

Module 3

Symbols for Welding

PART OF THE CWB CERTIFICATE PROGRAMS



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INTRODUCTION

A language of symbols may be defined as one that uses a specially designed system of signs in a carefully prescribed manner to convey a clear message, direction or idea.

The use of symbols in welding, brazing and nondestructive examination is one of these languages; and it is the purpose of this Module to instruct the student in its proper application.

As in any language, there must be rigid rules governing its use to ensure clarity, uniformity and universality of understanding. One has to learn the rules and abide by them before one can hope to enter into any meaningful and intelligent dialogue with others.

Considerable effort has been put into this Module to explain the rules that govern the use of welding, brazing and nondestructive examination symbols. Extensive examples are provided to illustrate the proper application of these rules. Exercises have been prepared for the student to test his own comprehension and understanding of these symbols. Also included is detailed information in areas closely related to the concepts inherent in a welding symbol in order to assist in a broader and finer perception and command of the symbols language.

This Module is directed at individuals representing welding, supervisory, drafting and engineering personnel, including those fulfilling quality control functions or otherwise wishing to enhance their technical versatility. Although engineering overtones may be noticeable in a few areas, the level of presentation was set primarily towards the drafting and supervisory personnel, with no real difficulties expected from the shop floor welding personnel.

To fully explore the scope of its application, it was considered important to arrange the material with a judicious selection of suitable examples so as to ensure that the student will not encounter any difficulties in mastering the symbols language. No effort has been spared to identify and elucidate the more important elements of symbols used in welding. Background reasoning has been provided for many of the rules to clarify their meaning.

Some of the examples tend to relate to structural work as governed by *CSA W59 Welded Steel Construction*, or *AWS D1.1 Structural Welding Code*. This should not, however, obscure the fact that the principles of welding symbols remain unchanged, even though applications may vary from structural to mechanical, depending on the requirements and the nature of the finished product.

Exercises for each section are provided separately.

Fundamentals of Welding Technology

1. FUNDAMENTAL CONCEPTS

1.1 Weld Symbols, Supplementary Symbols, Welding Symbols

1.1.1 Definitions

In welding symbols terminology there are several standard terms in common use. A very clear understanding of these terms is of particular importance, if not a precondition to any meaningful dialogue involving welding symbols.

These terms are:

- weld symbols
- supplementary symbols
- welding symbols

The definition of these terms and their inter-relation may be described as follows:

- 1) *Weld symbol* is a term used explicitly to designate a specific type of weld. The pertinent types of welds considered under the governing AWS A2.4 specification for "Symbols for Welding, Brazing and Nondestructive Examination" and the basic weld symbols representing them are shown in Fig. 1. Weld symbols as such become an integral part of any typical welding symbol.

GROOVE WELDS							
Square	Scarf*	V	Bevel	U	J	Flare-V	Flare-Bevel

Fillet	Plug or Slot	Stud	Spot or Projection	Seam	Back or Backing	Surfacing	Flange	
							Edge	Corner

*Used predominantly in brazed joints — see section on Brazing.

Fig. 1 — Basic Weld Symbols

- 2) *Supplementary symbol*, as the term implies, is used to provide complementary information to that given by the basic elements of a typical welding symbol.

Supplementary symbols are always used in conjunction with a welding symbol, and they are shown in Fig. 2:

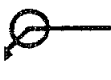
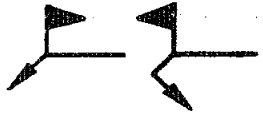
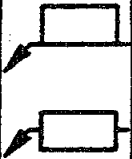
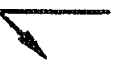
Weld all around	Field Weld	Melt Through	Consumable Insert (Square)	Backing or Spacer (Rectangle)	Contour		
					Flush or Flat	Convex	Concave
							

Fig. 2 — Supplementary Symbols

- 3) *Welding symbol*, in turn, provides comprehensive information with respect to the geometry of preparation, fit-up and welding of joints. It is composed of a number of standard elements, including a weld symbol, and uses any of the applicable supplementary symbols to effectively complement such information.

All the basic elements of a typical welding symbol, including references to supplementary symbols and their respective designated locations, are shown in Fig. 3.

It must be very clear from the preceding description that there is a very significant and distinct difference between the terms *weld symbol* and *welding symbol*.

Yet, many still appear to have the misconception that both terms share the same meaning.

The student is well advised, first, to ensure that he fully understands the exact meaning of these two terms and, second, to firmly resolve to use them only in the proper context.

After this brief introduction to the three basic symbol terms, a more extensive discussion of each will highlight their own significance in conveying specific welding information.

2.2 Basic Weld Symbols

Reference was already made to the primary purpose of a weld symbol. Its main and specific objective was described to be to graphically identify each type of weld.

In order to assist in this identification, the shape of the symbol, whenever possible, was made to conveniently reflect the relative configuration of the fusion faces as represented by a vertical section through the joint.

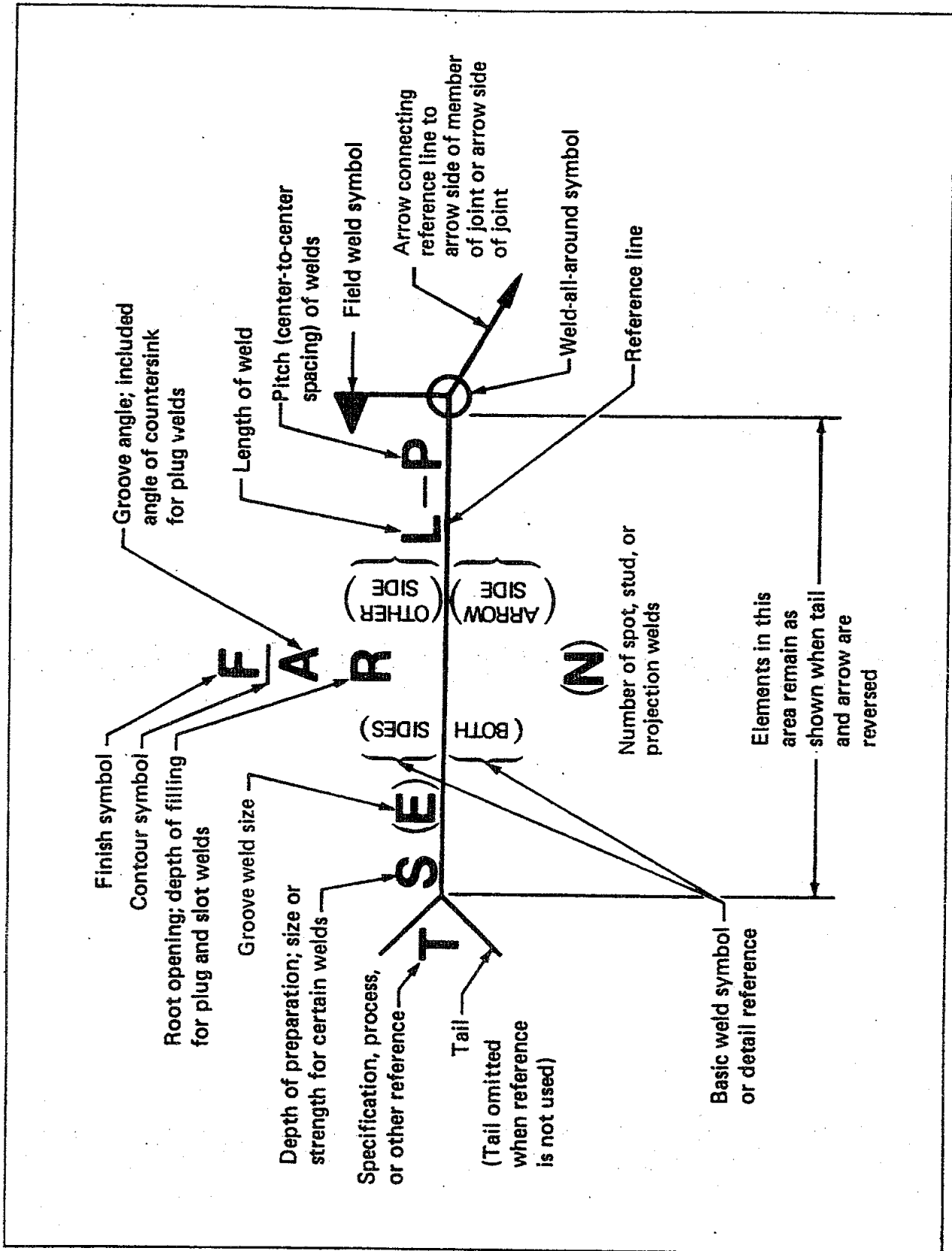
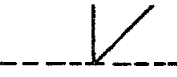
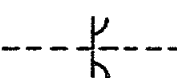
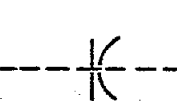
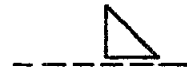


Fig. 3 — Standard Location of Elements of a Welding Symbol

A few examples will illustrate this particular and very commendable idea. Groove, fillet and plug welds will be used to demonstrate its practical sense and validity.

Types of Welds with Accentuated Fusion Faces	Weld Symbols
Square  Single-V  GROOVE WELDS Single-Bevel  Double-J  Double-Flare-Bevel 	    
FILLET WELDS	
PLUG WELDS	

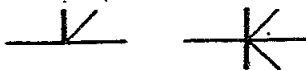
This "visual confrontation" of the shape of preparation in the fitted-up joint or of the cross-section of the weld with its own weld symbol proves extremely well the attractiveness of this approach as it registers visually their geometric similarity.

In the presentation or placing of weld symbols on the reference line there is one important point that must be rigidly observed. It concerns only weld symbols which, in their make-up, have one vertical line. The rule requires that the vertical line must always be on the left side in the weld symbol when read from the viewing position of the reader.

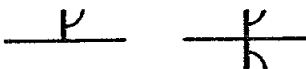
The pertinent weld symbols subject to that rule are symbols for:

Symbols for Welding

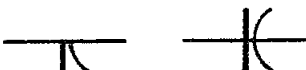
Single- or Double-
Bevel-Grooves



Single- or Double-
J-Grooves



Single- or Double-
Flare-Bevel-Grooves

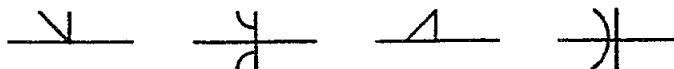


Single- or Double-
Fillet Welds



↑
Viewing Position of the Reader

Hence, all weld symbols as shown below, viewed from the same position as the symbols above, are *incorrect*:



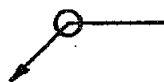
This rule points to the fact that proper attention must be given to the placement of a weld symbol on the reference line.

1.1.3 Supplementary Weld Symbols

As seen from Fig. 2, supplementary weld symbols are used to convey specific requirements. One can again observe that their graphic designations bear a very close visual likeness to the effect they mean to achieve.

Such close resemblance can certainly be claimed for the symbols denoting:

Weld all-around



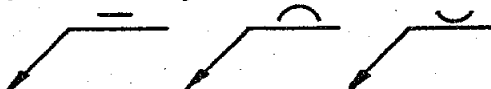
Melt-thru



Backing or Spacer material



Contour of the Finished Weld



Consumable insert

No such reasonable claim can be made by the flag designating a field weld, although one would generally associate a flag with the "outside" and an exposure to atmospheric conditions.

The rules governing the use of supplementary symbols will be discussed later.

1.1.4 *Welding Symbols and Standard Location of Elements*

The classic welding symbol listing all the basic elements that it may contain has already been shown in Fig. 3.

These basic elements, not all of which need to appear in the symbol, are as follows:

- reference line
- arrow
- basic weld symbol
- dimensions and other data
- supplementary symbols
- finish symbols
- tail
- references

These elements shall be discussed first in a general manner with the primary objective to acquaint the student with a number of basic concepts governing the use of welding symbols.

A far more exhaustive presentation of the proper use of these elements will be presented later, when dealing with individual types of welds in their specific area of application.

However, an intelligent discussion of the general principles of welding symbols requires a thorough understanding of the fundamental concepts of joints and welds.

2 *Types of Joints and Types of Welds*

2.1 *Types of Joints*

There are five basic types of joints:

BUTT — CORNER — TEE — LAP and EDGE

and they are all illustrated in Fig. 4. It may be easily seen that the criterion used in categorizing joints is the relative configuration of the two pieces of material to be welded.

The AWS A3.0 *Standard Welding Terms and Definitions* describes a joint as being the "junction of members or the edges of members which are to be or have been joined."

The reference to "junction of members" is describing the area of common contact between the two members and applies to the first four types of joints in Fig. 4. It has been indicated by shading.

The reference to "junction of edges" applies to the edge joint, shown at the bottom of Fig. 4.

The proper and clear understanding of the definition of a "joint" is of overriding importance. It is a precondition of a meaningful dialogue on the application of welding symbols and specifically on the *arrow* significance, which will be discussed shortly.

Symbols for Welding

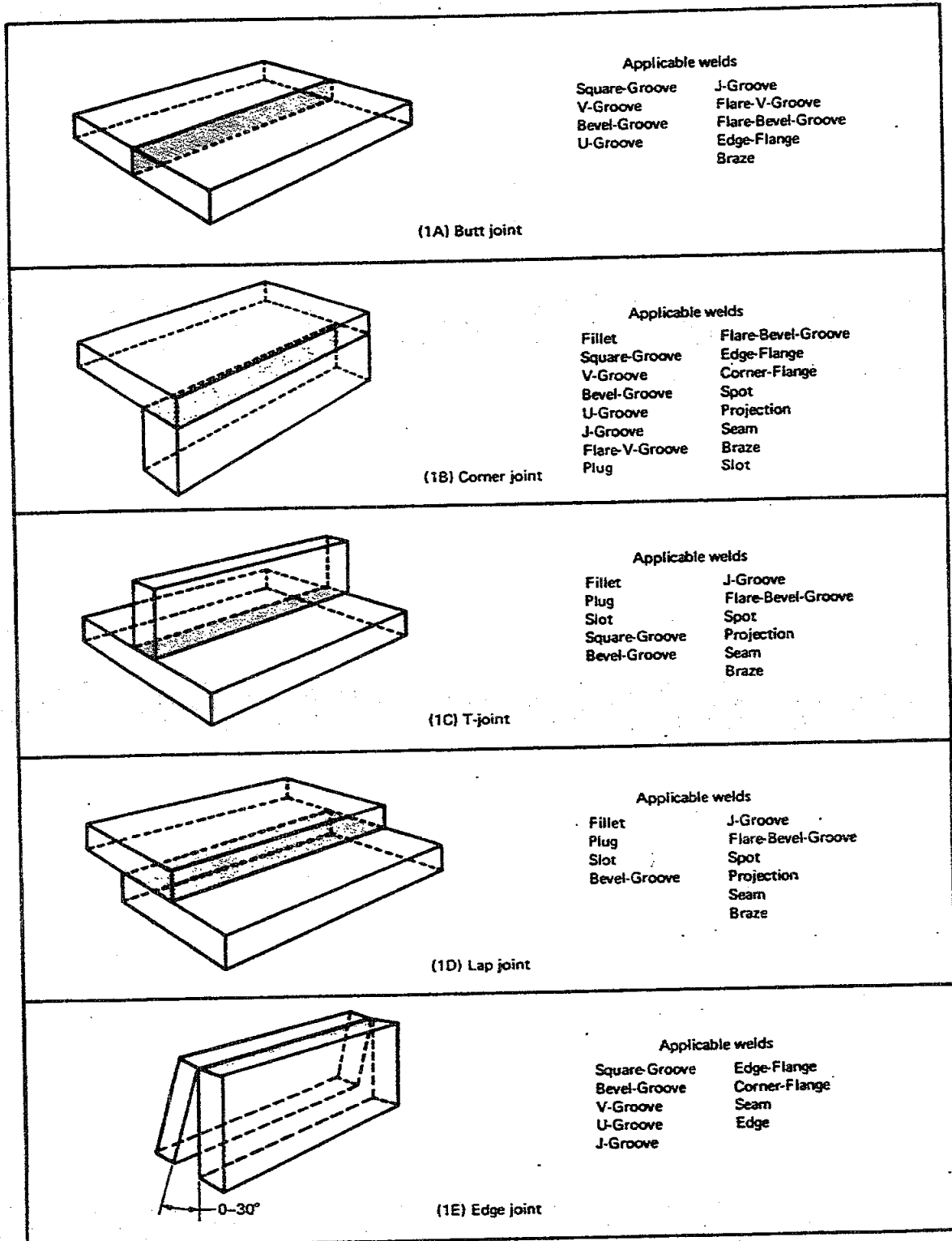


Fig. 4 — Basic Types of Joints

It may be of interest to note that the governing welding design specifications, CSA W59 *Welded Steel Construction* and AWS D1.1 *Structural Welding Code—Steel*, in their sections on prequalified joints use the following designations:

B	for butt joint
C	for corner joint
T	for T-joint
BC	for butt or corner joint
TC	for T- or corner joint
BTC	for butt, T-, or corner joint

Lap and edge joints are not included, as they are governed by other provisions of these specifications.

1.2.2 *Types of Welds*

There are considerable misconceptions in the common usage of the terms *welds* and *joints*. In most cases, they are taken to mean the same thing. They are mistakenly assumed to be interchangeable.

Unfortunately, such delinquent use of the official AWS terminology may occasionally be spotted in North American welding literature.

This has to be taken as evidence of insufficient care in the usage of the correct terms, especially by people who, by virtue of their exposure and involvement in welding operations on this continent, must be presumed to be better informed.

This situation is further aggravated by the fact that other English-speaking countries have not adopted the AWS terminology. There, the very common reference to a "butt weld" is completely in line with the accepted official practice.

The AWS is far superior in its definition of the two terms, as it provides logic, clarity and consistency.

One has to have a joint first before one can think about a weld.

There are many types of welds. The types of welds that may be considered for each of the basic joints are shown in Fig. 1.

All of these welds will receive some measure of attention in the course of further discussions.

Again, it may be of interest to note that the CSA W59 and the AWS D1.1 Codes have assigned an identification number to each of the types of welds which are of specific use in their area of application.

- | | |
|------------------------|--------------------|
| 1. square-groove | 6. single-U-groove |
| 2. single-V-groove | 7. double-U-groove |
| 3. double-V-groove | 8. single-J-groove |
| 4. single-bevel-groove | 9. double-J-groove |
| 5. double-bevel-groove | |

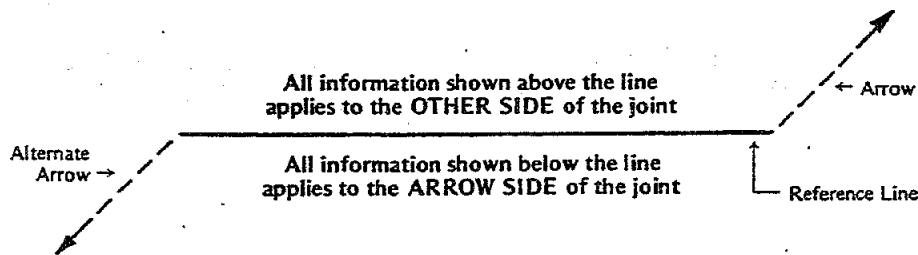
Symbols for Welding

1.3 General Provisions

1.3.1 Arrow Significance

Presently, attention will be given to the significance of the welding information placed *below* and *above* the reference line. As already stressed, a thorough and clear understanding of the principle governing the respective placement of such information is an absolute condition for proper application and interpretation of welding symbols.

The principle used is simple:



The rule as expressed above makes reference to:

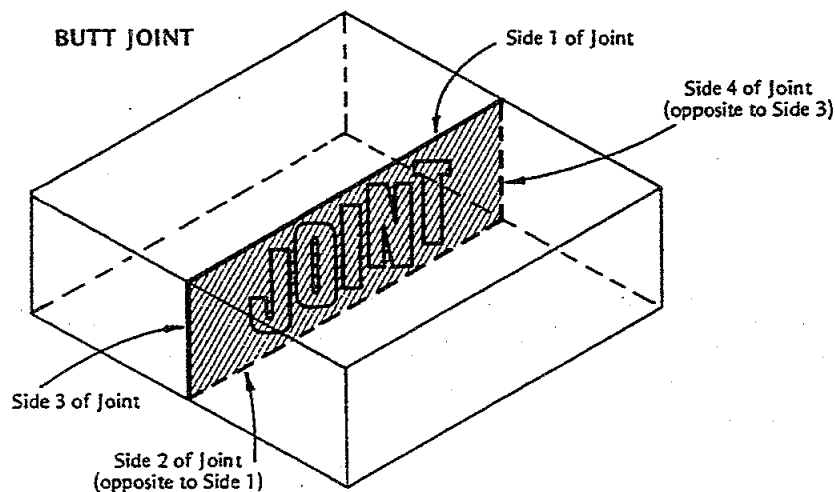
- ✓ the *arrow side* of the joint, and
- ✓ the *other side* of the joint.

These are two key concepts, and their proper application presupposes a clear understanding of the term "joint."

It has been already pointed out that the area of common contact between the members to be welded, identified by shading in Fig. 4, constitutes a *joint*.

The arrow side of the joint is obviously the side to which the arrow points. It is the *other side* of the joint which requires an easily recognizable identification.

Prior to the use of a number of clarifying examples, it will be advisable to illustrate these features of a joint which are essential and important when specifying welding information in a symbol. The butt joint of Fig. 4 will serve that purpose and help to identify *sides*.

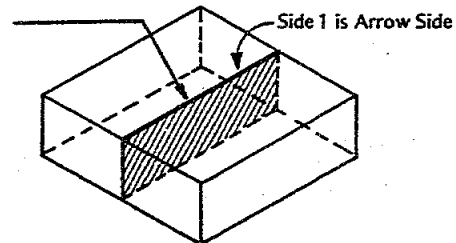


Fundamentals of Welding Technology

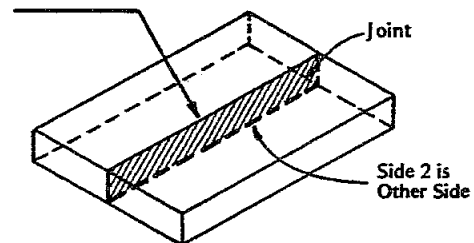
There are two pairs of opposite sides in the above butt joint. The joint itself, geometrically speaking, is a rectangle. The governing rule is as follows:

If any of the sides is defined as the *arrow side* by virtue of the arrow pointing to this side, then the *other side* is automatically the one *opposite* the arrow side.

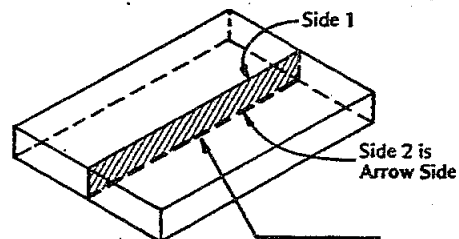
Hence, if the ARROW SIDE were Side 1 as identified by the symbol...



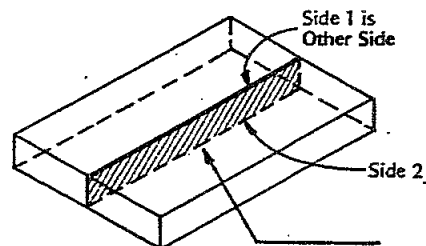
then the *other side* is automatically Side 2 (opposite to Side 1), as identified indirectly by the same symbol.



On the other hand, if the *arrow side* were Side 2 by virtue of the arrow pointing towards it,



then Side 1 becomes automatically the *other side* as identified indirectly by the same symbol.



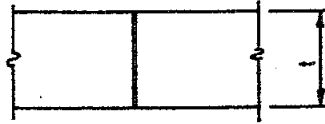
Similarly (although rather remote in this case), if the *arrow side* were Side 3, then Side 4 would have been the *other side*.

Because of the repeatedly stressed importance of proper understanding of the *arrow* and *other* sides of the joints, a good number of examples will be used to ensure with reasonable certainty that the student has indeed grasped their significance.

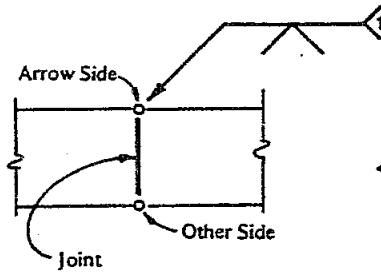
Symbols for Welding

EXAMPLE 1 GROOVE WELD IN A BUTT JOINT

Required:
A Single-V-Groove Weld



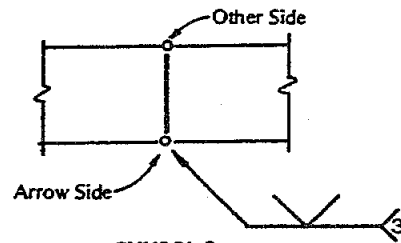
▼ ALTERNATIVE 1:



SYMBOL 1
indicates preparation to be made
from the Arrow Side

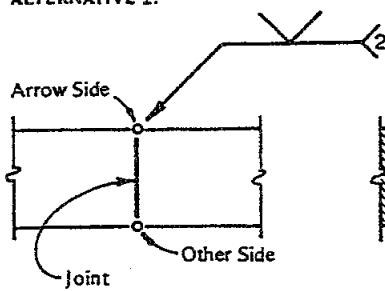


WELD

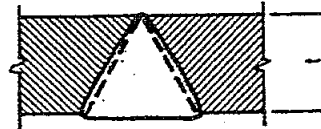


SYMBOL 3
Preparation from the same side
could have been obtained
using Symbol 3 as shown.

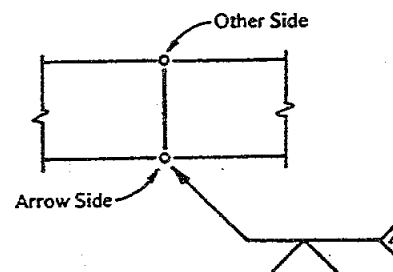
▼ ALTERNATIVE 2:



SYMBOL 2
indicates preparation from
the Other Side



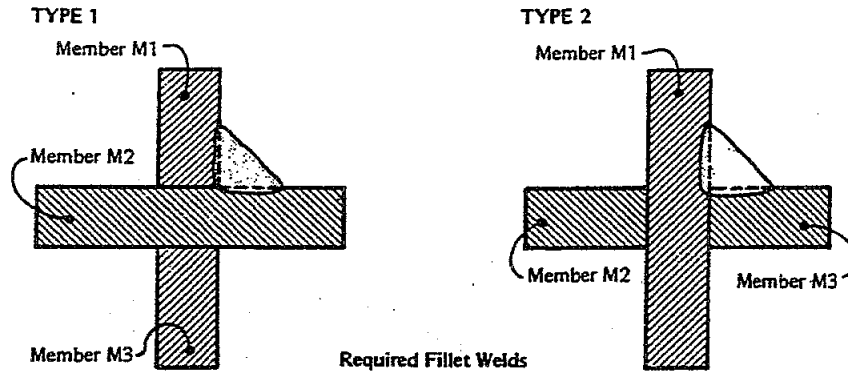
WELD



SYMBOL 4
Preparation from the same side
could have been obtained
using Symbol 4 as shown.

EXAMPLE 2

CRUCIFORM [DOUBLE-T-] JOINTS



The objective of this example is to call for the above single fillet welds

- (i) with a symbol on the arrow side, and
- (ii) with a symbol on the other side.

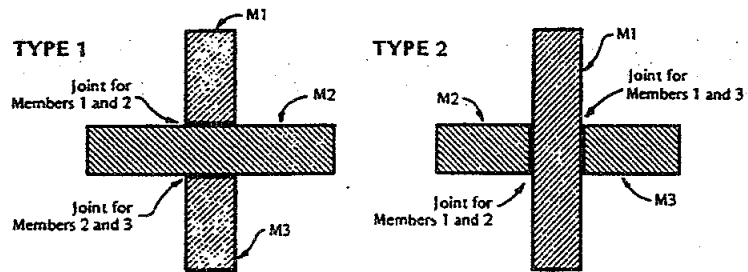
Imperative to the correct application of these symbols is the identification of the pertinent joints in each of the cruciform arrangements of members.

Since, as pointed out, a joint is described as the common area of contact between two members to be welded; and since, in the example in

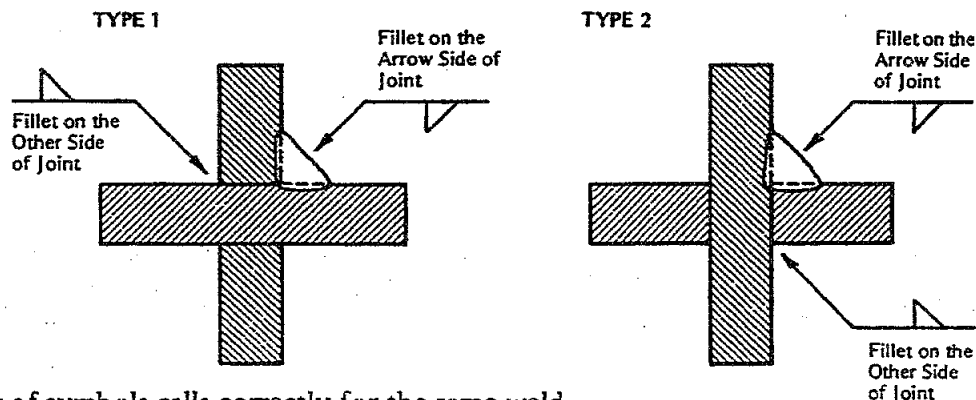
Type 1: — Member M1 is to be welded to member M2;

Type 2: — Member M1 is to be welded to member M3;

the common areas of contact and, therefore, the joints must be as shown.



Having identified the applicable joints for each type of arrangement, the proper placement of arrow side and other side weld symbols should present no problems.

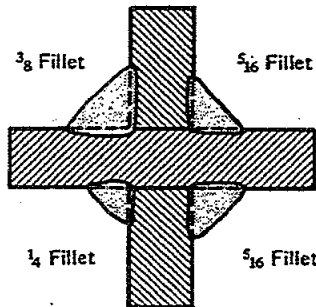


Each pair of symbols calls correctly for the same weld.

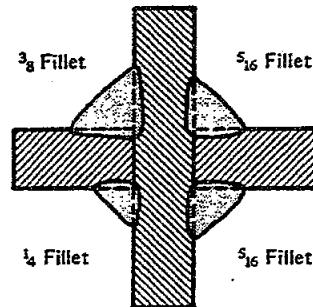
EXAMPLE 3

CRUCIFORM JOINTS SIMILAR TO THOSE IN EXAMPLE 2
BUT WITH FILLET SIZES SPECIFIED FOR EACH CORNER

TYPE 1



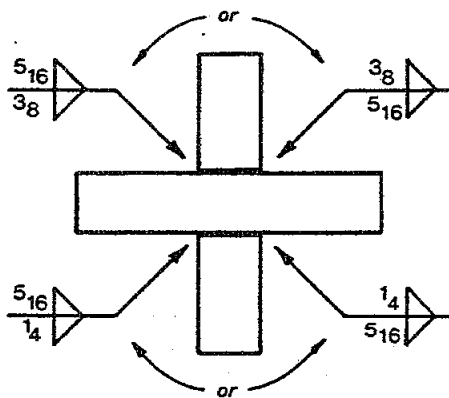
TYPE 2



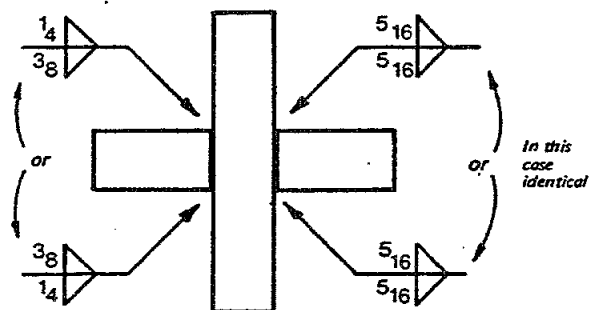
Desired Welds
showing *identical* arrangement for each type

The correct double fillet welding symbols for each type, respectively, will be:

TYPE 1



TYPE 2



Appropriate Symbols
for the Desired Welds

Either metric or imperial measures may be applied

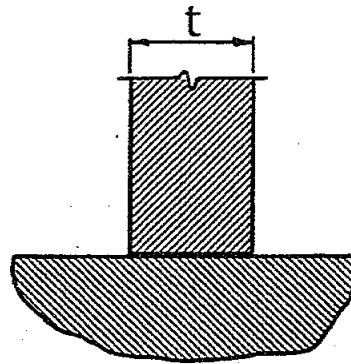
Identical arrangement of fillet welds in each type results in a marked difference in the application of proper welding symbols, and the only reason for it is the fact that the *joints* in each type are in different *planes*.

EXAMPLE 4

GROOVE WELD IN A T-JOINT

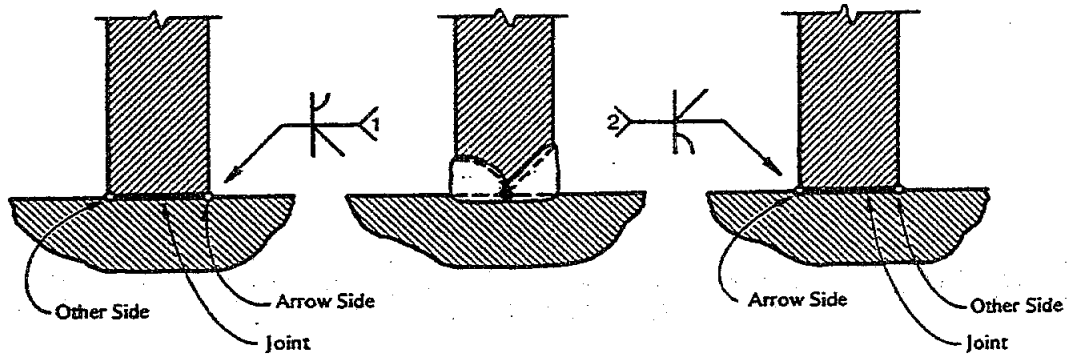
Required a combined
Bevel- and J-Groove-Weld

(A hypothetical requirement
considered only for the
purpose of exercise)



Assuming half a thickness preparation for each type of groove, the alternatives are:

▼ ALTERNATIVE 1:



SYMBOL 1

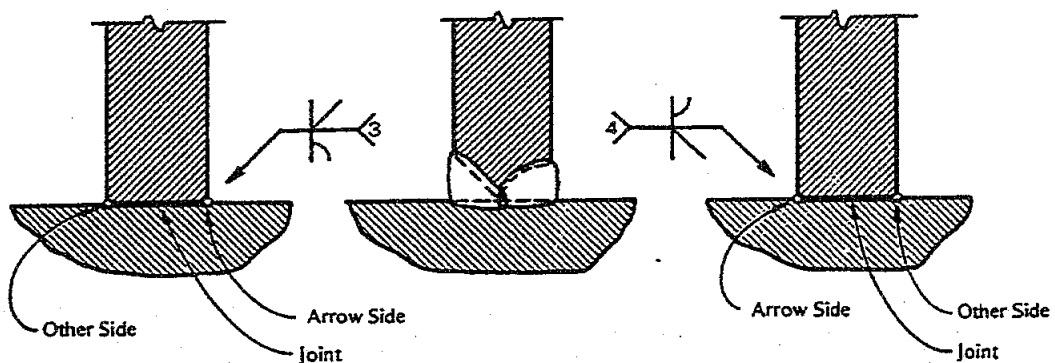
indicates bevel preparation from
Arrow Side and "J" preparation
for the Other Side

WELD

SYMBOL 2

Identical preparation of the Joint
can be obtained using Symbol 2

▼ ALTERNATIVE 2:



SYMBOL 3

indicates "J" preparation from the
Arrow Side and Bevel preparation
from the Other Side

WELD

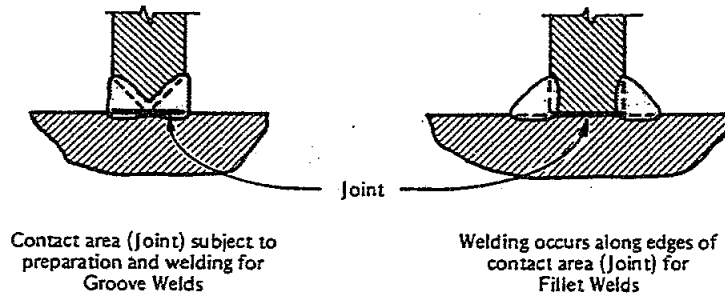
SYMBOL 4

Identical preparation of the Joint
can be obtained using Symbol 4

Symbols for Welding

As a concluding observation in the discussion of arrow significance it must be obvious that the identification of sides of joints for *groove welds* is exclusively related to the preparation of grooves from the respective designated arrow or other sides of joints.

In this case, the contact area constituting the joint is subject to preparation and subsequent welding; while in the case of fillet welds welding occurs along the edges of the contact area.



While the *arrow* and *other side* significance has a slightly different meaning for plug, slot, spot and seam welds, it has none for stud and surfacing welds. This meaning will be clarified when these particular welds are discussed.

Brief mention should also be made of resistance welded spot and seam welds for which the arrow has no side significance. This again will be brought to the attention of the student in due course.

An extensive array of Exercises prepared separately from this Module will further help in the understanding of the arrow significance and in the verification of this understanding.

1.3.2 Information in Tail of Welding Symbol

The tail of the welding symbol allows convenient placement of any type of information that will effectively complement the information conveyed by the other components of the symbol.

The conventions as used by individual companies and geared to their specific operations will have a great bearing on the type of information that each of them will consider sufficient in scope for their needs.

Such information may:

1. refer to a specific welding process, or
2. consist of a welding procedure specification number, or
3. show the expression "typical" when the required weld is representative of all welds shown in the drawing.

Two tabulations in the Appendix taken from the AWS A2.4 Specifications show a listing of letter designations for welding and allied processes cross-referenced alphabetically. Any office contemplating the use of abbreviated designations for welding processes is urged to take them from that official listing.

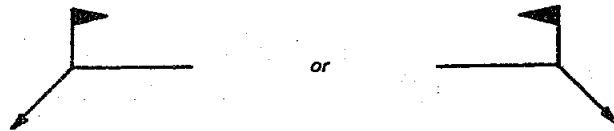
The omission of any reference in the tail of the symbol should only be considered if other means are used by the company to provide the pertinent complementary welding information... be it a *general* note on the drawing or directions issued in a separate document.

When no information is intended for placement, the tail may be omitted.

1.3.3 Field Weld Symbol

Welding in the field is generally understood to mean welding in a place other than that of initial construction. The erection phase of welded construction work will most likely involve welding in the field, or on site, as some may refer to it.

The weld symbol designating welding in the field must show a flag placed above and at right angle to the reference line at the junction with the arrow. The direction of the arrow is left optional. However, some may find preference in pointing it away from the arrow.



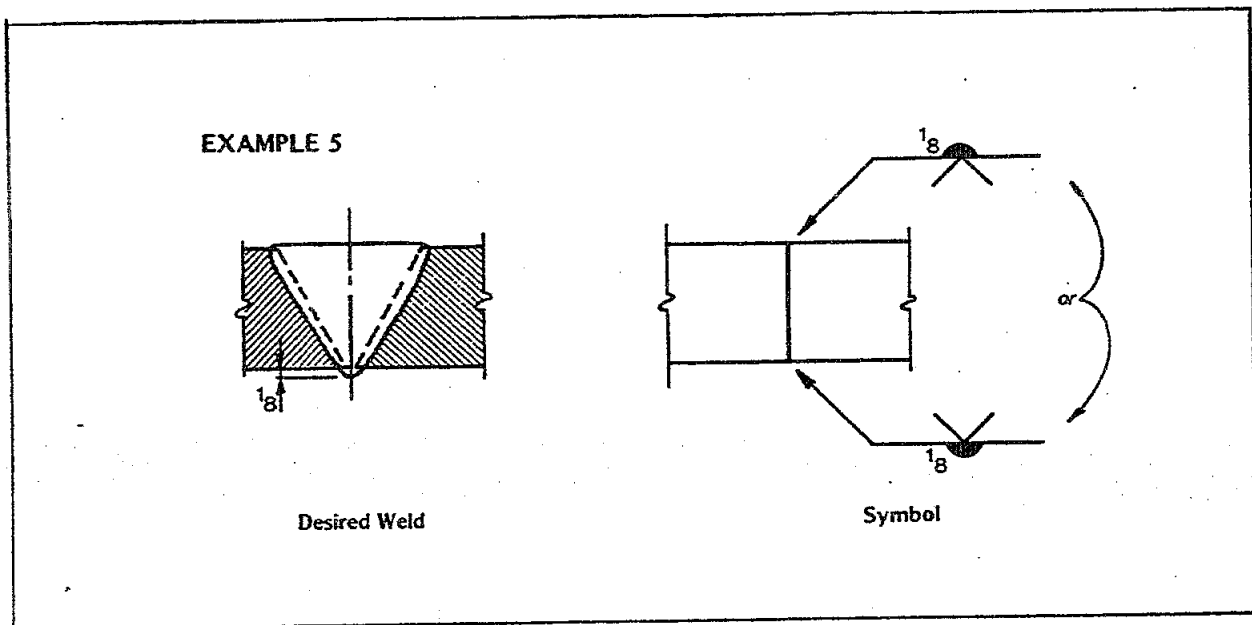
1.3.4 Melt-thru Symbol

Occasionally, there are conditions in a joint in which full or *complete joint penetration* is required that permit welding only from one side. As a visible manifestation of such penetration, a reinforcement may be specified for the *other side*.

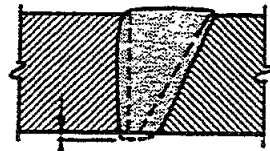
This reinforcement may be conveniently expressed by a *melt-thru* symbol, together with its required height, or without it when a specific height is of no significance.

When mechanical means are intended to obtain the desired contour, the supplementary contour symbols should be used with the user's preferred mechanical means specified to obtain it.

The following sketches will illustrate these provisions:

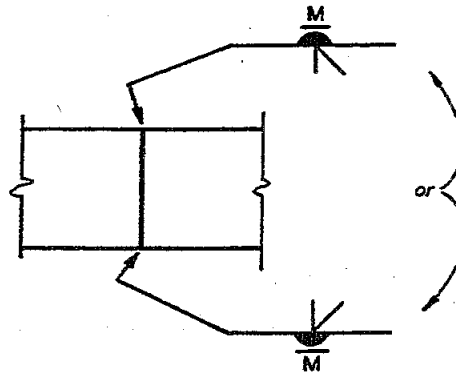


EXAMPLE 6



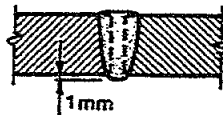
Reinforcement to be removed flush by subsequent Machining [M]

Desired Weld



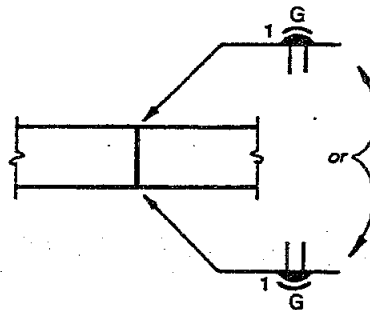
Symbol

EXAMPLE 7



Convex Reinforcement of 1mm to be provided by Grinding [G]

Desired Weld



Symbol

1.3.5 Extent of Welding Denoted by Symbols

When the length of a weld is not specified in the symbol, the welded length is the one between abrupt changes in the direction of welding.

A length of weld may also be designated by a dimensioned length of hatching.

As its name implies, the *all-around* welding symbol specifies a weld all around the joint, regardless of the number of planes involved.

All of the above variations to the extent of welding as covered by a welding symbol with or without supporting dimensioning are reviewed extensively in the section on fillet welds.

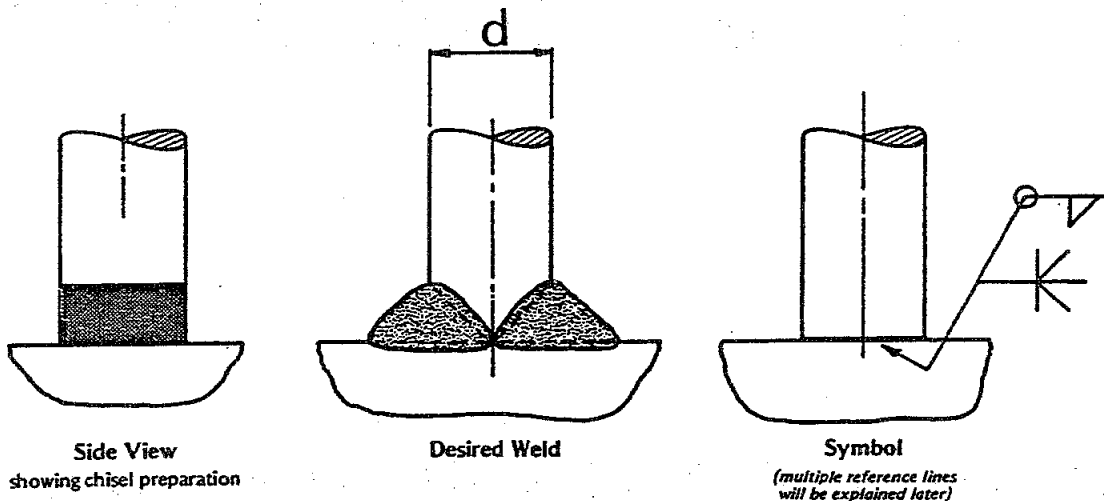
Should *intermittent* welds be required in the length of a joint, they should be dimensioned in the welding symbol in a manner as shown and thoroughly discussed in the section on fillet weld

Groove welds are normally continuous for the full length of the joint, in which case no reference to length need appear in the welding symbol.

However, there is one interesting case of an *all-around* weld involving a groove and a fillet weld which deserves specific mention. The following two examples will illustrate the point:

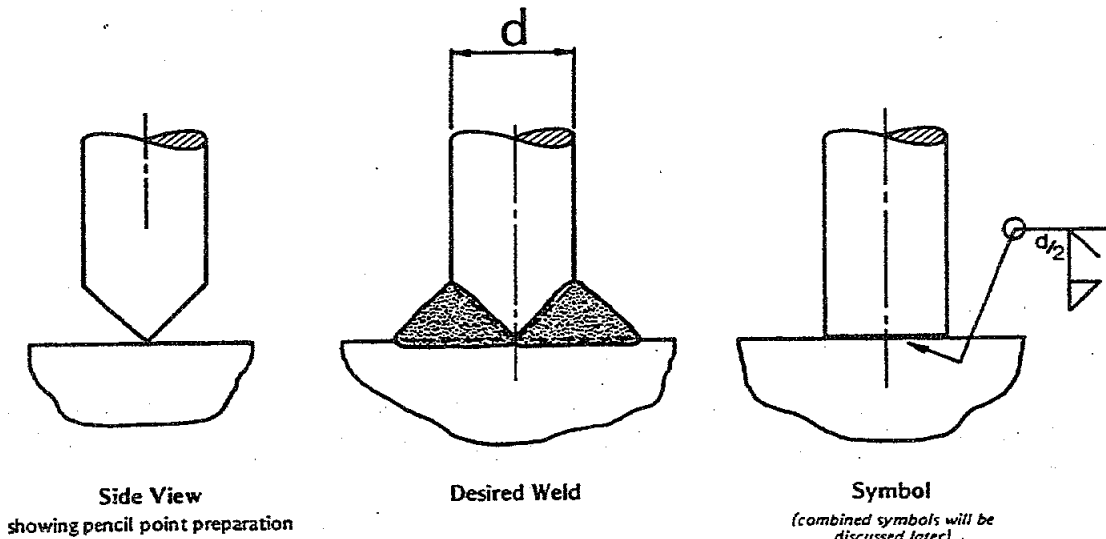
EXAMPLE 8

A ROUND BAR WELDED TO A BASE PLATE



EXAMPLE 9

A ROUND BAR SIMILAR TO EXAMPLE 8 WELDED TO A BASE PLATE



1.3.6 Finishing of Welds

The required contour of welds may be obtained without recourse to mechanical means. However, if such means are necessary to produce the required finish, the appropriate letter designation assigned to the following methods of finishing must be added to the contour symbol:

- C — Chipping
- G — Grinding
- M — Machining
- R — Rolling
- H — Hammering

It must be understood that these designations specify the method and not the degree of finish.

1.3.7 Break in Arrow

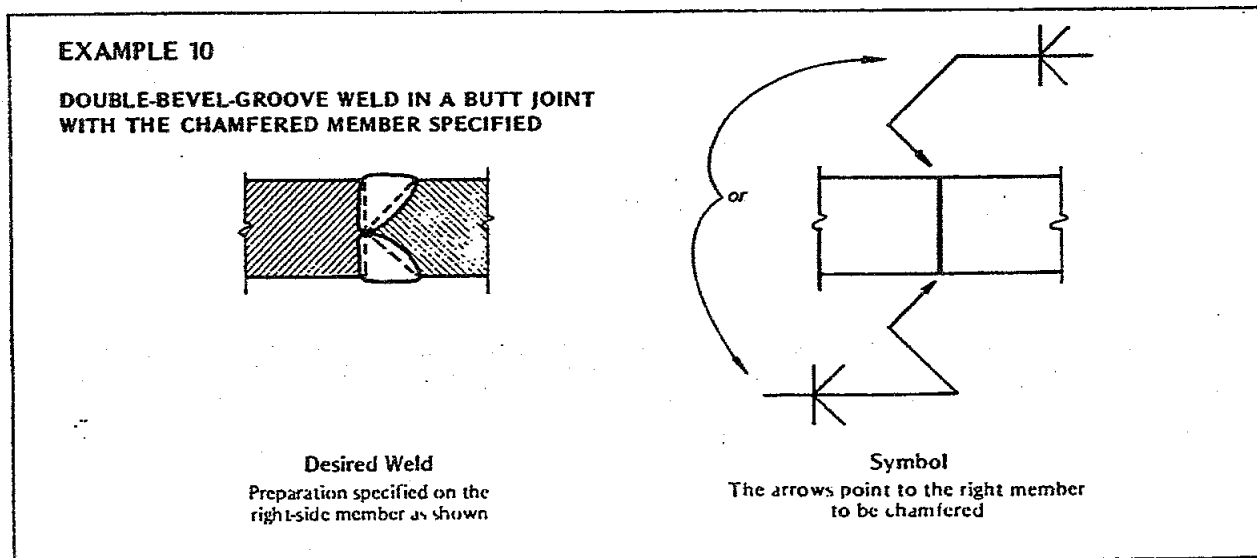
In most cases of groove welds, both members to be jointed require some form of preparation. Hence, the use of an ordinary welding symbol with an ordinary straight-line arrow is entirely satisfactory. However, such is not the case with groove welds requiring the preparation of only one member in the joint. If the preparation of one specific member is of importance, the welding symbol must have positive means to identify this member.

This is conveniently done by a break in the arrow, with the arrow pointing in the direction of the member to be chamfered.

It should be noted that the arrow need not touch this particular member. The only matter of importance is *the direction in which the arrow points* (to the left or to the right)!

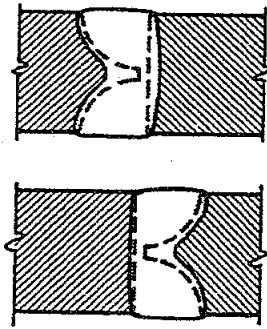
The arrow need not be broken if the welding symbol is not used to specify *which* member has to be prepared. There are, of course, situations in which only one member *can* be prepared, in which case a break in the arrow is superfluous.

The following examples will illustrate the points made:

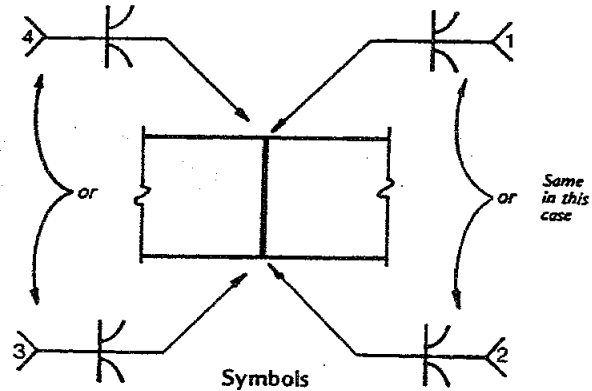


EXAMPLE 11

DOUBLE-J-GROOVE IN A BUTT JOINT WITH THE MEMBER TO BE CHAMFERED *NOT* SPECIFIED



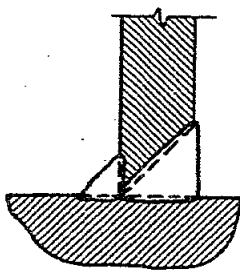
Desired Welds
Either of the two are acceptable



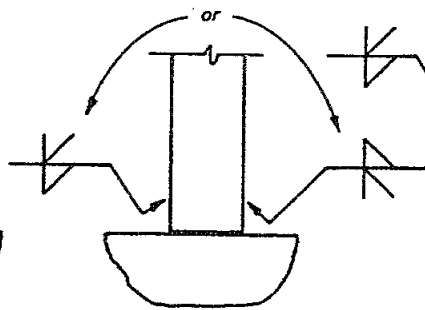
Pointing the arrow to the left or to the right member as shown has no significance with regard as to which member is to be chamfered because they are straight-line arrows without a break.

EXAMPLE 12

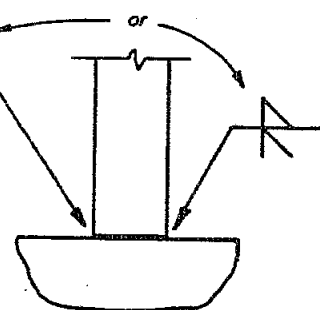
SINGLE-BEVEL-GROOVE AND A FILLET WELD IN A T-JOINT



Desired Weld



Symbol
Arrow with a Break



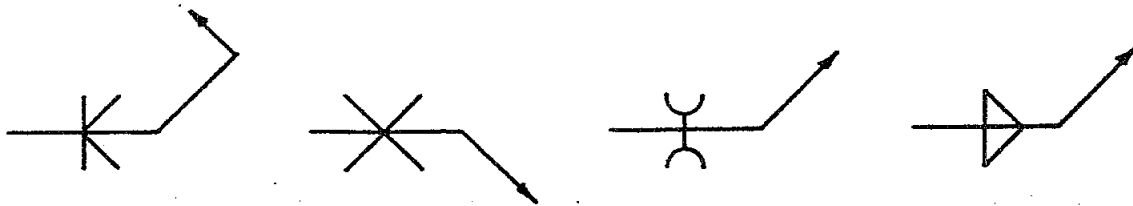
Symbol
Arrow without a Break is acceptable as only one (the intended) member can be prepared

[As a matter of principle, it is recommended to use the arrow with a break]

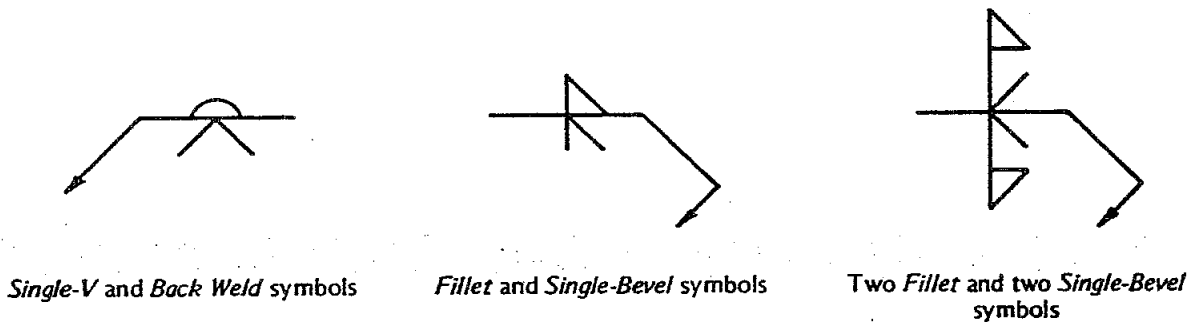
Symbols for Welding

1.3.8 Combined Weld Symbols

Normally, joints will require more than one type of weld symbol. Joints for which one type of weld symbol is sufficient are represented by welding symbols like the following:



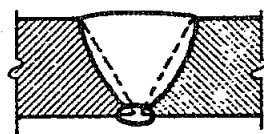
However, joints which require a combination of two or three different types of weld symbols are illustrated by the following welding symbols:



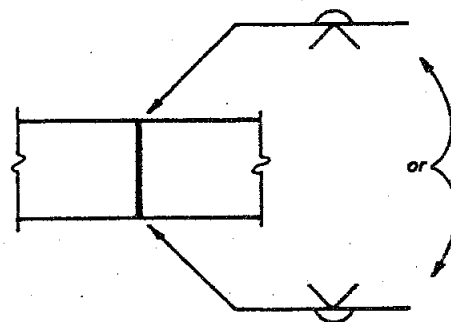
Each of the welds represented by the pertinent weld symbol must appear in the welding symbol, either in a single or in a combined arrangement.

EXAMPLE 13

A SIMPLE WELD SYMBOL COMBINATION



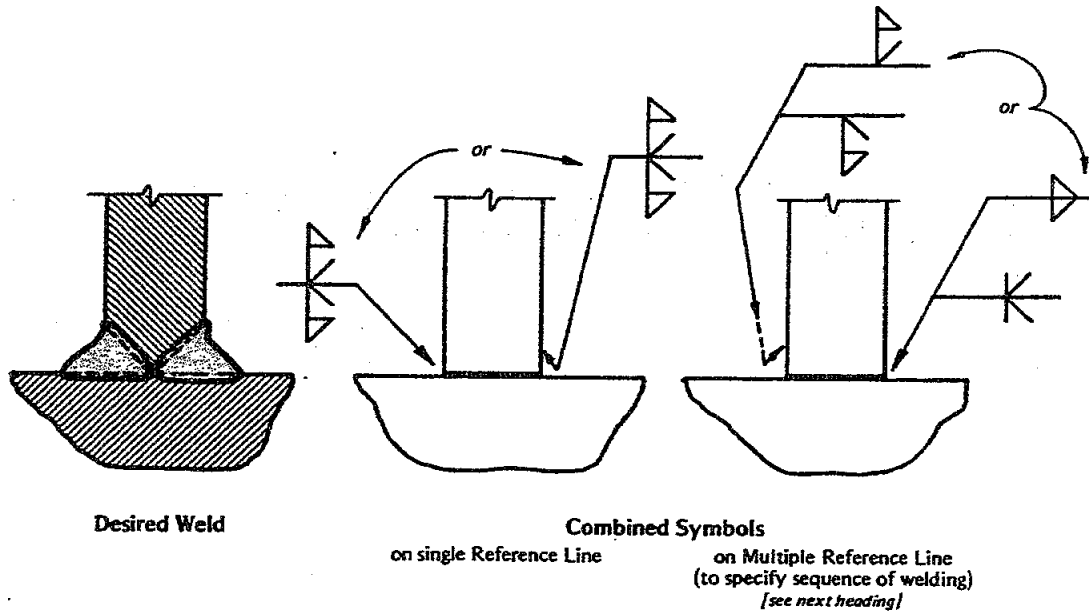
Desired Weld



Symbol
A combination of a V and
Back Weld symbols

EXAMPLE 14

A MULTIPLE WELD SYMBOL COMBINATION



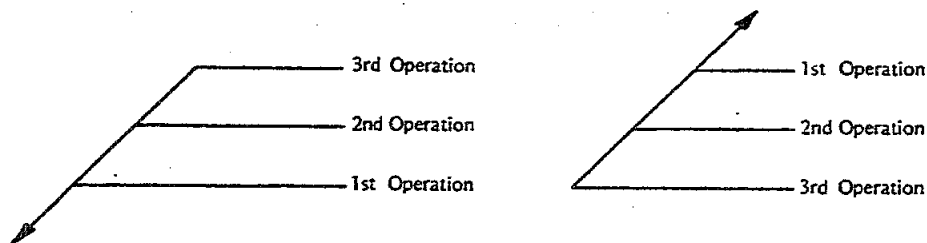
The rather frequent use of fillet welds to reinforce groove welds, especially in T-joints, gives rise to the use of multiple-weld symbol combinations.

1.3.9 Multiple Reference Lines

The very objective of the multiple reference line concept is to give the welding symbol the added capability to specify the sequence of welding operations as well as to provide additional information relative to the examination of welds or other operations.

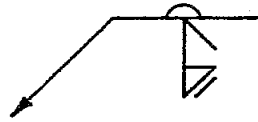
Two or more reference lines are feasible. They should, however, be used with good judgement.

The rule that applies to sequencing is very clear. It states that the operation that is desired *first* is to be shown on the reference line closest to the arrow. All subsequent operations are to follow the same sequencing order as the pertinent reference lines move away from the arrow. The welding symbol below explains this principle:

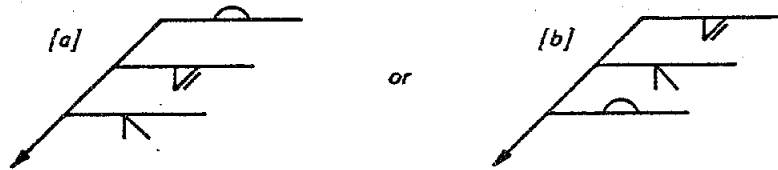


Symbols for Welding

When a sequence is to be specified for a joint defined by the following welding symbol...

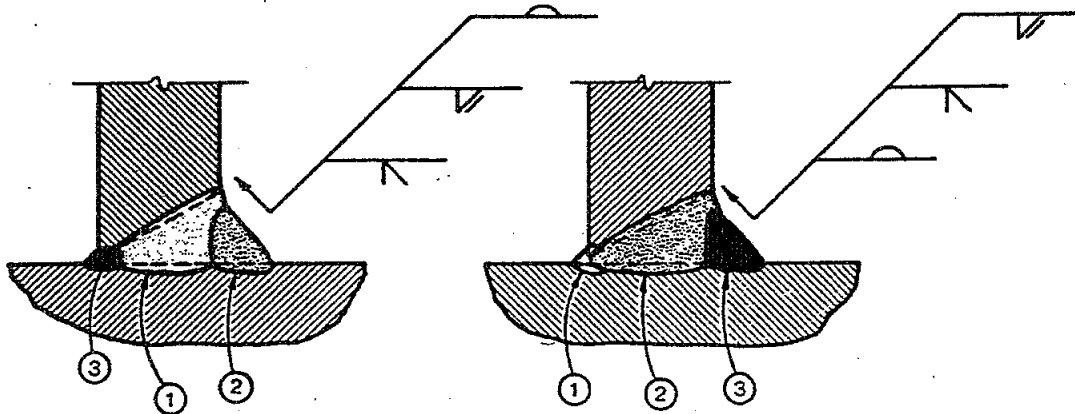


then these sequencing alternatives may be considered:



The specified sequence for each case will be:

- | | | | |
|---|--|--|--|
| <ol style="list-style-type: none"> 1) weld bevel-groove 2) weld flat fillet 3) put back pass | } <i>arrow side</i>
} <i>other side</i> | <ol style="list-style-type: none"> 1) put backing pass 2) weld bevel groove 3) weld flat fillet | } <i>other side</i>
} <i>arrow side</i> |
|---|--|--|--|



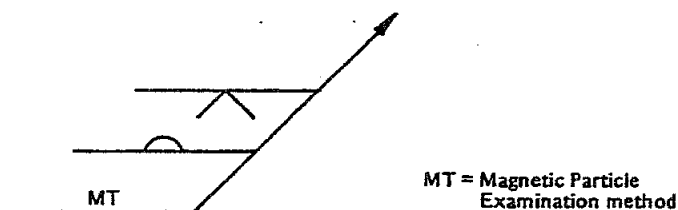
Desired Weld and Sequence

Desired Weld and Sequence

Weld examination requirements may also be placed on the second or third reference line — as, obviously, the first or the first two lines must provide a weld so that it then can be examined.

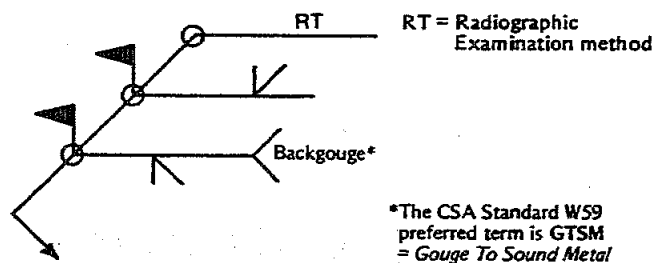
The letter designations for the examination methods will be found in the NDE section of this module.

Fundamentals of Welding Technology



- Sequence:
- 1) weld single-V on arrow side,
 - 2) weld back-pass on other side,
 - 3) inspect other side, using MT method.

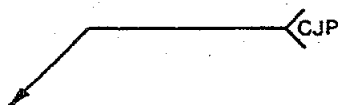
Supplementary symbols may also be used as applicable.



- Sequence:
- 1) weld the all-around arrow-side bevel-groove in the field;
 - 2) back-gouge from the other side (in the field, obviously);
 - 3) complete the all-around "other side" bevel groove in the field;
 - 4) inspect, in the field, the whole weld using the radiographic examination method.

1.3.10 Complete Penetration

Where complete joint penetration [that is penetration equal to the thickness of material] is to be obtained with no regard to the type of weld and joint preparation, the letters CJP must be shown in the tail of the welding symbol.



The definition of *complete joint penetration* groove welds may vary from one governing design standard to another. Important observations on this subject are offered in the section on groove welds.

1.3.11 Method of Drawing Symbols

The exact dimensions of the constituent elements of each weld symbol and supplementary symbol are shown in the Appendix. The graphic presentation of the *Design of Standard Symbols* has been taken from the AWS A2.4 specification, where it appears as Appendix A. It is recommended for use.

It will also be of interest to note that templates are available for drawing symbols. Information on those may be obtained from the AWS headquarters.

2. GROOVE WELDS

2.1 Location of Dimensions for Single-Groove Welds

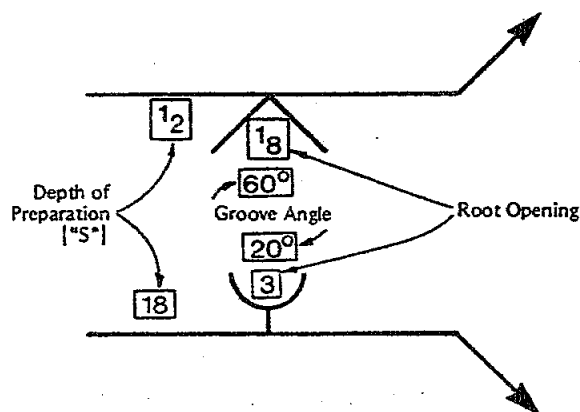
Although Fig. 3 shows the location of all the standard elements for any type of weld, including a groove weld, it will be of advantage to extract from that figure all these elements which specifically apply to grooves.

Since there are many types of grooves, as evident from Fig. 1, with each assigned its own weld symbol, specific and comprehensive information must be provided in the welding symbol to accurately describe the required preparation and fit-up of the two members in the joint.

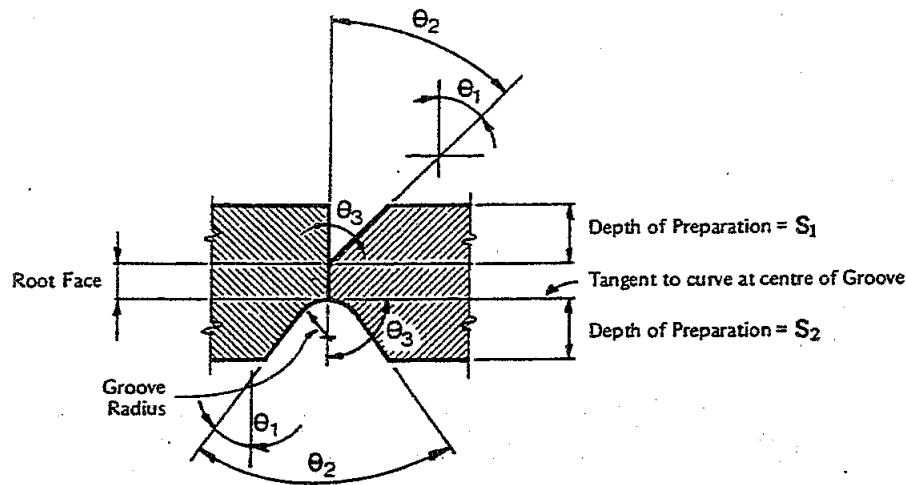
Besides the applicable weld symbol for the pertinent type of groove, the remaining information required will have to define:

- 1) The *depth of preparation* — also described as the depth of chamfer — from each side of the joint (*arrow side* and *other side*), and normally designated by the capital letter "S."
- 2) The angle at which such preparation should be made, also referred to as angle of chamfer, but officially termed the *bevel angle*. A few clarifying comments with respect to this angle will be in order as, again, there seems to be a generally rather vague understanding of what this particular angle means. They will be provided after all the remaining items essential to a groove weld are discussed.
- 3) The *root opening* required for proper fitting of the two members in the joint. Its primary objective is to provide adequate access for welding. It may be used as a trade-off item with other related factors in the joint for greater welding economy.

The location of these three elements in the welding symbol for single grooves is shown below:



Before proceeding with dimensioning requirements in welding symbols for other than single-groove welds, the issue of all the angles entering into groove weld terminology will be given its due attention. It is hoped that the next sketch will sufficiently clarify the definitions of the three types of angles that enter into this terminology.



There are *three* basic angles in the above joint, and they are *part of every groove except the square groove*.

- | | |
|--|----------------|
| 1) BEVEL ANGLE
(official AWS A3.0 term)
or
Angle of Preparation
or
Angle of Chamfer | } = θ_1 |
| 2) GROOVE ANGLE | } = θ_2 |
| 3) ANGLE AT THE
ROOT OF THE GROOVE | } = θ_3 |

For the *U-groove*, all three angles have different values with θ_2 being twice that of θ_1 .

For the *bevel-groove*, however, all the angles have the same value: $\theta_1 = \theta_2 = \theta_3$.

The angle of importance with respect to application in the symbol is the *groove angle* which, for bevel- and J-grooves, will also be the *bevel angle*. However, it is the groove angle (the angle contained between the fusion faces of the groove) which appears in the welding symbol.

The angle *at the root* of the joint associated exclusively with J- and U-grooves has strong design implications, as the governing specifications make the applicable effective throat of welds in such grooves a function of this particular angle.

In conjunction with this angle, it should also be noted that the *groove radius* for the J- and U-grooves is to be the user's standard radius. In such case, no additional cross-sections of the joint are required.

However, when this radius differs from the user's standard, such additional cross-sections are mandatory, as the welding symbol has no provisions to specify it.

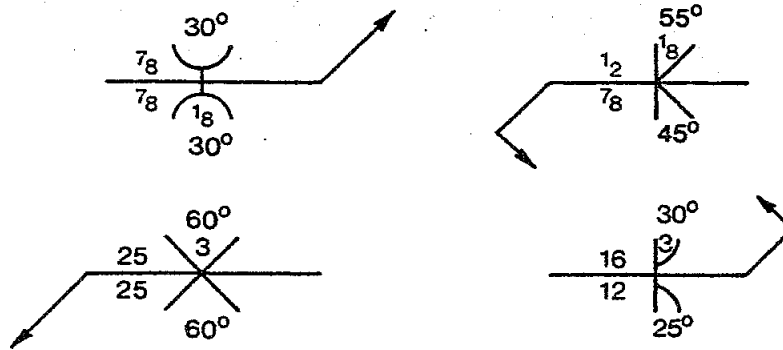
The same considerations apply to *root faces* of these two particular groove types.

2.2 Dimensions for Double-Groove Welds

In line with the general principle and irrespective of its appearance on one or both sides of the reference line, each weld symbol must be accompanied in the welding symbol by all the essential data considered necessary for the preparation, fit-up and execution of welding.

This has been stressed before.

The principle applies to all double-groove welds, and it makes no difference whether the data is identical or not on each side of the reference line. However, the size of the root opening, being common to both sides, need only appear once.



It may be the convention of the user, and known to all levels of appropriate personnel, to maintain standard angles for certain types of grooves prevalent in his operations. In such case, these standard angles need not be specified in the welding symbol.

The most likely standard angles may be 45° for bevel-grooves and 60° for V-grooves. However, it follows logically that, when angles other than the standard angles are to be used, they *must* be specified in the welding symbols.

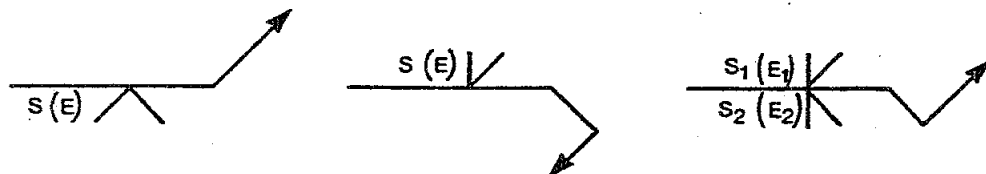
Identical procedures would apply in case of a general note placed on the drawing, stating that all angles be of certain values unless otherwise specified.

2.3 Depth of Preparation and Groove Weld Size

The AWS A2.4 specification has introduced the *groove weld size (E)* as a quantity to be shown in the welding symbol for groove welds. Presumably, this was done for the purpose of increasing its specifying capability, although it was originally meant to be an improved interpretation of previously used designations.

The specification ruled at the same time that this new quantity should

- appear in brackets: (E), and
- be located on the right side of the depth of preparation "S" and so share with it a common location in the welding symbol



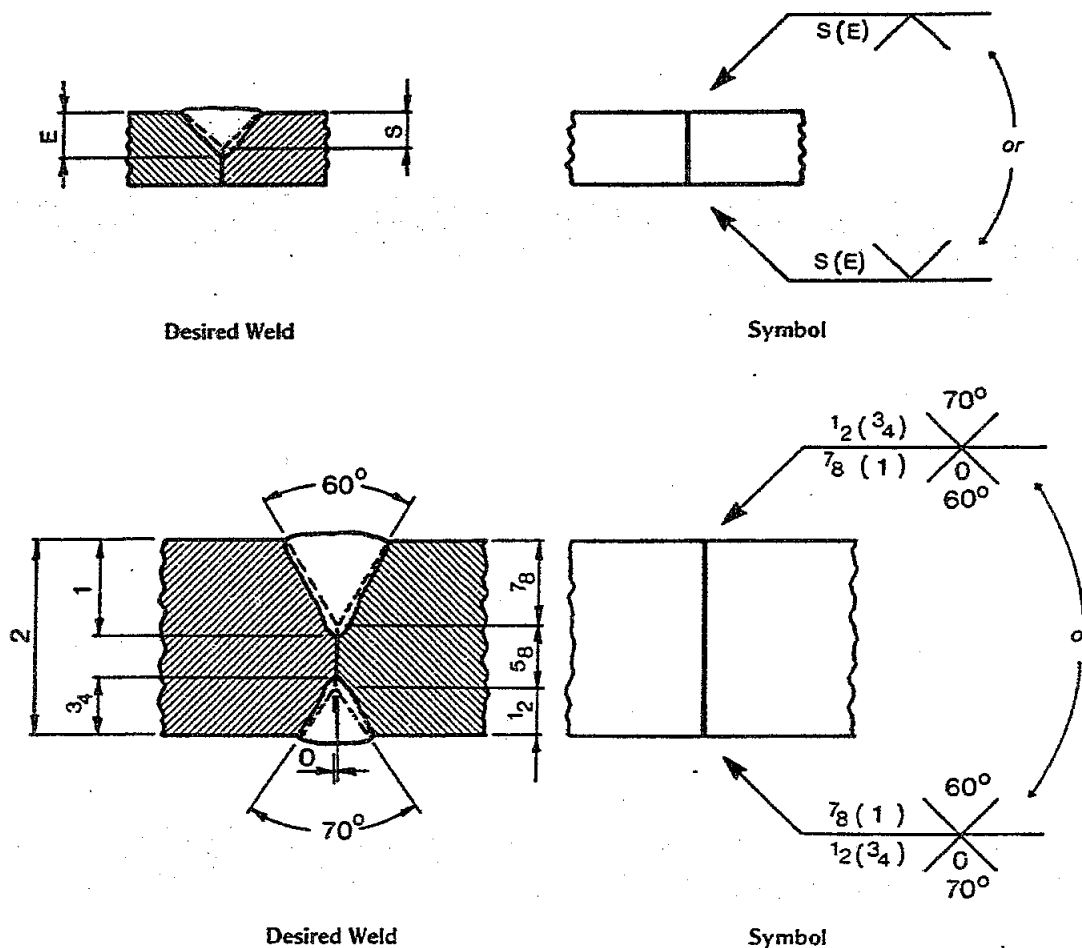
The term *throat of a groove weld*, while previously an acceptable term, is now considered a non-standard term for groove weld size.

Unfortunately, the weld size as defined in the AWS A2.4 specification purely from the point of view of logical symbol application, need not necessarily be the same — *and in many cases it is not* — as the weld size defined in the governing standards for design applications.

Therefore, caution must be exercised and appropriate distinction made when referencing weld sizes under the jurisdiction of one specification as compared with another.

While the application of the groove weld size concept is quite straight-forward and offers a clear advantage in a number of applications, this advantage is less visible and even confusing in others. A more elaborate discussion on the subject will follow later.

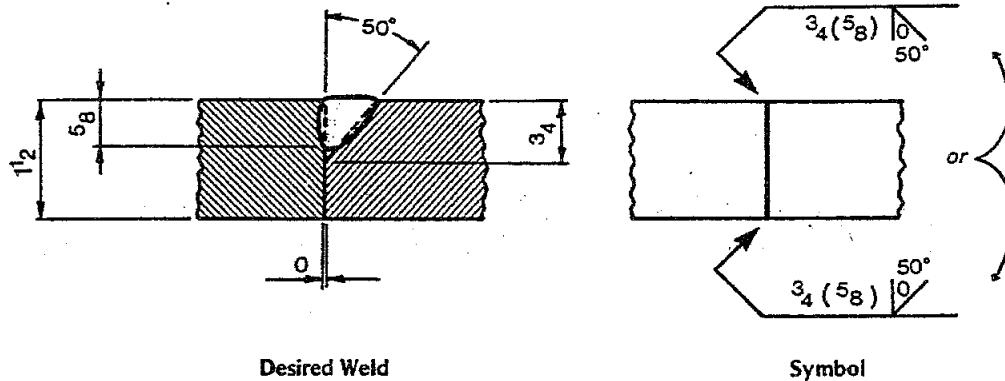
First, let's explore what is meant by *groove weld size* in the eyes of the AWS A2.4 specification, and how does that size relate to depth of preparation. Both are independent quantities. However, the magnitude of (E) relates strongly to the root geometry of the joint, the welding process, and the parameters of the welding procedure.



The quantity (E) is measured from the top of the plate to the furthest point where the weld penetrates the joint. The AWS A3.0 specification defines this as *joint penetration*.

Symbols for Welding

The value of (E) may be greater than "S" (as shown on preceding page). However, it may also be smaller than "S".



A multitude of conditions prevails in welded work. These conditions may either require rigid adherence to the application of standard symbols, or they may indicate a lesser need for the full-bodied welding symbols, with a freedom of decision on some of their elements left with the user.

In recognition of this situation, AWS A2.4 has provided for a range of different combinations in the application of groove weld size (E) and depth of preparation "S" in the welding symbol.

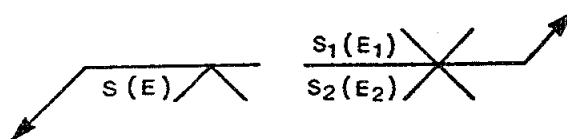
This flexibility, provided in direct response to specific needs of industry, deserves careful attention. All the pertinent case-combinations will be considered individually and discussed next.

In the most common welding symbol, both the *depth of preparation* and the *groove weld size* will be found. Such symbol will apply equally to single- and double-groove welds, but it is more straight-forward for cases of *partial* penetration than *complete* penetration grooves.

The following series of examples will make this observation much clearer:

SYMBOL APPLICATION — TYPE A

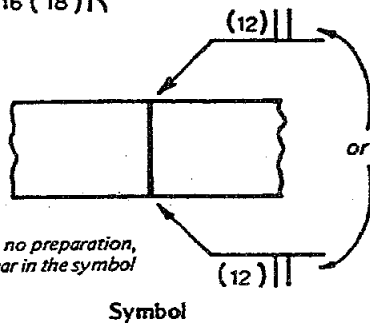
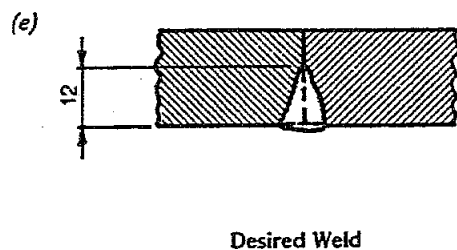
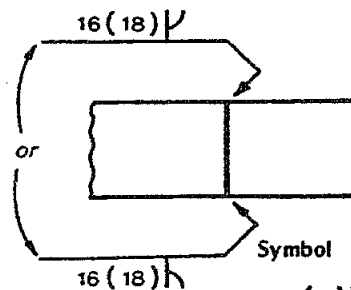
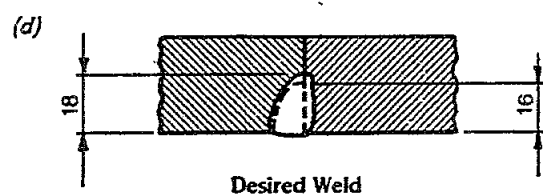
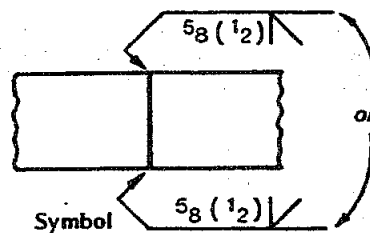
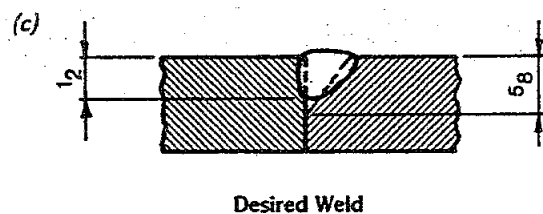
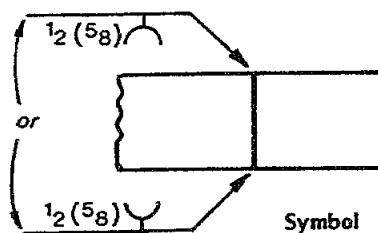
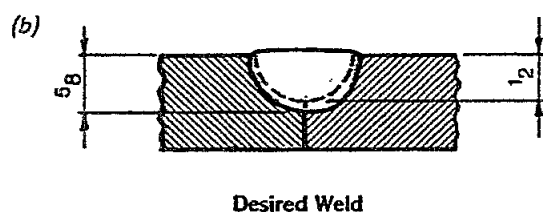
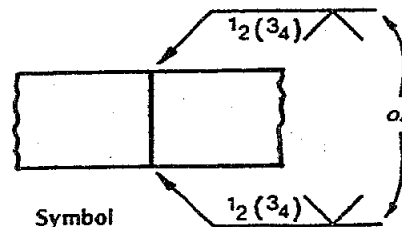
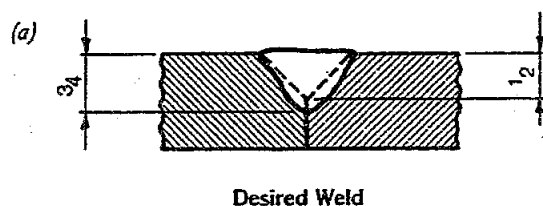
Depth of Preparation and Groove Weld Size Specified. (Three Examples are shown)



EXAMPLE 1

SINGLE-GROOVE WELDS IN JOINTS WITH PARTIAL PENETRATION

Only "S" and (E) need to be shown in the symbol.

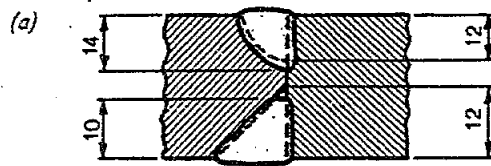


Square-groove weld has no preparation, hence "S" does not appear in the symbol

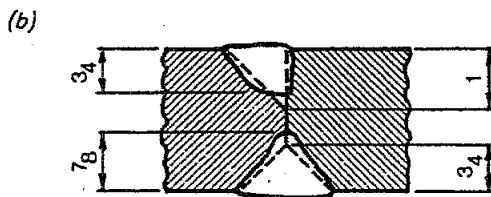
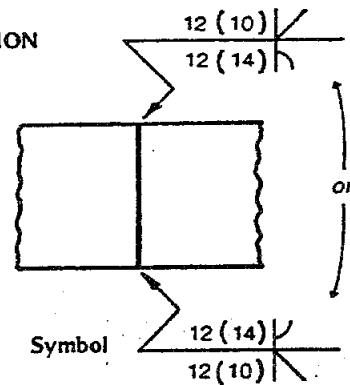
EXAMPLE 2

DOUBLE-GROOVE WELDS IN JOINTS WITH PARTIAL PENETRATION

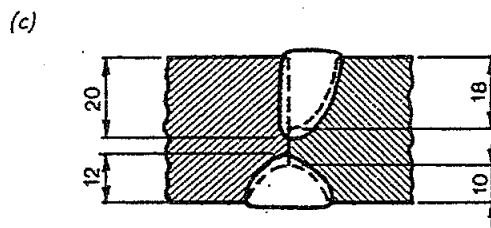
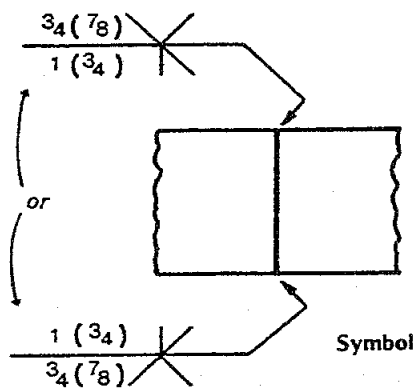
Only "S" and (E) need to be shown in the symbol.



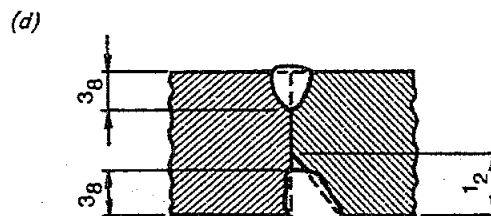
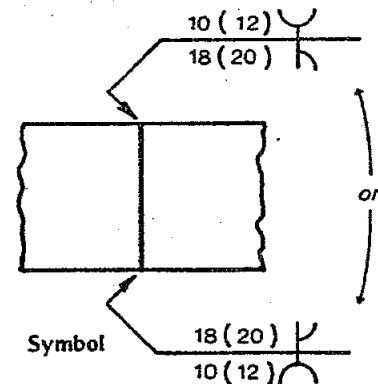
Desired Weld



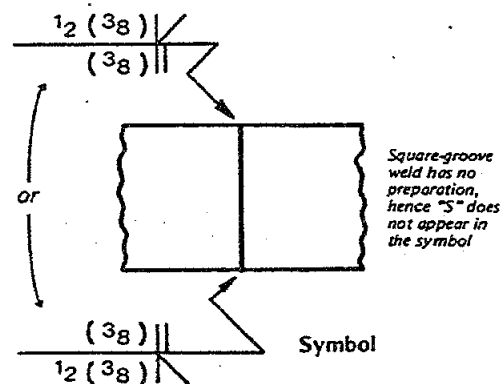
Desired Weld



Desired Weld



Desired Weld



Before proceeding to double-groove welds in joints having *complete penetration*, a few very important observations must be made.

For grooves welded from both sides, *complete penetration*—that is, penetration in the sense that the total combined penetration from both sides of the joint is at least equal to the thickness of the thinner of the two welded members—can be achieved in either one of two ways:

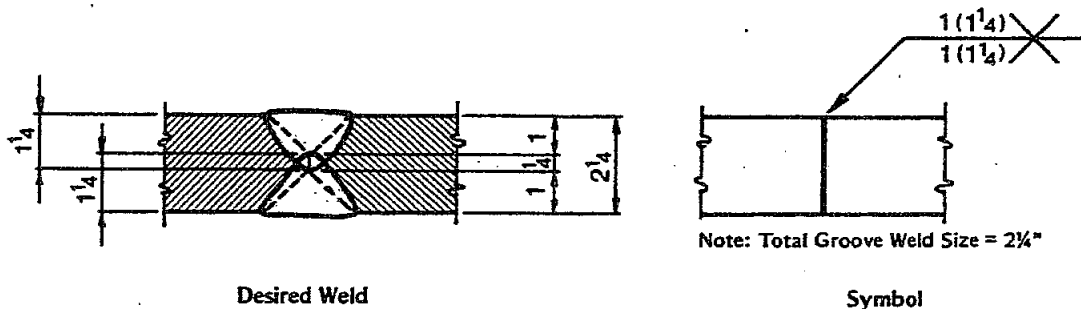
- 1) by adjusting the depth of preparation on each side (square grooves exempted) to the penetration characteristics of the process, so as to obtain an overlapping weld; or,
- 2) by welding the joint from the first side and gouging to sound metal from the second side, prior to welding on that side.

The essential distinction between these two ways is the absence, or the application, of gouging. It will be the responsibility of the user to be clearly aware which of the two operations will produce a groove weld size which meets the requirements of the governing specification under which he has contracted to do the work.

The foregoing discussion was meant to lead to the following important conclusion:

Double-groove welds with back-gouging or, more precisely, grooves in which back-gouging is required, constitute a separate situation as, in their case, the welding symbol's concept of *groove weld size* (E) loses its validity. Such grooves require an application of a special welding symbol which will be discussed in *Symbol Application, Type F*.

This clarification opens the door for the next example, dealing with double grooves in joints in which complete penetration has been obtained, but without the use of back-gouging. There is one feature characteristic to these particular grooves, and the following sketch of a joint intends to highlight it:



The point in question is that the sum of the two groove weld sizes in the symbol is $2\frac{1}{2}$ ", which is *greater* than the thickness of the material. The overriding rule is, however, that

in no case shall the the total groove weld size exceed the thickness of the thinner member in the joint.

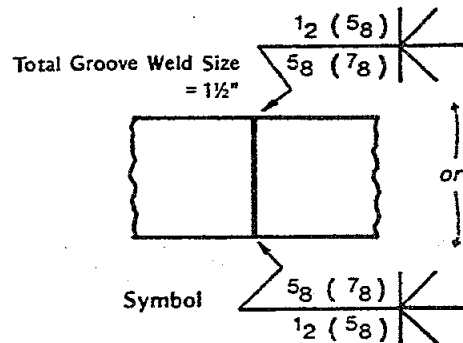
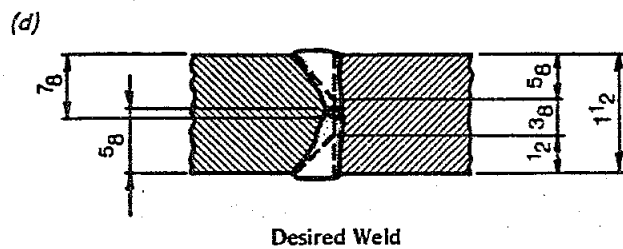
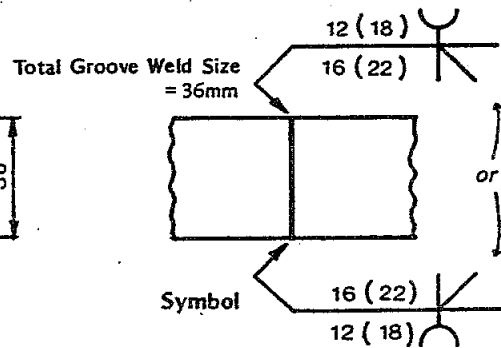
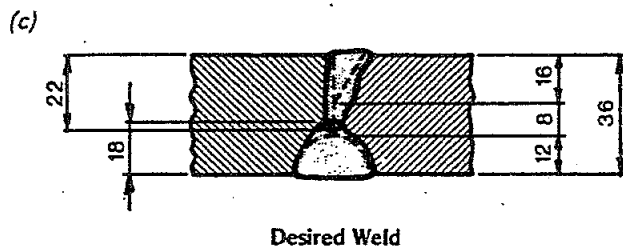
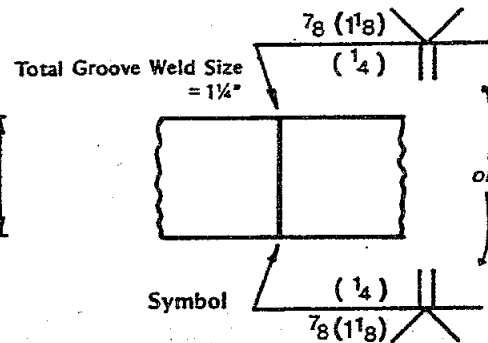
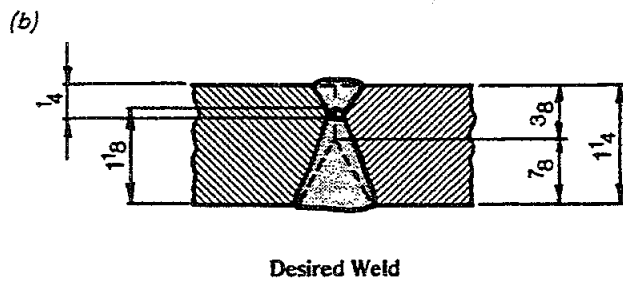
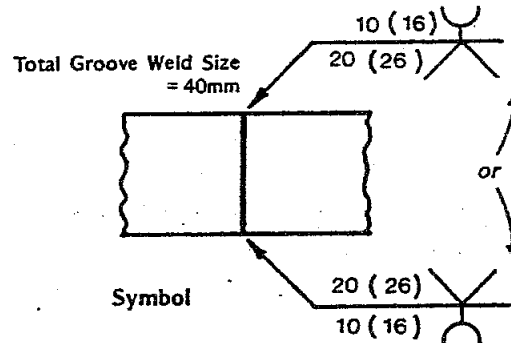
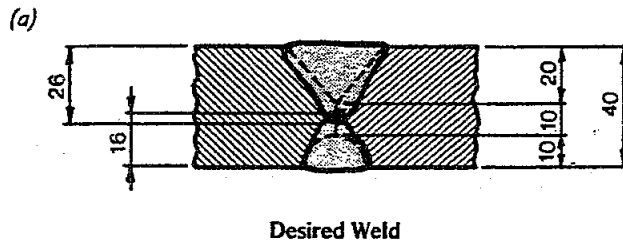
Hence, a note as shown will alert the student and, eventually, the authorities responsible for the approval of the drawings.

Symbols for Welding

EXAMPLE 3

DOUBLE-GROOVE WELDS IN JOINTS WITH COMPLETE PENETRATION AND NO BACK-GOUGING

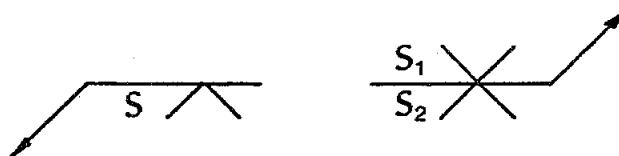
Only "S" and "(E)" need to be shown in the symbol.



Either metric or imperial measures may be applied

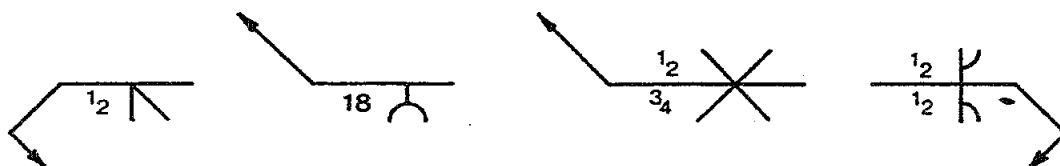
SYMBOL APPLICATION — TYPE B

Depth of Preparation specified, Groove Weld Size not specified.



Not very often would one consider specifying only the depth of preparation in the symbol, except perhaps in situations where a certain acceptable groove weld size can be reliably expected on the basis of accumulated satisfactory evidence obtained from identical and repetitive welding operations in the past. That is, if the groove weld size really matters for strength considerations.

If it does not, and no other tangible guarantees of some attainable weld size are available, it would be rather irresponsible and contrary to an orderly management of shop welding operations to leave the determination of such groove weld sizes to the discretion of the shop personnel. However, such welding symbols, when in use, will be:



It will serve no practical purpose to illustrate these symbols with some supporting sketches.

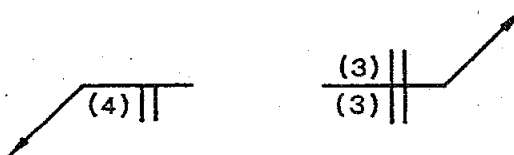
The user is certainly encouraged to provide comprehensive symbol information, unless he is satisfied that he has other means besides the welding symbol to fully convey it to the shop personnel.

SYMBOL APPLICATION — TYPE C

Groove Weld Size specified, Depth of Preparation not specified.



The legitimate application of this symbol type in shop drawings can only be claimed by square-grooves which, by virtue of their natural joint geometry, do not need preparation.



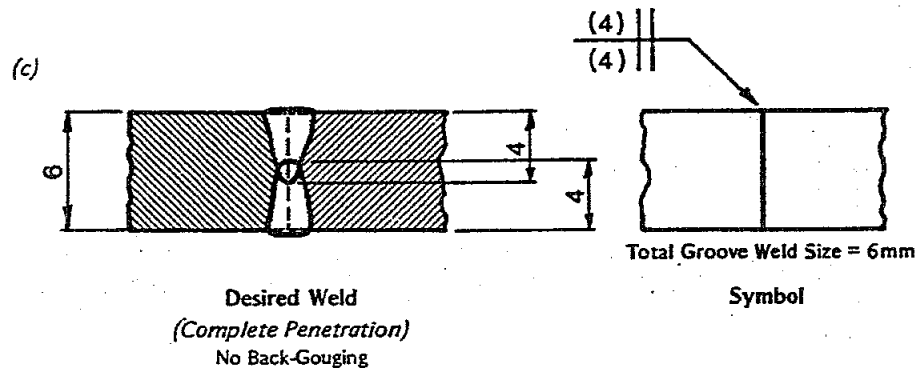
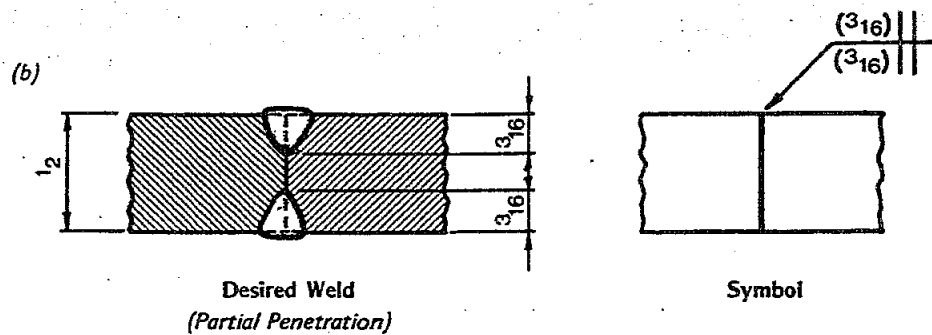
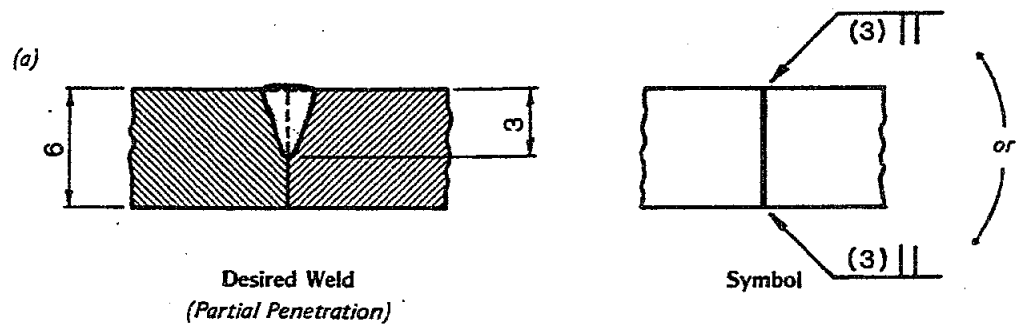
The joints may have partial penetration or complete penetration, depending on thickness and penetration characteristics of the welding process used.

Another area of potential application of this type of symbol on *shop drawings* is for grooves welded primarily from one side and requiring only a one-pass weld from the other. This latter weld may be claimed to be a square-groove weld, since the fusion faces in the root are the remaining parts of the original square-cut preparation. The other advantage of such argumentation is that effective throats can be justifiably assigned to them.

The following examples will explore applications where only groove weld size is specified.

EXAMPLE 4

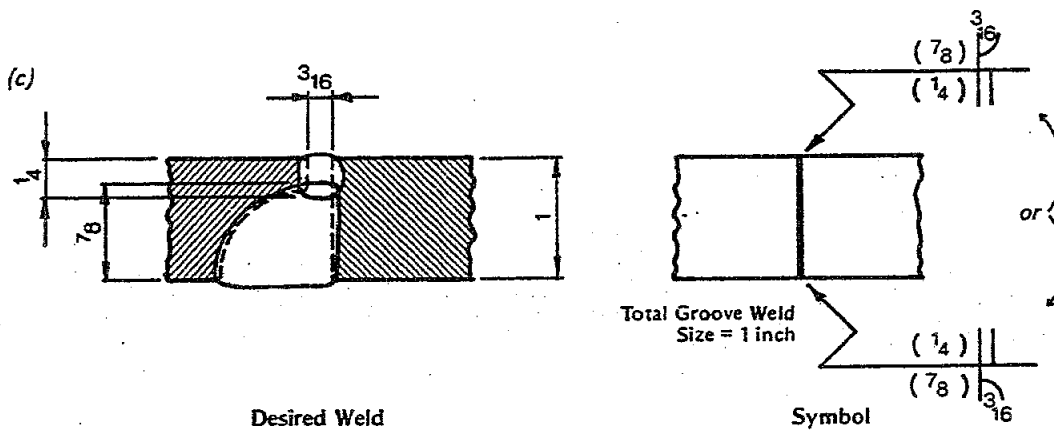
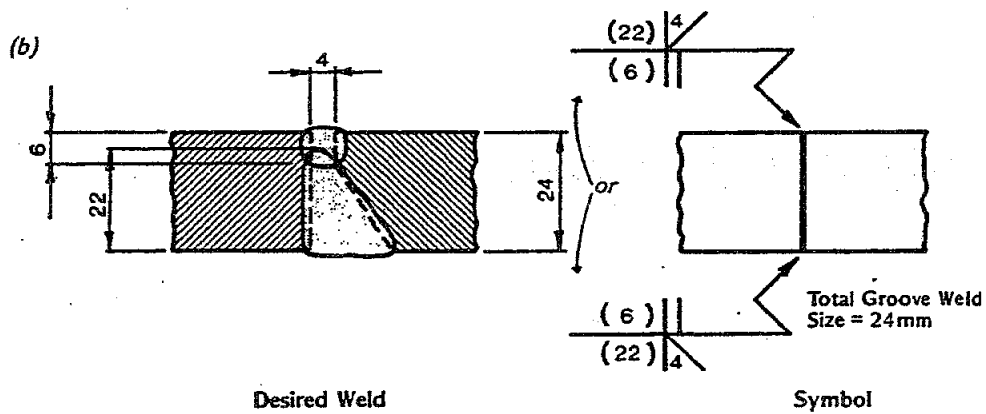
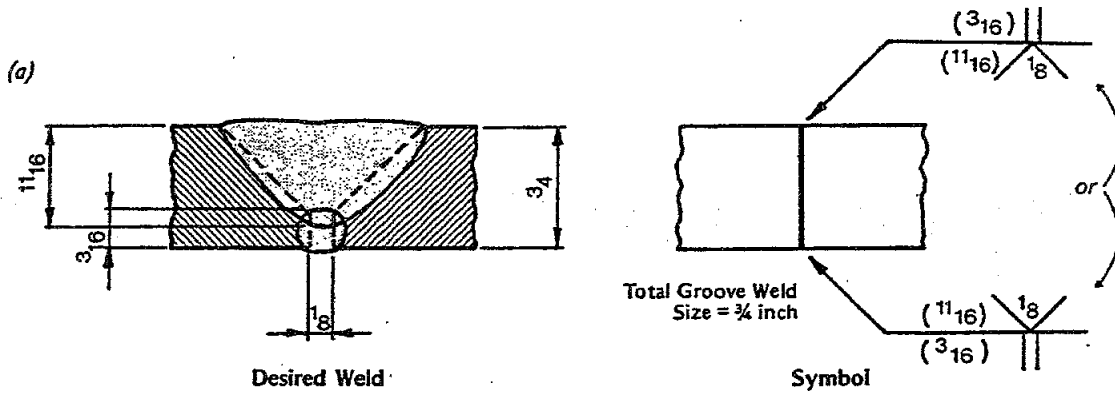
SQUARE-GROOVE WELDS – ONLY GROOVE WELD SIZE SPECIFIED



EXAMPLE 5

GROOVE WELDS IN JOINTS WITH COMPLETE PENETRATION

- NO BACK-GOUGING — PRIMARY WELD ON ONE SIDE. ONLY TOTAL GROOVE WELD SIZE IS SPECIFIED



Symbols for Welding

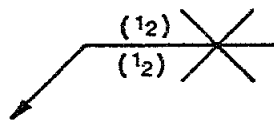
There are two other situations in which welding symbols specifying groove weld size only, will be used occasionally. Both are, however, associated with contract design or engineering drawings.

In the *first* one, the design authority specifies the required groove weld size on each side of the joint and indicates its preferred type of joint, leaving the depth of preparation and the groove angle to be determined by the fabricator to suit the welding process he anticipates to use.

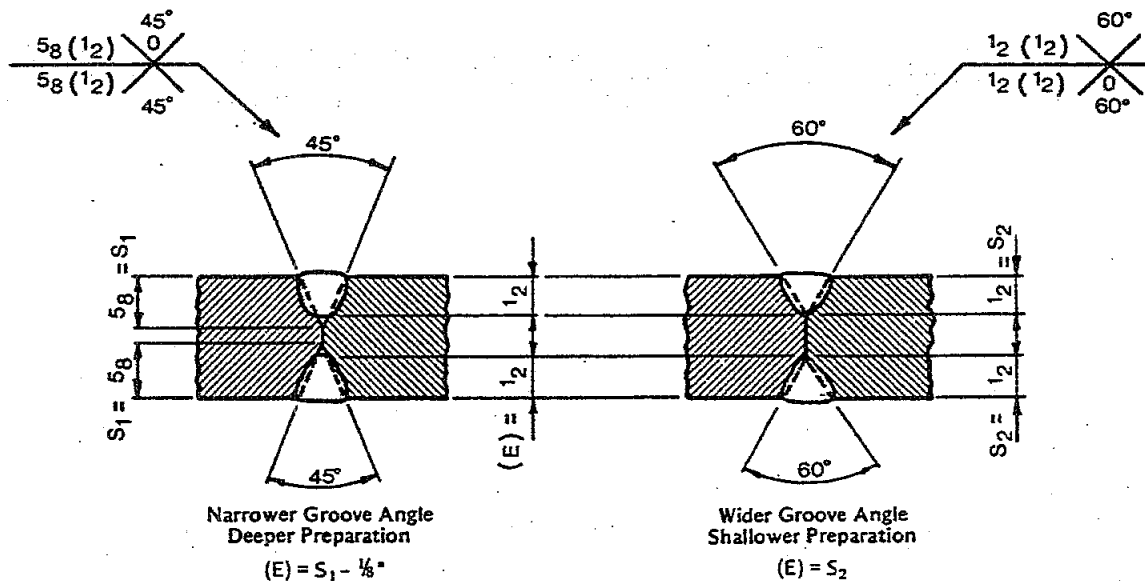
A very sensible and accommodating arrangement for both, as the designer has in his judgement the best type of joint for the service application, and the fabricator has an opportunity to satisfy the engineer's requirement in the most economic manner.

In most cases, these joints will be joints with partial penetration.

Assuming that for a $1\frac{1}{2}$ " thickness of material the particular symbol was



the fabricator, when working under the provisions of either CSA W59 or AWS D1.1, has (among others) the following options available to him:

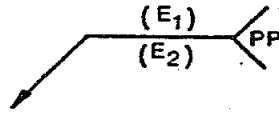


Fabricator's Possible Solutions

Symbols show two depths of preparation; both yielding the groove weld size specified on the design contract drawings.

The other situation to which reference was made earlier is one provided by CSA W59 as well as AWS D1.1. Both of these specifications suggest that, in case of joints with partial penetration

(PP), the designer specifies on his drawings only the groove weld size for each side of the joint in the following manner,



leaving the choice of the depth of preparation, the groove angle and the *type of groove* at the discretion of the fabricator. Hence, without compromising integrity and soundness, a still greater freedom of choice and greater potential for economics is provided.

Obviously, the alternatives available to him under these conditions are too numerous to mention.

SYMBOL APPLICATION — TYPE D

Groove Weld Size not specified, Depth of Preparation not specified.



This particular type of welding symbol has a limited but very specific and clearly defined area of application.

First of all, it is meant to apply exclusively to joints for which *complete penetration* is required and, furthermore, to only such joints which involve either *single-groove* or *symmetrical double-groove* welds.

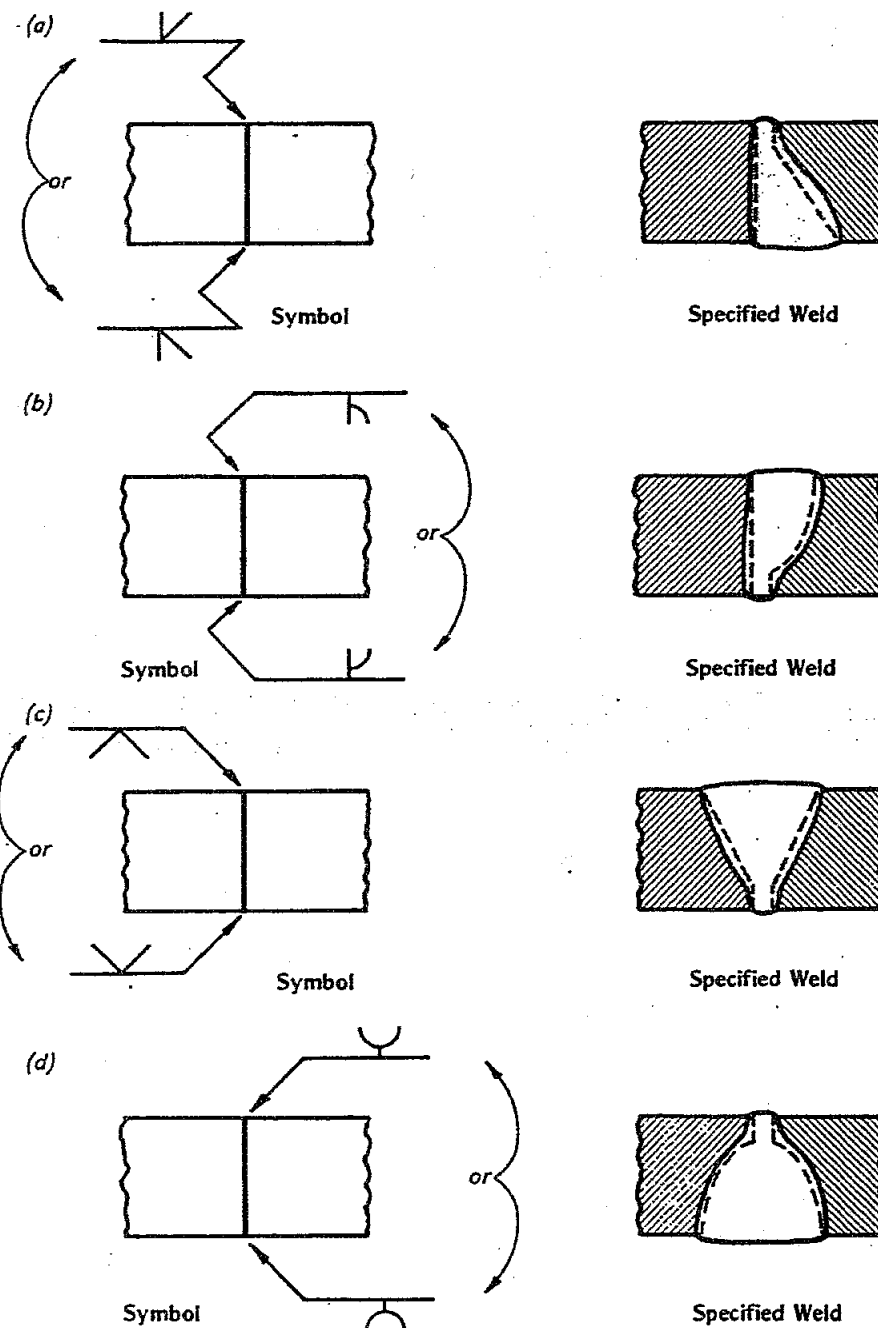
Such joints may or may not require back-gouging, depending on applicable governing specifications able to claim a *complete joint penetration groove* status for them. The user's convention or a gouging reference in the tail of the symbol will clarify whether such action is required.

The following examples of joints will illustrate the proper application and interpretation of this type of welding symbol:

EXAMPLE 6

SINGLE-GROOVE WELDS IN JOINTS WITH COMPLETE PENETRATION

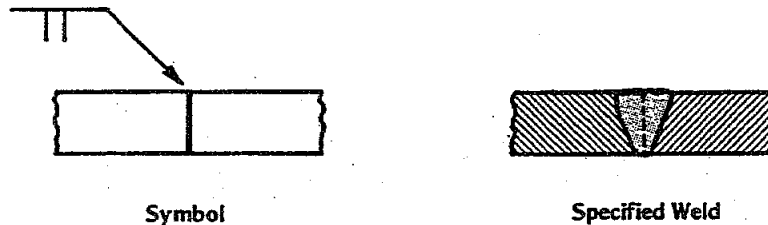
- NO DEPTH OF PREPARATION AND NO GROOVE WELD SIZE SPECIFIED IN THE WELDING SYMBOL:



- NOTES:
1. The welding symbols *need not* imply feather-edge preparation. The welds are still single-groove welds, in spite of the small root faces which are necessary to prevent burn-through.
 2. Single-groove welds welded from one side only (as shown), need not necessarily be considered complete joint penetration groove welds under some governing specifications (CSA W59, AWS D1.1).

In continuation of Example 6, a special reference must be made to joints with square groove welds to which this particular symbol is frequently applied.

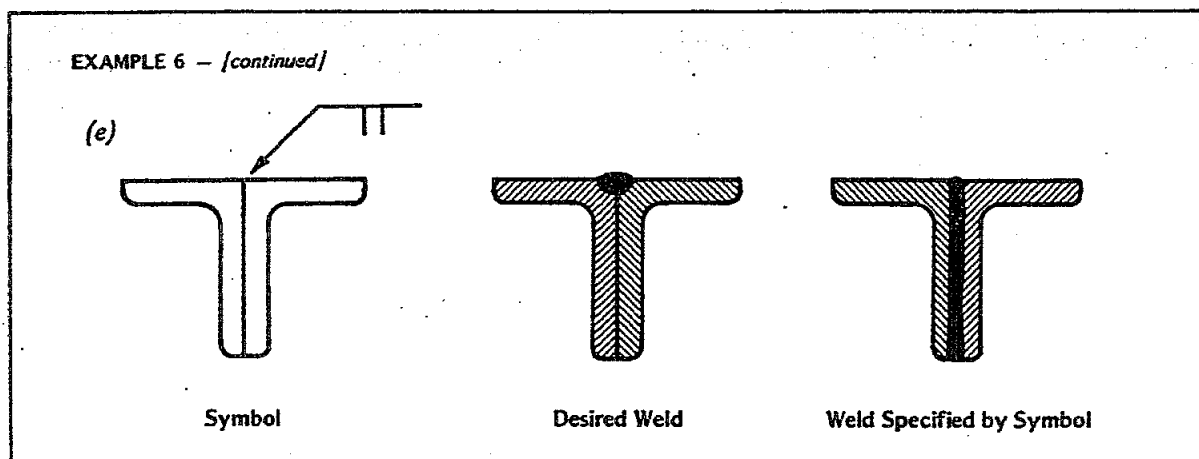
There are only a few thicknesses, up to a certain maximum depending on the welding process, which can be welded from one side for full penetration. For such thicknesses, the conditions for the welding symbol under discussion apply.



In accordance with the rule, the deletion of the groove weld size in the symbol with the depth of preparation naturally absent, means automatically that complete penetration is specified as shown.

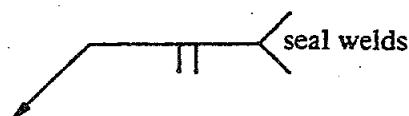
If, instead of complete penetration, a definite groove weld size smaller than the thickness of material is required, the joints in Example 4 illustrate the proper application of welding symbols. However, it is only too common that a square-groove symbol without the groove weld size specified in it, is erroneously used to designate a seal weld.

The following typical back-to-back double angle member will illustrate this point admirably:



Obviously, the weld as *specified* by the welding symbol is completely wrong. In order to specify the desired weld, meaning a weld intended to fulfill only a sealing function, the reference in the tail of the symbol must identify such function with the designation *seal welds*.

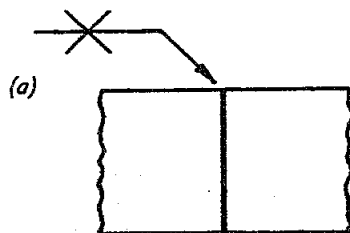
Hence, the proper symbol to use for the two angles above is:



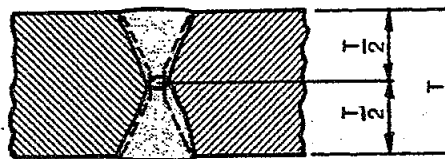
The student is well advised to take notice and rectify the erroneous use of the square-groove symbol for such applications.

EXAMPLE 7

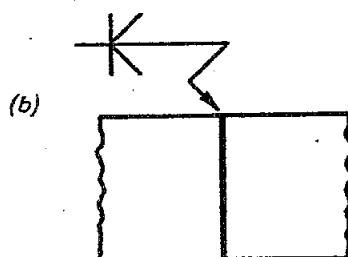
SYMMETRICAL DOUBLE-GROOVE WELDS WITH COMPLETE PENETRATION.
NO DEPTH OF PREPARATION AND NO GROOVE WELD SIZE SPECIFIED IN THE WELDING SYMBOL.



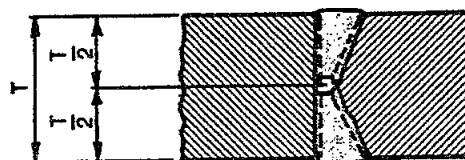
Symbol



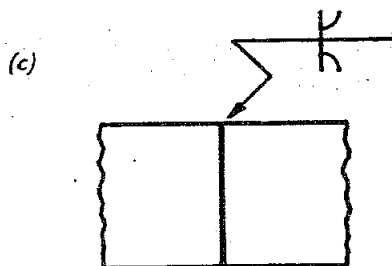
Specified Weld



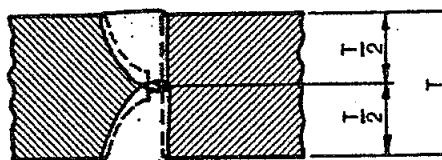
Symbol



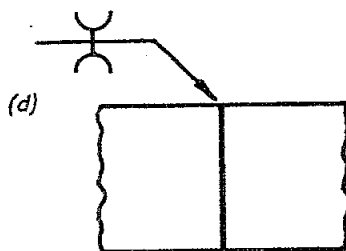
Specified Weld



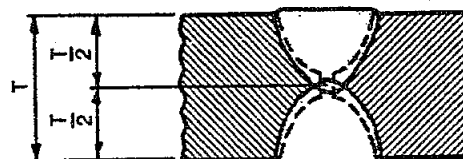
Symbol



Specified Weld



Symbol

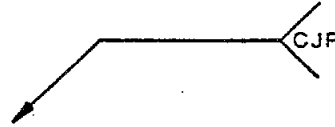


Specified Weld

- NOTES:
1. The welding symbols need not imply feather-edge preparation. Small root faces will be required to prevent burn-through and support molten metal.
 2. Back-gouging may be required by governing specifications for grooves welded from both sides as a condition for their recognition as *complete joint penetration* groove welds.
 3. Detail "c" of Example 4 shows the recommended use of symbols for square-groove welds in complete penetration joints.

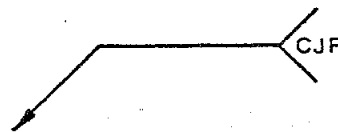
SYMBOL APPLICATION – TYPE E

Joint preparation optional, complete penetration required.



AWS A2.4 provides, primarily for the use of the design authority, an abbreviated form of welding symbol in which it can specify in a very simple way the required efficiency of a groove-welded joint.

A somewhat similar but not as far-reaching provision has already been discussed. It allows for joints with partial penetration to show in its symbol either the groove weld size or the type of groove only. However, in case of joints with complete penetration, the A2.4 specification permits the designer to specify this basic requirement by placing the letter designation "CJP" in the tail of the welding symbol without any other information shown in it.

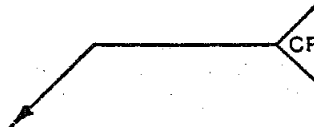


CJP = Complete Joint Penetration

This gives the fabricator total freedom in the selection of the type of joint, its geometry of preparation and fit-up to best suit the welding process selected for optimum production economy while still fully satisfying the designer's requirements.

Again, the possibilities that present themselves to the fabricator are beyond count. No clarification by sketches is necessary except to caution that back-gouging may be necessary for some of the joints in order to be recognized as complete penetration groove welds under the applicable governing specifications.

CSA W59 and AWS D1.1 make identical symbol provisions, except that the letter designation used in the latter is "CP", standing for "complete penetration."



In each case it is the fabricator's responsibility to translate the designer's symbols into full-fledged shop drawing symbols providing all the specific information necessary for execution of the welding required.

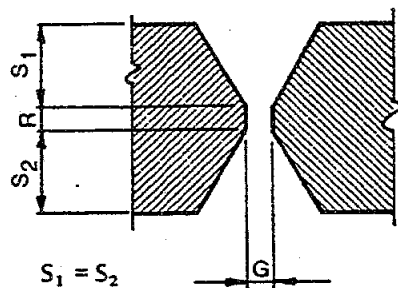
SYMBOL APPLICATION — TYPE F

Joints with complete penetration and back-gouging.

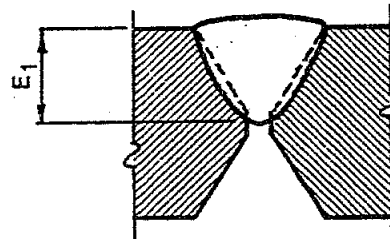
It has been pointed out already that the inclusion of the "groove weld size (E) concept" into the required welding symbol information has created a very difficult problem for joints with back-gouging.

It will be advisable to pin-point it first, and then discuss the modified symbols presentation as it appears in the latest edition of AWS A2.4.

A double-groove weld may be best-suited for the illustration of the progressive steps in welding a butt joint.

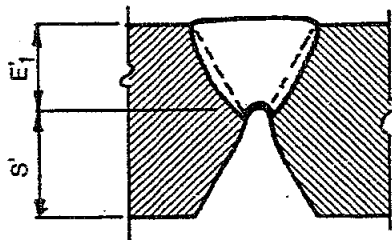


Joint BEFORE Welding



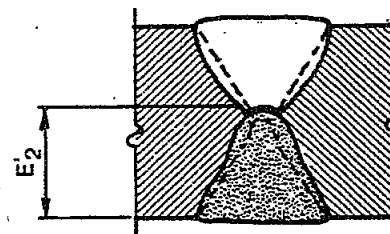
STEP 1

After welding first side



STEP 2

After back-gouging



STEP 3

Completed Weld

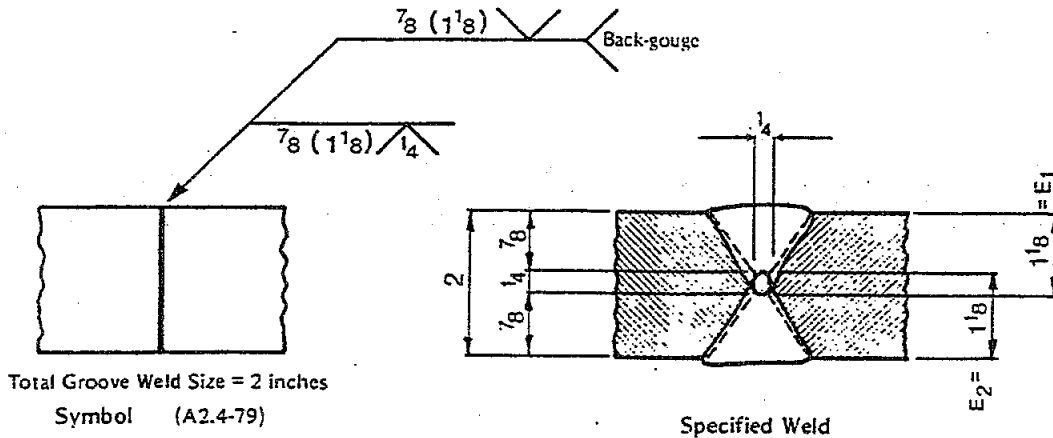
It can be easily recognized that the values of (E_1) and (E_2), if specified in the symbol, are changed in the course of back-gouging; hence, specifying them in the welding symbol would be meaningless. They would not be traceable, say, on a macro-etched section of the joint. Consequently, a valid question may be posed: Why specify a quantity in the symbol that is not measurable and, what is more significant, non-existent in the final weld?

However, the 1979 edition of the AWS A2.4 provided a symbol presentation which illustrates

EXAMPLE 8

DOUBLE-GROOVE WELD WITH BACK-GOUGING (A2.4-79 Symbol)

Assumed Values are: $S_1 = S_2 = \frac{7}{8}"$; $E_1 = E_2 = 1\frac{1}{8}"$; $R = \frac{1}{4}"$



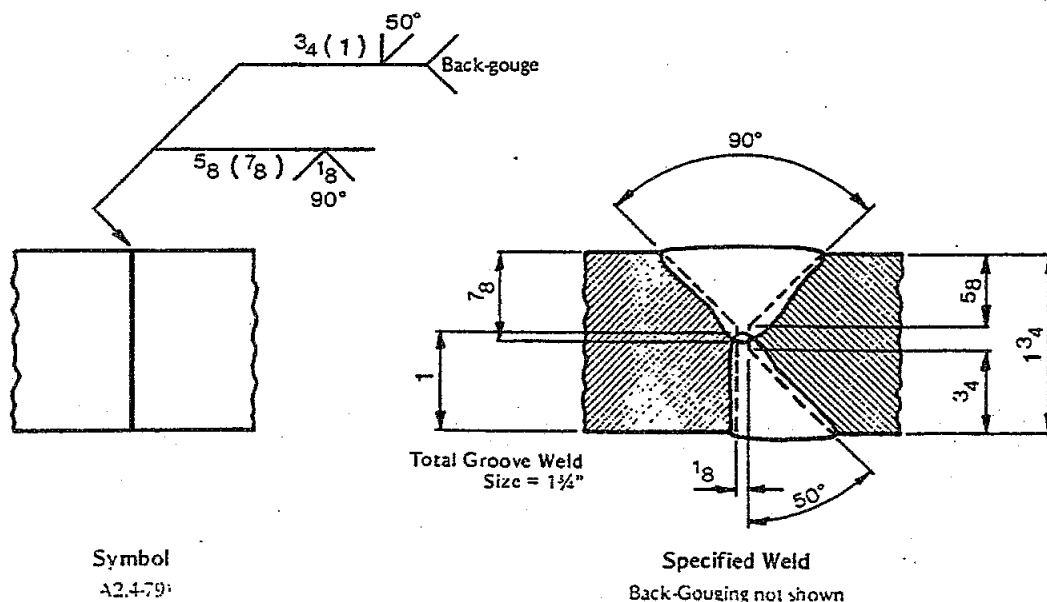
well the point in question when applied to a double-V groove weld with groove weld sizes as specified and shown in Example 8.

It has already been argued that the groove weld sizes of the two welds in the magnitude specified for each of them in the symbol could only be of practical significance if back-gouging were not part of the operation. Yet, such back-gouging was distinctly to be specified in the symbol.

Hence, for obvious reasons, this particular symbol presentation was correspondingly rectified in the 1986 edition of the A2.4 Code.

EXAMPLE 9

DOUBLE-GROOVE WELD WITH BACK-GOUGING (A2.4-79 Symbol)

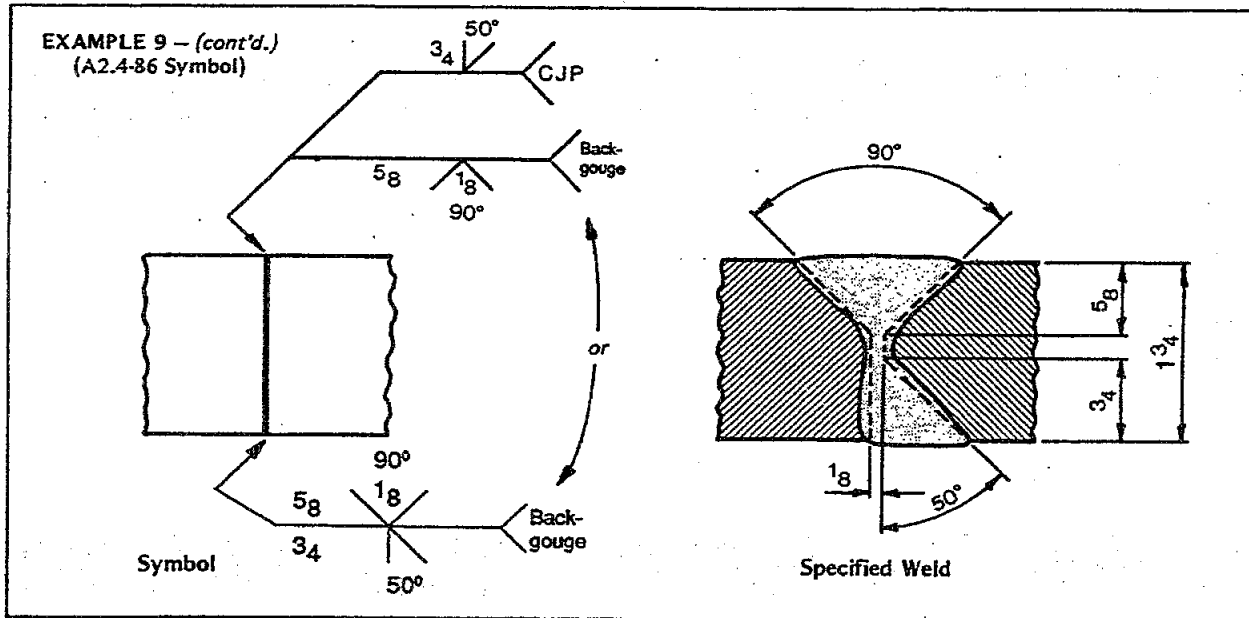


Symbols for Welding

The new symbol presentation disregards the groove weld size in the symbol but ensures that complete joint penetration is delivered by specifying

- 1) "back-gouge" in cases of either a single reference line or an optional double reference line symbol, and the placement of
- 2) "CJP" (Complete Joint Penetration) in the respective tail of the latter.

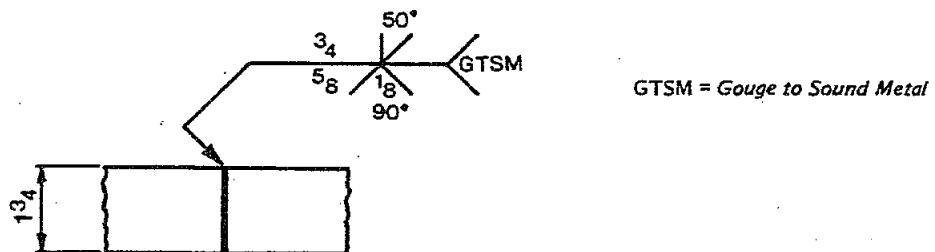
Example 9 showing a hypothetical double-groove weld will serve well to illustrate the inherent shortcomings of the discarded and the relative advantages of the new symbol presentation.



It should be noted that by using the double reference line, *sequencing* of welding may be correspondingly specified.

The *CSA W59 Standard*, which includes provisions for welding symbols by basically referencing AWS A2.4 has slightly modified this new symbol presentation.

Such symbol presentation for the preceding joint will be:



For complete penetration groove welds, the intent of CSA W59 is that by requiring gouging to sound metal (GTSM), or by specifying the effective throat (in the few cases identified) when GTSM is not required, complete joint penetration is obtained. This makes the use of the less convenient double reference lines not necessary. However, should sequencing be considered important, such double reference lines are open for use.

A few double-groove examples will further explain the new rule:

DOUBLE-GROOVE WELDS IN JOINTS WITH COMPLETE PENETRATION AND BACK-GOUGING

Depending on which side welding is to start:



A2.4 symbol convention



A *backing weld* is one which is deposited first, with the primary weld from the second side following later.

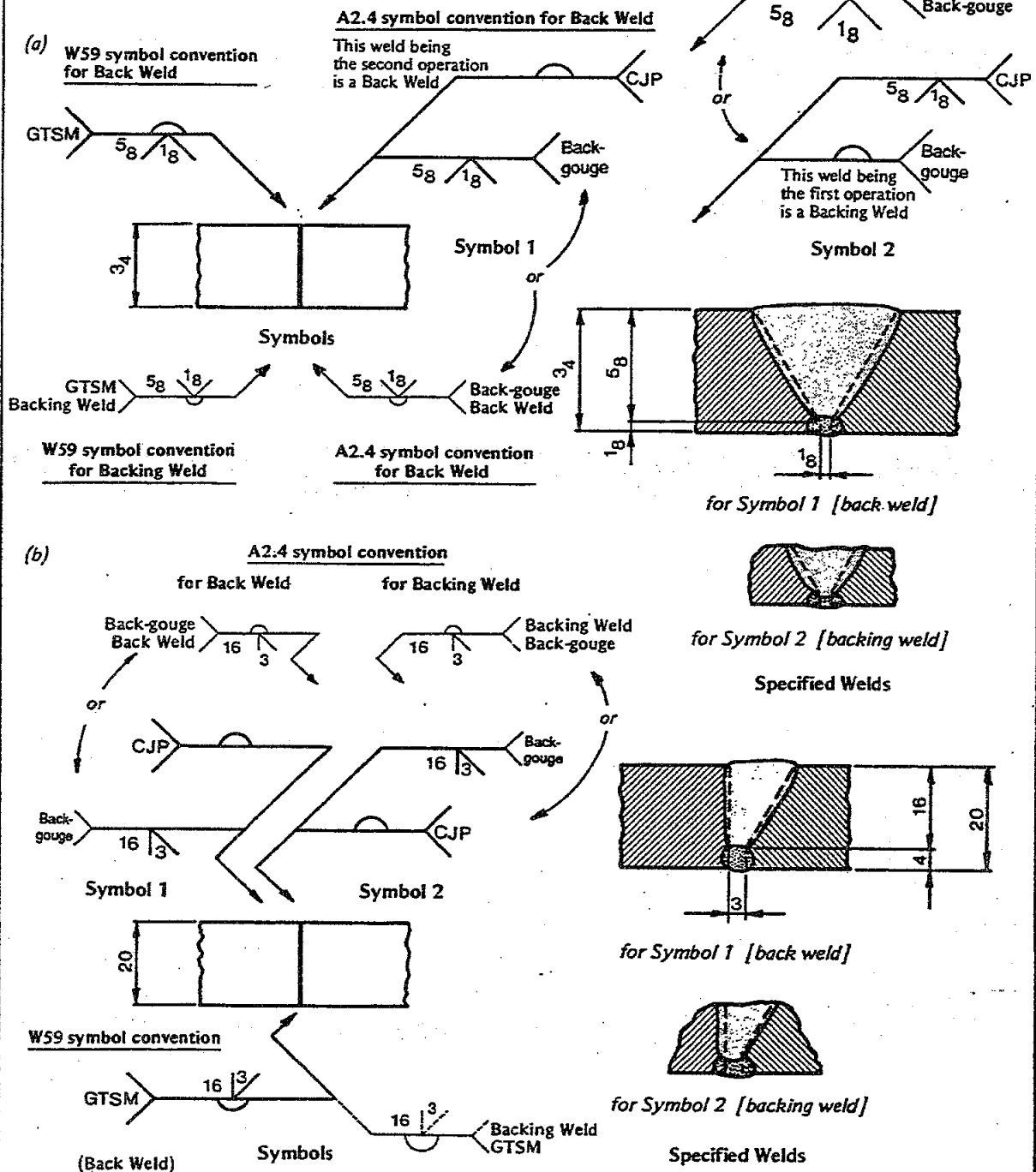
Symbols for Welding

A *back weld* is one which is done on the second side, after the primary weld has been deposited on the first side.

Since sequencing is involved, the multiple reference lines are preferred for use to indicate which of the two welds is intended, although single reference line symbols with pertinent tail information are also permitted as shown in Example 11.

EXAMPLE 11

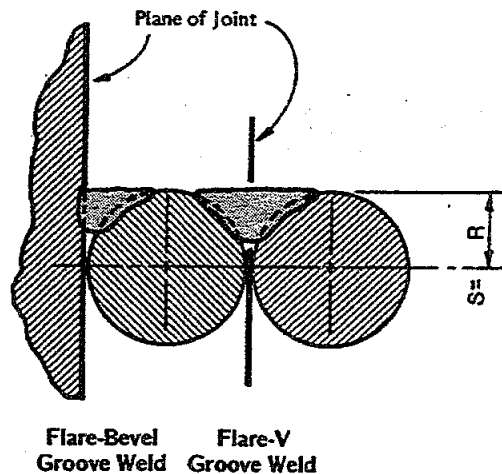
SINGLE-GROOVE WELDS IN JOINTS WITH COMPLETE PENETRATION USING BACK OR BACKING WELDS AND BACK-GOUGING.



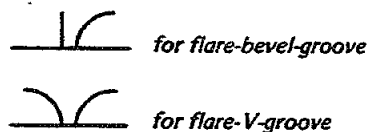
2.4 Flare-Groove Welds

There is a growing number of applications of flare-groove welds in welded fabrication. With the increasing popularity of circular or tubular profiles and greater design sophistication, such grooves are asserting their place in structural and other work.

There are two basic types of flare-grooves:



As shown in Fig. 1, the weld symbols for these grooves are also reflecting the shape of the joint which contains them:



There is no preparation involved for these grooves, as their curved configuration forms a joint in a natural way. However, the value of "S" in the symbol is taken as the radius in the case of circular shapes.

The concept of a "joint" is still applicable, although in flare-grooves one deals with a *line* of contact, and not an *area* of contact.

Hence, the joint of a flare-bevel-groove weld may be assumed to be the plane passing through the line of contact between the two members *parallel* to the face of the flat member; whereas the joint featuring a flare-V-groove may be considered *perpendicular* to the common axis of the round members of the joint.

These planes are indicated on the sketches. Since the concept of a joint exists, although in a somewhat stretched-out manner, it follows that the arrows of the symbol have a definite *side* — meaning *arrow* and *other side* — significance.

In case of flare-bevel-grooves on smaller-size bars, there will be a tendency for reasonable portions of the weld metal to stay outside the joint, with those portions increasing in proportion to the diminishing radius of the bar.

At some point, most of the weld may be *outside* of the joint, at which time it will cease to be a flare-bevel-groove and will become a fillet weld.

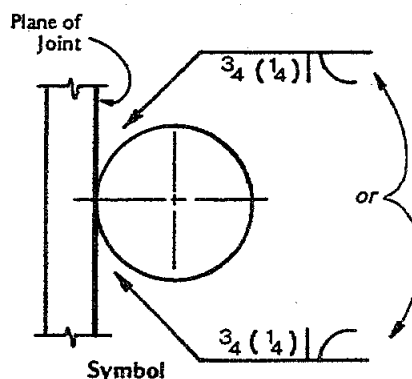
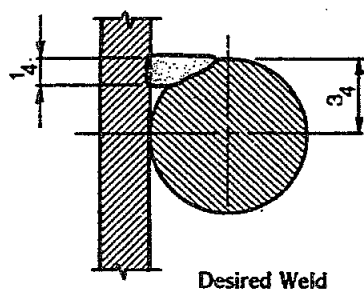
The achievable groove weld sizes of flare-groove welds have been defined in CSA W59 and in AWS D1.1. These standards may be used for guidance by users who have no resources to establish them on their own.

In line with the basic requirements, the effective weld size has to appear in the welding symbol. The application of flare-groove symbols will be illustrated in a number of examples:

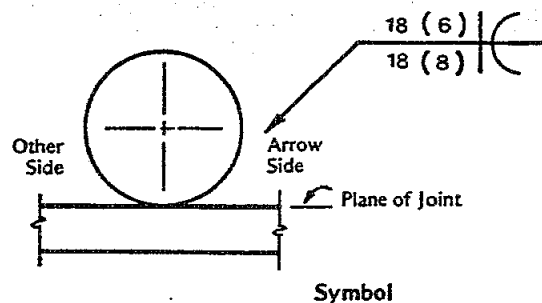
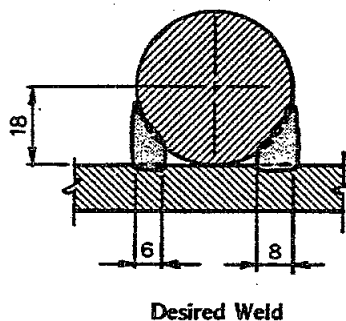
EXAMPLE 12

FLARE-BEVEL-GROOVE WELDS

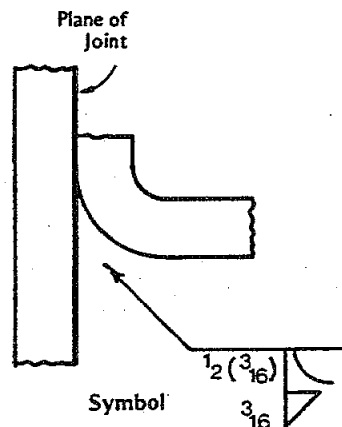
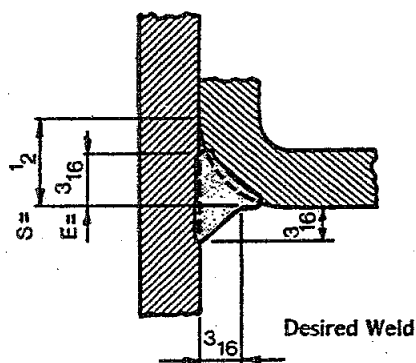
(a) Single-Flare-Bevel-Groove Weld



(b) Double-Flare-Bevel-Groove Weld

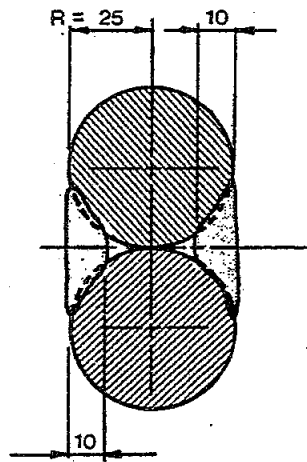


(c) Single-Flare-Bevel-Groove with a reinforcing Fillet Weld



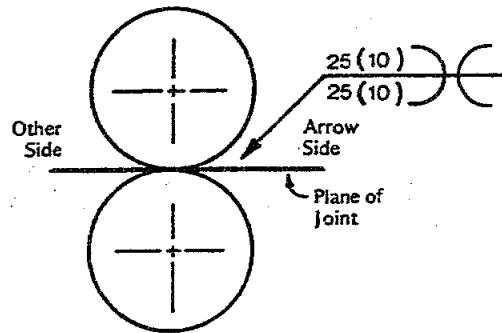
EXAMPLE 13

FLARE-V-GROOVE WELDS



Desired Weld

Horizontal Lap Splice of two round Bars of the same size

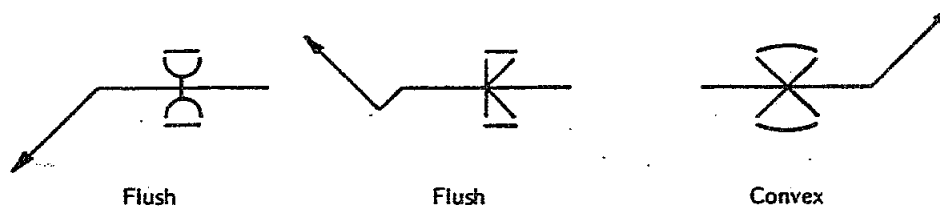


Symbol

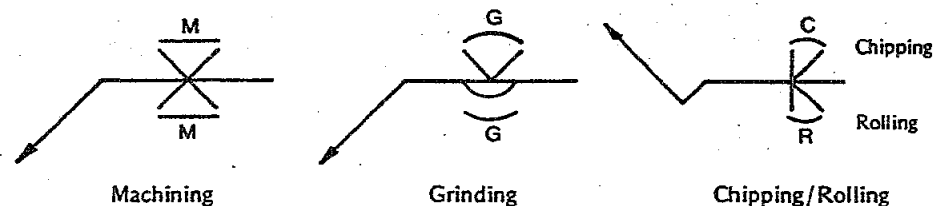
2.5 Surface Finish and Contour of Groove Welds.

The desired contour of groove welds may be obtained naturally or with recourse to mechanical means, these being left to the discretion of the user.

The following series of welding symbols shows the correct application of the required supplementary symbols.



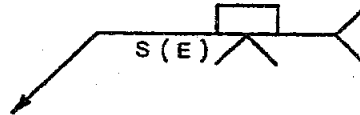
The most common contour for groove welds is the *flush* contour, and this is in view of its expectedly better performance in service. In order to further improve that performance, a mechanical finish may be considered:



2.6 Joints with Backing

Joints with backing are joints welded from one side. Such welds must be considered where there is no access for welding from the other side or where, if such access is feasible, the more skill demanding and less productive welding in overhead position, or welder discomfort, will dictate their use.

The welding symbol designating a groove with backing shows the groove and the supplementary backing symbols:



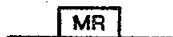
It should be noted that the supplementary symbol for backing is a rectangle while that for consumable inserts is square in shape.

All general rules governing the presentation of the required information in symbols apply equally to symbols for joints with backing. However, since backing is an exclusive and characteristic feature of such joints, additional information is required:

1. The type of backing material must be identified, and such identification (by means of an assigned letter) must appear inside the rectangle of the supplementary backing symbol.



2. The direction to remove the backing, if required, must also be placed in the rectangle, using the letter "R" for *removal*.



3. The dimensions of the backing must be specified in the tail of the symbol or elsewhere in the drawing.

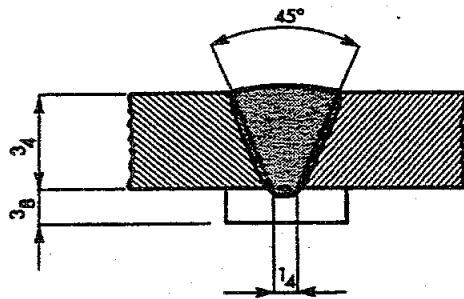
Many materials are successfully used as backing materials. As stated, they must be identified in the symbol. For the purpose of explanatory examples, only steel (S) will be used.

For joints in which there is no fusion into the backing material, the removal of such material need not be specified in the symbol.

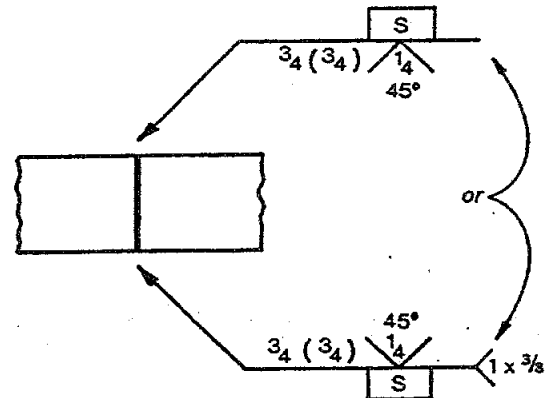
Joints with backing will be joints with *complete* penetration. However, the governing specifications should be consulted with respect to any action they may require, prior to according these joints a status of *complete joint penetration grooves*. Such action may likely relate to the actual backing material used.

EXAMPLE 14

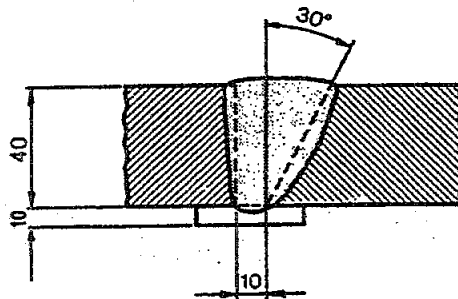
JOINTS WITH BACKING



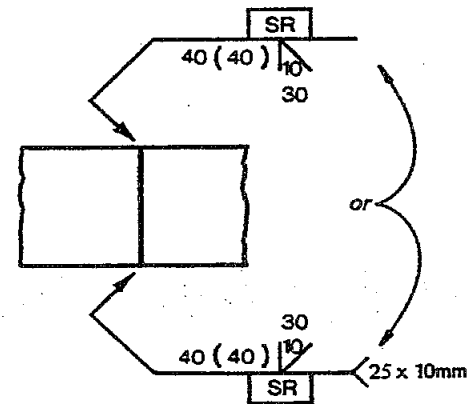
Desired Weld



Symbol



Desired Weld
(Backing to be removed)

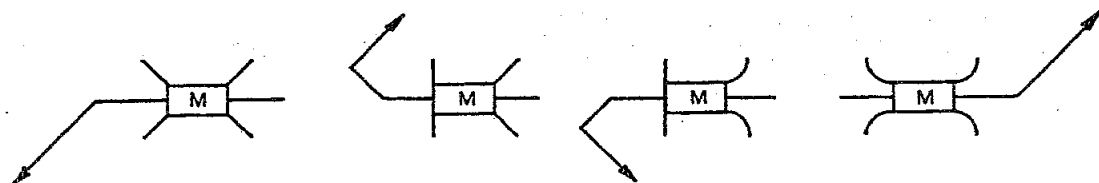


Symbol

2.7 Joints with Spacers

Welding symbols can be conveniently used to provide full information for joints using spacers. As in the case of backing, the material for the spacer has to be specified and its letter designation placed in the rectangle striding the broken reference line of the symbol. Most likely, it will be of the same material designation as that of the members of the joint.

Spacers can be used for any type of double-groove for which the typical symbol presentation will be:



Double-V-Groove

Double-Bevel-Groove

Double-J-Groove

Double-U-Groove

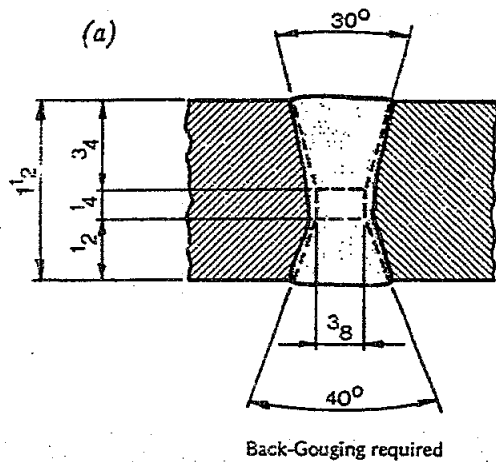
Symbols for Welding

The requirements for placement and dimensioning of the other elements in the symbol remain the same as for any other groove weld.

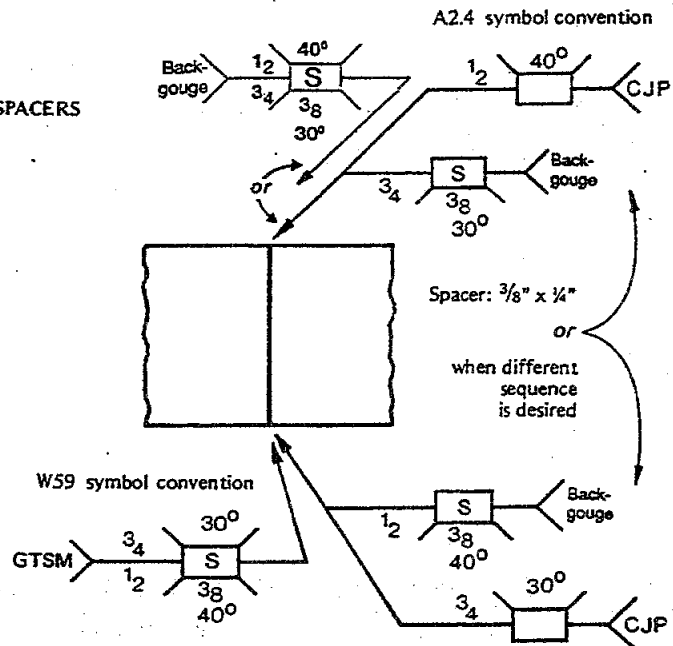
Since, in most cases, back-gouging will be required, the welding symbols will also be as already discussed for joints involving this operation.

EXAMPLE 15

JOINTS WITH COMPLETE PENETRATION USING SPACERS

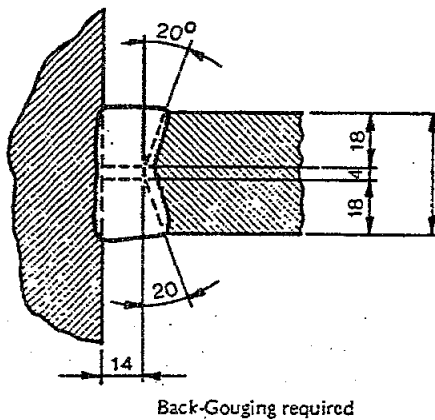


Desired Weld

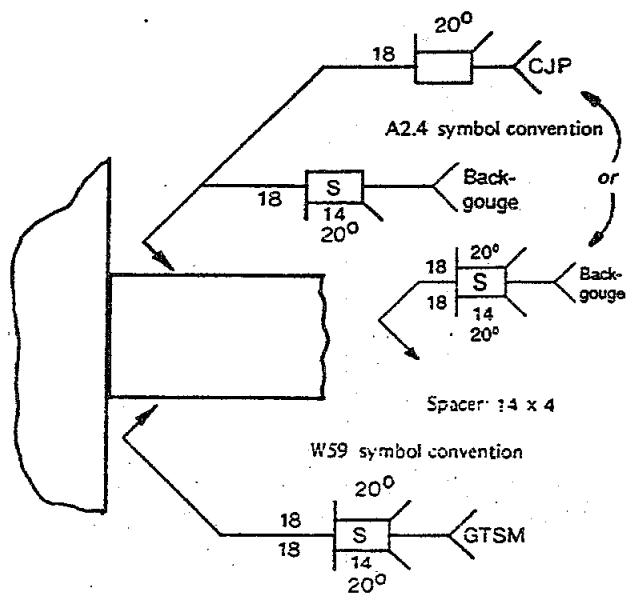


Symbols [A2.4 and W59]

(b)



Desired Weld



Symbols [A2.4 and W59]

2.8 Combination of Groove and Fillet Welds in T-Joints

T-joints are very common in structural fabrication. Any web-to-flange joint in an assembly of three plates into an "H" section (plate girders, welded wide flanges) involves a T-joint.

For these joints, the machine mode* of welding is preferred because of their length as well as requirements for better quality and overall economic considerations.

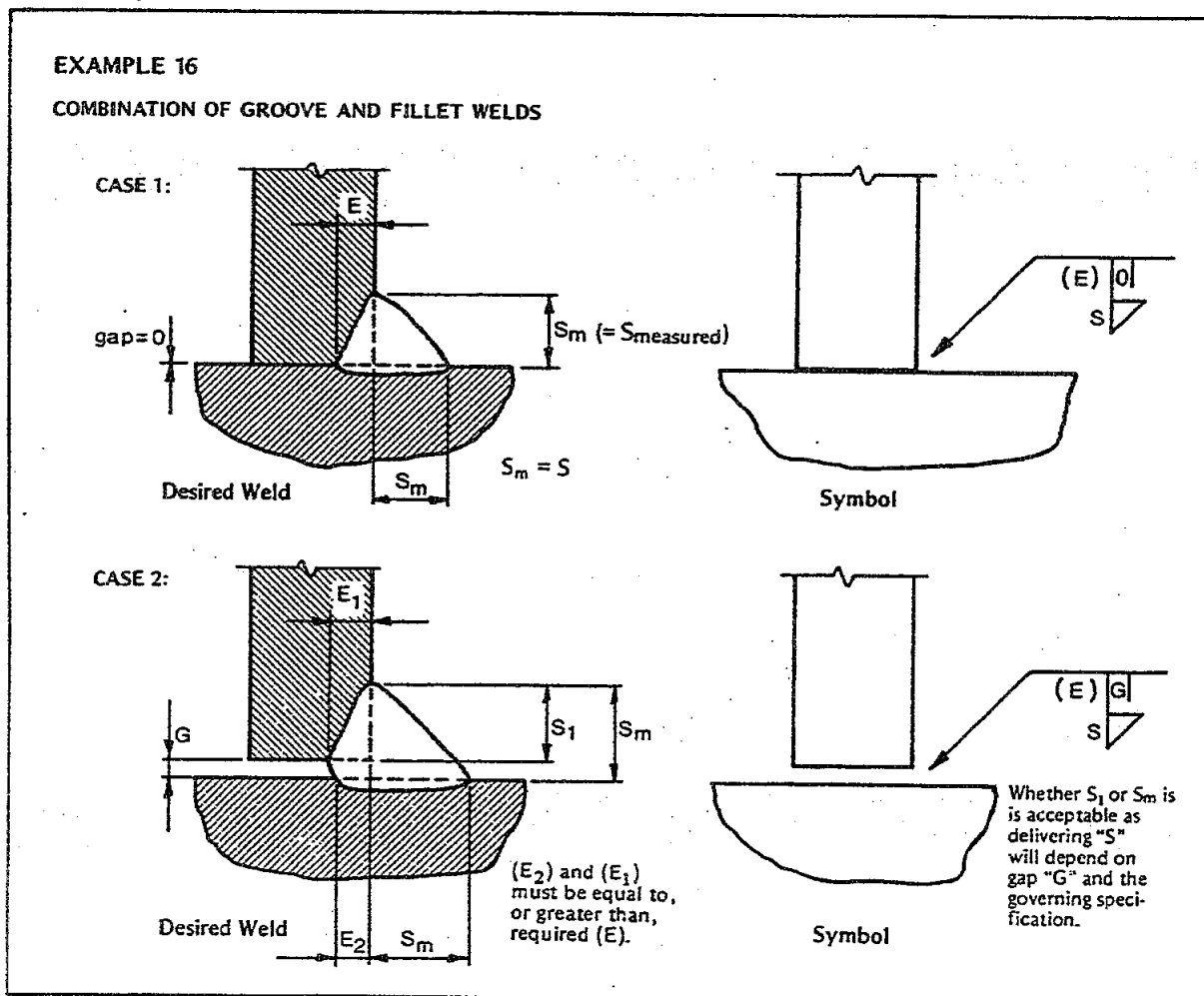
**Machine Welding* -- welding with equipment which performs the welding operation under constant observation and control of a welding operator.

Automatic Welding -- welding with equipment which performs the welding operation without adjustment of controls by a welding operator.

When welding processes with deeper penetration characteristics are used (like the submerged arc welding process -- SAW) for fillet welding of the joints, the additional root penetration can be claimed as adding to the effective throat of the combined square groove and fillet weld.

The extent of joint penetration in the groove part of the combined weld may be increased by an appropriate root opening. However, in either case, the gapless and the joint with a gap, the penetration as claimed must be verified in accordance with the requirements of the governing specifications.

The welding symbol presentation for each case is as follows:



2.9 CSA W59 Drawing Convention for Welding Symbols.

It is customary in shop fabrication to complete edge preparation of members to be jointed by groove welds prior to fitting-up of these members.

However, with the introduction of arc-air gouging and its expanding application to shop operations, a new practice was slowly being established.

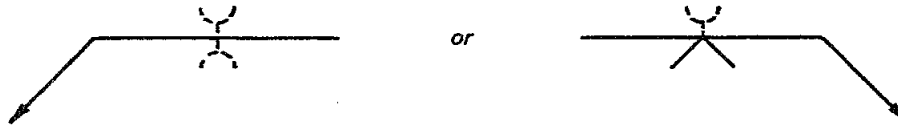
It took full advantage of the capabilities of the arc-air gouging process by using it for grooving purposes in certain joint situations.

The great convenience in that innovative approach was that such groove preparation would be done in the joint after fitting or on the second side of the joint after the first side was welded.

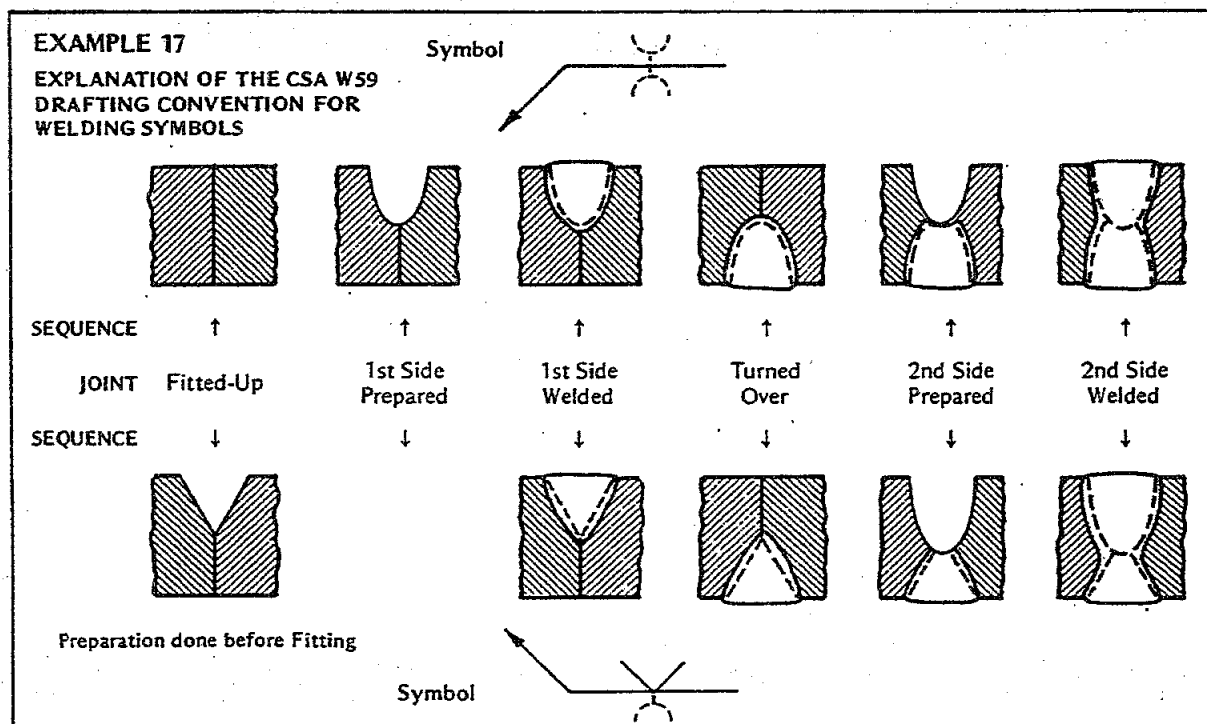
Both of these conditions will be explained in the examples that follow.

However, the question of an appropriate welding symbol comes first.

To indicate that groove preparation be made by air-gouging, the weld symbol for a U-groove is required by the CSA W59 Standard to be shown as a dotted symbol:



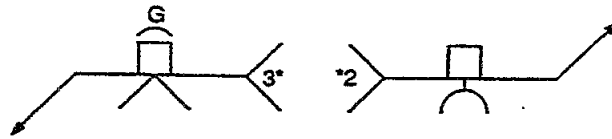
The solid lines indicate preparation *before* fitting. The sequence of operations implied by each symbol is illustrated below:



The purpose of this Example was to show the sequence of steps necessary to obtain a groove weld as specified by the welding symbol, using the CSA W59 symbol convention. The intent was to show the idea behind this convention without involving the student in any actual case.

2.10 Joints with Consumable Inserts

For welding operations employing consumable inserts, all rules governing the presentation of the required information in symbols are applicable as in case of joints with backing. Additionally, however, the AWS consumable inserts class* must be placed in the tail of the symbol:



**for insert class see AWS A5.30.*

It should be noted that the supplementary symbol for a consumable insert is square in shape.

3. FILLET WELDS

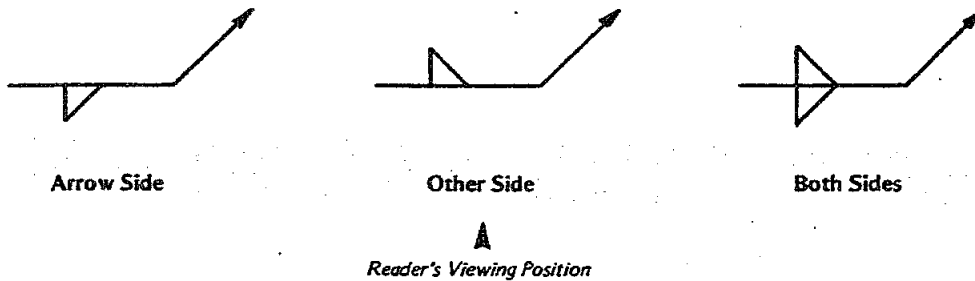
3.1 General

The composition of welding symbols for fillet welds is governed by a number of explicit rules. For proper application of such welds in welded fabrication these rules require that the following information be expressed in a prescribed manner and be placed at designated locations in the welding symbol unless specific *general notes* covering standard dimensions of fillet welds appear elsewhere on the drawing.

1. The Fillet Weld Symbol.

Rule:

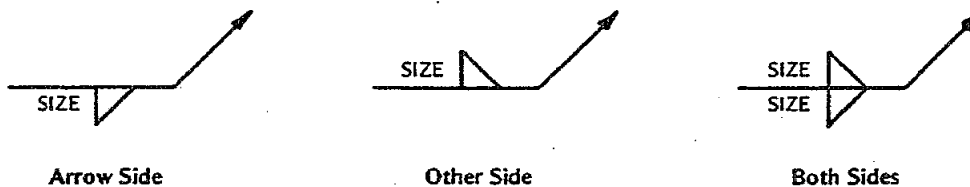
The vertical side of the triangle representing the weld symbol must always be on the *left* side from the reader's viewing position.



2. The Size of the Fillet Weld.

Rule:

The size must be shown for *each* weld symbol and must always appear to the *left* of each weld symbol.

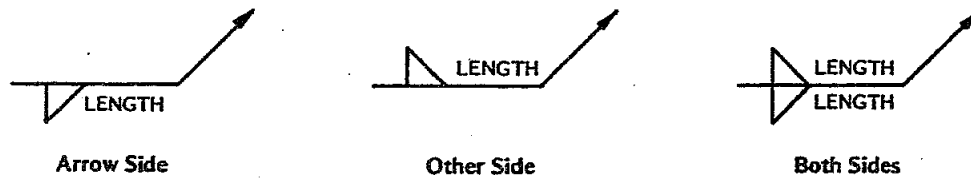


3. The Length of the Fillet Weld.

Rule:

The length must be shown for *each* weld symbol and must always appear on the *right* side

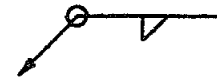
of each weld symbol. Absence of a specified length designates a length defined by the side of the joint between two points of abrupt change in the direction of welding.



Depending on the specific conditions or requirements for a given application, additional use may be made of the following supplementary symbols:

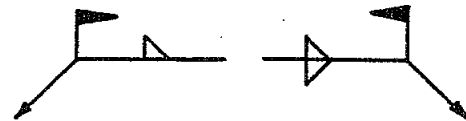
1. *Weld-All-Around:*

Symbol represented by an open circle placed at the junction of arrow line and reference line.



2. *Field Weld:*

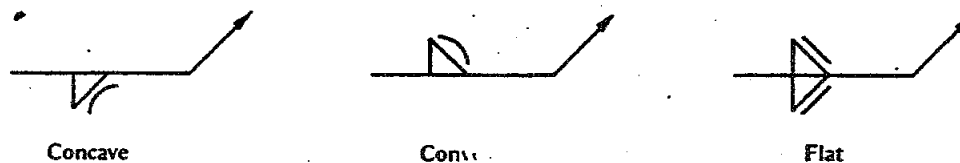
Symbol represented by a flag with its direction optional but preferably pointing away from the arrow and placed at the junction of arrow line and reference line.



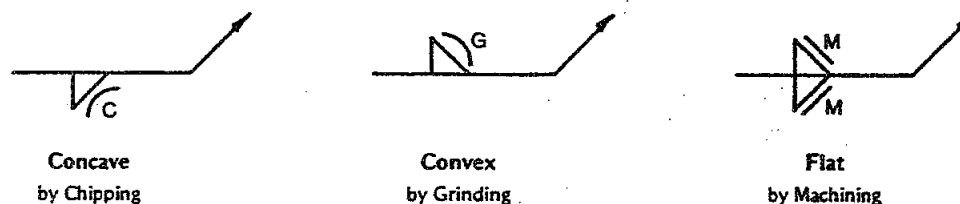
3. *Contours:*

Contours may be obtained in either one of two ways:

a) With no application of mechanical means:

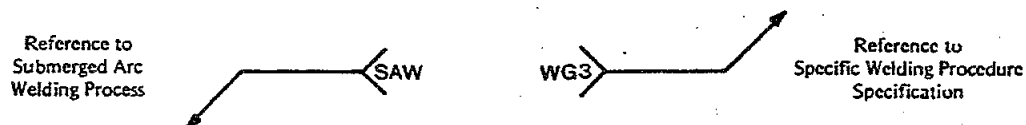


b) With application of mechanical means:



4. *References:*

The designated location for references is the tail of the welding symbol.

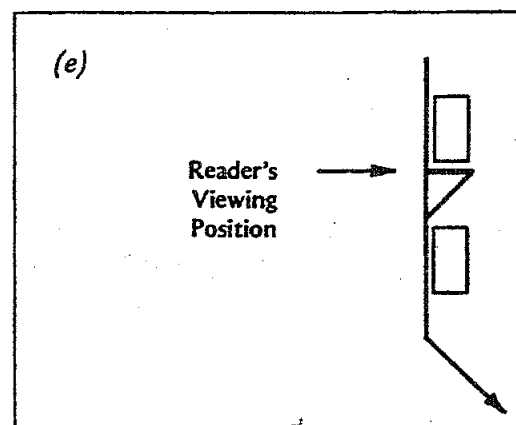
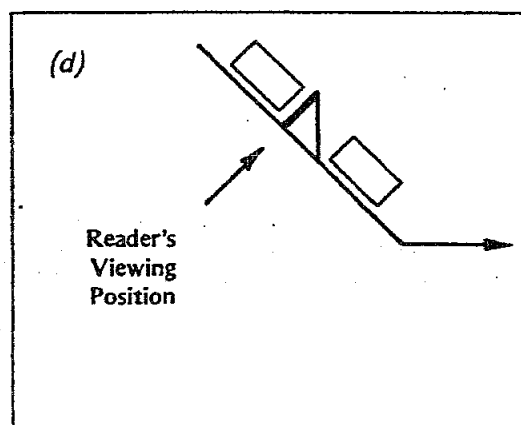
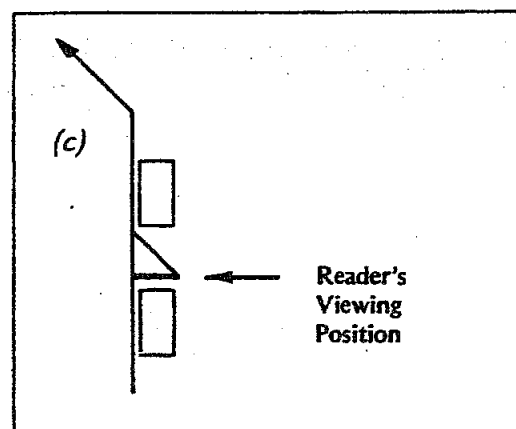
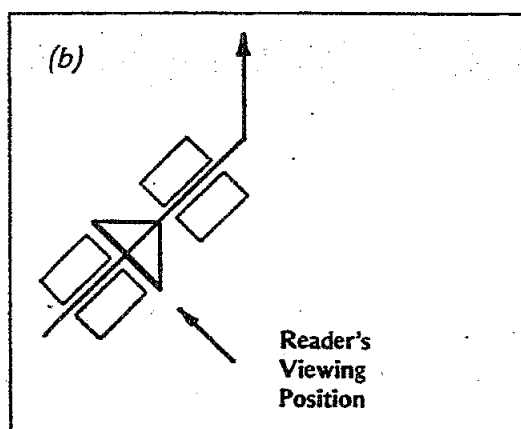
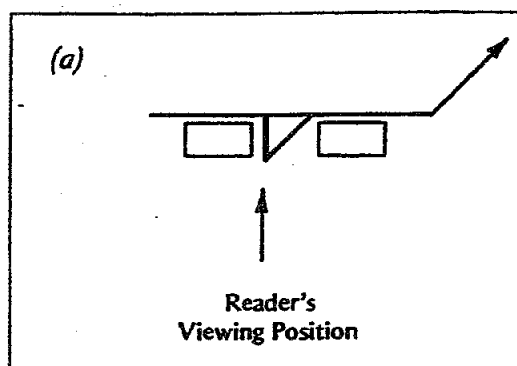


All of the mandatory principal elements of a typical fillet welding symbol will be discussed next in much greater detail with full attention given to the range of applicability of each of them. Extensive use shall be made of practical examples to illustrate and highlight points of specific interest or importance.

Reference shall also be made to governing specifications where their rulings affect the interpretation of certain aspects of fillet welding symbol information.

3.2 The Fillet Weld Symbol

As already stated, the vertical side of the weld symbol triangle must *always* appear on the left side when viewed from the reader's position:

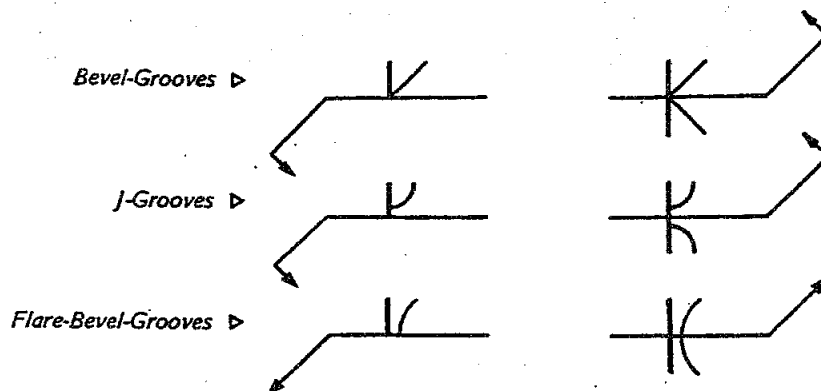


Obviously, the welding symbols will be placed and dimensioned in such a manner that they can be read from the same position of viewing as all the other dimensions on the drawing.

The most common convention in drafting is placing information so that it can be read from viewing positions (a) and (c), with any other position used only when it represents the user's convention or when conditions leave him no other option.

Note:

The same rule applies to the welding symbol for the following groove welds:

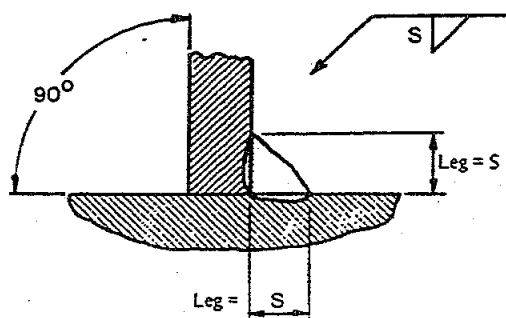


all of which have a vertical as part of their weld symbol.

3.3 Size of the Fillet Weld

3.3.1 Equal-legged Fillet Welds.

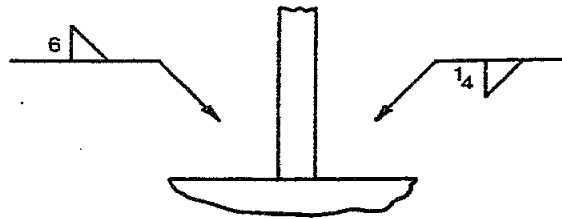
For an equal-legged fillet weld contained between two fusion faces at 90° relative configuration, the size is defined as the length of either of the two legs. This length, in the case of equal-legged fillet welds, is common to both legs. Therefore, the size of such a fillet appears in the welding symbol as one dimension — "S".



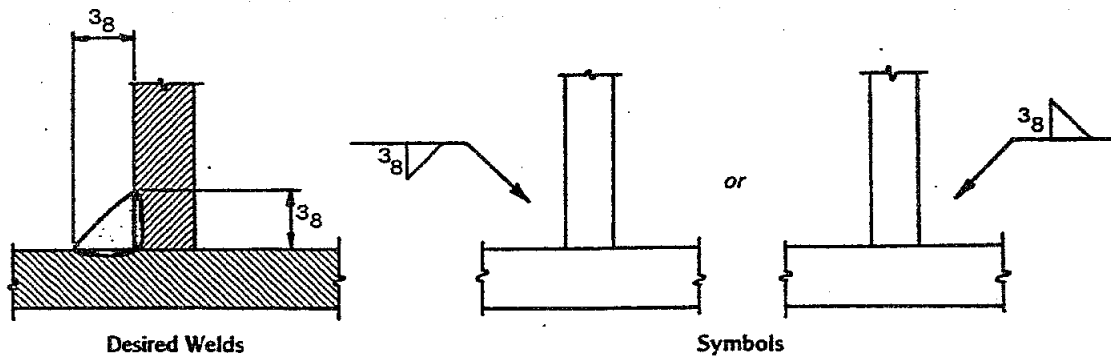
Assuming $S = 6\text{mm}$, and
 $S = \frac{1}{4}\text{ inch}$,

Symbols for Welding

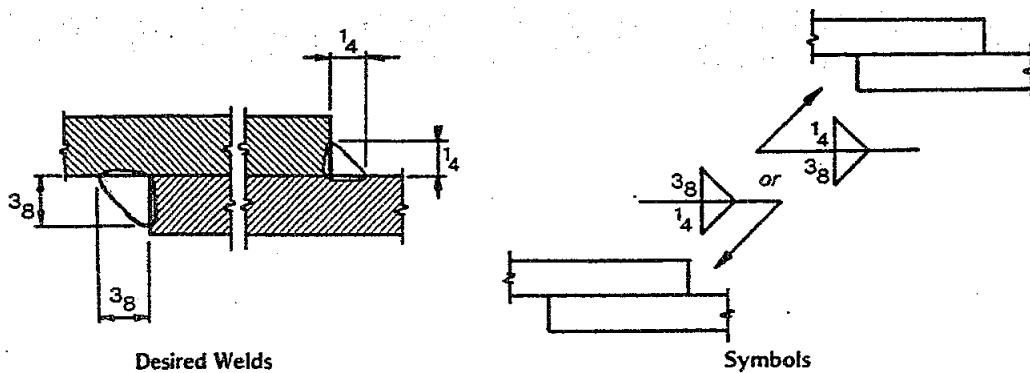
the welding symbols for the T-joint shown below are, correspondingly:



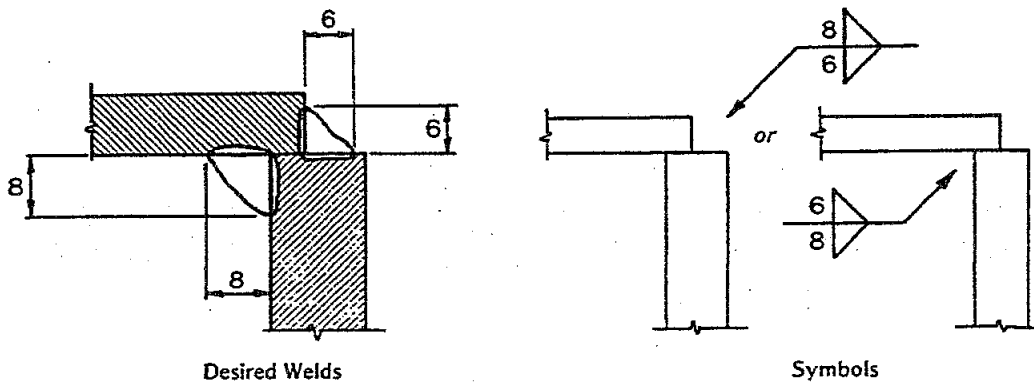
Similarly, for other situations, the corresponding welding symbols shall be as follows:



TEE [T-] JOINT



LAP [L-] JOINT



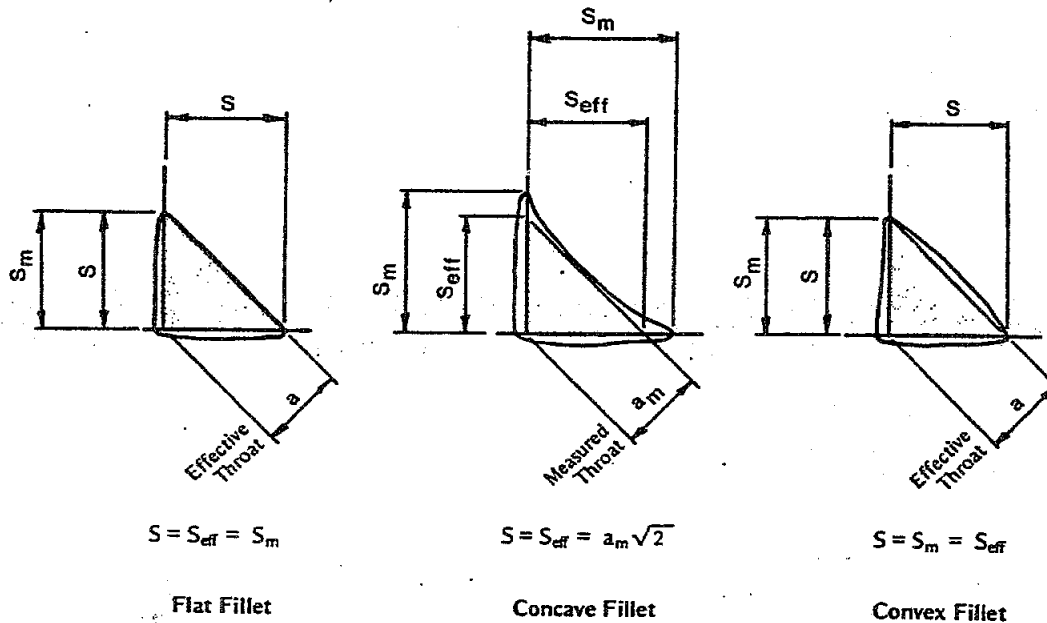
CORNER [C-] JOINT

Either metric or imperial measures may be applied

It should be well understood that the fillet size as specified must be the effective size delivered. The following terms will be used in future discussions of sizes, and defining them at this time will be very much in order:

- 1) The *Specified Size* is the size as it appears in the welding symbol and is designated by the letter "S."
- 2) The *Effective Size* is the size that corresponds to the specified size and is designated by the expression "S effective" = " S_{eff} ".
- 3) The *Measured Size* is the size established on the basis of measurement and is designated by the term "S measured" = " S_m ".

These sizes for the following three types of fillet welds are as shown:



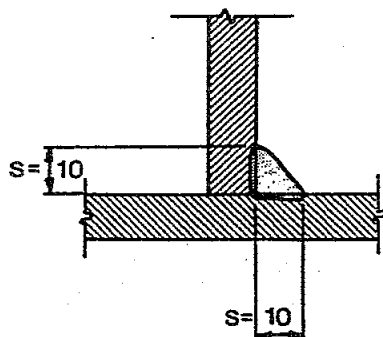
It is of interest to note that in some countries the size of the fillet as it appears in the welding symbol may be specifying the size of the throat of the weld rather than the size of the leg.

The *International Standards Organization* (ISO) responsible for the formulation of international standards has recently established its own position on this issue. Sub-committee 7 "Graphical Welding Symbols" of its Technical Committee 44 on Welding [ISO/TC44/SC7] has, in recognition of the entrenched practices in using one or the other system, officially accepted both, leaving it at the discretion of each country adopting the ISO standards to opt for the one system it prefers, either as a matter of free choice, or by virtue of established practice.

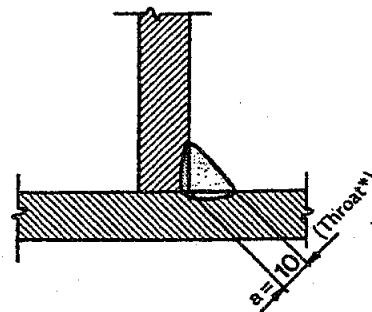
However, as a necessary precondition of such compromise, ISO has made it a mandatory requirement that each system be clearly identified by the following means:

Symbols for Welding

(a) Letter "z" to precede size
to designate LEG size
for the desired weld having
Leg Size = $S = 10\text{ mm}$

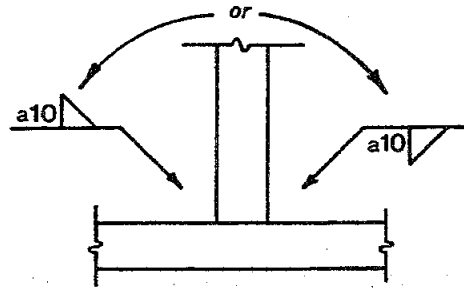
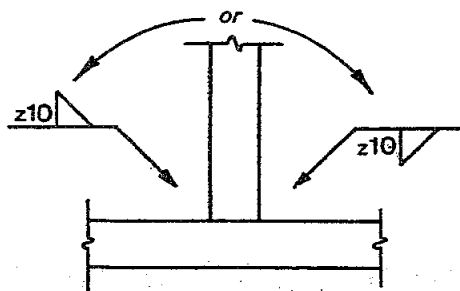


(b) Letter "a" to precede size
to designate THROAT size
for the desired weld having
Throat Size = 10 mm



*See preceding figure for
effective throats of fillets
with different profiles.

the corresponding welding symbols will be:



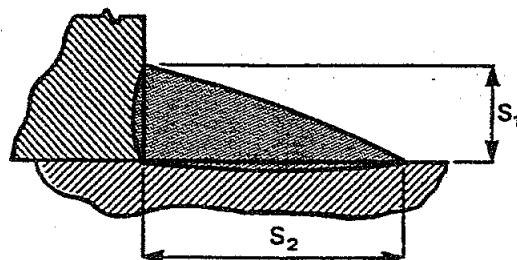
The interrelation of both sizes is expressed by:

$$z = a\sqrt{2} \quad \text{or} \quad a = \frac{z}{\sqrt{2}}$$

It should be understood that the designations z and a have no other significance except to identify the system. It is also very important for the student to be aware of the difference in interpretation attached to the definition of sizes of fillet welds between the AWS and the ISO concepts, both of which are used internationally. This awareness will be of specific importance to those who, because of involvement with international contracts, are exposed to dealing with foreign drawings.

3.3.2 Unequal-legged Fillet Welds.

There are situations which, for valid reasons, require the use of unequal-legged fillet welds. Obviously, the concept and the standard designation of *size* for such fillet welds in the welding symbol must be expanded in a manner that would clearly indicate the specific length required for *each* leg.



To meet this objective, a ruling has been adopted which requires such sizes to be expressed as a bracketed product representing the two leg lengths which, for the fillet weld shown at the bottom of the preceding page, are represented by:

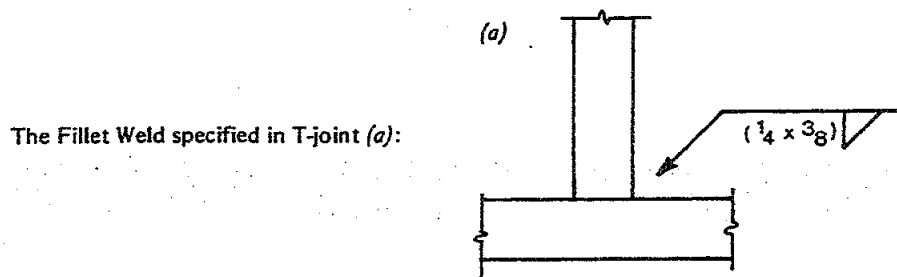
$$(S_1 \times S_2) \quad \text{or} \quad (S_2 \times S_1)$$

with the order of the elements in the bracket considered inconsequential.

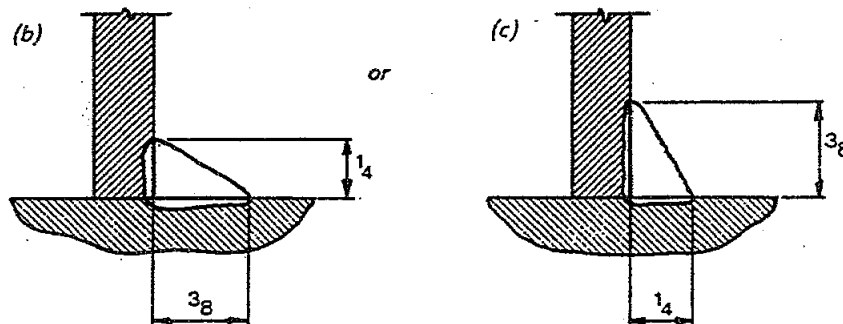
However, it is logical to assume that the underlying reason for choosing an unequal-legged fillet weld is the fact that it was found necessary to have one specific leg length of the fillet fuse into one designated member of the joint. Unfortunately, the ruling as adopted does not provide sufficient guidance to ensure that the very intent of the specifier will, indeed, be met.

The shortcoming of the ruling is that it fails to link the individual leg length of the fillet with any specific member of the joint.

In recognition of this shortcoming, AWS A2.4 requires that a sketch of the joint complete with the desired orientation of the fillet weld be shown on the drawing whenever necessary. The following example will illustrate this point:



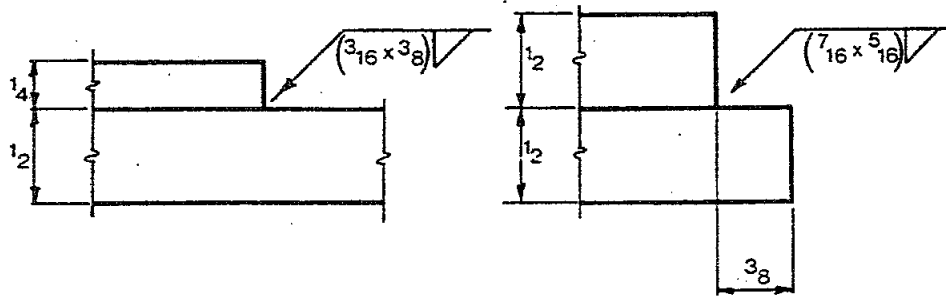
could be interpreted to mean:



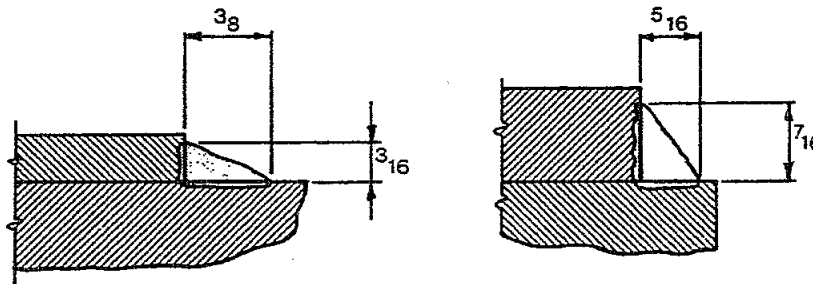
Consequently, in addition to the basic symbol under (a), an additional sketch showing either fillet weld (b) or (c) — as applicable — must be shown on the drawing. Only then will complete information be provided for an error-free interpretation at the time of welding. Such clarifying sketches may not always be necessary, although they may be considered.

This will apply mainly to joints in which the physical characteristics of the material or the specific geometry of the joint permit only one interpretation, as shown in the following examples:

Symbols for Welding



For these two joints, only one interpretation is possible:



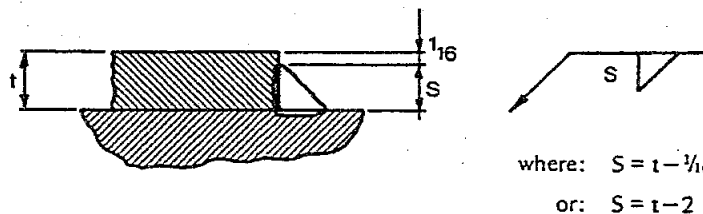
In each case, one of the specified leg lengths exceeds either the thickness of the material [as in (a)], or the available edge distance [as in (b)]. Hence, it is automatically disqualified for application to these particular sides of the joints.

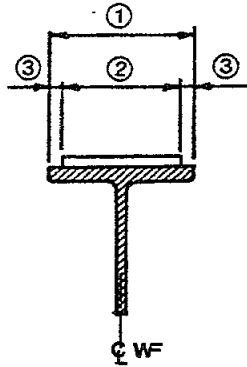
3.3.3 Minimum and Maximum Fillet Size.

It is advisable to point out that some governing design specifications like CSA W59 [*Welded Steel Construction*] or AWS D1.1 [*Structural Welding Code*] stipulate *minimum* fillet sizes as a function of material thickness.

On the other hand, *maximum* fillet sizes may be set either by considerations of balanced design, that is by keeping the capacity of the welds reasonably close to that of the parent metal; or by requirements of good welding practice.

With regard to the latter, specific reference is made to welding against a cut edge where the maximum recommended fillet size for thicknesses over 1/4 inch (6mm) is:



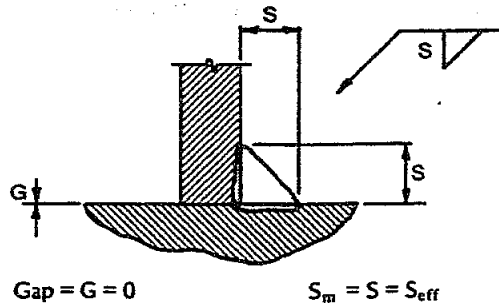


Long-length lap joints with narrow edge distances [3] for side fillets will also warrant consideration of reduced maximum fillet sizes to allow for misalignment and inaccuracies in cutting [2], and for tolerances in rolling [1].

3.3.4 Fillet Sizes in Joints with Gaps.

Another point of importance to bring to the attention of the student is the relationship between the size of the fillet as specified by the welding symbol and the *gap* in the joint.

It has already been stated in 3.3.1 that the *specified* size is the *effective* size to be delivered. The preceding discussions dealt only with gap-less fit-up situations in which the *measured* size (S_m) is also the *specified* size (S) and the *effective* size (S_{eff}):



By earlier definition, the *measured* size is, of course, the size established by outside measurement.

With no gap present in the joint, the length of fusion into both sides is determined by the measured length of the legs, thus providing acceptable assurance that the specified effective size has been delivered. This assurance has been based on the well-founded and proven assumption that fusion into the root of the joint has been obtained and maintained.

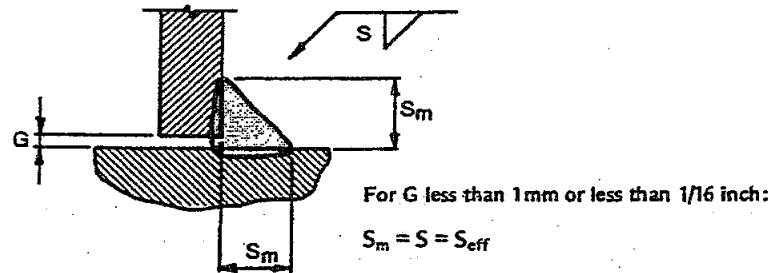
However, how is the effective size related to a joint with a gap?

It is, again, the governing specifications that provide explicit rules with respect to sizes of fillets in joints with such gaps. The basic principle in their provisions is common to most standards, except that they may differ slightly in the limiting dimensions set by their acceptance criteria.

Two acceptable gap situations are generally defined:

Symbols for Welding

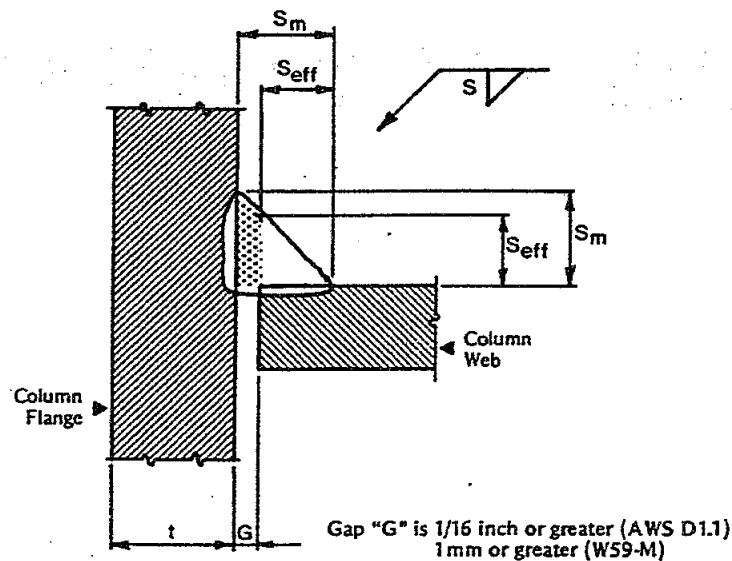
- 1) In the *first* one, a maximum gap is defined for which no increase in the measured sizes of fillet welds is required. In CSA W59-M, as well as in AWS D1.1, this maximum gap is set at less than 1mm and $\frac{1}{16}$ inch, respectively.



- 2) In the *second* one, another maximum gap is defined for which an increase by the actual amount of the gap is required in the measured size. In the same two standards, this maximum gap is set at:

- $\frac{3}{16}$ " (5mm) for thicknesses less than 3" (75mm);
- $\frac{5}{16}$ " (8mm) for thicknesses 3" (75mm) or greater.

The following sketch showing a typical joint used in the fabrication of heavy columns illustrates the above provisions:



The measured and the required effective sizes of the fillet weld are dimensioned on the sketch. The ruling of the two standards require that

*in order for the specified effective size of the fillet weld to be delivered,
 the measured size must be increased by the amount of the gap.*

Hence, $S_m = S_{eff} + G$

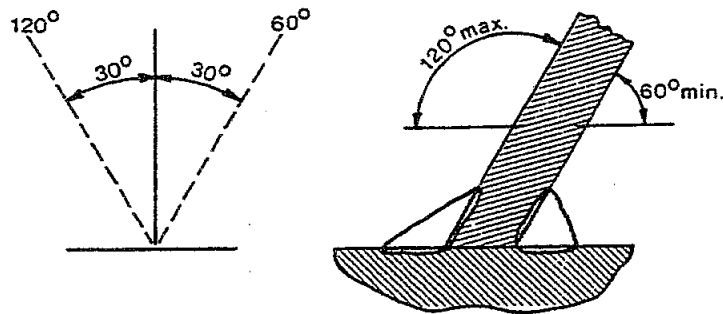
where $G_{max} = \frac{3}{16}$ " (5mm) for thicknesses less than 3" (75mm);
 $= \frac{5}{16}$ " (8mm) for thicknesses of 3" (75mm) or greater.

For gaps greater than $\frac{3}{16}$ " (5mm) the same standards require a sealing weld or a suitable backing material prior to depositing the final weld. It is also clear that gaps greater than $\frac{3}{16}$ " and $\frac{5}{16}$ " (5 and 8mm, respectively) as related to the pertinent thicknesses of material are not permitted.

3.3.5 Sizes of Fillets in Skewed Connections.

- 1) To what extent of relative angular orientation of the fusion faces does a fillet weld remain indeed a fillet weld?

The answer can be found in the governing welding design specifications. CSA W59 and AWS D1.1 state that welds with fusion faces extending from 60° to 120° are considered fillet welds.

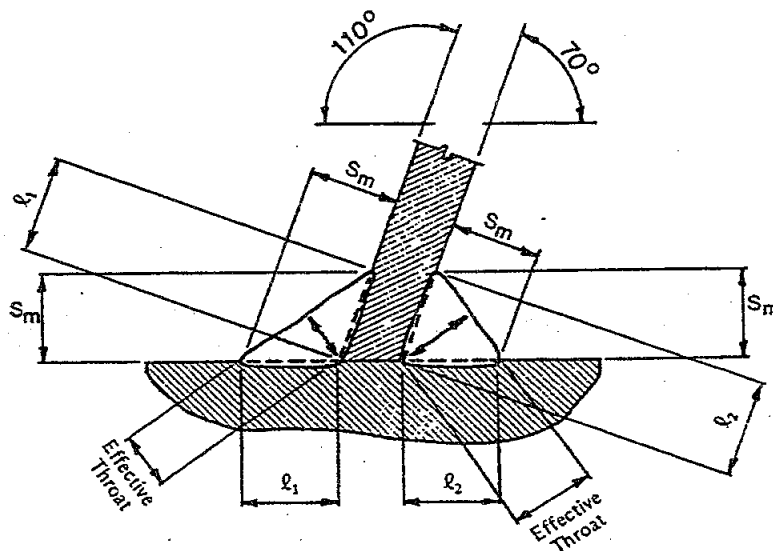


Welds with angles of less than 60° or more than 120° between fusion faces are considered partial joint penetration groove welds.

The same two standards may also be consulted for information inter-relating effective sizes of fillets at 90° configuration to the measured sizes in the skewed orientation for joints with and without gaps.

- 2) It is a fact to be recognized that it is beyond the scope of the typical welding symbol to provide all the information necessary for proper execution of welding at all times.

Since the use of welding symbols for fillet welds in skewed joints is not feasible, sketches of actual joints showing the required dimensions are necessary:

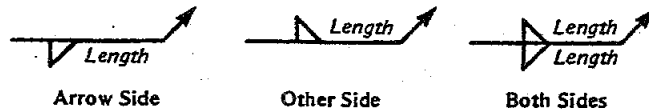


The measured dimensions " S_m " are sufficient to fully define the size of the fillets for a given angle of skew (70° in above joint, on the acute side). The leg length dimensions " l " are used as check dimensions while the effective throat sizes are of theoretical value. However, they are both closely related to the " S_m " dimensions, which are the only ones that can be practically and conveniently measured from the outside. They may also be shown on the sketch.

3.4 Length of Fillet Welds

3.4.1 General.

As stated previously, the designated location for the length of the fillet weld is the right side of the weld symbol.

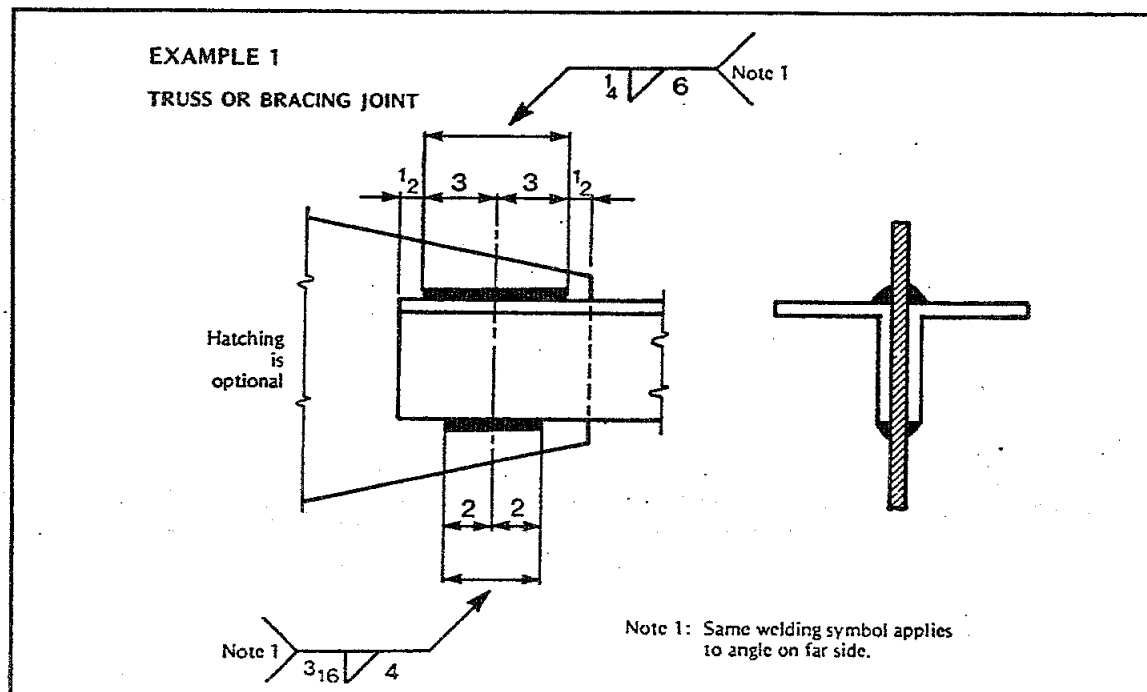


3.4.2 Length of Fillet Specified.

The length of the fillet weld, when specified, is the effective length. This means it is the length of a full-size, full-bodied fillet weld without any reduction for starts or crater terminations.

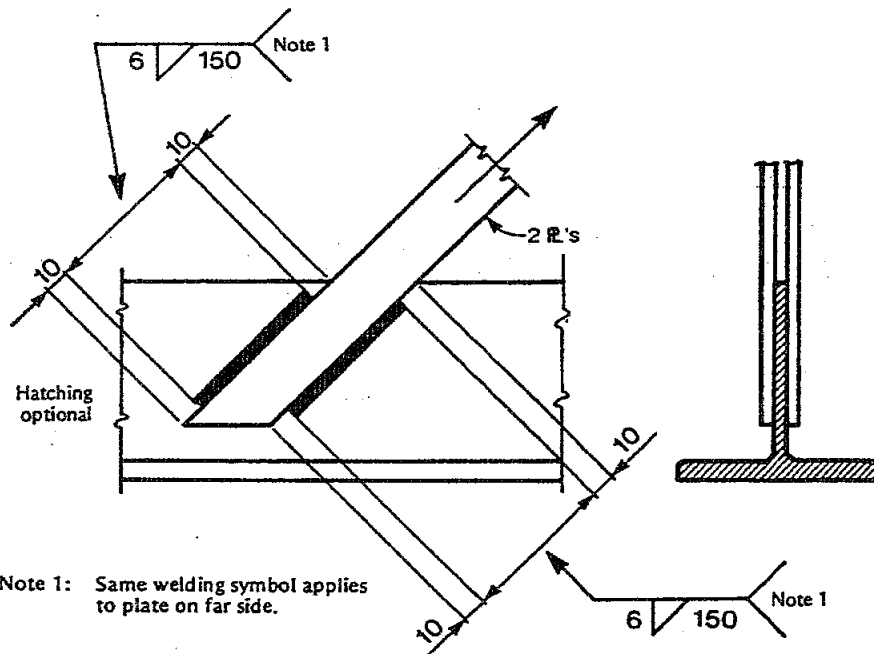
A *crater* is the terminal end of a weld rapidly diminishing in the size of both legs and, even more drastically, in the size of the throat. The craters are due to improper technique on the part of the welder or lack of enforcement of proper technique on the part of the supervisor. Craters are generally considered poor welding practice and, although tolerated for somewhat less significant fabrications, they are prohibited by governing specifications for critical applications.

Since the welding symbol has no provisions to designate the exact location of a specified weld length, additional dimensioning must be used for that purpose. Where advisable or preferable, hatching may also be used to supplement such dimensioning. A few examples will serve to illustrate the point:



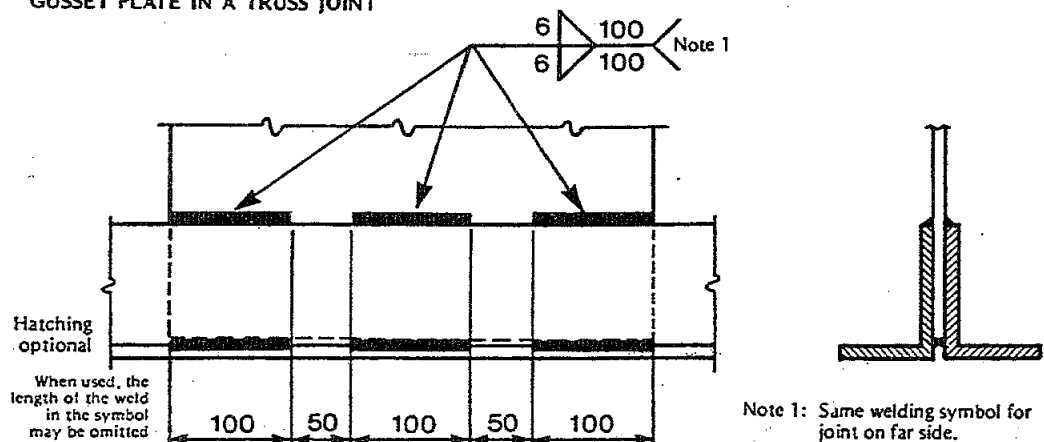
EXAMPLE 2

TRUSS JOINT



EXAMPLE 3

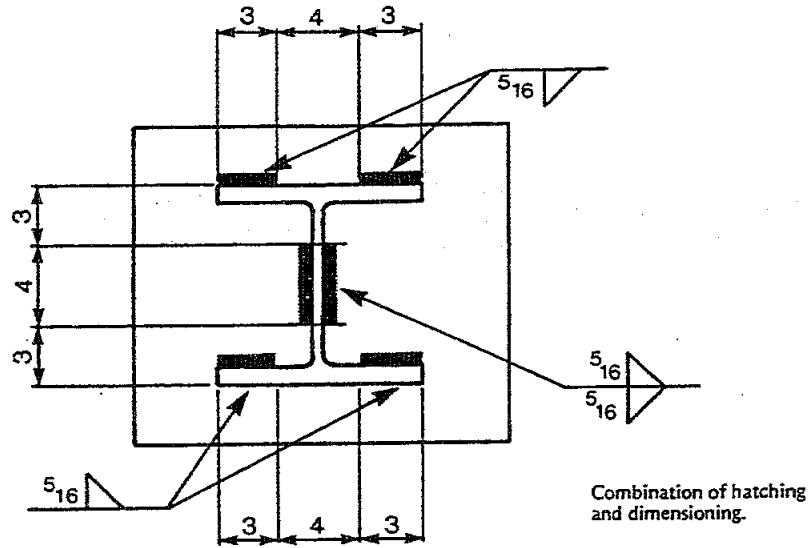
GUSSET PLATE IN A TRUSS JOINT



Symbols for Welding

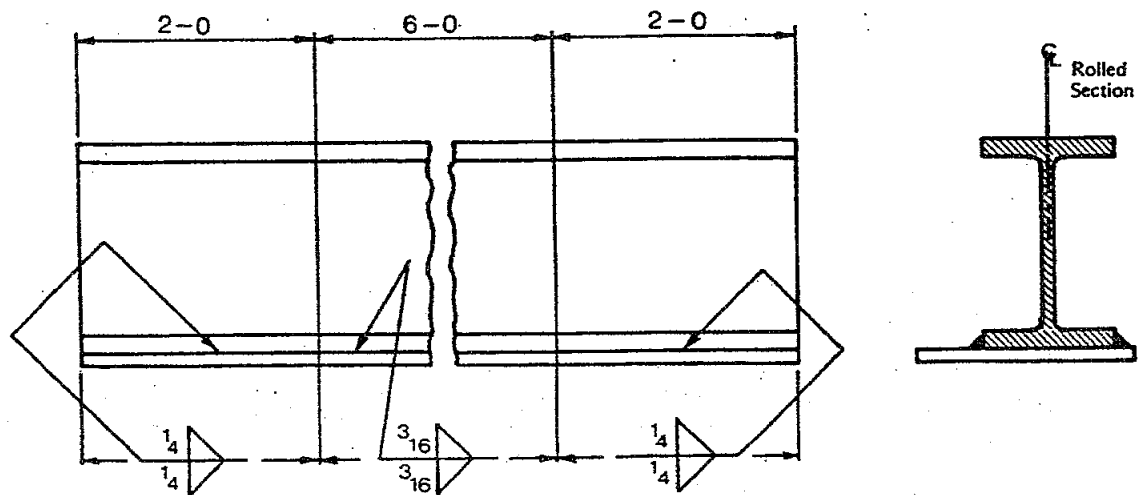
EXAMPLE 4

COLUMN-TO-BASE-PLATE DETAIL



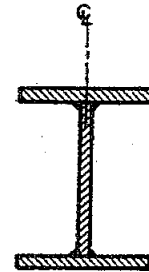
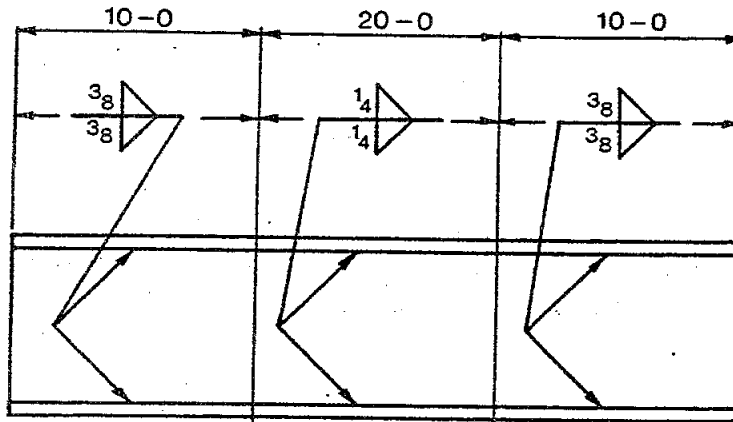
EXAMPLE 5

LINTEL



EXAMPLE 6

PLATE GIRDER



The type of welding in Examples 5 and 6 was chosen primarily to illustrate the principle in the application of symbols combined with dimensioning. It does not necessarily reflect actual practice.

3.4.3 Length of Fillet Not Specified.

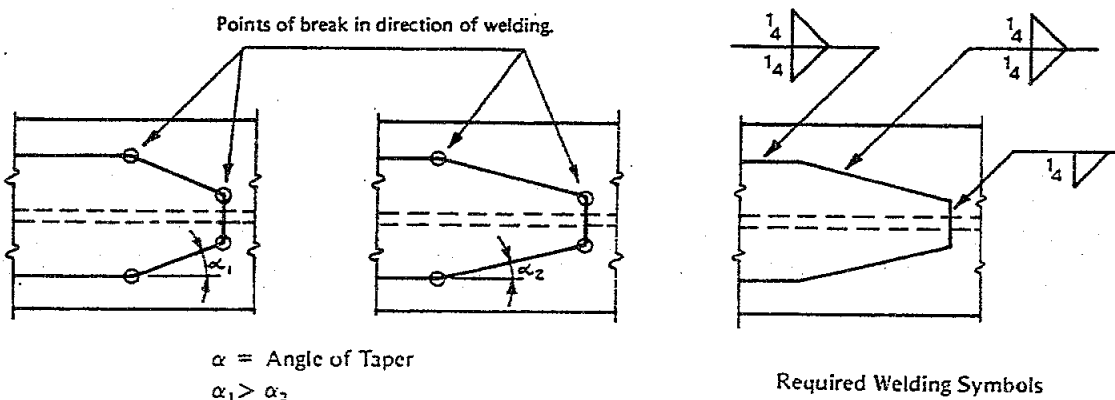
When the length of the fillet is not specified, or not specified and at the same time not supplemented by additional dimensioning, the length to be welded is the length of the joint on the respective "arrow" or "other" side for which there is not any change in the direction of welding.

The term *any change* has not been specifically defined in the AWS A2.4 specification, but should be taken to mean a break in direction of straight-line welding at a point generally identifying such a break.

This interpretation is explained in the following Example:

EXAMPLE 7

TAPERED COVER PLATE



Symbols for Welding

In the accepted interpretation of the term *any change*, the extent or amount of change in the direction of welding as expressed by the angle of taper (α) in the above example has no significance. What matters is a pronounced breaking point at which the direction changes, irrespective of the amount.

Hence, two welding symbols are required at the tapered end, as shown on the detail at right. Obviously, a welding symbol for the whole cover plate, including an *all-around* weld symbol, will achieve identical results.

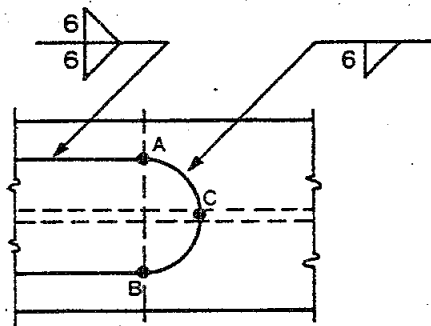
Another feature of interest in the tapered detail is the fact that, for a double-fillet weld symbol, the *arrow* and *other* sides of the joint need not be parallel.

The principle which dictates the use of separate welding symbols for any distinct change in the direction of welding implies indirectly that, for any curved configuration of the joint, one welding symbol will suffice. One may contend that such conclusion is not only logical but the only one possible. Supporting it is the fact that any point on a curve is a point of change in direction, requiring, in theory, a separate symbol... which, in reality, is an obvious absurdity.

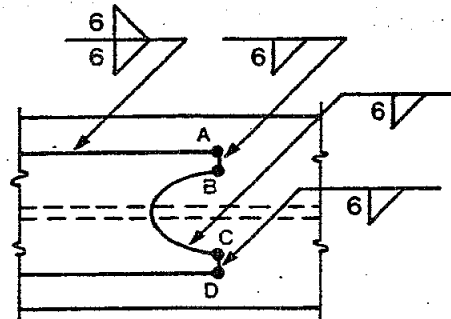
Example 8 shows the proper symbol application for the joints under consideration:

EXAMPLE 8

COVER PLATE DETAILS WITH SEMI-CIRCULAR AND PARABOLIC SLOT ENDS.

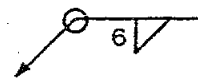


A and B are points of change in direction



A, B, C and D are points of change in direction

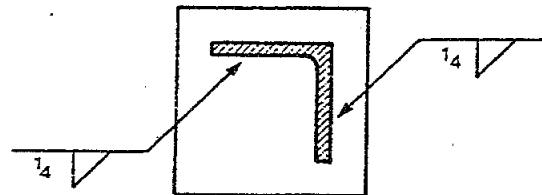
Obviously, the *all-around* weld symbol would easily produce the same extent of welding required by the welding symbols shown in Example 8 and used for illustration purposes only.



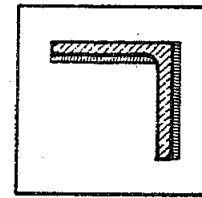
Other examples illustrating the application of welding symbols for fillets without specifying the length are shown next:

EXAMPLE 9

ANGLE POST
TO BASE
PLATE DETAIL.



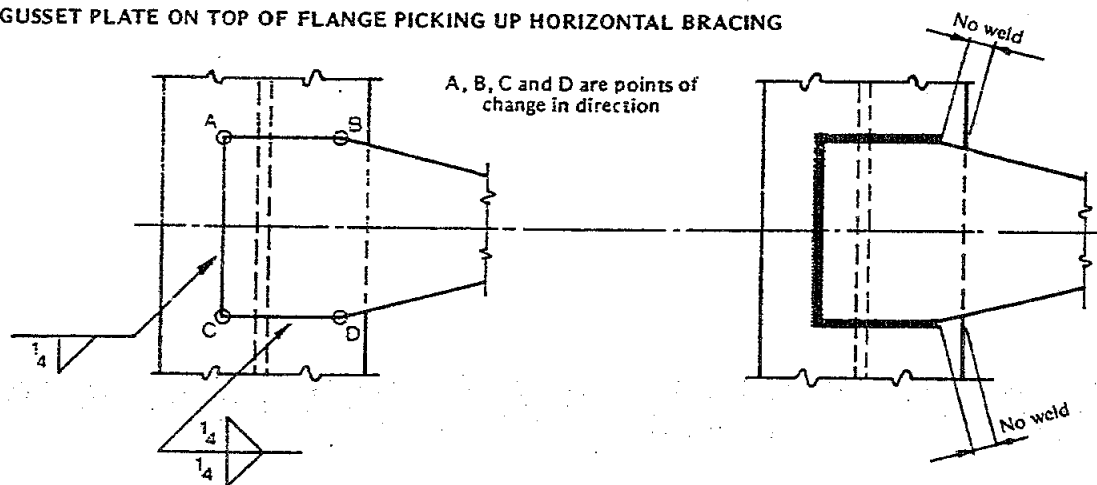
Symbols



Resulting Welds

EXAMPLE 10

GUSSET PLATE ON TOP OF FLANGE PICKING UP HORIZONTAL BRACING

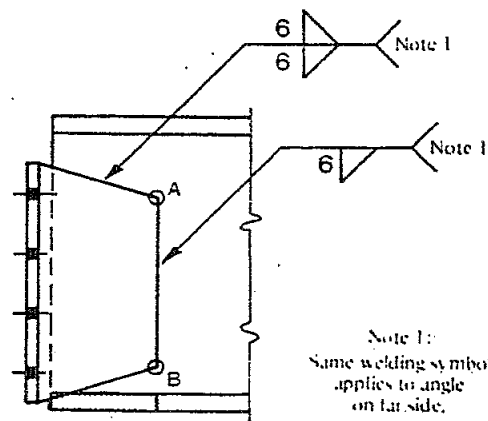


Symbols

Resulting Welds

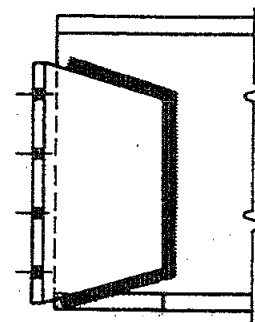
EXAMPLE 11

HEADER ANGLES
WITH LONGER
LENGTH OF
OUTSTANDING LEGS
TO ACCOMMODATE
AN ADDITIONAL
HORIZONTAL LINE
OF HIGH-TENSILE
BOLTS.



A and B are points of
change in direction

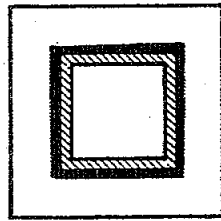
Symbols



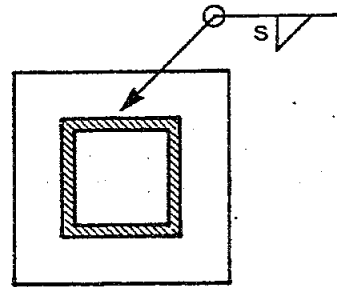
Resulting Welds

3.4.4 "All-Around" Supplementary Symbol.

The all-around supplementary symbol must be shown in the welding symbol when a circumferential weld is required and abrupt changes in the direction of welding are involved. This procedure is well illustrated in the case of a hollow structural section (HSS), rectangular in profile and welded to a base plate:

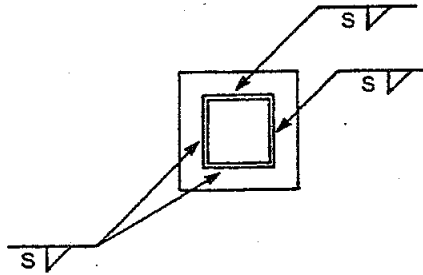


Desired Weld



Required Welding Symbol

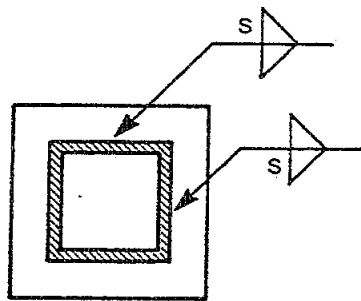
Each corner represents an abrupt change in direction, and were it not for the all-around symbol used, each of the four sides would have required a separate welding symbol:



Hence, an *all-around* symbol provides the greatest convenience and simplicity and should be preferred for use.

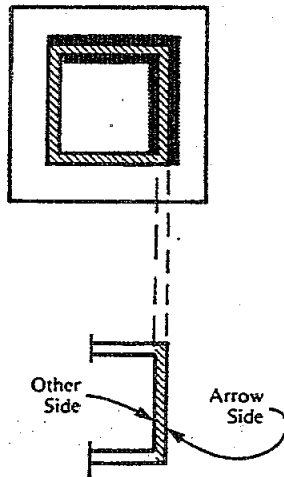
This is also an appropriate example to re-emphasize the basic rule governing the designation of *arrow* and *other* sides of the joint in the hope of preventing what seems to be a rather common error.

Appropriate reference is made here to the two welding symbols shown next and *erroneously* expected to result in a circumferential weld:



The welding required by these two symbols is, of course, far from what is intended; and it is impossible as well, since it would involve welding *inside* the section.

Welds as Specified

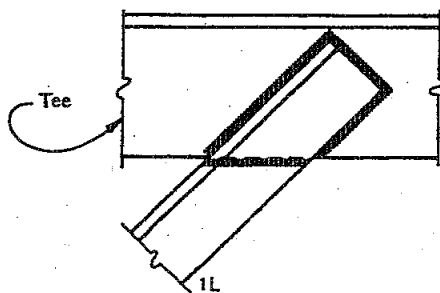


It should be kept in mind that the *arrow* side of the joint is the "outside wall—base plate" junction; whereas the *other* side is the "inside wall—base plate" junction.

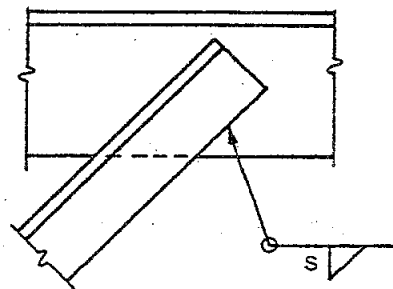
The common area of Contact constituting the joint is hatched.

The *all-around* symbol may involve welding in two or more planes as shown in the next two examples:

(a) Joint in Truss Work with Fillets in two planes:



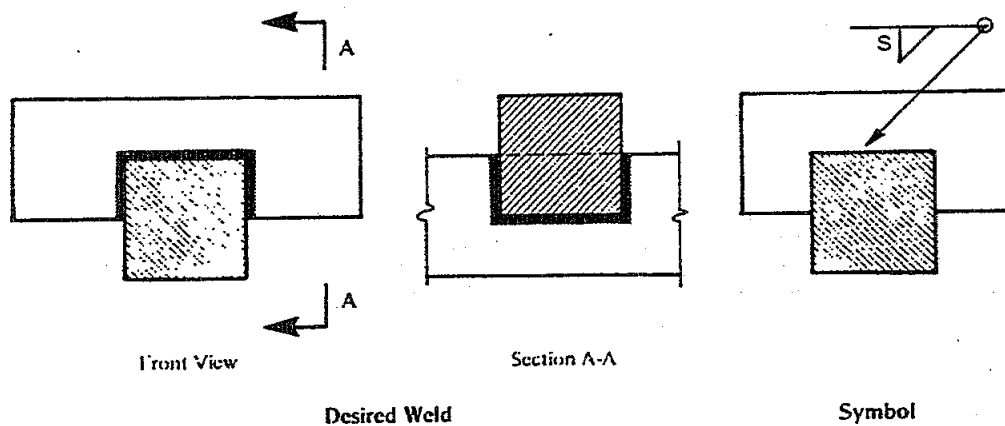
Desired Weld



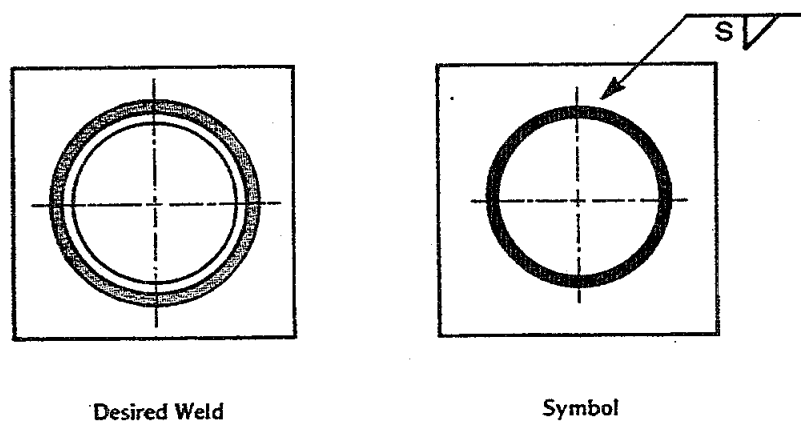
Symbol

Symbols for Welding

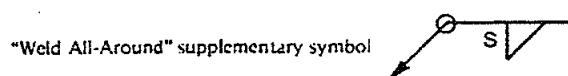
(b) *Joint with Fillets in more planes than two:*



Based on the previously discussed conclusive interpretation that a curved configuration does not constitute an abrupt change, the circumferential weld on a circular hollow section welded to a base plate (as shown below, left) requires only one symbol to properly convey the designer's intent (as shown below, right):



The use of the *all-around* supplementary symbol is actually not necessary in this case, as the welding symbol as shown cannot help but deliver a circumferential weld. It is, however, advisable to include it as a matter of principle.



3.5 Intermittent Fillet Welds

3.5.1 General.

There are three types of intermittent fillet welds, although the first one is inherent in the remaining two:

- 1) basic intermittent fillet welds, applicable to a single line of fillet welds;
- 2) chain intermittent fillet welds, and
- 3) staggered intermittent fillet welds;

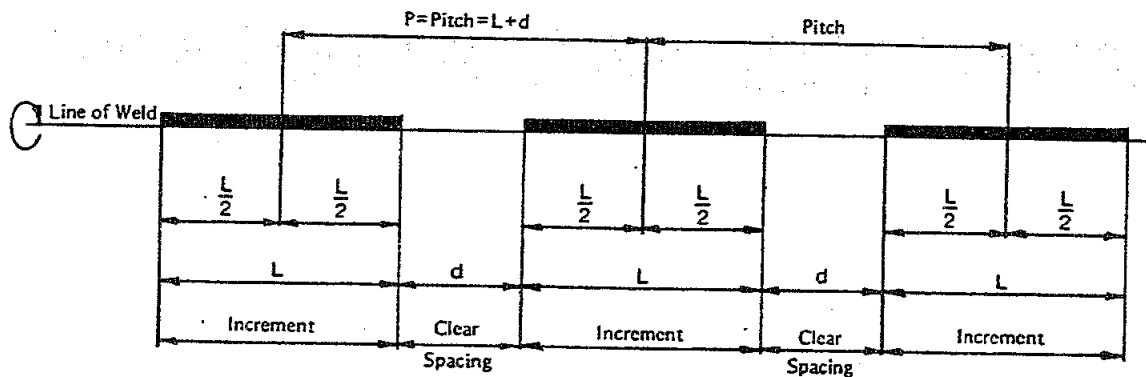
with the last two applicable to double-fillet welds.

Since any one of the three types represents a line or lines of welds with included *unwelded* portions in each line, it is extremely important to understand the rules governing the dimensioning of such welds.

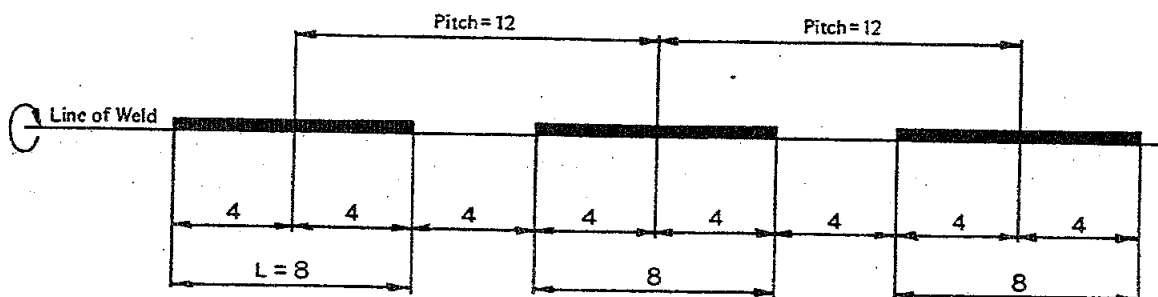
This dimensioning introduces the concept of *pitch*. Pitch, in turn, is defined as the distance between the centres of *increments* on *one* side of the joint.

Hence, if two sides of the joint, that is the *arrow* side and the *other* side, are to be welded using intermittent fillet welds, a pitch must be designated for *each* side or, in other words, for each line of weld.

The following sketches will help explain the fundamental concept and the rules governing its application:

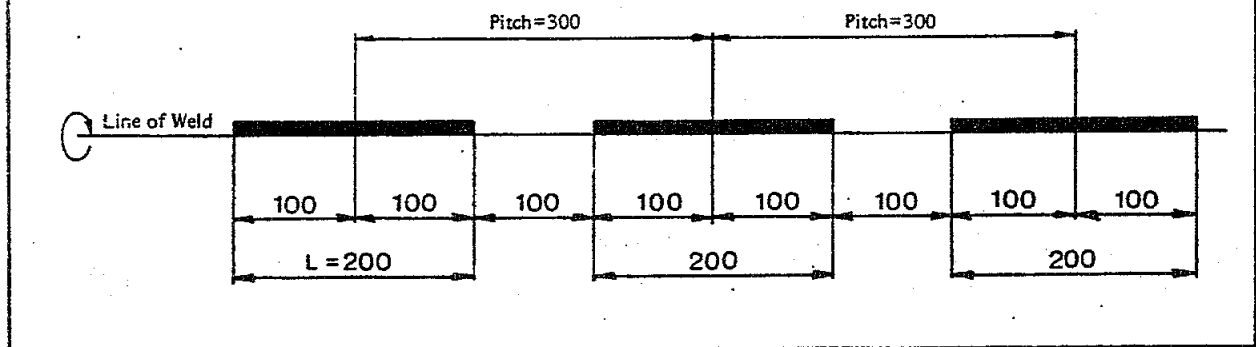


EXAMPLE 12 IMPERIAL UNITS



EXAMPLE 13

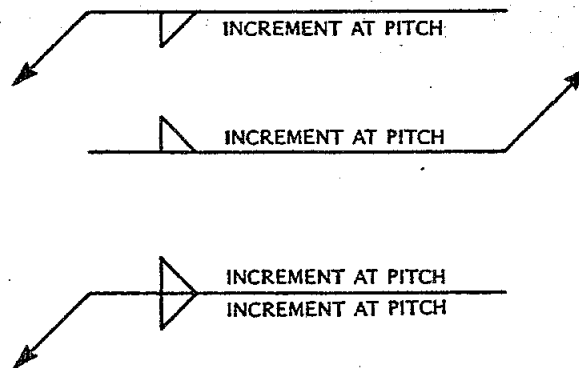
METRIC UNITS



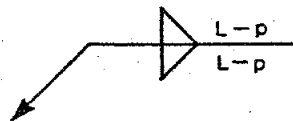
Since *increment* and *pitch* relate to the length and arrangement of welds, they must

- 1) appear to the right of the weld symbol in accordance with the governing rules, and,
- 2) be jointly expressed in a standard form with the length of the increment placed first.

This, illustrated in a typical welding symbol, will show:

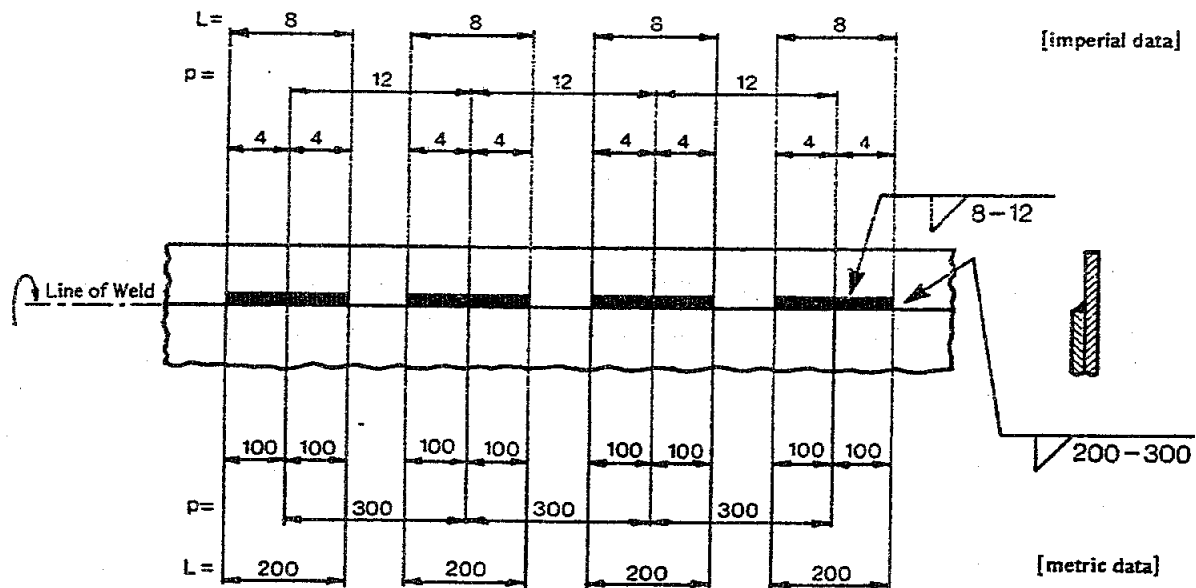


Using the letter designations for increment (*L*) and pitch (*p*), the expression in the welding symbol will take the following form:



The rules, when applied to the *imperial* data of Example 12, or to the *metric* data of Example 13, will result in the following welding symbols:

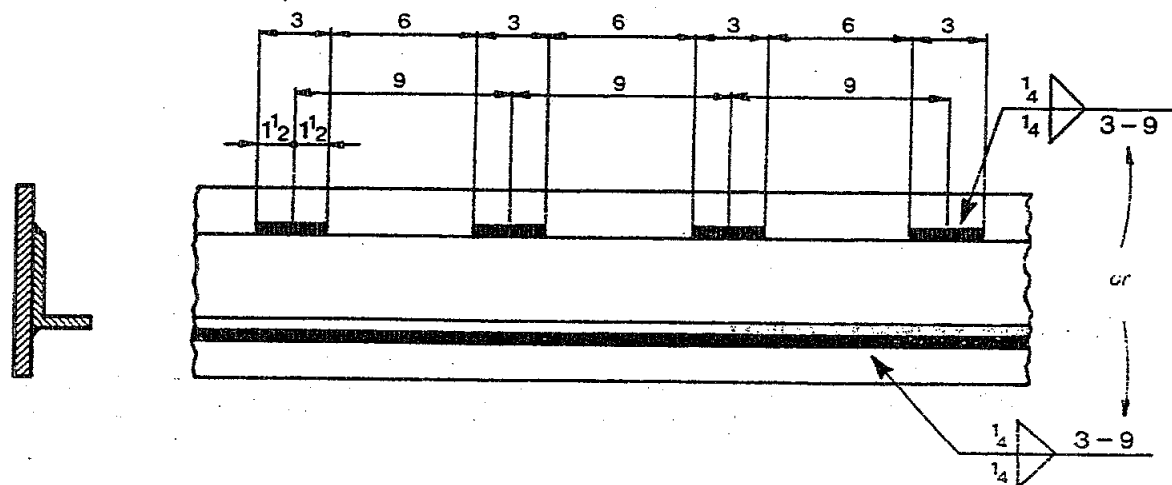
EXAMPLE 14



3.5.2 Basic Intermittent Fillet Welds.

As stated earlier, this type of intermittent fillet weld is used only for a single line of fillet weld as shown in Example 14. It may, however, also find application in situations as shown in Example 15.

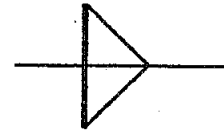
EXAMPLE 15



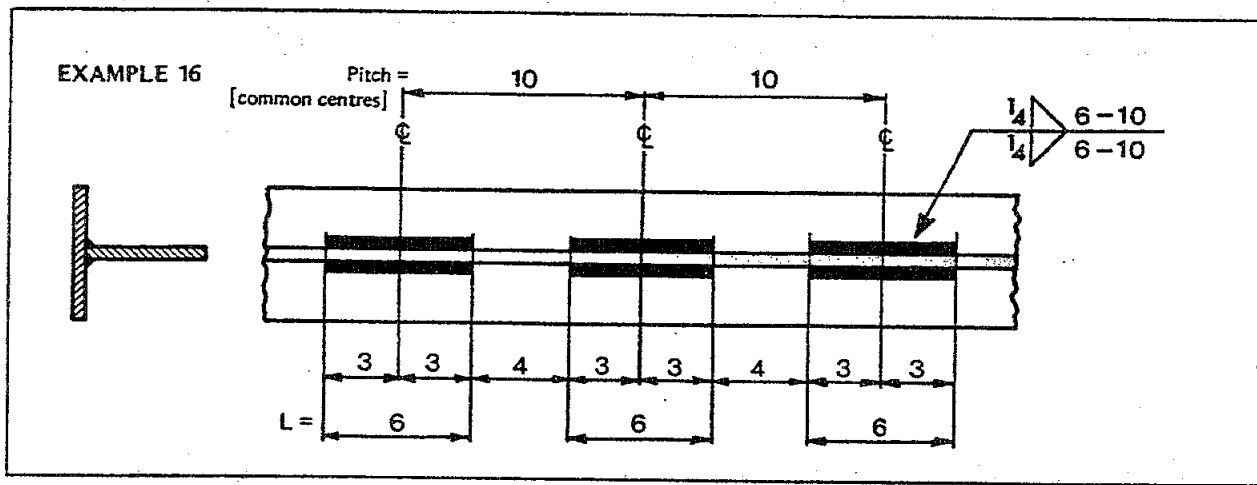
3.5.3 Chain Intermittent Fillet Welds.

This type involves double-fillet welds or, in other words, *two* lines of welds. The distinguishing characteristic of chain intermittent fillet welds is the relative alignment of their increments which is expressed by the rule that their centres must be maintained at the same relative location along the length of the joint.

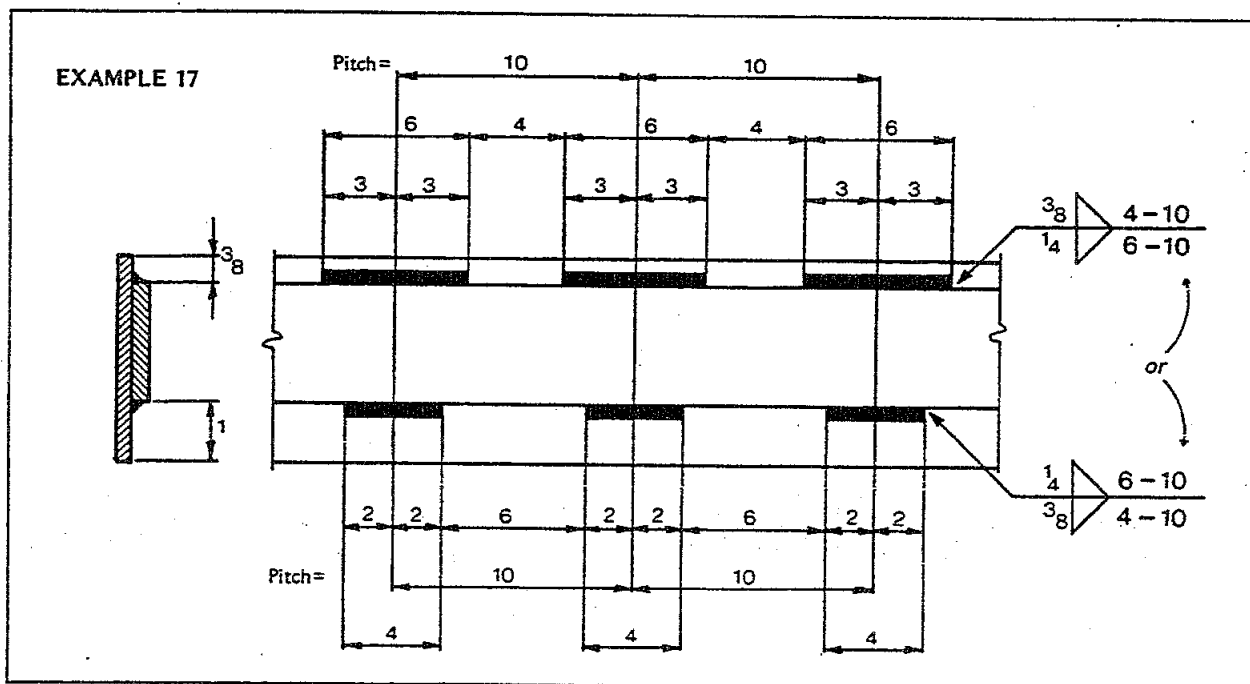
The visible indication of this mandatory relation is shown in the welding symbol by keeping the vertical sides of the two fillet weld symbols in one plane.



The rule regarding their common centres is explained in the following sketch:



Under normal circumstances the general tendency is to keep the length of the increments and the size of the fillets the same on both sides of the joint, if only to simplify fabrication and avoid errors.

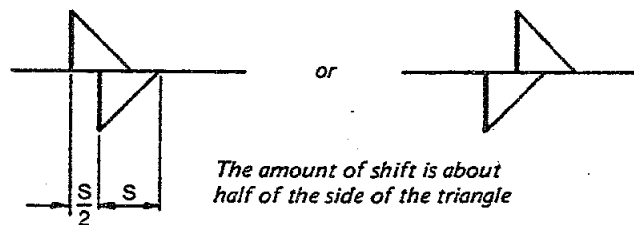


However, the applicable rules do not preclude the use of different fillet sizes and different lengths of increments on each side of the joint, provided that the essential condition, *the common pitch*, is maintained throughout. Specific circumstances may dictate such rather unusual and infrequent application. (See Example 17.)

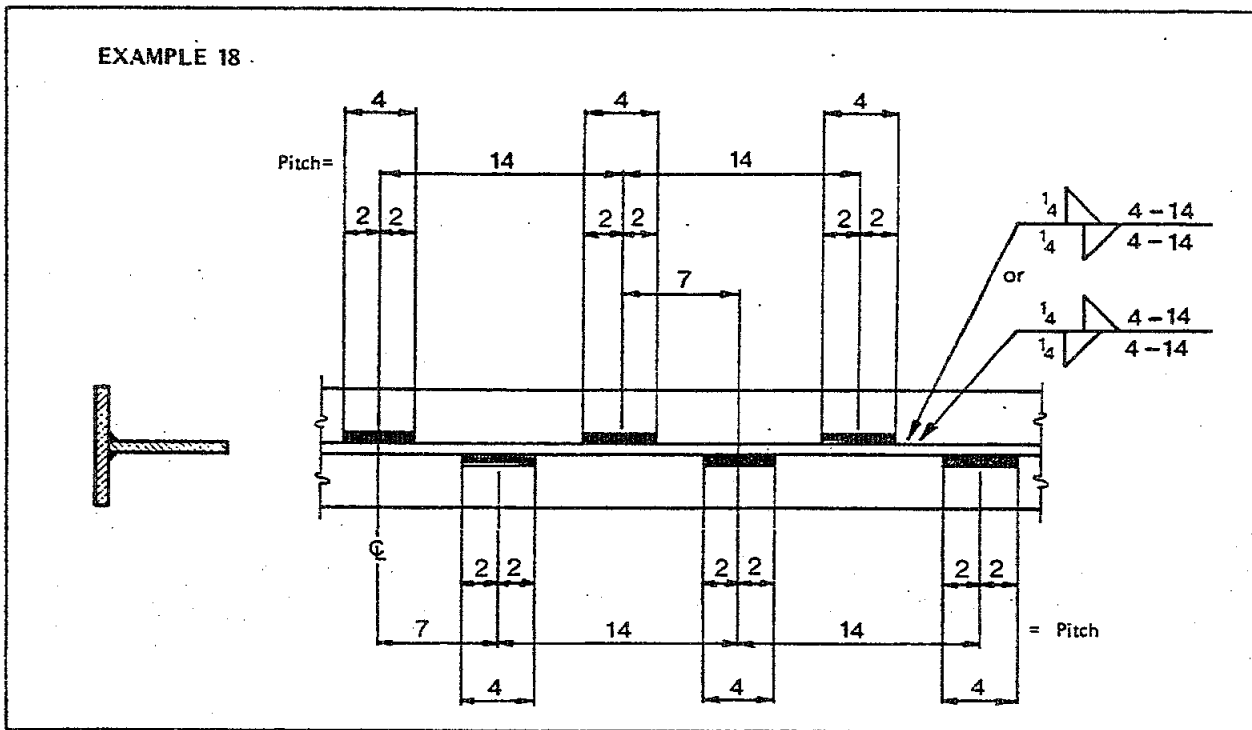
3.5.4 Staggered Intermittent Fillet Welds.

This type also involves double-fillet welds or two lines of welds. Its distinguishing characteristic is that the centres of increments on each side of the joint are shifted in relation to one another, with such shifting producing a symmetrical arrangement of increments on each side unless otherwise specified.

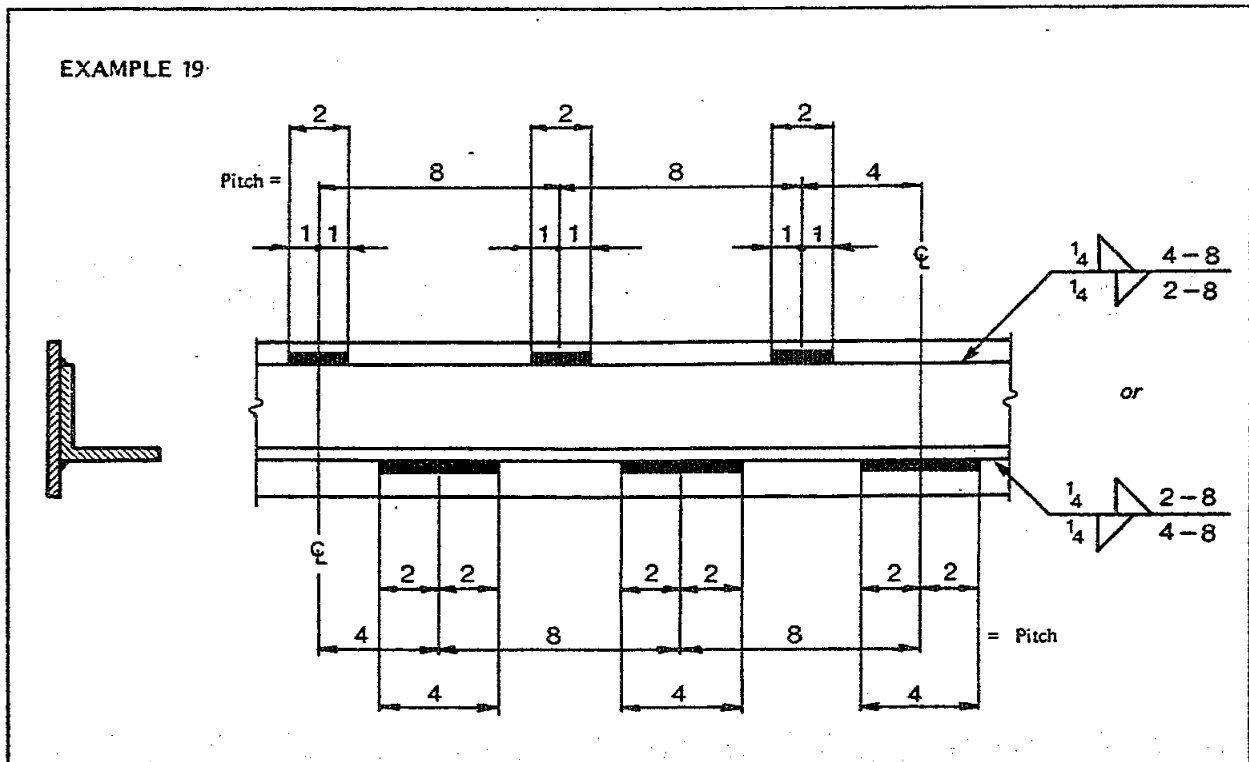
This shift in increments is indicated in the welding symbol by a visible shift of the two weld symbols on the reference line, out of the vertical plane characteristic of *chain* intermittent fillet welds.



Both presentations are equally valid, with no significance attached to the onset of staggering as to whether it should commence on the *arrow* side or on the *other* side of the joint. Example 18 shows a typical joint to help clarify these essential rules:



Again, as in the case of *chain* intermittent fillet welds, the size of the fillets and the length of the increments need not be the same on each side of the joint if special conditions warrant such an arrangement as shown in Example 19:



Only the length of one increment was made different, although a change in fillet size may also be considered.

3.5.5 Joints with Terminal Ends and Intermittent Fillet Welds.

In all cases of intermittent fillet welds, whether of the *chain* or the *staggered* type, "anchor" welds will normally be called for at both terminal ends of the joint.

There is always a measure of uncertainty associated with dimensioning these particular welds, due mainly to the lack of guidance on the part of the norm-setting specifications. If, on one hand, the governing design specifications provide clear and firm requirements for specific applications; say, welding of cover plates to beams or columns, there are many other instances of lesser significance where conclusive rules are not yet available.

The recommendations as put forward in this discussion can be said to reflect the general practice in this area and are offered for consideration by the responsible engineering and drafting personnel.

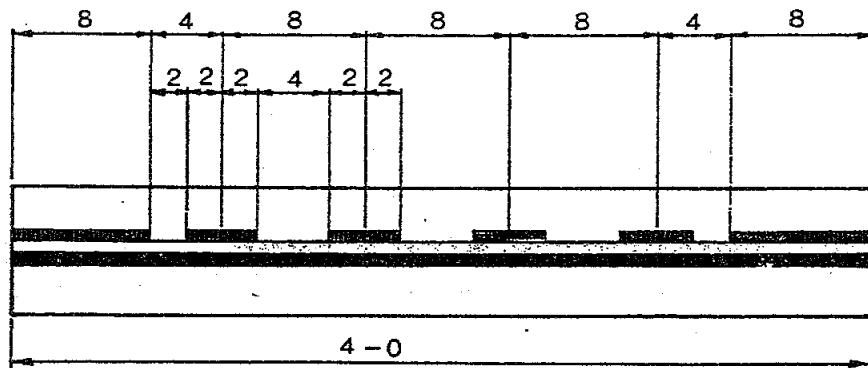
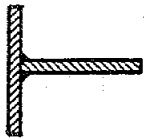
Firstly, the terminal welds should be much longer than the length of the increments set for the intermittent welds. This would be in full agreement with the anchoring function of the welds.

Secondly, the length of the terminal weld should be selected so that it will permit the first adjacent *unwelded* length to be not greater than the remaining *unwelded* segments along the line of welding.

A number of examples are used to illustrate these recommendations and show the required dimensioning.

EXAMPLE 20

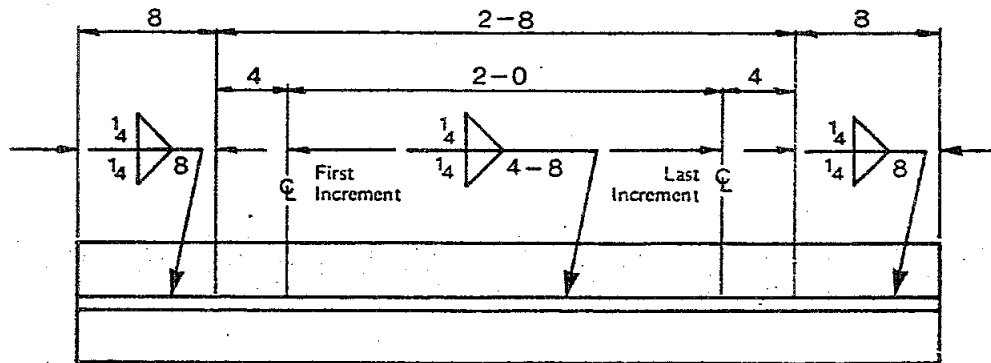
**AN INTERMITTENT
AND A
CONTINUOUS FILLET**



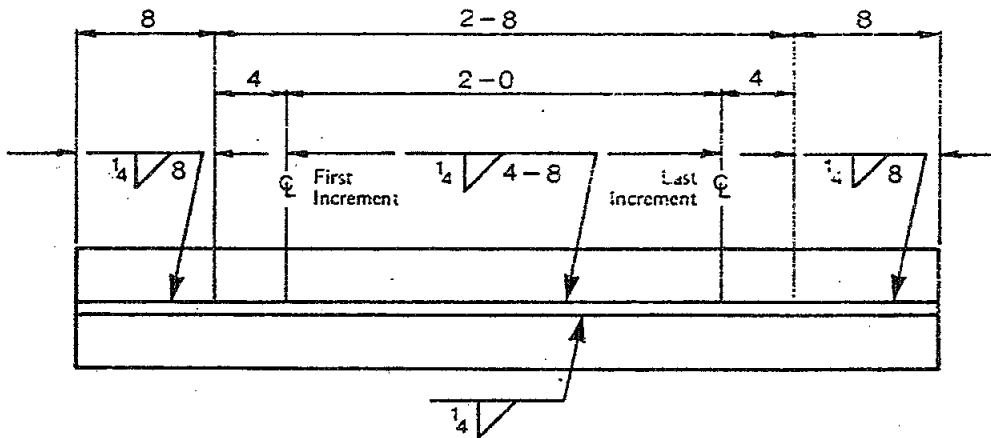
Desired Welds

Note: The first unwelded segment (2") is less than the remaining intermediate unwelded segments (4")

(a)
**Double-Fillet
Symbols**



(b)
**Single-Fillet
Symbols**



Welding Symbols and Dimensions.

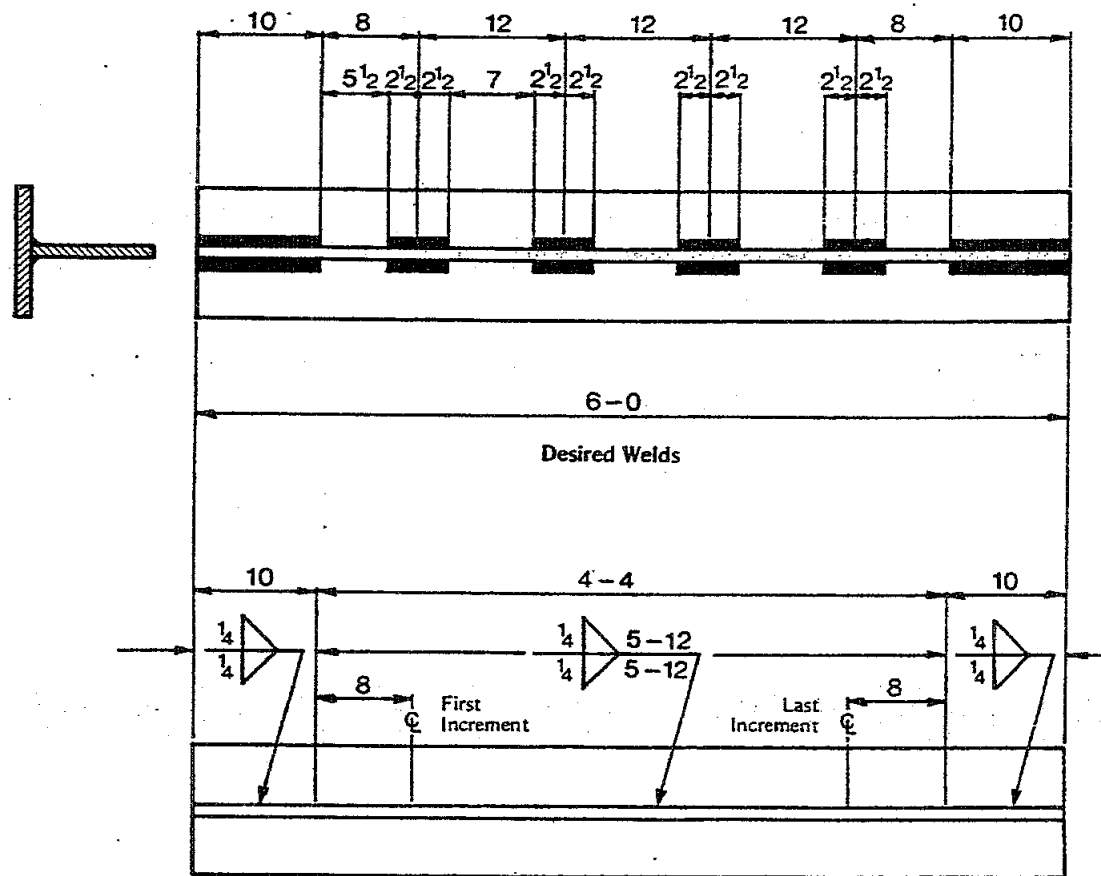
Since the first clear spacing adjacent to the terminal end is not the same as the clear spacing between the remaining intermittent welds, the location of the centre of the first and the last increment has been shown to further add clarity to the interpretation.

Note: The length "8" in the welding symbol for the terminal welds may be deleted, as this length is already specified on the dimensioning line.

Symbols for Welding

EXAMPLE 21

CHAIN INTERMITTENT FILLET WELDS



Welding Symbol and Dimensioning

Note: The first unwelded segment ($5\frac{1}{2}$ " is less than the remaining intermediate unwelded segments (7").
[See upper sketch.]

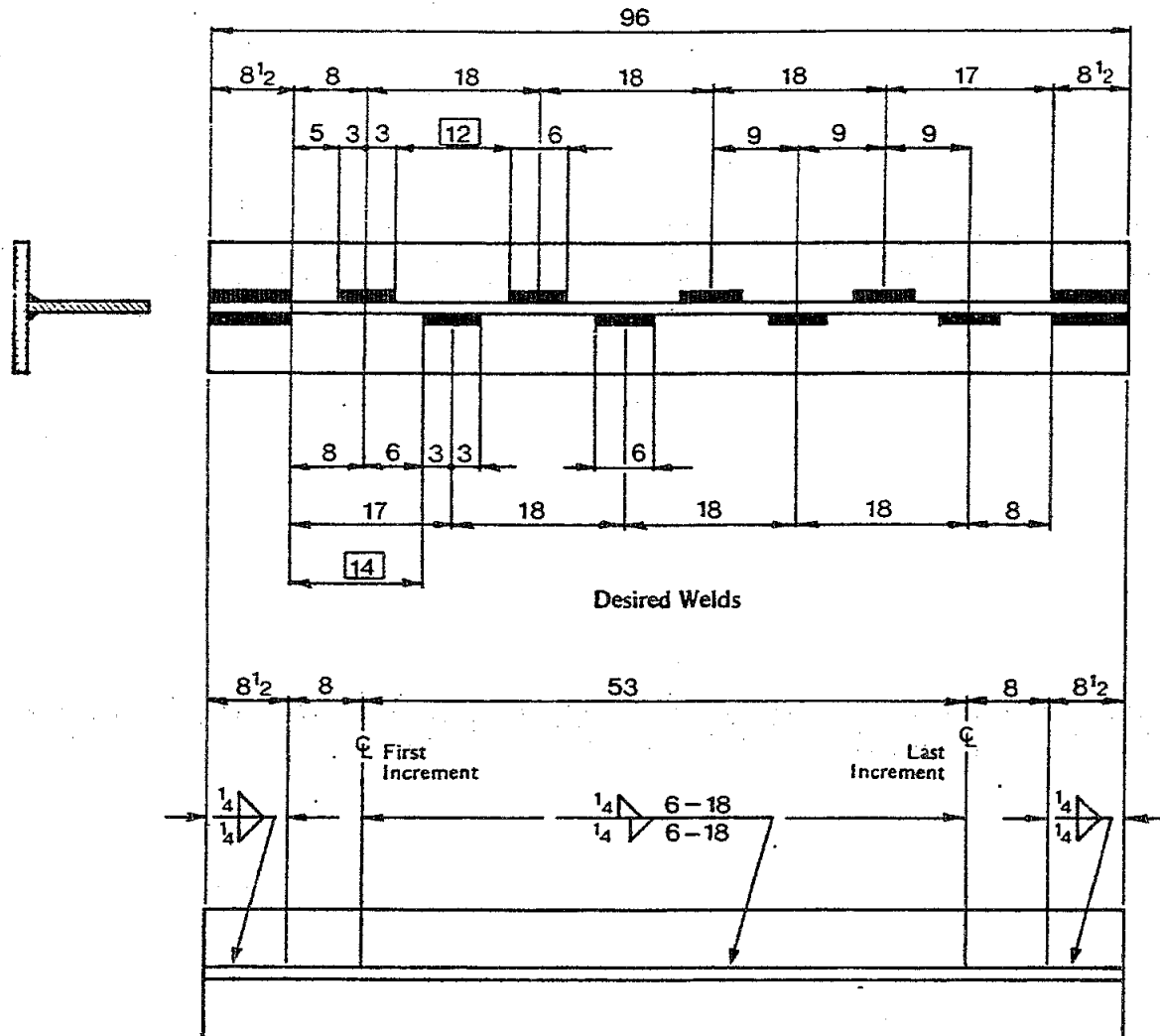
Since they are not the same, the centre of the first and the last increments must also be dimensioned.

The other desirable characteristic to be noted is that a uniform and symmetric arrangement of welds has been maintained throughout the full length of the joint, as shown in Example 22, on the following page:

Either metric or imperial measures may be applied

EXAMPLE 22

STAGGERED INTERMITTENT FILLET WELDS

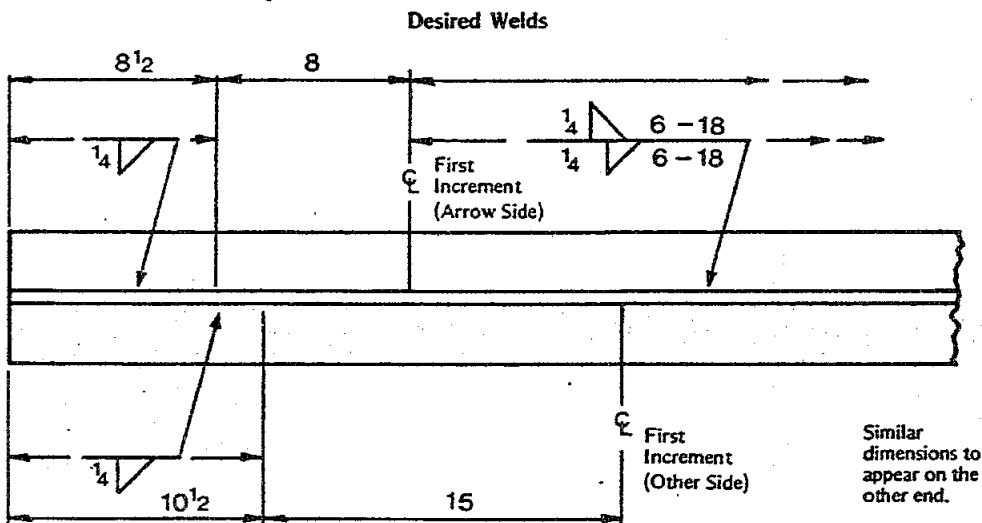
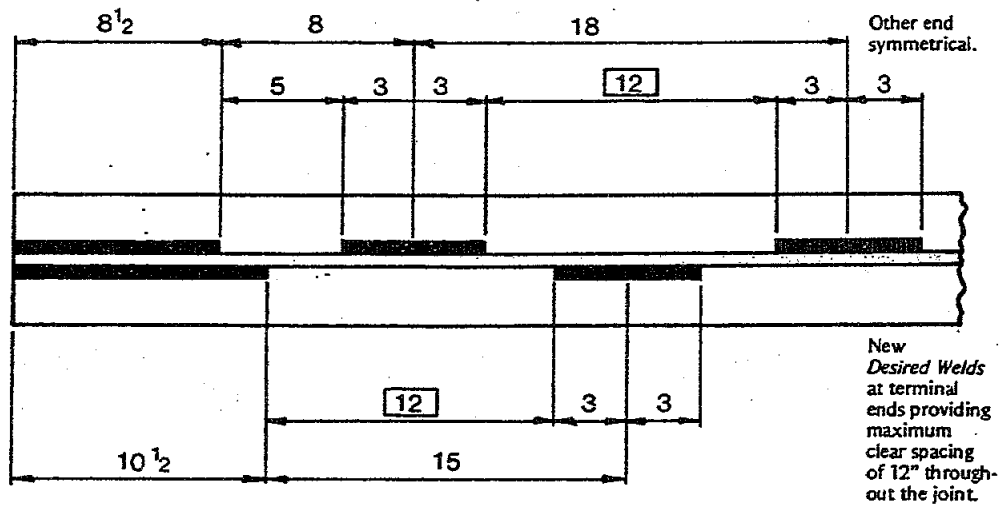


Welding Symbol and Dimensioning

The centres of the first and the last increments have also been shown and dimensioned to facilitate shop operations

Since the first clear spacing on the *other* side of the dimensioned sketch showing "desired welds" is greater (14") than the clear spacing between the intermediate welds in one line of welding (12"), it may not be acceptable to some authorities. In such case, the remedial measure would be to increase the length of the terminal weld on this particular side by the amount of the difference, as shown on the following page:

Symbols for Welding



Welding Symbol and Dimensioning

It may be the preference of some not to rely exclusively on welding symbols, but to include sketches of the desired welds as well. However, in the final analysis, it will be up to the company or the responsible drafting or engineering authority to exercise judgement as to what extent to use sketch presentations to supplement welding symbol and dimensioning information to ensure correct interpretation and execution of welding in full accordance with the directives as given on the drawings.

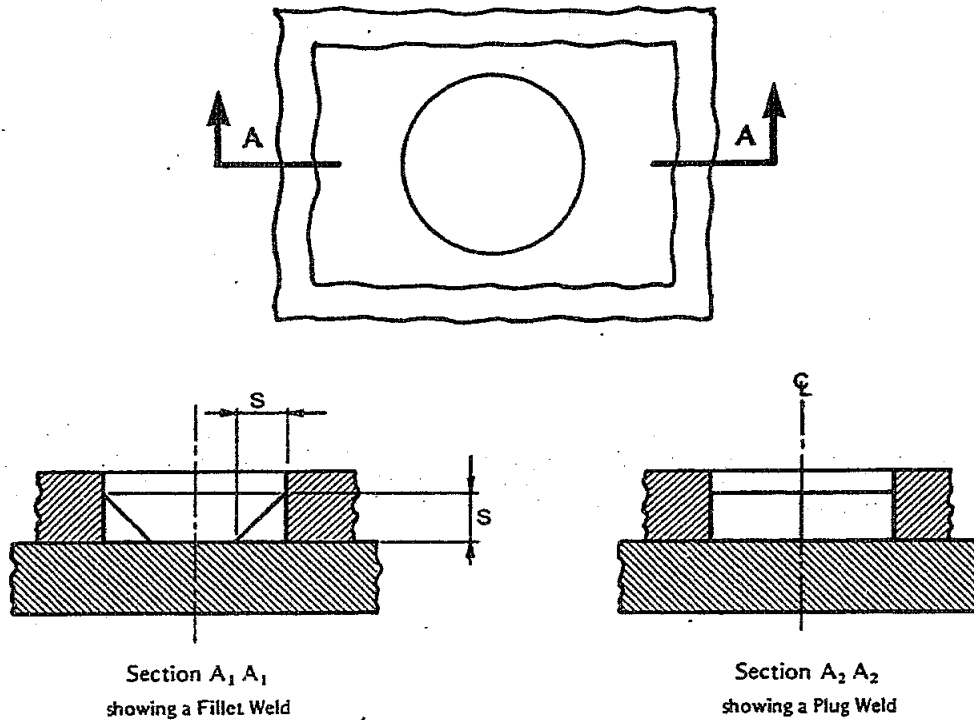
3.6 Fillet Welds in Holes and Slots

3.6.1 General.

A clear distinction must be made between the two types of welds that can be deposited in a hole or in a slot (elongated and closed or open-ended hole).

Since there seems to be substantial misunderstanding as to the proper designation of these welds, a brief clarification is very much in order before focusing the discussion back on fillet welds.

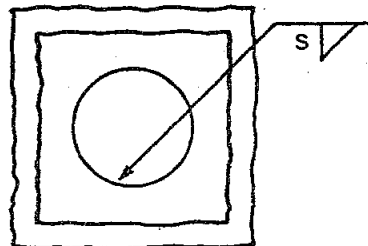
For a joint with a hole, section A-A shows the two types of welds that can be deposited. Each of them is a basic type of weld.



Plug welds shall be discussed separately. For now, no other references shall be made to them, except to point out the very obvious difference that exists between such welds and fillet welds when placed in identical holes. This fundamental difference is very vividly demonstrated by the cross-section of the joint.

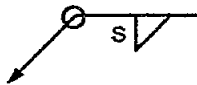
3.6.2 Fillet Welds in Holes.

In consideration of section A-A showing welds of size "S" in the hole, the required welding symbol for the circumferential weld will be:



Symbols for Welding

This symbol should be sufficient in view of the fact that the joint is a continuous curve and has no points of abrupt change in the direction of welding. However, customary practice suggests the addition of the *all-around* supplementary symbol for positive identification.

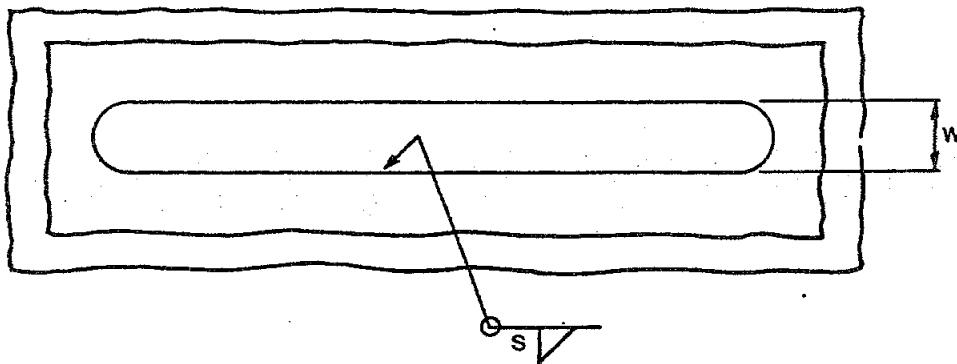


Such practice is recommended.

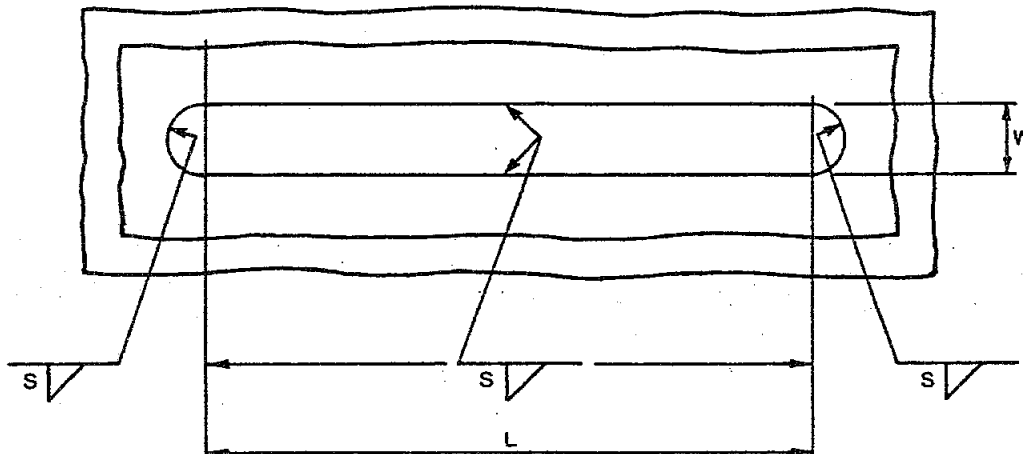
3.6.3 Fillet Welds in Slots.

For fillet welds in slots with marked points of change in the direction of welding, the following two welding symbol arrangements are acceptable:

(a) *The obvious one: using an "all-around" symbol:*

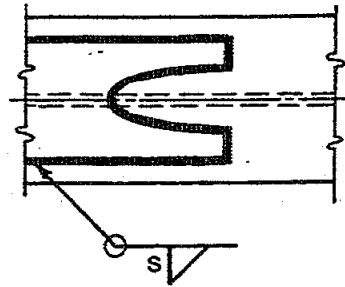


(b) *The alternate one using dimensioning and welding symbols:*

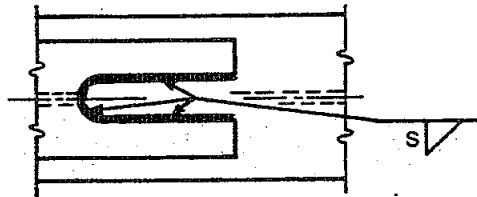


This will be, for obvious reasons, the less-preferred alternative. It is shown only in order to cover all the possible ways welding symbols can be used to convey welding requirements.

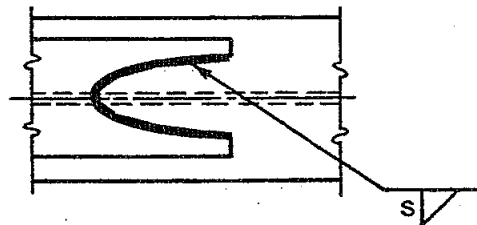
In the case of open slots the convenient "all-around" symbol would mean in addition to welding within the slot, also welding across the ends and sides of the slotted plate. If this is indeed desired, then such a symbol is the proper one to use:



For fillet welds in the slot *only*, when the sides of the slot are parallel, the symbol is:



... and when the sides of the slot are *not* parallel, the symbol is:

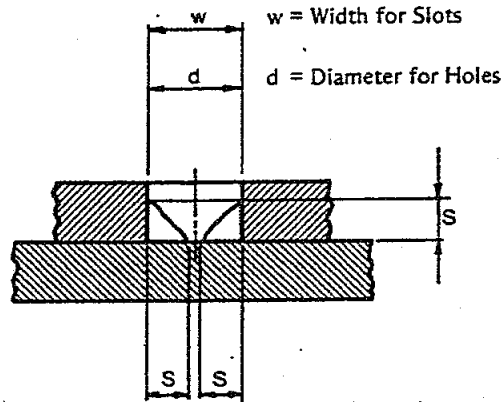


3.6.4 Important Relationships for Fillets in Holes and Slots.

It should be recognized that for welds in slots and circular holes to be correctly identified as fillet welds, certain limiting relationships must be met.

The most important of these is the *size of the fillet to the diameter of the hole or width of the slot* relationship:

Symbols for Welding



Since the diameter of the hole or the width of the slot can only accommodate two fillet weld leg sizes, it follows that:

“ d ” must be equal to or greater than $2S$, and

“ w ” must be equal to or greater than $2S$;

or, vice versa:

“ S ” can only be equal to or less than $d/2$ or $w/2$.

Expressed algebraically, the governing rules are:

$$d \geq 2S$$

$$S \leq d/2$$

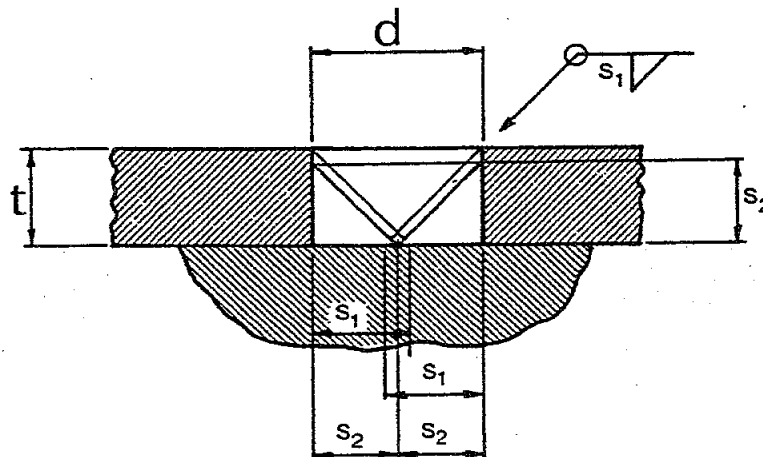
$$w \geq 2S$$

or

$$S \leq w/2$$

If the fillet size condition cannot be met, then the *toes* of the welds start to overlap, gradually losing their identity as fillet welds. With increasing overlap, such loss of identity will be more pronounced.

The overlap means also a loss in sizes of the horizontal legs as compared with the specified size, giving rise to concern about the reduction in design strength of the joint.



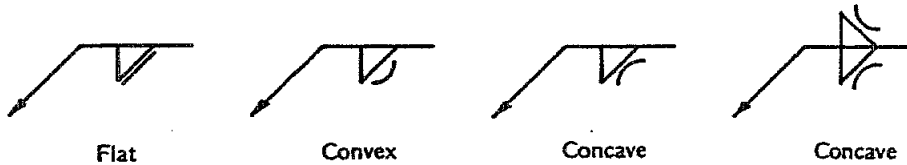
The fillet size " S_1 " equal to the thickness " t " results in an overlapping toe situation. The reduced size " S_2 " equal to half of the hole diameter is the maximum fillet size that can be specified.

Governing design specifications regulate also the thickness of material " t " to the diameter of hole " d " or the width of slot " w " relationship from the point of view of access for welding. Although they may make specific reference to plug and slot welds, these rules will be equally valid for fillets in holes and slots.

It should also be recognized that the execution of welding in holes is a difficult and skill-challenging operation because of confined space, short duration of arc, stops and restarts. As the hole diameter increases, a marked improvement in quality can be expected.

3.6.5 Surface Finish and Contour of Fillet Welds.

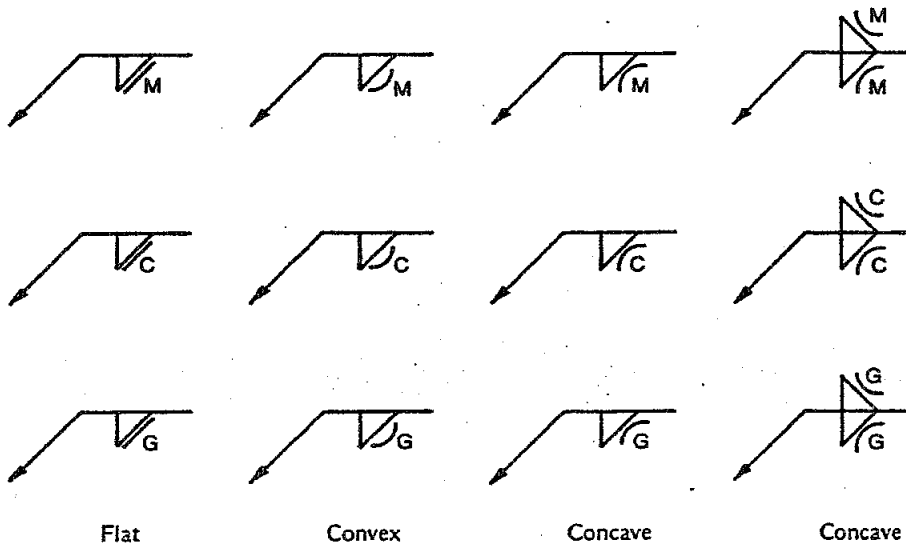
Contours of fillet welds that can be obtained by welding without recourse to any mechanical means are identified in the welding symbol at locations shown below. The contours as designated by supplementary weld symbols must be used:



Contours of fillet welds to be obtained by mechanical means like

- chipping (C),
- grinding (G), or
- machining (M),

must be shown at locations as indicated, with the user identifying his preferred method of providing the required profile.



Symbols for Welding

It is very seldom that these contours for fillet welds are required in structural work. They are, however, more common in precision-made mechanical assemblies where the shape and finish of fillet weld profiles are expected to either enhance the service performance of the welded product, or where its appearance is of overriding importance.

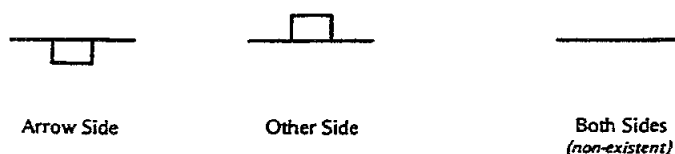
4. PLUG AND SLOT WELDS

4.1 General.

Plug and slot welds are other types of welds produced by the electric arc welding process. Although not used as extensively as groove and fillet welds, they have found their own area of application in welded work.

Since both types of welds have several common rules governing their symbol presentation, they will be treated jointly when these particular rules are discussed.

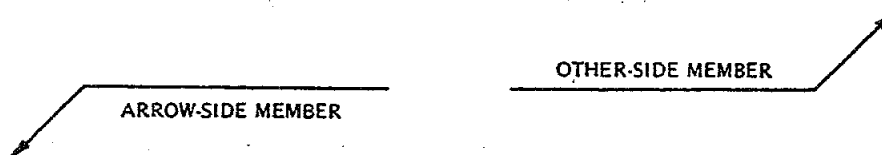
One common feature is the weld symbol. It is always represented by a rectangle, irrespective of whether the fusion faces inside the hole or slot are perpendicular or sloping.



The placement of the weld symbol above or below the reference line is subject to the same rules as apply to grooves and fillets. However, the meaning of "arrow" and "other" side had to be adjusted to the specific nature characterizing these welds. This difference is explained next:

4.2 Arrow and Other Side Holes and Slots.

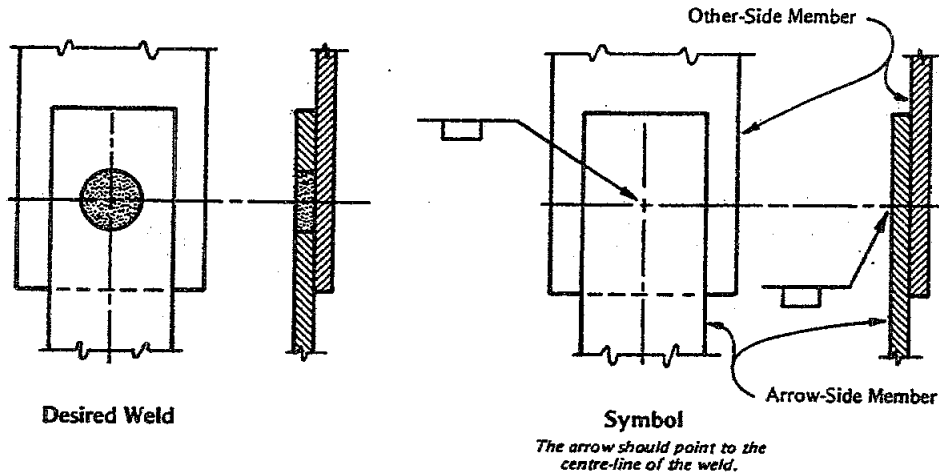
A fundamental observation points to the fact that the concept of a *joint* or *common area of contact* considered of principal importance in the establishment of *arrow side* and *other side* for groove and fillet welds does not apply to joints involving plug and slot welds. Consequently, a new and much simpler concept was established which introduces two new terms: the *arrow-side member* and the *other-side member*. The weld symbol is placed on the respective side of the symbol's reference line to convey welding information pertinent to that side.



In the light of this convention, it is obvious that the proper location and direction of the arrow must be given careful attention. The following sketches will help explain this new application of an already established principle.

EXAMPLE 1

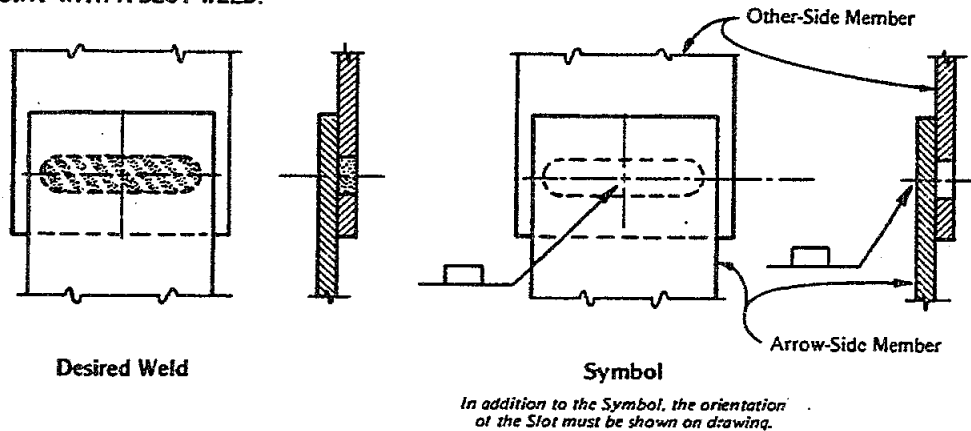
LAP JOINT WITH A PLUG WELD.



Plug Weld on the "Arrow-Side Member"
(Equally valid for a Slot Weld)

EXAMPLE 2

LAP JOINT WITH A SLOT WELD.



Slot Weld on the "Other-Side Member"
(Equally valid for a Plug Weld)

Symbols for Welding

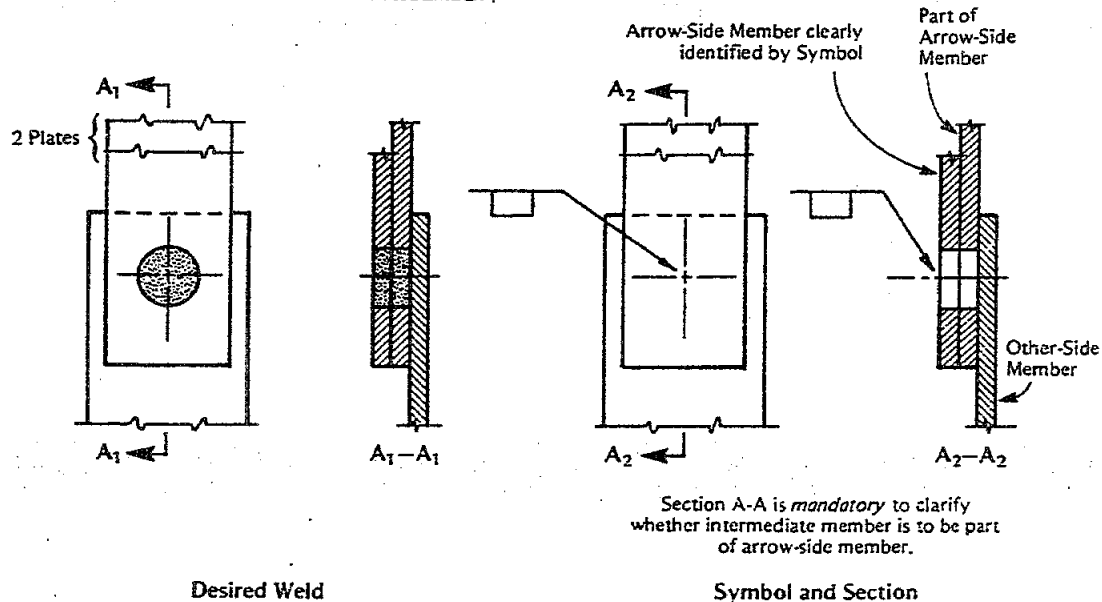
The designation of *arrow-side member* and *other-side member* for plug and slot welds in a three-member assembly cannot be expressed fully by means of a welding symbol.

Slot welds must be defined by welding symbols *and* comprehensive sketches. Therefore, they present no interpretation problems to shop personnel responsible for the execution of welding.

While symbols for *plug* welds in *two-member* assemblies should provide clear and complete information, complementary sketch presentation is required in the case of *three-member* assemblies. Example 3 attempts to explain this theory in detail:

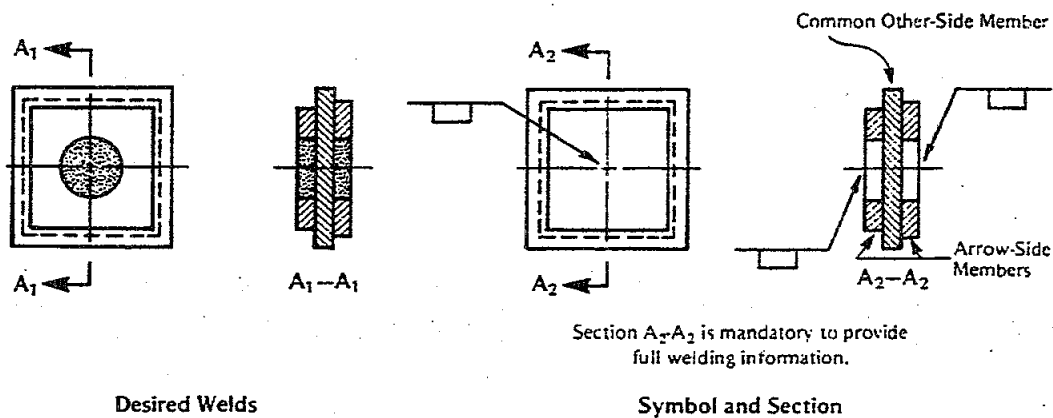
EXAMPLE 3

ONE PLUG WELD IN THREE-MEMBER ASSEMBLY.



EXAMPLE 4

TWO PLUG WELDS IN THREE-MEMBER ASSEMBLY.



These two examples portray some rather remote situations for which the use of plug welds may be contemplated. Hence, some guidance regarding arrow-side and other-side member designations is considered advisable.

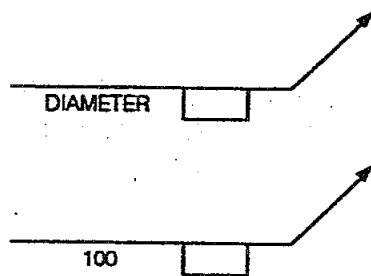
4.3 Plug Welds

Information required for the application of plug welds must include the following:

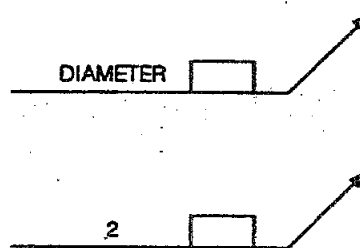
- a) Size of hole
- b) Angle of countersink
- c) Depth of filling
- d) Spacing of welds
- e) Reference to contour and surface finish if required.

4.3.1 Size of Plug Welds.

In line with the common principle, the size of the plug weld is expressed by the diameter of the hole and must be placed on the *left* side of the weld symbol.



Weld in the Arrow-Side Member



Weld in the Other-Side Member

The size of the weld and, hence, the proper diameter of the hole to be designated in the welding symbol in case of *countersunk* holes is described in section 3.2.

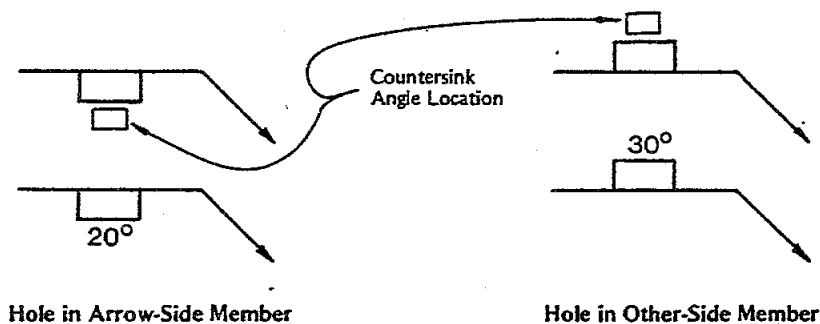
It should also be noted that the governing design specifications may relate the minimum hole diameter to the thickness of material in which a plug weld has to be made. CSA W59 and AWS D1.1 set this minimum at

$$\begin{aligned}d_{\min} &= t + 8\text{mm} \quad (\text{CSA W59-M [metric]}) \\ &= t + \frac{5}{16} \text{ in.} \quad (\text{CSA W59 and D1.1 [imperial]})\end{aligned}$$

4.3.2 Angle of Countersink.

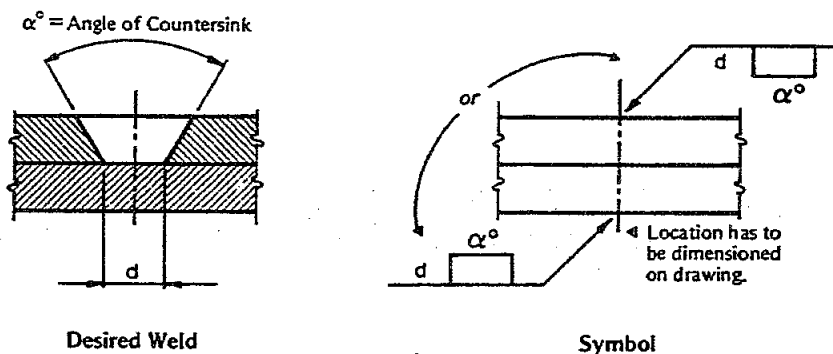
In order to facilitate welding and provide easier access to the root, hence greater assurance of soundness, countersunk holes with circumferentially sloping sides may be considered. When specified in the symbol, the angle of countersink must be placed *outside* the horizontal side of the weld symbol.

Symbols for Welding



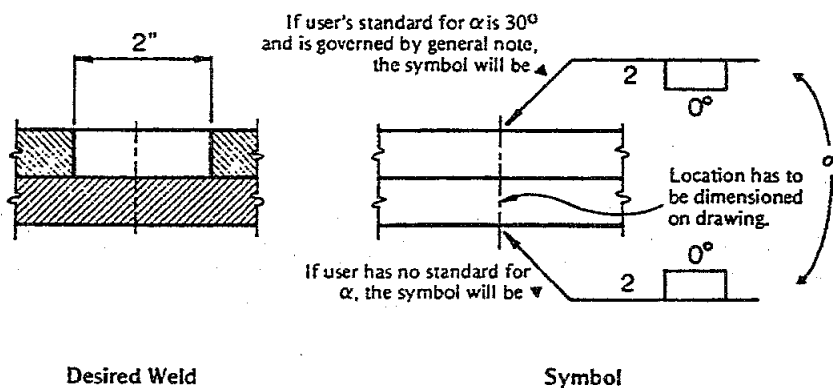
If the angle of countersink is always the same for a particular user (user's standard), it need not appear in the welding symbol. A reference to the standard angle will most likely be made in a separate general note on the drawing. In such case, any angle different from the established standard, including a deviation to a 0° angle, must appear in the symbol. When no standard angle of countersink is set by the user, and no general note appears on the drawing, the applicable angle of countersink *must* be specified in the welding symbol. The absence of such specification denotes an angle equal to zero and, hence, no taper on the side of the hole.

EXAMPLE 5

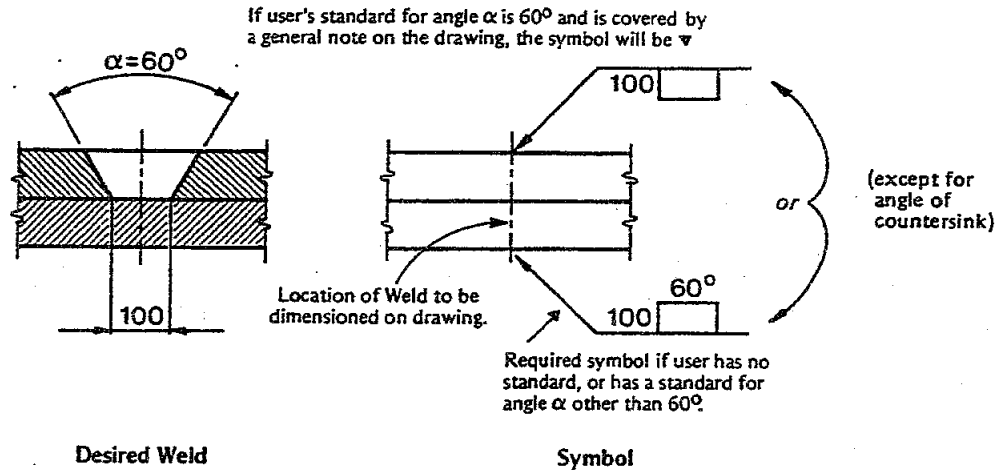


It should be noted that the diameter "d" is the diameter of the bottom of the hole, exclusive of the angle of countersink. Further examples will help clarify the use of size and angle of countersink in the symbols.

EXAMPLE 6

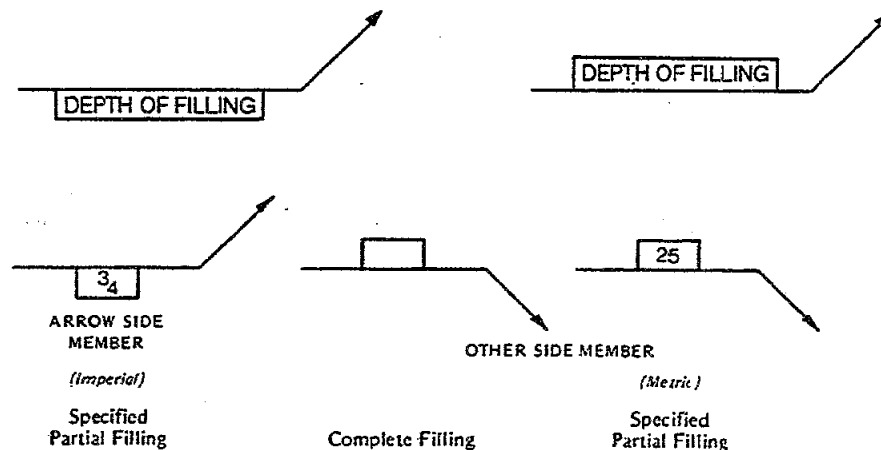


EXAMPLE 7



4.3.3 Depth of Filling.

If complete depth of filling is required, it need not be specified in the welding symbol. However, if the depth of filling required is less than complete, it *must* be specified and shown inside the weld symbol:

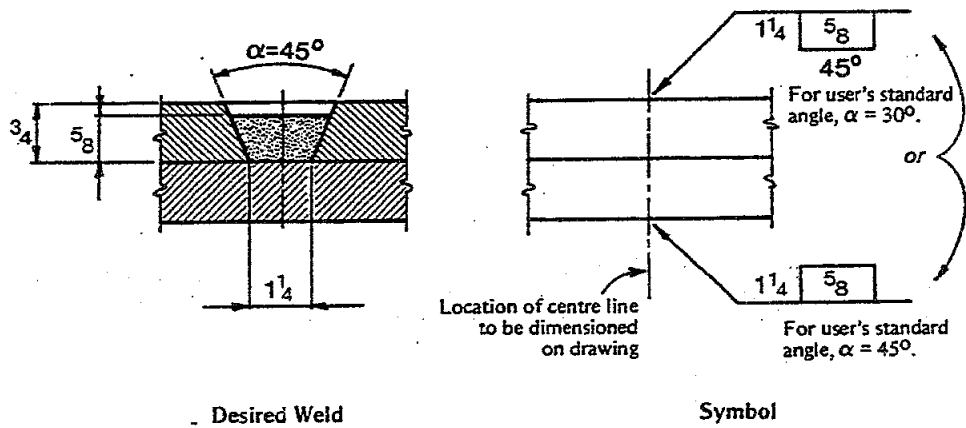


It should again be noted that the governing specifications may have their own requirements with respect to the minimum acceptable depth of filling for plug welds.

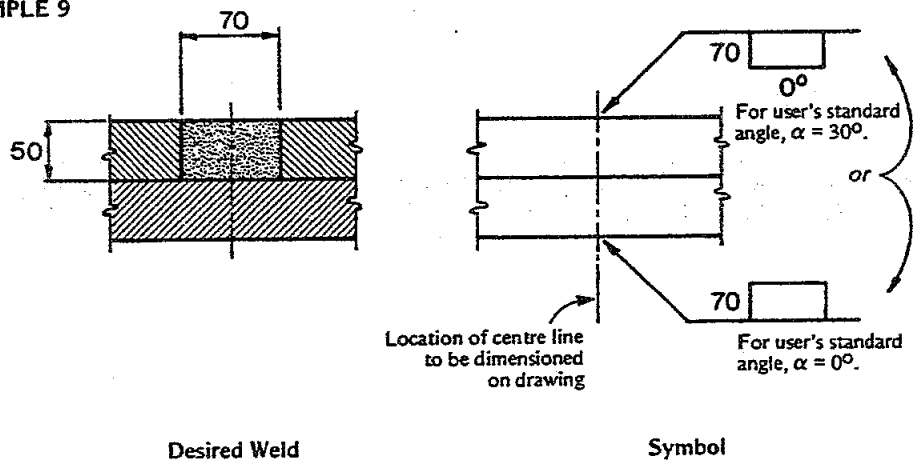
In the case of CSA W59-M and AWS D1.1, the rules require complete filling for thicknesses of material up to and including 16mm, or 5/8 inch, with the depth of filling for thicker materials to be 16mm, or 5/8 inch, or half of the material thickness, whichever is smaller.

The following examples show the proper use of depth of filling in welding symbols:

EXAMPLE 8

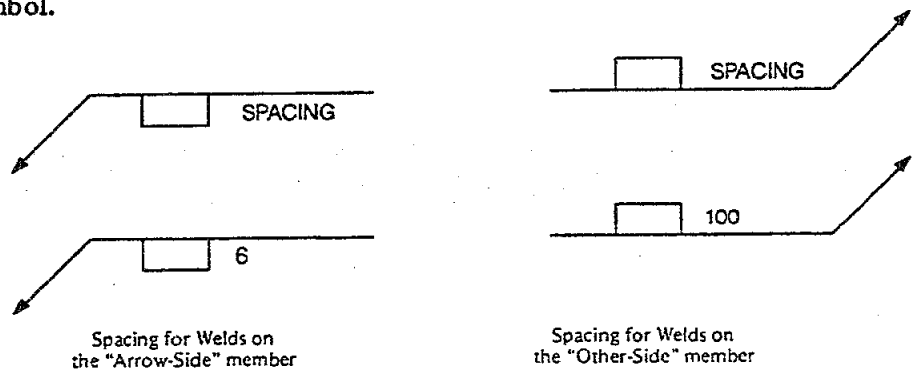


EXAMPLE 9

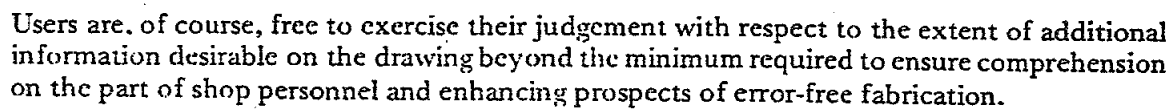


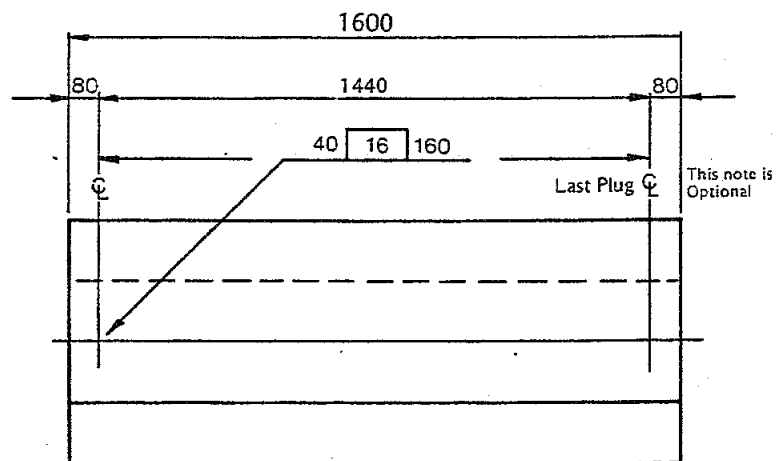
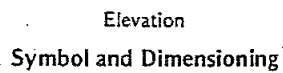
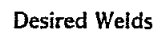
4.3.4 Spacing of Plug Welds

The concept of *pitch* is used to designate the centre-to-centre spacing of plug welds. As in the case of other welds, the assigned standard location for length is at the *right* side of the weld symbol.



ANGLE AND A PLATE.





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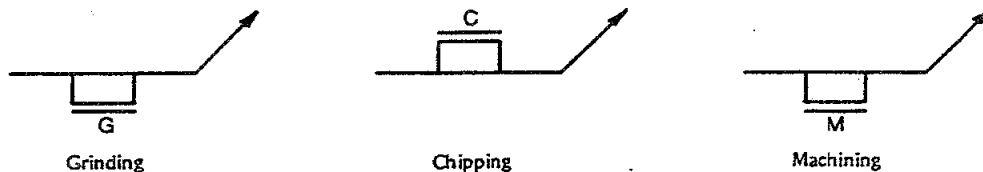
4.3.5 Contour and Surface Finish.

The most common service application of joints with completely filled plug welds will most likely require the welds to be flush with the base material. The contour of plug welds not completely filled will generally not give ground for concern. As for any other type of weld, the required flat contour may be acceptable when obtained

- (i) without recourse to any mechanical means, in which case the supplementary *flush* symbol is placed in the welding symbol; or



- (ii) with recourse to mechanical means, either preferred by the user or dictated by the service application of the product. In each case, however, the pertinent customary finishing designation must be used.



4.4 Slot Welds

Complete welding information for slot welds must include the following:

- | | |
|-----------------------------|--------------------------------|
| a) length and width | d) spacing |
| b) angle of countersink | e) depth of filling |
| c) orientation and location | f) contour and surface finish. |

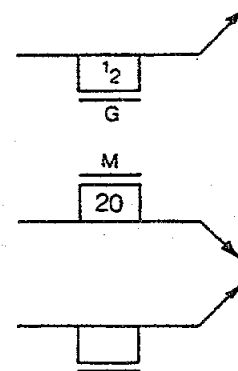
Unfortunately, out of all the above data required, only the last two stand entirely on their own and can be shown in the welding symbol. Consequently, all remaining information must be provided on drawings by means of sketches or pertinent details, combined with symbols, as will be shown on the typical examples that follow.

The concept of *arrow-side members* and *other-side members* common to plug and slot welds was discussed earlier and is presumed to be clearly understood. Also discussed was the depth of filling as well as the contour and surface finish for which the same provisions apply. The following will summarize these points:

Slot in the *arrow-side member* with $\frac{1}{2}$ -inch depth of filling and flush contour obtained by grinding.

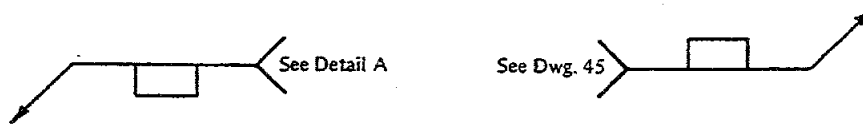
Slot in the *other-side member* with 20mm depth of filling and flush contour obtained by machining.

Slot in the *arrow-side member* completely filled with flat contour obtained without recourse to mechanical means.



Symbols for Welding

Since the remaining required information (items [a] to [d]) does not lend itself for inclusion in the symbol, it must be presented on a drawing by means of sketches and details. The proper reference to these details is made in the tail of the welding symbol:

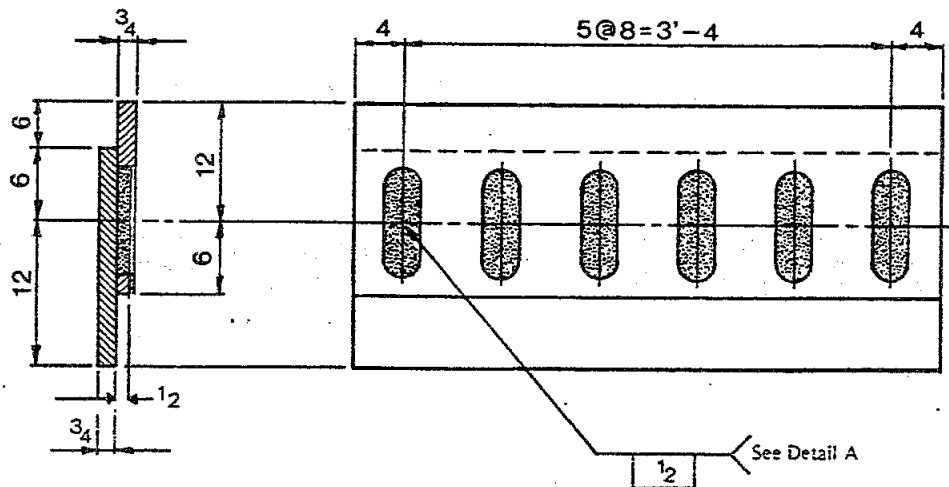


The arrow must point to centre line of the weld.

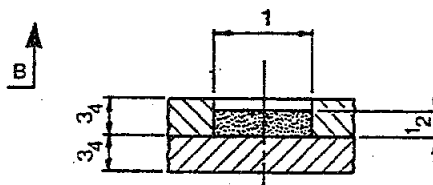
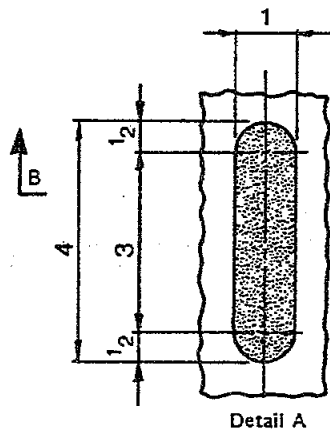
The following two examples will help illustrate the proper presentation of all requirements and the extent of details as they should appear on the shop drawing:

EXAMPLE 12

TWO PLATES WELDED USING SLOT WELDS.



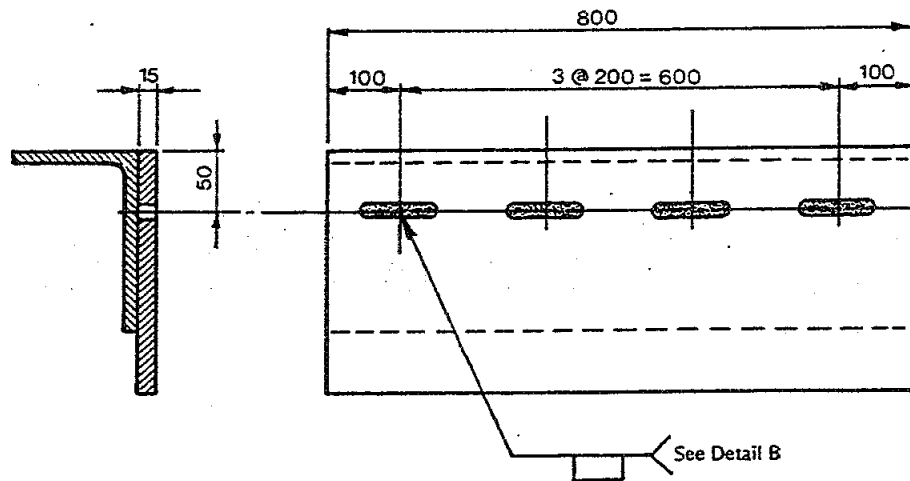
This detail, as such, gives only the *spacing, orientation and location* of the centres of slots within the length and width of the plates. The symbol specifies $\frac{1}{2}$ " *depth of filling*. Hence, the additional information to be included in Detail A must be the *full geometry* of the slot, although the end view may have been used to dimension the length of the slot.



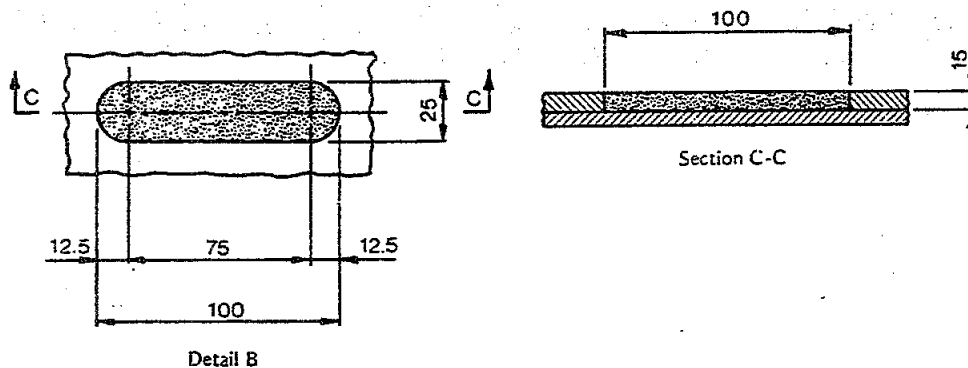
Section B-B

EXAMPLE 13

SLOT WELDS JOINING AN ANGLE AND A PLATE.



To complement all the information necessary, Detail B must show the geometry of the slot, although the width of the slot could have been shown on the end view. The welding symbol indicates that the slot is to be filled completely.



Again, it should be noted that the governing specifications may have their own rules for slot welds relative to width-to-thickness of material ratios, longitudinal and lateral spacing, and minimum depth of filling.

These specifications should be consulted by the specifying engineering or drafting personnel.

5. SPOT, SEAM AND STUD WELDS

5.1 Spot Welds

5.1.1 General

A spot weld is defined by AWS A3.0 *Standard Welding Terms and Definitions* as "a weld between or upon overlapping members in which coalescence may start to occur on the faying* surfaces or may proceed from the outer surface of one member. The weld cross section [plan view] is approximately circular."

This type of weld does not require a prepared hole. It can be made by a number of welding processes. In accordance with the definition, it involves either:

- a) fusion into one piece of material by penetration from the other piece of material; or
- b) localized fusion at the interface of both materials.

It is because of these two characteristics of spot welds that the *arrow side* and *other side* significance may not be applicable, depending on the welding process used. However, the reference to the welding process in the tail of the symbol will help identify either of the two types of spot welds. This will become evident from a number of sketches that follow.

AWS A2.4 calls for the same weld symbol to be used for projection welds — with the resistance projection welding process (PW) properly identified in the tail of the welding symbol.

Since an embossment is essential to the nature of these welds, the *arrow side* and *other side* maintain their ordinary significance and are used to indicate in which member this embossment should be either placed or made.

If the projection is not the user's standard type, the full geometry of the projection must be shown in both, the symbol and the drawing.

The weld symbol must appear either above or below the reference line, as applicable; but never on the reference line. Again, some sketches will illustrate these requirements.

The welding information shown in the spot welding symbol includes:

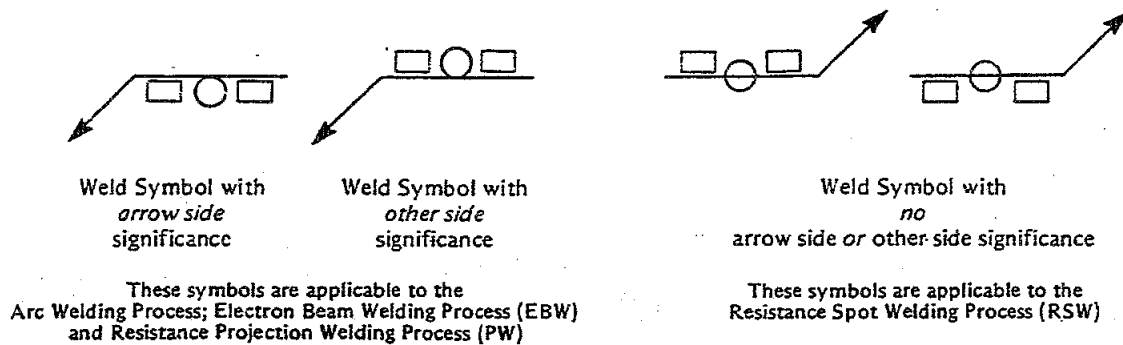
- 1) weld symbol;
- 2) process reference;
- 3) size or strength;
- 4) spacing, extent, number of spots;
- 5) contour.

5.1.2 The Weld Symbol

The weld symbol representing spot and projection welds is a hollow circle placed either above, below, or astride the reference line, together with all other information appearing on the same

*Faying surface is the mating surface of a member which is in contact or in close proximity to another member to which it is to be joined.

side; or, in the case of the weld symbol being astride the reference line, the placement of such information on either side is optional:



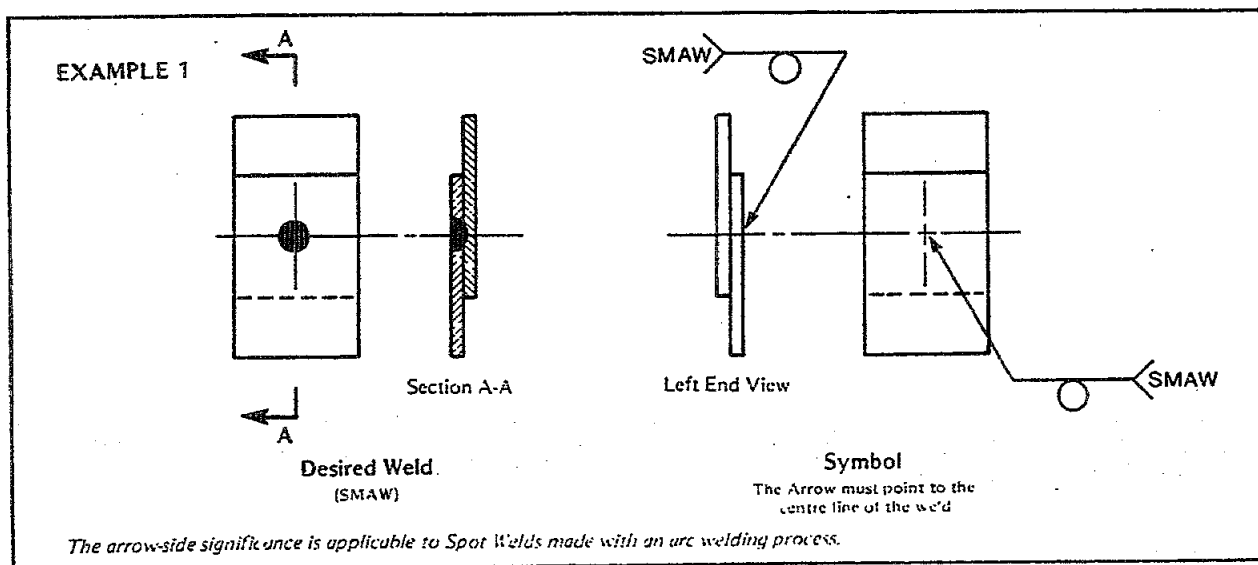
5.1.3 Welding Process Reference

Welding processes *must* be identified in the tail of the welding symbol. They will govern the location of the weld symbol; i.e., *above*, *below*, or *astride* the reference line. In other words, the *process* will determine whether the "arrow" and "other" side significance is applicable.

The following welding processes are preferred for spot welding:

- a) Arc welding processes —
 - ✓ shielded metal arc welding (SMAW);
 - ✓ flux cored arc welding (FCAW);
 - ✓ gas metal arc welding (GMAW);
 - ✓ gas tungsten arc welding (GTAW).
- b) Electro beam welding (EBW);
- c) Resistance welding processes:
 - ✓ spot welding (RSW);
 - ✓ projection welding (PW).

The following examples will illustrate the use of weld symbols, the relevant significance of *sides* and their inter-relation with the welding processes:

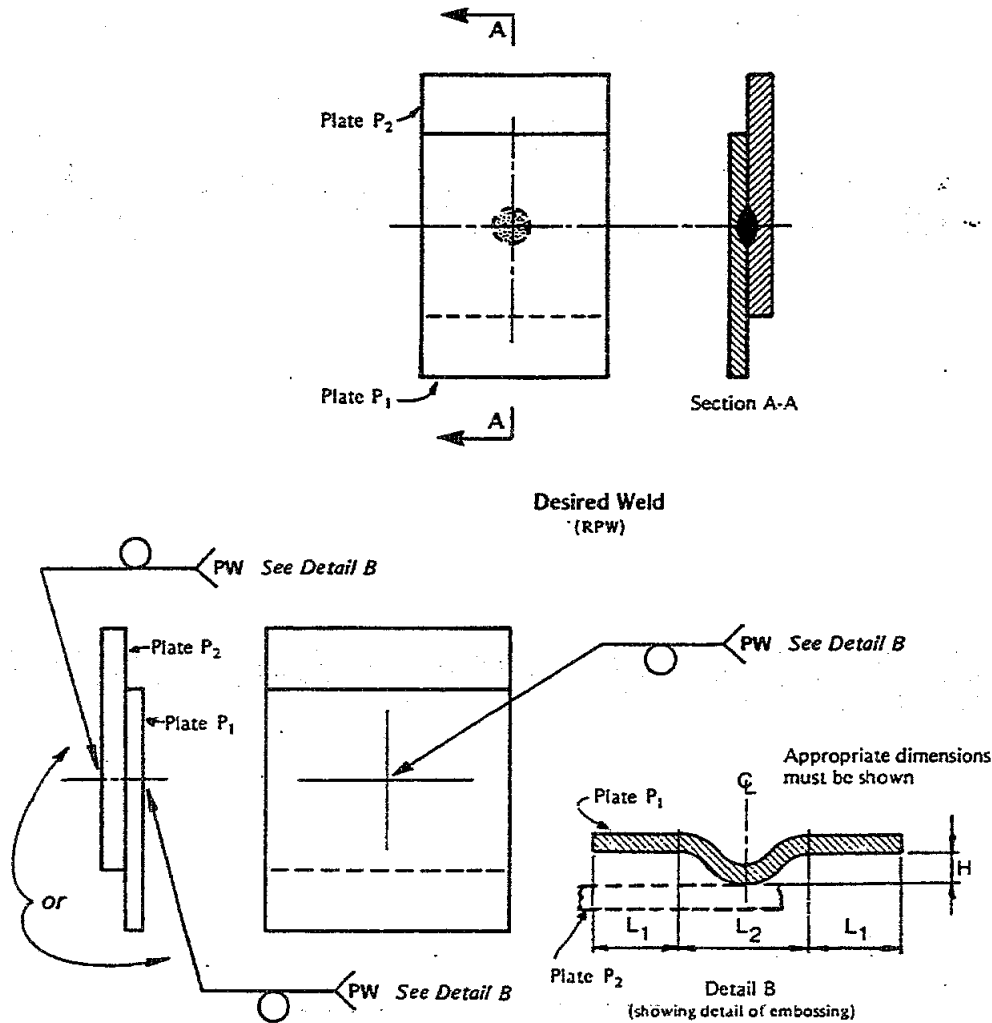


The arrow side significance is applicable to spot welds made with an arc welding process.

Symbols for Welding

EXAMPLE 2

JOINT WITH A PROJECTION WELD



Symbols and Detail

Symbols (and alternatives) require thinner plate member (P₁) to be embossed, since "side" significance is applicable.

IMPORTANT:

A resistance *projection* weld (weld nugget) is between the interfaces of both plates, and the weld symbol for it is placed *above* or *below* the reference line — with *arrow-side member* and *other-side member* significance applicable.

However, a resistance *spot* weld of similar proportions requires a weld symbol striding the reference line, in which case the weld symbol has *no* side significance.

5.1.4 Size and Strength of Spot Welds

It is customary to define a spot weld either by the size of the spot expressed as the diameter of the circular area of fusion at the interface of both members, or by its required strength.

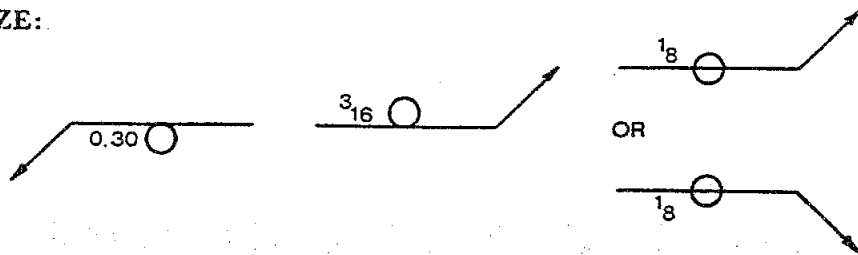
In accordance with the general rule, either of the two designations has to be placed on the left side of the weld symbol.

The size is measured in metric or imperial units of length, while strength, most likely *shear* strength, is expressed in *newtons* (N or kN) per spot in the metric system; or in *pounds* (lbs) per spot in the imperial system. The strength in the latter system may be designated just by a plain number (500 — meaning lbs.); whereas in the metric system the number *must* be followed by the designation N or kN (2 kN — meaning 2 kilonewtons). This requirement is intended to prevent confusion and mistaking size for strength or vice versa.

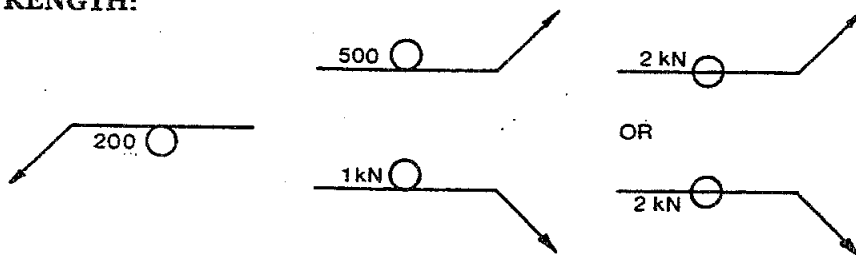
It is, however, imperative to use one system for all the information in the welding symbol which, at the same time, should be the same system of units used for the whole drawing.

Either *size* or *strength*, whichever is more pertinent, must be placed to the left of the weld symbol:

SIZE:



STRENGTH:



Weld Symbol with
arrow side
significance

Weld Symbol with
other side
significance

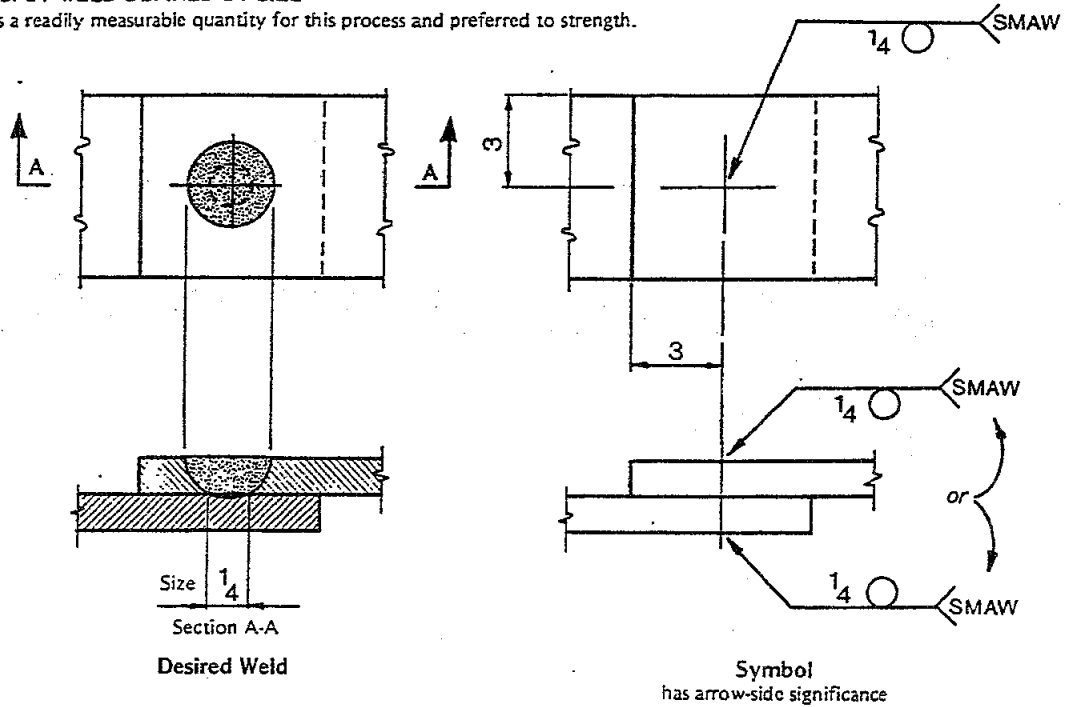
Weld Symbol with
no
arrow side or other side significance

The definition of *size* of spot welds requires an explanation: Firstly, it is reasonably assumed and implied by definition that the area of fusion, or the “nugget,” is circular in shape in plan view, and that its diameter is a reliable measure and indication of size. Secondly, the sizes of spot welds for each of the basic welding processes have very characteristic and distinctly differing weld nuggets. These are shown in Example 3, where arc spot welds are defined by *size*, which is a readily measurable quantity for this process and preferred to strength:

EXAMPLE 3

ARC SPOT WELD DEFINED BY SIZE

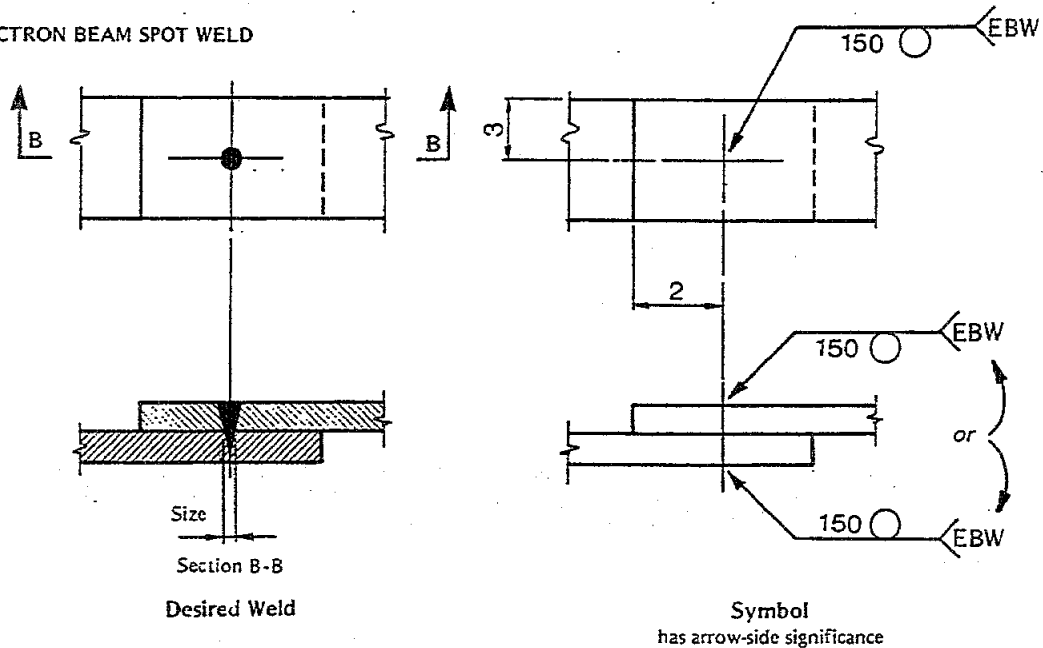
Size is a readily measurable quantity for this process and preferred to strength.



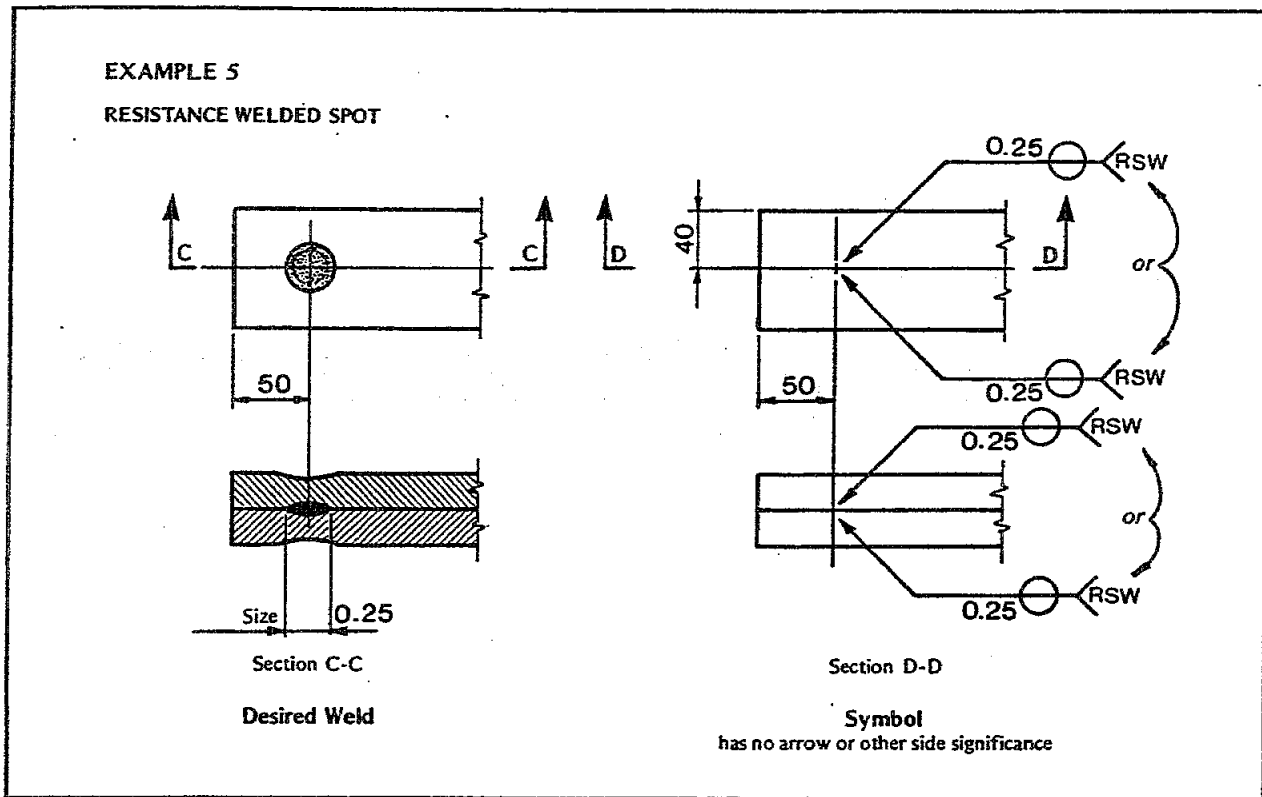
In Example 4, an electron beam spot weld is defined by *strength* (150 lbs/spot). Size of EB spot is not an easily measurable quantity.

EXAMPLE 4

ELECTRON BEAM SPOT WELD



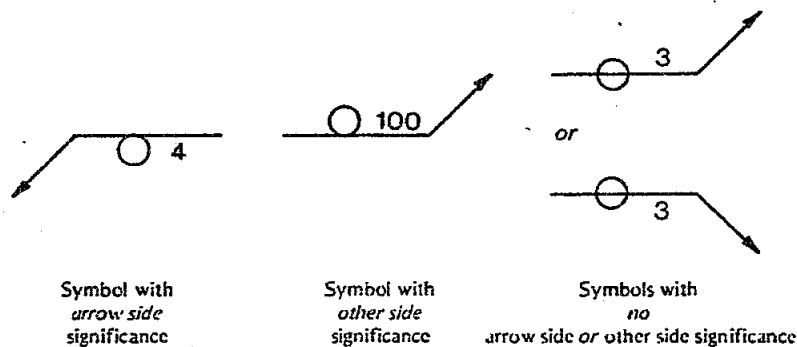
Example 5 illustrates a resistance-welded spot where the size is readily measurable:



5.1.5 Spacing, Extent and Number of Spot Welds

5.1.5.1 Spacing:

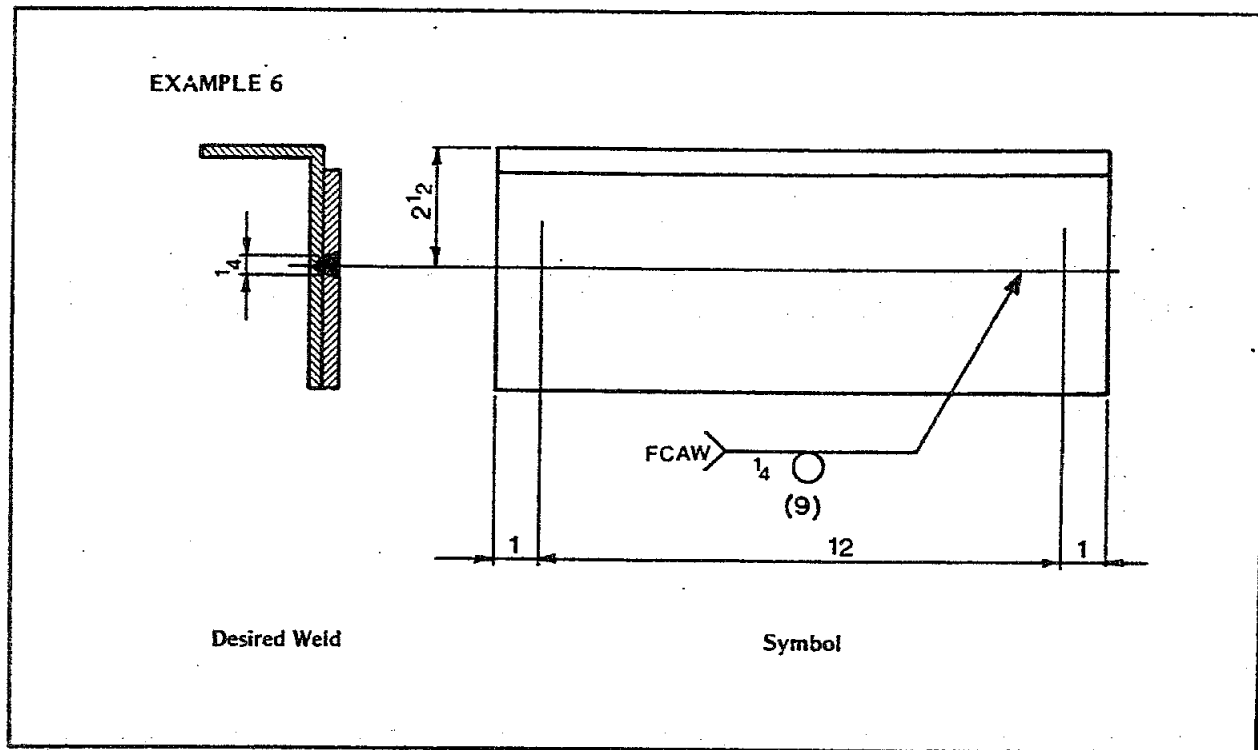
As is the case with intermittent fillet welds and plug welds, *pitch* is used to designate centre-to-centre spacing of spot welds. This spacing has to appear on the right side of the weld symbol.



5.1.5.2 Extent of Spot Welding:

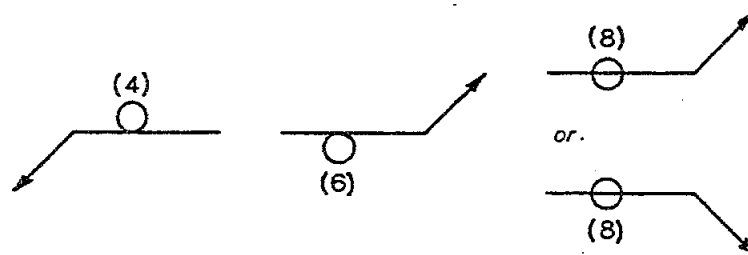
When spot welds are required only in a part of the total length of the joint, as defined by abrupt changes in direction of welding, the extent of such welding has to

be designated by additional dimensioning. Example 6 illustrates this particular point. In it the extent and number of welds (9) are specified, but spacing is *not* designated. (FCAW process.)



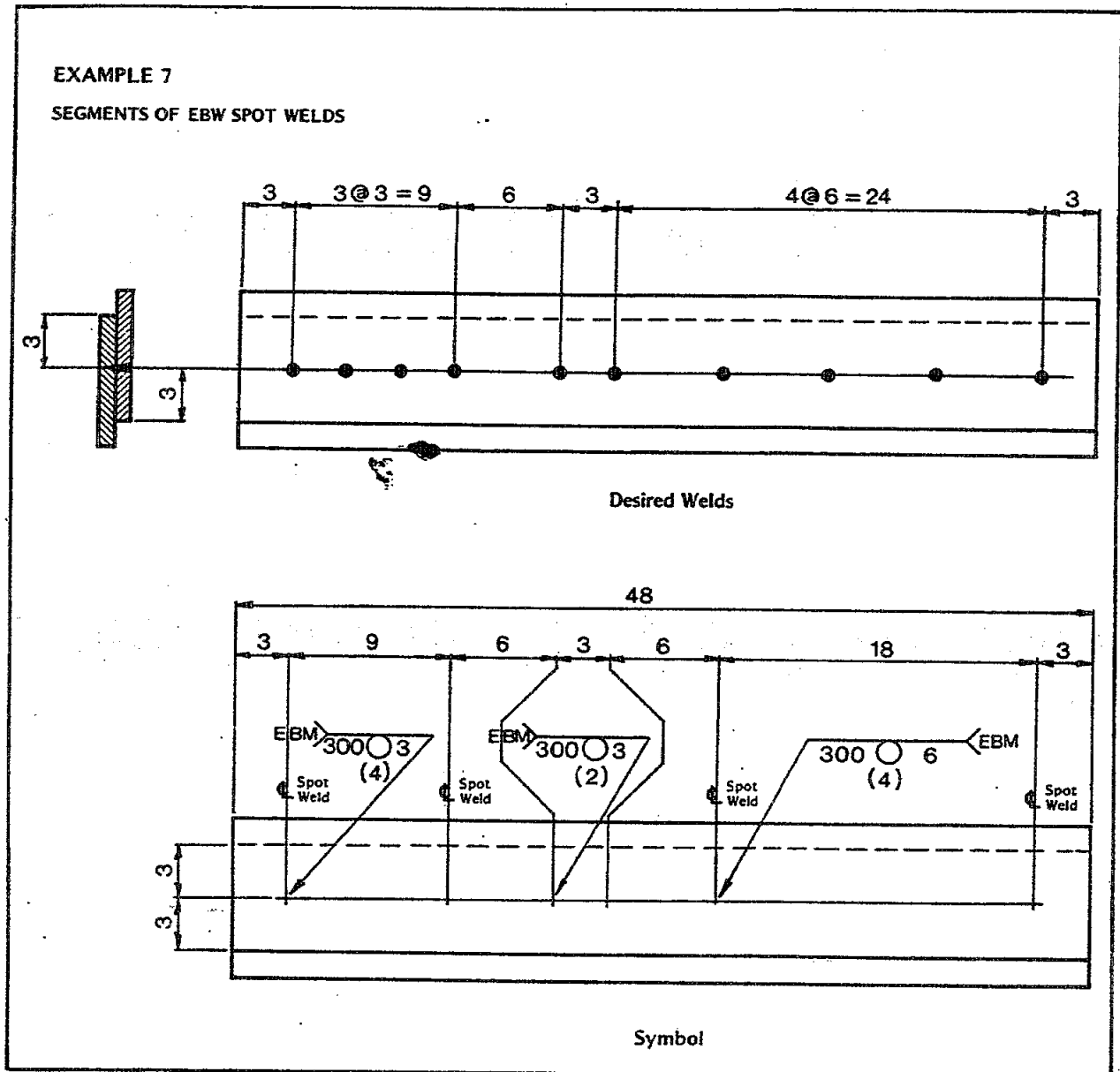
5.1.5.3 Number of Spot Welds:

When a definite number of spot welds is required within a given length of the joint, such number must be put in brackets and placed above or below the weld symbol:



The following series of examples will demonstrate the application of rules regarding the extent of spot welding and the number of spot welds.

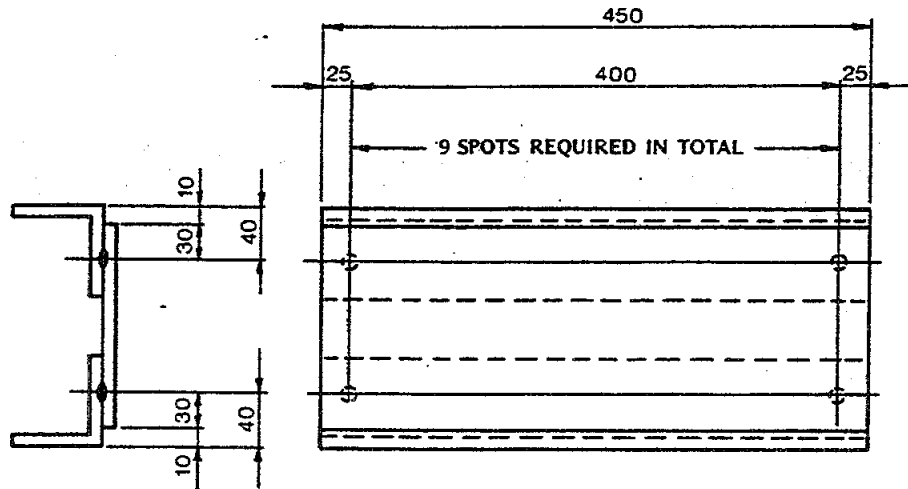
Example 7 shows segments of EBW spot welds with different spacing in the length of the joint.
Strength required: 300 lbs/spot:



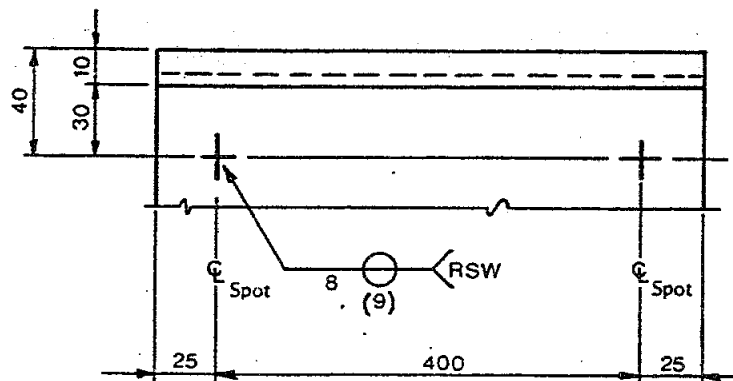
Symbols for Welding

Example 8 illustrates resistance-welded spot welds of 8mm size, with spacing of welds not specified but a given number of welds (9) required:

EXAMPLE 8

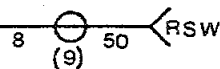


Desired Welds
as shown on *engineering drawing*

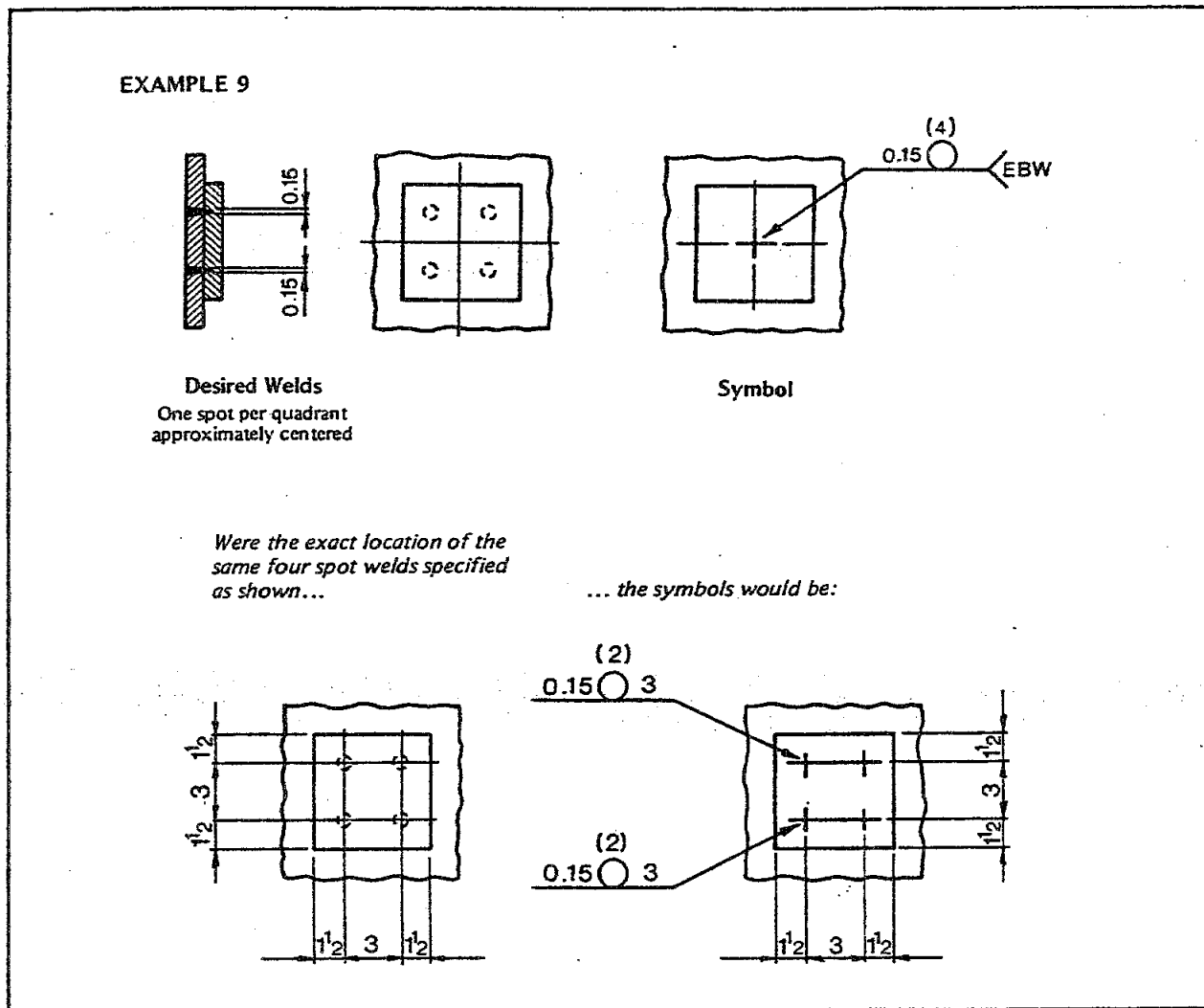


Symbol
as shown on *detail drawing*
with Shop left to decide on spacing

If drafting office chooses to decide on spacing, the symbol is likely to be:



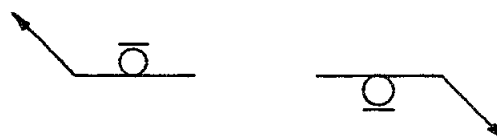
When a definite number of spot welds is required and their exact location is not specified, it must be assumed that any random location within the intended area will be acceptable. There is, however, a tendency to arrange them in a reasonably symmetrical pattern by the welding operator. The welding symbol must show the number of spots required, and (preferably) an additional sketch should show the general area for each spot.



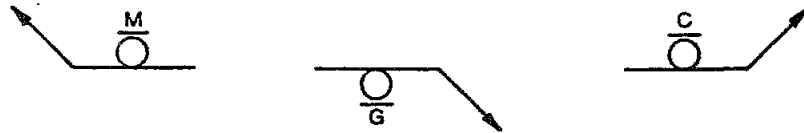
In the top portion of Example 9 there are four *random* 0.15-in. EBW spot welds with only a general area for their location indicated. In the lower panel of the Example the exact location of the four spot welds is specified.

5.1.6 Contour and Surface Finish of Spot Welds

When, in the case of arc spot welds and electron beam spot welds, the exposed surfaces are to be flush with the base metal, the flush contour symbol must be added to the weld symbol:



If the flat surface of the spot weld is to be given an additional finish, the mechanical means to be used to obtain such finish should also be shown in the welding symbol in the customary manner.



5.2 Seam Welds

5.2.1 General

Seam welds may be defined as continuous spot welds except that continuity for some processes may be provided by a single weld or a series of overlapping spot welds.

The same welding processes are used for seam welds as are for spot welds. Hence, the *arrow-side* and *other-side* significance as discussed for spot welds also applies to seam welds. The information to be included in the welding symbol consists of:

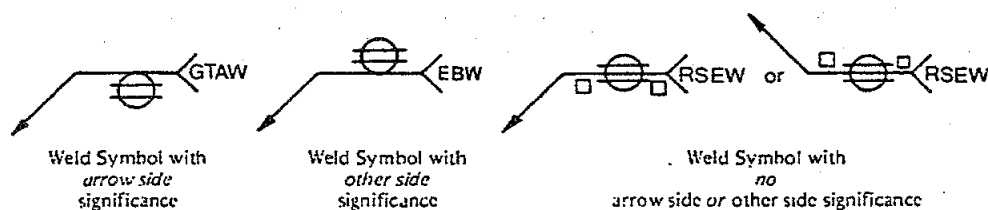
- 1) weld symbol;
- 2) process reference;
- 3) size or strength;
- 4) length and spacing;
- 5) orientation, and
- 6) contour.

It will suffice to discuss in detail only those aspects of symbol presentation which differ from that of spot welds.

5.2.2 Weld Symbol and Process Reference

The weld symbol for seam welds is the same as that for spot welds except for the addition of two horizontal lines across the open circle parallel to the reference line. The process reference appears in the tail of the symbol.

The seam weld produced by the *resistance* welding process is referred to as RSEW.



5.2.3 Size, Strength and Specific Length of Seam Welds

The size of seam welds is defined in exactly the same manner as that of spot welds, except that the diameter of the fusion area in the latter becomes the width of the fusion area for seam welds.

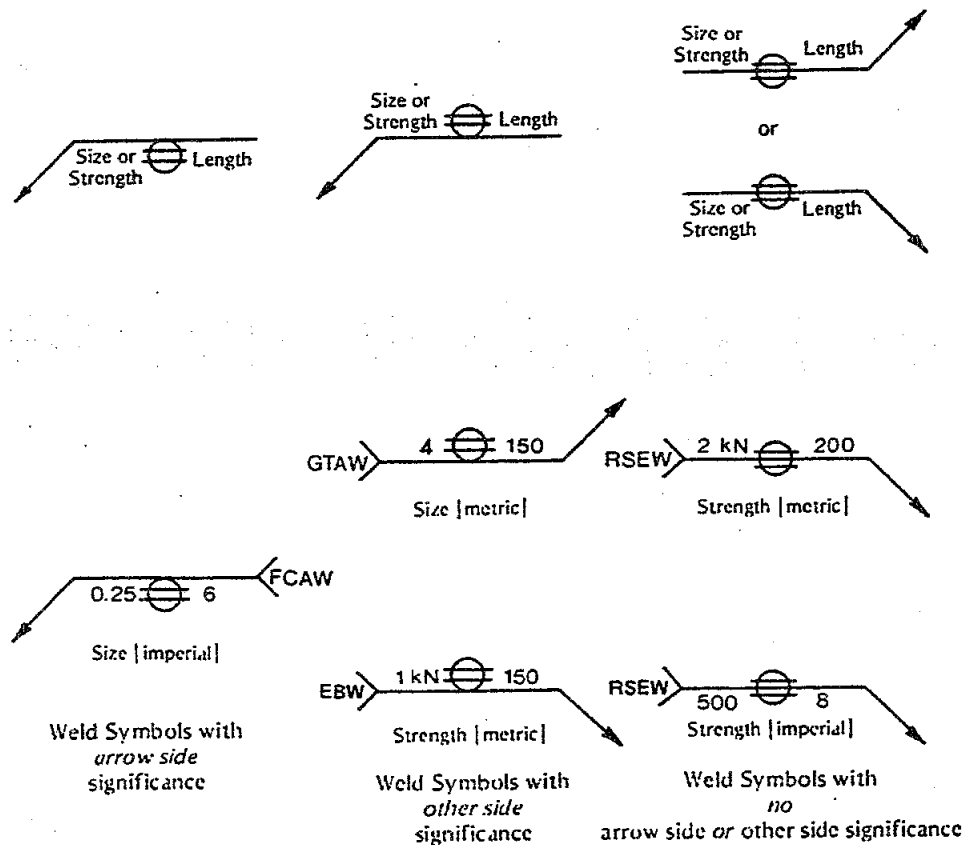
The size can be dimensioned in millimeters, or in fractions or decimals of an inch.

When strength is intended for use in the welding symbol, it must be designated as *strength per unit length* which is

newton/mm in the metric system

pounds/inch in the imperial system

The length of seam welds, if specified, must appear on the right side of the weld symbol. The location of these designations in the welding symbol is illustrated in the following series of symbols:



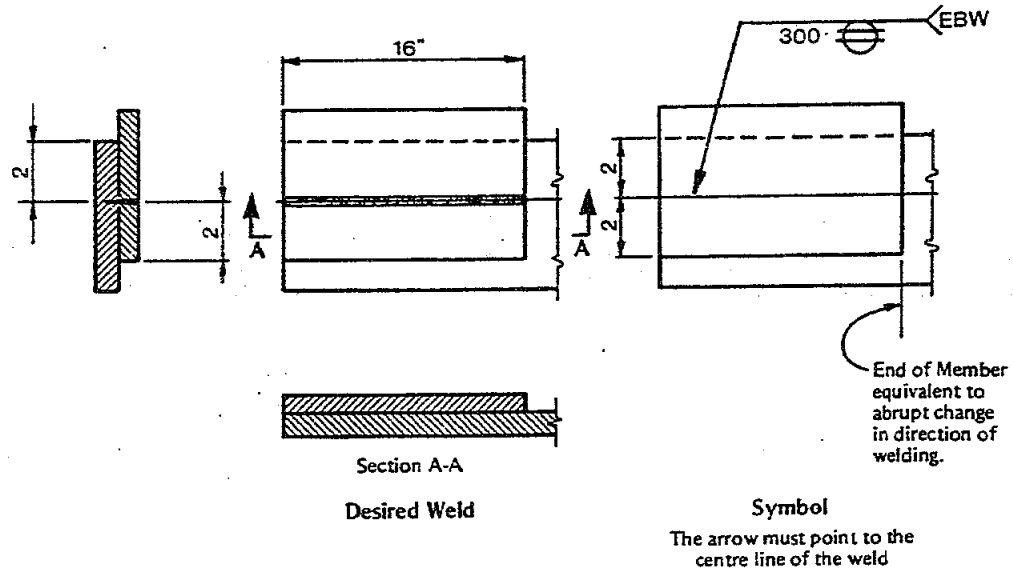
5.2.4 Length of Seam Weld Not Specified in the Symbol

When not specified in the welding symbol, the length of a seam weld is taken to be equal to the length of the joint between abrupt changes in direction of welding. However, if the required length of a seam weld is less than the distance between the abrupt changes in the direction of welding, the extent of the weld must be dimensioned on the drawing. Examples 10 and 11 are designed to illustrate these points:

Symbols for Welding

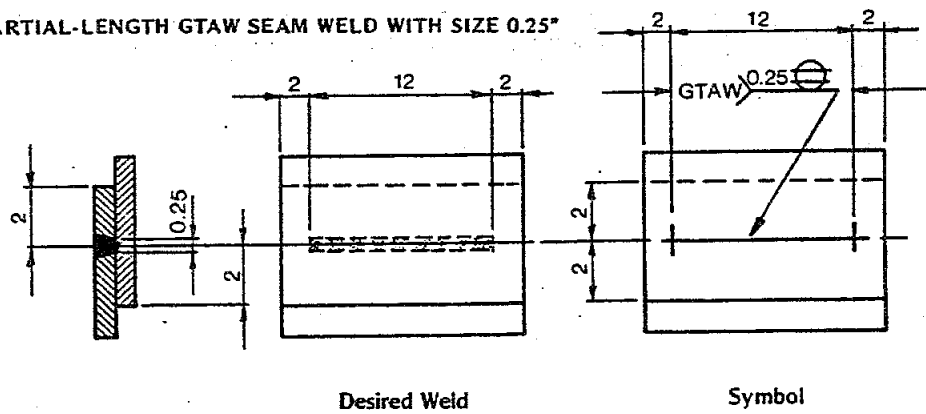
EXAMPLE 10

FULL-LENGTH EBW SEAM WELD WITH STRENGTH OF 300 lb/in.



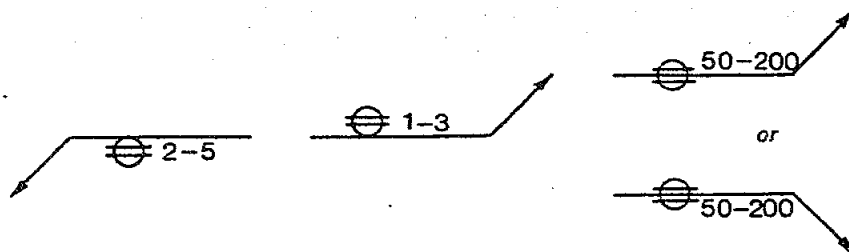
EXAMPLE 11

PARTIAL-LENGTH GTAW SEAM WELD WITH SIZE 0.25"



5.2.5 Spacing of Intermittent Seam Welds and Orientation

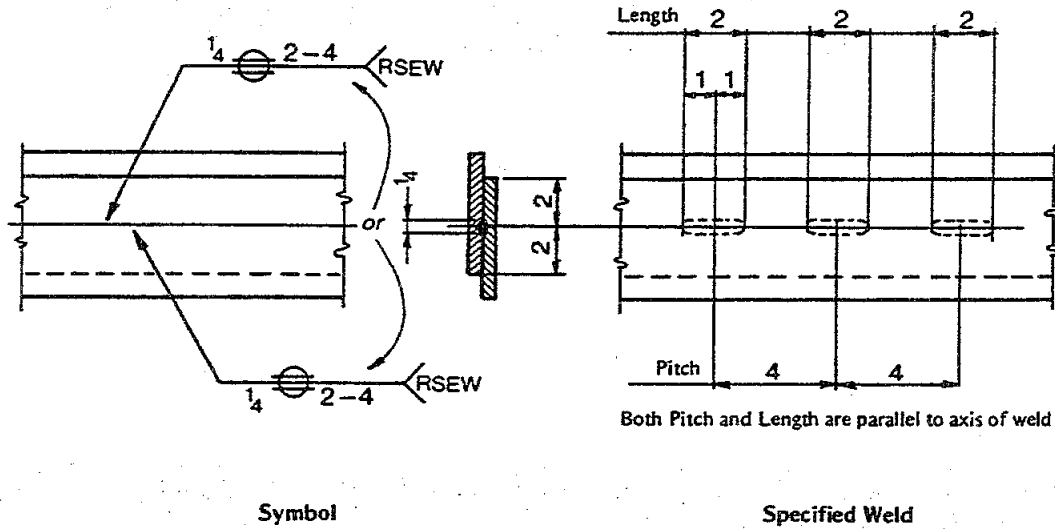
As in the case of spot welds, *pitch* is used to indicate the centre-to-centre spacing of the increments for seam welds. The pitch and the length of these increments must be shown on the right side of the weld symbol:



Unless otherwise specified, both the length *and* the pitch as expressed in the symbol are automatically assumed to be measured *parallel* to the axis of the weld, as explained in Example 12 showing the interpretation of length and pitch *without* a drawing:

EXAMPLE 12

INTERPRETATION OF LENGTH AND PITCH *WITHOUT* A DRAWING

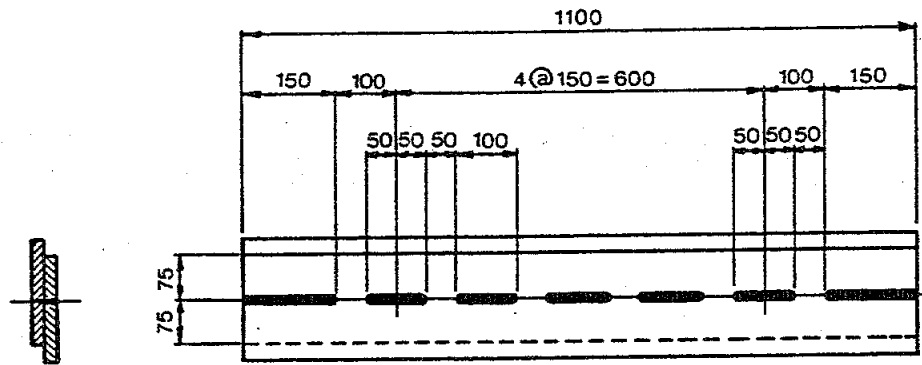


Depending on the application, it may be advisable, or even required, to terminate the seam weld at the end of the joint. In such case, the length of that end increment should be kept the same or greater than the lengths of the intermediate increments whose lengths and spacing so adjusted that both terminal seal welds are of equal length. A suggested way to present this type of situation is shown in Example 13 as an intermittent seam weld with terminal ends — EBW welds with 200 lbs/in. strength capacity:

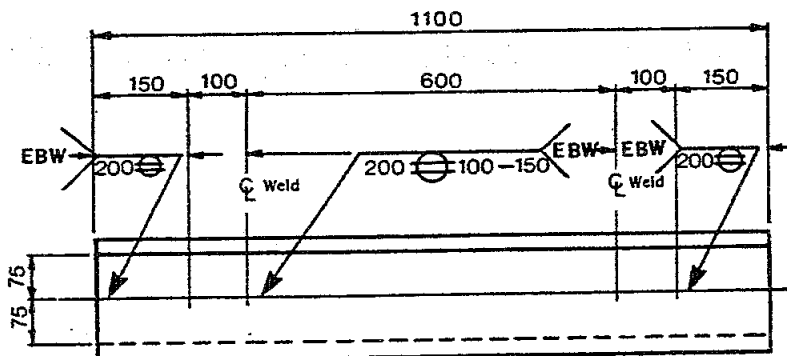
Symbols for Welding

EXAMPLE 13

INTERMITTENT EBW SEAM WELD WITH TERMINAL ENDS — 200 lbs/in. CAPACITY



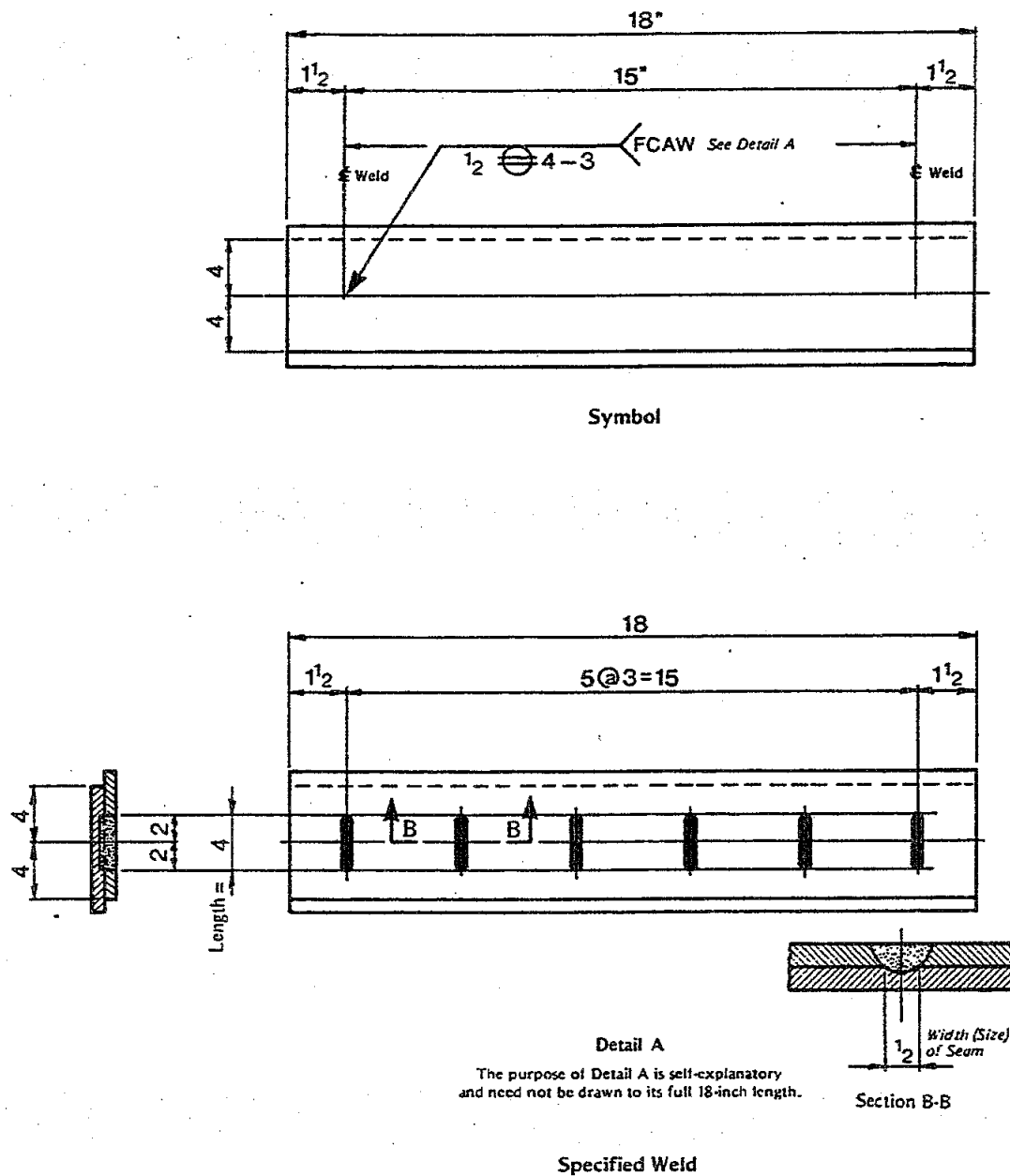
Desired Welds



Symbols and Dimensions

When the orientation of increments for seam welds is other than parallel to the length of the joint or to the direction of general progress of welding, a separate sketch must be provided to show the orientation of the welds. Example 14 illustrates this particular case of an arc seam weld $\frac{1}{2}$ inch wide with vertically oriented increments:

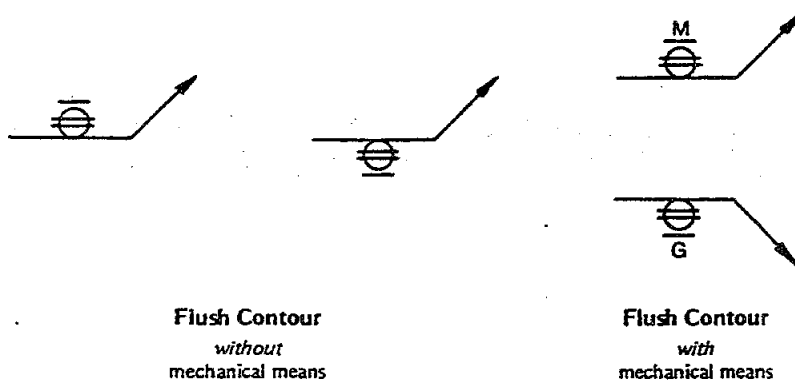
EXAMPLE 14



Symbols for Welding

5.2.6 Contour and Surface Finish

The observations with respect to contour and surface finish for seam welds are the same as discussed for spot welds. The symbols and their application are identical:



5.3 Stud Welds

5.3.1 General

Stud welding is generally defined as a "term for joining a metal stud or similar part to a workpiece, where welding may be accomplished by arc, resistance, friction or other process with or without external gas shielding." (AWS A3.0)

Arc stud welding is the more widely used stud welding process. Its preferred application in structural work is in composite construction in which the studs are primarily relied upon to provide calculated shear resistance. In this type of construction the studs are welded to the top elements (flanges) of structural shapes with the use of a stud welding gun.

There are, of course, other than shear applications for studs.

Where the distribution of studs is governed by design considerations, such longitudinal and transverse distribution on a member must be duly dimensioned on shop drawings. This can be conveniently done using the weld symbol introduced into the 1986 edition of AWS A2.4.

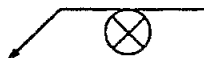
The stud weld symbol is represented by a circle with an inscribed "x".



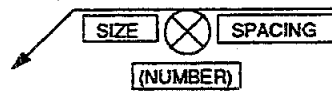
5.3.2 Rules Governing the Use of Stud Weld Symbols

5.3.2.1 SIDE SIGNIFICANCE. The usual "joint" concept is not applicable to stud welds and, because of it, the welding symbol has no *arrow* or *other* side significance.

The rule is, however, that the arrow point to the surface to which the stud is to be welded and that the stud symbol be always placed *below* the reference line:



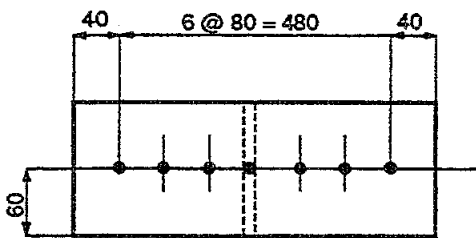
5.3.2.2 REQUIRED DIMENSIONS AND THEIR LOCATION. The only dimensions discussed in the stud welding symbol are the size, spacing and the number of studs, all placed at their customary location.



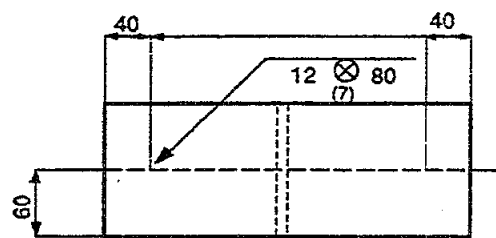
Each single line of stud welds has to be identified on the drawing by a welding symbol with dimensions for the first and last stud weld specified additionally. The two examples #1 and #2 will clarify their proper application.

EXAMPLE 1

Stud Welds in Single Line



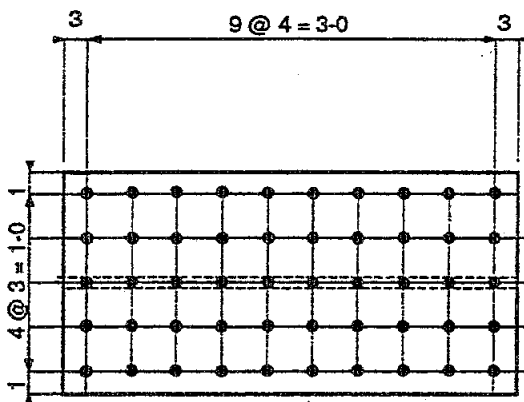
Desired Welds



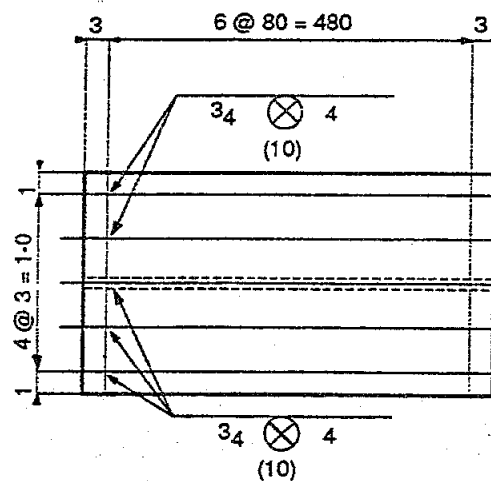
Symbol

EXAMPLE 2

Stud Welds in Multiple Lines



Desired Welds



Symbols

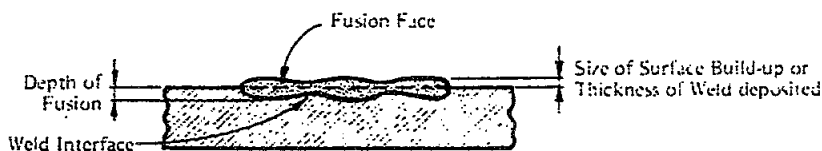
6. SURFACING WELDS

6.1 General

As its name implies, a surfacing weld is applied to a surface. A building up of surfaces may be required for a variety of reasons, the most common of which are:

- a) correction of dimensions,
- b) providing transition between different metals,
- c) providing corrosion- or wear-resistance.

The characteristics of a surfacing weld are shown in the sketch below:



Depending on the welding process to be used and the required thickness to be restored by surfacing, single- or multi-pass welds in single or multi-layers may be involved. The weld symbol for a surfacing weld consists of two "back" or "backing" weld symbols side by side:

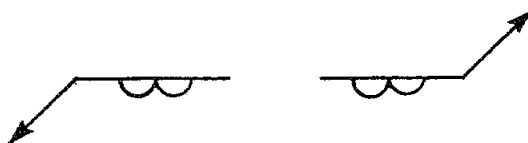


6.2 Rules Governing the Use of Surfacing Weld Symbols

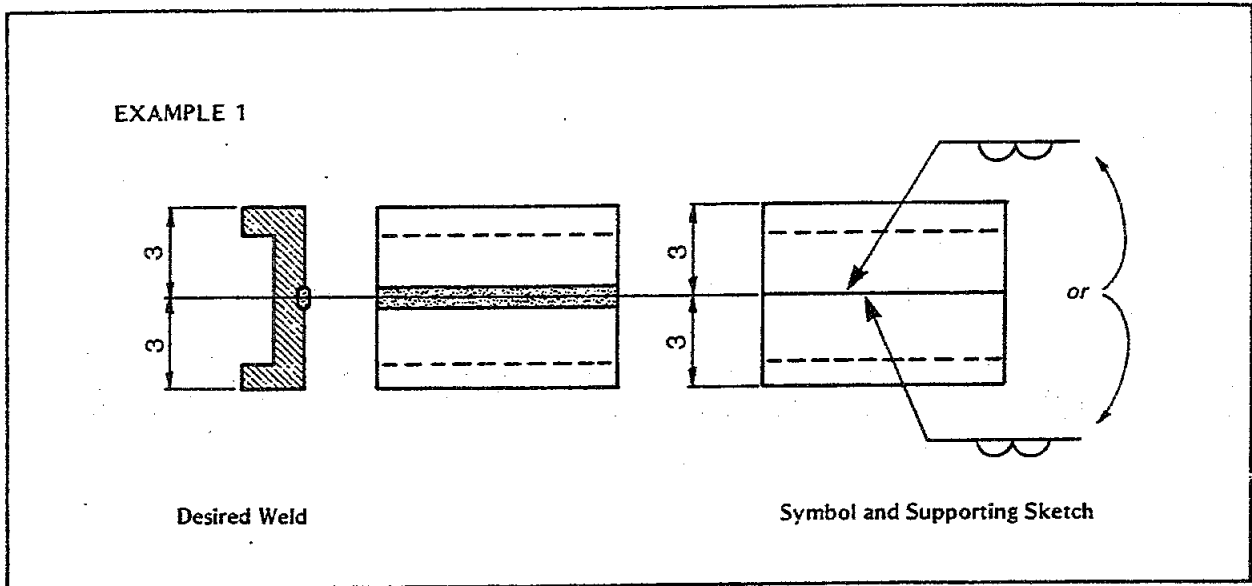
6.2.1 Side Significance

Since the *joint concept* is not applicable to surfacing welds, the welding symbol has no *arrow* or *other* side significance.

The area on which the surfacing weld is to be deposited is simply identified by the arrow pointing to it with the surfacing symbol *always* placed *below* the reference line:

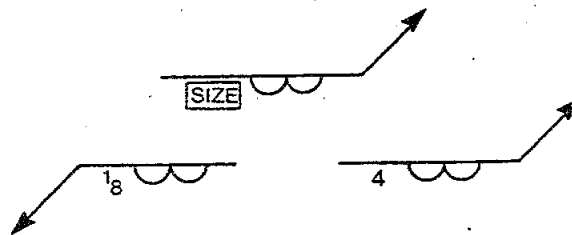


The following example will illustrate the required application of the welding symbol:



6.2.2 Required Dimensions and their Locations

The only dimension that is required to be placed in the surfacing welding symbol, *when of significance*, is the *size* (thickness) of the built-up welding. When specified, it has to appear to the *left* of the surfacing weld symbol and on the *same* side of the reference line. Additionally, the direction of welding may be specified in the tail of the symbol (*axial* or *longitudinal* and *circumferential* or *lateral*).

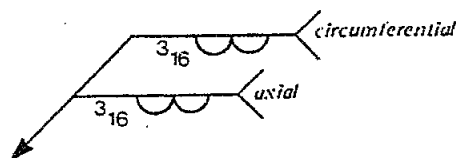


It also follows that, when no specific thickness of deposit is required, no size dimension need be shown in the welding symbol.

AWS A2.4-79 did not provide any guidance for application of surfacing symbols for cases in which multi-layer build-up is involved. The Code may have taken the view that specifying the required size is sufficient, thereby implying that the option to obtain it with either one or two layers is left to the discretion of the user.

This has been sanctioned in the 1986 edition of the Code.

If surfacing in two layers is of importance, advantage can be taken of the multiple-reference-line welding symbol. The desired size for each of the layers may be specified which, in the symbol below, would provide a total surfacing weld of $3/8$ inch.



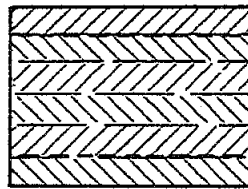
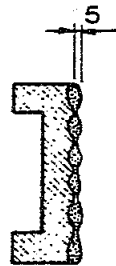
Symbols for Welding

6.2.3 Extent, Location and Orientation of Surface Welds

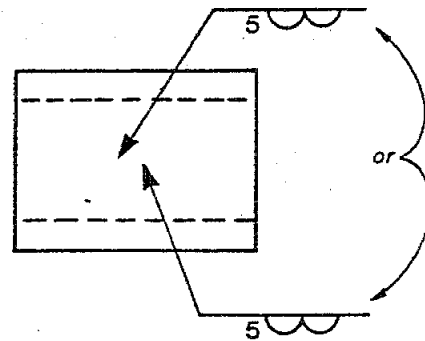
When an entire area of a plane or curved surface is to be built up by welding, no dimension other than the *size* (thickness of deposit) needs to be shown in the welding symbol.

EXAMPLE 2

SINGLE-LAYER SURFACING WELD



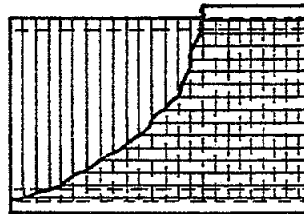
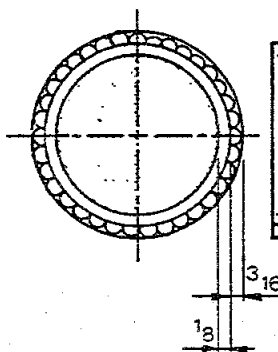
Desired Weld



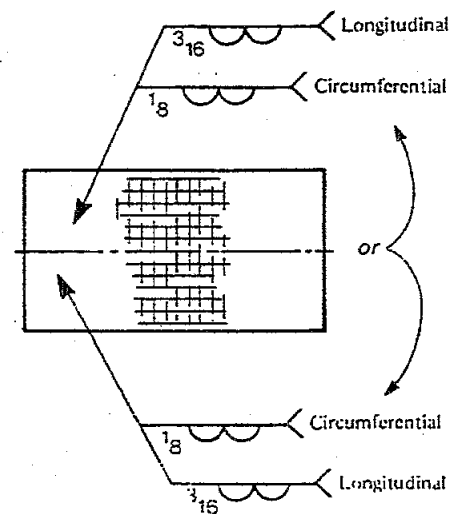
Symbol and Supporting Sketch

EXAMPLE 3

TWO-LAYER SURFACING WELD



Desired Surfacing Weld



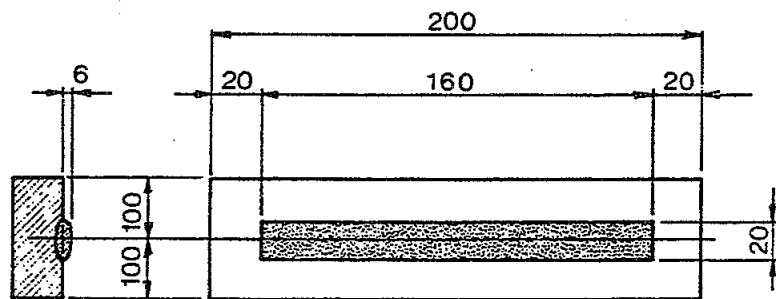
Symbol and Supporting Sketch

In addition to the identification of the required orientation of the surfacing welds in the tail of welding symbol, they may be schematically indicated in the sketch. The user's standard convention should be used for this purpose.

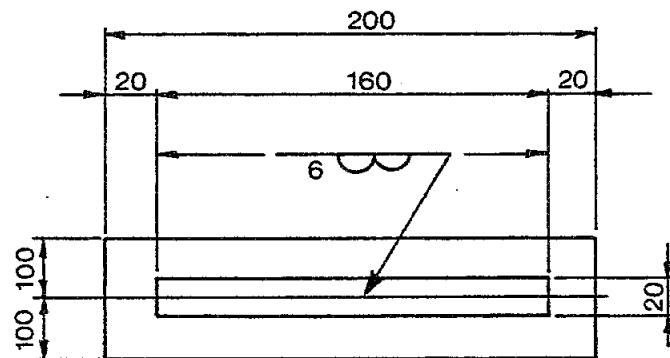
When a specific localized part of a product requires a surfacing weld of a certain width and size, the information can only be conveyed to the shop by means of an additional sketch. Example 4 will explain the required symbol and supporting data presentation:

EXAMPLE 4

SPECIFIED LENGTH AND WIDTH



Desired Surfacing Weld



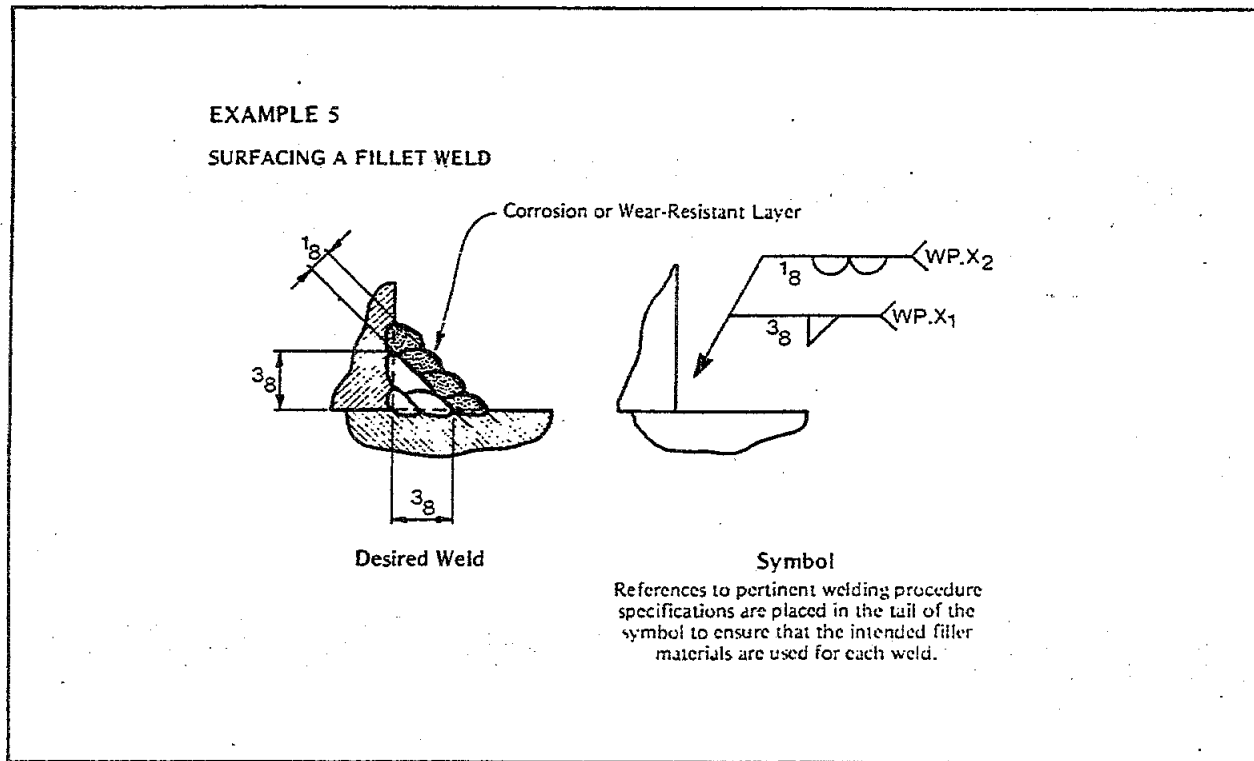
Symbol and Supporting Sketch

The width of the deposit may involve one pass as shown in the Example. Should the width be, say 30mm, and the size (6mm) stay the same, only the width dimension need to be altered on the supporting sketch, with the welding symbol remaining unchanged. The number of passes within that width is left to the discretion of the user.

6.3 Other Applications

6.3.1 Surfacing a Weld Face

As pointed out earlier, another possible application of surfacing is to provide corrosion- or wear-resistance to mild steel weld metal. This is shown in Example 5, as applied to the face of a fillet weld:

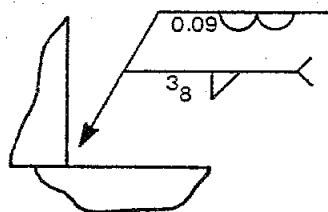


The same Example may be used to illustrate the application of a surfacing symbol for the purpose of increasing the size of the fillet. In such case, however, the size of the surfacing weld will have to be calculated from the increment in the leg size as required for the new fillet weld.

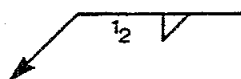
If the new required size were to be $\frac{1}{2}$ inch, the leg size increment would amount to $\frac{1}{8}$ inch. Translated into the thickness of a surfacing weld, this dimension would become:

$$\frac{1}{8} \times 1.4 = 0.089 = 0.09 \text{ in.}$$

Hence, in order to obtain a $\frac{1}{2}$ -inch fillet weld from the $\frac{3}{8}$ -inch size by surfacing, the required welding symbol would be:



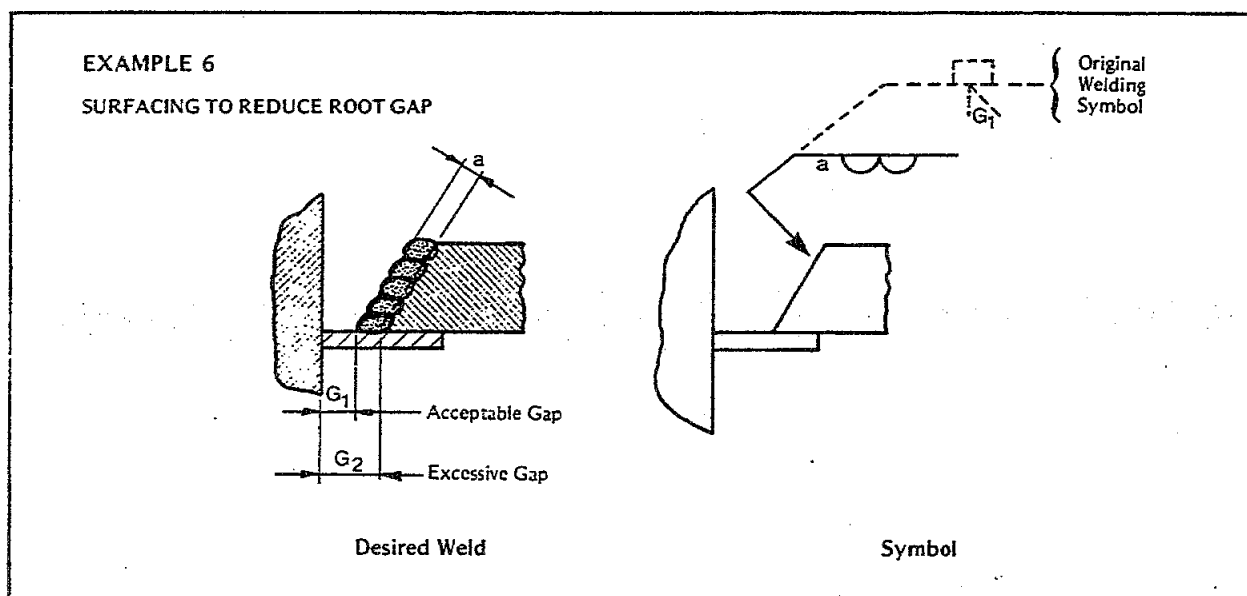
Obviously, this is a rather cumbersome procedure. Normally, one would request the $\frac{1}{2}$ -inch size, using a customary symbol:



leaving it to the shop to use a sufficient number of passes on top of the existing $\frac{3}{8}$ -inch fillet to produce the required $\frac{1}{2}$ -inch fillet size.

6.3.2 Correction of Dimensions

Surfacing may be conveniently used in situations where, because of cutting errors, members are shorter than the required length, consequently resulting in excessive root openings in some of the joints. These openings may be reduced to the required dimensions by surfacing — customarily referred to as “buttering” — thus restoring the original geometry of the joint for final welding. Example 6 shows a case of a single-bevel-groove weld on backing featuring an excessive root gap (G_2):



The size of the surfacing weld “a” as its essential dimension will have to restore the originally specified root opening “ G_1 .”

This weld will be deposited first, in accordance with the rule governing multiple reference lines, with the weld proper following next.

Since there may be some doubt as to which side of the joint is to be surfaced — although in bevel joints the arrow break could be interpreted to identify this particular face — a supporting sketch may be required.

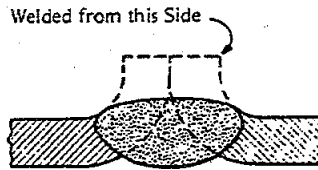
The surfacing weld symbol may be shown separately. It will most likely be shown in a case of unexpected excessive root gaps in field joints.

If fusion into the backing bar is to be avoided, one may consider using a copper backing solely for the duration of the surfacing operation with subsequent substitution of the originally designated backing material for the completion of the weld proper in the joint.

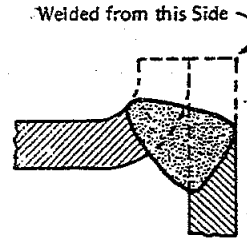
7. FLANGE WELDS

7.1 General

A flange weld is defined as a weld made on the edges of two or more members to be joined, usually in light-gauge metal, with at least one of the members being flanged.



Joint A



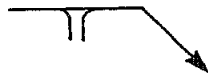
Joint B

One of the characteristic features of flange welds is that they can only be made from one side. Welding from both sides is neither feasible nor necessary.

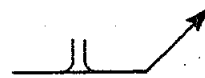
7.2 Side Significance and Types of Joints

The "joint" concept applies to flange welds and, consequently, the welding symbols do have *arrow side* and *other side* significance. There are only two types of practical flange welds feasible, and their designation relates more clearly to the arrangement of material *after* flanging has been performed and *before* welding is to commence. The two types in question are:

- (1) EDGE-FLANGE WELDS — represented by Joint "A" already shown above, and the following welding symbol:

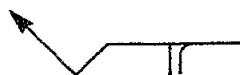


"Arrow Side" Significance

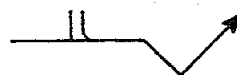


"Other Side" Significance

- (2) CORNER-FLANGE WELDS — represented by Joint "B" shown above, and the following welding symbol:

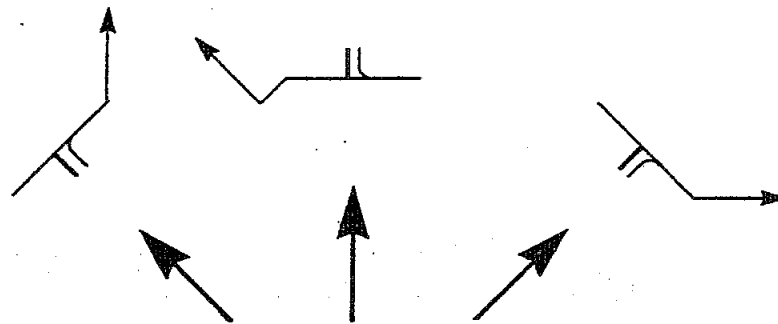


"Arrow Side" Significance



"Other Side" Significance

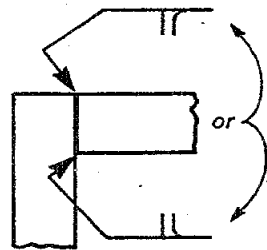
It should be noted that, for corner-flange welds, the vertical line in the weld symbol must always appear on the left side when viewed from the reader's position:



Reader's Viewing Positions

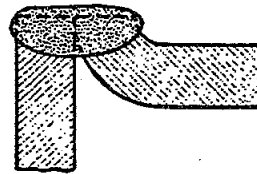
Also, in the case of the same corner-flange welds, but only when the joint is *not detailed*, the arrow of the welding symbol *must* be broken and point to the member to be flanged. The following sketches will serve to explain this rule:

CASE 1 — JOINT NOT DETAILED:

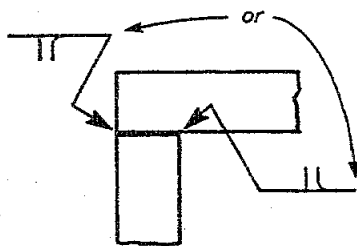


Symbol

(Arrow broken to identify the member to be flanged)

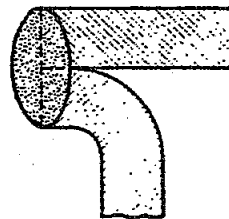


Desired Weld



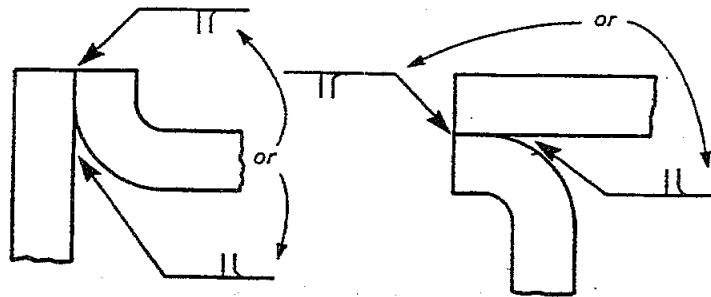
Symbol

(Arrow broken to identify the member to be flanged)



Desired Weld

CASE 2 — JOINTS DETAILED:



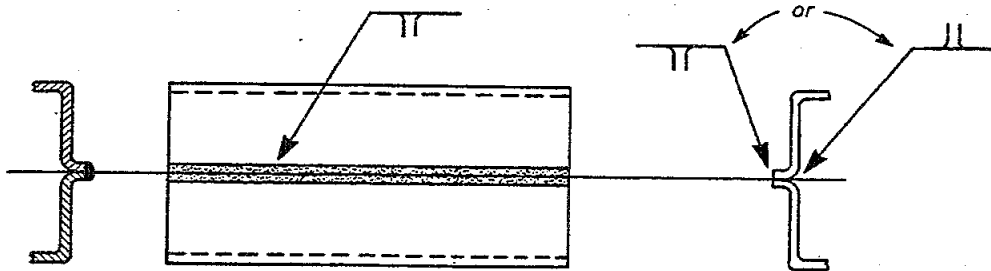
Symbols

(Break in Arrow not necessary as detail identifies flanged member)

The next series of examples will assist in the understanding of the application of the appropriate welding symbols:

EXAMPLE 1

EDGE-FLANGE WELDS: *FLANGING DETAILED*



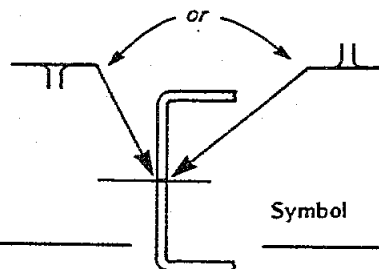
Desired Weld

Symbol
(Flanging detailed)

Symbol may be placed on the elevation but end view must be shown to identify flanging in a more definite manner.

EXAMPLE 2

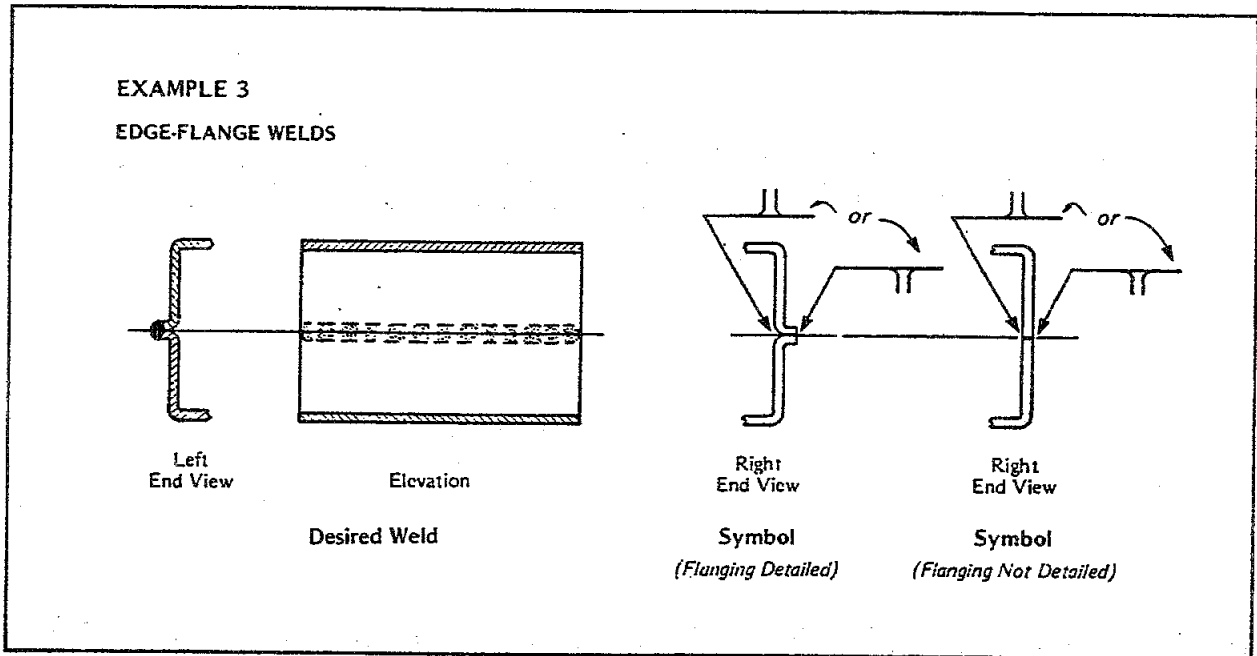
EDGE-FLANGE WELDS: *FLANGING NOT DETAILED*



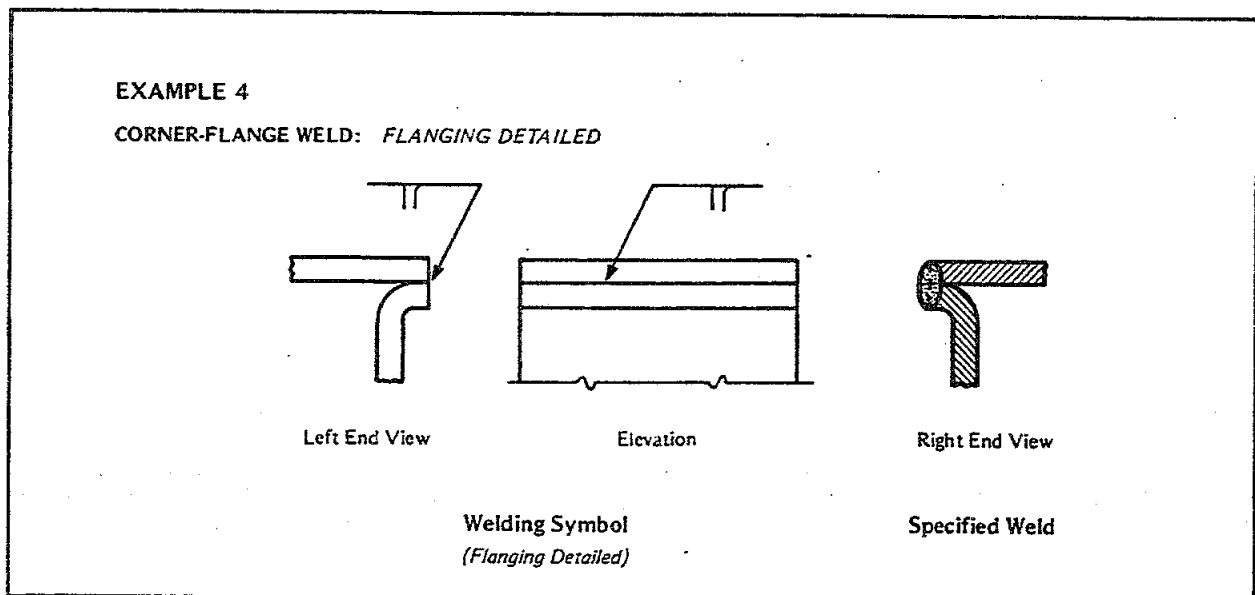
Symbol

With the desired weld being the same as shown in Example 1, the welding symbol for an end view not showing flanging will be as illustrated in Example 2 — Flanging Not Detailed.

In Examples 1 and 2, both members have to be flanged. It is essential to clarify whether flanging, and subsequently welding, is to be done from the inside or from the outside of the profile.



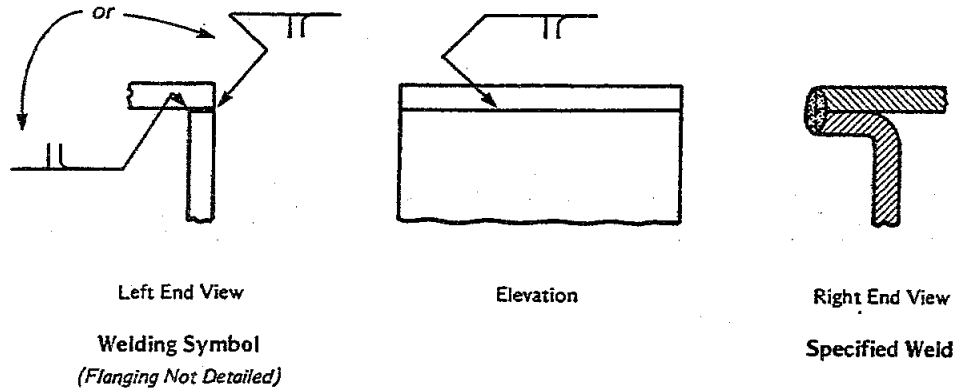
The concluding comment of Example 2 also applies to this example.



It should be noted that the arrow has not been broken, as the detail (left end view) identifies the member to be flanged.

EXAMPLE 5

CORNER-FLANGE WELD: *FLANGING NOT DETAILED*



Since the left end view does not show flanging, the welding symbol (by means of the break in the arrow) has been used to identify the member to be flanged. The correctly finished joint is shown in the right end view.

Placing the symbol on the elevation with no end views shown may be causing interpretation problems. A symbol on a cross-section or end view is much more positive in specifying the requirements.

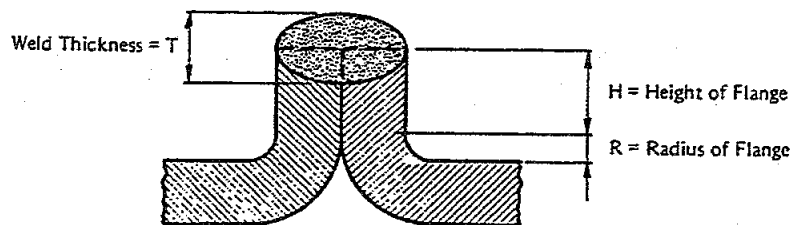
7.3 Dimensions of Flange Welds

In conformance with the general principle, all dimensions pertaining to flange welds have to be placed, together with the weld symbol, on the *same* side of the reference line.

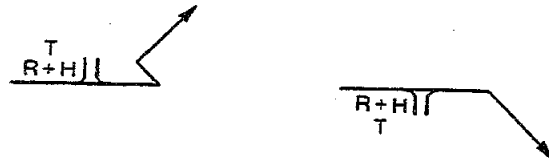
There are three dimensions considered essential to the application of flange welds and should be included in the welding symbol:

- (1) weld thickness — designated by "T";
- (2) height of flange — designated by "H";
- (3) radius of flange — designated by "R".

These three dimensions are illustrated below:



All three of these dimensions must be placed to the left of the weld symbol in one particular order: The radius "R" must be followed by the height "H" and connected with it by a "plus" (+) sign. Both values must read in the same order from left to right. The thickness of the weld "T" is to be placed *outward* (above or below) the flange dimensions.



AWS A2.4 stipulates that the *root opening* shall not be shown in the welding symbol. However, if such root opening is desired, it is to be shown on the drawing.

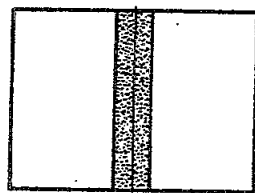
Since flange welds are presumed to be deposited for the full length of the joint, the same code makes no specific reference to it. Its omission, in accordance with the general principles, designates welding for the full length of the joint.

However, should there be a situation in which a partial length flange weld is acceptable, the required welded length has to be detailed on the drawing. This may not preclude the flanging operation being done for the full length of the joint.

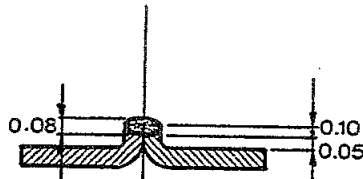
The following examples illustrate the proper application of flange weld symbols, together with the pertinent dimensions.

EXAMPLE 6

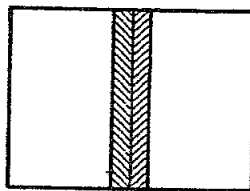
EDGE-FLANGE WELDS



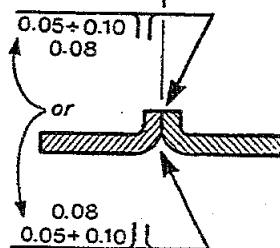
Top View



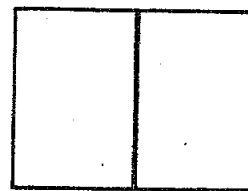
Desired Weld



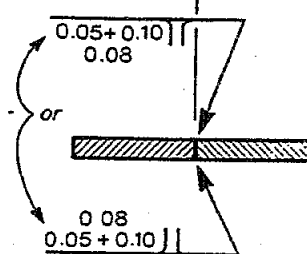
Top View



Welding Symbol
(Flanging Detailed)



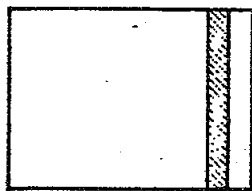
Top View



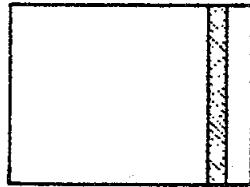
Welding Symbol
(Flanging Not Detailed)

EXAMPLE 7

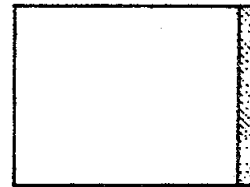
CORNER-FLANGE WELDS



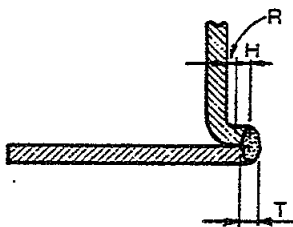
Top View



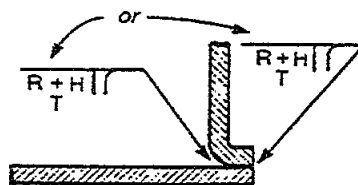
Top View



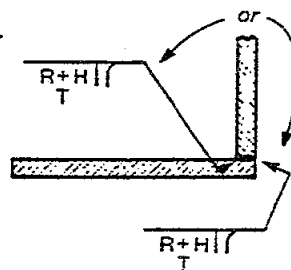
Top View



Desired Weld



Welding Symbol
(Flanging Detailed)
(No Break in Arrow)



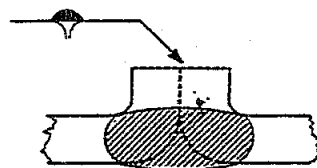
Welding Symbol
(Flanging Not Detailed)
(Break in Arrow)

7.4 Multiple Joint Flange Welds

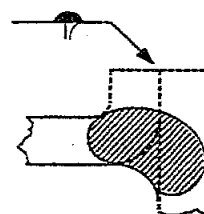
In all cases in which intermediate elements between the two outer pieces are a part of the total joint, the welding symbol required for the two outside pieces in the joint shall apply, regardless of the number of intermediate pieces between them. Depending on the type of weld (edge or corner), flanging shall apply only to the outer piece or pieces. In order to make this information clear, the recommended practice is to show it on the drawing. The following examples will help clarify these provisions:

7.5 Flange Welds with Complete Penetration

Edge and corner flange welds requiring complete penetration may be specified by addition of the "melt-thru" symbol to the corresponding flange weld symbol.



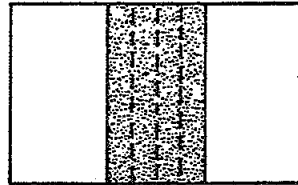
a) edge flange welds



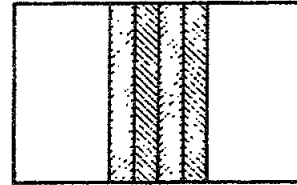
b) corner flange welds

EXAMPLE 8

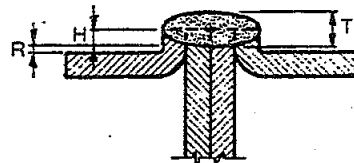
EDGE-FLANGE WELD



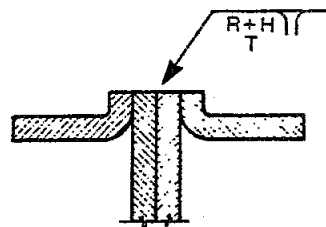
Top View



Top View



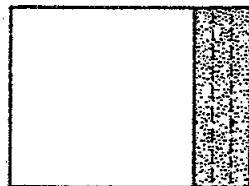
Desired Weld



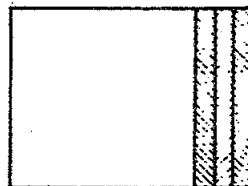
Welding Symbol
(Flanging Detailed)

EXAMPLE 9

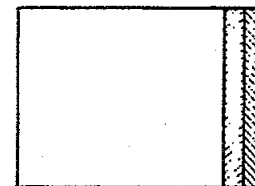
CORNER-FLANGE WELD



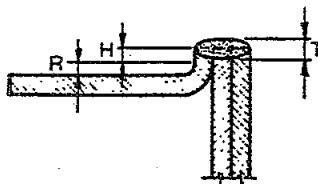
Top View



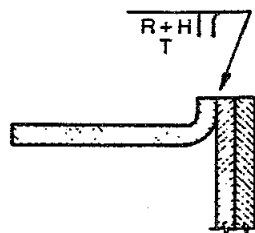
Top View



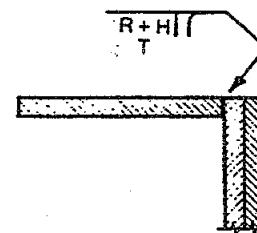
Top View



Desired Weld



Welding Symbol
Flanging is detailed,
hence Break in the Arrow
is not required.



Welding Symbol
Flanging is NOT Detailed,
hence Break in the Arrow
IS required to identify
the Member to be flanged.

8. BRAZED JOINTS

8.1 General

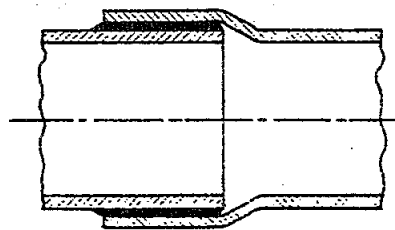
AWS A2.4 considers three distinct welding symbol variations for brazed joints. The *first* one involves no preparation in the joint except cleaning. The *second* one involves a *scarf joint*, which is a joint used exclusively for brazing operations. The *third* one involves the use of arc welding symbols.

8.2 Application of Brazing Symbols

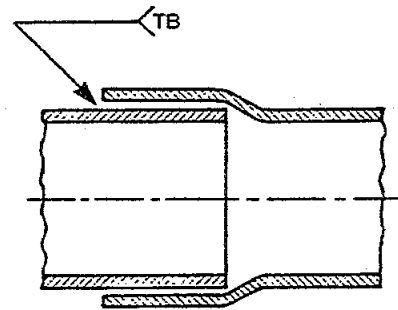
- 1) A brazing operation which involves no preparation except cleaning requires only the reference line, the arrow and the identification of the brazing process in the symbol. Examples 1 and 2 illustrate this requirement:

EXAMPLE 1

TORCH-BRAZED [TB] JOINT



Desired Braze

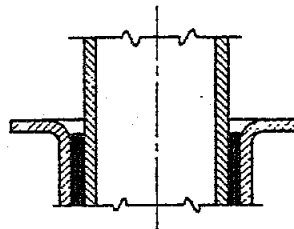


Symbol

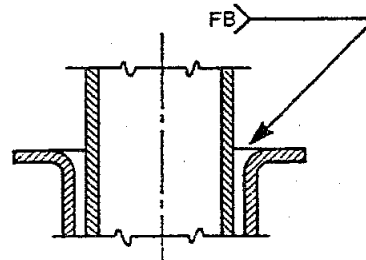
The Brazing Process, in this case Torch Brazing [TB], must be shown in the Tail of the Symbol.

EXAMPLE 2

FURNACE-BRAZED [FB] JOINT



Desired Braze



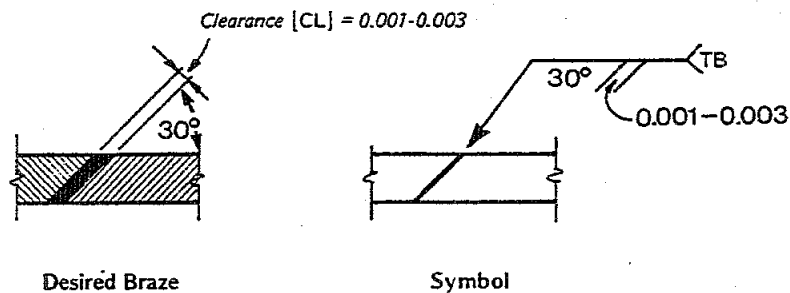
Symbol

- 2) In the case of the unique *scarf joint*, the information required in the symbol includes the *angle of scarfing* and the *clearance* between the two elements in the joint.

The angle of scarfing is to be placed to the left of the scarf symbol, and the clearance, in accordance with the basic rule, between the two diagonal lines of the scarf symbol. The next example will illustrate the proper application of the scarf symbol:

EXAMPLE 3

JOINT WITH A SCARF BRAZE



Desired Braze

Symbol

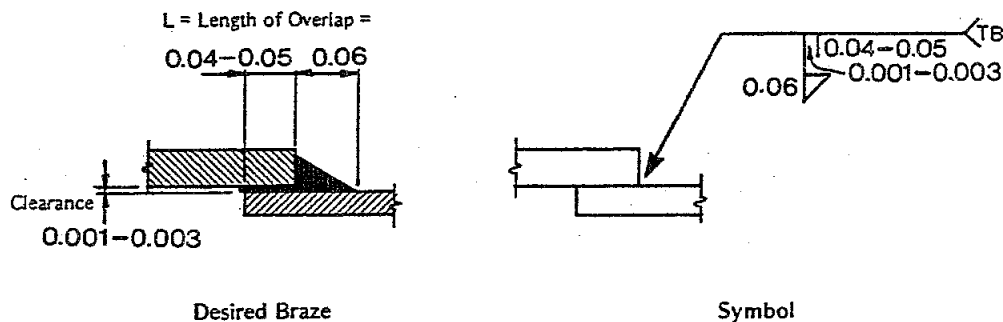
If reference to a drawing is required to provide additional information, such reference should be placed in the Tail of the Symbol.

- 3) In a good proportion of brazed joints, the arc welding symbols can be used to full advantage.

In lap joints, the length of the overlap may be required. If so, the length is placed on the right side of the weld symbol in accordance with the general rule. A number of examples are used to clarify the application of arc welding symbols to brazed joints:

EXAMPLE 4

LAP JOINT WITH REINFORCING FILLET WELDS

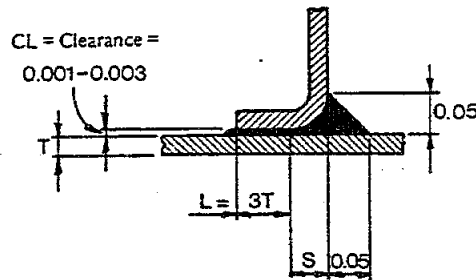


Desired Braze

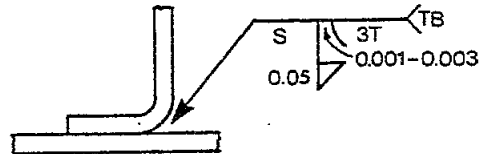
Symbol

EXAMPLE 5

T-JOINT WITH OVERLAP AND REINFORCING FILLET WELD



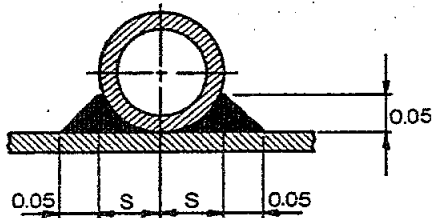
Desired Braze



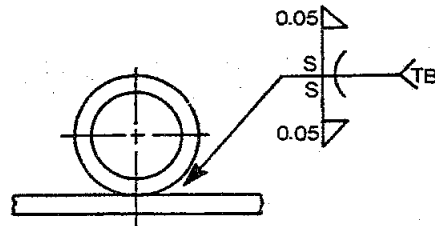
Symbol

EXAMPLE 6

LAP JOINT WITH FLARE-BEVEL GROOVE AND REINFORCING FILLETS



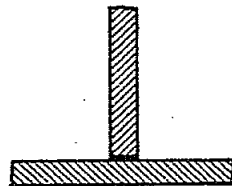
Desired Braze



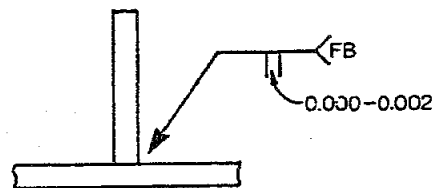
Symbol

EXAMPLE 7

T-JOINT



Desired Braze



Symbol

9. NONDESTRUCTIVE EXAMINATION SYMBOLS [NDE]

9.1 Letter Designations for Examination Methods

The AWS A2.4 specification has assigned an individual letter designation to each of the current nondestructive examination methods. These designations are used to identify the pertinent examination method in the nondestructive examination symbol.

The examination methods and their corresponding letter designations are as follows:

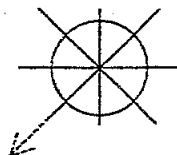
Acoustic emission	AET
Eddy current	ET
Leak	LT
Magnetic particle	MT
Neutron radiographic	NRT
Penetrant	PT
Proof	PRT
Radiographic	RT
Ultrasonic	UT
Visual	VT

9.2 Elements of the Examination Symbol and their Location

In order to convey the required nondestructive examination information, the examination symbol must include the following elements, but need not necessarily show all of them:

- ✓ reference line,
- ✓ arrow,
- ✓ examination method letter designation,
- ✓ dimensions, areas and number of examinations,
- ✓ supplementary symbols,
- ✓ tail,
- ✓ codes, specifications and other references.

Besides the standard supplementary symbols for "all-around" and "field" operations, an additional symbol for "direction of radiation" has been introduced:



The standard locations of these elements are shown very clearly in Fig. 5:

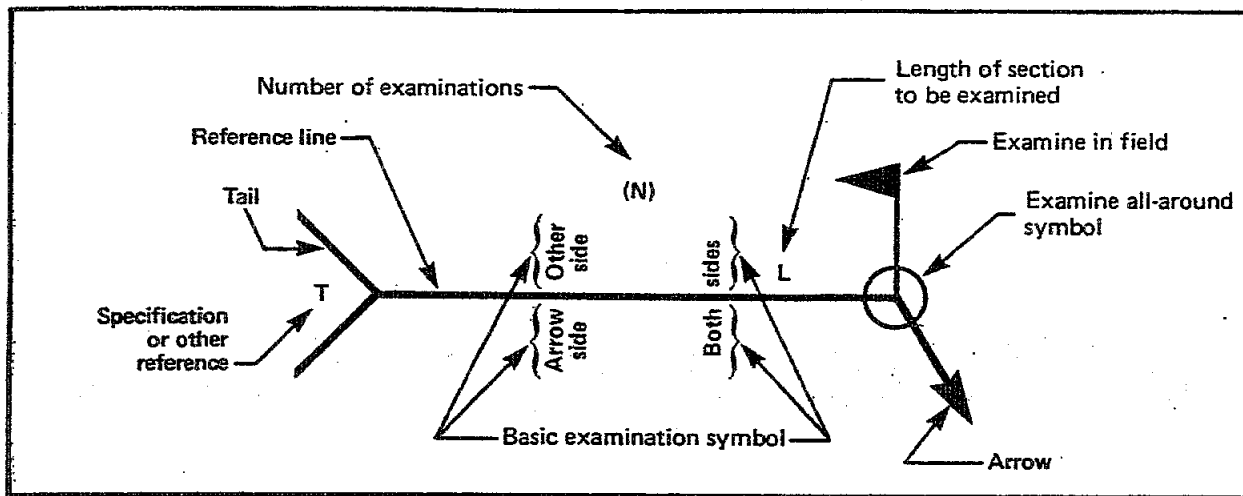
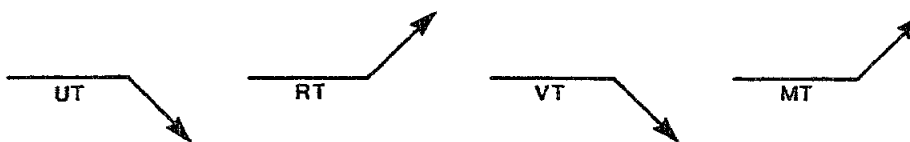


Fig. 5 – Standard Location of Elements

9.3 Arrow-Side Significance

The A2.4 Code specifies that the arrow should connect the reference line with the part to be tested. It rules also that the side of the part to which the arrow points is to be considered the arrow side. It therefore follows that the side opposite the “arrow” side is the “other” side.

In accordance with the fundamental principle, all examinations by a selected method to be performed on the arrow side are to be indicated by the appropriate letter designation placed *below* the reference line or, in general terms, on the side of the reference line closer to the reader’s viewing position:



If examination is to be performed on the side opposite to the *arrow* side, that is... the *other* side, the letter designation has to be placed *above* the reference line or, in general terms, on the reference line away from the the viewing position of the reader.

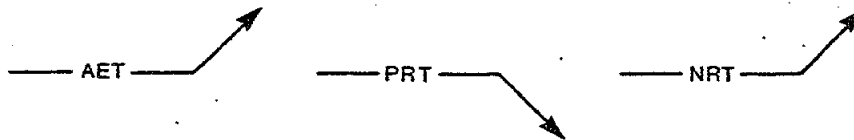


Symbols for Welding

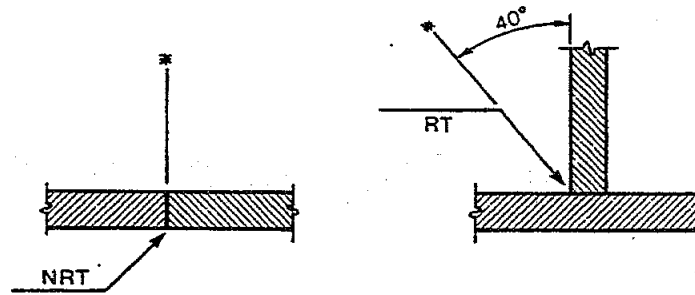
When examinations are to be performed on both sides of the part, pertinent letter designations must be specified on both sides of the reference line, even if the examination methods are identical.



Should the NDE symbols have no arrow- or other-side significance, they must be *centred* on the reference line, as shown below:



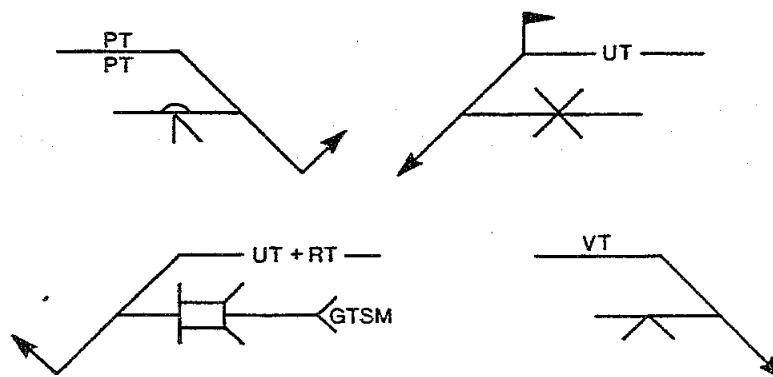
In cases of radiographic or neutron radiographic examinations it is possible to use the symbol to indicate the direction of radiation by specifying the angle in the following manner:



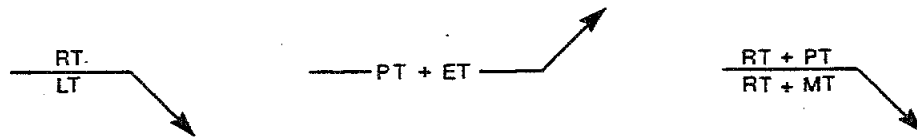
9.4 Combined Welding and NDE Symbols

The possibility of combining welding and NDE symbols is of great practical advantage. It permits the shop to obtain full information prior to the execution of welding and serves as an indication of the quality of work required.

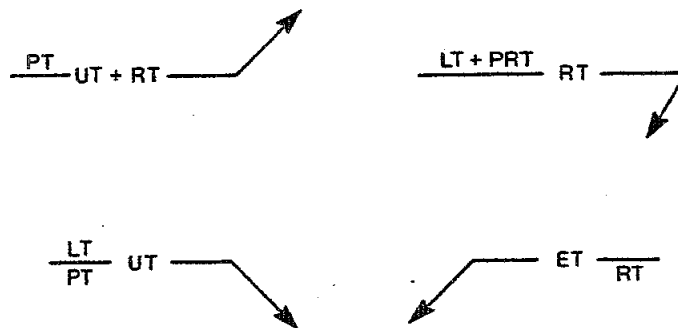
Such combinations are common. Since the examination of final welds can only be performed after welding is completed, it should be obvious that multiple reference lines must be used to specify the sequence of operations.



It is also possible to specify more than one examination method in the symbol:



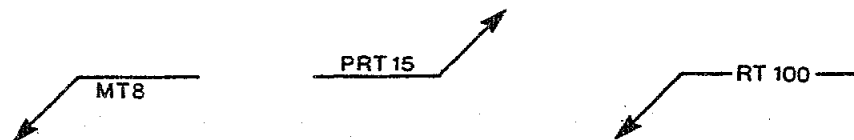
Examination methods having and not having arrow-side significance can be combined. However, the symbol must properly reflect this significance:



The tail of the symbol should be used for pertinent procedural specifications or other references essential to the proper application of the examination method.

9.5 Extent of NDE Examination

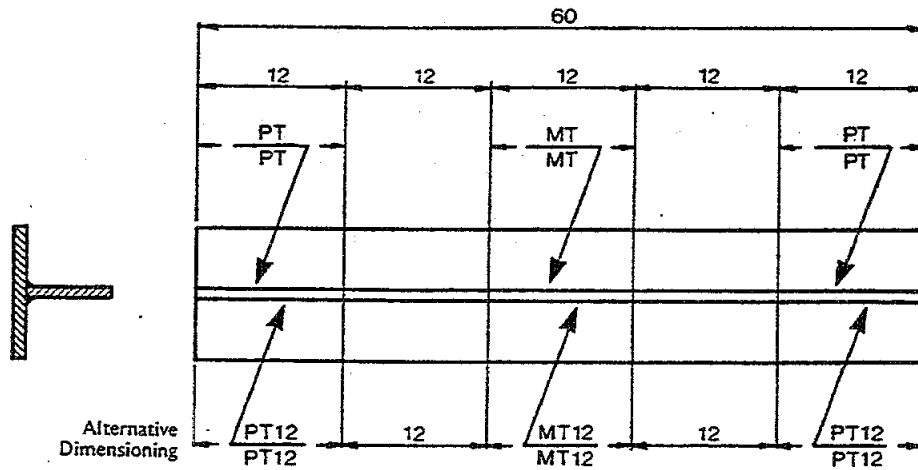
When a specific length is subject to examination, it should be placed on the right side of the letter designation for the selected examination method.



In order to specify the exact location of a specific length or lengths of the joint to be examined, supporting information must be provided on the drawing. The following example illustrates this requirement:

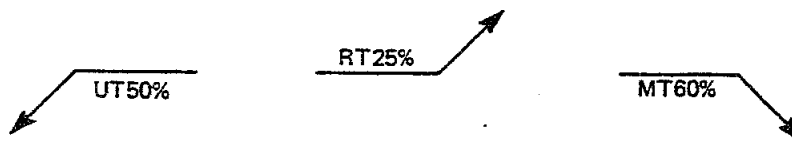
EXAMPLE:

SPECIFIED LOCATION FOR NDE

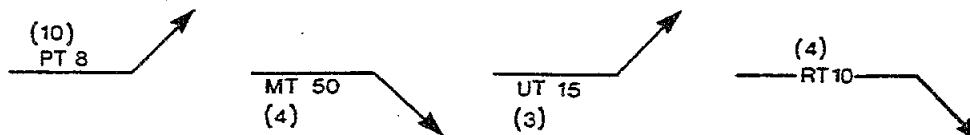


If the entire length of a joint is to be examined, this length need not be specified in the NDE symbol.

On occasion, only a given percentage of the total length of a joint will be subject to examination with the exact location(s) of the segment(s) to be determined just prior to such examination. The following examination symbol is used to indicate such required percentage length:

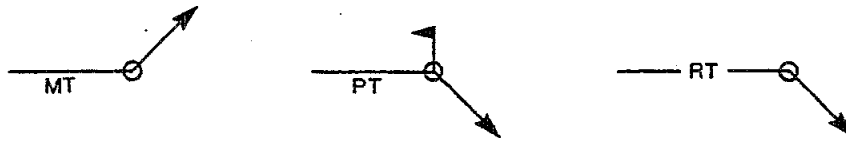


An examination symbol can also be used to specify a given number of examinations at random locations. This number is placed in brackets and positioned as shown in the symbols below. The required length to be examined may also be included in the symbol:



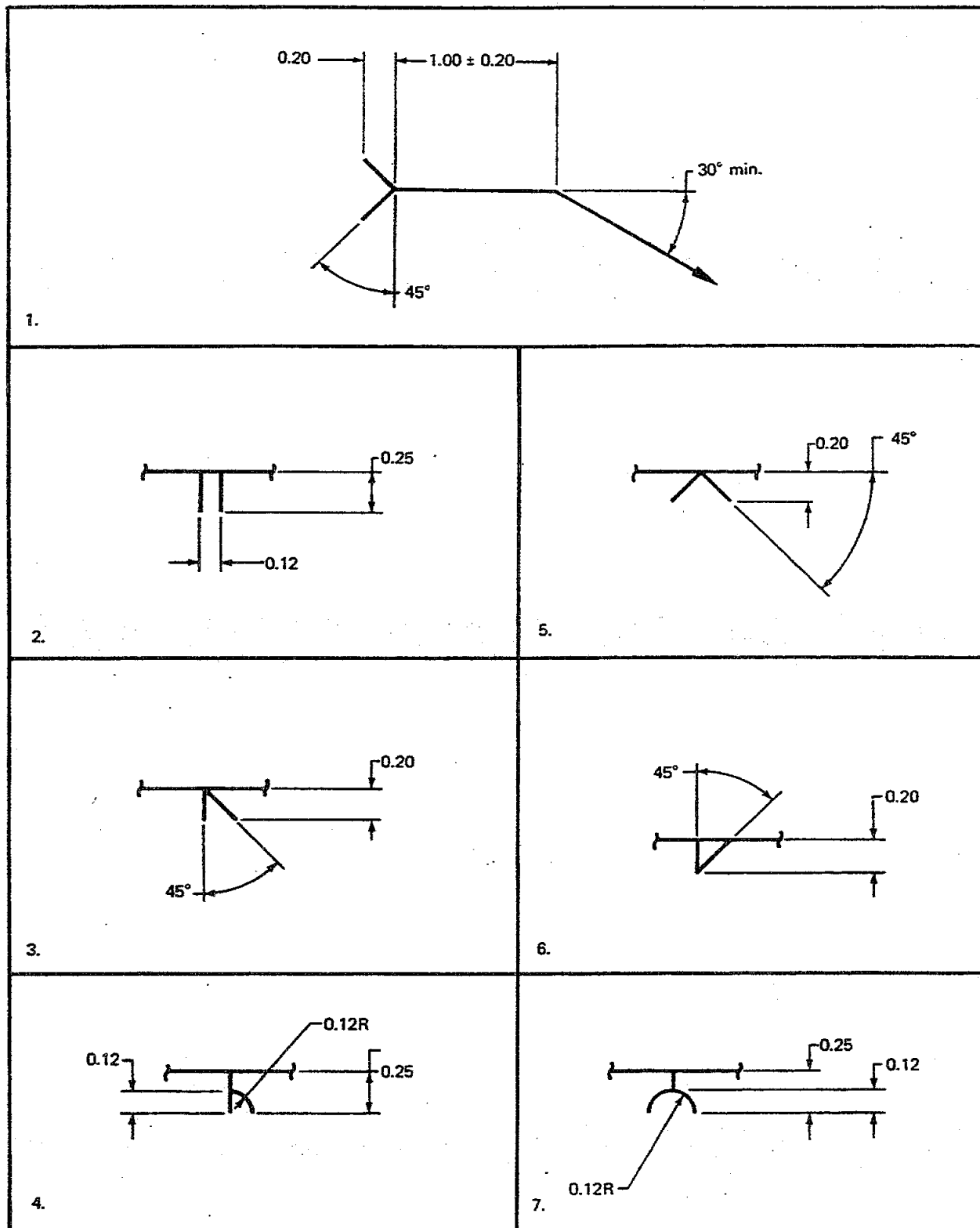
Fundamentals of Welding Technology

The all-around symbol is used to specify examination of the weld around the whole joint:



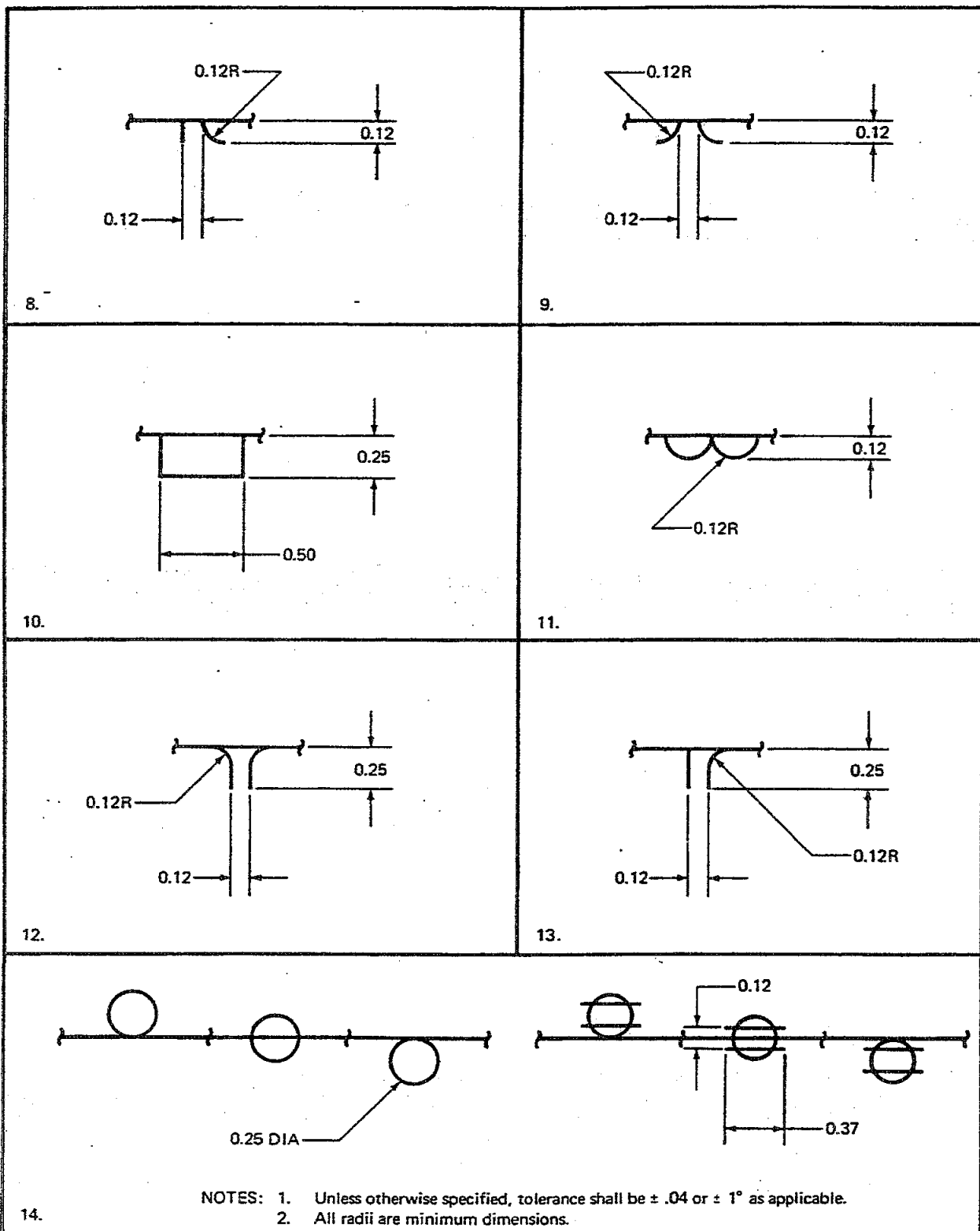
With the use of welding and nondestructive examination symbols, effective means are provided for more responsible control of the cost of inspection without detracting from the integrity of welded fabrication.

10. APPENDIX • DESIGN OF STANDARD SYMBOLS — (Dimensions in inches)



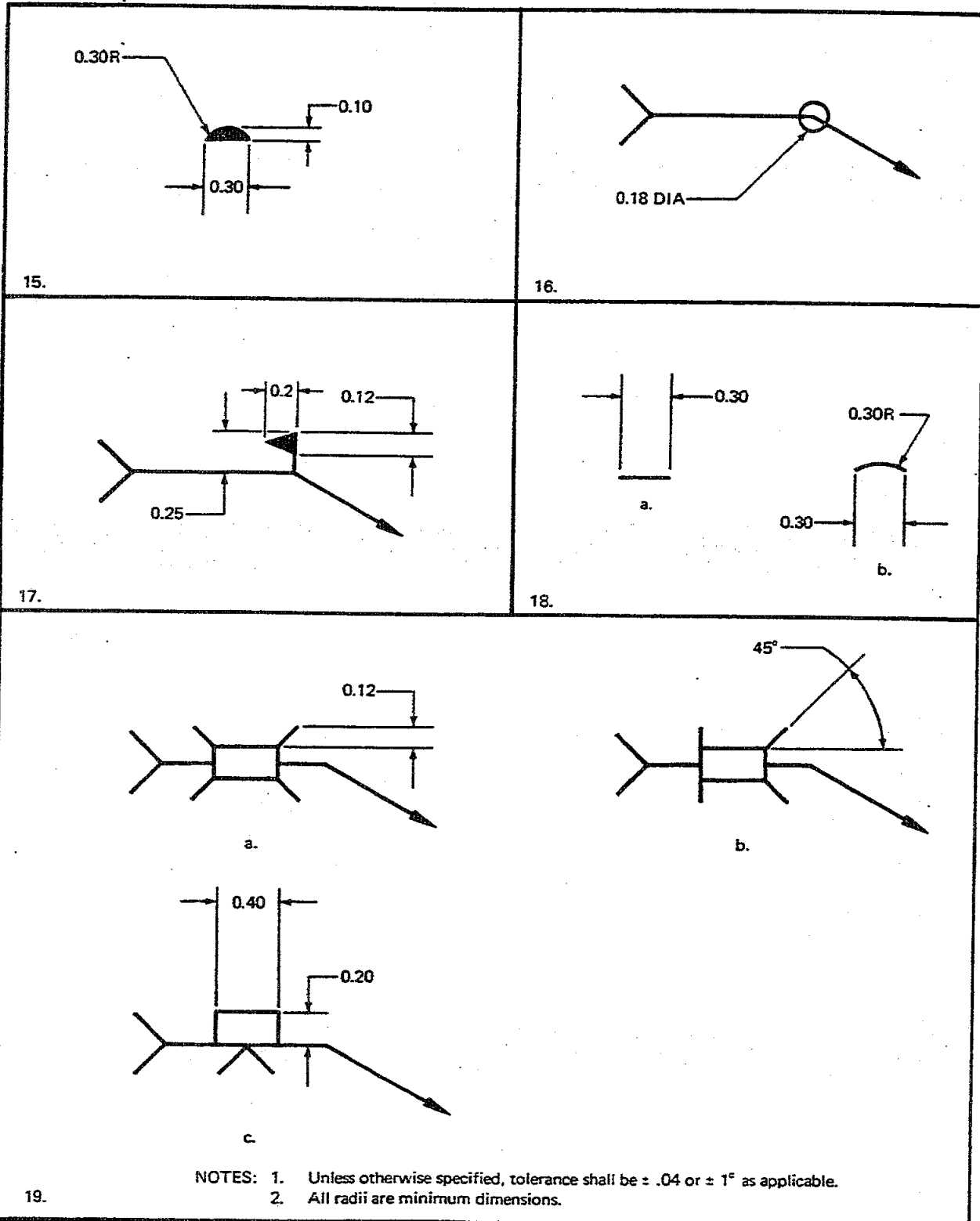
Notes: 1. Unless otherwise specified, tolerances shall be $\pm .04$ or $\pm 1^\circ$ as applicable.
2. All radii are minimum dimensions.

DESIGN OF STANDARD SYMBOLS — (Dimensions in inches)



Symbols for Welding

DESIGN OF STANDARD SYMBOLS — (Dimensions in inches)



Fundamentals of Welding Technology

Designation of Welding and Allied Processes by Letters

Listed alphabetically by Process

<i>Welding and Allied Processes</i>	<i>Letter Designation</i>	<i>Welding and Allied Processes</i>	<i>Letter Designation</i>
adhesive bonding	ABD	soldering	S
arc welding	AW	dip soldering	DS
atomic hydrogen welding	AHW	furnace soldering	FS
bare metal arc welding	BMAW	induction soldering	IS
carbon arc welding	CAW	infrared soldering	IRS
gas	CAW-G	iron soldering	INS
shielded	CAW-S	resistance soldering	RS
twin	CAW-T	torch soldering	TS
electrogas	EGW	wave soldering	WS
flux cored arc welding	FCAW	solid-state welding	SSW
gas metal arc welding	GMAW	coextrusion welding	CEW
pulsed arc	GMAW-P	cold welding	CW
short circuiting arc	GMAW-S	diffusion welding	DFW
gas tungsten arc welding	GTAW	explosion welding	EXW
pulsed arc	GTAW-P	forge welding	FOW
shielded metal arc welding	SMAW	friction welding	FRW
stud arc welding	SW	hot pressure welding	HPW
submerged arc welding	SAW	roll welding	ROW
series	SAW-S	ultrasonic welding	USW
brazing	B	thermal cutting	TC
arc brazing	AB	arc cutting	AC
block brazing	BB	air carbon arc cutting	AAC
carbon arc brazing	CAB	carbon arc cutting	CAC
diffusion brazing	DFB	gas metal arc cutting	GMAC
dip brazing	DB	gas tungsten arc cutting	GTAC
flow brazing	FLB	metal arc cutting	MAC
furnace brazing	FB	plasma arc cutting	PAC
induction brazing	IB	shielded metal arc cutting	SMAC
infrared brazing	IRB	electron beam cutting	EBC
resistance brazing	RB	laser beam cutting	LBC
torch brazing	TB	air	LBC-A
Other Welding Processes		evaporative	LBC-EV
electron beam welding	EBW	inert gas	LBC-IG
high vacuum	EBW-HV	oxygen	LBC-O
medium vacuum	EBW-MV	oxygen cutting	OC
non-vacuum	EBW-NV	chemical flux cutting	FOC
electroslag welding	ESW	metal powder cutting	POC
flow welding	FLOW	oxyfuel gas cutting	OFC
induction welding	IW	oxyacetylene cutting	OFC-A
laser beam welding	LBW	oxyhydrogen cutting	OFC-H
thermit welding	TW	oxynatural gas cutting	OFC-N
oxyfuel gas welding	OFW	oxypropane cutting	OFC-P
air acetylene welding	AAW	oxygen arc cutting	AOC
oxyacetylene welding	OAW	oxygen lance cutting	LOC
oxyhydrogen welding	OHW	thermal spraying	THSP
pressure gas welding	PGW	arc spraying	ASP
resistance welding	RW	flame spraying	FLSP
flash welding	FW	plasma spraying	PSP
percussion welding	PEW		
projection welding	PW		
resistance seam welding	RSEW		
high frequency	RSEW-HF	Suffixes for Optional Use in Applying	
induction	RSEW-I	Welding and Allied Processes:	
resistance spot welding	RSW	Automatic	AU
upset welding	UW	Machine	ME
high frequency	UW-HF	Manual	MA
induction	UW-I	Semi-Automatic	SA

Symbols for Welding

Designation of Welding and Allied Processes by Letters

listed as alphabetical cross reference by Designation

<i>Letter Designation</i>	<i>Welding and Allied Processes</i>	<i>Letter Designation</i>	<i>Welding and Allied Processes</i>
AAC	air carbon arc cutting	IRS	infrared soldering
AAW	air acetylene welding	IS	induction soldering
ABD	adhesive bonding	IW	induction welding
AB	arc brazing	LBC	laser beam cutting
AC	arc cutting	LBC-A	laser beam cutting — air
AHW	atomic hydrogen welding	LBC-EV	laser beam cutting — evaporative
AOC	oxygen arc cutting	LBC-IG	laser beam cutting — inert gas
ASP	arc spraying	LBC-O	laser beam cutting — oxygen
AW	arc welding	LBW	laser beam welding
B	brazing	LOC	oxygen lance cutting
BB	block brazing	MAC	metal arc cutting
BMAW	bare metal arc welding	OAW	oxyacetylene welding
CAB	carbon arc brazing	OC	oxygen cutting
CAC	carbon arc cutting	OFC	oxyfuel gas cutting
CAW	carbon arc welding	OFC-A	oxyacetylene cutting
CAW-G	gas carbon arc welding	OFC-H	oxyhydrogen cutting
CAW-S	shielded carbon arc welding	OFC-N	oxynatural gas cutting
CAW-T	twin carbon arc welding	OFC-P	oxypropane cutting
CEW	coextrusion welding	OFW	oxyfuel gas welding
CW	cold welding	OHW	oxyhydrogen welding
DB	dip brazing	PAC	plasma arc cutting
DFB	diffusion brazing	PAW	plasma arc welding
DFW	diffusion welding	PEW	percussion welding
DS	dip soldering	PGW	pressure gas welding
EBC	electron beam cutting	POC	metal powder cutting
EBW	electron beam welding	PSP	plasma spraying
EBW-HV	electron beam welding — high vacuum	PW	projection welding
EBW-MV	electron beam welding — medium vacuum	RB	resistance brazing
EBW-NV	electron beam welding — non-vacuum	RS	resistance soldering
EGW	electrode gas welding	RSEW	resistance seam welding
ESW	electroslag welding	RSEW-HF	resistance seam welding — high frequency
EXW	explosion welding	RSEW-I	resistance seam welding — induction
FB	furnace brazing	RSW	resistance spot welding
FCAW	flux cored arc welding	ROW	roll welding
FLB	flow brazing	RW	resistance welding
FLOW	flow welding	S	soldering
FLSP	flame spraying	SAW	submerged arc welding
FOC	chemical flux cutting	SAW-S	series submerged arc welding
FOW	forge welding	SMAC	shielded metal arc cutting
FRW	friction welding	SMAW	shielded metal arc welding
FS	furnace soldering	SSW	solid-state welding
FW	flash welding	SW	stud arc welding
GMAC	gas metal arc cutting	TB	torch brazing
GMAW	gas metal arc welding	TC	thermal cutting
GMAW-P	gas metal arc welding — pulsed arc	THSP	thermal spraying
GMAW-S	gas metal arc welding — short-circuiting arc	TS	torch soldering
GTAC	gas tungsten arc cutting	TW	thermit welding
GTAW	gas tungsten arc welding	USW	ultrasonic welding
GTAW-P	gas tungsten arc welding — pulsed arc	UW	upset welding
HPW	hot pressure welding	UW-HF	upset welding — high frequency
IB	induction brazing	UW-I	upset welding — induction
INS	iron soldering	WS	wave soldering
IRB	infrared brazing		

AMERICAN WELDING SOCIETY

Basic Welding Symbols and Their Location Significance									
Location Significance	Fillet	Plug or Slot	Spot or Projection	Stud	Seam	Back or Backing	Surfacing	Flange Corner	Flange Edge
Arrow Side									
Other Side				Not used			Not used		
Both Sides		Not used	Not used	Not used	Not used	Not used	Not used	Not used	Not used
No Arrow Side or Other Side Significance	Not used	Not used		Not used		Not used	Not used	Not used	Not used
Location Significance	Groove							Scarf for Brazed Joint	
	Square	V	Bevel	U	J	Flare-V	Flare-Bevel		
Arrow Side									
Other Side									
Both Sides									
No Arrow Side or Other Side Significance		Not used	Not used	Not used	Not used	Not used	Not used	Not used	
Supplementary Symbols					Location of Elements of a Welding Symbol				
Weld-All Around	Field Weld	Melt-Thru	Consumable Insert	Backing Spacer	Contour				
					Flush	Convex	Concave		
Basic Joints									
Identification of Arrow Side and Other Side of Joint									
Butt Joint		Corner Joint							
T-Joint		Lap Joint							
Edge Joint		Process Abbreviations							
	Where process abbreviations are to be included in the tail of the welding symbol, reference is made to Table 1, Designation of Welding and Allied Processes by Letters, of AWS A2.4-86. AMERICAN WELDING SOCIETY, INC. 550 N.W. LeJeune Rd., Miami, Florida 33126								

STANDARD WELDING SYMBOLS

Typical Welding Symbols		
Double-Fillet Welding Symbol Weld size Length Omission indicates that weld extends between abrupt changes in direction or as dimensioned	Chain Intermittant Fillet Welding Symbol Pitch (distance between centers) of increments Size (length of leg) Length of increments	Staggered Intermittant Fillet Welding Symbol Pitch (distance between centers) of increments Size (length of leg) Length of increments
Plug Welding Symbol Includes angle of countersink Size (diameter of hole at root) Pitch (distance between centers) of welds Depth of filling in inches (omission indicates filling is complete)	Back Welding Symbol Back weld 2nd operation 1st operation	Backing Welding Symbol Backing weld 1st operation 2nd operation
Spot Welding Symbol Size or strength Number of welds Pitch Process RSW	Stud Welding Symbol Size Pitch Number of studs	Seam Welding Symbol Size or strength Increment length Pitch Process RSEW
Square-Groove Welding Symbol Weld size Root opening	Single-V Groove Welding Symbol Depth of preparation Weld size Root opening Groove angle	Double-Bevel-Groove Welding Symbol Weld size Weld size Arrow points toward member to be prepared
Symbol with Backgouging Depth of preparation Back gouge	Flare-V Groove Welding Symbol Weld size	Flare-Bevel-Groove Welding Symbol Weld size
Multiple Reference Lines 1st operation on line nearest arrow 2nd operation 3rd operation	Complete Penetration Indicates complete penetration regardless of type of weld or joint preparation CJP	Edge Flange Welding Symbol Radius Weld size Height above point of tangency
Flash or Upset Welding Symbol Process reference FW	Melt-Thru Symbol Weld size	Joint with Backing R R indicates backing removed after welding
Joint with Spacer Joint with spacer	Flush Contour Symbol Flush contour	Convex Contour Symbol G
With modified groove weld symbol Double bevel groove		

*It should be understood that these charts are intended only as shop aids. The only complete and official presentation of the standard welding symbols is in A2.4.

GUIDES AND EXERCISES

MODULE 3

SYMBOLS FOR WELDING

SYMBOLS FOR WELDING

MODULE 3

Guides & Exercises

To obtain maximum benefit from this module we suggest that you follow this guide and complete the exercises as indicated. It is important that you work through the text methodically, studying each section thoroughly before moving on. The exercises are designed to give you an indication of whether you have learned the material and can move on or whether you need to go back and study the section again.

Do the exercises honestly. They will not help you unless you take them seriously. If you get a question wrong go back through the text until you understand where you have gone wrong and know the correct answer.

The length of time required to complete the module will vary from student to student. Find your own pace. Do not rush. Remember you are trying to teach yourself something, not win a race.

Some people like to underline sections when they read a text. We suggest that you use caution if you do this. What you think is important first time you read it may be different after reading it three times. We suggest you read a section three times thoroughly before highlighting anything.

The last exercise is designed to give you an indication of whether you are ready to take the WIC closed-book exams. The exercise questions are of a similar standard to the official exams. Do not take the exam until you feel you are ready and you may wish to study several Modules before taking the exams on each. The details of the examination procedures are on a separate sheet.

If you have any difficulties with this Module do not hesitate to ask for help. You may find you learn more by attending some of the seminars and you should also contact your local WIC Chapter to see if they can be of assistance. Remember, if you fail the examination you can always try again later.

MODULE 3

EXERCISES

Section 1 - Fundamentals

1. Joints and Welds

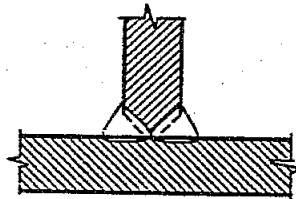
State whether the description as given is correct or not. If not, provide correct description.

(a)



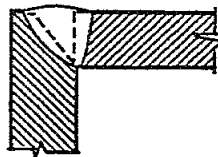
Butt Weld

(b)



Tee Butt Weld

(c)



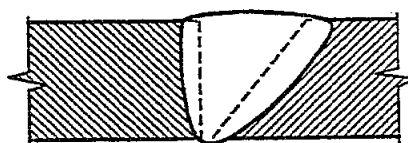
Corner Butt Weld

MODULE 3

2. Symbol Application

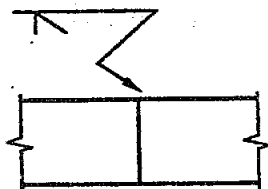
For the joint as shown in 2 and 3 a proper welding symbol is required. State whether the symbol applications are correct or not. If not, give reason.

Example 2.

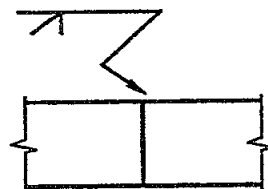


Single bevel groove weld in a butt joint

(a)



(b)



MODULE 3

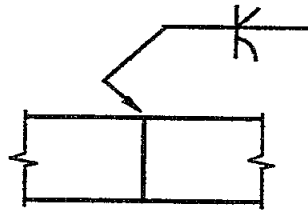
Example 3

Joint extremely unlikely in practice but selected for the sole purpose of our exercise.

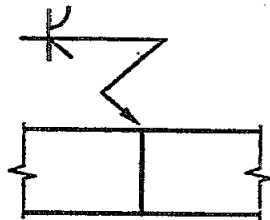


Butt joint with single bevel and single J-preparation as shown.

(a)

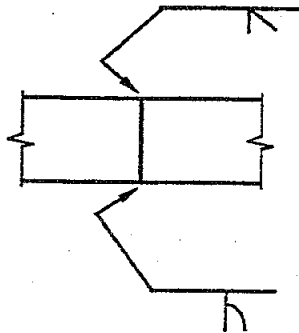


(b)



Note (1) - Depth of preparation is of no concern in this exercise. Section on groove welds will deal with this aspect.

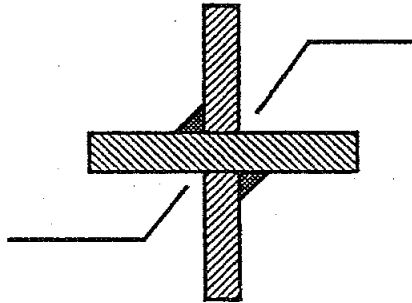
Note (2) - Obviously two separate symbols can be used to specify the required preparation. Such correct symbols without the depth of preparation, will be as shown, however, their use will be far less preferred than that of the double combined symbol.



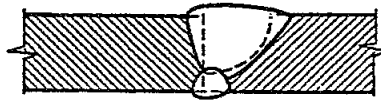
MODULE 3

4. Complete welding symbols for the following joints.

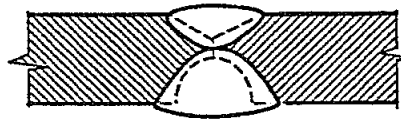
(a)



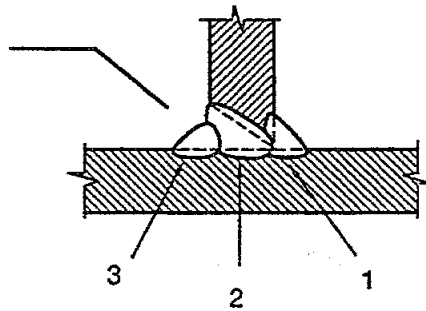
(b)



(c)



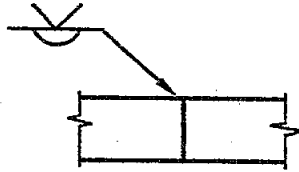
(d)



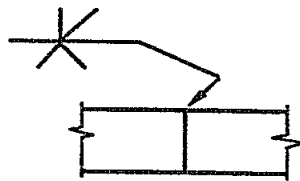
MODULE 3

5. Draw required joint preparation and welds.

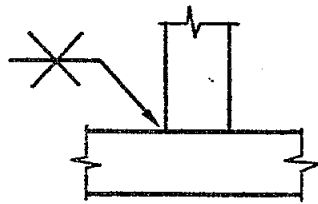
(a)



(b)



(c)



MODULE 3

ANSWERS

(Section 1)

1.

- (a) Incorrect.
A (square) groove weld in a butt joint.
- (b) Incorrect.
A (double bevel) groove weld in a T-joint.
- (c) Incorrect.
A (single bevel) groove weld in a corner joint.

2.

- (a) Correct.
Symbol specifies preparation on arrow side in agreement with sketch.
- (b) Incorrect.
Symbol is correct with respect to preparation from arrow side but weld symbol is incorrect. The vertical line of the bevel symbol must be on the left.

3.

- (a) Incorrect.
Symbol specifies reverse preparation to that shown in sketch although in the proper member.
- (b) Correct.
Correct preparation on proper member.

MODULE 3

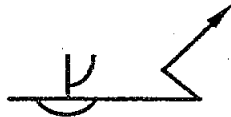
ANSWERS (Section 1) continued

4.

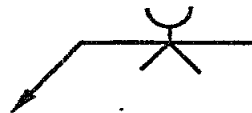
(a)



(b)



(c)

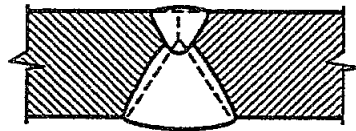


(d)

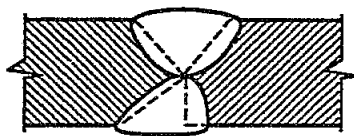


5.

(a)



(b)



(c)

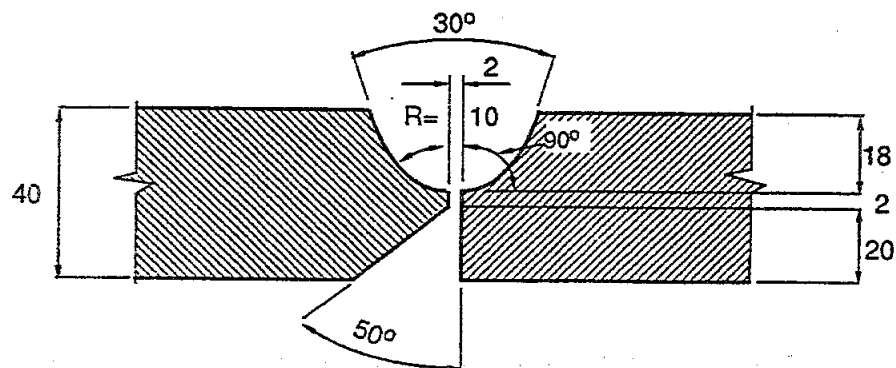
Symbol calls for an impossible weld. A V-groove weld requires preparation of thickness faces of both members. The face of the horizontal member is its surface, not its thickness.

MODULE 3

EXERCISES

Section 2 - Grooves

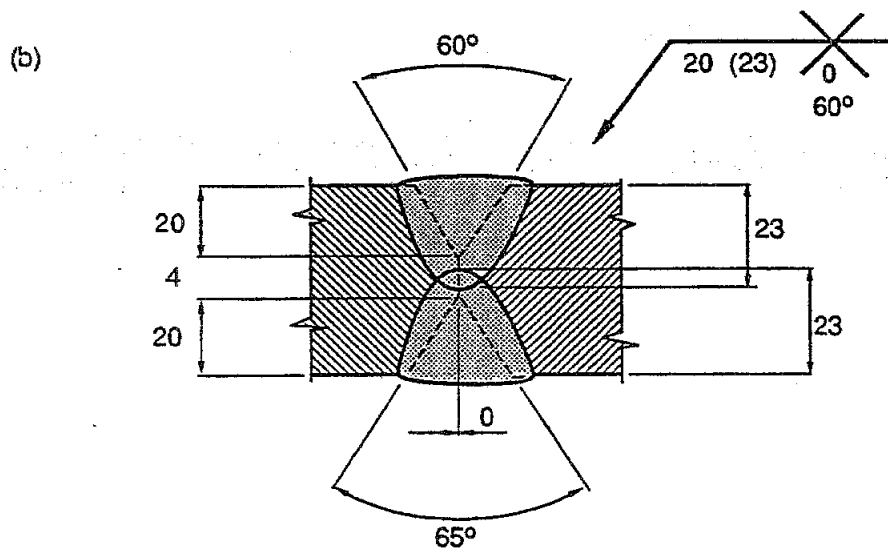
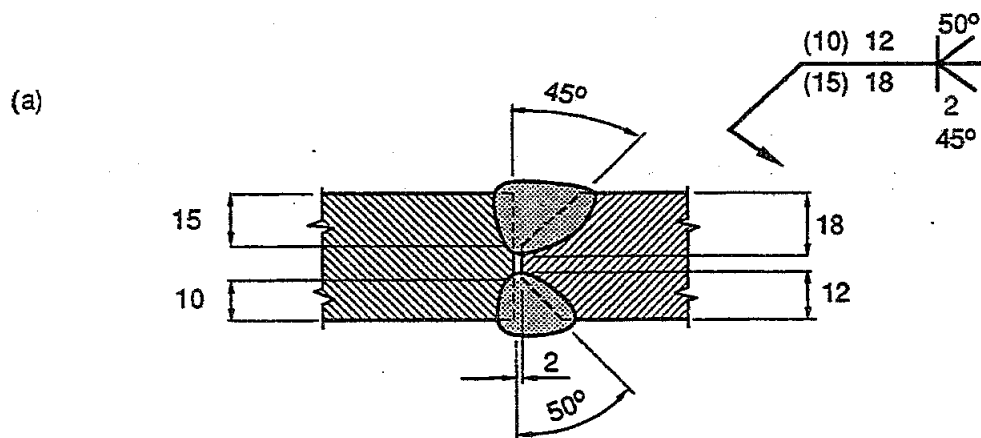
1. For the joint as shown, resolve whether the suggested statements are correct or not. If not, give a reason.



- (a) The bevel angles for the "U" and bevel grooves are 30° and 50° respectively.
- (b) The single bevel groove has no angle at the root, only the "U" groove has one.

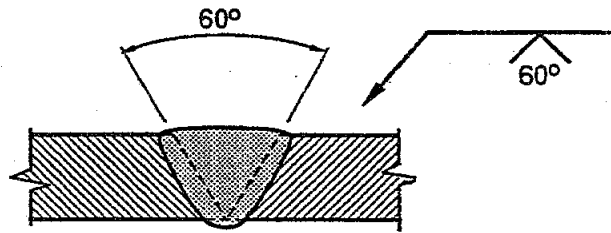
MODULE 3

2. State whether the applied welding symbol specifies the preparation and welding of the joint as shown. If not, give reason.

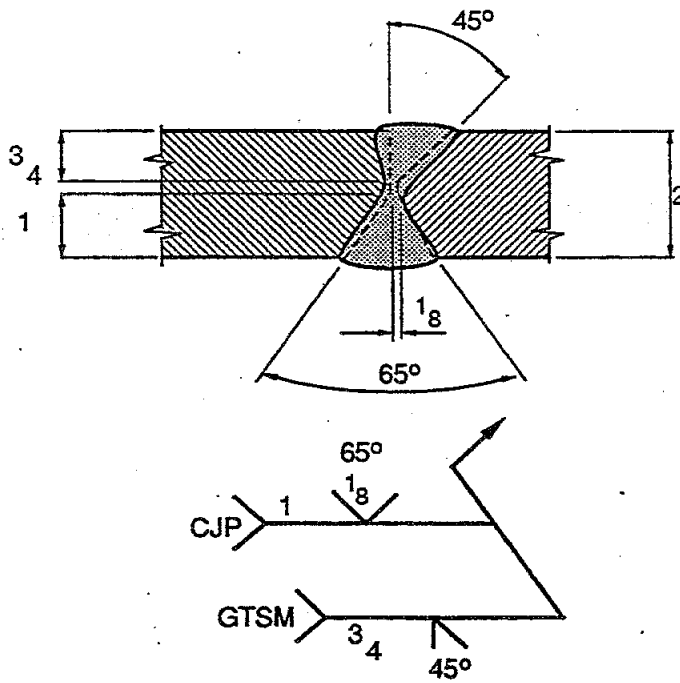


MODULE 3

(c)



(d)



MODULE 3

ANSWERS

(Section 2)

1.

(a) Incorrect.

- the bevel angle for the "U" groove is $30^\circ / 2 = 15^\circ$
- the bevel angle for the bevel groove is 50°

(b) Incorrect.

Both grooves have an angle at the root except for:

- (i) the single bevel groove, the bevel angle (50°) is at the same time the angle at the root, while:
- (ii) in the "U" groove, the angle at the root is shown to be 90° .

2.

(a) Incorrect.

Symbol is correct except that weld sizes (12) and (18) should appear in brackets and not depths of preparation as shown in the symbol.

(b) Incorrect.

The applicable groove information for the other side should appear above the reference line.



(c) Correct.

A single groove symbol without depth of preparation and weld size specified denotes preparation for full thickness and penetration equal to the thickness.

MODULE 3

ANSWERS (Section 2) continued

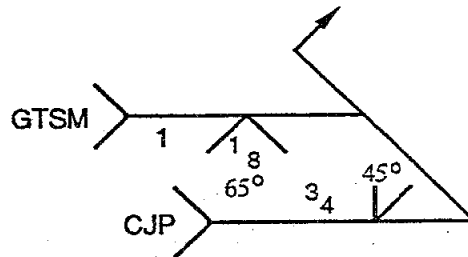
(d) Incorrect.

- The vee symbol and dimensions should be below the reference line as the groove is on the arrow side.

The tail on the same reference line should show "GTSM" as this operation must follow the completion of the "V" groove weld.

- The bevel symbol and dimensions should be above the reference line as the bevel groove is on the "other" side.

The tail on the same reference line should show "CJP" designation, so that after completion of all operations specified in the symbol, the finished groove weld will be a complete joint penetration groove weld. The correct symbol will be:



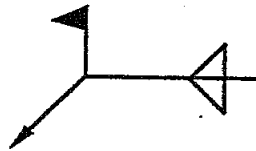
MODULE 3

EXERCISES

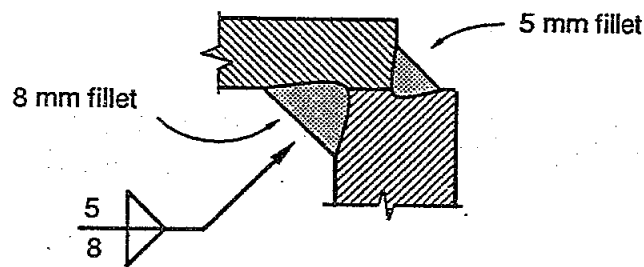
Section 3 - Fillet welds

1. State whether the welding symbols as shown or applied are correct or whether they specify the welds as required. If not, give reason.

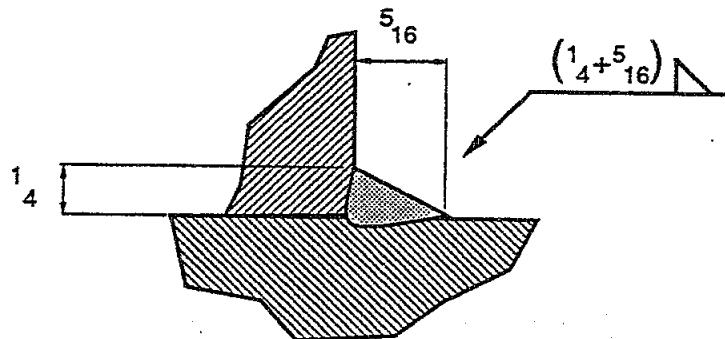
(a)



(b)



(c)

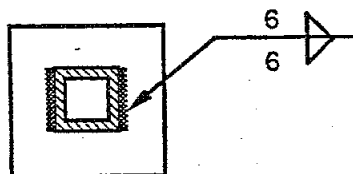


MODULE 3

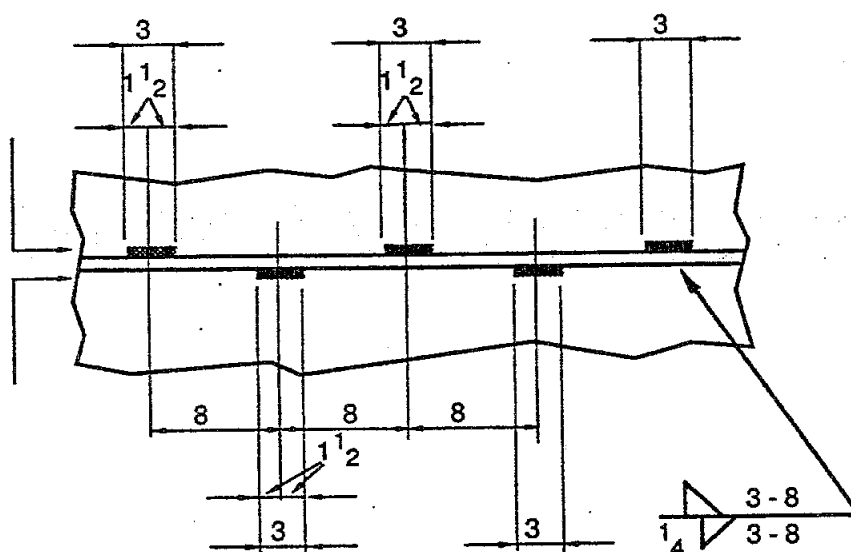
EXERCISES (Section 3) continued

1.

(d)



(e)



MODULE 3

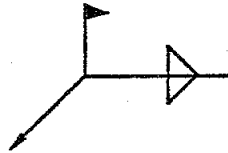
ANSWERS

(Section 3)

1.

(a) Incorrect.

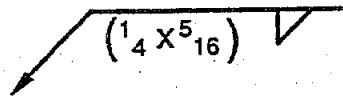
- Fillet weld symbol should have its vertical line on the left.
- Pointing direction of the flag is optional. Hence either is acceptable.



(b) Correct.

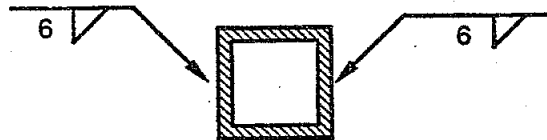
(c) Incorrect.

- Weld symbol and dimensions should be placed below the reference line.
- The two sizes in the brackets should have an "x" and not a "+" sign between.
- Any order of leg sizes is acceptable. Hence symbol should be:



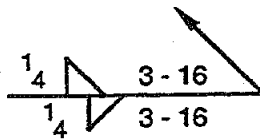
(d) Incorrect.

- The "other" side of the joint is inside the hollow section. Hence the proper symbols are:



(e) Incorrect.

- Pitch is the center to center spacing of increments on one line of welds, which in the example is 16".
- The 1/4 fillet size must be specified below and above the reference line. Hence correct symbol is:



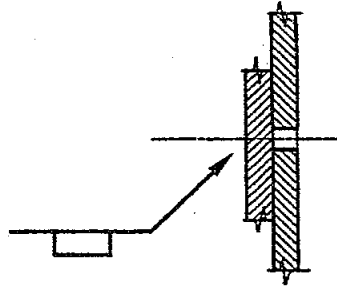
MODULE 3

EXERCISES

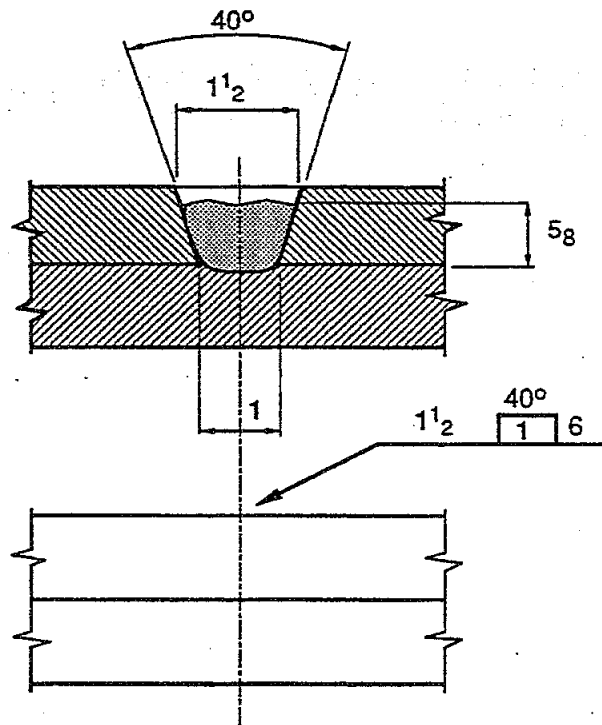
Section 4 - Plug and Slot Welds

1. Provide answers to questions asked, or state whether the welding symbol specified welding as shown. If not, give reason.

(a)



- (b) Plug welds as shown with spacing 6" c/c:



- (c) Can the orientation and the location of seam welds be specified in the welding symbol?

MODULE 3

ANSWERS

(Section 4)

1.

(a) Incorrect.

Plug weld is made in the "other" side member, hence weld symbol must be above reference line.



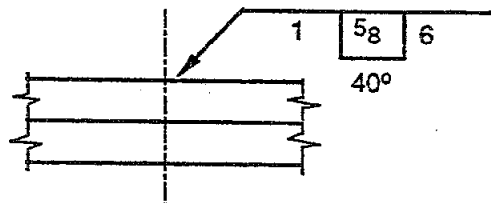
(b) Incorrect.

- Weld symbol and dimensions should appear below reference line as plug weld in the arrow side member.

- The diameter of the plug is 1" and should appear on the left side of the weld symbol.

- The depth of filling is 5/8 and should appear inside the plug weld symbol.

Hence correct symbol is:



(c) No.

Supporting detail drawings must be provided to show both the orientation and location of seam welds.

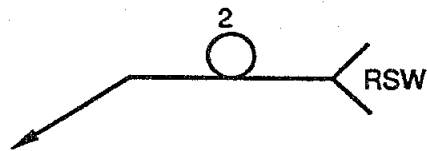
MODULE 3

EXERCISES

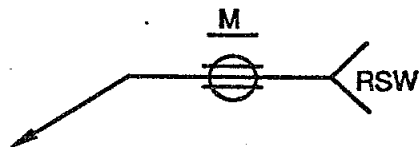
Section 5 - Spot Welds - Seam Welds

1. State whether the symbols or symbols and statements as shown are correct or not. If not, give reason.

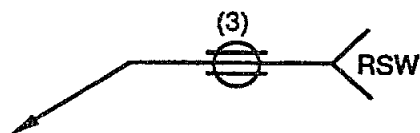
(a)



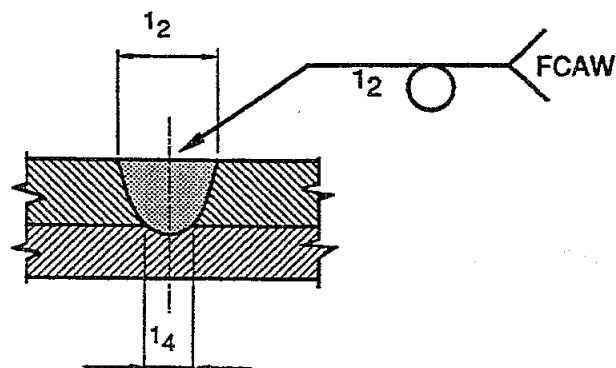
(b)



(c)



(d)



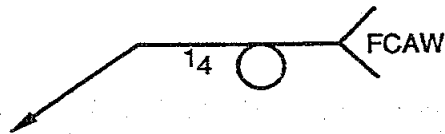
MODULE 3

ANSWERS

(Section 5)

1.

- (a) Incorrect.
RSW process has no side significance. Hence symbol must stride the reference line.
The number of spots should be put in brackets: (2)
- (b) Incorrect (impossible).
The weld is not exposed. Hence it cannot be machined.
- (c) Incorrect.
The number of welds is not applicable to seam welds.
- (d) Incorrect.
The size of the weld is $1/4$ " and not $1/2$ ". Hence the symbol should be:



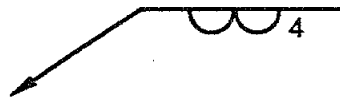
MODULE 3

EXERCISES

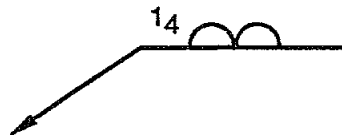
Section 6 - Surfacing Welds

1. State whether symbols as shown are correct or not. If not, give reason.

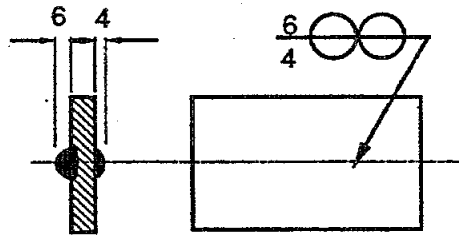
(a)



(b)



(c)



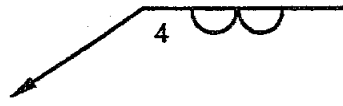
MODULE 3

ANSWERS

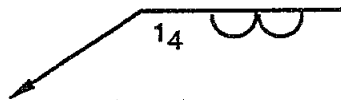
(Section 6)

1.

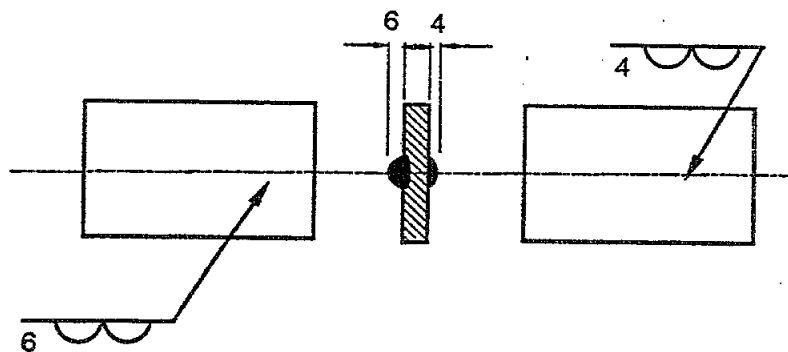
- (a) Incorrect.
Size (4 mm) should be to the left of surfacing symbol.



- (b) Incorrect.
Surfacing symbol must always be below the reference line.



- (c) Incorrect.
Arrow has no side significance. Separate symbols are required for each side.



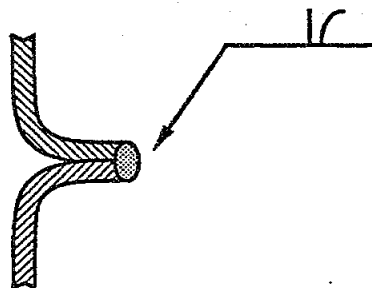
MODULE 3

EXERCISES

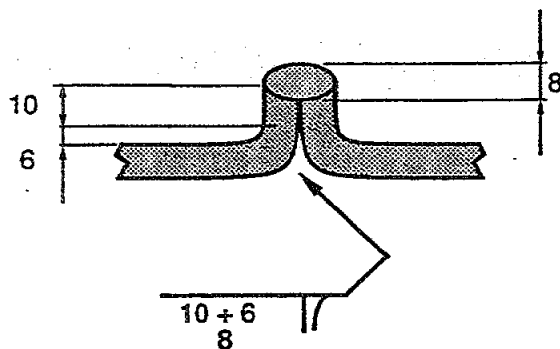
Section 7 - Flange Welds

1. State whether symbols as shown are correct or not. If not, give reason.

(a)



(b)



MODULE 3

ANSWERS

(Section 7)

1.

(a) Incorrect.

- Weld symbol is for single bevel flare groove weld and not for edge-flange weld.
 - Weld symbol is on the wrong side of reference line - as welding is shown to be on the arrow side;
- Hence symbol should be:



(b) Incorrect.

- Break in the arrow is not required;
- Dimensions and weld symbol should appear above the reference line.
- Weld symbol is for corner-flange and not for edge-flange weld as required;
- The order of dimensions is not correct. The welding symbol should be:



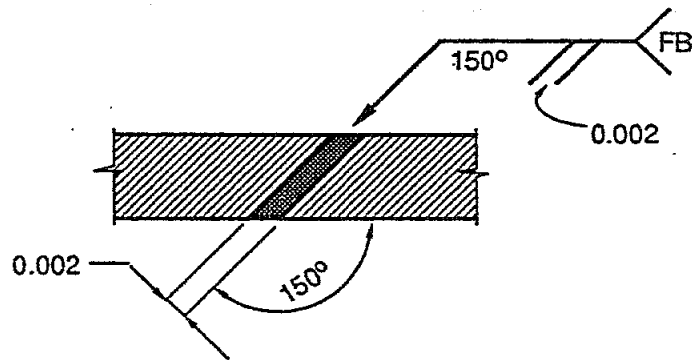
MODULE 3

EXERCISES

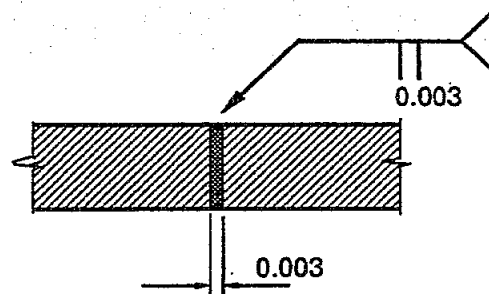
Section 8 - Braze Joints

1. State whether the symbols as shown are correct or not. If not give reason.

(a)



(b)



MODULE 3

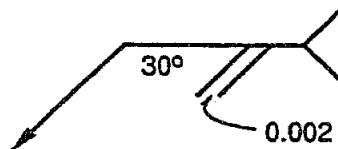
ANSWERS

(Section 8)

1.

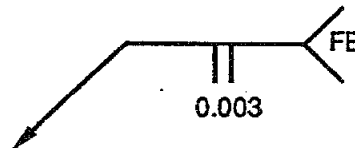
(a) Incorrect.

The scarf angle in the symbol is not correct. It should be $180 - 150 = 30^\circ$. Hence, the symbol should be:



(b) Incorrect (incomplete).

The brazing process is missing in the symbol. If furnace brazing is to be used the symbol will be:



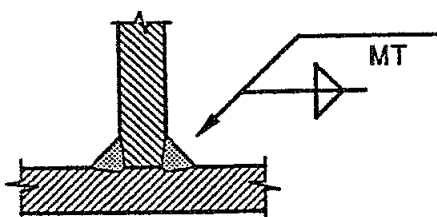
MODULE 3

EXERCISES

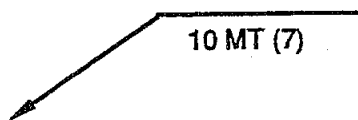
Section 9 - NDT

1. State whether the symbols as shown are correct or correctly reflect the given requirements or not. If not, give reason.

- (a) Required: complete examination of the welded T-joint.



- (b)



MODULE 3

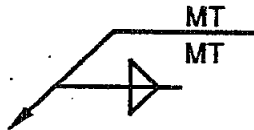
ANSWERS

(Section 9)

1.

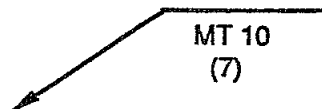
(a) Incorrect (incomplete).

The test symbol should specify NDT on both the arrow and other sides:



(b) Incorrect.

- The length of the segment must appear on the right side of the basic test symbol.
- The number of locations (7) must be placed as shown below in the correct symbol:



MODULE 3
SYMBOLS FOR WELDING
TEST

This test is designed to determine whether you are ready to attempt the formal examination.

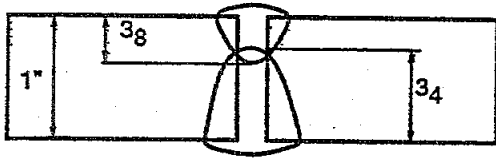
Complete the ANSWER SHEET and compare the results with the TEST KEY. If you have a pass mark less than 70% you are advised to re-study the material.

MODULE 3

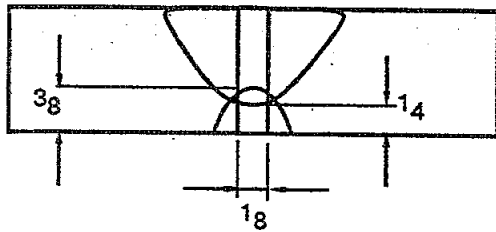
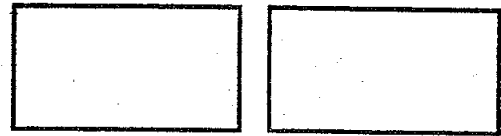
Question 1

Indicate the welds and geometry of joint which agrees with the welding symbol shown below.

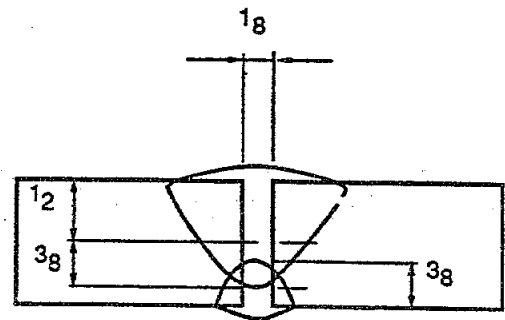
(3/8) 1/8
(3/4) 1/8



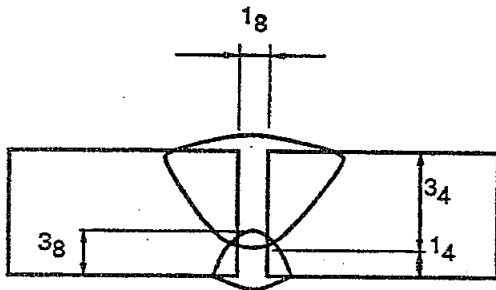
(a)



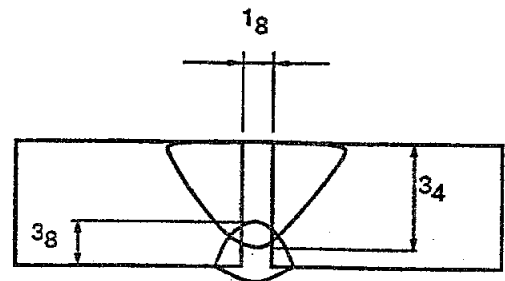
(b)



(c)



(d)

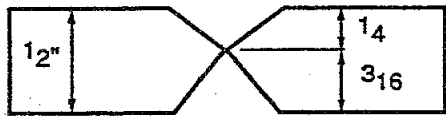


(e)

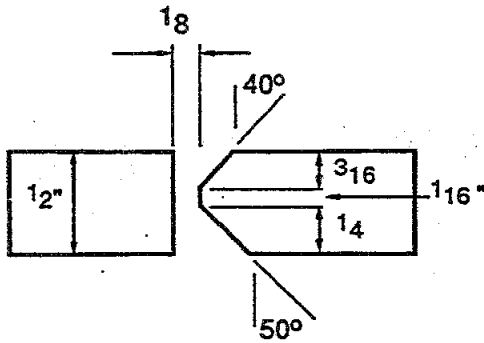
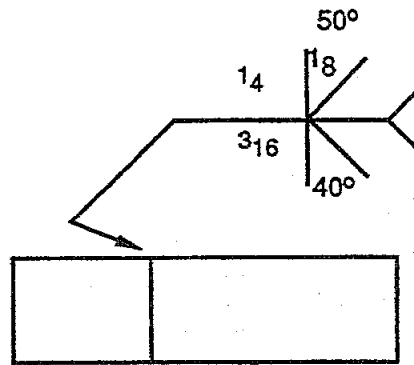
MODULE 3

Question 2

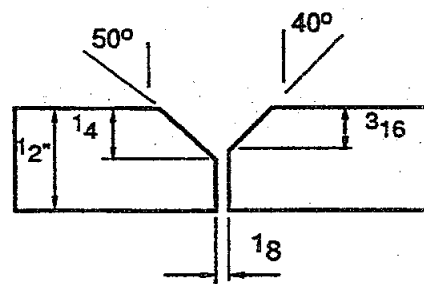
Show the correct joint geometry for the welding symbol shown.



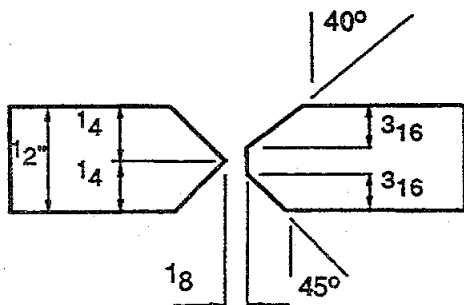
(a)



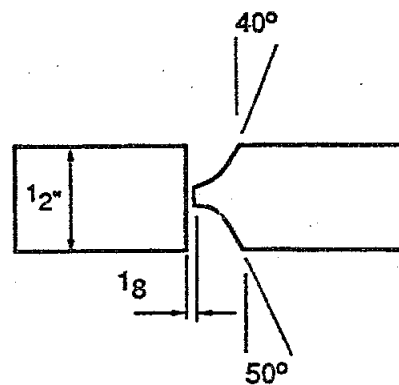
(b)



(c)



(d)

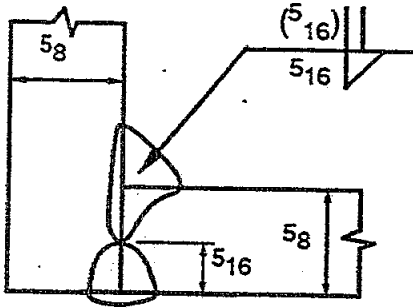


(e)

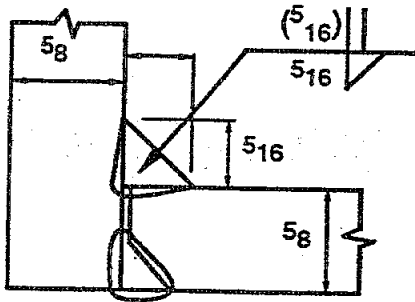
MODULE 3

Question 3

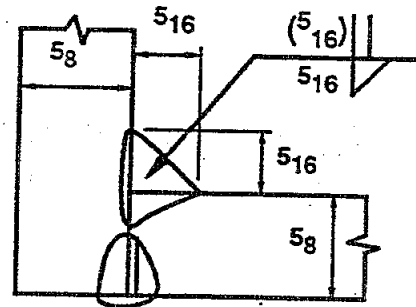
Select the correct preparation and weld indicated by the welding symbol. Select the correct answer (a) to (e) inclusive.



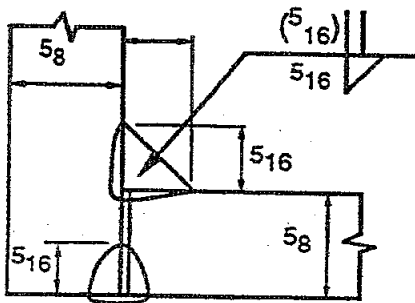
a)



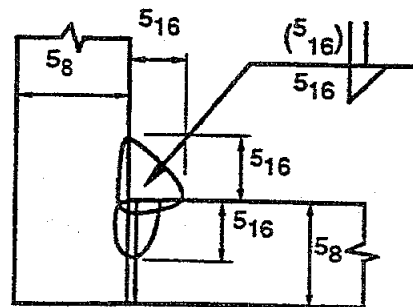
b)



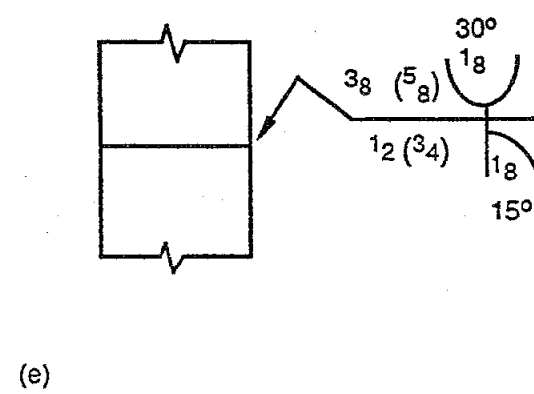
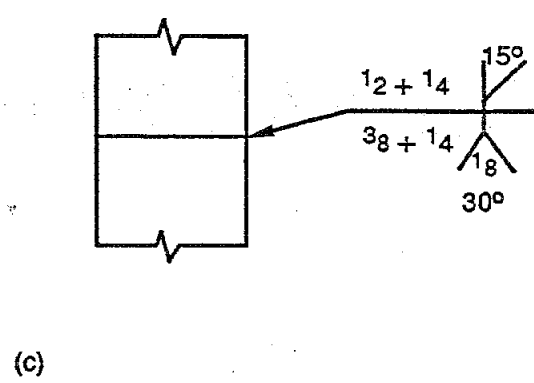
(c)



d)



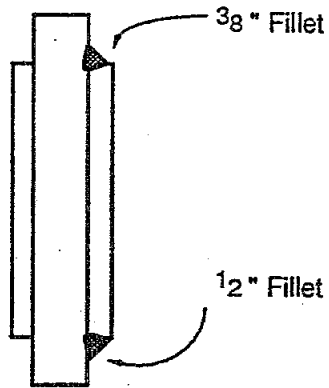
(e)



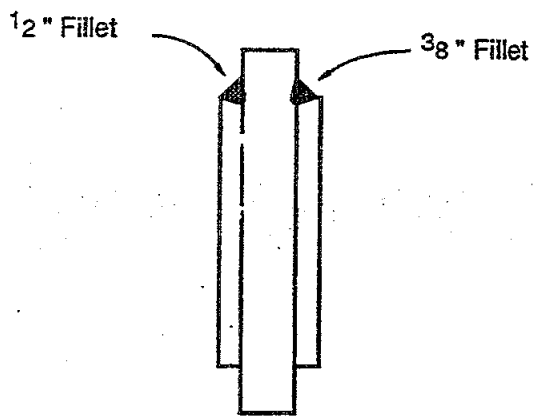
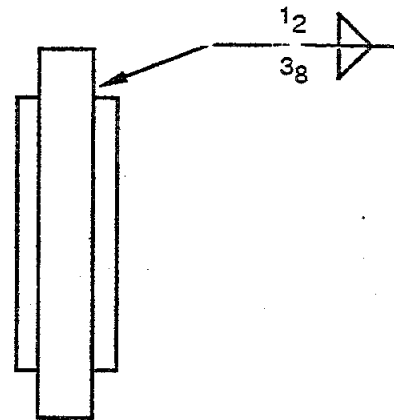
MODULE 3

Question 5

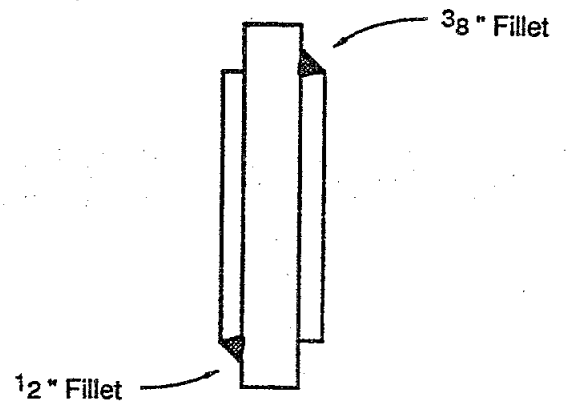
Select the welds which agree with the welding symbol shown below.



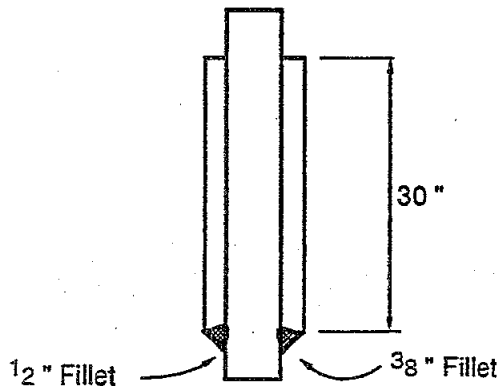
(a)



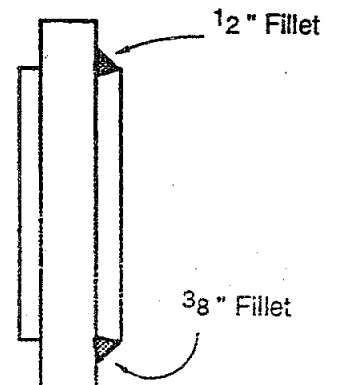
(b)



(c)



(d)



(e)

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Answer Sheet - Module 3

Complete the "Answer Sheet" and compare the results with the "Test Key". If you have a pass mark less than 70%, you are advised to re-study the material.

Please circle only ONE letter corresponding to the answer you think is most correct.

QUESTION	ANSWERS				
1	a	b	c	d	e
2	a	b	c	d	e
3	a	b	c	d	e
4	a	b	c	d	e
5	a	b	c	d	e

The answer key below is provided for your use in the event that you wish to retest yourself.

QUESTION	ANSWERS				
1	a	b	c	d	e
2	a	b	c	d	e
3	a	b	c	d	e
4	a	b	c	d	e
5	a	b	c	d	e

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Test Key - Module 3

Compare your answer sheet to this key.

QUESTION	ANSWERS				
1	a	b	c	d	(e)
2	a	(b)	c	d	e
3	a	b	c	(d)	e
4	a	b	c	d	(e)
5	(a)	b	c	d	e

