

IS : 812 - 1957

*Indian Standard*

**GLOSSARY OF TERMS  
RELATING TO WELDING AND  
CUTTING OF METALS**

(Seventh Reprint MARCH 1998)

UDC 621.791 : 001.4

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## GLOSSARY OF TERMS RELATING TO WELDING AND CUTTING OF METALS

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## *Indian Standard*

# GLOSSARY OF TERMS RELATING TO WELDING AND CUTTING OF METALS

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 11 February 1957, on approval by the Building Division Council of the draft finalized on 15 June 1956, by the Structural Steel Sectional Committee.

**0.2** In the course of recent years, considerable developments have been made in the application of welding technique. This has resulted in an increase in the number of terms used, necessitating standardization of terminology on more exact basis, so as to avoid ambiguity and confusion arising out of misinterpretation of terms. It is hoped that this standard glossary of terms will help in fixing a more precise meaning to words which, because of their convenience, have acquired too general a significance.

**0.3** In a number of cases information is available where more than one term is being used for the same purpose. Such alternate terms have been grouped together. The terms given first are recommended for use and the use of terms given in brackets is deprecated.

**0.4** Taking into consideration the views of the producers, consumers, technologists, etc, the Sectional Committee responsible for the preparation of this standard felt that it should be related to the trade practices followed in the country in this field. Furthermore, due weightage had to be given to the need for international co-ordination between standards prevailing in different countries of the world. These considerations led the Sectional Committee to derive assistance from the following standards and publications:

IRS PRB. 100 (N) : 1945 CODE OF PRACTICE FOR ELECTRIC ARC  
500

WELDING OF MILD STEEL STRUCTURES. Ministry of Railways,  
Government of India.

B.S. 499: 1952 GLOSSARY OF TERMS (WITH SYMBOLS) RELATING TO  
THE WELDING AND CUTTING OF METALS. British Standards  
Institution.

WELDING HANDBOOK, 3RD ED. (1951) American Welding Society,  
New York.

## WELDING AND CUTTING PROCESSES

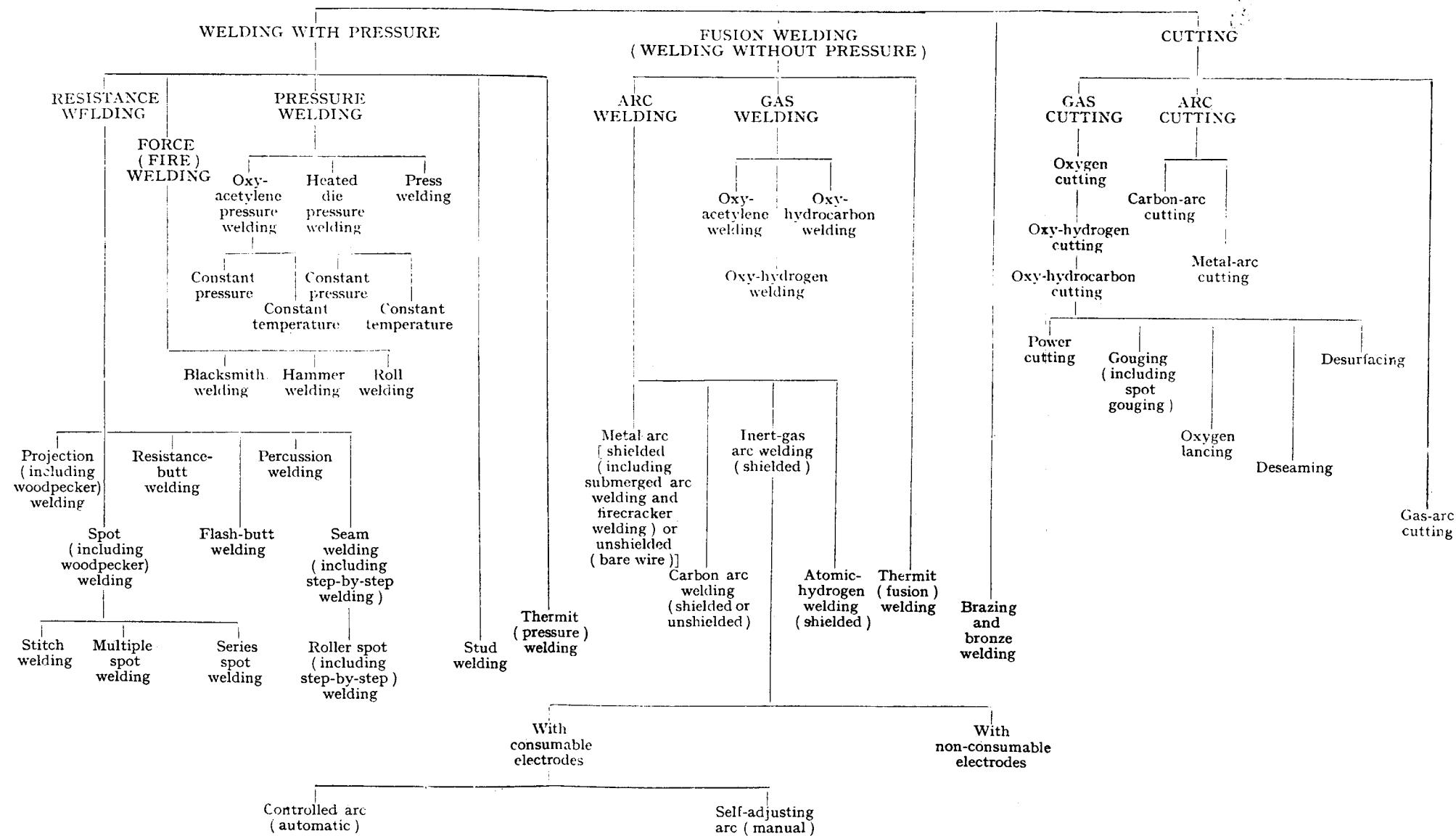


FIG 1 CHART SHOWING DERIVATION OF WELDING AND CUTTING PROCESSES

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**0.5** This standard defines the terms relating to welding and cutting of metals. Other Indian Standards being formulated in the field of welding comprise the following:

- a) Scheme of symbols for welding
- b) Specification for covered electrodes for metal arc welding of mild steel
- c) Classification and coding of covered electrodes for metal arc welding of mild steel and of low alloy high-tensile steels
- d) Code of practice for use of metal arc welding for general construction in mild steel
- e) Code of practice for training and testing of metal arc welders
- f) Code of practice for safety and health requirements in electric and gas welding and cutting operations
- g) Code of practice for resistance spot welding for light assemblies in mild steel
- h) Code of practice for use of welding in tubular construction
- j) Code of practice for use of welding in pipelines
- k) Code of practice for inspection of welds
- m) Procedure code for manual metal arc welding of structural steel
- n) Code of practice for use of welding in structures subject to dynamic loading-bridges

**0.6** This standard is intended mainly to cover the technical definitions of terms, and it does not necessarily include all the legal meanings of the terms.

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## 1. SCOPE

**1.1** This standard defines the terms relating to welding and cutting of metals.

## 2. ARRANGEMENT

**2.1** For convenience of reference and comparison of terms on related processes, this glossary has been divided into seven main classes and each has been dealt with under a separate part of the standard. Parts I to IV deal with terms relating to welding processes and parts V to VII are devoted to terms relating to testing, weld imperfections and cutting. The terms in each part have further been grouped together under suitable and convenient sub-classes, and under each part the terms have been listed in alphabetical order. The terms common to the whole class have been dealt with under the heading 'General Terms' which precedes other sub-classes.

**2.2** A chart showing derivation of welding and cutting processes is also given for reference (see Fig 1).

**2.3** An index to all the terms defined under Parts I to VII is given in Part VIII, where all terms including the alternatives mentioned in parentheses have been listed in one alphabetical sequence according to IS : 382-1952 Practice for Alphabetical Arrangement.

## PART I WELDING IN GENERAL

### 3. COMMON TERMS

**3.1 As-Welded** — The condition of weld metal, welded joints and components after welding prior to any subsequent thermal or mechanical treatment.

**3.2 Butt Weld** — A weld in which the weld metal lies substantially within the extension of the planes of the surfaces of the parts joined or within the extension of the planes of the smaller of the two parts of differing size (see Fig 2).

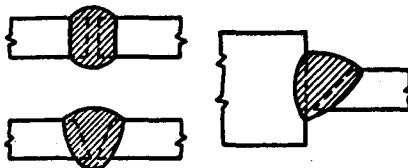


FIG 2 EXAMPLES OF BUTT WELDS

**3.3 Chipping Goggles** — A protective device enclosing a space in front of the eyes to shield them from injury during chipping or grinding. They are fitted with two plain glasses.

#### 3.4 Deposited Metal ( Added Metal )

- In Welding** — Filler metal after it becomes part of the weld
- In Bronze Welding or in Brazing** — Filler metal after it becomes part of the joint.

**3.5 Deposition Efficiency** — The ratio of the weight of deposited metal to the net weight of core wire of electrodes consumed, exclusive of stubs.

**3.6 Electrode Holder** — A device to hold an electrode and to convey current to it. It may be part of a welding machine, or a manual device held by an operator.

**3.7 Face Mask** — A protective device worn in front of the face to shield it from injury during welding. It is fitted with welding glass(es) and plain glass(es).

**3.8 Face Shield ( Hand Screen, Hand Shield )** — A protective device held in the hand to shield the face and throat from injury during welding. It is fitted with a window consisting of welding glass and plain glass.

**3.9 Faired ( Tapered ) Member** — The thicker member of a joint tapered down to the thickness of the thinner member.

**3.10 Filler Metal** — Metal to be added in welding or brazing.

**3.11 Fixed Shield** — An independently mounted device to protect the whole of the face and throat from injury during welding. It is fitted with welding glass and plain glass.

**3.12 Full Penetration** — Welding, using a technique which ensures full penetration.

**3.13 Flux** — Fusible material used in welding or oxygen-cutting to dissolve and facilitate removal of oxides and other undesirable substances. Also commonly used to designate covering of covered electrodes.

#### 3.14 Fusion Penetration

- a) *In Fusion Welding* — The depth to which the parent metal has been fused.
- b) *In Spot, Seam, or Projection Welding* — The distance from the interface to the edge of the weld nugget, measured in each case on a cross-section through the centre of the weld and normal to the surface ( see Fig 3 ).

NOTE — ' Depth penetration ' is sometimes used as an alternative term in fusion welding, but ' fusion penetration ' is preferred.

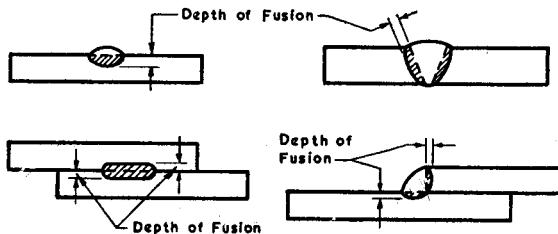


FIG 3 FUSION PENETRATION

**3.15 Fusion Zone** — The portion of a weld in which parent metal has been fused ( see Fig 4 ).

**3.16 Heat-Affected Zone** — Parent metal metallurgically affected by the heat of welding ( or cutting ), but neither melted nor made plastic ( see Fig 4 ).

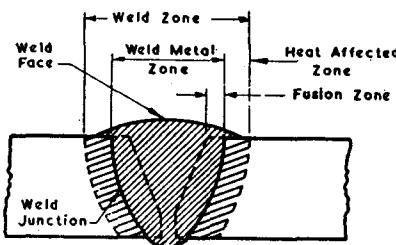


FIG 4 VARIOUS ZONES OF A TYPICAL WELD

**3.17 Helmet ( Head Screen )**—A protective device supported on the head and arranged to shield the face and throat from injury during welding. It is fitted with a window consisting of welding glass and plain glass.

**3.18 Ignition Powder**—A readily ignitable mixture, usually of powdered aluminium and oxidizing material, used for initiating the reaction in thermit pressure welding and thermit fusion welding.

**3.19 Longitudinal Axis of Weld**—A line through the length of a weld, perpendicular to the cross-section at its centre of gravity ( see Fig 5 ).

**3.20 Melt Run**—A line of parent metal which has been melted by passing a welding flame or arc along the surface of the plate.

**3.21 Parent Metal ( Base Metal )**—The metal to be joined or cut.

**3.22 Plain Glass ( Cover Glass )**—Clear glass or other transparent material used to protect the surface of welding glass.

**3.23 Peening**—The mechanical working of metals by means of hammer blows.

**3.24 Penetration ( Through ) Pass**—The first run of a multi-run butt weld, the penetration bead of which can be seen.

**3.25 Residual Welding Stress**—Stress remaining in a metal part or structure as a result of welding.

**3.26 Strength Weld**—A weld designed to be under stress.

**3.27 Stress Relief Heat Treatment**—Uniform heating of an assembly or portion thereof to a suitable temperature below the lower critical point for sufficient time to reduce the residual stresses followed by uniform cooling.

**3.28 Stubs**—Waste ends of electrodes and welding rods.

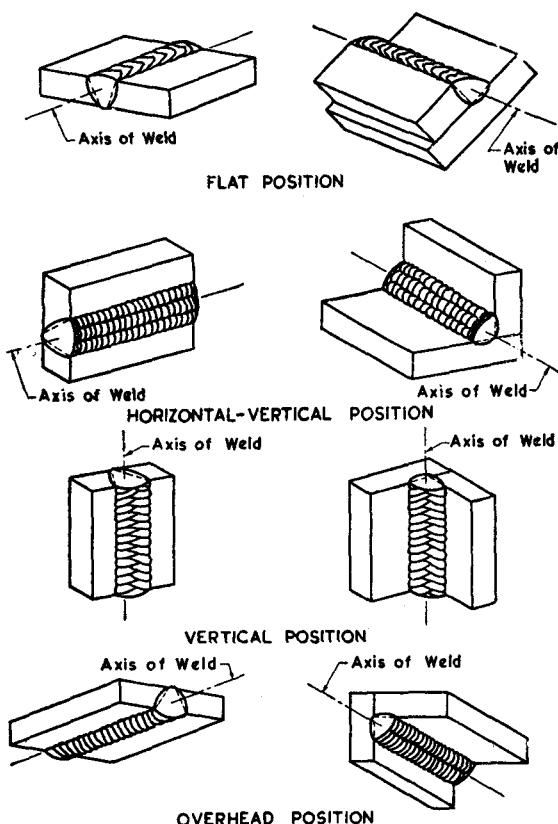


FIG 5 LONGITUDINAL AXIS OF WELDS

**3.29 Surfacing** — The deposition of filler metal by welding process on to a metal surface to obtain desired properties.

**3.30 Weld** — A union between two pieces of metal at faces rendered plastic or liquid by heat or by pressure, or both. Filler metal may be used to effect the union.

**3.31 Weld Gauge** — A device designed for checking the shape and size of welds ( see Fig 6 ).

**3.32 Weld Metal** — All metal melted and/or made plastic in making a weld.

**3.33 Weld-Metal Zone** — The portion of a weld consisting of weld metal ( see Fig 4 ).

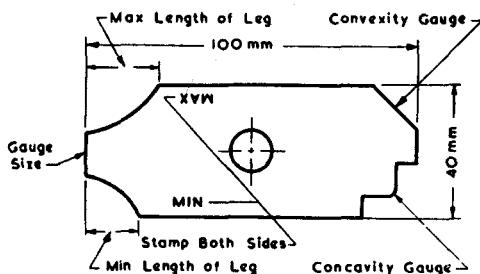


FIG 6 TYPE OF WELD GAUGE

**3.34 Weld Width** — Distance between the toes of the weld.

**3.35 Weld Zone** — The sum of the weld-metal zone and the heat-affected zone (*see Fig 4*).

**3.36 Welded Joint** — For the purposes of design calculations, a full strength butt joint is a joint produced by a fully penetrated weld or by fully penetrated welds between parts of equal section aligned and lying within the included angle of 135° to 180° in such a manner that the flow of normal stresses does not undergo any considerable deviation in the zone of the joint.

**3.37 Welder** — The operator who performs the welding operation.

**NOTE** — This term is often used in the United States of America to describe a welding machine.

**3.38 Welder's Sleeve** — Covering to protect the arm during welding.

**3.39 Welder's Spats** — Coverings to protect the upper part of the feet and ankles during welding.

**3.40 Welding** — The making of a weld.

**3.41 Welding Apron** — An apron, usually of leather or asbestos, used to protect the welder from harmful radiation and spatter.

**3.42 Welding Glass (Filter Glass)** — A light-filter to protect the eyes from harmful radiations emanating from an electric arc or a gas flame.

**3.43 Welding Gloves** — Gloves to protect the hands, or gauntlets to protect the hands and forearms, from heat and metal splashes due to welding.

**3.44 Welding Goggles** — Goggles with tinted lenses used during welding or oxygen cutting to shield eyes from injury during welding or cutting.

**3.45 Welding Procedure** — A specified course of action to be followed in welding, including a list of materials and tools to be used. Three typical examples of welding procedure are given under **3.45.1** to **3.45.3**

**3.45.1 Arc Welding**

- a) Classification and size of electrodes,
- b) Current and open-circuit voltage,
- c) Length of run per electrode, or speed of travel,
- d) Number and arrangement of runs in multi-run welds,
- e) Position of welding,
- f) Preparation and set-up of parts,
- g) Welding sequence, and
- h) Pre- or post-heating.

**3.45.2 Gas Welding**

- a) Specification and diameter of filler rod and, if required, specification of the flux;
- b) Gas pressures and nozzle size;
- c) Manipulation and angles of rod and blowpipe and, if required, correct application of flux;
- d) Technique of welding;
- e) Edge preparation and, if required, tacking;
- f) Position of welding and number of runs;
- g) Welding sequence; and
- h) Pre- or post-heating.

**3.45.3 Resistance Welding**

- a) Electrodes sizes and permissible variations,
- b) Particulars of machine settings,
- c) Welding sequence, and
- d) Particulars of tests required.

**3.46 Welding Rod** — Filler metal, in wire or rod form, used in gas welding and brazing processes, and those arc welding processes wherein the electrode does not furnish the filler metal.

**3.47 Welding Sequence** — The order and/or direction in which either welds or runs are made.

**3.48 Welding Technique** — The manner in which an operator manipulates an electrode, a blowpipe or the like.

**3.49 Welding Thermit** — A mixture of iron oxide, finely divided aluminium, steel and de-oxidizers. On ignition of the mixture, an exothermic reaction takes place, resulting in the production of molten metal which acts as a source of heat for the subsequent welding and also as added metal.

NOTE 1 — This is also known as 'standard welding thermit' or (in the USA) as 'forging thermit' to differentiate it from welding thermits containing other alloying metals or materials added for specific purposes.

NOTE 2 — 'Thermit', as such, is a mixture of metallic oxides and finely divided aluminium, the heat from the chemical reaction between which produces molten metal. This material has no application in welding except as a source of heat.

## PART II WELDING WITH PRESSURE

### 4. GENERAL TERMS

**4.1 Faying Surface** — That surface of a member which is in contact with another member to which it is to be joined.

**4.2 Gather (Shortening)** — The reduction in length accompanying the production of upset metal.

**4.3 Initial Pressure** — The first steady or peak pressure, normal to the surface contact area, applied during a welding cycle.

**4.4 Interface** — The contact area between faying surfaces.

**4.5 Pressure Contact Area** — The initial surface contact area of the components through which pressure is transmitted.

**4.6 Sheet Separation** — In spot, seam and projection welding, the gap surrounding the weld, between faying surfaces, after the joint has been welded.

**4.7 Upset Metal** — Parent metal proud of the normal surfaces of the work as a result of forging or pressing.

**4.8 Upset Pressure** — Pressure producing, or tending to produce, upset metal.

NOTE — Upset pressure may be expressed as force or as pressure per unit of pressure contact area.

**4.9 Welding Pressure** — The pressure, at the abutting surfaces of a workpiece, required to consolidate a weld.

NOTE — In the resistance welding, this is the electrode pressure less the pressure required to overcome rigidity of the workpiece when bringing the abutting surfaces into contact.

## 5. TERMS RELATING TO EQUIPMENT

**5.1 Angle Electrode**—An electrode in which the tip is not normal to the axis of the shank (*see Fig 7*).



FIG 7 ANGLE ELECTRODE

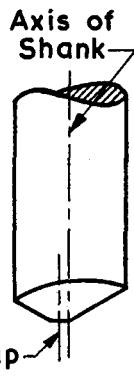


FIG 8 OFFSET ELECTRODE



FIG 9 VERTICAL ELECTRODE

**5.2 Arc Damper (Arc Blow Compensator)**—A device for centralizing an arc in a stud welding tool.

**5.3 Arm**—A member of a welding machine which conducts current to an electrode holder, or supports a conductor conveying current to it, and which is required to withstand the welding pressure.

**5.4 \*Battery Spot-Welding Machine**—A spot-welding machine in which a battery is used to provide the welding current.

**5.5 Bolster**—An electrode holder intended for mounting on the platen of a projection-welding machine.

**5.6 Burner**—A multi-jet blowpipe used to supply the heat for oxy-acetylene pressure welding.

NOTE — Burners are usually shaped to the section of the parts joined and may be split to facilitate removal. They are sometimes water-cooled. The term is sometimes erroneously applied to operatives.

**5.7 \*Condenser-Discharge Spot-Welding Machine (Capacitor Spot-Welding Machine)**—A spot-welding machine in which a large momentary current is obtained in the secondary circuit by discharging a capacitor through the primary circuit.

\*These machines are sometimes referred to as 'stored energy machines'.

**5.8 Electrode Shank**—The portion of an electrode intended to be held by, and to make electrical contact with, an electrode holder.

**5.9 Electrode Tip**—The portion of an electrode for spot or for stitch welding intended to make contact with the workpiece.

**5.10 Electrode Wheel**—A rotatable electrode of disk form.

**5.11 Ferrule**—A collar or ring of refractory material, surrounding the base of the stud during stud welding, to protect and contain the molten metal and, where required, to shape the weld fillet.

**5.12 Foot-Operated Welding Machine (Pedal-Operated Welding Machine)**—A welding machine in which mechanical pressure is applied by means of a pedal.

**5.13 Gun Welding Machine**—A portable spot-welding machine having a single electrode through which manual pressure is applied directly to one component of the workpiece; the electrical circuit is completed through a cable connection to the other component of the workpiece.

**5.14 Hand-Operated Welding Machine**—A welding machine (usually for flash welding) the operation of which is controlled by hand.

**5.15 \*Inductor Spot-Welding Machine**—A spot-welding machine in which a large momentary current is obtained in the secondary circuit by interrupting a direct current in the primary circuit.

**5.16 Insert**—A small piece of metal, usually hard wearing and/or of comparatively high resistivity, used as an electrode tip or attached to a welding die and projecting sufficiently beyond it to make contact with the workpiece where welding is required.

**5.17 Motor-Operated Welding Machine**—A welding machine in which the travel of the electrodes is obtained, and the mechanical pressure is applied, by means of a motor-driven mechanism.

**5.18 Offset Electrode**—An electrode in which the centre of the electrode tip is offset from the axis of the electrode shank (*see Fig 8*).

**5.19 Pad Electrode (Flat Electrode)**—An electrode in which the electrode tip is larger than the weld required, the size of the weld being controlled by the diameter of the other electrode tip.

**5.20 Platen**—Part of a resistance-welding machine on which welding dies are mounted and which conveys pressure and welding current to them.

**NOTE**—Use of platens is generally confined to projection-welding, flash-welding and butt-welding machines.

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\*These machines are sometimes referred to as ' stored energy machines '.

**5.21 Plier Spot-Welding Machine (Pincer Spot-Welding Machine)**—A portable spot-welding machine in which pressure is applied to the electrodes by means of a lever system similar to that of pincers.

**5.22 Portable-Spot Welding Machine**—A spot-welding machine in which the electrodes, the moving arms and the pressure application device are connected flexibly to the transformer and control gear so as to provide a limited amount of portability.

**5.23 Power-Operated Welding Machine**—A welding machine in which mechanical pressure is applied pneumatically or hydraulically.

**5.24 Resistance-Welding Electrode (Electrode)**—A replaceable portion of a resistance-welding machine which transmits current, and usually applies pressure, to the workpiece.

**5.25 Stud Welding Tool (Stud Welding Gun)**—An appliance for holding and operating the stud during stud welding, and for conveying pressure and current to it during the weld cycle.

**5.26 Vertical Electrode**—An electrode in which the electrode tip is normal to the axis of the electrode shank (see Fig 9).

**5.27 Welding Dies**—A member usually shaped to the work contour to clamp the parts being welded and conduct the welding current.

## 6. TERMS RELATING TO FORGE WELDING

**6.1 Blacksmith Welding**—A group of welding processes wherein weld is produced by heating in a forge or other furnace and by applying pressure by manual hammering.

**6.2 Double-Glut Butt Joint**—A butt joint incorporating two wedge-shaped gluts (see Fig 10).

**6.3 Forge Welding (Fire Welding)**—Any welding process in which the weld is made by hammering or other impulsive pressure while the surfaces to be united are plastic.

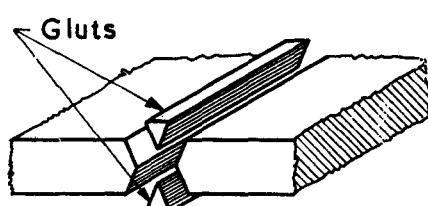


FIG 10 DOUBLE-GLUT BUTT JOINT  
(BEFORE FORGING)

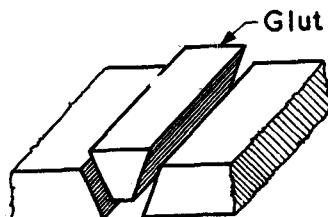


FIG 11 SINGLE-GLUT BUTT JOINT  
(BEFORE FORGING)

**6.4 Glut** — Metal, usually in the form of a bar, added during blacksmith welding to facilitate the making of a joint (*see Fig 10, 11 and 12*).

**6.5 Hammer Welding** — Forge welding in which weld is produced by heating in a forge or other furnace and by applying pressure mechanically.

**6.6 Plain Butt Joint (Jumped Joint)** — A butt joint in which the ends to be welded are usually upset before welding, i.e. their area is increased by hammering (*see Fig 13*).

**6.7 Roll Welding** — Forge welding in which weld is produced by heating in a forge or other furnace and by applying pressure progressively by mechanically operated rolls.

**6.8 Scarf Joint** — A joint in which the weld lies at an angle to the axis of the parts joined (*see Fig 14*).

**6.9 Single-Glut Butt Joint** — A butt joint incorporating a blunt-wedge-shaped glut (*see Fig 11*).

**6.10 Split Joint** — A double scarf joint in which the tapered end of each part to be joined is split longitudinally into two halves which are bent in opposite directions, so that the parts to be joined can be interlocked to prevent lateral motion during welding (*see Fig 15*).

**6.11 Square Corner Joint** — A corner joint incorporating a glut (*see Fig 12*).

**6.12 Tee Butt Joint** — A tee-joint in which the end of the stalk of the tee is upset before welding (*see Fig 16*).

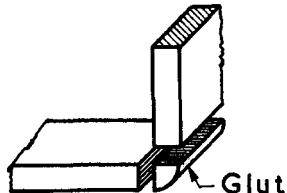


FIG 12 SQUARE CORNER JOINT  
( BEFORE FORGING )

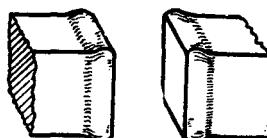


FIG 13 PLAIN BUTT JOINT  
( BEFORE FORGING )

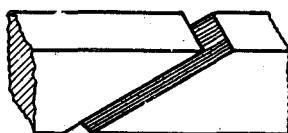


FIG 14 SCARF JOINT  
( BEFORE FORGING )



FIG 15 SPLIT JOINT  
( BEFORE FORGING )

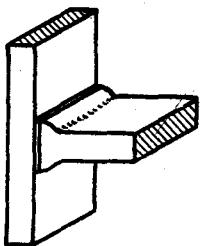


FIG 16 TEE BUTT JOINT  
( BEFORE FORGING )

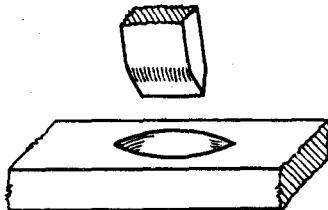


FIG 17 TEE SPLIT JOINT  
( BEFORE FORGING )



FIG 18 VEE JOINT ( BEFORE FORGING )

**6.13 Tee Split Joint** — A tee-joint in which the end of the stalk of the tee is tapered and welded within a split formed in the table of the tee (*see* Fig 17).

**6.14 Vee Joint** — A double scarf joint formed between a wedge on the end of one part to be joined and a vee notch in the end of the other (*see* Fig 18).

## 7. TERMS RELATING TO PRESSURE-WELDING

**7.1 Cold Welding ( Press Welding )** — Pressure-welding in which pressure alone is used.

**7.2 Constant-Pressure Pressure-Welding** — Pressure-welding in which gather occurs during the period of increasing temperature at a constant pressure.

**7.3 Constant-Temperature Pressure-Welding** — Pressure-welding in which gather occurs during the application of suddenly increased pressure at a substantially constant temperature.

**7.4 Deformation** — The local percentage reduction in the total thickness of sheets or plates at a pressure-welded lap joint.

**7.5 Heated-Die Welding** — Pressure-welding in which the surfaces to be united are made plastic by heat transferred from heated press tools of suitable shape. Such tools are known as 'dies'.

**7.6 Heating Time** — In pressure-welding, the time, if any, during which the parts to be joined are held together whilst being heated under reduced pressure until welding temperature is reached.

**7.7 Oxy-Acetylene Pressure-Welding** — Pressure-welding in which an oxy-acetylene flame is used to make plastic the surfaces to be united. No filler metal is used.

**7.8 Pressure-Welding (Solid-Phase Welding)** — Any welding process in which the weld is made by sustained pressure while the surfaces to be united are plastic.

**7.9 Welding Time** — In pressure-welding, the time during which the parts to be joined are maintained at welding temperature under full welding pressure.

## 8. TERMS RELATING TO RESISTANCE WELDING

**8.1 Back Pressure** — The pressure or the force (a) tending to separate the electrodes, or (b) in a dual-pressure cycle, reducing the electrode pressure by acting in opposition to the forward pressure.

**NOTE** — Back pressure may or may not be present under (a) during the making of a weld depending on the type of machine.

**8.2 Butt-Seam Welding** — A modification of seam welding, used for making butt welds, in which the electrode wheels rotate continuously but do not apply the welding pressure.

**8.3 \*Chill Time** — The period of time between the end of welding current and the start of post-heat current.

**8.4 \*Cool Time (Off-Time)** — In pulsation and seam welding, the period of time between two successive heat times in the same weld cycle.

**8.5 Cross-Wire Weld** — A resistance weld at the point of contact between crossed wires or rods with pressure applied continuously.

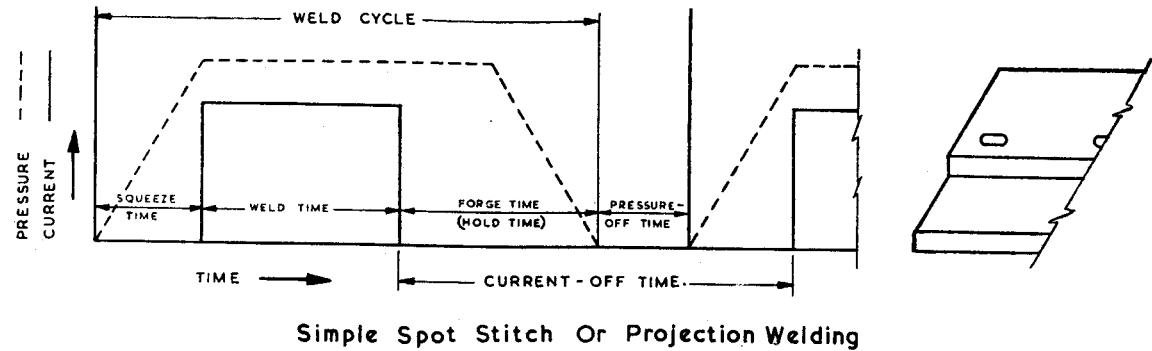
**8.6 \*Current-Off Time** — The period of time between the cessation of current in one weld cycle and the beginning of current in the next.

**8.7 Cycle** — An arbitrary unit of time, of duration equal to that of one cycle of the alternating current supply.

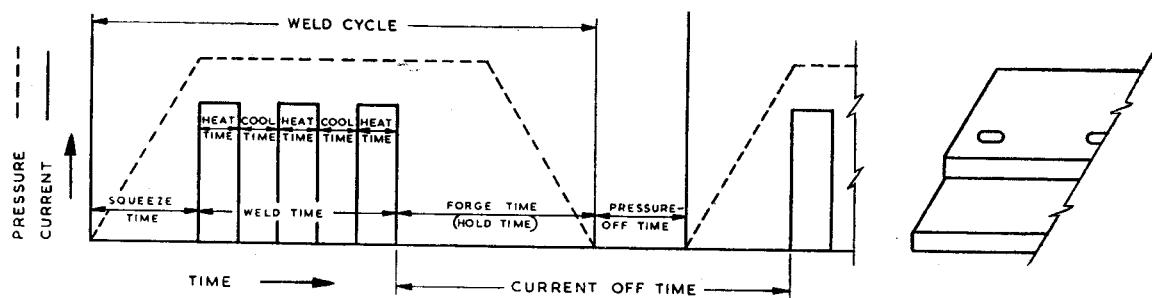
**NOTE** — The term as here defined is used in a sense different from that in the definitions under 8.8 and 8.9.

**8.8 Dual-Pressure Cycle** — A cyclic alternation, during a weld cycle, of two different predetermined electrode pressures.

\*For diagrammatic representation, see Fig 19 to 23.

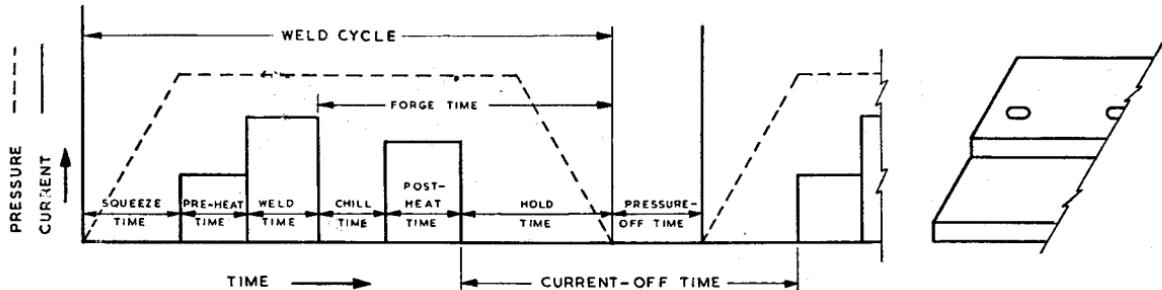


**Simple Spot Stitch Or Projection Welding**



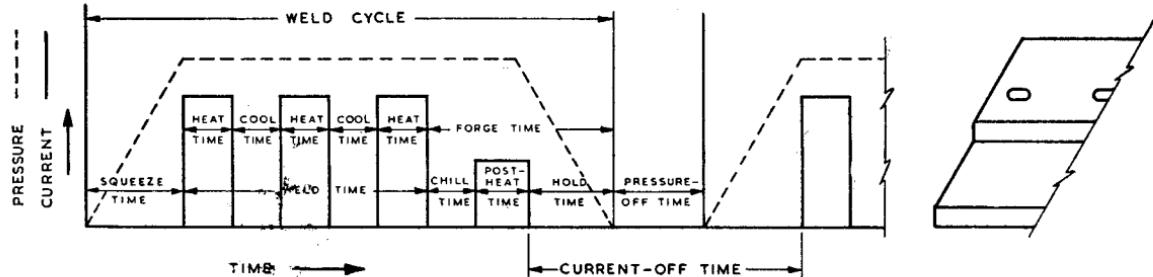
**Pulsation Spot Or Projection Welding**

FIG 19 TIME AND PRESSURE DIAGRAMS FOR SIMPLE FORMS OF RESISTANCE WELDING



Spot Or Projection Welding, Programme Control

22



Pulsation Spot Or Projection Welding, Programme Control

FIG 20 TIME AND PRESSURE DIAGRAMS FOR FORMS OF RESISTANCE WELDING WITH PROGRAMME CONTROL

**8.9 Duty Cycle** — The percentage ratio of duration of current flow during a period to the period.

**8.10 Edge Distance** — The distance between the toe of the weld and the nearest edge of the workpiece.

**8.11 Electrode Contact Area ( Clamp Contact Area )** — The area through which current passes from an electrode or a clamp to the work-piece.

**8.12 Electrode Pressure** — The pressure transmitted by the electrodes to the workpiece.

NOTE — This is the forward pressure less any back pressure.

**8.13 Fin ( Flash )** — An extrusion of metal extending outward beyond the upset in the form of a fin.

**8.14 Flash Welding ( Flash-Butt Welding )** — A resistance-welding process wherein coalescence is produced, simultaneously over the entire area of abutting surfaces, by the heat obtained from resistance to the flow of electric current between the two surfaces, and by the application of pressure after heating is substantially completed. Flashing and upsetting are accompanied by expulsion of metal from the joint.

**8.15 Flashing Allowance ( Burn Off )** — In making a flash weld, the length allowed for the total shortening of both components due to flashing.

**8.16 Flashing Current** — The current flowing during flashing time.

**8.17 \*Flashing Time** — The period in flash welding from the start of continuous flashing to the time when upset pressure is applied.

**8.18 \*Forge Time** — The period of time between the cessation of welding current and the end of the weld cycle.

**8.19 Forward Pressure** — The pressure or the force required to move the electrodes towards each other and to keep them in contact with the workpiece.

NOTE — Forward pressure is the sum of the pressures required (a) to overcome any back pressure, (b) to overcome friction and inertia, and (c) to provide electrode pressure.

**8.20 \*Heat Time ( On-Time )** — The duration of each successive welding current impulse during either pulsation or seam welding.

**8.21 \*Hold Time** — In spot and projection welding, the time during which force is applied at the point of welding after the last impulse of current ceases to flow.

In seam, flash and upset welding, the time during which force is applied to the work after current ceases to flow.

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\*For diagrammatic representation, see Fig 19 to 23.

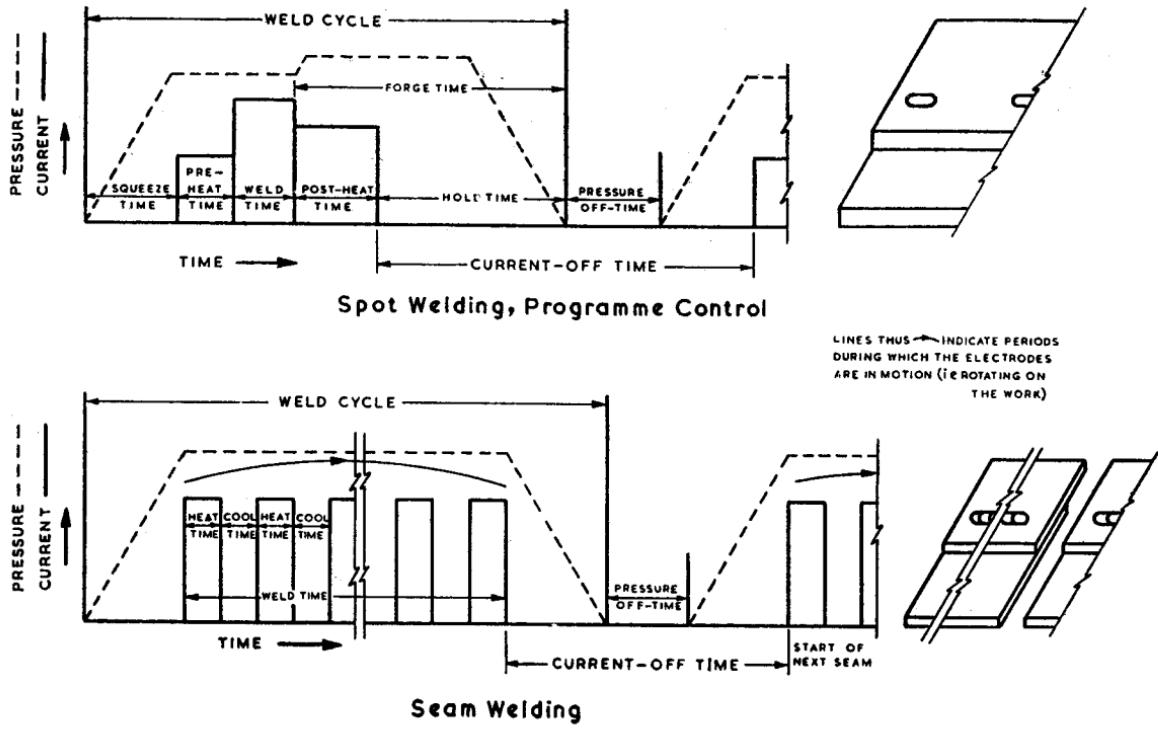
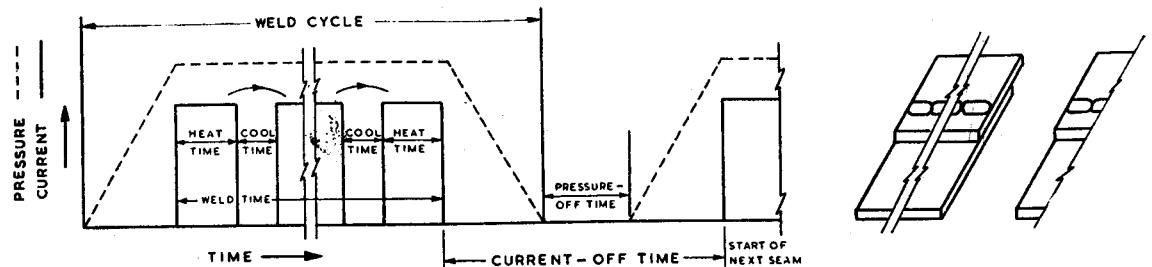
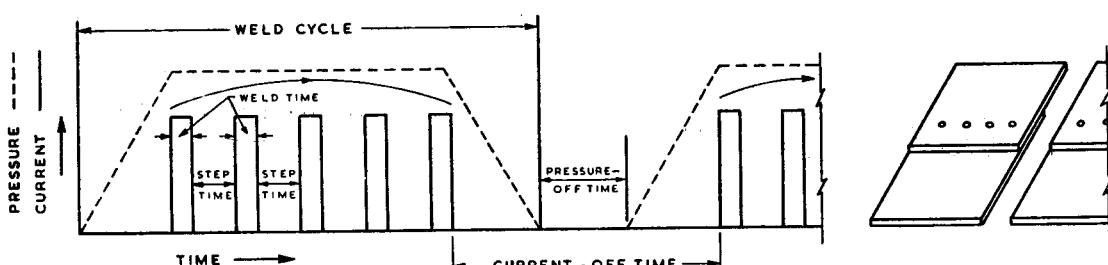


FIG 21 TIME AND PRESSURE DIAGRAMS FOR SPOT WELDING (PROGRAMME CONTROL) AND SEAM WELDING



**Step-by-Step Seam Welding**

LINES THUS INDICATE PRESSURE PERIODS  
DURING WHICH THE ELECTRODES ARE IN MOTION  
(i.e., ROTATING ON THE WORK)



**Roller Spot Welding**

FIG 22 TIME AND PRESSURE DIAGRAMS FOR STEP-BY-STEP SEAM WELDING AND ROLLER SPOT WELDING

- 8.22 Machine Stroke** — The maximum operational stroke obtainable.
- 8.23 Mash Weld** — A seam or stitch weld, between two components of equal thickness with a small amount of overlap, so made that the ultimate thickness of the workpiece at the weld approximates to that of a component.
- 8.24 Multiple-Spot Welding** — Spot welding in which, by the use of more than two electrodes, two or more welds are made simultaneously or in an automatically-controlled sequence.
- 8.25 Operational Stroke** — The distance through which the electrode(s) may travel from rest to the final position during welding.
- 8.26 Percussion Welding** — A resistance-welding process wherein weld is produced, simultaneously over the entire area of abutting surfaces, by the heat obtained from an arc produced by a rapid discharge of stored electrical energy, with impact pressure applied during or immediately following the electrical discharge.
- 8.27 Pick-Up** — Particles of the surface of the workpiece which adhere to the surface of the electrodes, or *vice versa*. (For definition of the term applicable to gas welding, see 14.13.)
- 8.28 \*Post-Heat Time** — The time during which a completed weld is heated by current for metallurgical reasons.
- 8.29 \*Pre-Heat Time** — The time during which pre-heating current flows. In flash welding, it is the time between the first passage of current and the start of continuous flashing.
- 8.30 Pre-Heating Current** — Current used to raise gradually the temperature of a workpiece from ambient temperature to a pre-determined value below welding temperature just before the application of welding current.
- 8.31 \*Pressure-Off Time** — The period of time between two successive weld cycles.
- 8.32 Programme Control** — A pre-determined automatic sequence of operations within a weld cycle.
- 8.33 Projection Welding (Woodpecker Welding)** — Resistance welding in which throughout the making of a weld the pressure is applied at a small projection or projections on one or more of the workpieces. The projections collapse during welding.
- 8.34 Pulsation Welding (Woodpecker Welding)** — Spot or projection welding in which the welding current is interrupted one or more times without release of pressure or change of location of the electrodes.

\*For diagrammatic representation, see Fig 19 to 23.

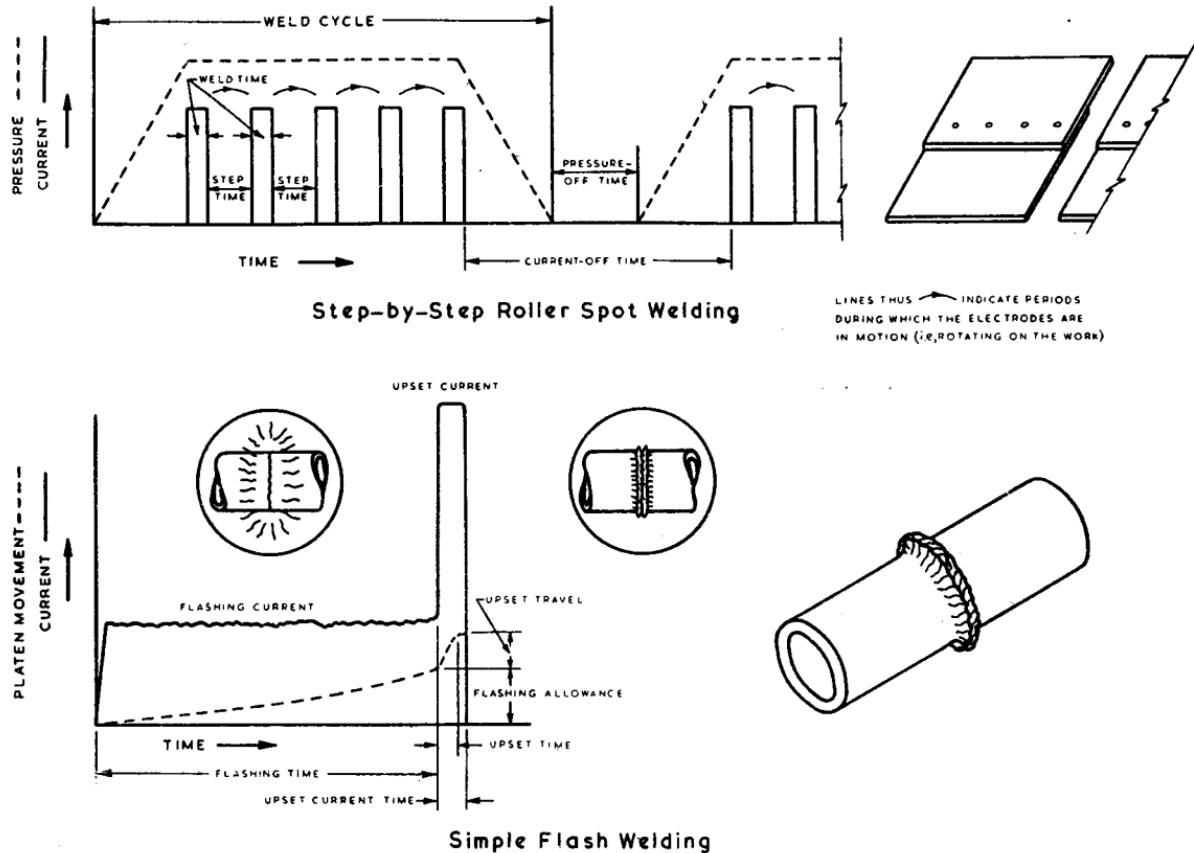


FIG 23 TIME AND PRESSURE DIAGRAMS FOR STEP-BY-STEP ROLLER SPOT WELDING AND SIMPLE FLASH WELDING

**8.35 Resistance Welding (Upset Welding)** — Welding in which pressure is applied between abutting surfaces at some stage in the process, and in which welding heat is produced by the electrical resistance at, and adjacent to, these surfaces during the passage of an electric current.

**8.36 Resistance-Butt Welding** — A resistance-welding process wherein weld is produced, simultaneously over the entire area of abutting surfaces or progressively along a joint, by the heat obtained from resistance to the flow of electric current through the area of contact of those surfaces. Pressure is applied before heating is started and is maintained throughout the heating period.

**8.37 Roller-Spot Welding** — Resistance welding in which pressure is applied continuously, and current impulsively, to produce a series of intermittent linear welds, the workpiece being between two electrode wheels or between an electrode wheel and an electrode bar. The electrode wheels apply the pressure, and may be rotated continuously or stopped during the passage of current.

**8.38 Seam Welding** — Resistance welding in which pressure is applied continuously, and current impulsively, to produce a linear weld, the workpiece being between two electrode wheels, or between an electrode wheel and an electrode bar. The electrode wheels apply the pressure, and may be rotated continuously or stopped during the passage of current.

**8.39 Series-Spot Welding** — Spot welding in which two or more welds are made simultaneously in electrical series (see Fig 24).

**8.40 Spot Welding** — A resistance-welding process wherein weld is produced by the heat obtained from resistance to the flow of electric current through the work parts held together under pressure by electrodes. The size and shape of the individually formed welds are limited primarily by the size and contour of the electrodes.

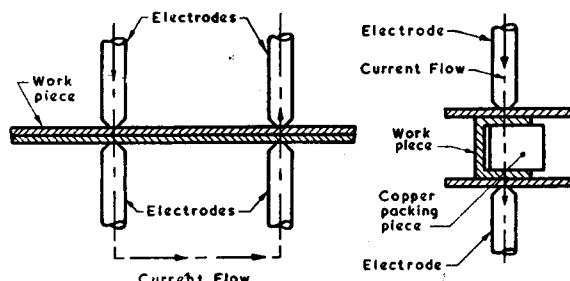


FIG 24 EXAMPLES OF SERIES-SPOT WELDING

**8.41 \*Squeeze Time** — The period of time between the application of pressure by electrodes to the workpiece and the first passage of current.

**8.42 \*Step Time** — The time between successive weld times in roller-spot welding and in step-by-step roller-spot welding.

**8.43 Step-By-Step Welding** — Seam or roller-spot welding in which the electrode wheel is stationary during the passage of current and rotates when no current is flowing.

**8.44 Stitch Welding** — Spot welding in which successive welds overlap.

**8.45 Throat Depth (Throat)** — In a resistance-welding machine, the distance from the centre-line of the electrodes or platens to the nearest point of interference for flatwork or sheets. In the case of a seam-welding machine with a universal head, the throat depth is measured with the machine arranged for transverse welding.

**8.46 Throat Gap** — The minimum unobstructed distance between the arms of a welding machine.

**8.47 Total Allowance** — In resistance-butt welding, the upset allowance. In flash welding, the sum of the flashing and upset allowances.

**8.48 Tread** — The peripheral surface of an electrode wheel.

**8.49 Upset Allowance** — The length allowed for the total shortening of both components due to upset.

**8.50 Upset Current Time** — The duration of current from the commencement of upset travel.

**8.51 \*Upset Time** — The duration of upset travel.

**8.52 Upset Travel** — The distance travelled by the moving head of a resistance-butt or flash welding machine in forging a weld. In resistance-butt welding, it is the travel from the point where the components are first brought together to the position where the weld is completed. In flash welding, it is the travel from the point where the components have been brought together at the end of flashing to the position where the weld is completed.

**8.53 Wearing Depth** — The distance between the tip of an electrode, or the tread of an electrode wheel, and that part at which further use becomes impracticable.

**8.54 Weld Contact Area** — The area through which welding current passes from one component to another during resistance welding.

**8.55 \*Weld Cycle** — The time required for one complete welding operation.

\*For diagrammatic representation, see Fig 19 to 23.

**8.56 Weld Nugget** — The fusion zone of a spot, projection or seam weld (*see Fig 25*).



FIG 25 WELD NUGGET

**8.57 Welding Current** — The current flowing through the welding circuit during the making of a weld. In resistance welding, the current used during preweld or postweld intervals is excluded.

**8.58 \*Weld Time** — The total time between the start of welding current and the end of the welding current during the making of one weld.

NOTE — A seam weld is considered to be one weld.

## 9. TERMS RELATING TO STUD WELDING

**9.1 Lift** — The distance, if any, by which the stud is retracted, where necessary, from the parent metal in order to initiate the arc in stud welding.

**9.2 Stud Welding** — Welding in which fusion is effected by the heat of an arc between one end of a stud and a parent metal surface, and consolidation by the application of pressure.

## 10. TERMS RELATING TO THERMIT PRESSURE WELDING

**10.1 Thermit Combined Weld** — A weld used for joining rails. The heads of the rails are joined by thermit pressure welding, with or without the interposition of a shim of suitable metal, and the feet and webs of the rails are joined simultaneously by thermit fusion welding.

**10.2 Thermit Crucible** — The vessel in which the thermit reaction takes place in thermit pressure welding and in thermit fusion welding. It has a hole in the bottom through which the molten metal passes (*see Fig 26*).

**10.3 Thermit Pressure Welding** — A welding process in which the parts to be joined, when in contact, are heated by means of ignited welding thermit and are then pressed together to form a weld.

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\*For diagrammatic representation, *see Fig 19 to 23*.

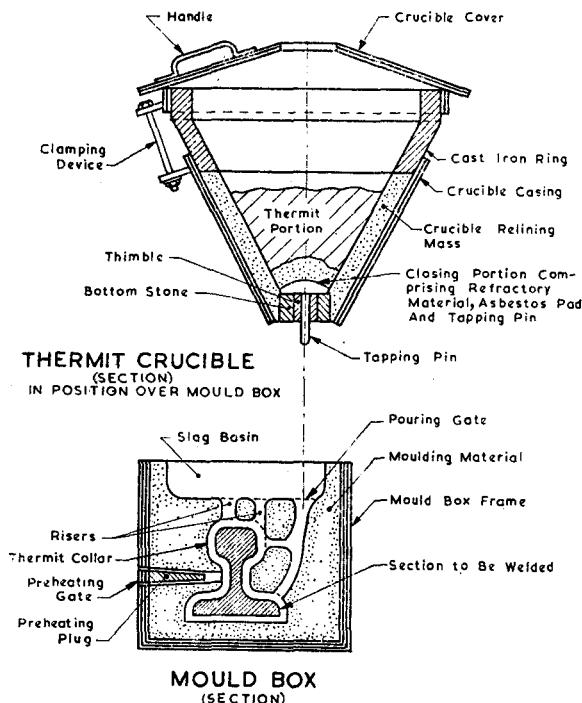


FIG 26. SET UP OF APPARATUS FOR A THERMIT FORM OF WELD

### PART III FUSION WELDING (WELDING WITHOUT PRESSURE)

#### 11. GENERAL TERMS

**11.1 Angle of Bevel** — The angle at which the edge of a component is bevelled in preparation for making a butt weld. The angle should be measured as shown in Fig 27 and 28.

**11.2 Automatic Welding** — Fusion welding in which control of the welding operation is predominantly automatic

**11.3 Back-Step Sequence** — A longitudinal sequence wherein the weld bead increments are deposited in the direction opposite to the progress of welding the joint (*see* Fig 29). (*See* also block sequence.)

**11.4 Back Weld** — A weld deposited at the back of a single-but weld after the main weld (*see* Fig 30).

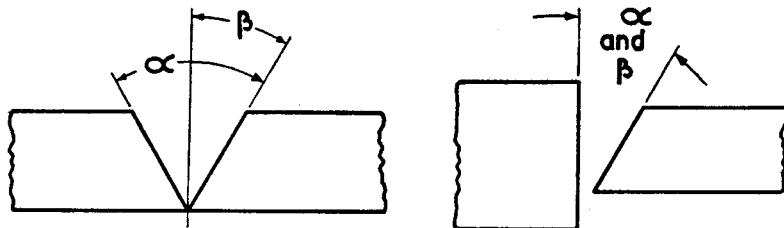


FIG 27 EXAMPLES OF INCLUDED ANGLE AND ANGLE OF BEVEL

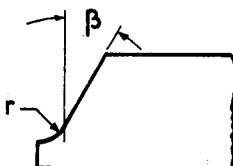


FIG 28 ROOT RADIUS ( $r$ )  
AND ANGLE OF BEVEL ( $\beta$ )

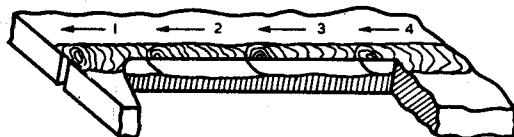


FIG 29 BACK-STEP SEQUENCE

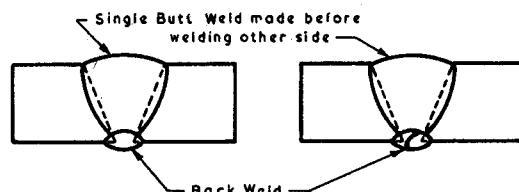


FIG 30 BACK WELDS

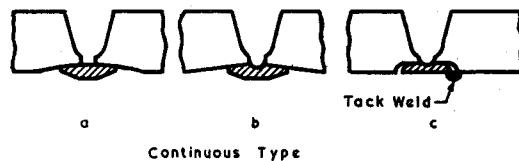


FIG 31 TYPICAL BACKING RINGS

**11.5 Backing Ring** — Backing in the form of a ring generally used in the welding of piping (see Fig 31).

**11.6 Backing Strip** — A piece of metal placed at a root and penetrated by weld metal. It may remain as part of the joint or may be removed by machining or other means (see 13.6 and Fig 32).

**11.7 Balanced Welding** — A welding procedure such that deformation due to shrinkage on cooling is controlled by proper disposal and sequence of welds.

**11.8 Block Sequence** — A combined longitudinal and build-up sequence for a continuous multiple-pass weld wherein separated lengths are completely or partially built up in cross-section before intervening lengths are deposited. (See back-step sequence and see Fig 33.)

**11.9 Bead** — A single run of weld metal deposited on a surface (see Fig 34).

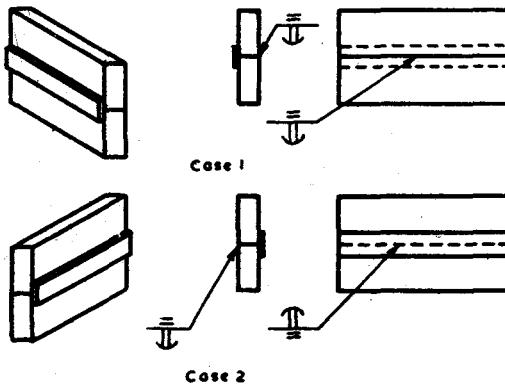


FIG 32 BACKING STRIP

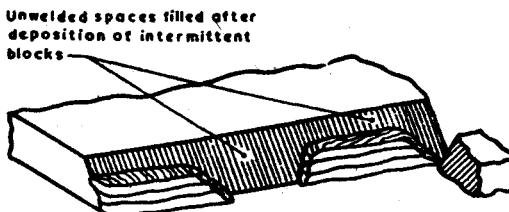


FIG 33 BLOCK SEQUENCE

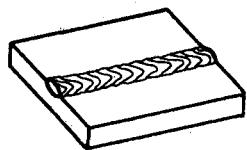


FIG 34 BEAD WELDS

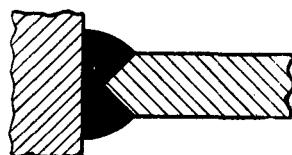
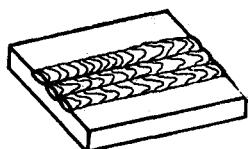


FIG 35 DOUBLE-BEVEL BUTT WELD

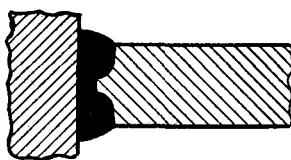


FIG 36 DOUBLE-J BUTT WELD

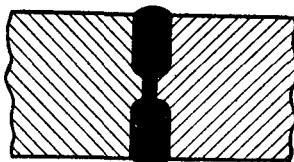


FIG 37 DOUBLE-U BUTT WELD

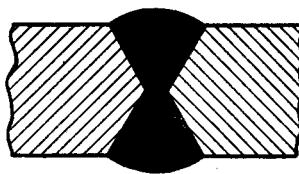


FIG 38 DOUBLE-V BUTT WELD

**11.10 Close Joint** — A preparation in which the components to be joined are substantially in contact before welding.

**11.11 Composite Joint** — A joint wherein welding is used in conjunction with a mechanical joining process.

**11.12 Concave Fillet Weld** — A fillet weld in which the weld face is concave.

**11.13 Continuous Weld** — Welding where the continuity is not broken by recurring unwelded spaces.

**11.14 Convex Fillet Weld** — A fillet weld in which the weld face is convex.

**11.15 Convexity** — The maximum distance from the face of a convex fillet weld perpendicular to a line joining the toes.

**11.16 Double-Bevel Butt Weld** — A butt weld in the preparation of which the edge of one component is double bevelled and the fusion face of the other component is at right angles to the surfaces of the first component (see Fig 35).

**11.17 Double-J Butt Weld** — A butt weld in the preparation of which the edge of one component is prepared so that in cross-section the fusion face is in the form of two opposing J's and the fusion face of the other component is at right angles to the surfaces of the first component (*see Fig 36*).

NOTE — All preparations covered by terms defined under **11.16**, **11.19**, **11.55** and **11.58** may or may not have root faces. Those covered by definitions under **11.17**, **11.18**, **11.56** and **11.57** always have root faces.

**11.18 Double-U Butt Weld** — A butt weld in the preparation of which the edges of both components are prepared so that in cross-section the fusion faces form two opposing U's having a common base (*see Fig 37*).

**11.19 Double-V Butt Weld** — A butt weld in the preparation of which the edges of both components are double bevelled so that in cross-section the fusion faces form two opposing V's (*see Fig 38*).

**11.20 Downhand Position (Flat Position)** — A position in which the weld slope does not exceed  $10^\circ$  and the weld rotation does not exceed  $10^\circ$  (*see Fig 39*).

**11.21 Edge Preparation** — Squaring, grooving or bevelling an edge in preparation for fusion welding (*see Fig 40*).

**11.22 Edge Weld** — A weld used for joining two or more components in which the edges joined are substantially in the same plane and in which the weld metal covers a part or all of the edges joined and lies substantially outside their plane (*see Fig 41*).

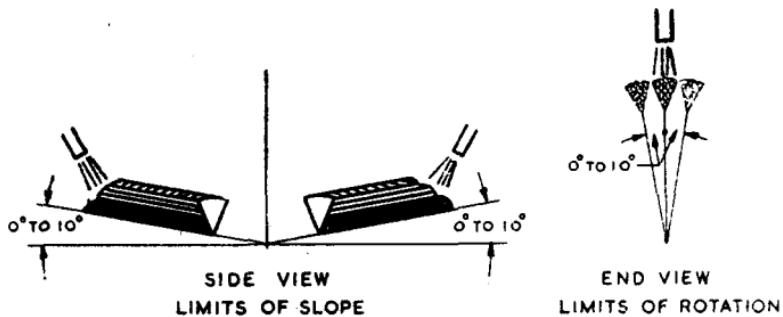


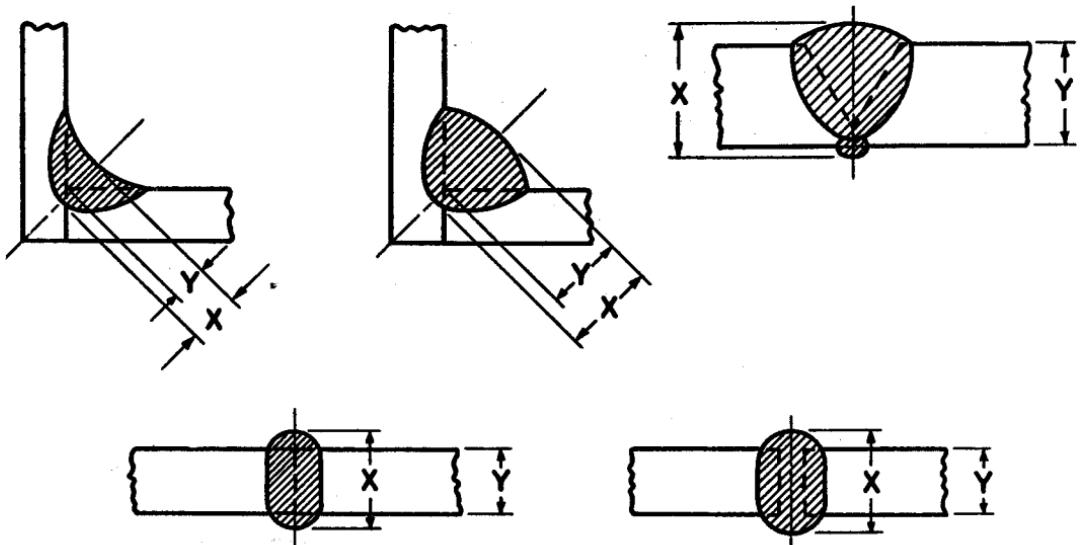
FIG 39 DOWNHAND (FLAT) POSITION



FIG 40 EXAMPLES OF EDGE PREPARATION



FIG 41 EDGE WELD



X = Throat Thickness

Y = The Effective Throat Thickness  
as usually adopted

FIG 42 EXAMPLES OF THROAT THICKNESS

**11.23 Effective Length of Weld** — The length of weld throughout which the correctly proportioned cross-section exists.

**11.24 Effective Throat Thickness** — A dimension arbitrarily adopted as throat thickness for purposes of design (see Fig 42).

**11.25 Full Fillet Weld** — A fillet weld whose size is equal to the thickness of the thinner member joined.

**11.26 Fillet Weld** — A weld of approximately triangular cross-section joining two surfaces approximately at right angles to each other in a lap joint, tee joint or corner joint (see Fig 43 and 44).

**11.27 Fusion Face** — The portion of a surface, or of an edge, which is to be fused in making a fusion weld (see Fig 45).

**11.28 Fusion Welding** — Any welding process in which the weld is made between metals in a state of fusion without hammering or pressure.

**11.29 Gap** — The minimum distance, intentional or otherwise, at any cross-section between edges, ends or surfaces to be joined (see Fig 46).

#### **11.30 Gas Envelope**

- In Atomic Hydrogen Welding* — An envelope of gas surrounding an arc fan.
- In Gas Welding* — An envelope of gas surrounding an inner cone.
- In Inert Gas or Other Types of Arc Welding* — An envelope of gas surrounding an arc.

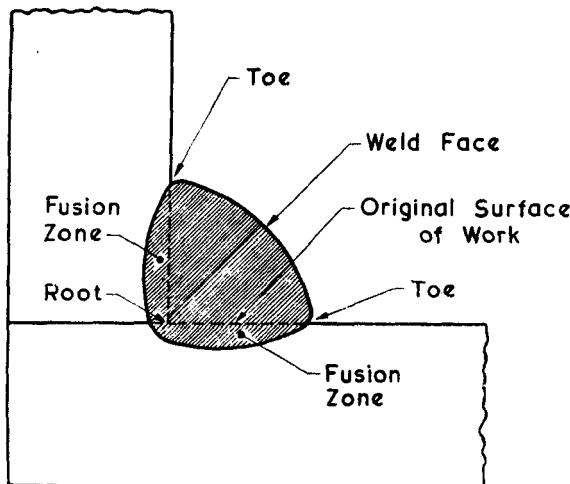


FIG 43 FILLET WELD

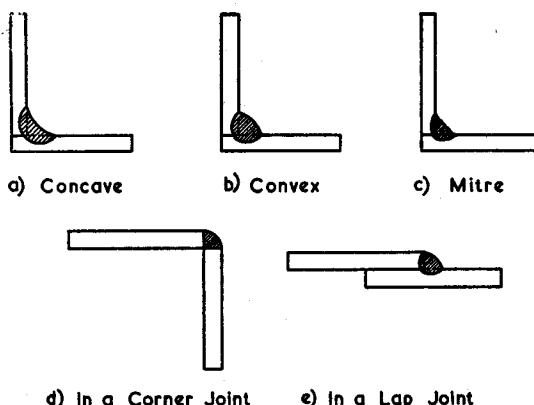


FIG 44 EXAMPLES OF FILLET WELDS

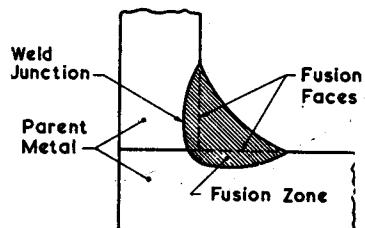


FIG 45 FUSION FACE

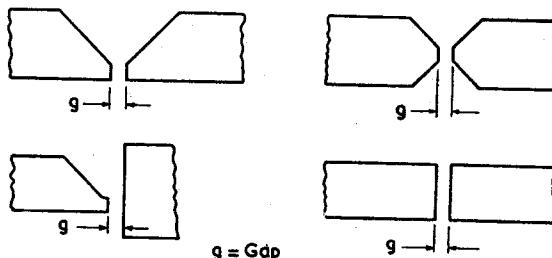


FIG 46 EXAMPLES OF GAP

**11.31 Horizontal-Vertical Position** — A position in which the weld slope does not exceed  $10^\circ$  and the weld rotation is greater than  $10^\circ$ , but does not exceed  $90^\circ$  (see Fig 47).

NOTE — The terms 'horizontal-vertical overhand weld' and 'horizontal-vertical underhand weld' are sometimes erroneously used to describe the welds shown respectively in Fig 47A and 47B. In the United States, the horizontal-vertical position is designated as the horizontal position.

**11.32 Inclined Position** — A position in which the weld slope exceeds  $10^\circ$  but not  $45^\circ$  and in which the weld rotation does not exceed  $90^\circ$  (see Fig 48).

**11.33 Included Angle** — The angle between the planes of the fusion faces of parts to be welded (see Fig 27).

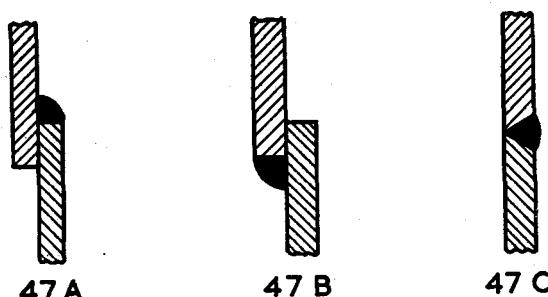


FIG 47 HORIZONTAL-VERTICAL POSITION

**NOTE** — The correct terms to be used for Fig 47A and Fig 47B are respectively 'horizontal-vertical fillet weld' and 'overhead fillet weld'. Figure 47C shows a 'horizontal-vertical butt weld'.

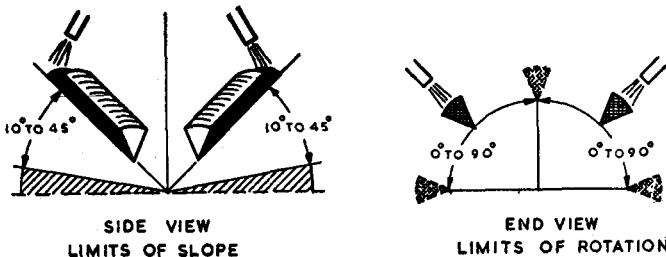


FIG 48 INCLINED POSITION

**11.34 Intermittent Weld** — Welding with a series of welds at specified intervals along a joint (*see Fig 49*).

**11.35 Leg** — A fusion face in a fillet weld (*see Fig 50*).

**11.36 Leg Length** — The distance from the root to the toe of a fillet weld, measured along the fusion face (*see Fig 50*).

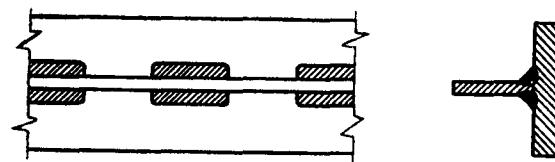
**11.37 Manual Welding** — Fusion welding in which the welding device is held and manipulated by hand.

**11.38 Mitre Fillet Weld (Flat Face Fillet Weld)** — A fillet weld in which the weld face is approximately flat.

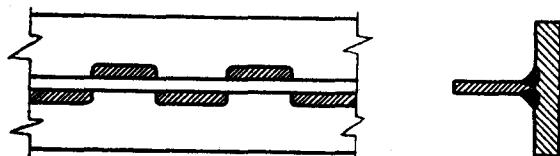
**11.39 Molten Pool** — The pool of liquid metal caused by the arc or flame.

**11.40 Open Joint** — A preparation in which the components to be joined are separated by a specified gap before welding.

**11.41 Overhead Position** — A position in which the weld slope does not exceed 45° and the weld rotation is greater than 90° (*see Fig 51*).



Chain Intermittent Fillet Welding



Staggered Intermittent Fillet Welding

FIG 49 INTERMITTENT WELD

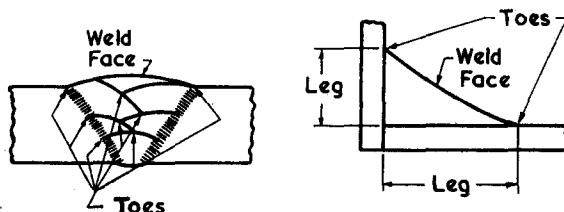
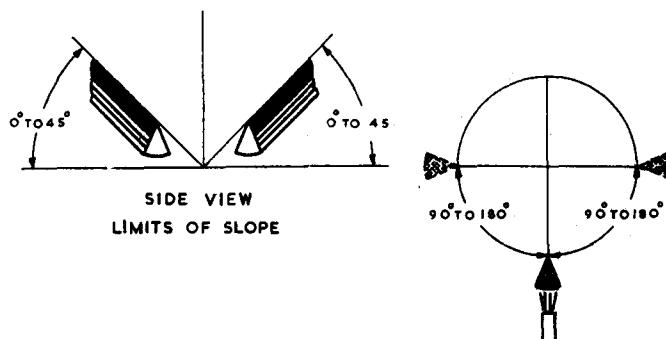


FIG 50 EXAMPLES OF WELD FACES, TOES AND LEGS



END VIEW  
LIMITS OF ROTATION

FIG 51 OVERHEAD POSITION

**11.42 Penetration Bead** — Metal protruding through the root of a fusion butt weld (see Fig 52).

**11.43 Plug Weld** — A weld made by filling a hole in one component of a workpiece with filler metal so as to join it to the surface of a continuous component exposed through the hole (see Fig 53).

**11.44 Reinforcement** — Weld metal lying outside the plane joining the toes (see Fig 54).

#### 11.45 Root of Preparation

- In the Preparation of V-, U-, J- and Bevel-Butt Welds* — The zone in the neighbourhood of, and including, the gap.
- In an Open Square Butt Weld* — The zone between the prepared edges adjacent to a backing strip.
- In Parts Assembled for Fillet Welding* — The zone in the neighbourhood of the actual or projected intersection of the fusion faces (see Fig 55).

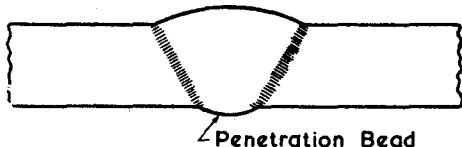


FIG 52 PENETRATION BEAD

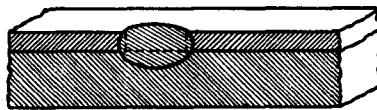


FIG 53 PLUG WELD

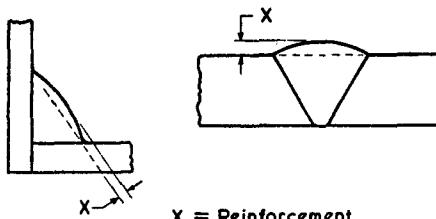


FIG 54 EXAMPLES OF REINFORCEMENT

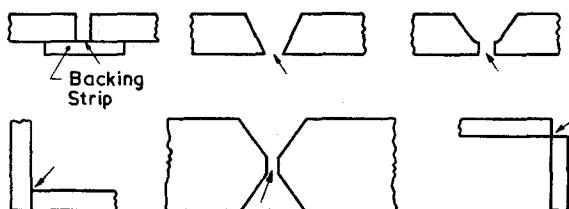


FIG 55 ROOTS OF TYPICAL WELD PREPARATIONS  
( Arrow-head indicates the root of preparation )

**11.46 Root of Weld** — The points, as shown in cross-section, at which the bottom of the weld intersects the base metal surfaces (*see Fig 56*).

**11.47 Root Face (Nose)** — The unbevelled or ungrooved portion of a fusion face at the root (*see Fig 57*).

**11.48 Root Radius** — The radius of the curved portion of the fusion face in a component prepared for a single-J, single-U, double-J or double-U weld (*see Fig 28*).

**11.49 Run (Pass)** — The metal deposited during one passage of the electrode or blowpipe in the making of a joint.

**11.50 Run-Off Plate(s)** — A piece, or pieces, of metal so placed as to enable the full section of weld metal to be maintained up to the end of a joint.

**11.51 Run-On Plate(s)** — A piece, or pieces, of metal so placed as to enable the full section of weld metal to be obtained at the beginning of a joint.

**11.52 Seal Weld (Sealing Weld)** — A weld used to assist in obtaining a liquid-tight or gas-tight joint (*see 11.53 and Fig 58*).

**11.53 Sealing Run (Backing Run)** — The final run deposited on the root side of a fusion weld (*see 11.52*).

**11.54 Semi-Automatic Welding** — Arc welding with equipment which controls only the filler metal feed. The advance of the welding is usually manually controlled.

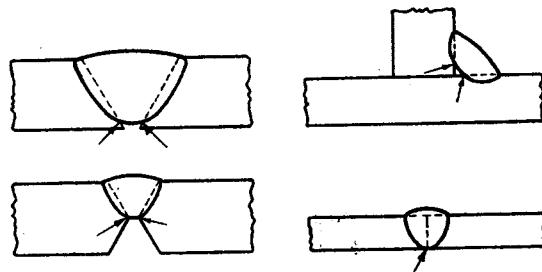


FIG 56 ROOTS OF WELD  
( Arrow-head indicates the root of weld )



FIG 57 ROOT FACES  
( Arrow-head indicates the root face )



FIG 58 SEAL WELD

**11.55 Single-Bevel Butt Weld** — A butt weld in the preparation of which the edge of one component is bevelled and the fusion face of the other component is at right angles to the surfaces of the first component (see Fig 59).

**11.56 Single-J Butt Weld** — A butt weld in the preparation of which the edge of one component is prepared so that in cross-section the fusion face is in the form of a 'J' and the fusion face of the other component is at right angles to the surfaces of the first component (see Fig 60).

**11.57 Single-U Butt Weld** — A butt weld in the preparation of which the edges of both components are prepared so that in cross-section the fusion faces form a 'U' (see Fig 61).

**11.58 Single-V Butt Weld** — A butt weld in the preparation of which the edges of both parts are bevelled so that in cross-section the fusion faces form a 'V' (see Fig 62).

**11.59 Size of a Butt Weld** — The effective throat thickness of a butt weld (see Fig 63).

**11.60 Size of a Fillet Weld** — The minimum leg length of a convex or mitre fillet weld or 1.414 times the effective throat thickness of a concave fillet weld (see Fig 64).

**11.61 Skip Sequence (Wandering Sequence)** — A longitudinal sequence where continuous weld is obtained by depositing weld increments at planned intervals.

**11.62 Slot Weld** — A method of joining two contiguous components by depositing a fillet weld round the periphery of a hole in one component so as to join it to the surface of the other component exposed through the hole (see Fig 65).

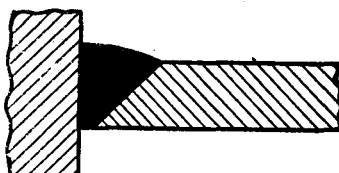


FIG 59 SINGLE-BEVEL BUTT WELD

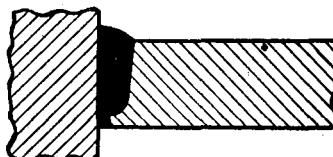


FIG 60 SINGLE-J BUTT WELD



FIG 61 SINGLE-U BUTT WELD



FIG 62 SINGLE-V BUTT WELD

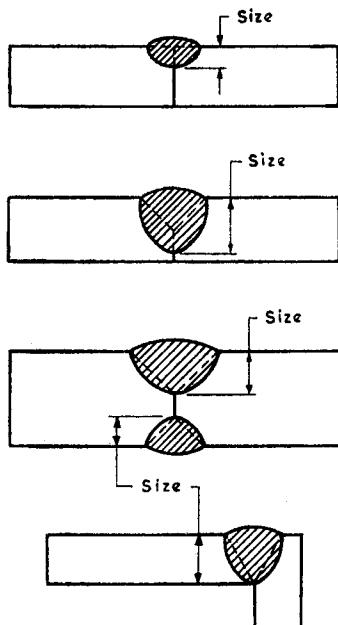


FIG 63 SIZE OF BUTT WELD

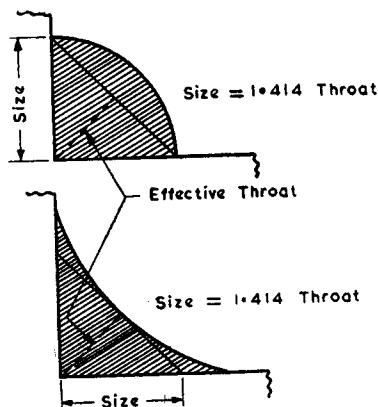


FIG 64 SIZE OF FILLET WELD

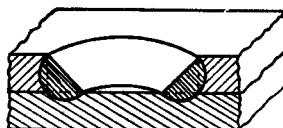


FIG 65 SLOT WELD

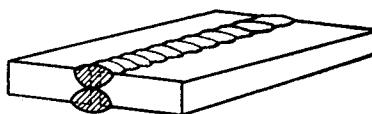
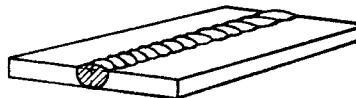


FIG 66 SQUARE BUTT WELD

**11.63 Square Butt Weld** — A butt weld in the preparation of which the fusion faces lie approximately at right angles to the surfaces of the components to be joined and are substantially parallel to one another (see Fig 66)

**11.64 Tack Weld** — A relatively small weld made to hold parts together to assist assembly or to maintain alignment of edges during welding.

**11.65 Throat Thickness** — The minimum thickness of weld metal in a fusion weld measured as under (see Fig 42):

- For a Fillet Weld or a V-, U-, J- or a Bevel-Butt Weld — Along a line passing through the root.
- For a Close Square-Butt Weld — In the plane of the abutting faces.
- For an Open Square-Butt Weld — At the centre of the original gap in a plane parallel to the fusion faces.

**11.66 Toe of Weld (Weld Edge)** — The junction between the face of a weld and the parent metal.

**11.67 Vertical Position** — Any position in which the weld slope exceeds  $45^\circ$  and the weld rotation is greater than  $90^\circ$  (see Fig 67).

**11.68 Weaving** — Transverse oscillation of the arc end of an electrode or of a blowpipe nozzle during the deposition of weld metal (see Fig 68).

**11.69 Weld Face** — A surface of a fusion weld exposed on the side from which the weld has been made (see Fig 50).

**11.70 Weld Junction** — The boundary between the fusion zone and the heat-affected zone (see Fig 4).

**11.71 Weld Rotation** — The angle between the upper portion of the vertical reference plane passing through the line of a weld root, and a line drawn through the same root intersecting the weld surface at a point equidistant from either toe of the weld (see Fig 69-71).

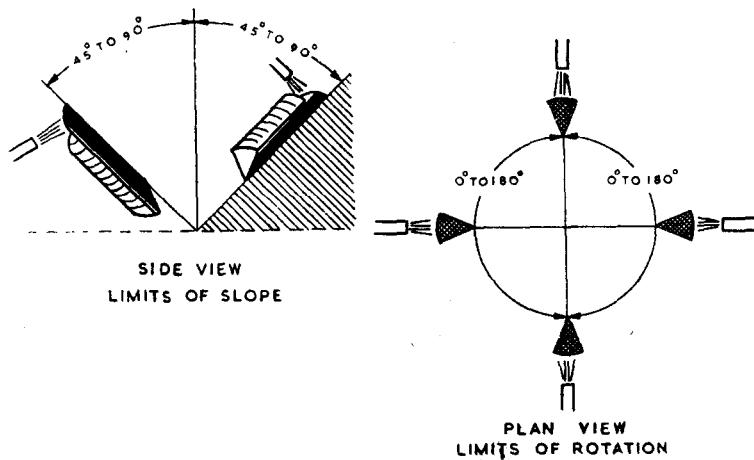


FIG 67 VERTICAL POSITION

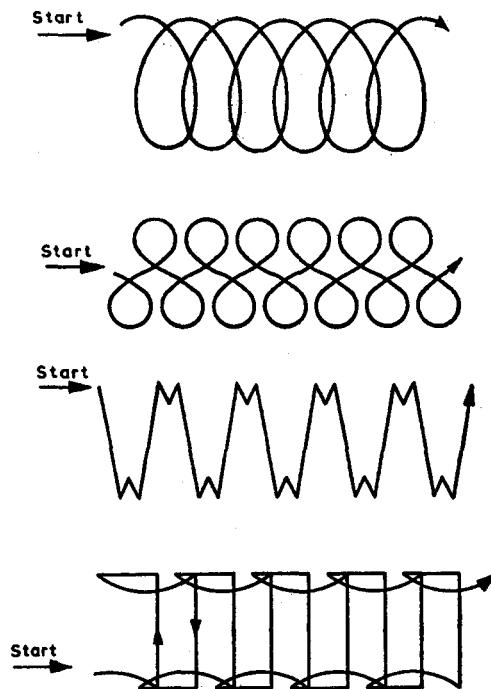


FIG 68 WEAVE MOTIONS

**11.72 Weld Slope** — The angle between the line of the root of a weld and the horizontal (see Fig 69-71).

## 12. TERMS RELATING TO ARC WELDING

**12.1 Arc Fan** — The characteristic fan-shaped flame produced in the neighbourhood of the atomic hydrogen arc.

**12.2 Arc Voltage** — The voltage across the welding arc.

**12.3 Arc Welding** — Fusion welding in which heat for welding is obtained from an electric arc or arcs.

**12.4 Arcing Time Factor** — The ratio of arcing time to the total time the supply is available for the arc.

**12.5 Atomic-Hydrogen Welding** — Arc welding in which hydrogen, passing through an arc between two non-consumable electrodes, is

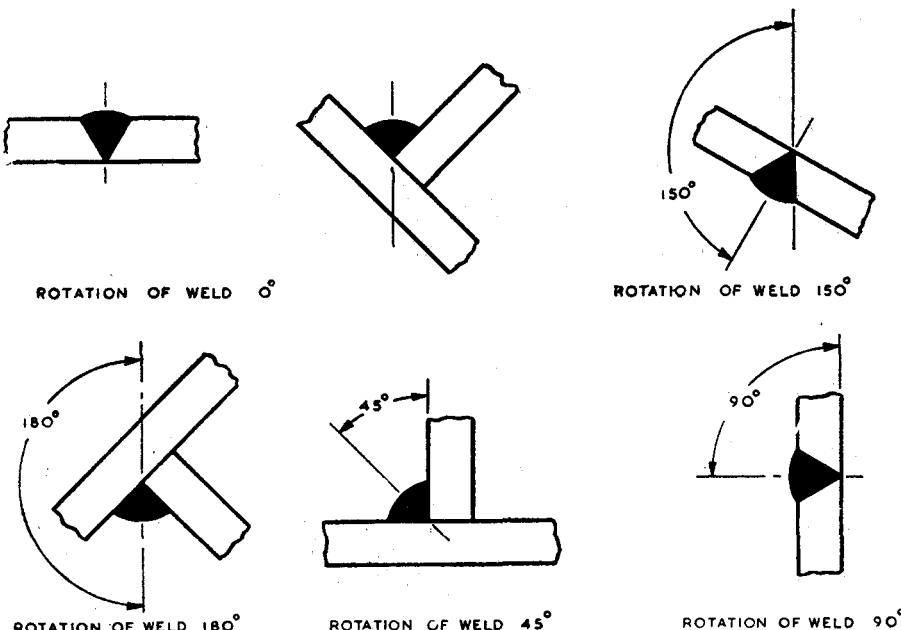


FIG 69 DIAGRAMS TO ILLUSTRATE WELD ROTATION

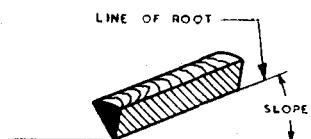


FIG 70 DIAGRAM TO ILLUSTRATE WELD SLOPE

atomized and then recombined thereby to supply the heat for welding. Shielding is obtained from hydrogen. Pressure may or may not be applied and filler metal may or may not be used.

**12.6 Bare Metal-Arc Welding** — An arc welding process wherein weld is produced with an electric arc between a bare or lightly-coated metal electrode and the work and no shielding is used. Pressure is not used and filler metal is obtained from the electrode.

**12.7 Burden** — The layer of melt and fused metal above the welding zone in submerged-arc welding.

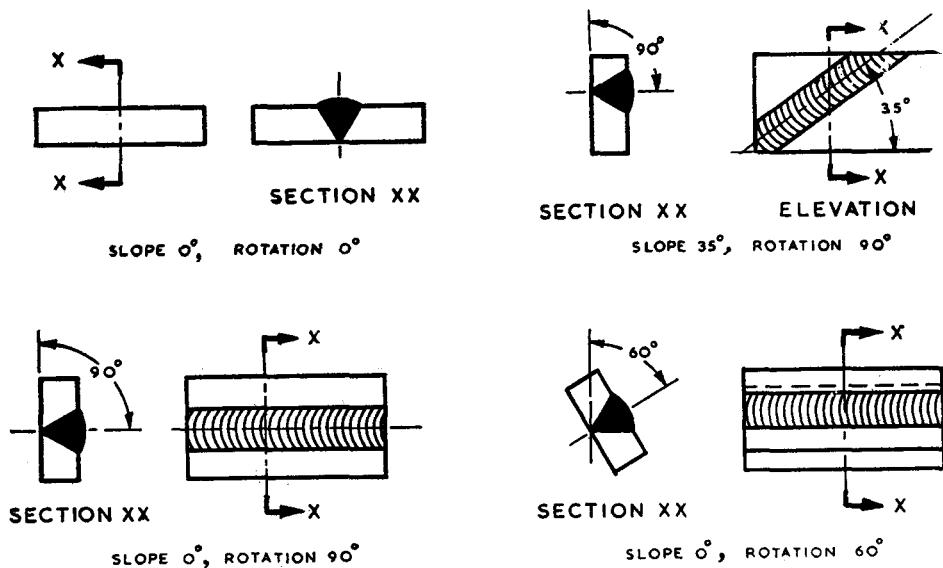


FIG 71 EXAMPLES OF 'SLOPE' AND 'ROTATION'

**12.8 Carbon-Arc Welding** — Arc welding with a carbon electrode or electrodes. Filler metal may be used.

**12.9 Continuous Test Current** — The maximum current that an arc-welding set can supply continuously at the rated welding load voltage without exceeding a specified temperature-rise.

**12.10 Controlled-Arc Welding** — Metal-arc welding in which the rate of feed of the electrode is controlled by the arc voltage.

**12.11 Controlled Tungsten-Arc Welding** — Inert-gas tungsten-arc welding in which the arc length is controlled by the arc voltage.

**12.12 Electrode Negative** — Direct-current arc welding in which the electrode is connected to the negative pole of the supply (see Fig 72).

NOTE — This has sometimes been known in British practice as 'reversed polarity' and in American practice as 'straight polarity'. Both these terms are deprecated.

**12.13 Electrode Positive** — Direct-current arc welding in which the electrode is connected to the positive pole of the supply (see Fig 73).

NOTE — This has sometimes been known in British practice as 'straight polarity' and in American practice as 'reversed polarity'. Both these terms are deprecated.

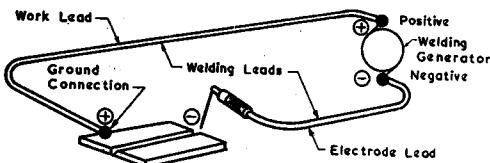


FIG 72 ELECTRODE NEGATIVE

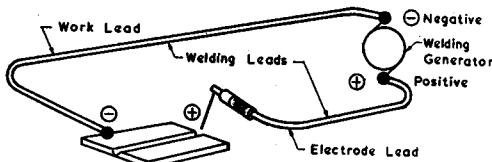


FIG 73 ELECTRODE POSITIVE

**12.14 Firecracker Welding** — Shielded-arc welding in which an electrode is laid on the parent metal. An arc is started between one end of the electrode and the work and travels along the work as the electrode melts. The electrode is shielded or is enveloped in a suitable flux.

**12.15 Fused Melt** — Glass-like material formed from melt during submerged-arc welding.

**12.16 Inert-Gas Arc Welding** — Shielded-arc welding in which the shielding medium is an inert gas, as in argon-arc welding and helium-arc welding.

**12.17 Inert-Gas Metal-Arc Welding** — Inert-gas arc welding using a consumable electrode.

**12.18 Inert-Gas Tungsten-Arc Welding** — Inert-gas arc welding with a non-consumable electrode of tungsten.

**12.19 Maximum Welding Current** — The maximum current permitted by the current regulator to be drawn from a single welding point at a specified welding load voltage.

**12.20 Metal-Arc Welding** — Arc welding with a metal electrode or electrodes the melting of which provides the filler metal.

**12.21 Metal-Run-Out** — Molten metal inadvertently lost from a weld by gravitational flow through a joint.

**NOTE** — The term is used mainly in submerged-arc welding, where the effect arises from incorrect edge preparation.

**12.22 Nominal Hand-Welding Current** — The maximum permissible current to be drawn from a single welding point when working continuously with an arcing time factor of 0.75.

**12.23 Open-Circuit Voltage** — The voltage between the output terminals of a welding set ready to weld, but carrying no current.

**12.24 Self-Adjusting Arc Welding** — Metal-arc welding in which an electrode is fed at a constant speed while the arc length is maintained substantially constant by the inherent electrical characteristics of the welding current circuit.

**12.25 Shielded-Arc Welding** — Arc welding in which the arc and the weld metal are protected from the atmosphere by a shielding medium.

**12.26 Striking Voltage** — The minimum voltage at which an arc may be struck.

**12.27 Submerged-Arc Welding** — Arc welding in which a bare wire electrode is used; the arc is enveloped in a powdered flux, some of which fuses to form a removable covering of slag on the weld.

**12.28 Test Load Factor** — A function of the arcing time factor used to obtain the continuous test current.

**12.29 Time of Recovery** — The time required, after a disturbance has taken place in a circuit, for either the current or the voltage, or both, to recover to a specified percentage of their values before the disturbance.

**12.30 Welding Load Voltage** — The voltage between the output terminals of an arc-welding set (i.e. those to which the electrode and return leads are connected) when a specified current is flowing.

### 13. TERMS RELATING TO EQUIPMENT

**13.1 Air-Acetylene Blowpipe ( Bunsen Type )** — A blowpipe incorporating an injector to produce a flame suitable for lead-burning or soldering.

**13.2 Air-Acetylene Blowpipe ( High Temperature Type )** — A blowpipe incorporating an injector with a hooded head to produce a flame suitable for brazing.

**13.3 Arc-Welding Electrode ( Electrode )** — A rod of metal (which may be used as filler metal), or a rod of carbon, between one end of which and either the work or another electrode, the arc is formed.

**13.4 Arc-Welding Set ( Arc-Welding Plant )** — Apparatus for providing and controlling electrical energy for a single welding arc (single-operator welding set) or for two or more welding arcs (multi-operator welding set).

**13.5 Atomic-Hydrogen Torch** — An electrode holder carrying the electrodes and incorporating a means of supplying hydrogen to the arc in atomic-hydrogen welding.

**13.6 Backing Bar** — Backing piece of metal or other material used to assist in making a weld but not intended to become part of the weld ( see also 11.6 ).

**13.7 Bare Electrode** — A filler-metal electrode, used in arc welding, consisting of a metal wire with no coating other than that incidental to the drawing of the wire.

**13.8 Cast-Iron Thermit** — Welding thermit with the addition of ferro-silicon for the thermit fusion welding of cast-iron.

**13.9 Constant-Voltage Welding Generator** — A direct-current welding generator forming part of an arc-welding set and having a terminal voltage which remains substantially constant from full load to no load.

**13.10 Consumable Electrode** — An arc-welding electrode which provides filler metal.

**13.11 Cored Electrode** — A metal electrode with a core of flux and/or other materials to modify the properties of the weld metal and to facilitate welding.

NOTE — The term 'flux' in this context is used in its ordinary engineering sense. The core is sometimes loosely described as flux, whether or not other materials are present.

**13.12 Covered Electrode** — A filler-metal electrode, used in arc welding, consisting of a metal core wire with a relatively thick covering to modify the properties of the weld metal and to facilitate welding.

**13.13 Covered Filler Rod (Coated Filler Rod)** — A filler rod with a covering of flux and/or other material to modify the properties of the filler metal.

NOTE — The term 'flux' in this context is used in its ordinary engineering sense. The covering is sometimes loosely described as flux, whether or not other materials are present.

**13.14 Drooping-Characteristic Welding Generator** — A direct-current welding generator forming part of an arc-welding set and having a terminal voltage which drops automatically from the open-circuit voltage to the arc voltage when an arc is struck.

**13.15 Dual-Gas Economizer** — An auxiliary device for temporarily cutting off the supply of gas and oxygen, except for that to a pilot jet.

NOTE — It is actuated by depressing a lever, which generally takes the form of a hook upon which the blowpipe is hung; it obviates resetting the flame after interruptions of welding.

**13.16 Fillet Weld Extension**—A device for attachment to the welding head of a submerged-arc welding machine to enable fillet welds to be made.

**13.17 Fillet Weld Guide**—A fillet weld extension fitted with a guide wheel.

**13.18 Fitted Hose**—A length of hose each end of which is fitted with a hose coupling nipple and a hose coupling nut.

**13.19 HF Unit (HF Ionizer)**—A high frequency electrical oscillator used to enable an arc to be struck without contact between the electrode and the workpiece.

**13.20 Hooded Head**—A tubular device with an injector fitted into one end and series of apertures in the base of the tube wall through which a stream of air is induced.

**13.21 Hose Coupler**—A metal component, consisting of a hexagonal centre portion with threaded ends, for connecting two lengths of fitted hose.

**13.22 Hose Coupling Nipple**—A metal component, one end of which is secured in the tail piece by the hose coupling nut and the other end inserted into the hose.

**13.23 Hose Coupling Nut**—A nut, provided with a shoulder on one face, used for securing the hose coupling nipple in position in the threaded hose connection.

**13.24 Hydrogen Valve**—An electrically operated on-off valve used in atomic-hydrogen welding to allow hydrogen to flow only when an arc is struck.

**13.25 Inert-Gas Shield**—A tube, usually of refractory material, which forms the nozzle of an inert-gas shielded-arc torch and confines the gas to the immediate neighbourhood of the arc.

**13.26 Inert-Gas Shielded-Arc Torch**—A combined electrode holder and gas tube so arranged as to enable an electric arc to be formed in an inert-gas envelope.

**13.27 Lightly Coated Electrode**—A filler-metal electrode, used in arc welding, consisting of a metal wire with a light coating applied subsequent to the drawing operation, primarily for stabilizing the arc.

**13.28 Melt**—The powdered flux used in submerged-arc welding.

**13.29 Melt Distributing Assembly**—A system of channels and guides, attached to the welding head of a submerged-arc welding machine, for conveying the melt and securing an even and sufficient burden.

**13.30 Melt Hopper** — A hopper, attached to a submerged-arc welding machine, for storing the melt and feeding it to the melt distributing assembly.

**13.31 Non-Consumable Electrode** — An arc welding electrode which does not provide filler metal.

**13.32 Pre-Heating Gate** — An opening in a mould to facilitate pre-heating of parts to be joined by thermit fusion welding (*see Fig 26*).

**13.33 Plugging Material** — Refractory material placed on top of the tapping pin to prevent its melting.

**13.34 Sheathed Electrode** — A covered electrode with an external sheath, usually of metal.

**13.35 Spacer Strip** — A metal strip or bar inserted in the root of a joint prepared for a groove weld to serve as a backing and to maintain root opening during welding (*see Fig 74*).

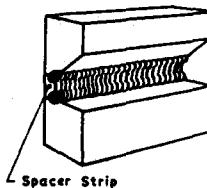


FIG 74 SPACER STRIP

**13.36 Stone** — A ring of refractory material, usually pressed magnesite, built into the bottom of a thermit crucible for the reception of a thimble.

**13.37 Tapping Pin** — A metal plug closing the hole in a thimble (*see Fig 26*).

**13.38 Thimble** — A renewable ring of refractory material (usually magnesite) inserted in a stone, through the centre of which the molten metal passes (*see Fig 26*).

**13.39 Threaded Hose Connection** — The threaded component (inlet or outlet) on a welding or cutting appliance into which the bull-nose end of the hose coupling nipple is inserted.

**13.40 Wax Pattern** — Wax introduced between parts to be joined by means of thermit fusion welding. It forms the foundation for the mould and is removed by the pre-heating operation.

**13.41 Welding Blowpipe** — A device used in gas welding for controlling the admixture of gases so as to produce a flame suitable for welding.

**13.42 Welding Head** — A device used for automatic arc welding and comprising an electrode feed mechanism and means for conveying current to the electrode(s). It may include electrode straightening gear and the head may be stationary and the work in motion or *vice versa*.

**13.43 Welding Regulator** — A valve, for attachment to a gas cylinder or pipeline, to reduce the pressure to the working-pressure of the blowpipe.

NOTE — After adjustment by the operator, the valve maintains the working-pressure automatically.

## 14. TERMS RELATING TO GAS WELDING

**14.1 All-Position Rightward Welding** — A variation of rightward welding in which the flame is approximately normal to the molten pool (*see Fig 75*).



FIG 75 ALL-POSITION RIGHTWARD WELDING

**14.2 Backfire** — The momentary recession of the flame into the blowpipe followed by immediate re-appearance or complete extinguishment of the flame, usually accompanied by an explosive sound.

**14.3 Carburizing Flame** — A reducing flame in which gas or gases burnt are carbonaceous.

NOTE — In an oxy-acetylene carburizing flame the inner cone is not sharply defined and is surrounded by a quantity of unburned gas known as a 'feather'.

**14.4 Flame Snap-Out** — Harmless unintentional extinction of a gas welding flame, sometimes accompanied by a minor explosion.

**14.5 Flashback** — Dangerous retrogression of a gas welding flame beyond the blowpipe body into the hose, with subsequent explosion.

NOTE — The violence of the explosion depends upon where it occurs.

**14.6 Full-Fusion Welding** — A name given to gas (fusion) welding to distinguish it from surface-fusion (semi-fusion) welding and non-fusion welding.

**14.7 Gas Welding** — A group of welding processes wherein weld is produced by heating with a gas flame or flames, with or without the application of pressure and with or without the use of filler metal.

**14.8 Inner Cone** — The inner part of a gas welding flame adjacent to the blowpipe nozzle (*see Fig 76*).

**14.9 Leftward Welding (Forward Welding)** — Welding in which the flame is directed towards the unwelded part of the joint (*see Fig 77*).

**14.10 Neutral Flame** — A gas flame wherein the portion used is neither oxidizing nor reducing (*see Fig 78*).

NOTE — In an oxy-acetylene neutral flame the quantities of gas and admixed oxygen are generally approximately equal and the inner cone is sharply defined, except for a haze or mistiness at its extremity.

**14.11 Non-Fusion Welding** — A term applied to the deposition, by the oxy-acetylene process, of filler metal on parent metal without fusion of the latter.

**14.12 Oxidizing Flame** — A gas flame wherein the portion used has an oxidizing effect due to the existence of excess of oxygen over fuel gas (*see Fig 79*).

**14.13 Pick-Up** — That property of a flux which causes some of it to adhere to the heated end of a filler rod, i.e. the property which gives rise

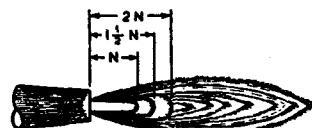


FIG 76 COMPOSITION DIAGRAM SHOWING INNER CONES OF VARIOUS FLAMES

NOTE — N = Neutral Flame,  $1\frac{1}{2}$  N and 2 N are reducing flames for non-fusion welding and for the welding of some non-ferrous metals (*see 14.11*).

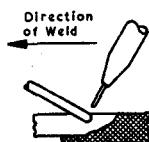


FIG 77 LEFTWARD WELDING

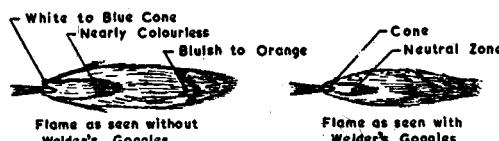


FIG 78 NEUTRAL FLAME

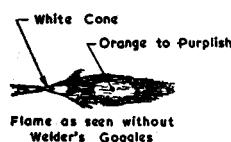


FIG 79 OXIDIZING FLAME

to the 'tuft' which is applied to the molten pool. (For definition of the term applicable to resistance welding, see 8.27.)

**14.14 Reducing Flame** — A gas flame wherein the portion used has reducing effect due to the existence of excess of fuel gas over oxygen (see Fig 80).

**14.15 Rightward Welding ( Backward Welding )** — Welding in which the flame is directed towards the welded part of the joint (see Fig 81).

NOTE — The use of the term 'backhand welding' in this connection is deprecated.

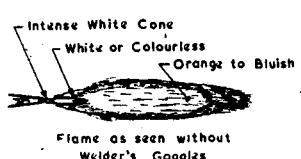


FIG 80 REDUCING FLAME

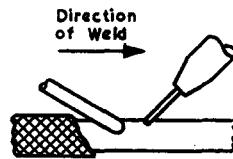
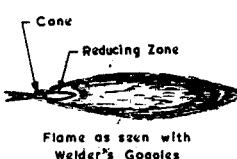


FIG 81 RIGHTWARD WELDING

**14.16 Surface-Fusion Welding ( Semi-Fusion Welding )** — Gas welding in which a carburizing flame is used to melt the surface of the parent metal, which then unites with molten metal from a suitable filler rod.

NOTE — This application is used for Linde welding, hard surfacing, building-up and the like.

**14.17 Sustained Backfire** — Possibly harmful retrogression of a gas welding flame into the blowpipe neck or body, the flame remaining alight.

NOTE — It is usually accompanied by popping or squealing and sometimes there is a small pointed flame at the nozzle.

## 15. TERMS RELATING TO THERMIT FUSION WELDING

**15.1 Collar** — Weld metal projecting around the periphery of weld made by thermit fusion welding (see Fig 26).

NOTE — It has the effect of supplying sufficient metal for feeding the main section on cooling and also of ensuring fusion at the extreme edges of the parts being joined.

**15.2 Thermit Fusion Welding** — A fusion welding process in which welding heat is obtained from welding thermit and the molten metal acts as added metal. The parent metal is pre-heated.

## PART IV BRAZING AND BRONZE WELDING

### 16. GENERAL TERM

**16.1 Stopping-Off Agent** — Lamp-black, graphite, or similar material placed on a workpiece around the joint to prevent molten filler metal from adhering to adjacent surfaces.

### 17. TERMS RELATING TO BRAZING

**17.1 Brazing** — A process of joining metals in which molten filler metal is drawn by capillary attraction into the space between closely adjacent surfaces of the parts to be joined. In general, the melting point of the filler metal is above 500°C.

**17.2 Brazing Alloy** — Filler metal used in brazing.

**17.3 Dip Brazing** — A process in which a workpiece is partially or totally immersed in a bath of molten filler metal which is covered by a layer of molten flux.

**17.4 Flame Brazing ( Torch Brazing )** — A process in which heat for brazing is obtained from a gas flame from a manually operated blowpipe or torch.

**17.5 Furnace Brazing** — A process in which brazing heat is obtained by putting a complete workpiece into a furnace which may contain a protective atmosphere.

**17.6 Induction Brazing** — A process in which brazing heat is obtained by inducing high-frequency electric current within the material in the neighbourhood of the joint. A protective atmosphere may be used.

**17.7 Resistance Brazing** — A process in which brazing heat is obtained by

- a) the passage of an electric current between the parts to be joined, as in resistance welding, or
- b) the passage of an electric current through two carbon electrodes and the parts to be joined. The greater part of the brazing heat is generated in the electrodes and conducted to the joint.

**17.8 Salt Bath Brazing** — A process in which brazing heat is obtained by immersing a complete workpiece in a bath of molten salt of suitable melting point. The salt used should act as a flux.

**17.9 Spelter** — A brazing alloy consisting nominally of 50 percent copper and 50 percent zinc.

**NOTE** — The term ' spelter ' is not used here in the ordinary metallurgical sense.

## 18. TERMS RELATING TO BRONZE WELDING

**18.1 Bell Butt Joint** — A joint between two pipes of the same diameter, in which one pipe end is swaged out to receive the end of the other pipe (*see Fig 82*).

**18.2 Branch Tee Saddle Joint** — A joint between a branch pipe set at 90° to a main pipe, the end of the branch pipe being shaped to fit snugly against the main pipe (*see Fig 83*).

**18.3 Bronze Filler Metal** — A filler metal used for bronze welding, consisting basically of copper and zinc. It may also contain nickel, manganese, and/or other metals.

NOTE — The term 'bronze' is not used here in the ordinary metallurgical sense.

**18.4 Bronze Welding** — A method of joining metals by means of the deposition of molten copper-rich filler metal on the parts to be joined, without necessarily fusing them. In general, the melting point of the filler metal is above 850°C.

NOTE — The meaning now attached to the term is quite arbitrary, since bronze is not used and the process is not necessarily welding. Bronze welding, unlike brazing (*qv*), does not depend upon capillary attraction.

**18.5 Diminishing Bell Butt Joint** — A joint between two pipes of different diameters, in which the end of the smaller pipe is swaged out to fit the bore of the larger pipe (*see Fig 84*).

**18.6 Short Bell Branch Joint** — A branch joint in which the metal round a hole in a main pipe is swaged out to receive the end of a branch pipe (*see Fig 85*).

**18.7 Weldable Fitting** — A specially shaped component of suitable copper alloy, fitted to copper or copper-alloy pipe to facilitate joining them by bronze welding.

## PART V TESTING

### 19. TERMS RELATING TO TESTING

**19.1 All-Weld Test Piece** — A block of metal consisting of one bead or of a number of beads fused together. It may, or may not, include portions of parent metal.

**19.2 All-Weld Test Specimen** — An all-weld test piece after preparation for testing.

NOTE — Some test specimens may have portions of parent metal at their ends to facilitate gripping during testing, but all parent metal is removed from the portion under test.

**19.3 Cruciform Test Piece** — A flat plate to which two other flat plates or bars are welded at right angles. It may be of Type A or Type B as shown in Fig 86.

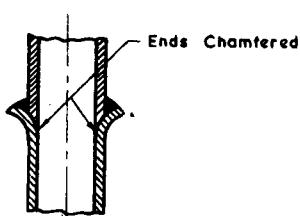


FIG 82 BELL BUTT JOINT

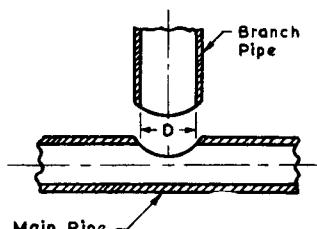


FIG 83 BRANCH TEE SADDLE JOINT

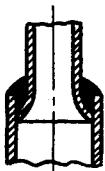


FIG 84 DIMINISHING BELL BUTT JOINT

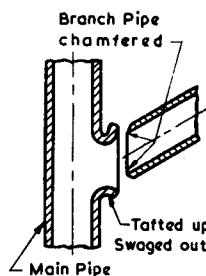
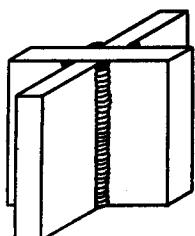
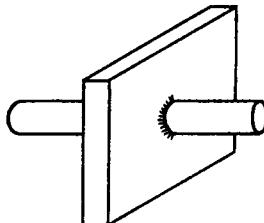


FIG 85 SHORT BELL BRANCH JOINT



86 (A) Test Piece-Type A



86 (B) Test Piece-Type B

FIG 86 CRUCIFORM TEST PIECES

**19.4 Cruciform Test Specimen** — A portion cut from a cruciform test piece of Type A (see Fig 86) and prepared for testing as shown in Fig 87 or the whole of a test piece of Type B (see Fig 86).

**19.5 Flattening Test (In Bronze Welding)** — A test in which a bronze welded pipe joint (see 18.1, 18.2, 18.5 and 18.6) is flattened until the internal walls are substantially in contact.

**19.6 Free Bend Test** — A bend test made by pre-setting the ends of a specimen to promote bending, and by concluding the test without using a former.

**19.7 Guided Bend Test** — A bend test made by bending the specimen round a former.

**19.8 Hot Cracking Test** — A test designed to indicate the cracking propensities of metal while it is solidifying after it has been deposited from an electrode.

**19.9 Normal Bend Test ( Face Bend Test )** — A bend test in which a specified side of the weld specimen is adjacent to the bending former, namely:

- a) the side containing the root or to which the root is nearer, or
- b) the side other than that containing the last-made run when the root is central, or
- c) the inner side of a pipe or tube in welds made with pressure.

**19.10 Notch-Break Specimen ( Nick-Break Specimen )** — A test specimen in which small notches are cut to promote fracture in a pre-determined position for inspection of the interior of the weld.

**19.11 Reverse Bend Test** — A bend test in which the side other than that specified for a normal bend test is adjacent to the bending former.

**19.12 Shear-Test Piece** — A test piece incorporating an agreed number ( usually not more than three ) of spot or projection welds ( see Fig 88 ).

**19.13 Shear-Test Specimen** — A shear-test piece prepared for testing in a tensile testing machine by drilling out or otherwise rendering ineffective those welds not to be tested.

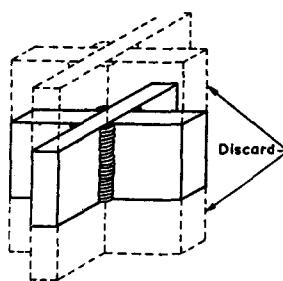


FIG 87 METHOD OF OBTAINING CRUCIFORM TEST SPECIMEN

**NOTE** — The test is a tensile test of the fillet welds in which the free ends of the parts welded on are gripped in tensile testing machine.

**19.14 Slug Test** — A test of a spot weld or of a projection weld in which the plates containing the weld are forced apart by bending one plate until the two separate.

**NOTE** — In a good weld, the weld metal adheres to one of the plates and is called a slug.

**19.15 Test Piece** — Components welded together in accordance with a specified welding procedure, or a portion detached from a welded structure, for test.

**19.16 Test Specimen** — A portion detached from a test piece and prepared as required for testing.

**19.17 Tongue-Bend Test Specimen** — A portion so cut in two straight lengths of pipe butt-welded together as to produce a tongue containing a portion of the weld. The cuts are made so that the tongue is parallel to the axis of the pipes and the weld is tested by bending the tongue round a former (see Fig 89).

**19.18 Transverse Bend Specimen** — A test specimen for a bend test, which is transversely bisected by the portion of the weld included in it.

**19.19 Transverse Tensile Specimen** — A test specimen for a tensile test, which is transversely bisected by the portion of the weld included in it.

**19.20 U-Tensile Test** — A method of tensile testing spot or projection welds. After welding the test plates are bent as shown in Fig 90 and the specimen is then pulled apart.

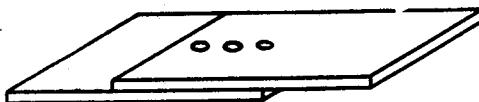


FIG 88 SHEAR-TEST PIECE

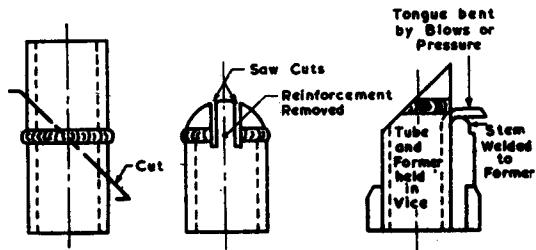


FIG 89 TONGUE-BEND TEST SPECIMEN

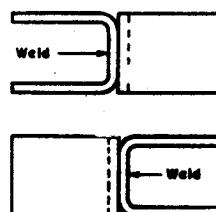


FIG 90 U-TENSILE TEST SPECIMEN

## PART VI WELD IMPERFECTIONS

### 20. TERMS RELATING TO WELD IMPERFECTIONS

**20.1 Blowhole** — A large cavity due to entrapped gas.

NOTE — This term is conveniently applied to cavities exceeding 1·6 mm (or  $\frac{1}{8}$  in.) in diameter.

**20.2 Capillary Pipe** — A fine pipe extending along the junction of weld and parent metal.

NOTE — The defect is caused by faults in the parent metal (e.g. laminations or layers of segregation) mostly occurring along the whole length of the metal concerned.

**20.3 Crack** — A discontinuity produced either by tearing of the metal while in a plastic condition (hot crack or hot tear) or by fracture when cold (cold crack or cold tear).

**20.4 Crater** — A depression left in weld metal where the arc was broken or the flame was removed.

**20.5 Edge of Plate Melted Off** — An imperfection in a fillet weld due to a free edge of a plate being melted off and insufficiently built up (see 21.1.3).

**20.6 End Crater** — A crater at the end of a weld or at the end of a joint (see 21.1.2.1).

**20.7 Exposed Inclusion** — An inclusion near the surface, exposed, but not completely removed, by dressing.

**20.8 Exposed Porosity** — Porosity near the surface, exposed, but not completely removed, by dressing.

**20.9 Gas Pore** — A small cavity due to entrapped gas.

NOTE — This term is conveniently applied to cavities not exceeding 1·6 mm (or  $\frac{1}{8}$  in.) in diameter.

**20.10 Inclusion** — Slag or other foreign matter entrapped during welding.

**20.11 Incomplete Inter-Run Penetration** — A gap occurring in a multi-run weld where the weld metal fails to fill a crevice formed by a previous run or runs. The crevice is usually at the toes of the underlying run or runs (see 21.2.6).

**20.12 Incomplete Root Penetration** — A gap left by failure of weld metal to fill the root (see 21.2.7).

**20.13 Incorrect Profile ( Incorrect Contour )** — A departure of the shape and/or size of an otherwise correctly formed weld from that specified.

**20.14 Lack of Fusion** — Lack of union in a weld.

NOTE — Lack of union in a weld may be

- a) between deposited metal and parent metal, or
- b) between parent metal and parent metal, or
- c) between deposited metal and deposited metal (*see 21.2.8 and Fig 91*)

**20.15 Lack of Inter-Run Fusion** — Lack of union between adjacent runs of weld metal in a multi-run weld (*see 21.2.8*).

**20.16 Lack of Root Fusion** — Lack of union between weld metal and parent metal, or between the adjacent faces of the parent metal at the root (*see 21.2.8*).

**20.17 Lack of Side Fusion** — Lack of union between weld metal and parent metal at a side of a weld outside the root (*see 21.2.8*).

**20.18 Overlap** — An imperfection at a toe or root of a weld caused by metal flowing on to the surface of the parent metal without fusing to the latter (*see 21.1.10*).

**20.19 Pipe** — An elongated or tubular cavity in weld metal due to entrapped gas (*see 21.2.9*).

**20.20 Porosity** — A group of gas pores (*see 21.2.10*).

NOTE — Porosity may be conveniently differentiated according to size as fine, medium, or coarse, and may occur as clusters or chains, or may be scattered.

**20.21 Root Concavity** — An intermittent broad groove, or series of cavities, occurring in submerged-arc welding in the penetration bead, or in the root, of a weld.

NOTE — The imperfection occurs when a copper backing-bar is used, and is caused by fused flux powder trickling through the irregular abutting faces of the parent metal and the copper backing-bar.

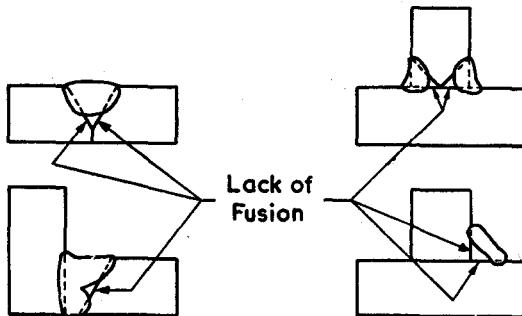


FIG 91 LACK OF FUSION

**20.22 Root Groove** — A shallow groove occurring tortuously in the root of a butt weld during welding (*see 21.1.13*).

**20.23 Shrinkage Groove** — A shallow groove in the parent metal along each side of a penetration bead.

**20.24 Undercut** — A groove cut into the base metal along the toe of a weld and left unfilled by the weld metal (*see 21.1.18*).

**20.25 Underflushing** — A reduction in metal thickness due to excessive dressing (*see 21.1.19*).

## 21. TERMS RELATING TO WELD IMPERFECTIONS APPROPRIATE FOR RADIOGRAPHIC EXAMINATION

### 21.0 Introduction

**21.0.1** The terms given under **21.1** and **21.2** are intended to be comprehensive, with the exception of those relating to characteristic defects confined to specialized methods, such as flash butt welding or spot welding, in which radiographic inspection is not yet in general use.

**21.0.2** Since the terms primarily concern radiographic inspection of welds, the definitions have been amplified by means of diagrams and illustrative radiographs. The radiographs have been selected with the one object of illustrating the salient features of the defects, and the examples have been chosen to facilitate their reproduction in half-tone blocks. Consequently, the faults are rather more marked than is usual, in order to compensate for losses in the printing process. The radiographer will appreciate that the image of a given defect on a photographic film becomes more ill-defined and more indistinct as the thickness of metal increases, or if salt intensifying screens are used instead of metal screens, etc. Moreover, the sharply defined contours of a blowhole, or a pipe viewed end-on, may be blurred and diffused by halation, so that interpretation may be more difficult than these illustrations would suggest.

**21.0.3** Not only is interpretation more difficult when these conditions are present, but it is also complicated by the fact that defects of more than one kind often occur together: porosity is often mixed with fine inclusions; incomplete penetration or lack of fusion may be accompanied by inclusions, or may be partially obscured by overlying defects in other runs of the weld; cavities may be partially filled with foreign matter, while inclusions sometimes have cracks radiating from sharp edges and corners.

**21.0.4** In some of the terms, the radiographic shadows are characteristic of a particular defect (e.g. crack, blowhole); in others, the first interpretation is not free from ambiguity (e.g. lack of side fusion may be indistinguishable from capillary piping; undercut from a line inclusion). Tube-shift or stereo-radiographic exposures as also the position of the image relative to the centre-line of the weld may assist in resolving the ambiguity. For the sake of completeness a few imperfections, such as overlap, which cannot in general be detected radiographically, have also been included. Other surface imperfections in the weld or adjacent metal, which are readily seen by visual surface inspection, have also been included since they may be revealed in the radiograph. They would be removed in the final surface dressing where this is required by specification, but if their elimination is incomplete they are liable, in the first examination of the radiographs, to be interpreted erroneously, as internal defects, and are therefore of significance in radiographic inspection.

**21.0.5** The terms are defined under the following two headings:

- a) Surface imperfections in the weld or adjacent metal, and
- b) Internal defects in the weld or adjacent metal.

**21.0.6** This distinction between surface imperfections and internal defects has been drawn because of the different standards of acceptance which would normally be applied in the two cases.

**21.0.7** Surface imperfections are generally removed in the final dressing of the surface of the weld where this is required by specification, but, if their elimination is incomplete, they are liable to be interpreted erroneously as internal defects in the first examination of the radiographs. Where visual inspection of the surface is impracticable, surface imperfections may be distinguished from internal defects by stereo-radiography or tube-shift methods.

## **21.1 Surface Imperfections in the Weld or Adjacent Metal**

**21.1.1 Chipping Mark** — An indentation resulting from chipping in preparation or dressing. It gives rise to a dark shadow of corresponding shape in the radiograph.

**21.1.2 Crater** — A depression left in a weld where the arc was broken or the flame was removed. It appears in the radiograph as a dark shadow varying in density and shape with the dimensions of the imperfection.

**21.1.2.1 End crater** — A crater at the end of a weld or joint. It gives a radiographic image similar to that of a crater.

**21.1.3 Edge of Plate Melted Off** — An imperfection in a fillet weld due to a free edge of a plate being melted off and insufficiently built up.

It appears in the radiograph as a dark ribbon with diffuse edges corresponding in position to the toe of the weld (see Fig 92).

**21.1.4 Excessive Penetration Bead (Excessive Under-Bead)**—Excess of metal protruding through the root in a fusion butt weld. It appears in the radiograph as a continuous or intermittent light irregular band within the image of the weld (see Fig 93).

**21.1.5 Exposed Inclusion**—An inclusion near the surface, exposed, but not completely removed, by dressing. The radiographic image is similar to that given by an inclusion situated wholly within the metal (see also 21.2.5).

**21.1.6 Exposed Porosity**—Porosity near the surface, exposed, but not completely removed, by dressing. The radiographic image is similar to that given by porosity situated wholly within the metal (see also 21.2.10).

**21.1.7 Grinding Scratch**—A groove in the surface of parent metal or of a weld made by a grinding wheel or surfacing tool. A grinding scratch, if of sufficient depth, may give a radiographic appearance similar to that of a welding defect.

**21.1.8 Incompletely Filled Groove**—A continuous or intermittent channel in a butt-weld face where the thickness of the throat is less than that of the parent metal. It appears in the radiograph as a dark area corresponding to the size and shape of the defect. When present at a fusion face, the radiographic appearance is similar to that of undercut, except that the edge of the image corresponding to the edge of the fusion face preparation is straight (see Fig 94).

**21.1.9 Incorrect Profile (Incorrect Contour)**—A departure of the shape and/or size of an otherwise correctly formed weld from that specified. The presence of this defect may sometimes be inferred from the variation in density of the radiograph in the region of the weld.

**21.1.10 Overlap**—An imperfection at a toe or root of a weld caused by an overflow of weld metal on to the surface of the parent metal without fusing to the latter. Visual and radiographic examination may give an exaggerated impression of the width of the reinforcement fused to the parent plates. It is not possible to detect overlap

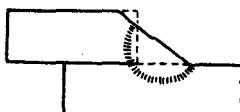


FIG 92 EDGE OF PLATE MELTED OFF



FIG 93 EXCESSIVE PENETRATION BEAD



FIG 94 INCOMPLETELY FILLED GROOVE

radiographically, but it may usually be revealed in steel welds by magnetic crack detectors (see Fig 95).

**21.1.11 Peening Mark** — An indentation, due to a peening blow, in the weld or parent metal. It gives rise to a dark shadow of corresponding shape in the radiograph.

**21.1.12 Root Concavity** — An intermittent broad groove or series of concavities in an under-bead, or in the root of a weld. It appears in the radiograph as a series of dark areas along the centre of the weld seam varying in density according to the depth of the imperfection. It is usually intermittent (see Fig 96).

**NOTE** — The imperfection occurs in submerged-arc welds when a copper-backing plate is used and is caused by fused flux powder trickling through the irregular abutting faces of the parent metal and becoming entrapped between the weld metal and the copper-backing plate.

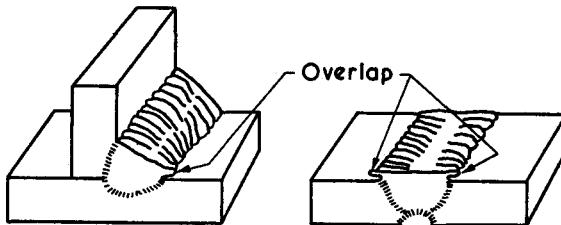


FIG 95 OVERLAP

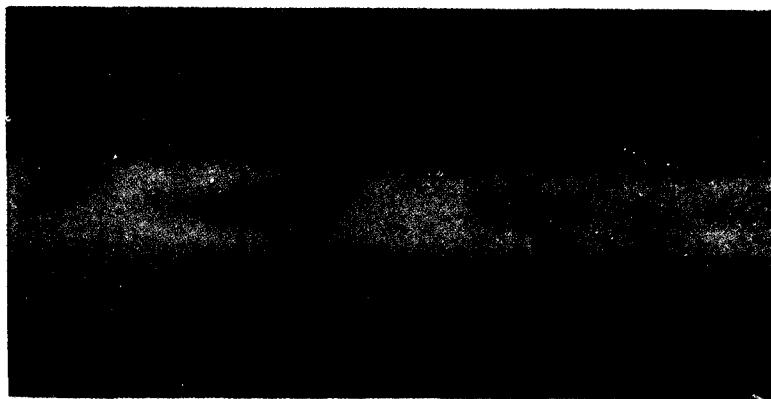


FIG 96 ROOT CONCAVITY

**21.1.13 Root Groove** — A shallow groove in the root of a butt weld formed during welding. The edges of the groove are smoothly continuous with the metal surface on both sides. It may be present even though full fusion has occurred. It appears in the radiograph as a dark band varying in density according to the depth of the groove ( see Fig 97 ).

**21.1.14 Shrinkage Groove** — A shallow groove in the parent metal along each side of an under-bead in a butt weld. The radiograph shows each groove as a dark band varying in density according to its depth ( see Fig 98 and 99 ).

NOTE — The imperfection occurs in gas welding and is caused by plastic deformation and/or oxidation of the parent metal adjacent to the roots of the weld.

**21.1.15 Spatter ( Splatter, Splash, Spitting )** — Globules of metal expelled during arc welding on to the surface of parent metal or of a weld. Spatter appears in the radiograph as small light rounded area ( see Fig 100 ).

**21.1.16 Surface Pitting** — An imperfection in the surface of the parent metal usually in the form of small depressions which may be so



FIG 97 ROOT GROOVE



FIG 98 MACROGRAPH OF SHRINKAGE GROOVES



FIG 99 RADIOGRAPH OF SHRINKAGE GROOVES

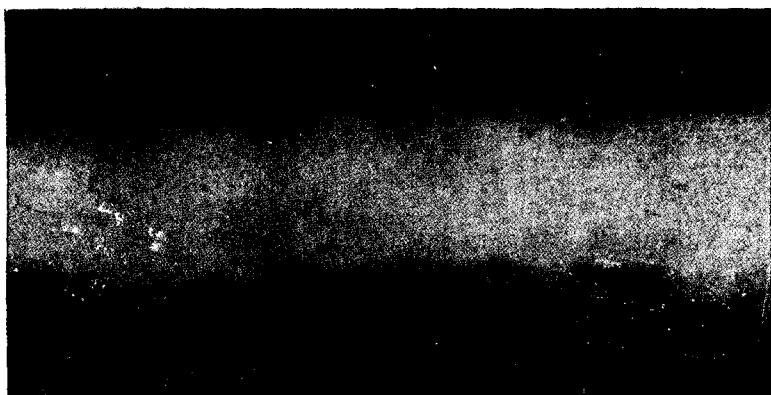


FIG 100 SPATTER

close to a weld as to be mistaken for a welding defect. The imperfection appears in the radiograph as small dark images (see Fig 101).

**21.1.17 Torn Surface**—A surface irregularity due to the removal of tack-welded jigs and the like. The radiographic appearance corresponds in outline to that of the affected area and may be either light or dark, depending on whether the tack or the parent metal has been torn.

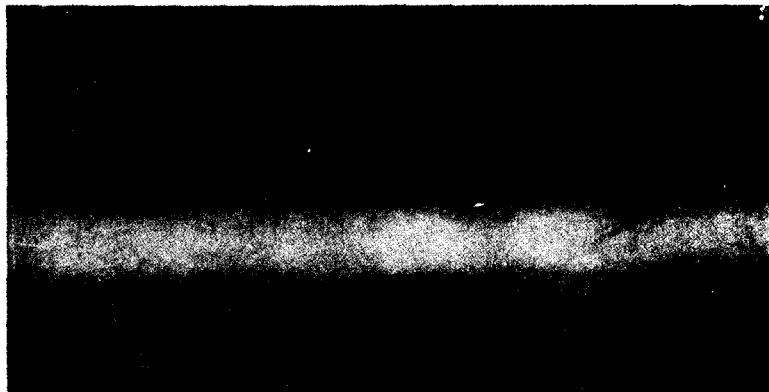


FIG 101 SURFACE PITTING



FIG 102 UNDERCUT

**21.1.18 Undercut**—A groove or channel along a toe of a weld caused by wastage of the parent metal. It appears in the radiograph as a dark line, sometimes broad and diffuse, in a position corresponding to the toe of the weld (*see Fig 102 and 103*).

**21.1.19 Underflushing (Excessive Dressing, Excessive Grinding)**—A reduction in metal thickness due to excessive dressing. The imperfection

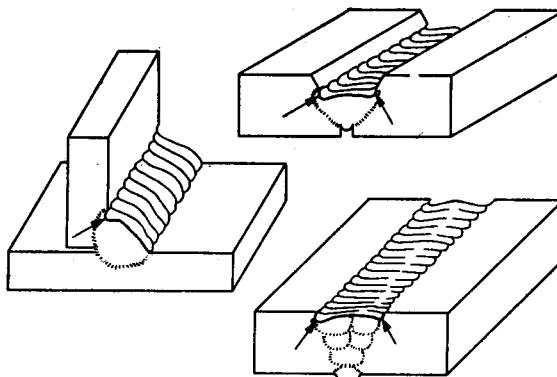


FIG 103 EXAMPLES OF UNDERCUT  
( Arrow-head indicates the undercut )



FIG 104 UNDERFLUSHING

produces a characteristic appearance of extended dark areas with diffuse edges ( see Fig 104 ).

## 21.2 Internal Defects in the Weld or Adjacent Metal

**21.2.1 Blowhole ( Void, Gas Pocket )**— A large cavity due to entrapped gas. It appears in the radiograph as a dark shadow of rounded contour ( see Fig 105 ).

NOTE.— This term is conveniently applied to cavities exceeding 1.6 mm ( or  $\frac{1}{16}$  in. ) in diameter.



FIG 105 BLOWHOLES

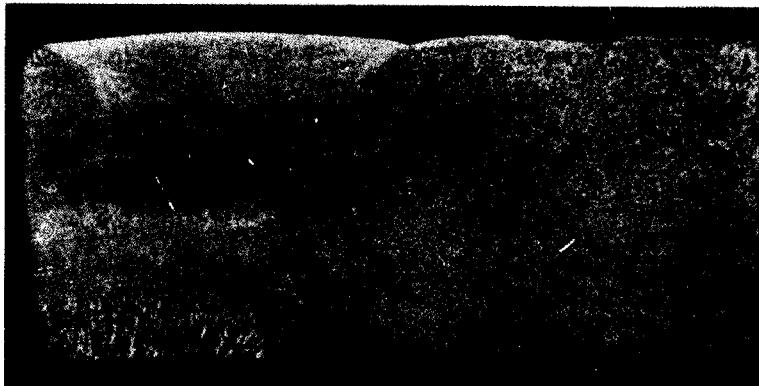


FIG 106 MACROGRAPH OF CAPILLARY PIPES

**21.2.2 Capillary Pipe** — A fine pipe extending along the junction of a weld and parent metal. It appears in the radiograph as a straight, dark, rather diffuse line which may be either continuous or intermittent (see Fig 106 and 107).

NOTE — The defect is caused by faults in the parent metal (e.g. lamination or layers of segregation), mostly occurring along the whole length of the metal concerned.



FIG 107 RADIOPHOTOGRAPH OF CAPILLARY PIPES

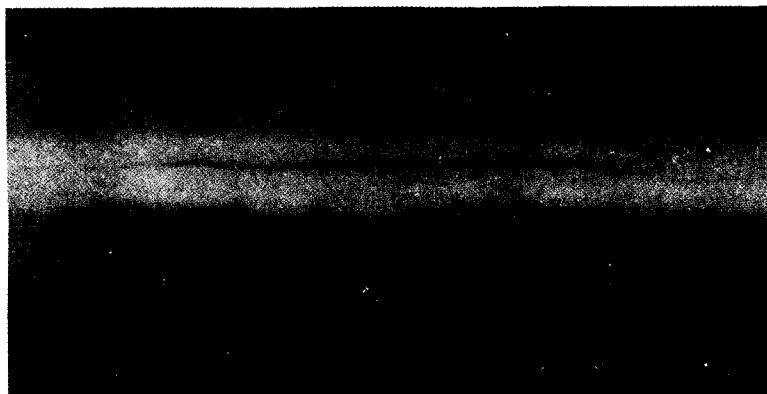


FIG 108 CRACK

**21.2.3 Crack (*Hot Tear, Springing*)**—A discontinuity produced either by tearing of the metal while in a plastic condition (hot crack), or by fracture when cold (cold crack). Radiographically, the former is revealed as a fine dark line wandering in direction and tapered at the ends; often discontinuous, when the segments are roughly parallel but slightly displaced and possibly overlapping. A cold fracture gives, in general, a shadow which is finer, straighter, continuous and free from bifurcations (see Fig 108).

NOTE 1 — The detection of a crack, or part of it, is dependent on its orientation relative to the X-ray beam and accordingly it may not be equally well

revealed along its entire length. As the orientation diverges from the optimum direction for detection, the radiographic shadow becomes broadened and increasingly difficult to recognize.

**NOTE 2** — Cracks may be further differentiated as longitudinal, transverse, crater, centre line, fusion zone, under-bead, weld metal, or parent metal cracks, and it is helpful to include such descriptions in radiographic reports.

**21.2.4 Gas Pore** — A small cavity due to entrapped gas. The radiographic appearance is a sharply defined dark shadow of circular contour (*see also 21.2.10*).

**NOTE** — This term is conveniently applied to cavities not exceeding 1.6 mm (or  $\frac{1}{8}$  in.) in diameter.

**21.2.5 Inclusion (Slag, Slag Trap)** — Slag or other foreign matter entrapped during welding. The defect is usually more irregular in shape than a gas cavity. The radiographic image is, in general, of lower contrast than that of a gas cavity of the same dimensions. The inclusions are more generally encountered in the following forms (*see Fig 109*):

- a) *Large isolated inclusion* — This appears in the radiograph as a dark shadow of irregular contour.
- b) *Cluster of small inclusions* — This appears in the radiograph as a group of dark ill-defined spots.
- c) *Line inclusion* — This appears in the radiograph as a dark shadow with wavy edges along the weld, often occurring in a long, continuous run. It is sometimes found along both edges of a run of welding in roughly parallel lines, rather like tram lines or wagon



FIG 109 INCLUSIONS

tracks. It may also appear as a series of dashes somewhat similar to characters in the Morse alphabet (see Fig 110).

**NOTE** — The defect may be accompanied by fine cracks, although these are not always revealed in the radiograph.

**21.2.6 Incomplete Inter-Run Penetration (Lack of Inter-Penetration)**— A gap occurring in a multi-run weld where the weld metal fails to fill a crevice formed by a previous run or runs (usually at the toes of the underlying run or runs). It appears in the radiograph as a dark, intermittent or continuous line which may have both edges wavy or one edge straight and the other wavy (see Fig 111).

**21.2.7 Incomplete Root Penetration (Lack of Root Penetration, Non-Penetration)**— A gap left by failure of the weld metal to fill the root. It appears in the radiograph as a dark continuous or intermittent line which may have both edges straight or one edge straight and the other wavy (see Fig 112).

**21.2.8 Lack of Fusion (Lack of Adhesion, Non-Adhesion, Adhesion)**— Lack of union in a weld between weld metal and parent metal, or between



FIG 110 LINE INCLUSIONS



FIG 111 INCOMPLETE INTER-RUN PENETRATION



FIG 112 INCOMPLETE ROOT PENETRATION



FIG 113 LACK OF SIDE FUSION



FIG 114 LACK OF ROOT FUSION

parent metal and parent metal, or between weld metal and weld metal. Its radiographic detection depends on its orientation with respect to the X-ray beam. It occurs in the following forms:

- Lack of side fusion*—Lack of union between weld metal and parent metal at a side of a weld outside the root. When revealed in the radiograph, it appears as a dark, straight line, of low intensity, with sharply defined edges (*see Fig 113*).
- Lack of root fusion*—Lack of union between weld metal and parent metal, or between the adjacent faces of the parent metal at the root. When revealed in the radiograph, it has a similar appearance to that of lack of side fusion (*see Fig 114 and 115*).
- Lack of inter-run fusion*—Lack of union between adjacent runs of weld metal in a multi-run weld. When revealed in the radiograph, it appears as a faint line with sharply defined edges (*see Fig 116*).

**21.2.9 Pipe (Worm Hole)**—An elongated or tubular cavity due to entrapped gas. It appears in the radiograph as a dark shadow of which the shape depends on the orientation of the defect. If the pipe is end-on

to the X-rays, a very dark rounded shadow is produced, often showing halation at the edges; if it is at an angle to the X-rays, an elongated shadow is produced (see Fig 117).

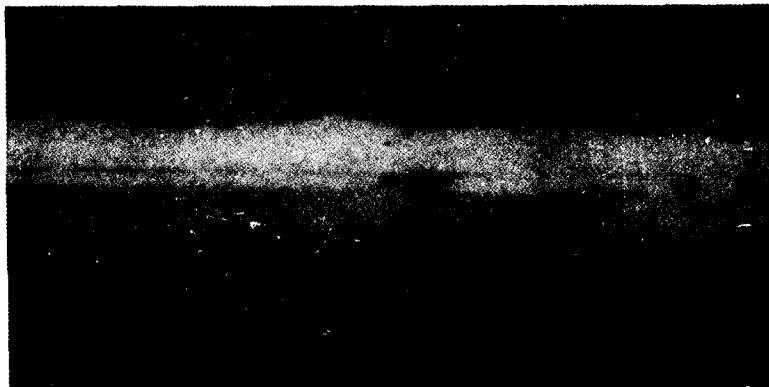


FIG 115 LACK OF ROOT FUSION



FIG 116 LACK OF INTER-RUN FUSION

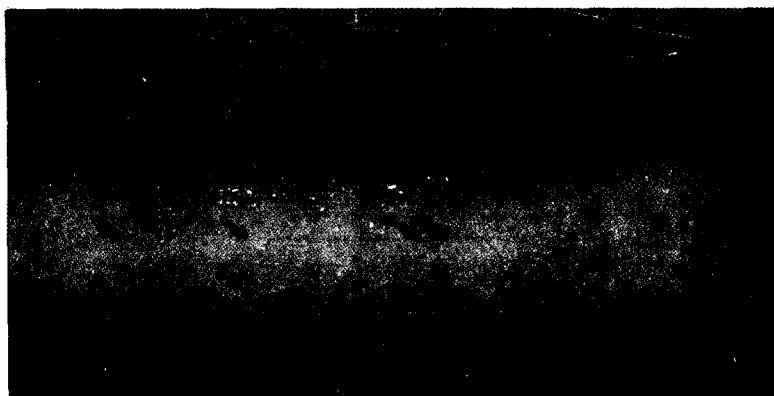


FIG 117 PIPES

**21.2.10 Porosity** — A group of gas pores. Porosity has a radiographic appearance of dark shadows of circular contour (see 21.2.4 and Fig 118).

NOTE — Porosity may conveniently be differentiated according to size as fine, medium or coarse. It may occur as clusters or chains or may be scattered.

## PART VII CUTTING

### 22. GENERAL TERMS

**22.1 Cutting Oxygen** — Oxygen used at a relatively high pressure for gas cutting.

**22.2 Drag** — A component of the distance between the two ends of a drag line, measured as shown in Fig 119.

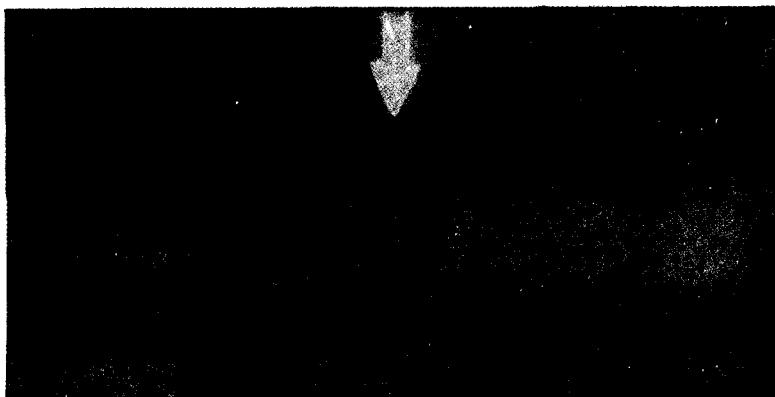


FIG 118 POROSITY

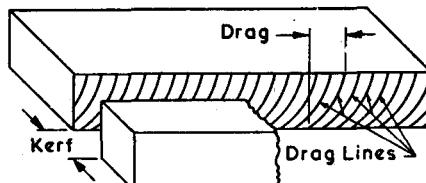


FIG 119 DRAG AND KERF

**22.3 Drag Lines** — The serrations left on the face of the cut by the gas cutting or arc cutting.

**22.4 Gas Cutting** — The cutting of metal by the chemical action of oxygen with or without other materials.

NOTE — The metal is raised to ignition temperature progressively and then cut by a jet of oxygen which also removes molten material from the cut.

**22.5 Kerf** — Gap left after cutting (*see Fig 119*).

**22.6 Stack Cutting** — The gas cutting of a stack of plates usually clamped together.

## 23. TERMS RELATING TO ARC CUTTING

**23.1 Carbon-Arc Cutting** — The cutting of metal by melting a narrow strip with the heat of an arc between a carbon electrode and the metal to be cut.

**23.2 Metal-Arc Cutting** — The cutting of metal by melting a narrow strip with the heat of an arc between a metal electrode and the metal to be cut.

## 24. TERMS RELATING TO EQUIPMENT

**24.1 Cutting Blowpipe** — A device used in gas cutting for controlling the gases used to produce ignition temperature and for controlling and directing the stream of cutting oxygen.

NOTE — A cutting blowpipe is sometimes erroneously called a cutter or burner.

**24.2 Cutter Guide** — A device, attached to a manual cutting blowpipe, for maintaining the nozzle at a constant distance from the surface of the metal to be cut and assisting the operator in cutting to a required shape.

**24.3 Floating Head** — A holder for the blowpipe in a gas-cutting machine; it permits vertical movement of the blowpipe.

NOTE — In conjunction with a device riding on the surface of the work, it enables a constant distance to be maintained between the blowpipe nozzle and the work.

**24.4 Gouging Blowpipe** — A cutting blowpipe designed for gouging.

NOTE — It is sometimes erroneously called a gouging cutter.

**24.5 Oxygen Lance** — A steel tube used for oxygen lancing. It may be packed with steel wires which, with the tube, are consumed in the process.

**24.6 Oxygen-Lance Holder** — A device for holding an oxygen lance and for controlling the flow of oxygen through it.

## **25. TERMS RELATING TO GAS CUTTING**

**25.1 Deseaming ( Scarfing )** — The removal of surface defects from cold ingots, blooms, billets and slabs by means of manual gas cutting.

**25.2 Desurfacing** — The removal of surface layers from hot blooms, billets and slabs by means of a gas-cutting machine.

**25.3 Gouging** — The forming of a groove by means of gas cutting, using a special blowpipe.

**25.4 Oxygen-Arc Cutting** — Cutting in which ignition temperature is produced by an electric arc, and oxygen is conveyed through the centre of a covered electrode, the latter being consumed in the process.

**25.5 Oxygen Lancing** — Cutting or boring holes in metals or other materials by means of an oxygen lance.

**NOTE** — The end of the oxygen lance is first brought to ignition temperature and oxygen is then passed through it whilst the lance is pressed against the metal or other material.

**25.6 Pre-Heating Oxygen** — Oxygen used at a relatively low pressure in conjunction with fuel gas for raising to ignition temperature the metal to be cut by gas cutting.

**25.7 Powder Cutting** — Gas cutting in which powder is used in addition to the cutting oxygen.

**25.8 Spot Gouging** — Gouging in which the groove is short.

## PART VIII ALPHABETICAL INDEX OF TERMS

	Clause No.		Clause No.
<b>A</b>		<b>B</b>	
Added Metal ...	3.4	Backfire ...	14.2
Adhesion, Lack of ...	21.2.8	Backfire, Sustained ...	14.17
Agent, Stopping-Off ...	16.1	Backing Bar ...	13.6
Air-Acetylene Blowpipe:		Ring ...	11.5
Bunsen Type ...	13.1	Run ...	11.53
High Temperature Type ...	13.2	Strip ...	11.6
Allowance, Flashing ...	8.15	Back Pressure ...	8.1
Total ...	8.47	Back-Step Sequence ...	11.3
Upset ...	8.49	Backward ( Backhand ) Welding	14.15
Alloy, Brazing ...	17.2	Back Weld ...	11.4
All-Position Rightward Welding ...	14.1	Balanced Welding ...	11.7
All-Weld Test Piece ...	19.1	Bar, Backing ...	13.6
All-Weld Test Specimen ...	19.2	Bare Electrode ...	13.7
Angle Electrode ...	5.1	Bare Metal-Arc Welding ...	12.6
Angle, Included ...	11.33	Base Metal ...	3.21
Angle of Bevel ...	11.1	Battery Spot-Welding Machine ...	5.4
Apron, Welding ...	3.41	Bead ...	11.9
Arc Blow Compensator ...	5.2	Bead, Excessive Penetration ...	21.1.4
Arc Cutting, Carbon- Metal- ...	23.1	Penetration ...	11.42
Oxygen- ...	23.2	Bell Branch Joint, Short ...	18.6
Arc Damper ...	25.4	Bell Butt Joint ...	18.1
Fan ...	5.2	Bend Specimen, Transverse ...	19.18
Arcing Time Factor ...	12.1	Bend Test, Face ...	19.9
Arc Voltage ...	12.4	Free ...	19.6
Welding ...	12.2	Guided ...	19.7
-Welding Electrode ...	12.3	Normal ...	19.9
-Welding Plant ...	13.3	Reverse ...	19.11
-Welding Set ...	13.4	Bend Test Specimen, Tongue ...	19.17
Arc Welding, Carbon- Controlled- ...	12.8	Bevel, Angle of ...	11.1
Controlled Tungsten- ...	12.10	Blacksmith Welding ...	6.1
Inert-Gas ...	12.11	Block Sequence ...	11.8
Metal-... ...	12.16	Blowhole ...	20.1, 21.2.1
Self-Adjusting ...	12.20	Blowpipe, Air Acetylene:	
Shielded- ...	12.24	Bunsen Type ...	13.1
Submerged- ...	12.25	High Temperature Type ...	13.2
Area, Clamp Contact ...	8.11	Blowpipe, Cutting ...	24.1
Electrode Contact ...	8.11	Gouging ...	24.4
Pressure Contact ...	4.5	Welding ...	13.41
Weld Contact ...	8.54	Bolster ...	5.5
Arm ...	5.3	Branch Joint, Short Bell ...	18.6
As-Welded ...	3.1	Branch Tee Saddle Joint ...	18.2
Assembly, Melt Distributing ...	13.29	Brazing ...	17.1
Atomic-Hydrogen Torch Welding ...	13.5	Brazing Alloy ...	17.2
Automatic Welding ...	12.5	Brazing, Dip ...	17.3
	11.2	Flame ...	17.4
		Furnace ...	17.5
		Induction ...	17.6

	Clause No.		Clause No.		
Brazing, Dip ( <i>Contd</i> ):					
Resistance	...	17.7	Constant-Temperature Welding	...	7.3
Salt Bath	...	17.8	Constant-Voltage Welding Generator	...	13.9
Torch	...	17.4	Consumable Electrode	...	13.10
Bronze Filler Metal	...	18.3	Contact Area, Clamp	...	8.11
Bronze Welding	...	18.4	Electrode	...	8.11
Burden	...	12.7	Pressure	...	4.5
Burner	...	5.6	Weld	...	8.54
Burnt-Off	...	8.15	Continuous Test Current	...	12.9
Butt Joint, Bell	...	18.1	Continuous Weld	...	11.13
Diminishing Bell	...	18.5	Contour, Incorrect	...	20.13, 21.1.9
Double-Glut	...	6.2	Control, Programme	...	8.32
Plain	...	6.6	Convex Fillet Weld	...	11.14
Single-Glut	...	6.9	Convexity	...	11.15
Tee	...	6.12	Cool Time	...	8.4
Butt Seam Welding	...	8.2	Cored Electrode	...	13.11
Butt Weld	...	3.2	Corner Joint, Square	...	6.11
Butt Weld, Double-Bevel	...	11.16	Coupler, Hose	...	13.21
Double-J	...	11.17	Coupling Nipple, Hose	...	13.22
Double-U	...	11.18	Coupling Nut, Hose	...	13.23
Double-V	...	11.19	Cover Glass	...	3.22
Single-Bevel	...	11.55	Covered Electrode	...	13.12
Single-J	...	11.56	Filler Rod	...	13.13
Single-U	...	11.57	Crack	...	20.3, 21.2.3
Single-V	...	11.58	Cracking Test, Hot	...	19.8
Size of	...	11.59	Crater	...	20.4, 21.1.2
Square	...	11.63	Crater, End	...	20.6, 21.1.2.1
<b>C</b>					
Capacitor Spot-Welding Machine	...	5.7	Cross-Wire Weld	...	8.5
Capillary Pipe	...	20.2	Crucible, Thermit	...	10.2
Carbon-Arc Cutting	...	23.1	Cruciform Test Piece	...	19.3
Welding	...	12.8	Test Specimen	...	19.4
Carburizing Flame	...	14.3	Current, Continuous Test	...	12.9
Cast-Iron Thermit	...	13.8	Flashing	...	8.16
Chill Time	...	8.3	Maximum Welding	...	12.19
Chipping Goggles, Mark	...	3.3, 21.1.1	Nominal Hand-Welding	...	12.22
Clamp Contact Area	...	8.11	Current-Off Time	...	8.6
Close Joint	...	11.10	Current, Pre-Heating	...	8.30
Coated Filler Rod	...	13.13	Current Time, Upset	...	8.50
Cold Welding	...	7.1	Current, Welding	...	8.57
Collar	...	15.1	Cutter, Gouging	...	24.4
Combined Weld, Thermit	...	10.1	Cutter Guide	...	24.2
Compensator, Arc Blow	...	5.2	Cutting Blowpipe	...	24.1
Composite Joint	...	11.11	Cutting, Carbon-Arc	...	23.1
Concave Fillet Weld	...	11.12	Gas	...	22.4
Concavity, Root	...	20.21, 21.1.12	Metal-Arc	...	23.2
Condenser-Discharge Spot-Welding Machine	...	5.7	Cutting Oxygen	...	22.1
Cone, Inner	...	14.8	Cutting, Oxygen-Arc	...	25.4
Connection, Threaded Hose	...	13.39	Powder	...	25.7
Constant-Pressure Pressure-Welding	...		Stack	...	22.6
ing	...	7.2	Cycle	...	8.7
			Cycle, Dual-Pressure	...	8.8
			Duty	...	8.9
			Weld	...	8.55

	<i>Clause No.</i>		<i>Clause No.</i>
<b>D</b>			
Damper, Arc	...	Electrode, Non-Consumable	... 13.31
Deformation	...	Offset	... 5.18
Deposited Metal	...	Pad	... 5.19
Deposition Efficiency	...	Electrode Positive	... 12.13
Depth Penetration	...	Pressure	... 8.12
Depth, Throat	...	Electrode, Resistance Welding	... 5.24
Wearing	...	Electrode Shank	... 5.8
Deseaming	...	Electrode, Sheathed	... 13.34
Desurfacing	...	Electrode Tip	... 5.9
Die Welding, Heated-	...	Electrode, Vertical	... 5.26
Dies, Welding	...	Electrode Wheel	... 5.10
Diminishing Bell Butt Joint	...	End Crater	20.6, 21.1.2.1
Dip Brazing	...	Envelope, Gas	... 11.30
Distance, Edge	...	Excessive Dressing	... 21.1.19
Distributing Assembly, Melt	...	Grinding	... 21.1.19
Double-Bevel Butt Weld	...	Penetration Bead	... 21.1.4
Double-Glut Butt Joint	...	Under-Bead	... 21.1.4
Double-J Butt Weld	...	Exposed Inclusion	20.7, 21.1.5
Double-U Butt Weld	...	Porosity	20.8, 21.1.6
Double-V Butt Weld	...	Extension, Fillet Weld	... 13.16
Downhand Position	...	<b>F</b>	
Drag	...	Face Bend Test	... 19.9
Drag Lines	...	Face, Fusion	... 11.27
Dressing, Excessive	...	Face Mask	... 3.7
Drooping-Characteristic	...	Face, Root	... 11.47
Generator	...	Face Shield	... 3.8
Dual-Gas Economizer	...	Face, Weld	... 11.69
Dual-Pressure Cycle	...	Factor, Arcing Time	... 12.4
Duty Cycle	...	Test Load	... 12.28
<b>E</b>		Faired ( Tapered ) Member	... 3.9
Economizer, Dual-Gas	...	Fan, Arc	... 12.1
Edge:		Faying Surface	... 4.1
Distance...	...	Ferrule	... 5.11
Of Plate Melted Off	...	Filler Metal	... 3.10
Preparation	...	Filler Metal, Bronze	... 18.3
Weld	...	Filler Rod, Covered ( Coated )	... 13.13
Edge, Weld	...	Fillet Weld	... 11.26
Effective Length of Weld	...	Fillet Weld, Concave	... 11.12
Throat Thickness	...	Convex	... 11.14
Electrode	...	Fillet Weld Extension	... 13.16
Electrode, Angle	...	Fillet Weld, Flat Face	... 11.38
Arc Welding	...	Full	... 11.25
Bare	...	Fillet Weld Guide	... 13.17
Consumable	...	Fillet Weld, Mitre	... 11.38
Electrode Contact Area	...	Size of	... 11.60
Electrode, Cored	...	Filter Glass ( Welding Glass )	... 3.42
Covered	...	Fin	... 8.13
Flat	...	Fire Welding	... 6.3
Electrode Holder	...	Firecracker Welding	... 12.14
Electrode, Lightly Coated	...	Fitted Hose	... 13.18
Electrode Negative	...	Fittings, Weldable	... 18.7
		Fixed Shield	... 3.11

	<i>Clause No.</i>		<i>Clause No.</i>
Flame Brazing	...	17.4	Generator:
Flame, Carburizing	...	14.3	Constant-Voltage Welding ... 13.9
Neutral	...	14.10	Drooping-Characteristic Weld-
Oxidizing	...	14.12	ing ... 13.14
Reducing	...	14.14	Glass, Cover ... 3.22
Flame Snap Cut	...	14.4	Filtcr ... 3.42
Flash	...	8.13	Plain ... 3.22
Flashback	...	14.5	Welding ... 3.42
Flash-Butt Welding	...	8.14	Gloves, Welding ... 3.43
Flashing Allowance	...	8.15	Glut ... 6.4
Current	...	8.16	Goggles, Chipping ... 3.3
Time	...	8.17	Welding ... 3.44
Flash Welding	...	8.14	Gouging ... 25.3
Flat Electrode	...	5.19	Gouging Blowpipe (Cutter) ... 24.4
Flat Face Fillet Weld	...	11.38	Gouging, Spot ... 25.8
Flat Position	...	11.20	Grinding, Excessive ... 21.1.19
Flattening Test	...	19.5	Grinding Scratch ... 21.1.7
Floating Head	...	24.3	Groove, Incompletely Filled ... 21.1.8
Flux	...	3.13	Root ... 20.22, 21.1.13
Foot-Operated Welding Machine	5.12		Shrinkage ... 20.23, 21.1.14
Forge Time	...	8.18	Guide, Cutter ... 24.2
Welding	...	6.3	Fillet Weld ... 13.17
Forward Pressure	...	8.19	Guided Bend Test ... 19.7
Welding	...	14.9	Gun, Stud Welding ... 5.25
Free Bend Test	...	19.6	Gun Welding Machine ... 5.13
Full Fillet Weld	...	11.25	
Full-Fusion Welding	...	14.6	
Full Penetration	...	3.12	<b>H</b>
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Under-Bead, Excessive ...

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**PRINTED AT SIMCO PRINTING PRESS, DELHI, INDIA**