COMPUTER CALCULATION OF WELDOLET

ACCORDING TO BONNEY FORGE AND RTOD D0501

Date: Za 27-Jan-2001
Time: 16:17:57

Project: DEVELOPMENT OF FUTURE PROSPECTS
Jobnr: PV2001

ABSTRACT:

This is an example calculation showing an automatic released drawing of the branch connection with a weldolet of Bonney Forge (r).
The amount of data and results and their arrangement are such that the assessment can be performed in a manner identical to a fully manual calculation.
The advantage of a drawing released by the programme itself is that it clearly shows what configuration is calculated and thus avoiding discrepancies.

This programme (from 1983) showed the cross sectional area of the material present around the opening in the wall and nozzle as well as the additional reinforcing material. It also calculates exactly the d’2;g.

The method adopted here is the method originally used by Bonney Forge to get type approval back in 1970 based on the ’Grondslagen’.
This method was dropped later by the Rules for Pressure Vessels because it was to complicated.

For this reason it should be accepted by the authorized body without any problem. However no company that I worked for allowed me using it, they rather used the basic calculations they were familiar with.

REFERENCES:

Rules for Pressure vessels RToD G0501 par.1
Rules for Pressure vessels RToD D0201
Rules for Pressure vessels RToD D0501
Rules for Pressure vessels RToD W0301 appendix 1
Grondslagen RI-1 of the Dutch Technical Scientific Service (TWD)
Hand calculations of Mr. R.W. Schneider of Bonney Forge USA
Bonney Forge is a registered trademark.

1	PVo	Za 27-Jan-2001	Modified drawing layout			
0	PVo	Za 11-Nov-2000	First Issue			
REV	BY	DATE	DESCRIPTION	CHECKED	PROJECT APPROVAL	THIRD PARTY APPROVAL

STATUS CODE	DOCUMENT NUMBER	REVISION	STATUS
A Preliminary for information only B For review C Authorized for construction	WEB SITE EXAMPLE	1	B

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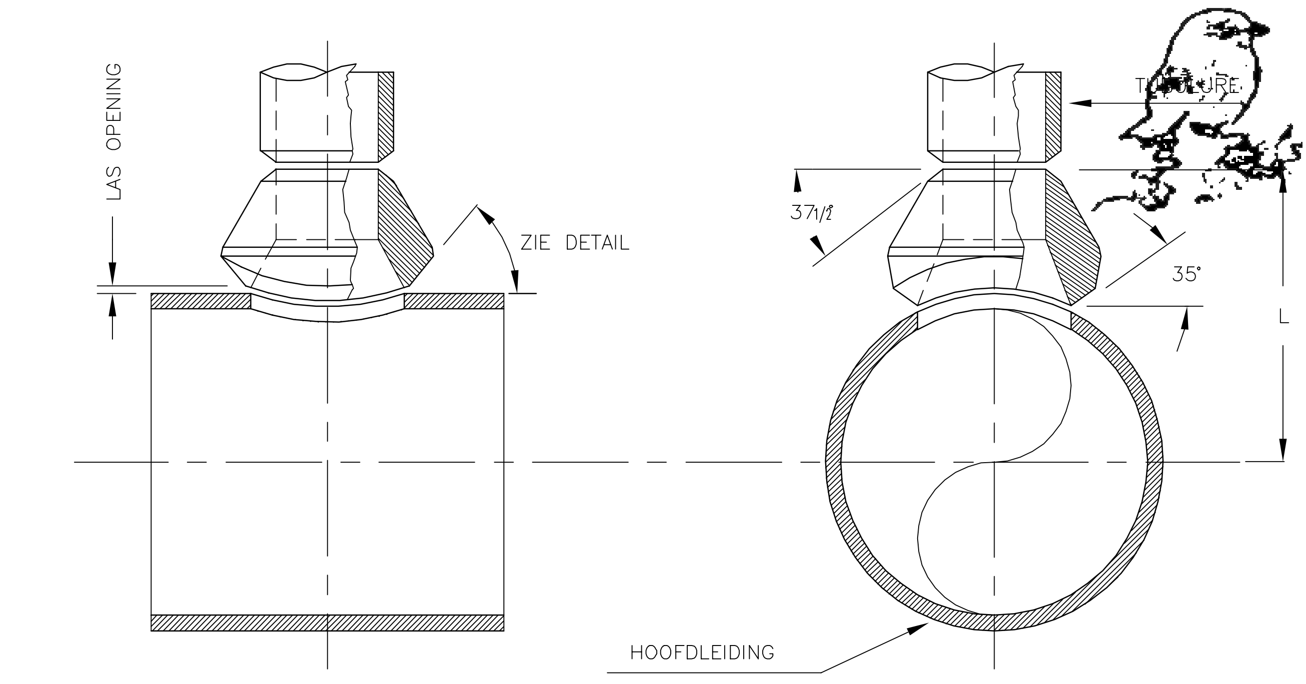
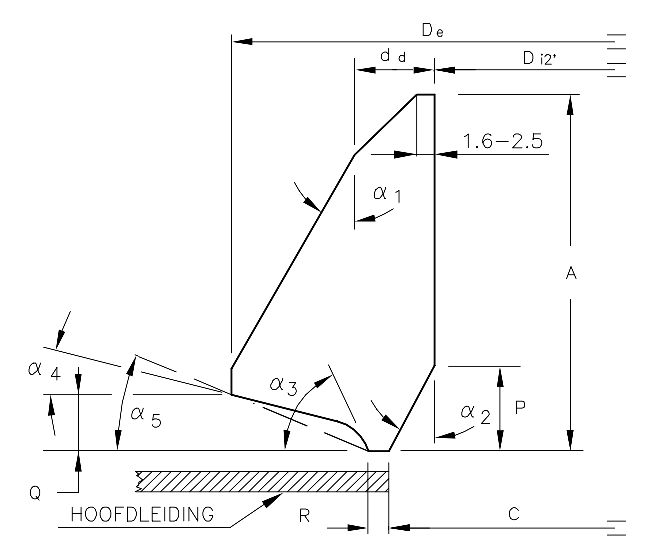


INVOER GEGEVENS

		HOOFDLEIDING		TUBULURE		WELDOLET	
BEREKENINGSDRUK	P_d	1.600	MPa	1.600	MPa		
UITWENDIGE MIDDELLIJN	D_e	406.400	mm	88.900	mm	122.200	mm
NOMINALE WANDDIKTE	d_d	7.900	mm	5.500	mm	5.500	mm
CORROSIE TOESLAG	d_c	1.500	mm	1.500	mm	1.500	mm
TOLERANTIE	d_t	0.988	mm	0.688	mm	0.500	mm
FORMULE WANDDIKTE	d	5.412	mm	3.313	mm	3.500	mm
MATERIAAL		API 5L X52		St 37.2		ASTM A 105N	
METAALTEMPERATUUR	ϑ_m	120.000	°C	120.000	°C	120.000	°C
WARMREKGRENS	$R_e(\vartheta_m)$	296.000	N/mm^2	203.000	N/mm^2	203.000	N/mm^2
ONTWERPSPANNING	f	198.320	N/mm^2	136.010	N/mm^2	136.010	N/mm^2
VERZWAKKINGSFACTOR	z	1.000		1.000		1.000	



VOLGENS W0301 BIJLAGE 1

L	250.200	mm
$D_{i2'}$	81.900	mm
A	44.500	mm
C	93.600	mm
P	13.597	mm
Q	16.400	mm
R	1.600	mm
LASOPENING	2.500	mm
α_1	36.371	°
α_2	30.000	°
α_3	0.000	°
α_4	0.000	°
α_5	50.000	°

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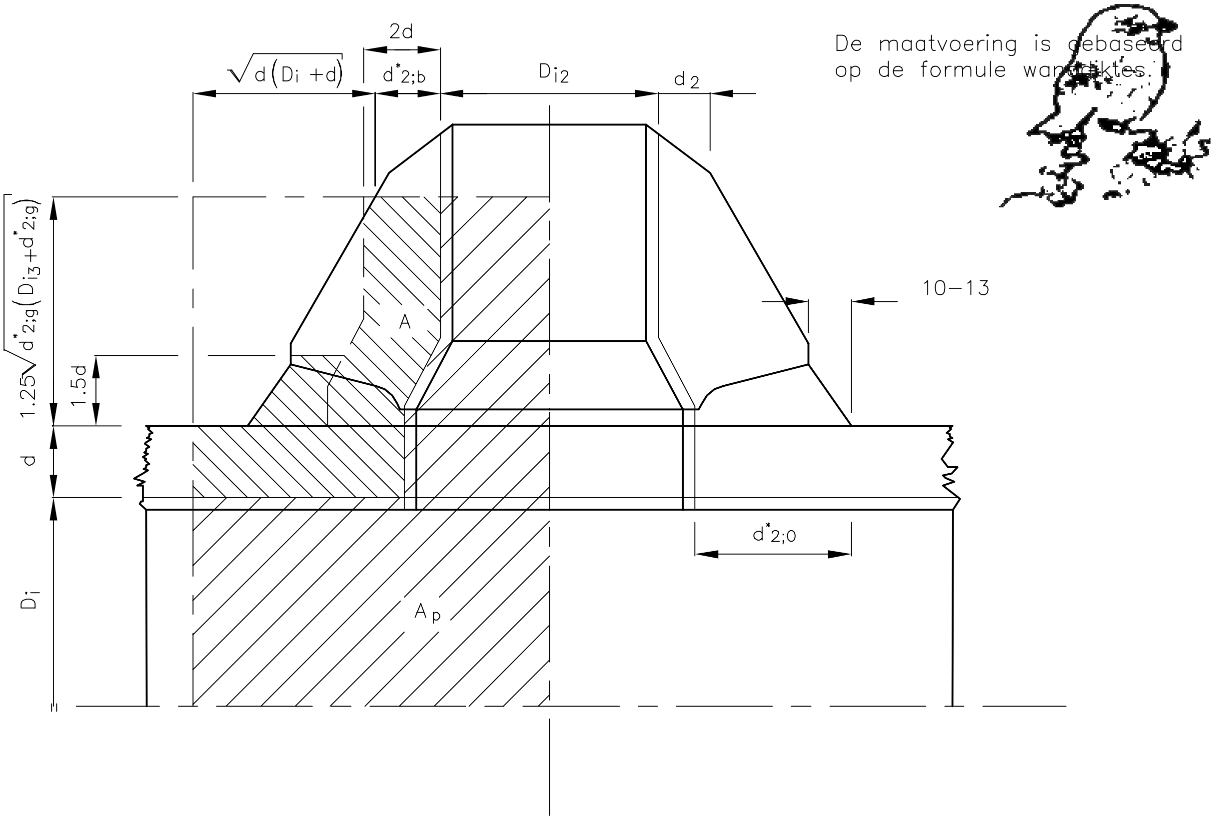
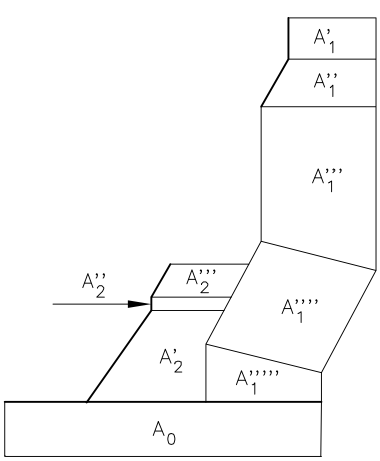


BEREKENING

MAATVOERING

$d = d_d - d_c - d_t$	5.412	mm	$D_{i3} = D_{i2}$	81.900	mm	$\sqrt{d(D_i + d)}$	46.587	mm
1.5d	8.119	mm	$d^*_{2;0} \geqq 2d$	22.300	mm	$1.25\sqrt{d^*_{2;g}(D_{i3} + d^*_{2;g})}$	43.835	mm
$d_2 = d_{d_2} - d_{c_2} - d_{t_2}$	3.500	mm	$d^*_{2;b} \leqq 2d$	3.627	mm			
$D_i = D_e - 2d$	395.575	mm	$d^*_{2;g} = 0.5(d^*_{2;b} + d^*_{2;0})$	12.964	mm			

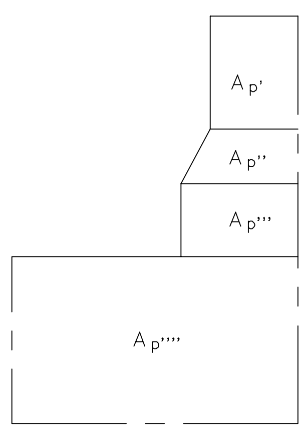
BEPALING OPPERVLAK A



A_0 = 230.310

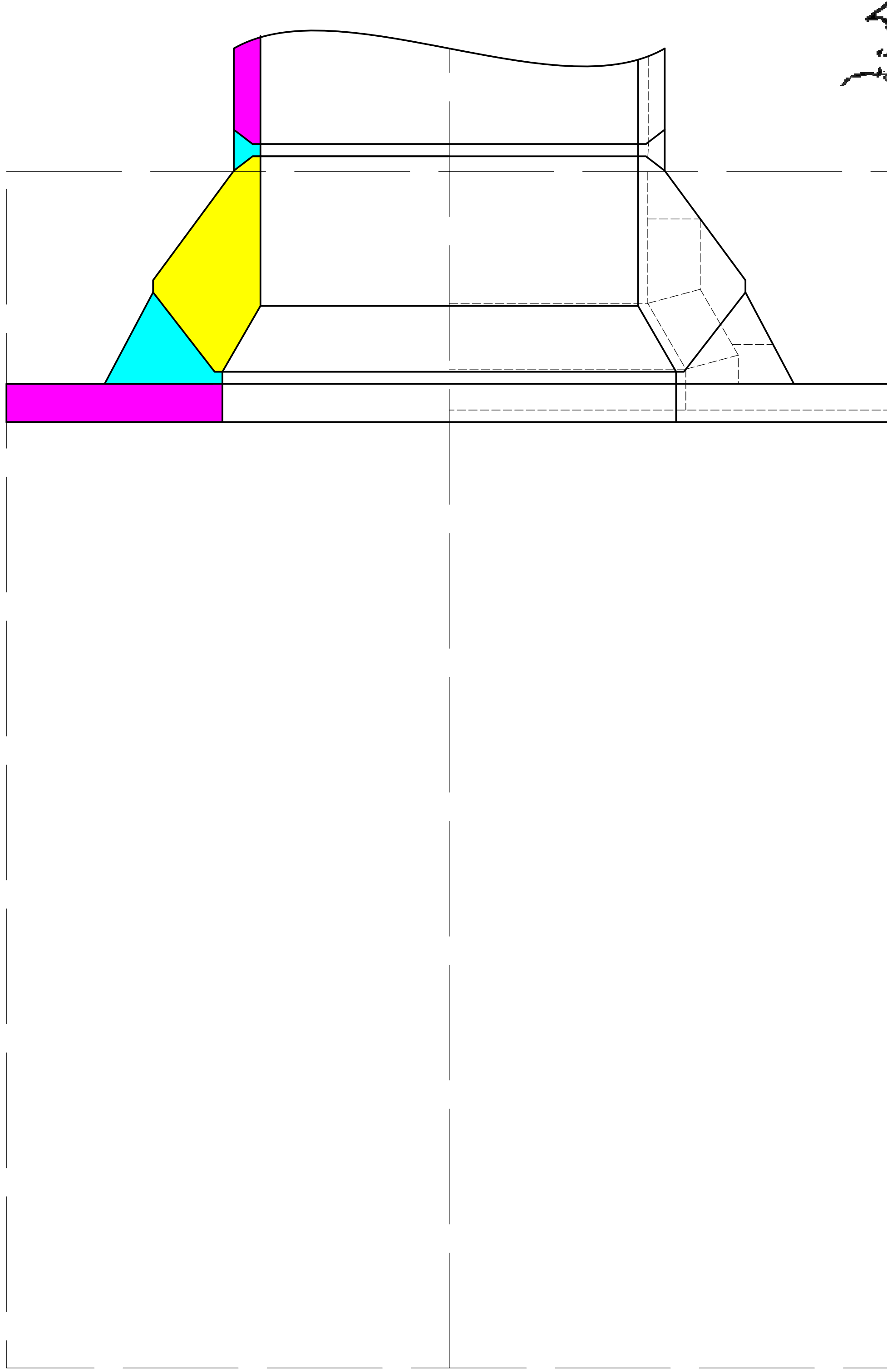
A'_1 = 0.000
A''_1 = 70.623
A'''_1 = 172.970
A''''_1 = 169.952
A'''''_1 = 48.563 +
A_1 = 462.108

A'_2 = 77.100
A''_2 = 0.000
A'''_2 = 0.000 +
A_2 = 77.100



$A_{p'}$ = 1113.942
$A_{p''}$ = 610.147
$A_{p'''}$ = 412.282
$A_{p''''}$ = 18068.178 +
A_p = 20204.549

Example for Website



From Stoomwezen sheet D0501 par. 6 we derive the following formula for the load-carrying cross-sectional area of the branch connection:

$$A := A_o + \frac{f_1}{f} \cdot A_1 + k \cdot \frac{f_2}{f} \cdot A_2$$

We calculated the following auxiliary values:

A_0 is the cross-sectional area of the material present around the opening in the wall and nozzle to be introduced, in so far as the design stress thereof is at least equal to that of the wall

$A_o = 230.310 \cdot mm^2$

A_1 is the cross-sectional area of the material present around the opening in the nozzle to be introduced, in so far as the design stress f_1 thereof is less than the design stress f of the wall

$A_1 = 462.108 \cdot mm^2$

A_2 is the cross-sectional area of the additional reinforcing material with a reinforcement efficiency k and a design stress f_2 to be introduced,in so far as that material is effectively connected to the wall.

Factor $\mathbf{f_2} / \mathbf{f}$ shall not be introduced higher than 1

$A_2 = 77.100 \cdot mm^2$

A_p is the area on which the pressure acts; in the figures this is indicated by coarse hatching.

$A_p = 20204.549 \cdot mm^2$

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the design stresses f_1 and f_2 are established in the same way as f. For this,therefore, the Stoomwezen sheet applicable to the wall is also used.

$f = 198.320 \cdot MPa$ $f_1 = 136.010 \cdot MPa$

$k = 0.75$ $f_2 = 136.010 \cdot MPa$

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the load-carrying cross-sectional area of the branch connection A is derived according :

$$A := A_o + \frac{f_1}{f} \cdot A_1 + k \cdot \frac{f_2}{f} \cdot A_2 \qquad A = 732.761 \cdot mm^2$$

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the auxiliary value z_3 is calculated according Stoomwezen sheet D0501 paragraph 6:

$D_i = 395.575 \cdot mm$ $d = 5.412 \cdot mm$ $P_d = 1.600 \cdot MPa$

$$z_3 := \frac{D_i + d}{d} \cdot \frac{A}{2 \cdot A_p + A} \qquad z_3 = 1.320$$

this z_3 is also known as the strenght reduction coëfficient and should be greater than a required minimum. This minimum is calculated according the following:

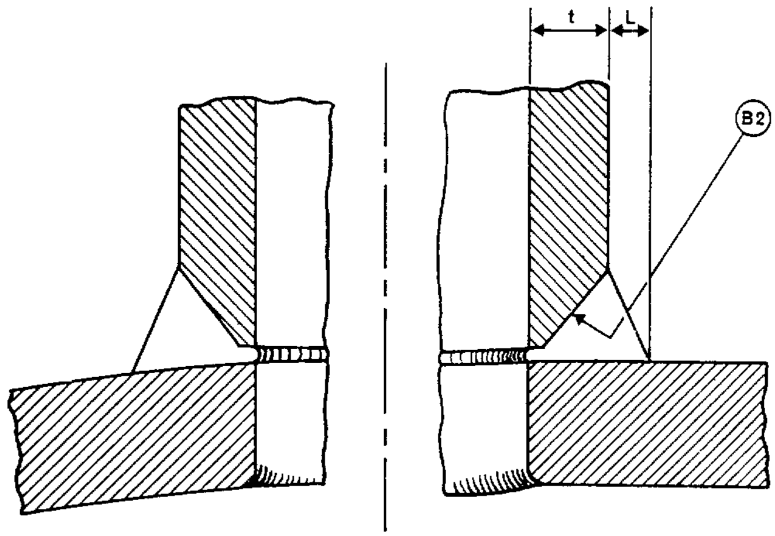
$$z_{min} := \frac{P_d \cdot (D_i + d)}{2 \cdot d \cdot z.f} \qquad z_{min} = 0.299$$

The $z_3 \geq z_{min}$ criterium is fulfilled

PART 1
SECTION 1
SHEET 1

SET-ON BRANCHES

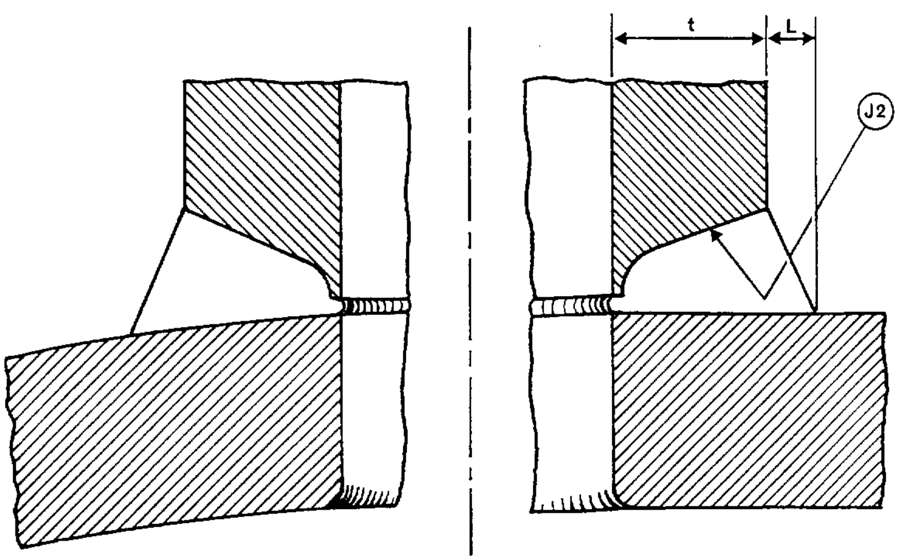
See p. 2–4(b)



L = **t**/3 min. but not less than ¼ in./6 mm

Preference should be given to the detail shown in Fig. 1.1b *if* **t** *exceeds about* ⅝ in./16 mm

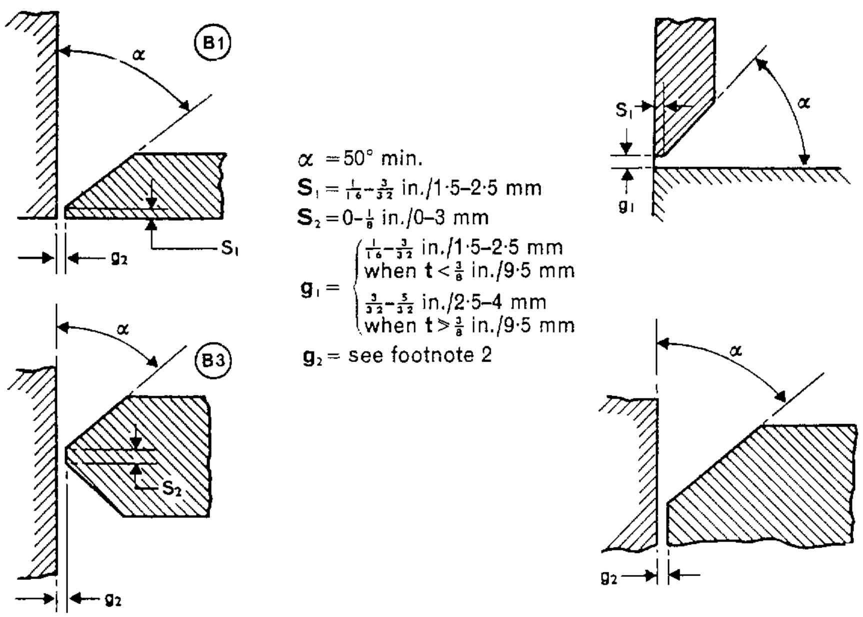
Fig. 1.1a



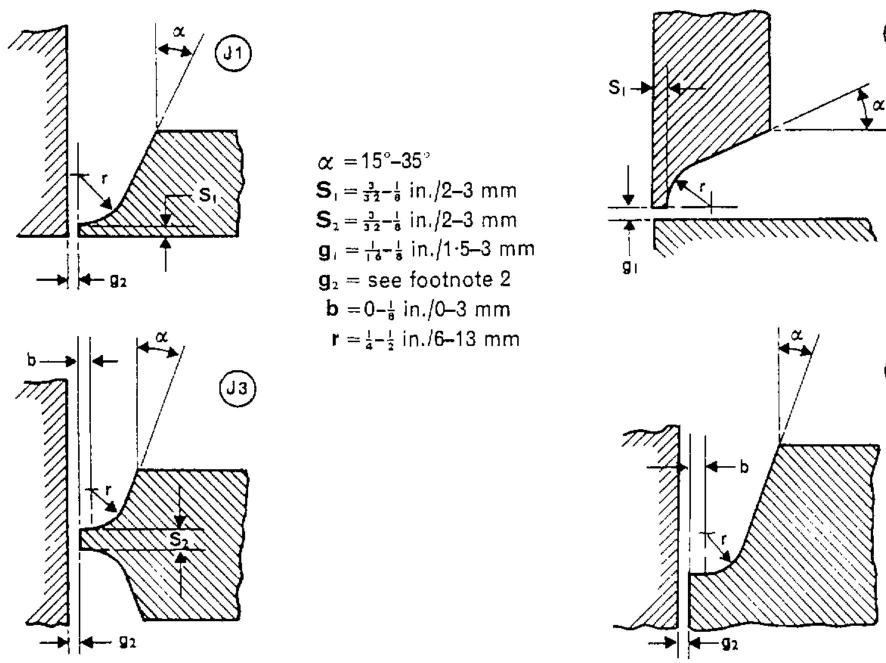
L = **t**/3 min. but not less than ¼ in./6 mm

Fig. 1.1b

STANDARD WELD DETAILS



$\alpha = 50°$ min.
$S_1 = \frac{1}{16}–\frac{3}{32}$ in./1·5–2·5 mm
$S_2 = 0–\frac{1}{8}$ in./0–3 mm
$g_1 = \begin{cases} \frac{1}{16}–\frac{3}{32} \text{ in./1·5–2·5 mm when } t < \frac{3}{8} \text{ in./9·5 mm} \\ \frac{3}{32}–\frac{5}{32} \text{ in./2·5–4 mm when } t > \frac{3}{8} \text{ in./9·5 mm} \end{cases}$
g_2 = see footnote 2



$\alpha = 15°–35°$
$S_1 = \frac{3}{32}–\frac{1}{8}$ in./2–3 mm
$S_2 = \frac{3}{32}–\frac{1}{8}$ in./2–3 mm
$g_1 = \frac{1}{16}–\frac{1}{8}$ in./1·5–3 mm
g_2 = see footnote 2
$b = 0–\frac{1}{8}$ in./0–3 mm
$r = \frac{1}{4}–\frac{1}{2}$ in./6–13 mm

Footnote—1. These recommendations which comply with Document IIS/IIW-79-61 entitled *Recommended Joint Preparations for Fusion Welding of Steel* have been included for general guidance. Discretion must be used in applying the maximum and minimum dimensions quoted which are subject to variation according to the welding procedure employed (e.g. size and type of electrodes); also to the position in which the welding is carried out.

2. It is recommended that in no case should the gap between the branch and shell exceed $\frac{1}{8}$ in./3 mm. Wider gaps increase the tendency to spontaneous cracking during welding, particularly as the thickness of the parts joined increases.