WELDING JIGS AND FIXTURES

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Summary

New Markets and technological improvements requires the constant solving of new-coming problems; either located in area of increasing measurements or enormous production outputs, followed up with extreme Tolerances and extreme thicknesses in both ways.

In a rush for solutions, the whole branch of producers even do not “produce” the common names for a new product; it’s normal to find the same item under the several names. So, it is not unusual that the terms as: jig, fixture, device, equipment, tool, machine or unit can be used for the same!

Even without the new tasks, every handle of metal parts is unpractical and hard, concerning their own specific weight or toughness. Invented to help the welders at the beginning of industrial welding production, a lot of elementary jigs and fixtures are still in use, almost without any change in form or goal. The other, sophisticated and built

with newest achievements in electronics, disengage the welders from the hard work, improve the quality and outfit of welds.

1. General

1.1. Objectives

The solutions in a race for higher productivity with coexistent demand of top-possible quality in a field of welded products are mainly oriented in the following directions:

- replacing of the constructive and technological solutions on the product, with aim of using mechanized welding instead manual
- utilizing the simple manipulators for easier product positioning
- buying new fixtures, automatic or robotic machines

The decision which one of above mentioned directions to choose have to be based primary on the quantity of the same or similar products. Recognizing the usual financial problems as a certain limit, it is important to point on the possibility of collecting the equipment in "step by step" way. For such approach, a complete further production technology must be developed at the very beginning.

1.2. Concepts

Basic ideas of each Jig or Fixture are:

- providing the most preferable position to weld: "downward in V-groove"
- being helpful to the welder in mutual positioning of two different parts or two part ends

Naturally, in a first case, than is not relevant if the weld be fulfilled manually or by use of some semi-automatic processes (GMAW / GTAW) or fully automatic (SAW).Also, that position provides better quality of the weld, ensuring proper gas or slag segregation.

Every Fixture ensures stable clamping of product's parts always on the same place, what is the main precondition for mechanized or automatic welding.

Further positive effect of Jigs and Fixtures are reduction of auxiliary workers and Cranes, because the product will be clamped only at the beginning and released at the end of production cycle. All the other movements are mechanized, actuated by stable or remote controls.

Advantage of superb weld outfit in comparison with ones done in "forced" positions is also important nowadays, when market competition challenge the producers to think about every possible detail on the final product.

1.2. Historical Review

From the beginning of commercial welding, some Jigs were necessary to help welders in their tasks. Either simply screw-type clamps for equalizing/centering of the parts or sheet's end was the very first tools.

Later, when the "real" welding production starts, the circumferential containers have been the first ones done with new technology: welding instead forging. To rotate them, Rotators or Rollers were invented. Driven by the electrical motor, through Reducer and leather belts, rolls of Rotators was capable to rotate containers with one speed. That was not too much, but always better than rolling the part on the workshop's floor. Later, the Positioning tables were invented for help during the welding on asymmetrical parts.

After the development of the first automatic welding system – SAW in the late 40-ies of 20-th century, the Column & Boom or Manipulator type was introduced. That Fixture allows welding of longitudinal and circumferential welds.

Application of DC motors with regulation for each movement, allowed practically the shape of Fixtures we find today.

Constant industrial development after the World War II, specifically in electronic, improved the Fixtures to high level, "smart" machines as automatic or robotic ones.

2. Main types of Jigs, Fixtures and Machines

2.1. Mechanical Jigs

Major problem for manual welders stays always in fact that the arms was occupied – electrode in one hand, protective shield in other; no space to handle with product. No matter if it was only tack-welding or welding, there was no way to keep parts together.

A whole pile of specific Jigs has been invented to help, and here are some examples:

- sheet treated in bending machine always stays "open"; the only way to fix the ends is by
- use of two Jigs, one a side, capable for:
  a. clamping the shell's ends tight and adjust the distance (see Figure 1);
  b. adjusting the distance between the ends
- a pair of tubes is hard to held, align and tack-weld; it is simply with outside mounting Jig, capable to align and adjust the distance (see Figure 2)
- a pair of tubes or tube and flange to held, align and weld around is possible with inside mounting Jig with two centering tools. Opening of tools is provided by screw and separate keys (see Figure 3)

As conclusion, all the mechanical Jigs use some screw-type adjustment of level, shape or distance, keeping the parts still during welding.

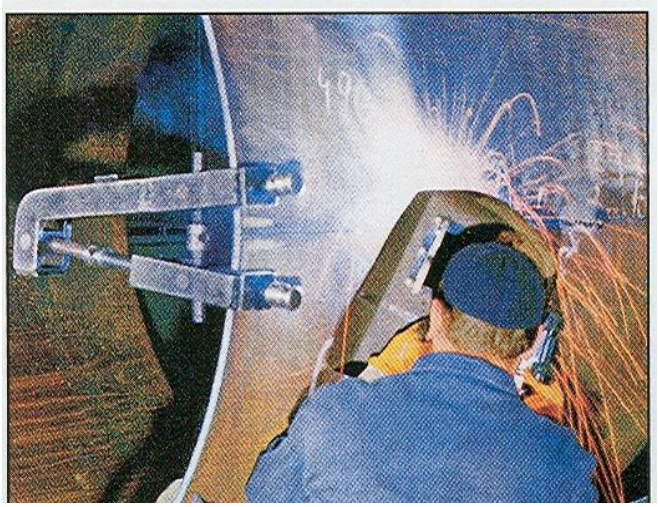

Figure 1. Mechanical Jig for clamping / adjusting the sheet's ends
Courtesy: "Uniweld – strojevi", Croatia

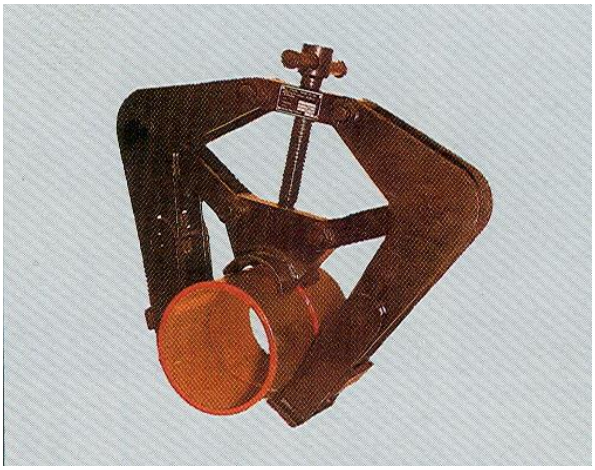

Figure 2. Mechanical Jig for clamping / centering two tubes Courtesy: "Uniweld – strojevi", Croatia

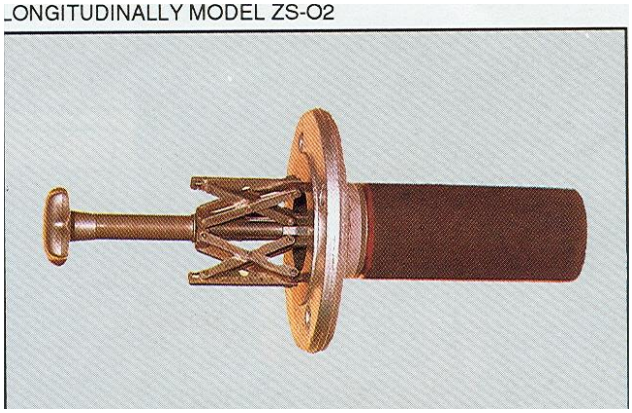

Figure 3. Mechanical Jig for internal centering of two tubes or flange/tube Courtesy: "Uniweld – strojevi", Croatia

2.2. Auxiliary Devices

Sometimes it is not enough to use some Jig to solve the problem; on the big constructions problem occurs in fact how to help welder to come to and stay still during the operation, without additional efforts. For such purposes, a wide range of specialized welding ladders, electric or hydraulic platforms or carriages was developed, helping welders to stand firmly above the floor or to avoid crawling (see Figure 12).

2.3. Fixtures

During welding, specially machined one, there are only three possible ways to achieve the proper weld:
A) By moving the product while Torch stands still
B) By moving the Torch while product stands still
C) By moving simultaneously Torch and product

Motorized Fixtures developed for manipulation with the product during welding can be divided in two major groups: Rotators and Turntables (Positioners). Rotator provides rotation of the product along the longitudinal axis, supporting product on minimum 4 points, with at least one power roll. Turntables are capable to rotate product with its table, but depending of type, also to tilt or lift, providing the best position for welding.

Fixtures as Welding Manipulators provide the linear movement or position of one or more Torches, while Longitudinal Seamers clamps two flat sheets or two ends of cylindrical sheet and provide linear movement of Torch.

Fixtures known also as Machines are designed from two or more Fixtures, combining manipulation with product and Torch, as Welding centers. Robotic cells consist usually from one or more Turntables with one or more Robotic arms to move the Torch(es).

2.3.1. Rotators

Concerning the way of product support, there are two major types of Rotators: conventional and self-aligning. Both types consists minimum of two items, usually named Power and Idle units. Concerning the design, each Rotator can be stable, manually driven on rails or with motorized drive along the rails. Division based on roll coating knows the rubber, Vulcolane and steel rolls. Range of Diameters for Rotators lies within limits of 60 – 10000 mm, with weights from 100 kg up to 800 tons.

Usually, all the producers of Rotators place the circumferential speed of rolls to lie in the area between the 120 ÷ 1200 mm per minute, to cover practically all the known speeds of welding processes. In cases with special requirements, welding speed must be specified by Order!

Housings of Rotator's rolls are able to slide along the main frame, to suit the different Diameter of product. Most of Rotators are designed in a way that "half-angle" between the vertical axis and the line from contact point to the midpoint of product have to be

from 20º up to 40º. Construction of sliding the housings can be or with several fixed points on the frame or indefinite by use of the tool spindle.

Using Rotator, it is possible to weld manually, semi-automatic or automatically all the circumferential welds, but also the longitudinal ones. Primary, Rotators are appointed for containers or similar products with round cross-section, but even the other forms could be rotated, using the additional dividable rings. Than those rings rotate upon the rolls, but Rotator itself use only to turn the product in position.

Torque for rotation on rolls depends naturally from the product's weight and eccentricity, as Diameter, too. Simple Equation for Torque calculation consists from:

Weight	Q (kg)
Product's Dia.	D (m)
Roll resistance	f (steel = 0,0005 ; rubber = 0,007)
Eccentricity	% (5 ÷ 20)
Roll's Dia.	d (m)

$$M = Q \times f \times d/D + \%/100 \times Q \times d/2 \left(\mathrm{kg\,m}\right)$$

It is important to notice that the products with more than 20% of eccentricity must be balanced with mountable counterweights to provide smooth rotation! Otherwise, unexpected slide downwards or arresting upwards can occur.

Welding the Products with extreme length can be solved with two Power units and few Idler units for better aligning and support.

Figure 4. Power unit of 50 t "self-aligning" type Rotator, stable, Vulcolane rolls, tool spindle adjustment of blocks Courtesy: "Uniweld – strojevi", Croatia

For welding of containers with bigger or extreme wall thickness, it is always wise to use self-aligning type of Rotators, because of the possible "creeping" problem. Rotators for those purposes are equipped with additional "anti-creep devices" for compensation of possible axial movement of product.

Nowadays, usual drives for Rotators are standard AC frequency controlled motors with brakes, activated by remote control with 10 m cable. Usual knobs on simply remote control box are Safety stop, direction of rotation and potentiometer for speed regulation. On the more sophisticated remote controls, a LED – display for speed is an appendix.

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Biographical Sketch

Borivoj Rihtar has received his diploma of Engineering (Dipl. Ing.) from the Fakultet strojarstva i brodogradnje, Zagreb, Croatia in 1979. After completing the additional studies, he became a welding specialist (similar to today's EWE). After couple of years spent in a construction firm, he joined the TPK-PAN in Zagreb, Croatia in 1981. From that time he is in charge for project development and construction of various Fixtures (until today over than 300 by himself only). In a couple of past years he starts to instruct the welding engineers on the EWE course in the "Jigs and Fixtures" field.