

Reg  
Thomas

Design  
Notebook 1

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U.B.A.S. Up to  $\frac{1}{2}$ " dia = EN. 32A. Over  $\frac{1}{2}$ " dia = EN. 32B.

Phoenix = E.N. 1A.

M.S. = E.N. 1A.

Hecla = EN 24

Jessops H.B. = EN 53.

EN 33 - KE 128

K.E. 42 - FREE CUTTING STAINLESS STEEL.

EN. 2. Cold Working.

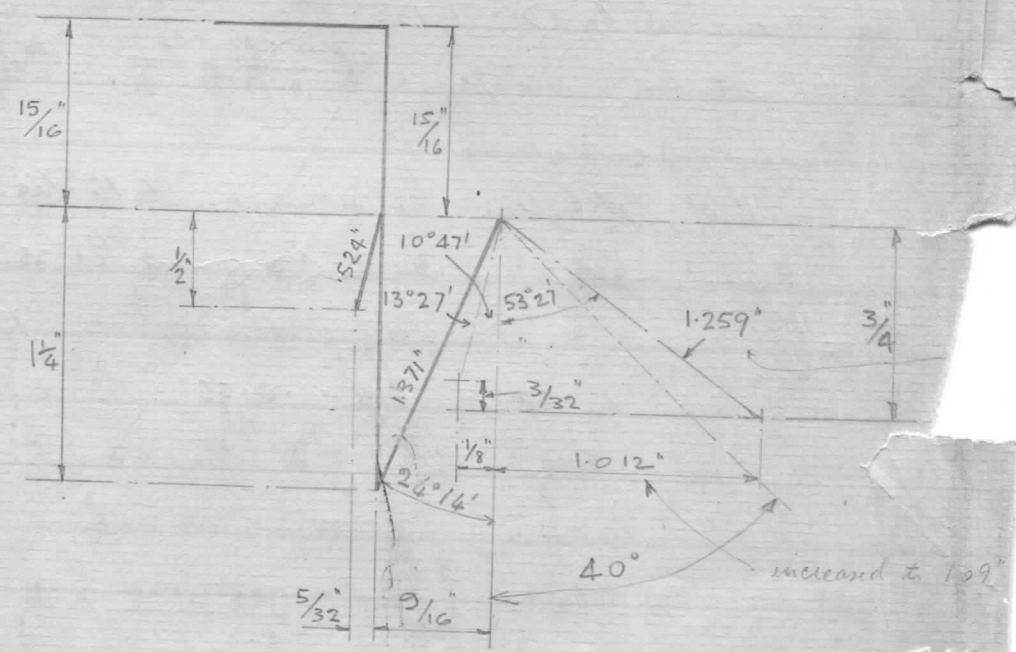
EN. 2A Deep Drawing

VERTEX POWER INSTRUMENT.

- LENSSES - ADJUSTABLE FOR LENGTH.
- EYE LENSES AND GRATICULE - ROTATABLE.
- TARGET AND ILLUMINATION - ADJUSTABLE. RACK AND PINION.
- METHOD OF HOLDING LENS TO BE TESTED - 2 SPRING LOADED PINS AT BACK. 4 FIXED PINS IN FRONT. FLAT REST ADJUSTABLE VERTICALLY AND HORIZONTALLY?
- MARKING DEVICE - 3 DOTTING POINTS. WHEN NOT IN USE TO BE IN BASE AND TO REST ON INKED PAD.
- LIGHT SWITCH - AUTOMATIC?
- SCALE - DIVIDED INTO QUARTER DIOPTRES TO BE READ THROUGH

4-2-45.

Spectacle Rest. To be shortened and sliding across.  
 Screen for Bulb. Fixed to Dial Bracket.



Movement of Target  $\pm 24.7$  mm. for  $\pm 20D$ .  
Allow  $2''$  movement.

Ratio of Pinion to Rack 2:1  $\therefore$  Pitch circ. of pinion =  $1'' = .318''$  dia

Make Pitch Dia of Pinion  $.325''$  dia. Normal D.P = 40

$\therefore$  Pitch circ =  $1.021''$

Movement of Target for ID =  $\frac{24.7}{20}$  mm =  $1.235$  mm =  $.0486''$

Movement of Pinion for ID =  $\frac{.0486 \times 360}{1.021} = 17.136''$

Dia of Indexing Dial =  $1\frac{3}{16}''$ . Make division for ID on outside edge  $.08''$

Movement for ID =  $7^{\circ}44'$   $7.733''$

Pitch Dia of Driven Gear =  $\frac{.325 \times 17.136}{7.733} = .72''$  dia

Make Pitch Dia of Driven Gear  $.700''$  dia.

Make Pitch Dia of Pinion  $.300''$  dia Normal D.P = 40

$\therefore$  Pitch Circ =  $.9425''$  length of Rack =  $1885''$

Movement of Target for ID =  $.0486''$

$\therefore$  Movement of Pinion for ID =  $\frac{.0486 \times 360}{.9425} = 18.563''$

Movement of Indexing Dial for ID =  $7.733''$

Pitch Dia of Driven Gear =  $\frac{.300 \times 18.563}{7.733} = .72''$  dia.

Make Pitch Dia of Driven Gear  $.675''$  dia.

Then Movement of Dial for ID =  $\frac{.300 \times 18.563}{.675} = 8.25''$

$\therefore$  Division on outside edge =  $.0855''$

21-3-45.

Rack:  $\frac{1}{16}$  Normal Circular Pitch.

Complete length of Rack =  $2\frac{1}{2}$ " Helix angle  $30^\circ$

Indexing Gear  $\frac{1}{16}$  Normal Circular Pitch Helix Angle  $60^\circ$

No of teeth = 17 Pitch Dia =  $\frac{\frac{1}{16} \times 17}{3.1416 \times \cos 60} = \frac{1.0625}{3.1416 \times .5} = \underline{\underline{.676}}$ "

Movement of Target for 40D. = 1.94492"

Pitch Circ of Indexing Gear =

22-3-45

Ratio of Rack to Pinion = 1:2 (modified below)

Circular Pitch =  $\frac{1}{16}$

Length of Rack (Operating) = 1.94492" Helix Angle =  $45^\circ$

Circular Pitch in plane of rotation =  $\frac{\frac{1}{16}}{\cos 45^\circ} = \frac{\frac{1}{16}}{.70711} = .0884$ "

No of Teeth on Rack (Operating) =  $\frac{1.94492}{.0884} = 22.0014$

Then No of Teeth on Pinion = 11. Pitch Dia =  $\frac{11 \times .0884}{3.1416} = .3095$ "

Modified Ratio = 11 : 22.0014

Ratio between Rack & Indexing Dial = 1 :  $\frac{11}{12}$

Ratio between Pinion & Indexing Gear = 22.0014 :  $\frac{11 \times 11}{12}$   
= 22.0014 : 10.0833

Indexing Gear. Circular Pitch =  $\frac{1}{16}$  Helix Angle =  $45^\circ$

Circular Pitch in plane of rotation = .0884"

No of teeth on Indexing Gear =  $\frac{22.0014 \times 11}{10.0833} = 24$

Then Pitch Dia =  $\frac{24 \times .0884}{3.1416} = \underline{\underline{.6753}}$ " dia.

Ratio Between Rack & Indexing Dial = 22.0014 : 24 = 1 :  $\frac{22.0014}{24}$

Movement of Dial for 40D =  $\frac{22.0014}{24} \times 360^\circ = 330.021^\circ$

3.7  
 Pinion. Tooth angle =  $30^\circ$  N° of teeth = 10 Normal Pitch = 40

$$\text{Pitch Dia} = \frac{10}{40 \times \cos 30^\circ} = \frac{10}{40 \times 0.86603} = \underline{.289'' \text{ P.D.}}$$

Indexing Gear Tooth angle =  $60^\circ$  N° of Teeth = 27 Normal Pitch = 40

$$\text{Pitch Dia} = \frac{27}{40 \times \cos 60^\circ} = \frac{27}{40 \times .5} = 1.35$$

$$24.7 \text{ mm} = .97246'' \quad \text{Total Movement of Target} = 1.94492''$$

Make movement of Dial  $330^\circ$  for  $1.94492''$  movement of Target.

$$\text{Then - } \frac{12}{360} \times 1.94492 = 2.12173'' = \text{Normal Pitch Circle of Indexing Gear.}$$

$$\therefore \text{Pitch Dia} = .675''$$

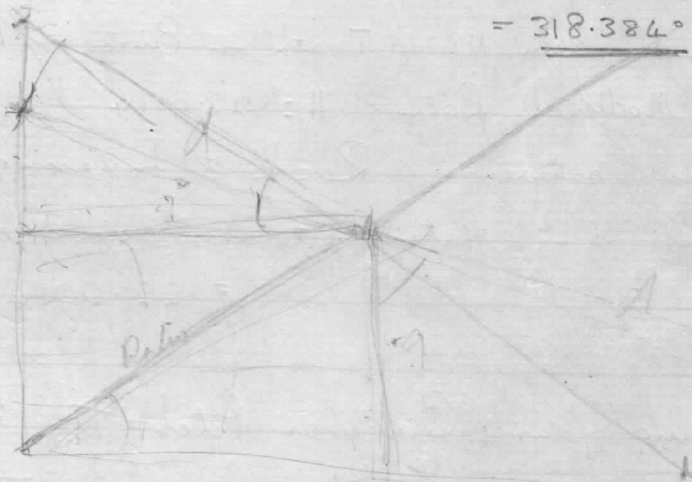
$$D = \frac{N}{P_n \cos \alpha} \quad \therefore \text{N}^\circ \text{ of teeth} = .675 \times 40 \times .5 = 13.5$$

Make N° of teeth = 14

$$\text{Then Pitch Dia} = \frac{14}{40 \times .5} = \underline{.700'' \text{ Pitch Dia.}}$$

$$\text{The Pitch Circle} = 2.19912''$$

$$\text{The movement of Dial} = \frac{2.19912}{1.94492} \times \frac{1.94492}{2.19912} \times 360 = \underline{318.384^\circ}$$



$$P.D. = .675 \quad \text{Circular Pitch} = \frac{1}{16}''$$

$$N^\circ \text{ of teeth} = \frac{3.1416 \times .675 \times 16 \times .5}{\frac{1}{16}} = 16.965$$

Make N° of Teeth 17

Ratio of Rack to Pinion = 1:2 (modified below)

Circular Pitch =  $\frac{1}{16}$

Length of Rack (operating) = 1.94492" Helix Angle =  $30^\circ$

Circular Pitch in plane of rotation =  $\frac{\frac{1}{16}}{\cos 30^\circ} = \frac{\frac{1}{16}}{.86603} = .0722"$

No. of teeth on Rack (operating) =  $\frac{1.94492}{.0722} = 26.938$

Then No. of teeth on Pinion = 13.469 Say 13

Then Pitch Dia =  $\frac{13 \times .0722}{3.1416} = .2988" \text{ dia.}$

Modified ratio = 13:26.938

Ratio between Rack & Indexing Dial =  $1 : \frac{11}{12}$

∴ Ratio between Pinion & Indexing Gear =  $26.938 : \frac{11 \times 13}{12}$   
=  $26.938 : 11.917$

Indexing Gear. Circular Pitch =  $\frac{1}{16}$  Helix angle =  $60^\circ$

Circular Pitch in plane of rotation =  $\frac{\frac{1}{16}}{\cos 60^\circ} = \frac{\frac{1}{16}}{.500} = .125"$

No. of teeth on Indexing gear =  $\frac{26.938}{11.917} \times 13 = 29.4$  Say 30

Then Pitch Dia =  $\frac{30 \times .125}{3.1416} = \frac{3.75}{3.1416} = 1.1937"$

Addendum =  $\frac{1}{N.D.P.} = .0199"$

Whole depth of tooth = .0429"

Sched V100. Items 14, 16, & 17 stored from .04" to .10" Thick. Item 22 altered to 1/8" thick  
 Item 18 altered to 3/16" thick

Item 20 deleted.

Item 25 Material Glass <sup>Chance</sup> Arc Screen. Order sample with transmission as per sample.

Alter Cells to take thicker glass. Item 87 added.

Alter Drgs V.112, V.113, & Scrap Drg. V.116.

70711) 628000 (0888  
 565688  
 623120  
 565688  
 574320  
 565688  
 8632

888) 19449.2 (21.90225  
 1776  
 1689  
 888  
 8012  
 7992  
 2000  
 1776

0888  
 11  
 8880  
 888  
 .9768

31416) 97680 (3109  
 94248  
 34320  
 31416  
 290400  
 282744  
 76560

21-90225  
 11  
 21902250  
 2190225  
 24092475

0888  
 24  
 17760  
 3552  
 21312

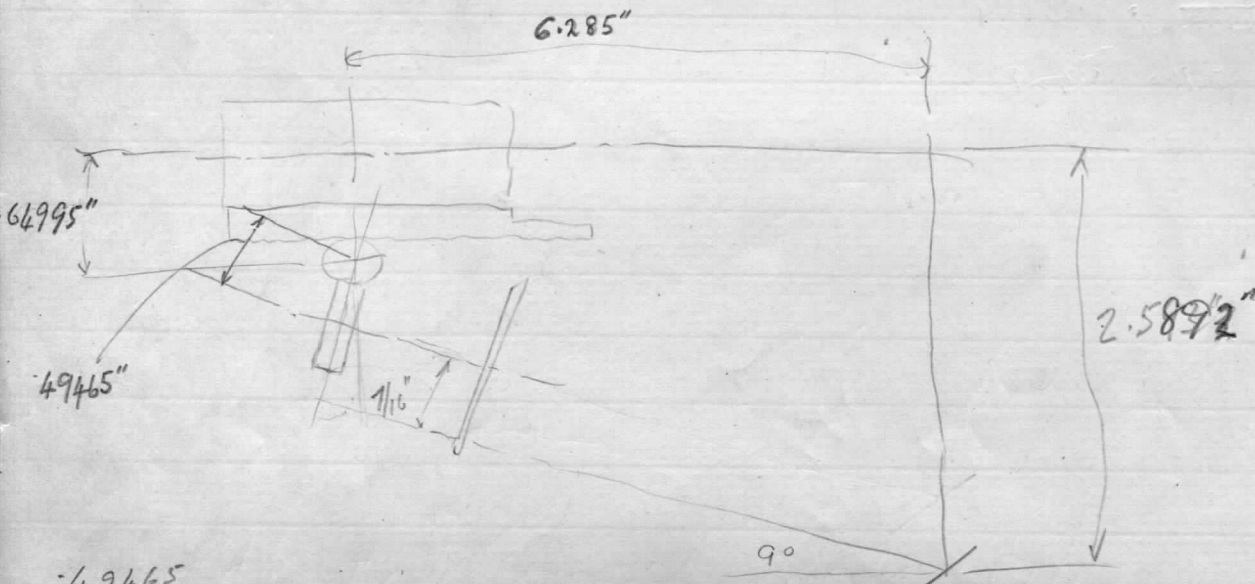
100833) 2409247.5 (23.89344  
 201666  
 392587  
 302499  
 900885  
 806664  
 942210  
 907497  
 347130  
 302499  
 446310  
 403332  
 429780

31416) 213120 (67838  
 188496  
 246240  
 219912  
 263280  
 251328  
 119520  
 94248  
 252720  
 251328

15  
 300  
 24

21-90225  
 15  
 21902250  
 10951125  
 32853375

328°  
 40  
 3-7306  
 360 + 1°



49465  
 43750  
 92215

23-3-45 Ratio of Rack to Pinion = 1:2

Normal D.P. = 50      Equivalent Normal Circular Pitch = .0628

Length of Rack (Operating) = 1.94492"      Helix Angle = 45°

Circular Pitch in Plane of Rotation =  $\frac{.0628}{\cos 45^\circ} = \frac{.0628}{.70711} = .0888"$

∴ No. of teeth on rack (operating) =  $\frac{1.94492}{.0888} = 21.90225$

Then No. of teeth on pinion =  $\frac{21.9}{2} = 11$       ∴ Pitch Dia =  $\frac{11 \times .0888}{3.1416} = .3109" \text{ dia}$

Modified Ratio = 11 : 21.90225

Ratio between Rack & Indexing Dial = 1 :  $\frac{1}{12}$

∴ Ratio between pinion and Indexing Gear = 21.90225 :  $\frac{11 \times 11}{12}$   
= 21.90225 : 10.0833

Indexing Gear Normal D.P. = 50      Helix Angle = 45°

Circular Pitch in Plane of rotation = .0888"

No. of teeth on indexing gear =  $\frac{21.90225 \times 11}{10.0833} = 23.8934$

Say 24

Then Pitch Dia =  $\frac{24 \times .0888}{3.1416} = .6784" \text{ dia}$

∴ Ratio between Rack & Indexing Dial = 21.90225 : 24

Movement of Dial for 40 D =  $\frac{21.90225}{24} \times 360^\circ = 328.53375^\circ$

Dia. of Dial =  $1\frac{3}{16}"$       Circ = 3.7306"

∴ Distance between divisions on outside edge for 1 D =  $\frac{3.7306}{360} \times \frac{328.53375}{40}$   
= .08511"

Distance between divisions for  $\frac{1}{4} D =$  .02128"

Addendum = .0200"

Whole Depth of tooth = .0431"

$$\frac{1}{2} \text{ chord} = 10.09375 \times \sin 48.534625^\circ$$

$$= 10.09375 \times .74088$$

$$= 7.498''$$

49 mm

$$\begin{array}{r} 888 \ 19291 \ (21.7241) \\ \underline{1776} \\ 1531 \\ \underline{888} \\ 6430 \\ \underline{6216} \\ 2140 \\ \underline{1776} \\ 3640 \\ \underline{3552} \\ 880 \end{array}$$

$$\begin{array}{r} 21.7241 \\ \underline{11} \\ 2172410 \\ \underline{217241} \\ 9389651 \end{array}$$

$$\begin{array}{r} 3015 \\ \underline{360} \\ 24 \\ \underline{2} \end{array}$$

$$\begin{array}{r} 100833 \ 2389651 \ (23.6) \\ \underline{201666} \\ 372991 \\ \underline{302499} \\ 704920 \end{array}$$

$$\begin{array}{r} 360.0000 \\ 325.8615 \\ \underline{34.1385} \\ 2 \ 17.06925 \\ \underline{2} \\ 8.534625 \end{array}$$

$$\begin{array}{r} 21.7241 \\ \underline{15} \end{array}$$

$$\begin{array}{r} 2172410 \\ 1086205 \\ \underline{3258615} \end{array}$$

$$\begin{array}{r} .1484088 \\ 10.09375 \end{array}$$

$$\begin{array}{r} 148408800000 \\ 13356792000 \\ \underline{445226400} \\ 103886160 \\ \underline{7420440} \\ 1498001325000 \end{array}$$

$$\begin{array}{r} 325.8615 \\ 3.7306 \\ \underline{97758450000} \\ 22810305000 \\ \underline{977584500} \\ 19551690 \\ \underline{121565891190} \end{array}$$

$$\begin{array}{r} 360 \\ \underline{40} \\ 14400 \end{array}$$

$$\begin{array}{r} 8.534625 \ 8^\circ 32' 5'' \\ \underline{60} \\ 32077500 \\ \underline{46500} \end{array}$$

$$\begin{array}{r} 4 \ .08442 \\ \underline{.021105} \end{array}$$

$$\begin{array}{r} 12 \ 2876^{30} \\ \underline{240} \end{array}$$

$$\begin{array}{r} 1483848 \\ \underline{240} \\ -1484088 \end{array}$$

$$\begin{array}{r} 144 \ 12.156589119 \ (.08442) \\ \underline{1152} \\ 636 \\ \underline{576} \\ 605 \\ \underline{576} \\ 298 \\ \underline{288} \\ 10 \end{array}$$

$$\begin{array}{r} .00002 \\ \underline{40} \\ .00080 \end{array}$$

$$\begin{array}{r} 16 \ 3258615 \ 2.03663 \\ \underline{32} \end{array}$$

$$\begin{array}{r} 58 \\ \underline{48} \\ 106 \\ \underline{96} \\ 101 \\ \underline{96} \\ 550 \\ \underline{470} \end{array}$$

$$\begin{array}{r} 2 \ 203663 \\ \underline{4018325} \\ 60 \\ \underline{1098900} \\ 60 \\ \underline{59340} \end{array}$$

$$\begin{array}{r} 138 \\ \underline{51} \\ 87 \end{array}$$

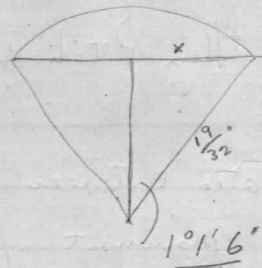
$$\frac{19}{32} \times \frac{26}{9} = \frac{95}{8} \cdot 11\frac{1}{2}$$

$$\sin = \frac{x}{19\frac{1}{32}}$$

$$x = \frac{19}{32} \times .0177723 \cdot 01$$

$$\frac{17 \times 3}{16} = \frac{51}{16} = 3\frac{3}{16}$$

$$24 : 71.7$$



$$\begin{array}{r} .59375 \\ .0177723 \\ 5937500000 \\ 4156250000 \\ \underline{4156250000} \\ 118750000 \\ \underline{179125} \\ .010552303125 \\ \underline{.021104606250} \end{array}$$

$$\begin{array}{r} .0177723 \\ 11.875 \\ 177730000 \\ 177723000 \\ \underline{142178600} \\ 124408100 \\ \underline{888615} \\ .2110460625 \end{array}$$

$$17 \times 3\frac{3}{16} = 17 + 3\frac{3}{16}$$

$$\begin{array}{r} 0180341 \\ 0177135 \\ \underline{00002909} \\ 0177632 \\ \underline{01777229} \end{array}$$



$$\begin{array}{r} 103663 \\ \underline{60} \\ 219780 \end{array}$$

$$\begin{array}{r} .1978 \\ \underline{60} \\ 118680 \end{array}$$

Enlarged Graphic Drawing Scale 17/1

$$\angle \theta = 32.58615^\circ$$

$$O/Dia = 20\frac{3}{16}''$$

$$\begin{array}{r} .04 \\ .6794 \\ \underline{.7194} \end{array}$$

24-3-45

Ratio of Rack to Pinion = 1:2 (modified below)

Normal D.P. = 50      Equivalent Normal Circular Pitch = .0628"

Length of Rack (Operating) = 49 mm = 1.9291"      Helix Angle = 45°

Circular Pitch in plane of rotation =  $\frac{.0628}{\cos 45^\circ} = \frac{.0628}{.7071} = .0888"$

∴ N° of teeth on Rack (Operating) =  $\frac{1.9291}{.0888} = 21.7241$

Then N° of teeth on pinion =  $\frac{21.7}{2} = 11$       ∴ Pitch Dia =  $\frac{11 \times .0888}{3.1416} = .3109"$  dia.

Modified ratio = 11 : 21.7241

Ratio between Rack & Indexing Dial = 1 :  $\frac{11}{12}$

∴ Ratio between Pinion & Indexing Gear = 21.7241 =  $\frac{11 \times 11}{12}$   
= 21.7241 = 10.0833

Indexing Gear Normal D.P. = 50      Helix Angle = 45°

Circular Pitch in plane of rotation = .0888"

N° of teeth on indexing gear =  $\frac{21.7241}{10.0833} \times 11 = 23.6$       Say 24

Then Pitch Dia =  $\frac{24 \times .0888}{3.1416} = .6784"$  dia.

∴ Ratio between Rack & Indexing Dial = 21.7241 : 24

∴ Movement of Dial for 40 D =  $\frac{21.7241}{24} \times 360^\circ = 325.8615^\circ$

Dia. of Dial =  $1\frac{3}{16}"$       ∴ Circ = 3.7306"

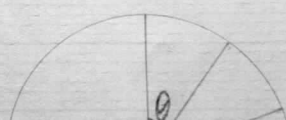
∴ Distance between divisions on outside edge for 1 D =  $\frac{3.7306}{360} \times \frac{325.8615}{40}$   
= .08442"

Distance between divisions for  $\frac{1}{4}$  D = .0211" (length of arc)

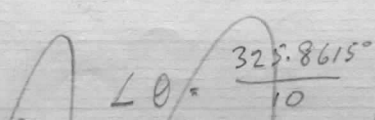
Chordal length = .0211"

Angle between division for  $\frac{1}{4}$  D = 2.03663° = 2°-2'-12"

Window 4.3 mm x 2.8 mm = .17" x .09"



W.M.



Enlarged Geometrical Drawing

$40^\circ \times \frac{325.8615^\circ}{10} = 325.8615^\circ$

26-3-45.

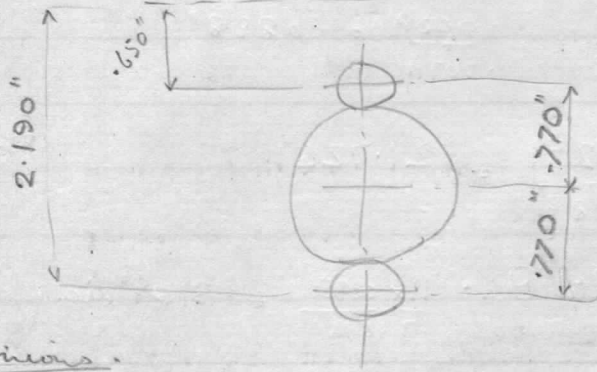
Spin Gears

$1\frac{1}{2} \times 40^5$

$\frac{40}{3}$   
12.0

$2 \overline{) 311}$   
1555  
1945  
3000  
6500

$\frac{5}{4} \times 40$



$\frac{1937}{.0042}$   
4945  
2000  
1975  
0.23

$2 \overline{) 2.200}$   
1.100  
1.100  
0.000  
0.000  
0.000  
0.000  
0.000

$\frac{1.55}{.130}$   
12.3

Pinion

D.P. = 50

Pitch Dia = .320"

O/dias = .360"  $\frac{+0.000}{-0.001}$

N° of teeth = 16

Whole Depth of teeth = .0431"

Gear

D.P. = 50

Pitch Dia = 1.22" dia

O/dia = 1.260"  $\frac{+0.000}{-0.001}$

N° of teeth = 61

Whole Depth of teeth = .0431"

$\frac{1.55}{.130}$   
12.3

$\frac{13}{46} \times 50 = 150$

$\frac{22}{165}$   
1.55

$6 \overline{) 1.30}$   
.325

$5 \overline{) 1.6}$   
.32

$32 \times 50 = 1500$   
1500  
1500  
0

$\frac{18}{515}$   
1.230  
50  
6150

$\frac{61}{50}$   
 $5 \overline{) 6.1}$   
1.22

$2 \overline{) 1.54}$   
.77

$2 \overline{) 2.19}$   
1.095  
1.095  
0.000  
0.000  
0.000

$\frac{11}{50}$   
0.22

$\frac{.77}{.16}$   
4.8125

$\frac{1.22}{.50}$   
2.44

27-3-45

Add items 75 & 76.

Item 57 altered to  $1\frac{5}{16}$ " dia

Item 65 "  $\frac{1}{4}$ " dia

Item 68 "  $\frac{3}{8}$ " dia  $\times \frac{3}{4}$



Conference with Mr Brown.

6-6-45.

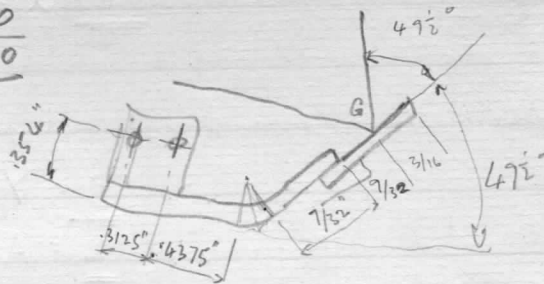
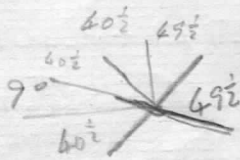
1. Possibility of traversing Spectacle Rest by means of worm with knob positioned at right-hand end of Rest.
2. Enlarge Main Casting to eliminate protrusions and give outside appearance more aesthetic lines.
3. Contour of top of Main Casting to be convex instead of concave, Clamping Tube at top rear of instrument being covered by casting. This eliminates crevices where dust collects.
4. Suggest "Arims" be cast on left side of Main Casting.
5. Base to be covered with baize to prevent scratching table.

.93215  
1-0125  
 932150000  
 9321500  
 1864300  
 466075  
.943801875

.15838  
 6.285  
95028000  
 3167600  
 1267040  
 79190  
.99541830  
 180  
130 1/2  
49 1/2

.64995  
 .9438  
 .9954  
2.58915

.66101  
 .229  
9220200  
922020  
416909  
.10557129



.175  
 .104  
.279

.64945  
 .606  
38967000  
389670  
.39356670

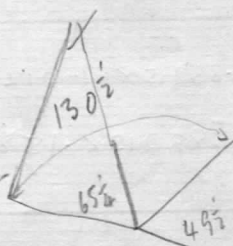
.1875

.104  
.372

180  
 130

90  
 48  
243

.15663  
 .5435  
78215000  
6257200  
4692900  
78215  
.085019705

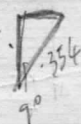


2.5892  
 .3936  
2.9828  
 .6346  
.482

.3496  
 .0850  
.6346

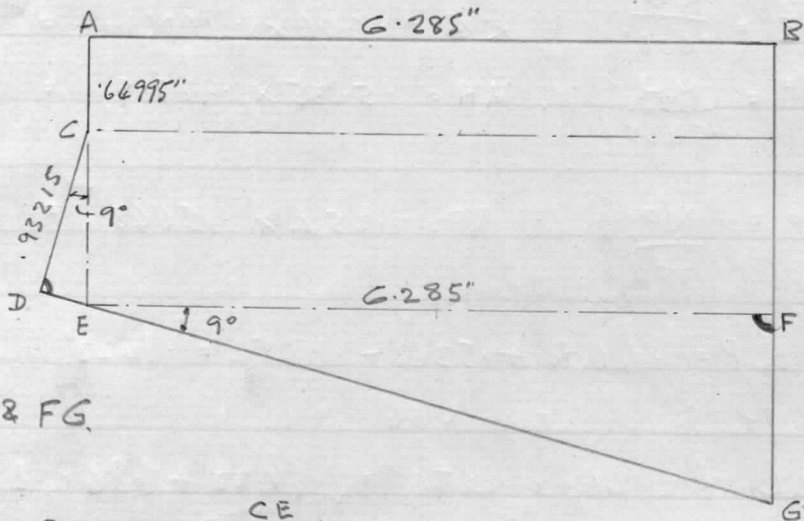
.98769  
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29630700  
49384500  
395076  
.34964226

.15663  
 .3125  
929000  
13000  
460



.692  
 .292  
.99  
 .001

.4775  
 .106  
.5835



To find CE & FG

$$\Delta CED, \text{Secant } 9^\circ = \frac{CE}{CD}$$

$$\therefore CE = CD \times \text{Secant } 9^\circ$$

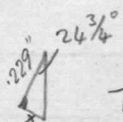
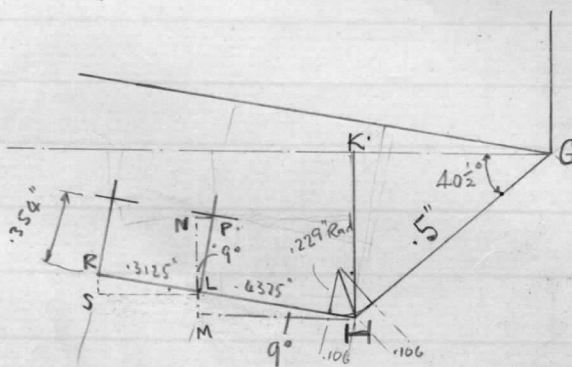
$$= .93215 \times 1.0125 = \underline{\underline{.9438}}$$

$$\Delta EFG, \text{Tan } 9^\circ = \frac{FG}{EF}$$

$$\therefore FG = EF \times \text{Tan } 9^\circ$$

$$= 6.285 \times .15838 = \underline{\underline{.9954}}$$

$$\therefore BG = .64995 + .9438 + .9954 = \underline{\underline{2.5892}}$$



$$\text{Tan } 24 \frac{3}{4}^\circ = \frac{x}{.229} \quad \therefore x = .229 \times .46101 = .106$$

$$\Delta KGH \quad \text{Sine } 40 \frac{1}{2}^\circ = \frac{KH}{.606} \quad KH = .606 \times .64945 = .3936$$

$$\Delta LHM \quad \text{Sine } 9^\circ = \frac{LM}{.5435} \quad LM = .5435 \times .15643 = .085$$

$$\Delta NPL \quad \text{Cosine } 9^\circ = \frac{NL}{.354} \quad NL = .354 \times .98769 = .3496$$

$$\therefore \text{Distance from P to G} = 2.5892 + .3936 - (.085 + .3496) = 2.5482$$

✓

$$\Delta KGH \text{ Cosine } 40\frac{1}{2}^\circ = \frac{KG}{.606} \quad \therefore KG = .606 \times .76041 = .4608''$$

$$\Delta LHM \text{ Cosine } 9^\circ = \frac{MH}{.5435} \quad \therefore MH = .5435 \times .98769 = .5368''$$

$$\Delta NPL \text{ sine } 9^\circ = \frac{NP}{.354} \quad \therefore NP = .354 \times .15643 = .0554''$$

$$\therefore \text{Distance from G to P} = .4608 + .5368 - .0554 = .9422''$$

$$\text{Distance from G to Edge of casting} = 1.84$$

$$\therefore \text{Distance from P to Edge of casting} = .9422 + 1.84 = 2.7822''$$

$$\Delta RLS \text{ Cosine } 9^\circ = \frac{SL}{.3125} \quad \therefore SL = .3125 \times .98769 = .3087''$$