Resistance welding process & applications and limitations

Objectives: At the end of this lesson you shall be able to
- **explain the principle and types of resistance welding process**
- **explain the main elements of a resistance welding machine**
- **state the applications of resistance welding in industry and its advantages.**

Principle of resistance welding: Resistance welding is a welding process wherein coalescence is provided by the heat obtained from the resistance offered by the work to the flow of electric current in a circuit and the joint is effected by the application of pressure.

The fundamental principle on which all resistance welding is based is as follows.

The heat is generated due to the resistance offered by the parts to the passage of heavy electric current for a fraction of a second.

Heat produced at the junction is calculated by the formula

$$H = I^2Rt$$

where H for Heat, I stands for the amount of current in amps.

R for resistance offered in ohms

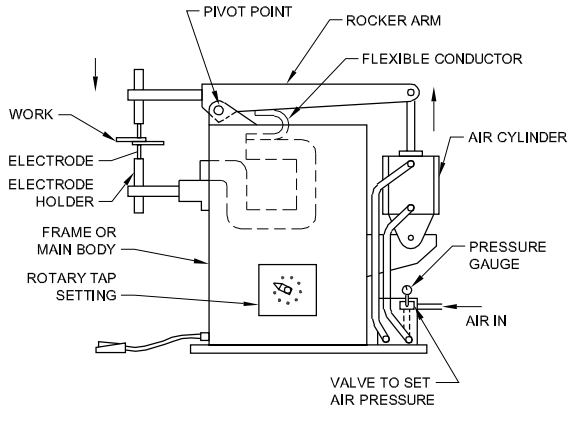
t - time taken for duration of current flow in seconds.

This heat at the junction of the two parts changes the metal to a plastic state, and when combined with the correct amount of pressure, fusion takes place.

The different types of resistance welding machines are spot welding, seam welding, projection welding, flash butt welding and upset welding machines.

A standard rocker arm type resistance welding machine is shown in Fig.1. The main parts are:

Fig 1



ROCKER ARM TYPE RESISTANCE WELDING MACHINE

1 The frame: It is the main body of the machine which differs in size and shape for the stationary and portable types.

2 Force mechanism: The compressed air cylinder and the pivoted rocker arm gives the necessary high pressure to the lever to which the upper electrode holder is attached.

3 The electric circuit: It consists of a step down transformer which provides for the necessary current to flow at the point of weld.

4 The electrodes: The electrodes include the mechanism for making and holding contact at the weld area.

5 The timing controls: The switches which regulate the value of current, current flow time and contact period time as the timing controls.

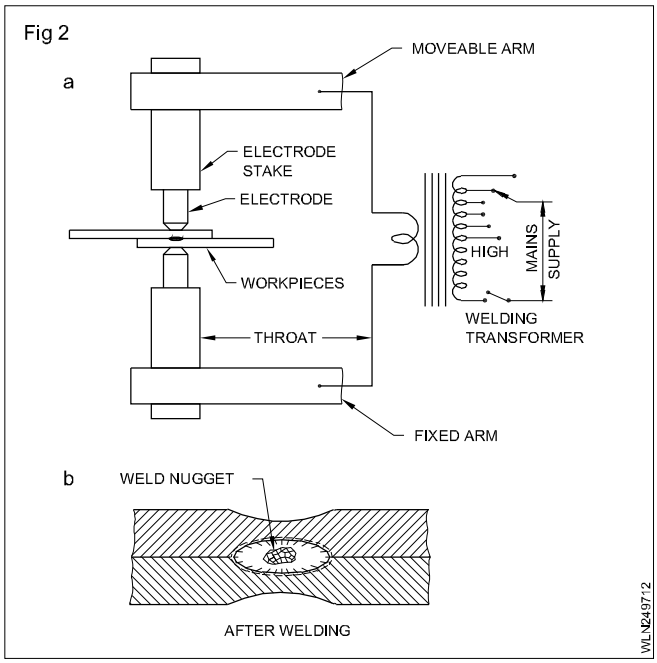
6 Water cooling system to circulate cooling water to the electrodes.

This is the additional part consisting of a water reservoir and flow system.

Spot welding: This type of resistance welding machine is most commonly used for resistance welding. The material to be joined is placed between two electrodes as shown in Fig 2a. Pressure is applied after a quick shot of electricity is sent from one electrode through the job to the other electrode.

Spot welding is made in three steps.

Fig 2



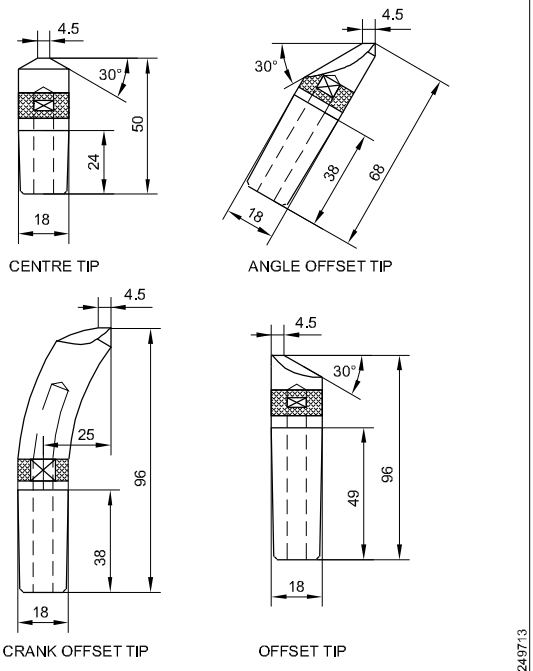
The first step is when the parts to be joined are clamped between the electrodes. In the second step, a high current is allowed to pass through the clamped members and is raised to the welding temperature. The third step sees the current being cut off and high pressure being applied to the joint and the joint completed. A nugget is formed as shown in Fig 2b.

A special copper alloy material has been developed for use as electrodes.

Cooling of the electrodes is accomplished by internally circulating water.

Electrodes are of many shapes and sizes, the most common being the centre tip and offset tip types. (Figs 3 and 4)

Fig 3



FOUR STANDARD TYPES OF ELECTRODES

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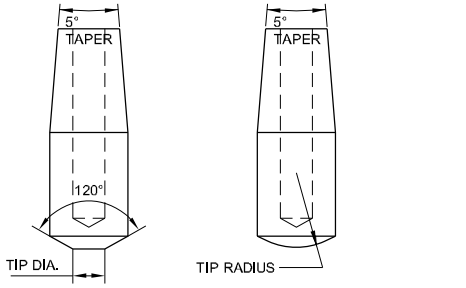
Fig 4



THE RADIUS OF THE DOMED TIP (RIGHT) VARIES FROM 25mm FOR WELDING 26 S.W.G. MATERIAL, UPTO 150mm FOR 3 S.W.G. THE DIAMETER OF FLAT PART OF THE OTHER ELECTRODE VARIES FROM 4mm TO 12mm FOR SIMILAR MATERIAL THICKNESS.

TWO STANDARD TYPES OF CENTER TIP ELECTRODE

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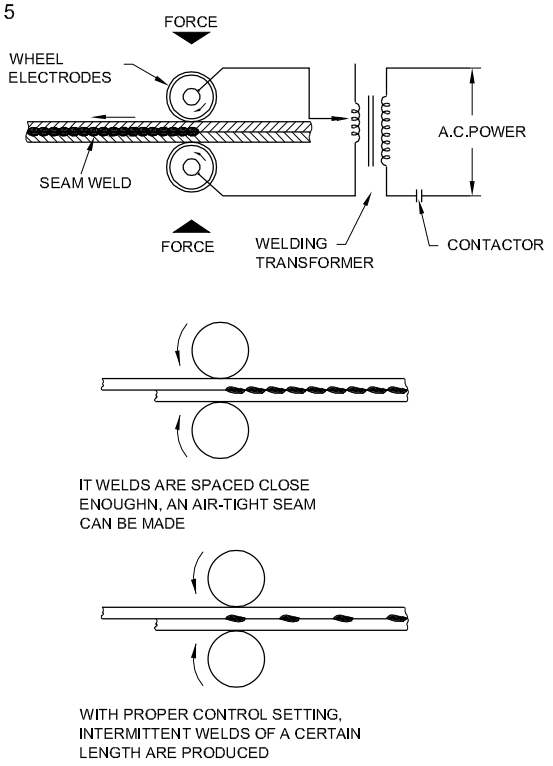
Regular spot welding leaves slight depressions on the metal. These depressions are minimized by the use of larger sized electrode tips and by inserting 1.6 mm copper sheets between the electrode and the job.

Spot welds may be made one at a time or several welds may be completed at one time.

Spot welding is utilized extensively for welding steel, and when equipped with an electronic timer, it can be used for other materials, such as aluminium, copper, stainless steel, galvanised metals etc.

Seam welding: Seam welding is like spot welding except that the spots overlap one another, making a continuous weld seam. In this process the metal pieces pass between the roller type electrodes as shown in Fig 5.

Fig 5



RESISTANCE SEAM WELDING PROCESS

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As the electrodes revolve, the current is automatically turned 'on' and 'off' at intervals corresponding to the speed at which the parts are set to move. With proper control, it is possible to obtain airtight seams suitable for containers, water heaters, fuel tanks etc.

When spots are not overlapped long enough to produce a continuous weld, the process is sometimes referred to as roller spot welding.

Cooling of the electrodes is accomplished either by circulating water internally or by an external spray of water over the electrode rollers.

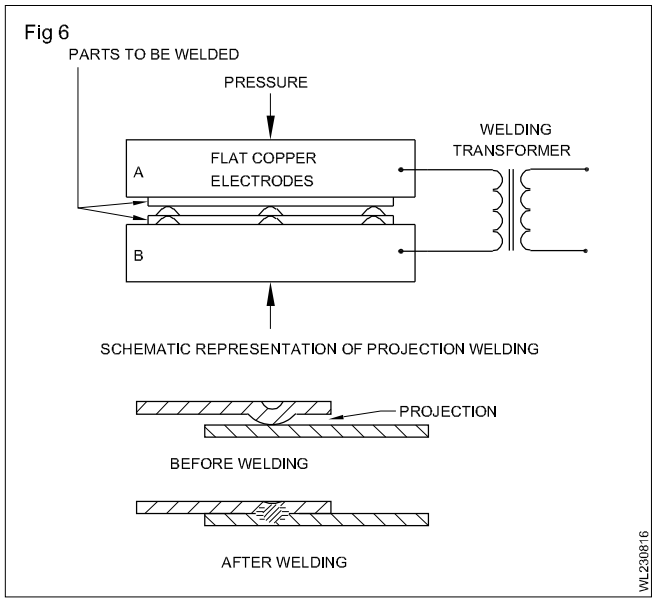
Both lap and butt joints are welded by seam welds. In the case of butt joints, foils of filler metals are used on the joints.

Projection welding: Projection welding involves the joining of parts by a resistance welding process which closely resembles spot welding. This type of welding is widely used in attaching fasteners to structural members.

The point where welding is to be done has projections which have been formed by embossing, stamping or machining. The projections serve to concentrate the

welding heat at these areas and facilitate fusion without the necessity of employing a large current. The welding process consists of placing the projections in contact with the mating part and aligning them between the electrodes (flat copper electrode) as illustrated in Fig 6.

Fig 6

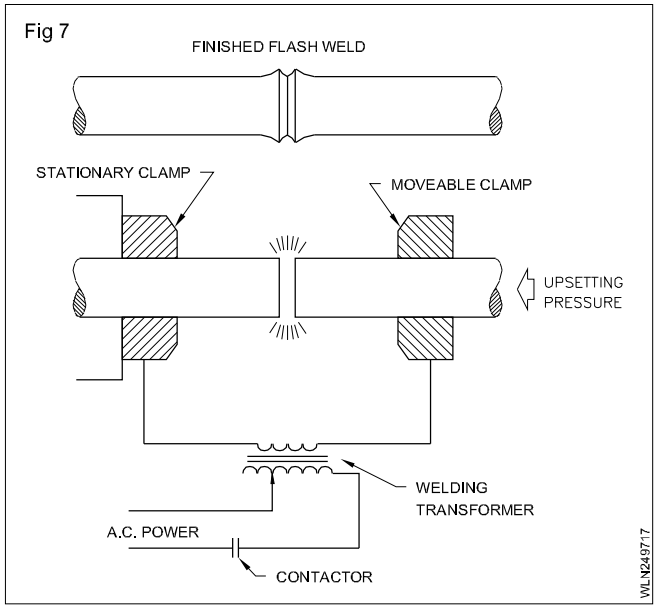


Either single or a multitude of projections can be welded simultaneously.

Not all metals can be projection-welded. Brass and copper do not lend themselves to this method because the projections usually collapse under pressure. Galvanised iron and tin plates, as well as most other thin gauge steels, can be successfully projection-welded.

Flash butt welding: In the flash butt welding process the two pieces of metals to be joined are firmly held in clamps which conduct current to the work. (Fig 7)

Fig 7



The ends of two metal pieces are moved towards and away from each other until an arc is established. The flashing action across the gap melts the metal, and as the two molten ends are forced together, fusion takes place. The current is cut off just before the heavy pressure is applied through the movable clamp.

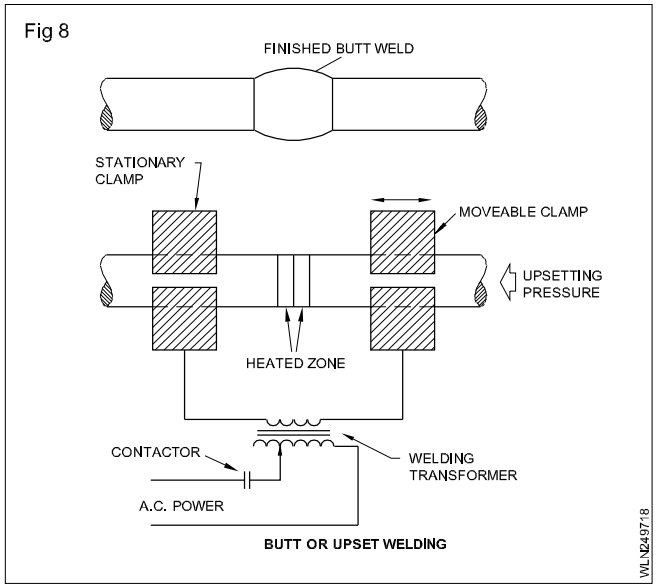
Flash butt welding is used to butt-weld plates, bars, rods, tubing and extruded sections. It is not generally recommended for welding cast iron, lead and zinc alloys.

The only problem encountered in flash butt welding is the resultant bulge at the point of the weld. It should be removed by grinding or machining if the part needs finishing.

Butt or upset welding (Slow butt weld)

In butt welding the metals to be welded are in contact under pressure. An electric current is passed through them, and the edges are softened and fused together as illustrated in Fig 8.

Fig 8



This process differs from flash butt welding in that constant pressure is applied during the heat process which eliminates flashing. The heat generated at the point of contact results from resistance. The operation and control of the butt welding process is almost identical to that of flash butt welding.

Butt or upset welding is limited to parts with a cross-section area of not more than 200-250 mm^2. Bars with cross-sectional area of 250mm^2 and above are joined by flash butt welding.

Application: Spot, seam and projection welding is widely used in the production of cars, tractors, farm machines, rail coaches etc. where thin sheets are to be joined.

Large sections like square, rectangular, cylindrical rods with regular and irregular end faces are welded without any edge preparations by flash butt or butt welding processes.

Advantages of resistance welding

- Widely used for joining sheet metals.
- Speedy process.
- No distortion.
- Less skilled operators can do the job.
- No problem of edge preparation.