ENGINE-LATHE OPERATOR. INSTRUCTOR'S GUIDE. PART OF SINGLE-TOOL SKILLS PROGRAM SERIES. MACHINE INDUSTRIES OCCUPATIONS.

NEW YORK STATE EDUCATION DEPT., ALBANY. BUREAU OF CONTINUING EDUCATION. CURRICULUM DEVELOPMENT. NEW YORK STATE EDUCATION DEPT., ALBANY. BUREAU OF SECONDARY CURRICULUM DEVELOPMENT.

72

167p.; For related documents see CE 009 501

EDRS PRICE MF-$0.83 HC-$8.69 Plus Postage.

DESCRIPTORS Adult Education; *Curriculum; Curriculum Guides; Hand Tools; *Industrial Education; Instructional Materials; Job Skills; *Machine Tool Operators; *Machine Tools; Metals; Metal Working Occupations; Post Secondary Education; Secondary Education; *Skill Development; Student Projects; Vocational Education

ABSTRACT Expected to help meet the need for trained operators in metalworking and suitable for use in the adult education programs of school districts, in manpower development and training programs, and in secondary schools, this guide consists of four sections: Introduction, General Job Content, Shop Projects, and Drawings for the Projects. General Job Content lists the content outline in the left column and teaching points and techniques in the right column. The 16 names of shop projects and drawings for the projects include Multi-Diameter Shaft, Ball Peen Hammer, Die Wrench, Fly Tool Face Cutter, Self-Centering Vise, Close Quarter, Hacksaw, Bench Vise, Lathe Dieholder, Eccentric Test Shaft, Tap Wrench, Micrometer Boring Head, Surface Gage, Arbor Press, Lathe Mandrel, Lathe Center and Morse Taper, and Grinding Vise. Sixteen job sheets for the shop projects are included. The top section of each job sheet includes operator's job title, project name, time needed, and related drawing number, performance objectives, operations, equipment, and materials needed. The bottom section of the job sheet has two columns—the left column lists the procedure and the right column lists the techniques and related information. (HD)
Engine Lathe Operator

INSTRUCTOR'S GUIDE

Part of
SINGLE-TOOL SKILLS PROGRAM
MACHINE INDUSTRIES OCCUPATIONS

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of Continuing Education Curriculum Development
Bureau of Secondary Curriculum Development
Albany, New York 12224
1972
THE UNIVERSITY OF THE STATE OF NEW YORK

Regents of the University (with years when terms expire)

1985 Everett J. Penny, B.C.S., D.C.S., Vice Chancellor - - White Plains
1978 Alexander J. Allan, Jr., LL.D., Litt.D. - - Troy
1973 Charles W. Millard, Jr., A.B., LL.D., L.H.D. - - Buffalo
1977 Joseph T. King, LL.B. - - Queens
1974 Joseph C. Indelicato, M.D. - - Brooklyn
1979 Francis W. McGinley, B.S., LL.B., LL.D. - - Glens Falls
1986 Kenneth B. Clark, A.B., M.S., Ph.D., Litt.D. - - Hastings on Hudson
1983 Harold E. Newcomb, B.A. - - Owego
1981 Theodore M. Black, A.B., Litt.D. - - Sands Point

President of the University and Commissioner of Education
Ewald B. Nyquist

Executive Deputy Commissioner of Education
Gordon M. Ambach

Deputy Commissioner for Elementary, Secondary, and Continuing Education
Thomas D. Sheldon

Associate Commissioner for Instructional Services
Philip B. Langworthy

Assistant Commissioner for Instructional Services (General Education)
Bernard F. Haake

Director, Division of School Supervision
Gordon E. Van Hooft

Chief, Bureau of Secondary Curriculum Development

Chief, Bureau of Continuing Education Curriculum Development
Herbert Bothamley

Assistant Commissioner for Occupational Education
Robert S. Seckendorf

Director, Division of Occupational Education Instruction
Robert H. Bielefeld

Chief, Bureau of Trade and Technical Education
Carl G. Benenati
The Engine Lathe Operator course contained in this book is intended to help fill the need for men trained to operate machine tools. The backgrounds of those who enter the course will very likely cover a broad range of qualifications, but it is likely that many men with little education or experience will be included. Completion of this course alone, obviously will not make anyone a full-fledged machinist.

This course is the first to be published in what we hope will be a series of instructor’s guides in the Single-Tool Skills Program. Although written primarily as an adult course it is also quite suitable for use at the secondary school level. It was produced as a joint project of the two curriculum bureaus named on the title page.

The Single-Tool Skills Program is one of the programs in a broad plan covering machine industries occupations. The original plan was conceived by Robert S. Hunter, former associate in the Bureau of Trade and Technical Education. A number of teachers were involved in the overall planning for machine industries occupations, and also wrote material for the course guides. They are: Elek D. Csont, Seneca Vocational High School, Buffalo; Jack Grossman, Alexander Hamilton High School, Brooklyn; Alfred Kagan, Sewanhaka High School, Floral Park; Gilbert Pultz, Jefferson Vocational and Technical Center, Watertown; William G. Stewart, North Senior High School, Binghamton; William F. Tiedemann, Central Technical High School, Syracuse; and Joseph Waldinsperger, College of Continuing Education, Rochester Institute of Technology, Rochester.

Other members of the State Education Department took part in the overall planning, and in the further detailed planning which resulted in the production of this publication. They are E. Noah Gould, associate in the Bureau of Continuing Curriculum; G. Earl Hay, supervisor in the Bureau of Secondary Curriculum; and Edward Shattuck and Charles A. Stebbins, both associates in the Bureau of Trade and Technical Education.

Messrs. Kagan, Pultz, Stewart, Tiedemann, and Waldinsperger wrote the Engine Lathe Operator course contained in this booklet. Mr. Gould directly supervised the writing and edited the manuscript.

GORDON E. VAN HOOFT, Director,
Division of School Supervision

HERBERT BOTHAMLEY, Chief
Bureau of Continuing Education
Curriculum Development
Message to the Instructor

This Engine Lathe Operator course is expected to help meet the need for trained operators in metalworking. The course is suitable for use in the adult education programs of school districts, in Manpower Development and Training programs, and in secondary schools.

Anyone who completes this course successfully will be qualified for an entry-level job as operator of an engine lathe. After completing the course some students may go on to other single-tool courses and become qualified to operate more than one machine tool. It is even possible that a student with outstanding ability, by completing the courses for several machine tools, could become a machinist.

The 16 shop projects in this course are listed on pages vi and vii. There is no requirement that any student complete all projects, or even all jobs within any project. The instructor may determine which projects a given student should complete, and may, if he wishes, use projects other than those included in this book.

The teacher for this course would ideally be a person with not only good training and experience in machinist skills, but also several years of teaching experience. The best sources from which to draw such teachers are the faculties of schools giving machine tool courses, and from the ranks of those employed as machinists, and supervisors of machinists.

Adult Education Directors, Occupational Education Directors, and teachers who have any questions or comments should direct them to either the Bureau of Trade and Technical Education or to one of the Bureaus named on the title page.

CARL G. BENENATI, Chief
Bureau of Trade and Technical Education

ROBERT H. BIELEFELD, Director
Division of Occupational Education
Contents

Foreword .................................................. iii

Message to the Instructor ................................. iv

List of Shop Projects ..................................... vi

List of Drawings for Shop Projects ....................... viii

List of Drawings and Jobs Covered on Each ........... ix

INTRODUCTION ........................................... 1

GENERAL JOB CONTENT ................................ 4

JOB SHEETS FOR SHOP PROJECTS ........................ 12

BIBLIOGRAPHY .......................................... 80

DRAWINGS FOR SHOP PROJECTS .......................... 81
### Shop Projects

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Time (hrs.)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Multi-diameter shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job 1. Step turning (rule sizes)</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Job 2. Step turning (micrometer sizes)</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Job 3. Knurled chamfered shaft</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Job 4. Die threading and undercutting</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Job 5. Thread turning</td>
<td>5</td>
<td>18</td>
</tr>
</tbody>
</table>

| II. Ball peen hammer |             |      |
| Job 1. Handle | 12         | 19   |
| Job 2. Cap | 4          | 21   |
| Job 3. Head | 6          | 23   |
| Job 4. Pin | 2          | 25   |

| III. Die Wrench |             |      |
| Job 1. Body | 5          | 26   |
| Job 2. Handle | 7         | 28   |

| IV. Fly tool face cutter |             |      |
| Job 1. Body | 3 1/2       | 30   |

| V. Self-centering vise |             |      |
| Job 1. Jaw-actuating screw | 7         | 32   |
| Job 2. Guide rod | 1          | 34   |
| Job 3. Knurled handle | 3          | 35   |

| VI. Close quarters hacksaw |             |      |
| Job 1. Frame | 1          | 37   |
| Job 2. Handle | 6         | 38   |
| Job 3. Adjustable blade retainer | 2          | 40   |
| Job 4. Pin | 1 1/2       | 42   |

| VII. Bench vise |             |      |
| Job 1. Nut | 3          | 43   |
| Job 2. Washer | 2         | 44   |
| Job 3. Handle | 4         | 45   |
| Job 4. Guide pin | 1         | 46   |
| Job 5. Fixed and movable jaws | 4         | 47   |
| Job 6. Screw | 6          | 49   |

<p>| VIII. Lathe dieholder |             |      |
| Job 1. Sliding holder | 8          | 50   |
| Job 2. Tapered shank support | 12       | 52   |</p>
<table>
<thead>
<tr>
<th>Project No.</th>
<th>Time (hrs.)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>IX. Eccentric test shaft</td>
<td>30</td>
<td>54</td>
</tr>
<tr>
<td>Job 1. Shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X. Tap wrench</td>
<td>8</td>
<td>57</td>
</tr>
<tr>
<td>Job 1. Chuck body</td>
<td>10</td>
<td>59</td>
</tr>
<tr>
<td>Job 2. Wrench body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job 3. Handle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XI. Micrometer boring head</td>
<td>1/2</td>
<td>62</td>
</tr>
<tr>
<td>Job 1. Stop pin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job 2. Dial</td>
<td>4</td>
<td>63</td>
</tr>
<tr>
<td>Job 3. Shank</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td>Job 4. Dovetail slide</td>
<td>3</td>
<td>65</td>
</tr>
<tr>
<td>XII. Surface gage</td>
<td>1</td>
<td>66</td>
</tr>
<tr>
<td>Job 1. Adjustment screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job 2. Scriber point</td>
<td>1 1/2</td>
<td>67</td>
</tr>
<tr>
<td>XIII. Arbor press</td>
<td>2</td>
<td>68</td>
</tr>
<tr>
<td>Job 1. Rack pad</td>
<td>2</td>
<td>69</td>
</tr>
<tr>
<td>Job 2. Table</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>Job 3. Sleeve</td>
<td>5</td>
<td>71</td>
</tr>
<tr>
<td>Job 4. Gear shaft</td>
<td>3 1/2</td>
<td>72</td>
</tr>
<tr>
<td>Job 5A &amp; 5B. Handle and end</td>
<td>8</td>
<td>74</td>
</tr>
<tr>
<td>Job 6. Column</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XIV. Lathe mandrel</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Job 1. Mandrel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XV. Lathe center, Morse taper</td>
<td>4</td>
<td>76</td>
</tr>
<tr>
<td>Job 1. Lathe center, No. 3 Morse taper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XVI. Grinding vise</td>
<td>2 1/2</td>
<td>77</td>
</tr>
<tr>
<td>Job 1. Lead screw nut</td>
<td>2 1/2</td>
<td>78</td>
</tr>
<tr>
<td>Job 2. End nut</td>
<td>2</td>
<td>79</td>
</tr>
<tr>
<td>Job 3. Lead screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total time for shop projects</td>
<td>230</td>
<td></td>
</tr>
</tbody>
</table>

vii
<table>
<thead>
<tr>
<th>DWG. NO.</th>
<th>TITLE OF DRAWING</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Multi-Diameter Shaft: Step Turning, Rule &amp; Micrometer Sizes</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>Multi-Diameter Shaft: Knurled Chamfered Shaft</td>
<td>83</td>
</tr>
<tr>
<td>3</td>
<td>Multi-Diameter Shaft: Die Threading &amp; Undercutting</td>
<td>84</td>
</tr>
<tr>
<td>4</td>
<td>Multi-Diameter Shaft: Thread Turning</td>
<td>85</td>
</tr>
<tr>
<td>5</td>
<td>Ball Peen Hammer: Assembly</td>
<td>86</td>
</tr>
<tr>
<td>6</td>
<td>Ball Peen Hammer: Details</td>
<td>87</td>
</tr>
<tr>
<td>7</td>
<td>Die Wrench</td>
<td>88</td>
</tr>
<tr>
<td>8</td>
<td>Fly Tool Face Cutter</td>
<td>89</td>
</tr>
<tr>
<td>9</td>
<td>Self-Centering Vise: Assembly</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>Self-Centering Vise: Jaw-Actuating Screw</td>
<td>91</td>
</tr>
<tr>
<td>11</td>
<td>Self-Centering Vise: Guide Rod</td>
<td>92</td>
</tr>
<tr>
<td>12</td>
<td>Self-Centering Vise: Knurled Handle</td>
<td>93</td>
</tr>
<tr>
<td>13</td>
<td>Close Quarters Hacksaw: Assembly</td>
<td>94</td>
</tr>
<tr>
<td>14</td>
<td>Close Quarters Hacksaw: Details</td>
<td>95</td>
</tr>
<tr>
<td>15</td>
<td>Bench Vise: Assembly</td>
<td>96</td>
</tr>
<tr>
<td>16</td>
<td>Bench Vise: Details</td>
<td>97</td>
</tr>
<tr>
<td>17</td>
<td>Bench Vise: Fixed and Movable Jaws</td>
<td>98</td>
</tr>
<tr>
<td>18</td>
<td>Lathe Dieholder: Sliding Holder</td>
<td>99</td>
</tr>
<tr>
<td>19</td>
<td>Lathe Dieholder: Tapered Shank Support</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>Eccentric Test Shaft</td>
<td>101</td>
</tr>
<tr>
<td>21</td>
<td>Tap Wrench</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Micrometer Boring Head: Assembly</td>
<td>102</td>
</tr>
<tr>
<td>23</td>
<td>Micrometer Boring Head: Dial, Shank, and Stop Pin</td>
<td>103</td>
</tr>
<tr>
<td>24</td>
<td>Micrometer Boring Head: Dovetail Slide</td>
<td>104</td>
</tr>
<tr>
<td>25</td>
<td>Surface Gage: Assembly</td>
<td>105</td>
</tr>
<tr>
<td>26</td>
<td>Surface Gage: Details</td>
<td>106</td>
</tr>
<tr>
<td>27</td>
<td>Arbor Press: Assembly</td>
<td>107</td>
</tr>
<tr>
<td>28</td>
<td>Arbor Press: Gear Shaft, Rack Pad, and Rack</td>
<td>108</td>
</tr>
<tr>
<td>29</td>
<td>Arbor Press: Table</td>
<td>109</td>
</tr>
<tr>
<td>30</td>
<td>Arbor Press: Sleeve, Table, Pin, and Cover Plate</td>
<td>110</td>
</tr>
<tr>
<td>31</td>
<td>Arbor Press: Handle and End</td>
<td>111</td>
</tr>
<tr>
<td>32</td>
<td>Arbor Press: Column</td>
<td>112</td>
</tr>
<tr>
<td>33</td>
<td>Arbor Press: Base</td>
<td>113</td>
</tr>
<tr>
<td>34</td>
<td>Lathe Mandrel</td>
<td>114</td>
</tr>
<tr>
<td>35</td>
<td>Lathe Center, Morse Taper</td>
<td>115</td>
</tr>
<tr>
<td>36</td>
<td>Grinding Vise: Assembly</td>
<td>116</td>
</tr>
<tr>
<td>37</td>
<td>Grinding Vise: Lead Screw Nut</td>
<td>117</td>
</tr>
<tr>
<td>38</td>
<td>Grinding Vise: Lead Screw and End Nut</td>
<td>118</td>
</tr>
</tbody>
</table>

viii
MACHINE INDUSTRIES OCCUPATIONS
SINGLE-TOOL SKILLS PROGRAM
ENGINE LATHE OPERATOR COURSE

DRAWINGS AND JOBS COVERED ON EACH

<table>
<thead>
<tr>
<th>DRAWING NUMBER</th>
<th>PROJECT No.</th>
<th>PROJECT NAME</th>
<th>LATHE JOBS COVERED</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>Multi-Diameter Shaft</td>
<td>1,2</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
<td>83</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>4</td>
<td>84</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>5</td>
<td>85</td>
</tr>
<tr>
<td>5</td>
<td>II</td>
<td>Ball Peen Hammer</td>
<td>1,2,3,4</td>
<td>86</td>
</tr>
<tr>
<td>6</td>
<td>III</td>
<td>Diagonal Wrench</td>
<td>1,2,3,4</td>
<td>87</td>
</tr>
<tr>
<td>7</td>
<td>IV</td>
<td>Fly Tool Face Cutter</td>
<td>1</td>
<td>88</td>
</tr>
<tr>
<td>8</td>
<td>V</td>
<td>Self-Centering Vise</td>
<td>1,2,3,4,5,6</td>
<td>90</td>
</tr>
<tr>
<td>9</td>
<td>VI</td>
<td>Close Quarters Hacksaw</td>
<td>1,2,3,4,</td>
<td>94</td>
</tr>
<tr>
<td>10</td>
<td>VII</td>
<td>Bench Vise</td>
<td>1,2,3,4,5,6</td>
<td>95</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>1</td>
<td>96</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td>2</td>
<td>97</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td>3</td>
<td>98</td>
</tr>
<tr>
<td>14</td>
<td>VIII</td>
<td>Lathe Dieholder</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>15</td>
<td>IX</td>
<td>Eccentric Test Shaft</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>16</td>
<td>X</td>
<td>Tap Wrench</td>
<td>1,2,3</td>
<td>101</td>
</tr>
<tr>
<td>17</td>
<td>XI</td>
<td>Micrometer Boring Head</td>
<td>1,2,3,4</td>
<td>102</td>
</tr>
<tr>
<td>18</td>
<td>XII</td>
<td>Surface Gage</td>
<td>1,2,3,4,5,6</td>
<td>103</td>
</tr>
<tr>
<td>19</td>
<td>XIII</td>
<td>Arbor Press</td>
<td>1,2,3,4,5,6</td>
<td>104</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td>1,4,</td>
<td>105</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td>2</td>
<td>106</td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td>3</td>
<td>107</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
<td>5</td>
<td>108</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td>Base</td>
<td>109</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>XIV</td>
<td>Lathe Mandrel</td>
<td>1</td>
<td>110</td>
</tr>
<tr>
<td>35</td>
<td>XV</td>
<td>Lathe Center, Morse Taper</td>
<td>1</td>
<td>111</td>
</tr>
<tr>
<td>36</td>
<td>XVI</td>
<td>Grinding Vise</td>
<td>1,2,3</td>
<td>112</td>
</tr>
<tr>
<td>37</td>
<td></td>
<td></td>
<td>1</td>
<td>113</td>
</tr>
<tr>
<td>38</td>
<td></td>
<td></td>
<td>2,3</td>
<td>114</td>
</tr>
</tbody>
</table>
Introduction
As shown in the Contents, the Engine Lathe Operator course consists of this Introduction, General Job Content (which explains what the operator's job includes), Shop Projects, and the drawings for the projects.

The job for which the trainee would be qualified upon completion of this course is referred to in the Dictionary of Occupational Titles (under the code number 604.280) as engine lathe setup operator, tool; precision lathe operator; and toolroom lathe operator. Another applicable job title is lathe operator, production, (machine shop), code number 604.885.

The general objective of the course is to train men, in a comparatively short time, to be placed as engine lathe operators. The course is not intended to give a broad training in metalworking, but only the skill to operate one kind of metalworking machine. By keeping the objective narrow, the training time is kept to a minimum, and the trainees are made available for work without a long delay.

Since one important purpose of this course is to help those with a minimum of background, the prerequisites for admission should be broad enough so none will be barred who could be made employable. The operating authorities for each program, school, and school district determine the prerequisites for this course, and can adapt them to any special local conditions.

The minimum prerequisites we suggest for a trainee (and they are not mandatory) are that he have enough ability to understand and follow the course instructions (either written or oral), so he can produce the simplest workpiece included in the course. Such a trainee will, perhaps, be able to qualify only as a production machine operator, where all the machine setups are made for him. Another trainee with more background will possibly qualify for jobs requiring more skill, such as engine lathe setup operator or toolroom lathe operator.

We believe that enough general information about the job and more than enough shop projects are included for the trainee to reach the general objective of the course. All essential engine lathe skills are used in the shop projects a number of times. The schools may use everything in the course, they may select only some of the material, they may make changes in it, and they may use other material not contained here. They may also determine the length of the class periods, their frequency, and the total amount of time to be spent in training. For those that need a guide: A typical night class runs 2 1/2 to 3 hours, either once or twice a week, for 30 weeks.

In some of the shop projects of this course the workpieces are not completed because operations are required on metalworking machines other than the engine lathe. The other single-tool courses which we hope to produce will, when published, provide for the additional operations.

The drawings in this course are numbered serially, beginning with No. 1. When any other single-tool courses are published the drawings in them will continue the same series of numbers. The shop projects in the other courses
may also refer back to the drawings in the Engine Lathe Operator course. In fact, some of the drawings included with this course require no engine lathe operations, but, for convenience, are included here with other drawings of an assembly requiring some lathe work.

Drawings 34 and 35 contain tables giving several different sets of dimensions for the workpieces pictured. These permit the instructor to select the set of dimensions which he finds best for each student or for the conditions under which his class operates. As a shop project is assigned to a student, we recommend that the instructor give him a copy of the Job Sheet and applicable drawings. In the drawings, all dimensions are in inches unless otherwise indicated.

Each drawing has four blocks for information at the bottom, with the one at the upper right blank. We suggest that the instructor have the student write the numbers of the project and job for which he is using the drawing, in that blank space. Each Job Sheet has the words Unit No. in the upper left corner, but no number is given. The instructor may wish to write a number in this space to fit in with his own method of organizing his classroom and shop work.

The Job Sheets show two references which are especially recommended for the machine work. The bibliography gives the complete citations for these two books and also contains additional references.

Following are the abbreviations used in the text and drawings of this course:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT.</td>
<td>actuate</td>
</tr>
<tr>
<td>ACTG.</td>
<td>actuating</td>
</tr>
<tr>
<td>ALUM.</td>
<td>aluminum</td>
</tr>
<tr>
<td>ASSY.</td>
<td>assembly</td>
</tr>
<tr>
<td>CHAM.</td>
<td>chamfer</td>
</tr>
<tr>
<td>CBORE.</td>
<td>cold roller bore</td>
</tr>
<tr>
<td>CRS</td>
<td>cold rolled steel</td>
</tr>
<tr>
<td>CSK.</td>
<td>countersink</td>
</tr>
<tr>
<td>DIA.</td>
<td>diameter</td>
</tr>
<tr>
<td>DP</td>
<td>diametral pitch</td>
</tr>
<tr>
<td>DR</td>
<td>drill</td>
</tr>
<tr>
<td>DR or DR. ROD</td>
<td>drill rod</td>
</tr>
<tr>
<td>EQ. SP.</td>
<td>equally spaced</td>
</tr>
<tr>
<td>FAO</td>
<td>finish all over</td>
</tr>
<tr>
<td>HD</td>
<td>head</td>
</tr>
<tr>
<td>HDL.</td>
<td>handle</td>
</tr>
<tr>
<td>HGT.</td>
<td>height</td>
</tr>
<tr>
<td>HEX.</td>
<td>hexagonal</td>
</tr>
<tr>
<td>HT.</td>
<td>height</td>
</tr>
<tr>
<td>LG.</td>
<td>long</td>
</tr>
<tr>
<td>LGTH.</td>
<td>length</td>
</tr>
<tr>
<td>MATL.</td>
<td>material</td>
</tr>
<tr>
<td>MED.</td>
<td>medium</td>
</tr>
<tr>
<td>PT.</td>
<td>part</td>
</tr>
<tr>
<td>R or RAD.</td>
<td>radius</td>
</tr>
<tr>
<td>REQD.</td>
<td>required</td>
</tr>
<tr>
<td>R.H.</td>
<td>right-hand</td>
</tr>
<tr>
<td>SCR.</td>
<td>screw</td>
</tr>
<tr>
<td>SOC.</td>
<td>socket</td>
</tr>
<tr>
<td>SPEC.</td>
<td>specifications</td>
</tr>
<tr>
<td>SPHER.</td>
<td>spherical</td>
</tr>
<tr>
<td>STL.</td>
<td>steel</td>
</tr>
<tr>
<td>SQ.</td>
<td>square</td>
</tr>
<tr>
<td>TYP.</td>
<td>typical</td>
</tr>
<tr>
<td>W.</td>
<td>width</td>
</tr>
</tbody>
</table>
General Job Content
CONTENT OUTLINE

I. Types of Machines

II. Machine Parts

III. Machine Accessories
   A. Tool holders
   B. Work holders

IV. Cutting Tools

V. Measurement and Inspection

VI. Blueprint Reading

VII. Speeds and Feeds

TEACHING POINTS AND TECHNIQUES

Discuss the various types of lathes, such as: bench type, toolroom precision, and geared head.

Give the names, locations, and uses of the various parts of the lathe, for example, bed, headstock, and carriage.

Establish familiarity with standard tool holding devices, including:
   1. standard tool-bit holder
   2. standard boring bar holder
   3. cut-off tool holder

Note that the tool post grinder may be used to do many operations, such as internal and angle grinding.

Identify the work holding devices, such as: chucks, collets, and steady rests.

Mention the different kinds of cutting tools, some of which are: cutoff, tool-bit, and circular form relief thread.

Discuss the tool in terms of clearance, rake angle, and chip groove.

Demonstrate the procedures in grinding and sharpening the various cutting tools.

List and explain the various types of measuring tools. Some of these are: micrometer, indicator, telescoping gage, and vernier height gage.

Introduce and cover all necessary blueprint reading. For example:
   1. theory of orthographic projection
   2. language of lines
   3. sectional views
   4. tolerance
   5. finishing symbols

Emphasize the importance of speeds and feeds relative to machining time, cutter life, and finish.

Point out that different materials require different cutting speeds based on the kind of cutting tool material used. For example:

A carbide cutting tool can machine cast iron at 210-450 feet per minute and brass at 600-900 feet.
per minute. A high speed cutting tool can machine soft cast iron at 70-170 feet per minute and brass at 200-300 feet per minute.

Calculate the r.p.m. of a piece of work based on the material being machined, the diameter of the work, and the material in the cutting tool. For example:

What r.p.m. should a lathe revolve at in order to machine a 2-inch diameter piece of brass that is machined at 300 feet per minute? The formula is:

\[
\text{r.p.m.} = \frac{\text{SF} \times 4}{\text{DIA.} \times 2} = \frac{300 \times 4}{2} = 1200
\]

1200 r.p.m.

Make available charts and tables which will enable the student to select proper speeds and feeds for a particular job.

Note that speeds are expressed as advance in inches per revolution of work.

Note further that optional feed is correlated to the depth of cut and the finish required.

VIII. Trade Mathematics
Introduce and cover all necessary trade mathematics, such as basic arithmetic, constants, and formulas.

IX. Coolants
Explain that the use of coolants or cutting oils will increase tool life and give a better finish on the work. Point out that each different material requires a different type of cutting fluid.

Some cutting fluid categories are:
1. straight mineral oils
2. soluble oils (water emulsions)
3. chemical-water mixtures (synthetic)

X. Care and Maintenance
Call attention to the fact that the accuracy of the work depends on the proper care and maintenance of the machine. Observe some rules such as
1. Level the lathe properly.
2. Oil the lathe properly.
3. Thoroughly clean the ways.

Explain further that the care of small tools is very important in the development of a good workman. Some rules are:
CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

XI. Safety

Introduce the personal safety rules that must be used when operating the machine:
1. Wear close fitting clothes.
2. Wear safety glasses.
3. Make sure all guards are in place.
4. Keep hands away from moving parts.

Demonstrate how to avoid particular dangers, such as:
1. Use pliers to remove chips entwined on the workpiece or the cutting tool.
2. Use a cradle on the bed or a bar through the spindle when mounting and removing chucks.
3. Remove chuck keys from the chuck immediately after use.
4. Remove, protect, or position tool bits safely away when setting up or measuring a job.
5. Support long pieces before running at high speeds.
6. If a long piece extends from the back of the spindle, tie a rag around it. However, long thin diameters are dangerous in any case.
7. Turn the machine by hand for a complete revolution after setting up.
8. When you hear unusual noises from your machine, stop it and find out what is causing them.

XII. Trade Terms

Explain all trade terms peculiar to the trade, for example:

gib—a wedge-shaped strip that can be adjusted to maintain a proper fit between movable surfaces of a machine tool

XIII. Work Processes

A. Facing

Explain that facing is one of the first operations usually done on the engine lathe. Illustrate some of the turning or facing tools that may be used for this operation.

Demonstrate that facing can be done by holding work in the chuck, between centers, or in both chuck and steady rest.
B. Center drilling

State that center drilling with a combination drill and countersink is done to prevent a twist drill from wandering when starting to drill a hole in the end of a piece of work. Also that center drilling might also be done to make permanent center holes in order to mount the piece of work between centers.

Emphasize that when center drilling for permanent center holes, the size of the combination drill and countersink should be in proportion to the diameter of the work piece. For example: A No. 3 combination drill and countersink should be used to drill a 3/16-inch diameter hole in the end of a 1-inch diameter work piece.

Call attention to the fact that when long pieces are to be center drilled, one method that may be used is the use of both chuck and steady rest.

C. Drilling

Explain that drilling is an operation that machines a round hole in a piece of work to a desired depth.

Indicate further that the twist drill is usually held in the tail stock spindle by means of a drill chuck or drill socket. Emphasize that a standard drill will not finish a hole to precision requirements.

Point out that the core drill is used to enlarge an existing hole that does not require the characteristics of a reamed hole.

D. Reaming

Mention that reaming is done to make a hole: round, straight, or tapered, or sized to precision dimensions.

Indicate further that the drilled hole, prior to reaming, must be drilled undersize. For example:

1. Drill a hole .120" in diameter for a 1/8" reamer.
2. Drill a hole .368" in diameter for a 3/8" reamer.
3. Drill 1/8" undersize for holes over .25" diameter.

State that reamers and drills are held in the same way.

E. Straight turning

Define straight turning as an operation by a turning tool for reducing the outside diameter of a piece of work to a given diameter.
TEACHING POINTS AND TECHNIQUES

Discuss the important points for the proper set-up during straight turning. Some examples are:

1. Position of the tool post
2. Position of the lathe dog
3. Trueness of the headstock center

Emphasize that chip control is important and should be handled by means of a proper chip groove, ground on the tool so as to curl and break the chips. Elaborate on the use of the steady rest and the follower rest for long slender work.

Discuss the method and problems involved in machining an eccentric such as a crankshaft. Some examples include laying out more than one set of center holes, and using braces to avoid bending the work pieces.

Emphasize that turning usually requires roughing and finishing cuts.

Explain that a shoulder is a point at which two diameters meet. State further that there are several types of shoulders which require different shaped tools. Two of these are filleted corner and chamfered.

Elaborate on the procedure in facing a square shoulder. For example, give details on roughing out the material in the corner, and amount of material that should be left for finishing.

List the different methods of machining a taper, such as by use of taper attachment and compound rest. Point out the importance of setting the cutting tool on center.

Explain that due to the extreme accuracy and high quality of work required today, the offset method of cutting a taper should be discouraged, except for special situations.

Explain that boring is done to enlarge and/or true a hole.

Emphasize the importance of using a short, large boring bar to overcome such problems as chatter and bell-mouthed holes.

Call attention to the fact that external threads can be cut by chasing with a single-pointed tool or by use of a die. State further that threads
can be chased internally by means of a boring bar or by use of thread tap.

Emphasize the importance of locating the thread tool on center and aligning it properly. Describe the procedure in chasing left hand and multiple threads.

Define knurling as a means of rolling depressions in the surface of a piece of work.

Explain the problems involved when knurling. For example: bending of small work and double tracking.

Define form turning as machining special shapes by means of tools formed to the desired outline.

State further that forming or contour turning can be done with a single-point tool by manipulating both the carriage and crossfeed handles.

Emphasize the importance of location of the tool, proper speeds, and proper coolant. Explain the method of filing and polishing work as it revolves.

Emphasize that the following trade terms are used interchangeably with the term grooving: recess, relief, and undercut.

Explain a few of the reasons for grooving, such as:
1. To run out space for a thread tool at a shoulder
2. To avoid a fillet on a ground shaft

Add that grooving can be done internally as well as externally.

Elaborate on the fact that the width of the grooving tool depends on the particular job. Some factors are size of the thread that is being chased, and amount of stock that is left for grinding.

Emphasize the proper setup for the cutting-off operation such as having the tool on center and at a right angle to the work.

Mention the problems involved in using a cutoff tool, such as chatter and breakage.
TEACHING POINTS AND TECHNIQUES

N. Backing-off

Demonstrate the procedure in setting up a backing-off attachment.

Make the necessary calculations in order to set the lathe for the proper degree of clearance on a cutter that is to be backed-off.

O. Filing

Demonstrate moving a single-cut file across a revolving workpiece by taking long even strokes for:
1. removing burrs and rounding edges
2. blending-in form cut outlines
3. fitting parts

Stress the safety procedures when using the left-hand filing method.

P. Polishing

Note that this operation sometimes is used to produce a fine finish with strips of abrasive cloth contacting round work that is revolving at high speeds.

Explain that the finer the abrasive, the finer the resulting finish, and that a machine oil lubricant sometimes is used to improve the finish.
Job Sheets for Shop Projects.
Objectives:
Using the equipment, materials, and operations listed here the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Tool bits
- Center drill
- 6" and 12" rules
- Screw
- Calipers
- Layout dye

Operations
1. Facing
2. Center drilling
3. Straight turning
4. Shoulder turning
5. Layout

Materials
- Hot rolled steel
- SAE 1018, 1/2" dia. x 6 1/2" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and remove sharp edges.
2. Mount 3-jaw chuck and locate work in chuck.
3. Face end to clean up.
4. Mount chuck and center drill in tailstock and machine center hole in part.
5. Remove from chuck and layout overall length.
6. Remount in chuck, face to layout line and center drill.
7. Remove chuck and mount lathe centers and drive plate.
8. Attach lathe dog and mount workpiece between centers.
9. Rough turn "A" diameter up to lathe dog.
11. Refer to III B and IV in content outline.

TECHNIQUES AND RELATED INFO.
5. Use layout dye, combination square and scriber, or surface plate and surface gage with scriber.
6. Do not face beyond layout line.
7. Check lathe center alignment.
8. Check clearance between lathe dog tail and drive-plate slot. Use proper tension for tailstock center and lubricate if necessary.
9. Set calipers with steel rule graduations and practice feel on standard size piece.
10. Finish turn "A" diameter to caliper setting.
11. Remove lathe dog and layout length of dia. A.
12. Mount lathe dog on dia. A, locate between centers, rough turn "B" dia. to layout line.
13. Layout and rough turn each diameter to length.
14. Finish turn all diameters to caliper size and length.
15. Remove all sharp edges, recheck measurements, and submit for inspection and grade.

11. Use layout dye.
12. Use copper or other soft metal to protect turned dia. from dog.
13. Use subtraction to find distances of shoulders from each other for chucking.
14. Use a sharp-pointed tool to finish shoulders square.
15. Use left-hand filing for safety near lathe dog.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Lathe centers
- Drive plate
- Lathe dog
- Toolholder
- Tool bits
- 6" rule
- 1" and 2" micrometer

Materials:
- Hot rolled steel
- SAE 1018

Selected references:
- Machining Fundamentals by Walker
- Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Clamp lathe dog on diameter G at small end of workpiece.
2. Mount between centers and turn A diameter to size.
3. Remove workpiece and relocate dog on A diameter.
4. Turn B diameter to size and square shoulder.
5. Turn each diameter to size using same method.
6. Remove sharp edges with a file.
7. Recheck dimensions and submit for inspection and grade.

Operations
1. Straight turning
2. Shoulder turning
3. Micrometer reading

Materials
- Hot rolled steel
- SAE 1018

PROCEDURE

2. Start a trial cut and check size with micrometer. Make necessary adjustments to finished size.
3. Use soft metal to protect finished surface.
4. Take trial cut and check with micrometer and make necessary adjustments to hold correct size.
5. Check center tension and lubrication if necessary.
Unit No. Operator's job title: Engine lathe operator
Project 1 Project Name: Multi-diameter shaft
Job No. 3 Job Name: Knurled chamfered shaft D.O.T. No. 604.280

Drawing No. 2 Time: 4 hours

Objectives
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown off the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Straight turning
2. Chamfering
3. Knurling
4. Layout

Materials
Same piece of hot rolled steel SAE 1018 as used on Jobs 1 and 2, Project No. 1.

Equipment:
Engine lathe
Lathe centers
Drive plate
Lathe dog
Tool bits
6" rule
1" and 2" micrometers

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Place dog on small end and mount between centers. Turn large end to 1 1/8" dia., 2 1/2" long.
2. Knurl with medium pitch knurling tool.
3. Set lathe compound to 45° and chamfer end.
4. Reverse dog and turn middle section to 7/8" dia.
6. Turn small end to 7/16" dia.
7. Knurl with fine pitch knurling tool.
8. Set compound and cut required chamfers on two shoulders and end.
9. Hand finish for inspection and grade.

10. Stress cleaning spindles before setting up lathe centers. Check alignment of tailstock.
11. Point out that knurling setup is square to workpiece and knurling rolls centered on center line of work.
12. Remind students that cutting tool height is on center line.
13. Protect knurled surface with soft material under dog.
14. Point out need for proper pressure and lubricant.
15. Differentiate between compound settings for angles.
Unit No. Operator's job title: Engine lathe operator
Project I Project Name: Multi-diameter shaft
Job No. 4 Job name: Die threading and undercutting D.O.T. No. 604.280

Drawing No. 3 Time: 2 hrs.

Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Straight turning
2. Undercutting
3. Chamfering
4. Threading with split adjustable die

Equipment:

<table>
<thead>
<tr>
<th>Item</th>
<th>Tool bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine lathe</td>
<td>Tool bits</td>
</tr>
<tr>
<td>Lathe centers</td>
<td>3/16-13 die and die stock</td>
</tr>
<tr>
<td>Drive plate</td>
<td>6&quot; rule</td>
</tr>
<tr>
<td>Lathe dog</td>
<td>1&quot; micrometer</td>
</tr>
<tr>
<td>3-jaw chuck</td>
<td>Test nut</td>
</tr>
</tbody>
</table>

Materials
Same piece of hot-rolled steel SAE 1018 as used on Jobs 1, 2, 3 of Project No. 1

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE
TECHNIQUES AND RELATED INFORMATION

1. Place dog on small end, set between centers and turn large end to 3/4" dia., 4 1/2" long.
2. Reverse dog and turn 9/16" dia. to .500-.499" dia., 2 7/32" long.
3. Set tool and make undercut to depth.
4. Set up chamfering tool bit to 45° angle and form chamfer on end.
5. Remove work and centers and mount 3-jaw chuck. Chuck on 3/4" dia.
6. Start die on 3/4" dia. turning the spindle by hand.
7. Remove work from lathe and clamp in bench vise to finish die cut thread by hand.
8. Remove sharp edges and turn in for inspection and grade.

1. Review correct procedure for setting up lathe for straight turning.
2. Introduce finish turning to close tolerance.
3. Use thread formulas for minor diameter of thread.
4. Stress that the tool bit must be on center for proper cutting action.
7. Point out method of breaking off chips by backing up a half-turn. Use oil.
Operator's job title: Engine lathe operator

Project I

Project Name: Multi-diameter shaft

Job No. 5

Job name: Thread turning

Drawing No. 4

Time: 5 hrs.

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Lathe centers
- Drive plate
- Lathe dog
- 3-jaw chuck
- Tool bits
- 6" rule
- 1" micrometer
- Thread micrometer (11-pitch)
- Center gage

Materials
- Same piece of hot-rolled steel SAE 1018 as used on Jobs 1, 2, 3, 4 of Project No. 1

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Clamp stock in bench vise and saw off 2" dia. threaded end at the undercut.
2. Mount in 3-jaw chuck and face and center drill.
3. Attach dog, set up lathe centers and drive plate, turn stock to size.
4. Chamfer end to 45°.
5. Reverse dog and finish turn other end.
6. Set up tool bit and cut 3/16" undercut.
7. Set up chamfering tool and chamfer end.
8. Set compound at 30° and adjust threading tool bit to correct height and alignment.
9. Adjust speed to slow and set gears to 11 threads per inch.
10. Cut threads to proper depth using compound infeed.
11. Remove sharp edges and hand in for inspection and grade.
Project Name: Ball peen hammer

Job name: Handle

Drawing Nos. 5, 6

Time: 12 hrs.

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Tap
- Collet assembly
- Drill chuck
- Lathe tool bits
- Fine knurling tool
- Drills

Materials:
- 24 ST aluminum, \( \frac{3}{8} \)" dia. x \( \frac{3}{8} \)"

Operations:
1. Facing
2. Center drilling
3. Straight turning
4. Taper turning
5. Knurling
6. Drilling
7. Tapping
8. Polishing

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE
1. Mount collet assembly with \( \frac{3}{8} \)" collet. Fasten workpiece with drawbar allowing \( \frac{1}{2} \)" stock to project.
2. Set lathe tool for facing and face both ends. Finish to length as per drawing.
3. Center drill both ends.
4. Place stock on centers and drive with lathe dog.
5. Set lathe tool for turning.
6. Remove .010-.015 from section D. Turn to 4" length.
7. Fine knurl to fit \( \frac{3}{8} \)" collet.
8. Layout section B and C lengths.
9. Mount collet assembly with \( \frac{3}{8} \)" collet. Fasten section A with drawbar and support knurl end with center.
10. Arrange lathe to obtain taper using taper attachment.
11. Set 4" radius lathe tool for taper turning and take eight trial cut over section C.

TECHNIQUES AND RELATED INFO.
4. Discuss use of soft material between workpiece and dog to prevent marring.
6. Point out that workpiece must run true before knurling.
7. Elaborate on knurling technique to avoid double tracking.
10. Demonstrate use of the taper attachment.
12. Caliper at both ends of section C to test accuracy of taper. If taper is not correct adjust setting to correct error.
13. Rough turn tapered section C.
14. Finish turn tapered section C as per drawing.
15. Arrange lathe for straight turning.
16. Rough turn section A and section B.
17. Finish turn section A and section B as per drawing.
18. Turn work end for end and hold section D with 13/4" collet with 13/4" projecting. True up with center if necessary.
19. Mount drill chuck in the tailstock with 5/8" drill.
20. Deep-hole drill to depth as per drawing. Use lubricant and prevent chip buildup by frequently withdrawing drill.
22. Set tool for counterboring 60° × 1/16" depth and chamfer.
23. Start 9/16"-18 tap square for two turns supporting with center.
24. Finish tap by hand.
25. Debur and polish.
26. Hand in for inspection and grade.
Unit No. Operator's job title: Engine lathe operator
Project Name: Ball peen hammer
Job No. 2. Job name: Cap
D.O.T. No. 604.280

Drawing Nos. 5-6

Time: 4 hrs.

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Engine lathe
3-jaw chuck
Drill chuck
Collet assembly
Tool bits
Center drill

Operations
1. Facing
2. Center drill
3. Turning
4. Chamfering
5. Knurling
6. Filing
7. Polishing
8. Cutting off
9. Threading
10. Recessing

Materials
24 ST aluminum, \( \frac{3}{8} \)'' dia. x \( 3\frac{1}{2}'' \)

PROCEDURE TECHNIQUES AND RELATED INFO.

1. Place stock in 3-jaw universal chuck with stock projecting 1\( \frac{1}{2}'' \).
2. Elaborate on use of formula for proper r.p.m.
3. Arrange for proper spindle speed.
4. Demonstrate drill chuck uses.
4. Set lathe for facing and face end.
5. Support with tailstock center.
6. Center drill from tailstock spindle.

5. Set lathe for turning.
6. Turn knurled diameter to .740''.
7. Rough turn threaded diameter plus \( \frac{1}{2}'' \).
8. Set up and fine knurl as per drawing.
9. Set lathe for turning and finish turn \( \frac{3}{8}'' \) diameter to .560'' and shoulder to \( \frac{3}{8}'' \).

10. Set tool for recessing.
11. Cut recess for threading.
12. Set tool for chamfering.
13. Chamfer 45° x \( \frac{1}{16}'' \).
14. Arrange gearing for cutting thread as per drawing.
15. Set compound to the right 30° to cut right-hand thread. Compound infeed is .75

No. of threads
16. Cut \( \frac{9}{16} \)"-18 thread to fit tapped hole of part 2.
17. Withdraw tailstock.
18. Set cutoff tool and cut off work \( \frac{1}{32} \)" plus length indicated on drawing.
19. Mount collet assembly with \( \frac{1}{8} \)" collet.
20. Screw cap into handle Part 2. Place handle in lathe collet with cap end projecting \( \frac{1}{2} \)".
21. Set lathe tool for facing and face end of cap to length as per drawing.
22. Round end of cap (form tool or file).
23. File lightly to remove tool marks, then polish.
24. Hand in for inspection and grade.
Unit No.  Operator's job title: Engine lathe operator
Project II  Project Name: Ball peen hammer
Job No.3  Job name: Head  D.O.T. No.604.280

Time: 6 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Center drill
- 4-jaw independent chuck
- Drill chuck
- Tool bits
- Center rest

Operations
1. Facing
2. Straight turning
3. Filing
4. Polishing
5. Measuring
6. Laying out
7. Forming
8. Center drilling
9. Cut off

Materials
- CRS SAE 1018, 1" dia. x 6\(\frac{1}{2}\)" long

PROCEDURE

1. Place stock in 4-jaw independent chuck with 4\(\frac{1}{2}\)" projecting. Adjust jaws so that stock runs true.

2. Face end.

3. Center drill end of stock.

4. Adjust tailstock to support end of work.

5. Set right-hand turning tool with left-hand toolholder for turning.

6. Rough turn \(\frac{7}{8}\)" dia. plus \(\frac{1}{2}\)"

7. Rough turn \(\frac{5}{8}\)" dia. plus \(\frac{3}{16}\)"

8. Finish turn \(\frac{5}{8}\)" and \(\frac{3}{16}\)" diameters.
   File lightly and polish with emery cloth.

9. Layout and mark location of the concave grooves as per drawing.

10. Rough turn both grooves using a \(\frac{3}{16}\)" round nose turning tool.

Selected references:
- Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith
PROCEDURE

11. Finish turn both grooves as per drawing. Polish grooves with emery cloth.

12. Place center rest in position with jaws in line with 3/8" diameter section of work and clamp center rest to lathe bed.

13. Adjust center rest jaws to center up on 3/8" dia. section and withdraw tailstock. Put oil on work to lubricate jaws.

14. Set lathe tool for facing and face to length as per drawing. This operation should remove the center hole from the end of work.

15. Set concave forming tool for turning ball.

16. Rough turn ball end and finish turn.

17. File ball lightly and polish with emery cloth.

18. Remove center rest from lathe.

19. Set cutoff tool and cut off work 3/4" plus length indicated on drawing.

20. Place work in lathe chuck. Use soft metal around work to prevent marring of surface by chuck jaws. Grip on center section, allowing large end to project 1" and true as before.

21. Set lathe tool for facing and face to length as per drawing.

22. Round face as per drawing.

23. File face lightly to remove tool marks. Polish with emery cloth.

24. Hand in for inspection and grade.

13. Bring jaws up lightly to 3/8" dia, so that concentricity remains true.
Unit No.  Operator's job title: Engine lathe operator

Project II  Project Name: Ball peen hammer

Job No. 4  Job name: Pin  D.O.T. No. 604.280

Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment: Engine lathe
Collet attachment and 1/8" collet
Tool bits

Operations
1. Facing
2. Filing
3. Polishing
4. Measuring

Materials
Lathe file
Polishing cloth
6" scale

CRS SAE 1018, 1/8" dia. x 1" long

Selected references: Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE  TECHNIQUES AND RELATED INFO.

1. Mount collet assembly and tighten workpiece in 1/8" collet.
2. Face one end to clean up.
3. Face opposite end to 7/8" length.
4. File both ends to 1/16" radius. Run at slightly higher speed than for turning.
5. Polish with emery cloth.
6. Hand in for inspection and grade.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- 3-jaw chuck
- Drill chuck
- Center drill
- 1/4" drill
- 3/4" machine reamer
- Boring tool and holder
- Carriage stop
- 6" rule
- Inside caliper
- Inside micrometer
- Toolholder and tool bits

Materials:
- SAE 1018 CRS, 1 5/8" dia. x 3" long

Selected references:
- Machining Fundamentals by Walker
- Machine Technology by McCarthy & Smith

PROCEDURE
1. Select stock and remove sharp edges.
2. Locate in 3-jaw chuck to face end and file radius.
3. Reverse piece and true up faced side in 3-jaw chuck.
4. Face to length and file radius.
5. Center drill:
   5A. Drill through with 5/8" drill.
6. Drill through with 7/8" drill.
7. Ream with 3/4" machine reamer.

TECHNIQUES AND RELATED INFO.
2. Demonstrate use of single-cut file. Stress safety when filing work close to chuck jaws.
3. Use parallel to true up faced side with chuck face. Caution: Be sure to remove parallel before starting machine!
6. Use reamer to check hole for oversize condition before drilling all the way through. Point out proper speed and feed for drilling. CSX4 = 544 r.p.m. Use light feed.
7. Introduce slower speeds for reaming and use of cutting oil.
8. Set up boring tool and carriage stop.

9. Bore to size and depth.

10. Break sharp edges and submit for inspection and grade.

8. Demonstrate depth setting with carriage stop using \( \frac{3}{8} \)" block between carriage and stop.

9. Explain boring principles and set up. Stress this point: Do not power feed against carriage stop. Introduce the use of inside calipers for checking diameter of bore. Make final size check with inside micrometer.

10. Show how to break sharp edges with emery cloth.
Unit No.  Operator's job title: Engine lathe operator
Project III Project Name: Die Wrench
Job No. 2 Job name: Handle D.O.T. No. 604.280

Drawing No. 7 Time: 7 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Facing 5. Taper cutting
2. Center drilling 6. Under-cutting
4. Straight turning 8. Radius forming

Equipment:
Engine lathe
Collet attachment
Threading tool
3" and 1/2" collets
Center gage
Lathe centers
Outside calipers and 6" rule
Drive plate
1" micrometer
Lathe dog
1/2"-28 thread gage

Materials
SAE 1018 CRS.
2 pieces 1/2" dia. x 3 1/2" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

Procedure
TECHNIQUES AND RELATED INFO.

1. Select stock and remove sharp edges.
2. Demonstrate correct procedure for mounting collet attachment and using collets. Stress clean spindle and correct key alignment.

3. Face and center drill one end of both pieces.
3. Explain the value of doing each operation on both pieces before doing the next operation.

4. Reverse in collet and face and center drill.
4. Point out the need to remove the center on radius end later, thus controlling the hole depth.

5. Attach lathe dog and locate between centers.
5. Review technique of center mounting and checking to eliminate taper.

6. Allow for center removal on radius end when measuring length of knurled portion.

7. Straight turn 3/4" dia. to length.
8. Introduce hand feed turning with radius tool. Use calipers to check small diameter of taper.
8. Set compound to 1 1/2° angle with center line and turn taper.
9. Straight turn thread diameter.

10. Make undercut at shoulder.

11. Cut thread to fit gage.

12. Locate in collet on 1/2 diameter and face off center on large end.

13. Form radius on end.

14. Remove all sharp edges and polish.

15. Submit for inspection and grade.

9. Stress the plus .000" tolerance on O.D. of thread.

10. Use tool bit ground to 1/8" width to plunge cut to depth. Check diameter with calipers.

11. Review threading setup with compound at 30°. Use a narrow point threading tool to thread to 1/16" undercut. Tool must be at center height. Compound infeed is .75 No. of threads.

12. Stress use of appropriate size collet to hold 1/2" knurled diameter of oversize.

13. Use radius tool or file.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- 4-jaw independent chuck
- Micrometer carriage stop
- Right-hand toolholder
- Rough turning tool
- 1" radius turning tool
- Chalk
- Dial indicator
- 1" micrometer
- 6" rule

Materials:
- 1 pc. CRS S.A.E. 1018. 2" dia. x 2\(\frac{7}{8}\)" long

Selected references:
- Machine Tool Technology by McCarthy and Smith
- Machining Fundamentals by Walker

PROCEDURE

1. Cut stock to length as per drawing, using a power saw.
2. Remove all burrs with a file.
3. Mount a 4-jaw independent chuck on lathe spindle.
4. Clamp 2" dia. stock in 4-jaw chuck. Leave 1\(\frac{11}{16}\)" extending from chuck jaw faces.
5. True up work to a total indicator runout of .001".
6. Face to clean up saw marks.
7. Set up a turning tool and rough turn to \(\frac{1}{16}\)" dia. by \(\frac{1}{8}\)" long.

TECHNIQUES AND RELATED INFO.

1. Cut stock \(\frac{3}{16}\)" to \(\frac{1}{4}\)" longer than finished length.
2. Caution: Use a cradle to eliminate damage to lathe ways and the need for holding a heavy chuck.
3. Use the concentric rings to set jaws for 2" dia. stock.
4. Explain the meaning of total indicator runout (T.I.R.).
5. Caution: Do not remove more material than necessary to achieve a smooth surface.
6. Set rough turning tool slightly above center and away from direction of feed. Select the proper roughing speed and feed.
8. Set up finish turning tool with \( \frac{1}{8} \) radius on nose of leading edge.

9. Turn to \( .625\text{\(\frac{1}{2}\)} \) dia. and face shoulder to \( 1\text{\(\frac{1}{2}\)} \) length.

10. Turn chamfers \( 1\text{\(\frac{1}{16}\)} \times 45^\circ \) on end of shank and on body.

11. Check all sizes for correct dimensions before removing from chuck.

12. Place finished diameter in a \( \frac{5}{8} \) collet and skim cut \( 2\text{\(\frac{1}{2}\)} \) dia. to run true.

13. Remove all sharp edges with a file and emery cloth.

14. Submit for inspection and grade.

8. Use a micrometer carriage stop and set for required length as indicated on drawing.

9. Check micrometer calipers for accuracy using a sizing standard.

10. Use compound set to proper angle.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Collet attachment
- Tool bits
- Center drill
- Drill chuck
- Lathe centers
- Hermaphrodite calipers

Operations
1. Facing
2. Center drilling
3. Turning
4. Recessing
5. Chamfering
6. Layout
7. Measuring
8. Threading

Materials
- CRS 1020, \( \frac{1}{2} \)" dia. x \( \frac{4}{8} \)"

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Mount collet chuck assembly with \( \frac{1}{2} \)" collet.
2. Arrange for proper spindle speed.
3. Set lathe tool for facing.
4. Face both ends to length as per drawing.
5. Drill \( \frac{1}{4} \)" dia. hole (with No. 2 center drill) in both ends, using drill chuck in tailstock spindle.
6. Remove drill chuck and replace tailstock center.
7. Arrange headstock for turning between centers.
8. Place shaft between centers in lathe. Drive with lathe dog.
9. Layout shoulder dimensions.
10. Set lathe tool for turning.
11. Rough turn \( \frac{3}{8} \)" diameter. Finish turn to \( \frac{4}{10} \)".
12. Set tool for recessing \( \frac{1}{8} \)" slot.
13. Recess to \( \frac{3}{8} \)" diameter by \( \frac{1}{8} \)" width.
15. Chamfer \( \frac{1}{16} \)" x 45° all edges as per drawing.
16. Turn piece end for end. Drive with lathe dog and protect \( \frac{3}{8} \)" dia. with soft material.

8. Discuss common error of binding lathe dog.
PROCEDURE

17. Arrange gearing for cutting as per drawing.
18. Set tool for thread cutting.
20. Cut left-hand thread. Fit to mating part.
21. Remove all burrs and polish.
22. Submit for inspection and grade.

TECHNIQUES AND RELATED INFO.

18. Set compound at 29° or-30° to the right to cut right-hand thread.
20. Set compound 29½° or 30° to the left to cut left-hand threads.
Unit No. Operator's job title: Engine lathe operator
Project V Project Name: Self-centering vise
Job No.2 Job name: Guide rod D.O.T. No. 604.280

Drawing No. 9, 11 Time: 1 hour

Objectives
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Engine lathe
Collet chuck attachment
Tool bits
Vernier calipers

Selected references
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith.

Operation

1. Facing
2. Chamfering
3. Measuring

Materials
CRS 1020, ¼" dia. x 4½"

PROCEDURE

1. Mount collet chuck attachment with ¼" collet. Tighten with draw bar and have stock projecting ½".
2. Set lathe tool for facing and chamfering.
3. Face one end. (Duplicate operations for both rods.)
4. Chamfer end ¼" x 45°.
5. Turn piece end for end and take light facing cut.
6. Remove stock and measure overall length.
7. Finish facing to length as per drawing.
8. Chamfer end ½" x 45°.
9. Remove burrs and polish.
10. Submit for inspection and grade.
Unit No.  Operator's job title: Engine lathe operator
Project V  Project Name: Self-centering vise
Job No.3  Job name: Knurled handle  D.O.T. No. 604.280

Drawing Nos. 9, 12  Time: 3 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- 3/4", 11/32", and 3/16" drills
- 3-jaw universal chuck
- Boring tool
- Tool bits
- 3/8" machine reamer
- Drill chuck
- 1/8" hardened mandrel
- Center drill
- Lathe file
- Knurling tool
- Micrometer
- Hermaphrodite calipers

Selected references:
- Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Place stock in 3-jaw universal chuck with 1 3/8" projecting.
2. Set lathe tool for facing and face end.
3. Center drill end of stock with center drill held in drill chuck in tailstock spindle.
4. Remove drill chuck and replace with tailstock center.
5. Adjust tailstock to support end of work.
6. Set lathe tool for turning.
7. Take light cut on 1/16" diameter so that stock is clean and runs true for 1" length.
8. Set medium knurl and knurl machined surface.
9. Remove the tailstock center and replace with drill chuck.

TECHNIQUES AND RELATED INFO.

1. Remove burrs from workpiece and adjust so stock runs true.
2. See content outline, Item VII, Speeds and Feeds.
3. Adjust the lathe to a slow back geared speed and a fairly rapid feed. Force the knurls slowly into the work surface until a pattern begins to develop, then feed toward headstock and flood with cutting fluid.
10. Drill through hole with \( \frac{1}{16} \)" drill.
11. Redrill with \( \frac{11}{32} \)" drill.
12. Set boring tool and bore to \( .365 \)".
13. Use \( \frac{3}{8} \)" machine reamer and ream to size.
14. Remove workpiece and press \( \frac{3}{8} \)" dia. hardened mandrel through reamed hole.
15. Arrange lathe for turning between centers. Clamp lathe dog on the larger diameter mandrel end and mount between centers.
16. Layout shoulder lengths as per drawing.
17. Set lathe tool for turning and facing.
18. Rough turn \( \frac{2}{8} \)" diameter and shoulder dimensions plus \( \frac{1}{12} \)".
19. Finish turn \( \frac{2}{8} \)" diameter.
20. Face \( \frac{5}{8} \)" shoulder as per drawing.
21. Face \( \frac{6}{8} \)" shoulder as per drawing.
22. Round all sharp edges with lathe file.
23. Polish with emery cloth.
24. Press out hardened mandrel.
25. Submit for inspection and grade.

10. Back drill out frequently to remove chips from flutes.
12. This operation trues hole and pilots reamer straight.
13. Locate reamer in the bored hole before tightening in the drill chuck. Use a cutting speed about that for a similar size drill, and a slow steady feed with a cutting fluid.
14. Enter small end of mandrel in hole and position so that larger diameter of the mandrel is at the knurled end. Use oil in hole before pressing in arbor press.
24. Support on knurled end and press small end of mandrel through the workpiece on the arbor press.
Unit No. | Operator's job title: Engine lathe operator
---|---
Project VI | Project Name: Close quarters hacksaw
Job No. 1 | Job name: Frame | D.O.T. No. 604.280

**Objectives**

Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

**Equipment:**
- Engine lathe
- 3-jaw chuck
- Toolholder
- Tool bits
- Die and die stock
- Cutting oil
- 12" rule
- Single-cut mill file

**Operations**
- 1. Facing
- 2. Threading with die
- 3. Radius forming

**Materials**
- SAE 1018 CRS,
- 1 pc. \( \frac{5}{16} '' \) dia. \( \times 11\frac{3}{8} '' \) long

**Selected references:**
- Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

**PROCEDURE**

1. Select stock and remove sharp edges.
2. Mount in 3-jaw chuck and face end.
3. Form radius with radius tool.
4. Reverse, face to length, and chamfer.
5. Locate die, support with tailstock, and revolve machine by hand to cut thread.
6. Remove burrs and polish.
7. Submit for inspection and grade.

**TECHNIQUES AND RELATED INFO.**

1. Select a 3-jaw chuck for more holding power during the die threading operation.
2. Use file or forming tool.
3. Follow the die with the tailstock to keep it straight. Support die stock handle with toolholder shank. Use cutting oil whenever threading steel.
Unit No. Operator's job title: Engine lathe operator
Project VI Project Name: Close quarters hacksaw
Job No. 2, Job name: Handle D.O.T. No. 604,280

Drawing Nos. 13,14 Time: 6 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Collet attachment
- Lathe centers
- Drive plate
- Lathe dog
- Knurling tool
- Toolholder and tool bits
- Drill chuck
- Center drill
- No. 6 and \( \frac{1}{16} \)" drills
- \( \frac{1}{4} " - 20 \) tap and handle

Materials
- Aluminum 24 ST, 1" dia. x 5" long

Techniques and related info.

Procedure

1. Select stock and remove sharp edges.
2. Set up collet attachment and 1" collet.
3. Locate work in collet, face, and center drill.
4. Reverse piece, face to length, and center drill.
5. Locate between centers with dog and drive plate.
6. Turn to \( 0.927" \pm 0.002", 4\frac{1}{4} " \) long.
7. Turn to \( 0.875 \pm 0.002", \frac{3}{8} " \) long.
8. Knurl with medium pitch knurl.
9. Remove dog and lathe centers and remount collet attachment.
10. Locate in collet and turn end to \( 0.875" \pm 0.002", \frac{7}{8} " \) long.
11. Turn \( 0.500" \pm 0.002", \frac{5}{16} " \) long.
12. Set compound to \( 30^\circ \) off centerline and cut angle to blend with \( \frac{1}{8} " \) dia.

3. Stress cutting speeds for aluminum and use kerosene for cutting fluid. Aluminum is machined over 300 ft. per minute.
5. Locate dog close to end to clear knurling tool.
6. Turn \( 0.010" \) undersize before knurling.
8. Bring size up to \( 0.937 \pm 0.002 " \) for fit in collet.
10. Point out need to be careful not to mar work with collet. Avoid heavy cuts when holding in a collet.
12. Caution: do not run into \( 0.500" \) dia. when machining the \( 30^\circ \) angle.
PROCEDURE

13. Mount drill chuck and No. 6 drill in tailstock and drill hole 1\(\frac{1}{2}\)" deep.

14. Start \(\frac{1}{4}\)"-20 tap in drilled hole, guiding it with tailstock center; tap \(\frac{3}{8}\)" deep.

15. Remove tap, reverse work in collet and drill \(\frac{5}{16}\)" dia., \(3\frac{3}{4}\)" deep.

16. Remove drill chuck, locate \(\frac{13}{16}\)" drill in tailstock spindle and drill \(3\frac{3}{4}\)" deep.

17. Remove work and finish tapping \(\frac{1}{4}\)"-20 thread at the bench.

18. Remove burrs and polish.

19. Submit for inspection and grade.

TECHNIQUES AND RELATED INFO.

14. Guide the tap with tailstock center to assure straight threads.

15. Use pilot drill to depth before using large drill. Use kerosene for lubricant on aluminum.
Unit No.  Operator's job title: Engine lathe operator
Project VI  Project Name: Close quarters hacksaw
Job No. 3  Job name: Adjustable blade retainer  D.O.T. No. 604.280

Drawing Nos. 13,14  Time: 2 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Engine lathe
3-jaw chuck
Toolholder
Tool bits
Die and die stock
Cutting oil
Tail stock center
Jacobs chuck
Center drill
Lathe file
Emery cloth

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith


PROCEDURE

1. Mount 3-jaw chuck on the spindle.
2. Select \( \frac{3}{4} \)" dia. x 3\( \frac{1}{4} \)" long stock and remove sharp edges.
3. Tighten 3-jaw chuck with \( \frac{1}{4} \)" projecting.
4. Take facing cut.
5. Mount Jacobs chuck and center drill in tailstock. Center drill.
6. Layout \( \frac{1}{2} \)" shoulder length plus \( \frac{1}{4} \)" with hermaphrodite.
7. Rough turn .250" diameter while supporting end with tailstock center.
8. Finish turn .250' diameter and face shoulder to layout.
9. Face off end to \( \frac{1}{2} \)" shoulder distance.
10. Chamfer end \( \frac{1}{8} \)" x 45°.

TECHNIQUES AND RELATED INFO.

1. Stress that mating spindle and inside of chuck must be free of burrs and chips when mounting.
2. Caution: After tightening workpiece, remove the chuck wrench immediately.
3. Demonstrate that the tailstock and headstock must be in alignment for this operation.
4. The \( \frac{3}{4} \)" excess will be removed after turning.
5. Do not cut shoulder distance beyond layout line.
6. Discuss reason for supporting long slender work this way.
7. Point out that a chamfer prevents a knife edge on the thread and is a lead for the die.
11. Locate die on work and backup with tailstock.
12. Turn spindle by hand, follow with tailstock, and cut thread to 7/8" length.
13. Turn piece around and cut off to overall length.
14. File sharp corners, then polish.
15. Submit for inspection and grade.
Unit No.  Operator's job title: Engine lathe operator

Project VI.  Project Name: Close quarters hacksaw

Job No. 4.  Job name: Pin  D.O.T. No. 604.280

Drawing No. 1342  Time: ½ hour

Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment: Engine lathe
Collet assembly and ¼" collet
Tool bits
Emery cloth

Operations
1. Face
2. Facing
3. Polishing
4. Measuring

Materials
½" drill rod, ¾" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Mount collet assembly and tighten workpiece in a ½" collet.
2. Face one end to clean up.
3. Face opposite end to ½" length.
4. Polish ends with emery cloth.
5. Submit for inspection and grade.
Unit No. Operator's job title: Engine lathe operator

Project VII Project Name: Bench vise

Job No. 1 Job name: Nut D.O.T. No. 604.280

Drawing Nos. 15, 16 Time: 3 hours

Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe
3-jaw chuck
Center drill, Jacobs chuck
\(\frac{1}{8}\), \(\frac{1}{4}\), and \(\frac{3}{8}\) drills
\(\frac{5}{8}\)-11 tap

Operations
1. Facing
2. Center drilling
3. Drilling
4. Tapping
5. Measuring
6. Filing
7. Polishing

Materials
CRS 1\(\frac{1}{2}\)" dia. x 1" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount in 3-jaw chuck and tighten.
3. Face end to clean up surface.
4. Reverse workpiece on parallel and tighten. (Caution: Remove parallel.)
5. Face end to \(\frac{1}{8}\)" length.
6. Center drill.
7. Drill through with \(\frac{1}{8}\)" pilot drill in tailstock.
8. Drill through with \(\frac{1}{4}\)" drill.
9. Drill through with \(\frac{3}{8}\)" drill.
10. Set up \(\frac{5}{8}\)-11 tap to be guided square with tailstock.
11. Tap through; reverse spindle intermittently to break chip.

9. Demonstrate how to use drill as a reamer to maintain size.
10. Use cutting oil and slow speed.
11a. Show how to use the unclamped tailstock, with the tap held in a drill chuck and the entire assembly guided by hand pressure.
11b. Other operations will be done on threaded stud of the vise jaw.
Unit No.  Operator's job title: Engine lathe operator

Project VII  Project Name: Bench Vise

Job No. 2  Job name: Washer

D.O.T. No. 604.280

Drawing Nos. 15, 16

Time: 2 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe
3-jaw chuck
Toolholder and tool bits
Center drill and Jacobs chuck
1", 1/2", and 1/4" drills

Materials
1" micrometer
6" scale
Lathe file
Emery cloth
CRS 1 1/2" dia. x 1 1/2" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Extend stock 1" from face of 3-jaw chuck and tighten.
3. Take facing cut to clean up surface.
4. Turn O.D. to clean up surface to 1 1/2" length.
5. Chamfer 45° x 1/16".
6. Center drill.
7. Drill 1" deep with 1/2" pilot drill.
8. Drill 1" deep with 1/4" drill.
9. Drill 1" deep with 1/8" drill.
11. Face remaining piece to clean up.
12. Chamfer 45° x 1/16".
14. Polish and deburr.
15. Submit for inspection and grade.

10. Use cutoff tool 1" to 3" wide.
Unit No.  Operator's job title: Engine lathe operator
Project VII  Project Name: Bench vise
Job No. 3  Job name: Handle  D.O.T. No. 604.280
Drawing Nos. 15, 16  Time: 4 hours

Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe
3-jaw chuck
Center drill and Jacobs chuck
Toolholder and tool bits
Fine knurling tool

Operations:
1. Facing
2. Turning
3. Knurling
4. Cutting off
5. Center drilling
6. Chamfering
7. Filing

Materials
CRS ½" dia. x 6" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Tighten in 3-jaw chuck and face end.
3. Center drill.
4. Extend 5" from chuck face, support with tailstock center, and tighten work.
5. Rough turn ⅜" dia. to ⅜" and face shoulder to ⅝".
6. Finish turn ⅛" dia. and face shoulder to ⅝".
7. Mount fine knurl and knurl to within ⅛" of chuck face.
8. Cut off to ⅞" length. (Part A)
9. Face off remainder to clean up. (Part B)
10. Center drill.
11. Drill ⅛" depth with ⅜" drill.
   Countersink to ⅛" dia.
12. Cut off to ⅜" length.
14. Chamfer both ends (Part B) to 45° x ⅛".
15. Tighten Part A in ⅜" collet.
16. Chamfer both ends 45° x ⅛".
17. Finish turn ⅛" dia. x ⅛" length.
18. Deburr and polish.
19. Submit for inspection and grade.

55
Unit No. Project VII Project Name: Bench vise
Job No. 4 Job name: Guide pin D.O.T. No. 604.280

Drawing Nos. 15, 16 Time: 1 hour

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe
Collet assembly and \( \frac{1}{2} \)" collet
Toolholder and tool bits
Lathe file
Emery cloth
6" scale

Operations
1. Facing
2. Chamfering
3. Measuring
4. Filing
5. Polishing

Materials
Drill rod \( \frac{1}{2} \)" dia. x 3\( \frac{3}{8} \)" long (2 required)

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith.

PROCEDURE

1. Select stock and deburr.
2. Mount collet assembly with \( \frac{1}{2} \)" collet.
3. Tighten workpiece and face one end.
4. Reverse and face to 3\( \frac{3}{8} \)" length.
5. Chamfer 45° x \( \frac{1}{8} \)".
6. Deburr and polish.
7. Submit for inspection and grade.
Unit No.  Operator's job title: Engine lathe operator

Project VII  Project Name: Bench vise

Job No. 5  Job name: Fixed and movable jaws  D.O.T. No. 604.280

Drawing No.: 15 17  Time: 4 hours

Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Facing  5. Threading
3. Turning  7. Forming
4. Undercutting  8. Polishing

Equipment:
Lathe  Indicator
4-jaw chuck  Toolholder and tool bits
Height gage  Knurling tool
Layout plate  Lathe file
Center punch  Emery cloth
Center drill

Materials
CRS 1 ½" x 1 ½" x 7 ¼"

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount 4-jaw chuck and tighten workpiece.
3. Face one end to clean up.
4. Reverse workpiece and face overall length to 7".
5. Layout center at 5/8"-11 thread on ends and center panel.
6. Center drill.
7. Mount workpiece in 4-jaw chuck and tighten jaws until hole runs true. Leave 3" extending from chuck face.
8. Rough turn 21/2" dia. and face shoulder to 2 ½" length.
9. Undercut 5/8" width x 1 ½" dia.
10. Finish turn to .625" dia. and face shoulder to 2 ½" length.
10A. Chamfer 45° x 1 ½".
11. Set for threading ¾"-11 thread.
12. Thread to 1 ½" length.

TECHNIQUES AND RELATED INFO.

2. Show how concentric rings on chuck are used to center workpiece.
5. Demonstrate use of height gage on layout plate.
6. Use shop practice to select alternatives for center drilling.
7. Use tailstock center to get approximate center and then indicate center drilled hole concentric with spindle.
12. Fit to mating nut.
14. Take skim cut to clean up 1\(\frac{1}{2}\)" dia. on nut.
15. Set up medium knurling tool and knurl O.D. of nut.
16. File \(\frac{1}{6}\)" radius on either end of nut.
17. Deburr and polish.
18. Submit for inspection and grade.
Unit No.  Project VII  Operator's job title: Engine lathe operator

Job No. 6  Project Name: Bench vise

Job name: Screw  D.O.T. No. 604.080

Drawing Nos. 15, 16  Time: 6 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe
3-jaw chuck
Toolholder and tool bit
Center drill
Jacobs chuck
Collet assembly and 1/2" collet

Operations
1. Facing
2. Center drilling
3. Turning
4. Undercutting
5. Threading
6. Forming
7. Polishing
8. Measuring

Materials
Lahe file
Emery cloth
1" micrometer
6" scale
Tailstock center

CRS 1" dia. x 5 5/16" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount 3-jaw chuck and tighten shaft.
3. Face off end to clean up.
4. Center drill.
5. Extend work 4" from chuck face, support with tailstock center, and tighten.
6. Finish turn 1 1/8" dia. to 3" length.
7. Rough turn 3/8" dia. to 3 1/2" length.
8. Finish turn .500" dia. and face shoulder to 3 1/2" length.
9. Chamfer 45° x 1/8".
10. Undercut 1/8" width x 1/8" dia.
11. Setup for threading.
12. Thread 1/2"-13 UNC.
13. Mount collet assembly with 1/2" collet.
14. Reverse workpiece and tighten.
15. Face to overall length 5 3/16".
16. Finish turn 3 3/16" dia. x 1/8" length.
17. Finish 1 15/16" R.
18. Debur and polish.
19. Submit for inspection and grade.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- 3-jaw chuck
- Collet attachment, collets
- Toolholder and tool bits
- Headstock, tailstock centers
- Micrometer stop
- Jacobs chuck, center drill

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr ends.
2. Mount 3-jaw chuck and tighten workpiece.
3. Take facing cut to clean up rough surface.
4. Center drill.
5. Reverse workpiece and take facing cut to 3/4" length.
6. Center drill.
7. Extend workpiece 2 1/2" to support end in tailstock center and tighten chuck.
8. Rough turn 1.00" diameter plus 1/8" and face shoulder to 4 1/2".
9. Remove chuck and mount workpiece between centers with drive dog clamped to 1 1/4" diameter.
10. Take a small finish cut to clean up 2 3/8" diameter.
11. Mount coarse knurl and knurl 2 3/8".
12. Finish turn 1/2" depth on either side of knurl to 3 1/2" width.
13. Finish 1 1/16" radius on either end.
14. Reverse workpiece and finish turn 1.00" diameter and face shoulder to 2 3/4" length.

Materials
- CRS 7/8" dia. x 3 1/2" long
- Driving dog
- 1/2" micrometer
- Vernier caliper
- Knurling tool
- Lathe file and emery cloth
- Driving dog
- Vernier caliper
- Knurling tool
- Lathe file and emery cloth

TECHNIQUES AND RELATED INFO.

11. Emphasize the use of oil and backgears.
13. File or use a form tool.
14. Protect knurl with soft material.
15. Undercut \( \frac{11}{32} \) diameter x \( \frac{1}{8} \) width.
16. Finish \( \frac{1}{8} \)" radius.
17. Mount collet assembly and hold shank in a 1" collet.
18. Pilot drill with \( \frac{1}{8} \)" drill to \( \frac{13}{16} \)" depth.
19. Finish drill \( \frac{9}{16} \)" diameter to \( \frac{3}{4} \)" depth.
20. Mount boring tool and micrometer stop, then rough bore 1.500" diameter to \( \frac{11}{32} \)" diameter x .490" depth.
21. Finish bore 1.500" diameter to fit die and face inside shoulder to \( \frac{1}{2} \)" depth.
22. Deburr and polish.
23. Submit for inspection and grade.
Unit No.  
Operator's job title: Engine lathe operator

Project VIII  
Project Name: Lathe dieholder

Job No. 2  
Job name: Tapered shank support  
D.O.T. No. 604.280

Drawing No. 19  
Time: 12 hours

Objectives: 
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Facing
2. Turning
3. Center drilling
4. Undercutting
5. Taper turning

Materials
Micrometer 1" and 2"
CNRS 2" dia. x 7 1/2" long
No. 3 Morse taper adapter
Set of radius gages

Equipment:
Engine lathe
3-jaw chuck
Toolholder and tool bits
Headstock and tailstock centers
Jacobs chuck, center drill
Driving dog

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

TECHNIQUES AND RELATED INFO.

PROCEDURE

1. Select stock and deburr ends.
2. Mount 3-jaw chuck and tighten workpiece.
3. Take facing cut to clean up rough surface.
4. Center drill.
5. Reverse workpiece and face end to 7 3/8" length.
6. Center drill.
7. Rough turn tapered shank to 1" diameter and face shoulder to 4 7/8" length.
8. Undercut 13/16" diameter with radius tool to a length of 4 3/8".
9. Finish turn .680" diameter to 1/8" length.
10. Finish 1/8" radius on the end.
11. Set up taper attachment for given taper.
12. Rough turn taper to .840" small end and .991" large end.

8. Describe alternate methods for grinding single point form tools and checking them with a radius gage.
9. Use file or a form tool.
10. If attachment is not available, use offset tailstock method. Describe advantages of taper attachment.
11. Demonstrate how to compensate for errors of taper until correct one is achieved.
13. Finish turn taper leaving grinding stock .805" small end and .956" large end.

14. Remove centers from lathe and mount tapered end of workpiece into headstock. Use adapter or bore-tapered nest if necessary.

15. Finish turn 2" diameter to clean up surface.

16. Pilot drill ½" hole to 2" depth.

17. Drill ¼" hole to 2" depth.

18. Mount boring tool then rough bore ½" diameter and 2" depth.

19. Finish bore 1.002" ± .001" diameter to 2" depth.

20. Finish ½" radii on 2" diameter.


22. Submit for inspection and grade.

13. Show how to use micrometer, tapered adapter, or tapered gage for fitting.

14. Check for runout to make sure taper is seated correctly.

19. Describe "go" and "no go" plug gages. Use mating part for a sliding fit.

20. Use file or form tool.
Unit No. Operator's job title: Engine lathe operator
Project IX Project Name: Eccentric test shaft
Job No. 1 Job name: Shaft D.O.T. No. 604.280
Drawing No. 20

Objectives:
Using the equipment, materials, and operations listed here, the student
will be able to produce the piece shown on the drawing in accordance
with the time and accuracy requirements specified.

Equipment:
Engine lathe
Jacobs chuck, center drill
3-jaw chuck
Toolholder Lathe file
Center gage Emery cloth
Thread micrometer Driving dog
Headstock and tailstock V-block centers Height gage

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

Operations
1. Facing 7. Taper
2. Straight turning 8. Eccentric turning
3. Layout 9. Grooving
5. Chamfering 11. Polishing

Materials
CRS 1020, 2'' dia. x 6 1/4''

PROCEDURE
1. Select stock and deburr ends.
2. Mount 3-jaw chuck and tighten work-piece.
3. Take facing out.
4. Center drill to no greater than 1/4'' diameter.
   Caution: If this hole is any larger it would break into the eccentric center hole.
5. Reverse shaft in 3-jaw chuck.
6. Take facing cut to overall length of 6 1/6''
7. Center drill (no greater than 1/4'' dia.).
8. Rough turn areas J and K to 1 1/2'' diameter and face shoulder length to 5/8'' of blueprint dimension.
9. Tighten dog on 1 1/8'' diameter and mount shaft between centers.
10. Take a skim cut along entire length so that the O.D. is concentric with the centers.
11. Remove the dog, color both ends of the shaft with layout dye, and fasten in a V-block.

TECHNIQUES AND RELATED INFO.
2. Discuss reasons for avoiding excessive overhang and runout.
4. Point out that r.p.m. for this operation applies to the dia. of the center drill.
8. Support end with the tailstock center.
9. Demonstrate methods to check alignment and concentricity of centers.
10. Explain the importance of concentricity for all diameters.
12. Take the assembly to a layout plate and scribe a centerline on both ends with a height gage.

13. Turn the centerline 90° and scribe a line on either end .250" up from the center.

14. Center punch the intersection of these lines and center drill both sides. Caution: Do not break into true centers.

15. Tighten dog on area K and mount between true centers.

16. Rough turn areas A, B, and C to 1\frac{1}{16}" dia. and face shoulder of section C to \frac{3}{8}" of blueprint length.

17. Rough turn areas D and E to .250" dia. and face shoulder of section E to \frac{1}{8}" of blueprint length.

18. Rough turn areas F, G, H, and I to \frac{13}{16}" dia.

19. Reverse workpiece, tighten dog on area A, place between eccentric centers and rough turn area H and I to 1\frac{1}{8}" dia. Caution: Leave \frac{1}{16}" stock on either side of shoulders for areas H and I in order to finish face.

20. Place between true centers, rough turn area B to 1.560" dia., and face shoulder to \frac{1}{8}" of given dimension.

21. Finish turn areas J and K to 1.000" dia. and face shoulder of area J to given dimension.

22. Finish turn area F to 1.888" dia.

23. Remount between eccentric centers, finish, turn areas H and I to 1.125" dia., and face to give shoulder dimensions.

24. Finish turn area H to .625" dia. and face to give shoulder dimension.

25. Remount between true centers, finish turn area G to 1.500" dia. and face to given shoulder dimension.

12. Discuss technique for scribing centerline by touching off from the top of the shaft with the gage and subtracting the radius.

14. Explain the principle of eccentricity. Use the drill press or local shop practice to center, drill eccentric centers.

16. To maintain proper concentricity of several diameters, rough turn all dimensions before finish turning to size.

19. Use undercutting tool. Explain to student how this tool is used in-between interfering diameters.

20. Use undercutting tool.

22. Demonstrate the use of the formula O.D. = \frac{\text{No. of teeth} + 2}{2} \times \text{diametral pitch}.

23. Use undercutting tool.

24. Use undercutting tool.

25. Use undercutting tool.
PROCEDURE

26. Finish turn area J to .750" dia. and face to given shoulder dimension.

27. Reverse workpiece, clamp dog to area K, and mount between centers.

28. Finish turn area A to .700" dia. and face shoulder to given dimension.

29. Finish turn areas B and C to 1.000" dia. and face the shoulder of C to the given dimension.

30. Finish turn areas D and E to 1.187" dia. and face shoulder of E to the given dimension.

31. Finish turn area E to .875" dia. and face shoulders of E to the given dimensions.

32. Finish turn taper for area B by feeding along compound angle. Maintain .750" dia. x 1.125" length.

33. Reverse workpiece, clamp dog to area A and mount between centers.

34. Finish ⅛" radii on area F.

35. Chamfer area K, ⅛" x 45°.

36. Set gearbox for 1"-8 UNC-LH and position threading tool and compound for left-hand threading.

37. Cut 1"-8 UNC-LH thread to size.

38. Deburr and polish.

39. Submit for inspection and grade.

TECHNIQUES AND RELATED INFO.

27. Protect surface with soft material between set screw and workpiece.

28. Review formula for minimum turned dia., when given the size of a hexagon across the slats.

31. Use undercutting tool.

32. Review formula: angle of compound = \( \frac{.125}{1.125} \)

34. Use form tool or file. Show the use of the radius gage.

36. Discuss important considerations for threading such as: compound angle, direction of feed, fitting and depth of cut.

37. Fit to nut, thread micrometer, or 3-wire measurement.
Unit No. 1  Operator’s job title: Engine lathe operator

Project X  Project name: Tap wrench

Job No. 1  Job name: Chuck body

D.O.T. No. 604.280

Drawing No. 1  Time: 8 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Facing 7. Cutting
2. Center drilling 8. Tapping
3. Straight turning 9. Chamfering
4. Taper turning 10. Filing
5. Drilling 11. Polishing
6. Boring

Equipment:
Lathe
Toolholder
Tool bits
Collet assembly and 1” collet
Jacobs chuck and center drill
Centers and driving dog

Materials
Medium knurling
CRS 1” dia. x 2½” long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount collet assembly with 1” collet.
3. Tighten workpiece in collet and face one end to cleanup.
4. Center drill.
5. Reverse workpiece and face end to clean up.
6. Center drill.
7. Clamp driving dog to one end and mount assembly between centers.
8. Finish turn to .980” dia. x 2” length.
9. Mount medium knurl, then knurl .980” dia. to 1½” length. (Do not raise knurl above 1” dia.).
10. Mount collet assembly and light workpiece (1” collet).
11. Set compound to given angle and turn 5⁄8” dia. to 5⁄8” length along given angle.
12. Mount 1⁄16 pilot drill in tailstock chuck and drill to 1½” depth.
13. Mount 3⁄32” drill and drill to 1½” depth.
14. Set up for boring 1⁄4” tapered hole, feeding with compound at given angle.

9. Set lathe for low r.p.m.’s and use oil on knurl.

14. Show that side clearance is critical for small hole boring.
15. Finish bore $\frac{1}{2}''$ tapered hole to $\frac{7}{8}''$ depth.

16. Cut off to $1\frac{1}{16}''$ length.

17. Reverse workpiece and hold knurled dia. in a $1''$ collet.

18. Face to overall length of $1\frac{1}{2}''$.

19. Bore to tap drill size for a $\frac{3}{4}''$-16 tap to $\frac{5}{8}''$ depth.

20. Set up for tapping the $\frac{3}{4}''$-16 hole and tap to depth.

21. Chamfer end to $\frac{1}{16}''$ depth.

22. Deburr and polish.

23. Submit for inspection and grade.

17. Demonstrate that back face should not run out.

20. Describe the use of the starting tap and the bottoming tap.
Unit No. Operator's job title: Engine lathe operator

Project X Project Name: Tap wrench

Job No. 2 Job name: Wrench body D.O.T. No. 604.280

Objectives
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Facing 6. Form
2. Center drilling 7. Turning
3. Drilling 8. Threading
5. Reaming 10. Polishing

Equipment:
Lathe
Collet assembly and Centers and driving dog
3/4" collet
Jacobs chuck and center Lathe file
* drill Emery cloth
Toolholders and tool bits Drills, letter C drill
5/8" drill
Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

TECHNIQUES AND RELATED INFO.

PROCEDURE

1. Select stock and deburr.
3. Tighten workpiece in collet and take facing cut on end.
4. Center drill to 1/2" dia.
5. Reverse workpiece and face end to 3/4". (Note: 1/2" will be removed in later operation.)
6. Center drill to 1/2" dia.
7. Mount 7/8" drill, drill in tailstock and drill to 2 3/4" depth.
8. Mount small boring tool to enter 7/8" hole and bore to .240" dia., 1/2" depth.
9. Mount a "C" drill in the tailstock and drill to 2 3/4" depth.
10. Mount a 1/2" reamer and ream to 2 3/4" depth.
11. Set up for turning between centers and clamp driving dog on end opposite reamed hole.
12. Mount workpiece between centers and turn 3/8" diameter to 1 1/2" length.

* Note: Oil must be used and the drill retracted frequently.
7. Demonstrate that the bore hole is concentric and use as guide for the reamer.
8. Emphasize that speeds for reamers are less than for drills.
9. Protect surface with soft material.
10. Describe the use of a form tool for turning shoulders with fillets.
13. Turn \( \frac{3}{4} \)" diameter to \( \frac{3}{8} \)" length and maintain \( \frac{3}{8} \)" length for threaded area.

14. Set up for threading \( \frac{3}{4} \)-16 dia. and finish to size.

15. Remove from centers and tighten in a collet attachment with a \( \frac{3}{4} \)" collet.

16. Face off to remove center. Maintain \( \frac{1}{2} \)" length.

17. Set compound to given angle and finish turn nose to \( \frac{3}{4} \)" dia. by given included angle.

18. Reverse work piece and form spherical end with file and emery cloth.

19. Drill hole to intersect \( \frac{3}{8} \)" diameter. Use No. 20 drill.

20. Tap hole 10-32-UNC-2B.


22. Submit for inspection and grade.
Unit No.  Operator's job title: Engine lathe operator

Project  X  Project Name: Tap wrench

Job No. 3  Job name: Handle  D.O.T. No.604.280

Drawing No. 21  Time: 1 hour

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe
Collet attachment and 1" collet
Vernier caliper
Lathe file
Emery cloth
Toolbits

Operations
1. Facing
2. Undercutting
3. Filing
4. Polishing
5. Measuring

Materials
CRS ½" dia. x 4½"

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Set up collet assembly with ½" collet.
3. Tighten workpiece with draw bar and face both ends to 4" length.
4. Undercut center ⅜" wide by .220" dia.
5. File and polish ends.
6. Submit for inspection and grade.

4. Demonstrate use of vernier caliper for measuring small undercuts.
Unit No.  
Operator's job title: Engine lathe operator

Project No. XI  
Project Name: Micrometer boring head

Job No. 1  
Job name: Stop pin

Drawing Nos. 22, 23, 24

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Engine lathe
Collet attachment and 8" collet
Toolholder
Lathe file
Tool bits
1" micrometer
6" scale
Emery cloth

Operations:
1. Facing
2. Turning
3. Chamfering
4. Measuring
5. Filing
6. Polishing

Materials:
Drill rod 3/8" dia. x 3/8" long.

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount collet assembly and 8" collet.
3. Tighten workpiece and face end to clean up.
4. Reverse workpiece and face to overall length 3/32".
5. Rough turn .250" dia. to 9/32" and face shoulder to 1/4".

6. Finish turn .250" dia. to size and face shoulder to 1/4" length.
7. File 1/16" x 1/16" chamfer.
8. Debur and polish.
9. Submit for inspection and grade.

5. Illustrate how the lathe compound set parallel to the ways can be used for depth settings. Note: Lock the carriage.

72
Unit No. Operator's job title: Engine lathe operator

Project XI Project Name: Micrometer boring head

Job No. 2 Job name: Dial D.O.T. No.604.280

Drawing No. 22, 23 Time: 4 hours

Objectives
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Lathe, 3-jaw chuck
- Toolholder and tool bits
- No. 21 drill
- Jacobs chuck and center drill
- 1" micrometer
- Vernier caliper
- 6" scale

Operations
1. Facing
2. Drilling
3. Turning
4. Chamfering
5. Threading
6. Undercutting
7. Cutting off
8. Filing
9. Polishing
10. Measuring

Materials
- CRS 1018, 1" dia. x 2" long

Selected references:
- Machining Fundamentals by Walker
- Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr
2. Mount 3-jaw chuck, extend stock 1/4" from chuck jaw face, and tighten.
3. Take facing cut to clean up stock.
4. Center drill.
5. Drill No. 21 drill to 3/4" depth.
6. Rough turn 3/4" dia. to .530" and face shoulder to 3/8" length.
7. Finish turn .498 dia. to 3/8" length.
8. Chamfer end 45° x 1/8".
9. Mount cutoff tool and undercut 3/8" length to 3/4 x 1/2" dia.
10. Undercut .250" width to 3/8" dia.
11. Turn compound to 45° and finish 45° angle to .990" dia.
12. Deburr and polish.
13. Set up for threading 1/2"-20.
15. Deburr and polish.
17. Submit for inspection and grade.

9. Undercut is for clearance to machine 45° angle on dia.
13. Use compound at 30° for threading.
14. Fit thread to mating slide.
Objectives:
Using the equipment, materials and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe
3-jaw chuck
Jacobs chuck and center drill
Toolholder and tool bits
Drive dog

Materials
CRS SAE 1018, 3/4" dia. x 2 1/2"

1. Select stock and deburr.
2. Mount 3-jaw chuck and tighten workpiece.
3. Face one end to clean up.
4. Center drill end.
5. Reverse workpiece and face to 2" overall length.
6. Center drill end.
7. Mount centers, drive plate, and tighten drive dog to one end of workpiece.
8. Rough turn 3/4" dia. to 1/2" and face shoulder to 1 1/2" length.
9. Finish turn 3/8" diameter and face shoulder to 1 5/8" length.
10. Reverse workpiece and tighten drive dog on end.
11. Take light cleanup cut on 1/4" dia.
12. Rough turn 1/4"-20 thread to 1 1/2" and face shoulder to 1 3/8" length.
13. Finish turn 1/4"-20 thread to .500 and face shoulder to 1 5/8" length.
14. Undercut 1/16" x 1/16" deep.
15. Chamfer 1/16" x 1/16".
18. Deburr and polish.
19. Submit for inspection and grade.

10. Protect surface beneath dog with soft material.
17. Fit to mating part.
Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Lathe
- 4-jaw chuck
- Jacobs chuck
- Center drill, 1/16" drill
- 10-32 and 4'-20 tap
- 1-2" micrometer
- Tap wrench

Operations
1. Facing (4-jaw chuck)
2. Center drill
3. Drilling
4. Boring
5. Tapping
6. Measuring
7. Filing

Materials
- CRS SAE 1018, 1" x 1" x 1 1/2"
- Vernier calipers
- 1-2" micrometer

Selected references:
- Machining Fundamentals by Walker
- Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount 4-jaw chuck and indicate work concentric with spindle.
3. Face workpiece to clean up surface.
4. Center drill.
5. Drill with 1/16" pilot drill 1" deep.
6. Drill thru with No. 21 drill.
7. Drill 1/8" hole to 3/8" depth.
8. Mount boring tool and bore 23/64" hole to 3/8" depth.
9. Hand tap 1/2"-20 UNF-2B square to axis using tailstock to feed.
10. Retap with bottoming tap so that mating part threads flush.
11. Reverse workpiece and face to 1 3/8" length.
13. Deburr and polish.
14. Submit for inspection and grade.

2. Demonstrate that for greater accuracy indicating is done at the midpoints rather than the outer edge.
3. Mention that boring corrects drilling runout.
Unit No.  Operator's job title: Engine lathe operator

Project XII  Project Name: Surface gage

Job No. 1  Job name: Adjustment screw  D.O.T. No. 604.280

Drawing Nos. 25, 26  Time: 1 hour

Objectives: Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Knurling
2. Facing
3. Turning
4. Threading
5. Cutting off
6. Chamfering

Equipment:
Engine lathe
3-jaw chuck
Toolholder
Tool bits
10-32 die and diestock

Materials
Lathe file
1" micrometer
6" scale
Cutoff tool and holder

CRS ½" dia. x 2" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount 3-jaw chuck.
3. Locate workpiece in chuck with 1½" projecting from jaws.
4. Face end to clean up.
5. Rough turn to ¼" dia. x ½" long.
6. Finish turn .150" dia. x ¾" long.
7. Chamfer end with file.
8. Cut thread to shoulder with 10-32 die.
9. Knurl area 1" from end.
10. Set up cutoff tool square to centerline and on center, cut off piece 1" long, and chamfer head.
11. Deburr and polish.
12. Submit for inspection and grade.

9. Workpiece can be machined and cut off when held in this manner.

9. Use hand feed to start die straight, guiding it with the tailstock, or use tailstock die holder.

Stop cutoff part way and file chamfer on head.
Unit No.  Operator's job title: Engine lathe operator
Project XII  Project Name: Surface gage
Job No. 2  Job name: Scriber point
D.O.T. No. 604.280

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Engine lathe
Collet holder and collet
Toolholder
Tool bits
10-32 UNF die

Die stock
Micrometer
6" scale
File

Materials
Drill rod 3" dia. x 2 5/8" long

Operations
1. Facing
2. Turning
3. Threading
4. Taper turning
5. Chamfering
6. Filing
7. Polishing

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

Procedure
1. Select stock and deburr.
2. Mount collet holder and 2" collet.
3. Tighten workpiece in collet and face end to clean up.
4. Reverse in collet and face to length.
5. Rough turn thread to 13/16" dia. x 11/16" long.
6. Finish turn thread dia. to .190" x 11/16" long.
7. Cut thread with UNF 10-32 die.
8. Reverse piece in collet with projecting.
9. Set compound to 8° angle with centerline and turn point.
10. Use hand rotation and guide die with tailstock. Use cutting oil.
11. Take light cuts and fine feed to turn this length. Set turning tool exactly on centerline and take light cuts to prevent bending work.

12. File and polish to remove tool marks.
13. Submit for inspection and grade.
Objectives
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Facing
2. Turning
3. Taper turning
4. Measuring
5. Filing
6. Polishing

Materials
CRS SAE 1020, 3/4" dia. x 1 3/4" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount collet assembly with 7/8" collet and tighten workpiece to extend 1/8".
3. Face end to clean up.
4. Rough turn 3/4" dia. to 3/8" dia. and face shoulder to 3/16" length.
5. Finish turn 5/8" dia. and face shoulder to 3/16" length.
6. Turn compound 36° as in drawing, and turn taper to 1/4" diameter.
7. Reverse workpiece and tighten in 1/4" collet.
8. Face end to overall length 1 1/16".
9. Deburr and polish.
10. Submit for inspection and grade.

68
Unit No. Operator's job title: Engine lathe operator

Project XIII Project Name: Arbor press

Job No. 2 Job name: Table

D.O.T. No. 604.280

Drawing Nos. 27, 29 Time: 2 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations
1. Facing 5. Measuring
2. Center drilling 6. Filing
3. Drilling 7. Polishing
4. Reaming

Equipment:
Lathe 1" reamer
3-jaw chuck 1" micrometer
Toolholder and tool bits 6" scale
Center drill Lathe file
Jacobs chuck Emery cloth
1/2" drill

Materials
CRS SAE 1020, 2" dia. x
3/4"

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount 3-jaw chuck and tighten workpiece with face extending 1/2".
3. Face end to clean up.
4. Center drill.
5. Drill 1/2" hole through.
6. Ream through with 1/2" reamer.
7. Chamfer 45° x 1/16".
8. Reverse workpiece and face to overall thickness 1/2".
9. Deburr and polish.
10. Submit for inspection and grade.

5. Use reamer as gage to check hole before drilling completely through.

7. Extend on a parallel in order to clear for 1/2" dimension. Tighten jaws and remove parallel.
Unit No. Operator's job title: Engine lathe operator

Project XIII Project Name: Arbor press

Job No. 3 Job name: Sleeve D.O.T. No. 604.280

Drawing No. 27.30

Time: 3 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Lathe Toolholder and tool bits 3-jaw chuck Center drill Jacobs chuck
1" and Hu drills 5/32" reamer 1" mandrel 1-2" micrometer

Operations
1. Facing 5. Reaming
2. Center drilling 6. Filing
3. Drilling 7. Polishing

Materials
CRS SAE 1020, 11/4" dia. x 1 1/2" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE:

1. Select stock and deburr.
2. Mount 3-jaw chuck and tighten workpiece.
3. Face end to clean up.
4. Center drill.
5. Drill through hole with 1" drill.
6. Drill through hole with 23/32" drill.
7. Mount boring tool and bore to 2/16".
8. Ream hole through with 2/32" reamer.
9. Reverse workpiece and face to 1 13/16" overall.
10. Mount centers and drive plate, press 1/2" mandrel into reamed hole, and position between centers.
11. Rough turn outside diameter to 1 3/16".
12. Finish turn outside diameter to 1.167".
13. File bevel.
15. Submit for inspection and grade.

11. Demonstrate that the dog clamps on the large end of the mandrel.
Unit No. 4  
Operator's job title: Engine lathe operator  

Project XIII  
Project Name: Arbor press  

Job No. 4  
Job name: Gear shaft  
D.O.T. No. 604.280  

Drawing Nos. 27, 28  
Time: 3 hours  

Objectives: 
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Operations  
1. Facing  
2. Center drilling  
3. Drilling  
4. Tapping  
5. Turning  
6. Filing  
7. Polishing

Equipment:  
Lathe  
Toolholders and tool bits  
3-jaw chuck  
Center drill  
Jacobs chuck  
No. 6 drill  
\( \frac{1}{2}''-20 \) tap  

Materials:  
Centers and drive plate  
CRS SAE 1020, \( 1\frac{1}{8}'' \) dia.  
\( x \) 3'' long

Equipment Selection:  
Centers and drive plate  
CRS SAE 1020, \( 1\frac{1}{8}'' \) dia.  
\( x \) 3'' long

Selected references:  
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.  
2. Mount 3-jaw chuck and tighten work.  
3. Face end to clean up.  
4. Center drill.  
5. Drill No. 6 hole, \( \frac{3}{8}'' \) deep.  
6. Tap \( \frac{1}{2}''-20 \times \frac{1}{2}'' \) deep.  
7. Reverse work and face end to overall length 2\( \frac{23}{32}'' \).  
8. Center drill.  
9. Mount centers, drive plate, and clamp dog on the tapped end.  
10. Place between centers, rough turn .750'' dia. to \( \frac{13}{16}'' \), and face shoulder to 2\( \frac{13}{32}'' \) length.  
11. Finish turn 3/50'' dia. and face shoulder to 2\( \frac{1}{16}'' \) length.  
12. Reverse workpiece and clamp dog on end.  
13. Rough turn 1.166'' dia. to \( \frac{3}{16}'' \).  
14. Rough turn .500'' dia. to \( \frac{3}{8}'' \) and face shoulder to \( \frac{7}{8}'' \).  
15. Finish turn 1.166'' diameter to size.  
16. Finish turn .500'' dia. to size and face shoulder to \( \frac{7}{8}'' \).  
17. Deburr and polish.
18. Submit for inspection and grade.

4. Hold size of hole to \( \frac{3}{8}'' \) dia. in order to retain a tapered seat after drilling.  
7. \( \frac{1}{2}'' \) will be removed after cutting the gear.

12. Protect surface with soft material.
Unit No. Operator's job title: Engine lathe operator

Project XIII Project Name: Arbor press

Job No. 5A and 5B Job name: Handle and end D.O.T. No. 604.280

Drawing Nos. 27, 31 Time: 3½ hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Lathe
- Toolholder and tool bits
- Collet assembly, ⅜", ⅝" colléts
- Center drill
- Jacobs chuck
- No. 20 drill, No. 10 drill
- 10-32 UNF tap and cap screw

Materials:
- Tap wrench
- Lathe file
- Emery cloth
- 1" micrometer
- 6" scale
- 10-32 UNF counterbore

Selected references:
- Machining Fundamentals by Walker
- Machine Tool Technology by McCarthy & Smith

PROCEDURE

Job 5A. Handle

1. Select stock and deburr.
2. Mount collet assembly with ⅜" collet.
3. Tighten workpiece and face end to clean up.
4. Center drill.
5. Drill No. 20 hole ⅜" deep.
7. Reverse workpiece and face end to 4⅞" overall length.
8. Center drill.
9. Drill No. 20 hole ⅜" deep.
10. Start 10-32 UNF tap square.
11. Finish hand tapping both ends with 10-32 UNF tap.
12. Deburr and polish.
13. Submit for inspection and grade.

Job 5B. Handle end

1. Select stock and deburr.
2. Tighten workpiece in a ⅜" collet and face end to clean up.
3. Reverse workpiece and face to 1⅜" width.
4. Center drill.

82
5. Drill No. 10 hole through.
6. Counterbore $\frac{3}{16}$" diameter x $\frac{3}{16}$" deep.
6A. Countersink both ends $\frac{1}{4}$" deep.
7. Mount handle in $\frac{3}{8}$" collet and attach end with 10-32 UNF cap screw.
8. Turn compound 25° and turn taper to $\frac{3}{8}$" dia. on end.
9. Turn compound 25° in the opposite direction and turn the taper to $\frac{3}{8}$" dia. on end.
10. File $\frac{1}{2}$" radii.
11. Deburr and polish.
12. Submit for inspection and grade.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Lathe
- 4-jaw chuck
- Indicator
- Drills 1\(\frac{1}{16}\), 1\(\frac{1}{8}\), 1\(\frac{1}{4}\)
- Toolholder, tool bits: Emery cloth

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

**PROCEDURE**

1. Select stock and deburr.
2. Mount 4-jaw chuck and tighten workpiece to approximate location.
3. Indicate center drilled hole until it runs concentric with the headstock bearings.
4. Drill 1\(\frac{1}{16}\)" pilot hole through.
5. Drill 1\(\frac{1}{8}\)" hole through.
6. Drill 1\(\frac{1}{4}\)" hole to 1\(\frac{1}{4}\)" depth.
7. Mount boring tool and rough bore hole to 1.150" x 2\(\frac{3}{8}\)" depth.
8. Finish bore 1.168" x 2\(\frac{3}{8}\)" depth.
9. Bore .500" hole to .490".
10. Ream .500" hole to size.
11. Debur and polish.
12. Submit for inspection and grade.

**OPERATIONS**

1. Drilling
2. Indicate
3. Step
4. countersink

**MATERIALS**
- CRS SAE 1020, 1" x 3\(\frac{3}{4}\)"
- .168" is milled to size.
- Countersunk hole 1.168" dia. is located by a center drilled hole.

**TECHNIQUES AND RELATED INFO.**

1. Use tailstock center to pick up center drilled hole.
2. Note dotted line of counterbored hole.
3. Arbor press for right-handed operator.
4. Depth is measured at full diameter.
5. Use mating part from Job No. 4 as a plug gage.
6. Fit mating part.
Unit No. Operator's job title: Engine lathe operator

Project XIV Project Name: Lathe mandrel

Job No. 1 Job name: Mandrel D.O.T. No. 604.280

Drawing No. 34 Time: 3 hours

Objectives: Operations
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment: Materials
Engine lathe Tool bits 7/8 dia. x 6\(\frac{1}{4}\)" tool steel
3-jaw chuck Drill chuck
Lathe centers Center drill
Drive plate 6" rule
Toolholder 1" micrometer

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE TECHNIQUES AND RELATED INFO.

1. Select stock and deburr.
2. Locate workpiece in 3-jaw chuck and face end to clean up.
3. Center drill to 3/8" diameter.
4. Counterbore 1/2" deep x 7/8" dia. with facing tool bit.
5. Reverse workpiece and face to 6 1/8" overall length (A in drawing).
6. Center drill and counterbore to size.
7. Set up lathe centers and drive plate, and mount workpiece between centers with lathe dog on one end.
8. Turn C dia. to B length and chamfer end with a file.
9. Reverse workpiece with dog on turned end and turn C dia. to B length on other end.
10. Turn nominal dia. to size +.025" for grinding.
11. Deburr and polish.
12. Submit for inspection and grade.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- 3-jaw chuck
- Drill chuck
- Lathe centers
- Drive plate
- Lathe dog
- Toolholder
- Tool bits
- Center drill
- File
- Tool steel 1" dia. x 5 3/4" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr sharp edges.
2. Mount in 3-jaw chuck, face and center drill end.
3. Reverse workpiece, face to 5 9/16" length and center drill.
4. Set up lathe centers and drive plate.
5. Locate dog on workpiece, mount on centers and turn point end to 1/2" dia. x 1/2" long.
6. Turn D dia. leaving .025" grinding stock.
7. Set compound to 30° off centerline and machine shoulder to angle.
8. Reverse part and relocate dog on point end.
9. Turn E diameter to 5/8'' x 1/2'' long.
10. Set taper attachment to .602'' per foot and turn
11. Debur and polish.
12. Submit for inspection and grade.

TECHNIQUES AND RELATED INFO.

1. Pick dimensions desired from drawing.
2. Hold size of center hole to .375'' dia.
3. Repeat these operations for making more than one piece.
4. Check center alignment and concentricity.
5. Be sure tool bit is on center for taper turning. Check taper with gage and adjust attachment for correct fit.
Unit No. Operator's job title: Engine lathe operator

Project XVI Project Name: Grinding vise

Job No. 1 Job name: Lead screw nut D.O.T. No. 604.280

Drawing No: 36, 37 Time: 2.5 hours

Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
Engine lathe
3-jaw chuck
Toolholder and tool bits
6" scale
0-1" micrometer
Center drill
F-size drill
5/16"-18 UNC tap
Collet assembly
1/16" collet

Operations
1. Facing
2. Straight turning
3. Center drilling
4. Drilling
5. Tapping

Materials
CRS SAE 1020 1½" dia. x 2" long

Selected references:
Machining Fundamentals by Walker, and Machine Tool Technology by McCarthy & Smith

PROCEDURE TECHNIQUES AND RELATED INFO.

1. Select stock and deburr.
2. Mount 3-jaw chuck and tighten workpiece to extend 1/3" from jaw.
3. Take facing cut to clean up ends.
4. Rough turn .560" dia. to .590" and face shoulder to 1.300".
5. Finish turn .562" dia. and face shoulder to 1.320".
6. Center drill.
7. Countersink 1/8" deep.
8. Tap 1/20 UNC to .500" depth.
9. Mount collet assembly with 1/16" collet.
10. Tighten workpiece and face end to .115" shoulder diameter.
11. File all parts and finish.
12. Submit for inspection and grade.
13. Summarize how to get depth settings by using tailstock scale.
Objectives:
Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:
- Engine lathe
- Collet attachment
- 1" collet
- 0.1" micrometer

Operations:
1. Facing
2. Turning
3. Drilling
4. Tapping
5. Polishing

Materials:
- Drill rod 1/2" dia. x 1 1/8"
- 1/2"-20, and 5/8"-11 taps
- No. 7 and Letter "I" drills
- Toolholder and tool bits
- Tap wrench

Selected references:
- Machining Fundamentals by Walker
- Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount collet assembly with 1/2" collet.
3. Tighten stock, extending it by 1/16", and take facing cut to clean up.
4. Finish turn to .490" dia.
5. Center drill.
6. Drill No. 7 hole through.
7. Drill Letter "I" hole to .670" depth.
8. Tap 5/8"-24 Lh to 1/4" depth.
9. Tap 1/2"-20 through.
10. Deburr and polish.
11. Reverse workpiece and cut off end to 1 1/8" length.
12. Face end to overall length .990".
13. Deburr and polish.
14. Submit for inspection and grade.
Unit No. Operator's job title: Engine lathe operator

Project XVI Project Name: Grinding vise

Job No. 3 Job name: Lead screw D.O.T. No. 604.280.

Drawing Nos. 36, 38

Objectives: Time: 3 hours

Using the equipment, materials, and operations listed here, the student will be able to produce the piece shown on the drawing in accordance with the time and accuracy requirements specified.

Equipment:

- Engine lathe
- Collet assembly
- 3/16" and No. 3 drills
- 3/16" collets
- 0-1" micrometer
- Toolholder and tool bits
- 6" scale
- Center drill
- Vernier caliper

Selected references:

- Machining Fundamentals by Walker
- Machine Tool Technology by McCarthy & Smith

PROCEDURE

1. Select stock and deburr.
2. Mount collet assembly with 7/8" collet.
3. Extend work 3/4" and tighten in collet.
4. Facing cut to clean up.
5. Extend work 3/4", support with tailstock and tighten collet.
6. Finish turn 3/8" dia. to .340" and face shoulder to .345".
7. 1/16" will be removed later to eliminate center.
8. Finish turn .375" dia. to .312" and face shoulder to .315".
9. Set up lathe for threading left-hand.
10. Thread 1/8"-24 UNF thread.
11. Extend threaded section through 3/16" collet to 1" length and tighten.
12. Face off 1" to 3.465 dimension.
13. Deburr and chamfer slightly to eliminate cross thread at front end.
14. Reverse workpiece and face end to .315" dimension.
15. Finish turn .430" dia.
16. Center drill.
17. Drill 1/8" hole .200" deep.
18. Drill No. 3 hole .600" deep.
19. Deburr and polish.
20. Submit for inspection and grade.
Bibliography


Drawings for Shop Projects
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
+ .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

<table>
<thead>
<tr>
<th>JOB NO</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 1/2</td>
<td>1/4</td>
<td>1/8</td>
<td>15/16</td>
<td>7/8</td>
<td>3/4</td>
<td>5/8</td>
</tr>
<tr>
<td>2</td>
<td>1.450</td>
<td>1.207</td>
<td>1.079</td>
<td>.901</td>
<td>.806</td>
<td>.687</td>
<td>.577</td>
</tr>
</tbody>
</table>
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±0.005 ON DECIMAL DIMENSIONS
±\(\frac{1}{64}\) ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS.
\[ \frac{1}{8} \text{ undercut to } \frac{1}{32} \text{ under minor dia. of thread} \]

\[ \frac{1}{2} - \text{13 UNC to fit nut} \]

\[ \frac{1}{16} \times 45^\circ \]

Tolerances:
(Unless otherwise specified)

±0.005 on decimal dimensions
±\( \frac{1}{64} \) on fractional dimensions
±1° on angular dimensions

Drawn by: E.F.S.

Multi-diameter shaft
die threading and undercutting

Dwg. No. 3
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.
SCALE: 1
MULTI-DIAMETER SHAFT
THREAD TURNING

DWG. NO. 4
BALL PEEN HAMMER
ASSEMBLY
10-24 UNC

1000 DIA. BODY (1 REQUIRED)

3/4 DIA.

3/8 DIA.

3/8 DIA.

3/4 DIA.

1/2 DIA.

3/8 DIA.

1/4 DIA.

1/4 DIA.

R SPHERICAL

MED. KNURL

1/16 X 1/32 DEEP NECK

1/4 -28 UNF

TOLERANCES:

(UNLESS OTHERWISE SPECIFIED)

± .005 ON DECIMAL DIMENSIONS

± 1/64 ON FRACTIONAL DIMENSIONS

± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.

SCALE:

DIE WRENCH

DWG. NO. 7
2 DIA.

TOOL BIT

LG.

ALLEN HD. SET SCR.

4 REQ D.

8-32 UNC

4 HOLES

6X49, C,

NOTE:

(UNLESS OTHERWISE SPECIFIED)

±,005 ON DECIMAL DIMENSIONS

± 1/64 ON FRACTIONAL DIMENSIONS

± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.

SCALE:

FLY TOOL

FACE CUTTER

DWG.NO. 8
<table>
<thead>
<tr>
<th>NO.</th>
<th>NAME</th>
<th>MATL.</th>
<th>REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KNURLED HDL</td>
<td>CRS</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>SET SCREW</td>
<td>STL.</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>END PIECE</td>
<td>CRS</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>VISE JAWS</td>
<td>CRS</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>ACT. SCREW</td>
<td>CRS</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>GUIDE ROD</td>
<td>CRS</td>
<td>2</td>
</tr>
</tbody>
</table>
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±0.005 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.
SCALE: ————
SELF-CENTERING VISE
JAW-ACTUATING SCREW
DWG.NO. 10
NOTES:
MATL. 1/2 DIA. CRS
FILE 5/16 SQ. FLATS
BREAK ALL SHARP EDGES

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

NO. 3 DRILL & 1/4-28 UNF
MED. KNURL

1 1/4 DIA.

5/8

3/4 DIA.

3/16

3/8 REAM

NO. 30 DRILL & 1/8 REAM AT ASSEMBLY

MATL: ALUM.

DRAWN BY: E.F.S.

SCALE: ———

SELF-CENTERING VISE

KNURLED HANDLE

DWG. NO. 12
AN3IDR.

Chucking piece:

No. 31 DR.

\[ \frac{1}{4} \text{-20 UNC-2A} \]

Remove center

Mill slot

Drill

No. F(257) DR \times \frac{1}{2} DR.

\& \frac{5}{18} \text{ UNC-2B}

Stock:

\( \frac{1}{8} \text{ DIA.} \)

\( \frac{1}{16} \text{ DIA.} \)

Drill

Stock:

\( \frac{1}{8} \text{ DR.} \text{ ROD} \)

Stock:

\( \frac{1}{16} \text{ DIA.} \times 5 \frac{1}{2} \)

Tolerances:

(Unless otherwise specified)

\[ \pm 0.005 \text{ ON DECIMAL DIMENSIONS} \]

\[ \pm \frac{1}{64} \text{ ON FRACTIONAL DIMENSIONS} \]

\[ \pm 1^\circ \text{ ON ANGULAR DIMENSIONS} \]

Layout & File for hacksaw blade

No. 31 DR.

160° bend in vise

5\frac{1}{16} \text{ UNC-2A}

5\frac{1}{16} \text{ DIA.}

5\frac{1}{16} \text{ DIA.} \times 11\frac{1}{4}
Work as solid piece, after all machining, cut in half on bandsaw and mill saw cuts to size.
BENCH VISE DETAILS

Tolerances:
(Unless otherwise specified)
±.005 on decimal dimensions
±.01 on fractional dimensions
±1° on angular dimensions

DIA. 16

1/16 x 45° CHAM.

1/16 x 45° CHAM.

1/16 x 45° CHAM.

1/16 x 45° CHAM.

BENCH VISE SCREW

GUIDE PIN

FINE KNURL

BENCH VISE NUT

MED. KNURL

RIVET AT ASSEMBLY

PART A

PART B

DRAWN BY: E.F.S.

SCALE: .125

BENCH VISE DETAILS

DWG.NO. 16
.500 REAM 2 HOLES

27 DRILL 1/32 UNC-2B

17/32 DIA.

5/8-11 UNC-2A

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

BENCH VISE: FIXED JAW

BENCH VISE: MOVABLE JAW

DRAWN BY: E.F.S.

SCALE:__

BENCH VISE
FIXED AND MOVABLE JAWS

1/16 X 45° CHAM.

DRAWN BY: E.F.S.

SCALE: __

BENCH VISE
FIXED AND MOVABLE JAWS

1/16 X 45° CHAM.
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

NO. 3 MORSE TAPER

1/8 R(TYP)
.785 DIA.
.936 DIA.

13/16 DIA.

1.002 DIA.

5/8
4

1/4
2
2 1/2

LATHE DIEHOLDER
TAPERED SHANK SUPPORT

DRAWN BY: E.F.S.

SCALE: ——

129

DWG. NO. 19
NOTES:
ALL DIMENSIONS FOR THE HEX, GEAR, TAPER AND THREAD ARE TO BE WORKED OUT BY THE STUDENT, USING MACHINERY'S HANDBOOK AND SHOP NOTEBOOK.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS

DRAWN BY: EFS.

ECCENTRIC TEST SHAFT
DWG. NO. 20
TAP WRENCH

CHUCK BODY
MATL. CRS
1 REQ'D.

HANDLE
MATL. CRS
1 REQ'D.

ASSEMBLY

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± \( \frac{1}{64} \) ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.

SCALE:

DWG. NO. 21
PARTS LIST

<table>
<thead>
<tr>
<th>NO.</th>
<th>NAME</th>
<th>MATL. RÉQD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GRADUATED DIAL</td>
<td>CRS 1</td>
</tr>
<tr>
<td>2</td>
<td>PLATE</td>
<td>CRS 1</td>
</tr>
<tr>
<td>3</td>
<td>SHANK</td>
<td>CRS 1</td>
</tr>
<tr>
<td>4</td>
<td>DOVETAIL BLOCKS</td>
<td>CRS 2</td>
</tr>
<tr>
<td>5</td>
<td>DOVETAIL SLIDE</td>
<td>CRS 1</td>
</tr>
<tr>
<td>6</td>
<td>DOWEL PIN 4/6 DIA.X1/4</td>
<td>CRS 4</td>
</tr>
<tr>
<td>7</td>
<td>HEX.HD.CAP SCR. 5/6-8 UNC</td>
<td>CRS 2</td>
</tr>
<tr>
<td>8</td>
<td>STOP PIN</td>
<td>CRS 1</td>
</tr>
</tbody>
</table>

NOTES:
1. PARTS 2 AND 4 ARE MILLING MACHINE PROJECTS.
2. PARTS 6 AND 7 ARE PURCHASED.
3. PARTS 2, 4 AND 5 ARE ASSEMBLED TO A 2" SQ. AND THEN MACHINED ROUND.
3. 20 UNF-2A
1/2 x 45° CHAM.

No. 21 DR. THROUGH

502 .498 DIA.

DIAL, SHANK, AND STOP PIN

MACHINE TO 1/16 x 45° CHAM.

TO FIT UNDERCUT IN DIAL

MACHINE TO 1/4 SQUARE

3. SHANK MATL. CRS

STOP PIN MATL. DR. ROD HARDENED

FAO

TOLERANCE:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.

CALE:

MICROMETER. BORING HEAD

DIAL, SHANK, AND STOP PIN

DWG. NO. 23
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±0.005 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS

DRILL, 3/32 REAM x 7/8 DP
LOCATE AND REAM AFTER ASSEMBLY

MICROMETER BORING HEAD
DOVETAIL SLIDE
MATL. CRS
FAO

5

DRAWN BY: E.F.S.

SCALE: ————

MICROMETER BORING HEAD
DOVETAIL SLIDE

DWG. NO. 24
TOLERANCES:

(UNLESS OTHERWISE SPECIFIED)

±0.005 ON DECIMAL DIMENSIONS

±1/64 ON FRACTIONAL DIMENSIONS

±1° ON ANGULAR DIMENSIONS
No. 6 Drill, \( \frac{1}{4} \) -20 UNC - 2B x \( \frac{1}{2} \)

\( 32 \times 45^\circ \) Cham.

1.66
1.64

Drill and Ream through

\( \frac{1}{6} \) Dia.

\( \frac{3}{4} \)

5/16

REAM X 5/8

DIAMETRAL PITCH 12

LINEAR PITCH .262

DEPTH OF TOOTH .179

RACK MATL. C1020

1 REQD.

TOLERANCES:

(UNLESS OTHERWISE SPECIFIED)

±.005 ON DECIMAL DIMENSIONS

± \( \frac{1}{64} \) ON FRACTIONAL DIMENSIONS

±1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.

SCALE: --

ARBOR PRESS

GEAR SHAFT, RACK PAD, AND RACK

DWG. NO. 28
NOTE:
COUNTERSINK ALL HOLES TOP AND BOTTOM 3/32 DEEP BEFORE SLOTTING.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.
SCALE:
ARBOR PRESS TABLE

MATERIAL: C1020

1/16 x 45° CHAM.

2 DIA.

MAT. C1020
1 REQ'd.
ARBOR PRESS SLEEVE, TABLE PIN AND COVER PLATE

COVER PLATE

TOLERANCES:

±.005 ON DECENTRAL DIMENSIONS
±.001 ON ANGULAR DIMENSIONS

DRAWN BY: E.E. S.

SLEEVE, TABLE PIN AND COVER PLATE

DRILL AT 16° CHAM

ASSEMBLY

NO. 18 DRILL
4 HOLES

COVER PLATE

TOLERANCES:

(UNLESS OTHERWISE SPECIFIED)

±.005 ON DECENTRAL DIMENSIONS

DRAWN BY: E.E. S.

SLEEVE, TABLE PIN AND COVER PLATE

Press fit in pt. 12
Loose fit in pt. 1

TABLE PIN

3/25 DIA.

3X45° CHAM.

(2/16)

MATL. C1010

MATL. C1000

MATL. C1020

DIA.

1/16

1/16odd

1/16odd
HANDLE
MATL. C1020
1 REQD.

NO.20 DR. X 3/4 DEEP
10-32 UNC - 2B X 1 DEEP
2 HOLES

4 7/8

HANDLE END
MATL. CRS
2 REQD.

GEAR SHAFT SCREW
MATL. C1020
1 REQD.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.
SCALE: —

ARBOR PRESS
HANDLE AND END

DWG.NO. 31
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
\( \pm 0.005 \) ON DECIMAL DIMENSIONS
\( \pm \frac{1}{64} \) ON FRACTIONAL DIMENSIONS
\( \pm 1^\circ \) ON ANGULAR DIMENSIONS

MATERIAL: C1020
1 REQUIRED.

DRAWN BY: E.F.S.

ARBOR PRESS
COLUMN

DWG.NO.32
GRIND SLOT TO FIT COLUMN

\[ \frac{1}{4} \times 45^\circ \text{ BEVELED EDGES (TOP AND SIDES)} \]

\( \frac{3}{16} \) UNC-2A x \( \frac{3}{4} \)

TOLERANCES:

- \pm 0.005 on decimal dimensions
- \pm \frac{1}{64} on fractional dimensions
- \pm 1° on angular dimensions

MATL. C1020
1 REQ'D.

DRAWN BY: E.F.S.

SCALE:

ARBOR PRESS BASE

DWG. NO. 33
TAPER PER INCH .0005
DIAMETER OF SMALL END TO BE .0005 BELOW NOMINAL DIAMETER
ALLOW .025 ON NOMINAL DIA. FOR GRINDING

<table>
<thead>
<tr>
<th>NOMINAL DIA.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16</td>
<td>3/16</td>
<td>5/32</td>
<td>2 5/6</td>
<td>7/6</td>
<td>5/6</td>
<td>1/6</td>
<td>1/8</td>
</tr>
<tr>
<td>1/4</td>
<td>3 1/2</td>
<td>7/8</td>
<td>7/8</td>
<td>11/64</td>
<td>1/8</td>
<td>5/32</td>
<td></td>
</tr>
<tr>
<td>5/16</td>
<td>4 1/8</td>
<td>9/32</td>
<td>3 1/8</td>
<td>7/32</td>
<td>5/32</td>
<td>3/16</td>
<td></td>
</tr>
<tr>
<td>3/8</td>
<td>4 1/4</td>
<td>11/32</td>
<td>3 1/4</td>
<td>1/4</td>
<td>7/32</td>
<td>7/32</td>
<td></td>
</tr>
<tr>
<td>7/16</td>
<td>4 1/2</td>
<td>13/32</td>
<td>3 1/2</td>
<td>1/4</td>
<td>7/32</td>
<td>7/32</td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>5 1/8</td>
<td>5 1/8</td>
<td>15/32</td>
<td>3 7/8</td>
<td>5/16</td>
<td>7/32</td>
<td>1/4</td>
</tr>
<tr>
<td>9/16</td>
<td>5 3/8</td>
<td>17/32</td>
<td>4 1/8</td>
<td>5/16</td>
<td>7/32</td>
<td>9/32</td>
<td></td>
</tr>
<tr>
<td>5/8</td>
<td>5 1/2</td>
<td>19/32</td>
<td>4 1/4</td>
<td>17/32</td>
<td>1/4</td>
<td>9/32</td>
<td></td>
</tr>
<tr>
<td>11/16</td>
<td>6</td>
<td>3 3/4</td>
<td>2/32</td>
<td>4 1/2</td>
<td>3/8</td>
<td>1/4</td>
<td>5/16</td>
</tr>
<tr>
<td>3/4</td>
<td>6 1/8</td>
<td>23/32</td>
<td>4 5/8</td>
<td>1/4</td>
<td>5/16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13/16</td>
<td>6 1/4</td>
<td>25/32</td>
<td>4 3/4</td>
<td>13/32</td>
<td>5/16</td>
<td>5/16</td>
<td></td>
</tr>
<tr>
<td>7/8</td>
<td>6 3/8</td>
<td>27/32</td>
<td>4 7/8</td>
<td>17/32</td>
<td>5/16</td>
<td>3/8</td>
<td></td>
</tr>
<tr>
<td>15/16</td>
<td>6 1/2</td>
<td>29/32</td>
<td>5</td>
<td>9/16</td>
<td>5/16</td>
<td>3/8</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>7/8</td>
<td>31/32</td>
<td>5 1/4</td>
<td>9/16</td>
<td>5/16</td>
<td>3/8</td>
</tr>
<tr>
<td>1 1/2</td>
<td>7 1/4</td>
<td>1 1/6</td>
<td>5 1/2</td>
<td>9/16</td>
<td>5/16</td>
<td>3/8</td>
<td></td>
</tr>
<tr>
<td>1 1/4</td>
<td>7 1/2</td>
<td>1 3/16</td>
<td>5 3/4</td>
<td>5/8</td>
<td>3/8</td>
<td>7/16</td>
<td></td>
</tr>
</tbody>
</table>

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±10" ON ANGULAR DIMENSIONS

LATHE MANDREL

DRAWN BY: E.F.S.

SCALE: ——

DWG. NO. 34
**TOLERANCES:**
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± \( \frac{1}{64} \) ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

**MORSE TAPER TAPER PER FT.**

<table>
<thead>
<tr>
<th>Morse Taper</th>
<th>Taper Per Ft.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.598</td>
<td>3 1/8</td>
<td>3 5/8</td>
<td>.369</td>
<td>.475</td>
<td>.3125</td>
</tr>
<tr>
<td>2</td>
<td>.599</td>
<td>4 1/16</td>
<td>4 9/16</td>
<td>.572</td>
<td>.700</td>
<td>.500</td>
</tr>
<tr>
<td>3</td>
<td>.602</td>
<td>5 1/16</td>
<td>5 9/16</td>
<td>.778</td>
<td>.938</td>
<td>.625</td>
</tr>
<tr>
<td>4</td>
<td>.623</td>
<td>6 7/16</td>
<td>6 15/16</td>
<td>1.020</td>
<td>1.231</td>
<td>.750</td>
</tr>
<tr>
<td>5</td>
<td>.631</td>
<td>8 5/16</td>
<td>8 13/16</td>
<td>1.475</td>
<td>1.748</td>
<td>1.000</td>
</tr>
<tr>
<td>0</td>
<td>.6246</td>
<td>3 1/8</td>
<td>3 5/8</td>
<td>.252</td>
<td>.3561</td>
<td>.1875</td>
</tr>
</tbody>
</table>

**NOTE:**
ADD .025 TO DIMENSIONS C AND D FOR GRINDING.
MATERIAL: TOOL STEEL, HARDEN & DRAW.
F(.257) DRILL x .650 DP
5/16-18 UNC-2B x .500 DP

1 x 45° CSK

1.320

.115

.562

.560

.437

.435

.740

(.272) DRILL THROUGH
5/16-24 UNF-2B L.H.

LEAD SCREW NUT

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS
BROACH HEX. .215 ACROSS FLATS X .200 DEEP

LEAD SCREW MATL. 7/16 DIA. DRILL ROD

NO. 7 (.201) DRILL THROUGH 5/16-24 UNF-2B L.H. X 1/2 DEEP

END NUT MATL. 3/4 DRILL ROD HARDENED

1/4-20 UNC-2B THROUGH TOLERANCES:

(UNLESS OTHERWISE SPECIFIED)

± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

ADDITIONAL PARTS

SET SCREW 1/4-20 UNC-2AX 1/2 LG.

CAP SCREW 5/16-18 UNC-2A X 5/8 LG.

DRAWN BY: E.F.S.

GRINDING VISE LEAD SCREW AND END NUT

SCALE: ————

DWG. NO. 38