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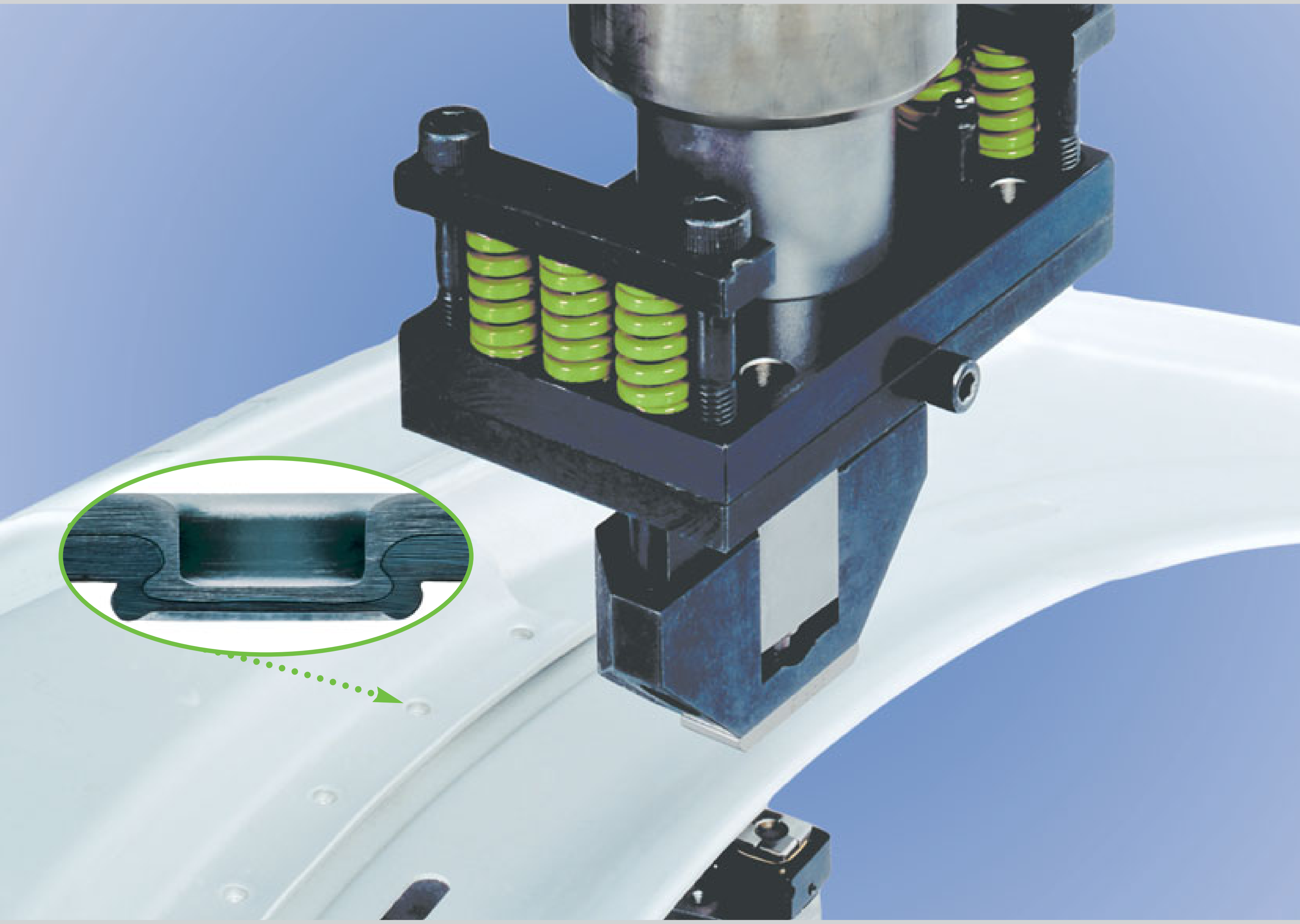
# General Principles

RIVCLINCH®



Clinching

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## What is Clinching?

The clinching process is a method of joining sheet metal or extrusions by localized cold-forming the materials. The result is an interlocking friction joint between two or more layers of material formed by a punch into a special die.

Coated and painted sheet metals can also be joined together with no damage to the surface finish.

With the aid of a punch/die combination an extremely strong snap-fastener type joint is produced.

The RIVCLINCH® joining technique can be used to join steel and stainless steel materials as well as aluminium and or non-ferrous materials in a cost effective, environmentally friendly process.

Depending on the choice of RIVCLINCH® joining tools, the resulting joint can be round or rectangular:

- Round joining is for sealed joints with no surface cutting
- Rectangular joining incorporating surface cutting, particularly for very hard materials or stainless steel.

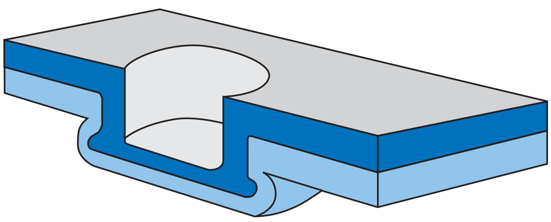
## *The Advantages of the* **RIVCLINCH®** *Joining Technique at a Glance:*

- Joints can be checked without damage
- No consumable items
- Low energy use
- No thermal load on joining zone
- No damage to surface finishes on workpiece
- Interim layers of film or adhesive can be incorporated in most cases
- No pre/post treatment required, e.g. no pre-cleaning or subsequent removal of spray deposits from around the joint
- Very good joint reproducibility
- Environmentally friendly workplace, no fumes or noise
- Minimum maintenance costs

## Geometry of the Joint

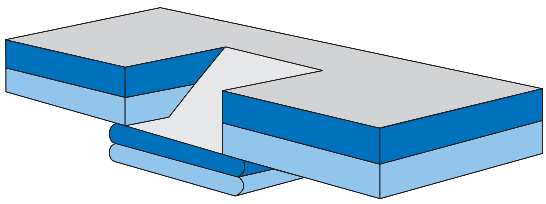
**Round point**

The pieces to be joined are subject to local deformation. The resulting joint is impervious and attractive.



**Rectangular point**

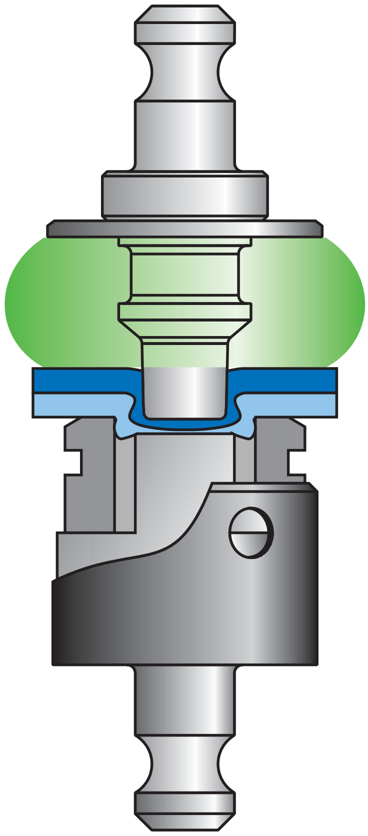
The rectangular point is the product of a combined cutting and deforming process. It is chiefly suited to hard materials and stainless steel.



## *Influential Variables on the Quality of a Clinch Point*

**Joining equipment**
- Design of the joining equipment
- Type of power production
- Static deformation behaviour
- Dynamic deformation behaviour
- Kinematics
- Control means

**Joining parts**
- Number
- Materials
- Material thickness
- Surface condition
- Geometry
- Accessibility

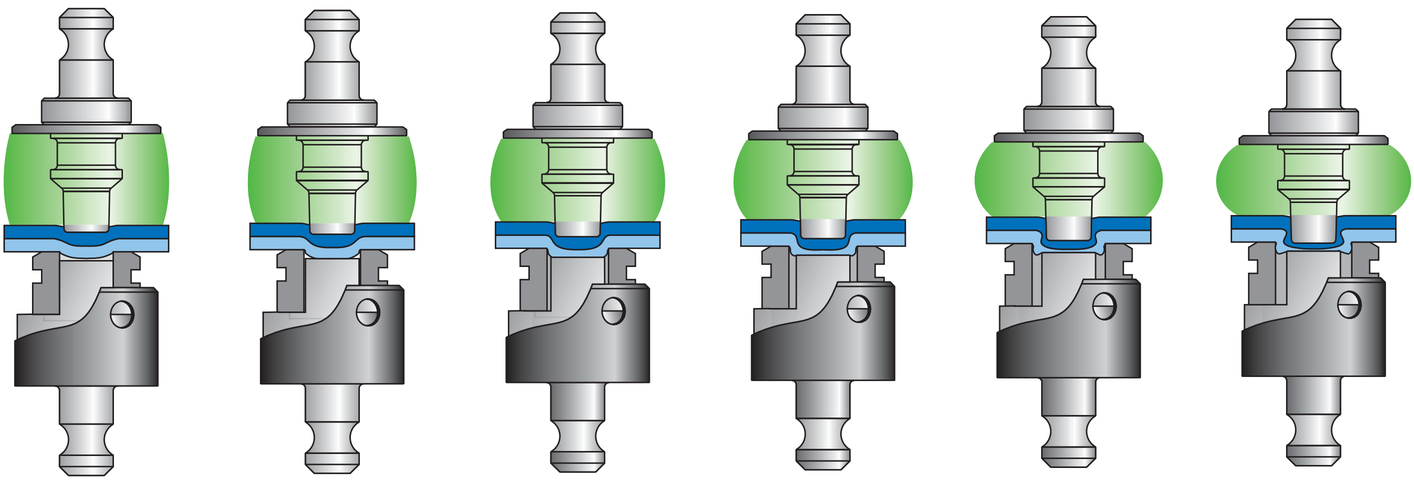


**Joining tool**
- Punch geometry
- Die geometry
- Stripper/stripping clamp
- Joining forces
- Stripping forces

**Joining process**
- Spatial orientation
- Cycle times
- Ambient influences

## RIVCLINCH® *Joining*

In the RIVCLINCH® joining process the materials to be joined are first forced into the die by the punch. As soon as the bottom-most material is sitting on the die anvil it starts to flow laterally under the pressure being exerted by the punch. This causes the movable die sections to be pushed outwards and allows the flowing of the material to form the button. The punch then travels back to its starting position either by the operator or a pneumatic timer removing the force. The joined part can now be removed and the side sections of the die are drawn back together by a spring.
This local deformation of the material forms an interlocking friction joint.
The RIVCLINCH® joining system can be incorporated into existing press systems or custom built machines.
It can be used to set one or several points at the same time and can be integrated within manual machines and into robotic equipment and systems.

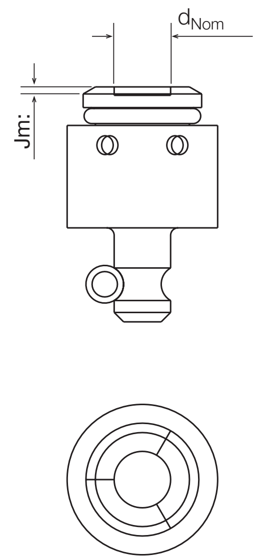


## *Tool Kits*

The central element of the RIVCLINCH® joining system is the tool kit. Each one is individually chosen for the particular application. The diameter of the joint, coupled with parameters such as the punch diameter or the die depth can be varied to suit the material to be joined.

Standard tool kits are available for round point joints with nominal diameters 3, 4, 5, 6, 7, 8 and 10 mm and rectangular point joints with nominal diameters of 4.3 mm, 5 mm and 6 mm.

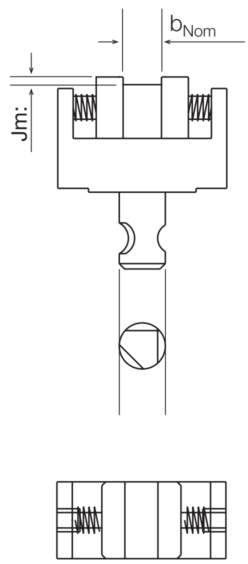
Tool kits can be integrated into hand held RIVCLINCH® units, presses or multistage tools.




**Dies for round point RIVCLINCH®**
The nominal diameter ($d_{Nom}$) of a RIVCLINCH® die is measured in the closed unloaded state. During the joining process the diameter expands depending on the application. For the button outer diameter, after the clinch point is complete, ($D_{button}$) the following formula provides a guide:

$$D_{button} = d_{Nom} \times 1.4$$

In comparison with the processes using one-piece dies, a clinch point diameter of $d_{Nom}$ = 6 mm corresponds to a die diameter of approx. 8 mm with a one-piece die.




**Dies for rectangular point RIVCLINCH®**
The nominal width ($b_{Nom}$) of the die in the RIVCLINCH® rectangular shape is measured in the closed unloaded state as for the round die. During the joining process the two die sections are pushed outward depending upon the application. For the joint width ($B_{button}$) the following formula provides a guide:

$$B_{button} = b_{Nom} \times 1.4.$$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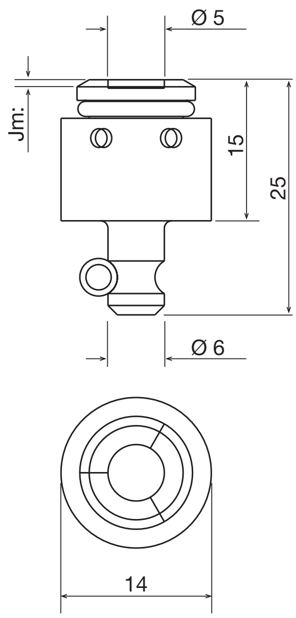
## Design of the Segmented Die Body

The RIVCLINCH® die comprises a basic die body and individual die ring segments, which are held in position by a steel spring. A safety cage secures the separate sections permanently to the die body preventing them from falling out. The die ring can be divided into 2, 3 or 4 segments with die designs being selected according to the application requirements.

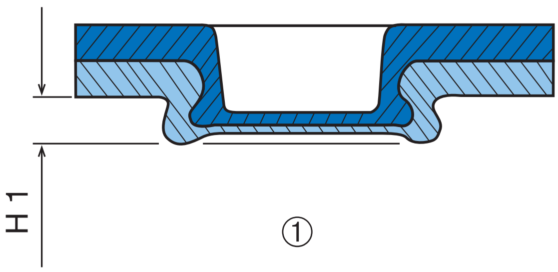
*Example: 3 segment RIVCLINCH® SR 503 die*



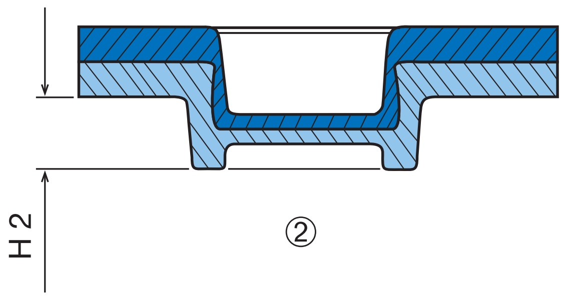

## Advantages Compared to the One-Piece Die Process

The RIVCLINCH® joining process has decisive advantages over joining with one-piece dies:

- Very high head stress values due to better back-flow of the material are possible because the dies open during the joining process enabling the material to flow sideways.
- More flexibility when joining materials of different sheet thickness with one tool kit.
- RIVCLINCH® principle produces a flat button (see diagram, H1 < H2).
- No material build-up (especially with galvanised or coated surfaces) caused by high radial force within the die. The die cannot 'burst' due to reduction of die volume. This also means the dies can have a longer service life.
- No stripper required on the die side to remove the material from the die, which can cause problems, particularly in automated systems.
- The materials cannot stick to the die thus allowing a slimmer tool design on the die side, thus providing better access to the workpiece.




*RIVCLINCH® joint with segmented die*




*Joint with closed die*

## *Economic Benefits of the* **RIVCLINCH®** *Joining Technique*

The primary aim of clinching, besides being a modern, innovative joining system, is to save production costs.

**Low investment costs**

- No extraction equipment required (no dangerous fumes, as from spot welding)
- No cooling water and therefore no costly installation required
- No expensive electrical installations for welding transformers are necessary
- Note the high costs that are associated in particular with the welding of galvanised steel plate and aluminium (Fig. 1)

**Low operating costs**

- Lower energy consumption when operating the tools
- No added electrical costs when equipment is idle (with booster operation)
- Low wear and tear costs thanks to long service life of tool kits (Fig. 2)
- No added electrical costs required for extraction equipment
- No cooling water required

**No post-processing costs**

- Surface finishes, e.g. galvanising, are undamaged
- No 'burn off' as with spot welding or the need for costly and time consuming re-galvanising to prevent undesirable corrosion

**Short production times**

- Faster joining process (approx. 0.5 sec for forming process, setting time depends on supply stroke and the design of the system used)
- Greater degree of automation possible –> higher unit quantities with few personnel!

**Simple to use**

- No need for highly qualified and expensive operatives

Comparison of costs of different joining processes and materials

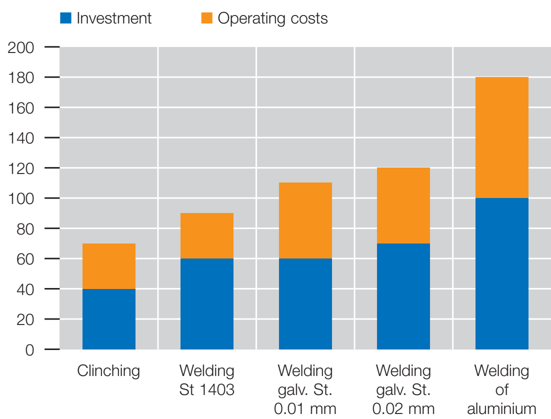



Fig. 1

Number of clinching points up to tool change

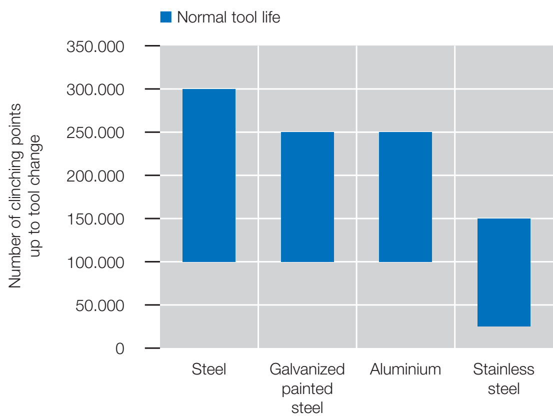



Fig. 2



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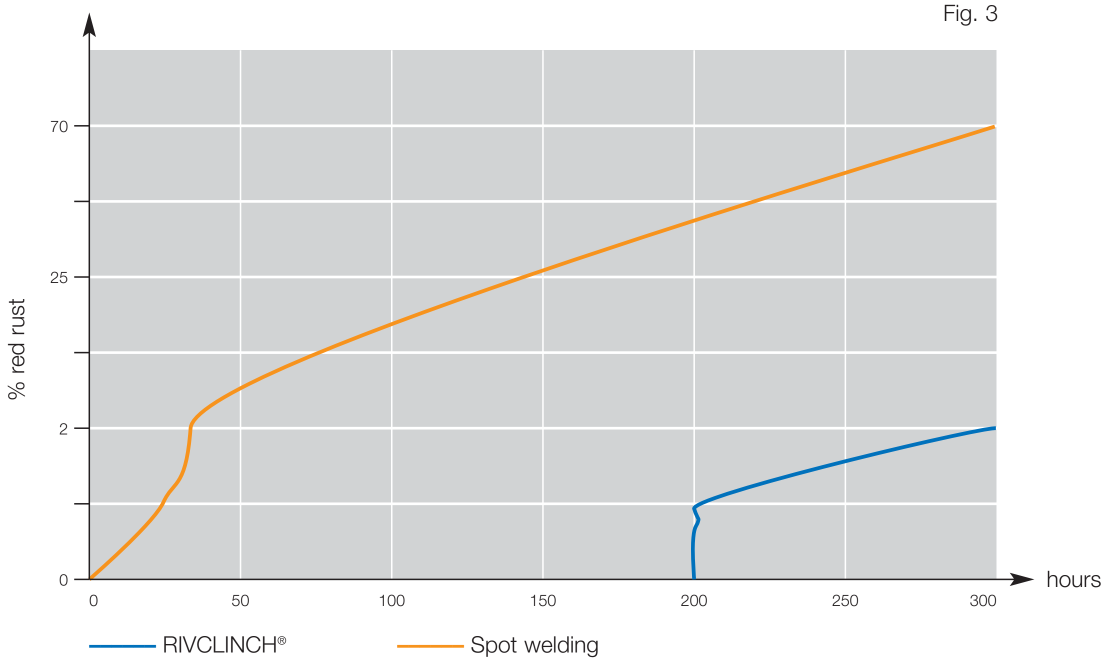
## *Economic benefits of the RIVCLINCH® Joining Technique*

Corrosion-resistant clinching in comparison to spot welding
Salt spray test according to DIN 50021
Material tested: galvanised steel plate
Thickness: 1 mm + 1 mm
Zinc layer: ~ 12 µm

Fig. 3

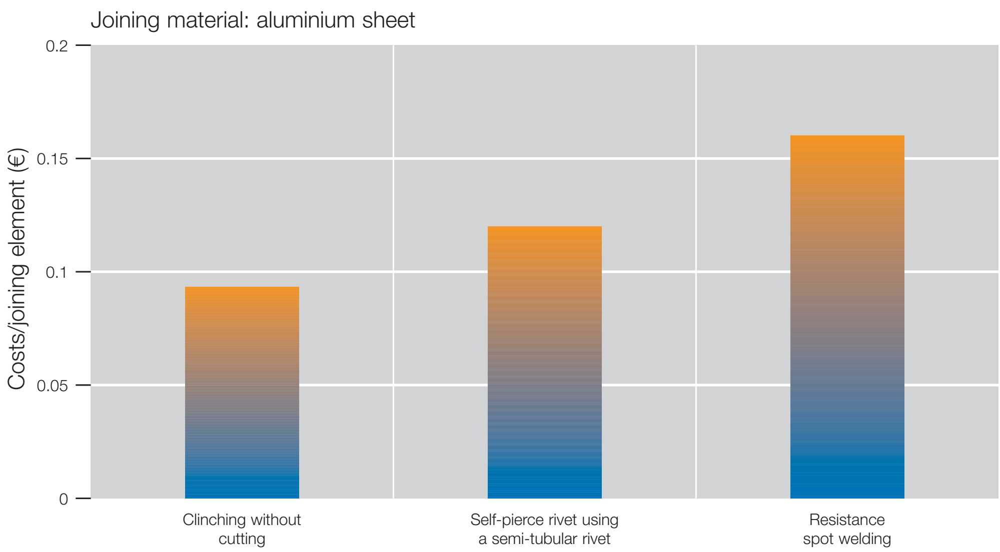



## *How high are the Costs for a Single Joint?*

The following graph illustrates the costs of a single joint.
These costs incorporate three main factors:

- Operating costs (electrical, air, water, extraction,...)
- Consumables (tools, electrodes,...)
- Costs of additional elements (self-pierce rivet)

The example given is for two aluminium sheets.
The ratios may vary for other material combinations, e.g. steel and steel.



## *Strength of Clinch Point*

We differentiate between three different areas in relation to strength values:
1. Static strength (quasi-static shearing stress and head stress test)
2. Dynamic strength (vibrating load/ continuous vibration test)
3. Crush strength (impact load / impact test)

The strength of clinch points is determined by the following factors in particular:

**Size of the joint**
With the same joining parameters, a 6 mm diameter joint is stronger than a 4 mm diameter joint, provided the material combinations permit a joint with the greater diameter.

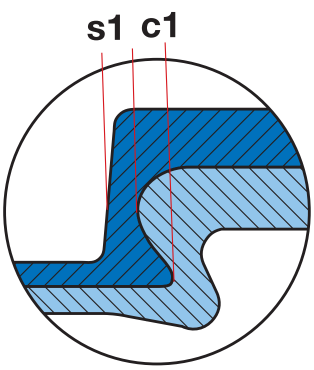
**Material type**
With the same joint size and similar material thickness, a joint between two sheets of steel is stronger than a joint between two sheets of aluminium.

**Material thickness**
A joint between materials, with thickness 2 x 2 mm is stronger than a 2 x 1 mm joint.

**Influence of the direction of joining**
In a joint between materials of different thickness the joining of "thick into thin" will produce the stronger joint than "thin into thick" (from the punch side).

For different materials the rule is "hard into soft".

**Joint parameters**
An optimum joint must fulfil two seemingly opposing criteria.
To achieve the ideal static tensile strength the measurement c1 must be as great as possible. However, the so-called "throat" s1 should be as large as possible to achieve the optimum dynamic and shearing tensile strength. The choice of targeted parameters determined by the operating conditions can provide the joint with the maximum possible strength.




A good compromise for most applications is represented by the following formula:

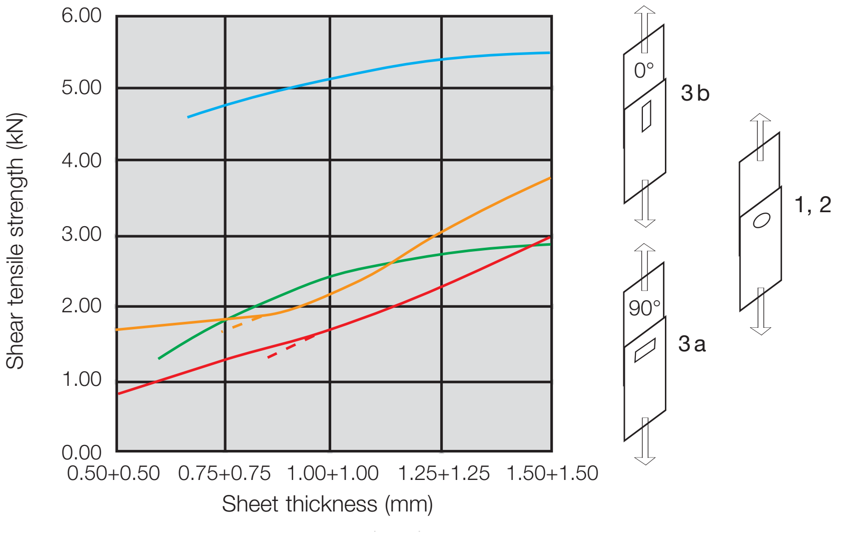
**c1 = s1 = 1/2 thickness of punch-side sheet**.

In order to make an accurate prediction of the strength of the joint in any application you need to carry out tests on the original materials.

We can do this for you, by:
- Using sheet materials to give an estimate of the component performance sampling of your components on the basis of sheet samples.
- Production of a sample using your component for your internal product evaluation.
- Free test report with micrograph of the joint for permanent records.
- Determining of shear and head stress values in our accredited test laboratory.
- Corrosion investigations in the salt spray test according to DIN 50021 in our accredited test laboratory.
- Production of "zero series” or prototypes at cost price on request.

The following tables are guideline values only and cannot replace tests carried out by our test department.

## *Strength Value of* **RIVCLINCH®** *Joints*



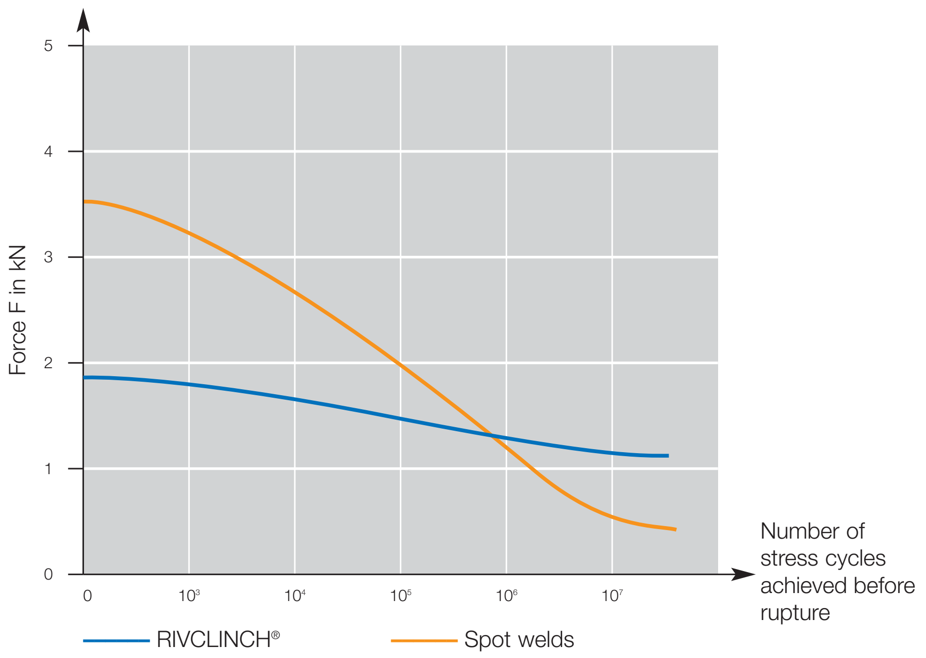

**RIVCLINCH® joints**
Static shear tensile strength depending on sheet thickness
Material: steel plate,
Strength ≅ 300 N/mm²
1. SR 504, Ø 5 mm
2. SR 804, Ø 8 mm
3a. ST 432, placed transverse with regard to load direction
3b. ST 432, placed longitudinally with regard to load direction

It should be noted that there is a directional dependency when making a rectangular joint. Basically the load direction in the case of the rectangular joint should be transverse with regard to the joining element, rather than longitudinal (3b) as in 3a in the table above, to achieve a greater strength.

The table above also shows that the enlargement of the diameter of the joint (1 to 2) is accompanied by an increase in strength.

## *Dynamic Strength of a* **RIVCLINCH®** *Joint*

The purely mechanical deformation, with no thermal load and consequential carbonising of the "edge zone", produces a permanently strong joining element. This indicates that a RIVCLINCH® joint has a longer service life than a spot weld.



## *Quality Assurance*

The ability to be able to repeat the equality of each clinch point is dependant upon many factors in the production environment, ranging from material tolerances, punch and die conditions to operator understanding.

When joining thin sheet steel, the critical features are

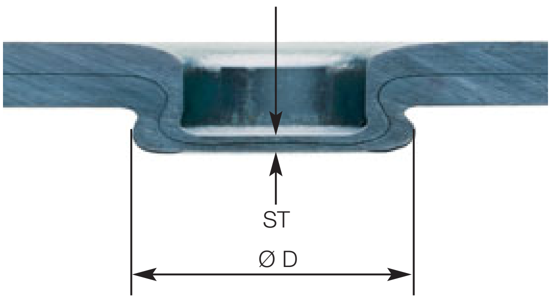
- The strength and deformation behaviour under different load conditions.
- Corrosion resistance of sheets with surface finishes.
- The imperviousness of the joint, not allowing any cut through when using a round point tool).
- Appearance of the joint in the visible area of a component.

## *Quality Control*

In clinching there is a direct relationship between the quality of the joint and its geometry. Therefore by undertaking a visual appraisal of the joint and measuring the characteristic sizes, gives a clear indication of the quality of the joint.

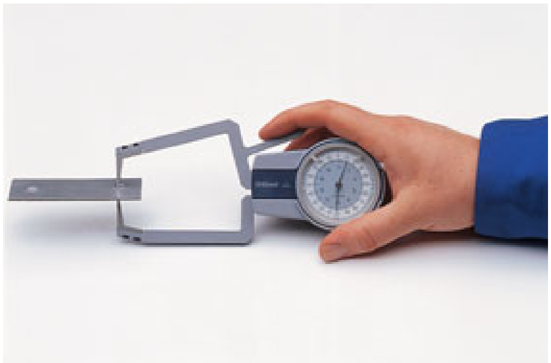
## *Testing the* **RIVCLINCH®** *Joint*

The RIVCLINCH® joint can easily be tested without damaging the joint by measuring the residual base thickness, "ST" and the joint diameter D on the component.




These values are predetermined in tests for each application and recorded, with a test number, in a test report. By measuring these sizes on the part and comparing the results with the reference data, the quality of the RIVCLINCH® joint can be determined with no damage to the part.

The measurement of the residual base thickness, "ST", is carried out using conventional clock gauge as shown in the picture. This allows quality checks to be carried out on random samples without damaging the parts themselves and interrupting production. This will increase the added value of your operation.



*Testing the residual base thickness ST*

Reliability and consistent joint quality are ideally achieved by, as far as is possible, the automation of the production processes. This prevents human error, which in conjunction with the statistical quality controls (post-process quality assurance) and process monitoring during clinching, will enable the manufacture of high quality and reproducible clinch points in mass production systems.

## *Process Monitoring*

Quality monitoring of automatic clinching systems is becoming increasingly important.

Safety critical components, for example in the automotive industry, as well as parts subject to documentation in all branches of industry, necessitate the monitoring of the joint quality and the joining system itself.

The RIVCLINCH® joining system offers the facility for controlling and recording the quality of the clinching process via force/distance monitoring.

Böllhoff offers a number of process monitoring options:

Simple in operation via a menu system, highly flexible in the adaptation to customer specific joining tasks plus the ability to communicate with high level controllers via defined interfaces, are only a few of the outstanding system features.

Dedicated sensors measure the progress of the riveting force (via the hydraulic pressure) and the punch movement. The resulting generated curve is compared with a reference curve implemented via a teaching process.

If the actual process curve is within the pre-specified tolerance range it is recorded as OK. If not, an error signal is given and the process is halted. Whilst the reference curve can be ‘taught’, a certain number of reference curves are also available for standard applications.

The following process errors are a sample of some of those that can be determined on the basis of the generated curve:

- No workpiece in place
- Total workpiece thickness incorrect
- Material too hard/too soft
- Damage to punch and die
- Fault in mechanical or hydraulic system

**The advantages at a glance**

- Online process monitoring
- Enveloping curve and window technique
- All quality parameters can be documented
- Can be integrated into other high level monitoring systems
- Individual statistical preparation of process related data and force/movement curves
- Data and curves print out option
- Menu-supported user guide with self-explanatory text, multi-lingual display
- No loss of data during power failure (buffer memory as standard)

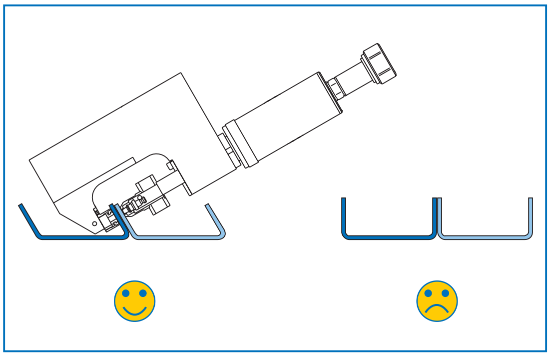
## *Curve Monitoring*

The tolerance range can envelop the reference curve in a linear form or be defined in sections. The reference limits for the joining force and the punch movement are detailed and monitored individually. If the process curve reaches the top value without an error signal, the clinching process is recorded as OK.

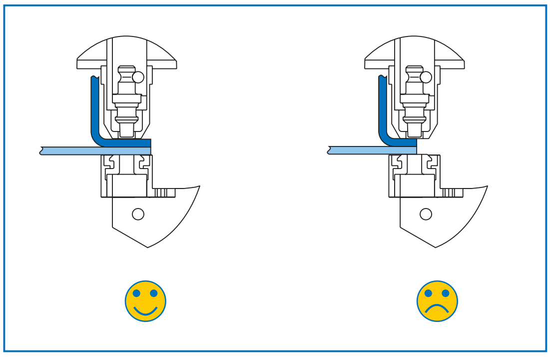
## *Joining Techniques at a Glance*

| | Clinching | Self-pierce riveting | Riveting | Screw fastening | Spot welding | Bonding |
|---|---|---|---|---|---|---|
| Corrosion of coated material | Little | Little | Little | Little | High | None |
| Joint and strength alteration at joining point | None | None | None | None | Yes | None |
| Dynamic load-resistance | Very good | Very good | Less good | Less good | Less good | Good |
| Crush load-resistance | Less good | Very good | Less good | Less good | Less good | Good |
| Static load-resistance<br>1. Shearing stress<br>2. Head stress | Good<br>Good | Very good<br>Very good | Very good<br>Very good | Very good<br>Very good | Very good<br>Very good | Good<br>Good |
| Process combined with bonding | Optimum | Optimum | Possible | Possible | Poor | – |
| Edges - burring - splinters | None | None | None | Edges | None | None |
| Joining consumables required | None | Punch rivet | Rivet | Nuts, bolts, washers, tap | None | Glue |
| Additional working processes | None | Supply | Drilling, supply, caulking | Drilling, supply, screwing | Post retreat-ment of treated surfaces | Supply, pressing, hardening |
| Cost per joint | Very little | Little | Very high | Very high | High | High |
| Energy consumption | Little | Little | High | High | Very high | Very high |
| Economy | Very good | Good | Poor | Poor | Less good | Less good |
| Environmentally friendly workplace | Very good | Very good | Good | Good | Poor | Very poor |
| Handling | Very simple | Simple | Simple | Simple | Simple | Time consuming |
| Reproducibility | Very good | Very good | Good | Good | Satisfactory | Good |
| Dependence of joint result on surface quality | Little | None | None | Little | High | Very high |
| Pre-processing | None | None | Drilling | Drilling | Washing, etching | Washing, etching |

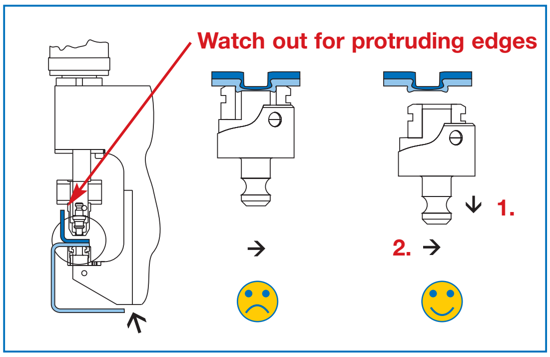
## Workpiece Design



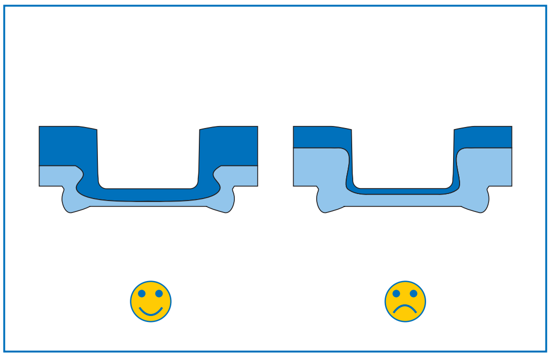
1. Ensure design allows access!



2. Provide sufficient flange width!

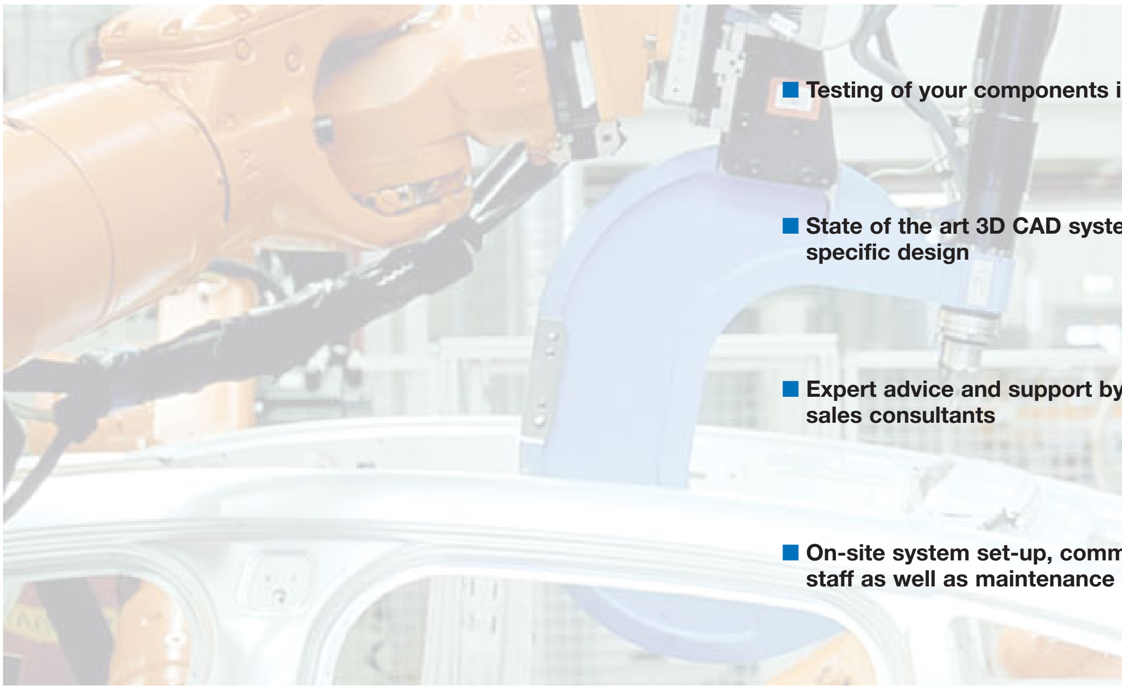



3. Leave sufficient clearance to allow removal from die. First move button out of the die (step 1) and then move the C-frame on (step 2).



4. Punching orientation "thick into thin"

## We will be available to help with your project from the first step to completion



- **Testing of your components in the application system**
- **State of the art 3D CAD systems support our customer-specific design**
- **Expert advice and support by our project managers and sales consultants**
- **On-site system set-up, commissioning, training of your staff as well as maintenance and service support**

## Application Examples of **RIVCLINCH®** Joints

### Automotive Industry

**More examples:**

- Front bonnets
- Rear bonnets
- Steering column brackets
- Doors
- Wings

Heat shield panel/ aluminium

### Automotive Supply Industry

**More examples:**

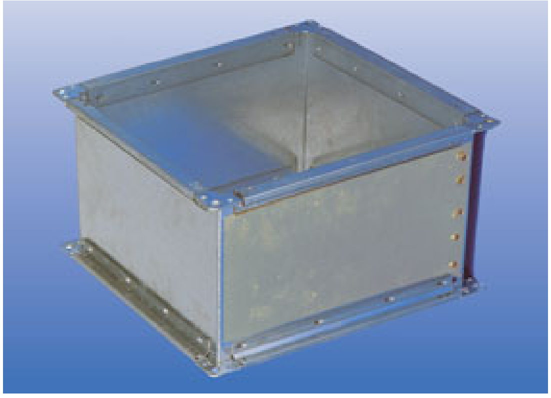
- Tank contacts
- Windscreen wiper motors, suspension
- Brake pedals
- Seat frames
- Mirror housings

Airbag cover / aluminium

### Heating, Air Conditioning, Ventilation

**More examples:**

- Filter units
- Heat exchangers
- Ventilator housings

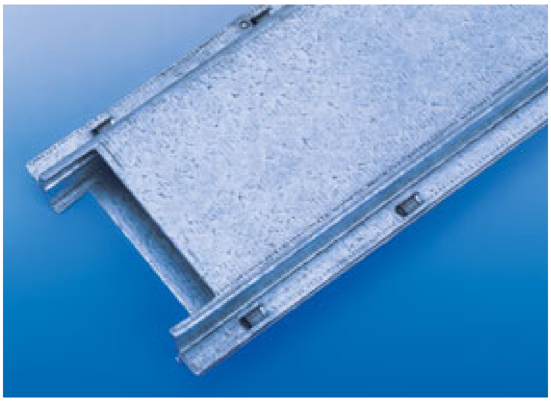


Ventilation duct / steel

### Sheet-metalworking Industry

**More examples:**

- Control cabinets
- Traffic signs
- Shelving
- Window frames



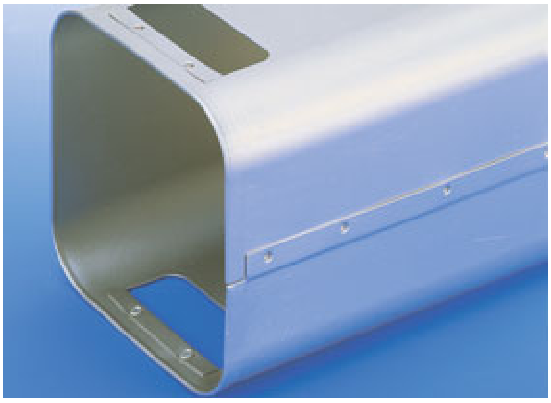
Cable duct / steel

## *Application Examples of* RIVCLINCH® *Joints*

### *Sheet-metalworking Industry*

**More examples:**

- Furniture fittings
- Lights
- Computer housings
- Drawers



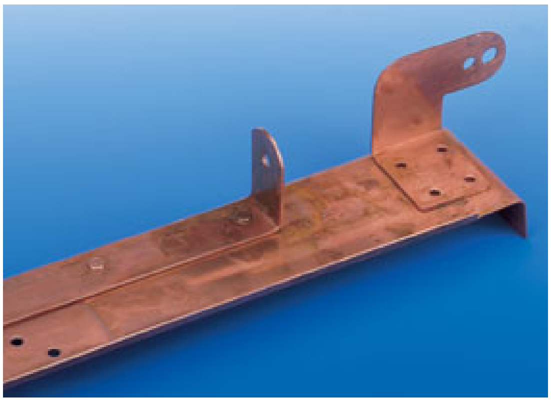
Waste container / aluminium

**More examples:**

- Industrial doors
- Light shafts
- White goods
- Sound proofing walls

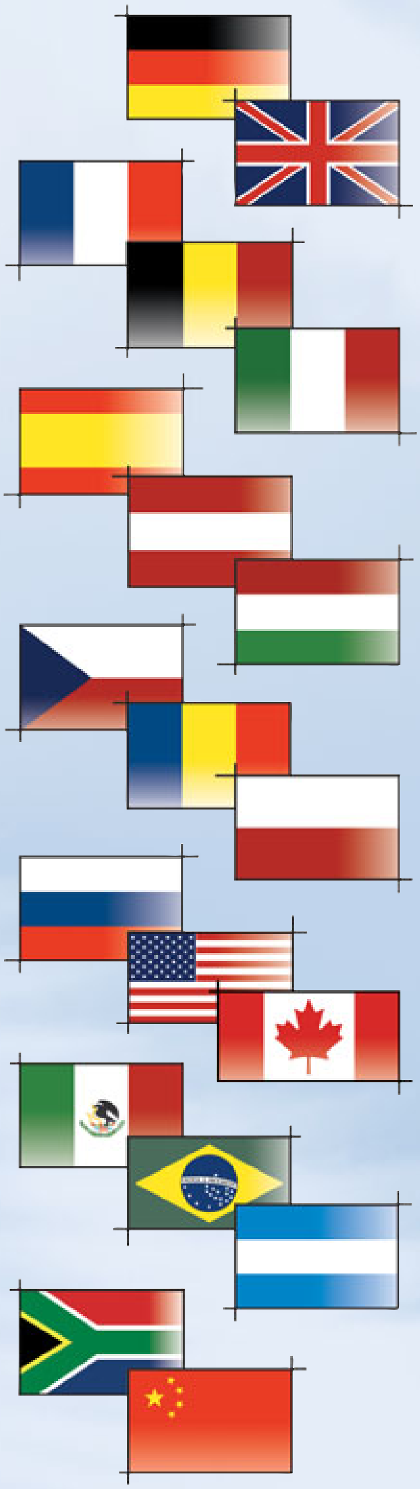
Bumper bracket/ steel

Hot air intake/ steel, aluminium coated



Fixing strip / copper

# *Böllhoff International*



**North Europe**
Wilhelm Böllhoff GmbH & Co. KG, Bielefeld
Böllhoff GmbH, Bielefeld with branches
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Leipzig, Munich, Nuremberg and Stuttgart,
Böllhoff Verbindungstechnik GmbH, Bielefeld
Böllhoff Systemtechnik GmbH & Co. KG, Bielefeld,
Böllhoff Schraubtechnik GmbH, Bielefeld
Böllhoff Produktion GmbH & Co. KG, Bielefeld and Sonnewalde,
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Bollhoff Fastenings Ltd., Birmingham, Great Britain

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