

NF Wire Forum

Aurubis Metals for Progress

BALLOFFET

BECHEM LUBRICATION TECHNOLOGY

kupfer_

NIEHOFF GRUPPE

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DIES KEY POINTS TO IMPROVE DRAWING PERFORMANCE

Christophe PAULIN
Sales Export Manager

Balloffet – Who we are

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- A European company
- 7th generation family owned
- Manufacturer of diamond dies for 155 years
- 170 employees
- Worldwide frontrunner company in the development of diamond die manufacturing technologies for mono and multi line wire machines
- Leader in the development of machines for die control, production and repair
- Worldwide represented





DRAWING DIES



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EXTRUSION TOOLS

Ultra fine DIES Ø > 6 µm









EQUIPMENT AND TRAINING

Shaped dies Stranding dies Enamelling guides







SPECIAL PRODUCTS







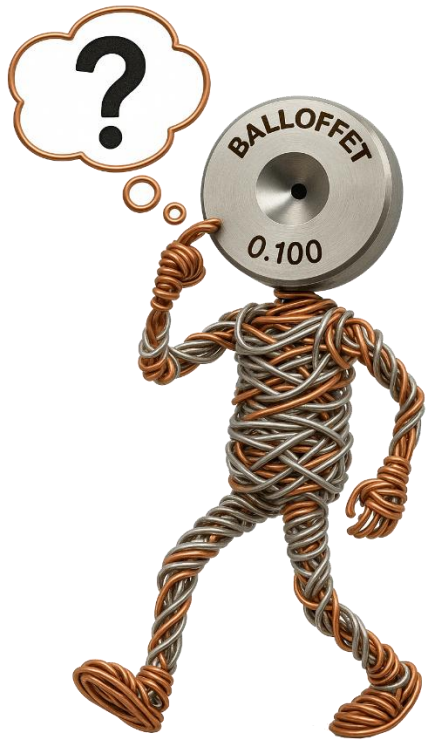
DIES KEY POINTS TO IMPROVE DRAWING PERFORMANCE

DRAWING PERFORMANCE PARAMETERS

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CUSTOMERS MAINLY ASK US TO:

- Reduce wire breaks
- Increase drawing speeds
- Reduce material losses
- Increase lubrication efficiency
- Reduce metal particles



HOW CAN DIES HELP TO IMPROVE ?

- Wire breaks ↘
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- Scrap reduction

THE DIAMOND

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- **Monocrystalline diamond**
  - **Natural diamond**
  - **Synthetic diamond**

- **Polycrystalline diamond (PCD)**



- Wire breaks ↘
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- Scrap reduction

MONOCRYSTALLINE DIAMOND

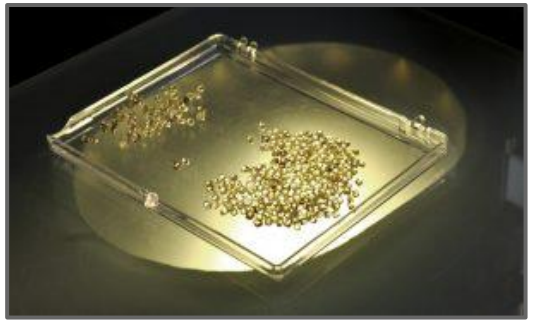
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NATURAL DIAMOND (100% individual internal selection)

BEST ROUGH DIAMOND

- Stone dimensions / weight
- Internal purity
- defect free for heat release
- Kimberley Certificate (Sustainable mines)







ALTERNATIVE WITH SYNTHETIC DAMOND (SSCD DIAMOND)

- Wire breaks ↘
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- Scrap reduction

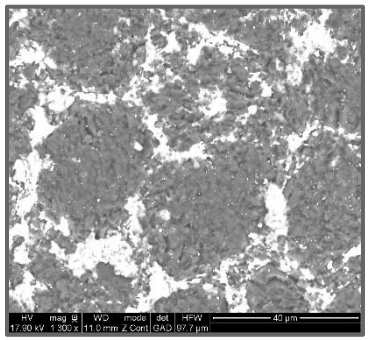
POLYCRYSTALLINE DIAMOND - PCD

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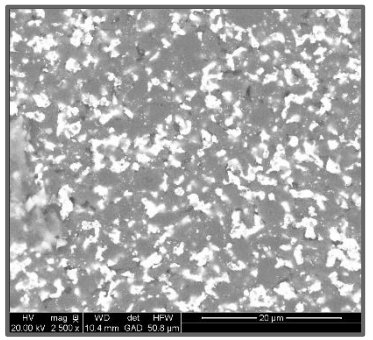


- Blank dimensions choice
- Grain (from 50 µm down to 1µm)
  Best balance life time / polishing level
- Premium quality

Blank grain 50 µm



Blank grain 5 µm

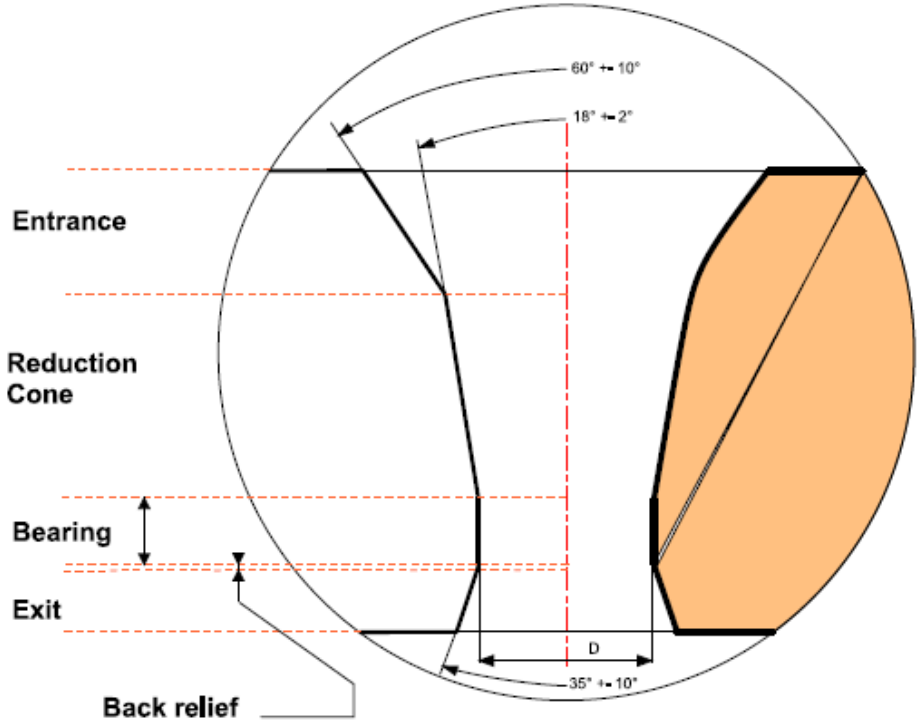


- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- **Scrap reduction**

DIE INTERNAL GEOMETRY

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- Entrance cone
- Reduction cone
- Bearing length
- Back Relief
- Exit cone



- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- **Scrap reduction**

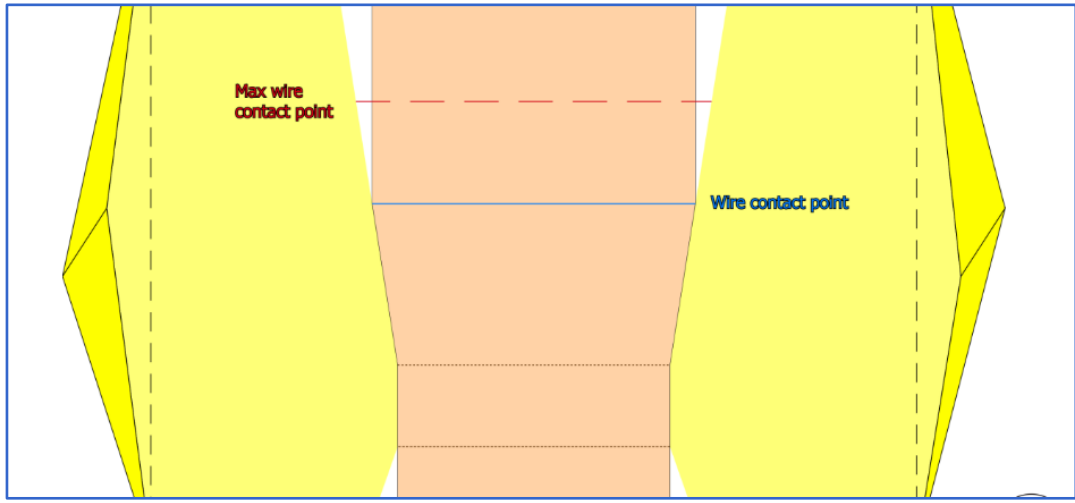
REDUCTION CONE

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ENSURES A REGULAR AND CONTROLLED REDUCTION OF WIRE Ø

Depends on :

- Drawn material (Standard Copper ND+PCD - 18°)
- Elongation (machine)
- Drawings specifications (metal type, machine)



FIND THE BEST ANGLE BALANCE

- Tight angle → excessive wire deformation zone → significant drawing forces → risk of wire breakage
- Wide angle → insufficient wire deformation zone → premature wear of the die.

- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- **Scrap reduction**

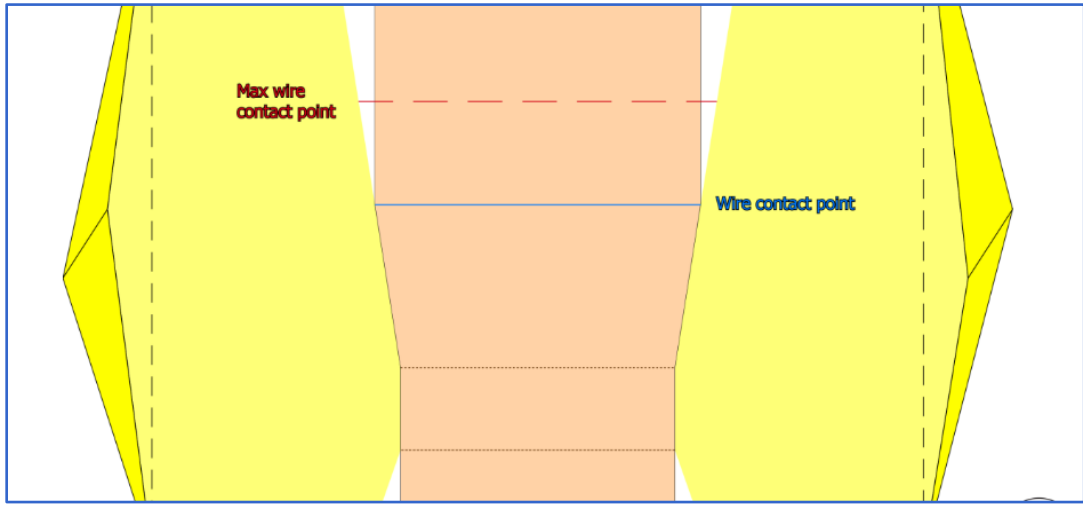
BEARING LENGHT

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ALLOWS TO BRING AND KEEP THE WIRE TO THE REQUIRED Ø

Depends on :

- Drawn material (Standard Copper ND 40% - PCD 30%)
- Wire application (soft and hard metals)
- Required characteristics (metal type, machine)



FIND THE BEST LENGTH BALANCE

- Short bearing → die life reduced
- Long bearing → significant drawing forces → risk of wire breakage

- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- **Scrap reduction**

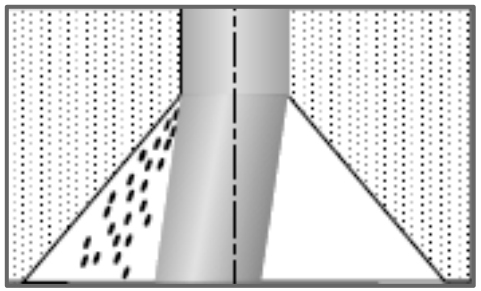
BACK RELIEF

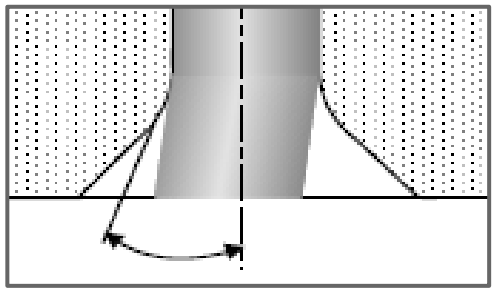
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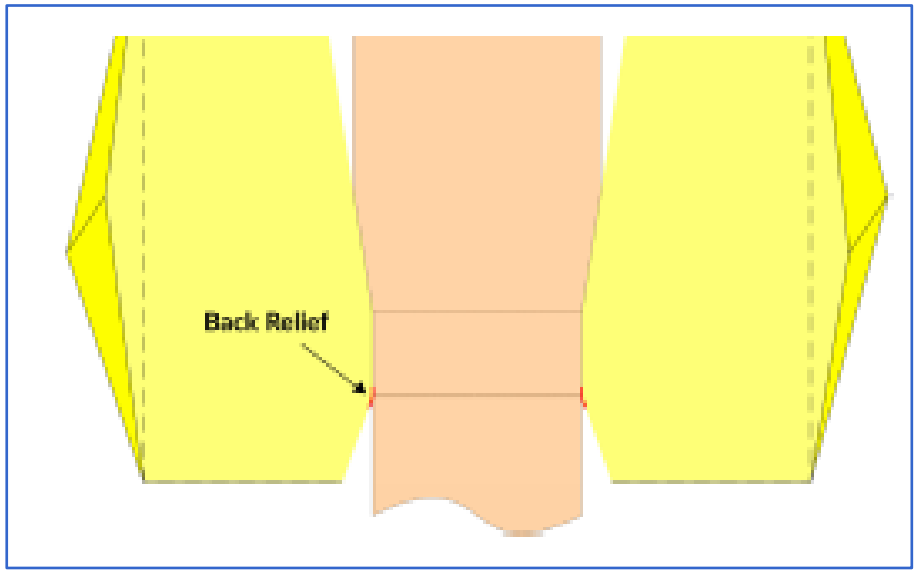
REDUCES WIRE SCRATCHES AND CREATION OF METAL PARTICLES

Blending between the bearing and the exit cone in order to round off sharp angles

- Avoids wire shaving
- Avoids creation of metal particles
- Mantains lubricants bath clean







Must be marked and systematic

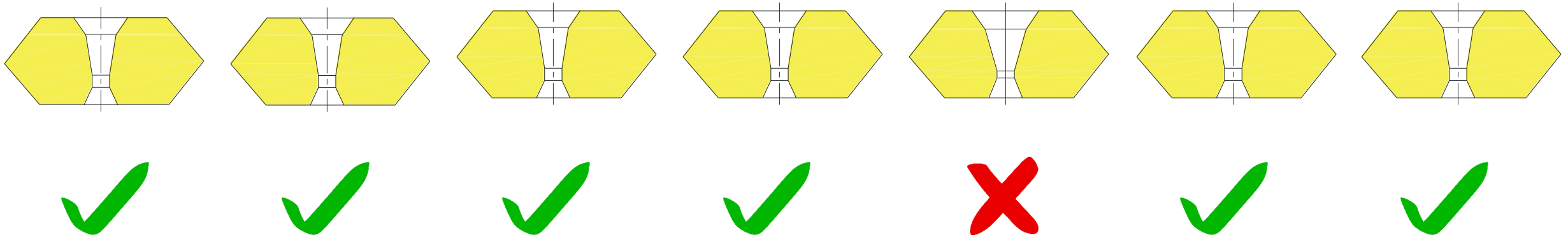
New and recut dies

- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- **Scrap reduction**

DIES GEOMETRY CONSISTENCY

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IN PARTICULAR FOR MULTILINE DIES SEQUENCES

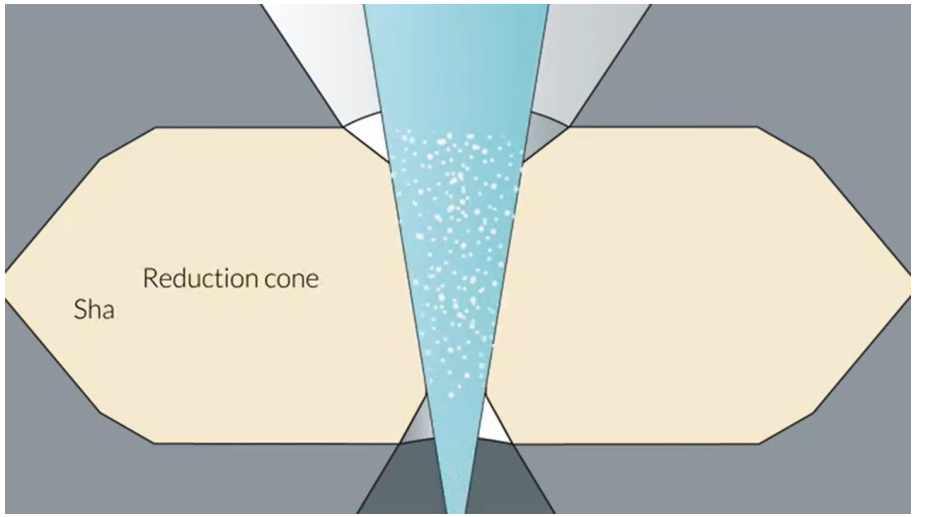


- **Wire breaks ↘**
- **Drawing speed ↗**
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- **Scrap reduction**

DIES GEOMETRY CONSISTENCY

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It is important to get the **optimal** geometry of the die according to the type of material to be drawn.



But

The **homegenity of dies geometry** within die sets is a **key factor** to ensure optimal drawing conditions.

*To ensure **the shapes consistency,** BALLOFFET uses **an ultrasonic shaping process (For ND and PCD).***

- **Wire breaks ↘**
- **Drawing speed ↗**
- **Material savings**
- Lubrication efficiency
- Scrap reduction

Dies diameter - Roundness

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A die set is determined by:

- The final wire diameter to be produced
- The drawing machine kinematic

Size Range (mm)	Soft Material		Hard Material		Standard Tolerance (mm)	Tightest Tolerance (on request)	Out of roundness (µm)
	A	B	A	B			
> 0.10 - 0.20	18°	0.3 - 0.5 Ø	14°	0.4 - 0.6 Ø	1.0	0.8	0.8
> 0.20 - 0.50					2.0	1.0	1.0
> 0.50 - 1.00					2.5	1.5	1.3
> 1.00 - 1.50					3.0	2.0	1.5
> 1.50 - 2.00					3.0	2.0	1.5
> 2.00					3.5	2.5	2.0

The die diameter has to be controlled with accurate method



Control by weight method



Control with laser micrometre 180° rotation of the wire



Control with laser micrometre X – Y measurement

- **Wire breaks ↘**
- **Drawing speed ↗**
- **Material savings**
- Lubrication efficiency
- Scrap reduction

DIAMETER & ROUNDNESS PRECISION

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FINAL DRAWING DIES

- Fit wire requirements (Ø and roundness)
- Material saving

PROCESS DIES

- ***Fits the drawing machine kinematics***

Material waste for 1 µm Ø deviation

(base 10500 USD per Cu ton)

Speed: 30 m/s Base: 1 Wire Time: 24 hours

- **Ø 0.20 mm → 1µ = 76.80 USD**

For 24 wires / 24 hours = 1843 USD

- **Ø 0.50 mm → 1µ = 181.72 USD**

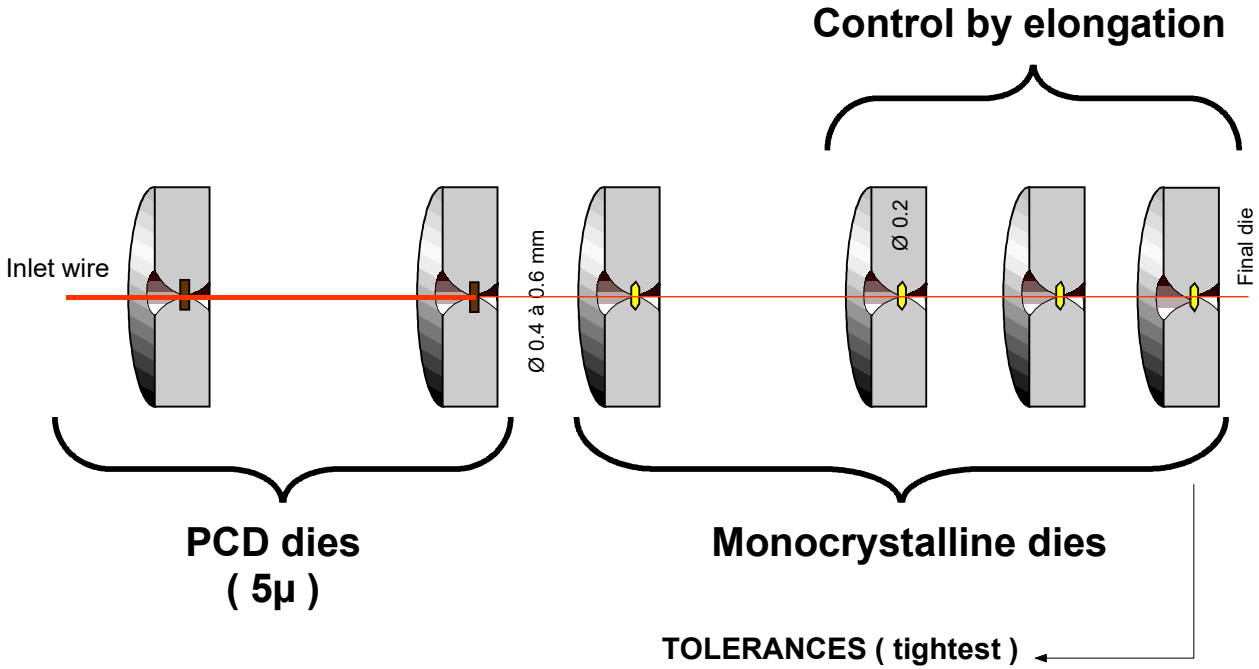
- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- Scrap reduction

ELONGATION

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Dies diameter / Wire elongation

- Ø down to 0.20 mm must be checked by drawing and measuring a copper wire sample
- Ø below 0.20 mm, **BALLOFFET does recommend to check/control the dies sets by Elongation**



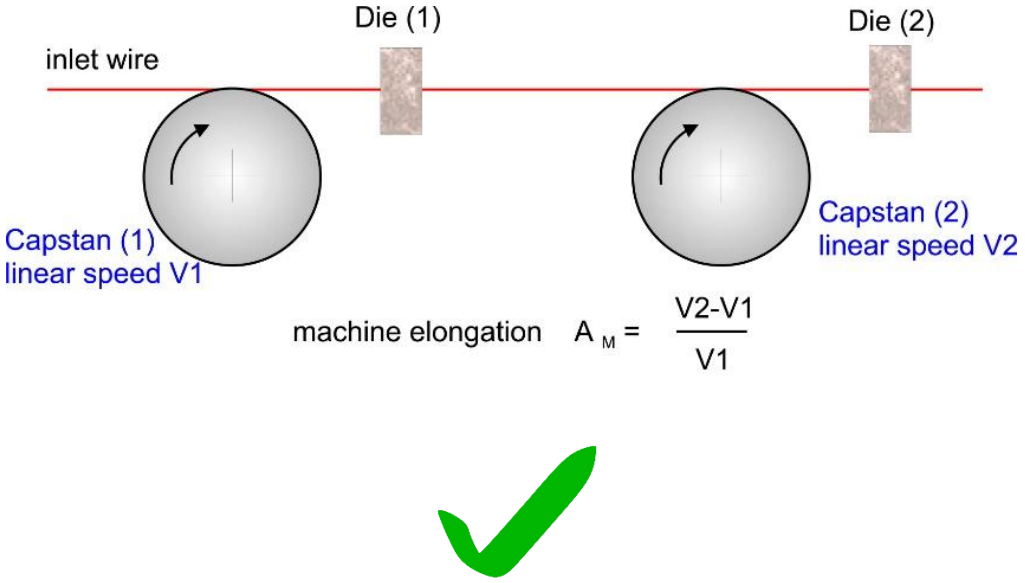
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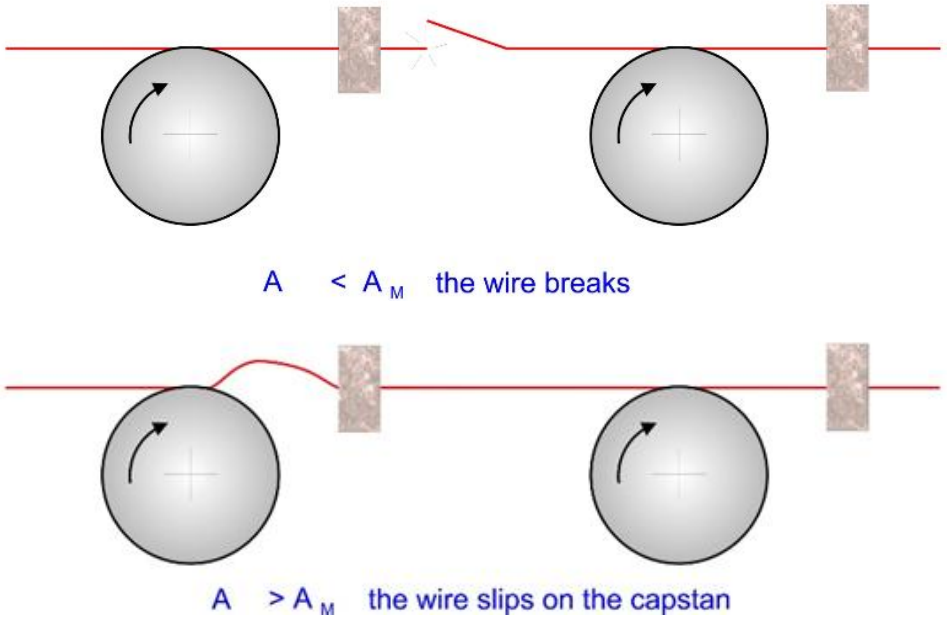
ELONGATION

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Dies diameter / Wire elongation : 3 cases

Slip % = Dies elongations – Machine elongations

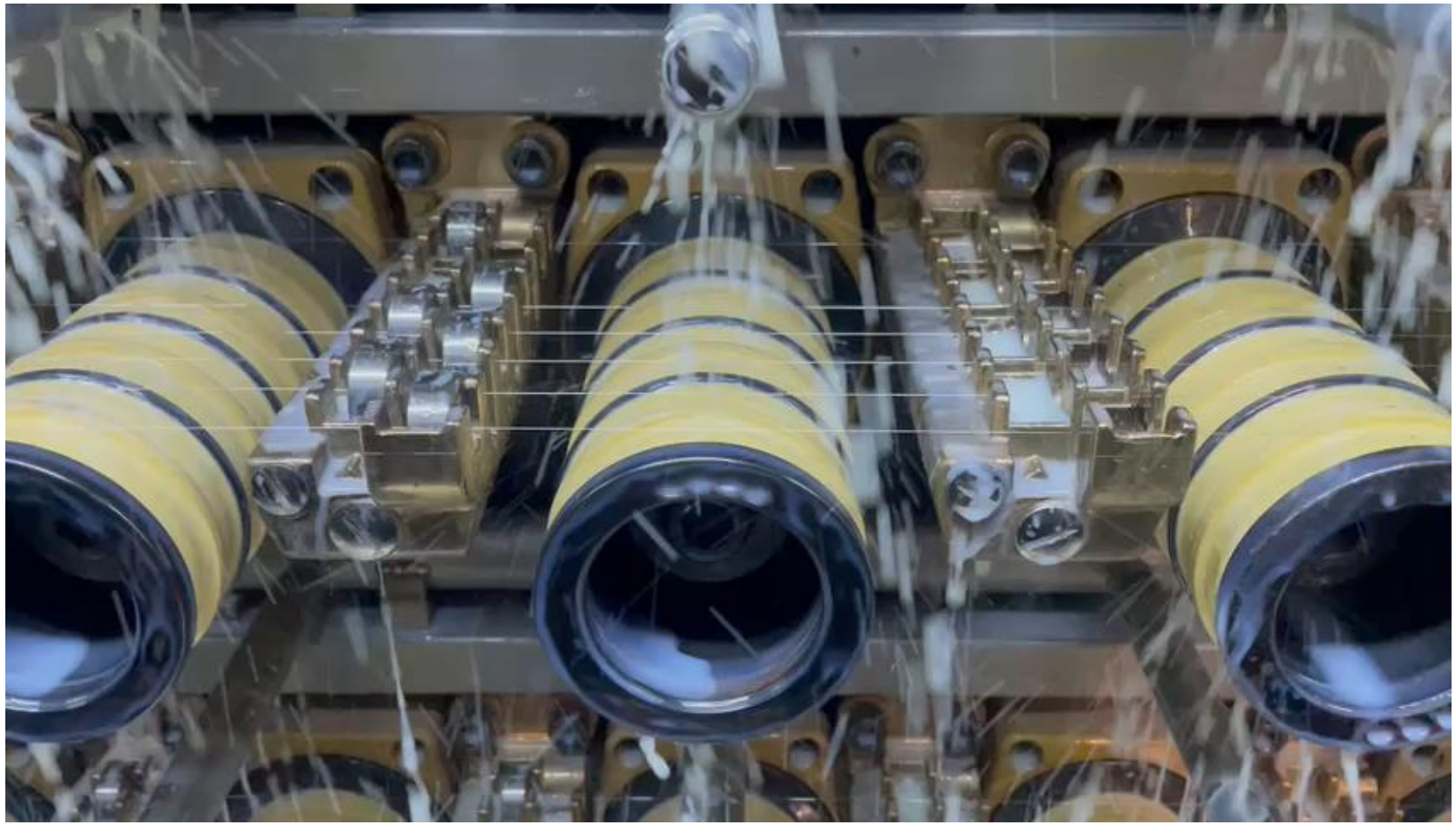




- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- Scrap reduction

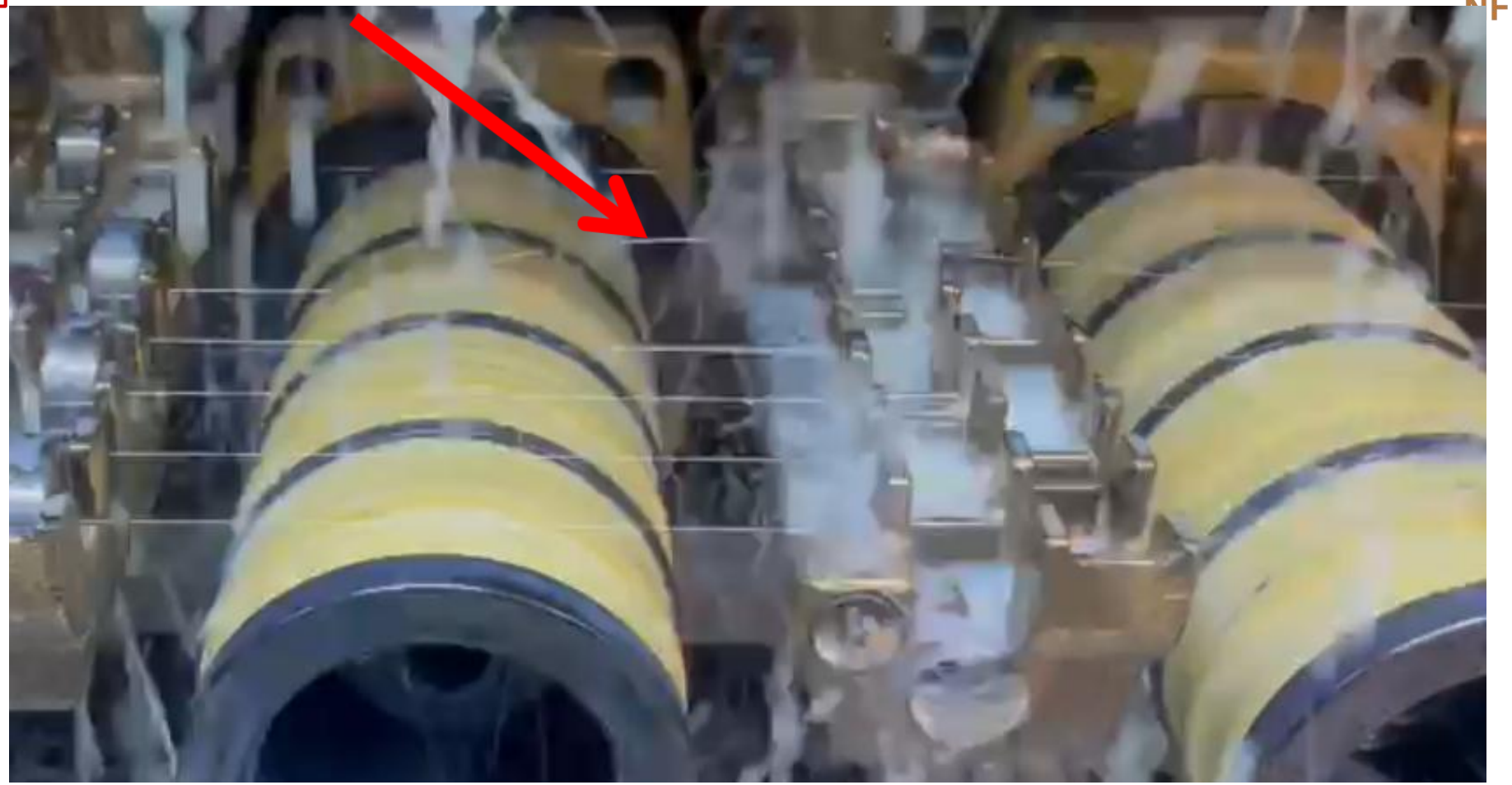
ELONGATION

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- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- Lubrication efficiency
- Scrap reduction

ELONGATION

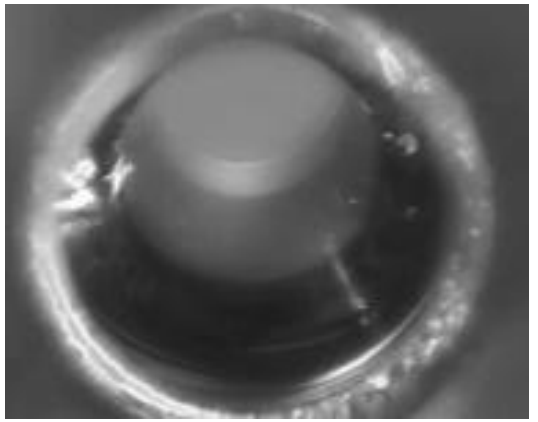


- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- **Lubrication efficiency**
- **Scrap reduction**

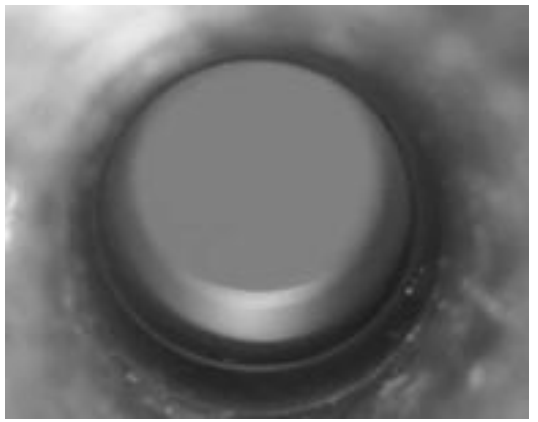
DIES POLISHING LEVEL

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All parts of the drawing dies must be polished :



- **Entrance** and **exit** Polishing :
  - Helps the lubrication process
  - Prevents the adhesion of drawn metal fine particles



- **Reduction cone**, **bearing** and **back relief**:
  - Contact zones with the wire.
  - Polishing (+ lubrication) helps to reduce frictional forces.
  - Good polishing → Less drawing forces → Wire breakage risk reduction
  - Ensures a good surface finish on the wire.

- **Wire breaks ↘**
- **Drawing speed ↗**
- Material savings
- **Lubrication efficiency**
- **Scrap reduction**

DIES POLISHING LEVEL

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As long as diamond keeps good polishing

NO DIE WEAR

↓

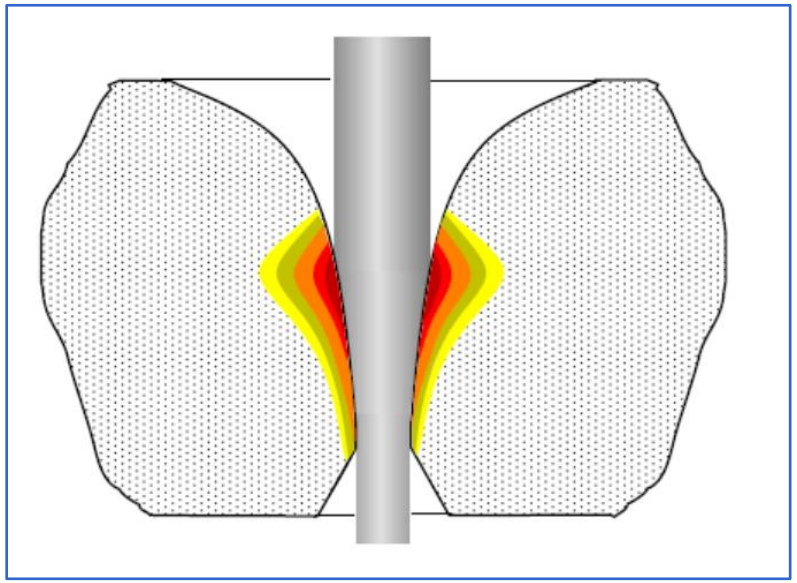
Step by step, the polishing gets damaged

(Due to loss of carbon atoms)

Diamond begins to wear

Contact point wire/die → Reduction cone → Bearing

EXPONENTIAL DIE WEAR

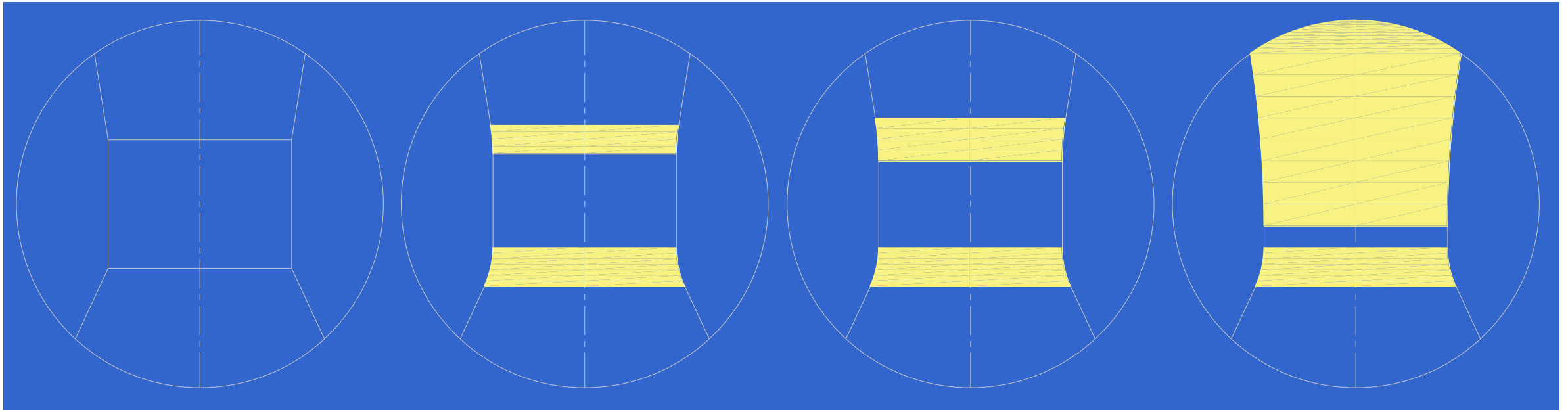


- Wire breaks ↘
- **Drawing speed ↗**
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DIES SPECIAL FINISHING

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DIES BLENDING (REDUCTION CONE/BEARING + BEARING/EXIT)



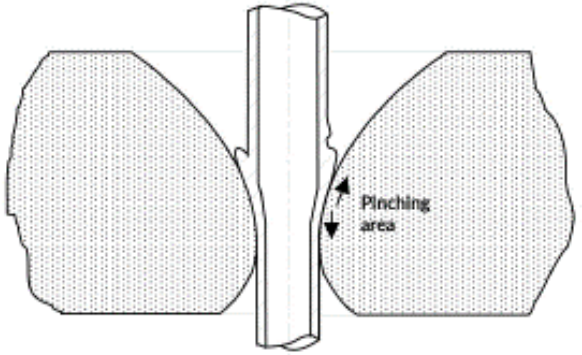
Back relief mark and finish/polish

- Wire breaks ↘
- **Drawing speed ↗**
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- **Scrap reduction**

DIES SPECIAL FINISHING

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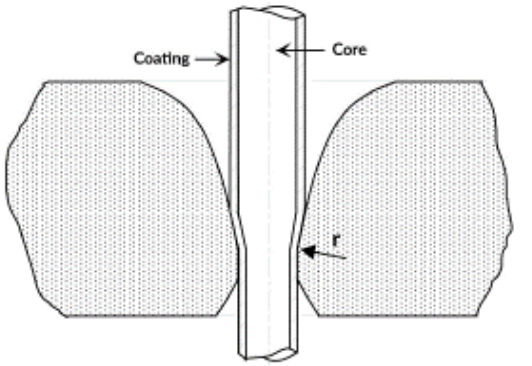
COATED WIRES DRAWING



Rounded profile to avoid

"Sock effect"

Only the core wire is drawn



Good geometric profile

- Wire breaks ↘
- Drawing speed ↗
- Material savings
- Lubrication efficiency
- Scrap reduction

TECHNICAL ASSISTANCE & SERVICE

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Assistance to determine the most fitted :

- geometry
- finishing
- diamond type
- blank size

Depending on:

- metal drawn
- elongation (machine / wire)
- expected drawing process improvement

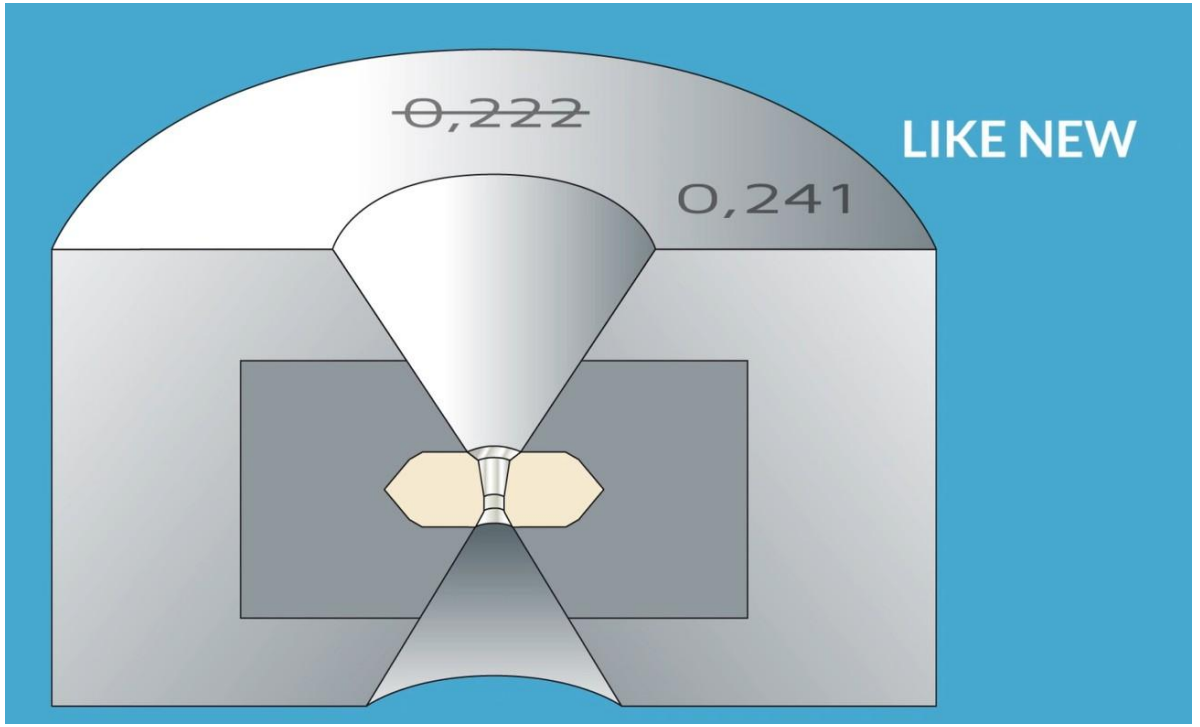
- Wire breaks ↘
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TECHNICAL ASSISTANCE & SERVICE

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REFURBISHING SERVICE

- Refurbishing adapted to each die
- Any original die maker
- Dies for ML process / RBD / finishers / Stranding …
- Complete geometry recut



- Wire breaks ↘
- Drawing speed ↗
- Material savings
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- Scrap reduction

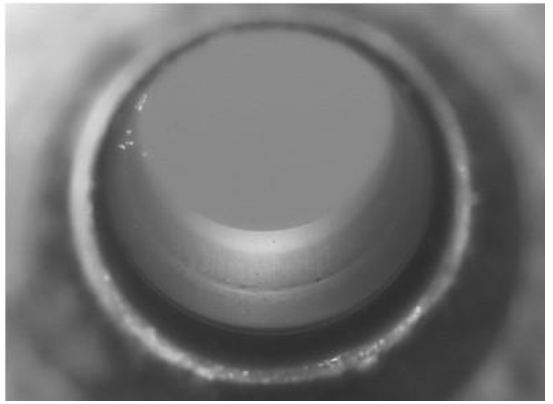
TECHNICAL ASSISTANCE & SERVICE

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TECHNICAL TRAINING

- Dies optical control
- Measurements technics
- Refurbishing equipment process / use
- On demand training by our team members





Questions and answers

For more information:

www.balloffetdie.com

For detailed questions:

balloffet@balloffetdie.com

Thanks for your attention