The course is intended to help meet, in a relatively short time, the need for trained operators in metalworking. It can be used by students with little education or experience and is suitable for use in adult education programs and in manpower development and training programs. The course is designed to be completed in approximately 30 weeks and can be adapted for use in secondary schools. On successful completion of the course the student will be qualified for an entry-level job as operator in a drill press; he will not qualify as a machinist. The guide includes a general job content outline for the teacher to use in explaining what the operator's job includes. There are 11 shop projects (comprising 19 jobs) accompanied by 32 pages of drawings for the projects. Three of the jobs introduce students to the use of metric measurement. For each job there is a job sheet providing details on performance objectives, equipment, operations, materials, references, procedure, techniques, and time required. (Author/PR)
INSTRUCTOR'S GUIDE
FOR AN ADULT COURSE

DRILL PRESS OPERATOR

PART OF
SINGLE-TOOL SKILLS
PROGRAM SERIES
Drill Press 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 12234
1975
THE UNIVERSITY OF THE STATE OF NEW YORK

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Chief, Bureau of Trade and Technical Education
Carl G. Benenati
Foreword

The Drill Press Operator course contained in this book is intended to help fill the need for people trained to operate machine tools. The backgrounds of those who enter the course will cover a broad range of qualifications, but it is likely that many people 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 fourth one to be published in a series of instructor's guides for the Single-Tool Skills Program. (Engine Lathe Operator was published in 1972, Surface Grinder Operator in 1973, and Milling Machine Operator in 1974.) Although written primarily as an adult course, the secondary level teacher can use the content of this book in a course he or she might develop for the students. Drill Press Operator 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; Edward Shattuck, former associate in the Bureau of Trade and Technical Education; and Charles A. Stebbins, associate in the last-named bureau.

Messrs. Kagan, Stewart, and Tiedemann wrote the Drill Press Operator course contained in this book. Most of the drawings in this guide are taken from previous publications in the series. The additional drawings needed and changes in old drawings were made by Eugene F. Stalica, Jr., professor at Hudson Valley Community College, Troy. Mr. Gould, who is in general charge of the Single-Tool Skills series, directly supervised the writing and edited the manuscript.

HERBERT BOTHAMLEY, Chief
Bureau of Continuing Education
Curriculum Development

GORDON E. VAN HOOFT, Director
Division of Curriculum Development
Message to the Instructor

This Drill Press 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, and in Manpower Development and Training programs. It can also be adapted for use in secondary schools.

Anyone who completes this course successfully will be qualified for an entry-level job as operator of a drill press. Some students may also complete other single-tool courses and qualify 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 11 projects in this course (which include 19 shop jobs) are listed on the page after Contents. There is no requirement that any student complete all projects, or even all jobs within any project. The instructor may determine which projects and jobs a given student should complete and whether to have him use conventional or metric dimensions. The instructor may also use other jobs not 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 teachers are the faculties of schools giving machine tool courses and the ranks of those employed as machinists and supervisors of machinists.

An administrator or instructor who has any questions or comments about this publication 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 Instruction
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<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Job 2. Threaded Jaw (inches)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>III. Parallels</td>
<td>Job 1A. Parallels (inches)</td>
<td>6</td>
<td></td>
</tr>
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<td></td>
<td>Job 1B. Parallels (millimeters)</td>
<td>6</td>
<td></td>
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<tr>
<td>IV. Bench Vise</td>
<td>Job 1. Screw</td>
<td>1½</td>
<td>23</td>
</tr>
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<td></td>
<td>Job 2. Fixed and Movable Jaws</td>
<td>3</td>
<td></td>
</tr>
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<td>V. Arbor Press</td>
<td>Job 1. Base</td>
<td>3</td>
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<td>VI. Tap Wrench</td>
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<td>1½</td>
<td>29</td>
</tr>
<tr>
<td>VII. 1-2-3 Block</td>
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<td>5</td>
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<td>VIII. Micrometer Boring Head</td>
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<td></td>
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<tr>
<td></td>
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<th>Covered Page</th>
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<td>24</td>
<td>Micrometer Boring Head: Dovetail Slide</td>
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<td>27</td>
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<td>None</td>
<td>57</td>
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<td>29</td>
<td>Arbor Press: Table</td>
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<td>30</td>
<td>Arbor Press: Sleeve, Table Pin, and Cover Plate</td>
<td>None</td>
<td>59</td>
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<tr>
<td>31</td>
<td>Arbor Press: Handle and End</td>
<td>None</td>
<td>60</td>
</tr>
<tr>
<td>32</td>
<td>Arbor Press: Column</td>
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<td>61</td>
</tr>
<tr>
<td>33</td>
<td>Arbor Press: Base</td>
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<tr>
<td>45.1</td>
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<tr>
<td>50A</td>
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<td>Parallel Clamp: Loose Jaw (Inches)</td>
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<td>69</td>
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<tr>
<td>57B</td>
<td>Parallel Clamp: Loose Jaw (Millimeters)</td>
<td>1B</td>
<td>70</td>
</tr>
<tr>
<td>58A</td>
<td>Parallel Clamp: Threaded Jaw (Inches)</td>
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<td>71</td>
</tr>
<tr>
<td>58B</td>
<td>Parallel Clamp: Threaded Jaw (Millimeters)</td>
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<td>72</td>
</tr>
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<td>59</td>
<td>Parallel Clamp: Straight Clip</td>
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<td>60</td>
<td>Parallel Clamp: Clamping Screw</td>
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<td>74</td>
</tr>
<tr>
<td>61</td>
<td>Parallel Clamp: Adjusting Screw</td>
<td>None</td>
<td>75</td>
</tr>
<tr>
<td>72</td>
<td>Motor Plate</td>
<td>X</td>
<td>76</td>
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</table>
Introduction

As shown in the contents, this Drill Press Operator course consists of this Introduction, General Job Content (which explains what the operator's job includes), Job Sheets for projects, and the drawings for the projects. The course covers the operation of the drill press only.

Objectives of the Course

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 606.380) as drill press operator; drill press operator; multiple spindle drill press operator, radial; gang drill press operator. Other job titles are also used under this and other code numbers.

The general objective of the course is to train persons, in a relatively short time, to be placed as drill press operators. Another important purpose is to help those with very little background. 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.

Units of Measurement

Generally speaking, conventional units of measurement (inches for linear dimensions, and degrees for angles) are used in this course. However, an attempt has been made to introduce the students to metric measurement by using millimeters for dimensions in several projects, in addition to the conventional units.

The United States is the only big country in the world which is not either using metric measurements or in a program for changing to metrics. Legislation is now pending in Congress which is likely to start us on a 10-year changeover period which would result in making metric units the predominant means of measurement. The much greater convenience of metric units and our increasing trade with countries on the metric system are the main forces pushing us toward metrication.

In American industry, some companies are already using metric measurements to a large extent in their products. Examples of such companies are the Beloit Tool Corporation of South Beloit, Illinois, and the Caterpillar Tractor Company of Peoria, Illinois. American metalworking companies using metric units are apparently continuing to use conventional thread
systems. This is because, according to some authorities, the conventional threads have some significant advantages over metric threads. References listed in the bibliography contain further information on metrics.

Metric Units in this Course

In this course the workpieces for three shop jobs have been designed in both conventional and metric units. Job Sheets and drawings using both inches and millimeters are included so an instructor can have a student make these pieces in either conventional or metric dimensions or both. These jobs are:

<table>
<thead>
<tr>
<th>Project</th>
<th>Job</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>1A &amp; 1B</td>
<td>Parallel Clamp Loose Jaw</td>
</tr>
<tr>
<td>II</td>
<td>2A &amp; 2B</td>
<td>Parallel Clamp Threaded Jaw</td>
</tr>
<tr>
<td>III</td>
<td>1A &amp; 1B</td>
<td>Parallels</td>
</tr>
</tbody>
</table>

In Projects II and III, Job IA is in conventional units and Job IB is in metric units. For these jobs, the only additional instruments suggested are a 15 cm. metric scale, a 0-25 mm. micrometer, and a metric dial indicator.

Drawings and Job Sheets

The drawings in this course are part of a serially numbered set beginning with No. 1, which appears in the Engine Lathe Operator course. The numbers continue through the drawings of other courses in the Single-Tool Skills Series including this one. They will be continued further in any other courses in the series which might be published later. Drawings in this course which are also in one of the other courses are reproduced here with the same drawing numbers. Some drawings appear in this book which are not needed for the shop projects of this course. They are included here for the convenience of keeping together all the drawings of an assembly. Those in this publication run from 13 through 62 of the series.

In the drawings, all dimensions are in inches unless otherwise indicated. A number of drawings contain tables giving several different sets of dimensions for the workpieces pictured. These tables 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.

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.

Assignment of Work to Students

As a shop project is assigned to a student, we recommend that the instructor give him copies of the applicable Job Sheets and drawings. The binding of this book permits easy removal of pages for copying. When copies are made the pages themselves must be kept clean and should not be used by
anyone working on a machine. After any copies are made the pages should be replaced in the book and the book should be kept in a looseleaf cover.

Each drawing has four blocks for information at the bottom and two of them are 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 one of these blank spaces on his own copy.

Many of the workpieces on which drilling is to be done in this course are those produced in other courses in the Single-Tool Skills series. If a given workpiece is not available as the output of another course in his shop, it is the instructor's responsibility to obtain the workpiece. In some cases, he may need to make it himself.

Administration of the Course

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 drill press skills are used in the shop jobs 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 adult night class runs 2½ to 3 hours, either once or twice a week, for 30 weeks.

The prerequisites for admission to an adult course should be broad enough so none will be barred who could be made employable. The operating authorities for each program, school, and school district have the responsibility for determining the prerequisites for such a 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 (both written and 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 drill press setup man.

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

Abbreviations used in this course are given on the next page.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>ALUM.</td>
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<tr>
<td>ASSY.</td>
<td>assembly</td>
</tr>
<tr>
<td>CHAM.</td>
<td>chamfer</td>
</tr>
<tr>
<td>CBORE.</td>
<td>counterbore</td>
</tr>
<tr>
<td>CM.</td>
<td>centimeter(s)</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>deep</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>H.D.</td>
<td>head</td>
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<td>HDL.</td>
<td>handle</td>
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<td>high-speed</td>
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<tr>
<td>LGTH.</td>
<td>length</td>
</tr>
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<tr>
<td>MM.</td>
<td>millimeters</td>
</tr>
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<tr>
<td>R or RAD.</td>
<td>radius</td>
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<tr>
<td>REOD.</td>
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<td>R.H.</td>
<td>right-hand</td>
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<td>SCR.</td>
<td>screw</td>
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<td>SPEC.</td>
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<td>steel</td>
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<td>TYP.</td>
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<tr>
<td>W.</td>
<td>width</td>
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</table>
Types of Machines

II. Machine Parts

III. Machine Accessories
   A. Toolholding
   B. Work holding

IV. Cutting Tools

V. Measurement and Inspection

VI. Blueprint Reading

General Job Content

I. Types of Machines

Provide information on types and designs of drill presses, such as:

1. standard
2. single-spindle sensitive
3. radial
4. gang
5. multiple-spindle

Point out that although treated as a category in itself, numerical control drilling follows the basic drilling theory and techniques. Numerically controlled drilling differs from basic drilling technique in that it uses a preprogrammed data system to position and feed the drills.

II. Machine Parts

Point out and name the drill press parts: base, column, and table.

III. Machine Accessories

   A. Toolholding
   B. Work holding

IV. Cutting Tools

Describe the various types of cutting tools used: drills, machine reamers, hand reamers, counterbores, step drills, and countersinks.

Identify the various parts of the cutting tools. Some parts of the drill are: body, shank, neck, tang, point, and web.

Explain the procedures followed in grinding and sharpening the various cutting tools.

V. Measurement and Inspection

List and explain the various types of measuring tools. These could include: micrometer, indicator, plug gages, and thread plug gages.

VI. Blueprint Reading

Introduce and cover all necessary blueprint reading, such as:
VII. Speeds and Feeds

The choice of speed and feed depends on:
1. composition and hardness of work material
2. cutting fluid efficiency
3. type and condition of machine
4. quality of finish required

Explain how to use the formula for calculating the speed of a drill. For example:

\[ \text{RPM} = \frac{4 \times \text{cutting speed}}{\text{dia. of drill}} \]

Explain how to read and use tap drill charts.

Make available charts and tables which will enable the student to select proper speeds and feeds for hand or automatic operations.

Demonstrate how the diameter of the drill, the material being machined, the nature of the tool-holders, and the finish required all correlate with the proper choice of speeds and feeds.

VIII. Trade Mathematics

Introduce and cover all necessary trade mathematics, such as basic arithmetic, use of constants, and use of formulas.

IX. Coolants

Develop an understanding of coolants, including:
1. water base type
2. oil type
3. chemically active sulphur-fatty type
4. sulphur-mineral oils

Give examples of particular drilling conditions and the kind of coolant to use. Explain how the proper coolant can increase tool life, give a better finish, and help maintain close hole tolerance.

X. Care and Maintenance

Provide information concerning the care and maintenance of the various types of drill presses, such as: wiping the spindle hole before inserting a tool and making sure the machine is properly oiled and cleaned.

XI. Safety

Introduce the following safe working practices for operating the machine:
1. Wear close fitting clothes.
2. Wear safety glass.
3. Make sure the guards are kept in place.
4. Keep hands away from moving parts.
5. Know how to operate the controls.

Discuss particular dangers to avoid when operating the machine, such as:
1. Never leave the chuck key in the chuck.
2. Never hold work with your hands. Clamp the workpiece securely with standard devices such as: a drill vise, straps, C clamps, parallel clamps, and stops.
3. Always use a brush to remove chips—never your hands or rags.
4. Keep your head away from the turning spindle to prevent hair entwining around it.
5. Never attempt to drill brass, copper, or bronze with a drill ground for steel. Demonstrate negative rake on the drill when drilling brass, copper, or bronze.
6. Ease up on the feed pressure as the drill begins to break through a hole.
7. Demonstrate the proper setup for drilling thin material including the holding device, the support, and the cutting tool.
8. Explain how the hand feed lever can injure the operator's face if he allows it to rotate uncontrolled while drilling to depth or when adjusting the column.

XII. Trade Terms

Explain all trade terms peculiar to the trade, such as press fit, pitch, jig, and flute.

XIII. Work Processes

A. Drilling

Mention that drilling is a very important phase of the trade, and that it is performed on a wide range of equipment. For example: the sensitive drill press, and the heavy duty radial drill press.

Continue by explaining that drills are classified as: number drills, letter drills, millimeter drills, and fractional drills.

Explain that in center drilling a combination drill and countersink is used to locate a hole and prevents the drill from wandering. Exhibit various sizes of center drills and explain how each is selected in proportion to the size of the drilled hole.

Discuss ways to achieve particular finishes and tolerances.
Explain the causes of drill failure, some of which are: speed too high, feed too high, and drill sharpening not properly done.

B. Boring

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

C. Counterboring

Discuss how a counterboring tool is used to enlarge a hole to a given diameter and depth, in order that a nut or bolt head may set flush or below the surface.

D. Countersinking

Point out that countersinking makes a cone-shaped enlargement on the end of a hole in order that a flathead screw seats properly to a particular depth.

E. Spot facing

Add that spot facing is similar to counterboring except that it is used to produce a shallow machined area on cast or forged surfaces.

F. Tapping

Explain how tapping is done with a drill press using friction drive tapping heads.

Point out how the actual cutting by the tap is done by the chamfer and the first full thread of the tap.

Impress upon the class the importance of runout, and tap alignment with the drilled hole. If these factors are not considered, then the threaded hole may not be square or the pitch diameter may be oversize. In extreme cases, these errors will result in broken taps.

Comment on some of the standard practices used in tapping:
1. Never tap through a hard bushing.
2. Countersink a hole before tapping.
3. Use spiral point or gun taps for through holes.

Direct attention to the importance of the tap and drill diameter and how it affects:
1. pitch diameter
2. depth of thread
3. amount of strain on the tap
4. quality of finish of the thread

Distribute material explaining the identification marking used on taps, for example:

\( \frac{1}{2} - 13 \) UNC
G. Gun Drilling
Describe the gun drill and its application. Point out that it is used on a machine designed especially for gun drilling.

Explain why the cutting fluid must be run at high pressures for this kind of operation.

H. Sub-land and Step Drilling
Discuss the application of subland drills and step drills. Show how the design of the drill allows for the drilling of two or more diameters, or for the combination of a drilling operation with counterboring, countersinking, or reaming.

I. Core Drilling
Mention the core drill and why it is used to improve the concentricity of a cast hole.

J. Reaming
Demonstrate how a reamer is used for good control of both size and finish. Explain the relationship between the size of the reamer and the predrilled size.

Mention that reaming is done to make a hole round, straight, smooth, and accurate.

Emphasize that the hole must be drilled undersize before reaming. For example: Drill 1/64" undersize for holes over 3/8" in diameter.

State that reamers and drills are held in the same way when used. Also, that reaming requires a slower speed than drilling.

K. Lapping and Honing
Demonstrate that under certain conditions abrasive cutting tools (either laps or hones) are used to size holes in hardened workpieces.
Job Sheets For Shop Projects
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up.
2. Clamping
3. Drilling blind holes
4. Center drilling

Equipment:
- Standard type drilling machine
- Fractional drill gage
- Set of fractional drills
  - 1/8", 1/16", 1/32" in increments
  - 1/8", 1/16", 1/32" in increments
- Drill chucks
- Straight edge
- 6" rule
- Counter-bore gage
- Drill Vise

Materials:
- One or more cast aluminum pcs.
- 1 1/2" x 3" x 6" from milling and layout operations

Selected references:
- McCarthy & Smith, Machine Tool Technology; 3rd edition
- The Use and Care of Twist Drills

PROCEDURE:
1. Select a cast aluminum block from stock and remove all burrs.
2. Set up a center drill in a quick release drill chuck on a standard drill press.
3. Select drill speed and set spindle depth stop.
4. Clamp a guide bar to the table.
5. Center drill all hole locations in the line of smallest holes.
6. Remove the guide bar and reset to align the middle line of holes.
7. Center drill the middle line of holes.
8. Remove the guide bar and reset and align for the line of biggest holes.

TECHNIQUES AND RELATED INFO.
1. Check overall dimensions and layout before drilling.
2. Demonstrate the drill changeover procedure. Use a No. 1 center drill.
3. Check the recommended drill speed on a drill speed chart.
4. The guide bar will assist in keeping the holes in a straight line. Calculate the distance the bar should be set from the centerline of the drill spindle.
5. Use cutting lubricant.
6. Clean the guide bar and machine table with a brush. Calculate the distance the bar is to be set from the centerline of the spindle.
7. Use a No. 3 center drill.
8. Use a No. 3 center drill.
PROCEDURE

9. Center drill the line of the biggest holes.
10. Remove the guide bar and the center drill and clean the machine.
11. Set the workpiece up in a drill vise.
12. Set up a 1/4" drill and set the depth stop.
13. Set the spindle r.p.m. and drill the 1/2" hole to the depth indicated on the drawing.
14. Drill all the holes 3/16" through 1/2", using the same procedure as above.
15. Clean all tools and the machine on completion of the job.

TECHNIQUES AND RELATED INFO.

10. Use a brush and a wiping cloth.
11. Tap the workpiece down to seat it on the parallels, using a soft hammer.
12. Check the drill size with a drill gage before chucking the drill. Discuss drill nomenclature.
13. Refer to a drill chart for spindle speed.
14. Use a wiping cloth and brush. Do not leave an excess of oil on the parallels or the drills. Return all tools to proper storage.
Project II  
Operator's job Title: Drill Press Operator

Job No. 1A  
Job Name: Loose Jaw (inches)

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
Gang drill press
1/2", 1/32", and No. 29 drills
7/8" counterbore
8-32 UNC tap

Operations:
1. Setting up
2. Blind hole drilling
3. Tapping
4. Counterboring
5. Through hole drilling

Materials:
2 or more loose jaws SAE 1020 steel 1" x 1/2" x 3/8" from milling operations
Cutting oil

PROCEDURE

1. Select stock from milling operations and remove all burrs.
2. Clamp a workpiece in the drill jig.
3. Set up the cutting tools as follows:
   Spindle No. 1: 1/2" drill
   Spindle No. 2: 1/32" drill
   Spindle No. 3: No. 29 drill
   Spindle No. 4: 7/8" counterbore
   Spindle No. 5: 8-32 UNC tap
   Spindle No. 6: 90° countersink

4. Set the spindle speed for each of the spindles.
5. Drill the 1/2", 1/32", and No. 29 holes.

6. Tap the 8-32-UNC hole.
PROCEDURE

7. Counterbore \( \frac{1}{16} '' \times \frac{3}{32} '' \) deep in the \( \frac{1}{11} '' \) hole.

8. Remove the workpiece from the drill jig and take off all burrs by countersinking.

9. Inspect the workpiece for hole sizes and depths.

10. Continue to machine remaining workpieces.

11. On completion of all pieces clean the machine and remove all tools.

12. Submit all work for inspection and grade.

TECHNIQUES AND RELATED INFO.

7. Review counterbore types and sizes.

8. Use a \( 90^\circ \) countersink.

9. Use a GO-No-Go thread plug gage.

10. Make periodic inspections of workpieces.

11. Clean tools with a rag. Return tools to proper storage.
Unit No. Operator's Job Title: Drill Press Operator

Project II Project Name: Parallel Clamp

Job No. 1B Job Name: Loose Jaw (millimeters) D.O.T. No. 606.380

Drawing No. 57B, Ref. No. 3 Time: 4 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up
2. Blind hole drilling
3. Tapping
4. Counterboring
5. Through hole drilling

Equipment:
- Gang drill press
- Tapping head
- 6.35 mm., 8.73 mm., 8-32 Go-No-Go plug and No. 29 drills
- 11.11 mm. counterbore
- 8-32 UNC tap
- Drill jig
- 90° countersink

Materials:
- 2 or more loose jaws SAE 1020
- 12.8 mm. x 13 mm. x 85.7 mm. from milling operations
- Cutting oil

Selected references:
McCarty & Smith, Machine Tool Technology; 3d edition
The Use and Care of Twist Drills

Procedure:
1. Select stock from milling operations and remove all burrs.
2. Clamp a workpiece in the drill jig.
3. Set up the cutting tools as follows:
   - Spindle No. 1: 6.35 mm. drill
   - Spindle No. 2: 8.73 mm. drill
   - Spindle No. 3: No. 29 drill
   - Spindle No. 4: 11.11 mm. counterbore
   - Spindle No. 5: 8-32 UNC tap
   - Spindle No. 6: 90° countersink
4. Set the spindle speed for each of the spindles.
5. Drill the 6.35 mm., 8.73 mm., and No. 29 holes.
6. Tap the 8-32 UNC hole.

Techniques and Related Info:
1. Use a double-cut file. Check all dimensions before starting.
2. Drill jig will have to be constructed.
3. Clamp all tools securely. Use drill chucks for all drills, counterbores, and countersinks. Use a tapping head for the tap. Discuss turret head drill press as an alternate machine.
4. Look up the recommended r.p.m. for each of the operations.
5. Set each of the spindle depth stops. Check the depths with a depth micrometer and correct the stops if necessary.
6. Tapping head setup is in accordance with type of head being used. Remove slip bushing from jig before tapping. Use cutting oil.
7. Counterbore 11.11 mm. x 2.38 mm. deep in the 8.73 mm. hole.
8. Remove the workpiece from the drill jig and take off all burrs by countersinking.
9. Inspect the workpiece for hole sizes and depths.
10. Continue to machine remaining workpieces.
11. On completion of all pieces, clean the machine and remove all tools.
12. Submit all work for inspection and grade.

7. Review counterbore types and sizes.
8. Use a 90° countersink.
9. Use a Go-No-Go thread plug gage.
10. Make periodic inspections of workpieces.
11. Clean tools with a rag. Return tools to proper storage.
Unit No. Operator's Job Title: Drill Press Operator

Project 11 Project Name: Parallel Clamp

Job No. 2 Job Name: Threaded Jaw (inches) D.O.T. No. 606.380

Drawing Nos. 58A Ref. No. 3 Time: 5 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Tapping
2. Countersinking
3. Through hole drilling

Materials:
2 or more threaded jaws SAE 1020, 1/2" x 1/2" x 3/8" from milling operations

Equipment:
Gang drill press
Drill jig
Drill chuck
Letter F drill
9/16-18 UNC tap
Tapping head
90° countersink
Go-No-Go thread plug gage

Selected references:
McCarthy & Smith, Machine Tool Technology; 3d edition
The Use and Care of Twist Drills

PROCEDURE

1. Select stock from milling operations and remove all burrs.

2. Place workpiece in drill jig and clamp it.

3. Set up the cutting tools as follows:
   Spindle No. 1: Letter F drill
   Spindle No. 2: 9/16-18 UNC tap
   Spindle No. 3: 90° countersink

4. Adjust the speeds and depth stops.

5. Drill the 2 holes (letter F drill) for the 9/16-18 UNC tap.

6. Tap the 1/2 holes.

7. Remove the work from the drill jig and take off all burrs.

TECHNIQUES AND RELATED INFO

1. Use a double-cut file. Check all sizes before proceeding.

2. Drill jig will have to be constructed.

3. Use a 2-fluted gun tap.

4. Calculate the r.p.m. in each case using the formula
   \[ \text{RPM} = \frac{4 \times CS}{D} \]
   or use a drill speed chart. Set depth stop so the drill does not penetrate the machine table.

5. Use cutting oil.

6. Use cutting oil.

7. Use a 90° countersink.
8. Inspect workpiece.

9. Remove all tools. Clean the machine and tools.

10. Submit all work for inspection and grade.

8. Remove all burrs and check the work with a \( \frac{5}{16} \) - 18 UNC Go-No-Go thread plug gage.

9. Use a wiping cloth. Return all tools to their proper locations.
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
10-spindle drilling machine
Suitable drilling fixture
10 suitable 7/16" drills

Materials:
2 or more parallels from milling operations

Selected references:
McCarthy & Smith, Machine Tool Technology; 3d edition

PROCEDURE
1. Select workpieces from milling operations and remove all burrs.
2. Set up the drilling fixture.
3. Set up the 10 tapered-shank drills of 7/16" dia.
4. Clamp the work in the drill fixture.
5. Align the 10 drills to the drill bushings and clamp the spindles in place. If space is restricted, do 5 holes at a time in two settings.
6. Set the spindle speed, depth stops, and all other necessary controls.
7. Set all coolant nozzles.

TECHNIQUE: AND RELATED INFO.
1. Inspect workpieces for sizes before proceeding.
2. Discuss the design and purposes of work holding fixtures.
3. Explain the Morse tapered system as applied to machine tools and drill diameters. Be sure all mating surfaces are clean and free of nicks and dirt.
4. Fixtures are usually provided with hardened guide bushings. Discuss the use of laps to fit hardened bushings.
5. Be sure all drills are of the same approximate length. Demonstrate the freehand method of sharpening a twist drill. Use a drill point gage.
6. Coolant flow should be directed on the drill bushings.
8. Drill the holes.

9. Remove and inspect the workpiece.

10. If the first piece is correct, continue to drill the assigned number of pieces. If not, make necessary adjustments.

11. Remove all tools. Clean the tools and machine on completion of the work.

12. Submit all workpieces for inspection and grade.

8. Observe the drill entering the drill bushings for drill deflection.

10. Clean the fixture of chips before inserting each new piece.

11. Use a shop cloth. Return all tools to their proper storage places.
Unit No. Operator's Job Title: Drill Press Operator

Project III Project Name: Parallels

Job No. 1B Job Name: Parallels (millimeters) D.O.T. No. 606.380

Drawing Nos. 508 Time: 6 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up fixture
2. Setting up spindle
3. Through hole drilling
4. Multiple spindle drilling

Equipment:
10-spindle drilling machine
Suitable drilling fixture
10 suitable 8 mm. drills

Materials:
2 or more parallels from milling operations SAE 1020
13 mm. x 19 mm. x 150 mm.

Selected references:
McCarthy & Smith, Machine Tool Technology; 3d edition
The Use and Care of Twist Drills

PROCEDURE

1. Select workpieces from milling operations and remove all burrs.
2. Set up the drilling fixture.
3. Set up the 10 tapered-shank drills of 8 mm. dia.
4. Clamp the work in the drill fixture.
5. Aline the 10 drills to the drill bushings and clamp the spindles in place. If space is restricted, do 5 holes at a time in two settings.
6. Set the spindle speed, depth stops, and all other necessary controls.
7. Set all coolant nozzles.

TECHNIQUES AND RELATED INFO.

1. Inspect workpieces for sizes before proceeding.
2. Discuss the design and purposes of work holding fixtures.
3. Explain the Morse tapered system as applied to machine tools and drill diameters. Be sure all mating surfaces are clean and free of nicks and dirt.
4. Fixtures are usually provided with hardened guide bushings. Discuss the use of laps to fit hardened bushings.
5. Be sure all drills are of the same approximate length. Demonstrate the freehand method of sharpening a twist drill. Use a drill point gage.
6. Coolant flow should be directed on the drill bushings.
8. Drill the holes.
9. Remove and inspect the workpiece.
10. If first piece is correct, continue to drill the assigned number of pieces. If not, make necessary adjustments.
11. Remove all tools. Clean the tools and machine on completion of the work.
12. Submit all workpieces for inspection and grade.

8. Observe the drill entering the drill bushings for drill deflection.
10. Clean the fixture of chips before inserting each new piece.
11. Use a shop cloth. Return all tools to their proper storage places.
Unit No.  Project IV  Job No. 1
Operator's Job Title: Drill Press Operator  Job Name: Screw
Project Name: Bench Vise  D.O.T. No. 606.380
Drawing Nos. 16  Time: 1\frac{1}{2} hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
Standard drill press
V-block
Speed chuck
90° countersink
\( \frac{17}{64} \)" drill

Selected references:
McCarty & Smith, Machine Tool Technology; 3d edition
The Use and Care of Twist Drills

PROCEDURE:
1. Select workpiece from lathe and layout operations.
2. Clamp workpiece in a suitable V-block.
3. Clamp a center drill in the speed chuck.
4. Set the spindle speed and center drill.
5. Remove the center drill and insert a \( \frac{17}{64} \)" dia. drill.
6. Drill the \( \frac{17}{64} \)" hole through the piece.

TECHNIQUES AND RELATED INFO.
1. Check all dimensions before proceeding.
2. Review uses and purposes of V-blocks as well as the various types. Do not clamp on the thread.
3. Point out that center drills come in various designs and sizes. Also, that there are charts recommending the sizes to be used. Illustrate the various kinds of drill chucks available and their purposes.
4. Use a moderate feed pressure.
5. Point out that the spindle does not have to be stopped to change the cutting tools.
6. Use cutting oil. Be careful that the V-block does not tilt which could result in a slanted hole. Use a jack if necessary.
<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>TECHNIQUES AND RELATED INFO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Remove the 1/4&quot; drill and insert a 60° countersink.</td>
<td>8. Point out that countersinks come in various angles and diameters.</td>
</tr>
<tr>
<td>8. Break all sharp edges around the hole.</td>
<td>9. Return all tools to proper locations.</td>
</tr>
<tr>
<td>9. Clean all tools and machine.</td>
<td></td>
</tr>
<tr>
<td>10. Submit for inspection and grade.</td>
<td></td>
</tr>
</tbody>
</table>
Unit No. Operator's Job Title: Drill Press Operator

Project IV Project Name: Bench Vise

Job No. 2 Job Name: Fixed and Movable Jaws D.O.T. No. 606.380

Drawing Nos. 17 Time: 3 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Center drilling
2. Drilling
3. Deep hole drilling
4. Setting up
5. Hand tapping

Equipment:
- Standard drill press
- \( \frac{1}{2} \), \( \frac{7}{8} \), and \( \frac{11}{16} \) drills
- \( \frac{1}{2} \)" rose reamer
- Drill chuck
- \( \frac{1}{2} \)-13 UNC tap

Materials:
- Tap wrench
- Drill chuck center
- Drill vise
- 90° countersink

Selected references:
- McCarthy & Smith, Machine Tool Technology; 3d edition
- The Use and Care of Twist Drills

**PROCEDURE**

1. Select stock from lathe and layout operations.

2. Clamp the work to the machine table in the step jaws of a drill vise.

3. Mount a center drill in the drill chuck and center drill all hole locations.

4. Remove the center drill and replace it with a \( \frac{1}{2} \)" drill. Drill all hole locations (5 holes).

5. Remove the \( \frac{3}{4} \)" drill.

6. Mount a \( \frac{31}{64} \)" drill in the machine spindle.

7. Drill the two cuter holes.

8. Replace the \( \frac{31}{64} \)" drill with the \( \frac{27}{64} \)" tap drill.

9. Drill the \( \frac{27}{64} \)" hole.

10. Remove the \( \frac{27}{64} \)" drill and replace with a \( \frac{1}{2} \)" rose reamer.

**TECHNIQUES AND RELATED INFO.**

1. Remove all burrs and check the sizes and layout before proceeding.

4. Review the reasons for the use of pilot holes. Use cutting oil. Do not allow chips to clog the drill flutes.

10. Check the condition of the reamer before using. Check the reamer dia. with a micro-meter.
<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>TECHNIQUES AND RELATED INFO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Ream the two outer holes.</td>
<td>11. Use cutting oil.</td>
</tr>
<tr>
<td>12. Replace the reamer with a drill chuck and a 90° countersink.</td>
<td></td>
</tr>
<tr>
<td>13. Break all sharp edges on both ends of all holes.</td>
<td></td>
</tr>
<tr>
<td>14. Insert a drill chuck center in the drill chuck and aline it with the ( \frac{27}{64} ) hole.</td>
<td>14. Center will be used to keep tap square with hole.</td>
</tr>
<tr>
<td>15. Tap the hole.</td>
<td>15. Use a flat tap wrench to drive the tap by hand. (Demonstrate the procedure.)</td>
</tr>
<tr>
<td>16. Send the work to the band saw to be cut into the two jaws and then to milling for finishing.</td>
<td></td>
</tr>
<tr>
<td>17. On return from milling, ream the remaining middle ( \frac{1}{2} )&quot; hole in the movable jaw.</td>
<td></td>
</tr>
<tr>
<td>18. Clean all tools and the machine.</td>
<td>18. Return all tools to the proper places.</td>
</tr>
<tr>
<td>19. Submit for inspection and grade.</td>
<td></td>
</tr>
</tbody>
</table>
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
- Standard drill press
- 1/16" and 1/32" drills
- 1/8" rose reamer
- Letter F drill
- 3/16" - 16 UNC tap
- T-bolts and nuts
- Gooseneck clamps
- Parallels
- Angle plate
- Vise
- Tapping head

Materials:
- Arbor press base 1" x 3" x 3 1/2"

Selected references:
- The Use and Care of Twist Drills

**PROCEDURE**

1. Select stock from milling and layout operations before the slots are milled.
2. Clamp the workpiece in a drill vise with step jaws.
3. Insert a 1/8" drill in the drill chuck.
4. Drill the two 1/8" holes.
5. Remove the 1/8" drill and replace it with a 3/32" drill.
6. Drill the two 3/32" holes.
7. Remove the 3/32" drill, insert a 15/64" drill, and drill the hole for the 1/8" reamer.

**TECHNIQUES AND RELATED INFO.**

1. Inspect workpiece for correctness of sizes before proceeding with the drilling.
2. Tap the work down with a soft hammer to seat it.
3. Use a quick release chuck. Check the drill for runout.
4. Do not allow the chips to become clogged in the flutes of the drill. Raise spindle frequently. Use cutting oil.
5. Do not allow the chips to become clogged in the flutes of the drill. Raise spindle frequently. Use cutting oil.
6. Clear the chips from the hole frequently.
7. Drill to 1/8" depth and check hole for oversize condition with the reamer before drilling through.
8. Remove the \( \frac{15}{30} \)" drill, replace it with a \( \frac{1}{4} \)" rose reamer, and ream the hole.

9. Remove the workpiece from the vise and clamp it to an angle plate.

10. Locate the point for drilling the tapped hole and clamp the angle plate to the machine table.

11. Set the depth stop to \( \frac{3}{4} \)" and drill the \( \frac{5}{6} \)" drill hole for the \( \frac{3}{8} \)" - 16 UNC tapped hole.

12. Open the \( \frac{5}{16} \)" hole to \( \frac{3}{8} \)" dia. to a depth of \( \frac{3}{8} \)".

13. Tap the \( \frac{3}{8} \)" thread.

14. Clean machine and all tools.

15. Return all tools to their proper storage places.

16. Submit work for inspection and grade.

8. Check the reamer to see that it is in good condition before using it. Use cutting oil.

9. Check the angle plate for squareness. Use parallel clamps.

10. Use T-bolts, straps, clamps, and step blocks.

11. Use cutting oil. Hole depth is at full dia.

12. This will provide relief for the tap.

13. Use an extension tap. Follow local shop setup procedure.

14. Use a brush and a shop cloth.

15. Return all tools to their proper storage places.

16. Submit work for inspection and grade.
Unit No. 1
Project VI
Job No. 1
Operator's Job Title: Drill Press Operator
Project Name: Tap Wrench
Job Name: Tap Wrench Body
D.O.T. No. 606.380

Drawing Nos. 21
Time: 1½ hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
Standard drill press
Center drill
Drill chuck
90° countersink
Rapid index head
3/8" drill
1/4" drill
Clamps

Selected references:
McCarthy & Smith, Machine Tool Technology; 3d edition
The Use and Care of Twist Drills

PROCEDURE
1. Select material from lathe operations and layout. Remove all burrs.
2. Clamp work in a rapid index head with a 3/8" collet.
3. Insert a drill chuck in the spindle.
4. Clamp a center drill in the drill chuck and center drill for the 1/4" hole.
5. Drill the 1/4" hole through the 3/8" dia.
6. Remove the 1/4" drill and replace it with a 90° countersink.
7. Countersink both ends of the 1/4" hole.
8. Remove all tools. Clean the tools and the machine.
9. Submit job for inspection and grade.
10. Send to lathe for drilling and tapping of the 10-32 UNC-2A hole.

Operations:
1. Setting up
2. Drilling
3. Alining spindle with hole layout

Materials:
Wrench body from lathe and layout operations

TECHNIQUES AND RELATED INFO.
1. Check all sizes before proceeding with drilling operations.
2. Aline spindle with hole layout and index head with table. Use a surface gage and suitable clamp.
3. Clean the tapered shank and the spindle hole with a shop cloth.
4. Check drill for runout. Use cutting oil.
5. Ease the feed pressure when the drill breaks through the work.
6. Return all tools to proper storage. Use a rag to remove all chips and oil.
Performance Objectives: Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up
2. Countersinking
3. Reaming
4. Drilling

Equipment:
- Standard drill press
- 1/2" reamer
- Box drill jig
- Fractional drill gage
- 1/2" drill
- Countersink
- 1.020" x 2.020" x 3.020" from milling operations

Materials:
- 2 or more pcs. SAE 1020
- Steel drill 1.020" x 2.020" x 3.020"
- Box drill jig

Selected references:
- McCarthy & Smith, Machine Tool Technology; 3d edition
- The Use and Care of Twist Drills

PROCEDURE
1. Select material from milling operations. Remove all burrs.
2. Check a 1/2" drill.
3. Clamp the workpiece in a drill jig.
4. Select and set spindle speed and depth stop.
5. Drill the 13 holes. Drill first hole to 1/8" depth and check hole for oversize condition before drilling through.
6. Replace the drill with a 1/2" rose reamer.
7. Change the spindle speed and the depth stop.
8. Ream all 13 holes.

TECHNIQUE AND RELATED INFO.
1. Check sizes before proceeding with drilling operations.
2. Check the drill size with a drill gage.
3. For hole location, use a plate template or a box drill jig.
4. Look up speed on a chart.
5. Use cutting oil and power feed.
6. If a box jig is used, change the slip bushings to accommodate the 1/2" reamer, otherwise follow local shop practice. Another method that could be used is to layout the holes and drill them while holding the work in a drill vise.
7. Use cutting oil and hand feed.
9. Replace the reamer with a \( \frac{3}{8} \)" 90° countersink and change the spindle speed.

10. Remove the work from the box drill jig. Clean the work and the machine table.

11. Remove all burrs.

12. Set the work up in a drill vise.

13. Set the depth stop to countersink to \( \frac{1}{32} \)" depth.

14. Countersink all 13 holes, both ends.

15. Clean the machine and all tools.

16. Submit all work for inspection and grade.

9. Use a slow speed to avoid chatter.

10. Use a brush.

11. Use a double-cut file.

13. CAUTION: Each dimension will require a change in the depth stop.

15. Return all tools to the proper locations.
Unit No. | Operator’s Job Title: Drill Press Operator
---|---
Project V | Project Name: Micrometer Boring Head
Job No. 1 | Job Name: Dovetail Blocks
D.O.T. No. | 606.380
Drawing Nos. | 22.2

Time: 2 1/2 hrs.

### Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

### Equipment:
- Standard drill press
- No. 2 center drill
- 11/4" drill
- 21/64" x .437" subland drill

### Materials:
- Drill vise and special 2 dovetail blocks from milling operations
- 90° countersink
- Drill gage

### Selected references:
- McCarthy & Smith, Machine Tool Technology, 3rd edition
- The Use and Care of Twist Drills

### Procedure

1. Select stock from milling operations and remove all burrs.
2. Clamp the laid-out dovetail block in a drill vise using a special 8° soft, parallel clamping block.
3. Clamp a center drill in a drill chuck and center drill all 6 holes.
4. Set up a 11/4" drill and drill 4 holes.
5. Remove the 11/4" drill and replace it with a 21/64" x .437" subland drill.
6. Set the r.p.m. and the depth stop.
7. Drill and counterbore the 21/64" x .437" holes to .343" depth.
8. Remove the workpiece from the vise and turn it and the 8° clamping block over.

### Technique and Related Info.

1. Check all sizes before proceeding.
2. Either an 8° clamping block should be constructed or an alternate machining method. The alternate method could be to cut the block in two and clamp the pieces in a vise.
3. Set the spindle/depth stop to obtain a 7/32" dia. countersink. Use cutting oil.
4. Check the drill size using a fractional drill gage. Do not allow drill to become clogged with chips.
5. Describe the advantages and the uses of subland and step drills.
6. Use cutting oil. Check the counterbore depth using a flush gage.
7. Clean and remove burrs from workpiece, clamping block, and vise.
PROCEDURE

9. Remove the subland drill and replace it with a 90° countersink.

10. Adjust the r.p.m. of the machine spindle.

11. Countersink the four $\frac{11}{64}$" holes to $\frac{7}{32}$" dia.

12. Countersink the two $\frac{21}{64}$" holes to break the sharp edges.

13. Clean all tools and the machine.

14. Submit workpiece for inspection and grade.

TECHNIQUES AND RELATED INFO

10. Calculate the r.p.m. using the formula

\[
R.P.M. = \frac{4 \times CS}{D}
\]

or a chart.

11. Set the spindle depth stop.

12. $\frac{11}{32}$" dia. should be suitable.

13. Return all tools to proper storage places.

Unit No.  Operator’s Job Title: Drill Press Operator

Project IX  Project Name: Precision Step Block

Job No. 1  Job Name: Precision Step Block  D.O.T. No. 606.380

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Clamping
2. Center drilling
3. Drilling
4. Counterboring
5. Countersinking
6. Spindle alignment
7. Deep hole drilling

Equipment:
- Standard drill press
- 5/8" drill
- Drill vise
- 7/8" counterbore
- T-bolts and nuts
- 3/4" x 90° countersink
- Dial indicator
- Wiggler
- Center drill

Selected references:
- McCarthy & Smith, Machine Tool Technology; 3d edition
- The Use and Care of Twist Drills

PROCEDURE

1. Check the machine table for squareness to the drill press spindle.
2. Select stock from milling and layout operations and check dimensions.
3. Clamp the work in a vise with step jaws.
4. Set up a centerfinder and locate the centerlines for the hole.
5. Clamp the vise securely when location is found.
6. Centerdrill for the 5/16" hole.
7. Remove the center drill and drill the 5/16" hole through the work.
8. Remove the 5/8" drill and replace it with a 7/8" counterbore.

Techniques and Related Info.

1. Use a dial indicator mounted in a drill chuck on a bent bar, and sweep the table by revolving the spindle. Indicator should read the same at four points opposite to each other. Adjust table if necessary.
2. Do not proceed if dimensions are not correct.
3. Use a soft hammer to seat the work.
4. Demonstrate the use of the centerfinder.
5. Check with centerfinder again, after clamping the vise, to be sure the latter did not shift.
6. Use cutting oil and raise the spindle frequently to clear out the chips.
7. Review types and sizes of counterbores.
<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>TECHNIQUES AND RELATED INFO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Set the r.p.m. and counterbore to ( \frac{5}{16} )&quot; depth.</td>
<td>9. Use cutting oil. Set the depth stop. Use a moderate hand feed rate.</td>
</tr>
<tr>
<td>10. Remove the counterbore and set up a 90° countersink.</td>
<td>11. Use a slow spindle speed to avoid chatter. Use cutting oil.</td>
</tr>
<tr>
<td>11. Countersink to ( \frac{1}{8} )&quot; depth.</td>
<td>12. Clean the vise and put side D down on the parallels.</td>
</tr>
<tr>
<td>12. Remove the burrs and turn the workpiece over in the vise.</td>
<td>13. Aline the pilot of the counterbore in the ( \frac{5}{16} )&quot; hole and carefully clamp the vise.</td>
</tr>
<tr>
<td>13. Loosen the vise and chuck a ( \frac{7}{16} )&quot; counterbore.</td>
<td>14. Use cutting oil and a moderate feed pressure.</td>
</tr>
<tr>
<td>14. Counterbore the ( \frac{5}{16} )&quot; hole to a depth of ( \frac{5}{16} )&quot;.</td>
<td>17. Clean all tools and machine. Return all tools to their proper locations.</td>
</tr>
<tr>
<td>15. Remove the counterbore and chuck a 90° countersink.</td>
<td></td>
</tr>
<tr>
<td>16. Countersink to ( \frac{1}{8} )&quot; depth.</td>
<td></td>
</tr>
<tr>
<td>17. Remove burrs.</td>
<td></td>
</tr>
<tr>
<td>18. Submit work for inspection and grade.</td>
<td></td>
</tr>
</tbody>
</table>
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Locating spindle in relation to layout
2. Center drilling
3. Drilling
4. Counterboring
5. Facing
6. Back-facing

Material:
1/4" X 4 1/2" X 6 1/2"
cast iron plate from milling and layout operations

Selected references:
McCarthy & Smith. Machine Tool Technology; 3rd edition
The Use and Care of Twist Drills

PROCEDURE

1. Select stock and deburr.

2. Insert part, clamp, and seat in step jaws.

3. Mount center drill in chuck, and move vise on table until center punch mark is directly below the drill for one of the "A" holes.

4. Clamp vise to table.

5. Hand feed center drill to full 60° depth.

6. Drill the 13/32" hole through.

7. Counterbore .594"x.531" deep.

8. Loosen vise and repeat above procedure for the other 3 "A" holes.

9. Move to the "B" hole and drill 13/32" through.

Techniques and Related Info.

1. Check overall dimensions and layout before starting.

3. Discuss alternate methods. For example: using wiggler or spotting with small diameter drill.

4. If radial drill is being used, move head over punch mark.

6. Use power feed .005"-.007" and proper r.p.m.

7. Use hand feed and proper r.p.m. Demonstrate use of depth gage.

9. Use power feed .005"-.007" and proper r.p.m.
PROCEDURE

10. Face to depth with \( \frac{7}{8} \)" facer.
11. Move to location of "C" hole.
12. Drill \( \frac{19}{32} \)" hole through.
13. Insert back facer with \( \frac{19}{32} \)" shank in chuck and drop through hole.

TECHNIQUES AND RELATED INFO.

10. Use hand feed.
12. Use power feed \( .005''-.007'' \) and proper r.p.m.
13. Hand feed upward to clean up surface. Discuss the importance of proper tool assembly so that the opposing cutting force does not pull out the back facer.
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
Single-spindle upright drill or small radial drill
Drill press vise with step jaws
Center drill

Materials:
1 1/4" x 4 1/2" x 6 1/2" cast iron plate
1/2" machine reamer (undersize)
Flat tap wrench

Selected references:
McCarthy & Smith, Machine Tool Technology; 3d edition
The Use and Care of Twist Drills

PROCEDURE
1. Locate spindle on layout for one "D" hole and center drill it.
2. Drill through with 13/32" drill (2 "D" holes).
3. Ream 1/2"-010 hole. Check with a micrometer. Locate the chamfer of the reamer in the drilled holes. Repeat for other "D" hole.
4. Check the holes with a .500" Go-No-Go gage.
5. Use expansion hand reamer until the Go-Gage enters and the No-Go does not.

TECHNIQUES AND RELATED INFO.
1. Use same procedure as for holes A, B, and C in Job 1.
2. Use .007" feed and proper r.p.m.
3. Discuss the differences between rose and chucking reamers. Engage feed lever then engage r.p.m. lever. Feed .015". The r.p.m. for reaming is one-half of that for drilling.
4. At this stage neither end should enter.
5. Demonstrate how to back the reamer off so it just passes through the hole; then expand it 1/8" turn for each pass.
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
- Single-spindle upright drill
- or small radial drill
- Drill Press vise
- Center drill
- \( \frac{5}{16} \)" drill

Selected references:
- McCarthy & Smith, Machine Tool Technology; 3d edition
- The Use and Care of Twist Drills

**PROCEDURE**

1. Locate the spindle on the layout for one of the "E" holes and center drill it.
2. Drill through with \( \frac{5}{16} \)" drill. Repeat for the other 3 "E" holes.
3. Countersink 90° to width \( \frac{13}{32} \)" at top of hole.
4. Tap through \( \frac{3}{4} " - 16 \). Use soluble oil.
5. Check threads with \( \frac{3}{4} " - 16 \) thread plug gage. The "Go" end should enter freely, the "No-Go" end only 1 to \( \frac{1}{2} \) threads deep.

**TECHNIQUES AND RELATED INFO.**

1. Use same procedure as for holes A,B,C, and D.
2. Use .07" feed. Figure r.p.m.
3. Discuss purpose of countersinking.
4. Use proper r.p.m. Put spindle in forward, and allow tap to pull itself in and through the hole. Before tap reaches end of threads, reverse it and apply light lifting pressure.
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Locate spindle in relation to layout
2. Center drilling
3. Drilling
4. Powertapping

Materials:
- 1 1/2" x 4 1/4" x 6 1/4" cast iron plate
- 1/8"-27 NP thread plug gage
- 3/16"-18 hole gage
- 3/16"-27 hole gage
- 3/16"-18 National pipe tap
- 1 1/8"-27 NP thread plug gage

Techniques and Related Info:
1. Use same procedure as for holes A, B, and C.
2. Demonstrate that hole gage should not enter hole.
3. Discuss importance of thread depth. Tap should not enter over half the threads.
4. Gage should not go beyond ground flat on gage.
5. After tapping to proper depth, the hole gage should not enter hole more than 1 to 1 1/2 threads deep.
6. Use same procedure as for holes A, B, and C.
7. Demonstrate that the hole gage should not enter the hole.
8. Use same procedure as for hole F, steps 3 and 5.
9. Use depth gage.
Unit No.  Operator's Job Title: Drill Press Operator

Project X  Project Name: Motor Plate

Job No. 5  Job Name: H Hole  D.O.T. No. 606.380

Drawing Nos. 72  Time: 2 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
- Center drill
- No. 4 taper pin
- 2" drill
- Drill press vise
- No. 4 straight or spiral-flute taper-pin reamer
- Tap wrench
- Hammer

Selected references:
- McCarthy & Smith, Machine Tool Technology; 3d edition
- The Use and Care of Twist Drills

Operations:
- 1. Locating spindle in relation to layout
- 2. Drilling
- 3. Machine reaming
- 4. Hand reaming
- 5. Countersinking

Materials:
- 1\(\frac{1}{4}\)" x 4\(\frac{1}{4}\)" x 6\(\frac{1}{4}\)" cast iron plate

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### PROCEDURE

<table>
<thead>
<tr>
<th>Operation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Turn the part back to its original position in the vise and position the spindle on the layout for hole H. Center drill for the hole.</td>
</tr>
<tr>
<td>2.</td>
<td>Drill through with 2(\frac{1}{2})&quot; drill.</td>
</tr>
<tr>
<td>4.</td>
<td>Clean out hole, try pin, ream until pin extends out top of hole about (\frac{1}{4})&quot;.</td>
</tr>
<tr>
<td>5.</td>
<td>Hand ream until pin extends out about (\frac{1}{8})&quot;.</td>
</tr>
<tr>
<td>6.</td>
<td>Countersink both sides of all holes to break edges (\frac{1}{16})&quot;.</td>
</tr>
<tr>
<td>7.</td>
<td>After completion of piece, clean the machine.</td>
</tr>
<tr>
<td>8.</td>
<td>Submit all work for inspection and grade.</td>
</tr>
</tbody>
</table>

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### TECHNIQUES AND RELATED INFO.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Use the same procedure as for holes A, B, and C.</td>
</tr>
<tr>
<td>2.</td>
<td>Use r.p.m. of half the drill speed.</td>
</tr>
<tr>
<td>3.</td>
<td>Clean hole and pin. Oil pin to prevent pickup. Tap pin into position with hammer. Rounded portion of large dia. of pin should be flush or barely above surface.</td>
</tr>
<tr>
<td>4.</td>
<td>Clean tools with a rag. Return tools to proper storage places.</td>
</tr>
</tbody>
</table>
Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the Procedure column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Equipment:
Sensitive single-spindle drill press
Drill jig
No. 31 drill

Selected references:
McCarthy & Smith, Machine Tool Technology; 3d edition
The Use and Care of Twist Drills

PROCEDURE
1. Select workpiece from lathe and layout operations and remove all burrs.
2. Set up a No. 31 drill in the drill chuck.
3. Clamp the work in a drill jig.
4. Drill the No. 31 hole in the \( \frac{1}{2} \)" diameter.
5. Drill the No. 31 hole in the \( \frac{1}{4} \)" diameter.
6. Remove the workpiece from the drill jig and inspect it.
7. Remove all tools.
8. Submit work for inspection and grade.

TECHNIQUES AND RELATED INFO.
1. Inspect workpieces for size before proceeding.
2. Discuss the reasons for using high r.p.m. when drilling small diameter holes.
3. Drill jig will have to be constructed. Explain other alternatives such as "V"-blocks, superspacers, and universal shaft jigs.
4. Use oil. Aline drill in bushing.
5. Remove all burrs.
6. Clean the machine and tools. Return tool to proper locations.
Bibliography


*Use and care of twist drills.* Cleveland Twist Drill Co., 1242 E. 49th St., Cleveland, O. Undated. (Freer in limited quantities.)

Drawings For Shop Projects
WORK AS SOLID PIECE.
AFTER ALL MACHINING,
CUT IN HALF ON BANDSAW
AND MILL SAW CUTS TO
SIZE.

DRAWN BY: E.F.S.
SCALE: ——

BENCH VISE ASSEMBLY

DWG. NO. 15
Bench Vise Details

**Bench Vise Screw**
- 1/16 x 45° Cham.
- 1/4 Dia.

**Guide Pin**
- 3 1/2 Dia.

**Bench Vise Handle**
- 5/8
- 2 5/8
- 11/16

**Part A**
- 5/8
- 1/4 Dia.

**Part B**
- 1/2 Dia.

**Tolerances:**
- ±0.005 on decimal dimensions
- ±1/64 on fractional dimensions
- ±1° on angular dimensions

**Drill CSK. One End Rivet at Assembly**
- 7/32

**Washer**
- 2 Req'd.

**Bench Vise Nut**
- 7/8

**Med. Knurl**
- 1/2 Dia.

**Fine Knurl**
- 1/16 x 45° Cham. (Typ)
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.

TAP WRENCH

REV. 8/1/72

DWG. NO. 21
## Parts List

<table>
<thead>
<tr>
<th>NO.</th>
<th>Name</th>
<th>MATL. REQD</th>
<th>CRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Graduated Dial</td>
<td>CRS 1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Plate</td>
<td>CRS 1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Shank</td>
<td>CRS 1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Dovetail Blocks</td>
<td>CRS 2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Dovetail Slide</td>
<td>CRS 4</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Dowel Pin 1/8 DIA x 1/4</td>
<td>CRS 2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Hex.hd Cap Scr. 5/16-18 UNC</td>
<td>CRS 2</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Stop Pin</td>
<td>CRS 1</td>
<td></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.
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 DECREMENTAL
± 1/64 FRACTIONAL
± 1/10 ANGULAR

MATERIAL: CR.S
FAO

DRAW BY: E.F.S.
SCALE:

MICROMETER BORING HEAD
PLATE

DWG.NO. 221

1/2

1

1.718

2

2

locate when assembling.

22 DR. 1/2 -20UNF-2B
locate when assembling.

6A DR. 1/4 REAM

15 DR. 1/4 REAM
this area rem.ved after all machinin

DRILL, .437 C BORE x .343
64
2 HOLES

4 HOLES

MATL. CRS (SAE 1020) or PHOSPHOR BRONZE (SAE 64) 2 REQD.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 DECIMAL
± $\frac{1}{64}$ FRACTIONAL
± $\frac{1}{2}$ ANGULAR

angle to be matched with angle of slide

DRG.NO. 22.2

MICROMETER BORING HEAD DOVETAIL BLOCKS
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± 0.005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1/2 ON ANGULAR DIMENSIONS

1/16 DRILL, 375 REAM X 7 DP.
LOCATE AND REAM
AFTER ASSEMBLY

5/32 R

5/32 DRILL, 10-32 UNC-2B
2/32 DRILL, 1/2-20 UNF-2B

MICROMETER BORING HEAD
DOVETAIL SLIDE
MATL. CRS
FAO

DRAWN BY: E.F.S.
SCALE: --
4 NO. 8-32 UNC x 1/2 FILLISTER HEAD SCREWS

4 NO. 8-32 UNC x 1/2 FILLISTER HEAD SCREWS

3-16 UNC x 1/8 HEX. SOC. HD. CAP SCREW

DRAWN BY: E.F.S.

SCALE:
NO.6 DRILL, 1/2 UNC-2B x 1/2 REAM x 8

DIAMETRAL PITCH 12
NO. OF TEETH 12

3/4 x 45° CHAM.

3/8 x 45° CHAM. (TYP)

1/4 x 45° CHAM.

1/8 x 45° CHAM. (TYP)

TO FIT COLUMN

TOLERANCES:
±1/64 ON DECIMAL DIMENSIONS
±1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS
NOTE:
COUNTERSINK ALL HOLES
TOP AND BOTTOM 1 DEEP
BEFORE SLOTTING.

MATL. C1020
1 REQ'D.

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
DWG. NO. 29
PROJECTIONS:

1. 3/8 DRILL AT ASSEMBLY
   - 1/16 x 45° CHAM.

2. 1.167 DIA.

3. 3/4 REAM

4. SLEEVE MATL. C1010 1 REQ'D.

5. PRESS FIT IN PT. 12
   LOOSE FIT IN PT. 1

6. 2.52 DIA.

7. 1/32 x 45° CHAM. (TYP)

8. TABLE PIN MATL. C1020 1 REQ'D.

9. COVER PLATE MATL. C1010 1 REQ'D.

10. NO. 18 DRILL 4 HOLES

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
SLEEVE, TABLE PIN AND COVER PLATE

DWG. NO. 30
NO.20 DR. x \(\frac{3}{4}\) DEEP, 10-32 UNC-2B x \(\frac{1}{2}\) DEEP, 2 HOLES

\[\text{\frac{3}{8} DIA.}\]

4\(\frac{7}{8}\)

HANDLE
MATL. C1020
1 REQD.

NO.10 DRILL THROUGH, \(\text{\frac{5}{16} DIA. CBORE} \times \frac{3}{16} \text{ DEEP,}\)

\[\text{\frac{3}{32} C SK. BOTH SIDES}\]

\[\text{\frac{1}{8} R(TYP) 25^\circ(TYP)}\]

\[\text{\frac{9}{16} DIA.}\]

15\(\frac{5}{32}\)

\[\text{\frac{5}{16} DIA.}\]

15\(\frac{64}{32}\)

HANDLE END
MATL. C R S
2 REQD.

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

DRAWN BY: E.F.S.
ARBOR PRESS
HANDLE AND END

SCALE: —

DWG.NO. 31
NO. 28 DRILL, 8-32 UNC-2B x 1/2
LOCATE FROM PART II

2.50 REAM 1.168 C'BORE x 47/64
FROM BACK SIDE

MAT L.C1020
1 REQD.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS
GRIND SLOT TO FIT COLUMN

1/16 x 45° BEVELED EDGES (TOP AND SIDES)

3/16 UNC-2A x 3/4

3/8 1 REQ.

MATL. C1020

TOLERANCES:
- ±.005 ON DECIMAL DIMENSIONS
- ± 1/64 ON FRACTIONAL DIMENSIONS
- ± 2° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.

SCALE: 1/1
NOTES:
MATL. CAST ALUM.
HOLES GO FROM \( \frac{1}{2} \) TO \( \frac{5}{32} \) BY 64 THS
FAO

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
\pm 0.005 DECIMAL
\pm \frac{1}{64} FRACTIONAL
\pm \frac{1}{2}^\circ ANGULAR

DRAWN BY: E.F.S.
SCALE: ______

DRILL STAND

DWG.NO. 42
NOTES:

1. TOOL STEEL

2. DR. THROUGH 1/2 DR. & STAINLESS STEEL

3. CSINK. 1/4, BOTH SIDES

4. LEAVE .015 ON EACH SURFACE FOR GRINDING

5. HEAT TREAT TO 60 C ROCKWELL

TOLERANCES:

(UNLESS OTHERWISE SPECIFIED)

±.0005 DECIMAL

±.005 ANGULAR
NOTES:
1. SAE 1020 MATL. HARDEN.
2. BREAK ALL SHARP CORNERS.
3. 13 HOLE S

TOLERANCES:
UNLESS OTHERWISE SPECIFIED
0.0005 DECIMAL
± 0.02 MM.
± 1/64 FRACTIONAL

DRAWN BY: E.F. S.
SCALE: 1/2 BLOCK

Dwg. No. 45.1
NOTES:

- MATERIAL: SAE 1020
- BREAK ALL SHARP EDGES
- HARDEN AND TEMPER
- FINISH GRIND TO 16 MICROINCHES
- 2 RM (MATCHED IN PAIRS)
- LEAVE .030 FOR GRINDING ON .500 AND .750 DIMENSIONS

TOLERANCES:

- .005 DECIMAL
- ± .064 FRACTIONAL
- ± 1° ANGULAR

(UNLESS OTHERWISE SPECIFIED)
8 DIA. 10 HOLES EQUALLY SPACED

NOTES:
MAIL: CRS SAE 1020
BREAK ALL SHARP EDGES.
HARDEN AND TEMPER, FINISH GRIND TO 16 MICRINOCHES.
2 REQD. (MATCHED IN PAIRS)

TOLERANCES:
±0.4 MILLIMETER (UNLESS OTHERWISE SPECIFIED)

DRAWN BY: V.C.L.
SCALE:

PARALLELS (MILLIMETERS)
<table>
<thead>
<tr>
<th>REF.NO.</th>
<th>FINISHED DIMENSIONS (INCHES)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**TOLERANCES:**

(UNLESS OTHERWISE SPECIFIED)

±.003 DECIMAL

± 1/64 FRACTIONAL

**MATERIAL:** CRS

**CASE HARDEN**

**PARALLEL CLAMP LOOSE JAW (INCHES)**

**DRAWN BY:** V.C.L.

**DWG.NO. 57 A**
### MATERIAL: CRS CASE HARDEN

### ALTERNATE JAW DESIGNS

<table>
<thead>
<tr>
<th>REF.NO.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
<th>CBORE.</th>
<th>L</th>
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<tbody>
<tr>
<td>1</td>
<td>54</td>
<td>8</td>
<td>8</td>
<td>4.0</td>
<td>25.4</td>
<td>19.1</td>
<td>1.6</td>
<td>12.7</td>
<td>3.18D X 3.97DP</td>
<td>9.56D</td>
<td>6.35 X 2.38DP</td>
<td>6-32 UNC X 3/16DP</td>
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<tr>
<td>2</td>
<td>69.9</td>
<td>9.5</td>
<td>9.6</td>
<td>4.8</td>
<td>31.8</td>
<td>25.4</td>
<td>2.4</td>
<td>19.1</td>
<td>4.76D X 4.76DP</td>
<td>7.15D</td>
<td>7.94 X 2.38DP</td>
<td>6-32 UNC X 5/32DP</td>
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<tr>
<td>3</td>
<td>85.7</td>
<td>13</td>
<td>12.8</td>
<td>6.4</td>
<td>38.1</td>
<td>31.8</td>
<td>3.2</td>
<td>19.1</td>
<td>6.35D X 6.35DP</td>
<td>8.73D</td>
<td>11.11 X 2.38DP</td>
<td>8-32 UNC X 5/32DP</td>
</tr>
<tr>
<td>4</td>
<td>101.6</td>
<td>16</td>
<td>15.8</td>
<td>7.9</td>
<td>44.5</td>
<td>38.1</td>
<td>4.0</td>
<td>254</td>
<td>7.94D X 7.94DP</td>
<td>10.32D</td>
<td>14.29 X 2.38DP</td>
<td>8-32 UNC X 5/32DP</td>
</tr>
<tr>
<td>5</td>
<td>127</td>
<td>19</td>
<td>19</td>
<td>9.5</td>
<td>60.3</td>
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<td>9.53D X 9.53DP</td>
<td>13.50D</td>
<td>17.46 X 2.38DP</td>
<td>8-32 UNC X 5/32DP</td>
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</tbody>
</table>

**TOLERANCES: UNLESS OTHERWISE SPECIFIED ±0.05MM.**

**FRACTIONAL: ±0.02**
H, TWO HOLES

ALTERNATE JAW DESIGNS

<table>
<thead>
<tr>
<th>REF. NO.</th>
<th>FINISHER DIMENSIONS (INCHES)</th>
<th>TOLERANCES:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A  B  C  D  E  F  G  H</td>
<td>(UNLESS OTHERWISE SPECIFIED)</td>
</tr>
<tr>
<td>1</td>
<td>2 1/8 5/16 5/16 5/32 1 3/4 1/16 10-24 UNC-2</td>
<td>±0.003 DECIMAL</td>
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<tr>
<td>2</td>
<td>2 3/4 3/8 5/16 7/16 1 1/4 1 3/16 3/8-20 UNC-2</td>
<td>±1/64 FRACTIONAL</td>
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<tr>
<td>3</td>
<td>3 7/8 5/8 1/2 1/8 1 1/2 1/8 5/8-18 UNC-2</td>
<td></td>
</tr>
</tbody>
</table>

MATERIAL: CRS
CASE HARDEN

DRAWN BY: V.C.L

PARALLEL CLAMP
THREADED JAW (INCHES)

DWG. NO. 58A
### Alternate Jaw Designs

<table>
<thead>
<tr>
<th>REF. NO.</th>
<th>MILLIMETERS</th>
<th>INCHES</th>
<th>MATERIAL</th>
<th>CASE HARDEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>1</td>
<td>54</td>
<td>8.0</td>
<td>8.0</td>
<td>4.0</td>
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<td>6.4</td>
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<tr>
<td>4</td>
<td>101.6</td>
<td>16.0</td>
<td>15.8</td>
<td>7.9</td>
</tr>
<tr>
<td>5</td>
<td>127.0</td>
<td>19.0</td>
<td>19.0</td>
<td>9.5</td>
</tr>
</tbody>
</table>

### Drawn by: V.C.L

PARALLEL CLAMP

THREADED JAW (MILLIMETERS)

DWG. NO. 58B

TOLERANCES: (UNLESS OTHERWISE SPECIFIED) ± 0.4 MM.
NOTES: BREAK ALL SHARP EDGES.
MATERIAL: CRS

FINISHED DIMENSIONS (INCHES)

<table>
<thead>
<tr>
<th>REF NO</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3/4</td>
<td>5/8</td>
<td>3/4</td>
<td>1/2</td>
<td>1/8</td>
<td>3/16</td>
<td>1/4</td>
<td>3/32</td>
<td>1/32</td>
</tr>
</tbody>
</table>

TOLERANCES: (UNLESS OTHERWISE SPECIFIED)
- ±.003 DECIMAL
- ±1/64 FRACTIONAL

DRAWN BY: V.C.L.
DWG. NO. 59

PARALLEL CLAMP STRAIGHT CLIP
ALTRENATE DESIGNS FOR KNURLED END

NOTES:
FINISH ALL OVER.
BREAK SHARP EDGES.
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
FRACTIONAL $\pm \frac{1}{64}$
DECIMAL $\pm .003$

| REF.NO. | FINISHED DIMENSIONS (INCHES) | | | | | | |
|---------|-------------------------------|---|---|---|---|---|---|---|---|
|         | A | B  | C | D | E | F | G | H | J | K | L | JAW OPENING |
| 1       | 5/16 | 2 3/32 | 1 1/4 | 5/8 | 5/16 | 1/4 | 5/32 | .120 | 1 5/32 | 10-24UNC-2 | 1 |
| 2       | 3/8  | 2 13/16 | 1 3/16 | 3/8 | 3/16 | 5/32 | .180 | 1 32/32 | 1/2-20UNC-2 | 1 1/2 |
| 3       | 1/2  | 3 5/8  | 2 3/8  | 7/8 | 16 3/8 | 3/32 | .240 | 3 16/32 | 5-18UNC-2 | 2 |
| 4       | 1/4  | 4 7/16 | 2 15/16 | 1 1/2 | 1 1/16 | 11/32 | .300 | 3 16/32 | 3-16UNC-2 | 2 1/2 |
| 5       | 5/4  | 5 3/4 | 4 1/8 | 9/16 | 1 3/16 | 7/32 | .360 | 4 16/32 | 1/2-13UNC-2 | 3 1/2 |

MATERIAL: CRS
CASE HARDEN

DRAWN BY: V.C.L.
PARALLEL CLAMP
CLAMPING SCREW

DWG.NO. 60
ALTERNATE DESIGNS FOR KNURLED END

NOTES

FINISH ALL OVER.
BREAK SHARP EDGES.
TOLERANCES:
(UNLESS OTHERWISE
SPECIFIED)
FRACTIONAL ± 


e

A

B

C

D

E

F

G

H

J

JAW OPENING

MATERIAL: CRS
CASE HARDEN

PARALLEL CLAMP
ADJUSTING SCREW

DRAWN BY: V.C.L

DWG.NO. 61

<table>
<thead>
<tr>
<th>REF.NO.</th>
<th>FINISHED DIMENSIONS (INCHES)</th>
<th>JAW OPENING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5/8 2 1/4 1 3/8 5/8 1/4 3/32 1/8 3/18 10-24UNC-2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3/8 3 2 3/4 5/16 9/32 1/8 1/4 1/4-20UNC-2</td>
<td>1/2</td>
</tr>
<tr>
<td>4</td>
<td>5/8 4 3/4 1 1 6 5/16 3/16 3/16 3 5/8 3/5-16UNC-2</td>
<td>2 1/2</td>
</tr>
<tr>
<td>5</td>
<td>3/4 6 1/8 4 3/8 1 1/2 1/2 3/8 1/4 1/2 1/2-13UNC-2</td>
<td>3 1/2</td>
</tr>
</tbody>
</table>