A MACHINABILITY EVALUATION OF GROUPS XII—XVI OILS

ON THE MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

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Project 2080

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CONCLUSIONS

1. The levels of 175 microinches for turning and 200 microinches for forming appear to be satisfactory in adjudging the tool life (number of pieces per tool grind) when evaluating cutting fluids on the multiple-spindle, automatic screw machine. In some cases, however, visual inspection of the samples was used to supplement the graphical data, as was explained in the "Test Results."

2. In the machining of various steels on a multiple-spindle, automatic screw machine, the 4316 oil shows better characteristics in heat transfer, and the resulting improvement in tool life (indicated by surface roughness as a criterion), than do the other oils, with oils L589 and 4332 running a close second in all-around performance.

3. Feeds of 0.0031 inch/revolution for turning and 0.001 inch/revolution for forming seem to give reasonable tool life on the various steels that are included in this study. The feed of 0.004 inch/revolution which was used on the second forming operation was definitely too heavy and resulted in short tool life in all cases. A cutting speed of 117.5 feet per minute is reasonable on the AISI 1141 and 4145 materials, but should be reduced for production on the 8620 steel to insure a larger number of parts per tool grind.
AN EVALUATION OF OILS NO. L581, L589, 4332, AND 4316 AS APPLIED TO THE
OPERATION OF A NEW BRITAIN-GRIDLEY, 6-SPINDLE, AUTOMATIC SCREW MACHINE
IN THE MACHINING OF AISI 1141, 4145, AND 8620 STEELS

Operating Conditions

Machine

A New Britain-Gridley Model 60, 6-spindle, automatic screw machine
was used in the testing of three steels and four oils for this series of
tests.

Oils

Oils No. L581, L589, 4332, and 4316 as received from the company
were used in the above machine. Test samples of each of the first two oils
were sent to the laboratory for verification of condition.

Steels

The certification of analysis of each material from the supplier
and the Brinell Hardness Number (BHN) are listed as follows:

<table>
<thead>
<tr>
<th>Steel</th>
<th>C</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Si</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>BHN</th>
<th>3000-kg Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1141</td>
<td>.41</td>
<td>1.37</td>
<td>.025</td>
<td>.090</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>223</td>
</tr>
<tr>
<td>4145</td>
<td>.44</td>
<td>1.04</td>
<td>.021</td>
<td>.021</td>
<td>.28</td>
<td>1.05</td>
<td>.13</td>
<td></td>
<td></td>
<td>223</td>
</tr>
<tr>
<td>8620</td>
<td>.21</td>
<td>.86</td>
<td>.019</td>
<td>.023</td>
<td>.31</td>
<td>.49</td>
<td>.17</td>
<td>.50</td>
<td></td>
<td>217</td>
</tr>
</tbody>
</table>

The 4145 and 8620 steels were prepared in an annealed and cold-drawn condi-
tion and the 1141 in a cold-finished state. All materials were 13/16 inch
outside diameter and from 10 to 12 feet in length.
Cutting Tools

**Turning.**—The turning tools were M-3-D High-Speed Steel (Universal Cyclops) of 6% Mo, 4% Cr, 2.4% V, and 6% W. The tools were ground to the following signatures:

<table>
<thead>
<tr>
<th>Oil</th>
<th>1st turn</th>
<th>2nd turn</th>
</tr>
</thead>
<tbody>
<tr>
<td>L581</td>
<td>17,2,8,8,6,0,1/64</td>
<td>17,2,8,8,6,0,1/64</td>
</tr>
<tr>
<td>L589</td>
<td>17,2,8,8,6,0,1/64</td>
<td>17,2,8,8,6,0,1/64</td>
</tr>
<tr>
<td>4332</td>
<td>17,2,8,8,6,0,1/64</td>
<td>8,15,8,8,6,0,1/64</td>
</tr>
<tr>
<td>4316</td>
<td>17,2,8,8,6,0,1/64</td>
<td>8,15,8,8,6,0,1/64</td>
</tr>
</tbody>
</table>

The signature was held constant on the first turning tool for all tests. However, the tool signature was varied on the second turning tool to observe any improvement in number of pieces produced before failure of the tool.

**Forming.**—The form tools were purchased as 18-4-1 High-Speed Steel (10% W, 4% Cr, 1% V). The following back-rake angles were ground on the tools:

<table>
<thead>
<tr>
<th>Oil</th>
<th>1st form</th>
<th>2nd form</th>
</tr>
</thead>
<tbody>
<tr>
<td>L581</td>
<td>15°</td>
<td>8°</td>
</tr>
<tr>
<td>L589</td>
<td>15°</td>
<td>0°</td>
</tr>
<tr>
<td>4332</td>
<td>15°</td>
<td>15°</td>
</tr>
<tr>
<td>4316</td>
<td>15°</td>
<td>15°</td>
</tr>
</tbody>
</table>

The back-rake angle on the first forming tool was held constant for all tests while the back rake on the second-form tool was varied to observe any improvement in number of pieces produced before failure of the tool and to determine if the feed rate of 0.004 inch per revolution was a deterrent to good performance.

**Test Method**

The AISI 1141 steel was machined under the first machine setup at 117.5 feet per minutes (556 rpm) and feeds of 0.0031 inch/revolution on the turning tools, 0.001 inch/revolution on the first form, and 0.004 inch/revolution on the second form, using the L589 oil. All machine spindles were checked for accuracy and variations in surface finish on the machined parts.
The No. 2 spindle was chosen as representative of the average of all six, and the work pieces that were retained for subsequent examination and surface-roughness inspections were taken from this same spindle at intervals of approximately thirty pieces throughout the life of the test. The three steels and four oils were tested under the above conditions.

Test Criteria

It was determined that values of surface roughness (microinches, rms) would be obtained from the first and second turn and the first- and second-form surfaces by averaging the values of three readings on each surface as measured by a micrometrical profilometer. These values were plotted as ordinate vs number of pieces as abscissa for each of the roughness inspections throughout the life of the test.

The drills that were used in producing 5/16-inch-diameter holes did not show consistent evidence of tool wear and thus were not included in the evaluation of the test data. In running tests on oils 4332 and 4316, the drilling operation was eliminated altogether.

Test Results

After all data had been plotted, it was observed that a value of 175 microinches, rms, was representative of average tool life for the turning tools and 200 microinches, rms, for the form tools. These values are shown on each of the Figs. 1 through 28 to indicate the number of pieces produced prior to tool failure (inability to produce desirable surface finish).

Figs. 1-6 show the results obtained in testing the L581 and L589 oils in turning 1141, 4145, and 8620 steel. Solid lines were used to show the trend of the first-turning operation while dashed or broken lines were used for the second turn.

Figs. 7-12 show the results obtained in testing the L581 and L589 oils in forming 1141, 4145, and 8620 steel. Solid lines were used to show the trend of the first-forming operation while dashed or broken lines were used for the second form.

Figs. 13-16 show the results obtained in testing the 4332 and 4316 oils in turning 1141 and 4145 steel. Solid lines were used to show the trend of
the first-turning operation while dashed or broken lines were used for the second turn. In most cases, two sets of turning tools failed prior to the failure of one set of form tools.

Figs. 17-20 show the results obtained in testing the 4332 and 4316 oils in forming 1141 and 4145 steel. Solid lines were again used to show the trend of the first-forming operation while dashed or broken lines were used for the second form.

Figs. 21-24 show the results obtained in any one turning operation, using one steel, for the four different oils, i.e., Fig. 22, first-turning operation on 4145 steel, using oils L581, L589, 4332, and 4316.

Figs. 25-28 show the results obtained in any one forming operation, using one steel, for the four different types of oil, i.e., Fig. 26, first-forming operation on 4145 steel, using oils L581, L589, 4332, and 4316.

The following is a quick reference chart to assist in finding the graph for any one operation with any combination of oil and steel. The numbers on the chart represent the corresponding figure numbers on the graphs.

<table>
<thead>
<tr>
<th>Graph Reference Chart</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td>L581</td>
</tr>
<tr>
<td><strong>1st turn</strong></td>
<td></td>
</tr>
<tr>
<td>1141</td>
<td>--</td>
</tr>
<tr>
<td>4145</td>
<td>3,22</td>
</tr>
<tr>
<td>8620</td>
<td>--</td>
</tr>
<tr>
<td><strong>2nd turn</strong></td>
<td></td>
</tr>
<tr>
<td>1141</td>
<td>1,23</td>
</tr>
<tr>
<td>4145</td>
<td>3,24</td>
</tr>
<tr>
<td>8620</td>
<td>5</td>
</tr>
<tr>
<td><strong>1st form</strong></td>
<td></td>
</tr>
<tr>
<td>1141</td>
<td>7,25</td>
</tr>
<tr>
<td>4145</td>
<td>9,26</td>
</tr>
<tr>
<td>8620</td>
<td>11</td>
</tr>
<tr>
<td><strong>2nd form</strong></td>
<td></td>
</tr>
<tr>
<td>1141</td>
<td>7,27</td>
</tr>
<tr>
<td>4145</td>
<td>9,28</td>
</tr>
<tr>
<td>8620</td>
<td>11</td>
</tr>
</tbody>
</table>

The following Table I shows the values of the number of pieces obtained prior to tool failure as defined by 175 microinches for turning and 200 microinches for forming. These values were found in the majority of cases by direct interpolation from the various graphs, in some cases, visual inspection superseded the graphical data. This was due to the
tendency of the built-up edge on the tool to produce a rough surface (profilometer readings above the average in microinches, rms) for a few samples and then a return to normal after the built-up edge had changed. On the other hand, a tool which had failed sometimes showed a tendency to produce a burnished or torn surface, resulting in a good profilometer reading (below the average in microinches, rms), but an unsatisfactory finish as shown by visual inspection. Therefore, direct interpolation alone, in some cases, does not give clear and accurate results.

In Table I the machining of AISI 1141 steel with the 4316 oil shows the most improvement in the number of pieces produced before tool failure in both the turning and forming operations. The 4332 and L589 oils show very little difference in the turning operation, but the forming cuts favor the 4332 oil over the L589 and indicate a similarity in performance with the 4316 oil. The worst performance is shown by the L581 oil in both the turning and forming operations.

In the machining of AISI 4145 steel, oils L581 and L589 show the best performance of the four in the turning operation, with slight differences in the number of pieces produced before tool failure. Oil L589, however, is definitely superior to the others in the forming operation. Oil 4316 rates second to the L589 in the forming operation, and oils L581 and 4332 third and fourth, respectively.

In the machining of AISI 8620 steel, oil L589 shows ability to aid in producing more pieces per tool grind than the L581 oil in each of the cases shown. This steel was not tested with the 4332 and 4316 oils at the request of Mr. Ford Teeter.

### TABLE I

**NUMBER OF PIECES OBTAINED PRIOR TO LOSS IN SURFACE FINISH**

<table>
<thead>
<tr>
<th>Steel</th>
<th>Oil</th>
<th>1st Turn 0.0031 feed 175 microinches</th>
<th>2nd Turn 0.0031 feed 175 microinches</th>
<th>1st Form 0.001 feed 200 microinches</th>
<th>2nd Form 0.004 feed 200 microinches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1141</td>
<td>L581</td>
<td>*</td>
<td>180</td>
<td>800+</td>
<td>88</td>
</tr>
<tr>
<td>1141</td>
<td>L589</td>
<td>555</td>
<td>335</td>
<td>900+</td>
<td>245</td>
</tr>
<tr>
<td>1141</td>
<td>4332</td>
<td>520</td>
<td>420</td>
<td>1080</td>
<td>525</td>
</tr>
<tr>
<td>1141</td>
<td>4316</td>
<td>660</td>
<td>660</td>
<td>1400+</td>
<td>750</td>
</tr>
<tr>
<td>4145</td>
<td>L581</td>
<td>405</td>
<td>485</td>
<td>440</td>
<td>80</td>
</tr>
<tr>
<td>4145</td>
<td>L589</td>
<td>380</td>
<td>135</td>
<td>850+</td>
<td>115 (Tool Failure)</td>
</tr>
<tr>
<td>4145</td>
<td>4332</td>
<td>190</td>
<td>230</td>
<td>230</td>
<td>75</td>
</tr>
<tr>
<td>4145</td>
<td>4316</td>
<td>220</td>
<td>220</td>
<td>525</td>
<td>65</td>
</tr>
<tr>
<td>8620</td>
<td>L581</td>
<td>*</td>
<td>125</td>
<td>0**</td>
<td>0**</td>
</tr>
<tr>
<td>8620</td>
<td>L589</td>
<td>180</td>
<td>190+</td>
<td>65</td>
<td>0**</td>
</tr>
</tbody>
</table>

*No test results. **Roughness over 200 microinches, rms, at start.
PROJECT 2030
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 556  F.P.M. 117.5
Feed: I.P.R. .0031
Parts Per Hour: 171
Cutting Fluid: Sinclair L-581
Material Cut: AISI - 1141 Steel
Tool Material: M-3-D H.S.S.
Tool Type: Box, 2nd Turn
Tool Signature: 17, 2, 8, 6, 0, 1/6

Fig. 1
PROJECT 2060
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

MACHINE: New Briton Gridley Mod. 60
SPEED: R.P.M. 750
F.P.M. 117.5
FEED: I.P.R. .0031
PARTS PER HOUR: 171

CUTTING FLUID: Sinclair L-581

MATERIAL CUT: AISI 1145 Steal

TOOL MATERIAL: M-3-D H.S.S.

TOOL TYPE: Box, 1st Turn & 2nd Turn

TOOL SIGNATURE: 17, 2, 8, 8, 6, 0, 1/6h

AVERAGE FAILURE

1ST TURN

2ND TURN

NUMBER OF PIECES

Fig. 3
PROJECT 2030
SINCLAIR RESEARCH LAB.

SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 556 P.P.M. 177.5
Feed: T.P.R. .0031
Parts Per Hour: 171
Cutting Fluid: Sinclair L-589
Material Cut: AISI L-1145 Steel
Tool Material: M-3-5 H.S.S.
Tool Type: Box, 1st Turn & 2nd Turn
Tool Signature: 17, 2, 8, 6, 0, 1/6

Fig. 4
**PROJECT 2080**

SINCLAIR RESEARCH LAB.

SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 536  T.P.M. 117.5
Feed: I.P.R. .001
Parts Per Hour: 171
Cutting Fluid: Sinclair L-581
Material Cut: AISI - 1L1 Steel
Tool Material: 18-8-1 R.S.S.
Tool Type: 1st & 2nd Form
Tool Signature: 5° Relief, 15° Rake

---

**2nd Form at .001 Feed 8° Back Rake**

**1st Form at .001 Feed 15° Back Rake**

**AVERAGE FAILURE**

---

Surface Finish x 10^-6 (R.M.S.)

**Fig. 7**
PROJECT 2080
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 556 F.P.M. 117.5
Feeds: I.P.R. .001
Parts Per Hour: 171
Cutting Fluid: Sinclair L-589
Material Cut: AISI 11L1 Steel
Tool Materials: 18-4-1 H.S.S.
Tool Types: 1st & 2nd Form
Tool Signature: 5° Relief, 15° Rake

2nd Form at .001, Feed 0° Back Rake

AVERAGE FAILURE

1st Form at .001, Feed 15° Back Rake

Fig. 8
PROJECT 2080
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mdc. 60
Speed: R.P.M. 117.5
Feed: I.P.R. .001
Parts Per Hour: 171
Cutting Fluid: Sinclair L-581
Material Cut: AISI 1115 Steel
Tool Material: 10-4-1 H.S.S.
Tool Type: 1st & 2nd Form
Tool Signature: 5° Relief, 15° Back

Fig. 9
PROJECT 2080
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Grisley Mod. 60
Speed: r.p.m. 550 F.P.M. 117.5
Feed: I.P.R. .001
Parts Per Hour: 171
Cutting Fluid: Sinclair L-589
Material Cut: AISI 4145 Steel
Tool Material: 18-8-1 H.S.S.
Tool Type: 1st Form
Tool Signature: 5° Relief, 15° Rake

AVERAGE FAILURE

Tool Failure

2nd Form at .001 Feed
0° Back Rake

1st Form at .001 Feed
15° Back Rake

NUMBER OF PIECES

Fig. 10
PROJECT 2080
SINCLAIR RESEARCH LAB.

SURFACE FINISH VS. NO. OF PIECES

1st Form at .001 Feed
15° Back Rake

2nd Form at .001
8° Back Rake

MACHINE: New Britain Gridley Mod. 60
SPEEDS: R.P.M. 556 - F.P.M. 117.5
FEED: 0.001
PARTS PER HOUR: 171
CUTTING FLUID: Sinclair L-581
MATERIAL CUT: AISI - 3620 STEEL
TOOL MATERIAL: 18-4-1 H.S.S.
TOOL TYPE: 1st & 2nd FORM
TOOL SIGNATURE: 5° Relief, 15° Rake

SURFACE FINISH x 10^-6 (a.m.s)

AVERAGE FAILURE

100
150
200
250
300
350

NUMBER OF PIECES

0 100 200 300 400

Fig. 11
PROJECT 2000
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 75 - 1170
Feed: I.P.M. .001
Parts Per Hour: 171
Cutting Fluid: Sinclair L-569
Material Cut: AISI 3620 Steel
Tool Material: 18-1-1 H.S.S.
Tool Type: 1st Form
Tool Signature: 5° Relief, 15° Rake

1st Form at .001 Feed
15° Back Rake

2nd Form at .001 Feed
0° Back Rake

AVERAGE FAILURE

Fig. 12
PROJECT 2080
SINCLAIR RESEARCH LAB.

SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 555  F.P.M. 117.5
Feed: I.P.M. .0031
Parts Per Hour: 171
Cutting Fluid: 4332
Material Cut: AISI 1141 Steel
Tool Material: M-3 D.H.S.S.
Tool Type: Fox, 1st & 2nd Turn

2nd Turn With
Tool Signature
8, 15, 8, 6, 9, 17/64
Average Failure

1st Turn With
Tool Signature
17, 2, 8, 8, 6, 0, 17/64

NUMBER OF PIECES

Fig. 13
PROJECT 2060
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Britain Gridley Mod. 60
Speeds: 2.5 FM = 550  T.P.M. = 127.5
Feeds: L.P.R. = 0.031
Parts Per Hour: 175
Cutting Fluids: MIB
Material Cut: AISI 1141 Steel
Tool Material: M-3-0 HSS
Tool Type: Box, 1st & 2nd Turn

--

AVERAGE FAILURES

1st Turn with Tool Signature
17,2,8,8,6,0,1/64

2nd Turn with Tool Signature
8,35,8,8,6,0,1/64

NUMBER OF PIECES

0 200 400 600 800 1000 1200 1400

SURFACE FINISH (GA. IN.)

75 100 150 200 250

Fig. 21
PROJECT 2080

SINCLAIRE RESERCH LAB.

SURFACE FINISH VS NO. OF PIECES

Machine: New Briton Gridley Mdl. 60
Speed: S.P.M. 556  F.P.M. 117.5
Feed: 11.1
Parts per Hour: 171
Cutting Fluid: 4332
Material Cut: AISI 4145 Steel
Tool Material: M-36D H.S.S.
Tool Type: Box, 1st & 2nd Turn

2nd Turn With
Tool Signature
6,15,3,5,6,0,1/64
Average Failure

1st Turn With
Tool Signature
17,3,2,8,6,0,1/64

Number of Pieces

FIG. 15
PROJECT 2060
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 556 P.P.M. 117.15
Feed: 
Parts Per Hour: 171
Cutting Fluid: 4316
Material Cut: AISI - 4145 Steel
Tool Material: M-3-D H.S.S.
Tool Type: Box, 1st & 2nd Turn

Fig. 16
PROJECT 2080
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Eriton Gridley Yod. 60
Speed: R.P.M. 556 F.P.M. 117.5
Parts Per Hour: 171
Cutting Fluid: 4332
Material Cut: AISI - 11L1 Steel
Tool Material: 13-41 HSS Steel
Tool Type: 1st & 2nd form
Tool Signature: 15" Back rake

Average Failure

1st Form at .001 I.P.M. Feed

2nd Form at .004 I.P.M. Feed

NUMBER OF PIECES

SURFACE PILE SE x 10^-6 (R.A.M.)
PROJECT 2050
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 555; F.P.M. 117.5
Parts Per Hour: 471
Cutting Fluid: 4332
Material Cut: AISI - 4145 Steel
Tool Material: 18-4-1 H.S.S.
Tool Type: 1st & 2nd Form
Tool Signature: 15° Back Rake

1st Form at .001 I.P.R. Feed
2nd Form at .004 I.P.R. Feed

Average Failure

NUMBER OF PIECES
PROJECT 2030
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.F.I. 556 F.P.M. 117.5
Parts Per Hour: 171
Cutting Fluid: 4315
Material Cut: AISI - 4145 Steel
Tool Material: 10-4-1 HSS
Tool Type: 1st & 2nd Form
Tool Signature: 15° Back Rake

NUMBER OF PIECES

SURFACE FINISH \times 10^{-4} (R.M.S.)

2nd Form at .004 I.P.R. Feed
Average Failure
1st Form at .001 I.P.R. Feed
PROJECT 2036
SINCLAIR RESEARCH LAB.

SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Model 60
Speed: r.p.m. 556  F.P.M. 117.5
Feed: f.p.m. 1.031
Parts Per Hour: 171
Material Cut: AISI 1141 Steel
Tool Material: M-3 H.S.S.
Tool Type: Box, 2nd Turn
Tool Signature:
- Oils = 4332, 4316 8,13,8,8,6,0,1/64
- Oils = L581, L589 17,2,8,8,6,0,1/64

NUMBER OF PIECES

SURFACE FINISH X 10^-6 (R.M.S.)

Average Failure

KEY:
- Oils
- 4316
- 4332
- L581
- L589

Fig. 23
PROJECT 2080
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 556  F.P.M. 117.5
Feed: T.P.R. .0031
Parts Per Hour: 171
Material Cut: AISI - 4145 Steel
Tool Material: M-9-5 H.S.S.
Tool Type: Box, 2nd Turn
Tool Signature:
011 = L581, L589 17.2, 8.8, 6.6, 0.1/64
014 = 4332, 4316 8.1, 5.8, 8.6, 0.1/64

SURFACE FINISH X 10^-6 (R.M.S.)

Average Failure

NUMBER OF PIECES

KEY:
011
014
-.--
-----------
--.--
-+---+

Fig. 24
PROJECT 2080
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 556 F.P.M. 117.5
Feed: I.P.R. 0.061
Parts Per Hour: 171
Material Cut: AISI - 4145 Steel
Tool Material: 16-4-1 H.S.S.
Tool Type: 1st Form
Tool Signature: 15° Back rake

Average failure

KEY:
011
4316
4332
L589
L531

LENGTH OF PIECES
PROJECT 2060
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod, 60
Speed: R.P.M. 556 F.P.M. 117.5
Feed: I.P.R. .004
Parts Per Hour: 171
Material Cut: AISI - 1141 Steel
Tool Material: 18-4-1 H.S.S.
Tool Type: 2nd Form
Tool Signature:

- Oil = L589 0° Back Rake
- Oil = L581 8° Back Rake
- Oils = 4332, 4316 15° Back Rake

Average
Failure

KEY:

--- Oil 4316
---- 4332
-------- L589
------------ L581

NUMBER OF PIECES

Fig. 27
PROJECT 2080
SINCLAIR RESEARCH LAB.
SURFACE FINISH VS. NO. OF PIECES

Machine: New Briton Gridley Mod. 60
Speed: R.P.M. 556 F.P.M. 117.5
Feed: 1.5 P.R. .002
Parts Per Hour: 171
Material Cut: AISI - 4145 Steel
Tool Material: 18-4-1 M.S.S.
Tool Type: 2nd Form
Tool Signature:
Oil = L589 0° Back Rake
Oil = L581 8° Back Rake
Oils = 4932, 4916 15° Back Rake

Average Failure

SURFACE FINISH x 10^5 (P.E.G.)

0 200 400 600 800
NUMBER OF PIECES

Fig. 28

KEY: Oil

L589
L581
4932
4916
