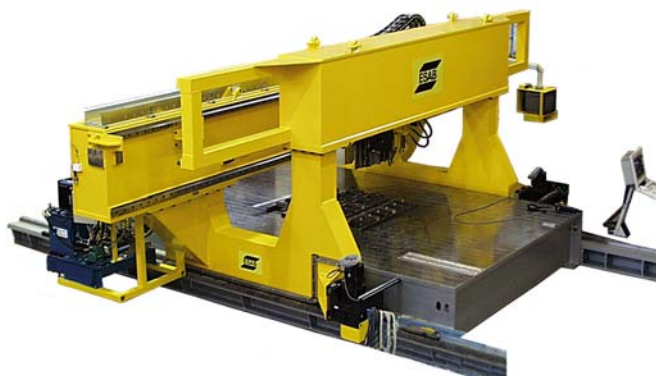
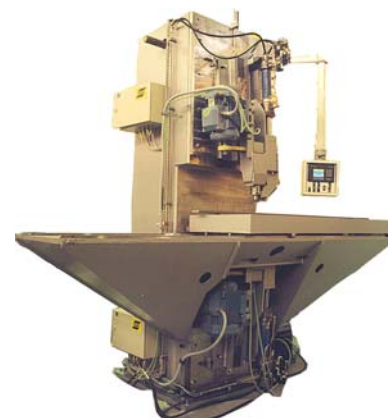
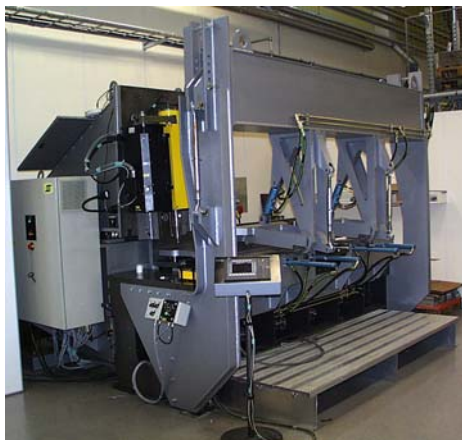




***Friction Stir Welding
within ESAB***

Machines built for the FSW process



Friction Stir Welding was invented by TWI in December 1991



TWI Group Sponsored Project 5651, "Development of the new Friction Stir Technique for welding Aluminium" was started 1992 and ESAB was one of the members.

This group sponsored Friction Stir Welding development project was conducted in three phases.

- Phase I proved FSW to be a realistic and practical welding technique, whilst at the same time addressing the welding of aluminium alloys of the 6000 series.
- Phase II successfully examined the welding of the general engineering aluminium alloys of the 2000 and 5000 series and aluminium lithium alloys. Process parameter tolerances, metallurgical characteristics and mechanical properties including fatigue have been established.
- Phase III developed pertinent data for further industrialisation of FSW and advanced tool design.

The International group of TWI members which sponsored the development of FSW



Alcan International

Aluminium Company of America

AMADA Corporation

Boeing Defense & Space Group

British Aerospace

ESAB AB

Finnyards OY

FMC Corporation

Gränges Technology

Hitachi Ltd.

Hydro Aluminium

Lockheed Martin

NASA

Raufoss AS

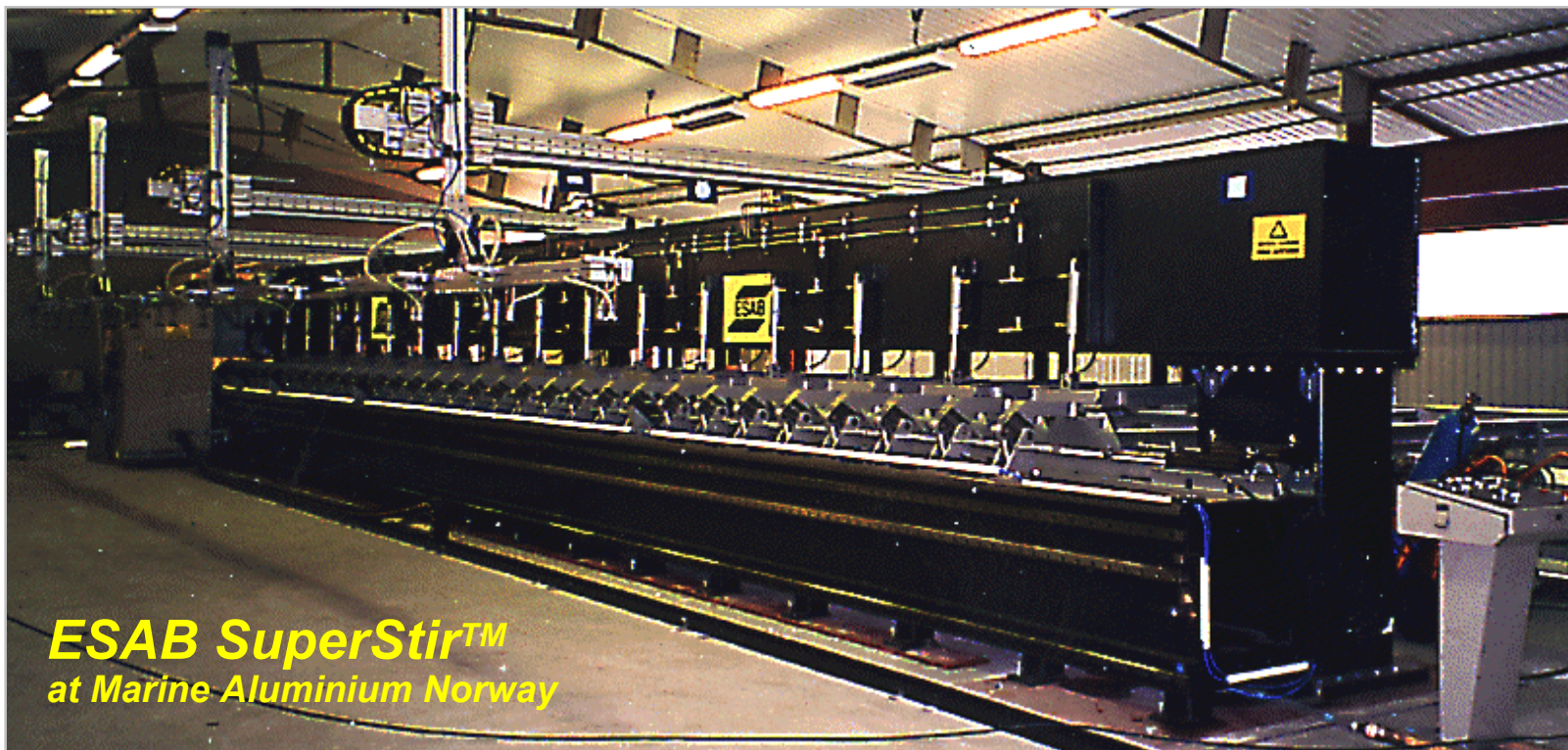
Rockwell International

Showa Aluminium

A O Smith

ESAB SuperStir™

Shipbuilding and Marine Industries



This **ESAB SuperStir™** is where all really started, the first production plant weighing 63 tons, capable of welding up to 16 meters long panels.

ESAB SuperStir™

Used at The Boeing Company Laboratory

This machine is designed for heavy duty welding of small workpieces.

Thickness 1.6-15(65) mm

Weld length 2 m



ESAB SuperStir™

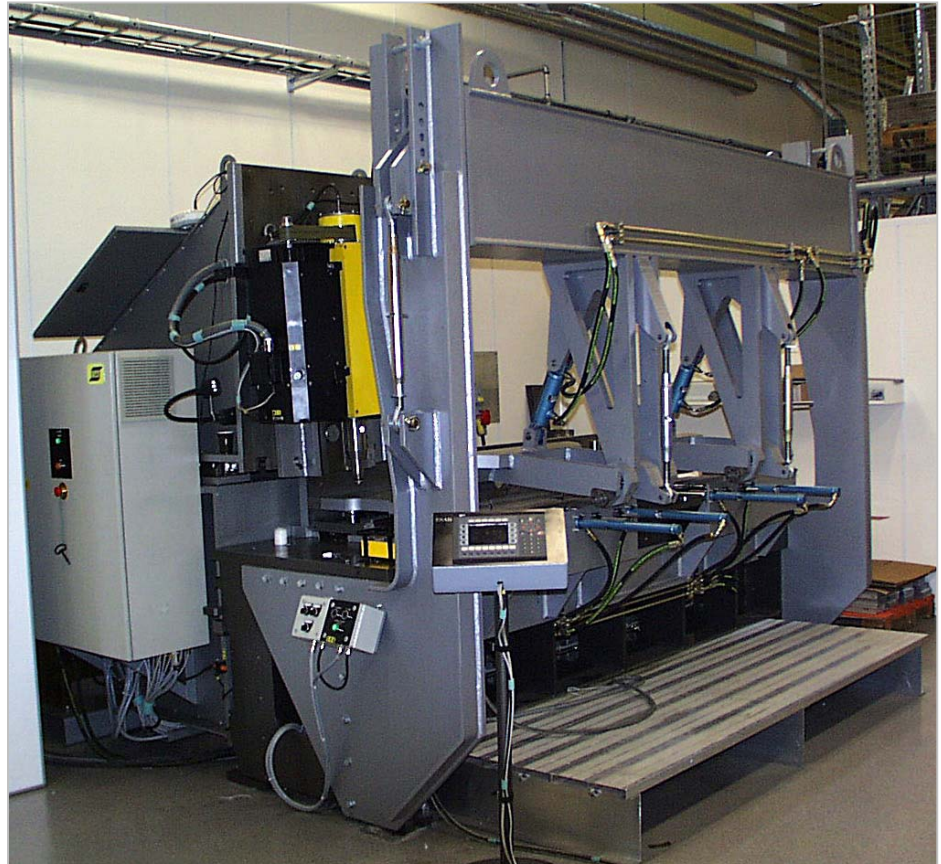
Used at ESAB Welding Engineering Lab in Laxå Sweden

FSW machine designed for small workpieces.

FSW 5 for 1.2 -15 (25) mm

Weld length 2 m

With hydraulic top and side clamping used in ESAB FSW welding laboratory for development and customer testing as well as prototype production.



ESAB SuperStir™

Aerospace Industry (Rocket fuel tanks)

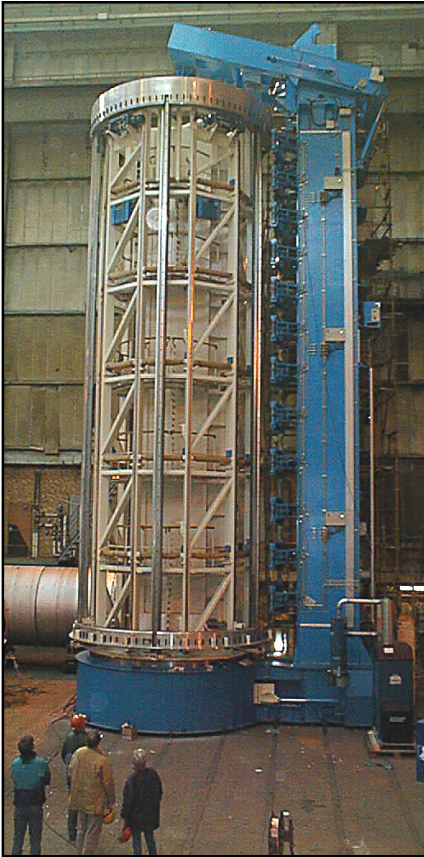
Installed at The Boeing
Company, US
Autumn 1998

The longitudinal welding
length is maximum 15
meters and diameters from
2.8 to approx. 4.5 meters
can be welded.



ESAB SuperStir™

Aerospace Industry (Rocket fuel tanks)



Two of these machines have been delivered to The Boeing Company 1998 and 1999

The plant is equipped with one milling head and one welding head travelling on the vertical main beam.

The parts to be welded are loaded on an indexing fixture and the edges are milled, welding is carried out and the final length of the tank is milled.

Tanks of 5 m diameter and max 12 m length can be welded

ESAB SuperStir™

Joining of extrusions at Sapa in Finspång Sweden



This universal panel welding machine is designed to weld panels either from single skin or double skin extrusions, and is equipped with 3 welding heads.

Max. welding length is 14.5 m and two heads are normally used, either two from the upper side or one from the upper side and one from the lower side.

ESAB SuperStir™

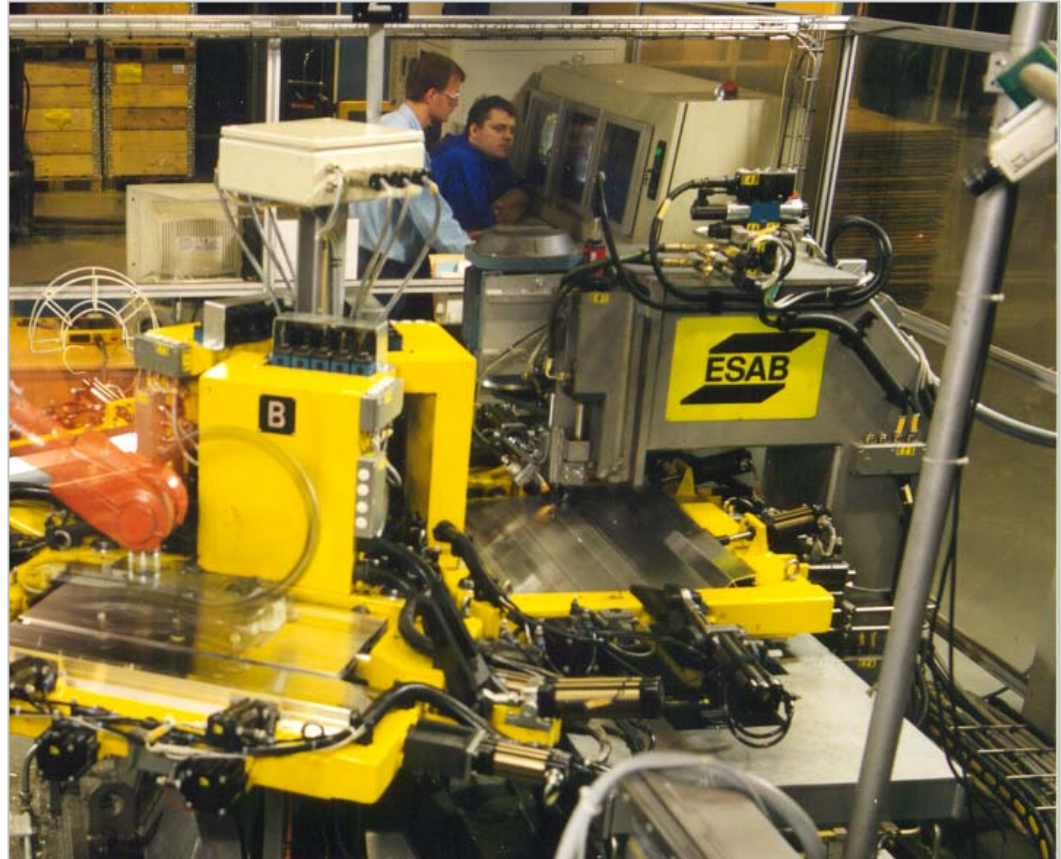
Automotive Industry



Sapa Finspång, Sweden

This welding machine is designed for straight welding of double skin extrusions using two heads.

The machine was part of a fully automatic line where parts were loaded and unloaded using a robotic.



ESAB SuperStir™

Aerospace Industry (Rocket fuel tanks)

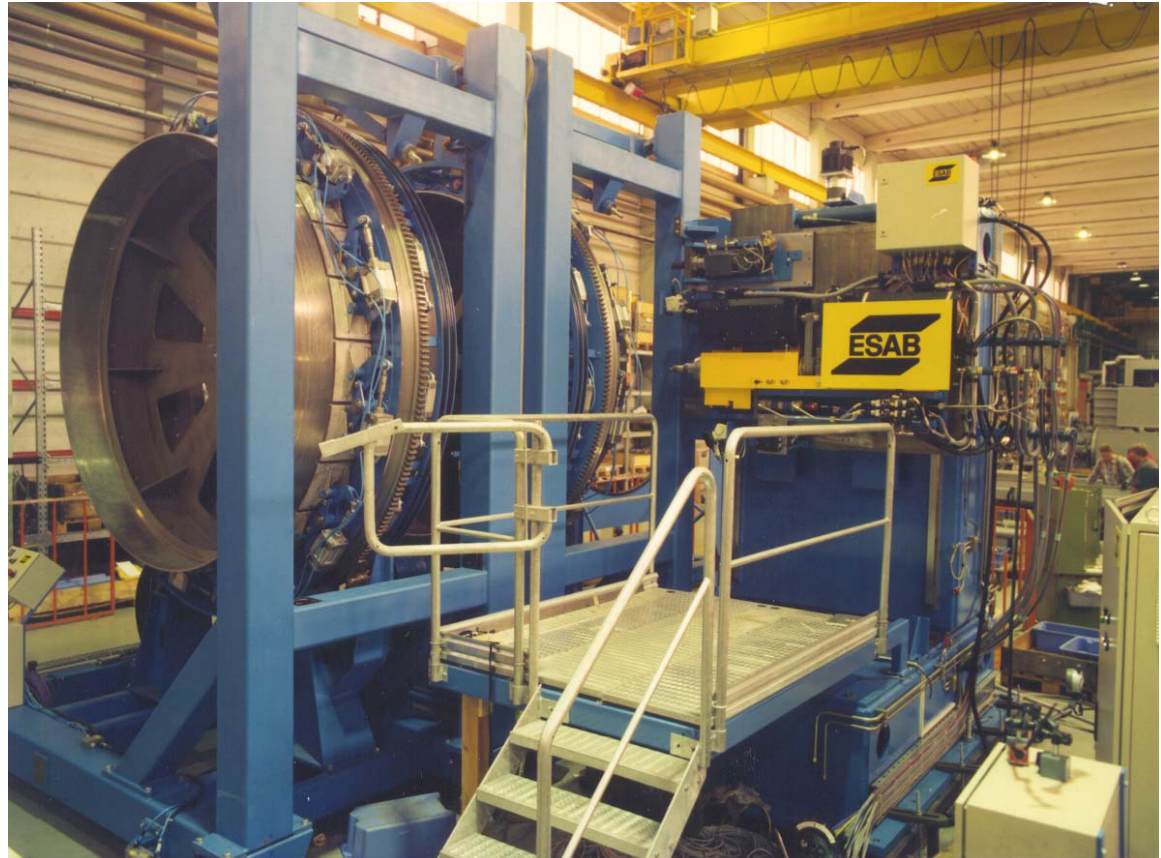


Delivered to The Boeing Company - end of 2000

Circumferential welding of fuel tanks.

Using the bobbin tool technique

Closing the end hole using a built in Friction plug welder



ESAB SuperStir™

Automotive Industry



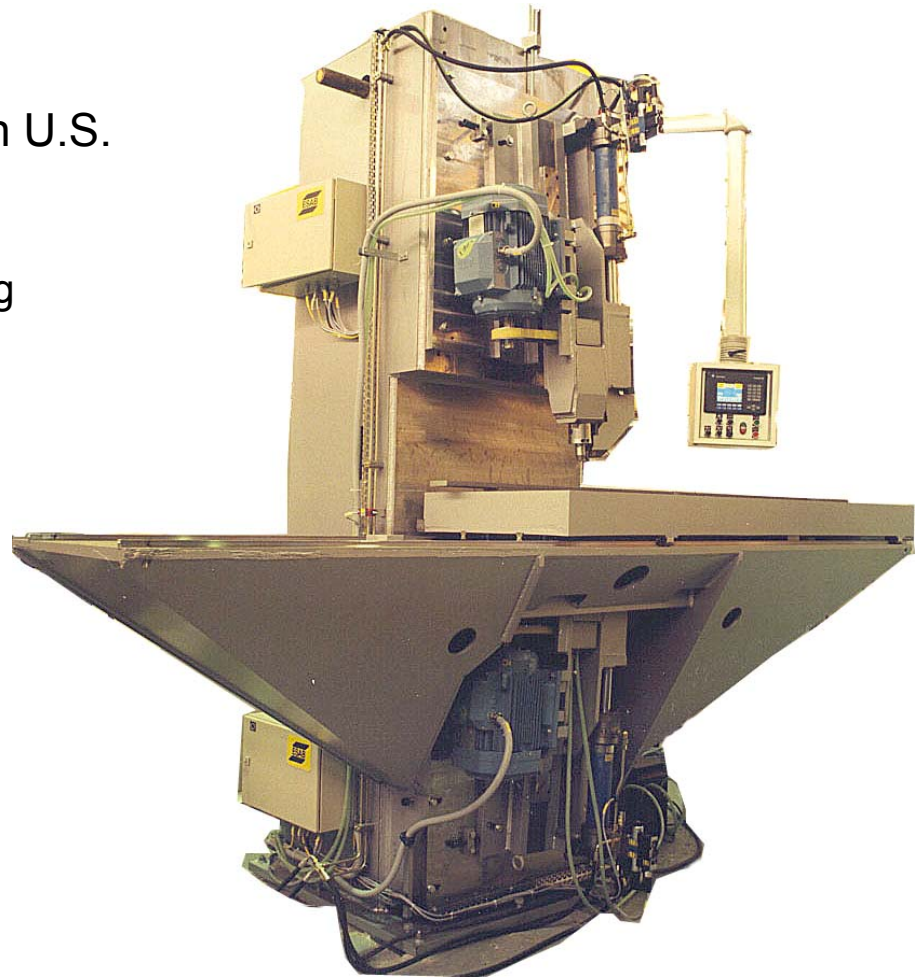
Delivered to **Tower Automotive** in U.S.

This machine is designed for producing prototype parts.

Converted for use in production.

Using two heads one from upper and from lower side.

Thickness 1.2-15 mm for longitudinal welding up to 2 meters



ESAB SuperStir™

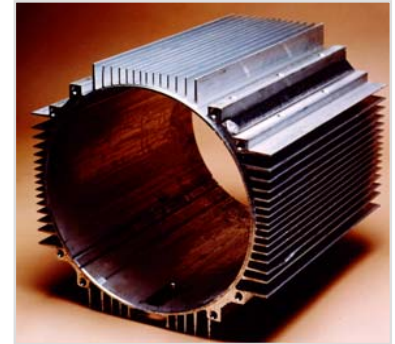
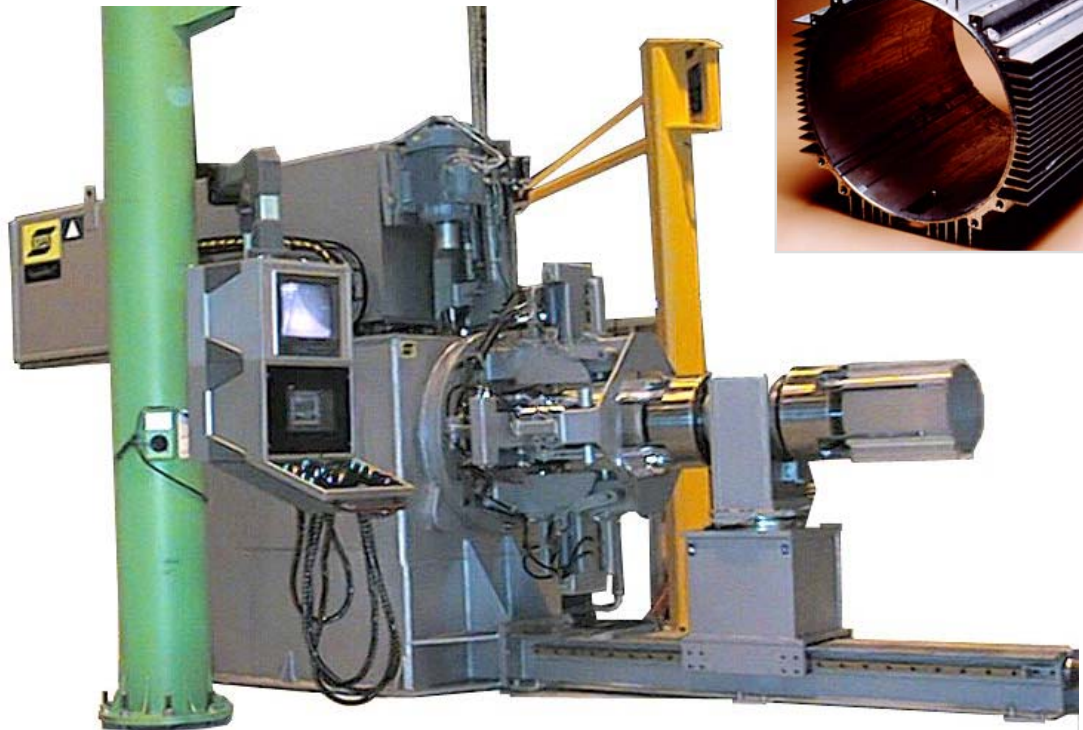
Hydro Aluminium



Plant for welding of medium size electric motor housings,
installed at Magnor Norway

Welds thickness up to
8 mm, longitudinal
welds in diameters
from 320 up to 420 mm

Also possible to weld
longitudinal welds on a
table up to 3 m



ESAB SuperStir™

Gantry Machine



Delivered to **TWI**, UK for laboratory purpose and prototype work

Equipped with two sizes of welding heads.

Working area 5 by 8 meter and max height is 1.7 m

Programmable welding paths

3D-welding together with
floor-mounted manipulators.

Offline or teach-in programming,
parameters registration,
TV-camera etc.

An all-round station built around
a stiff gantry (36 tons)



ESAB SuperStir™

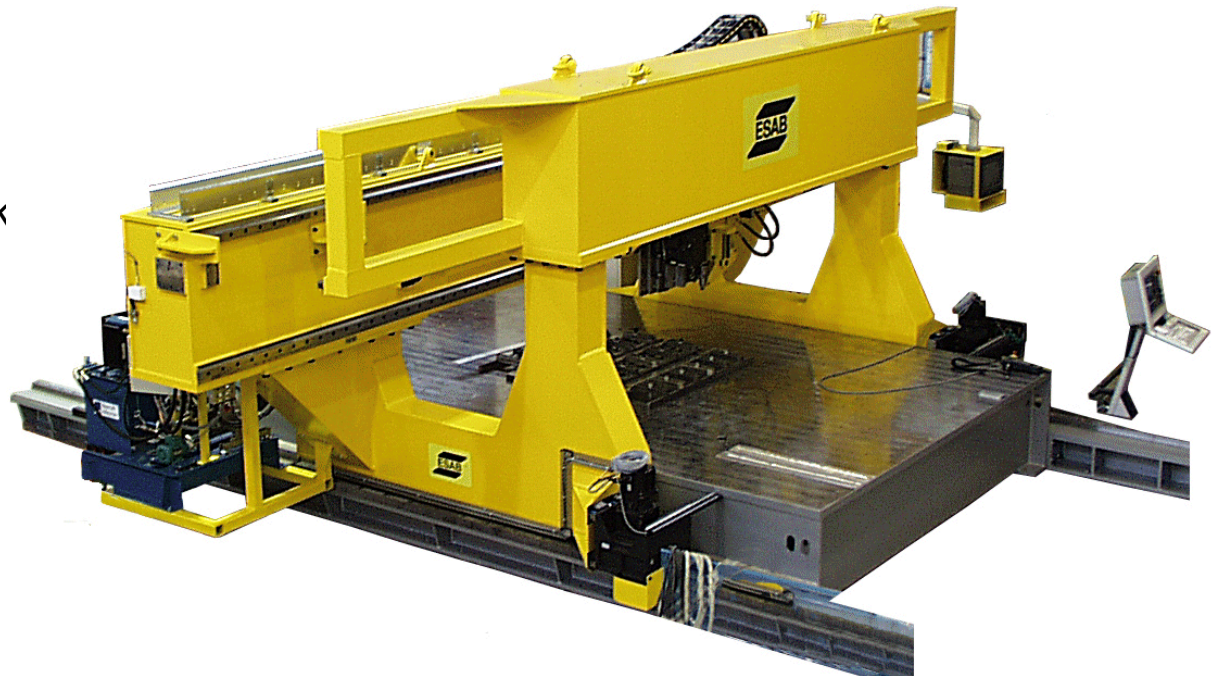
Gantry Machine



Delivered to DanStir ApS, Denmark for laboratory purpose, prototype and production work. 2007 the machine was moved to Bayards, Netherlands for panel welding

Working area 3 by 16 meter and max height is 1.3 m

Specification as TWI
also a welding table
3 by 5 m prepared for
fixtures of different work
objects.



ESAB SuperStir™

Used at *Institute de Soudure* in France



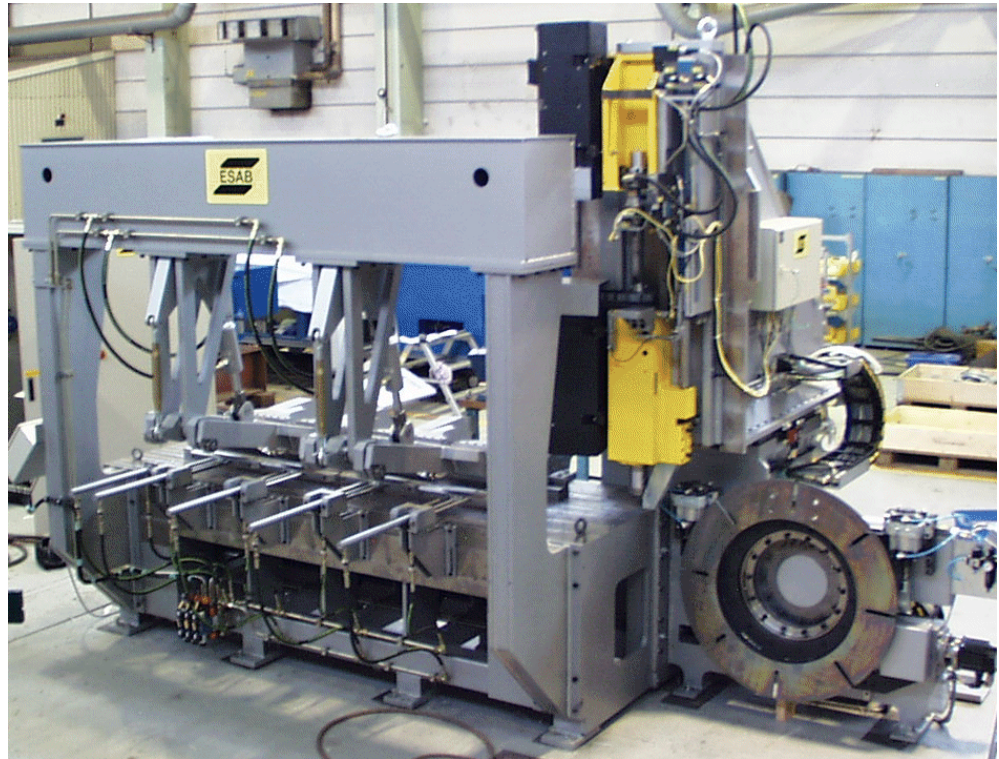
Ordered and used by EADS CCR and Institute de Soudure in France

For longitudinal welding and circumferential welding.

With hydraulic clamping.

For development, customer testing as well as prototype production.

Bobbin tool head



ESAB SuperStir™

Used at **EADS Ottobrunn, Germany**



FSW 5 for 1.2 -15 (25) mm

Maximum down force 100 kN

Longitudinal weld length 2 m

For development and testing as well as prototype production.

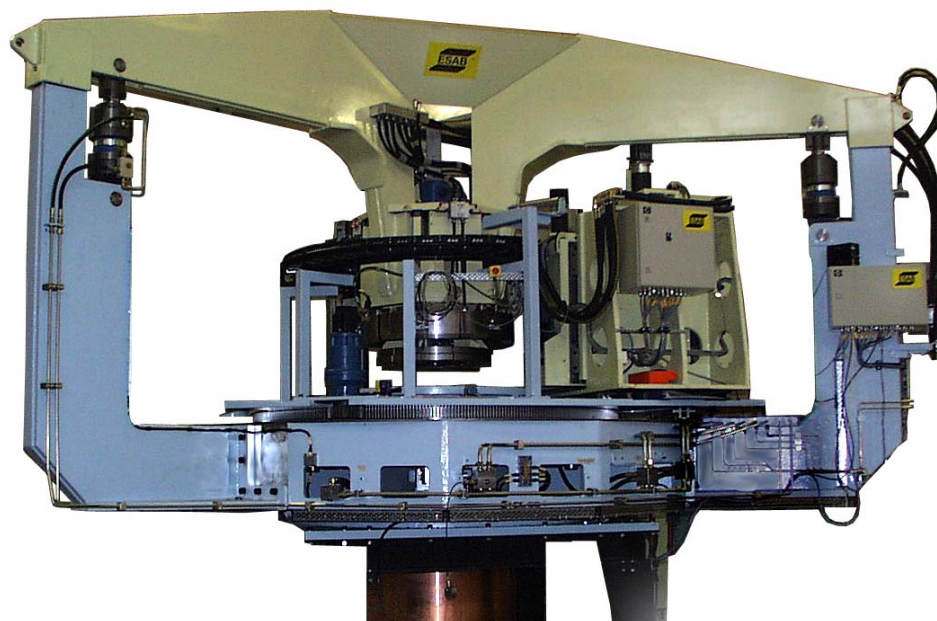


ESAB SuperStir™

*Installed at **SKB**, Sweden
(Swedish Nuclear Fuel and Waste Management Co)*

For welding of the outer shell of up to 50 mm thick copper canister for nuclear waste.

This FSW 8CA ESAB SuperStir™ plant is designed to produce seal welds of the outer shell at the **SKB** Canister laboratory in Oskarshamn, Sweden



ESAB SuperStir™

Used at Alenia Spazio R&D center Italy

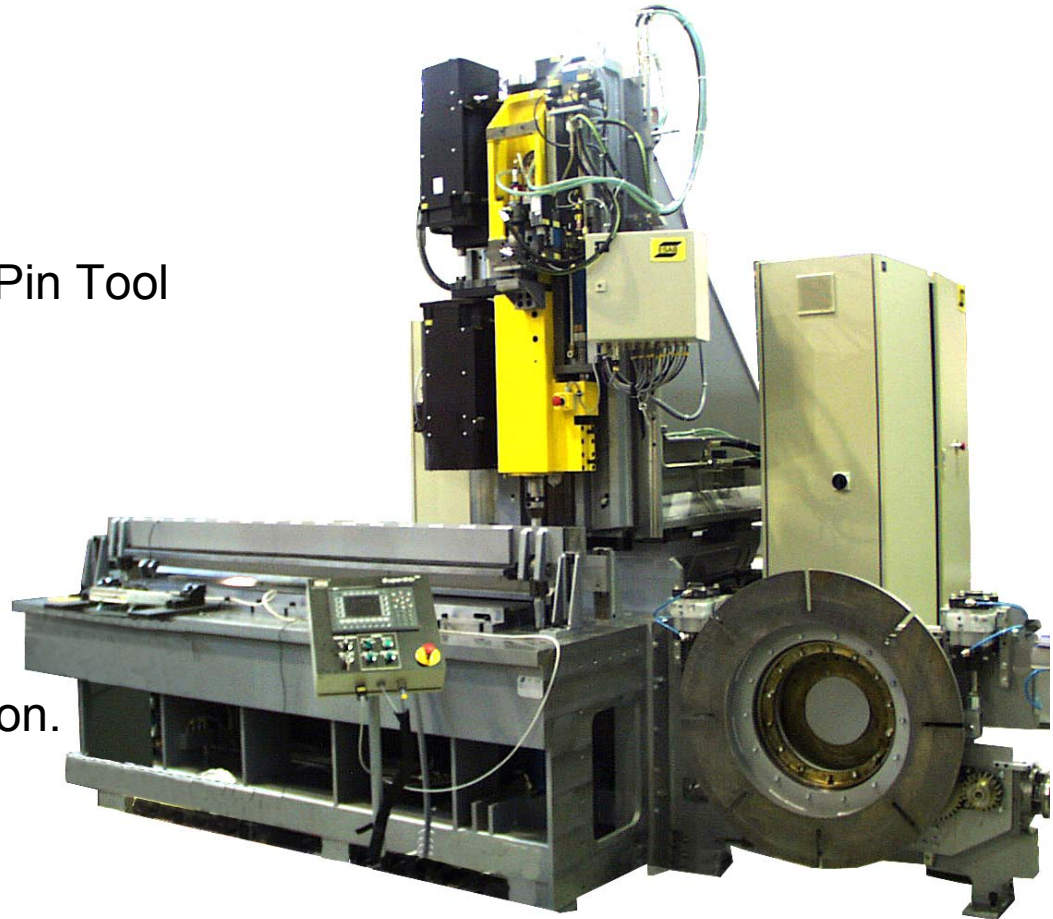


Bobbin tool and Retractable Pin Tool
head

For longitudinal welding
and circumferential welding

With hydraulic clamping

For development and testing
as well as prototype production.



ESAB FSW-system LEGIO™

During autumn 2002 ESAB launched the LEGIO™ system.

This modular system makes it possible to assemble welding stations to suit the most varied Friction Stir Welding applications.

The LEGIO™ system consists of five basic designs in a series of seven sizes and the framework is prepared for purpose built fixtures.



FSW 3UT

ESAB LEGIO™ FSW 5 UT

Delivered to KMT OY in
Finland

This machine is a LEGIO™
FSW 5UT with a weld length
of 6 meters.

The machine is used in job-
shop production.



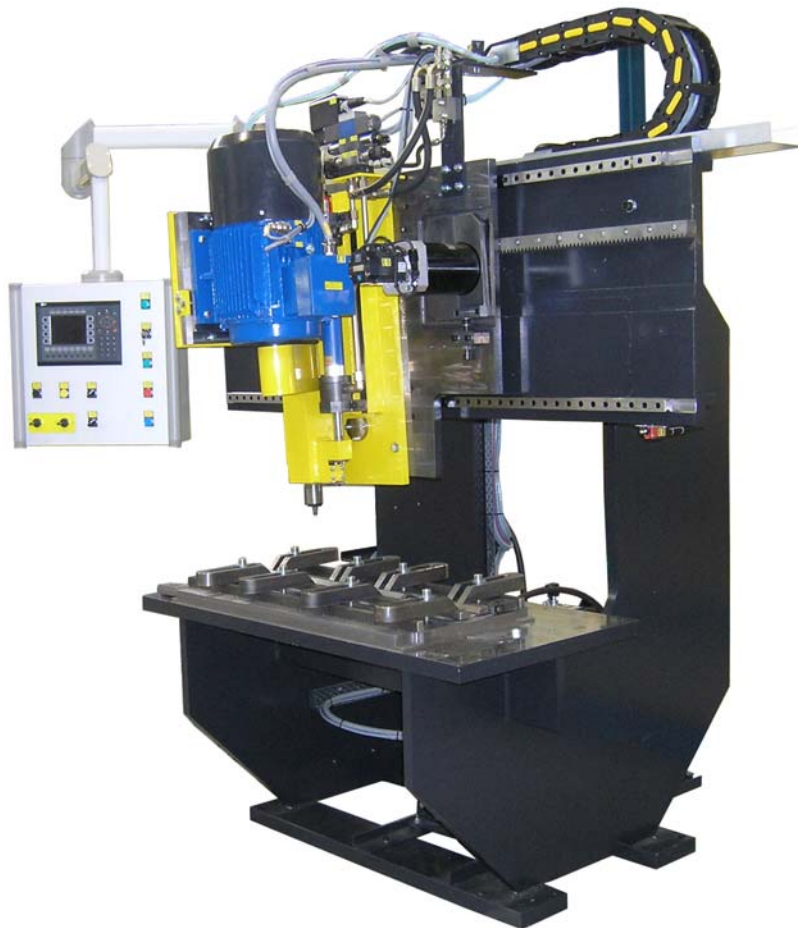
ESAB LEGIO™ FSW 3ST

Used for R&D at MPA University Stuttgart, Germany



This ESAB LEGIO™ machine, size 3 is designed for linear welding of aluminium in thickness 1-10 mm.

Standard welding speed up to 2 m/min



ESAB LEGIO™ FSW 5U

Used at Khrunichev State Research and Production Space Center, Russia



This ESAB LEGIO™ machine, size 5 is designed for 2-D welding of aluminium in thickness 1-35 mm.

Standard welding speed up to 2 m/min.



ESAB LEGIO™ FSW 4UT

Production unit for copper to copper and aluminium to aluminium, delivered to a confidential customer.

Down force 60 kN, spindle motor 18 kW.

Welding length max 1 m

Thickness 1-18 mm



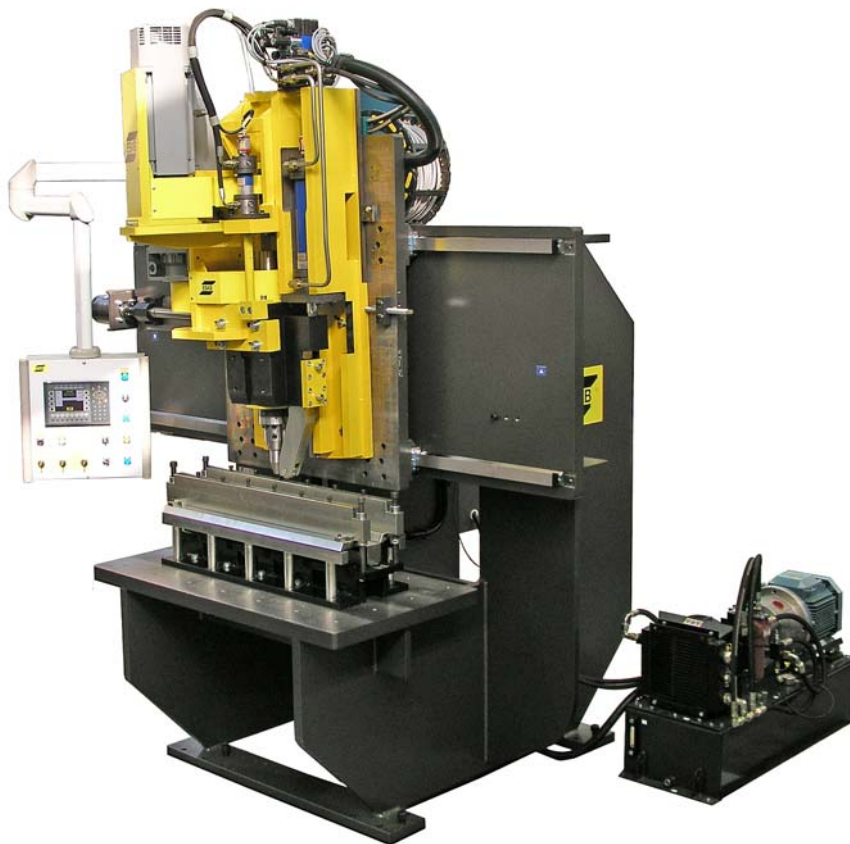
ESAB LEGIO™ FSW 5/3STL

Delivered to Cewac, Belgium
for laboratory use.

Bobbin tool and retractable pin
tool.

Down force 100 kN, two spindles
22 kW/11 kW.

Manual clamping system for max
1m, straight welds.



ESAB LEGIO™ FSW 5/3UTL

Delivered to Cewac, Belgium for development and testing as well as prototype production.

Bobbin tool and retractable pin tool.

Down force 100 kN, two spindles
22 kW / 11 kW.

Hydraulic clamping for 4 m welding length.

Four programmable axis;
X-axis 4000 mm, Y-axis 400 mm,
Z-axis 300 mm and a $\pm 30^\circ$ tilting in
X-direction.

The control system is capable of interpolating three electrical axis, in this case X, Y and tilt while using the Z-axis under force control.



ESAB LEGIO™ FSW 3UT



Delivered to CSM (Centro Sviluppo Materiali SpA), Italy to be used for R&D and small production work.

This ESAB LEGIO™ machine, size 3 is designed for 2-D welding of aluminium in thickness 1-10 mm and a welding length of 2 m.

Standard welding speed up to 2 m/min



ESAB LEGIO™ FSW 3UT

SLV, Berlin-Brandenburg, Germany



This ESAB LEGIO™ machine, size 3 is designed for 2-D welding of aluminium in thickness 1-10 mm and a welding length of 2 m.

Standard welding speed up to 2 m/min.

For R&D and small production work



ESAB LEGIO™ FSW 33ST

Euro-Composites, Luxembourg



ESAB LEGIO™ machine designed for straight welding of double skin extrusions to small panels using one upper and one lower head.

Welding length 3.1 m.



ESAB FSW 5/3U

AJT, USA



This machine is designed to weld pipe to pipe and flanges to pipes. The system is equipped with a unit for the rotary motion / welding speed.



ESAB SuperStir™ FSW 4LS

SMF GmbH, Germany



This machine is designed to join plates together by straight welds. The weld sequence start with the shoulder over a steel plate and the end hole will be parked on a run off tab.

ESAB SuperStir™

Aerospace Industry (Rocket fuel tanks)

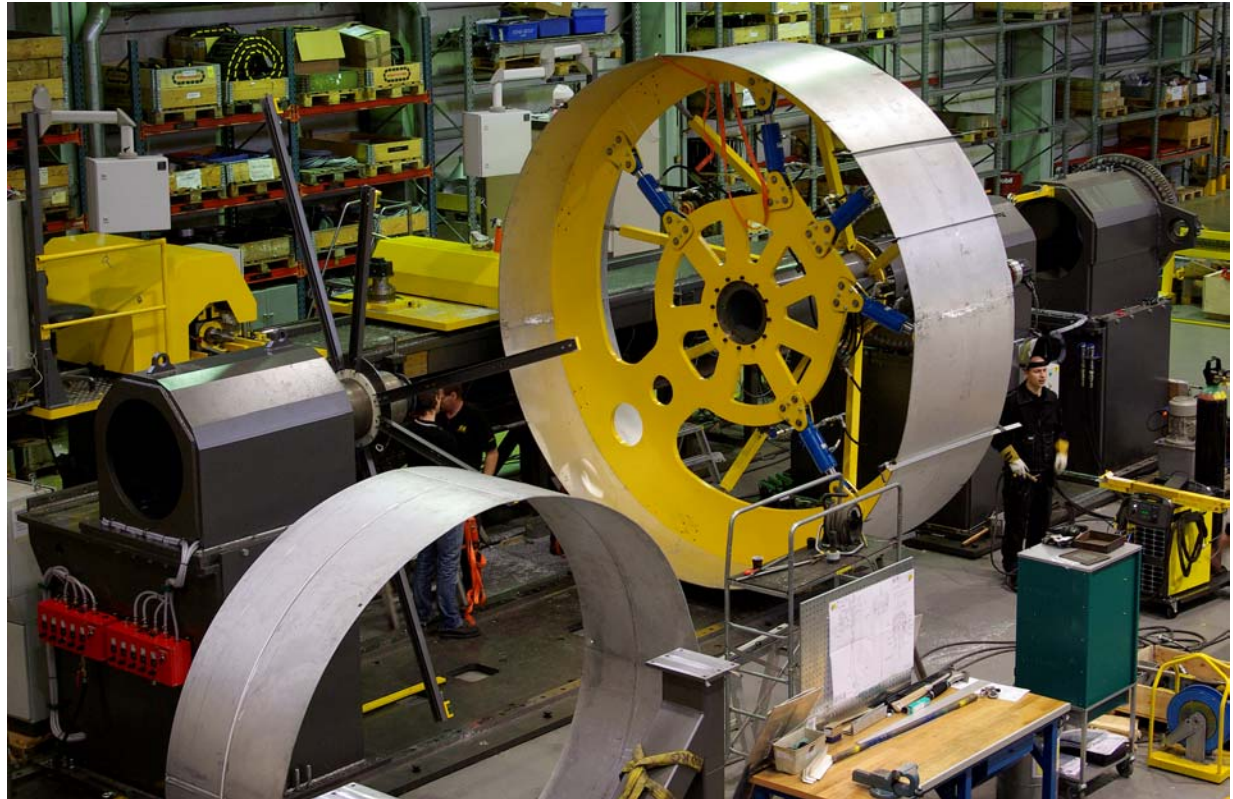


Delivered to
LPSC-ISRO, India
2008

Longitudinal
/circumferential
welding of fuel tanks.

Using basic and RPT
technique.

Equipped with milling
station for edge
finishing



ESAB SuperStir™

Air Craft Industry



Delivered to
Spirit Aero Systems, USA

Equipped with two welding heads, one upper and one lower to be used on the right hand side.

On the left hand side the machine has an open frame which gives possibility to feed through when welding plates.



ESAB FSW 3UL

IST, Portugal



ESAB LEGIO™ machine
designed for 2-D welding and
used for R&D and education in
FSW technology.



ESAB SuperStir™

Transport Industry



Delivered to Sespel, Russia

For longitudinal/circumferential
welding of tanks for trucks.



ESAB LEGIO™

Used at Rapid Technic AG, Switzerland



FSW 3UT designed for 2-D welding of aluminium in thickness 1-10 mm and a welding length of 2 m.

Standard welding speed up to 2 m/min.

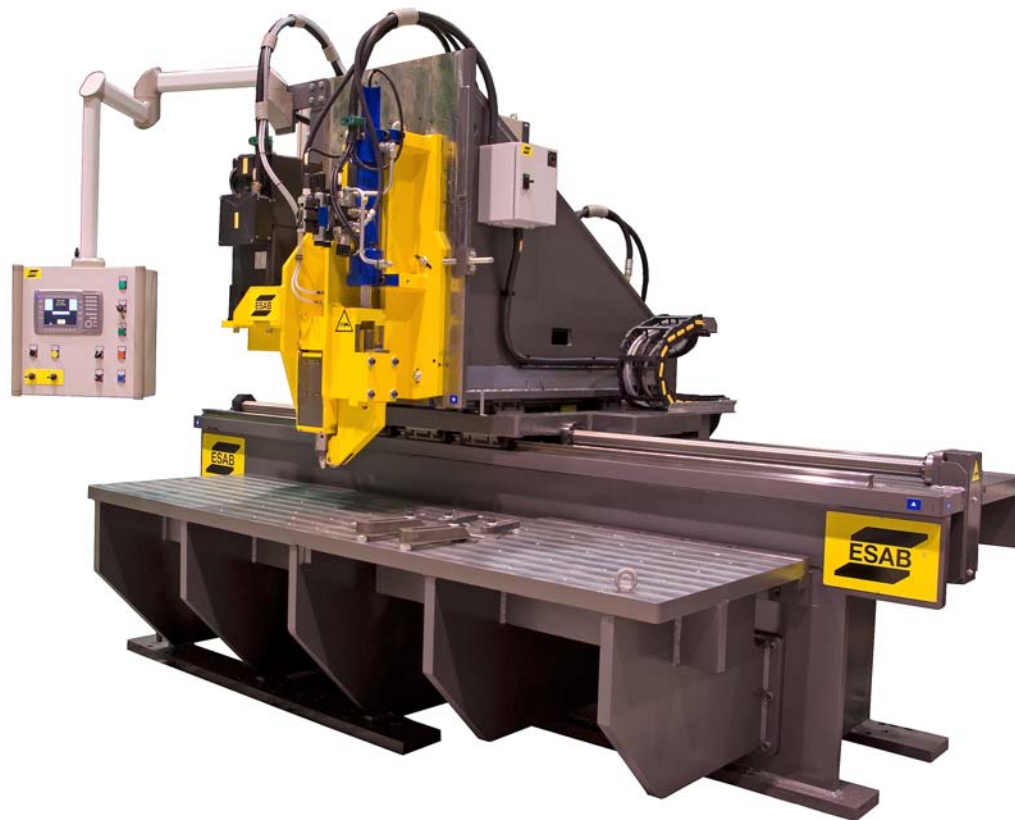
For a wide range of products.

ESAB FSW 4 UT

WEBRA, Sweden



ESAB LEGIO™ machine
designed for 2-D welding
of coolers.



ESAB Friction Stir Welding

Future Possibilities

- FSW with Robot
- FSW in steel

Rosio™

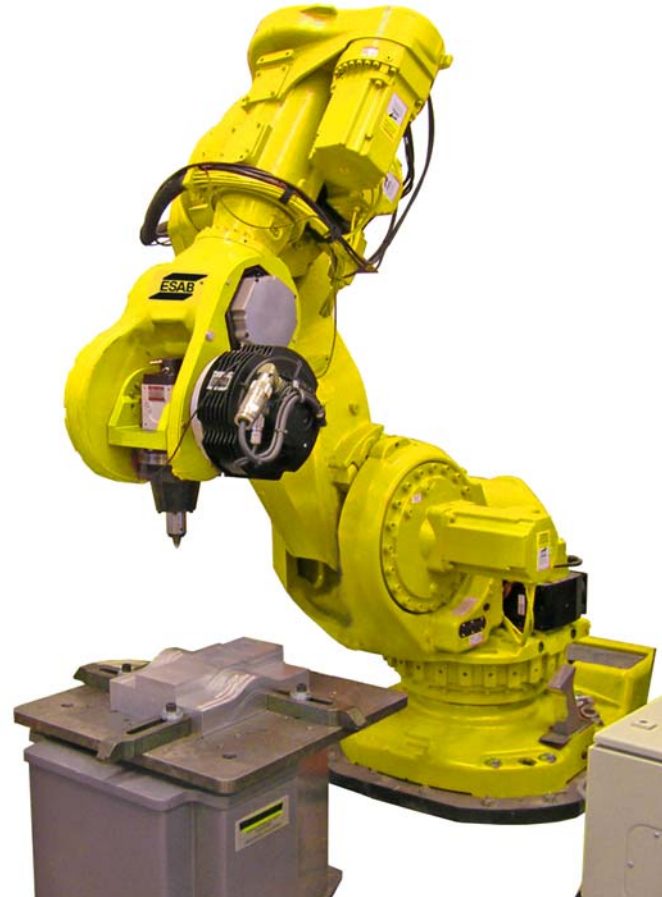
ESAB Robot FSW-system



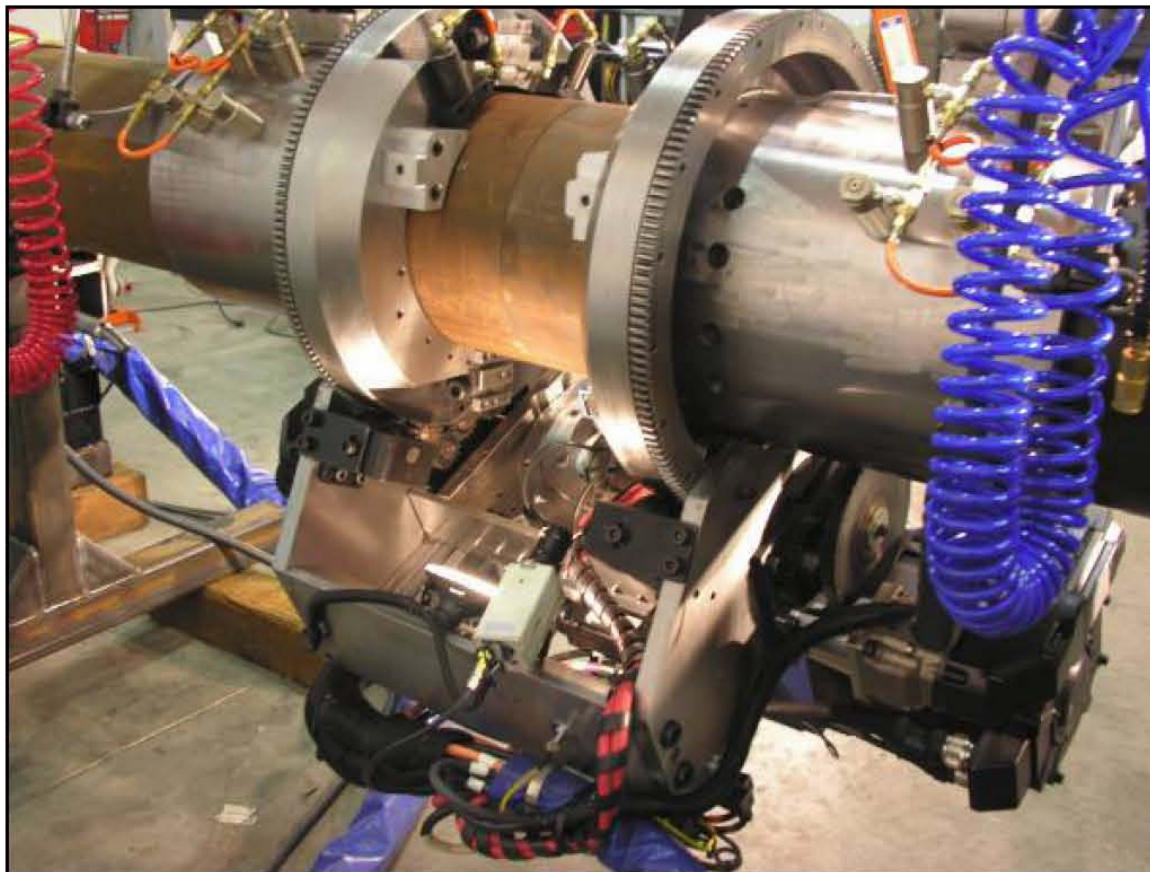
Introduction of a reliable robot solution to enhance the flexibility and productivity of Friction Stir Welding

New usage potential including 3D welding implies usage in new applications and areas.

A cost-effective solution.



ESAB Friction Stir Welding on steel



Orbital welding unit for pipes