KUNSTSTOFF

VERBINDUNGS-TECHNIK

R.R.S.

The rotary friction welding method

"Gigant RRS" Welding machines
for rotationally symmetric parts to be joined

KVT®
BIELEFELD

Rotation Friction Welding

A fast bonding procedure for mass-produced articles

There are diverse possibilities of joining plastic parts both of the same and of different consistencies. The polymer components can be connected with snap fasteners, screwed, riveted, stuck, or permanently and hermetically sealed. The known welding procedures are basically differentiated by the method of generating the fusion heat which is necessary for the bonding process. The most common welding alternatives, with applicability being determined from case to case, are included in the range offered by **KVT Bielefeld**:

- Heating of the joining zones by contact or radiation heat in **heated tool welding**.
- Heating of the joining zones by molecular friction as a result of high-frequency oscillations in **ultrasonic welding**.
- Electromagnetic heating of the joining zones of plastics by using insert heated tools in **EWS electromagnetic resistance welding**.
- Heating of the joining zones by interface friction as a result of vibration or rotation movements in **friction welding**.

Along with heated tool welding, rotation friction welding is one of the longest practised bonding procedures for thermoplastic materials. As the name rotation friction suggests, the surfaces to be welded together are heated by friction.

To produce a rotation friction bond, the pre--form to be welded on is set in rotation motion and at the same time pressed with its joining surface against the second workpiece which is firmly held in a special holding device. The joining surfaces of the two parts are rubbed against each other for a short time until weldable melt has been formed as a result of the friction heat. Then the friction movement is stopped and the seam is cooled down and forge bonded. Normally welding filler materials are not used.

This procedure is particularly suitable for connecting rotation symmetric pre-forms and has proved itself to be the ideal bonding technique for the production of mass-produced articles as the welding times of a few hundredths of a second are extremely short and a welding rate of 60 pieces and more per minute can be achieved.
Today rotation friction welding is also often used to weld pre-forms with circular interfaces on to larger semi-fabricated forms or blow-moulded articles.
The procedure has been firmly established in industrial production for many years.

New standard machines for rotation friction welding which were first launched on to the market in the eighties with modern controlling technology and selectable precise rotation speed settings for diverse process sequences have opened up new areas of application for this proven bonding technology.

The procedure:
Welding with rotation movement

Rotation friction welding is always deployed whenever the joining seam of the parts to be joined is rotation symmetric. With simultaneous application of the joining force, one of the parts to be welded is set in a rotation motion. Friction heat results on the interfaces of the parts to be welded as a result of the impact of the joining force and the rotation movement. As the heat of the interfaces increases, the friction coefficient also increases and this in turn accelerates the temperature rise. As opposed to other welding procedures, e.g. ultrasonic or vibration welding, in the case of rotation friction welding, the energy is constantly being converted which means that of all the rival methods of welding, this one is the quickest. Often welding times of only hundredths of a second are needed. For this reason, rotation friction welding is preferred for mass production with a welding capacity of more than 60 pieces per minute, e.g. in filling and welding machines for spice tins made out of polypropylene/PP.

In order to achieve high levels of welding seam strength when welding plastics of part crystalline materials, it is absolutely essential that the rotation movement be stopped abruptly once plastification has taken place. Otherwise the melt which is cooling down and thus hardening could be torn by further rotation motion. It would result in the so-called "melt fracture", also found in incorrect soldering with tin, (cold soldered joints). In order to avoid such a fracture, special constructive measures must be taken on the machine so that even in the case of materials which contains crystallines perfect rotation friction welding is guaranteed.

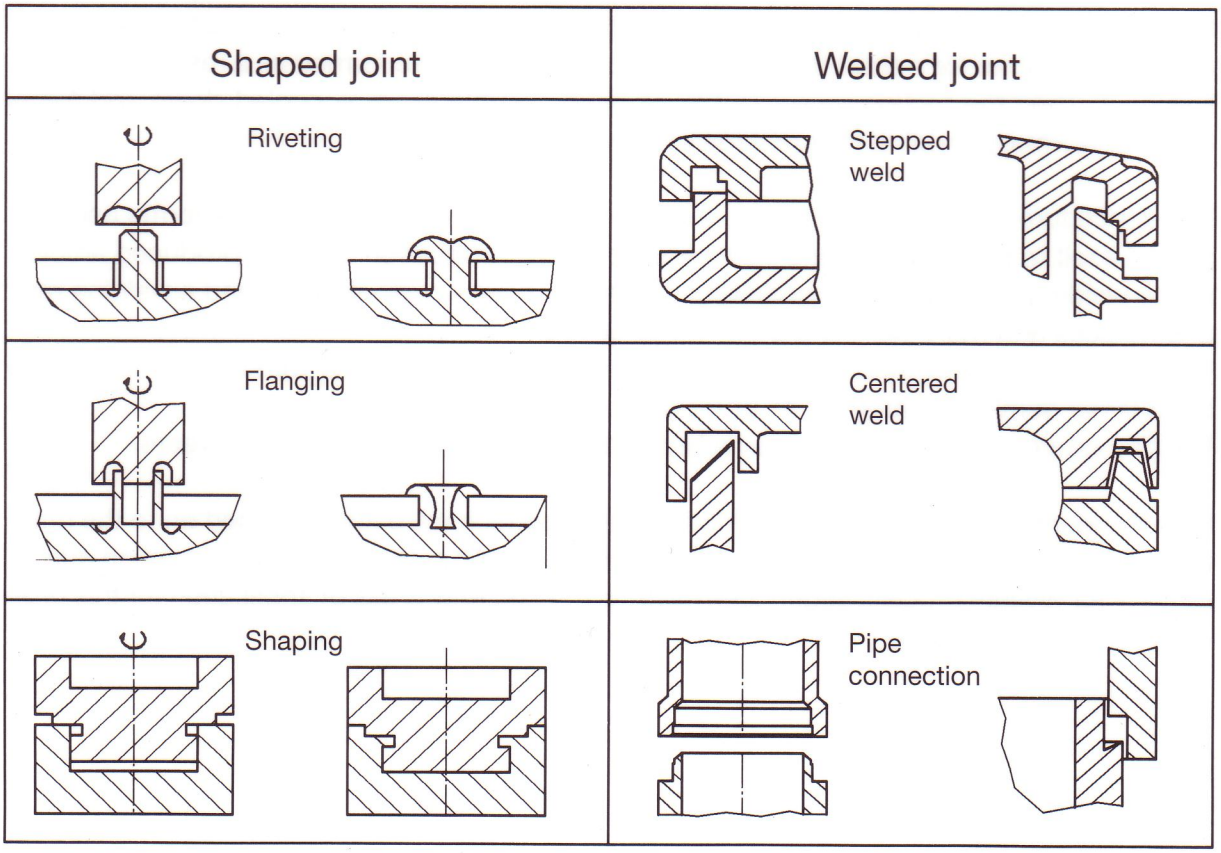
Welding with angular positioning

A special design solution is required every time the two halves of the piece to be welded must be in a precisely defined angular position to each other after welding. For such applications KVT Bielefeld offers machines in its range with exact angular positioning.

With the aid of appropriate joining zone geometry, the workpieces can be optimally prepared for the rotation friction welding procedure.

Rotary friction welding pointing-zone geometry for different applications

Some examples:



The Technology:

Two drive variants are available

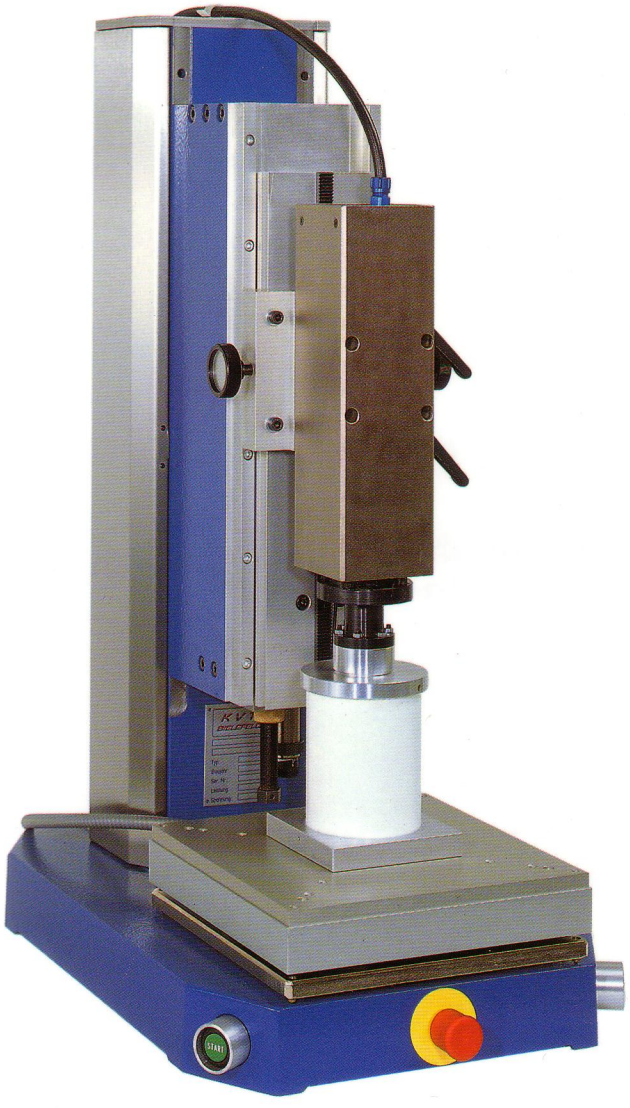
In the initial phase of rotation friction welding the procedure was frequently carried out on modified lathes. Today, there are modern welding machines on the market. They meet all the requirements of the user and offer a high degree of safety and controlling standards. Most of the standard machines are designed in the C stand form.
The essential components are as follows:

- Welding press "KVT GIGANT"
- Microprocessor controller
- Rotation drive and braking unit
- Workpiece holder and turning tool.

On account of the different requirements made on the drives of rotation friction welding machines, two different kinds of drive systems were developed by **KVT Bielefeld**:

- Pneumatic or electric spindle drive.
- Electromotor – hydromechanical drive.

Both versions are suitable for use on the presses of the GIGANT series of KVT Bielefeld or as installation components for special-purpose machines.



Rotary friction welding machine GIGANT 2500/R1-2P for universal use

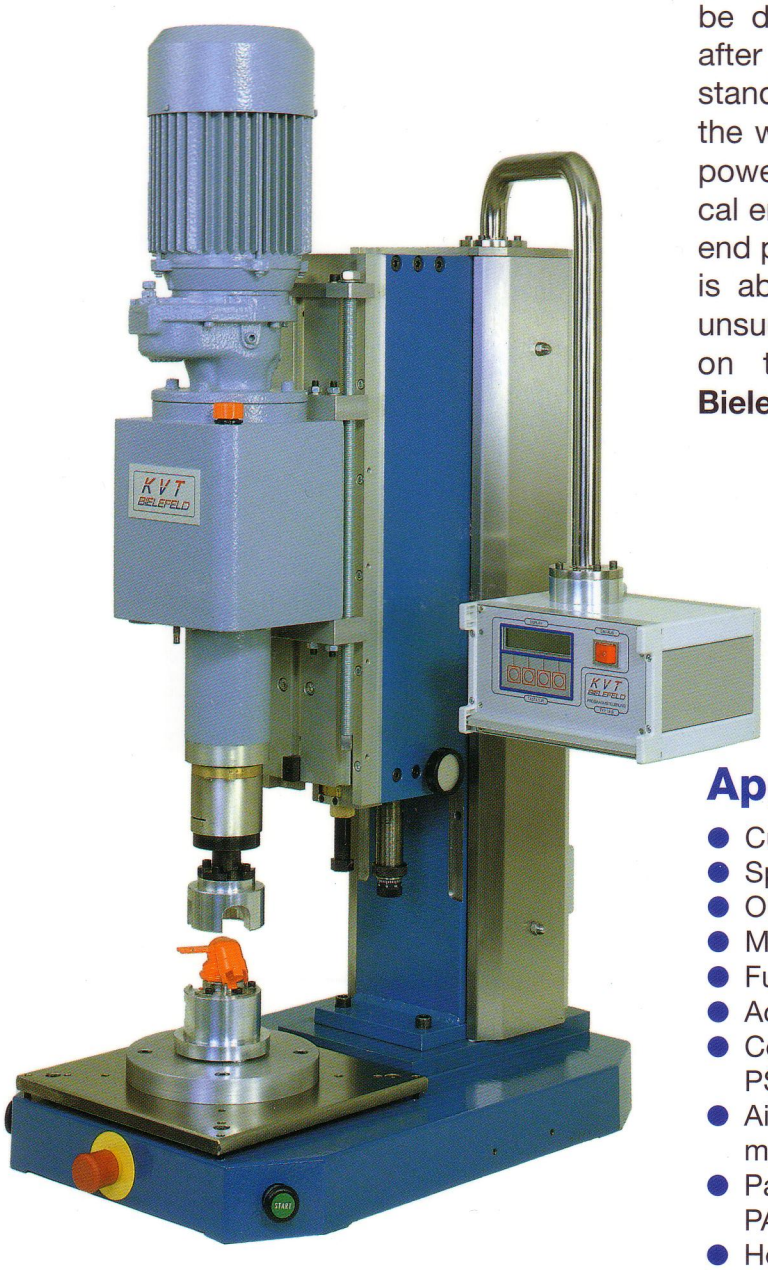
The pneumatic (electric) spindle drive

This kind of drive is deployed when welding parts which do not require a defined end position. In many cases the friction path is less than one full revolution. For this reason, these drives are supplied with angle encoding devices in order to switch off the drive power after fractions of a revolution.

The rest of the procedural sequence is largely identical to that already described. In application it has been proven that the pneumatic drives supplied by **KVT Bielefeld** are much superior to the electric drives with regard to dynamics and economic efficiency. When switching off the air intake, the entire drive moment of the pneumatic drive is converted into a braking moment – which is a particular advantage whenever the drive shaft must come to an abrupt standstill in order to guarantee prefect bonding results, as, for example, whenever polymers containing some crystallines are being processed. The pneumatic drives supplied by **KVT Bielefeld** are largely hardwearing and maintenance free. An electromotor spindle drive is also available as an alternative on request.

The electromotor hydro-mechanical drive

This drive is always deployed whenever parts which are positioned at exact angles to each other have to be welded. It is also considered whenever crystalline or high-tech plastics like PP, PE, PA, PI, PEP, PBTP etc, which require an abrupt stop in movement, are to be welded. The hydro-mechanical rotary gear is driven by a three-phase motor with corresponding power. The tool which holds and carries the rotating part is mounted to a scaled clamp coupling on the driveshaft. The rotating part is clamped and carried in a non-slip manner.



"Gigant2500/R1-5E" Rotary friction welding machine for welding with exact angular positioning

The welding procedure with angular positioning

Before the welding process begins, the plastic parts are inserted into the tools either manually or by machine. The parts are then pressed against each other by the welding press with the pre-selected joining force (trigger force). After the trigger force has been overcome, the electromotor which is already running with nominal rotation speed is coupled to the drive shaft via the hydromechanical turning gear. This causes tremendous acceleration and a rapid increase in the friction speed which itself brings about an extremely fast increase in the temperature on the rubbing surfaces. In most of the application cases to date, the gear shaft can be dismounted from the rotating motor after 1...5 revolutions and brought to a standstill on the last three revolutions of the welding process. While doing so, the power shaft moves towards a "mechanical end stop" which determines the exact end position. The precise angular position is absolutely reproducible and, to date, unsurpassed in its dimensional accuracy on the machines supplied by **KVT Bielefeld.**

Applications to date:

- Cups and little pots made out of PP
- Spice tins made out of PP and PS
- Oil mist separators made out of PA
- Moulds for optical lenses made out of PE
- Fuel gravity valves made out of POM
- Activated charcoal filters made out of PP
- Coils for winding materials made out of PS and ABS
- Air filters for passenger car engines made out of PP
- Passenger car heating fittings out of PA/GV 20
- Hose couplers for central locking
- Vacuum accumulators made out of PA/GV 30
- and lots more.

The options:

The machine controller

Since 1985, KVT ultrasonic welding machines have been controlled exclusively by micro-processors. As well as precisely controlling the processing sequences, they also facilitate the representation of visual information for the operator.
The machine controller type KVT 19 S can be deployed as a basic model for all KVT welding machines. It combines operator friendliness and high reliability along with economic efficiency achieved by a reasonable price-performance ratio. Different welding programs are available. An interface RS 232 is available as an option for the connection of printers and peripheral data processing equipment. Distance measuring systems can also be used. Database programs which provide quality assurance can also be supplied by KVT Bielefeld.

– KVT 19 S –

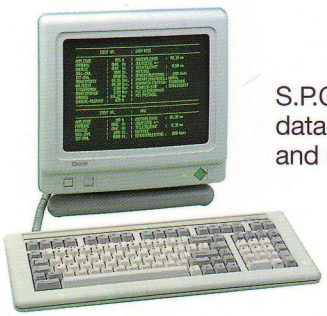
Microprocessor control, Type "Monitor"

Controller KVT "Monitor"

In 1987 **KVT Bielefeld** presented the first "Monitor controller" at the "Productronica" trade fair in Munich. The result of consistent upgrading of this model is the "KVT Monitor" as we know it today. By converting analogue measuring data into digital signals, all the parameters of a welding procedure can be set, monitored, regulated and recorded.
Looked at individually, these are:

- Joining force and joining distance
- Welding energy and process times
- Tolerances of the parts

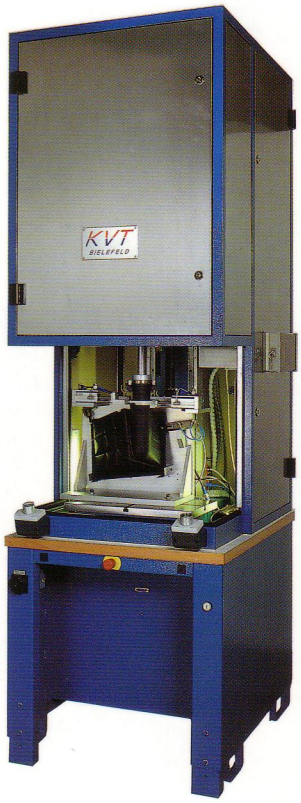
Malfunctions in the process sequence, defects in the system or on the parts to be welded as well as exceeding or failure to reach the desired values are saved as "current events" in a "logbook" along with details of the date and time they occurred. It is also possible to store the records of 20 process sequences of different products in a program memory and they can be called up in a matter of seconds. To adapt the welding machine, it is only necessary to change the tools because the working program is already available in the program memory.
Further process data can be loaded from peripheral data stores via the existing serial interface.



S.P.C. – External data management and evaluation

Active safety while working

KVT Bielefeld developed the protective sound-proof machine hood type **KVT 010/SO** to protect the operating staff from injury and irritation caused by a high level of noise. The special feature of the hood is that it is fitted with a transparent, u-shaped, angled and automatically operated protective front door which closes off the working area of the machine in a soundproof and safe manner during the welding process. However, when opened, the workpieces can be accessed without any hindrance. This development ensures not only a high level of safety and operator friendliness at the work place, but also a high production output as a result of short cycle times on the welding machine.



The distance measuring system for welding joints following given joining measurements

By using so-called high-speed computers – i.e. microprocessors with particularly high processing speeds for digital data – all KVT welding machines can be equipped with a distance measuring system. These are linear measures with a resolution of 0.002 mm which are installed on the feed unit. These enable particularly defined welding by stating the admissible melting measure and checking that it is observed.
The measuring system also enables highly precise checking for dimensional accuracy of the workpieces before welding.

Rotary friction welding machine	Art. - No.	Press stroke in mm	Press power in mm	Tool clamping surface mm	Adjusting height mm	Compressed-air connection max.	Welding diameter, standard values	Cleartext display control	Weight excluding tool
GIGANT 1500/R1-3P-DI	3611	80 (50)	1,5 kN	296 x 296	260 x 320	8 bar	0- 20 mm	19 S (S-P/Monitor	100 kg
GIGANT 1500/R1-2P-DI	3612	80 (50)	1,5 kN	296 x 296	260 x 320	8 bar	10- 60 mm	19 S (S-P/Monitor	100 kg
GIGANT 1500/R1-1P-DI	3613	80 (50)	1,2 kN	296 x 296	260 x 320	8 bar	20-100 mm	19 S (S-P/Monitor	100 kg
GIGANT 2500/R1-2P-DI	3622	100 (80)	2,5 kN	296 x 296	330 x 320	8 bar	10- 60 mm	19 S (S-P/Monitor	110 kg
GIGANT 2500/R1-1P-DI	3623	100 (80)	2,5 kN	296 x 296	330 x 320	8 bar	20-100 mm	19 S (S-P/Monitor	110 kg
Rotary friction welding machine with exact angular positioning									
GIGANT 2500/R1-3E	3801	100 (80)	2,5 kN	296 x 296	330 x 320	8 bar	5-150 mm	19 S (S-P/Monitor	130 kg
GIGANT 2500/R1-5E	3802	100 (80)	2,5 kN	296 x 296	330 x 320	8 bar	25-250 mm	19 S (S-P/Monitor	130 kg
GIGANT 4000/R1-3E	3811	160 (100)	4,0 kN	296 x 296	420 x 500	8 bar	5-150 mm	19 S (S-P/Monitor	160 kg
GIGANT 4000/R1-5E	3812	200 (160)	4,0 kN	296 x 296	420 x 500	8 bar	25-250 mm	19 S (S-P/Monitor	160 kg

HIGH-TECH FROM BIELEFELD

Rotation friction welding

Heated tool welding

Ultrasonic welding

Thermoforming machine

Electromagnetic resistance welding

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