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Welding and allied processes — Vocabulary —

Part 2:
Soldering and brazing processes and related terms

Soudage et techniques connexes — Vocabulaire —

Partie 2: Termes relatifs aux procédés de brasage tendre et de brasage fort

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 857-2 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 7, *Representation and terms*.

Together with ISO 857-1, this part of ISO 857 cancels and replaces ISO 857:1990, which has been technically revised.

ISO 857 consists of the following parts, under the general title *Welding and allied processes — Vocabulary*:

— *Part 1: Metal welding processes*

— *Part 2: Soldering and brazing processes and related terms*

Introduction

ISO 857:1990 has been revised in two new parts, ISO 857-1, *Welding and allied processes — Vocabulary — Part 1: Metal welding processes*, and ISO 857-2, *Welding and allied processes — Vocabulary — Part 2: Soldering and brazing processes and related terms*.

ISO 857-1 is restricted to welding processes for metallic materials and the welding processes are structured in a more systematic way than in ISO 857:1990. The processes have been classified according to their physical characteristics, e.g. pressure or fusion welding, and the type of energy source. A number of new processes have been added and a number of obsolete processes have been removed.

ISO 857-2 is restricted to soldering and brazing processes and is organized in the same manner as ISO 857-1. New definitions have been added in order to provide a better understanding of such processes.

The numbers in parentheses following the name of the process refer to the numbering used in ISO 4063. Most of the definitions are accompanied by schematic figures given as examples.

Requests for official interpretations of any aspect of this part of ISO 857 should be directed to the Secretariat of ISO/TC 44/SC 7 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Welding and allied processes — Vocabulary —

Part 2:
Soldering and brazing processes and related terms

1 Scope

This part of ISO 857 defines terms used for metal soldering and brazing processes, as well as related terms.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

3 Terms and definitions

3.1
soldering/brazing
joining processes in which a molten filler material is used that has a lower liquidus temperature than the solidus temperature of the parent material(s), which wets the surfaces of the heated parent material(s) and which, during or after heating, is drawn into (or, if pre-placed, is retained in) the narrow gap between the components being joined

NOTE 1 These processes are generally carried out with metals but they can also be carried out with non-metallic materials. The filler material always has a different chemical composition from the components being joined.

NOTE 2 If the process is carried out without capillary attraction, it is often described as braze welding.

3.1.1
soldering
joining process using filler metal with a liquidus temperature of 450 °C or less

3.1.2
brazing
joining process using filler metal with a liquidus temperature above 450 °C

3.1.3
coating
deposition of a layer or layers of material on a surface to obtain desired properties and/or dimensions

3.1.4
filler metal spreading and gap filling

3.1.4.1
wetting
spreading and adhesion of a thin continuous layer of molten filler metal on the surfaces of the components being joined

3.1.4.2
de-wetting
separation of solid filler material which, although it had spread over the surfaces of the components to be joined, had failed to bond to them because of e.g. inadequate cleaning or fluxing

3.1.4.3
flow path
distance through which the molten filler metal flows in the joint

3.1.4.4
capillary attraction
force, caused by surface tension, which draws the molten filler metal into the gap between the components being joined, even against the force of gravity

3.1.4.5
bonding process
process by which a bond is created between the liquid phase of the filler metal and the solid parent metal due to metallurgical reaction

3.2
materials for soldering or brazing

3.2.1
filler metal
added metal required for soldered or brazed joints, which can be in the form of wire, inserts, powder, pastes, etc.

3.2.2
flux
non-metallic material which, when molten, promotes wetting by removing existing oxide or other detrimental films from the surfaces to be joined and prevents their re-formation during the joining operation

3.2.3
binder
substance with which filler metals and/or fluxes are bound as powders or pastes so that they can be applied to the joint as paste or can be moulded into filler metal shapes

3.2.4
soldering and brazing stop-off
substance used to prevent undesirable spreading of molten filler metal

3.2.5
parent material
material being brazed/soldered

3.2.6
protective atmosphere for soldering or brazing
gas atmosphere or vacuum round a component, either to remove oxide or other detrimental films on the surfaces to be joined or to prevent the re-formation of such films on surfaces which have previously been cleaned

3.2.6.1
reducing gas atmosphere
gas which reduces oxides owing to its high affinity for oxygen

3.2.6.2
inert gas atmosphere
gas which prevents the formation of oxides during the soldering or brazing process

3.2.6.3
vacuum
pressure sufficiently below atmospheric so that the formation of oxides will be prevented to a degree sufficient for satisfactory soldering or brazing, because of the low partial pressure of the residual gas

NOTE As a vacuum can only eliminate oxides to a very limited extent, preparatory cleaning of the surfaces to be wetted is of the greatest importance.

3.3
process conditions

3.3.1
characteristic temperatures

3.3.1.1
melting temperature range of the filler metal
temperature range extending from the commencement of melting (solidus temperature) to complete liquefaction (liquidus temperature)

NOTE Some filler metals have a melting point rather than a melting range.

3.3.1.2
soldering or brazing temperature
temperature at the joint where the filler metal wets the surface or where a liquid phase is formed by boundary diffusion and there is sufficient material flow

NOTE With some filler metals, this is below the liquidus temperature of the filler metal.

3.3.1.3
equalizing temperature
preheating temperature
temperature at which the components being joined are held so that they are uniformly heated through

NOTE It is lower than the solidus temperature of the filler metal.

3.3.1.4
effective temperature range
temperature range within which a flux or a protective atmosphere is effective

3.3.2
characteristic times

3.3.2.1
soldering or brazing time
time period for the soldering or brazing cycle

3.3.2.2
heating time
time during which the soldering or brazing temperature is reached

NOTE It includes the equalizing (preheating) time and can also include other times, e.g. the degassing time.

3.3.2.3
equalizing time
preheating time
time during which the components to be soldered or brazed are held at the equalizing/preheating temperature

3.3.2.4
holding time
time during which the joint is kept at the soldering or brazing temperature

3.3.2.5
cooling time
time during which the joint cools down from the soldering or brazing temperature to ambient temperature

NOTE It can include the time necessary for the post heat treatment of the soldered or brazed parts.

3.3.2.6
total time
period which includes the heating time, the holding time and the cooling time

3.3.2.7
effective time
time during which the flux remains effective during the soldering or brazing operation

NOTE It is dependent on the procedure used.

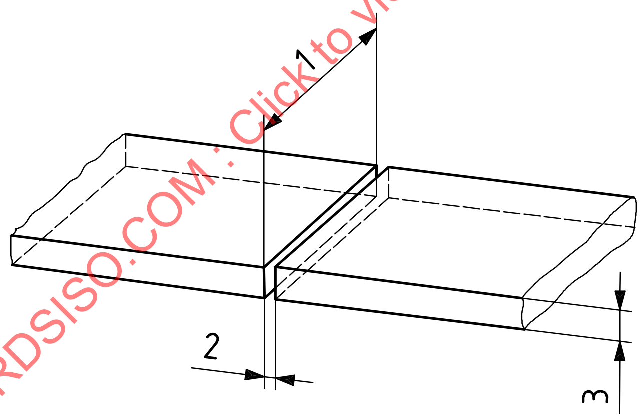
3.4
soldering or brazing geometry

3.4.1
closed joint
joint in which the gap is filled principally by capillary action with filler metal, i.e. either a butt joint or a lap joint between parallel faces of the components to be soldered or brazed

NOTE 1 See Figures 1 and 2.

NOTE 2 The lap width and length determine the area over which the components will be joined.

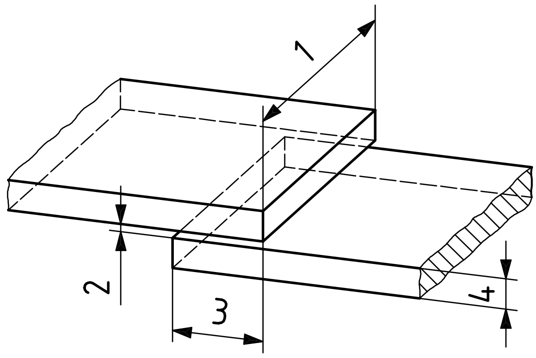
NOTE 3 For soldering/brazing with radiation and soldering/brazing with an electric arc, mixtures of joint types, i.e. butt weld at raised edge or butt weld at lap joint, are also possible.



Key

1 closed joint length
2 closed joint width (assembly gap)
3 component thickness

Figure 1 — Closed butt joint



Key

1 closed joint length

2 closed joint width (assembly gap)

3 lap length

4 component thickness

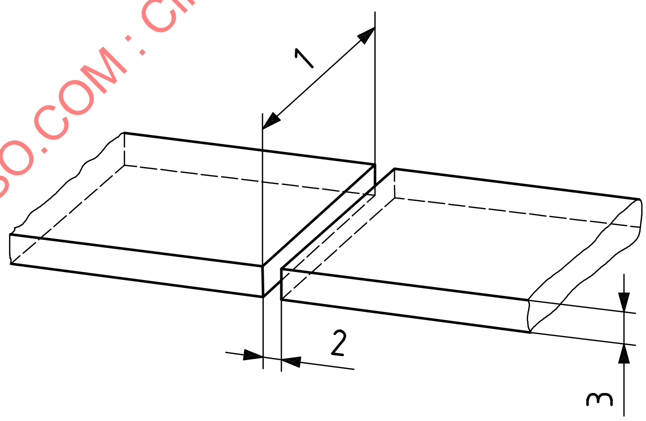
Figure 2 — Closed lap joint

3.4.2
open joint
joint in which the gap is filled with filler metal by gravity

NOTE 1 See Figure 3, which shows two components with parallel faces prepared for soldering or brazing.

NOTE 2 This process is often described as braze welding.

NOTE 3 For soldering/brazing with radiation and soldering/brazing with an electric arc, mixtures of joint types, i.e. butt weld at raised edge or butt weld at lap joint, are also possible.



Key

1 open joint length

2 open joint width (assembly gap)

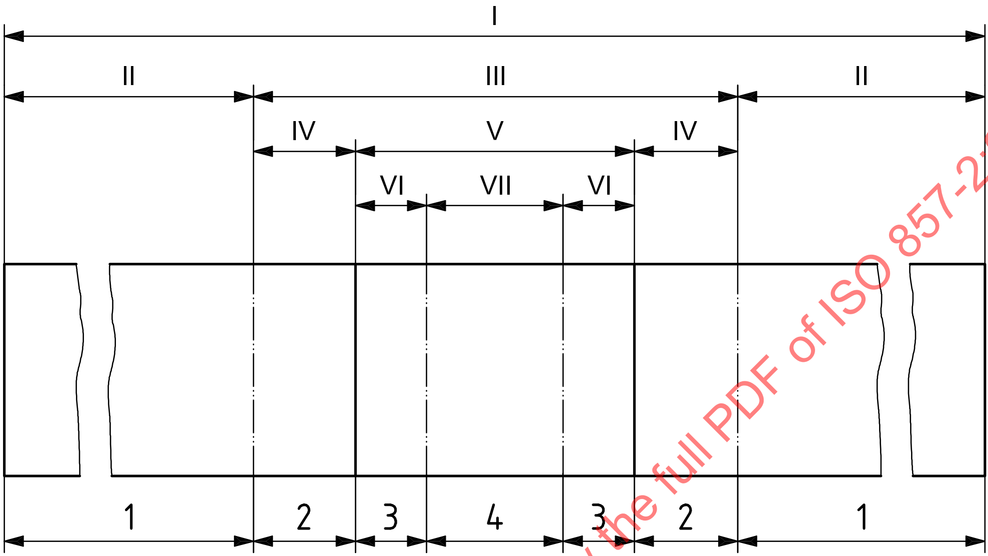
3 component thickness

Figure 3 — Open butt joint (square butt joint)

3.4.3
soldering or brazing gap
narrow, mainly parallel gap between the components to be soldered or brazed, measured at the soldering or brazing temperature

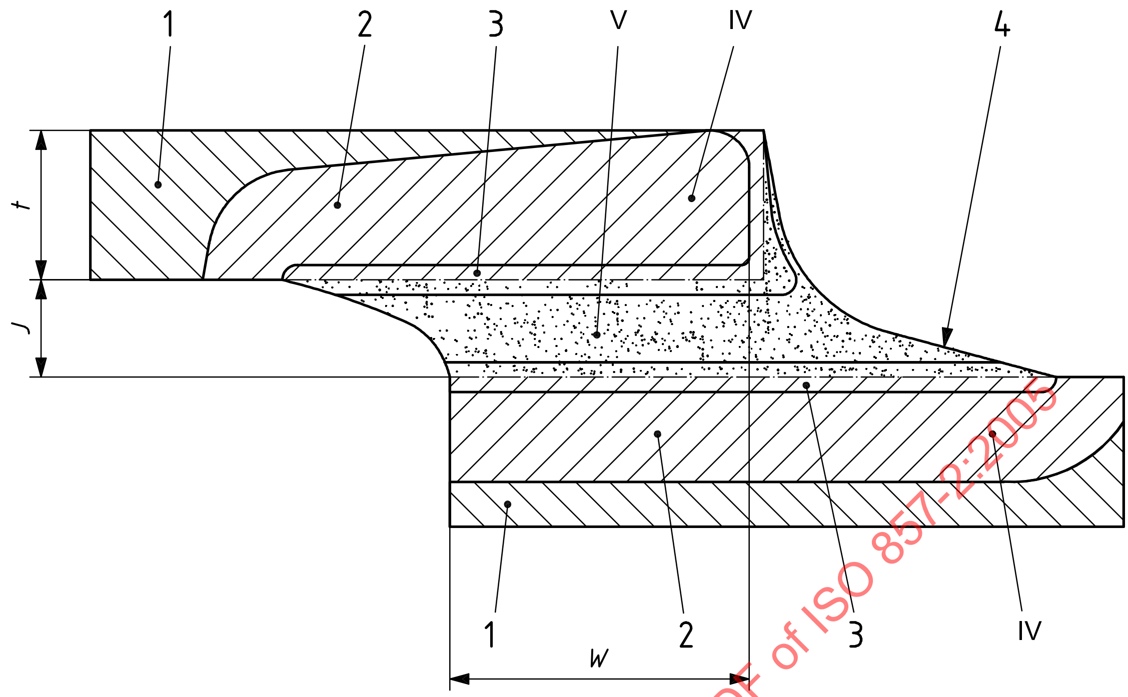
3.4.4
assembly gap
narrow, mainly parallel gap between the components to be soldered or brazed, measured at room temperature

3.5
soldered/brazed assemblies
Terms relating to soldered/brazed assemblies are illustrated in Figures 4 and 5.



Terms relating to components	soldered/brazed assembly/component	I
	parent material zone	II
	soldered/brazed joint	III
	heat-affected zone	IV
	soldering/brazing seam	V
	diffusion/transition zone	VI
	solder/braze metal zone	VII
Terms relating to materials	parent material	1
	parent material affected by the soldering/brazing process	2
	diffusion/transition zone	3
	solder/braze metal	4

Figure 4 — Terms relating to components and materials in soldered/brazed assemblies



Key

	Material		Assembly		Dimensions
1	parent material	IV	heat-affected zone	t	component thickness
2	parent material affected by the soldering/brazing process	V	soldering/brazing seam	J	effective joint width
3	diffusion/transition zone			W	lap length
4	solder/braze metal				

Figure 5 — Schematic diagram of a soldered/brazed joint

3.5.1
assembly

3.5.1.1
soldered or brazed assembly
assembly formed by soldering or brazing two or more components together

NOTE An assembly may subsequently become a component in another, larger, assembly.

3.5.1.2
soldering or brazing seam
region of the joint comprising the solder/braze material and the diffusion/transition zones

3.5.1.3
heat-affected zone
zone of parent materials affected by the soldering/brazing process

3.5.2
materials

3.5.2.1
parent material affected by the soldering/brazing process
material with properties different from those of the parent material due to the influence of the soldering/brazing process

3.5.2.2
diffusion zone
transition zone
layers formed during soldering or brazing with a chemical composition that is different from that of the parent material(s) and that of the solder or braze metal

3.5.2.3
solder or braze metal
metal formed by the soldering or brazing process

NOTE Because the filler metal has melted, its chemical composition may change due to reactions with the parent material(s).

3.6
soldering/brazing procedures

3.6.1
manual soldering or brazing
soldering or brazing in which all operations are carried out manually

3.6.2
mechanized soldering or brazing
soldering or brazing in which all the main operations, except the handling of the workpiece, are carried out mechanically

3.6.3
automatic soldering or brazing
soldering or brazing in which all operations, including all auxiliary operations such as changing the workpiece, are carried out automatically

3.6.4
soldering and brazing with filler metal applied
process during which the components are heated up to the soldering or brazing temperature in the area of the joint, and the filler metal is brought to its melting point mainly by contact with the components to be soldered or brazed

3.6.5
soldering or brazing with filler metal inserted
process during which the filler metal is placed in the area of the joint before heating, and is then heated to the soldering or brazing temperature together with the components to be soldered or brazed

3.6.6
dip soldering or brazing
process during which the components to be soldered or brazed are dipped in a bath of molten salt, molten flux or molten filler metal

3.6.7
soldering or brazing with components coated with filler metal
process during which the filler metal is applied before soldering/brazing by coating (e.g. by plating, electrocoating or vapour deposition)

Annex A
(informative)

Process descriptions based on energy sources
(numbers in parentheses refer to ISO 4063)

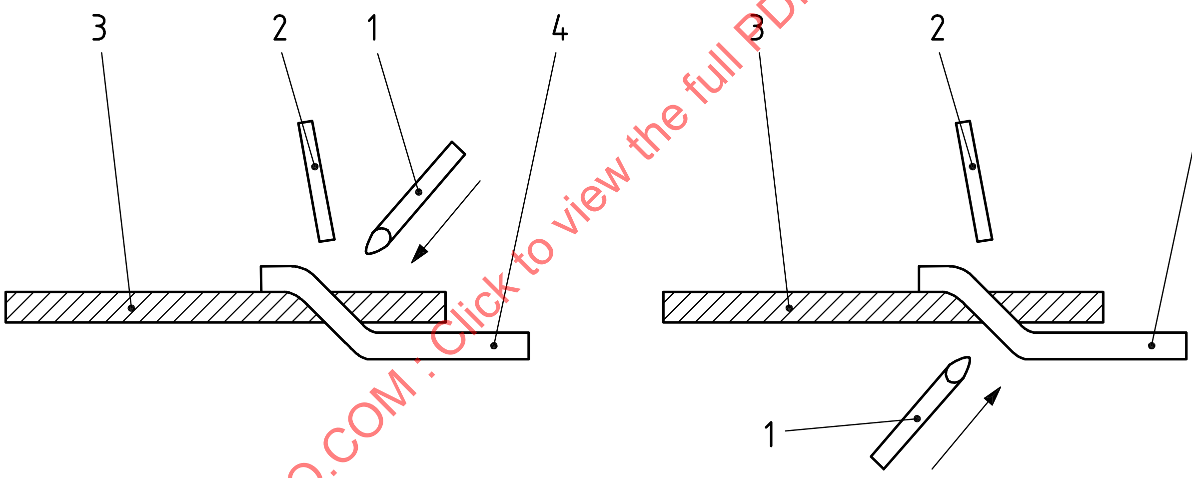
A.1 Soldering

A.1.1 Soldering with solid heat-supply media

A.1.1.1 Soldering with soldering iron (952)

See Figure A.1.

Heating the soldering point and melting the filler metal are carried out using a soldering iron operated manually or mechanically. A soldering iron with a heat capacity, shape and tip suitable for the soldering point is used. Both of the components to be joined and the filler metal are brought to the brazing/soldering temperature using a flux, either separately or in the form of a flux-cored filler metal.



Key

1 tip of soldering iron
2 flux-cored solder
3 printed-circuit board
4 conductor

Figure A.1 — Examples of soldering with a soldering iron (printed-circuit board)

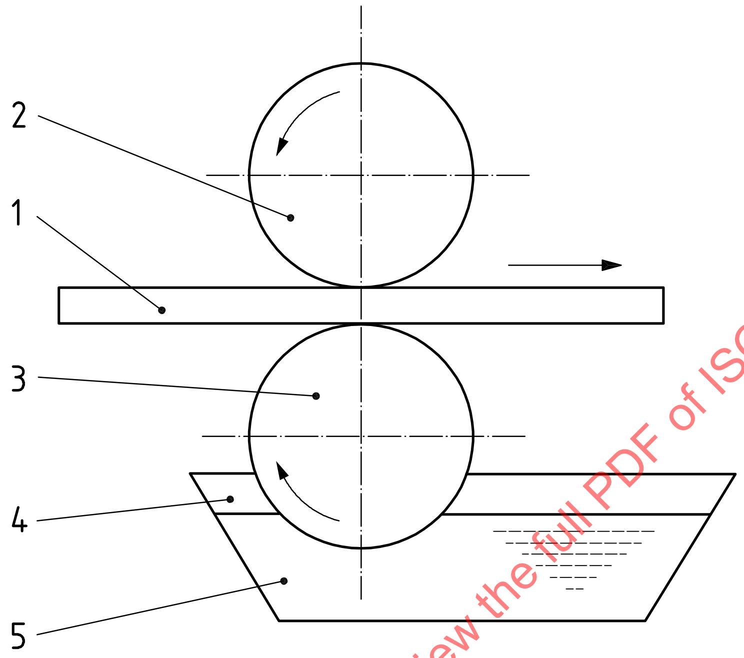
A.1.1.2 Soldering with preheated blocks (96)

The components are brought to the soldering temperature by heat from a heated metal block (e.g. a hotplate). The filler metal is usually applied in the form of flux-cored filler metal or as solid wire. In the latter case, flux is applied to the joint beforehand. This process is of importance in soldering thick workpieces to thinner sheet-metal components.

A.1.1.3 Roller tinning (96)

See Figure A.2.

The surface is heated by a roller turning in liquid filler metal, which is thus wetted with filler metal. Flux is applied to the surface beforehand. The solder is thus made to flow over the surface.



Key

1 flat component (e.g. printed-circuit board)

2 counter-roller

3 soldering roller

4 layer of salts to protect filler metal in bath

5 filler metal bath

Figure A.2 — Roller tinning

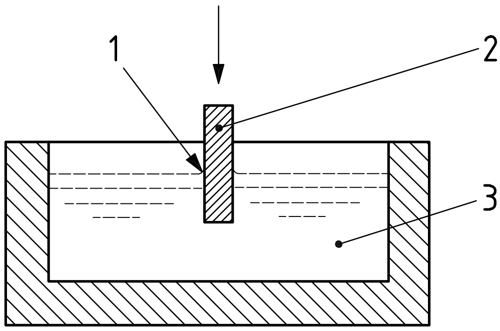
A.1.2 Soldering with liquids

A.1.2.1 Dip soldering (944)

See Figure A.3.

The components are soldered by dipping them in a bath of liquid filler metal. They are wetted with flux before dipping. The dipping speed is selected so that it is just high enough to ensure that each component reaches the soldering temperature during dipping. A visible sign of this is the presence of a positive meniscus (concave surface) at the interface between the filler metal surface and the component.

The component to be soldered may be either cold or preheated before dipping.



Key

1 positive meniscus (concave surface)

2 component

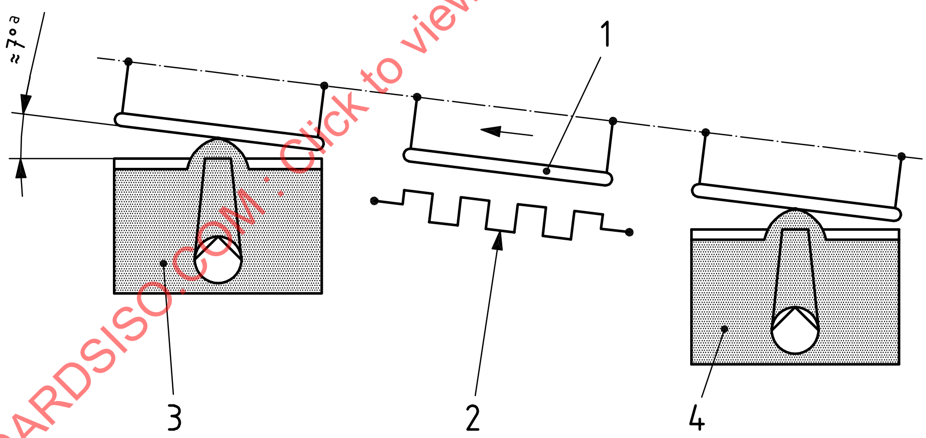
3 filler metal bath

Figure A.3 — Dip soldering

A.1.2.2 Wave soldering (951)

See Figure A.4.

The liquid filler metal is applied by a solder wave produced by a pump and a nozzle. This process is mainly used, in conjunction with a wave or spray fluxer and a flux dryer, to solder printed circuits. It is desirable to use a feed angle of about 7° between the surface of the bath and the printed circuits.



Key

1 printed-circuit board

2 dryer

3 filler metal bath with solder wave

4 wave or spray fluxer (flux with foam wave)

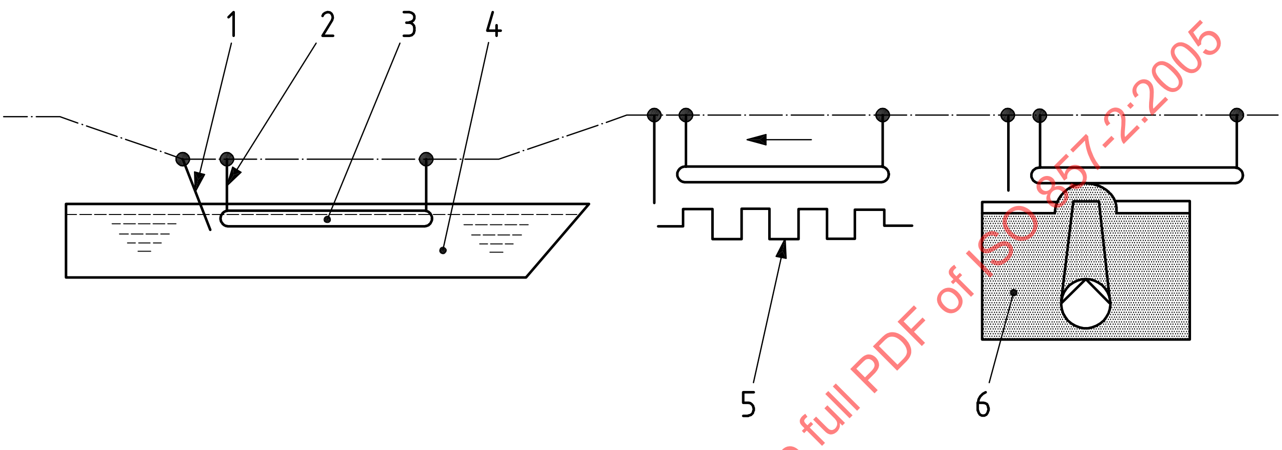
a Feed angle.

Figure A.4 — Wave soldering

A.1.2.3 Drag soldering (956)

See Figure A.5.

The filler metal bath used has a large surface area but is very shallow. The surfaces of the flat components being soldered (printed-circuit boards) are first wetted with flux and dried. The printed-circuit boards are then immersed in the bath: the run-in and run-out angles may be the same or different (e.g. 8° to 10°) and the depth of immersion about half the circuit-board thickness. A rigid strip mounted immediately in front of the circuit board removes oxide from the surface of the filler metal bath as the circuit board moves through the bath. The soldering time is determined by the speed of the circuit boards and the length of the filler metal bath.



Key

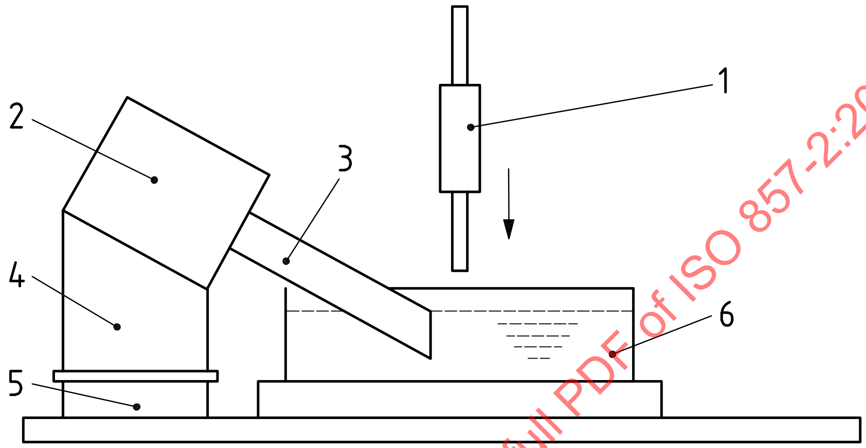
1 rigid strip
2 holder
3 printed-circuit board
4 filler metal bath
5 dryer
6 wave or spray fluxer (flux with foam wave)

Figure A.5 — Drag soldering

A.1.2.4 Ultrasonic soldering (947)

See Figure A.6.

The area to be soldered of the component is dipped into a heated bath of liquid filler metal. This area is then freed from oxide by the action of a sonotrode, the cavitation occurring at the metal breaking up and detaching oxide layers. To avoid shadow effects, it is convenient to have a two-sided arrangement (two sonotrodes placed opposite each other). In this way, the clean metal (e.g. aluminium) can be tinned without the use of flux.



Key

1 component
2 utrasonic generator
3 sonotrode
4 support structure with cooling fan
5 base
6 filler metal bath

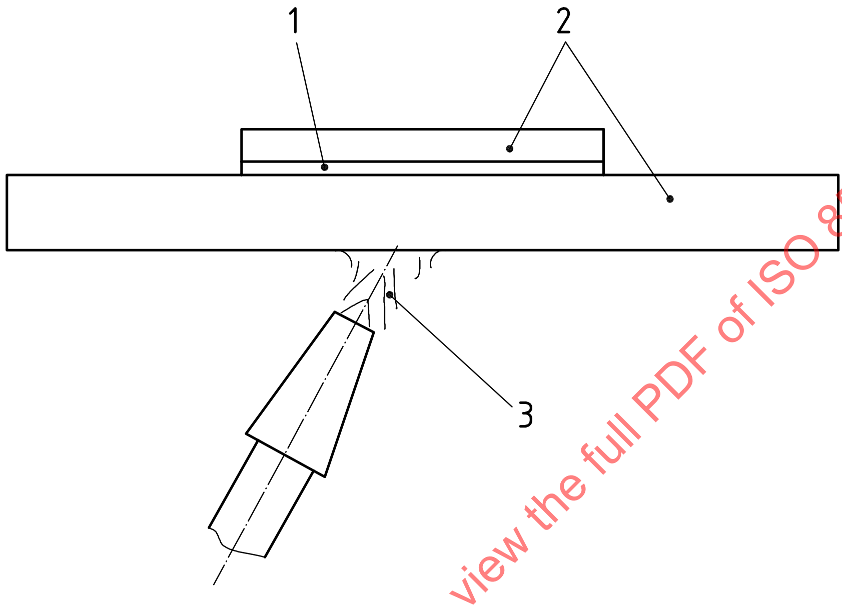
Figure A.6 — Ultrasonic soldering

A.1.3 Soldering with gases

A.1.3.1 Flame soldering (942)

See Figure A.7.

Heat is supplied by combustion of a gaseous fuel. The flame is not applied directly on to the fluxed joint because this would damage the flux. The joint area is kept evenly heated by movement of the blowpipe. The filler metal is either laid between the components or fed in when the soldering temperature is reached.



Key

1 flux and filler metal

2 components

3 flame

Figure A.7 — Flame soldering

A.1.3.2 Hot gas soldering (96)

Air is heated either by passing it through an electric heater or by burning it in a flame, and the hot air/combustion gases blown through a nozzle on to the components to be soldered. The filler metal is placed between the components after application of the flux, or it is fed in after the soldering temperature has been reached. Other gases may be used instead of air.

A.1.4 Infrared soldering (941)

An infrared light source, located at the focal point of a semi-elliptical mirror, is used. The emitted rays are focused at the second focal point where they impinge on the component to be soldered, to which the filler metal and flux have already been applied. Most metal components reflect part of the incident radiant energy at their surface, the rest being converted into heat at a depth of few micrometres.

A.1.5 Soldering using an electric current

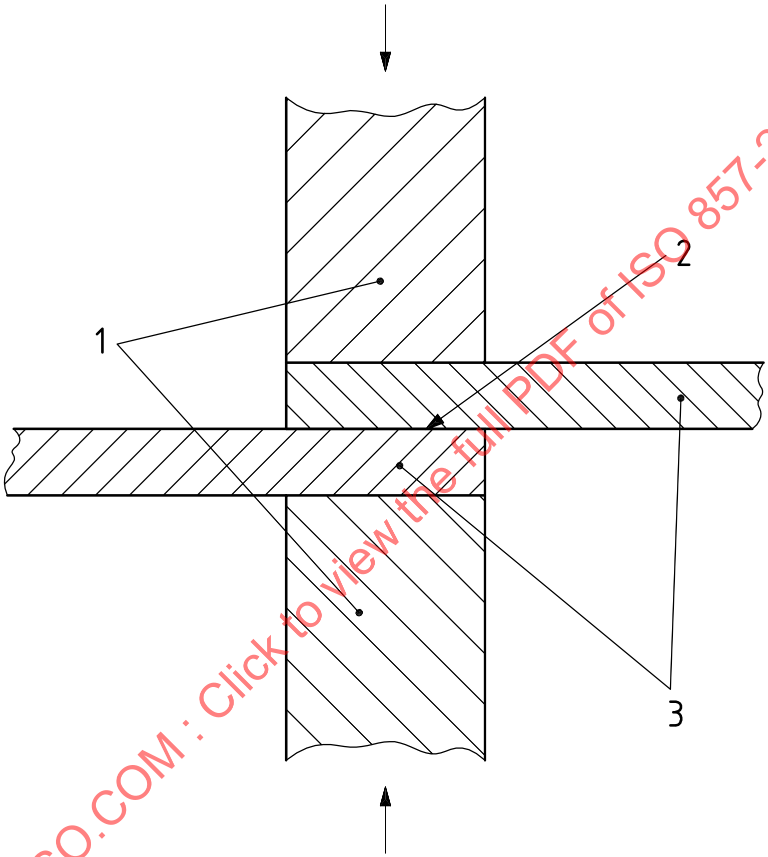
A.1.5.1 Induction soldering in air (946)

After the components to be joined have been treated with flux and filler metal, the heat necessary for soldering is generated in the component by an induced alternating current. The filler metal is then introduced between the components, or it is fed in when the soldering temperature has been reached. The soldering is carried out in air.

A.1.5.2 Resistance soldering (948)

See Figure A.8.

After the application of flux and filler metal, the components to be soldered are pressed together by two electrodes through which an electrical current is passed. The heat necessary for soldering the joint is generated by the resistance of the electrodes to the electrical current. The determining factors for the heating process are the electrical resistance at the joint faces and the electrical resistance of the electrodes and the components. Typical electrode materials are carbon, tungsten, molybdenum and copper alloys.



Key

1 electrodes

2 joint to be soldered

3 components (e.g. tinned copper strip)

Figure A.8 — Resistance soldering

A.1.6 Furnace soldering (943)

A.1.6.1 General

The components are heated in a furnace. The process is also suitable for mass production of small- to medium-size workpieces. The components are fixed in position, with the flux and filler metal already applied. Filler metal preforms may also be used.

A distinction is made between discontinuous furnaces, e.g. chamber or shaft furnaces, and continuous furnaces, e.g. continuous-feed furnaces.

A.1.6.2 Reflow soldering with heating by hot gas

After the application of flux and filler metal, the components (e.g. printed-circuit boards) are heated by means of a hot gas flow. For most components, a filler metal cream or paste is used.

A.1.6.3 Reflow soldering with IR or laser heating

The components (e.g. printed-circuit boards) are heated by means of infrared or laser radiation. Infrared radiation heats the whole component. Laser radiation heats only the area of the joint.

A.1.6.4 Reflow soldering with heating by means of vapour condensation (vapour-phase soldering)

A condensing vapour is used to heat up the components (e.g. printed-circuit boards) to the soldering temperature. The temperature will not exceed the boiling point of of the liquid used to produce the vapour.

A.2 Brazing

A.2.1 Brazing using liquids for heating

A.2.1.1 Dip brazing (914)

The components to be brazed are heated by dipping them in a bath of molten filler metal. The bath has to be made of a suitable material (ceramic material or graphite). A flux covering is needed for the components before they are dipped in the bath.

A.2.1.2 Salt-bath brazing (915)

The components are heated by dipping them in a bath containing a mixture of molten salts. The bath is made of a suitable material. Many salt mixtures have also a flux action. The composition of the salt mixture depends on the nature of the parent metal and of the filler metal. Filler metal preforms are placed in the immediate proximity of the joint area prior to immersion.

A.2.1.3 Flux-bath brazing

Flux-bath brazing involves the immersion of the components in a bath of suitably active molten flux. Filler metal preforms are placed in the immediate proximity of the joint area prior to immersion.

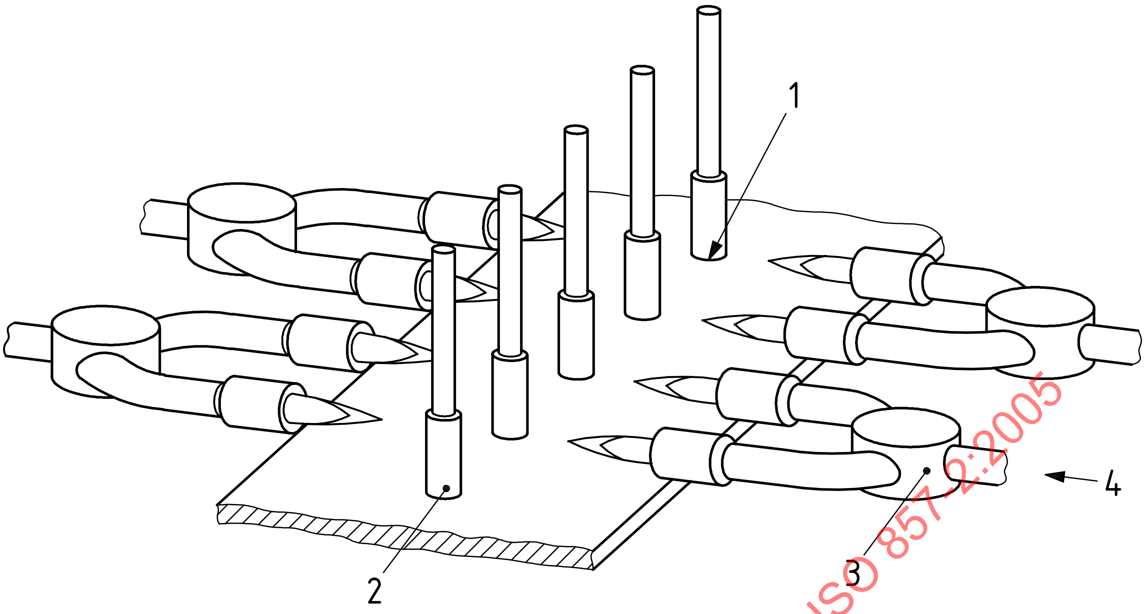
A.2.2 Flame brazing (912)

A gas-operated torch is used as the heat source. The torch is adjusted to produce a neutral or slightly reducing flame. The way the heat is applied depends on the nature of the joint being brazed and the filler metal used:

— for manual brazing, generally the torch is moved so as to heat the components to be brazed as uniformly as possible in the joint region;

— for mechanized or automatic brazing, normally the components are moved (see Figure A.9);

— suitable gaseous fuels are acetylene, propane, hydrogen or natural gas, burnt together with oxygen, compressed air or aspirated air.



Key

1 brazing filler metal
2 component
3 flame-array burner
4 fuel/air mixture

Figure A.9 — Flame brazing with fixed burners

A.2.3 Brazing with an electric arc (93)

Metal arc brazing processes can be subdivided into gas-shielded metal arc brazing (known as gas metal arc brazing in the US) and gas-shielded brazing with a non-consumable electrode.

The principle of metal arc brazing is almost identical to that of gas metal arc welding, i.e. (tungsten) plasma arc welding with filler wire. The most commonly used filler wires are copper alloys. The melting ranges of these filler materials are lower than those of the parent material(s).

Usually, metal arc brazing processes are used with thin steel sheets, which may be coated or uncoated.

Due to the lower melting range of the filler material, there is less risk of damage to any coating as well as less risk of the heat affecting the workpiece.

Metal arc brazing does not cause significant melting of the parent material(s). Usually, no flux is necessary.

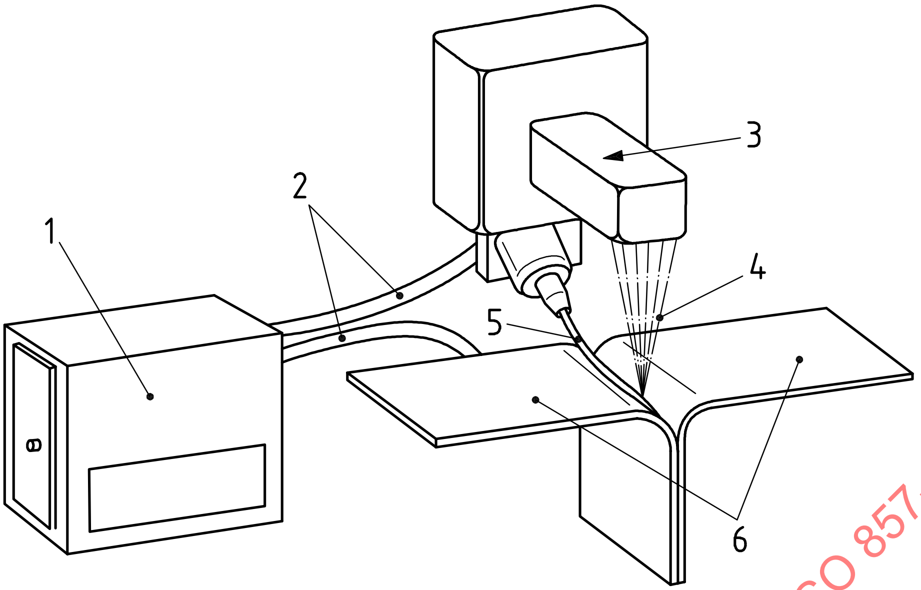
A.2.4 Brazing using radiation

A.2.4.1 Laser beam brazing (93)

See Figure A.10.

Laser beam brazing can be carried out with CO_2 or Nd:YAG lasers operating in a continuous or pulsed mode. The filler metal is usually applied as filler wire or as brazing paste.

A relatively new application for laser beam brazing is the joining of steel sheets, e.g. in the automobile industry. Laser beam soldering or brazing processes may also be carried out under a shielding gas or in a vacuum.



Key

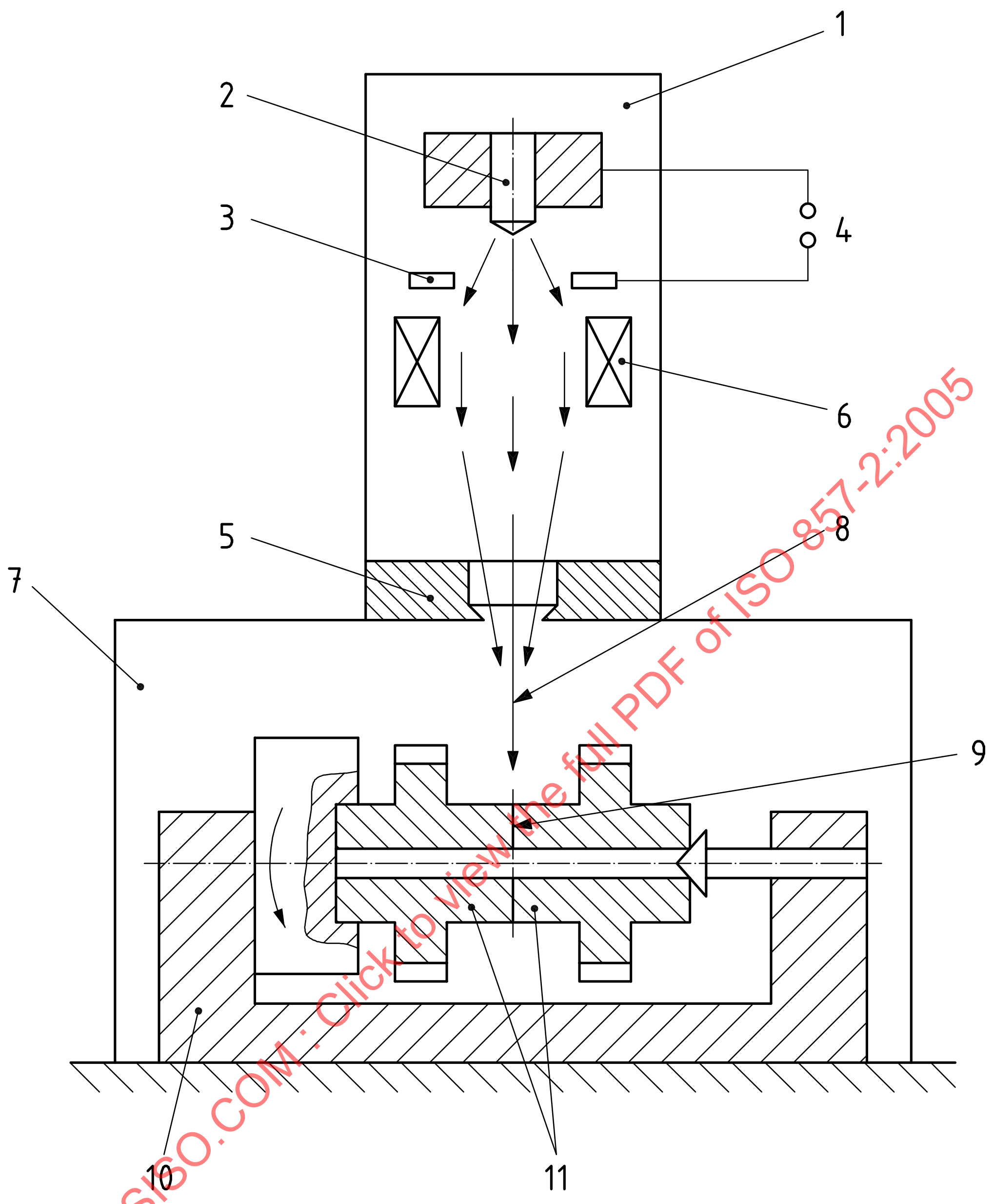
1 power supply
2 optical fibres
3 focussing optics
4 laser beam
5 filler wire
6 components

Figure A.10 — Laser beam brazing

A.2.4.2 Electron beam brazing (93)

See Figure A.11.

Heat is generated in the component, at the joint being brazed, by absorption of a focussed electron beam. The process is usually carried out under a vacuum.



Key

1 vacuum chamber
2 cathode
3 anode
4 terminals for power supply
5 beam-deflection system
6 focussing lens
7 brazing chamber
8 electron beam
9 joint
10 device for moving the workpiece, e.g. by rotating it
11 components

Figure A.11 — Electron beam brazing

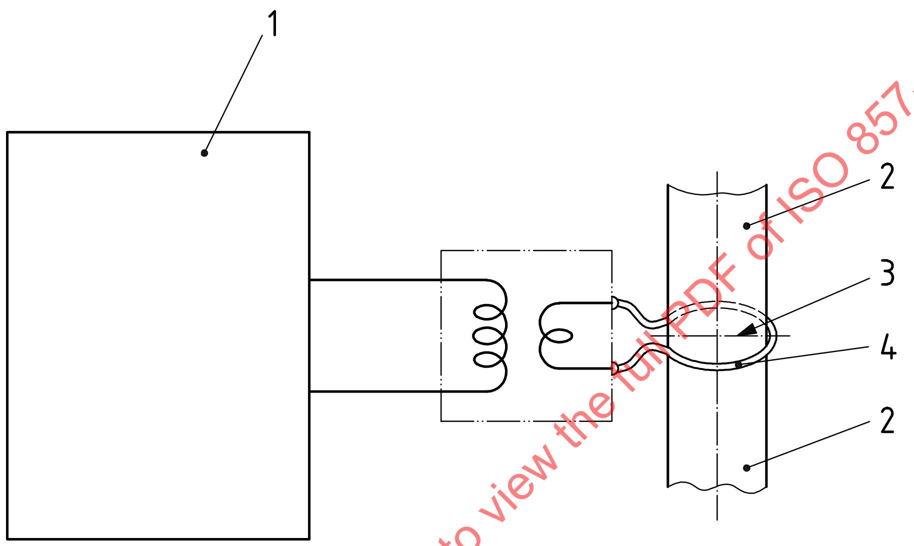
A.2.5 Brazing using electrical heating

A.2.5.1 Induction brazing (916)

See Figure A.12.

Heat is generated by an alternating current induced in the components to be brazed, Normally, this kind of brazing is carried out in air with a flux, but a protective atmosphere may also be used.

The energy density induced in the components decreases rapidly from the surface towards the interior. The depth of penetration is a function of frequency. Medium frequencies (1 000 Hz to 10 000 Hz) give a greater depth of penetration than high frequencies (100 kHz to several MHz).



Key

1 generator

2 component

3 joint

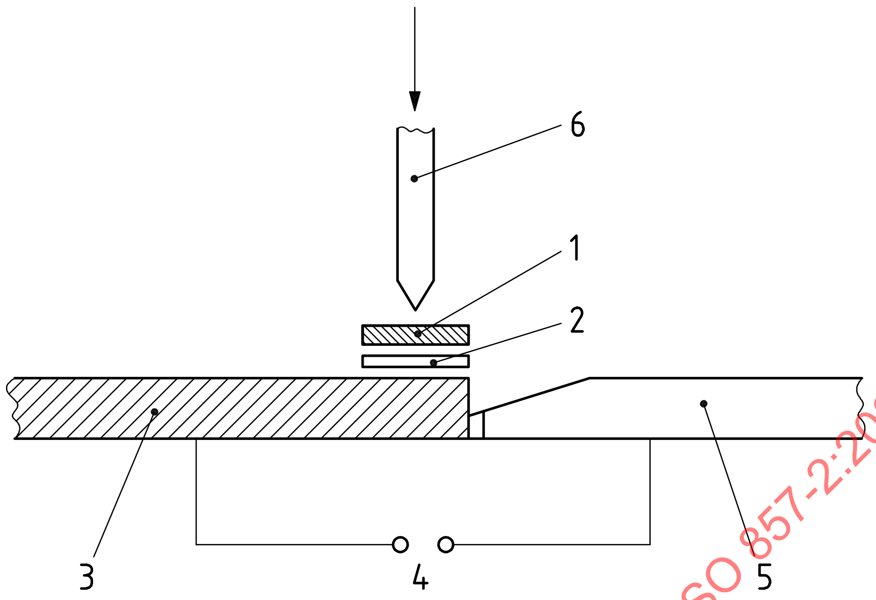
4 inductor

Figure A.12 — Induction brazing

A.2.5.2 Resistance brazing (918)

See Figure A.13.

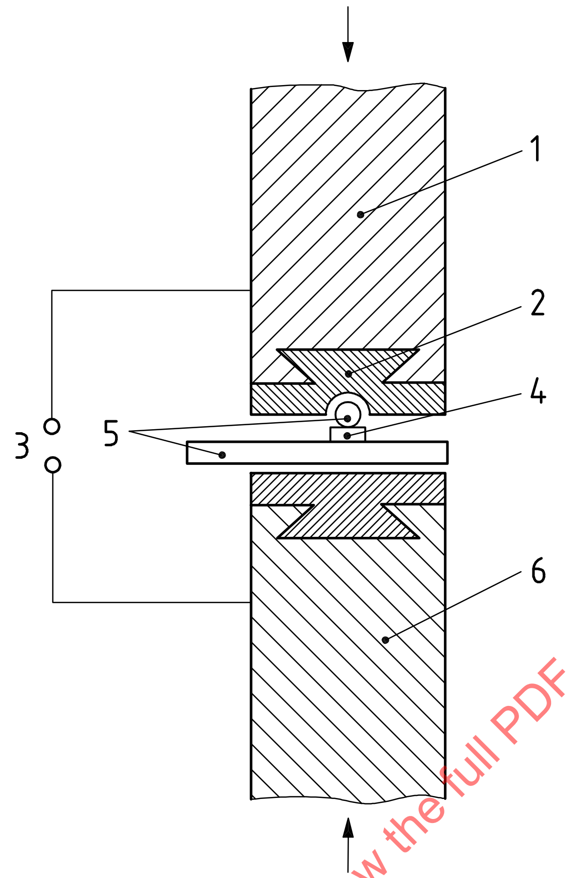
Heat is generated in the components at the joint by the resistance to the passage of an electric current. This electrical heating enables the components to be brazed either indirectly (see Figure A.13) or directly (see Figure A.14).



Key

1 first component
2 brazing filler metal, flux
3 second component (e.g. steel bar)
4 terminals for power supply
5 copper electrode
6 blank holder

Figure A.13 — Indirect resistance brazing



Key

1 electrode
2 shaped electrode tip (made of e.g. carbon, tungsten, molybdenum)
3 terminals for power supply
4 brazing filler metal, flux
5 components
6 counter-electrode

Figure A.14 — Direct resistance brazing

A.2.5.3 Furnace brazing (913)

The components to be brazed are heated by means of radiant heat and/or convection of the hot gas in the furnace. The components are fixed relative to each other. The brazing filler metal is put in place before heating starts. Usually, the process is carried out without flux in a reducing-gas atmosphere or in a vacuum. In some cases, an inert protective gas atmosphere may be used and/or flux, e.g. for aluminium alloys.

