

# Friction Welding

## **Overview**

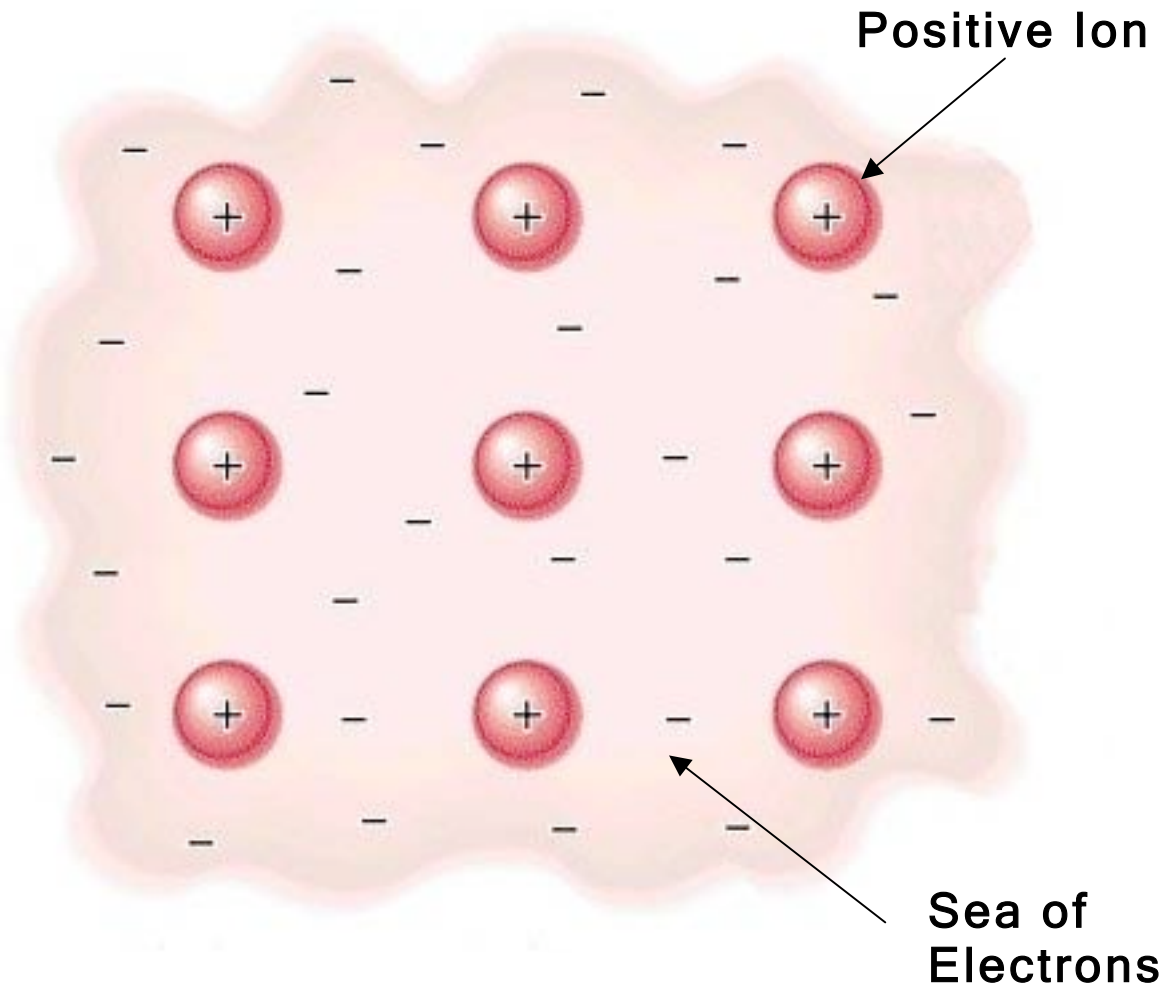
Friction welding is a solid state joining process which can be used to join a number of different metals. Friction welding achieves 100 per cent metal-to-metal joints, giving parent metal properties. It is the only joining process to do this. No addition material or fillers are required and there are no emissions from the process.

The process involves making welds in which one component is moved relative to, and in pressure contact, with the mating component to produce heat at the faying surfaces. Softened material begins to extrude in response to the applied pressure, creating an annular upset. Heat is conducted away from the interfacial area for forging to take place. The weld is completed by the application of a forge force during or after the cessation of relative motion. The joint undergoes hot working to form a homogenous, full surface, high-integrity weld.

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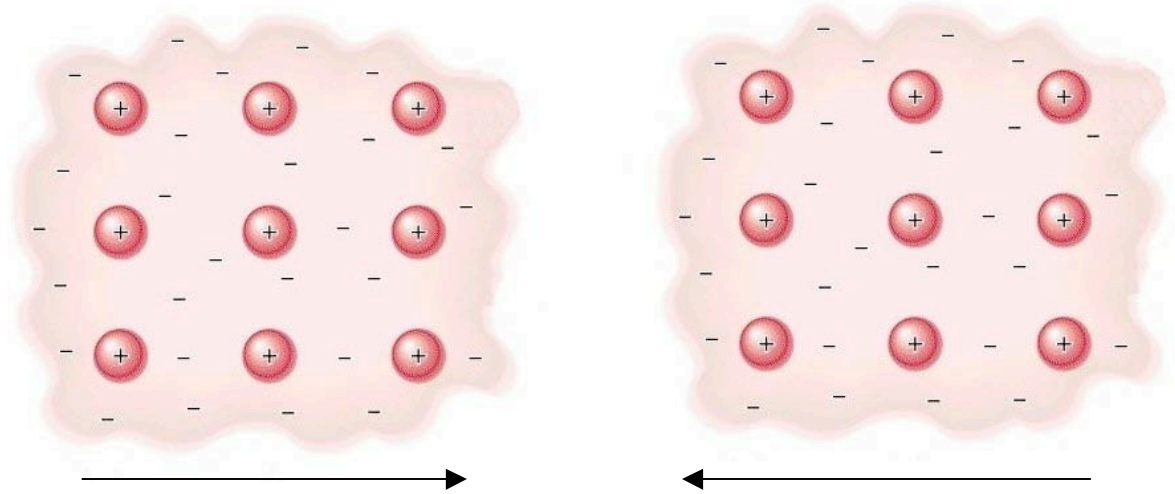
## Principle of friction welding

Metals are made up of positive ions 'floating' in a 'sea' of electrons.

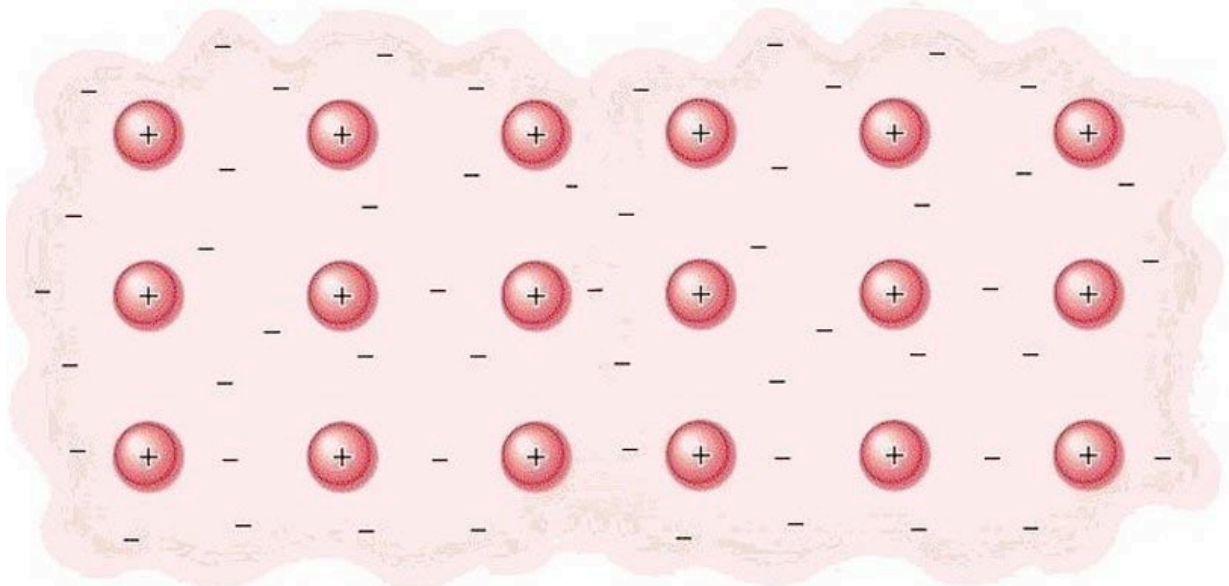


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In principle when two pieces of metal are brought together they form 1 piece.

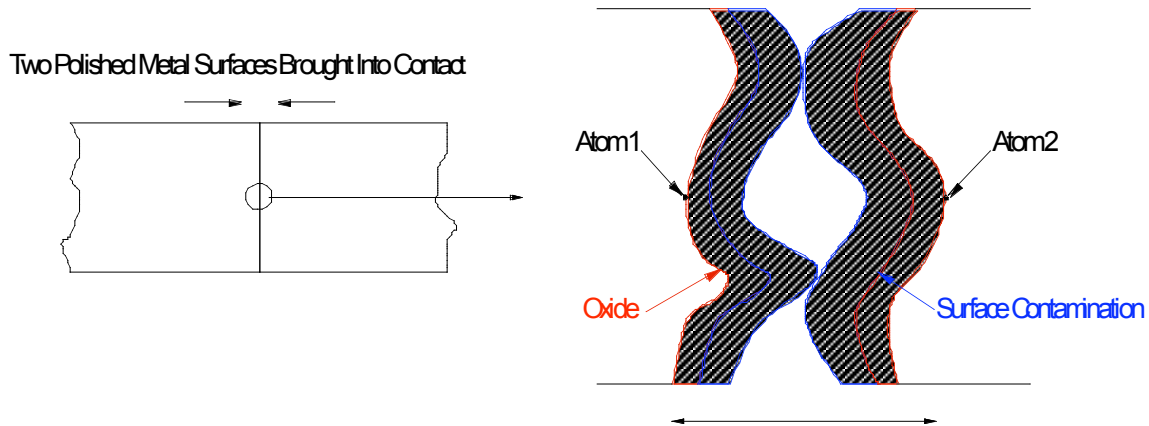


**Two Pieces of Metal Brought together form 1 piece**



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However, in a practical situation metal pieces do not spontaneously bond to each other and form 1 piece. This is because even polished metal surfaces have a layer of oxide and surface contamination. They are also not smooth enough for the atoms to be brought close enough to bond.



In friction welding, the surfaces are rubbed together to burn off the oxide and surface contamination layers and bring the atoms in close enough proximity to bond

## **Types of Friction Welding**

### **Rotary**

Rotary friction welding is the most common form of friction welding and has become the industry standard for a number of processes including welding API drill pipes and drill rods, joining of axle cases and spindles and welding of piston rods.

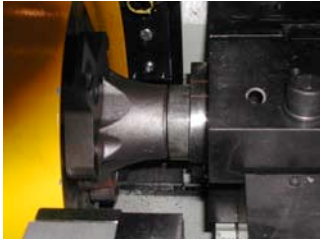
Rotary friction welding involves holding one component still while spinning the other component and bringing the two together.

Thompson Friction Welding are the world leaders in rotary friction welding having supplied over 500 machines and have over 45 years experience.

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In order for a join to be successful the following processes must take place:

### Pre-Contact



One part is held stationary in a fixed clamp. The other part is held in a rotating chuck

### First Friction



The chuck is accelerated to speed and the parts brought into contact under a light force

### Second Friction



The force is increased - plastic material starts to extrude from the weld interface

### Second Friction



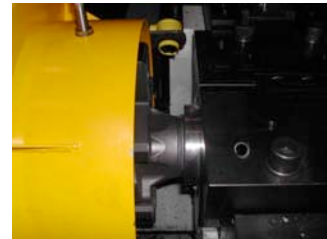
The second friction phase continues until sufficient material has been extruded

### Forge



Rotation is stopped - the force increased and the parts forged together

### Weld Complete



The weld is complete - a full area, homogenous bond

The rotary friction welding process is inherently flexible, robust and tolerant to different qualities of materials. The parameters involved are the rotational speed, time and force applied. There are optimum parameters for each particular weld that Thompson Friction Welding have calculated through years of experience. However, as the process is inherently robust and flexible, deviations on these parameters can still give a good weld.

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## Linear

In linear friction welding the same principles apply as rotary. One component is held still while the other is moved at speed and the two are brought together. The difference is that the moving component does not rotate, it is made to oscillate laterally.

The weld times for parts are similar no matter how big the part.

Due to the geometry, rotary friction welding does not have any friction in the centre of the rotating part. This portion of the weld must heat up conventionally rather than due to friction. This is not the same for a linear friction weld. Friction occurs throughout the weld surface. This means that weld times are very quick and do not vary hugely from part size to part size. The largest linear friction weld ever produced at Thompson Friction Welding had a weld time of around 4 seconds.



Because of the lateral motion of the weld, linear friction welding has the advantage of not needing a symmetrical part for welding.

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## **Advantages of Friction Welding**

Friction welding has become industry standard in a number of applications. Some of the advantages of the process are detailed below

- Weld monitoring can insure 100% weld quality
- Friction welding produces a 100% cross sectional weld area
- Far superior weld integrity compared to MIG welding
- Limited operator training require – full automation also possible
- The weld cycle is fully controlled by the machine
- Repeatable results
- Friction welding is a solid state process and does not suffer from inclusions and gas porosity.
- Friction welding required no consumables therefore becomes more cost effective over time
- Friction welding typically will complete a full cross sectional weld in 15% of the time it take MIG welding to produce an 85% cross sectional weld.
- Friction welding requires no special weld interface preparation welding)
- No post machining is needed for friction welded components in many cases
- Dissimilar materials can be joined with no alloying of the material

## **Applications**

Due to the advantages of friction welding, it has now become industry standard in a number of applications:

- Trailer axles – welding spindle to the case. Thompson Friction Welding are the only company to make a double ended machine which can weld two spindles to the same housing simultaneously. Advantages of this include
  - fast production time
  - extremely accurate weld
  - required machinery footprint reduction
- Piston rods – welding the eye or yoke to the shaft. Thompson Friction Welding has supplied many machines that can weld pre chromed bars without any damage to the delicate chrome surface.
- API drill pipes and drill rods – welding of connectors to pipes and rods. Thompson Friction Welding are at the forefront of technology advances in this area with new developments including internal flash removal over undulating surfaces.

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In addition, friction welding can replace different forms of joining in other applications, speeding up process times and giving superior weld integrity

- Air bag canisters
- Track rollers
- Drive shafts
- Anode hangers
- Engine valves
- Steering racks
- Turbo chargers

Linear friction welding has a number of key applications in the aerospace industry. Welding of bladed discs has great advantages and cost savings over traditional manufacturing methods. Thompson Friction Welding have produced the worlds largest linear friction welding machine.

## **Summary**

Friction welding enables the joining of materials giving a weld of high integrity with many advantages over other joining methods. It has been used in many applications and while it is now a very well established process, new developments are being made all the time by companies such as Thompson Friction Welding in both rotary and linear welding. The future of friction welding is secure with new uses in the aerospace industry.

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