569858 INWARD. J.

Form 27.

AUG.36

B.3

ROYAL AIR FORCE.

SKETCH BOOK.

(FOR USE OF THE AIRCRAFT APPRENTICES' TRAINING ESTABLISHMENTS, THE ROYAL AIR FORCE COLLEGE, AND THE OFFICERS' ENGINEERING COURSE, HENLOW.)

T. 2624. Wt: 6246 5,000 Bks. 12/33. Wy.& S. Ltd. 207493.

SEAT No

23

Fitter II
Course

AUG '36
B3

Nº 569858. INWARD. J.

Nº 3 WING

Seat Nº
23

LETTERING AND FIGURING.

All titles and remarks on a drawing invariably should be printed, not written.

Kinds of Type.

a) Block Type - for important entries - Headings, Titles, etc. A, B, C, D, E, F, etc..
b) Small Type - (script) for general purposes, e.g. a, b, c, d, e, f, g, (small capitals may be used if desired) Rear Spar.

Hints on Lettering.

1. Keep HEIGHT uniform, use DOUBLE GUIDE LINES on plain paper.
2. Keep SLOPE uniform - all vertical or all sloping. Occasional faint guide lines may be used if slope gives trouble.
3. Pack LETTERS CLOSELY TOGETHER to avoid SPACING difficulties.
4. Keep TYPE of letter uniform - dont mix capitals and smalls indiscriminately.
5. A plain style of lettering is advisable, without any unnecessary flourish.
6. Height. Width is a useful rule for proportions.
7. Fat letters are preferable, but if you have a good natural style, stick to it.
8. Avoid extremes of sizes - over-large or painfully small.

Hints of Figuring

1. Use PRINTED NUMERALS 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.
2. Guide lines are unnecessary.
3. Make FAT FIGURES.
4. Fraction line to be HORIZONTAL, thus $\frac{1}{4}$, $\frac{3}{4}$, $\frac{3}{8}$ etc.

569858 INWARD.J		
Aug 36/33	2 hrs	22/9/36

For dia 'A' of holes see table

These 2 Rivets Countersunk

Use Pressing PS45

0·45 Pitch

PERSONAL SCHEDULE

Drill 1/8 dia. Pilot hole bolt sides.

Drill & ream 1/4 dia Fit 8 in position.

0·08" Dia. rivets.

Use Pressing PS45

1/8" dia Rivet 1" Long

Distance Piece

0·25" dia. x 16 S.W.G. Tube

To be built up round 1½" o/o Tube which is enclosed in a split sleeve.

8

STANDARD ITEM SCHEDULE

	No off 4	Finish Black
WIRING PLATE	SCALE F.S.	ITEM No 345
SISKIN 3A	Mat M.S.	DRG. No 127/3A

DRAWING INSTRUMENTS

Drawing Board
½ Imperial - Only 1 Working Edge (L.H. Edge).

Tee Square
Pearwood - Blade tapered and bevelled. Stock always used against working edge of Board.

Boxwood Scale
Specially designed - Engineer's type - 6 scales - Dimensions may be taken from either end. Has Full Size, ½ F.S., ¼ F.S., ⅛ F.S., Full Size Decimal and Metric Scale.

Set Squares
Celluloid, 90°, 60°, 30° and 90°, 45°. Always use long edge as a bearing or sliding edge.

Protractor
Celluloid, Semi-circular. Measures either clock or anti-clockwise.

Compasses
6" - Needle point and lead are adjustable. Excessive tightening may strip thread.

Spring-Bows.
Needled point and lead adjustable - Always relieve tension on spring after use.

Ships Curves.
Celluloid - very brittle.

Pencils
At least 2 grades required - Sharpen point with pen knife. Trim points with sandpaper or emery cloth.

Rubber
The softer the better. Always clean edge on scrap paper before using.

Testing Instruments.

Tee Square
Look for slackness between blade and stock. Look for damaged edge.

Set Squares.
Draw angle - reverse square - re-draw angle - angles should coincide.

USE OF DRAWING INSTRUMENTS

For Horizontal Lines use Tee Square against working edge of Drawing Board.

For Vertical Lines use Set Square on Tee Square.

For Angles 30° 60° 45° 90° and multiples of 15° use appropriate Set Square (s) on the Tee Square (not on scale)

For other Angles use Protractor.

For Parallel Lines use Set Squares. Method:- 1) Place shorter edge of 1st Set Square on given line
2) Place long edge of 2nd Set Square against long edge of 1st Square.
3) Slide 1st Set Square against 2nd Set Square in required direction, keeping 2nd Set Square steady.

For Circles and Arcs of Circles use Compasses with modified chisel point.

For Circles and Arcs of Circles under 1/2 diameter use Spring Bow. Use screw for fine adjustment only

Note: Always set out Radii direct from Boxwood Scale to Paper and adjust Compasses or Spring Bows to this setting out.

Method of placing Compasses on Rule is correct for Workshops Practice but incorrect and inaccurate on Drawing Board.

For Other Curves - profiles etc., use Ships Curves.

For Lettering and Freehand Work use H. or H.B. pencil with round point.

For Drawing Lines use 2H or 3H pencil with chisel point.

ORTHOGRAPHIC PROJECTION.

ORTHO : Right, correct, true. PRO : forward.
GRAPHIC : writing or drawing. JECT : thrown.

ORTHOGRAPHIC PROJECTION implies a throwing forward of a true view of an object on to a flat surface called a PLANE.

It is based on the supposition that the object is placed in the angle formed by the intersection of a VERTICAL PLANE (V.P.) with a HORIZONTAL PLANE (H.P.). N.B. The line of intersection is called the ground line or XY line.

The view projected on to a V.P. is called an ELEVATION.

The view projected on to an H.P. is called a PLAN.

The following points hold good.

a) The PLAN is below the ground (or XY line) and the ELEVATION is above it.

b) The Plan and Elevation of the same point are exactly one under the other on a line perpendicular to the ground line. Therefore the PLAN of a SOLID should be directly under its ELEVATION.

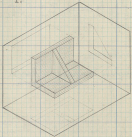
c) HEIGHTS above the H.P. are shown in the ELEVATION.

d) DISTANCES in front of the V.P. are shown in the PLAN.

e) The PROJECTORS are shown by lines joining the same points in PLAN and ELEVATION and are perpendicular to the ground line.

f) The positioning of Plans and Elevations can be varied to suit our convenience but it is usual to place them as if the object rested on the H.P.

1.



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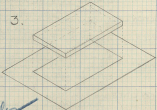

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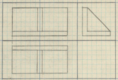
2.



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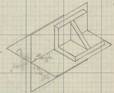

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DRAWING DETAILS.

CENTRE LINES.
1. Must be "CHAIN DOTTED" type.
2. Actual CENTRE must come at inter-section of two dashes.
3. Relative lengths of long and short dashes may be varied to suit job.

CONSTRUCTION LINES.
1. Faint continuous lines capable of being erased by one application of the rubber.
2. They form the basis for all other types of lines.

FULL LINES.
1. Continuous firm, clear lines.
2. Must not indent surface of paper.
3. Used to indicate edges which in an object can be seen.

LIMIT LINES.
1. Same strength as construction lines.
2. Should extend from line or edge located to slightly beyond arrow head.
3. Should follow general sense of the drawing, e.g. in isometric work.

DIMENSION LINES and FIGURES.
1. Same strength as construction lines.
2. Must be broken to receive dimension figures.
3. Should be outside the object wherever possible and well clear of the outline.
4. When centre lines cross a dimension line the dimension line is placed on one side.
5. Dimensions should be normal to dimension line.

DOTTED LINES
1. Short dashes evenly spaced.
2. Size depends on job.
3. Used for hidden outlines.
4. Same strength as full lines.

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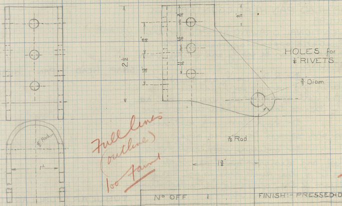


Full lines (outline)
100 Jamie
9

FORK FOR SKID TUBE Reqd for O.H. 6	No OFF 1 SCALE F.S MATERIAL:- M.S. 8. S.W.G	FINISH:- PRESSED & DRILLED PART No:- 9314 DRG. No H.S. 70

CONVENTIONAL REPRESENTATION OF RIVETS.

RIVETS. Rivets are permanent "fasteners" used to connect sheets or plates of metal.

TYPES of RIVETS chiefly used in the R.A.F. are SNAP HEAD, PAN HEAD, COUNTERSUNK, and TUBULAR.

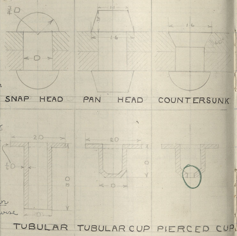
The CONVENTIONAL DRAWING SHAPES for the heads illustrated opposite approximate the actual shape and can be easily and quickly drawn

PROPORTIONS.

For R.A.F work a 1/4" diameter rivet hole is ·003" oversize for Mild Steel or ·006" oversize for light alloys or aluminium, but no account of this is taken on the drawing board.

For high class work rivet holes are drilled and reamered to required size.

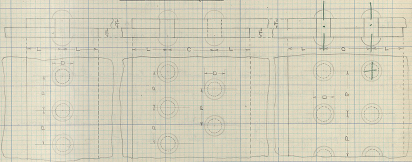
For ordinary work rivet holes are punched and designer must see that the diameter of the rivet hole is not less than the thickness of the plates to be riveted otherwise the punch will fail by crushing.



RIVETS (continued)

LAP and BUTT JOINTS. In lap rivetting one plate overlaps the other and the rivets pass through both plates. In butt rivetting the plates are kept in alignement and one or more ~~plates~~ butt straps or cover plates are placed over the joint and rivetted to each plate.

RIVETED JOINTS (LAP)



Single rivetted   Double staggered   Double chain

The PITCH is the distance from centre to centre of two rivets in the same line. In setting out rivet holes the distance between each hole should not be less than D (where D = diam of rivets). The minimum pitch = 2D. The distance between edge of plate and first line of rivets should not be less than 2D.

Minimum distance between rows. 2D for staggered and 2½D for chain riveting.

Note.

A single riveted lap joint has one row of rivets.

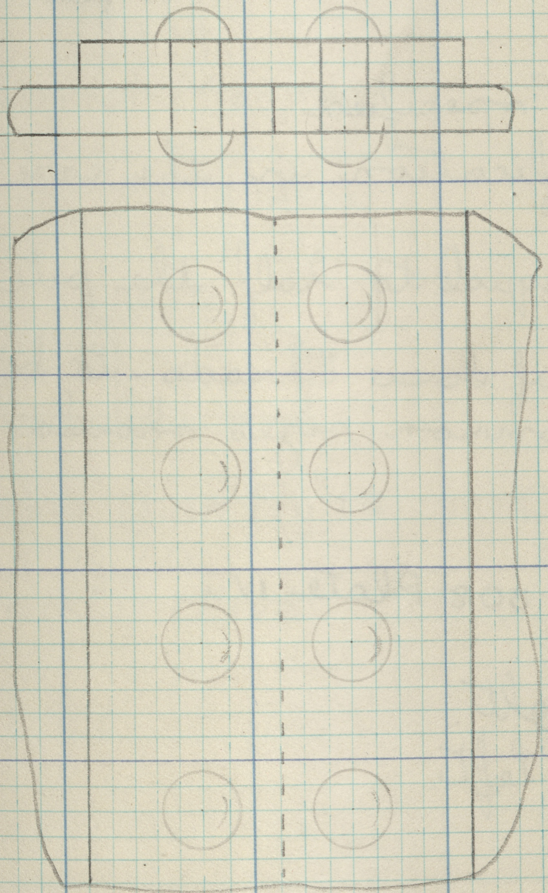
A single riveted butt joint has two rows of rivets.

A double riveted lap joint has two rows of rivets.

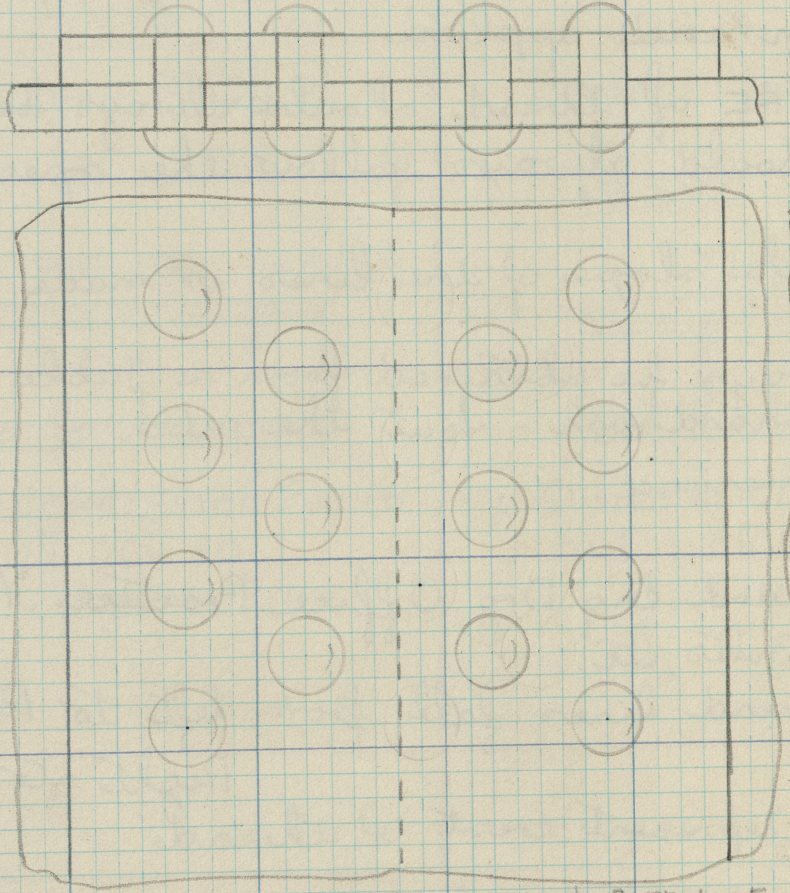
A double riveted butt joint has four rows of rivets.

i.e. the terms single and double refer to the number of rows of rivets passing through each plate in the joint.

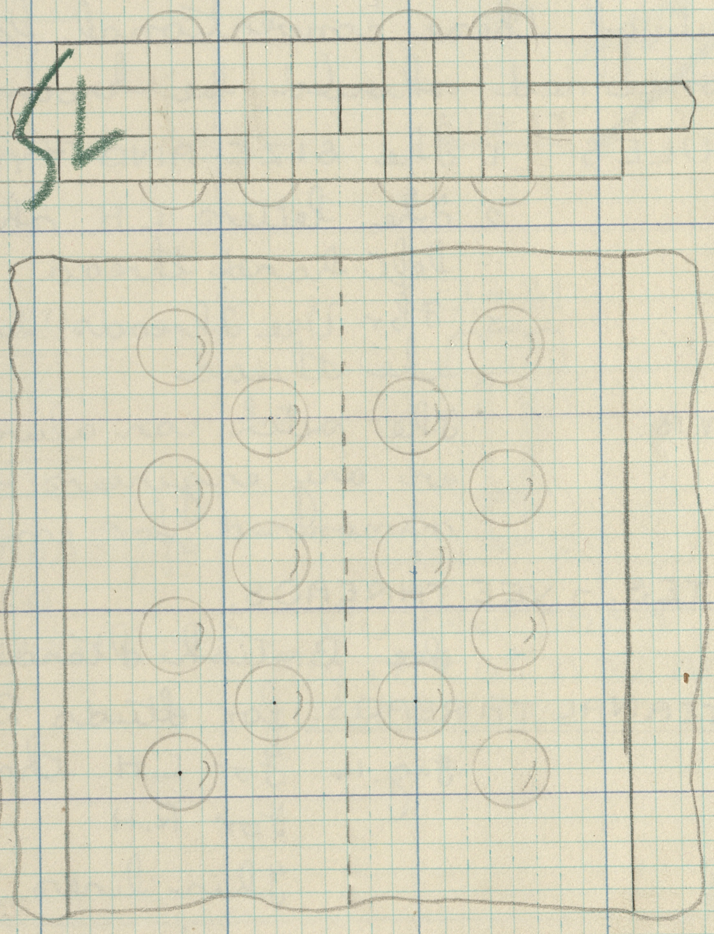
RIVETED JOINTS (BUTT).



Single riveted lap joint



Double riveted staggered Burr Joint



Double Riveted staggered Burr Joint

REPRESENTATION OF SCREW THREADS

The projection of a screw thread is based on ~~gives~~ a curve called a HELIX (pl. HELICES). To project this curve correctly for all the screw threads on a drawing would take considerable time, so in order to ~~same~~ save time screw threads are generally represented in one of the following CONVENTIONAL FORMS according to the circumstances under which the threads appears. A drawing or sketch can be completely spoiled by careless setting out of these conventional forms and it is extremely important that the few rules concerned should be known and applied.

RULES
1. The SIZE AND TYPE of thread should always be specified.
2. The letters L.H. should always follow the specification in the case of a left hand thread.
3. For Vee Threads the slope of the lines is made equal to half the pitch of the thread.

N.B. The pitch can always be obtained from a Table of Screw Threads - to be found in any engineer's handbook - but the pitch of common sizes should be memorised for convenience.

NOTES. - VEE THREADS.

See British Standard Eng. Drg. Office Practice No. 308 Plate IV.

EXTERNAL THREADS. for Studs, Bolts, etc.

Fig. 14. For L.H. thread lines fall from Left to Right.
For R.H .. .. Right to Left.
Thin lines represent crest of thread.
Thick .. .. root .. ..

Pronounce style

EXTERNAL THREADS | INTERNAL THREADS | ASSEMBLIES

¼ B.S.W. L.H. ¼ B.S.W.

FIG. 14.
Normal Method

SECTION ¼ B.S.P.

FIG. 16
Normal Method

¼ B.S.W

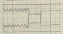


FIG. 18
Normal Method

FIG. 17.

¼ B.S.W. L.H. ¼ B.S.W.

FIG. 15

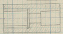
Quicker than Fig 14 but not so distinctive

FIG. 19 ¼ B.S.P.

Quicker than Fig 16 but not so distinctive.

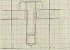
¼ B.S.W

FIG. 20.



Quicker than Fig 18 but not so distinctive

FIG. 21



Quicker than Fig 17 but not so distinctive

8

ALTERNATIVE METHODS FOR INDICATING SCREW THREADS

Use guide lines to get Root uniform.
Radius at end of stud = D ÷ ½" in this case.
Fig. 15. Quicker than Fig. 14 but not so distinctive.

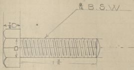
EXTERNAL THREADS (Section) for piping etc.
Fig 16. Zig Zag lines to be done freehand - use guide lines.
Fig 19. Slightly quicker the Fig. 16, but not so distinctive.

INTERNAL THREADS. For Tapped holes etc. Should always be shown in section.
Fig. 17. Used when mating with solid male member.
Note. Slope of lines is reversed to indicate threads at back of hole.
Fig. 18. Generally used. Zig Zag lines freehand - use guide lines.
Note: Back of thread is omitted for quickness. Observe "undercut" of thread.
Fig 20. Slightly quicker than Fig 18, but not so distinctive.

IMPORTANT. Do not mix methods in one drawing.

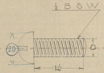
SQUARE THREADS: - See Rowarth's Elements of Eng. Drg. Plate 23.
Fig 7. Single Thread - note dotted lines, and altered slope Crest is opposite Root.
Fig 8. Double Thread - note dotted lines and altered slope. Crest is opposite Crest.
Fig 10. Single Thread - left hand.

EXTERNAL (SECTION). Fig 11. Single Thread.
Fig 12. Double Thread.



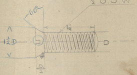
SET SCREW

SCALE 2F.S. (APPROX)



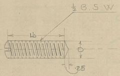
CUP-HEADED (SNAP) SCREW

SCALE



COUNTERSUNK HEAD SCREW

SCALE

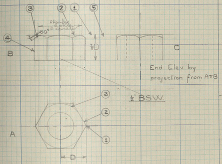


GRUB SCREW

SCALE

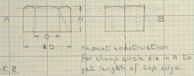
10

EASTER TERM 1937



CASE 1

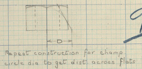
METHOD WHEN THREE VIEWS ARE REQUIRED



CASE 2

METHOD WHEN TWO VIEWS ARE REQUIRED

9



CASE 3

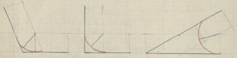
METHOD WHEN ONLY ONE ELEVATION IS REQUIRED

CONVENTIONAL REPRESENATION OF A NUT.

TANGENIAL ARCS.

Problem N°20 Drawing N° H.S. 182/35

To draw a circle of given radius to touch two given straight lines AB and BC



CASE 1 — Obtuse Angle

CASE 2 — Right Angle

CASE 3. — Acute Angle

ANALYSIS

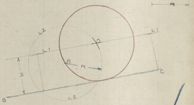
L1 is the LOCUS of Centres of all Circles (given rad. $\frac{3}{4}$") to touch AB.

L1a is the LOCUS of Centres of all Circles (given rad $\frac{3}{4}$") to touch BC.

Then Point O common to L1, L1a is Centre of required Circle to touch AB, BC.

Problem N°21 (Design)

To draw a circle of given radius to pass through a given point A and touch a given line BC.



ANALYSIS

L1 is LOCUS of Centres of all Circles rad. R to touch BC.

L2 is LOCUS of Centres of all Circles rad. R to touch pass through A.

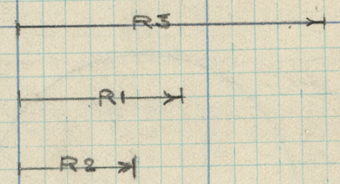
Then Point O common to L1, L2 is required centre

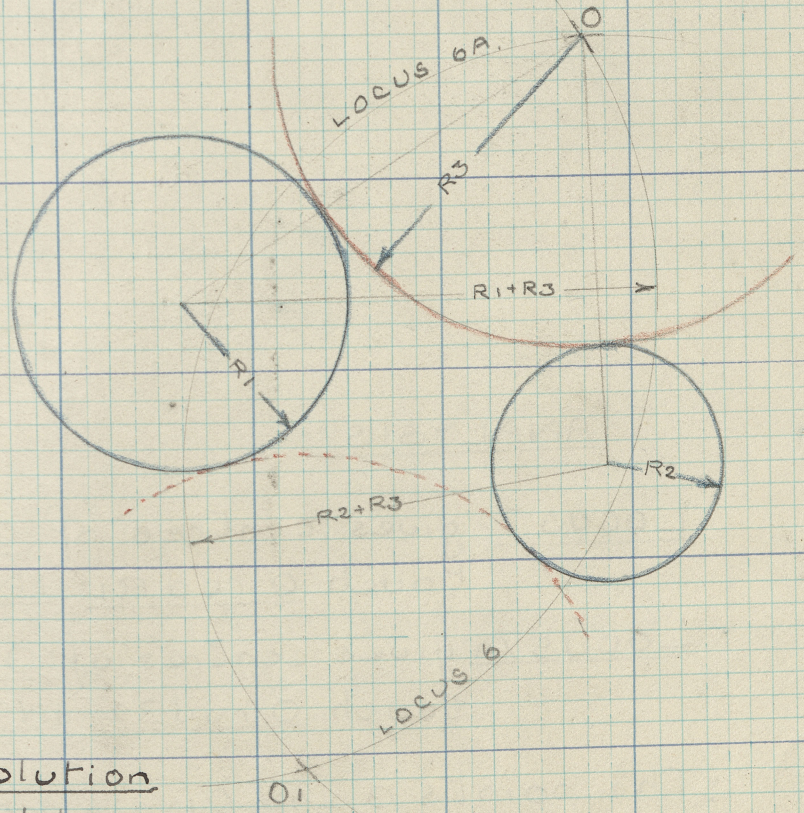
TANGENTIAL ARCS (cont).

PROBLEM No 26.

CASE 1

To draw a circle rad R_3 making EXTERNAL CONTACT with 2 given circles rad. R_1 and R_2.





Note. 2nd Solution is indicated by dotted arc, centre O_1

ANALYSIS

Locus 6 gives centres of ⊙ rad. R_3 to touch ⊙ rad. R_1. EXTERNALLY

Locus 6A gives centres of ⊙ rad. R_3 to touch ⊙ rad. R_2. EXTERNALLY.

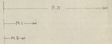
Then Pts O and O_1 are common centres, and Points of CONTACT are Pts P and P_1

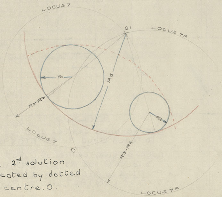
TANGENTIAL ARCS (cont)

PROBLEM N° 26 (Contd.)

CASE 2

To draw a circle rad. R3 making INTERNAL CONTACT with 2 given circles rad R1 and R2.





ANALYSIS.

LOCUS 7 gives centres of ⊙ rad. R3 to touch ⊙ rad. R1 INTERNALLY.

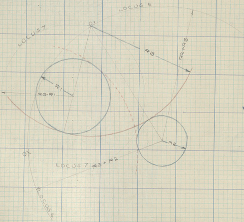
LOCUS 7A gives centres of ⊙ rad. R3 to touch ⊙ rad R2 INTERNALLY.

The points O and O1, are common centre

Points of CONTACT are pts P and P1.

NOTE 2nd solution indicated by dotted arc, centre. O.

PROBLEM No 26 (Cont'd)



CASE No 3.

To draw a circle rad R3 making INTERNAL CONTACT with a given circle rad R1 and EXTERNAL CONTACT with a given circle rad. R2.

R3
R1
R2

ANALYSIS

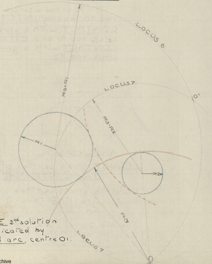
LOCUS 7. gives centres of O rad. R3 to touch O rad R1 INTERNALLY.

LOCUS 6. gives centres of O rad. R3 to touch O rad 2 EXTERNALLY.

The pts O and O1 are common centres and POINTS OF CONTACT are P and P1.

TANGENTIAL ARC (cont.)

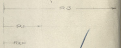
PROBLEM No 26.



NOTE 2nd solution is indicated by dotted arc, centre O1.

CASE No 4.

To draw a circle rad. R3 making EXTERNAL CONTACT with a given circle rad. R1 and INTERNAL CONTACT with a given circle rad R2.



ANALYSIS

LOCUS 6. gives centres of O's rad. R3 to touch O rad. R1. EXTERNALLY

LOCUS 7. gives centres of O rad. R3 to touch O rad. R2 INTERNALLY

Then pts O and O1 are common centres and POINTS OF CONTACT are P and P1.

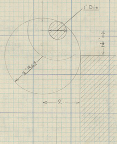
PREP FOR FEB 5th

A horizontal bar 1" dia. has its axis parallel to and 1¼" from a vertical wall. A tube 4" inside dia. is slid lengthwise over the bar and rests against the wall. Draw sections on a plane perpendicular to the axis of the tube showing the bar and tube in the required position. A) with a tube of negligable thickness

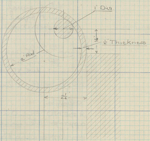
B) with a tube ¼" thick.

Note:- Your solution must indicate the construction for finding the tube centre.

½ F.S. Scale

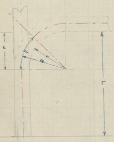


½ F.S. Scale



10

BENDING ALLOWANCES



DEFINITION. A BENDLINE is a line placed on the development drawing in such a position that it comes exactly in the middle of the bend when the job is completed. A length of metal required for a fitting is calculated along the mean line. This mean line unaffected by bending may be taken as half the thickness of the metal.

Development lengths are calculated half way round each bend, (ie. to centres of bends)

The minimum radius of bends equals one and a half T, where T equals thickness of metal.

Let L equal inside measurement of fitting.

Let r equal radius of bend.

Let R equal mean line of bend (mid line, neutral axis) radius.

Then BEND ALLOWANCE for one 90° bend equals $\frac{2\pi R}{8} - r$

" " " two 90° bends " $\frac{2\pi R}{4} - 2r$

and distances between centre of bend lines are

For one 90° bend $L + \left(\frac{2\pi R}{8} - r\right)$

" two 90° bends $L + \left(\frac{2\pi R}{4} - 2r\right)$

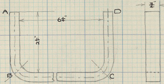
NOTE:– Bend lines thus —··—··—··—

9/

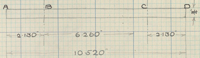
Definition

A BEND ALLOWANCE is a length which when applied to an appropriate inside dimension (L) on a bent up fitting, gives the developed length taken along the mean line of the material.

N.T.S



DEVELOPMENT.



Data. Inside rad. $\frac{3}{32}$"
Thickness. 16 S.W.G.

Calculation.

Length A to B along near line. $L + \left(\frac{2\pi R}{8} - r\right)$

$= 2.125 + \left(\frac{2 \times 3.142 \times .126}{8} - .09375\right)$

$= 2.125 + .099 - .094"$

$= 2.130"$

2.130"

Length B to C.

$= L + \left(\frac{2\pi R}{4} - 2r\right)$"

$= 6.25 + \frac{2 \times 3.142 \times .126}{4} - .1875$

$= 6.25 + .198 - .188"$

$= 6.260$

6.260

Total Length

A to B. 2.130
B . C. 6.260
C . D. 2.130

Total 10.520

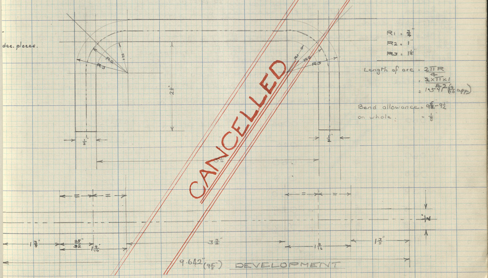
Working

10

BEND ALLOWANCES BY CALCULATION.

dec. places.

PREP. FOR FOR FEB. 26.



R.A.F. BEND ALLOWANCE GRAPH

When ever possible, is a GRAPH is used to obtain the position of bend lines on the development. The one adapted in R.A.F Schools of Technical Training (Marston Chart) is based on the length of the mean line and gives the bending allowance for a double right-angle bend.

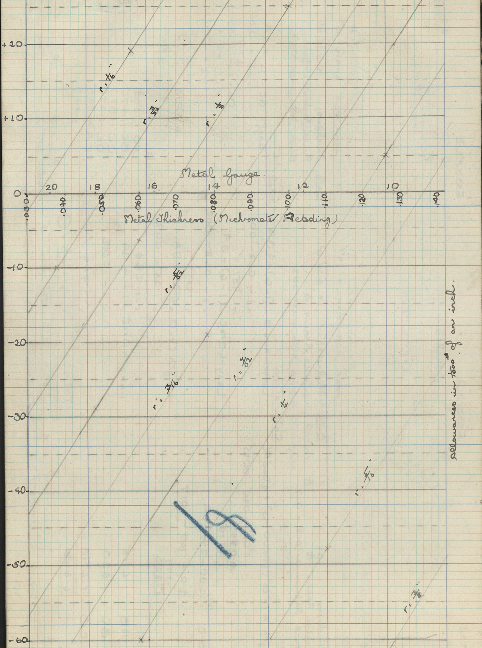
This allowance which is represented by ~~t +~~ $(\frac{2\pi R}{4} - 2r)$ (see pages 23 & 24) is read off the graph is ·001", and when applied to the appropriate inside dimension L on the bent up view, gives the required length between centres of bend-lines on the development.

Below ~~are~~ are tabulated appropriate values from which the chart on Page 26 may be constructed. The bending allowances in the table we obtained from the formula $(\frac{2\pi R}{4} - 2r)$

POINT Nº	METAL THICKNESS	INSIDE RAD. (r)	BEND ALLOWANCE	CALCULATION OF BEND ALLOWANCE FOR POINT Nº 1.
1	·060	$\frac{1}{8}$"	−·0065	Bend Allowance: $(\frac{2\pi R}{4} - 2r)$
2	·1	$\frac{1}{8}$"	+·025	$\frac{2 \times 3.142 \times .185}{4\,2} - \frac{1}{4}$
3	·060	$\frac{1}{4}$"	−·060	= ·291" − ·25"
4	·058	$\frac{1}{16}$"	+·019	= ·041"
5	·038	$\frac{3}{32}$"	−·0810	
6	·048	$\frac{5}{32}$"	−·029	
7	·078	$\frac{3}{16}$"	−·019	
8	·110	$\frac{5}{16}$"	−·048	
9	·126	$\frac{3}{8}$"	−·062	

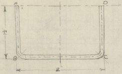
·185
1·571
·185
·9925
·8130
·0082
·2907

BENDING ALLOWANCE GRAPH FOR DOUBLE



NOTE. Minimum bending radius should not be less than 1½T.

Example 1



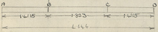
Data Thickness ·08
Inside Radius $\frac{3}{16}$
Bend Allowance ·018 – ·017

Calculation

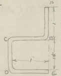
Length A to B = (1·500" – G) + ½ Bend All.
= 1·500" – ·080" – ·0085
0·0885
1·4115

Length B–C = (2·00 – 2G) + B.A.
= 2·0 – ·160 – ·017
·177
1·823

Totals
AB = 1·4115
BC = 1·823
CD = 1·4115
4·646



Example 2



PREP. FOR MARCH 19th

Data Thickness 18 S.W.G
Inside Radius $\frac{3}{32}$
Bend Allowance ·002

Calculation

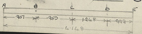
Length A to B = (1 – G) + ½ BA
= 1 – ·048 – ·001
= ·951 ✓

Length B to C = (1 – G) + BA
= 1 – ·048 – ·002
= ·950 ✓

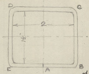
Length C to D = 1·25 + BA
= 1·25 – ·002
= 1·248 ✓

Length D to E = 1 + ½ BA
= 1 – ·0018
= ·999 ✓

Total = 4·148 ✓ (10)



Example 3



PREP. FOR APRIL 2nd

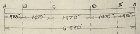
Data Thickness 16 S.W.G
Inside Radius $\frac{3}{16}$
Bend Allowance ·030

Calculation

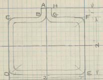
length BC = L + BA
= 1·5 – ·030
= 1·470
∴ DE = 1·470 (equal BC)
∴ CD = L + BA
= 2 – ·030
= 1·970
∴ EA & AB = 1·970 / 2
= ·985

Totals
AB = ·985
BC = 1·470
CD = 1·970
DE = 1·470
EA = ·985
6·880

10/

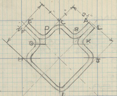


Example 4.



Data
Thickness .068
Inside Radius $\frac{5}{32}$"
Bend Allowance .014

Example 5.



Data.
Thickness 18. S. W. G
Inside Radius $\frac{3}{32}$"
Bend Allowance .002

CALCULATIONS

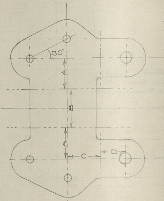
Length A : L + ½BA
: (½ + 5/16 − G) + (·005)
: ·8125 − ·064 + ·005
: ·8175
·064
: ·7535

Length B : L + BA
: 1 + ·010
: 1·010

Length C : L + ½BA
: (1·000 − ·064) + (−·0015)
: −·0655
·9345

Length D : L + ½BA
: (1·25 − ·5 − ·064) + (−·0015)
: ·5655
·6845

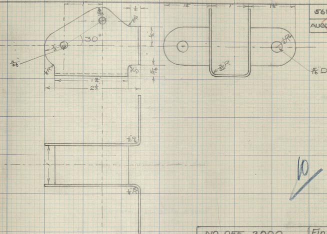
A = ·754"
B = 1·010"
C = ·935"
D = ·685"



DEVELOPMENT

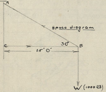
9/

569858 INWARD. J.	
AUG36/B3	TIME — 19/3/37

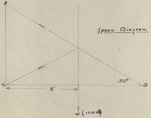


	NO. OFF 2000	Finish Enamelled Black
LUG FITTING	SCALE. F.S	ITEM NO. 11
Reqd for R.A.F Workshops Halton	Mat. M.S	DRG 2/2

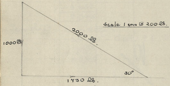
Ex. 1.



Ex. 2.



Scale 1 cms to 200 lbs.

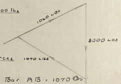


Triangle of Forces

Pull in Tie Bar AB = 2000 lbs.

Reaction at C " 1730 "

Scale 1 cms to 200 lbs

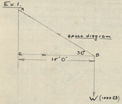


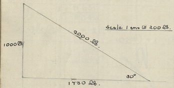
Triangle of Forces

Pull in Tie Bar AB = 1070 lbs.

Reaction at C = 1040 "

Ex 1.





Triangle of Forces

Pull in Tie Bar AB = 2000 lbs.

Reaction at C , 1730 ,,

GRAPHIC STATICS. (1).

Triangle of forces.

When three forces act on a body and keep it in equilibrium a triangle can be constructed such that its sides are parallel to the forces and represent the forces in magnitude.

If three forces act on a body and keep it in equilibrium the lines of action of the forces must pass through a common point.

Experiment.

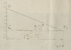
Attach three spring balances to different points on a flat rigid body and stretch the springs on a table or drawing board. Mark off on a sheet of paper the directions of the lines of action of the forces and their magnitudes.

Verify that the lines of action do meet at a common point.

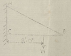
Draw the triangle of forces for the three forces.

Exercises.

In the wall crane shewn A.B.and C are assumed to be pin points.

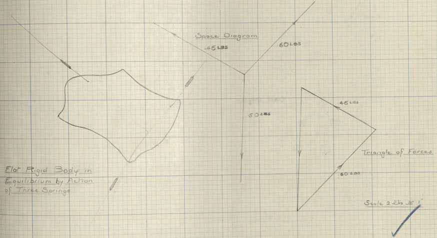


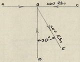
1. Find the pull in the tie bar AB. and the reaction at C when a load of 1,000 lbs. is hung from B.

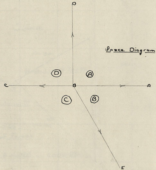


2. Find the pull in the tie bar and the reaction at C. when the load is hung from a point 8' 0" from C.

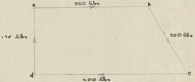
GRAPHIC STATICS







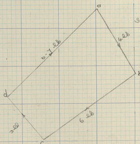
Space Diagram



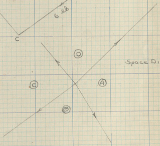
Vector Force Diagram

Scale 1" to 100 lbs.

Scale 1" to 2 lb



Vector Diagram



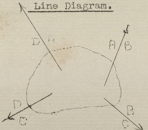
Space Diagram

GRAPHIC STATICS No. 2.

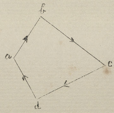
Polygon of Forces.

If a number of Co-planar forces act on a body and keep it in equilibrium then a polygon can be constructed such that its sides are parallel to the several forces and represent those forces in magnitude.

Line Diagram.



Vector Diagram.



Rules for BOW'S NOTATION.

Draw the line diagram showing all the externally applied forces.

Place letters, or numbers in the spaces between the lines of action of the several forces.

Each force is known by the two letters, or numbers on either side of its line of action.

When naming a force it is usual to pass clockwise round the body.

The force "x" is called the force AB and not the force BA.

The vector "ab" is parallel to the line of action of AB and the direction of the force is the direction of "a" to "b".

Note.

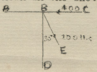
The arrowheads on the Vector diagram all go round the same way.

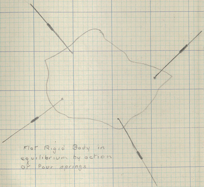
Experiment.

Take four spring balances and attach themm to different points on a flat rigid body. Stretch the springs on a table or drawing board. Mark off on a sheet of paper the lines of action of the four forces and their magnitude. Construct the polygon of forces and verify that that it "closes".

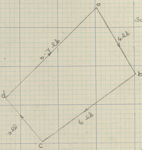
Exercise.

Find the loads in the members AB and BD for the fuselage joint shown in the sketch.



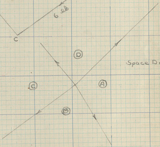


Flat Rigid Body in equilibrium by action of four springs



Scale 1" to 2 lb

Vector Diagram



Space Diagram

GRAPHIC STATICS. (3).

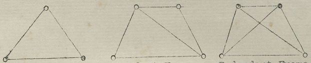
A "frame" is a structure "built up" from a number of simple members which are assumed to be either tension members or compression members.
The members in many cases are joined to each other by rigid bolted or riveted connections, but in the simple treatment of frames it is convenient to assume that all the connections are pin joints.

A frame with just sufficient members to hold it rigid is called a perfect frame.

The simplest frame is the triangle.

A fourth point can be incorporated in the structure by means of two additional members.

The addition of a third member would make the structure redundant.



Perfect Frame Perfect Frame Redundant Frame

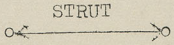
The force distribution in a redundant structure cannot be determined by the principles of statics.

Extension of Bow's Notation to deal with pin jointed structures.

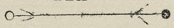
In addition to the letter, or number, between the externally applied loads, a letter or number, must be placed in each space of the structure.
For each pin in the structure a triangle or polygon of forces can be drawn.
All these polygon can be incorporated in one diagram called a force diagram force diagram arrow heads should not be used.

Arrow heads should be placed on the several members of a Line diagram at each end showing the direction of the force that the particular member is exerting on the pin at that end.

In the complete frame a compression member or strut would be shewn thus:,............... STRUT



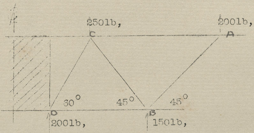
and a tension member or a tie thus:-...................... TIE



GRAPHIC STATICS.(4).

Exercise (1).

To determine the loads in the several members of the wing structure loaded as in figure.



1. Construct a triangle of forces for the point A.

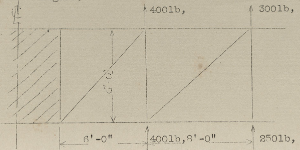
2. Using the same scale construct polygons of forces for the points B, C, and D, in the given order.

3. Assemble all these diagrams into a single force diagram.

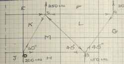
4. Tabulate the loads in the several members.

Exercise (2).

To determine the loads in the several members of the wing structure loaded as in figure.



Commence at the point (A) and note that the member AC carries no load.
This does not mean that the member AC is redundant.
An oblique load at A would set up a force in AC.

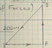


SPACE DIAGRAM

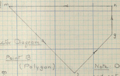
Member	Force	C or T
AB	275 LBS	T
BC	495	C
AC	200	C
BD	545	T
CD	650	T

Point A Vector Diagram
(Triangle of Forces)

Scale 1" to 200 LBS



Vector Diagram
Point B
(Polygon)
Scale 1" to 200 LBS

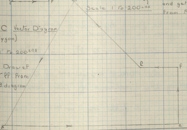


Note: Draw gh and get lg length from Point A Δ

Point C Vector Diagram
(Polygon)

Scale 1" to 200 LBS

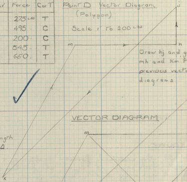
Note:- Draw ef and get lf from Point B diagram



Point D Vector Diagram
(Polygon)

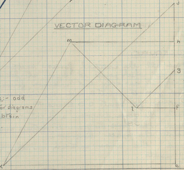
Scale 1" to 200 LBS

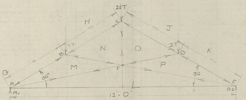
Draw hj and get mh and km from previous vector diagrams



Note:- add Vector diagrams to obtain this.

VECTOR DIAGRAM





Scale 1 to 2'

SPACE DIAGRAM

PROCEDURE.

1) Find all the external forces - reaction R_1 & R_2 must be found by taking moments.
2) Consider which point to begin at for the force diagram. In this case Point A is suitable since it has only two unknown forces.
3) Next pass to point B and superimpose or add its vector diagram to the one for Point A.
4) Continue for points C D E and F.
5) Scale the force diagram and enter the results in the FORCE COLUMN of the table of results.
6) "Read" the force diagram to obtain arrows indicating the directions of the forces at each point the space diagram.
7) "Read" the arrows entered on the space diagram and fill in C or T in the table of results.

To find R_2 take moments about A.

Clockwise moments. Anti clockwise moments

$\therefore (1 \times 3) + (2\tfrac{1}{2} \times 6) + (2 \times 9) = 12R_2$

$3 + 15 + 18 = 12R_2$

$R_2 = \frac{36}{12}$

$= 3$ tons

To find R_1 take moments about E

Clockwise moments. Anti-clockwise moments

$\therefore 12 \times R_1 = (2 \times 3) + (6 \times 2\tfrac{1}{2}) + (9 \times 1)$

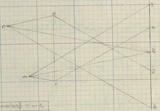
$= 6 + 15 + 9$

$= \frac{30}{12}$

$= 2\tfrac{1}{2}$ tons

FORCE DIAGRAM

Scale 1" = 2 tons



MEMBER	LOAD (TONS)	T or C
AB	7·5 TONS	C
BC	6 "	C
CD	6 "	C
DE	9 "	C
EF	8 "	T
FB	1·3 "	C
FA	6·5 "	T
FC	3·5 "	T
FD	2·625 "	C

PROJECTION OF A POINT

Standard Notes 2/2

1. Determine the position of the point with regard to H.P. and V.P.

2. Locate a ground line conveniently on the paper.

3. Draw a projector cutting the ground line at right angles.

4. Along the projector and above the ground line mark off the height of the point above the H.P.

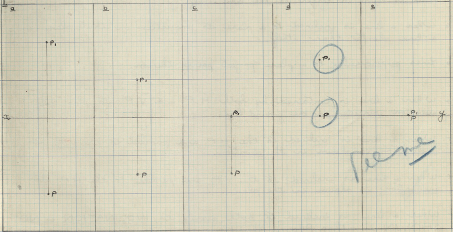
5. Similarly below the ground line mark off the distance of the point from the V.P.

Note. If the point be called (P) then the elevation will be (p_1) and the plan (p).
This notation is easy to follow and should be adopted for all exercises.

EXERCISE ON PROJECTION OF A POINT.

Darlings Workshop Drawings Plat No 1.

1.



PROJECTION OF A LINE.

Standard Notes 2/3

1. When a line is parallel to or contained by a plane its projection on that plane is equal in length to the line itself.

2. When a line is inclined to a plane its projection on that plane is a line shorter than itself.

3. Lines perpendicular to a plane project points thereon.

4. When a line is contained by both H.P. and V.P. its plan and elevation coincide in the ground line.

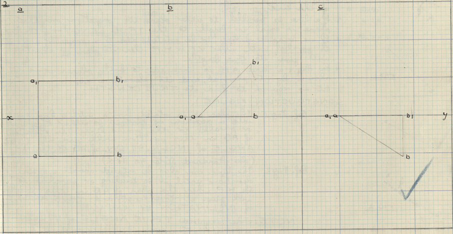
5. When a line is inclined to the H.P. and parallel to the V.P. its inclination is shown in the elevation.

6. When a line is inclined to the V.P. and parallel to the H.P. its inclination is shown in the plan.

7. When a line is inclined to both planes its INCLINATION is NOT SHOWN in either Plan or Elevation.

EXERCISE ON PROJECTION OF A LINE

Darlings Workshop Drawings: Plate No. 2



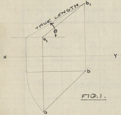


FIG. 1.

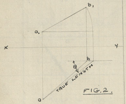


FIG. 2.

TRUE LENGTH OF A LINE.

1. If a line is inclined to either plane of projection, its projection on that plane is shorter than the actual length of the line.
2. If a line is parallel to either plane its projection on that plane is equal in length to the TRUE LENGTH of the line.
3. If we imagine a line to be rotated about a projector until it is parallel with either V.P. or H.P. then its plan or elevation will give its true length.
4. In Fig. 1 a line A.B. is inclined to both planes as is shown by its plan ab, and its elevation a,b,. It is required to find its TRUE LENGTH.

CONSTRUCTION FIGURE 1.

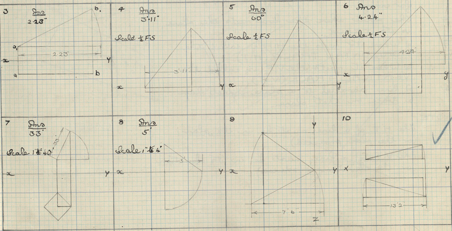
Ref. Fig. 1. The plan ab is rotated from b until a has moved into a position so that it is either touching or parallel to the ground line. The elevation of AB in this position will give its TRUE ANGLE of INCLINATION, of AB to the H.P.
(See Standard Note 2/5 No. 5.)

Ref. Fig 2. The line can also be rotated about a, b, in elevation until it is touching or parallel to the H.P. when the plan of AB in this position will gives it true length and TRUE ANGLE of INCLINATION to the V.P.

NOTE: The required TRUE ANGLE of INCLINATION determines which view must be rotated.

EXERCISE ON TRUE LENGTH OF LINES.

Darlings Workshop Drawings P.136 No 3-10.



TRACES OF LINES

1/ When a line is inclined to a plane, it will evidently meet that plane if produced far enough.

2/ The point where the line meets the plane is its TRACE.

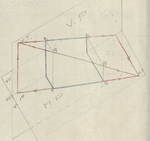
3/ a) Where its meets the H.P. is called the HORIZONTAL TRACE (H.T.)
b) Where it meets the V.P. is called the VERTICAL TRACE (V.T.)

4/ A line parallel to a plane cannot have a trace on that plane

NOTE.

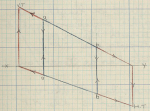
The H.T. of a line must be in its plan. (or the plan produced).

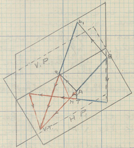
The V.T. of a line must be in its elevation (or the elevation produced).

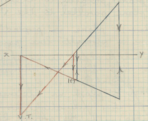


CASE I

H.T. and V.T. on 1st Quandrant

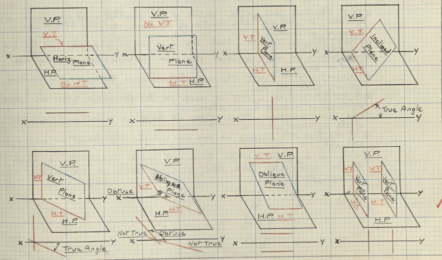

V.T
a
b1
x
Y
a
b
H.T


b1
V.P
a
B
A
H.T
V.T.
H.P


x
Y
H.T
V.T.

TRACES OF PLANES.

1. a) The trace of a line is a point.
   b) The trace of a plane is a line.
2. Since a plane has no thickness and is infinite in length and breadth it can only be shown in orthographic projection by its traces.
3. a) The H.T. of a plane is the line where it intersects the H.P.
   b) The V.T. of a plane is the line where it intersects the V.P.
4. When a plane is parallel to another plane it has no trace on that plane.
5. a) A plane parallel to the H.P. must be perpendicular to the V.P.
   b) A plane parallel to the V.P. must be perpendicular to the H.P.
6. When a plane is perpendicular to both H.P. and V.P. its traces form a straight line perpendicular to the ground line.
7. a) When a plane is inclined to the H.P. and perpendicular to the V.P. its inclination is shown by the angle which its V.T. makes with the ground line.
   b) When a plane is inclined to the V.P. and perpendicular to the H.P. its inclination is shown by the angle which its H.T. makes with the ground line.


V.P.
V.T.
Horiz. Plane
H.P.
No H.T.
V.P.
No V.T.
Vert. Plane
H.T.
H.P.
V.P.
V.T.
Vert. Plane
H.T.
H.P.
V.P.
V.T.
Inclined Plane
H.T.
True Angle
V.P.
V.T.
Vert. Plane
H.T.
H.P.
True Angle
V.P.
V.T.
Oblique Plane
Obtuse
H.T.
H.P.
Not True
Obtuse
Not True
V.T.
V.P.
Oblique Plane
H.P.
H.T.
V.P.
V.T.
Vert. Plane
H.T.
H.P.
x
y

SIMPLE SOLIDS

DEFINITION

1) AXIS. The line joining the centres of the parallel ends of a prism or a cylinder, or joining the centre of the base to the APEX in a pyramid or cone.

2) RIGHT SOLID. One in which the axis is perpendicular to the end faces or base.

3) OBLIQUE SOLID. One in which the axis is inclined to the end faces or base.

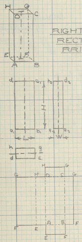
4) HEIGHT or ALTITUDE. The vertical distances between end faces or between apex and base.

5) A PYRAMID or CONE is said to be truncated when an upper portion is removed by a plane cut.
The lower portion standing on its base is called a FRUSTUM of the pyramid or cone.

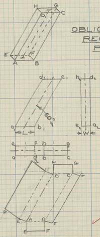
6) A REGULAR SOLID is one in which the base is a regular polygon.

7) When a surface can be laid out on a plane, it is said to be developable, and the figure obtained is called a DEVELOPMENT.

REGULAR SOLIDS



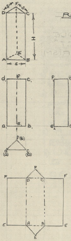
RIGHT RECT^R PRISM



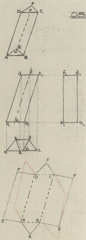
OBLIQUE RECT^R PRISM

REGULAR SOLIDS CONT

RIGHT TRIANGULAR PRISM



OBLIQUE TRIANGULAR PRISM

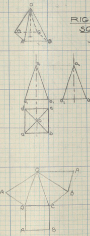


State construction

E/10

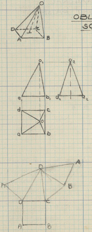
REGULAR SOLIDS CONT

RIGHT SQUARE PYRAMID



True length

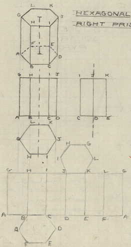
OBLIQUE SQUARE PYRAMID



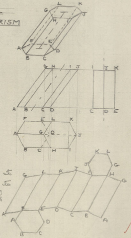
Find true length of OD and OC and mark out using compass.

REGULAR SOLIDS CONT

HEXAGONAL RIGHT PRISM



HEXAGONAL OBLIQUE PRISM

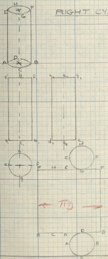


Project lines at right-angles to centre line of prism and step out sides with compass.

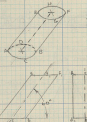
8/10

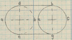
REGULAR SOLIDS CONT.

RIGHT CYLINDER

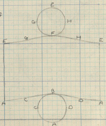


OBLIQUE RIGHT CYLINDER.



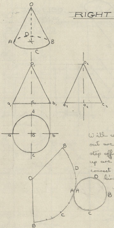


Project lines at rightangles to centre line of cylinder and step out points on base and top with compass.



REGULAR SOLIDS CONT.

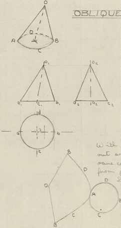
RIGHT CONE



With centre O swing out arc from B and step off points on base up arc, join up and connect by straight line to O. Affix circle ABCD.

7/10

OBLIQUE CONE



With centre O swing out arc from B, ~~then~~ with same centre swing out arcs from points on base, step out points on base. Affix circle ABCD.

?

SECTIONS.

1/ Where the construction of an object cannot be shown completely by views of the outside, it must be shown by cutting through the object on a suitable imaginary sectioning plane.

2/ The portion nearer to the observer is supposed to be removed, and a view of the cut surfaces thus revealed is now drawn. This view is called a section.

3/ The rules of projection must be observed in drawing sectional views, and the position of the sectioning plane always clearly indicated, e.g. Section on A.B.

4/ The cut surfaces must be neatly section lined by continuous lines at 45° to the xy line, care being taken that the section lining is equally spaced and not too close together.

Ref. Abbott P.15 Fig 1&2.

5/ Different materials in a section are indicated by alternating the direction of the section lines, but the same material is always section lined in the same direction in any one section.

6/ A section should show cut faces only. A sectional view shows in addition all edges lying beyond the cut face.

Ref. Abbott P.15 Fig. 1

7/ Solid Shafts, Nuts, Bolts, Cotters, Pins, Rivets, Screws, Balls, Rollers and other conventional items are not usually shown in longitudinal section, though the sectioning plane may pass through them. The same convention applies to Wheel Arms and Stiffening Webs.

Ref. Abbott P.19 Fig 201.

CIRCULAR WRAPPER FITTINGS

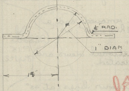


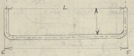
Fig. 2. represents a semi-circular wrapper fitting 1" dia. and Fig. 2A the same fitting in the form of a double right angle bend.

The semicircular length EF on Fig. 2. is calculated first. This length is equivalent to the "outside" length in the square fitting. 2A.

This length is equivalent to the "outside" length in the square fitting. Fig. 2A.

Therefore EF − twice the thickness would give the "inside length (L) assuming the ⅛" inside radii to be 90° bends.

The length between centre of bend lines = inside length + appropriate bend allowance.



e.g. Semi circ. length E.F. $= \frac{2\pi R}{2} = 3.142 \times (\frac{1}{2}'' + \frac{1}{16}'')$

$= 3.142 \times 0.5625''$

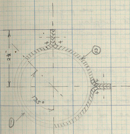
$= 1.767''$

$EF - 2T = (1.767'' - .250'') + (-.009)$

$= 1.508''$

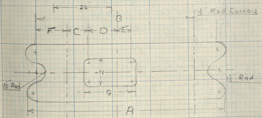
Length of each lug is a straight forward case of a 90° bend.

A very keen & quite sound year's work SB
Keep it up



Inside Rad ⅛"
Inner tube 2" O.D.
All metal 10. S.W.G
B.A. for doubler
angle bend = -.006

Length A = 7.491"
B = 4.753"
C = 1.205"
D = 1.172"
E = .335"
F = .869"
G = 2.507"



Length between centre of bend lines = 4.753"
Length of slot = 2.507"
Length from centre of bend to upper end of slot = .705"
Length from centre of bend to end of lug = 1.369"

22nd 31/8/37

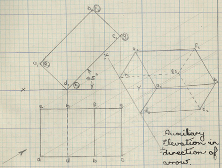
AUXILIARY VIEWS

Normally the views front elevation, plan, and end elevation are projected on to planes mutually perpendicular. Occasionally in order to display some particular aspect of an object a projection is required in a direction inclined to the 3 main planes of projection.

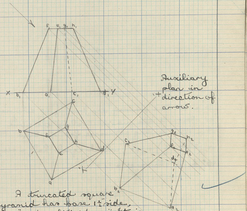
Ref. Fig. 287 Given plan and elevation of a rectangular prism inclined to H.P. and with axis parallel to V.P. it is required to project an additional elevation looking in direction of arrow A.

Procedure Since a new elevation is required, the projectors will be drawn from the old plan and parallel to the line of sight indicated by the arrow A. And X_1Y_1 drawn at right angles to these projectors will be the Horizontal Trace (or Ground) of the V.P. upon which the new elevation is to be projected.
Heights above the H.P. for the new elevation will be transfered from the old elevation along the appropriate projectors.
e.g. b_2 and f_2 in the new elevation are the same height above X_1Y_1 as they were above XY in the old elevation.
Finally the corners of the prism are joined by full or dotted lines to indicate edges.
Hint. Difficulty is sometimes experienced in deciding which lines should be full and which should be dotted, but by lettering corners and lining in obvious edges first it will be found that the new view soon takes shape.

Ref. Fig 288 Conditions are reversed – a new plan is required, therefore projectors will run from the old elevation and distances from the V.P. will be transfered from the old to the new plan which will be drawn below the new Vertical Trace (or Ground Line)



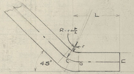
Draw Plan and Elevation of the rectangular prism ABCDEFGH, the axis being parallel to VP and 45° to H.P.



A truncated square pyramid has base 1½" side, top ½" side, altitude 1½". It is standing on HP with one edge of base at 60° to VP. Draw plan and elevation and also an auxiliary plan looking down at 45° to HP.

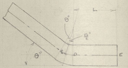
BENDING ALLOWANCES

45° BENDS



For a 45° bend provided the drawing is dimensioned as shown to the mid point along the curve then the bending allowance for one bend is $\left(\frac{2\pi R}{16} - \frac{r}{2}\right) + \cdot 1\, r$, which equals half a single 90° bend allowance + ·1 r.

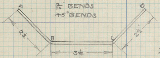
BENDS OF ANY ANGLES



For bends of any angle at all provided the drawing is dimensioned as shown to the centre for the arc i.e. to the beginning of the bend then the bending allowance is given by $\frac{2\pi R \times \theta}{360}$.

This is the easiest form of bending allowance but care must be taken to apply it to the appropriate dimensions.

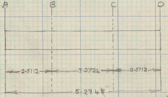
16 GAUGE
7/16" BENDS
45° BENDS



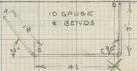
½ F S

B A for 1 45° bend = $\frac{2 \times 3{\cdot}142 \times 2{\cdot}875}{16} - \frac{{\cdot}1875}{2}$ ·1875
= ·0112

∴ AB = 2·5112"
BC = 3·2724"
CD = 2·5112"

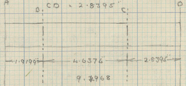


10 GAUGE
¼ BENDS



B.A for 1 62° bend = $\frac{2 \times 3{\cdot}142 \times 3/16 \times 62}{360 \times 2}$ 1·571 ·157 31 180 90 45
= ·1699

B.A for 1 90° bend = ·0325
∴ AB = 1·9199"
BC = 4·6374"
CD = 2·8395"



8/10

BENDING ALLOWANCES

CIRCULAR WRAPPER FITTING

Calculation :—

16 SWG = ·064

12 SWG = ·104

B.A. = ·003 (double)

dia of mid-line circle = 1·75 + ·064 = 1·814

∴ ⊙ce = π × 1·814

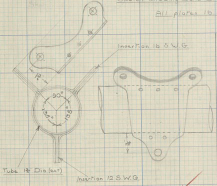
A :-	B :-	C :-	D :-
= (π × 1·814)/4 − (·064 + ·064 + ·064 + ·003 = ·195)	= (π × 1·814 × 135/360) − (·052 + ·032 + ·064 + ·064 + ·003 = ·215)	·8125 − ·0015 = ·811	·75 − ·0015 = ·749
= 1·425 − ·195 = 1·230	= 2·137 − ·215 = 1·922		

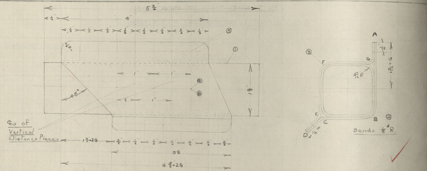
BENDING ALLOWANCES

CIRCULAR WRAPPER FITTING

Sketch showing Bend Line dimensions:—

All plates 16 S.W.G.



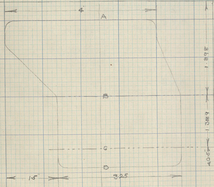


Ⲥ OF RIVETS TO BE MARKED OUT ON DEVELOPMENT 1/4" FROM BEND LINES ON PLATE 2.

ITEM No	DESCRIPTION	No OFF	MATERIAL	REMARKS
1	TUBE	1	M.S	1 3/8 × 1 3/8 × 6.
2	WRAPPER PLATE	1	"	5 × 9 × 16 S.W.G.
3	" "	1	"	" " "
4	RIVETS TUBULAR	5	"	2" × 1/4"
5	RIVETS	13	"	A.G.S.260 Pt Nº 18 (3/32)
6	DISTANCE PIECES	5	"	CUT FROM 8 × 7/8 × 12 S.W.G.

WRAPPER FITTING.	SCALE :- F.S.	DETAIL Nº 17
DEVELOPMENT EXERCISE.	MATERIAL :- M.S.	DRG Nº 901/17.

DEVELOPMENT OF PLATE Nº2



CALCULATIONS

A to B

Straight $= 1\frac{7}{16}" + \frac{1}{16} + \frac{11}{16} - \frac{5}{16}$

$= 1\frac{5}{8}"$ ✓

Curve $= \frac{1}{8} \times 2 \times \frac{22}{7} \times \frac{11}{32}$

$= \frac{121}{448}$

$= .273"$ ✓

Total $= 1.898"$ ✓

B to C

Curve $= .273"$ ✓

Straight $= 1\frac{3}{8} - \frac{5}{16} - .078$

$= .9845"$ ✓

Curve $= \frac{1}{16} \times 2 \times \frac{22}{7} \times \frac{5}{32}$

$= .0614$ ✓

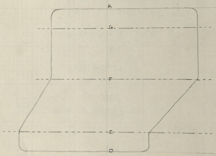
Total $= 1.3189$

C to D From drg 0.5. ✓

10/10

Mer.

DEVELOPMENT OF PLATE N°3



CALCULATIONS

A to G

Straight $= \frac{19}{16}'' + g - \frac{11}{16}'' - g - \frac{1}{8}''$

$= \frac{3}{8}''$

Curve $= \frac{1}{8} \times 2 \times \frac{22}{7} \times \frac{5}{32}''$

$= .1227$

Total $= .375'' + .1227'' = .4977''$

G to F

WORKING ITEM DRAWINGS

ITEM DRAWINGS

An Item in a machine assembly means a part complete in itself - i.e. not made up of two or more parts.

An Item drawing must give all the views and dimensions necessary for the manufacture of the item.

The standard Item Schedule must always appear on the Item Drawing.

DIMENSIONING

① A well dimensioned drawing gives every dimension which will be required during the process of manufacture of assembly.

② CENTRE LINES are indispensable for proper dimensioning

③ The dimensions should be arranged with care, so that there is no possibility of misreading them, and so that they can be found easily.

④ Keep dimensions clear of the drawing as much as possible, and use limit lines to indicate the length being dimensioned. Dimension lines should not cross limit lines.

⑤ ARROW HEADS must be sharp and touch the limit lines. Use outside arrows only when cramped for space inside the limit lines.

⑥ No dimension should be given twice on the same drawing

⑦ No essential dimension should need addition or subtraction of other dimension in order to obtain it.

⑧ OVERALL DIMENSIONS must always be given.

⑨ For COMPLETE CIRCLES give the DIAMETER; for ARCS give the RADIUS. (only 1 arrow)

⑩ All dimensions should read normal to the dimension line.

⑪ A machined face may often be used with advantage as a datum face.

7Hw

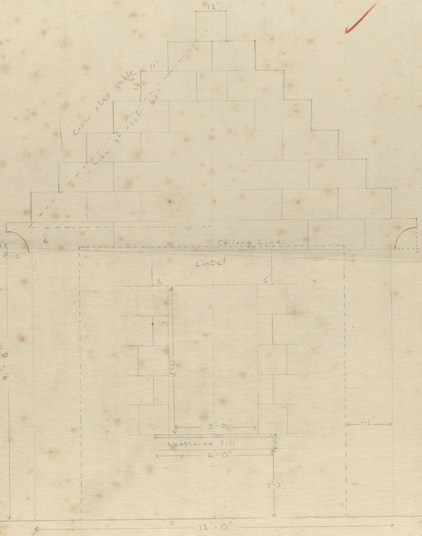


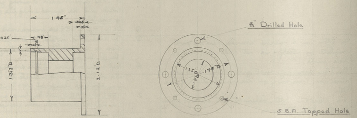
FIG. 119

2

J. INWARD
24.10.35 | No. 3

AN EXAMPLE OF TYPICAL ENGINE ITEM DRAWING

569858 P/a Sgt INWARD		
AUG/36/B1		9/3/38

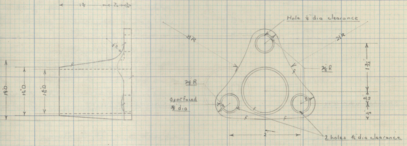


9/10

	No OFF :-	FI[illegible] :- MACHINED
BEARING HOUSING FOR WIRELESS GENERATOR	SCALE :- F.S.	I[illegible] No :-
WIRELESS GENERATOR	MATERIAL :- AL. ALLOY	D[illegible]ING No :-

AN EXAMPLE OF TYPICAL AIRFRAME ITEM DRAWING

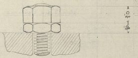
569858	$^{M}/_{A}$ J. INWARD
AUG/36/81	16/3/38



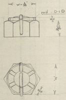
	Nº OFF :-	FINISH - MACHINED (as shown)
SOCKET BRACKET	SCALE :- NTS	ITEM Nº :-
JOINT 'J' D.H. 60	MATERIAL :- M.S.	DRAWING Nº :-

COMMON LOCKING DEVICES.

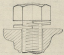
① LOCKNUT.



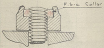
② CASTLE NUT
& SPLIT PIN



③ SPRING WASHER



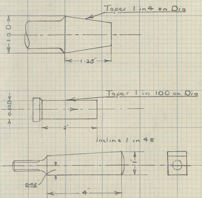
④ SIMMONDS NUT.



TAPERS

A taper should be defined as the alteration in dia. of or thickness of a part per unit length, the later being measured along the geometric centre line. Care should be taken on drawings to indicate tapers very definately. If taper is too small to show up on a drawing, the direction of taper should be indicated by an arrow as in Fig. 2.

It is important to give the dia. or thickness at one end of the taper usually the large end, also the length of the taper part.



KEYS

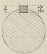


FIG 1

TAPER KEY

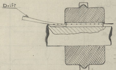


FIG 2

Removal of Taper Key

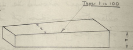


FIG 5

2

FEATHER KEY

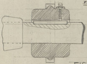


FIG 4

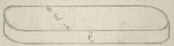
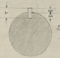


FIG 7

R.A.F. School of Technical Training
R.A.F., HALTON.
Zeal 8
Attainment 9 [illegible]
Easter 1938

WOODRUFF KEY



Mainly used on Tapered shafts

FIG 8

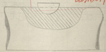


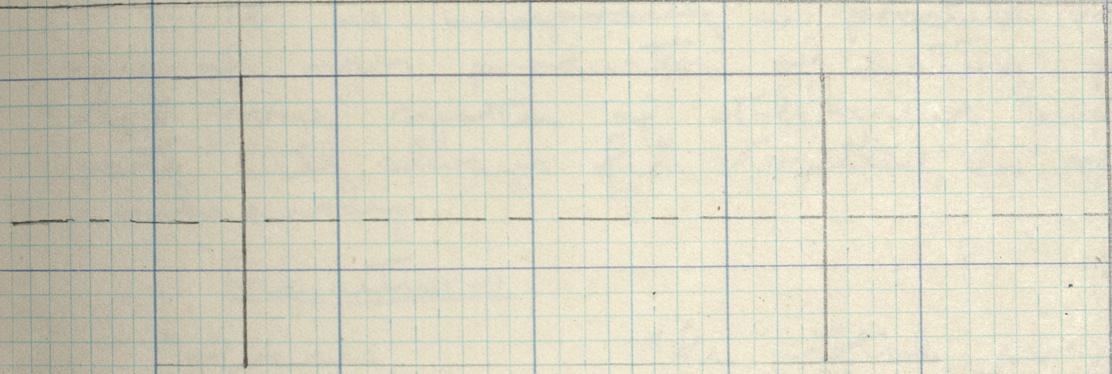
FIG 9

CONVENTIONAL REPRESENTATION OF SPRINGS.

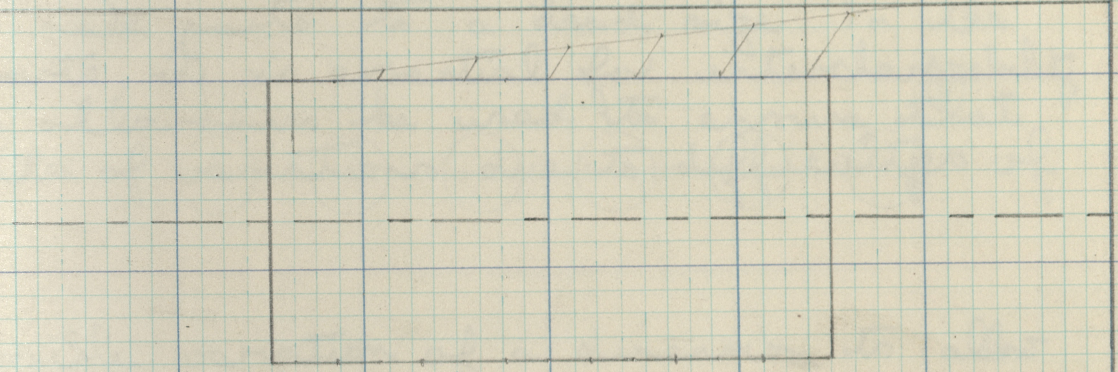
Data Required

① Free Length ② Mean Dia. of Coils

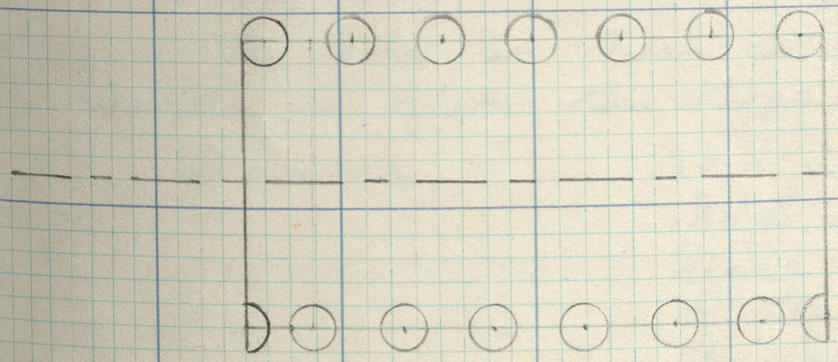
③ Gauge of Wire ④ Nº of complete Coils



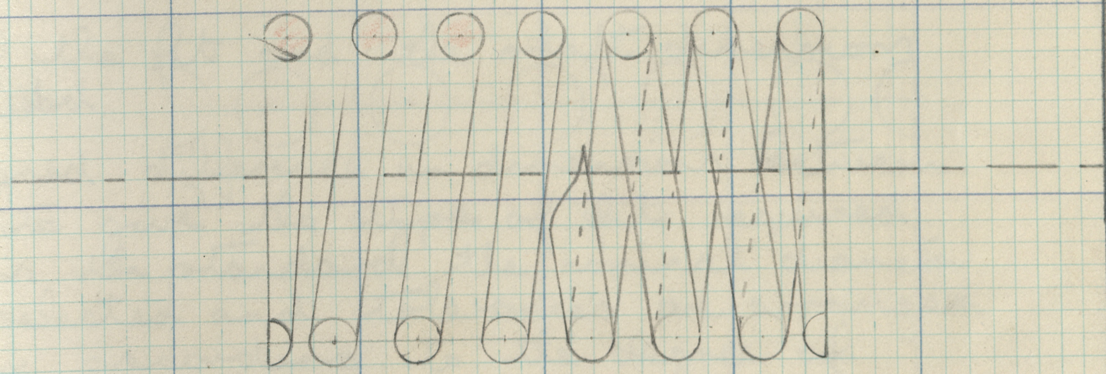
STAGE 1



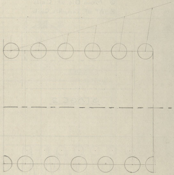
STAGE 2



STAGE 3



STAGE 4



Limits and Fits

It is impossible in practice to make parts to a dead size. In the case of mass production of mating parts, it is essential for interchangeability that some system of tolerances and allowances be used to ensure that parts will always fit together, in spite of variations due to difficulties of workmanship.

Definitions

Tolerance. The total permissible variation of a dimension to allow for difficulty of workmanship.

High Limit The large permissible dimension

Low Limit The smaller permissible dimension (the stated dimension is called the nominal dimension)

Mating Shafts with Holes

The hole is taken as the basis of the fit and the shaft dimensions adjusted to give the type of fit required.

Allowance. This is the designed difference in dimension between shaft and hole to give the type of fit required. Since the hole is the standard the nominal diameter of the hole is selected and tolerances are arranged on that diameter according to the degree of accuracy required.

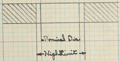
In the Unilateral System the tolerance is in one direction only ie every hole is of nominal size or large.

In the Bilateral System tolerance extends in both directions

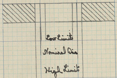
P.T.O.

	i.e. the tolerance is difference between high and low limits
Clearance	This is the amount of play between the mating surfaces.
Minimum Clearance	This is the difference between high limit of hole and low limit of shaft
Maximum Clearance	This is the difference between low limit of hole and high limit of shaft.
Interference	If the shaft is bigger than the hole the difference is called interference

Unilateral System



Bilateral System



Examples. Calculate in each of the following cases.

(a) Tolerance on shaft and on hole.
(b) High and low limits of each.
(c) Maximum and minimum clearance.

(a) Hole 3/8" dia + .00025" − .00025"

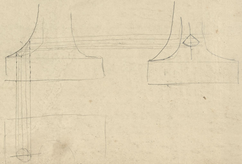
Shaft 3/8" dia + .00050" − .00025"

(b) Hole 3/4" dia + .00050" − .00025"

Shaft 3/4" dia − .00125" − .00275"

(c) Hole 3" dia + .001" − .0005"

Shaft + .0005" · .001



No. Wing.

A. B. 1

Rank. A/A No. Name. Inward.

Has permission to leave school at 11-15 hrs. for the purpose of attending Wing H.Q.

Date:- 16/3/38

for [signature]
Wing Education Officer,