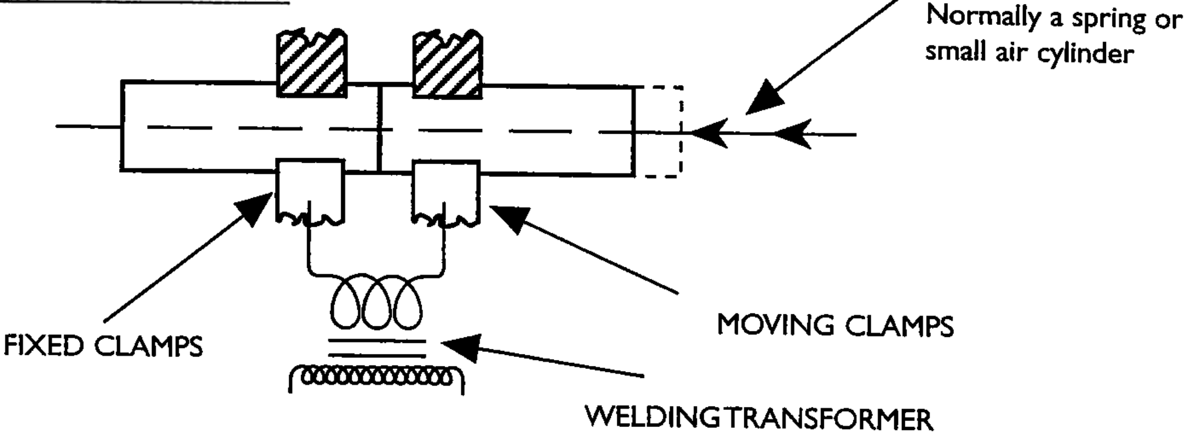
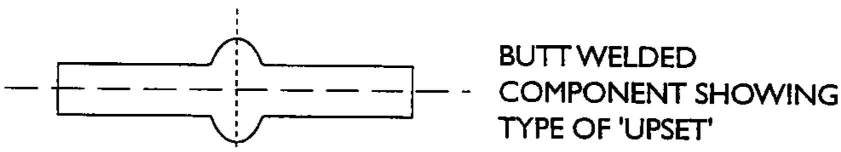
Flash Butt Welding

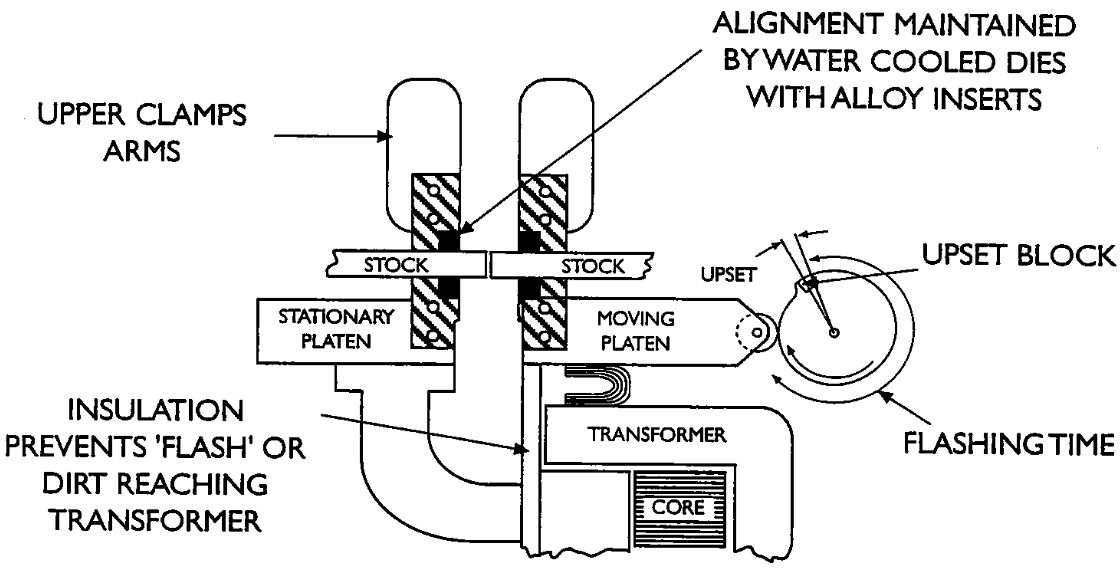
These methods of resistance welding are very similar in how they create a secure weld. It is a system ideally suited for joining metal parts together end to end, although "T" welds and angle welds can be produced by this method as well. Most materials can be butt or flash/butt welded including aluminium copper etc. The two methods are very similar to each other, differing only in that when butt welding, the parts are brought together without voltage and under light pressure, whereas in flash/butt welding the parts are bought together very slowly, with voltage, so that upon contact flash takes place.

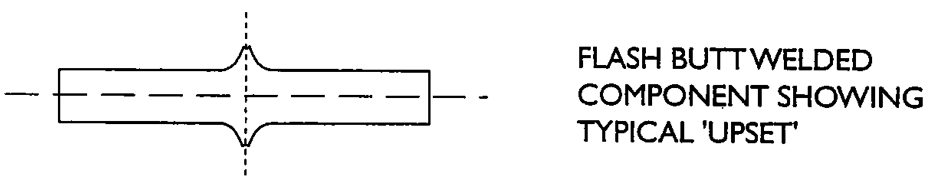
BUTT WELDING





FLASH BUTT WELDING





Butt and Flash-Butt welding

Butt Welding

How does Butt Welding Work

One of the earliest forms of resistance welding to be used in the metalworking industry is the butt welding process. Although flash welding and butt welding are accomplished on welding machines that are similar, the most notable exceptions are the applications of pressure and current.

In a basic butt weld, the two workpieces to be welded are first brought together under pressure. Current is then applied, heating the contact area enough to allow the applied pressure to forge the parts together. In other words, a butt weld is a single-stage operation of both current and pressure.

The pressure and current are applied throughout the weld cycle until the joint becomes plastic. The constant pressure (normally from an air cylinder) overcomes the softened area, producing the forging effect and subsequent welded joint. This is done without a change in current or pressure throughout the cycle.

The true butt weld has no flash splatter. The final upset at the weld joint is usually smooth and symmetrical. Very little ragged expulsion of metal is evident.

Examples of modern-day applications of the AC butt welding process are joining small-diameter wires and rods, such as coils for continuous line operations, band saw blade manufacture, and wire frame applications.

Developments in Butt Welding

Although butt welding was widely used during the early industrial years, it was limited because of the high current required to bring the ends of a large workpiece to the forging temperature. Careful end preparation was also needed. The welding surfaces of the workpiece had to be very clean, smooth, and parallel. If the proper preparation was not performed, hot spots in the weld face would be created from an uneven current flow.

Butt welding was thought to produce weaker welds than flash welding. The advance of modern microprocessor controls and the use of DC and finite control over the abutting surfaces have helped dispel this belief.

Early on, butt welding was limited to smaller machines of 5 to 100 KVA and single-phase AC. Larger applications required high currents. This high secondary current demand put a strain on the user's primary power supply and required large distribution equipment.

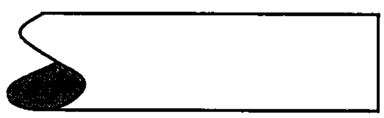
In later years, a three-phase DC power supply was applied to butt welding. A welding machine equipped with a three-phase DC power supply provides balanced line demand, reduced primary current, and a more even heating of the weld area. Inductive losses are minimised, allowing a greater freedom in machine design. Larger cross sections of both ferrous and nonferrous material have been successfully welded with the three-phase DC butt weld.

However, the three-phase DC power supply, with its rectification, physical size, and associated items required to support the butt weld system, involves increased costs. A three-phase control is required, as is increased water supply on the rectified secondary of the transformer.

Research studies have found that a narrower heat-affected zone (HAZ) can be produced on a three-phase DC butt welder. Additional tests have pointed out that there is no significant difference in weld quality of three-phase DC butt weld over single-phase AC flash welding.

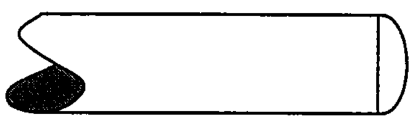
Butt welding is usually used for compact sections, general wire-work and band saw welding, although it can also be used for sheet metal components. Normally, the components are held in clamps, their ends abutting and under pressure. Current is then passed for a time and then as the temperature increases the pressure (the ends forge together under upset pressure) causes the moving clamps to close on the fixed clamps, in turn causing the ends to forge together usually deforming the metal in the weld area to form what is known as an upset.

Butt welding is very versatile and used in many trades, but care is needed in section for particular use. For the uses mentioned, wire-work such as it met in the manufacturing of wire trays, lampshades etc., is ideally suited to butt welding. Weld strengths are fairly high and in most instances welds do not need to be trimmed, nor is end preparation necessary except in large sizes and in cases where two different sizes of wire are to be welded.



NORMAL

POORLY CROPPED - UNACCEPTABLE



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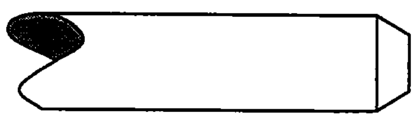


GOOD

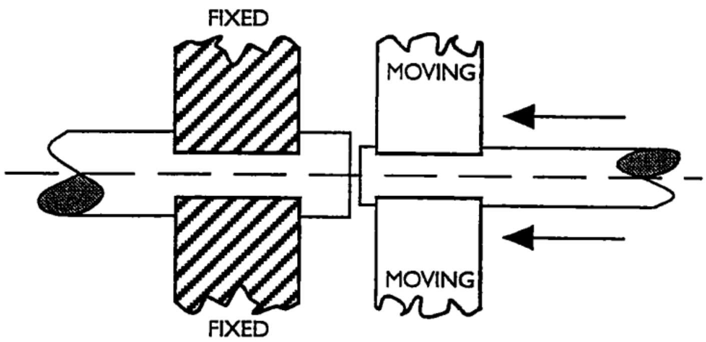
Butt and Flash-Butt welding

In all instances the components must be accurately aligned, particularly in small diameter wires, heat balance between two different sizes of components should be adjusted by varying the amount each component sticks out of the dies.

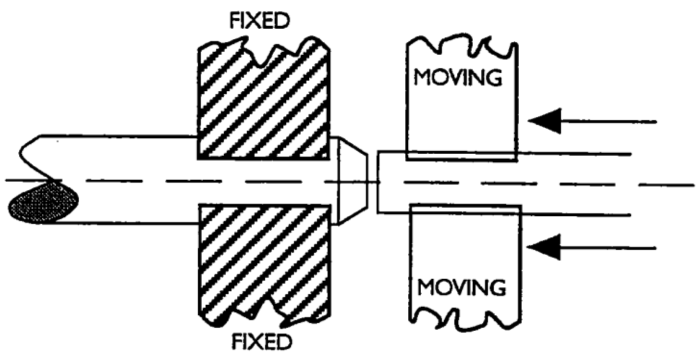
In other applications such as in wire drawing lines or for band-saw welding, more sophisticated controls are needed in that welds are required to be up to as near the parenting metal strength as possible. These controls ensure that current, time and pressure are held accurately and consistently to pre-determined values to ensure consistent we quality.

Some limitations to butt welding stem from end preparation on larger sizes and general difficulties when welding very thin wide materials. In the case of end preparation this is necessary to ensure even contact at the weld faces, otherwise an irregular heat pattern is generated with consequent poor weld quality. When welding thin material, great difficulty is experienced when welding wide strip, due to uneven heating across the width, again with poor weld quality.

With flash-butt welding there is no necessity to provide end preparation nor are there difficulties with wide strips.



In the image the larger diameter material protrudes more from the die than the smaller diameter



The opposite image it shows how the end of the larger diameter material is profiled to match the smaller diameters

Butt and Flash-Butt welding

Flash Butt Welding

How does Flash Butt Welding Work

The term "flash welding" is fairly self-descriptive—a "flashing" action is produced during the process. The heat is produced in the flash welding process by the flashing action resistance at the interface surfaces rather than contact resistance, as in the butt weld process. Whereas butt welding is a single-stage operation, flash welding is a two-stage process.

The first stage is the flashing action. The current applied to the workpieces produces a flashing or arcing across the interface of the two butting ends of the material. The flashing action increases to the point of bringing the material to a plastic state. This flashing action forms a HAZ very similar to a butt weld.

Once the area has become plastic and reached the proper temperature, the second stage of the operation begins – the upset or forging action. The two ends of the workpieces are then brought together with a very high force sufficient enough to cause the material to upset. This forces the plastic metal along with most of the impurities out of the joint.

Smooth, clean workpiece surfaces are not as critical with this process as they are for butt welding; because the flashing action burns away irregularities at the weld surfaces (see Figure 1). This allows joining of a wide variety of materials. Such items as wide, thin sheets of material; tubing; forgings; and ferrous and nonferrous materials can successfully be welded.

With the single-phase AC power supplies (transformers), applications with large cross-sectional areas can be welded with lower current demands because of the flashing action.

Flash welding can also be applied as shown in Figure 2. This door mitre example has rough edges, and the two ends do not perfectly match. Subsequent sanding and removal of excess flash and upset material with a final polish eliminates any sign of a joint. The flash action eliminates any preparation of the sheared edge of the extruded sheet metal workpiece.

In other applications, the flash or slag can be knocked loose for removal. The upset underneath the slag is solid metal similar to a butt weld and requires a cutting operation, trimming, or deburring for removal.

The disadvantage of this process is the flash itself. The operator and the surrounding area need to be protected, and smoke and fumes must be removed. The resultant slag particles build up around the machine surfaces, and frequent cleaning is needed.

Butt and Flash-Butt welding

Controlling the Flash Welding Process

The key to the flash welding process is the control of the two workpieces toward each other during the flashing operation.

Some of the earliest mechanisms for controlling the distance between the two workpieces for the proper flashing action were hand-operated. The operator controlled the current by a thumb button or automatic trip.

The operator became very skilled in controlling the amount of pressure of the two workpieces and resulting flashing action. By observing the heat colour of the area and the expulsion of the material, the operator knew when to apply heavier pressure for the second stage (or upset portion) of the flash weld.

Later developments included a motor-driven, variable-speed drive system tied to a gear-reducing unit and cam. This combination provided variable speed, bringing the two workpieces together with acceleration toward the end of the flash welding stage. This acceleration is required because of the increased amount of material expelled as the temperature increases, which in turn increases the resistance between the two materials.

An upset block provided on the cam allowed for the second stage (upset) to be initiated at the proper time. The current was initiated and subsequently turned off by limit switches strategically placed to work in conjunction with the cam, and it could be turned on or off to facilitate the proper heating.

As alloys and special materials were being developed in the industry, they required an entirely different rate of rise on the cam and a change of upset. This caused the cam to be altered or changed when going from one cross section to another or from one alloy to another. For instance, aluminium alloys require a rapid or high-speed upset because of their narrower HAZ. This caused an extremely rapid rise on a cam to accommodate these alloys, and success was mediocre at best.

Air over oil cylinders were then used but were limited to smaller cross sections of workpieces.

Another way to control the movement of the two workpieces in flash welding is with a hydraulic/servo valve combination. This provides control and high pressures with rapid acceleration. Flash welding machines with hydraulic operation in use today can generate upset pressures of more than 200 tons.

Most flash welding machines use single-phase AC power supplies. As with the butt weld process, three-phase DC can also be used. Although this does not eliminate the flashing action, it does result in reduced primary current, less material loss, and a narrower HAZ. However, capital costs are higher, and requirements for the process are the same as for DC butt welding, mentioned previously.

Butt and Flash-Butt welding

Developments in Flash Welding

Controls – Flash welding's versatility has increased with the addition of electronic and microprocessor controls that accurately control and monitor the flash welding process. These controls include:

1. Feedback information to determine velocity and acceleration of the two workpieces as they come together.

2. Current monitoring.

3. Flash voltage action.

Pre-flash and Preheating -Other developments include additional stages before the flash welding (see Figure 3). These include a burn-off or preflash that allows the ragged ends of unprepared parts to be squared up before a second stage of preheating. The preheating portion of the flash welding operation allows for heat to be generated into the interface of the weld without a discernible amount of material being lost.

This preheating action is an oscillation of the two workpieces against each other. After the two ends of the workpieces are brought together, the resistance in the material allows heat to be generated, and the two ends are pulled apart (before becoming molten), allowing a cooling effect at the interface of the material.

Once the ends begin to cool and solidify, the process is repeated and continued in a rapid motion until heat is generated back into both workpieces. With this process:

1. A large cross-sectional area can be welded with lower current demand.
2. Heat can be generated in high-strength alloys without a large loss of material by the flashing action.
3. The temperature gradient remains more uniform.

Once the proper HAZ has been reached with the preheat stage, the flash weld stage is then initiated for a short period of time, followed by the upset or forging force.

In many cases, when welding steels with extremely high alloys or carbon content, cracking is possible if the weld is cooled too rapidly to room temperature. If the preheating is insufficient, the cracking may be prevented by a final process in the flash weld called post heating. The post heat cycle can be incorporated in a flash weld machine and adjusted for the desired temperature.

Butt and Flash-Butt welding

As mentioned previously, the two components are clamped, made electrically alive and the slowly bought together. The touching of the two parts causes heavy arcing and flashing. This initial flashing serves to remove any irregularities in the two contact faces. On very large machines it is normal to provide what is known as pre-flash which gives the facility of removing large irregularities before normal flashing occurs. It is sometimes an advantage to pre-heat the components to ensure that the heat caused is well soaked into the components. Use of pre-heat allows a smaller welding transformer to be used and giving a greater assurance of consistent welding. It should be noted however, that the time cycle is increased when using pre-flash. With these facilities end preparation can be removed and far as this wide strip is concerned, the welding of thin strip up to 60#2 or 80" wide is not uncommon.

The following factors are important in flash welding:

a) Workpieces must be clamped in a particular position with a consistent overhang of dies. The clam ping pressure must be heavy enough to hold the components rigidly against a longitudinal upset for that could be up to 5 tonnes per square inch.

b) The settings of the machine, whereby the flashing distance, amount of the upset and the time of these values are created, must be capable of consistent and accurate resetting.

c) The point of upset, the amount of upset and the time for the upset must be accurate and the rate of application of upset pressure must be exceedingly rapid.

Remember, occasionally the upset produced on components has to be removed, sometimes for a cosmetic reason, sometimes of necessity. Upset tripping equipment (sometimes referred to as scarfers) are as many and as varied as the flash butt welding machines themselves.

Conclusion

As with other resistance welding processes, technology is rapidly changing the application of both the butt weld and the flash weld. The continued development of controls, AC and DC power supplies, advanced hydraulics, and servo valves has improved both processes. At the same time, this advanced technology has broadened the applications that can be performed.

Because of the variety of products and materials that can be welded with either flash or butt welding, each application must be reviewed on its own merits. Production requirements, utilities, cleanliness, and cosmetics of the weld itself all play an important part in the choice of these two joint resistance welding processes.

Butt and Flash-Butt welding

When properly applied, both produce quality welds without gas shielding or filler materials. These processes are in use today for applications including automotive, agricultural, and construction wheels in various alloys, turbine and jet engine rings, aircraft landing gears, flywheel ring gears, and more in various alloys including nickel base, aluminium, tungsten, and copper.

Flash and butt welding are each a distinct part of the resistance welding family. Misunderstandings in the early years of development gave them the unfounded reputation of being black art. Today, developments in technology have allowed both butt welding and flash welding to become highly controlled, accurate, and reliable processes for the fusion of metals.