

**UNIVERSITY  
OF  
SOUTHAMPTON**

EXPERIMENTAL RIG  
DESIGN  
DRAWINGS

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Ship Science Dept.  
Ph.D 1984



## INTRODUCTION

This suite of drawings describes an experimental rig for use in the 7' x 5' section of the Southampton University wind tunnel.

The rig attempts to simulate the conditions found over the surfaces of 2-D, thin, highly cambered, aerofoil sections in the presence of various leading edge (L.E.) obstructions, similar to those encountered on yacht sails behind masts or luff-groove systems.

The rig basically consists of a thin (5 mm), variable camber aerofoil of chord 0.7 m designed to span the full 7' width of the tunnel. The variable camber is achieved by adopting a cloth / aluminium stiffener / rubber laminate construction.

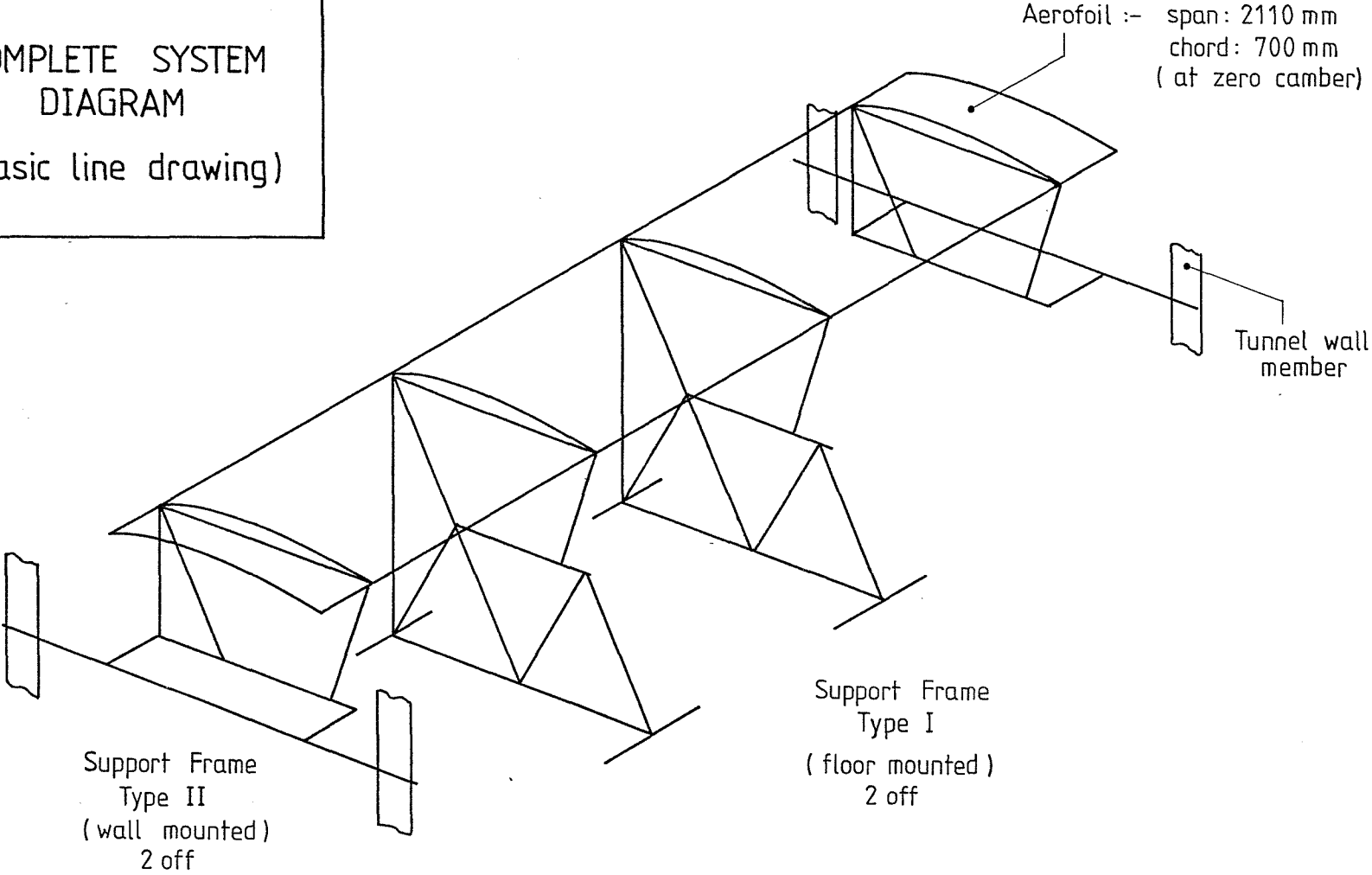
The aerofoil is supported by four frame-work structures which prevent the thin aerofoil distorting under aerodynamic loading. At each support position the frames provide facilities for varying incidence angle ( $-5^{\circ} \rightarrow 25^{\circ}$ ) and for setting the camber distribution ( $CR = 0 \rightarrow 18\%$ ), whilst always keeping the leading edge at the same location within the tunnel for easy mast attachment.

The camber distribution is set using a modular 'plug-in' type arrangement of threaded jacks. Two complete sets of these are specified to provide a means of resetting the aerofoil camber without the need for time consuming adjustment of all the individual screw jacks during actual tunnel testing.

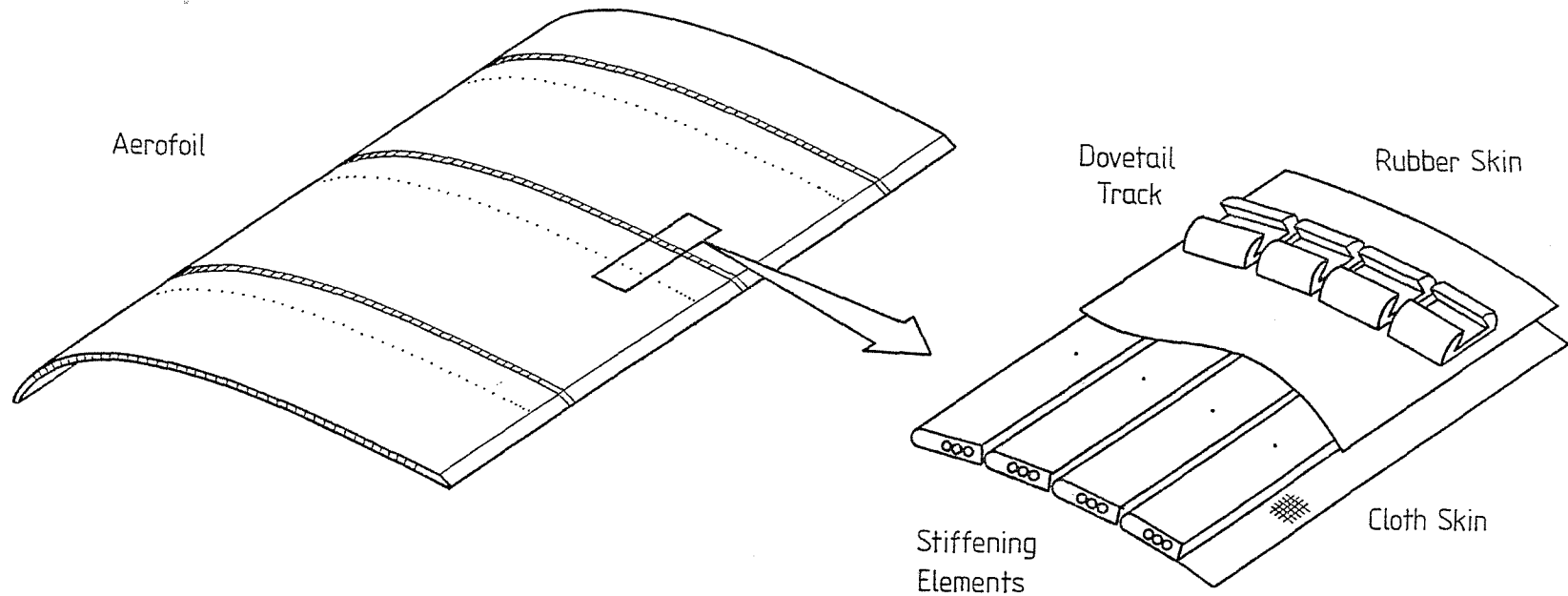
Two types of support frame are used, those at extreme span positions being attached to the tunnel walls, while those at the mid span positions are attached to the tunnel floor.

Because of the four support frames the 7' span of the aerofoil is subdivided into three minor spans. Along both upper and lower surfaces of each of these minor spans runs a row of pressure tapping holes and a 'mouse track'. The latter is to allow a miniturized, self-contained boundary layer tranverse unit (called a 'mouse') to move over the aerofoil surfaces and record necessary data.

COMPLETE SYSTEM  
DIAGRAM  
(basic line drawing)

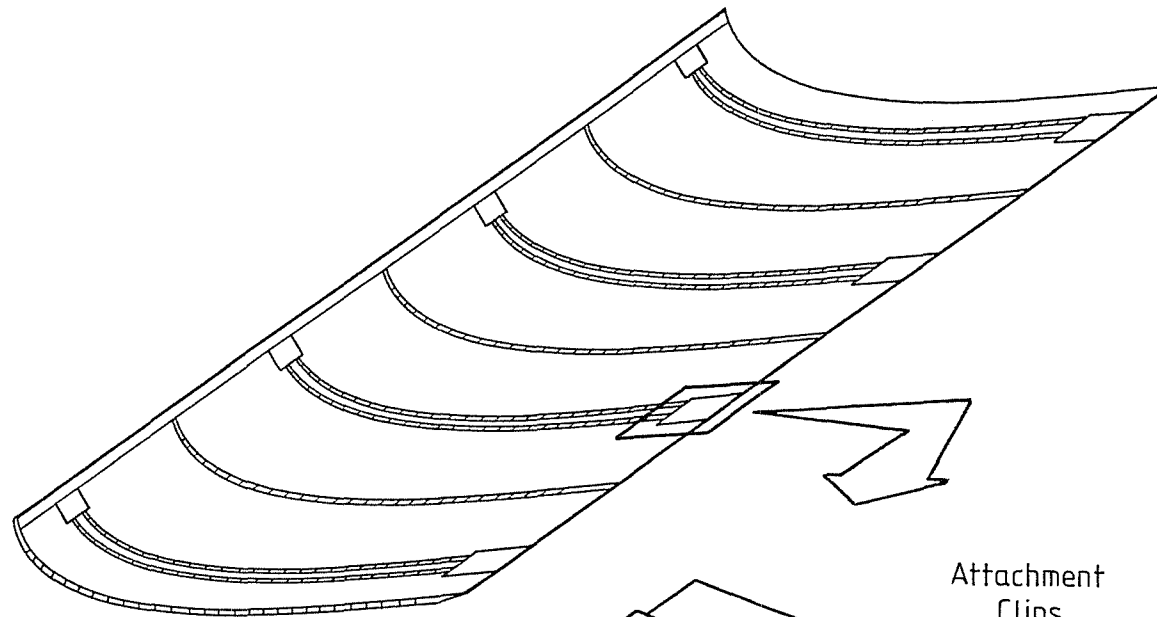


Not to Scale



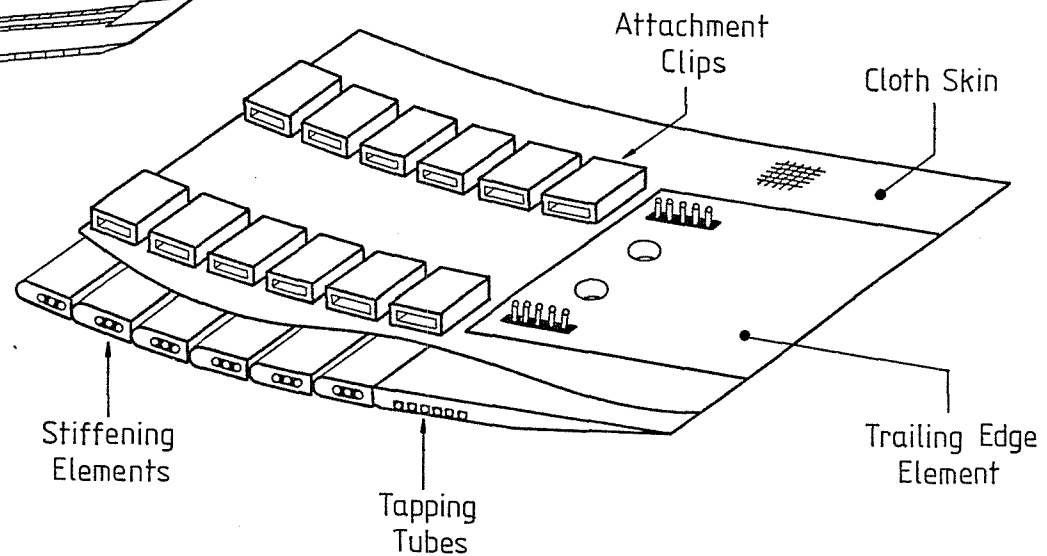
SUB-SYSTEM  
DIAGRAM

Aerofoil  
( Upper Surface  
View )

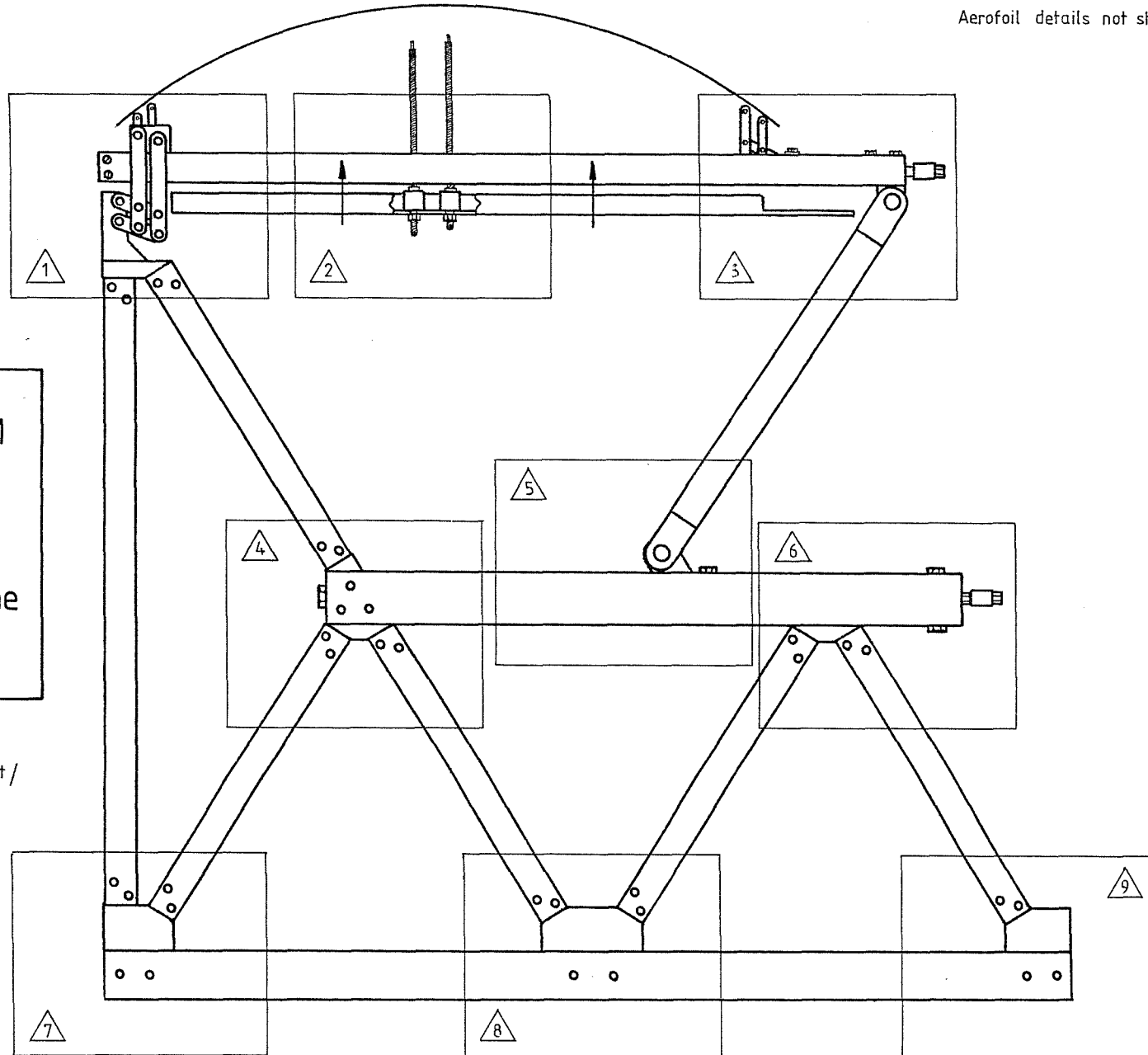


SUB-SYSTEM  
DIAGRAM

Aerofoil  
( Lower Surface  
View )




Aerofoil details not shown



SUB - SYSTEM  
DIAGRAM

Support Frame  
Type I

 : indicates Arrangement /  
Assembly drawing numbers.

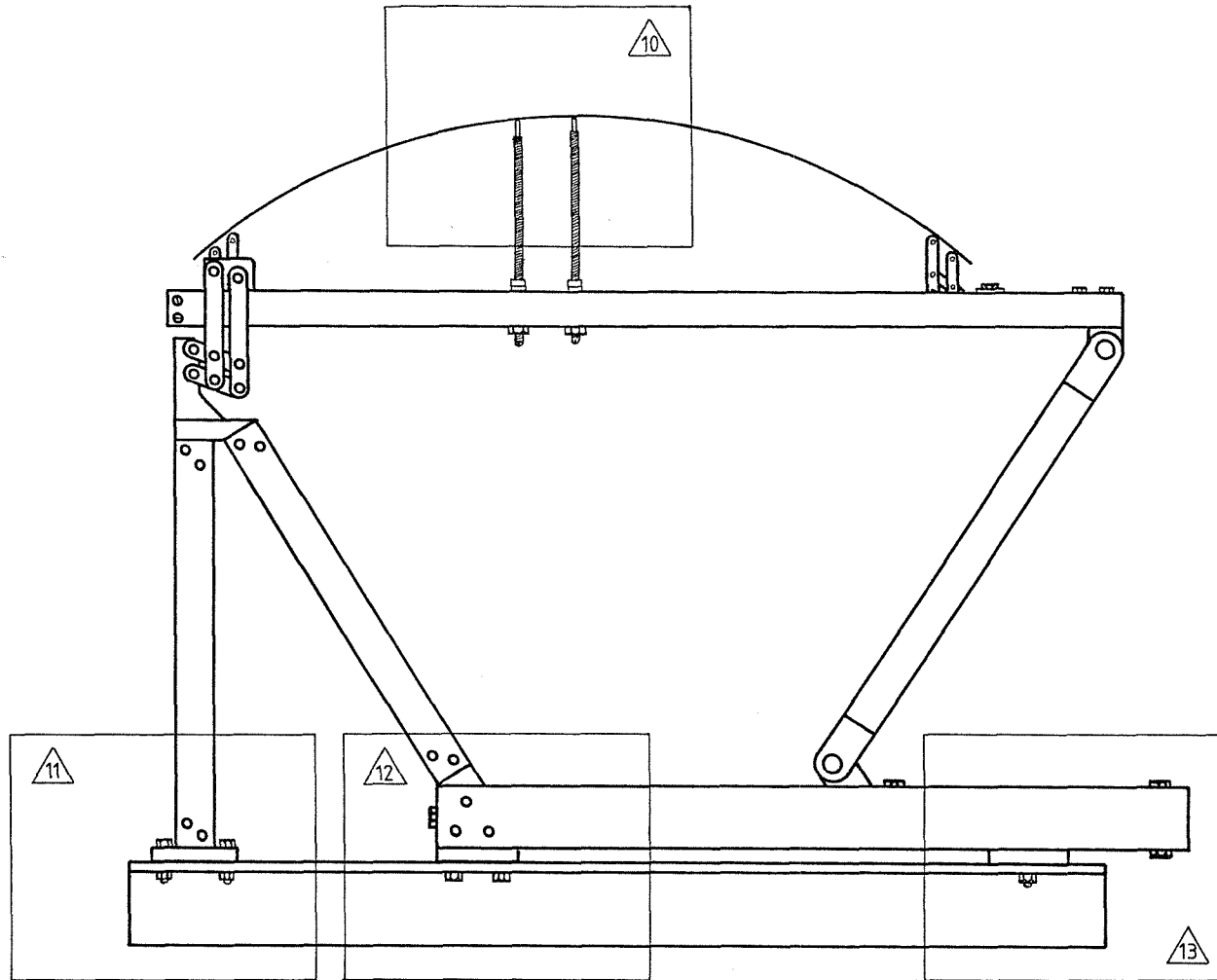
Scale : 1 : 5



Aerofoil details not shown

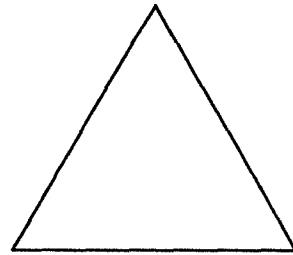
SUB - SYSTEM  
DIAGRAM

Support Frame  
Type II



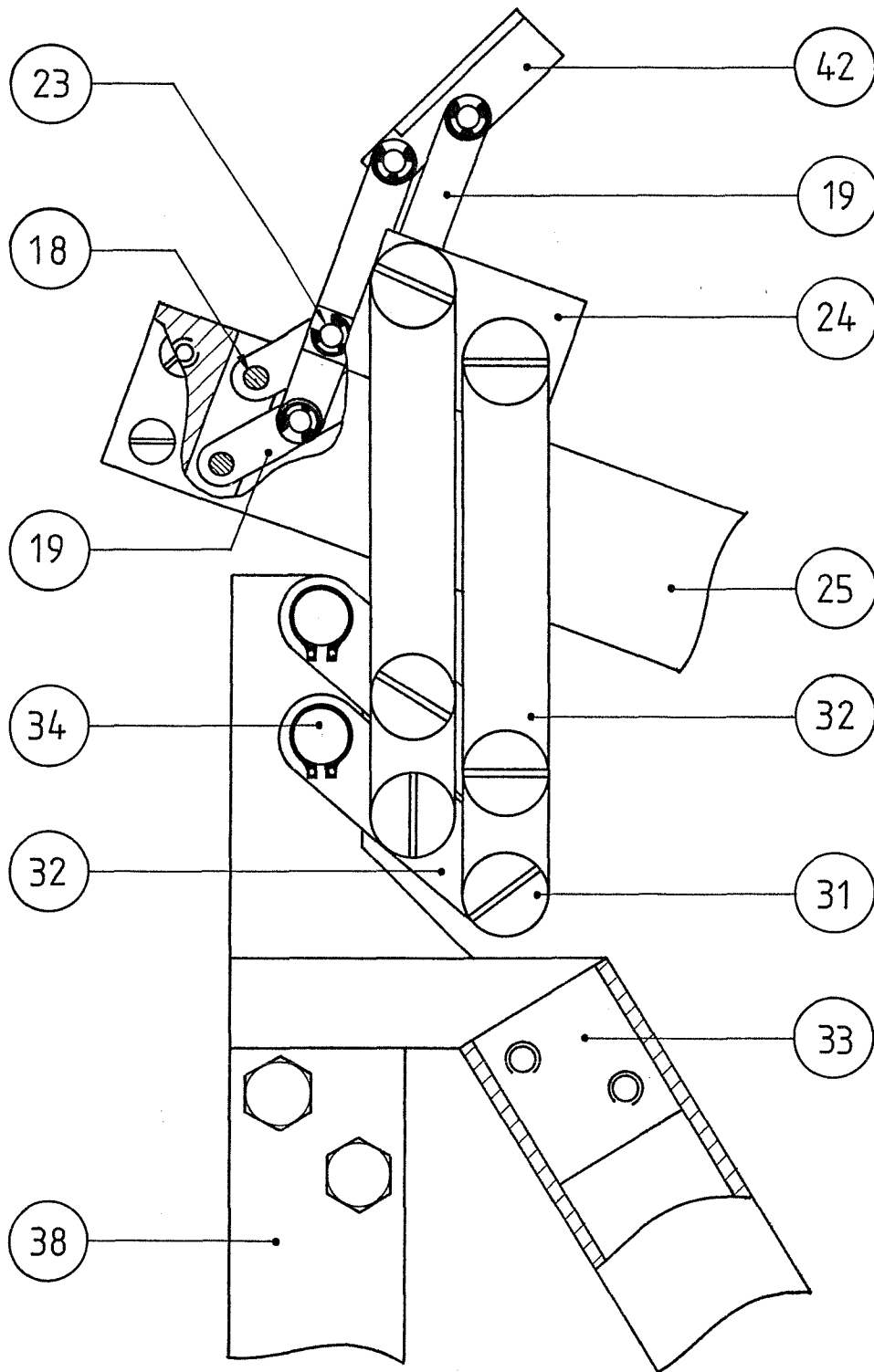
Scale: 1:5

ASSEMBLY



DRAWINGS




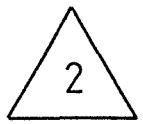
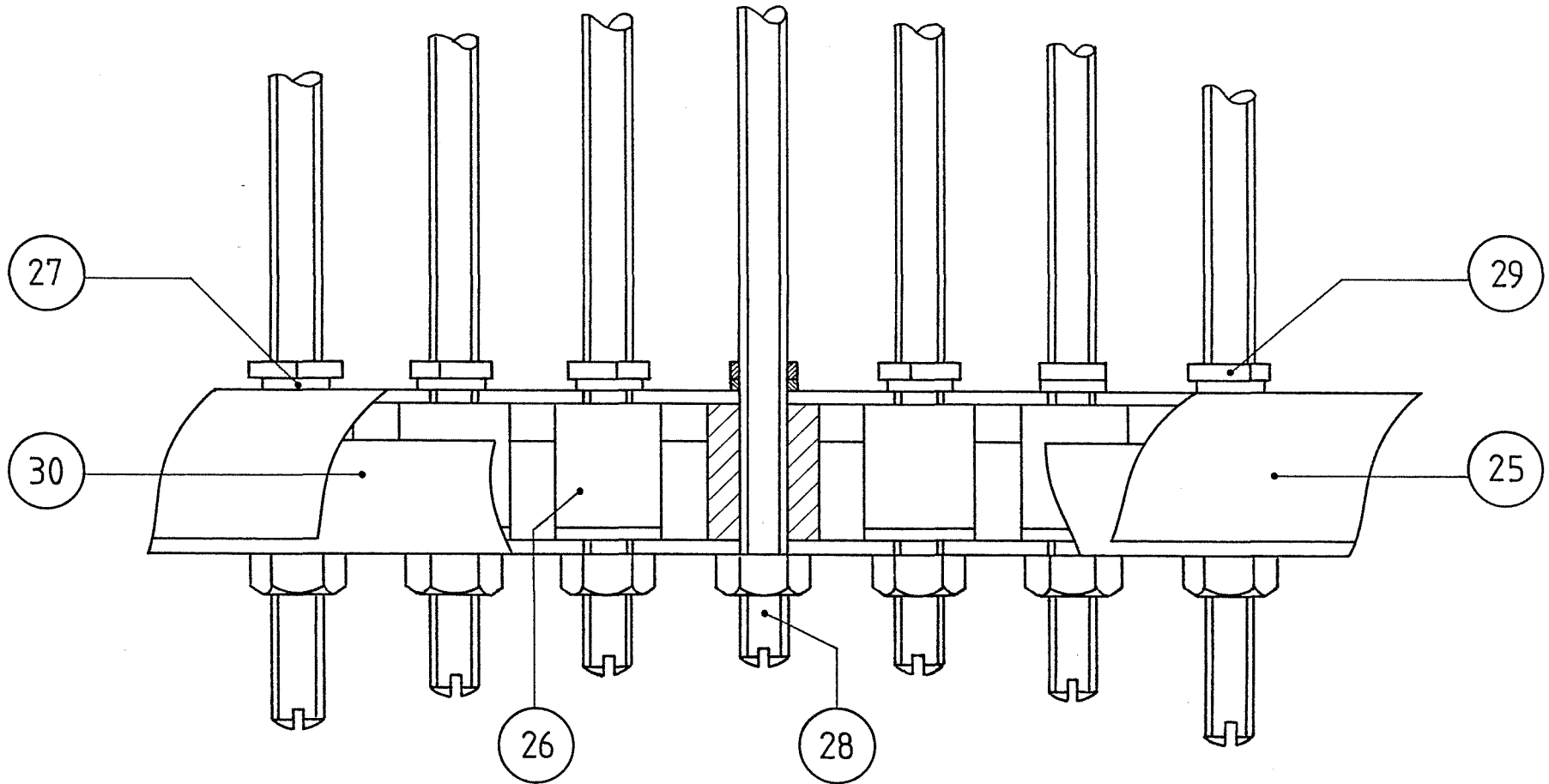


1

LEADING EDGE ASSEMBLY

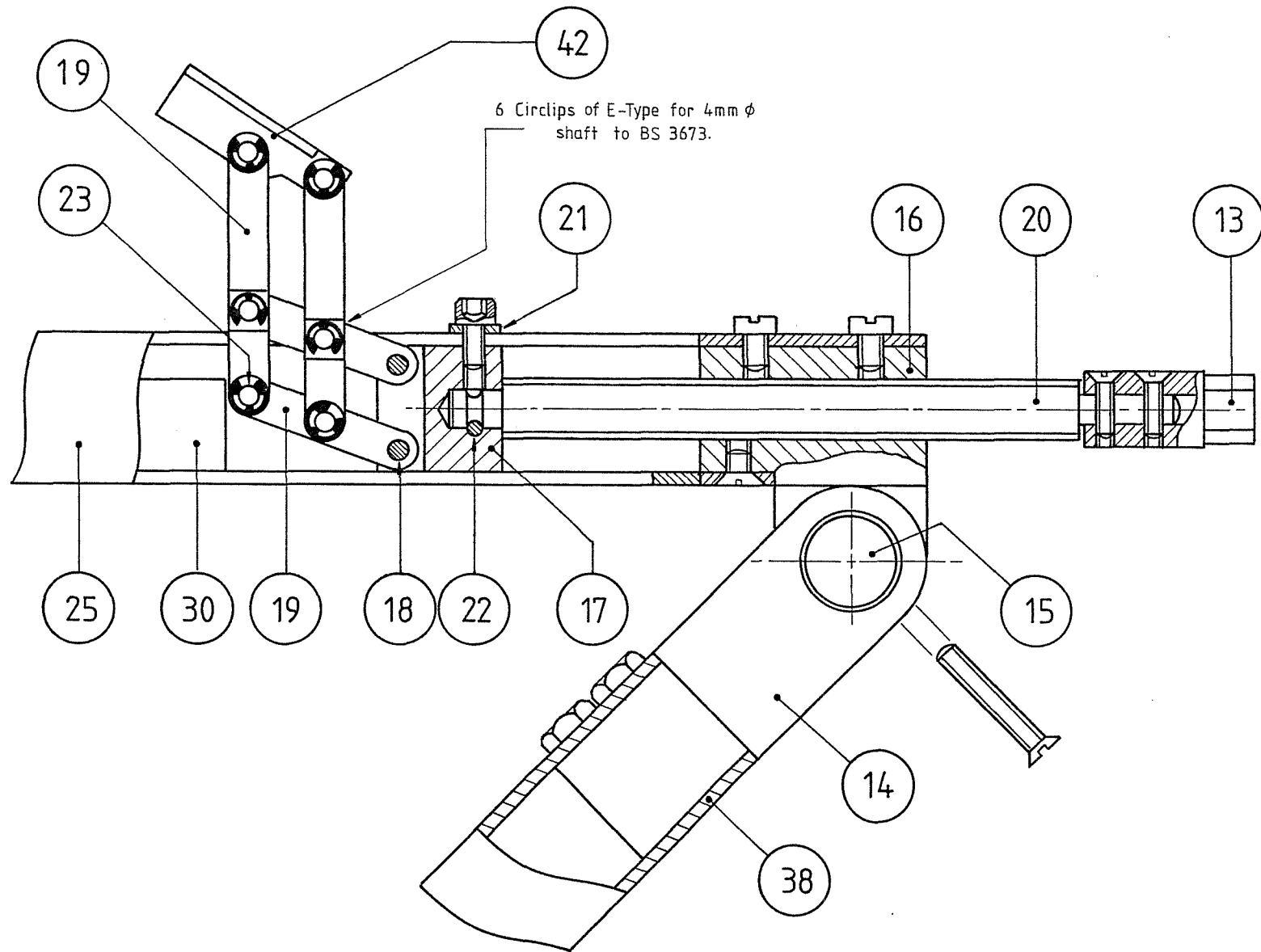
Scale: 1:1

Attachment to aerofoil shown in drawing 



CHORD LINE ASSEMBLY

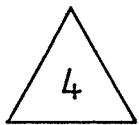
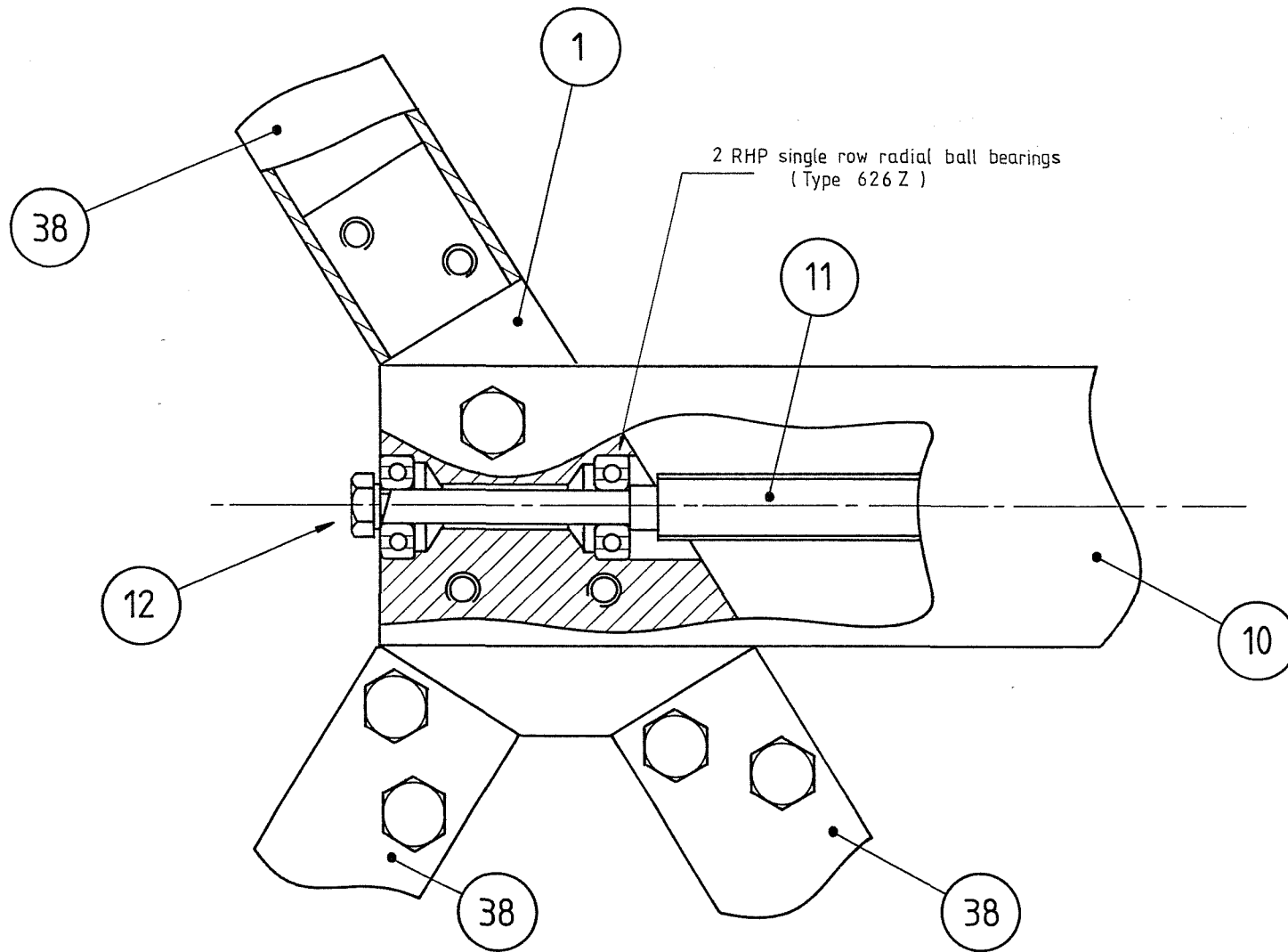
Scale: 1:1



3

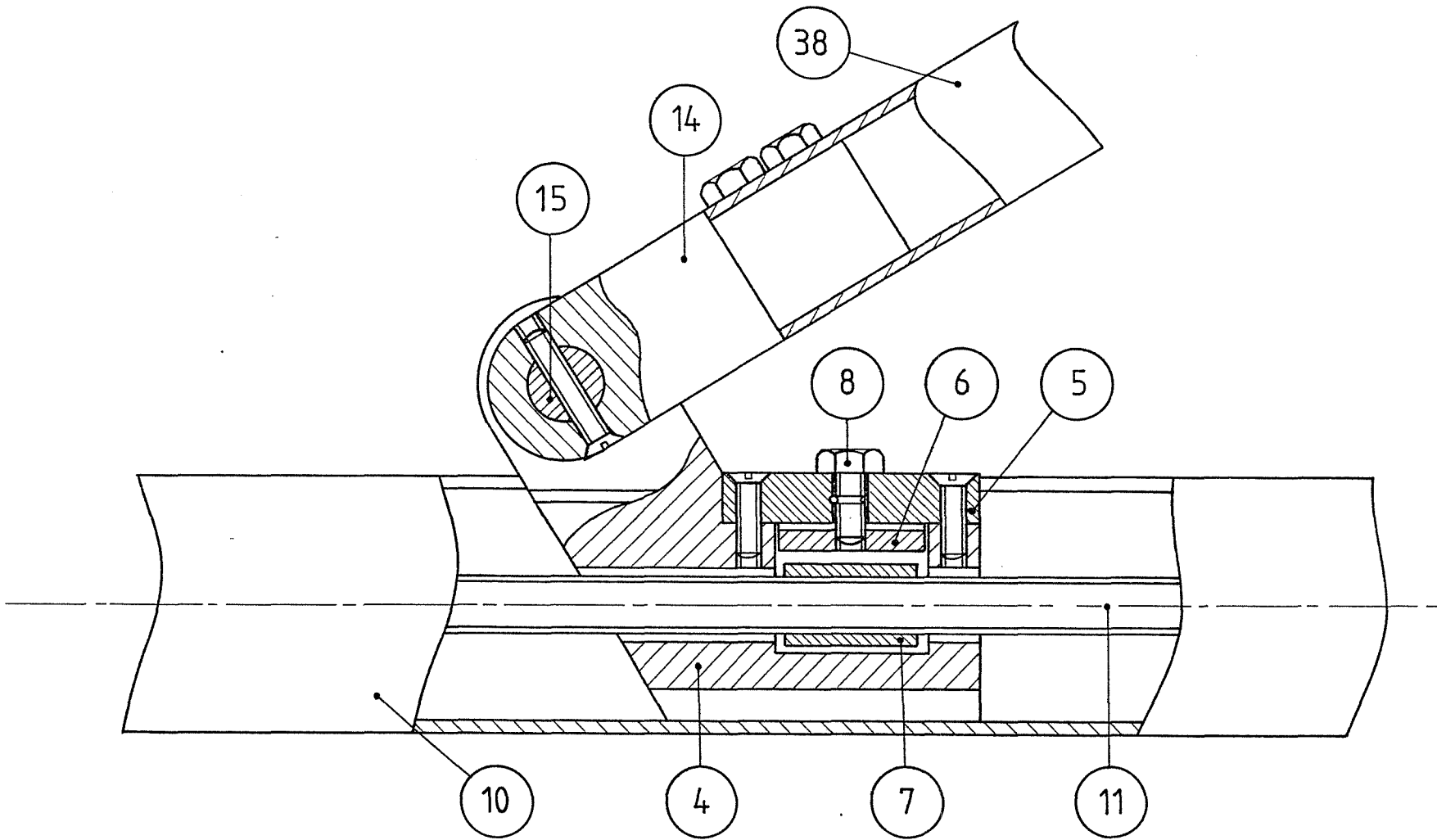
T.E. ATTACHMENT ASSEMBLY

Scale: 1:1



FORWARD BEARING ASSEMBLY ( Type I Support Frame )

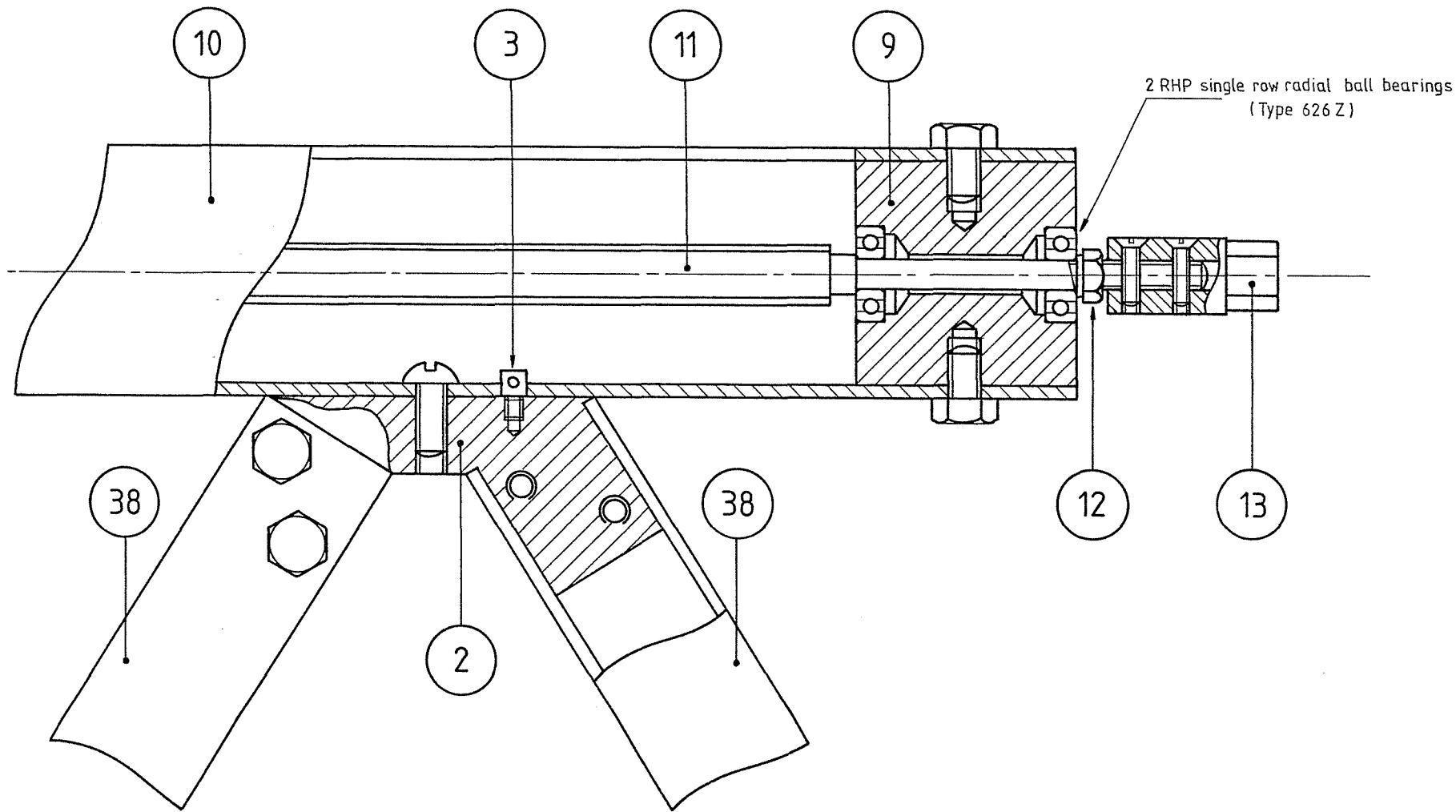
Scale: 1:1



5

CARRIAGE ASSEMBLY

Scale: 1:1



6

REAR BEARING ASSEMBLY ( Type I Support Frame )

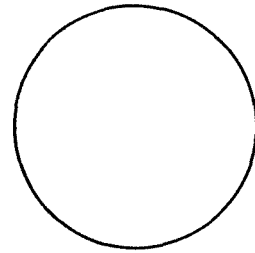
Scale 1:1

ASSEMBLIES  $\triangle 7$   $\triangle 8$  AND  $\triangle 9$  INVOLVE ONLY COMPONENTS  $\textcircled{35}$  ,  $\textcircled{37}$   
AND  $\textcircled{36}$  RESPECTIVELY, PLUS VARIOUS POSITIONINGS OF  $\textcircled{38}$  AND  $\textcircled{57}$ .  
UPON INSPECTION OF THE DETAILED COMPONENT DRAWINGS MENTIONED,  
TOGETHER WITH THE SUB-SYSTEM DIAGRAM FOR THE SUPPORT FRAME TYPE  
I, THE THREE ASSEMBLIES ARE SELF EVIDENT AS REGARDS CONFIGURATION  
AND DO NOT REQUIRE INDIVIDUAL DRAWINGS.

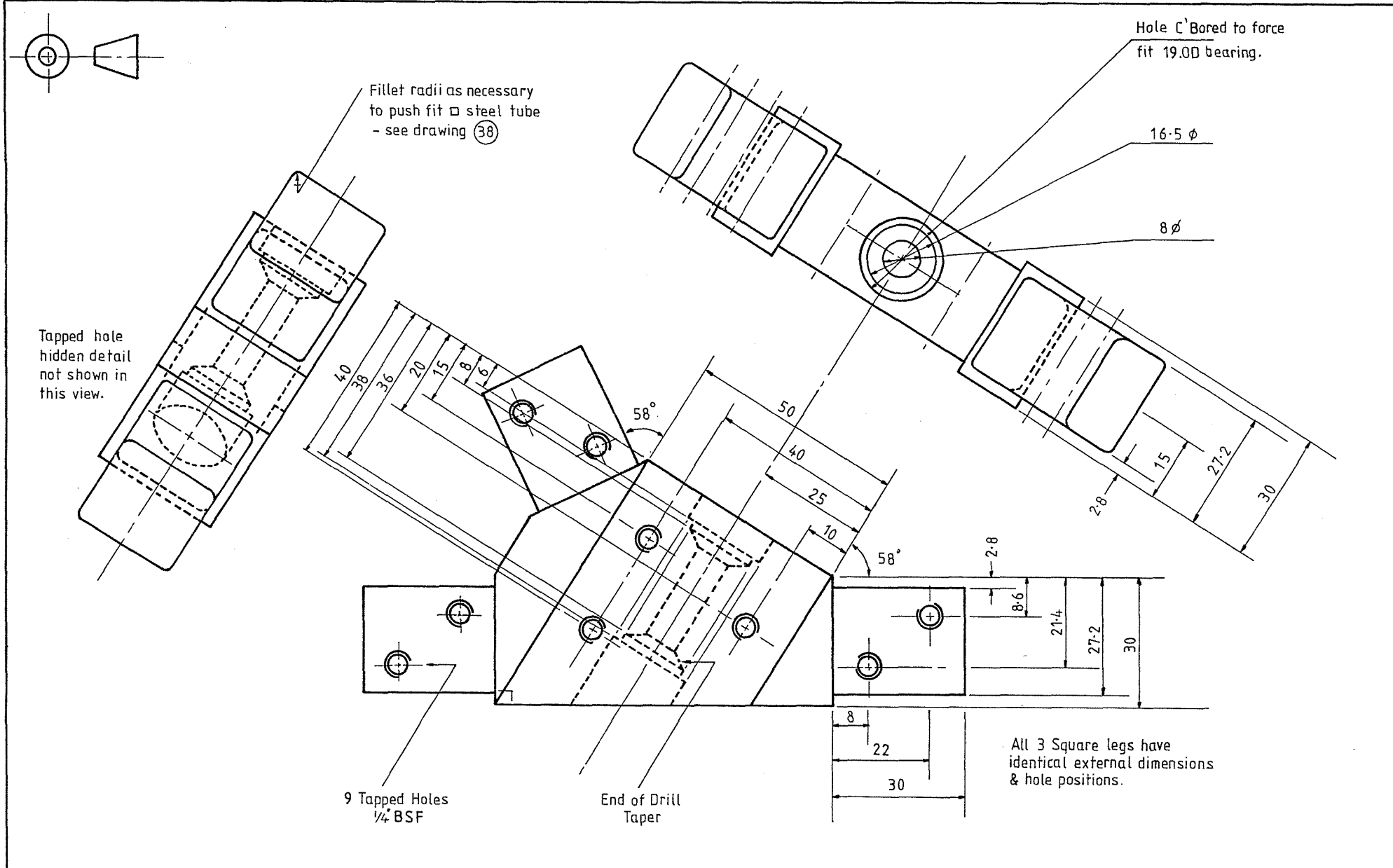


ASSEMBLIES  $\triangle 12$  AND  $\triangle 13$  ARE IDENTICAL TO THOSE OF  $\triangle 4$  AND  $\triangle 6$  BUT  
WITH  $\odot 1$  REPLACED BY  $\odot 39$  AND  $\odot 2$  REPLACED BY  $\odot 41$ , RESPECTIVELY.  
NO INDIVIDUAL DRAWINGS ARE THEREFORE NECESSARY.

DETAILED COMPONENT



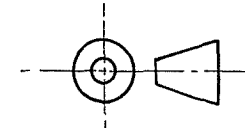
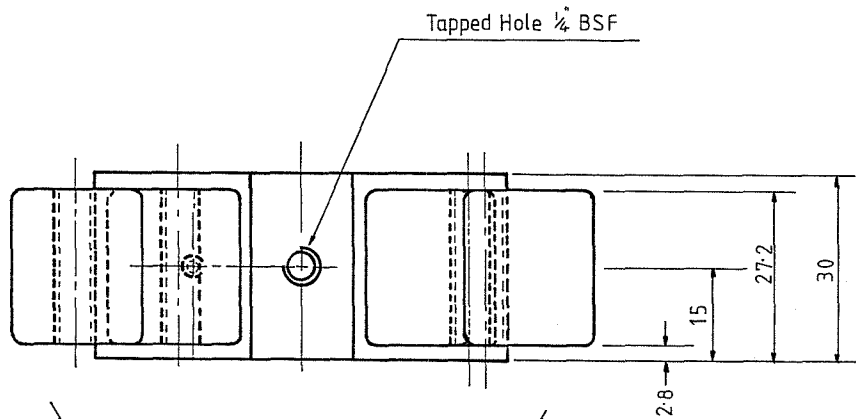
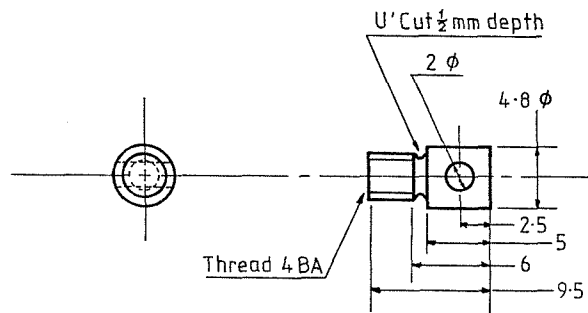
DRAWINGS



1

4-WAY CENTRAL FRAME JOINT  
/ FORWARD BEARING HOUSING

Material: Mild Steel	
General Tolerance: $\pm 0.1$ mm & $\pm 0.2^\circ$	
Dimensions: mm's	
Quantity: 2 off	Scale: 1:1

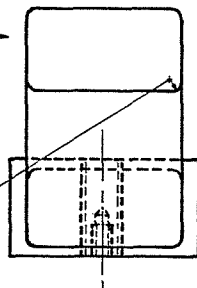


3

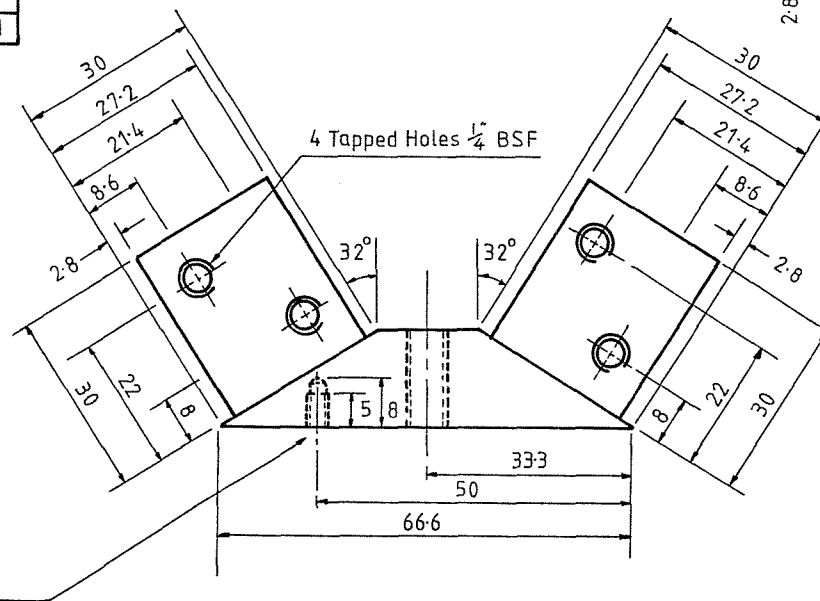
LOCATION STUD

Material: Mild Steel
Gen. Tol.: ±0.1 mm
Dimensions: mm's
Quantity: 4 off   Sc. 2:1

For clarity not all tapped hole hidden detail is shown in this view



Fillet radii as necessary to push fit □ steel tube — see drawing (38)

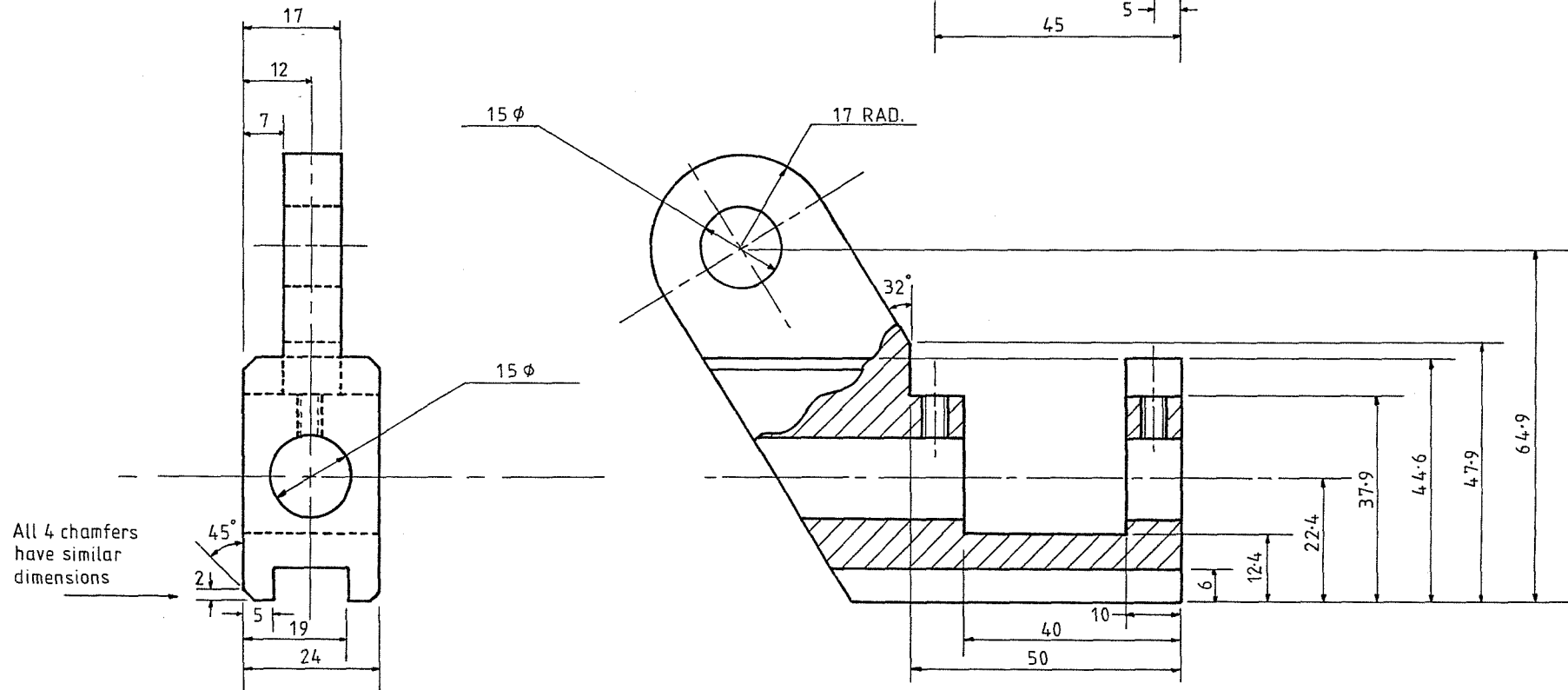
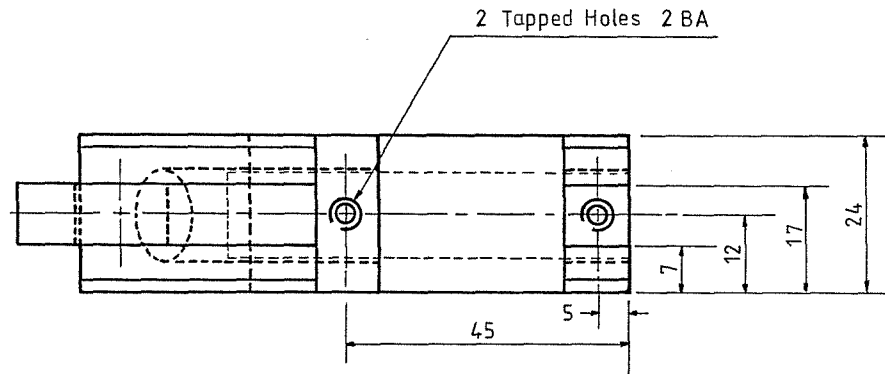
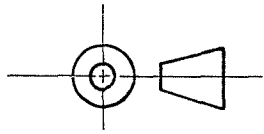


Blind Tapped Hole 4 BA

2

3-WAY REAR FRAME JOINT

Material: Mild Steel
General Tolerance: ±0.1mm & ±0.2°
Dimensions: mm's
Quantity: 2 off   Scale: 1:1



4

CARRIAGE

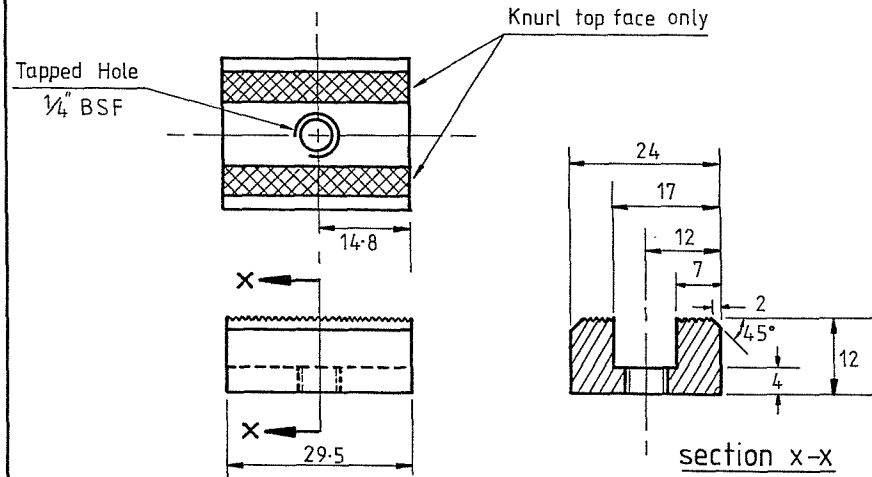
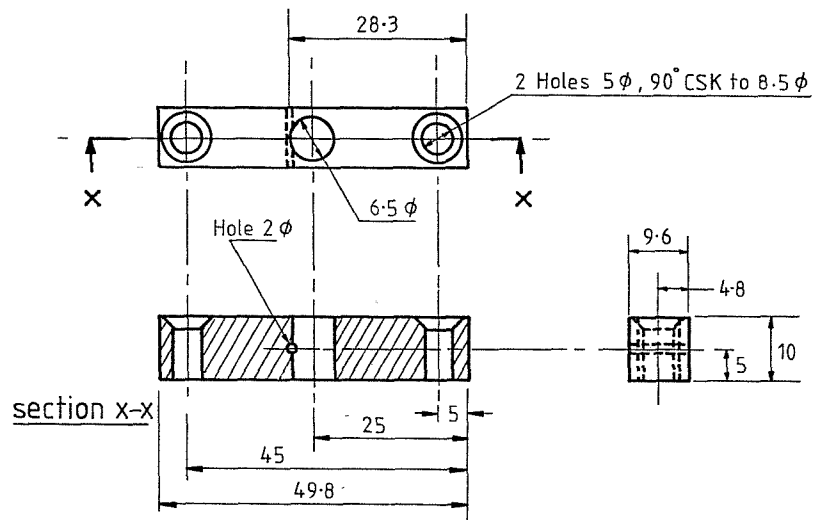
Material: Mild Steel

General Tolerance:  $\pm 0.1\text{mm}$  &  $\pm 0.2^\circ$

Dimensions: mm's

Quantity: 4 off

Scale: 1:1



5

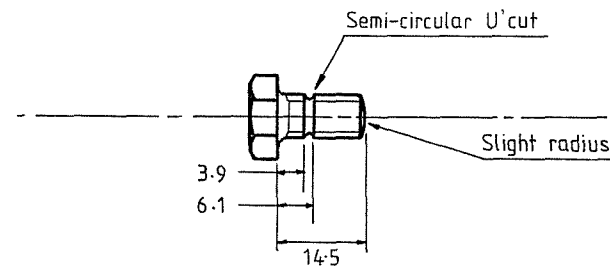
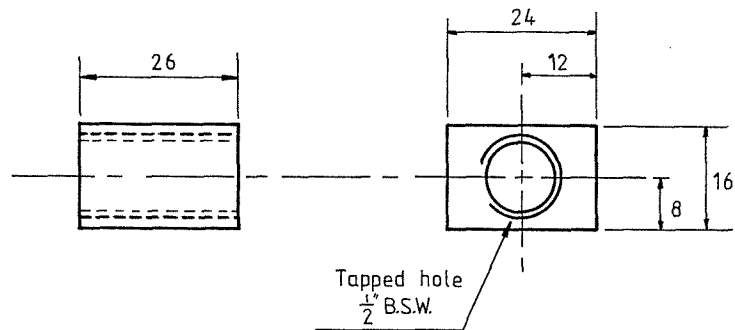
CARRIAGE CLAMP BRIDGE

Material: Mild Steel  
 General Tolerance:  $\pm 0.1$  mm  
 Dimensions: mm's  
 Quantity: 4 off | Scale: 1:1

6

CARRIAGE LOCKING JAW

Material: Medium Carbon Steel, H & T to 340°C  
 (dark blue) | Gen. Tol.:  $\pm 0.1$  mm  
 Dimensions: mm's  
 Quantity: 4 off | Scale: 1:1



7

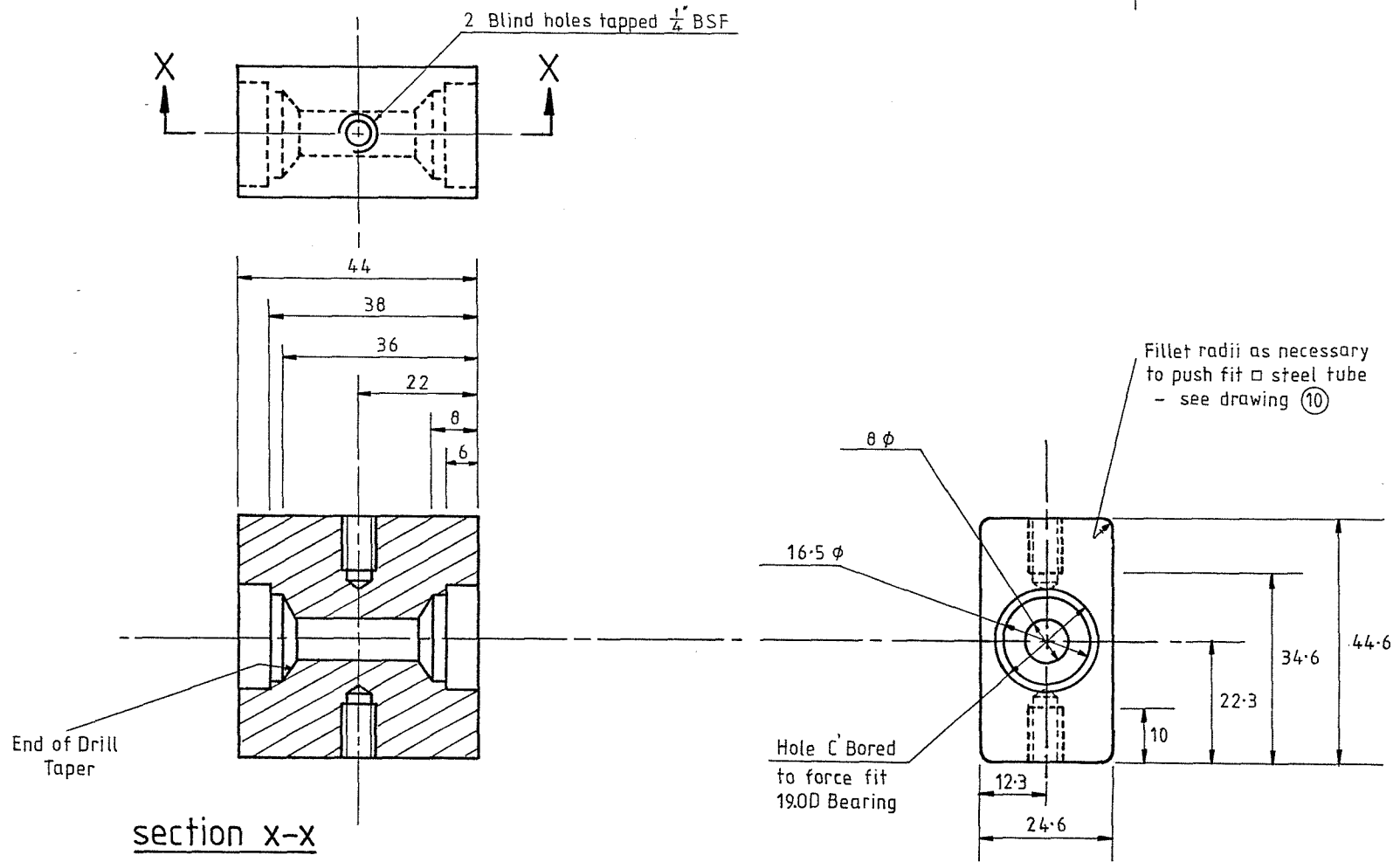
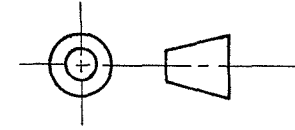
ACTUATING NUT

Material: Mild Steel  
 General Tolerance:  $\pm 0.1$  mm  
 Dimensions: mm's  
 Quantity: 4 off | Scale: 1:1

8

CARRIAGE LOCKING SCREW

Material: Steel 1/4 B.S.F., Full bearing head type,  
 Standard hexagon screw | Gen. Tol.:  $\pm 0.1$  mm  
 Dimensions: mm's  
 Quantity: 4 off | Scale: 1:1



9

REAR BEARING HOUSING

Material: Mild Steel

General Tolerance:  $\pm 0.1$  mm

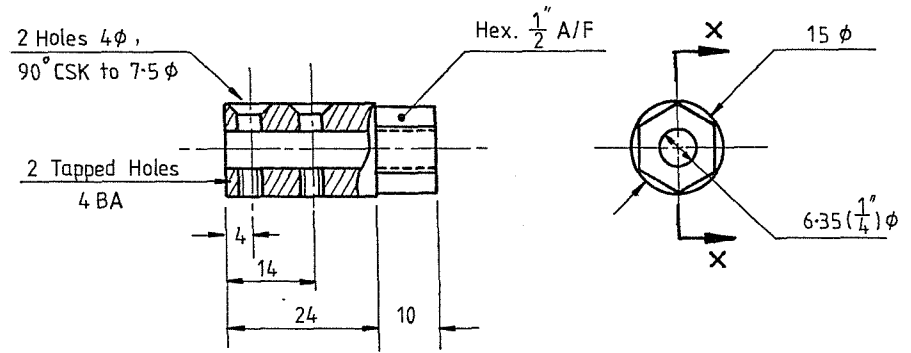
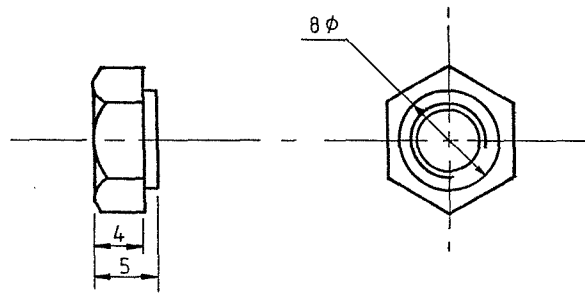
Dimensions: mm's

Quantity: 4 off

Scale: 1:1







12

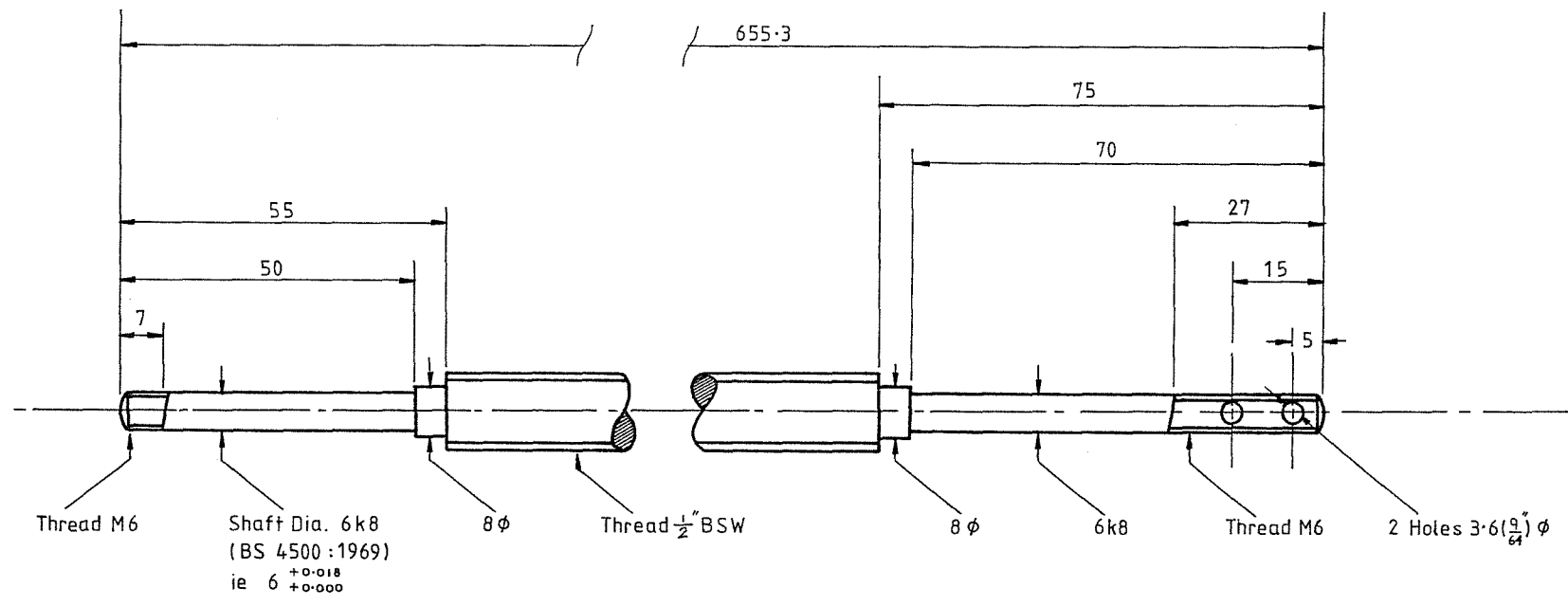
THRUST NUT

Material: Standard M6 Nut (BS.3692)  
 Dimensions: mm's  
 General Tolerance:  $\pm 0.1\text{mm}$   
 Quantity: 8 off      Scale: 2:1

13

SCREW DRIVE

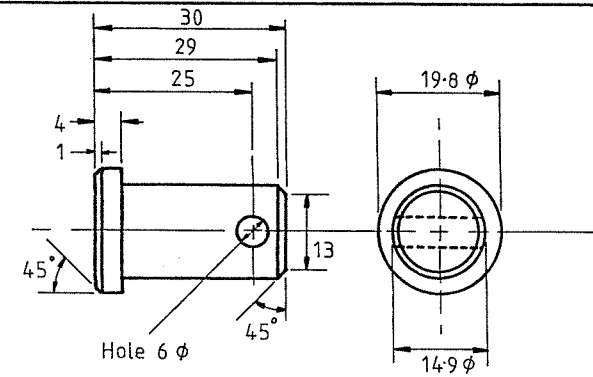
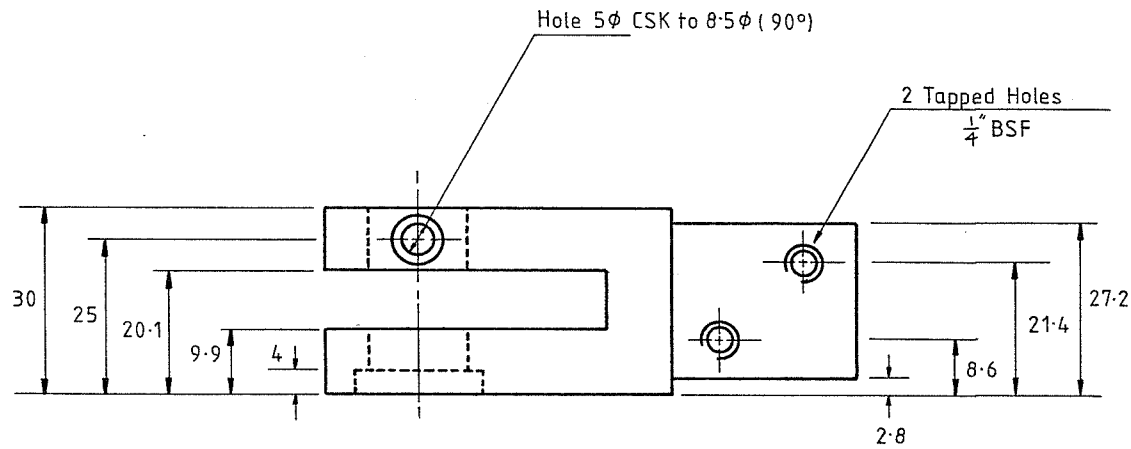
Material: Carbon Steel H&T (Blue)  
 Dimensions: mm's  
 General Tolerance:  $\pm 0.1\text{mm}$   
 Quantity: 8 off      Scale: 1:1



11

LEAD-SCREW

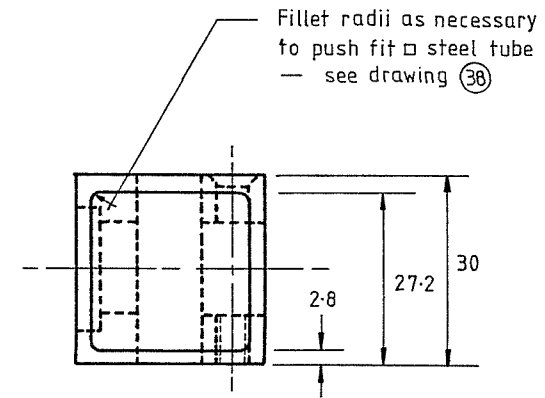
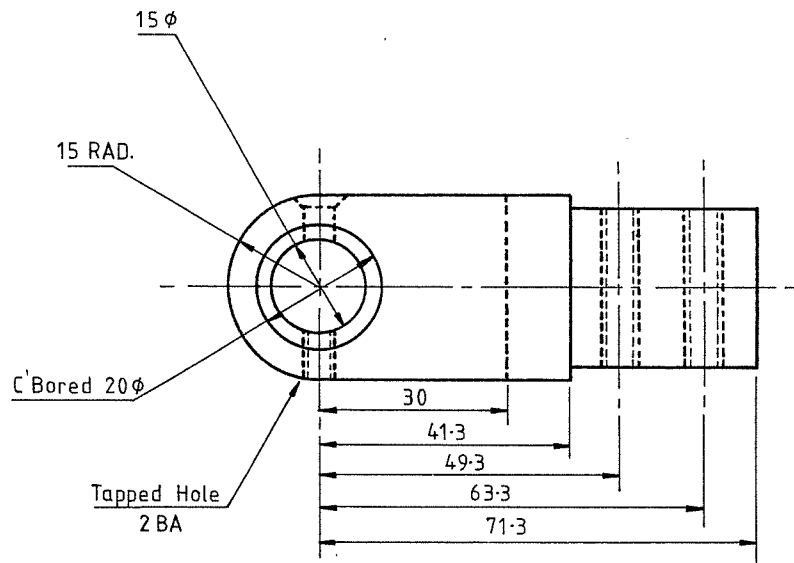
Material: Steel  $\frac{1}{2}$ " BSW Studding  
 Supplier: E.M. Lawson & Son Ltd.  
 Dimensions: mm's      General Tol:  $\pm 0.1\text{mm}$   
 Quantity: 4 off      Scale: 1:1



15

CLEVIS PIN

Material: Mild Steel
General Tolerance: $\pm 0.1$ mm
Dimensions: mm's
Quantity: 4 off Scale: 1:1



For clarity not all tapped hole hidden detail is shown in this view.

14

JACK MORTISE PIVOT

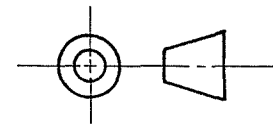
Material: Mild Steel

General Tolerance:  $\pm 0.1$  mm

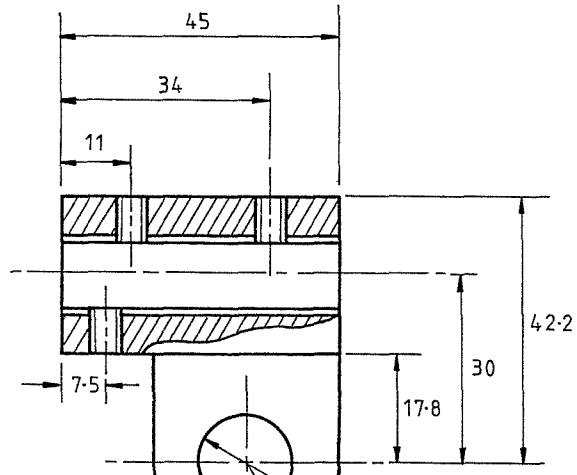
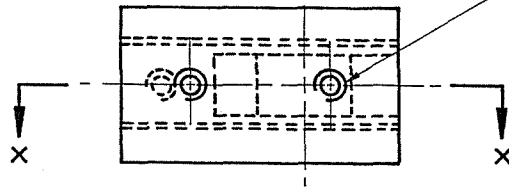
Dimensions: mm's

Quantity: 8 off

Scale: 1:1



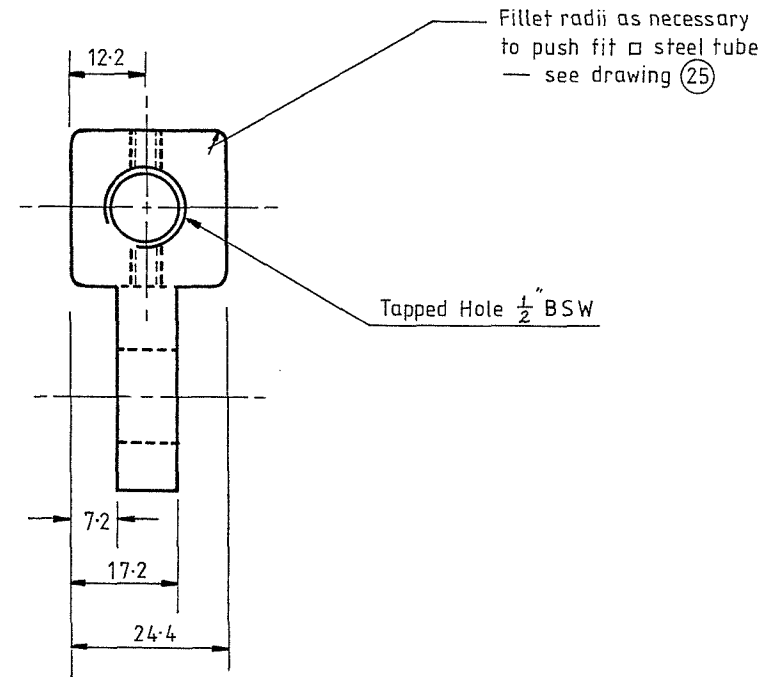
3 Tapped Holes 2 BA



partial section X-X

15φ

15 RAD



16

JACK TENON PIVOT

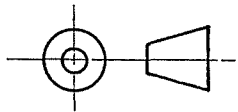
Material : Mild Steel

General Tolerance : ± 0.1mm

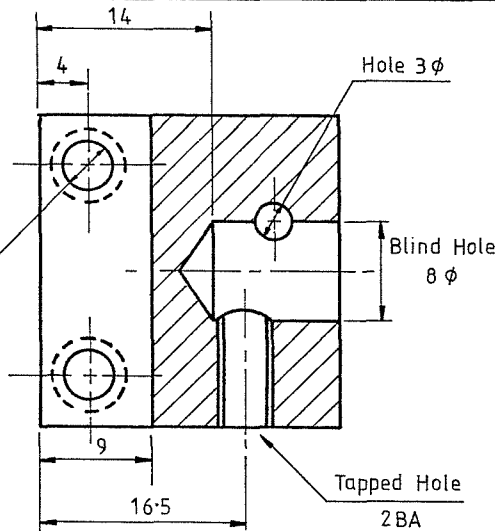
Dimensions : mm's

Quantity : 4 off

Scale : 1:1



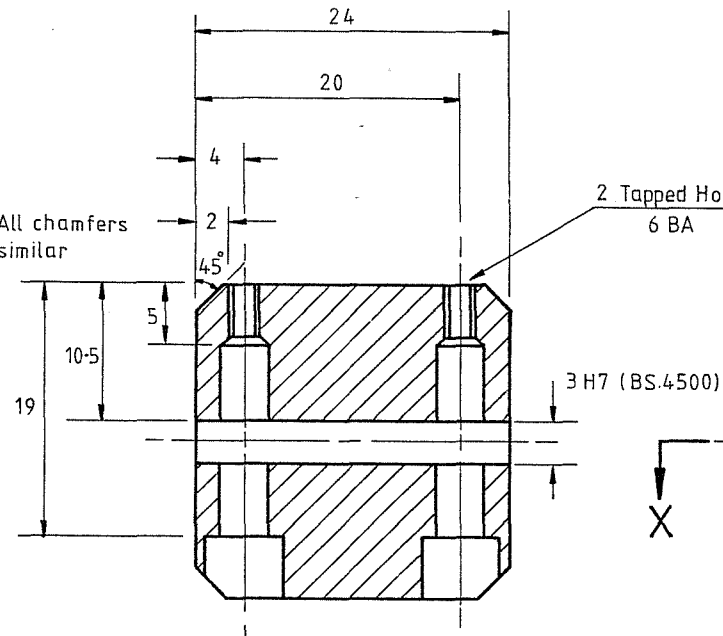
section X-X



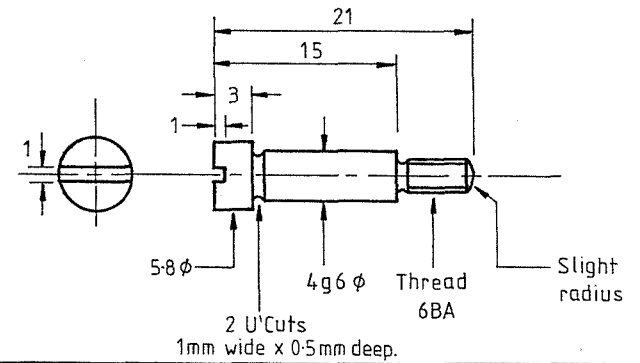
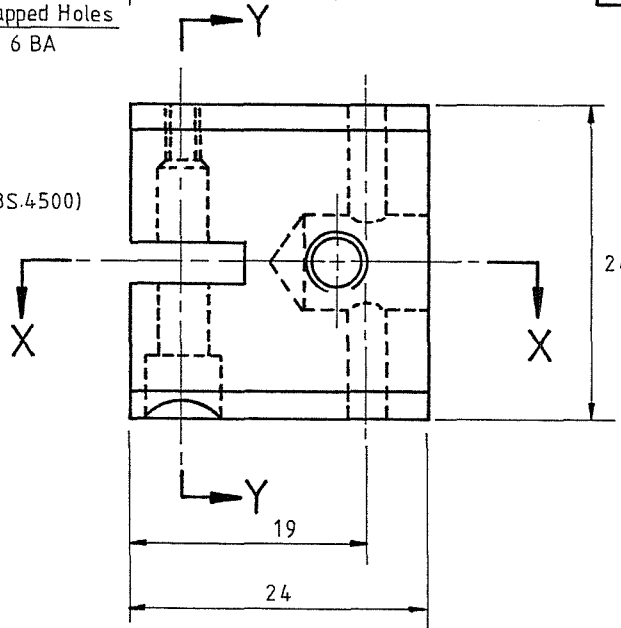
2 Drilled Holes  
4 φ, C Bored 6 φ

2 Tapped Holes  
6 BA

All chamfers  
similar



section Y-Y



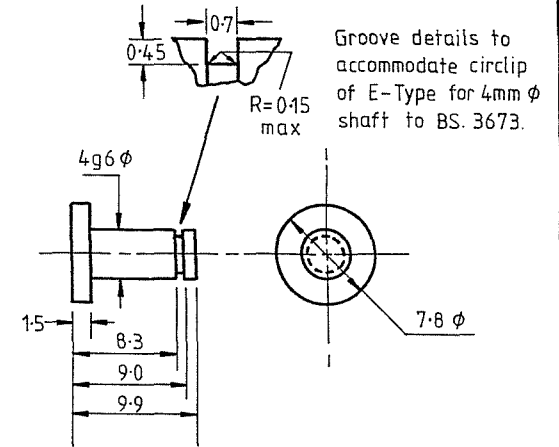
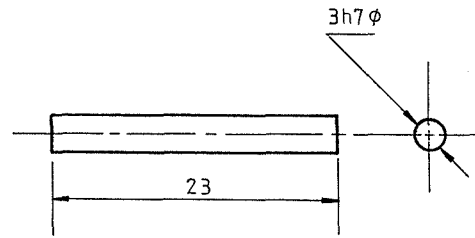
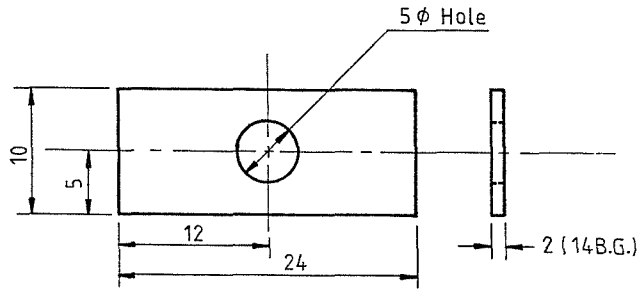
18	<b>SHOULDER SCREW PIVOT</b>	Material: Mild Steel
		General Tol: ±0.1mm
		Dimensions: mm's
		Quantity: 16 off   Scale: 2:1

17

T.E. LINKAGE BASE

Material: Mild Steel
General Tolerance: ± 0.1mm
Dimensions: mm's
Quantity: 4 off   Scale: 2:1

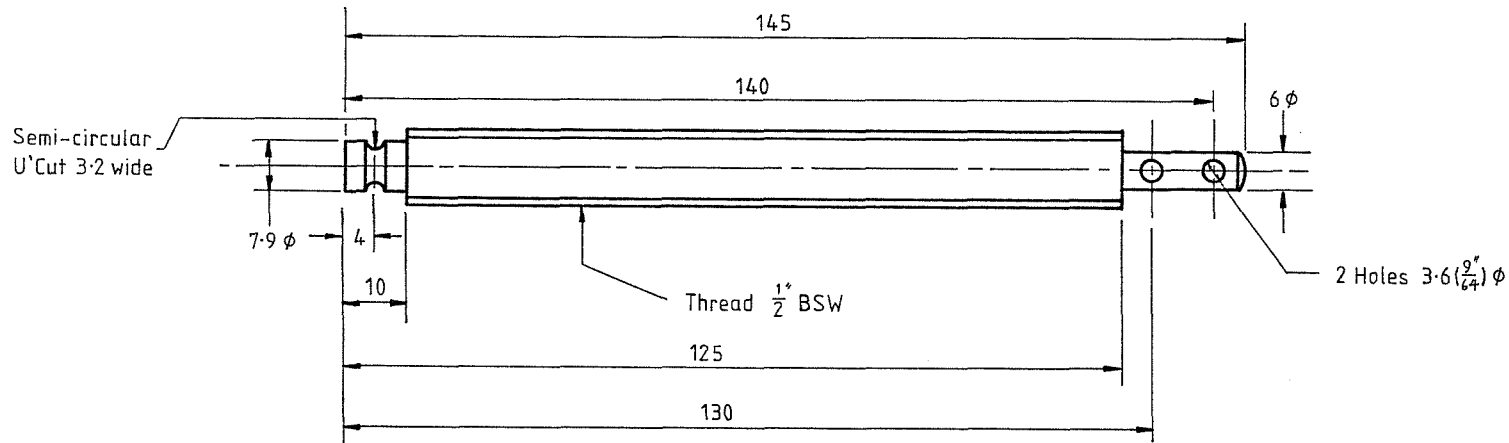




21	T.E. LOCKING PLATE	Material: Mild Steel
		Gen. Tol. : $\pm 0.1$ mm
		Dimensions: mm's
		Quantity: 4 off   Sc: 2:1

22	DOWEL PIN	Mat: Steel H&T (Blue)
		Gen. Tol. : $\pm 0.1$ mm
		Dimensions: mm's
		Quantity: 4 off   Sc: 2:1

23	LINKAGE PIVOT	Mat: Steel H&T (Blue)
		Gen. Tol. : $\pm 0.1$ mm
		Dimension: mm's
		Quantity: 4 off   Sc: 2:1

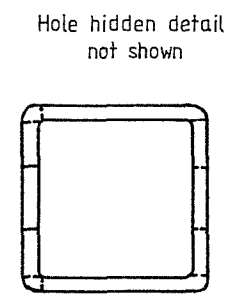
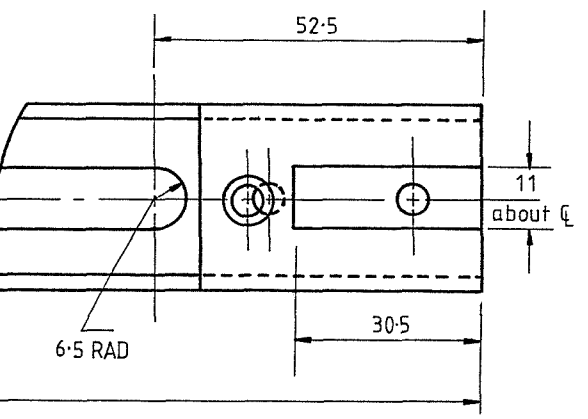
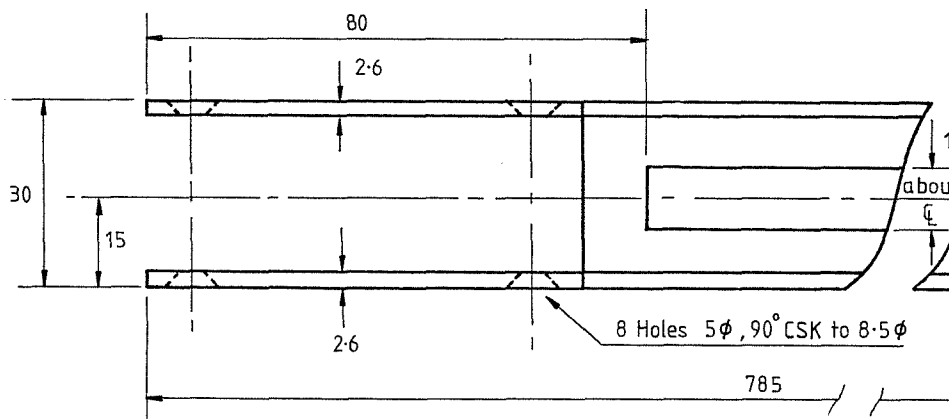
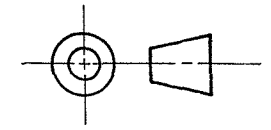
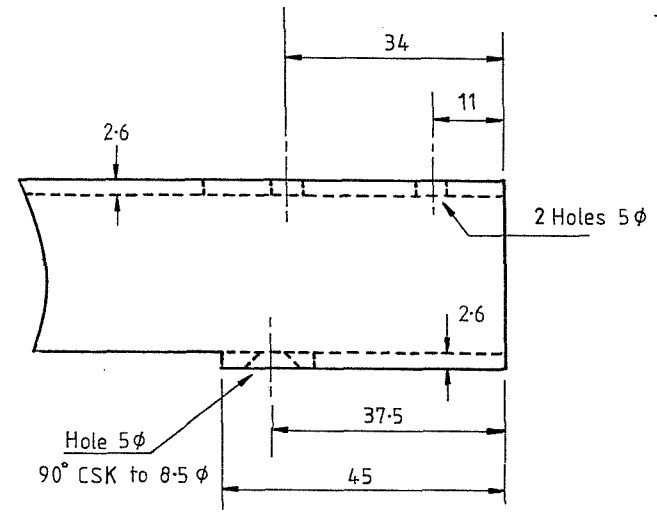
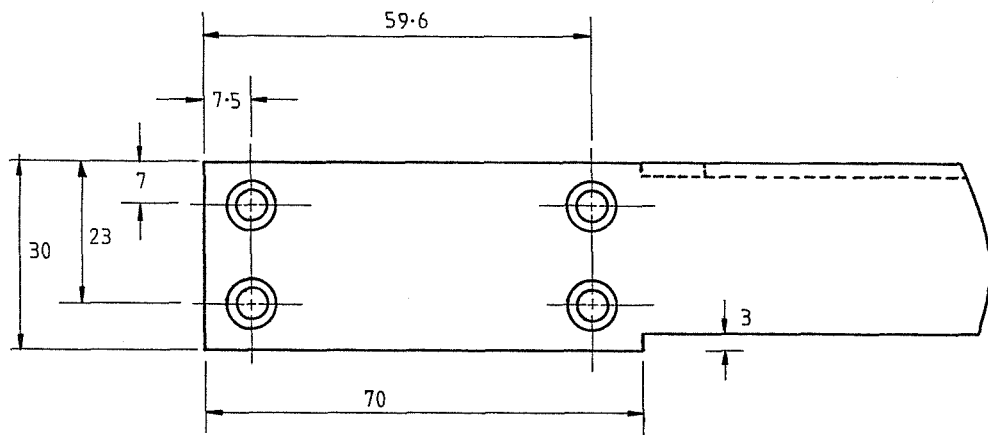


20	CHORD ADJUSTMENT SCREW	Material: Mild Steel
		General Tolerance: $\pm 0.1$ mm
		Dimensions: mm's
		Quantity: 4 off   Scale: 1:1

Material: Mild Steel
General Tolerance: $\pm 0.1$ mm
Dimensions: mm's
Quantity: 4 off   Scale: 1:1



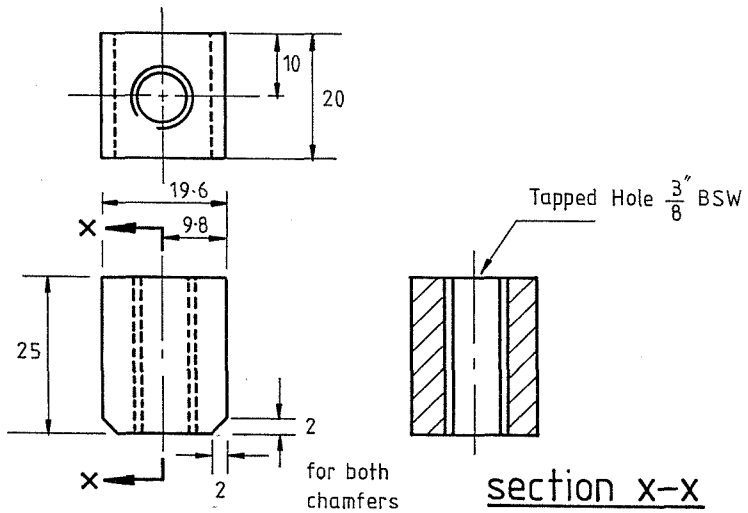




25

CHORD LINE GUIDE

Material: 30 x 30 x 2.6 Steel Tube	
Supplier: UBM Engineering Ltd	
Dimensions: mm's	Gen. Tol. : ±0.1 mm
Quantity: 4 off	Scale: 1 : 1



DESIGN CHANGE

Component no longer required

26

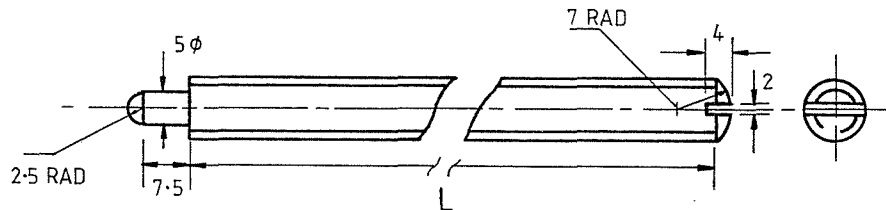
CAMBER SCREW BASE

Material: Mild Steel	
General Tolerance : $\pm 0.1$ mm	
Dimensions : mm's	
Quantity: 160 off	Scale: 1:1

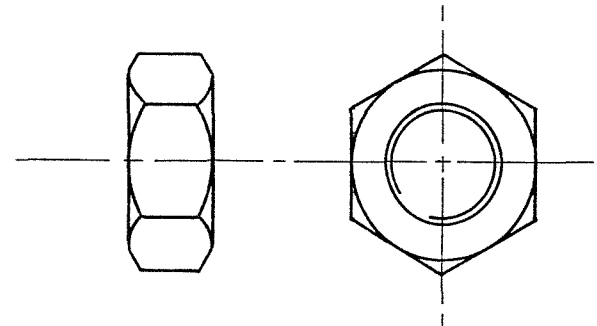
27

LOCATION TAG

Material:	
General Tolerance: $\pm 0.1$ mm	
Dimensions: mm's	
Quantity: off	Scale: 1:1



Quantity	L (mm)
40	70
40	90
40	105
40	125
30	145
35	165
15	175
16	180



28

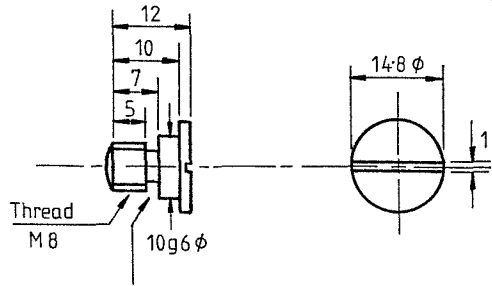
CAMBER SET SCREW

Material: 3/8" Steel Studing (BSW)	
General Tolerance : $\pm 0.1$ mm	
Dimensions : mm's	
Scale : 1 : 1	

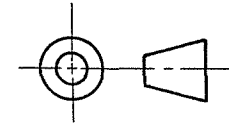
29

CAMBER LOCK-NUT

Material: Hex. 3/8" BSW Lock-nut	
General Tolerance : $\pm 0.1$ mm	
Dimensions: mm's	
Quantity: 80 off	Scale: 2:1



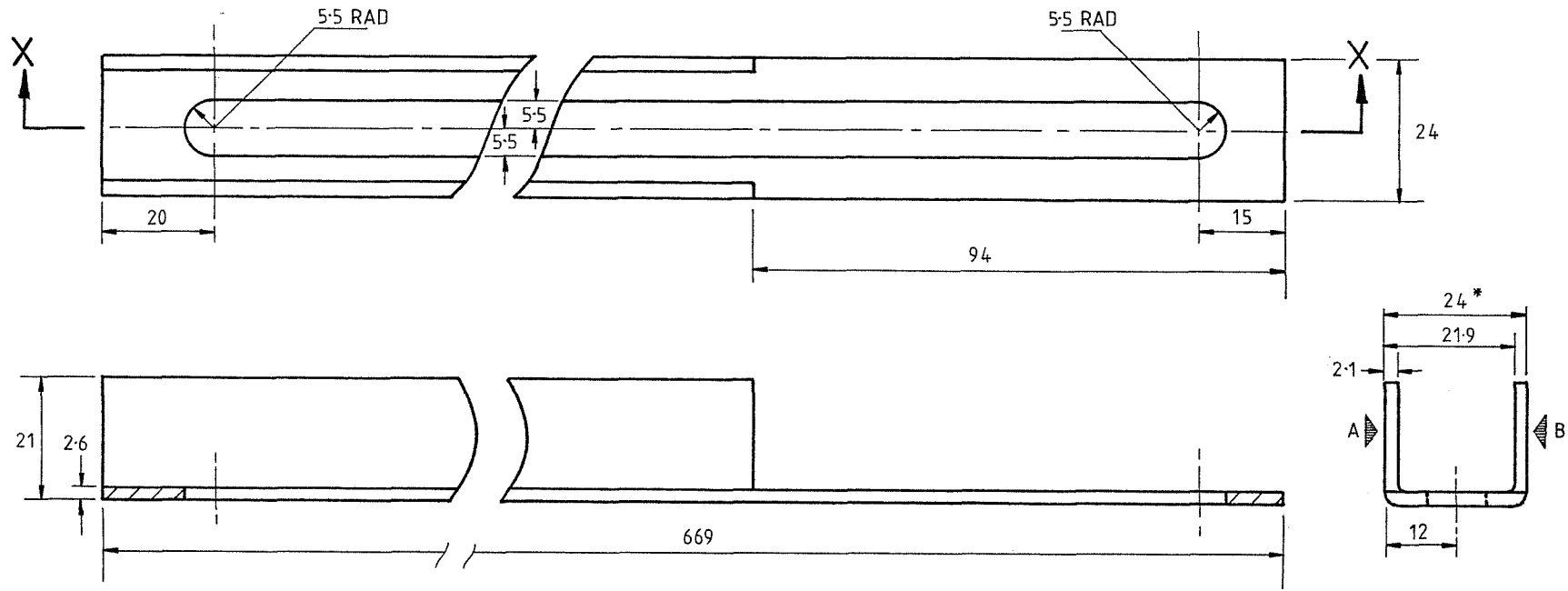
U'Cut depth 1 mm (□ form)



31

L.E. FRAME PIVOT

Material : Mild Steel
General Tolerance : ± 0.1 mm
Dimensions : mm's
Quantity : 48 off   Scale : 1:1

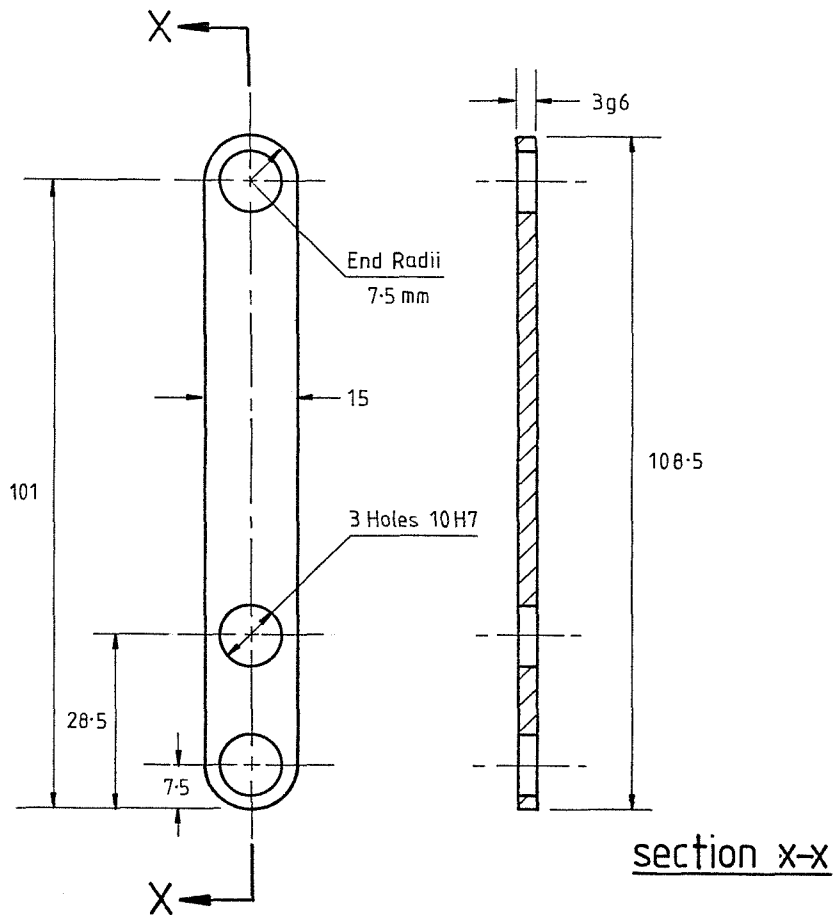


\* Note: to achieve this dimension using standard 25 x 25 x 2.6 tube requires the removal of 0.5 mm from 2 external surfaces (marked A & B)

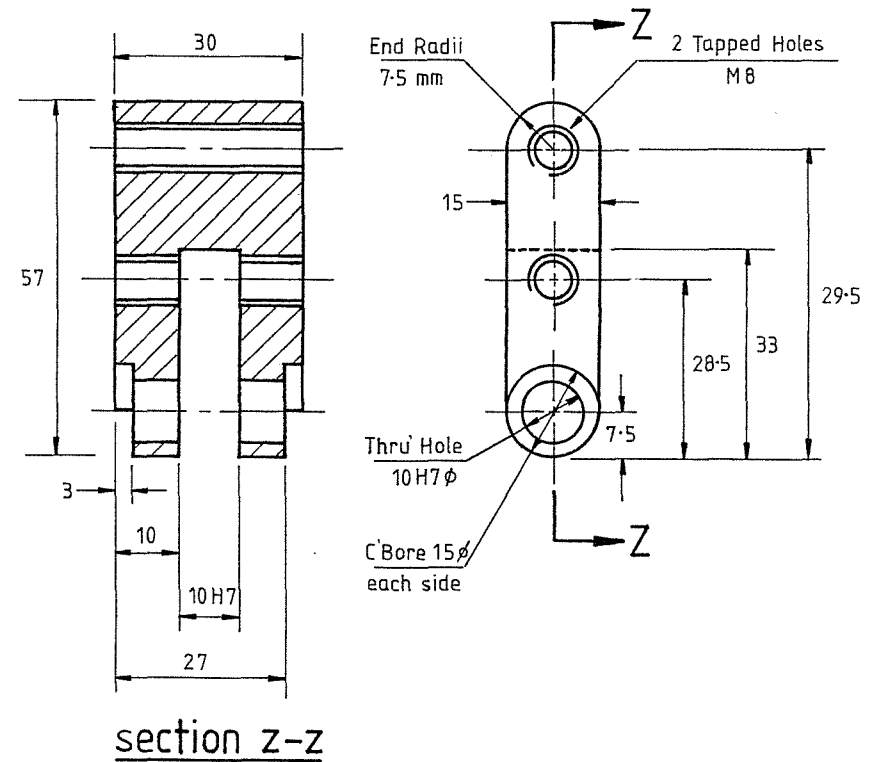
30

CAMBER CASSETTE FRAME

Material: 25x25x2.6 Steel Tube
Supplier: UBM Engineering Ltd.
Dimensions : mm's   General Tol: ± 0.1 mm
Quantity: 8 off   Scale: 1:1



Quantity: 16 off



Quantity: 8 off

32

L.E. ATTACHMENT LINKS

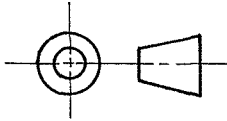
Material: Mild Steel

General Tolerance:  $\pm 0.1$  mm

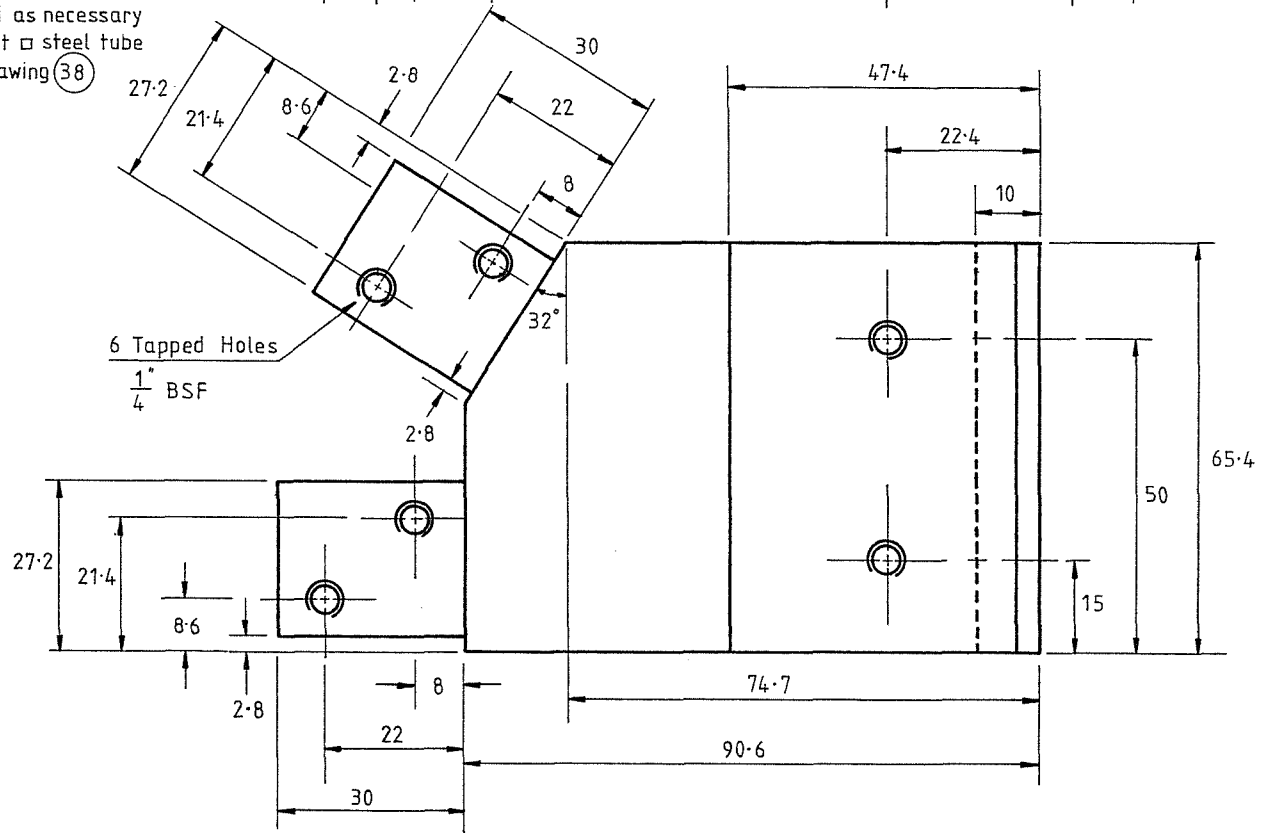
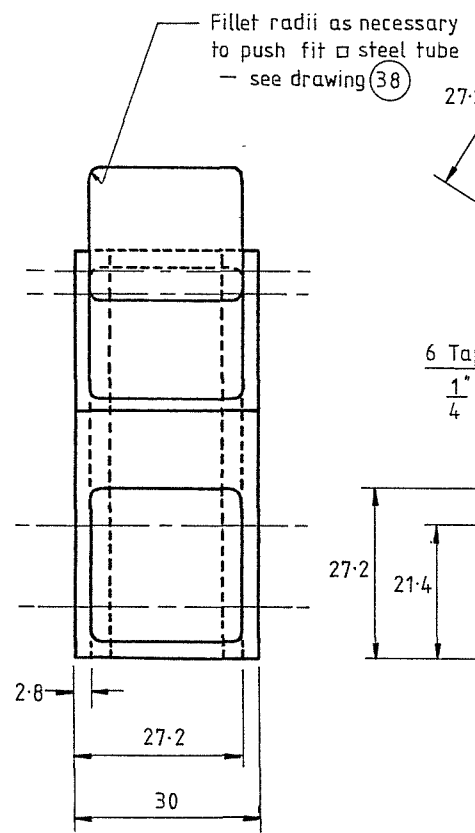
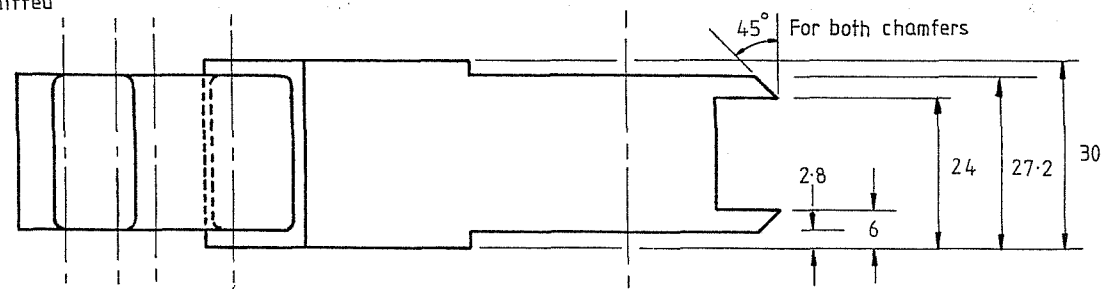
Dimensions: mm's

Scale: 1:1





Tapped hole hidden detail omitted

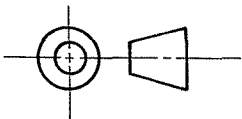


35

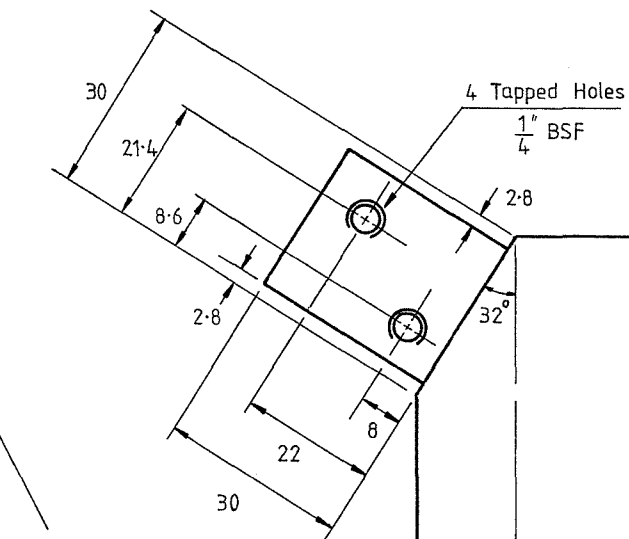
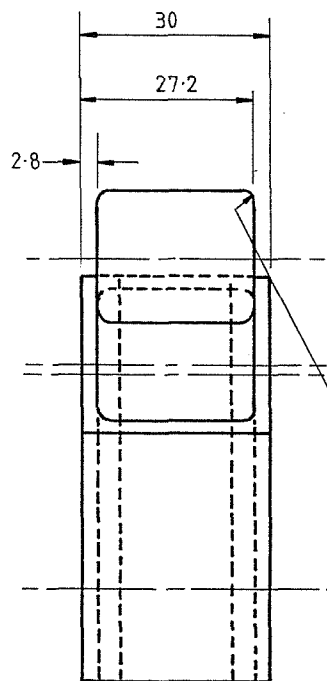
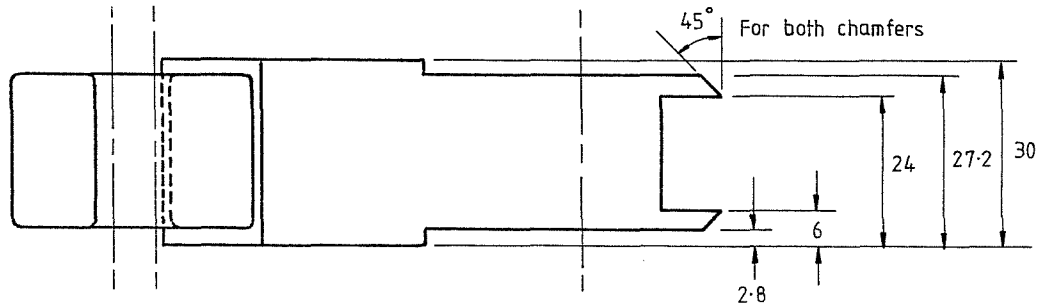
LOWER FRONT FRAME JOINT

Material: Mild Steel	
General Tolerance: $\pm 0.1$ mm & $\pm 0.2^\circ$	
Dimensions: mm's	
Quantity: 2 off	Scale: 1:1

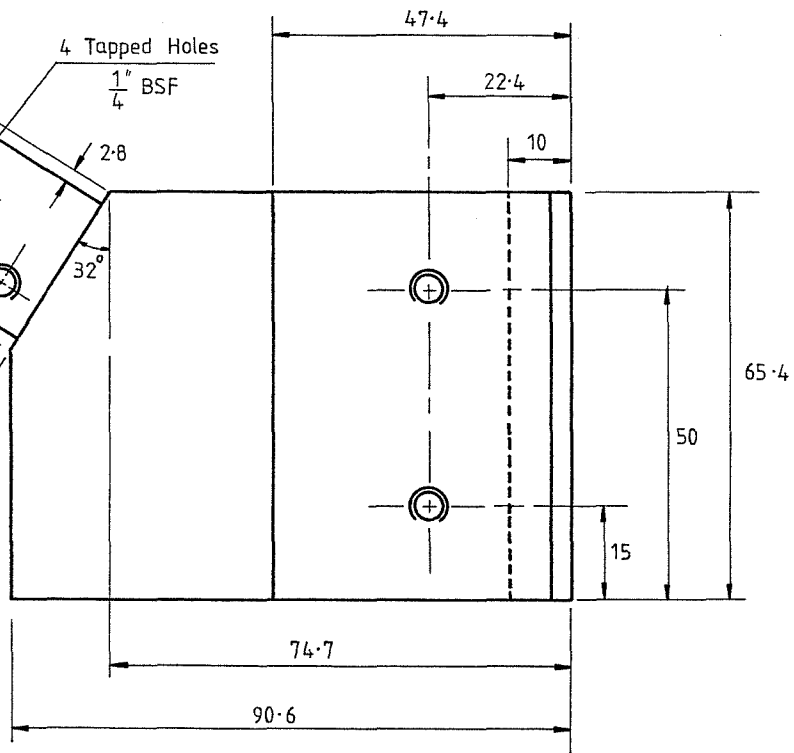




Tapped hole hidden detail omitted



Fillet radii as necessary to push fit  $\square$  steel tube — see drawing (38)



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LOWER REAR FRAME JOINT

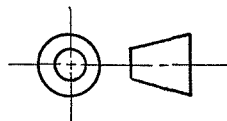
Material: Mild Steel

General Tolerance:  $\pm 0.1$  mm &  $\pm 0.2^\circ$

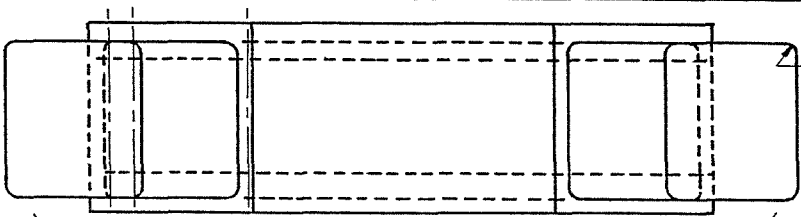
Dimensions: mm's

Quantity: 2 off

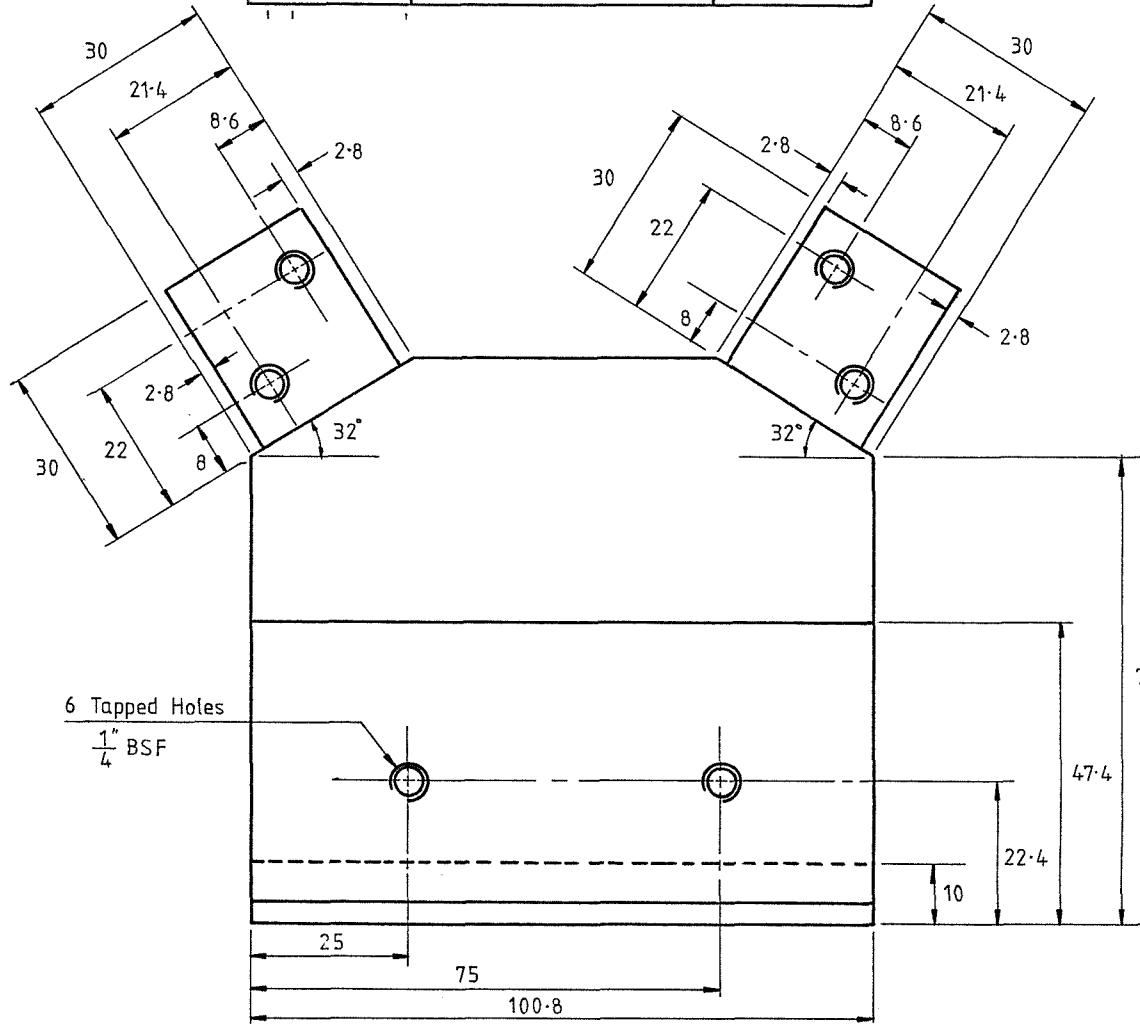
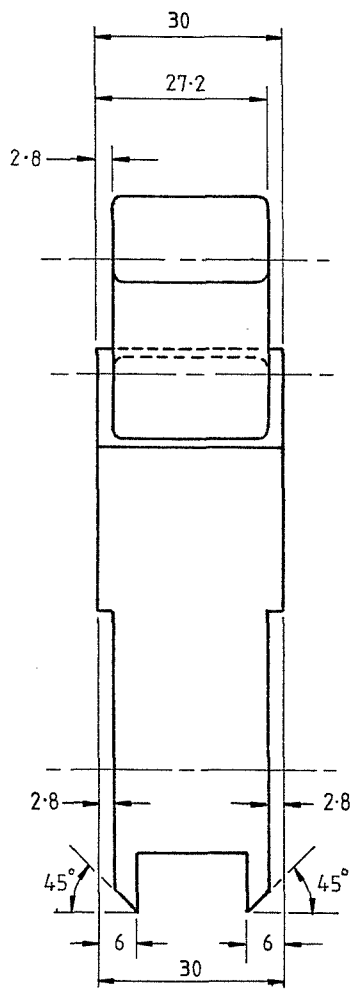
Scale: 1:1



Tapped hole hidden detail omitted



Fillet radii as necessary  
to push fit  $\square$  steel tube  
— see drawing (38)



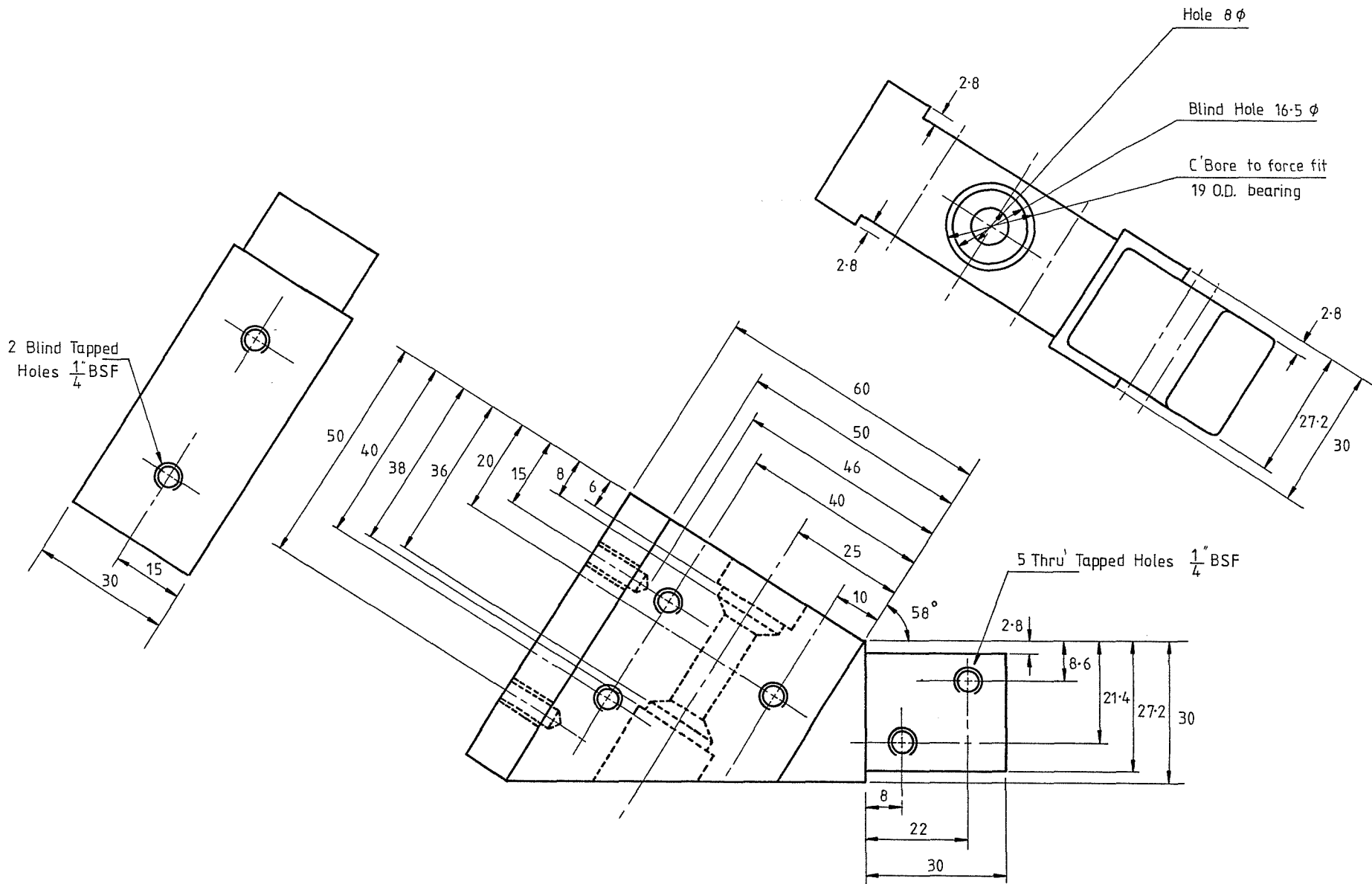
6 Tapped Holes  
 $\frac{1}{4}$ " BSF

37

LOWER MIDDLE FRAME JOINT

Material: Mild Steel	
General Tolerance: $\pm 0.1$ mm & $0.2^\circ$	
Dimensions: mm's	
Quantity: 2 off	Scale: 1 : 1

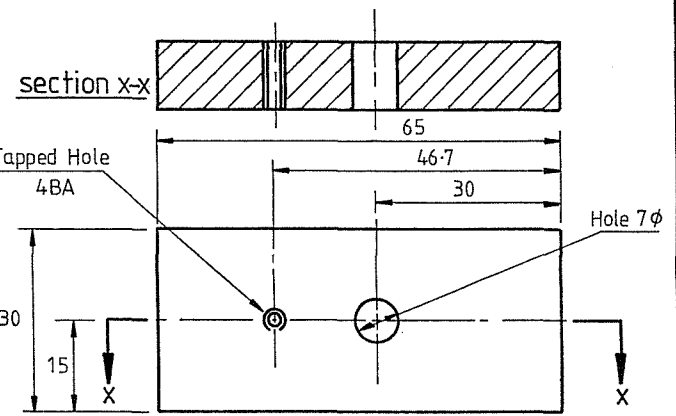
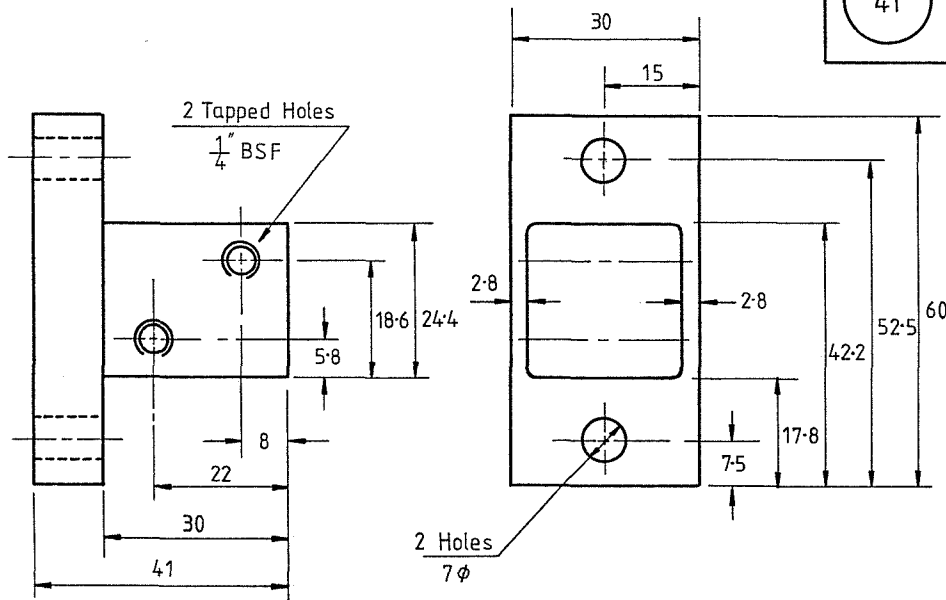
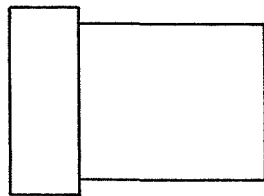
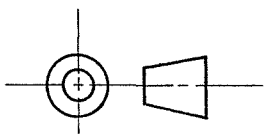




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FORWARD BEARING HOUSING  
(Type II S.F.)

Material: Mild Steel  
 General Tolerance:  $\pm 0.1 \text{ mm}$  &  $\pm 0.2^\circ$   
 Dimensions: mm's  
 Quantity: 2 off | Scale: 1:1



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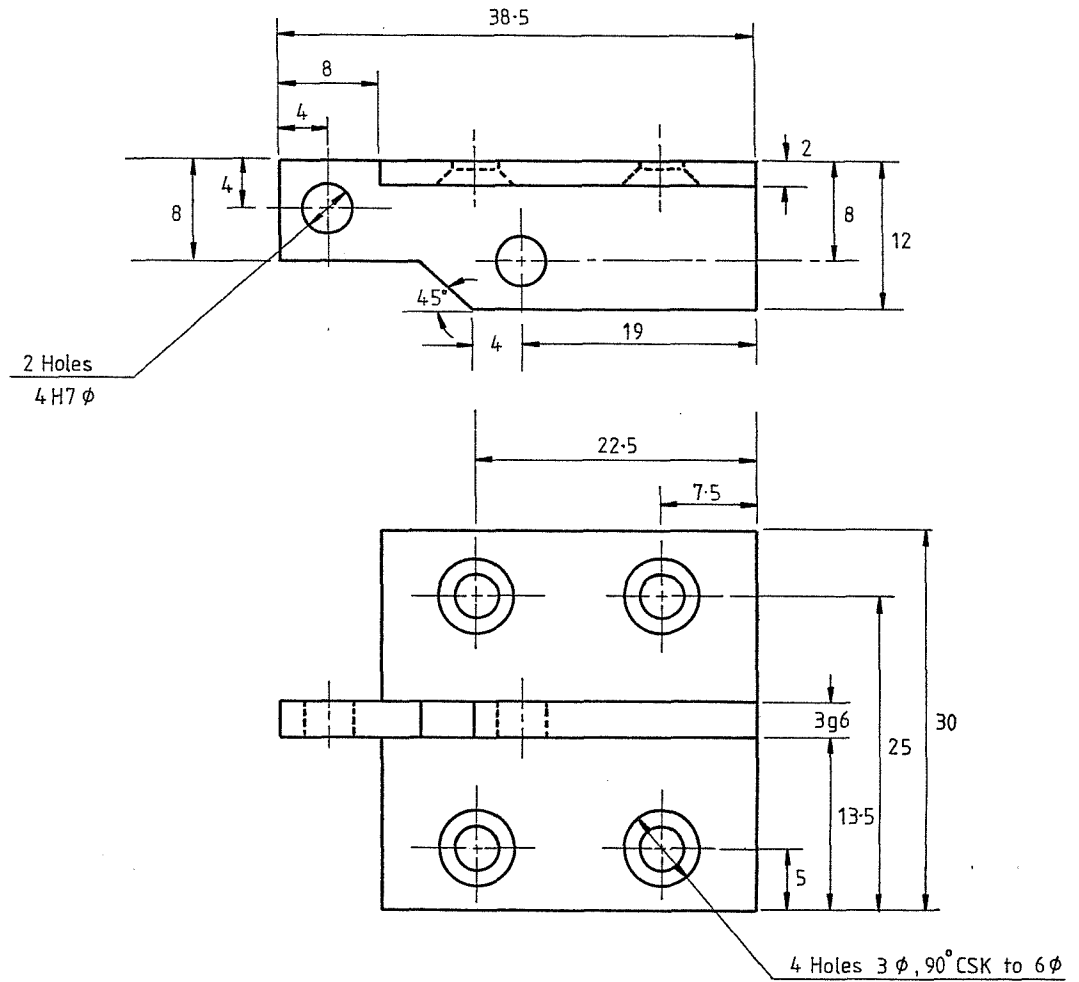
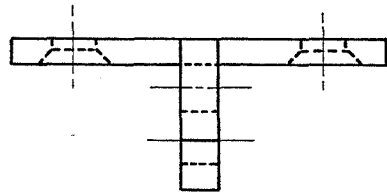
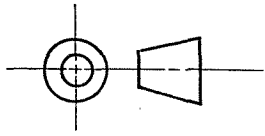
FIXING PLATE (Type II)

Material : Mild Steel	
General Tolerance : ± 0.1 mm	
Dimensions : mm's	
Quantity : 2 off	Scale : 1:1

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'T' JOINT (Type II S.F.)

Material : Mild Steel	
General Tolerance : ± 0.1 mm	
Dimensions : mm's	
Quantity : 2 off	Scale : 1:1



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AEROFOIL ATTACHMENT PLATE

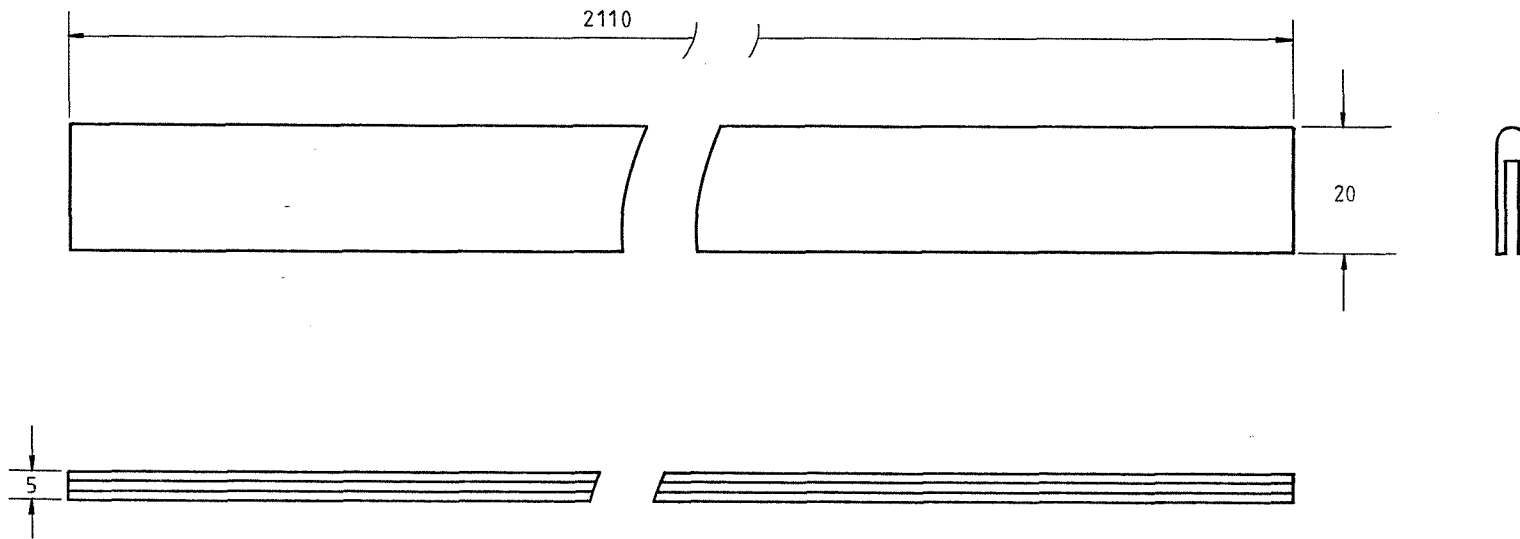
Material : Mild Steel

General Tolerance :  $\pm 0.1$  mm

Dimensions : mm's

Quantity : 8 off

Scale : 2:1



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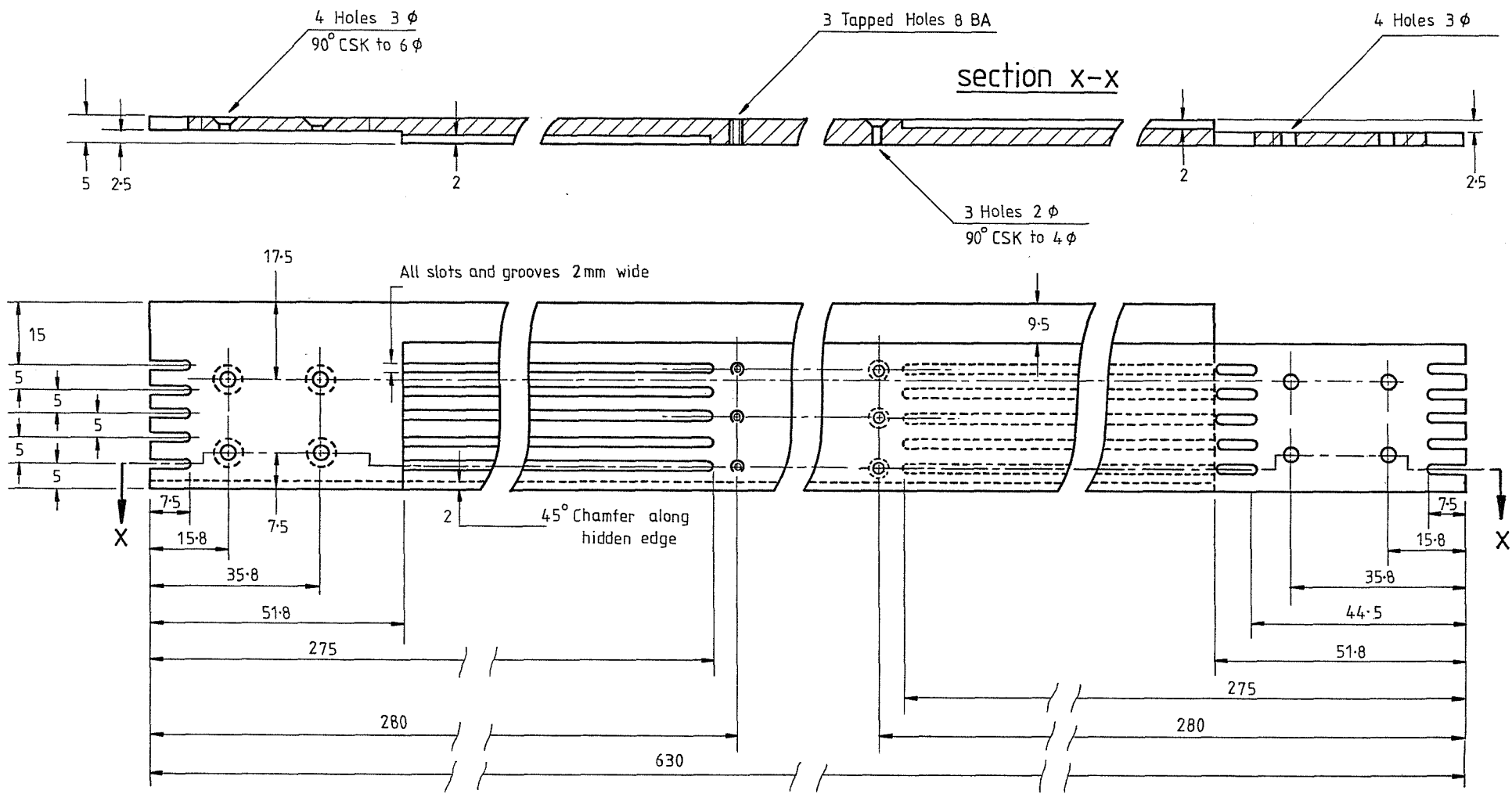
AEROFOIL STIFFENING ELEMENT

Material: Extruded Al. Section No. 924

Supplier: SAS Ltd

Dimensions: mm's | General Tol. :  $\pm 0.1$  mm

Quantity: 65 off | Scale: 1:1

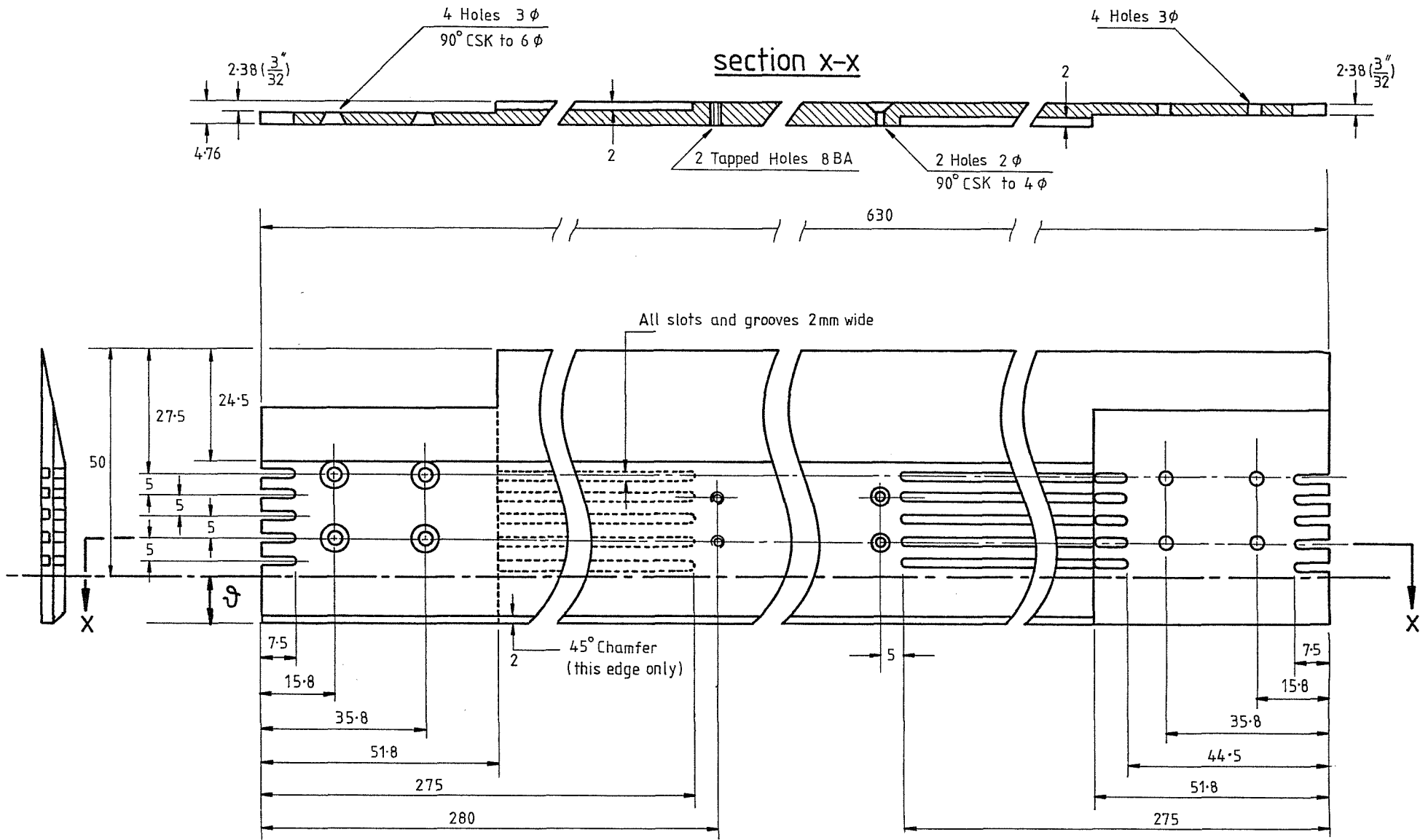


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AEROFOIL L.E. STIFFENER

Material : Mild Steel Flat 40x5 mm	
Supplier : K.R. Whiston Ltd	
Dimensions : mm's	General Tol : $\pm 0.1$ mm
Quantity : 3 off	Scale : 1:1

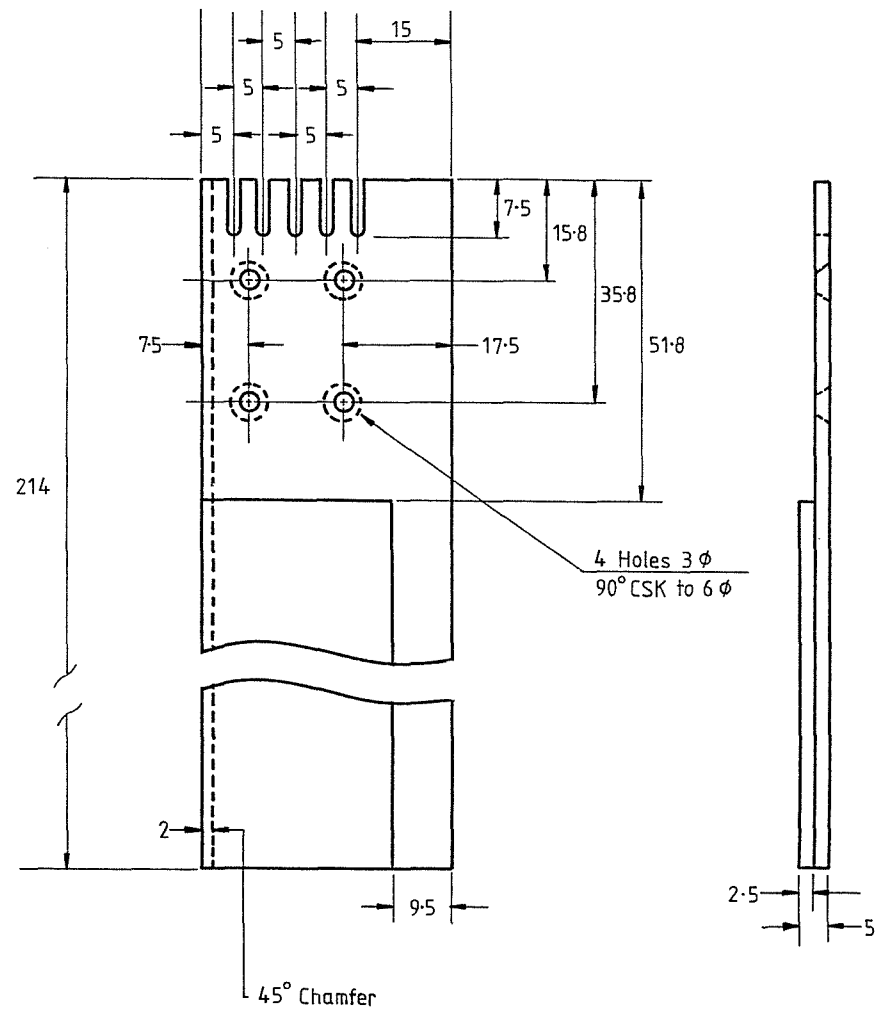
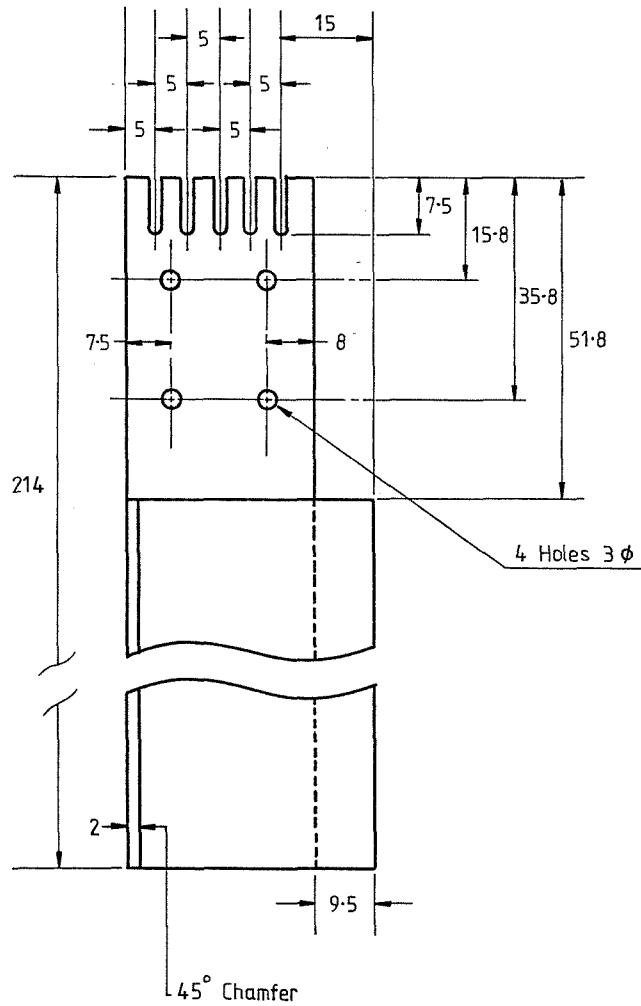
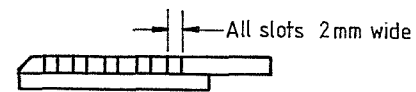
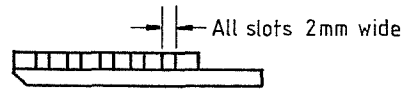




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AEROFOIL T.E. STIFFENER

Material : Aluminium 63.5 x 4.76 mm	
Supplier : SAS Ltd.	
Dimensions : mm's	General Tol : ± 0.1mm
Quantity : 3 off	Scale : 1 : 1



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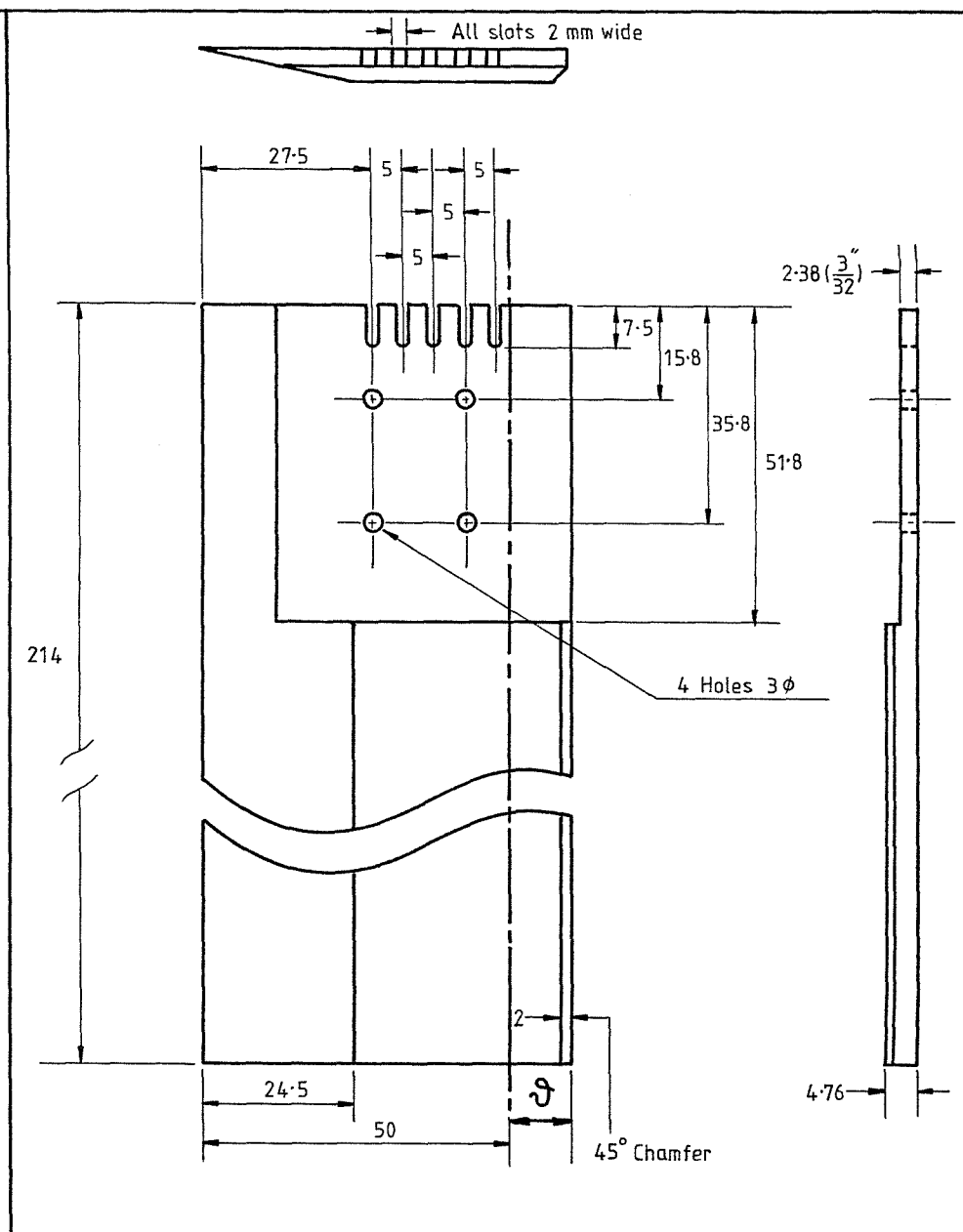
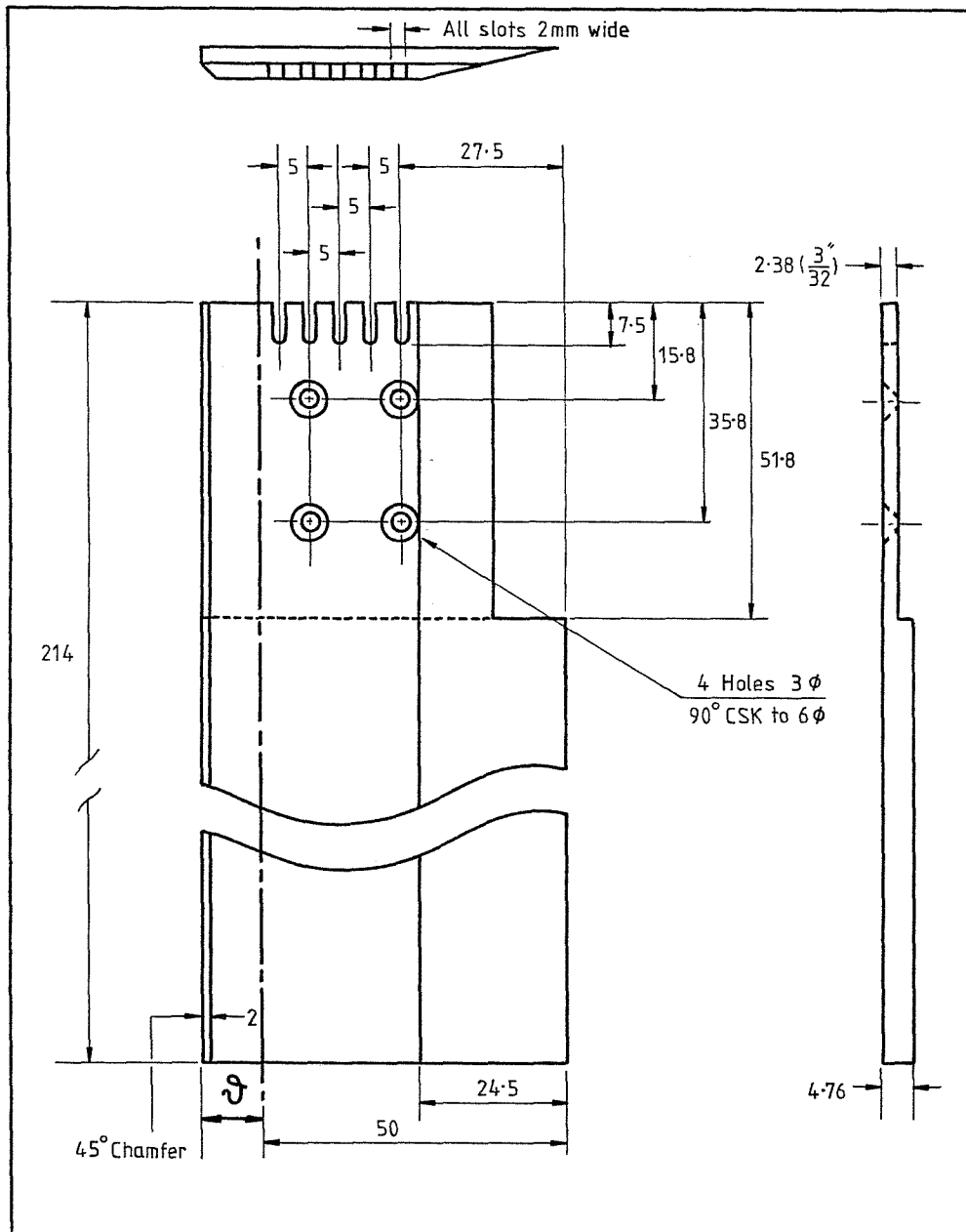
L.E. STIFFENER ENDS

Material: Mild Steel Flat 40x5 mm

Supplier: K.R. Whiston

Dimensions: mm's | General Tol: ±0.1mm

Quantity: 1 off each type | Scale: 1:1



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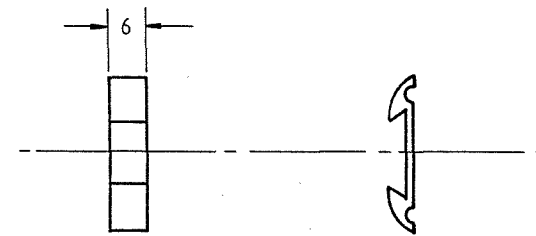
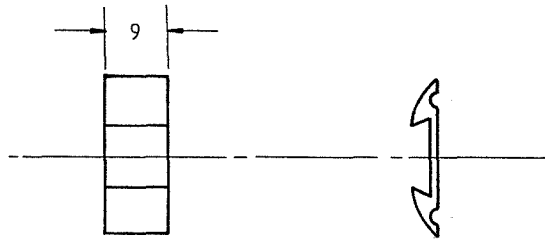
T.E. STIFFENER ENDS

Material : Aluminium 63.5 x 4.76 mm

Supplier : SAS Ltd

Dimensions : mm's | General Tol : ± 0.1 mm

Quantity : 1 off each type | Scale : 1:1



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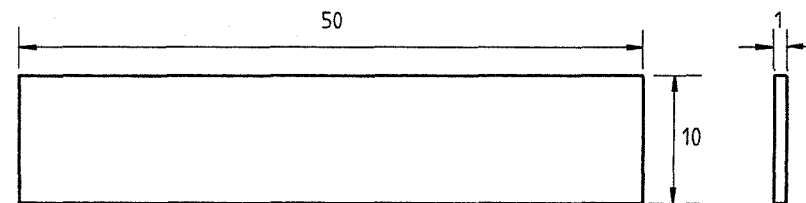
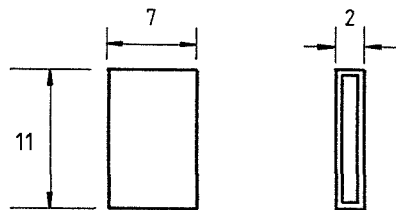
UPPER SURFACE TRACK

Material: Extruded Al. Section 986  
 Supplier: SAS Ltd.  
 Dimensions: mm's General Tol:  $\pm 0.1$   
 Quantity: 195 off Scale: 1:1

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LOWER SURFACE TRACK

All details as for (49)  
 Quantity: 455 off



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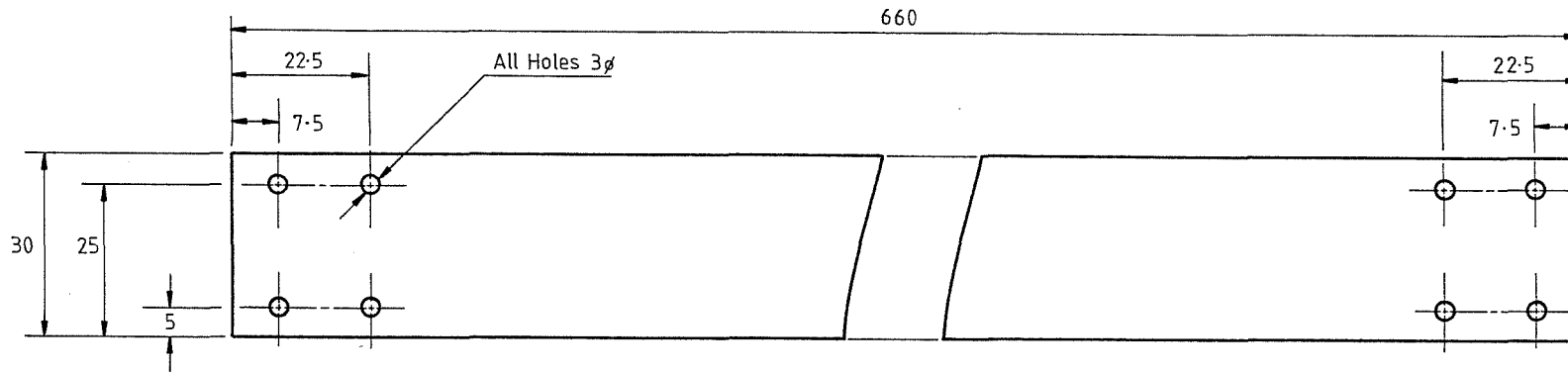
CLIP ( FEMALE )

Material: Brass Hollow 11x2x0.5 mm  
 Supplier: G.M.H. Bunce Ltd  
 Dimensions: mm's General Tol:  $\pm 0.1$   
 Quantity: 195 off | Scale: 2:1

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CLIP ( MALE )

Material: Steel  
 Dimensions: mm's  
 General Tolerance:  $\pm 0.1$  mm  
 Quantity: 80 off | Scale: 2:1



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TENSION STRIP

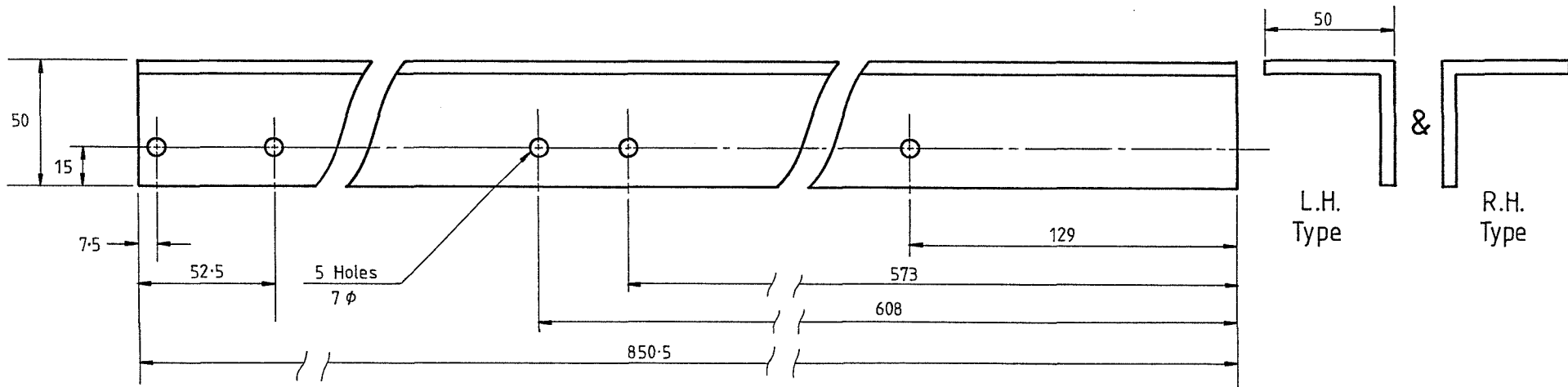
Material : Spring Steel

Dimensions : mm's

General Tol. :  $\pm 0.1$  mm

Quantity : 4 off

Scale : 1:1



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FRAME BASE  
(TYPE II S.F.)

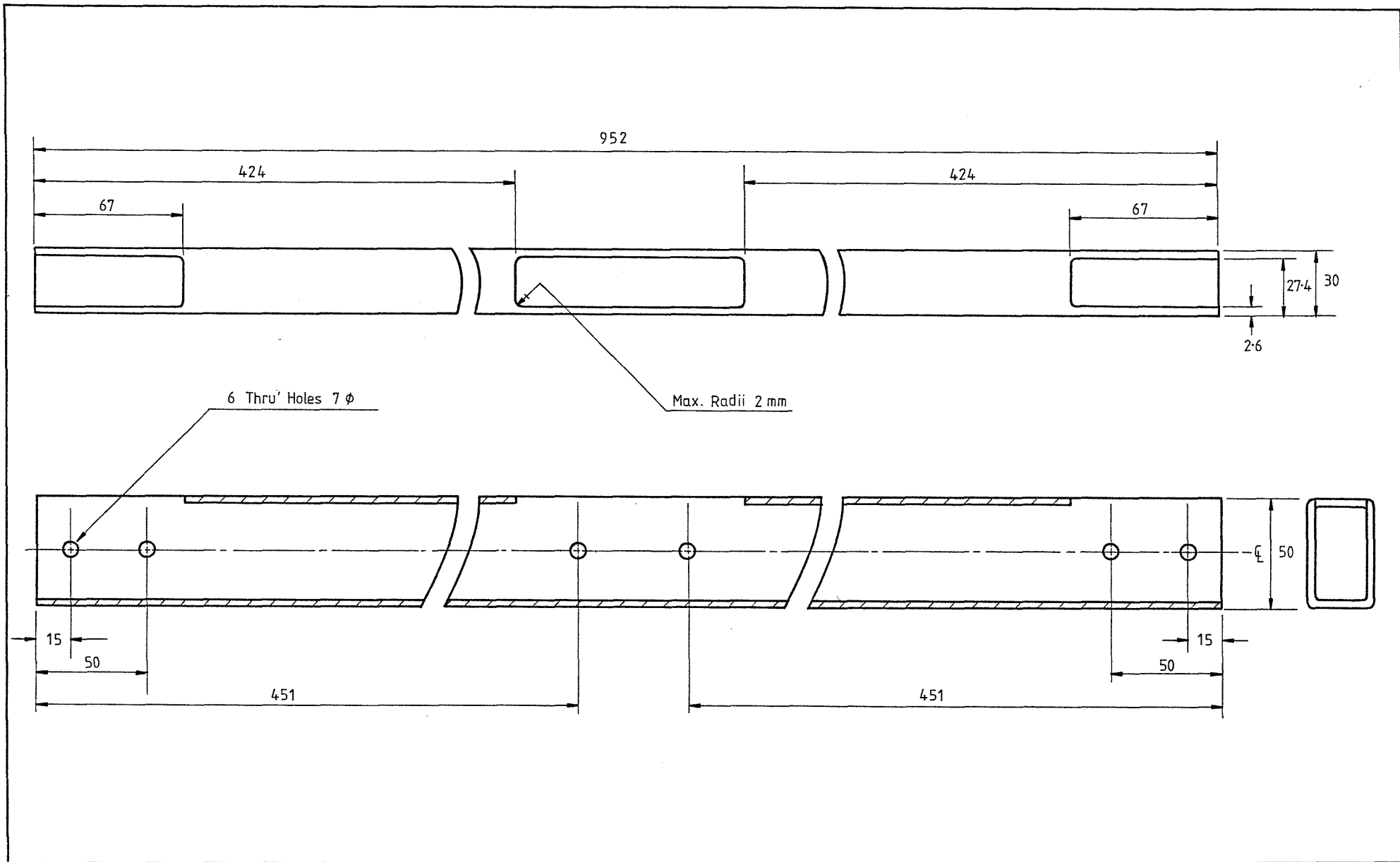
Material : Steel Equal Angle 50 x 50 x 5

Supplier : UBM Engineering Ltd.

Dimensions : mm's | General Tol :  $\pm 0.1$  mm

Quantity : 1 off each type

Scale : 2:1



<div style="border: 1px solid black; border-radius: 50%; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center;">57</div>	FRAME BASE	Material: 50x30x2.6 Steel Tube	
		Supplier: UBM Engineering Ltd	
		Dimensions: mm's	General Tol: $\pm 0.1$ mm
		Quantity: 2 off	Scale: 2:1

**STOCK LISTS**

COMPONENT	MANUFACTURER	LENGTH	QUANTITY	DRAWING No.
Circlips E-Type for 4 mm $\phi$ shaft to BS 3673	—	—	48	① & ③
Circlips C-Type for 10 mm $\phi$ shaft to BS 3637	—	—	8	①
Steel Tube 30x30x2.6	UBM Engineering Ltd.	326.7	18	③⑧
		605.3	2	③⑧
		785	4	②⑤
Steel Tube 25x25x2.6	UBM Engineering Ltd.	669	8	③⑩
Steel Tube 50x30x2.6	UBM Engineering Ltd.	623.3	4	⑩
		952	2	⑤⑦
Aluminium Flat 9.2x6.35	SAS Ltd.	14	160	⑤③
Aluminium Flat 19x3.2	SAS Ltd.	14	80	⑤①
Aluminium Flat 9.2x4.76	SAS Ltd.	214	130	④⑧
		630	195	④③



COMPONENT	MANUFACTURER	LENGTH	QUANTITY	DRAWING No.
Aluminium Flat 63.5x4.76	SAS Ltd.	214	2	(47)
		630	3	(45)
Spring Steel Strip 4 mm wide 31 or 32 BG	—	9	160	(54)
Brass Hollow 11x2x0.5	G.M.H. Bunce Ltd.	3 ft	14	(49) & (50)
Mild Steel Flat 40x5	K. R. Whiston Ltd.	214	2	(46)
		630	3	(44)
$\frac{3}{8}$ " BSW Steel Studding	E. M. Lawson & Son Ltd.	31.5 m	—	(28)
Square Steel Rod 20x20	UBM Engineering Ltd.	25	160	(26)
$\frac{1}{2}$ " BSW Steel Studding	E. M. Lawson & Son Ltd.	145	4	(20)
		655.3	4	(11)
M6 Nut to BS 3692	—	—	8	(12)

COMPONENT	MANUFACTURER	LENGTH	QUANTITY	DRAWING No.
¼" BSF, Full Bearing head type, standard hexagon screw	—	14.5	4	⑧
8 BA Screws	—	—	214	△23
Rubber sheet 2110x690	—	—	1	△22
Rivet 90° CSK head 3∅ shank, Al. Alloy BS4620 1970.	—	10	16	△19
Rivet 90° CSK head 3∅ shank, mild steel BS 4620 1970.	—	10	16	△15
Rivet, Flat head 2∅ shank, Al. Alloy BS4620 1970.	—	8	730	△21 & △14
Polyester sail cloth M80	Vectis Sailcloth Ltd.	—	1	△17
Rivet, Flat head 1∅ shank, Al. Alloy.	—	16	160	△18

COMPONENT	MANUFACTURER	LENGTH	QUANTITY	DRAWING No.
Plastic tapping tube. 1.5 O.D.	—	113m	—	△16
$\frac{3}{8}$ " BSW Nuts	—	—	80	△2
$\frac{1}{4}$ " BSF Bolts Steel	—	—	74	General Use.
Single row radial Ball Bearings Type 626 Z	R.H.P. Bearing Ltd.	—	16	△4 & △6
Steel Equal Angle 50x50x5	UBM Engineering Ltd.	850.5	2	⊙55