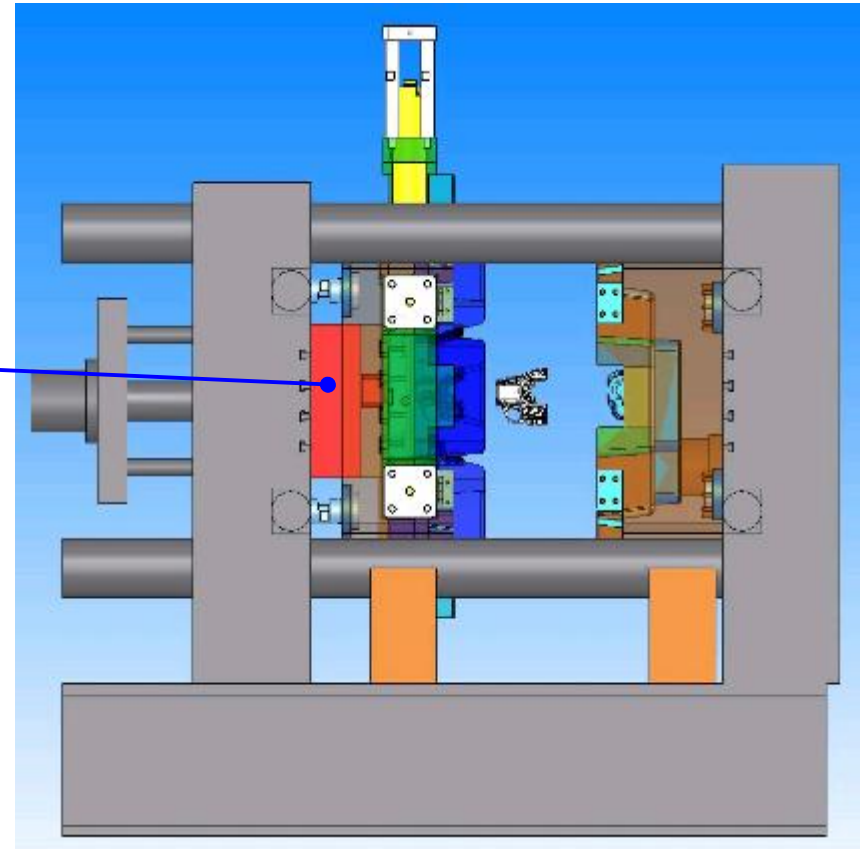
- die opens after solidification time 2
- slides are being pulled back



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# Operating sequence 04

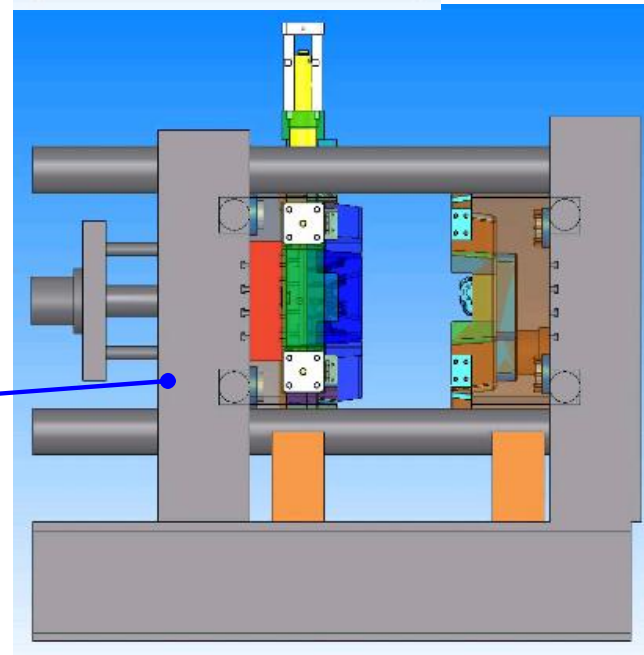
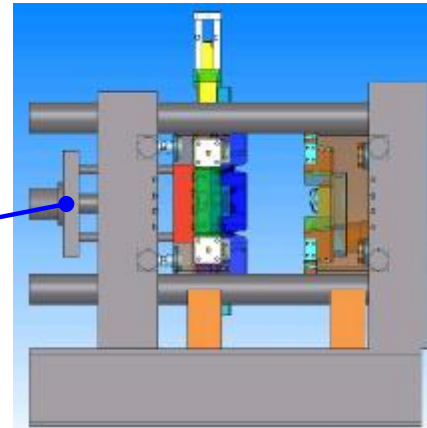
- robot moves in and grips casting
- ejector moves back (stroke 2)
- extraction of casting
- spray cycle starts



Patent applied for

# Operating sequence 05

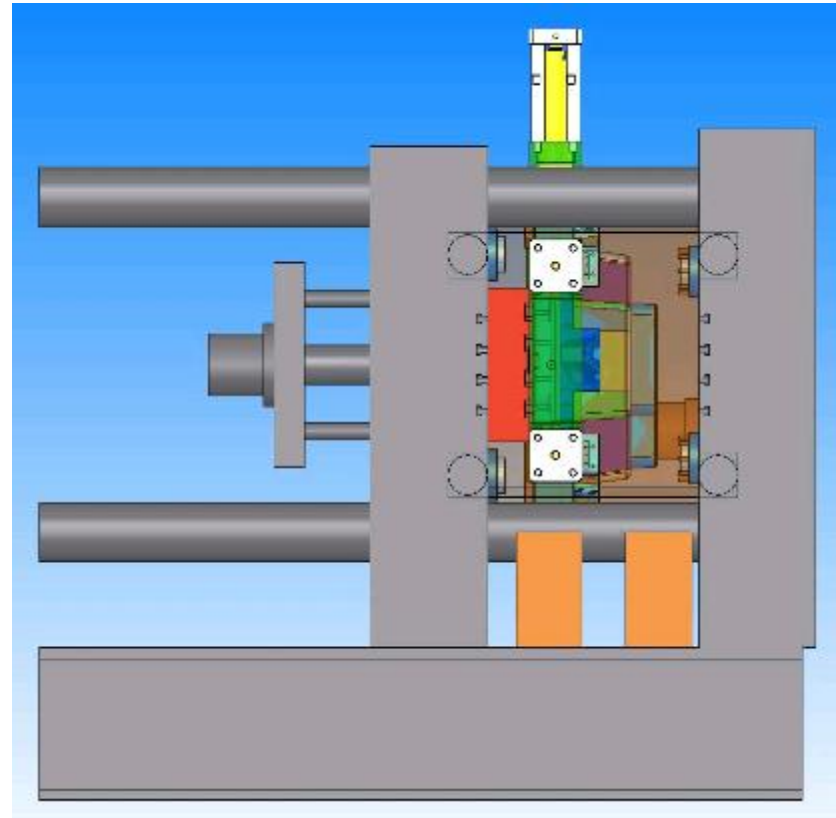
- ejector moves forward
- spray / blow
- insert liners
- slides move in
- release quick clamping system
- machine platen ejector side connects with die



Patent applied for

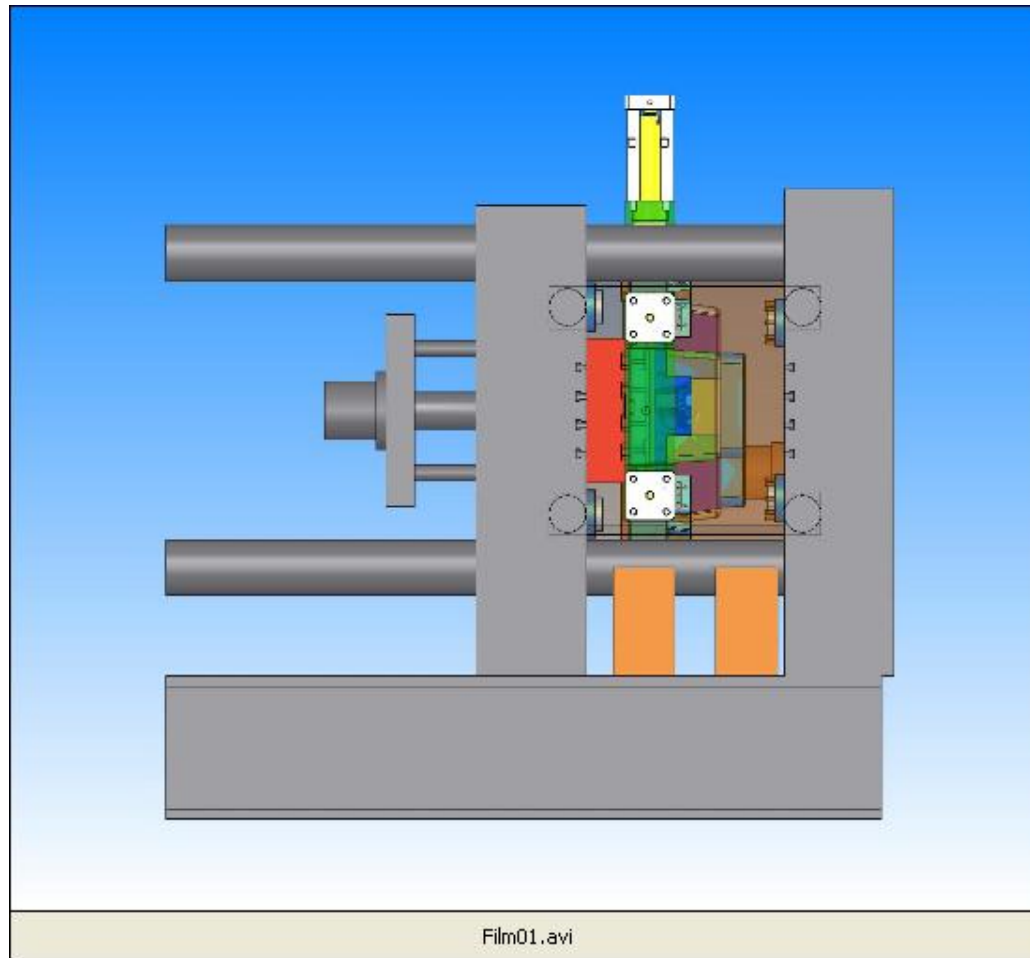
# Operating sequence 06

- fasten quick clamping to secure die
- filling of shot sleeve
- metal injection



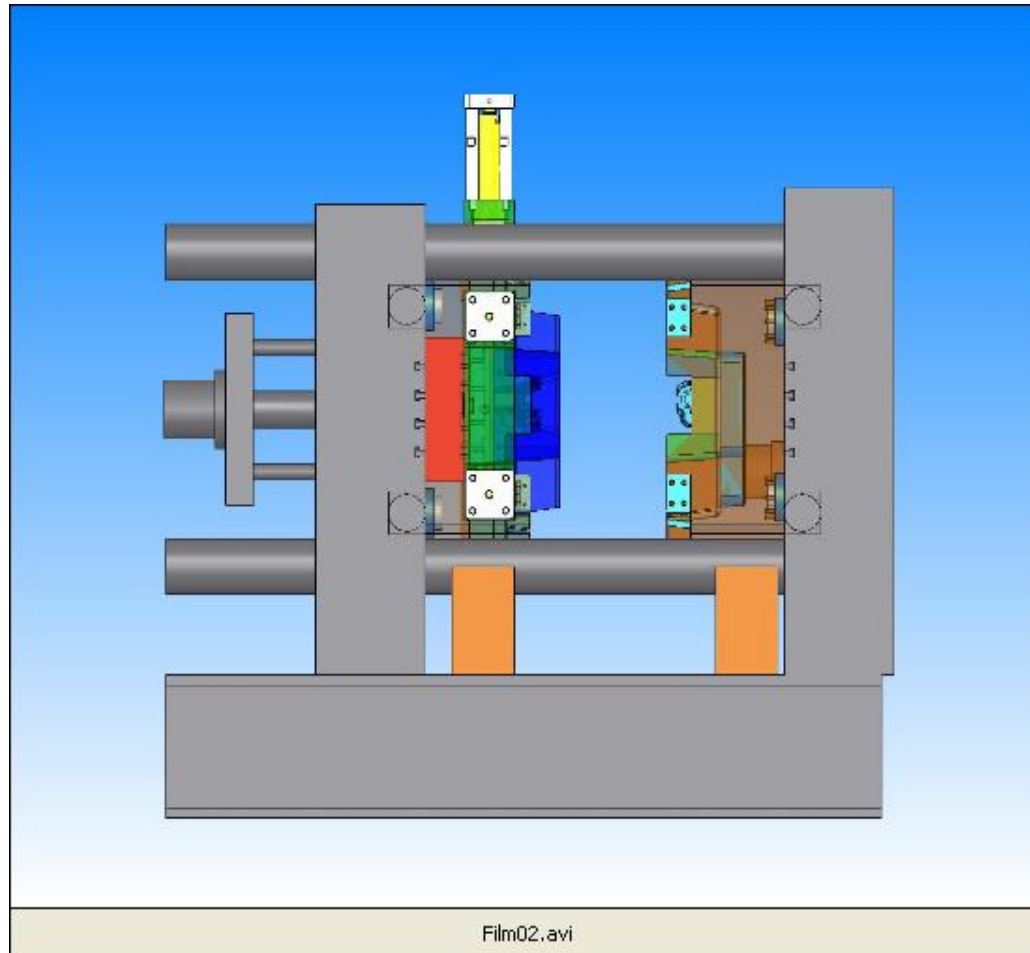
Patent applied for

# Movie – side view



Patent applied for

# Movie – replacement of mobile insert



Patent applied for

# Operational efficiency and spare parts

**Main developmental aims:**

**change perishable items with die remaining on DCM**

**keep die on DCM for up to 25,000 shots**

**Interchangeability of:**

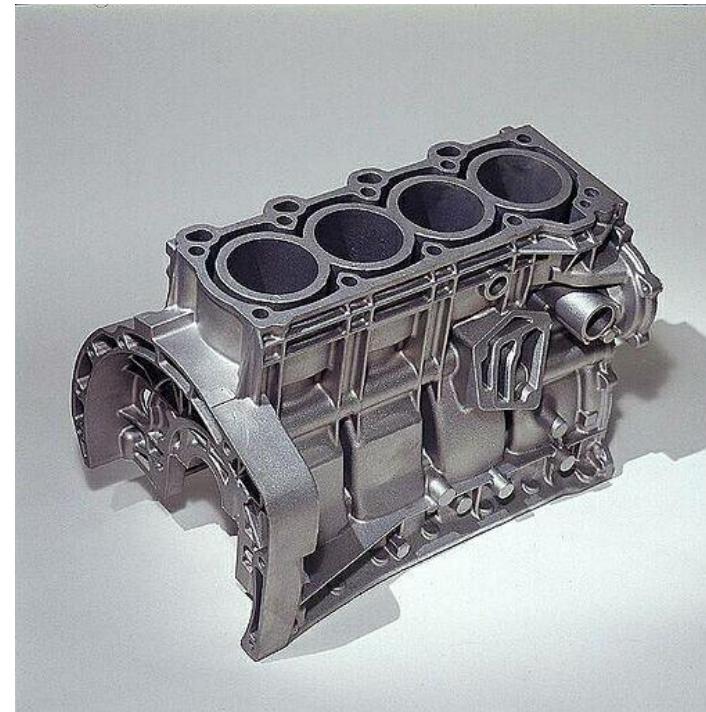
- mobile insert (incorporating water jacket insert, mandrels and core pin in one unit)
- core pins
- partial inserts
- slides



# Advantages of the new die concepts

## The economic case:

- shorter cycle time and with part geometry optimised for HPDC
- longer water jacket life
- increased uptime (availability)
- fewer die change-overs
- smaller and lighter dies
- reduced tear and wear of shot sleeve and plunger
- lower investment



**Thanks for your attention**





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