A TRADE EXTENSION

VOCATIONAL EDUCATION PROGRAM

FOR ENGINE LATHE OPERATORS

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By

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CHAPTER I

INTRODUCTION

The demand for skilled workers in defense industries has set the nation off on an educational and training program that is unmatched in history.

The combined efforts of all educational agencies are hard put to find teachers and training equipment. In some cases, both are being loaned by the industries that need trained workers.

When the training program was planned by the Office of Education, it contemplated training 700,000 workers for the defense industries by June 30, 1941. The estimate at present calls for a million to be trained by that time, and the program is steadily increasing in capacity.

Three general divisions summarize the various types of vocational courses offered to prepare workers for defense industries. These are: first, that for the person who once did mechanical work but whose skill now needs polishing; second, that for the man who already has a position but wants to qualify for something better; third, that for the inexperienced person who wants and needs to get started.

W. P. A. workers, and other people chosen by the employment service from its files, fit into the first group. In the second, workers in defense plants are trained during their spare time for the allotted positions ahead of them.

A big difference lies between the labor problem of 1941 and the crisis of the 1917 period. The shortage now is of the skilled workers. The demand today is for men who can build or operate machinery.

In Tulsa, for example, men are being trained in machine shop practice, care and grinding of carbide tools, jig and fixture design (as related to the machine shop), welding, motor analysis, blue print reading, pattern making, sheet metal layout, wing construction, heavy plate layout, structural layout, heat treatment of metals, and electrical circuits. These courses not only prepare men for occupations to be available in Tulsa, but those elsewhere in the state and nation.

> Special care is being exercised to assure that the training carried on under the defense program is given only in occupations found in industries that are essential to the national defense. The occupations are determined by the advisory commission to the Council of National Defense.[1]

Purpose

Since industry needs many men highly skilled in the work they are to perform and quickly prepared for employment in national defense, those selected as teachers generally need assistance in satisfactorily planning teaching and testing procedures. It is the purpose of this study to reveal how systematic testing of engine lathe operators can emphasize points that need instruction in order to bring the operators to the point where industry can make use of them.

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1. School Life, The Defense Training Program, by Lyle W. Ashby, Volume 26:1, page 5.

The methods used in recording the results of the tests given to the operators and the tests themselves will be valuable to the public schools also, since they are methods used by industry itself.

The Problem

Due to the need for securing the greatest good from efforts spent in National Defense Training classes, concerning content and operations to be taught in their respective fields, it is necessary for each teacher to make an analysis of his trade, in order to teach it adequately. A course outline is then made from this analysis. It is impossible to teach the machinist trade as a whole in a trade extension program operating only a few weeks, therefore, problems concerned with teaching the engine lathe is the subject of this study. Since such a limitation has been used in this study, the responsibilities of the engine lathe operator have been analyzed and tests made for each. This study is based on an examination of methods of instruction that have proven effective in actual shop teaching, and advocates other teaching methods.

Need of the Study

A search of the literature pertaining to aids or tests for determining acceptable abilities and understandings fails to uncover sufficient tests to meet the needs for

supplemental Vocational Education for prospective skilled workers in industries essential to national defense.

This study will, therefore, meet some immediate needs of machine shop teachers in national defense classes and other teachers of prospective engine lathe operators by providing tests for determining adequate preparation of these workers. It will also act as a guide for organizing additional training programs in machine shop practice and other trades as well. The study stresses the importance of a thorough testing program in any type of training program.

Scope of the Study

The study is limited to the operations involved in successfully operating an engine lathe, to the methods used in selecting trainees, to testing suggested for use at the beginning and end of the training program, and recommended methods of instructing trainees. An analysis of the responsibilities of the engine lathe operator has been made by men in industry who are serving as instructors in defense training classes.

Tests have been made to determine the student's proficiency in each unit or phase of the responsibilities of the engine lathe operator. By recording test scores on each factor included on the analysis chart, the instructor can easily see points which need to be taught each learner.

A copy, or drawing, of the tests devised by Tulsa instructors in national defense classes is included in this thesis. Recommended methods of improving instruction are also included.

The study includes material that has already been successfully used in Tulsa, and that can be used by other teachers of machine shop, either in defense classes, or day trade classes. Some of the following material has been provided to teachers before this study was completed. The following chapters describe the initial training of the average machinist seeking additional training, his age, education, type of training wanted, and what he is doing at the present time.

This thesis attempts to show the value of a thorough testing program. The need for more instruction sheets for efficient workmen is evident from the fact that the material already developed has been such a time saver for the teachers of machine shop, also the instruction sheets now available do not cover all operations needed in the defense program.

CHAPTER II

SELECTION OF TRAINEES

Method Used in Securing Data Concerning Trainees Qualifications

In order to secure data relative to qualifications of trainees, a thorough study was made of the records of those persons having had training in the national defense machine shop training classes, or who were in such classes at the time this study was made.

Instead of sending questionnaires to individuals who had had training, and personally interviewing those now in training at the shops, data contained on Application For Training forms, used by the Tulsa education officials in the national defense program, were used to provide the information desired from enrollees and graduates. For obvious reasons, applications of those not accepted for training were not investigated.[1]

Information Secured from Application for Training Forms

Information concerning the trainee's age, his education, his employment record, type of training wanted, what trainee is doing at present, and the name and address of his employer, can be found on this form as prepared by those who entered into the training program.

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1. See appendix for copy of Application for Training Form used, page 90.

At the time this study was completed, 116 men had received some training in machine shop or had started in the classes just organized. Hundreds of others had made application for training, but were not accepted because of limited facilities, or because they did not have the proper qualifications for entering the classes. Of the 116 men mentioned above, only one was unemployed.

Limitations of Information Received on Application Forms

In the application forms studied, one reason for maladjustment of trainees is their inability to fill out Applications for Training Forms properly. Some reasons given for providing incomplete information called for, when the individuals were questioned, were: (1) Fear that the National Defense Training Office was another government agency seeking information about the individual's private affairs, (2) Reluctance to give information his employer could use as a basis for his dismissal. The latter attitude was taken by several men who were, and are, holding jobs for which they have not had proper training.

Trainees frequently failed to state their age, therefore, it is impossible to construct a true graph showing the age distribution in the national defense training machine shop classes. The following comments concerning ages are

based upon those who did fill in the blanks. The picture might be entirely changed had all the applicants answered all questions fully.

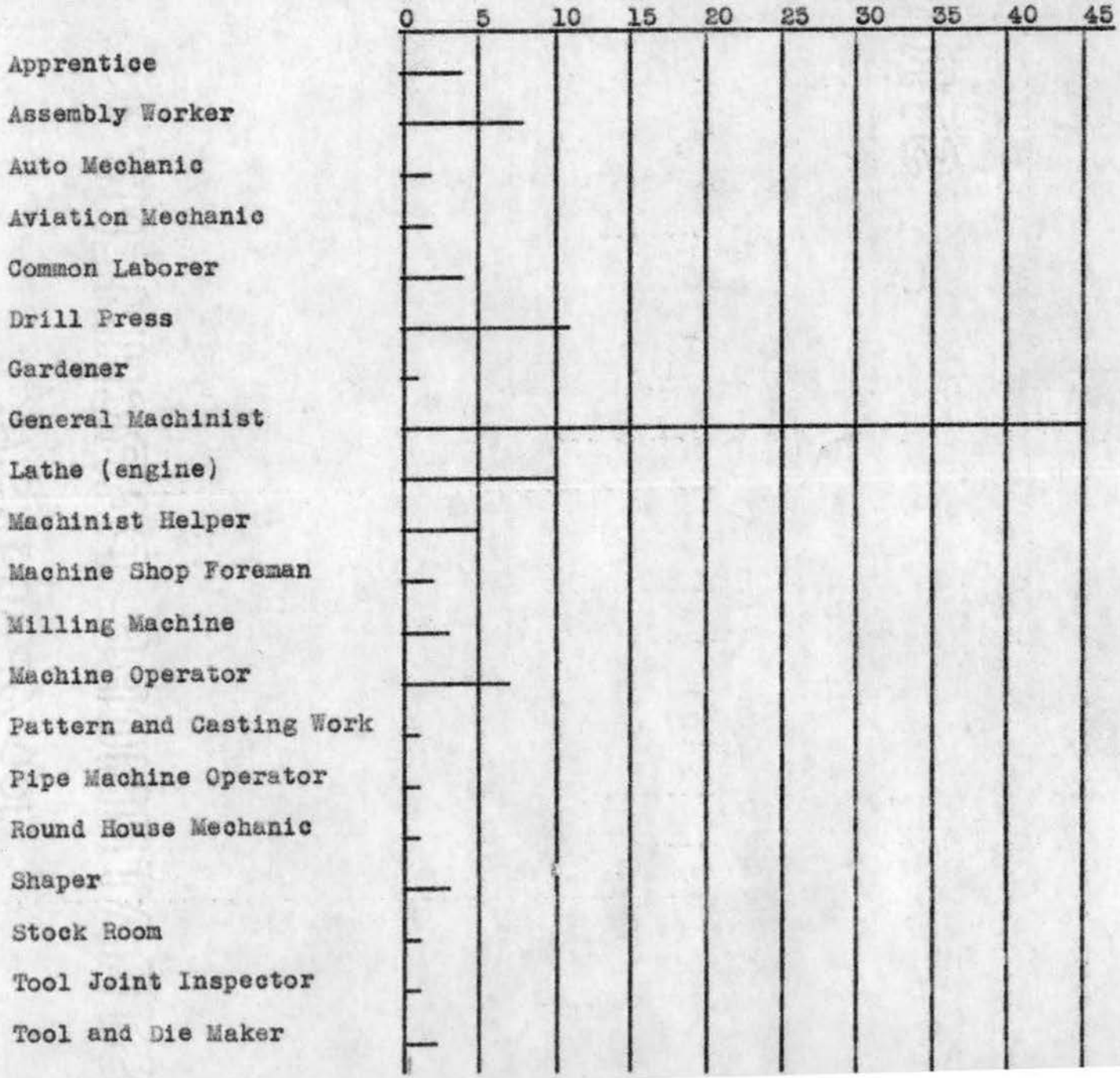
The age spread in the machine shop classes is 41 years, there being men in the classes from the ages of 17 to 58. There have been a few men above the age of 45 in these classes, while the larger number of men fall in the lower age bracket. The largest number is from 25 to 30 years of age.

When asked to supply information concerning the extent of one's education, the average man, with little formal school training, is especially reluctant to admit this deficiency, even though he is well trained in some field that would make up for such deficiency. He thinks this fact might be used as a weapon against him. People who can hardly read or write offer many excuses for this lack of training. Some really never had an opportunity to take advantage of the training offered by the public schools, while others dropped out of school because of family financial difficulties, and others were situated in localities where advantages were not available.

Types of Work Experience Listed

If a careful study is made of Table No. I, showing the types of work experience listed in the application forms,

...LOYMENT LISTED ON THE APPLICATION FORMS STUDIED



several pertinent facts can be noted. It includes nearly all types of workers usually found in a production machine shop. Of the 22 different types of experiences listed, those classified as general machinist are in the majority. This, however, is about the ratio that would be found in a shop today, according to the instructors in the defense classes.

One operator, not listed, and much needed in most defense industries, is the bench man. All machinists seem to enjoy machine work, but when asked to do something that includes considerable hand filing, for instance, they dislike it. This does not lessen the need, however, and must be remembered by those in charge of the class, or by the supervisor. According to one instructor there should be about as many skilled bench men as there are operators of the shaper and milling machine in a shop. That ratio would vary in some shops depending on the contracts under construction, or the usual type work produced in the shop.

Some of the types of work experience listed are vague, but since a personal interview with each applicant was impossible, the experience was listed as recorded on the application blank. Some experience, or work titles, such as round-house mechanic, gardener, machine operator and production worker, offered little descriptive assistance.

Since there were only a few of this kind listed, little concern has been given them.

Some information will be given later about assembly workers, as the unemployed auto mechanics of this community are to be trained for that line of work.

According to good authorities, the apprentice figure is somewhat exaggerated. There are no indentured apprentice machinists in Tulsa. This is an alarming fact, considering the number of machine shops that employ union men.

Recommended Training for Applicants in Tulsa

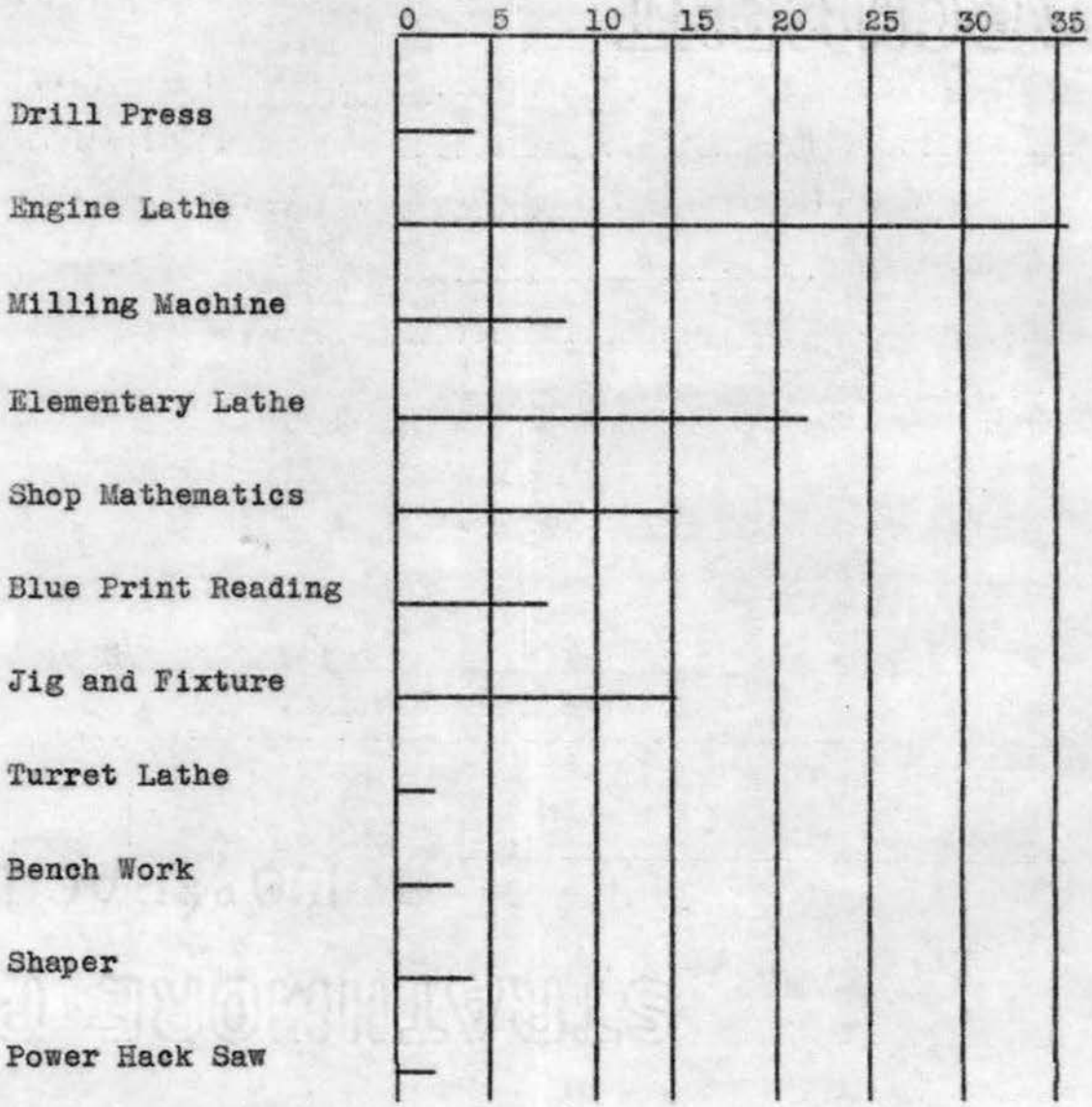
In Table II, the recommended training for applicants in Tulsa is shown. A large percentage of the men were recommended for some type lathe work. This is easily explained because there is a need at the present time for engine lathe operators, and it is fortunate that the Tulsa public schools have more lathes in their highschool shops than all other machines combined.

After some of the men had completed 80 hours of training in machine shop, they found they were much in need of either shop mathematics or blue print reading; so when the next class started, those who were really interested in improving themselves enrolled in one of the latter classes.

All but one person in the supplementary classes were employed at the time of their enrollment in these classes. Those in the pre-employment classes had to have a referral

TABLE II

RECOMMENDED TRAINING FOR APPLICANTS IN TULSA



card from the local state employment office before being admitted to class. Therefore, the cooperation between the two agencies, employment service and national defense, as well as vocational education, was very close.

A large percentage of the men being trained in the machine shop classes are receiving the training they wanted. A few, however, are not getting turret lathe, shaper, or milling machine practice as had been their choice. It is quite possible that those who have asked for that particular training, will get it at a later date when more equipment for national defense classes is available.

There is a high correlation between the individual's experience and the training desired. If he has had experience running an engine lathe, he usually wants some instruction so that he can become a better operator; or, if he has had adequate training on a lathe, then he frequently desires to learn to operate a more complicated machine. This is the case with most applicants in the defense program.

Summary of Findings

In summing up the findings accumulated from the applications for training in machine shop, the following should be noted:

(1) Only 116 men, of many more asking for training, could be admitted to classes because of

limited equipment possessed by the public schools.

(2) Men of all ages are entering the classes and receiving instruction they want.

(3) More men have been recommended for engine lathe because of employment opportunities and the number of machines available.

(4) Few men have been recommended for either turret lathe, shaper, or milling machine practice, since so few of these machines are available.

(5) Men making application for training have had all types of experience usually found in the machine shop.

CHAPTER III

PROCEDURES IN DEVELOPMENT OF COURSE OF STUDY

Study of Available Material

The teachers of machine shop in the national defense classes were somewhat confused, at first, as to what to include in their courses. Consequently, a study of the following texts was made: Machine Shop Operations, by Barrett; Advance Machine Work, by Smith; How to Run a Lathe, by South Bend Lathe Works; and Machine Shop Manual, by Ford machine shop instructors. A thorough digest of these references revealed an abundance of material to be taught trainees. The instructors were even surprised at the exceptional store of knowledge. It was evident their instruction had to be limited to part of the material available to properly increase the employability of each trainee in the allotted time for each course.

Making the Analysis

In order that important elements would not be missed, an analysis of machine shop practice was made by the teachers. This was then further subdivided into operations that could be performed on each machine. Typical jobs or exercises were selected to provide experiences trainees needed. Table III lists the operations and technical related knowledge necessary

to successfully operate an engine lathe. The use of such materials are well explained by recognized leaders. Their comments include the following:

> An analysis on the job basis gives us only the convenient units of production, while an analysis based on the operations and items of information of the trade gives us convenient units of instruction.[1]

> The outlining of units of instruction from a reasonably satisfactory occupational analysis involves no outstanding difficulties. It is, however, important that such units be laid out with respect to two important principles, as follows:
>
> 1. Each unit should be sufficiently limited in scope for the average learner to grasp the new ideas involved.
> 2. The units should be arranged in progressive order or sequence based upon the learning difficulties which have been identified.[2]

> The activities in connection with which a subject may be used, are analyzed to discover exactly what the individual is to do, and then the subject material necessary to assist in the performance of these activities is collected and organized.[3]

> The result aimed at in such analysis is typified by the cooking recipe, which tells us just what to do at every point.[4]

Analysis came into prominence in a period similar to the present crisis. During the first World War, when men had to be trained in a short period of time, Charles R. Allen and others, introduced the analysis in teaching ship

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1. R. W. Selvidge, Individual Instruction Sheets, Peoria, Ill., The Manual Arts Press, 1926.
2. Frank Cushman, Training Procedure, John Wiley and Sons, Inc., New York.
3. W. W. Charters, Activity Analysis and Curriculum Construction, Journal of Educational Research, Vol. V, p. 357.
4. Boyd H. Bode, Modern Educational Theories, The MacMillan Company, New York, 1927.

TABLE III

LIST OF ENGINE LATHE OPERATIONS AND

RELATED TECHNICAL KNOWLEDGE

A. Reading the rule (or scale)

B. Use of caliper (caliper feel)

C. Reading of micrometers

D. Use of machine controls

E. Care of machine

F. Turning between centers (rough)

G. Facing and turning on chuck work

H. Use of compound for angles and tapers

I. Use of taper attachment

J. Use of tail stock off-set for tapers

K. Turning and boring to tolerances of .002

L. Outside thread cutting (Nat. form)

M. Inside thread cutting (Nat. form)

N. Outside thread cutting (Acme form)

O. Inside thread cutting (Acme form)

P. Use of follower rest

Q. Use of steady rest

R. Drilling with tailstock

S. Use of tool post grinder

T. Grinding tools for different materials

U. Knowledge of cutting speeds for different materials

V. Knowledge of cutting speeds for tool steel

W. Knowledge of machine lubricants and cutting compounds

X. General attitude

builders by analyzing the trades, then teaching specific units or operations in the trades.

During the present crisis, the Federal Security Agency has published a List of Occupations -- Approved by the Office of Production Management for Vocational Training Courses for Defense Workers -- which states the operations that must be taught in the defense classes if they are to be reimbursed with federal funds. For example:

> Machinist II 4-75.010 - Carries through to completion the construction and repair of all kinds of metal parts, tools, and machines; understands blue prints and written specifications; uses skillfully all machinist's hand tools including scrapers, chisels, files, and measuring instruments; operates all machine tools, including lathes, milling machines, planers, shapers, and specialized machines that have been developed from them; possesses knowledge of shop mathematics, the use of charts and tables, the efficient planning of shopwork, the dimensions and uses of standard bolts, screws, threads, and tapers; must be familiar with the working properties of such metals as aluminum, brass, cast and wrought iron, and various steels; and should be capable of shaping metal parts to precise dimensions within the close tolerances prescribed.[1]

Development, Purposes, and Uses of the Analysis Chart

The analysis chart was developed by teachers of machine shop in the defense program and their supervisors by keeping two thoughts in mind. (1) There are certain operations and technically related information each trainee should know or be

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1. Federal Security Agency, U.S. Office of Education, Vocational Division, Vocational Training for Defense Workers, Social Security Board, Bureau of Employment Security, U.S. Employment Service Division, List of Occupations, 1941, p. 204

able to do. These are represented on the chart by A to W.

(2) Success attained in performing the operations and understanding the technically related information topics is measurable. The numbers 0 to 100 represent the individual's percent of ability in each item as measured by tests developed for each operation or related topic.

The analysis chart was used by the teachers to record the individual's ability to perform the lathe operations, and his knowledge in related technical factors both in the beginning and at the close of the course.

This chart proved a valuable instrument to the supervisor in checking instruction offered in each class. Some instructors were very cooperative in giving the tests and in following this individual testing with proper instructions on items where the individual was weak. Other instructors failed to organize their instruction hence they had no schedule of operations or work experience and related information topics to teach, such as are included as factors on the analysis chart. All had to be taught the value of organizing what they were to teach, as well as how to test and record student accomplishments to assure employability.

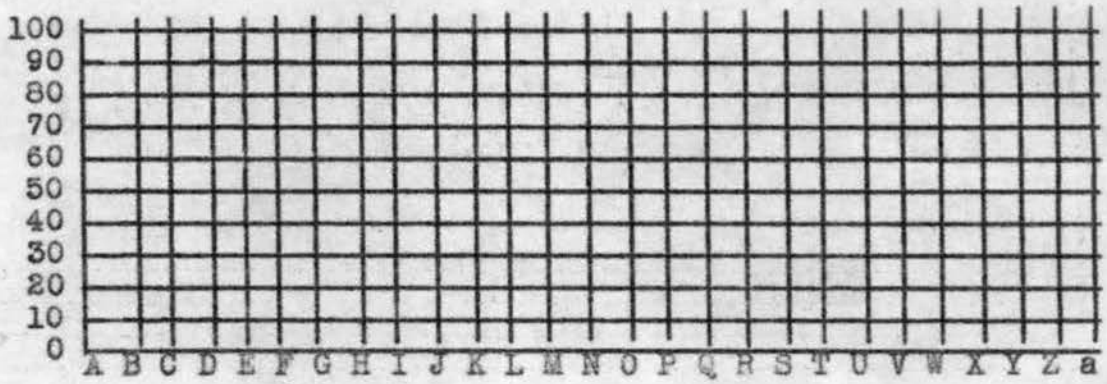
If a test had five parts, each correct answer would give the trainee 20 points on the graph for that particular operation. Definite factors in engine lathe operations and related technical knowledge are represented by letters A to W.

Figure I

NATIONAL DEFENSE INDUSTRIAL TRAINING PROGRAM
Present Experience and Ability Chart

Name_____ Trade_____
Date Start - Red Line - 1st Analysis
Date Finish - Blue Line - 2nd Analysis Course No._____

This chart is intended to show the ability, by analysis, of the trainee upon his entrance into class. After the course had been completed a second analysis was given to show his progress. The significance of the percentages can only be understood by referring to the key for those ratings. The above analysis is not the opinion of the instructor but was the result of definite tests.



The analysis chart is seldom used to record the rate of student learning. It points out to the instructor where the learner needs help, and shows the latter where his weaknesses lie. Less time will be consumed in bringing men up to an employable level, because instruction and training can be concentrated on the weak points.

The number on each chart represents the trainee's percentage in each of the tests as will be discussed in Chapter IV.

The time element should be considered in almost all lettered factors. Industry works on time, so must the people that are being trained for industry. Accuracy is important also. The tolerances in government contracts are much less than those found in most commercial contracts. Some of the men in the classes at the present time are capable of doing the work if given enough time, but are not employable because of the speed factor.

Other forms of accomplishment could have been used, and would probably have been equally as effective, such as the block-graph, bar-graph, etc. However, the line-graph is simple for all to understand.

The national defense teachers of Tulsa should have the thanks of day school teachers for working and experimenting with this chart. It will undoubtedly assist in further developments along this line.

Figures II and III show definite improvement in the work as engine lathe operators. Figure IV shows this person wasted not only his time but the time of the instructor as well.

The following chart provides space to record in graphic form the individual's ability to perform each operation or job, and his knowledge of related technical factors. The red line records the learner's knowledge and ability to perform the work of an engine lathe operator at the time he entered training, while the blue line shows his record by the close of an eight weeks, or sixty-four clock hours, course.

PRESENT EXPERIENCE AND ABILITY CHART

OF THREE MACHINE SHOP TRAINEES

WHO HAVE COMPLETED FOUR WEEKS TRAINING

Figure II

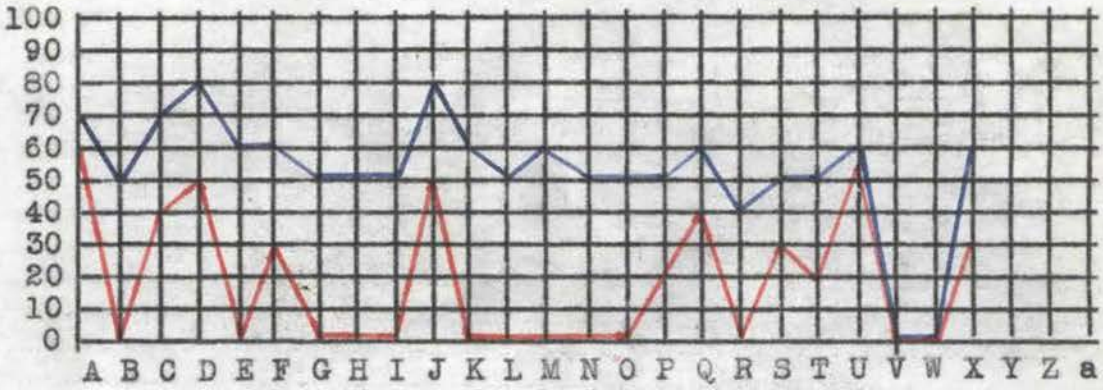


Figure III

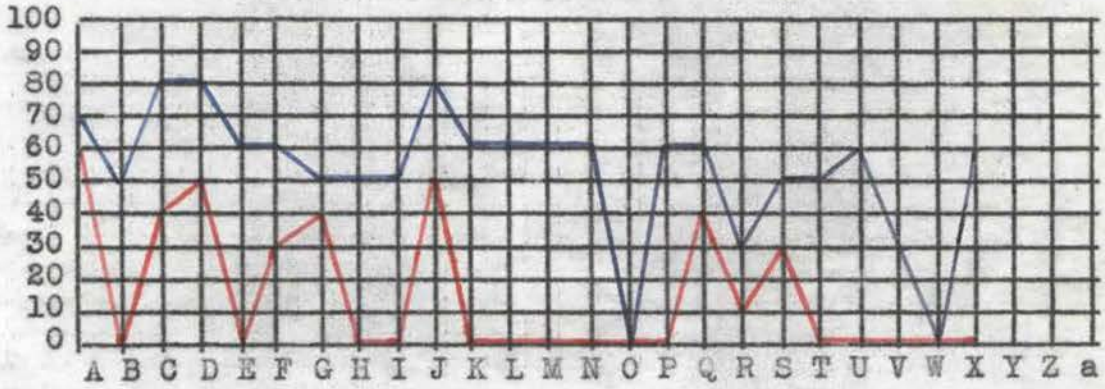
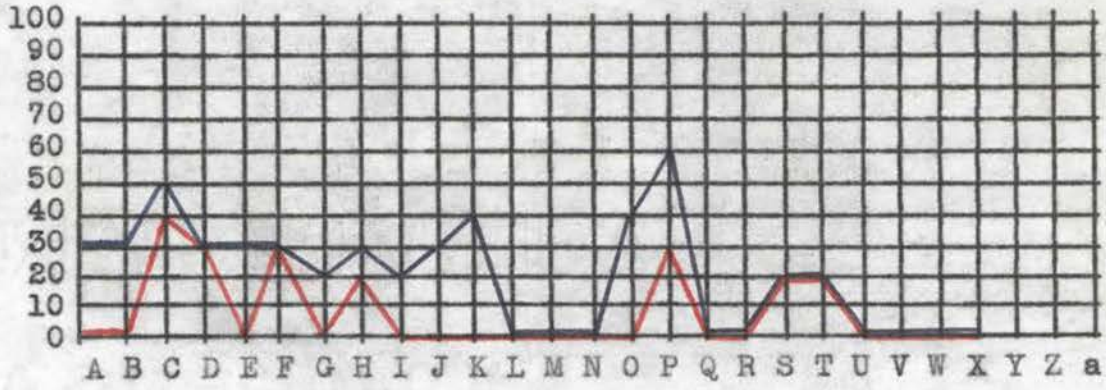


Figure IV



CHAPTER IV

MEANS USED IN DETERMINING ADEQUACY OF THE KNOWLEDGE AND EFFICIENCY OF TRAINEES AT BEGINNING AND END OF TRAINING PERIOD

Need for Testing

When the analysis of engine lathe operations was completed, and the instructional material developed from this analysis was used in the shop classes, complications arose. Men, who were supposed to have had experience in some of the basic operations, were found to be lacking in this experience, or needed further preparation badly. Several cases in the refresher classes were found where men could not do the minimum work required by the beginning student. Others would have been retarded in their training had they been required to start with such elementary work as reading the rule. The tests were developed chiefly to determine the trainee's ability in operating an engine lathe successfully and knowledge of the necessary related technical information. After the tests were given, the instructor and student knew where the emphasis in training needed to be placed.

Tests Developed for Each Operation and Use Made of Each

Some of the tests on the following pages were constructed by a group of instructors and their supervisors,

while others were made by individual instructors. Though some of the tests on the first operations are quite lengthy, they have proved very valuable in discovering the individual's knowledge about certain operations and his speed and accuracy in others.

Other items need to be considered in constructing suitable tests for such an educational program; i.e., ease of administration and checking or grading. Broadly interpreted, these include the ease with which the test can be duplicated for class use, given and interpreted. Tests and scales were made to serve many functions, including:

(1) To reveal interests
(2) To discover aptitudes and capacities
(3) To measure achievement
(4) To reveal personality traits and character
(5) To stimulate learning
(6) To reveal strengths and weaknesses of teaching.[1]

The tests on the pages to follow were used to determine the training needed by each person enrolled, as well as to determine when each person had successfully learned those operations tested. These tests are based on an analysis of engine lathe operations and related technical knowledge. The list of factors used as test topics includes: (A) Reading the rule, (B) Use of calipers, caliper feel, (C) Reading of micrometers, (D) Use of machine controls, (E) Care of machine, (F) Turning between centers (rough), (G) Facing and turning on chuck work, (H) Use of compound rest for

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1. F. Theodore Struck, Ph.D., Creative Teaching, John Wiley and Sons, Inc., New York, 1938, p. 434.

angles and tapers, (I) Use of taper attachment, (J) Use of tail stock off-set for tapers, (K) Turning and boring to tolerances of .002, (L) Outside thread cutting (Nat. form), (M) Inside thread cutting (Nat. form), (N) Outside thread cutting (Acme form), (O) Inside thread cutting (Acme form), (P) Use of follower rest, (Q) Use of steady rest, (R) Drilling with tail stock, (S) Use of tool post grinder, (T) Grinding tools for different materials, (V) Knowledge of cutting speeds for tool steel, and (W) Knowledge of machine lubricants and cutting compounds.

TEST A

Reading the Rule (or Scale)

Developed by W. J. Dickenson

This test determines your ability to read the rule (or scale) as a machinist should do it. You will be given a machinist's scale or rule, and with a scriber, asked to point out the common sizes here indicated, as used by machinists. You must definitely know the size at the first attempt, thus giving you a plus on this point, a guess is not enough. A second attempt at a size indicates your need for instruction and is thus marked with a minus. This method determines your percentage of efficiency in reading the rule in shop practice.

Indicate each of the following:

1.	2.
7/16	9/16
21/32	21/32
7/64	7/64
5/32	5/32
13/32	13/32
27/32	27/32
29/64	29/64
63/64	19/32
47/64	63/64
19/32	47/64

The above test is one of the most important because it deals with one of the basic tools used by all machinists.

The time required to administer the test is probably longer than most of the others, because of the individual attention required. One time-saving method in giving the test is to give it to small groups.

Due to the time required to give this test, some instructors did not use the ten point rating but devised their own. For example, the rule test has ten points and some instructors give learners one dimension in 64ths and require them to locate it within 30 seconds or the trainee is rated as needing further instruction in reading the rule.

TEST B

Use of Caliper (Caliper Feel)

These tests are to determine your skill in using calipers. The limits of tolerance should not exceed those indicated. If you are beyond this limit, you will be marked minus indicating a need for training on this point, likewise if your answer is correct, this will be marked plus; thus arriving at the percentage of your ability on the total test.

a. Set calipers to 2 41/64 outside .012
Set calipers to 1 15/32 outside
Set calipers to 11 5/16 outside

b. Set calipers to 4 49/64 inside .012
Set calipers to 1 17/32 inside
Set calipers to 10 49/64 inside

c. Measure 5 outside diameters to 1/128. Use test piece B.

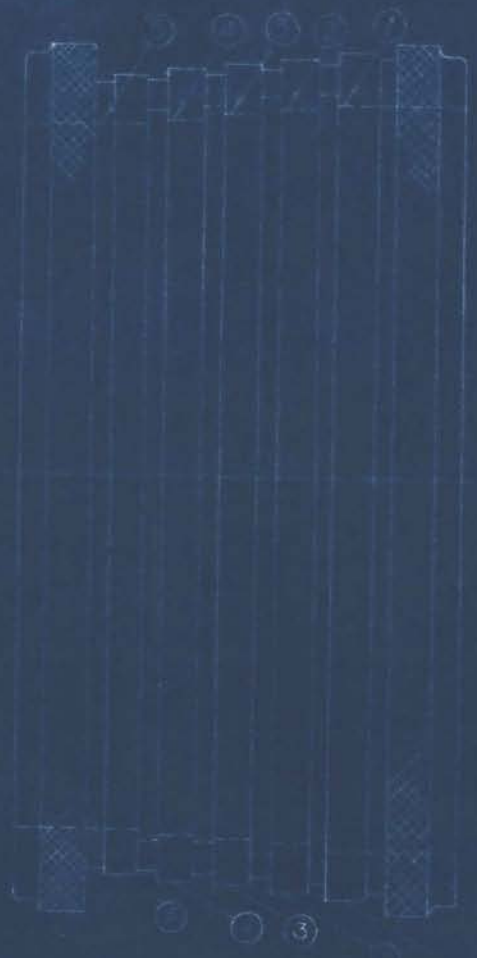
d. Measure 5 inside diameters to 1/128. Use test piece B.

e. Measure an outside diameter and transfer to inside caliper and give size limits of 1/128. Use test piece B.

TEST PIECE "B"

INSIDE DIAMETERS

No. 1. 3 19/16"
No 2 3 21/32"
No 3 3 23/32"
No 4 3 25/32"
No 5 3 27/32"



OUTSIDE DIAMETER

No 1 4 3/64"
No 2 4 5/64"
No 3 4 7/64"
No 4 4 9/64"
No 5 4 11/64"

7

National Defense Training Program Tulsa Okla 5-12-41.

f. Record diameter 1/128 limit of root of thread with thread caliper. Use threaded test piece.

g. File sample to .002 limit using inside micrometers and a set of calipers. Use test filing bar.

h. As if boring a hole without using inside micrometers, set inside calipers from outside micrometers to 1½", bore a hole to this size. Instructor will check on accuracy to .003 limit.

i. Measure distance between two holes and give center distance. Use test piece B.

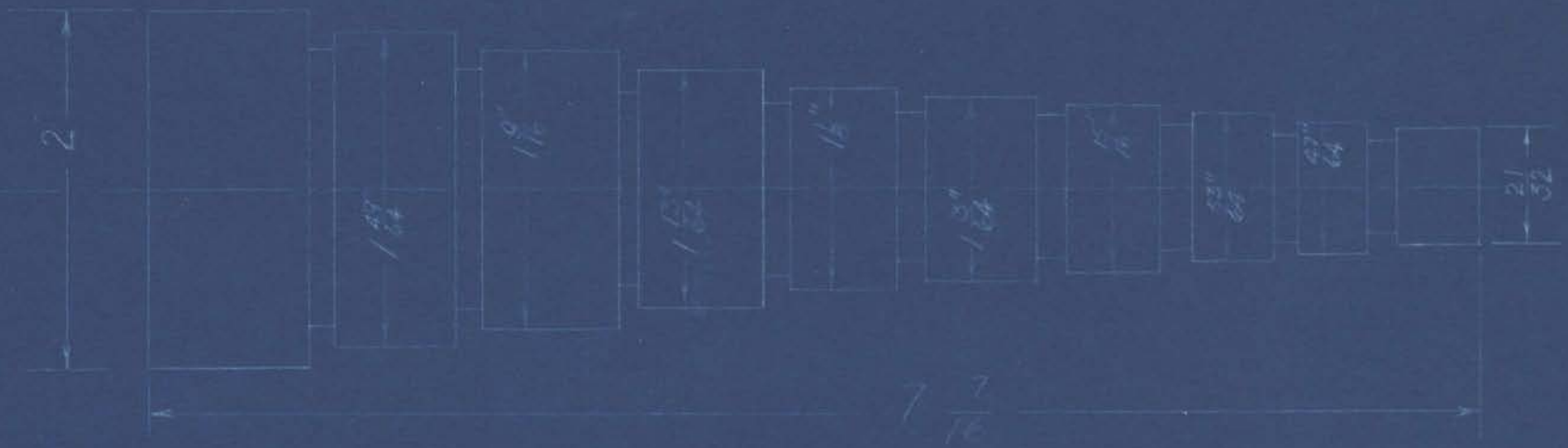
j. Measure top and bottom of taper and give sizes. Use test piece D.

Note: In all these tests, the instructor will check with micrometers rather than by estimating distance.

The caliper test is quite lengthy but accurate in determining a person's ability in using the tool. Instead of the lengthy ten point test, one machine shop instructor gives considerable consideration to just the way a person handles and holds the calipers, but the trainee must be able to feel to .006 inside and outside or he needs more instruction and training in the use of the calipers.

Test piece "C" is used in testing the skill of an individual in reading the micrometer, factor (C). The diameters of this test piece should be varied in making a set of testing bars. A set will speed up the administration of this test because the instructor does not have to wait for each member of the class to use the same test bar. With a number of bars of various sizes, there is less chance of the sizes of each becoming generally known. To speed up the grading of the

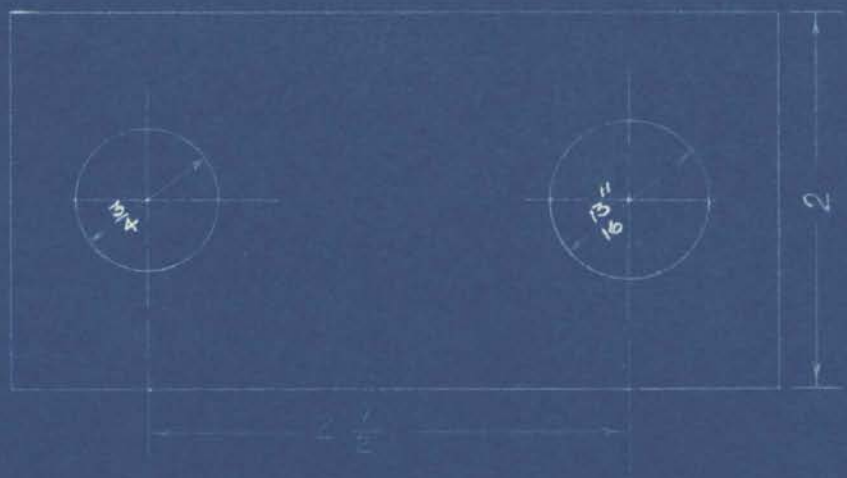
TEST PIECE "C".



TEST PIECE "D"

Taper per foot = 1½"

TEST PIECE D



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tests, it is suggested that each bar should be numbered or lettered, then a sheet with the correct dimensions for each bar should be available for immediate checking.

If a beginning student can adjust and operate each of the main controls on a lathe and name them, then he does not need further instruction on this point, factor (D).

A good machinist must have good tools to turn out good work, and to keep tools in good condition, they must have the proper care. If an individual does not give the following answers, or answers equally as good, when questioned about the care of machinery, factor (E), then he needs further training.

(1) Oil
(2) Keep machine clean
(3) Keep tools off ways
(4) Do not use hammer on machine
(5) Cover ways when filing and grinding

The most reliable test is one where the individual does not realize that he is being tested. In the operation of turning between centers, (factor F) the trainee is given verbal instruction to turn a shaft between centers to a certain size. To do this correctly he should follow the steps practiced by skilled machinists. They are:

(1) Cut material to length
(2) Center each end (either on drill press or in lathe)
(3) Select dog
(4) Mount between centers
(5) Face each end
(6) Rough turn
(7) Finish turn

The same method of testing is given in facing and turning on chuck work, factor (G), but the procedure by the trainee should be as follows:

(1) Select stock
(2) Check for clean up
(3) Mount in chuck
(4) True up
(5) Face end
(6) Rough turn
(7) Finish turn

The test for the use of compound rest for angles and tapers, factor (H), is short and consists of two points:

(1) Set the compound to proper degree
(2) Set tool on center

To use the taper attachment correctly, factor (I), a trainee should be able to:

(1) Properly connect attachment to the lathe
(2) Set to specified angle
(3) Set tool on center

Another method of cutting tapers is by off-setting the tail stock, factor (J). Some shops, however, do not allow the tail stock to be changed once it is properly adjusted. A student would not need more training in cutting tapers by off-setting the tail stock if he :

(1) Set tail stock over to proper taper
(2) Set tool on center
(3) Set up work between centers
(4) Checked work for taper
(5) Used care to adjust driving dog

For testing in turning and boring to tolerances of .002, factor (K), the vise handle (see Chapter IV) is given the trainee as a project to complete. By this time, the

instructor has had an opportunity to see him work and can judge for himself if the student is far enough along for this project. He should proceed with any similar work in this order:

(1) Rough turn or bore
(2) Check for exact size
(3) Start finish cut
(4) Check for size
(5) Use michrome dial for exact size
(6) Mike for size

Cutting threads is one of the most important operations taught in the classes. If the trainee follows the procedure practiced by machinists, he needs no further instruction in cutting national form outside threads, factor (L). The procedure is:

(1) Turn to size
(2) Set up type of thread
(3) Set compound at 30°
(4) Rough thread to near size
(5) Put in finishing tool
(6) Take successive cuts on each side of thread
(7) Cut out center of thread
(8) Check for size

Procedure for cutting inside national form threads, factor (M), is the same as for outside threads.

Operations in cutting acme form threads, factor (N) and (O), are similar to cutting national form threads, but the instructor should see that the trainee follows these steps:

(1) Turn shaft to size
(2) Grind tool to gage and pitch to gage
(3) Rough with narrow tool to near size
(4) Finish with tool ground to gauge, use care and take light cuts not to exceed .002".
(5) Finish to size
(6) Polish off wire edges
(7) Check for size

To use the follower rest, factor (P), properly the trainee should:

(1) Attach follower rest to saddle of lathe
(2) Adjust jaws of follower rest to bear directly on finished diameter of the work following the cutting edge of tool on the opposite side of the work

To use the steady rest, factor (Q), properly the trainee should:

(1) Place the steady rest on the lathe
(2) Place work between centers
(3) Slide steady rest to proper position
(4) Adjust jaws upon the work
(5) When the work is centered properly so that it revolves freely, clamp jaws in position, fasten the work to the head spindle of the lathe and slide tail stock out of the way

The trainee would need further instruction in drilling with the tail stock, factor (R), if he could not drill a hole in a practice piece to size with .002" tolerance on sizes of 3/4 inch or less.

To use the tool post grinder, factor (S), the trainee should be able to:

(1) Mount the grinder
(2) Place stock between centers
(3) Dress grinding wheel
(4) Grind within .005

If the trainee were given practice pieces of cold rolled steel to grind as tools for different materials, factor (T), he should be able to grind the following tools for cutting cast iron, mild steel, cast brass, or aluminum:

(1) Round nose tool
(2) Threading tool
(3) Right or left hand turning tool
(4) Right or left hand side tool

To test the trainee's knowledge of cutting speeds for different materials, factor (U), the multiple choice type question would serve the purpose. The trainee should be able to select the correct speed for each material listed:

(1)	Soft cast iron	30	60	75
(2)	SAE 1020 machine steel	90	130	50
(3)	Free machining brass	100	300	150
(4)	Aluminum	75	125	90
(5)	Bronze	90	150	200

The trainee should select the correct answer (50) from the following statement if he is familiar with the cutting speeds for tool steel, factor (V).

> The cutting speed for tool steel (annealed) is (1) 90 (2) 110 (3) 50.

A suggested test of a trainee's knowledge of machine lubricants and cutting compounds, factor (W), is a recognition test. If the trainee can recognize the common machine lubricants and cutting compounds and tell where each is used, he would not need further instruction on these items.

He should recognize the following:

(1) Lard Oil
(2) Soda - water mixture
(3) Mineral lard oil mixture
(4) Kerosene
(5) Turpentine

Final agreement on content to be taught should be satisfactory to student, advisory committee, and instructor. The final record of student accomplishment should accurately describe the operations and information topics on which the student is properly prepared.

CHAPTER V

RECOMMENDED METHODS FOR INSTRUCTING TRAINEES ON LATHE OPERATIONS

Various types of instructional material appear in machine shops. Blue prints of the finished part or project, with verbal instruction from the instructor, are the most common methods of instilling skill in the men.

Types of Instructional Materials

All instructors realize the need for better instructional material, but few find time to devote to the development of it. Those who have taken a few hours for the development of such material have been able to carry on better teaching and have time to spend on other pressing problems.

A course in teaching techniques offered defense teachers covers methods of developing instructional material such as job analysis, operation analysis, planning and presenting a unit of instruction, satisfactory for use in defense classes. These meetings provide the instructors with a start in teaching and planning instructional materials. One evidence that considerable time and effort had been spent by one instructor in preparing instructional materials is shown in the six job sheets for making the vise handle which follow. These were developed because trainees were attempting to go ahead without proper instructions. The instruction sheets aided in solving

this problem because each trainee was required to submit his work to the instructor when he had finished with the sheet given him. When he had followed instructions, he was given another sheet with the next step to complete. This procedure was followed until the vise handle was completed by each student.

Another similar set of instruction sheets were developed for making parts of the South Bend lathes. These two sets of instruction sheets, and those developed for use in the making of a screw driver illustrate some carefully prepared student directions.

Sources of Materials

A series of typical examples of instructional materials developed by the National Defense Industrial Training teachers and supervisors follows. A number of these blue prints were made from tracings developed in the Tulsa day school trade drafting classes. Other blue prints were made from tracings developed in the local National Defense office, and the remaining blue prints were made from tracings made by the writer after several conferences with the supervisor and teachers of machine shop.

The set of instruction sheets on how to cut a thread are a good example of this type of cooperation. After the shop teachers and supervisors had given their final recommendations on how to cut a thread, the writer checked these

instructions with the following authors and texts and added sketches where needed:

1. Machine Shop Operations, by J. W. Barritt
2. Advanced Machine Work, by Robert M. Smith
3. Shop Theory, by Henry Ford Trade School staff
4. How to Run a Lathe, by South Bend Lathe Works

Assistance Provided Teachers in Maintaining Efficient Instruction

In the weekly meeting of defense instructors, emphasis was given to the importance of class organization, from the beginning of the first class until the course is finished.

Some procedures stressed are: (1) Starting class with short talk with trainees altogether and a demonstration at this time if any is to be given. (2) Do not waste time at beginning of class because of poor preparation on your part. (3) Set up rules regarding use of equipment. (4) Have a method of checking tools. (5) Keep a progress chart on the class. (6) Practice shop safety at all times. (7) Take advantage of the reference materials available for your use in the library.

The use of such procedures are well explained by recognized leaders. Their comments include the following:

> In certain types of work, group discussion is most valuable. It helps to clarify ideas, develops new points of view, aids in oral expression, promotes an appreciation of the opinions of others, and has a decided socializing effect. It should

> always be the aim to get a very clear understanding of the instructions before the job is begun.[1]
>
> It should be made plain at the outset that any act that produces an accident hazard is a serious infringement upon approved practice.
>
> It is generally agreed that in teaching, much depends upon getting off to a good start.[2]

Projects and Instruction Sheets

In the following pages, copies of projects and instruction sheets will be found that have been developed by the National Defense teachers or by the writer after a series of conferences with these teachers and the local supervisor. The blueprints of the vee block, page 57, trammel points, page 58, drill press vise, page 59, pinion gear, page 60, back gear, page 61, tail stock clamp, page 62, starrett "V" block, page 63, the hand drill, page 70-74, tailstock spindle screw bearing, page 75, tailstock handwheel, page 76, back gear, page 77, 13" tail stock spindle screw, page 78, graduated collar, page 79, crossfeed handle, page 80, 11" tail stock spindle screw, page 81, tailstock spindle, page 82, are projects given to the trainee as an unsolved problem. He is to plan his own procedure for doing the entire job.

---

1. R. W. Selvidge, and Verne C. Fryklund, Principles of Trade and Industrial Teaching, The Manual Arts Press, Peoria, Ill., 1930.
2. F. Theodore Struck, Ph.D., Creative Teaching, John Wiley and Sons, Inc., 1938.

VISE HANDLES

Job Sheet # 1.

Operation # 1.

Place steel between centers of 16" lathe and rough turn one end to $1\frac{1}{4}$" diameter 4" long.

Tools Needed

Lathe dog to fit stock. Blue chalk, machine oil, calipers, scale and 3/8" rough turning tool.

Operation # 1.

Tools Needed

Place between centers of 11" lathe. Place lathe dog on small end. Rough turn to 1 11/16" diameter.

1¼" lathe dog, blue chalk, machine oil, scale, caliper, and ¾" roughing tool.

Operation # 2.

Rough turn same end to 1 3/8" diameter, 6 5/8" from end. "

Operation # 3.

Rough turn to 15/16" diameter. "
Undercut portion beginning 3 1/8" from end to 6 5/8".

Operation # 4.

Reverse ends in lathe and rough turn small end to 15/16" diameter. "

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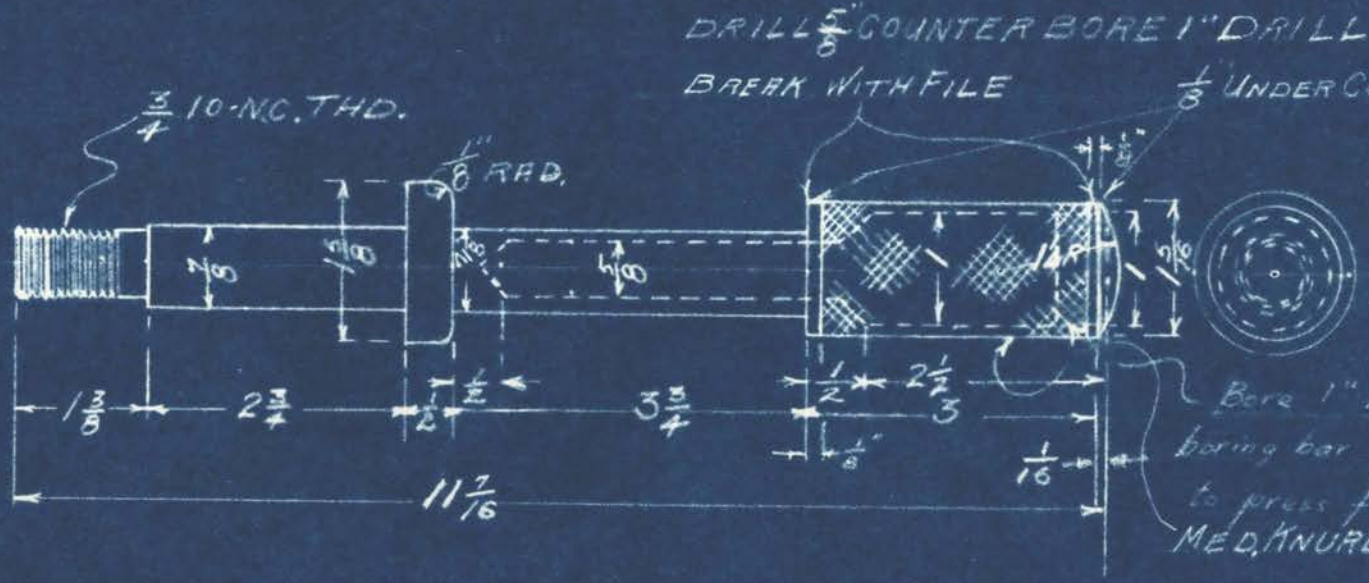


"VICE HANDLE"	
SCALE 1/2 TO 1"	
MATERIAL	C.R. BAR
6-1/4-41	TULSA, OKLA
DRAWN BY J.V.S.	CHECKED BY
NAT'L DEFENCE TRN'G. PROG.	

Job Sheet #4.

Operation # 1.	Tools Needed
Place small end in lathe chuck, place steady rest near knurled end and drill 5/8 " - 6½" deep.	Brass sheems, Steady rest and 5/8" drill.
Operation # 2.	
Drill 1" - 2 3/16" deep.	1" drill and 1" lathe dog.
Operation # 3.	
Bore 1 1/16" - 3/4" deep.	Small boring bar and small boring tool, telescope gage, and outside micrometers.

VISE HANDLES

Job Sheet # 5.

Operation # 1.

Make 1 1/16" plug 5/8" long. Press in 1 1/16" hole at .002 drive.

Tools Needed.

Turning tool,
parting tool,
micrometers,
cutting oil and scale.

Job Sheet # 6.

Operation # 1.

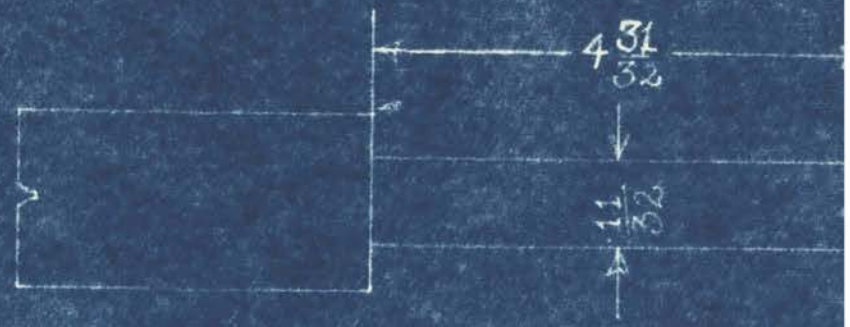
Place in chuck and
steady rest as per
job sheet # 4.
Radius as shown 1¼".
Undercut knurl 1 1/8"
each end.

TAILSTOCK SPINDLE SCREW
13" S. B. LATHE DETAILS PART 1

PERATION NO 1

T DOG ON WORK
CE END
UGH TURN O.D.

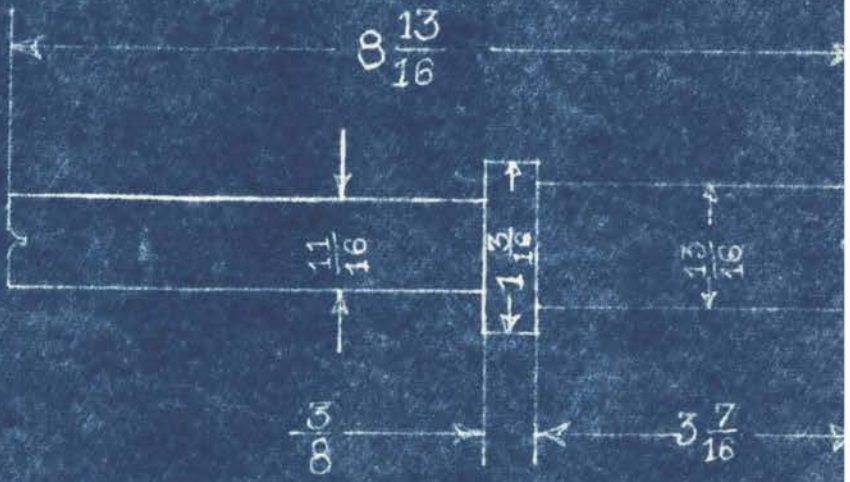
S IS THE SCREW END
OF JOB



ERATION NO 2

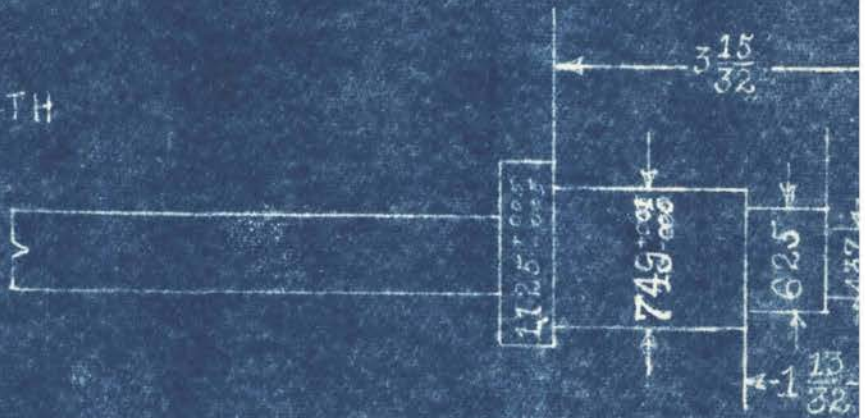
T DOG ON THE OTHER END
CE END OF JOB TO LENGTH
GH TURN TO 1 3/16 ALL
Y ACROSS
UGH TURN O.D. TO THE
NGTH OF 3 7/16 FROM END

PART LEFT IN CENTER
LL BE THE FLANGE



RATION NO 3

SH TURN FLANGE TO O.D.
SH TURN NEXT LARGE
TO O.D. AND FACE TO LENGTH
SH TURN AND FACE TO
GTH NEXT SIZE
H TURN AND FACE TO
ll THE SMALL SIZE

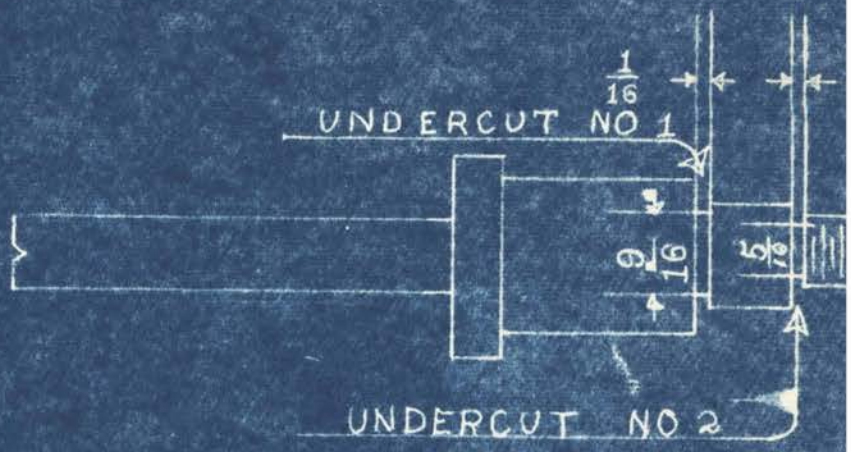


TAILSTOCK SPINDLE SCREW 48
13" S B LATHE DETAILS PART 2

R

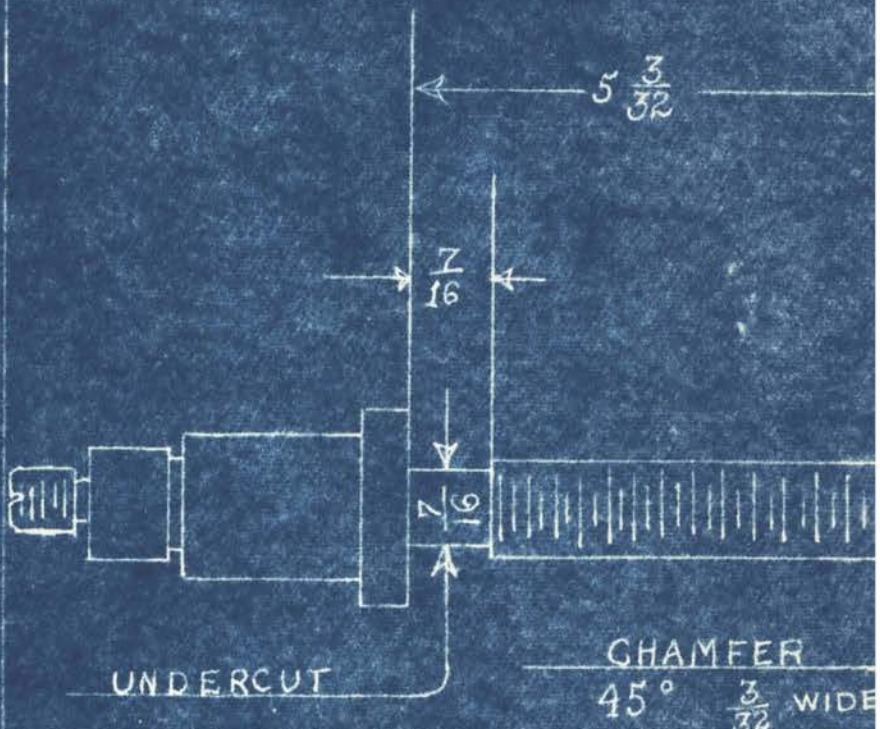
ERATION NO 4

KE UNDERCUT NO 1
KE UNDERCUT NO 2
T 7/16 14 NC-2 THREAD
AMFER FIRST THREAD
TH THREADING TOOL
LISH WITH EMERY
PAPER



RATION NO 5

T DOG ON OTHER END
NG A SHEET OF TIN
BRASS FOR PROTECTION
FINISHED WORK
SH TURN OD TO
GTH
KE UNDERCUT AS PER
NT
T 5/8 8LH ACME THREAD
MFER AS PER PRINT
ISH WITH EMERY PAPER



Operations in Making Hollow Handle Screwdriver

Project #2

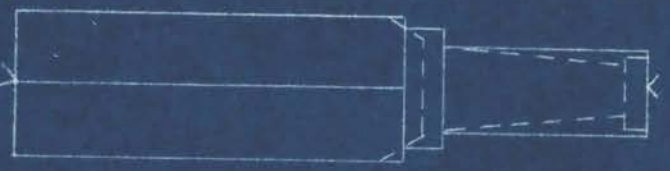
Check out material from helper and then cut off the size of material for handle.

1. One piece 1" round mild steel X 3 3/4" long.
2. Lay off for centers. Ref. S. B. pp-35.
3. Take to helper to drill center holes with combination center drill.
4. Set up lathe for turning between centers. Ref. S. B. pp-22.
5. Fasten lathe dog on one end of material and be careful to put in proper lubrication at dead center end. Ref. S. B. pp-
6. Use right hand turning tool properly, set in tool holder. Ref. pp-26. Rough turn to 29/32".
7. Turn end for end, putting dog on part already finished, and turn down unfinished portion to same size.
8. Take to milling machine and request man on that machine to mill hexagon portion.
9. Set up as before, putting the dog on the hexagon, Caution: Use brass to p rotect machined part.
10. From tailstock end, turn to largest diameter of turned portion. Ref. to blueprint for size.

6

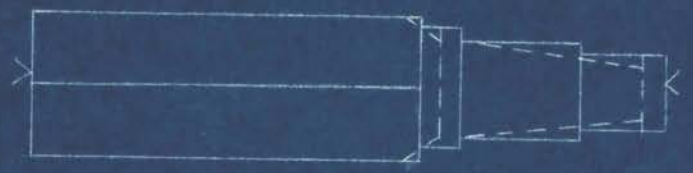
11. Turn to second largest diameter. Caution: Avoid turning too far. Allow for finishing bead.

7



12. Turn to third largest diameter.

8



13. Set compound to turn taper (95°) and turn tapered portion. Caution: Check dead center for lubrication.

9

14. Finish turn both beads to size, squaring in at each side of bead with right and left hand side, or facing tools.

15. Set compound to turn 60° portion between hexagon and large bead. Use round nose turning tool to meet the portion turned by side tool.

16. Finish by filing. Caution: Loosen center, put on fast speed, oil center, put feed reverse lever in neutral.

17. Polish with emery cloth and oil, using polishing stock.

Drill to Make Handle Hollow

18. Using four jaw, independent chuck. Caution: Use lathe board carefully wipe thread of lathe spindle, and inside thread on chuck, oil and pull on chuck by hand. Set up job with hexagon end out about 1" from the jaws. True up very accurately.

19. Get tapered shank drill from tool room, using sleeves if necessary. Caution: Be sure that there are no bumps or bruises on sleeve or drill before inserting in tailstock. Refer to South Bend. How to center a drill.

20. Set machine for proper speed and drill to depth. See blueprint.

21. Using boring tool, set compound at 1°, to bore tapered hole for plug. See blueprint.

22. Bore hole to size.

PLUG MATERIAL M. S. 1" Rd. X 2".

23. Set up in chuck allowing projection from jaws about 1".

24. Turn to size. See blueprint.

25 Use hand press; press into handle.

26. Set up handle in chuck and turn end of handle to radius as shown on blueprint, using radius gage.

27. File, and polish.

Drill for Shank

28. Turn end for end in chuck, repeating precaution in chucking.

29. Check out straight shank drill (see blueprint) and small Jacobs or spindle chuck, and drill to depth. (See blueprint.)

30. Check out material for shank. (See blueprint.)

31. See forging sheet for forge operation.

32. Insert shank into handle, flatten slightly with hammer by hammering round portion of the anvil or hammering block until it fits tight into the handle to avoid turning during drilling operation.

33. Take to helper at drill press #1 to drill pit hole. See that he slightly countersinks the hole at each side to hole pin.

34. Check out pin, insert and peen at each end.

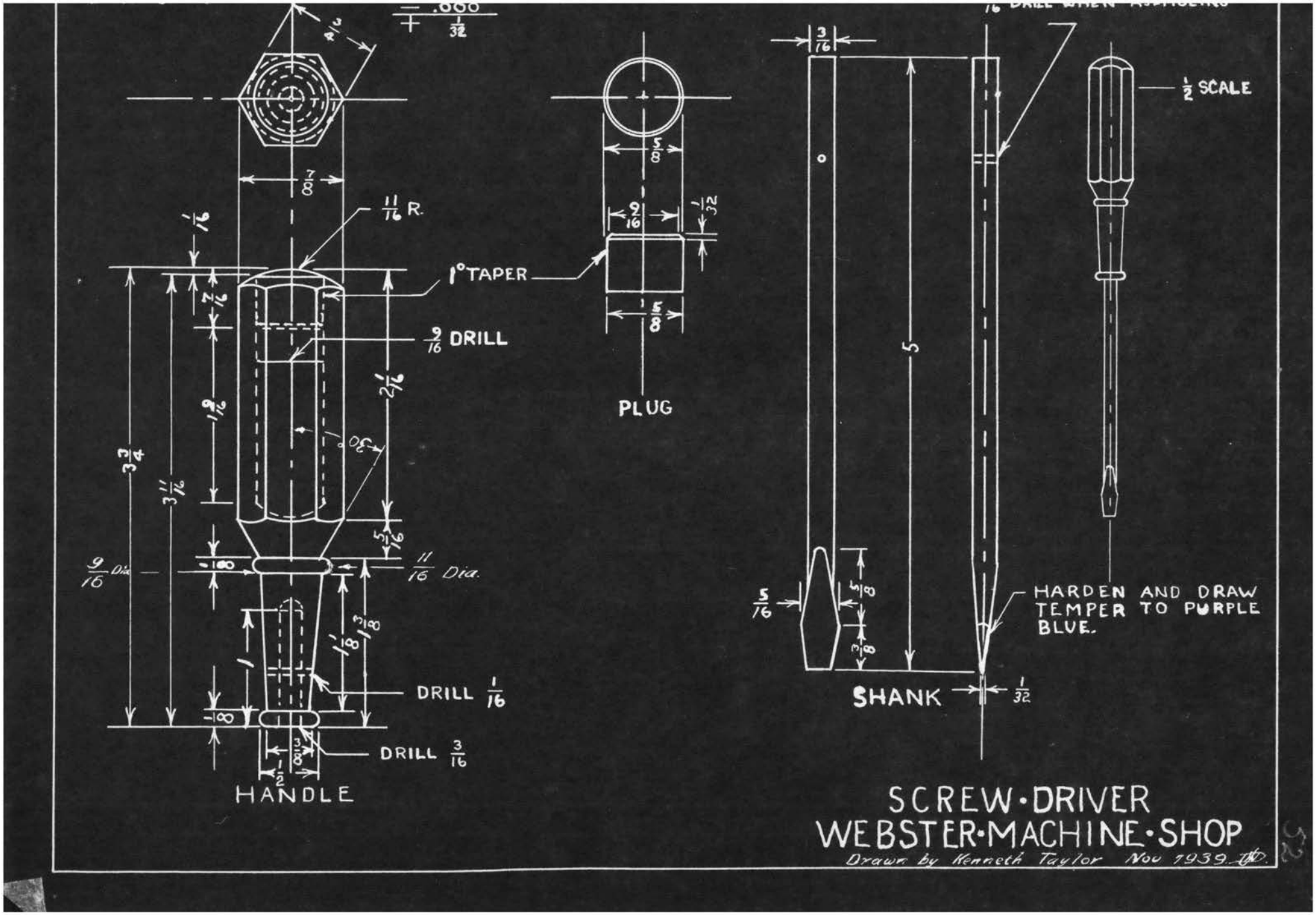
35. File entire handle, draw filing to finish.

36. Polish with emery cloth and oil.

37. Finish polish on lathe buffer.

38. Have inspector check with gages.

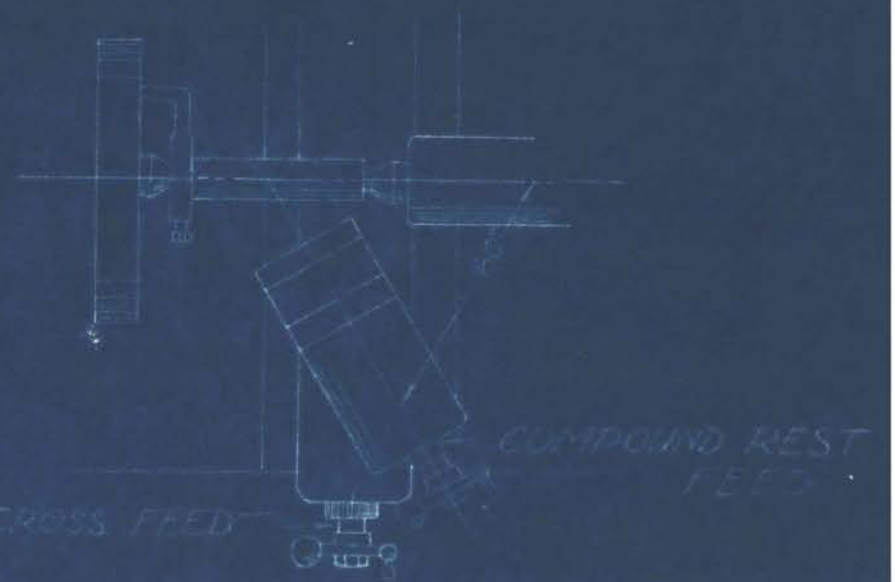
39. Report to instructor for credit.


.666 ± 1/32
A/3
7/8
11/16 R.
1/16
1° TAPER
9/16 DRILL
2 1/16
1 9/16
3 3/4
3 11/16
30°
5/16
1/8
9/16 Dia.
11/16 Dia.
1 1/8
1 3/8
1
DRILL 1/16
1/8
DRILL 3/16
3/16
1/2
HANDLE
5/8
9/16
1/32
PLUG
3/16
5
1/2 SCALE
5/16
5/8
3/8
HARDEN AND DRAW TEMPER TO PURPLE BLUE.
SHANK
1/32
SCREW-DRIVER
WEBSTER-MACHINE-SHOP
Drawn by Kenneth Taylor Nov 1939.

1. Turn the piece to the correct outside diameter (for production work on sizes of about 3", turn undersize about .010. Vary the amount more or less, according to the diameter.).

2. Set compound to 30°, or 60° to the center of the work.

   (Reference: Machine Shop Operations - Barrett - p.62.)



3. Set the tool (which must be ground correctly for angle and clearance.) on center and absolutely at right angles to the center of the work.

   (Reference: Advance Machine Work - Smith - p. 324)

4. Chamfer the end of the work about the same amount or slightly more than the width of the wall of the particular thread to cut.

   (Reference: Advance Machine Work - Smith - p.324)

5. A thread dial indicator is usually used for cutting long screw threads. This devise permits disengaging the half nuts at the end of the cut, returning the carriage to the starting point by hand, and then engaging the half nuts at the correct time so that the tool will follow the orginal cut. As the lead screw revolves the dial is turned and the numbers on the dial indicate points at which the half nuts may be engaged, which are as follows:

For all even numbered threads, close the half nuts at any line on the dial.

For all odd numbered threads, close the half nuts at any numbered line on the dial.

For all threads involving one-half of a thread in each inch, such as 11½, close the half nuts at any odd numbered line.

For quarter threads or eighth threads, return to the orginal starting point before closing the half nuts.

(Reference: How To Run A Lathe - South Bend Lathe Works - p.81.

If the lathe does not have thread dial indicator, the half nuts are not disengaged. The tool is backed out (Step 8) and the carriage is moved to starting point by the reverse switch.

6. For first, take a light cut for the full length of thread, and note graduation setting on crossfeed control. (See sketch of cross feed in operation 1 and 2.)

7. Check thread for correct threads per inch.

(Reference: Advanced Machine Work - Smith - p.330

operation on the other side. (During this operation, be careful to avoid letting the tool cut on booth sides at the same time.)

13. If the job is to be finished with a water finish, change the tool to a finishing tool. In rough commercial work, a reasonable finish can be made with the same tool, but a perfect thread cannot be finished with the same tool as was used for roughing out.

14. Set the finishing tool accurately, and take a light finishing cut on each side of the thread (oil finish) and now apply the water (cutting compound).

15. A few light cuts on each side or wall of the thread with this lubricant will produce the necessary finish required. A finish cut, very light in the bottom of the thread, taking care to avoid the tool cutting either side, but on the point only, will finish the job. Finish polishing with emery cloth; pressure applied by a stick is sometimes allowed.

8. For the beginner, it pays to put a chalk mark lengthwise on the job, to indicate just where the cut stopped which will be the length of the thread you are cutting.

9. Prepare for next cut by moving tool .005 to .015 in on compound, crossfeed graduation to be set on the point previously noted. (Use threading oil for lubricant.) (Many machinists cut a thread by the following steps of cuts. (1) scratch cut, (2).005, (3).010, (4).020, (5).020, (6).010, (7).005, (8).003, (9).003.)

10. As the first roughing cut is being taken prepare to pull out tool at the correct moment by watching the tool right up to the last thread but one. Immediately change your point of vision to the chalk mark and when it almost reaches center height, on the next revolution quickly back out the tool. This is the most significant point for a beginner to learn to avoid breaking the point off the tool. Repeat these roughing cuts by .005 or .010 steps until the crest or flat is about twice the width of the finished flat, in many coarse threads it is advisable to reduce the amount of each cut to about .003 for the last few cuts. (Be sure to only feed in on the compound during the operation.)

11. The next step calls for the most intricate part of tool manipulation. It is to take a cut on each side of the thread, allowing the tool to take a shearing cut over the full face or wall of one side of the thread. Many machinists prefer to cut the front side first, but it is immaterial. The important part is to back out on the crossfeed, and move the tool by use of the compound, feeding in, to the front side of the thread, so that the point of the tool is slightly out of the bottom, yet cutting as nearly as possible the full width of the thread side or wall.

(Reference: How To Run A Lathe - South Bend Lathe Works -p.76.

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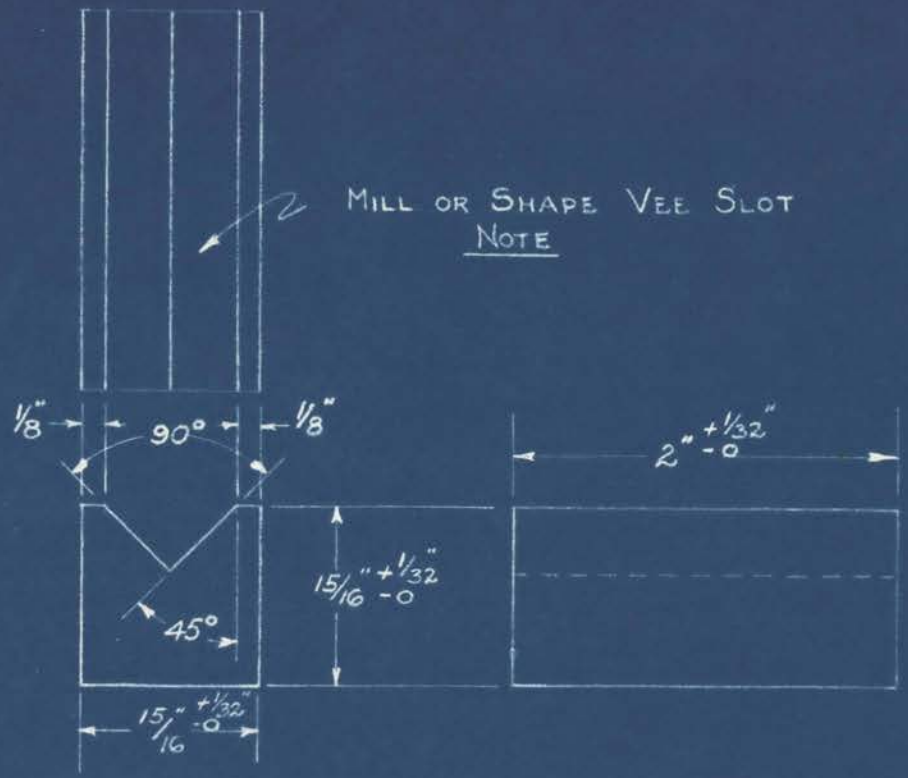
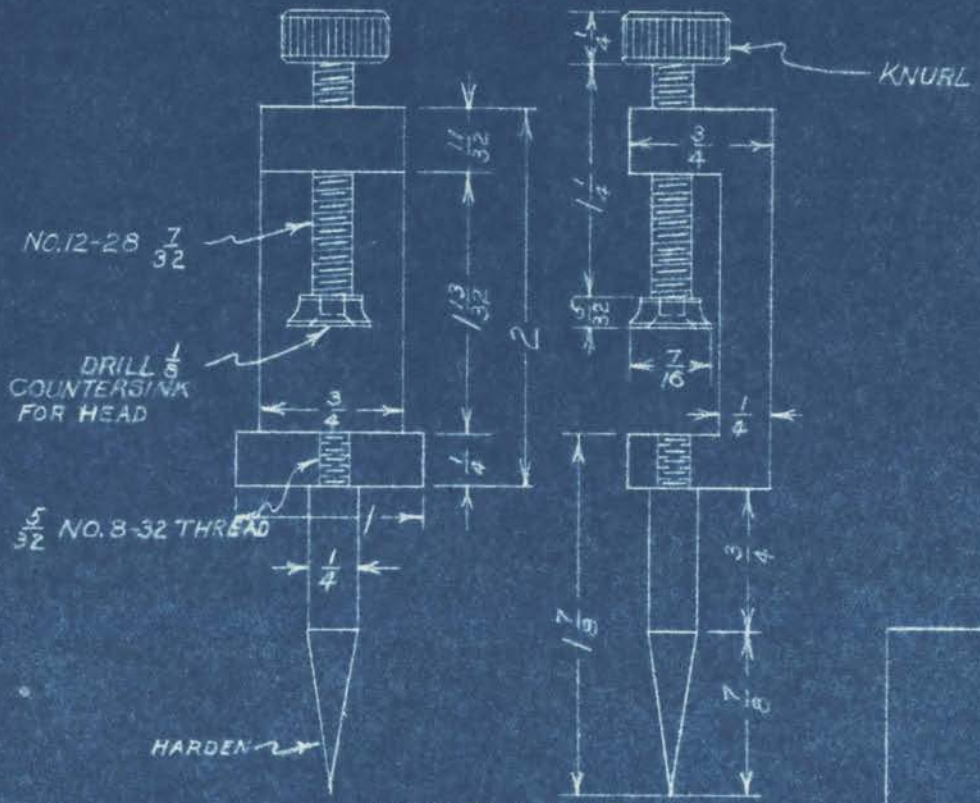


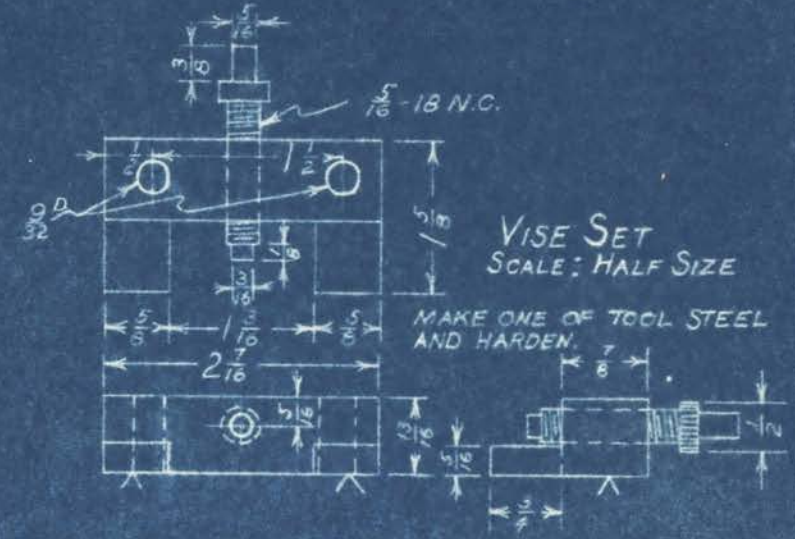
NOTE: WHEN USED AS BENCH PROJECT NO MACHINING OR GRINDING IS PERMITTED

VEE BLOCK		
SCALE FULL SIZE		
1. VEE BLOCK	MILD STEEL	1 REQ'D
DRAWN A.E.F. 3/31/41	CHECKED	
NAT'L DEFENSE IND. TRAINING TULSA OKLA		

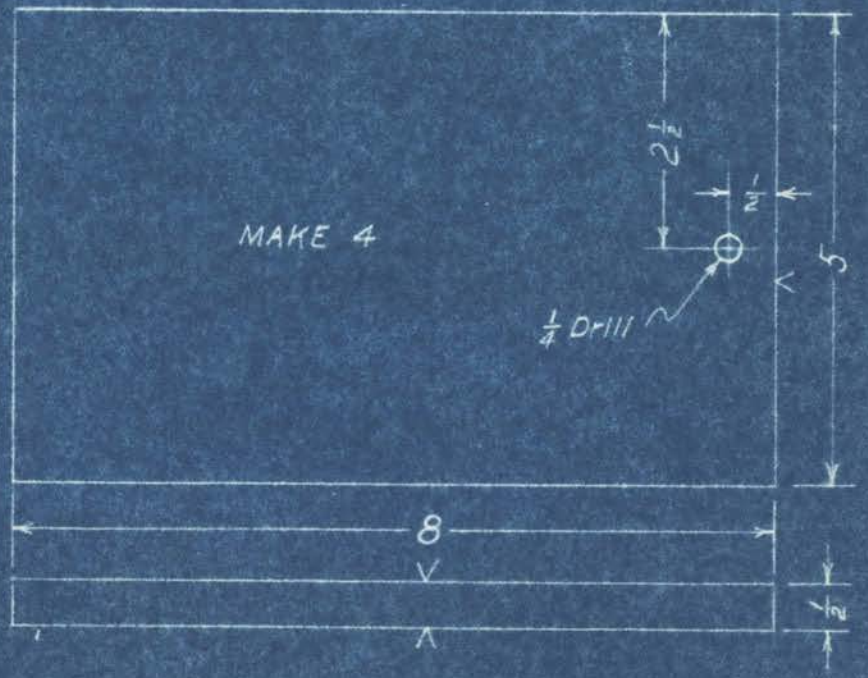
57



TRAMMEL POINTS
SCALE: FULL SIZE



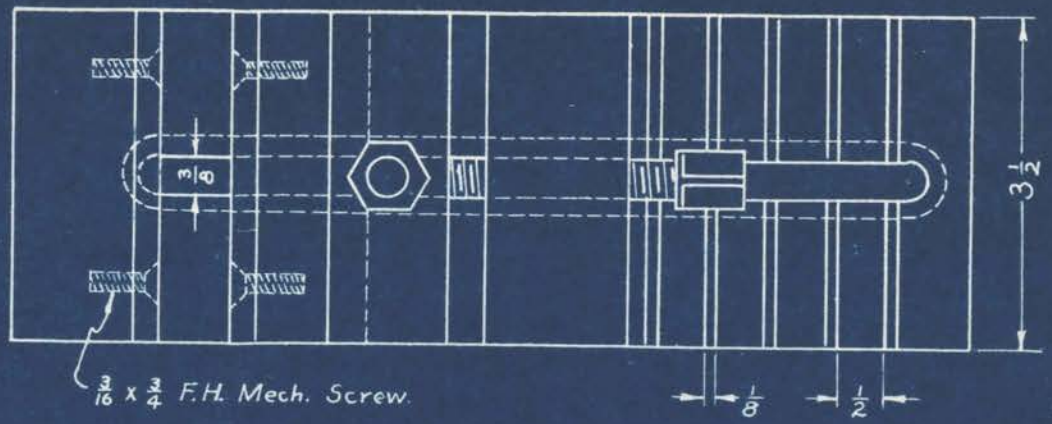
SURFACE PLATE

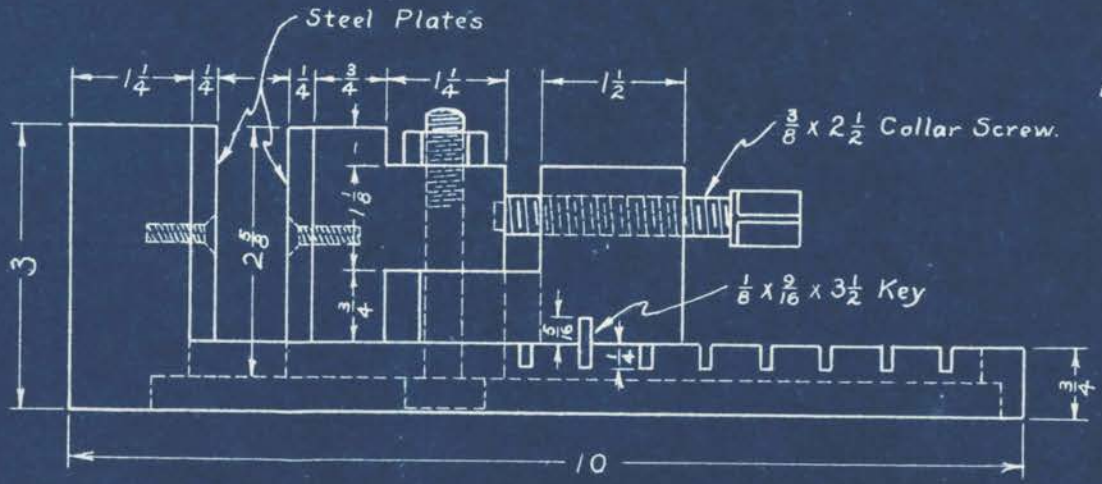


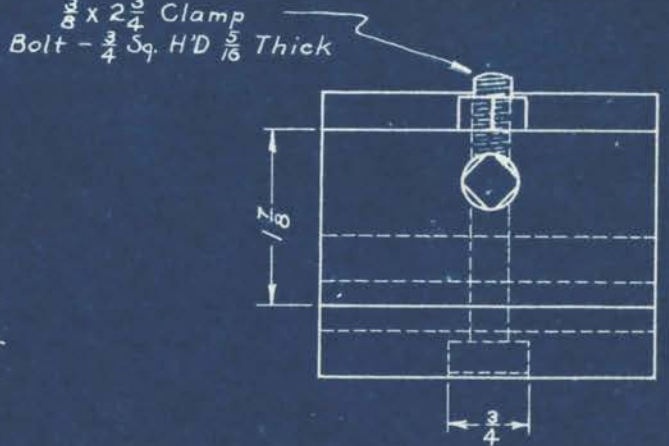
WILSON JUNIOR HIGH SCHOOL
DRAWN BY G.L.MARSH
TRACED BY G.A. STUNKARD

58

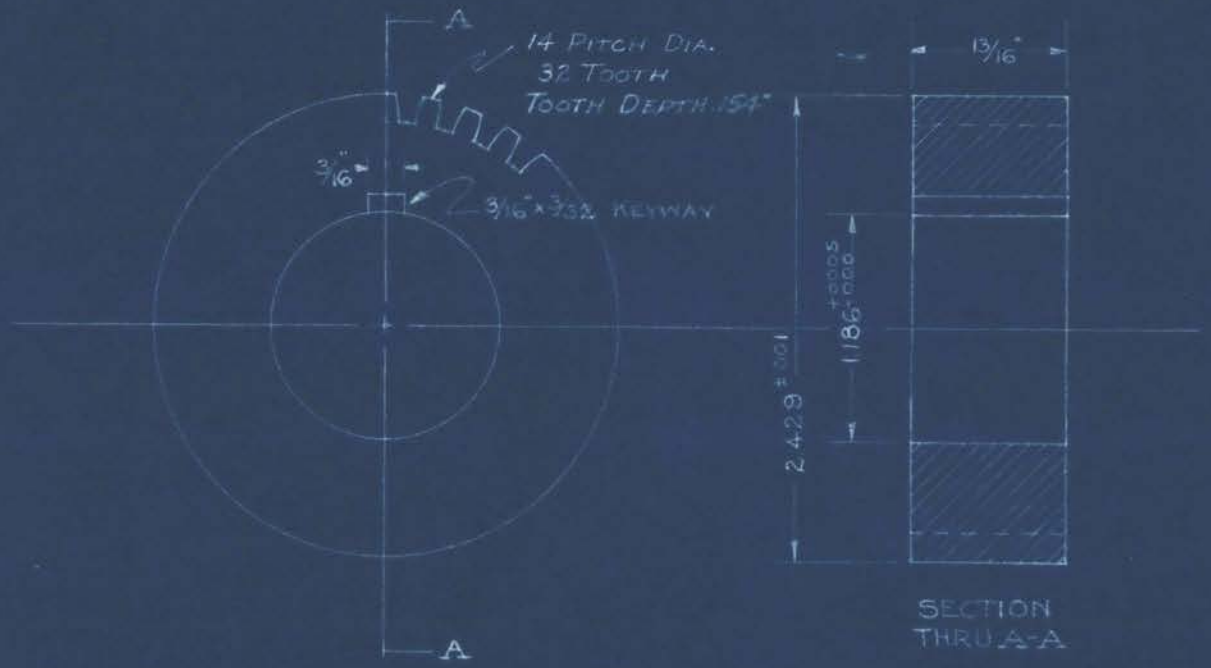
DRILL PRESS VISE







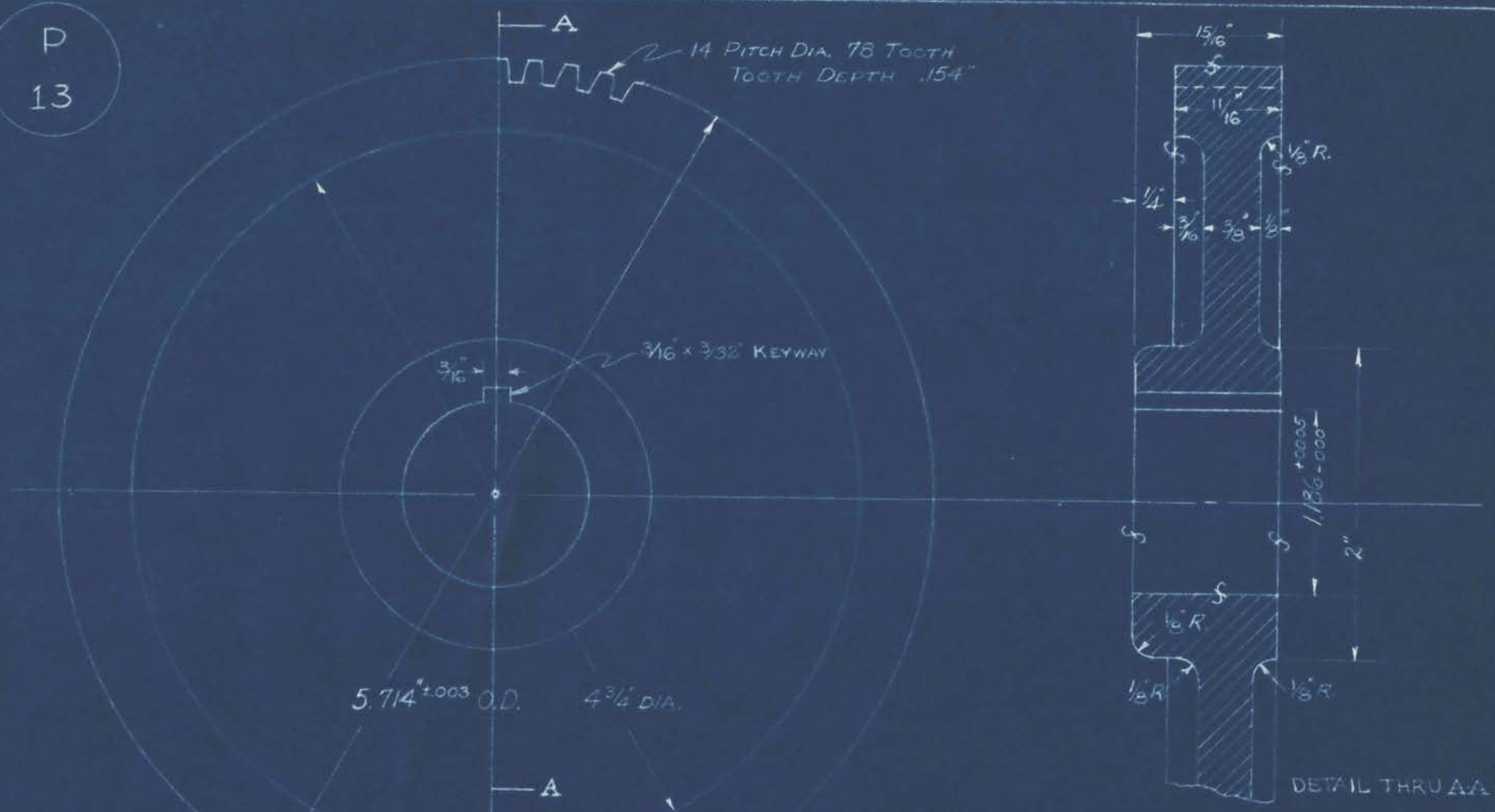
P
14



11" SOUTH BEND BACK GEAR		
SCALE FULL SIZE		
1 PINION GEAR	STEEL	1 REQD
DRAWN A.E.F 4/3/41	CHECKED	
NAT'L DEFENSE IND. TRAINING TULSA OKLA.		

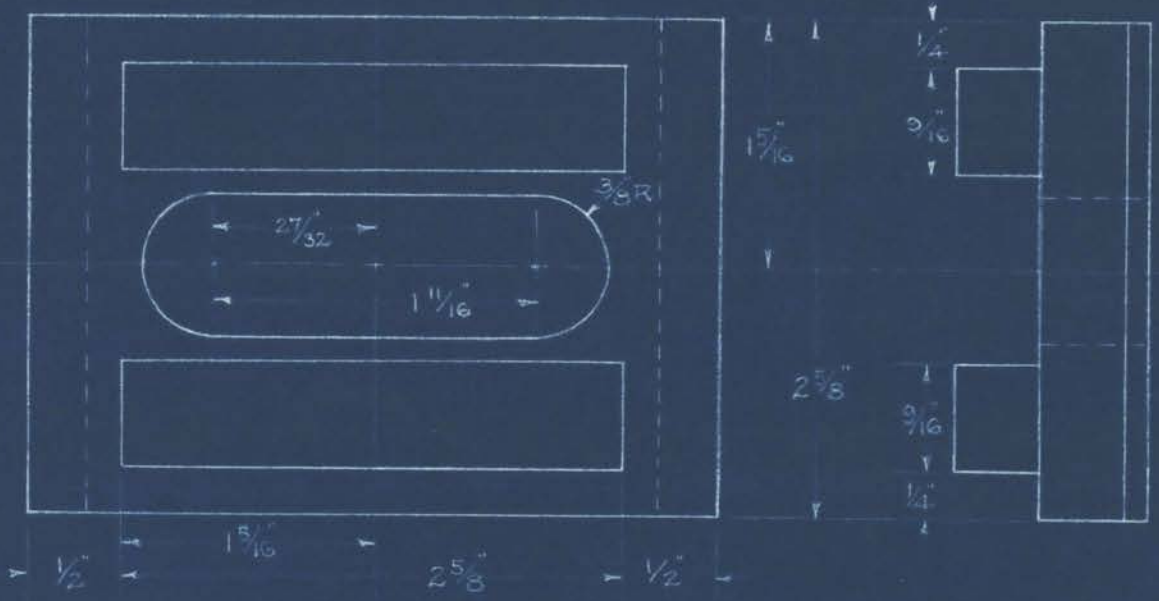
80

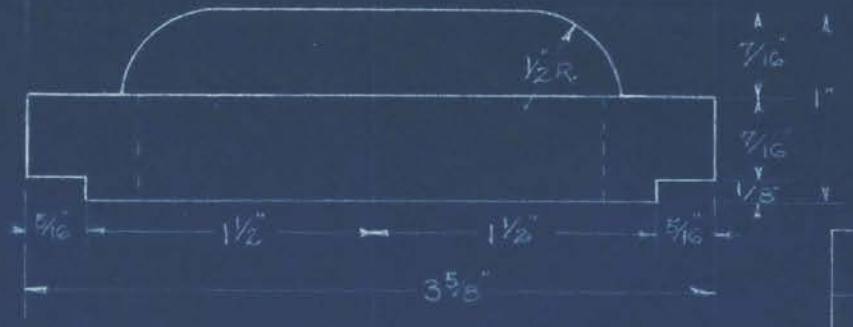
P
13



11" SOUTH BEND BACK GEAR		
SCALE FULL SIZE		
1. LARGE GEAR	STEEL	1 REQD
DRAWN A.E.F. 9/1/41	CHECKED	
NAT'L DEFENSE IND. TRAINING TULSA OKLA		

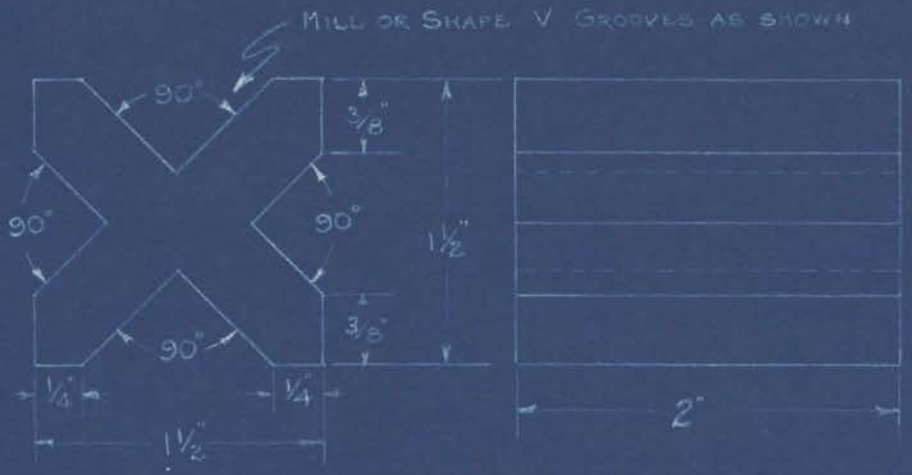
P
23





TAIL STOCK CLAMP		
SCALE FULL SIZE		
1. CLAMP	STEEL	
DRAWN A.E.T 4/11/41	CHECKED	
NAT'L. DEFENSE IND. TRAINING TULSA OKLA		

P
21



STARRETT V BLOCK		
SCALE FULL SIZE		
1. V BLOCK	STEEL	
DRAWN A.E.F. 4/11/41	CHECKED	

LATHE PROJECT NO. 2

HOLLOW HANDLE HAMMER HEAD

1st Unit

1. Check out stock. (Length of handle, head, and plug, plus 3/4".)
2. Set up between centers, and rough turn to largest diameter. (Allow 1/32" above finished sizes for finishing cut.)
3. With pointed tool such as rough threading tool, mark positions of lineal dimensions. (Allow 3/8" from tail stock end to avoid leaving center hole in peen end.)
4. Rough turn peen.
5. Rough turn center of head.
6. Rough turn rest of head.
7. Rough turn fillets using radius gage.
8. Finish turn fillets to size.
9. Finish turn peen and rest of head to size.
10. Turn down at each end to prepare for cutting off. (CAUTION. In using round nose tool, prevent digging in by keeping the point of the tool narrow.)
11. Polish to finish.
12. Take to the bench and cut off with hand hack saw, leaving each end of hammer head to be finished in four jaw chuck.
13. Chuck in four jaw chuck, using brass strips to protect finish, and finish peen to gage.
14. Reverse and finish face to gage.
15. Set up in chuck to drill for handle, using brass strips to protect finish.
16. Very carefully and accurately true up with brass pointer, center between shoulders and diameter of center portion. (Have foreman or instructor check.)
17. Face off carefully, avoiding heavy cuts and drill to tapping size, with drill in tail stock.
18. Counter bore, using right hand side tool. (Handle very carefully, starting from hole and working out. Finish counter bore diameter by backing out of bore to prevent digging in.)
19. Tap. (Support tap with dead center and tap by hand, locking spindle with back gear. Use lard oil, back up often to break chips.)
20. Get instructor's OK and place in stock with label attached. (Have you applied rust preventative?)

LATHE PROJECT NO. 2

HOLLOW HANDLE HAMMER PLUG

2nd Unit

1. Check out stock. (Use same piece as checked out.)
2. Rough turn to largest outside diameter.
3. Turn shoulder and diameter for threading.
4. Thread end to gage. (Polish thread.)
5. Knurl.
6. Rough out for radius on plug.
7. Using steady rest, drill to make plug hollow.
8. Cut off, with hack saw, holding job in the vise.
9. Chuck adapter No. 3 in four jaw chuck.
10. Screw in plug, finish radius end to radius gage and polish. (Check sizes.)
11. Take to milling machine. (Have milling machine man mill slot. Use milling adapter No. 4.)
12. Hand polish off burrs and check with instructor and get OK, and place project in stock with label attached. (Have you applied rust preventative?)

LATHE PROJECT NO. 2

HOLLOW HANDLE HAMMER HANDLE

3rd Unit

1. Check out stock. (Use remainder of stock.)
2. Rough turn to largest diameter. (Between center)
3. Reverse driving end, and offset tail stock to turn taper. (See South Bend Lathe Book, page 72.)
4. Turn taper to finished size.
5. Turn shoulder and diameter for threaded portion for head. (Use radius gage.)
6. Thread for head. (Have you passed test on cutting practice threads?)
7. Chuck adapter #1 in four jaw chuck, and screw threaded end of handle into it.
8. Set up steady rest, true by supported job with center, and gently move jaws of steady rest to make contact with straight portion of handle.
9. Check out taper shank drill as shown on blue print and drill to proper depth.
10. Bore for threading.
11. Thread to gage. (Have you passed test on practice internal threading?)
12. Chamfer thread as shown.
13. Use adapter No. 2 and screw into job.
14. Remove steady rest, and support job on dead center.
15. Knurl.
16. Check for complete finish, and size, and polish to finish.
17. Get instructor's OK and place project in stock with label attached. (Have you applied rust preventative?)

LATHE PROJECT NO. 2

HOLLOW HAMMER HANDLE CASE HARDEN

HEAD

4th Unit

1. Check out case hardening compound.
2. Using gas hot plate, heat compound until melted.
3. Suspend on hanger and allow face end only to go into solution to depth of ½".
4. Treat for three hours.
5. Repeat process at other end. (CAUTION. Avoid hardening thread.)

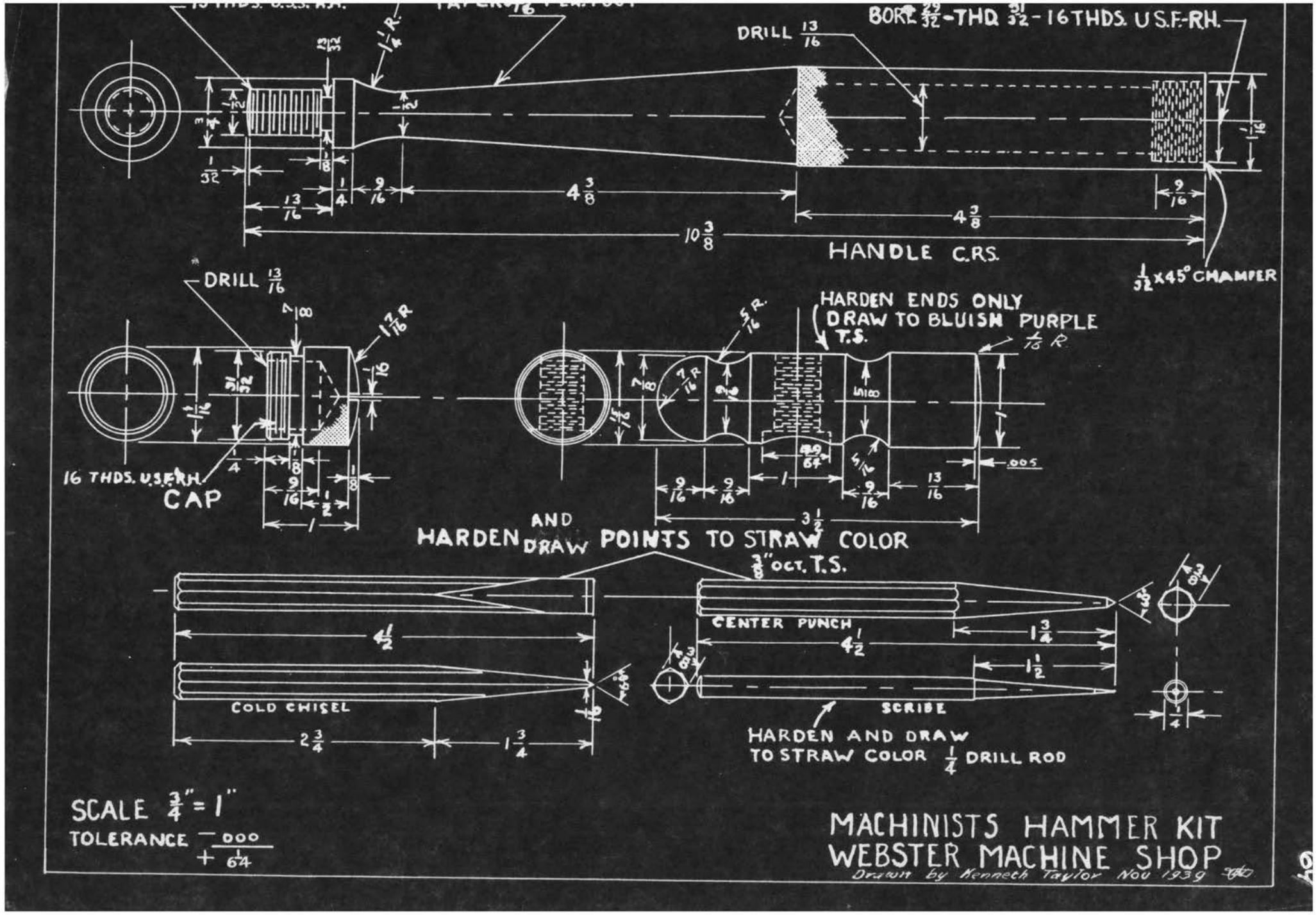
LATHE PROJECT NO. 2

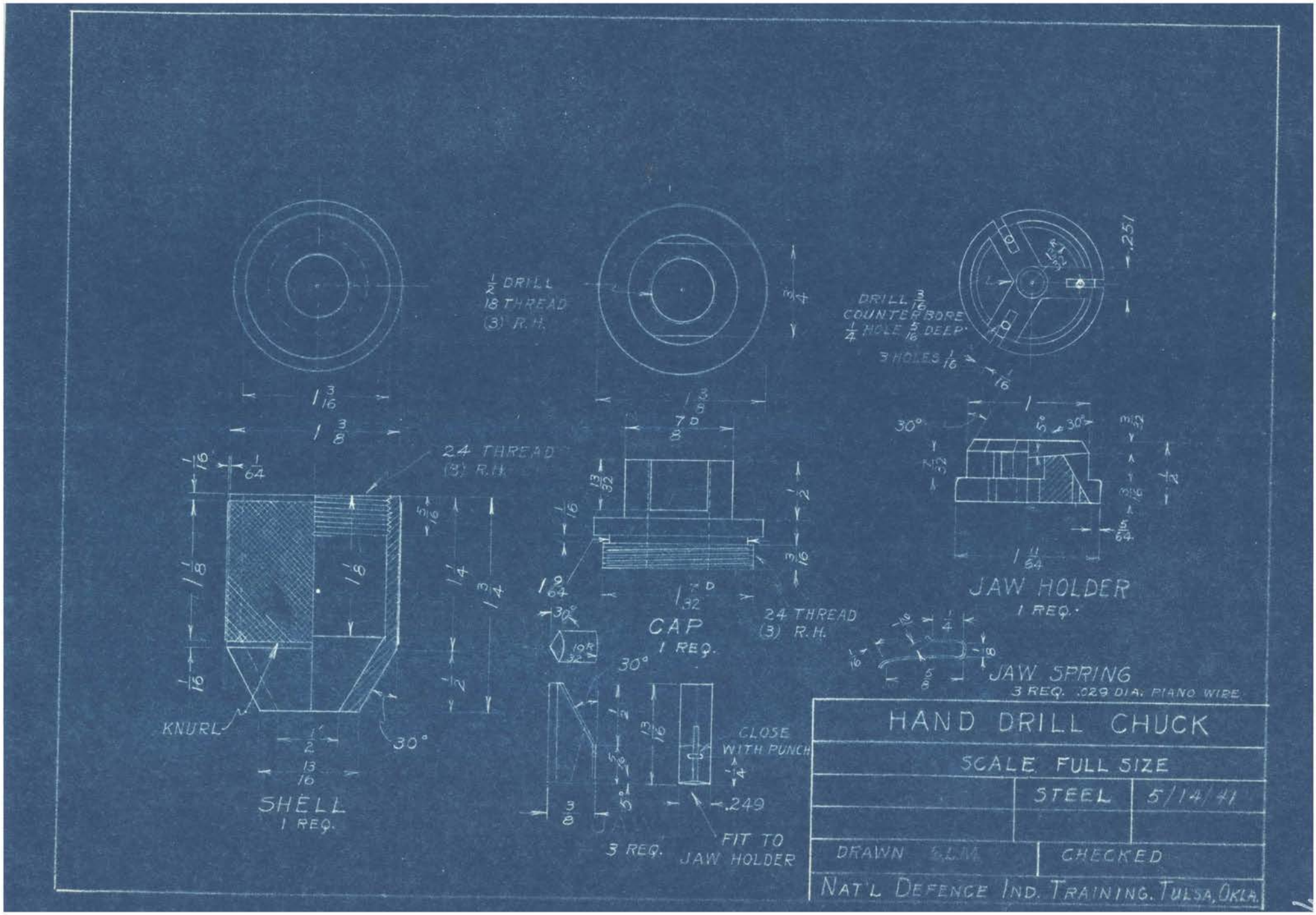
HOLLOW HANDLE HAMMER

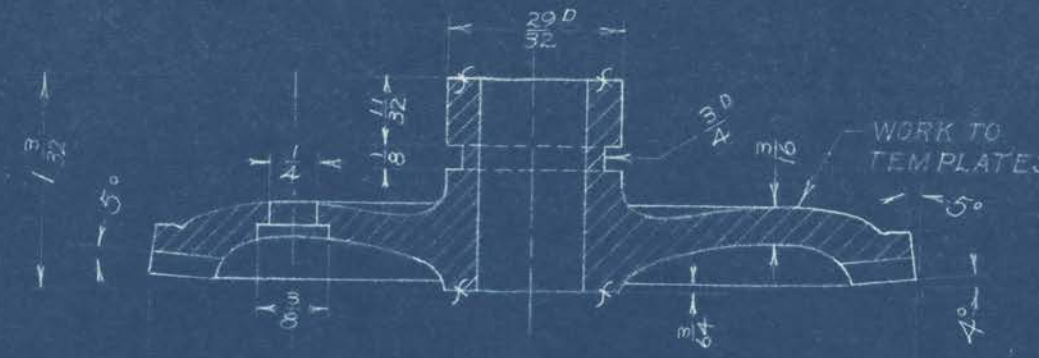
ASSEMBLY AND BENCH

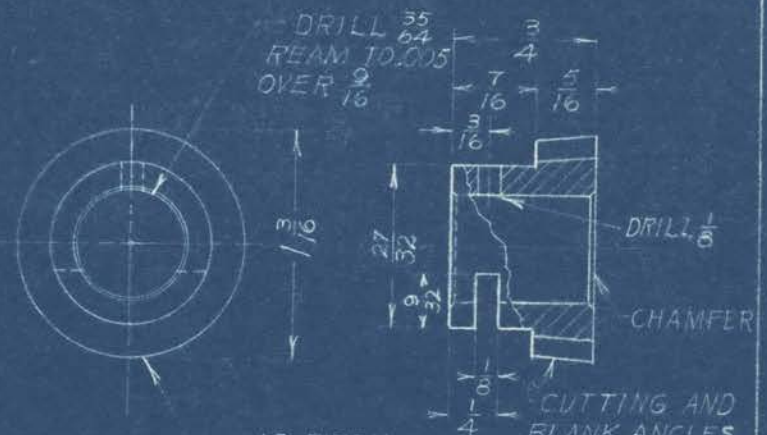
5th Unit

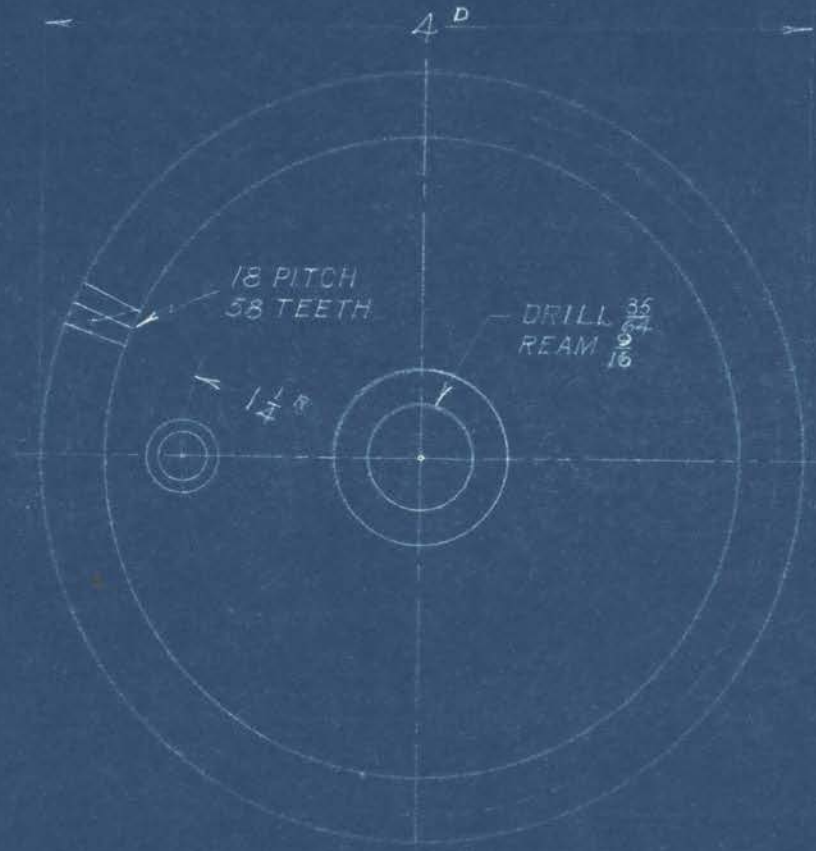
1. Check out handle, and head.
2. File slight countersink in head to fill by peening.
3. Using lead vise jaws, hold head in position and screw in handle tightly. (Be careful to avoid damaging knurled portion by using soft metal protectors between job and pipe wrench jaws.
4. Peen thread portion until all metal is filled in.
5. Rough off with file. (If any black shows, peen lightly to fill up.)
6. File off to finish.
7. Polish to finish.
8. Get instructor's OK and check in project to finished stock with label attached. (Have you applied rust preventative?)

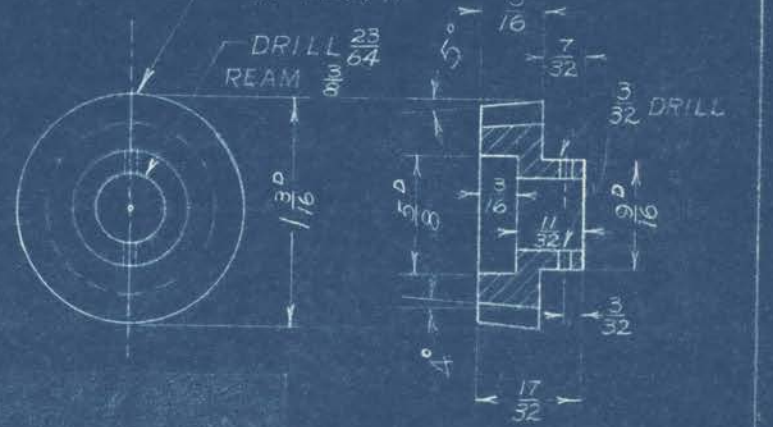

DRILL 13/16
BORE 29/32 - THD 31/32 - 16 THDS. U.S.F.-RH.
HANDLE C.R.S.
1/32 x 45° CHAMFER
DRILL 13/16
16 THDS. U.S.F.-RH.
CAP
HARDEN ENDS ONLY
DRAW TO BLUISH PURPLE
T.S.
HARDEN AND DRAW POINTS TO STRAW COLOR
3/8" OCT. T.S.
CENTER PUNCH
COLD CHISEL
SCRIBE
HARDEN AND DRAW
TO STRAW COLOR 1/4 DRILL ROD
SCALE 3/4" = 1"
TOLERANCE — .000 / + 1/64
MACHINISTS HAMMER KIT
WEBSTER MACHINE SHOP
Drawn by Kenneth Taylor Nov 1939


1/2 DRILL
18 THREAD
(3) R.H.
DRILL 3/16
COUNTER BORE
1/4 HOLE 5/16 DEEP
3 HOLES
24 THREAD
(3) R.H.
KNURL
30°
SHELL
1 REQ.
CAP
1 REQ.
24 THREAD
(3) R.H.
JAW HOLDER
1 REQ.
JAW SPRING
3 REQ. .029 DIA. PIANO WIRE
CLOSE
WITH PUNCH
.249
FIT TO
JAW HOLDER
3 REQ.
HAND DRILL CHUCK
SCALE FULL SIZE
STEEL
5/14/41
DRAWN
CHECKED
NAT'L DEFENCE IND. TRAINING. TULSA, OKLA.







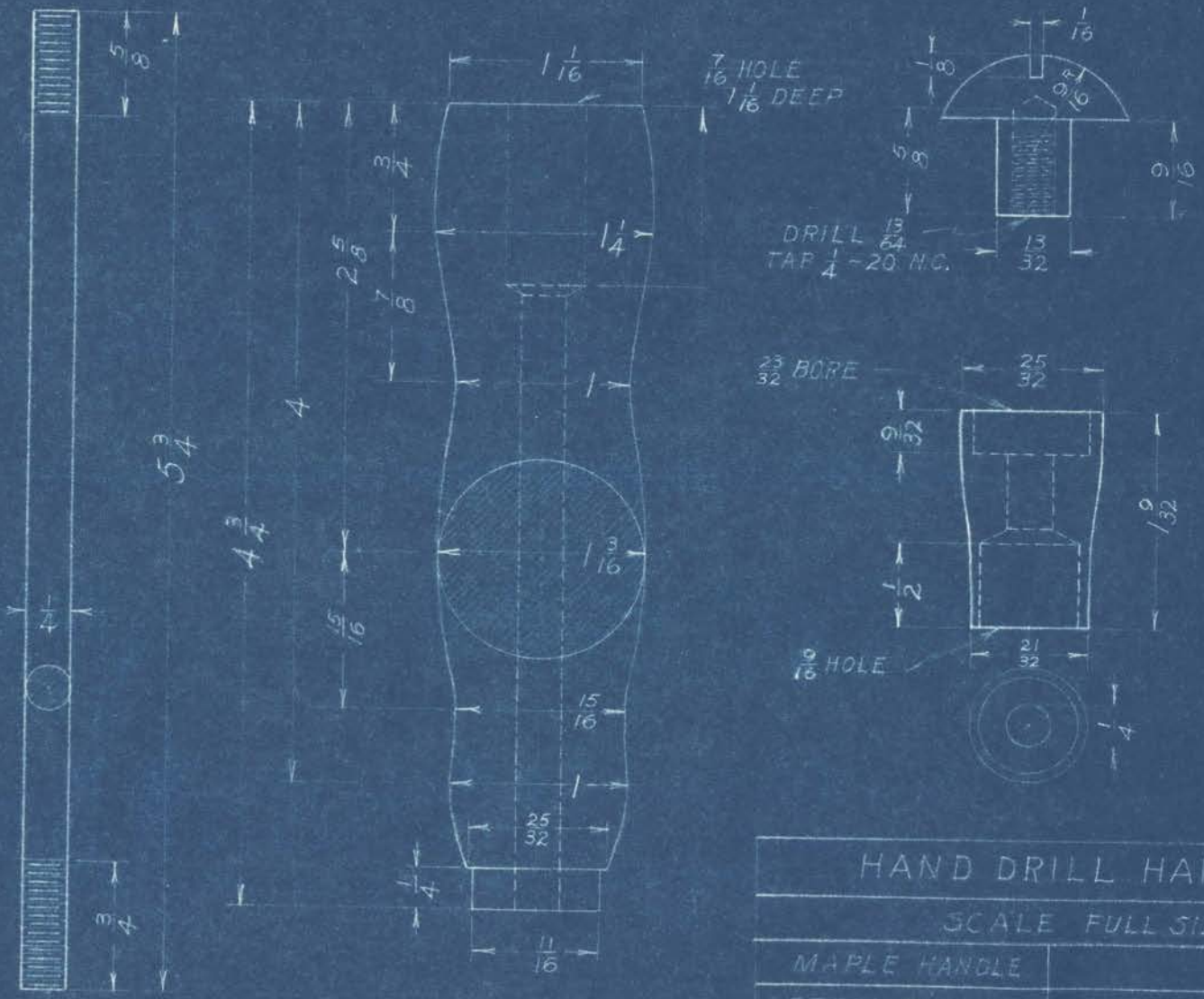


HAND DRILL GEARS

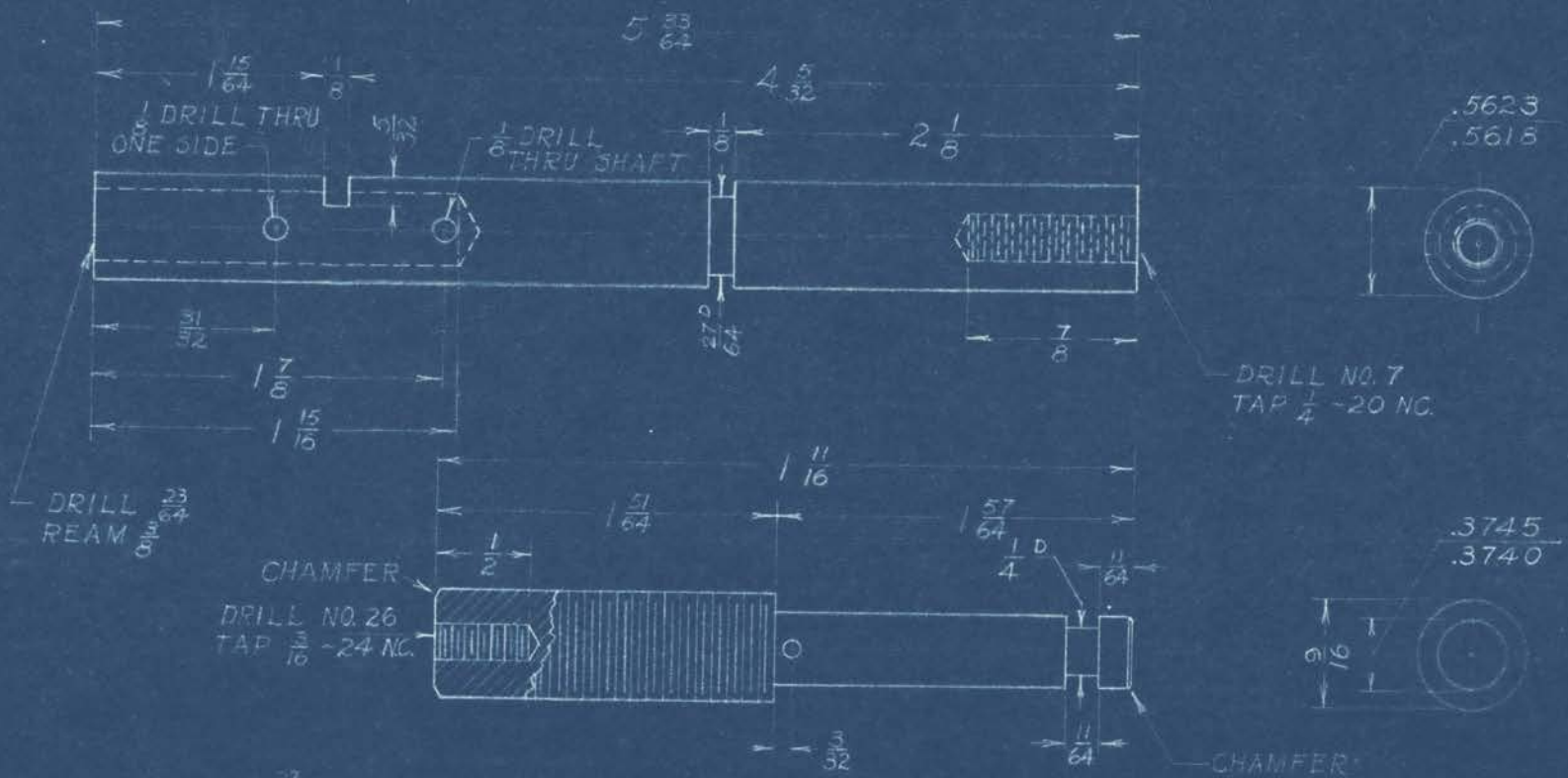
SCALE FULL SIZE

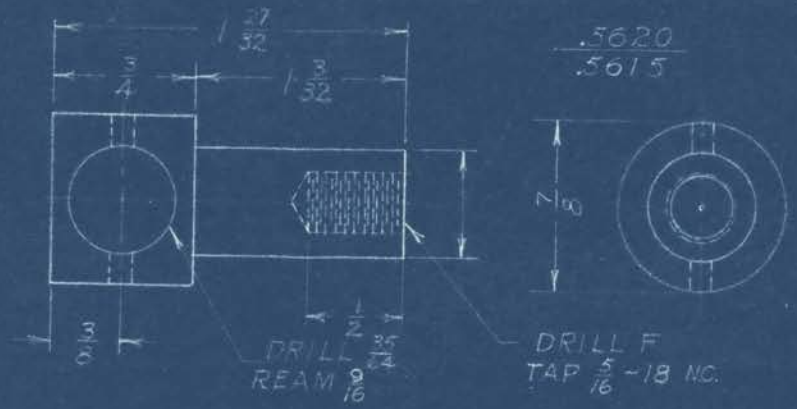
MACHINE STEEL		5/28/41
DRAWN G.L.M.	CHECKED	

NAT'L DEFENSE IND. TRAINING TULSA, OKLA.

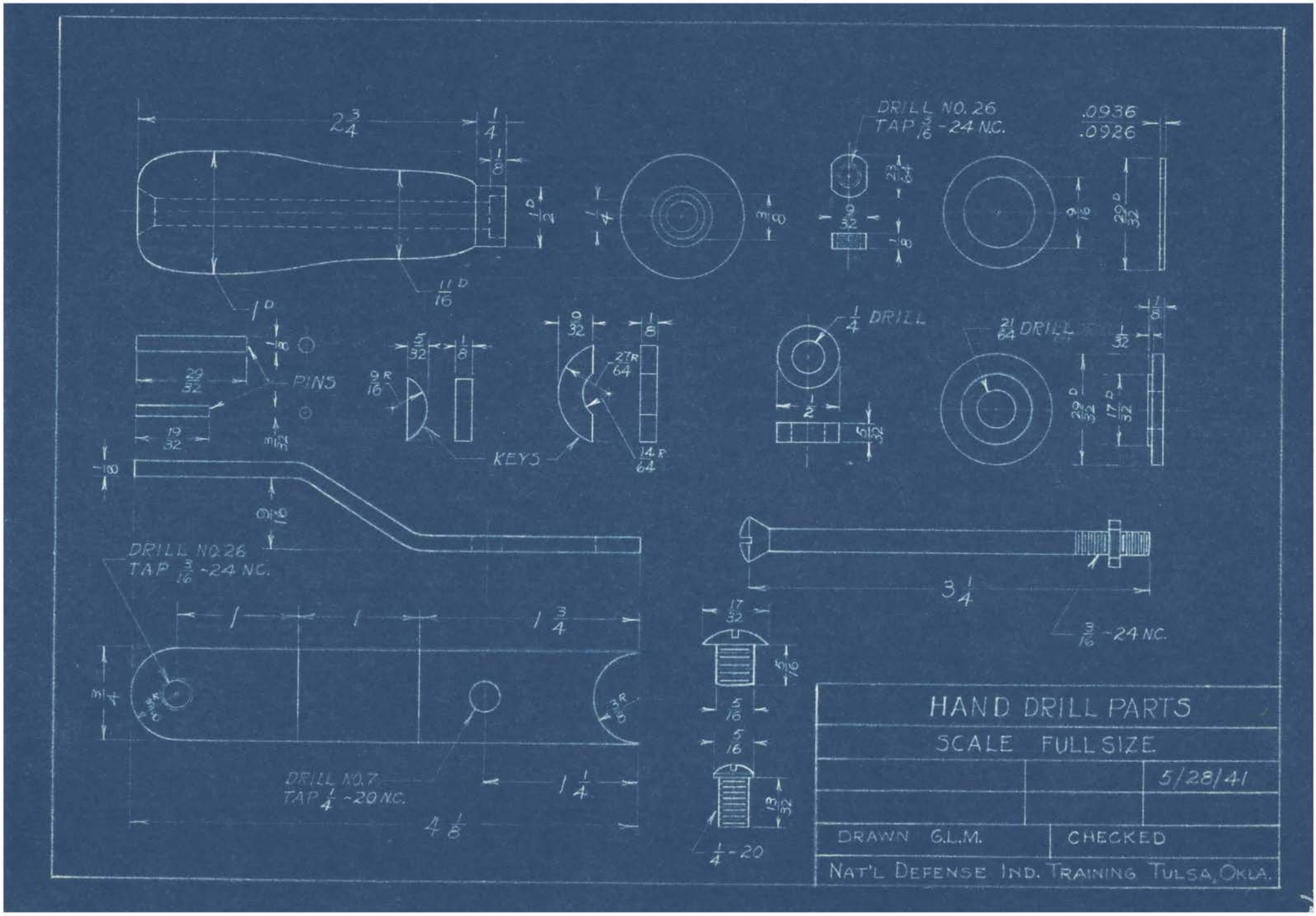


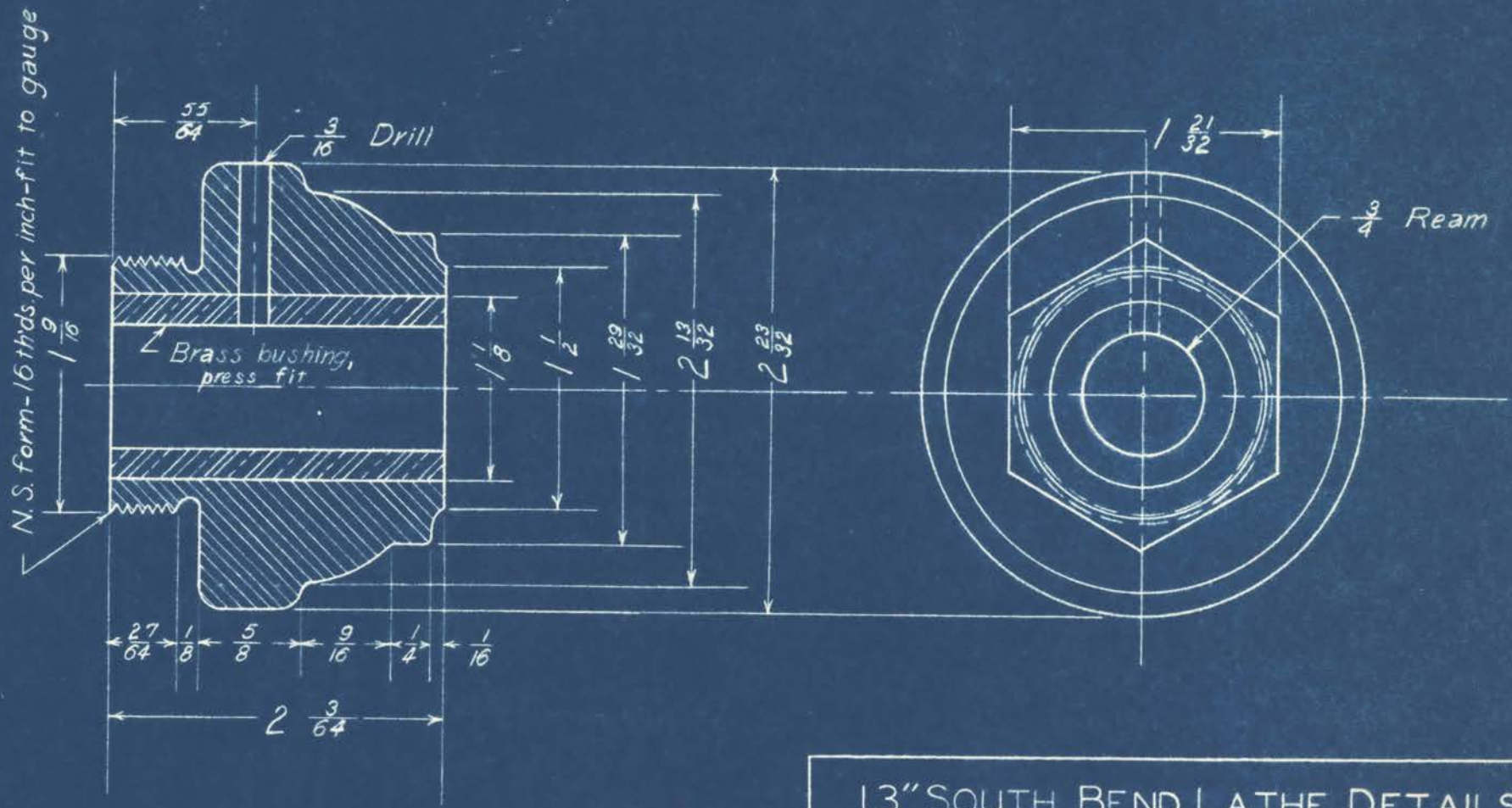
HAND DRILL HANDLE		
SCALE FULL SIZE		
MAPLE HANDLE		5 18 41
STEEL FITTINGS		
DRAWN G.L.M.	CHECKED	
NAT'L DEFENCE IND. TRAINING TULSA, OLK.		





HAND DRILL	
CENTER SHAFT	CHUCK SHAFT
GEAR ARM	5/28/41
SCALE FULL SIZE	
DRAWN G.L.M.	CHECKED
NAT'L DEFENSE IND. TRAINING TULSA OKLA.	


2 3/4
1/4
1/8
1 D
11/16 D
DRILL NO. 26
TAP 3/16 - 24 N.C.
.0936
.0926
29/32
19/32
PINS
5/32
9/16 R
27/64 R
14/64 R
KEYS
1/4 DRILL
21/64 DRILL
1/32
DRILL NO. 26
TAP 3/16 - 24 N.C.
1
1 3/4
3 1/4
3/16 - 24 N.C.
DRILL NO. 7
TAP 1/4 - 20 N.C.
4 1/8
1/4 - 20
HAND DRILL PARTS
SCALE FULL SIZE
5/28/41
DRAWN G.L.M.
CHECKED
NAT'L DEFENSE IND. TRAINING TULSA, OKLA.

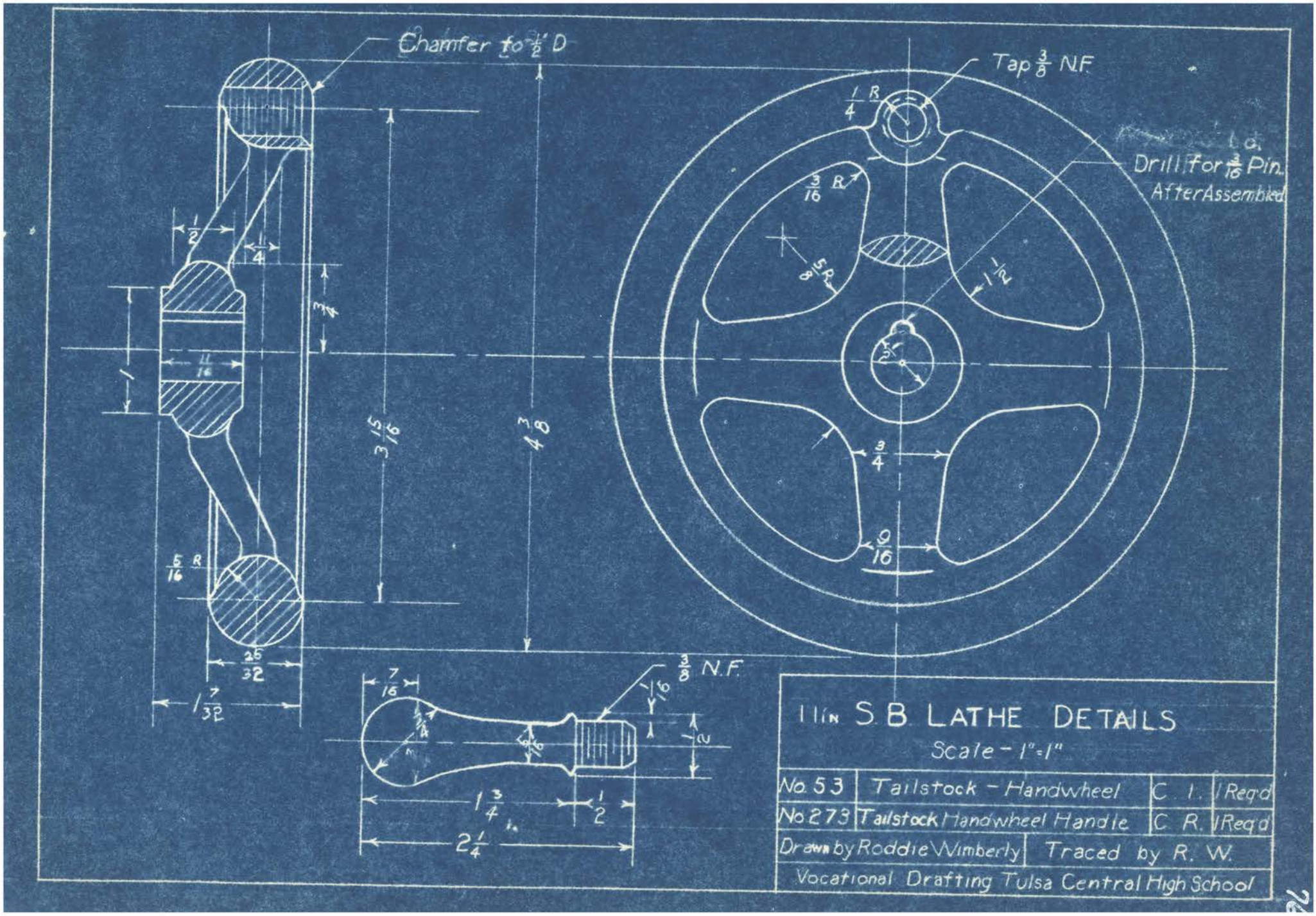


13" SOUTH BEND LATHE DETAILS

SCALE 1"=1"

No. 52	TAILSTOCK SPINDLE SCREW BEARING	C. I.	1 Reqd
DRAWN BY Odie H Bridgewater Jr.		TRACED BY O.H.B. Jr.	

VOCATIONAL DRAFTING - TULSA CENTRAL HIGH



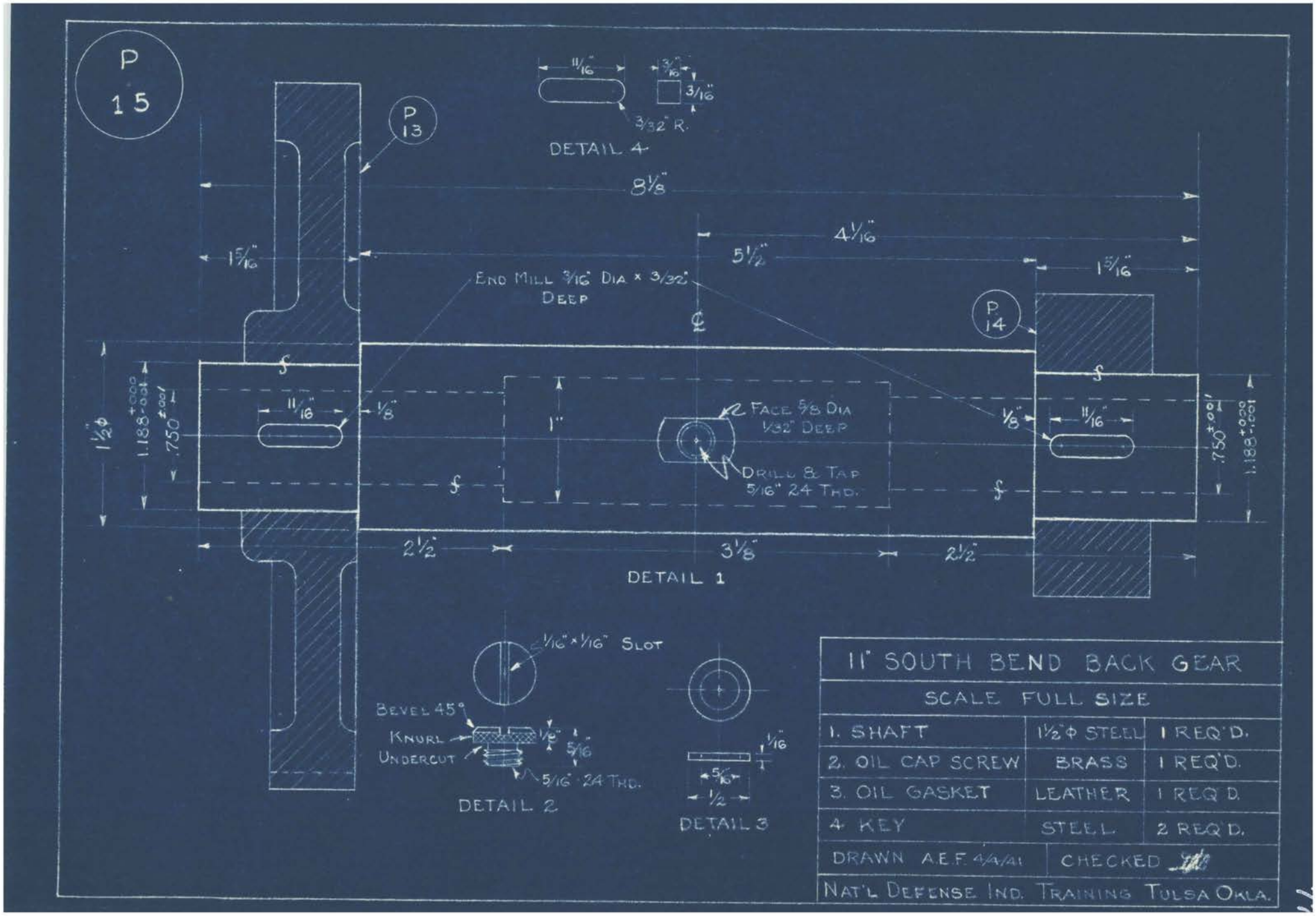
11in S.B. LATHE DETAILS

Scale - 1" = 1"

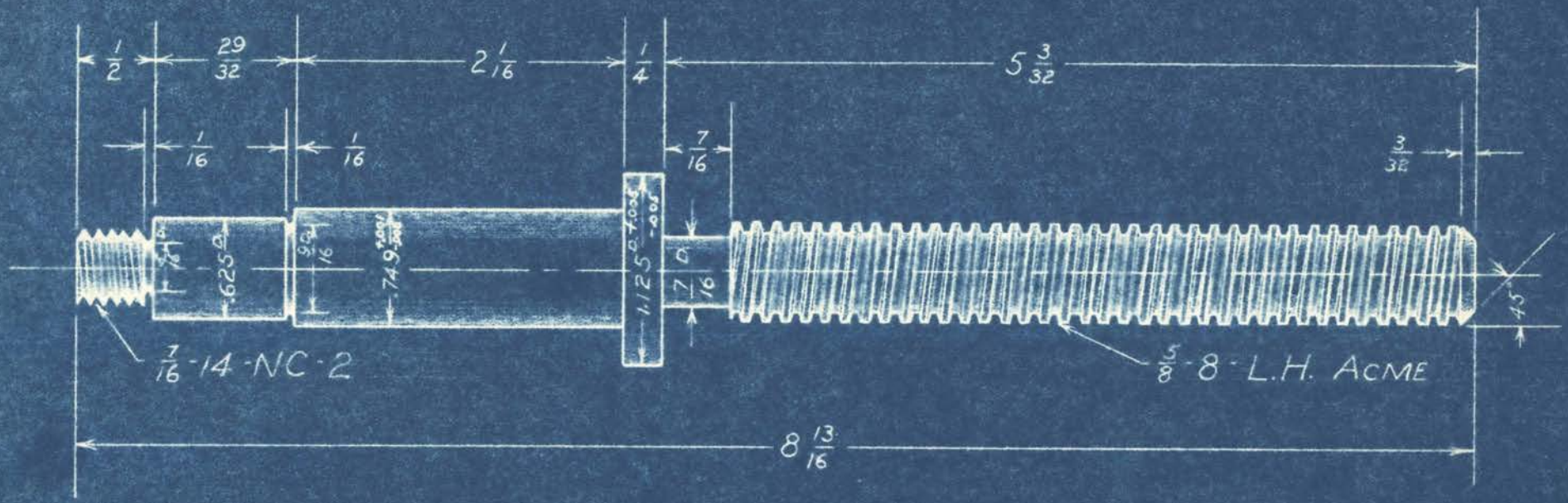
No. 53	Tailstock - Handwheel	C. I.	1 Req'd
No. 273	Tailstock Handwheel Handle	C. R.	1 Req'd

Drawn by Roddie Wimberly | Traced by R. W.

Vocational Drafting Tulsa Central High School



11" SOUTH BEND BACK GEAR		
SCALE FULL SIZE		
1. SHAFT	1½"Φ STEEL	1 REQ'D.
2. OIL CAP SCREW	BRASS	1 REQ'D.
3. OIL GASKET	LEATHER	1 REQ'D.
4. KEY	STEEL	2 REQ'D.
DRAWN A.E.F. 4/4/41	CHECKED	
NAT'L DEFENSE IND. TRAINING TULSA OKLA.		



finish all surfaces

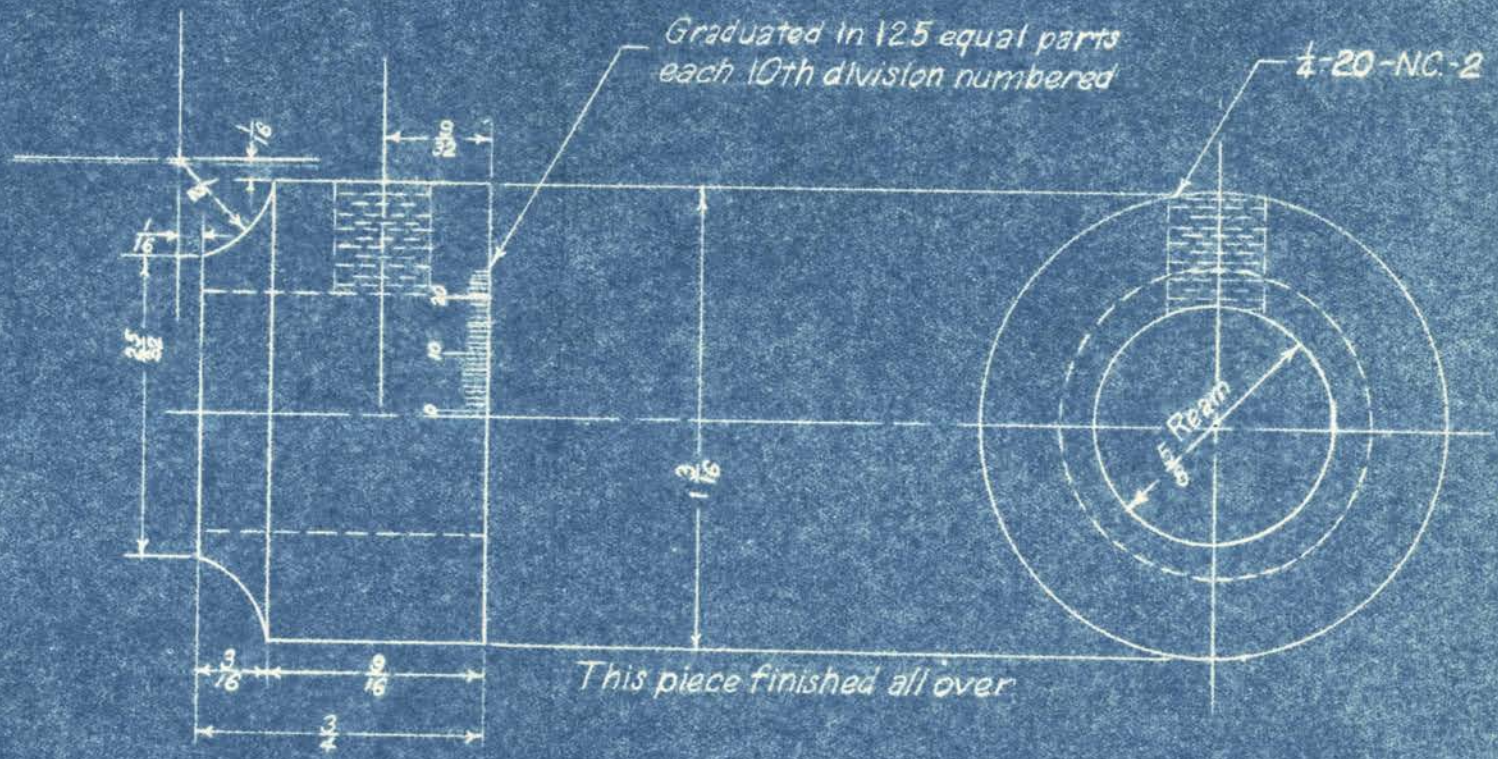
13"-S.B. LATHE DETAILS

Scale 1" = 1"

No. 226	TAIL STOCK SPINDLE SCREW	C.R.S.	1 Req'd

Drawn by J.R. Humphreys Traced by J.R.H.

Vocational Drafting - Central High School



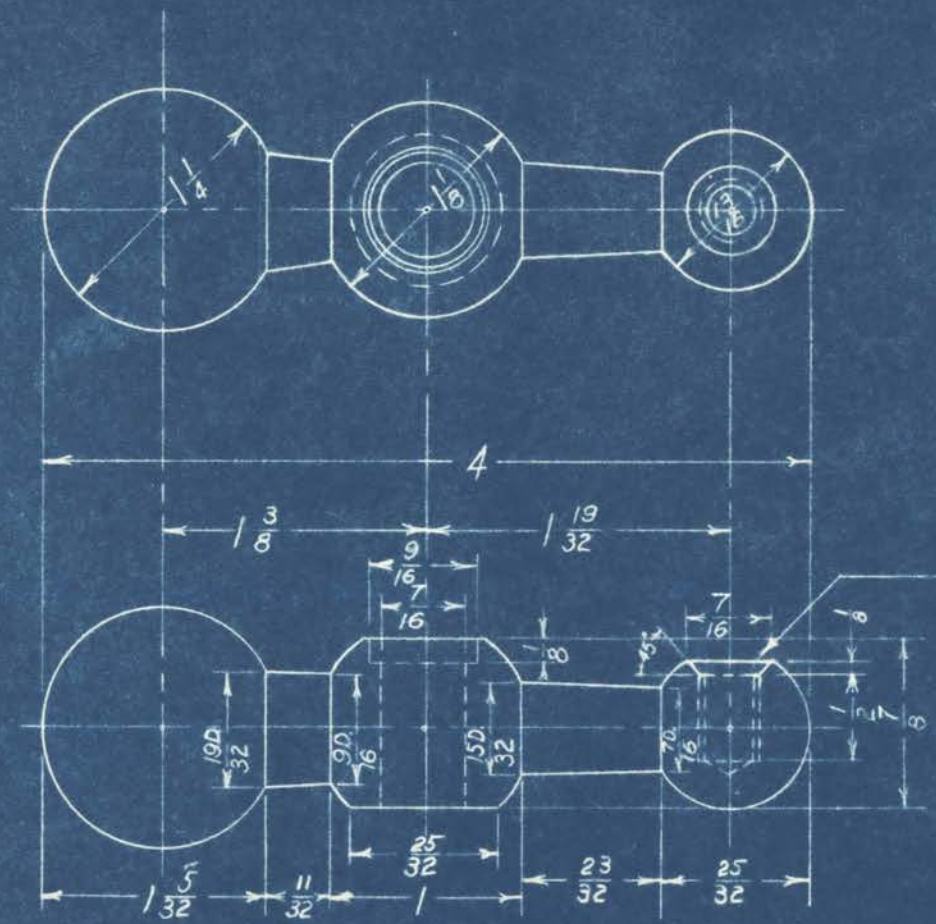
13" S. B. LATHE DETAILS

Scale - 2" = 1"

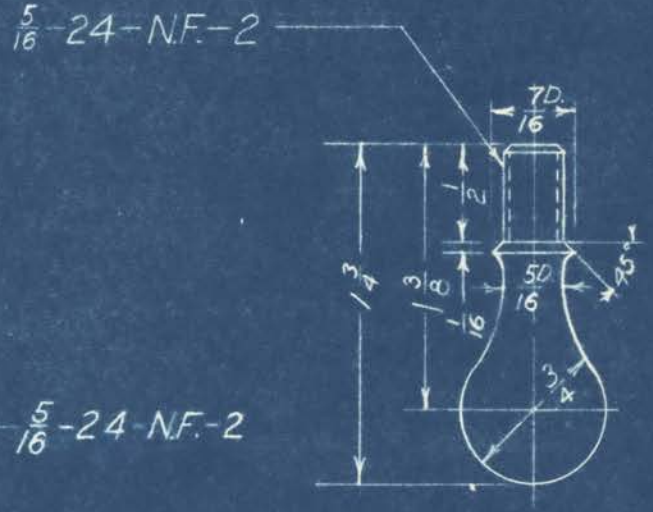
# 64	GRADUATED COLLAR	C. R. STEEL	1 req'd

Drawn by Sid. Lancaster — Traced by Sid. Lancaster

Vocational Drafting - Central High School



Finish all over.

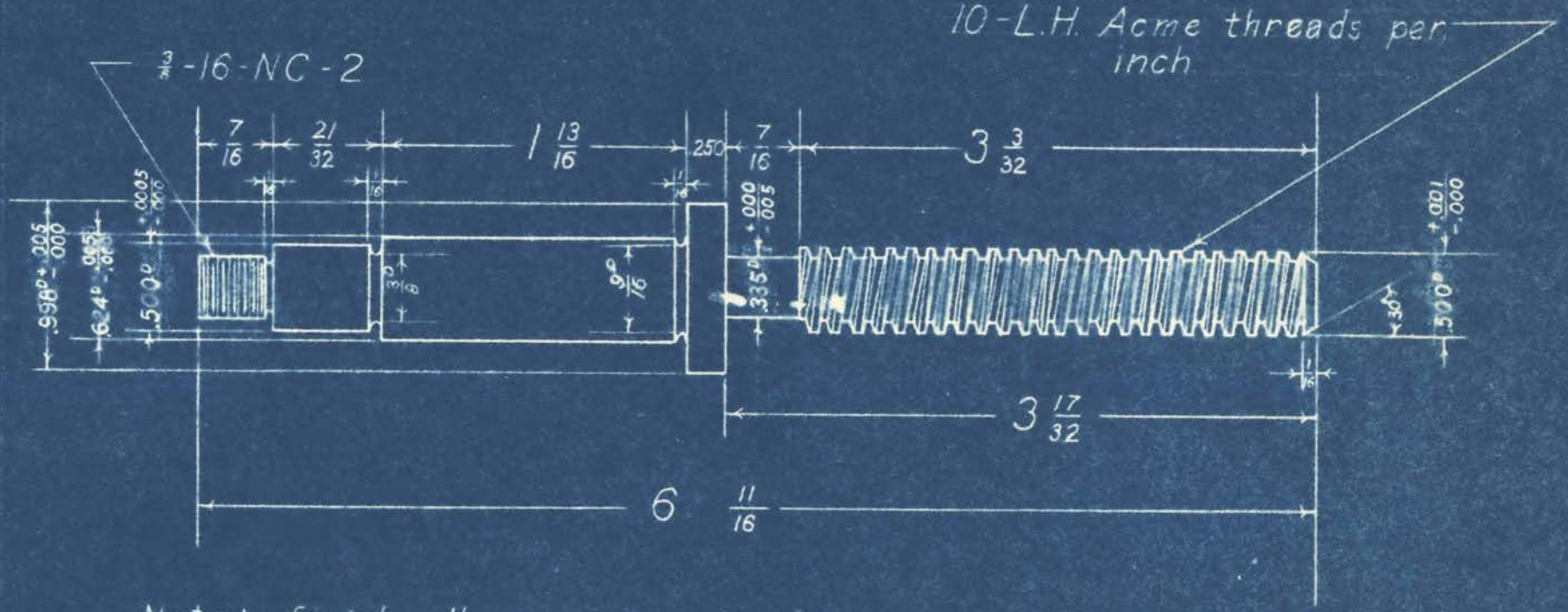


Finish all over.

13" SOUTH BEND LATHE DETAILS

Scale: 1"=1'

No.	Crossfeed Handle	C.R. Steel	1 Req'd
Drawn by G.A. Stunkard		Traced by G.A. Stunkard	
Vocational Drafting - Central High School			

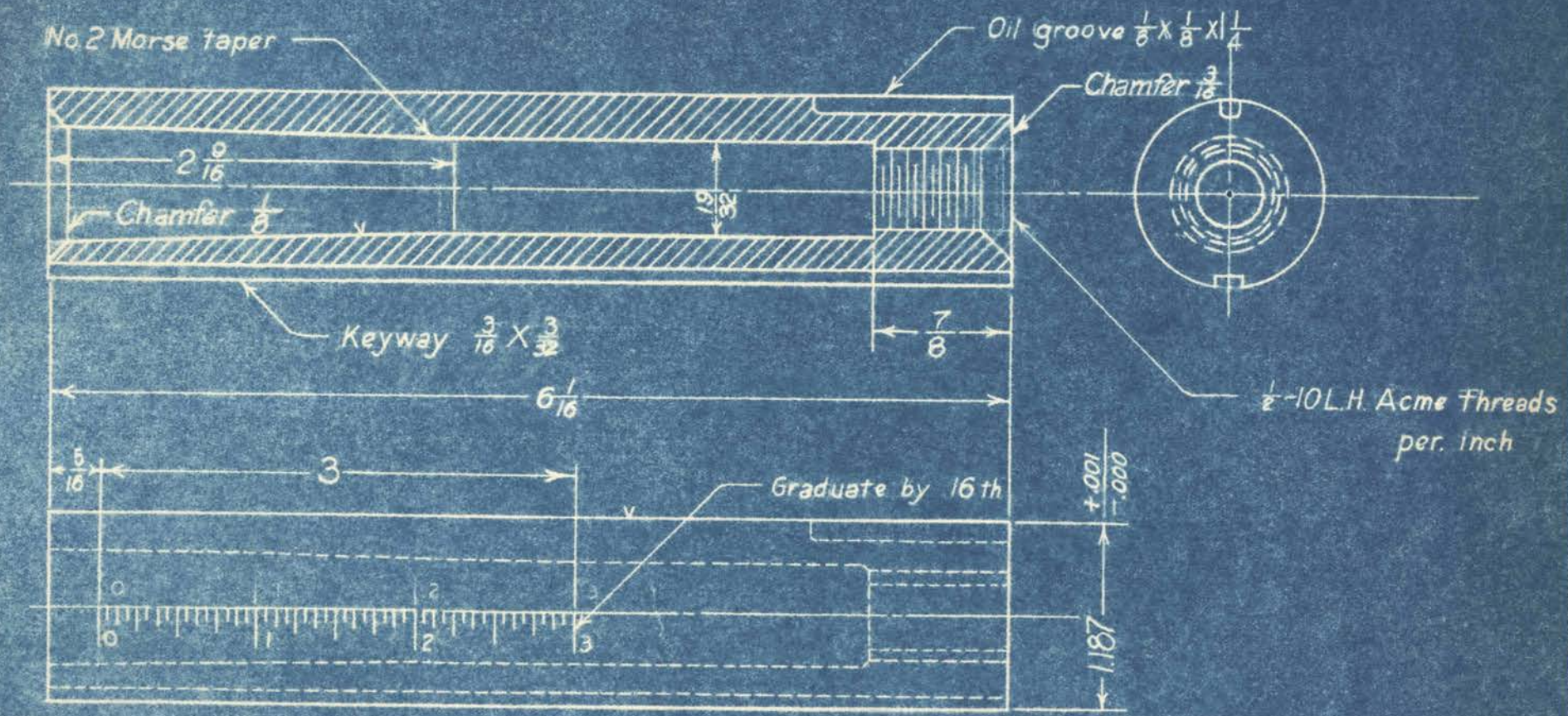


Note: finish all over

11" S. B. LATHE DETAILS

Scale 1" = 1"

No. 226	Tail Stock Spindle Screw	C.R. Steel	1 Req'd
Drawn by Dillard Iseley	Traced by Dillard Iseley		
Vocation Drafting			



11" S.B. LATHE DETAIL

Scale 1" = 1"

No. 201	Tailstock Spindle	C.S.	1 Req'd

Drawn by B. Kennett — Traced by B. Kennett

Vocational Drafting — Tulsa Central High

CHAPTER VI

SUMMARY OF FINDINGS AND CONTRIBUTIONS

Purpose of Study

As stated in the introduction, there is a demand for skilled workers in this country today. A training program planned by the Office of Education is turning over to industry thousands of individuals monthly to help fill this need. Some of the workers for this training program are selected from W.P.A. rolls, other trainees in the program are workers that have had a skill, but which needs replenishing, and others are workers who have had no experience when entering the training program.

It has been the purpose of this study to show how a course of study should be developed, to show instructional material to be developed from the course of study, to reveal how systematic testing of engine lathe operators can emphasize points that need instruction, to discuss the tests, show the value of a systematic method of recording the test results, and show the need for better methods of instructing.

Determining Initial Assets of Trainees

In the beginning of the National Defense Industrial Training program, some method had to be devised to record a prospective trainee's work experience. The application

for training blank, (page 90), is one of the several forms tried in Tulsa. Since some of the trainees had had little formal schooling, several of the forms contained information hardly legible.

Of the 116 men accepted for machine shop training, 45 classified their experience as general machinist. Next in number were operators of the drill press and lathe. Twelve other types of work experiences were listed, including assembly worker, auto mechanic, aviation mechanic, common laborer, machinist's helper, shop foreman, milling machine, pattern and casting work, pipe machine operator, round house mechanic, stock room attendant, tool joint maker, tool and die maker, and shaper.

One of the most significant points in determining the initial assets of trainees was the lack of men trained in bench work. Few men enjoy that type of work, consequently, there is a scarcity of skilled hand fillers.

Men of all ages have entered the machine shop classes and have benefited in some way from the experience gained therein. The ages vary from young men of 17 to older men of 58 with few years of active service left. There have been few men over 45 in the machine shop classes, and the majority of the trainees are from 25 to 30 years of age.

All information about the trainees in machine shop classes was taken from the application for training blank.

If a trainee was accepted for training, he took the tests, (Chapter IV) at various times to determine actually what he did know. People who fill out application blanks are prone to put down things they cannot do in actual practice. The series of tests developed by the teachers of machine shop and their supervisor, immediately revealed the extent of each trainee's ability. When a weak point in his former training or experience was found, then special emphasis was placed on that particular operation. For example, one trainee had cut threads of the national type for years, but had never cut any acme threads. During the course, special emphasis was placed on this operation for this trainee, and before the course was finished he was cutting acme type threads in the shop where he worked. Other similar examples are often told by the instructors in machine shop practice.

The need of better instruction sheets is a paramount issue in the national defense program. Breaking up the instructional material into small enough points so that nothing will be omitted is the greatest difficulty. It is hard for the skilled machinist to analyze all parts of a job and put it into a form the student can follow.

It is difficult for a machinist to explain why he selects certain cutting tools for a particular job. He can tell just by glancing at the tool whether it will do the job, but it is impossible for him to put into writing the

knowledge necessary to make proper selections of cutting tools.

The teacher training classes improved instruction immensely by giving the tradesmen, acting as instructors in the national defense classes, some of the facts known to the teaching profession.

Tests and Testing Procedures for Determining Satisfactory Learning

The tests and analysis chart were originated in the office of the supervisor of National Defense training in Tulsa. This study contains an accumulation of the best of these tests and a description of methodsfor their administration.

The need for testing arose with the variation of ability displayed in the first machine shop classes. The tests were developed chiefly to determine the trainee's ability in operating an engine lathe successfully at the beginning and end of the training program. The list of engine lathe operations and related technical knowledge, Table III, was used as a basis for developing the tests. Machinists who were acting as instructors in the national defense classes were responsible for their development and use in the machine shop classes. If the trainee could make a satisfactory showing on the tests then he was given instruction that would

challenge his ability, or instruction on another machine, but if he could not make a creditable showing, then emphasis was placed on items where the individual was weak.

Recommendations for further similar theses would include completion of such studies for other aspects of machine shop and all phases needed in National Defense or other types of Vocational Education programs.

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APPENDIX

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NATIONAL DEFENSE INDUSTRIAL TRAINING PROGRAM
2701 East 8th Street
Tulsa, Oklahoma Phone: 4-4082

APPLICATION FOR TRAINING

Date_____

Name_____ Married_____ Age_____

Address_____ Telephone_____

Employed..... Company_____

Address of Company_____

Unemployed.....

Telephone of Company_____

Nature of present Employment_____

Type of training wanted_____

_____

Extent of Schooling_____

EXPERIENCE:

	:No. of: :Years :	

Note: It is important to state whether you worked as a helper or apprentice, or tradesman.

Have you made application with the Oklahoma State Employment Service located at 125 West Third Street?_____
When?_____.

Further Comments:_____

_____

_____

TYPIST:

Winnifred Young Vogler
Stillwater, Oklahoma