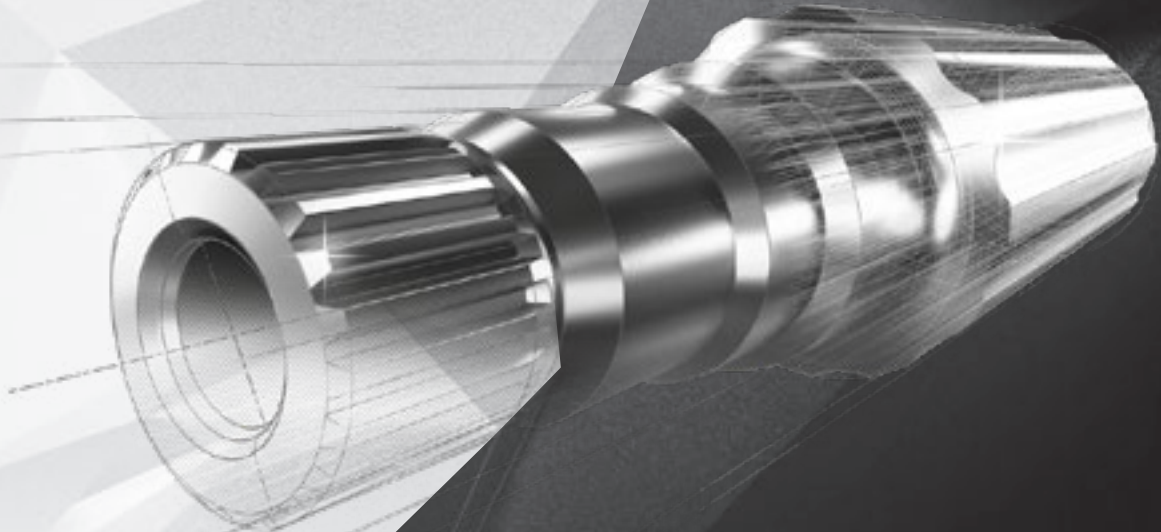


FELSS

The smarter way of forming.



ROTARY SWAGING

THE TECHNOLOGY

THE BENEFITS OF ROTARY SWAGING



LIGHTER

Hollow lightweight design parts with low weight.



STRONGER

Strengthening and greater stability of the workpiece – through increased hardness and tensile strength, as well as an uninterrupted grain flow.



RESOURCE EFFICIENT

Material savings through chipless production.



FASTER

Short cycle times in comparison to lathing.

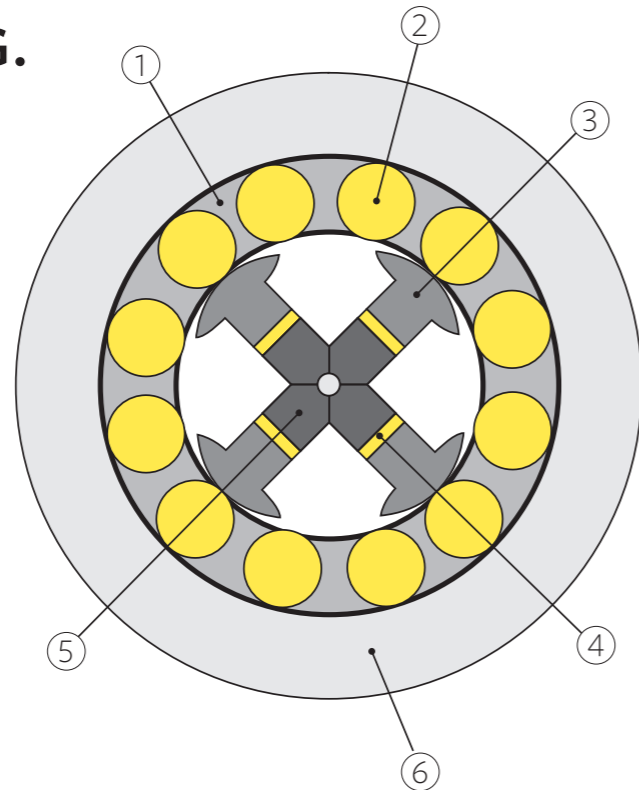


MORE PRECISE

Production of geometries close to the final contours.

WHAT CAN WE DO FOR YOU?

ROTARY SWAGING.



- 1 Roller cage
- 2 Pressure roller
- 3 Base jaw
- 4 Compensating plate or wedges
- 5 Die segment
- 6 Outer ring

PRECISE, JUST LIKE A CLOCKWORK.

The basic principle and the idea of rotary swaging are as fascinating as they are effective: Several die segments impact on the workpiece again and again in quick succession. The material starts to flow and is formed with high precision. At the same time, the workpiece is strengthened during cold forming, due the work hardening.

HOW DOES IT WORK?

The tools hit the workpiece at a rate of more than 1000 strokes per minute. The designed forming takes place through an incremental, step by step process. The actual stroke is only 0.25 to 1,5 millimeters per base jaw. In order to guarantee these critical mechanisms, rotary swaging systems achieve the accuracy of a clock mechanism.

THE SWAGING MECHANISM

The swaging mechanism inside the swaging unit is decisive for the forming process. The swaging shaft drives several base jaws, wedges and die segments. The roller cage with rollers has a continuous movement resulting from the rotation of the swaging shaft and specific curve shape of the base jaws. Wedges are in between the die segments and base jaws. By moving the wedges forward and backward the dies can open or close.

NC-ROTARY SWAGING.

NC technology makes it possible to influence the springing back of the material in the different workpiece sections by changing the feed rate or adjusting the diameters, making it possible to comply with very tight tolerances. This applies in particular when swaging precise internal Geometries as inner splines for example. With NC technology, complicated outer contours, such as a long tapers, can be produced with the use of two interpolating NC axes for workpiece feeding and swaging die closing. Change-over times are reduced further with NC technology. By adapting the working speed to the requirements of the various processing areas, the cycle time can be optimized. The use of NC technology makes it possible to group multiple process steps in one operation, due to intelligent tool design.

THE ADVANTAGES:

- Interpolating movements between feeding unit, swaging die closing and mandrel positions, freely programmable
- so higher design flexibility
- reduced cycle times
- freely programmable feeding speed
- minimized change-over times due to less change parts
- increased level of reproducibility
- highest level of process liability

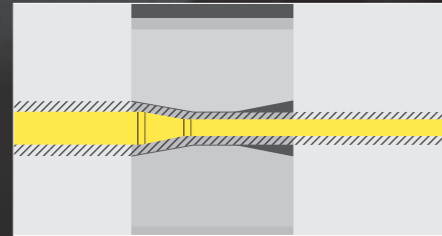
INFEED OR RECESS SWAGING.

1. INFEED SWAGING PROCESS

During infeed swaging the workpiece is fed axially into the swaging system. The rotating die segments are acting radially. First the fed workpiece is formed by the inlet taper of the dies, then by the cylindrical section.

Result:

- + Long, reduced diameter starting at the end of the workpiece
- + Flat transition angles of up to 10°

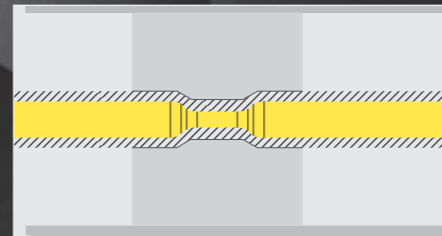


2. RECESS SWAGING

During recess swaging the workpiece first is fed into the opened die segments. By the axial movement of the wedges the dies are closing and forming the outer diameter of the workpiece.

Result:

- + forming of steep transition angles
- + recesses in the middle of the workpiece

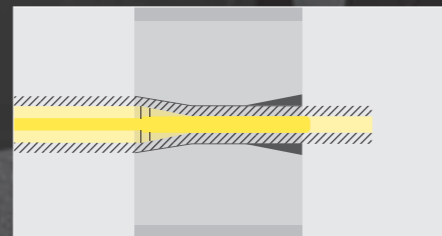


3. SWAGING OVER MANDREL

As well as for infeed swaging as for recess swaging a mandrel can be used to support the ID and so reduce the wall-thickness during swaging.

Result:

- + get a precise ID and so reduce the wallthickness
- + achieve different wall-thicknesses within one workpiece
- + use a profiled mandrel and so achieve complex inner profiles as inner splines



WORKING RANGE.

machine size	0	2	16	25	32	40	60	100	120
tube max (mm)	3	6	16	25	32	40	60	80	120
bar/wire max (mm)	2	4	10	12	16	25	40	50	70

SUITABLE MATERIALS AND WORKING AREA.

Materials: All materials with min. 10% elongation (High alloy steel, mild steel, stainless steel, aluminium, copper, brass)

Tolerances: Depending on the process and machine size between less than $\pm 0.01\text{mm}$ to $\pm 0.05\text{mm}$

Surface quality: with infeed swaging up to Ra 1.0, with recess swaging and ID over mandrel up to Ra 0.1

THE ADVANTAGES:

- Ready for installation
- Design freedom
- High surface quality and forming degrees



MORE PRECISE

Workpieces can be formed to the final shape even ready for assembly by rotary swaging.

CHARACTERISTICS: SURFACE CONDITION:

Rotary swaged surfaces showing a very good surface roughness. The achievable surface is comparable to a grinded surface.

Process	Achievable surface
Infeed swaging	Ra $< 1.0\mu\text{m}$ (for OD)
Recess swaging	2 Ra $< 0.1\mu\text{m}$ (for OD)
Swaging over mandrel	Ra $< 0.1\mu\text{m}$ (for ID)

DIMENSIONAL ACCURACY

Nominal size in mm (diameter)		Tolerance class				
		IT6	IT7 ID over mandrel	IT8 OD by recess swaging	IT9 OD by infeed swaging	IT10
above	up to	Tolerances				
·	3	6	10	14	25	40
3	6	8	12	18	30	48
6	10	9	15	22	36	58
18	30	13	21	33	52	84
30	80	16	25	39	62	100
50	80	19	30	46	74	120
80	120	22	35	54	87	140



LIGHTER

Simply replace the solid parts with rotary swaged workpieces made from tubes to considerably reduce the weight.

Achievable tolerances up to tolerance class 7 for inner diameters over mandrel, up to class 8 by recess swaging and up to class 9 by infeed swaging.

PROCESS-RELATED WALL THICKNESS CHANGES:

The forming of the external geometry also changes the inner contour of the component and its wall thickness. Variable wall thicknesses are possible.



intermediate shaft for passenger cars.



swaged workpiece with uninterrupted grain structure.



RESOURCE EFFICIENT

The volume of the blank is already the same as that of the formed workpiece so no waste of material.



STRONGER

Due to work hardening during cold forming the tensile and yield strength increase and so the workpiece is getting stronger.

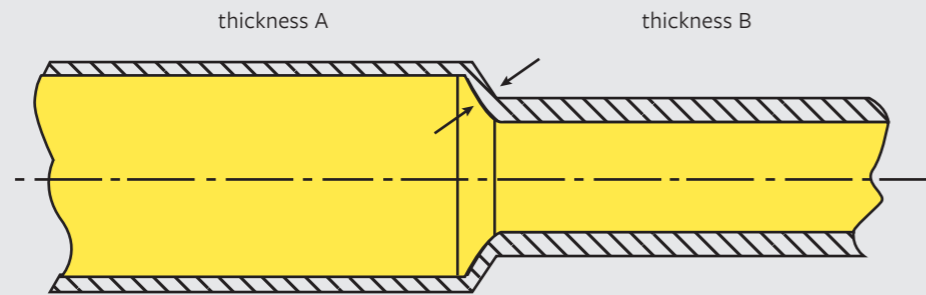
HOLLOW LIGHTWEIGHT CONSTRUCTION SHAFTS BY MEANS OF INTELLIGENT MATERIAL DISTRIBUTION:

- Highly precise internal and external geometries
- Incremental forming resulting in a high forming degrees
- Different wall-thicknesses are possible



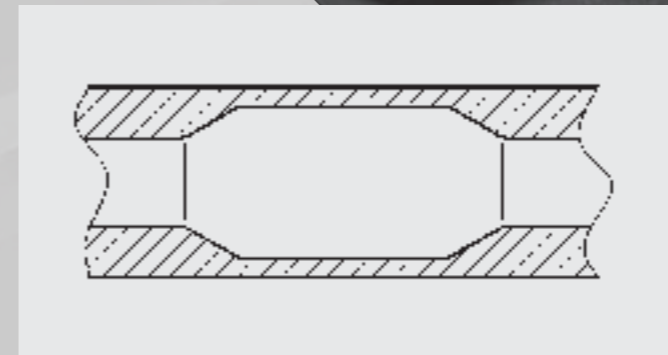
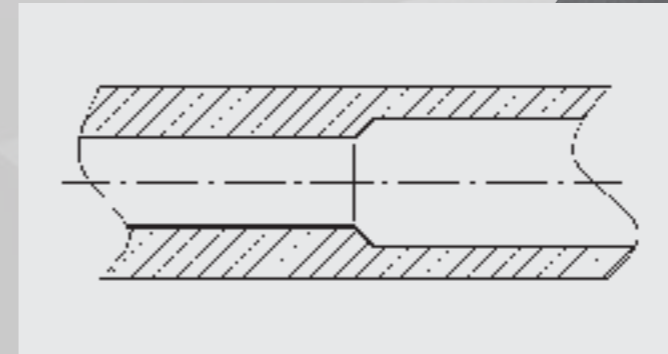
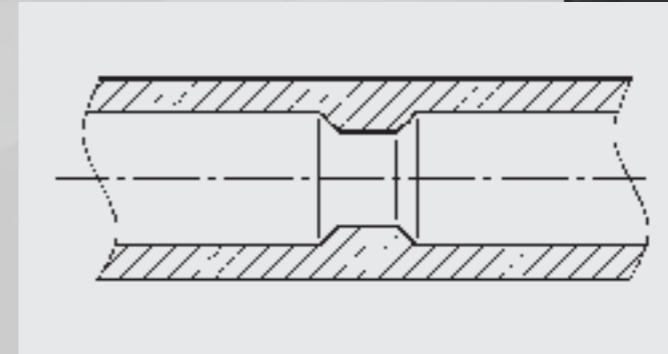
intermediate shaft for passenger cars.

PROCESS-RELATED WALL THICKNESS CHANGES



Example:
starting dia
40 x 3.0 mm
reduced to dia
28 x 4.2 mm

Forming of the external geometries.



MULTIPLE SHAPES AND FUNCTIONALITIES.

Rotary swaging is distinguished by a wide range of shapes and different forming degrees. It offers a much wider range of possibilities than most other cold forming processes. Therefore, only a few typical geometries are shown here.

FELSS COMPONENTS IN USE – OUR AUTOMOTIVE APPLICATIONS.

STEERING



Example: Steering Upper and Lower Shaft

Workpiece data:

- material: E355+N
- blank: tube section
- dia 32 x 2,5 mm length 276 mm

Process data:

- machine: HA40-11VUE-NC
- cycle time approx. 15 sec (i.e. 4 pcs/min)

Tasks:

- Keep an OPD tolerance of +/- 0.015 mm
- Keep the OD tolerance in a specific section of +/-0.02 mm
- Optimize the manufacturing solution to an output of 4 parts per minute, i.e. max 15 sec

Advantages of Felss solution:

- High dimensional stability
- High output
- Complete manufacturing solution

TRANSMISSION



Example: ATM stator shaft

Workpiece data:

- material: 20MnCr
- blank: tube section 51 x 8.0 mm

Process data:

- machine: HA100-1SUEH
- cycle time approx. 35 + 25 sec

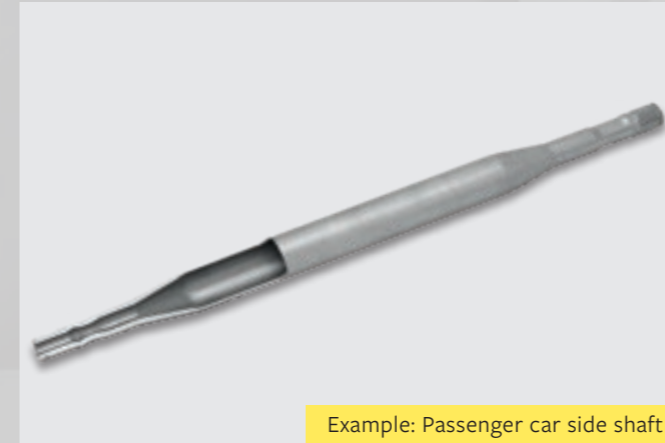
Tasks:

- Produce a variable wall-thickness tube as pre-form for further machining process
- so reduce the weight of the component

Advantages of Felss solution:

- Uninterrupted grain structure
- Higher strength due to work hardening

DRIVE TRAIN



Example: Passenger car side shaft

Workpiece data:

- material: 34 Mn B5 or 25 Cr Mo 4
- blank: tube section DIN 2393C
- dia 50 x 3.8 mm length 470 mm

Process data:

- machine: HA60-9SUE-NC
- cycle time approx. 22 sec

Tasks:

- Keep an OPD tolerance of +/- 0.015 mm
- Thick-thin tube with small wallthickness in the middle section for a good NVH behavior
- Keep variable wall-thicknesses as per OEM drawing

Advantages of Felss solution:

- Complete manufacturing solution including swaging, spline forming, machining, groove rolling

E-MOBILITY



Example: Rotor Shaft

Workpiece data:

- material: 30 MnB5
- blank: tube section 60 x 6.0 mm

Process data:

- machine: HA100-1 SUEH + Aximus Ho2
- cycle time approx. 22 sec

Tasks:

- Produce a lightweight rotor shaft starting from tube
- Form a special profile for the rotor in the middle section
- Close the shaft from one side by pressing-in a ball
- Offer a complete solution incl. Swaging, axialforming, machining, hardening, grinding

Advantages of Felss solution:

- Higher strength due to work hardening
- Offer a turn-key solution for the complete shaft design

ROTARY SWAGING PERFECTION.

THE ROTARY SWAGING MACHINES OF THE FELSS GROUP

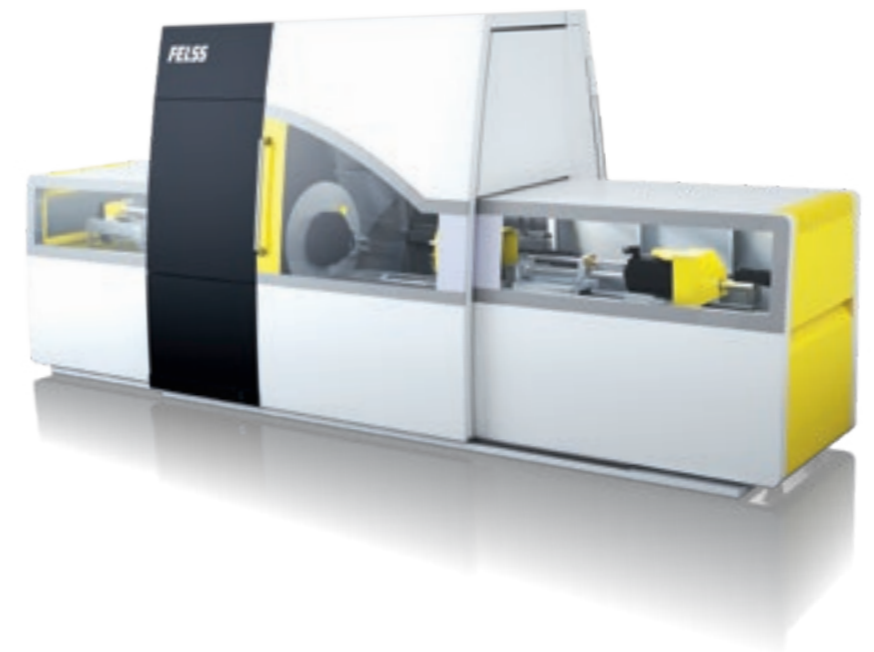
AT FELSS, MODULAR SYSTEMS ENSURE THAT EVERY SYSTEM IS DESIGNED PERFECTLY FOR YOUR NEEDS.



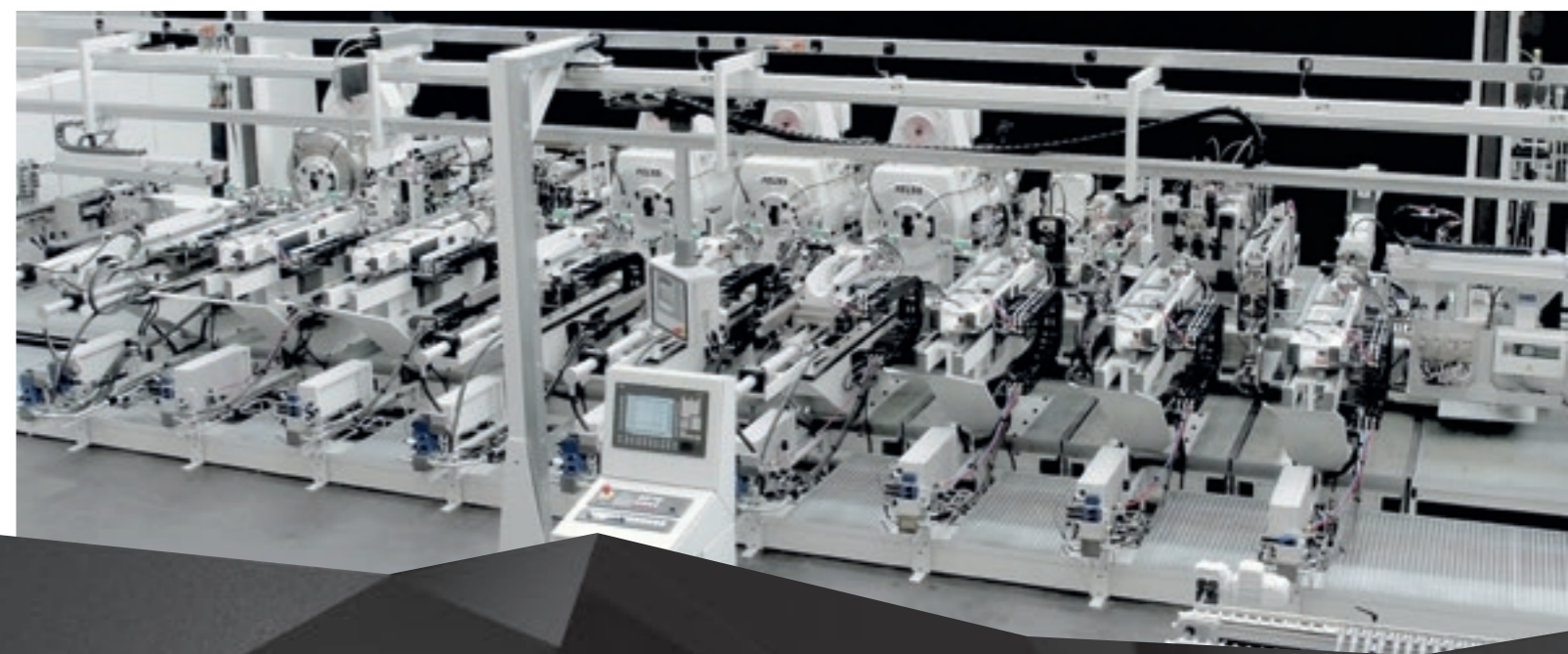
Fully automated single station swaging machines example: model HA 60-1VUEH-NC



Manual rotary swaging machines example: model FR16V



Generation e4.1ür first fully electrical driven rotary swaging machine. Implementation of Smart services (industry 4.0)



Transfer line example: model HA 40-9VUE-NC

MAKE: FELSS SYSTEMS.

MECHANICAL ENGINEERING

As experts in lightweight design, we realize optimal solutions and processes for our customers' individual machines, production systems, and process chains. Furthermore, we support customers at all times – be it with maintenance and training measures, with the providing of new tools, and with the possibility to further develop and expand upon systems on request.

BUY: FELSS ROTAFORM.

COMPONENT MANUFACTURING

The Felss Group offers component manufacturing extending from prototypes to large series. In the process, we concentrate not only on our core technologies, but instead also offer a broad range of services for ready-to-install components through additional in-house technologies.

FELSS SERVICE.

The Felss Group produces machines, manufactures components, and develops processes in the cold forming segment. Thanks to this experience, we know how important good support is. Our goal is to offer the best service in our industry. Close contact with our customers is essential for this. Thanks to this exchange and out decades of competence, we always have the appropriate solutions at the ready for you. As your partner, it is our ambitions to offer you individual and customized support. From classic support with malfunctions through the use of digital services to 24/7 support.



CONSULTATION, HELP LINE, FIELD SUPPORT



MODERNIZATION AND CONVERSION



TOOL SERVICE



REPLACEMENT AND WEARING PARTS



SERVICE AGREEMENTS



TRAINING MEASURES AND SEMINARS



DIGITAL SERVICES

FELSS

The smarter way of forming.

USA

COMPONENT MANUFACTURING
+ New Berlin // WI

GERMANY

MACHINE BUILDING
+ Königsbach-Stein
+ Pforzheim
+ Nesselwang

COMPONENT MANUFACTURING
+ Bretten-Gölshausen
+ Pforzheim

CHINA

COMPONENT MANUFACTURING
+ Wujiang

SLOVAKIA

COMPONENT MANUFACTURING
+ Ilava

SWITZERLAND

COMPONENT MANUFACTURING
+ Triengen

THE FELSS GROUP

MACHINE BUILDING: FELSS SYSTEMS

Machines, production systems and processes developed optimally.

COMPONENT MANUFACTURING: FELSS ROTAFORM

Component manufacturing by specialists – including in high volume.

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THE FELSS GROUP

The Felss corporate group, founded in 1905, is a provider of solutions in the field of cold forming of tubes and solid materials and a specialist for the automobile industry. Since the integration of the HMP companies purchased in May 2019, Felss now also serves numerous customers in other sectors. Among these are customers from industry, aerospace and precision mechanics.

As lightweight construction experts, we develop optimal processes, machines or also the finished product in component manufacturing for our customers. Around 1,100 employees work worldwide at our nine locations in Germany, Switzerland, the USA, China and Slovakia.

www.felss.com