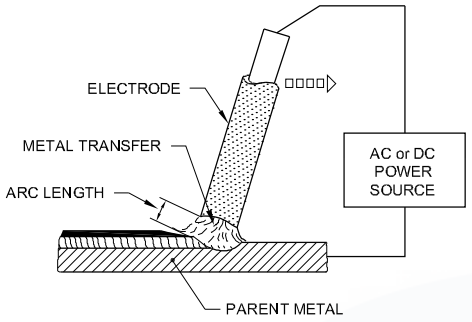
Arc length and its effects

Objectives : At the end of this lesson you shall be able to
- **define and identify the different types of arc lengths**
- **explain the effects and uses of different arc lengths.**

Arc length (Fig 1): It is the straight distance between the electrode tip and the job surface when the arc is formed. There are three of arc lengths.

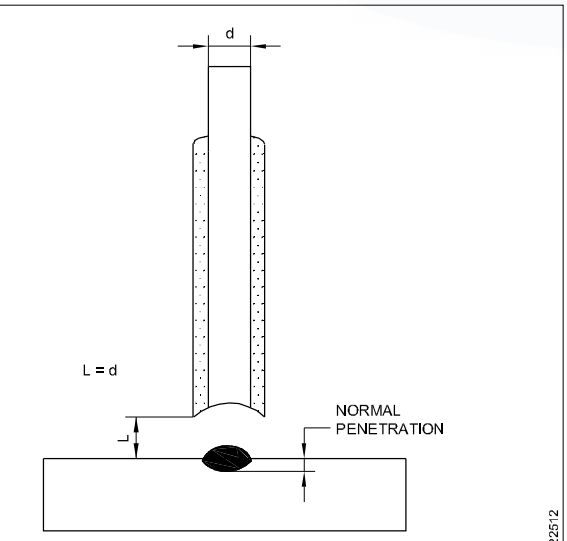
- Medium or normal
- Long
- Short

Fig 1



Medium, normal arc (Fig 2): The correct arc length or normal arc length is approximately equal to the diameter of the core wire of the electrode.

Fig 2



Long arc (Fig 3): If the distance between the tip of the electrode and the base metal is more than the diameter of the core wire it is called a long arc.

Short arc (Fig 4): If the distance between the tip of the electrode and the base metal is less than the dia. of the core wire it is called a Short arc.

Fig 3

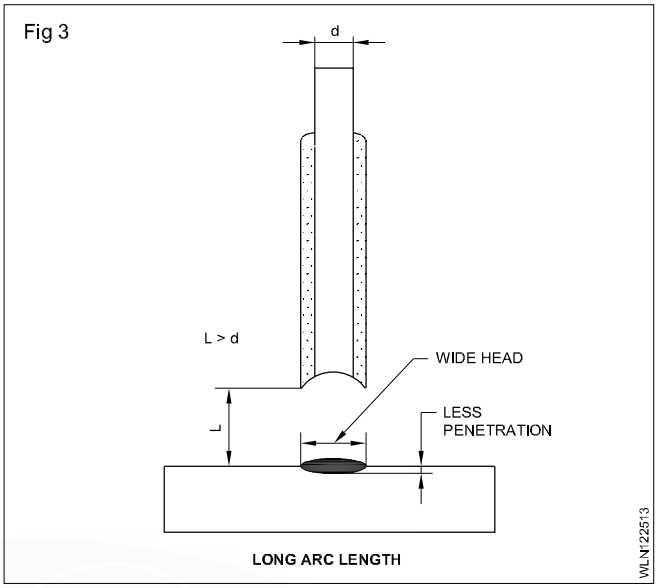
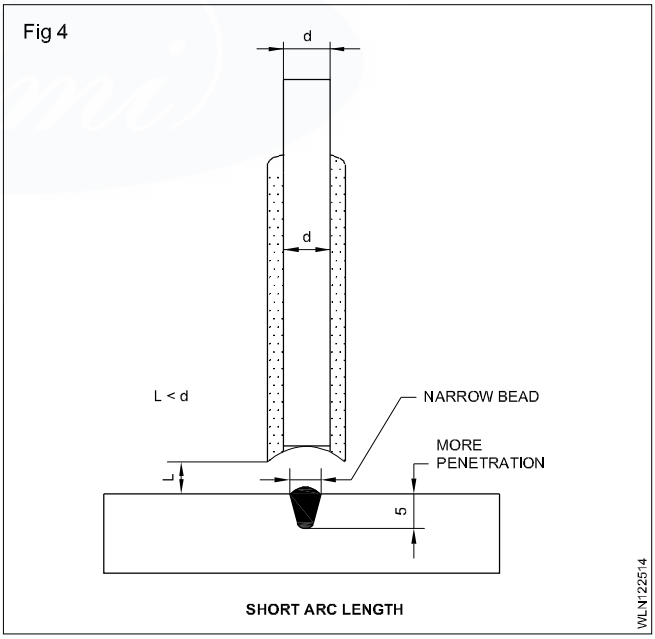


Fig 4



Effects of different arc length

Long arc

It makes a humming sound causing:

- Unstable arc
- Oxidation of weld metal
- Poor fusion and penetration
- Poor control of molten metal
- more spatters, indicating wastage of electrode metal.

Short arc: It makes a popping sound causing:

- the electrode melting fastly and trying to freeze with the job
- higher metal with narrow width bead
- less spatters
- more fusion and penetration.

Normal arc: This is a stable arc producing steady sharp crackling sound and causing:

- even burning of the electrode
- reduction in spatters
- correct fusion and penetration
- correct metal deposition.

Uses of different arc lengths

Medium or normal arc: It is used to weld mild steel using a medium coated electrode. It can be used for the final covering run to avoid undercut and excessive convex fillet/reinforcement.

Long arc: It is used in plug and slot welding. for restarting the arc and while withdrawing the electrode at the end of a bead after filling the crater. Generally long arc is to be avoided as it will give a defective weld.

Short arc: It is used for root runs to get good root penetration, for positional welding and while using a heavy coated electrode, low hydrogen, iron, powder and deep penetration electrode.

Metal transfer across the arc (Characteristics of arc)

Objectives: At the end of this lesson you shall be able to

- **explain the factors involved in the transfer of metal across the arc due to arc characteristics.**

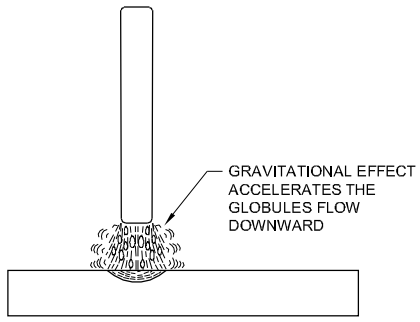
The electric arc has different arc characteristics which help in the transfer of metal across the arc. They are:

- gravity force
- gas expansion force
- surface tension
- electromagnetic force.

Gravity force (Fig 1): Molten globules formed at the arcing end of the electrode travel downwards towards the job in the molten pool.

Gravitational force helps the transfer of metal flat or down hand position and thus the deposition rate of weld metal is increased.

Fig 1

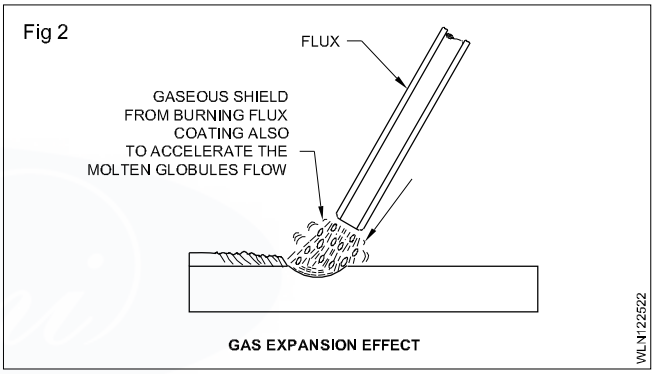


GRAVITY FORCE

Gas expansion force (Fig 2): Flux coating on the electrode melts due to the arc heat, resulting in the:

- Production of carbon monoxide and hydrogen mainly
- Formation of a sleeve of the flux at the arcing end due to a little higher melting point of the flux coating than the core wire.

Fig 2



GAS EXPANSION EFFECT

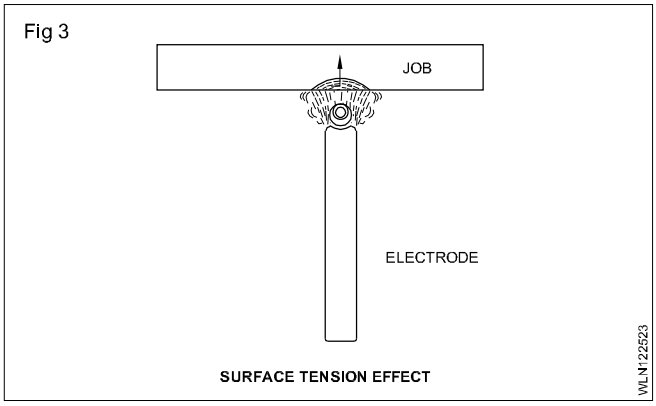
These gases expand and gain velocity. The flux sleeve direct these gases to flow in the direction of the molten metal. The gases flowing from the tip of the electrode have a pushing effect. Thus the metal globules are carried deep into the weld pool and influence penetration.

This effect of expanded gases is more useful in positional welding in metal transfer and influences penetration

Surface tension (Fig 3): It is the characteristic (Force) of the base metal to attract and retain the molten metal in it. This effect is more useful in the case of positional welding.

The short arc promotes more surface tension effect.

Fig 3

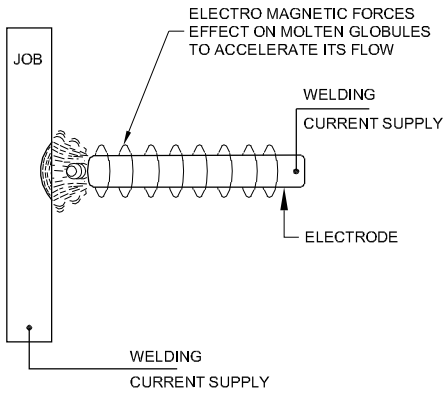


SURFACE TENSION EFFECT

Electromagnetic force (Fig 4): The current passing through the electrode forms magnetic lines of force in the form of concentric circles. This force exerts a pinch effect on the molten metal globule formed at the arcing end of the electrode. The globule is detached from the electrode and reaches the molten pool under the influence of the magnetic force.

This effect is more useful in positional welding.

Fig 4



ELECTRO MAGNETIC EFFECT

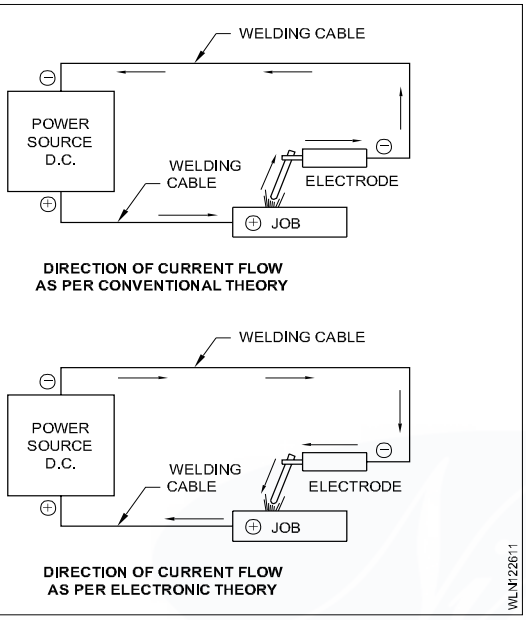
Polarity in DC arc welding

Objectives : At the end of this lesson you shall be able to

- **state the kinds and importance of polarity in arc welding**
- **describe the uses of straight and reverse polarity**
- **describe the methods of determining the polarity and explain the effects of using wrong polarity.**

Polarity in arc welding: Polarity indicates the direction of current flow in the welding circuit. (Fig 1)

Fig 1



Direct current (DC) Always flows from:

- the positive (higher potential) terminal to the negative (lower potential) terminal, as per the conventional theory
- negative terminal to positive terminal as per electronic theory.

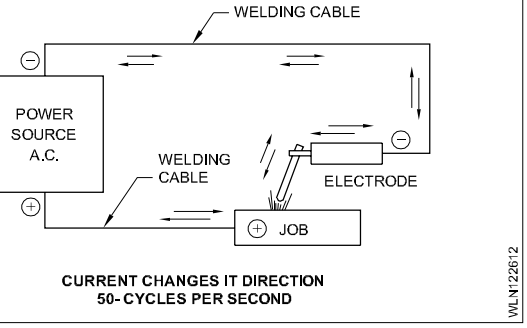
In older machines the electrode and earth cables are interchanged whenever the polarity has to be changed.

In the latest machines a polarity switch is used to change the polarity.

Flow of electrons is always from negative to the positive.

In AC we cannot utilize polarity as the power source changes its poles frequently. (Fig 2)

Fig 2



Importance of polarity in welding: In DC welding 2/3 of the heat is liberated from the positive end and 1/3 from the negative end.

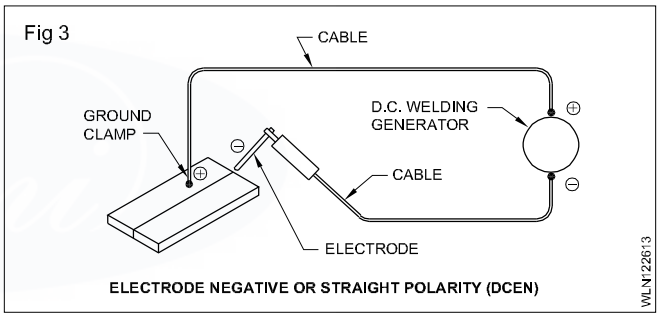
To have this advantage of unequal heat distribution in the electrode and base metal, the polarity is an important factor for successful welding.

Kinds of polarity

- Straight polarity or electrode negative (DCEN).
- Reverse polarity or electrode positive (DCEP).

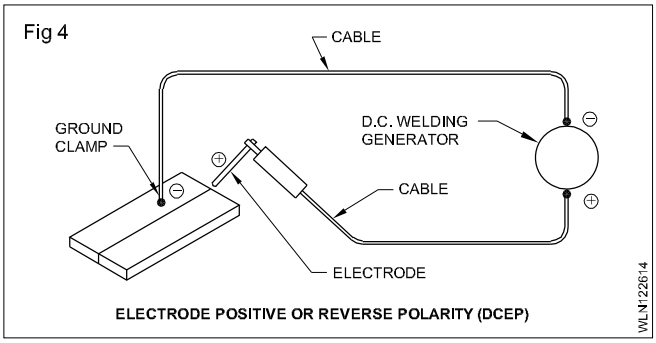
Straight polarity: In straight polarity the electrode is connected to the negative and the work to the positive terminal of the power source. (Fig 3)

Fig 3



Reverse Polarity: In reverse polarity the electrode is connected to the positive and the work to the negative terminal of the power source. (Fig 4)

Fig 4



Straight polarity is used for:

- welding with bare light coated and medium coated electrodes
- Welding the thicker sections in down hand position to obtain more base metal fusion and penetration.

Reverse polarity is used for:

- Welding of non-ferrous metals
- Welding of cast iron

- Welding with heavy and super-heavy coated electrodes
- Welding in horizontal, vertical and overhead positions
- Sheet metal welding.

DC is preferred to AC for hard facing and stainless steel welding.

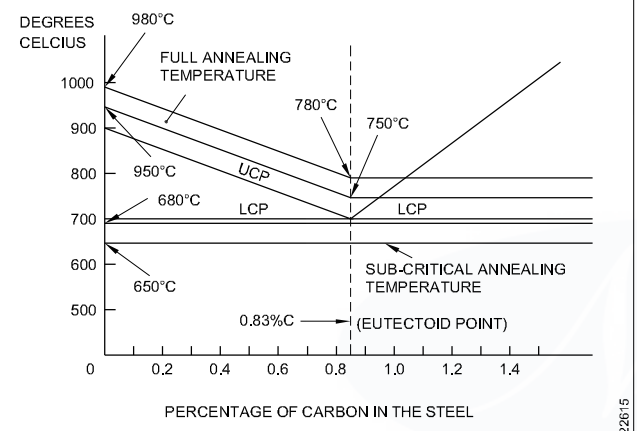
Choice of the polarity also depends on the instruction of the electrode manufacturers.

Determination of polarity: In order to get the best results it is essential to attach the electrode with the correct terminal of the welding machine.

Positive/negative terminals on a DC welding machine can be identified by the following tests.

Carbon electrode test (Fig 5): Strike an arc using normal range current with the help of a carbon electrode pointed at its end using DC.

Fig 5

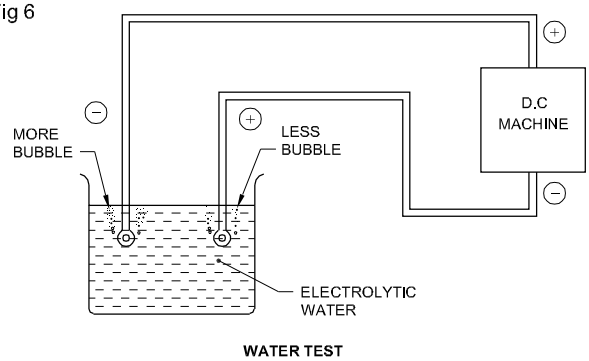


ANNEALING TEMPERATURES FOR PLAIN CARBON STEELS

The pointed end of carbon will become blunt soon if it is connected with the positive terminal, but there will be no change with the negative.

Water test (Fig 6): Put both terminals of the welding cable (connected with DC) in a container of electrolyte water separately.

Fig 6



WATER TEST

More and quick arising bubbles will indicate NEGATIVE while slow arising bubbles will indicate POSITIVE.

Indication of wrong polarity

If the electrode is used on wrong polarity it will result in:

- excess spatter and poor penetration
- improper fusion of the electrode
- heavy brownish deposition on the face of the weld metal
- difficulty in manipulation of the arc
- abnormal sound of the arc
- Poor weld bead appearance with surface defects and more spatter.

Weld qualify and inspection visual inspections

Objectives : At the end of this lesson you shall be able to
- **state the necessity of weld qualifies and inspection**
- **explain the qualify inspection- conducted to overcome the common welding trainers.**
- **describe the appearance of good and defective welds.**

Introduction

Welded joint in a welded structure (e.g. a bridge) are expected to possess certain service related capabilities. Welded joint are generally required to carry loading of various type which is subject to stress of either a simple or complex character as good or as bad as it may appear to be its in surface.

Welding qualify and inspection:

Inspection has to do with observation of the processes and product of manufacture to ensure the presence of desired qualities or properties.

In certain cases inspection may be entirely qualitative and involve only visual observation of surface defects of welded joints, etc. Whereas in other instances, inspection may involve the performance of the complicated test to determine whether specification required is met or not. Testing on the other hand, specifically refer to the physical performance of operation (Test) to determine quantitative measure of certain properties such as mechanical which will be explained later.

Testing aims to determine quality, i.e. to discover facts regarding the implication of the result, whereas inspection intends to control quantity through the application of established criteria and involves the idea of rejection of substandard product.

1 **Porosity:** It is entrapment of gases evolved during weld metal solidification

2 **Slag inclusions:** The oxides and non-metallic solid materials that and entrapped in the weld metal or between the base metal and used metal

3 **Overlap:** An excess or over flow of unfused used metal extending beyond the fusion limits over the surface of the base metal.

4 **Toe crack:** The crack occurs at the location of the toe at weld joint of base metal and weld metal. This may section the longitudinal or transverse cable.

5 **Lack of fusion:** It is incomplete or partial melting and fusion of weld metal.

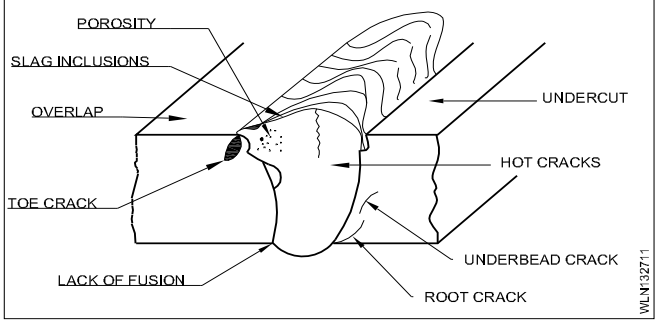
6 **Root crack:** The crack occurs at the root of a used joint

7 **Under bead crack**: It occurs under base metal due to improper, of used metal, at heat affected zone,

8 **Hot cracks:** It occurs at elevated temperature during cooling solidifying from the molten stage.

9 **Undercut:** It is a spot or continuous groove melted into base metal along the edge of weld and let in filled with weld metal.

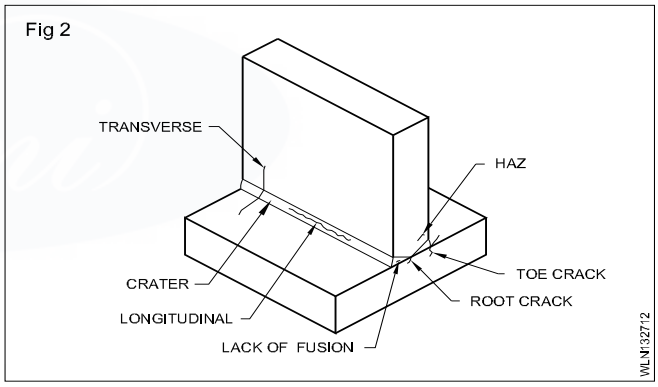
Fig 1



Common welding mistakes (Defects)

10 **Transverse crack:** The crack occurs at the location of the weld joint of base metal and weld, method across weld bead.

Fig 2

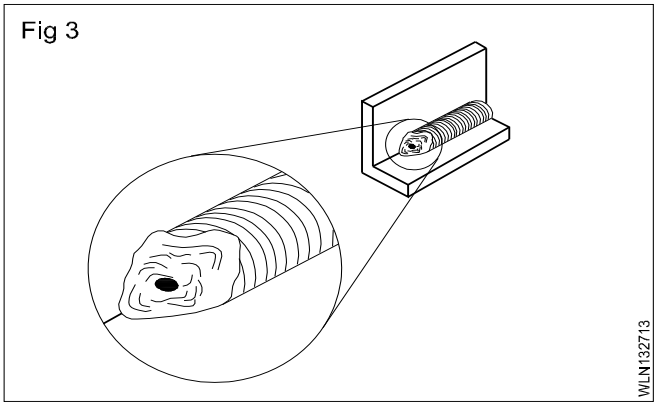


11 **Crater:** It is surface of the cavity extending into the weld bead as shown in figures.

12 **Longitudinal crack:** The crack covers at the location of the weld joint of base metal and weld metal along the face of weld seam

13 **HAZ - Heat affected zone:** The area of base metal which is melted and its micro structure properties affected by welding heat.

Fig 3



Weld gauger and its uses

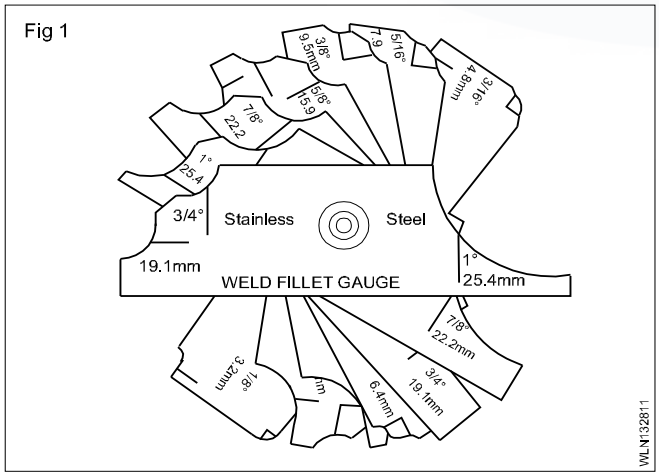
Objectives : At the end of this lesson you shall be able to
- **state the types of welding gauge**
- **explain the uses at weld fillet gauge.**
- **explain the uses of AWS type weld measurement gauge.**

Welding gauger: A set of individual leaves having the profile, made of, hardened and tempered , weld to straight with a clamping arrangement, The gauge is used to measure the leg size of weld reinforcement in butt welds, (concave and convex in case of fillet welder and) The weld joints are frequently checked for the above features, to ensure a proper weld to meet the size requirement of the component of structure which are inspected for coupling standards need stage inspection and the most suitable inspection procedure is to use the weld gauge, to attain better quality standard. The type of weld gauge weld belong the a category of weld in section, to check weld profile and its required size of bead.

- weld fillet gauge (Fig 1)
- AWS type weld measurement gauge (Fig 2)

Weld fillet gauge: To check fillet weld profile for acceptable limit, the fillet weld is checked for the leg size, using weld fillet gauge. Also concaving in weld face is also to be determined by comparing the weld face adjusting the gauge. (Fig 1)

Fig 1



The fig no.1 shown is set of weld fillet gauge, which are marked with metric and equivalent inch standard. The measuring blade is made of stainless steel and accordingly finished with are end for checking the leg size and concaving of the weld face. (Fig 2)

If one of the leg sizes is short then welding size is undersized, and this is not acceptable, (Fig 3)

Also the less concaving shows a gap between measuring face to face re-weld and this is also not acceptable.

Causes of the throat thickness of weld is less is also not acceptable.

Fig 2

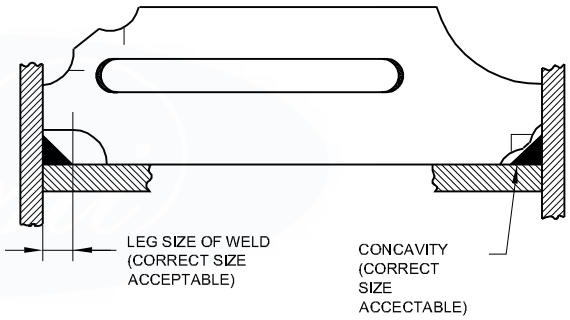
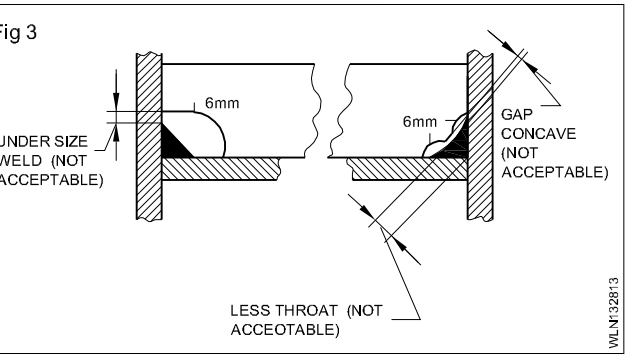


Fig 3



All weld measurement gauge

This gauge is more powerful than the standard fillet gauge. The following are the functions of this weld measurement gauge.

1 Leg size of fillet used.

2 Acceptable size of convexity.

3 Acceptable size of concavity.

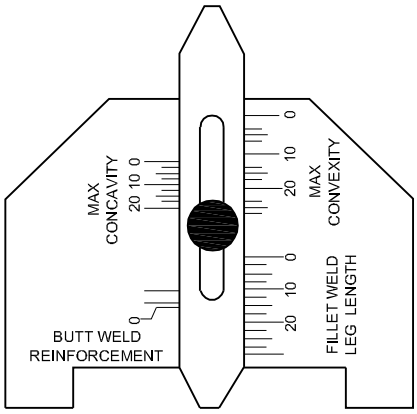
4 Acceptable reinforcement height on butt weld

The gauges consist of struck which can be suitably altered according to the position of the used bead for fillet used butt weld.

It consists of blade whose alignment is adjusted according to the weld bead surface.

According to the type of measurement the blade after positioning over the weld bead the locking screw as shown in (Fig 1) Is tightened suitably to determine the measurement .

Fig 1

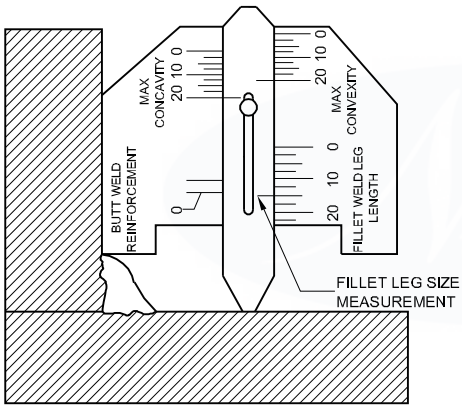


1 Leg size of fillet weld: To determine the fillet weld leg size the slot is placed against the toe of the weld as shown in (Fig 2)

On moving the pointer blade as shown in the figure down wards on the face of the other joint number.

The coincidence of the graduation scale defines the fillet issued leg measurement.

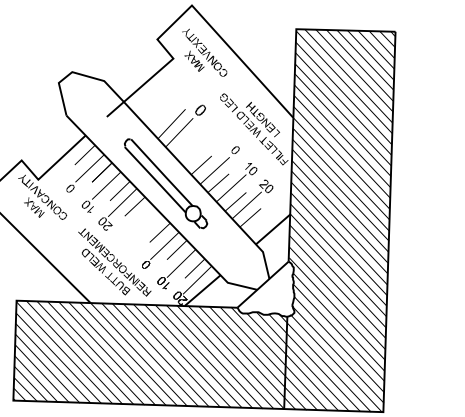
Fig 2



2 Acceptable size of convexity: To determine the acceptable size of convexity, the stock portion of the gauge having 45° angle sides to which both the members of the joints is placed as shown in Fig 3.

On sliding due pointer blade to touch the face of the weld, determines the convexity of reinforcement.

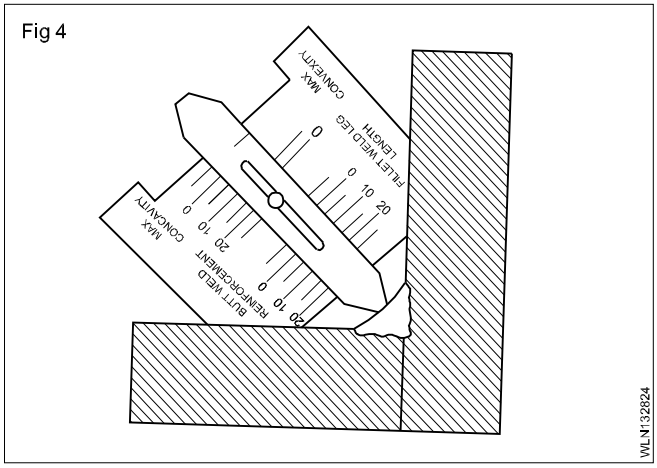
Fig 3



3 Acceptable size of convexity: To determine the acceptable size of convexity the stock portion of the gauge having 45° angle sides touching both the members of the joints is placed as shown in Fig 4.

On sliding the pointer blade to touch the face of the weld determines the concavity, formed due to under fill of the weld bead as shown in Fig 4.

Fig 4



4 Acceptable reinforcement height on butt weld: To determine the acceptable size of reinforcement height on butt weld, the spoke portion of the gauge, flat portion may be scatted on either size of butt weld as shown in Fig 5, on sliding the pointer blade downwards so as to touch the reinforcement placed on the butt weld.

The coincidence of the graduated scale determines the acceptable reinforcement height of the weld bead.

Fig 5