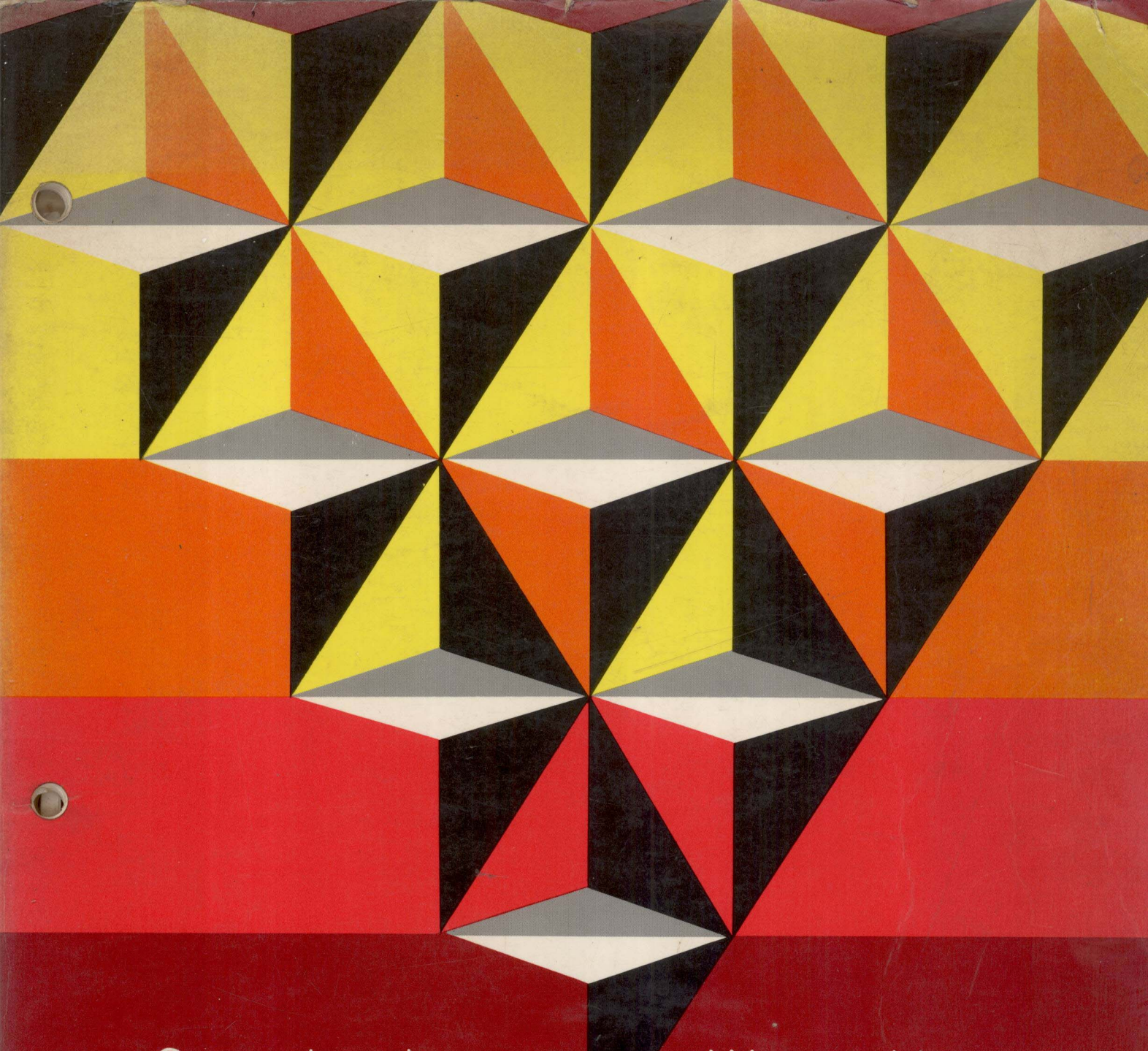

Seventh edition

Warren J. Luzadder
K. E. Botkin

Problems in engineering drawing

for design, product development, and numerical control

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by Luzadder and Botkin

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INTRODUCTION

Purpose of the Worksheets

Most of the worksheets in this volume are in the form of partial layouts. In basic drawing courses they make possible the presentation of the maximum amount of subject matter within a limited time. The student obtains a greater variety of experiences with layouts that are partly completed, because he need not copy those portions with which he is already familiar. Time is too precious, in many courses today, to be wasted in reproducing material presented in drawing texts and in doing other preliminary work that has no teaching value. More thorough learning is possible when a student can direct his full attention to new material.

Units of Measurement

Although it is expected that American industry will gradually change over to the use of SI (Systéme International) units of measurement over the next decade, the inch and pound have been retained as the units for some of the problems. When the SI system is used, the measurement values have been given in millimeters, centimeters, meters, kilometers, kilograms, and newtons. Those using the SI system commonly use millimeters for the dimension values on drawings of machine parts.

At this time, some corporations such as John Deere and International Harvester may be said to have gone almost totally metric. General Motors, Ford, IBM, TRW, and others are either in the process of making a complete change over or are dual dimensioning their drawings. However, it must be pointed out that the extended period of time needed for the American National Standards Institute (ANSI) to prepare and approve new standards for standard parts, threads, cylindrical fits, and so forth will tend to slow this movement toward a totally metric U.S.

Where problems show inch measurements and pounds, the instructor may suggest the use of millimeters for length, kilograms for mass, and newtons as the units of force. In converting to SI metric units, the student will acquire a better understanding of the metric system.

In the case of drawing problems No. 51, No. 58, and No. 60, which show both decimal inch and millimeter values, the millimeter values have been given to full millimeters for noncritical distances. For example, the 1.75 in. value on Dwg. No. 51 is given as 44mm instead of 44.45mm. To give the actual converted value (44.45) would be unrealistic and poor shop practice. For drilled and threaded holes the size values have been given to the nearest metric values listed in tables for small metric drills and metric threads.

General Arrangement and Recommended Uses

The problems are grouped under several commonly used headings: lettering, multiview drawing and sketching, dimensioning, etc. It is not expected, however, that the problems will be worked in numerical sequence. For example, it is recommended that the lettering practice consist of brief periods distributed over several weeks' time.

The instructions for certain of the sketches and multi-view drawings, which precede the dimensioning exercises, call for dimensioning. One way to utilize these advantageously is to complete a sketch or two requiring dimensions prior to discussion of dimensioning principles. The difficulties encountered make the problems on dimensioning more meaningful.

A further distinctive feature of some of the problems is the deliberate omission or incorrect representation of fillets and rounds on given pictures. The student has the opportunity to determine for himself from the function and operation of the parts just which surfaces should be finished and which corners should have fillets or rounds.

The dimensions placed on given pictorial drawings are not always correctly placed nor are they necessarily the ones needed. The intention is to make it impossible merely to do "copy work."

In using the worksheets, the instructor should select sheets adapted to the abilities and interests of the students and himself and even modify the printed instructions when a modification will better suit his needs.

Specific Suggestions

As previously mentioned, it is recommended that the lettering consist of brief exercises. On sheets where four statements are to be lettered, the lettering of a single statement should be sufficient for one class period. Each lettering exercise should be submitted by a student to his instructor for criticism before he proceeds with the next. Exercises involving the use of T-square and triangles, and those requiring the construction of geometrical formations, are designed to offer experience in the use of drafting instruments together with some study in applied geometry. Except in the case of circles, the designs may first be drawn lightly with a hard pencil and then darkened with a softer pencil after approval by an instructor.

On the sketches the lines should be sharp and

black, not broad and fuzzy, and as free from waviness as possible. The word "sketch" does not imply a carelessly executed line drawing. Sketching is the engineer's method of expressing his ideas, and every prospective engineer or technical trainee should attempt to develop proficiency in the art of sketching.

On line drawings designed to teach the basic principles of engineering drawing, the lines should be uniform, sharp and black. A student who is uncertain how well he understands a solution will be wise, usually, to make the construction in very light sharp lines, and then obtain the approval of his instructor before the lines are darkened with a softer (**2H**, **3H** or **4H**) grade of pencil.

Although the problems in this workbook have been designed for use with the text "Fundamentals of Engineering Drawing,"* they can be used with other texts that have an adequate presentation of the SI metric system. The authors will appreciate any criticisms and suggestions from users of these worksheets.

THE AUTHORS

*By Warren J. Luzadder, Prentice-Hall, Inc.

INSTRUCTIONS

Lettering Exercises

A lettering sheet should be placed over a pressboard or sheet of manila drawing paper. When the student is ready to letter, he should turn the sheet to the most convenient angle for lettering so that he does not feel cramped. Lettering should be done with a soft pencil, and an eraser should be handy to be used for the correction of any irregularities.

Drawings

No. 1. Refer to a textbook and reproduce the inclined capital letters and numerals. The height of each letter is six units. Determine the width of each character by counting the squares of its grid. It is recommended that the letters and numerals be made in the following order: **I, T, L, E, F, H, N, Z, X, A, V, M, W, K, Y, O, Q, C, G, D, J, U, S, &, P, R, B, 7, 4, 0, 6, 9, 5, 8, 3, 2.** The example at the bottom of the sheet shows how upper-case and lower-case characters should be located on this grid. (§ 2.32-2.35, 2.41-2.42)

No. 2. Reproduce the vertical capital letters and numerals. Follow the instructions given above for drawing No. 1. (§ 2.32-2.35, 2.41-2.42)

Nos. 3-4. Letter the statements, using the guide lines provided below each one. The finished work should be as nearly like the example as possible. It is suggested that in forming each character you attempt to follow the same order of strokes used on drawing No. 1. (§ 2.35, 2.37-2.42)

No. 5. Using 1/8″ capital letters, either vertical or inclined, as assigned, letter the dimensions and notes in accordance with the examples. Draw horizontal and vertical or inclined slope lines before starting to letter. (§ 2.35-2.42)

Use of Instruments and Geometrical Constructions

No. 6-7. On the upper third of the layout, measure each of the five lines using the indicated scale. Letter the scaled lengths on the guide lines at the right. For the two drawings given in the middle and lower portions of the layout, measure the distances indicated by a letter within a circle. Use the scale indicated. Letter the scaled distances on the guide lines provided. (§ 2.19-2.20)

No. 8. Using a T-square and triangles, complete the layout of a football field. The overall dimensions are 53.33 yards wide by 120 yards long. Use the scale of 1″ = 20 yards. (§ 2.9-2.17, 2.19, 2.23-2.24, 2.31, 3.7)

(a) Center the field on the sheet between the East and West stands.
(b) The end lines, goal lines, midfield line and side lines should be a continuous black line of uniform quality.
(c) Each 10 yard line should be a continuous black line of uniform quality, slightly lighter than the lines specified in item (b).
(d) Each 5 yard line should be of the same quality as those of item (c).
(e) All hash lines should be identified with a + mark from goal line to goal line. Locate the hash marks 53′ – 4″ inbounds from each side of the field. (Due to the scale, the hash marks for each yard line will be omitted.)
(f) Letter the name of the nearest National Football Conference team in 8-yard-high block letters in the north end zone. The name is to be centered.

Note. Goal posts, score boards, side line restriction markers for the teams, photographers, etc., have been omitted due to the scale.

No. 9. On the upper-half of the layout, the two streets indicated by the sets of short lines are 32′ and 40′ wide. Using the scale of 1′ = 20′, complete the curblines for the intersection. Use 20′ radii for each of the corners. Draw center lines for each street using the graphical symbol of a center line. Construct 5′ wide sidewalks with 4′ grass safety strips between the curbs and sidewalks. (§ 2.9-2.19, 2.21-2.25, 2.27, 2.31, 3.23-3.26)

(a) Perform constructions that are graphically and geometrically precise. For educational purposes identify the point of tangency of each arc with short marks perpendicular to the line.
(b) Center lines should be of lighter weight than lines for the curbs or sidewalks.
(c) Place 8′ crosswalks within the intersection as extensions of the sidewalks. Center the crosswalks with the sidewalks. Make the crosswalks of solid object line weight.

On the lower half of the sheet, using the scale of 1″ = 8′, draw a pair of parallel 2′ wide roller conveyors arranged with regard to points **A, B,** and **C** to satisfy the following conditions:

(a) Construct an inner radius about point **A** of 4′.

(b) Construct an inner radius about point **B** of 6′.
(c) The inner radii of 12′ are to clear point **C** by 5′. (§ 3.23-3.26)
(d) Construct an inner radius of 20′ which is tangent to the 4′ and 6′ radii.
(e) After completing the constructions for the several radii, identify the tangent points similar to the above problem. Complete the outlines of the conveyors.
(f) The illustration on the printed problem sheet is not to scale.

No. 10. Construct three geometric forms as follows: at **A**, draw a square tangent to the given circle (§ 3.16); at **B**, draw a regular hexagon tangent to the given circle; construct a regular hexagon using **CD** as the distance across corners. (§ 3.18)

To facilitate the layout of specific geometrical shapes a template is to be made in accordance with the design shown. Using a full-size scale, construct this template. Start with the given point. Determine the angle **CDB**. Show all construction. Refer to the text book and use approved geometric methods. (§ 2.9-2.10, 2.16-2.17, 2.20, 2.22, 2.31, 3.4, 3.10-3.11, 3.18, 3.23-3.26)

No. 11. Part 1: On the upper half of the sheet, make a precise graphical construction of a link that is a small part in an electric typewriter. Make the drawing ten times the size of the original. Place the .28 value in a horizontal position. The hole not dimensioned is .03 **D**. Provide .03 of material around the outer portions of the holes. Two outer edges are simply straight lines tangent to the arcs. The large arc is .25 **R**, and is tangent to the end arcs. Do not dimension the part. Make the center lines of the proper line weight to contrast with the outline of the part.

Note. A simple object of this sort in industry would include a material specification which would provide the thickness of the object. (§ 2.9-2.25, 2.31, 3.23-3.26)

Part 2: The handling of materials is an important part of many industrial processes. Using the sketch shown just above the record strip as a guide, make a precise scale layout of this conveyor system. Scale: 1″ = 1′ – 0″. Determine and record the values for **X**, **Y**, and **Θ**. Determine the length to the nearest inch. Use sharp and precise lines for accuracy. Show all construction and mark tangent points.

No. 12. Using an appropriate scale, make a half-size drawing of a gasket for a control cover. Do not dimension the drawing. Using geometrical principles, complete all construction to achieve graphical accuracy. Locate and mark all points of tangency with short lines 3mm long perpendicular to the object line or arc. Do not erase construction lines. The centers of the 130 **R.** and the 140 **R.** are to be located with graphical precision. (§ 2.9-2.25, 2.31, 3.23-3.26)

No. 13. Make either an instrumental drawing or a freehand sketch of the plate shown. The drawing, if made with instruments, should be full size. Locate the drawing (or sketch) to allow sufficient space for the dimensions, notes, and a title. (§ 2.9-2.25, 3.18, 3.24-3.26, 6.1-6.10)

No. 14. The linkage system shown is composed of five parts. The point of linkage slides back-and-forth in a horizontal groove as the arm revolves clockwise and counterclockwise about the center **A**. The movement is such that the arm revolves clockwise and counterclockwise to contact the solid stop rods at **B** and **C** respectively. (§ 3.22-3.23, 3.26)

(a) Draw the arm revolved in a clockwise direction until it comes in contact with rod **B**.
(b) Draw the arm revolved in a counterclockwise direction until it comes in contact with rod **C**.
(c) Determine and record in millimeters the total distance of travel of the point of linkage for the extreme contact points of the arm with rod **B** and rod **C**.

Multiview Drawing and Sketching

No. 15. Part 1: Using the grid provided, make a three-view freehand sketch of the rest block shown in the upper right-hand corner of the sheet. ***Part 2:*** Using the grid on the lower half of the sheet, make a three-view sketch of the angle block. (§ 5.1-5.17, 6.1-6.10)

No. 16. Part 1: Using the grid provided make a three-view freehand sketch of the stop block shown in the upper right-hand corner of the sheet. ***Part 2:*** On the lower half of the sheet make a multiview sketch of the trip block. (§ 5.1-5.17, 6.1-6.10)

No. 17. Make a multiview sketch of the ejector block. Do not dimension the sketch. (§ 5.1-5.17, 6.1-6.10)

No. 18. Complete the drawing of the hook bracket (freehand) by adding the front view and completing the top view. (§ 5.1-5.17, 6.1-6.10)

No. 19. Make a freehand multiview drawing of the slide bracket shown by the isometric drawing. Include dimensions and notes. Needed isometric axes dimensions may be directly preportioned to the given

dimensions. (§ 5.1-5.17, 6.1-6.10, 13.1-13.14)

No. 20. One view of an object is incomplete. For each object make an isometric drawing using the axes provided and add the missing line or lines. Sketch or draw with instruments as required by your instructor. (§ 5.9-5.11, 5.25-5.26, 6.12-6.15, 11.5-11.11)

No. 21. Add the third view of each object. Isometric axes have been provided for the preparation of isometric study sketches. These may be drawn either freehand or with instruments. (§ 5.9-5.11, 5.25-5.26, 6.12-6.15, 11.5-11.11)

No. 22. On the upper half of the sheet, complete the front and top views of the mounting jaw. On the lower half of the sheet complete a three-view drawing of the angle bracket. (§ 5.1-5.26)

No. 23. On the upper half of the layout, complete the three views of the adjustment block. Prepare an isometric study sketch using the axes provided. The overall shape of the block and its features are rectangular in form. The right front corner has been removed by an oblique plane containing points **A**, **B**, and **C**. On the lower half of the layout complete the top view. (§ 5.1-5.26, 6.12-6.15)

No. 24. Complete the views of the slotted base shown on the top half of the sheet. Place a finish mark symbol on each machined surface when it appears (projects) as a line, an edge view.

Complete the views of the inspection base on the lower half of the sheet. (§ 5.1-5.28, 5.38-5.44)

No. 25. Complete the side view of the guide block. Place finish marks where appropriate. The base is rectangular in shape and has two holes with spotfaces. (§ 5.1-5.28, 5.38-5.44)

No. 26. Draw a third view for the given two views of the slotted block. (§ 5.1-5.26)

Auxiliary Views

No. 27. Using the appropriate reference lines, construct the indicated auxiliary views per the instructions.

Upper left: Draw an auxiliary view of the inclined surface from the front view.

Upper right: Draw an auxiliary view of the inclined surface from the top view. As an exercise in projection, complete the projection of the *entire* object.

Lower half: Draw an auxiliary view of each of the inclined surfaces. There is a rectangular slot 10mm wide in the one inclined surface. (§ 8.1-8.13)

No. 28. Complete the front view and the top view of the rod support. Project an auxiliary view of the surface that appears as an edge view in the top view. Draw a section view B-B that is two times size. (§ 7.6, 8.1-8.14)

No. 29. Make a partial top view of the horizontal portion of the adjuster bracket. Use a conventional break to avoid showing the inclined member. Make an auxiliary view of the inclined surface in the front view. Use a conventional break to avoid showing the horizontal portion in the auxiliary view. (§ 8.1-8.13)

No. 30. Draw partial views of the adjustable bracket which will show normal views of the inclined and horizontal members. Add lines to complete the principal view. All values are metric. (§ 8.1-8.13)

Sectional Views

No. 31. Complete the front view as a full section. Draw over the lines in the partial view that is given. (§ 7.1-7.16)

No. 32. Make the indicated section drawing of the housing. Fill in all necessary lines. Do not dimension the drawing. (§ 7.1-7.16)

No. 33. Draw the bottom view as a regular orthographic view. Draw over the given lines and complete the visible or hidden lines justified by direct projection.

Draw the top view indicated by the indicated cutting plane. Make the view a full section. Show the holes, ribs, slots and keyway in a conventional manner. This comparison of views illustrates the need for sectioning of views to show interior features to better advantage. (§ 7.1-7.16)

No. 34. Prepare the indicated sectional views. The scale is full size. Do not dimension the drawing. (§ 7.1-7.16)

Dimensioning

No. 35.

1. Completely dimension the angle bracket. The part is finished all over. The scale is half size. Dimension in units assigned by your teacher.
2. Completely dimension the rod support. The part is machined from a casting. The scale is full size. Dimension in units assigned by your teacher. (§ 13.1-13.13)

No. 36. Completely dimension the four objects. The scale is full size for all parts. Dimension in units assigned by your teacher. (§ 13.1-13.13)

No. 37. Part 1: Completely dimension the slotted base. The four holes are drilled. The part is machined from a casting. The scale is half size. Dimension in units assigned by your teacher.

Part 2: Completely dimension the guide cover. The four holes are drilled. The part is machined from a casting. The scale is 1 : 4. Dimension in units assigned by your teacher. (§ 13.1-13.13)

No. 38. Part 1: Dimension the rod support plate using the baseline method which minimizes the accumulation of tolerances. The four holes are drilled. The part is made from a casting. It is machined all over. The scale is half size. Dimension in units assigned by your teacher.

Part 2: Dimension the lever hub. The part is made from a casting. The two holes are drilled. Not all surfaces are machined. The scale is full size. Dimension in units assigned by your teacher. (§ 13.1-13.13)

No. 39. Complete the top view of the eccentric adjuster. The scale is full size. The part is machined from bar stock and is machined all over. The thread is M16 X 1.5. Dimension in metric units. (§ 13.1-13.13, 14.1-14.20)

No. 40. Complete the top view showing only one-half of the circular shaped extension hub. There are six equally spaced holes, one hole through each boss on each lug. There are six ribs equally spaced between the lugs. The scale is full size. The part is machined from a casting. The ribs are 4mm. Add the necessary dimensions, notes, finish marks and title. (§ 13.1-13.13)

Screw Threads and Fasteners

No. 41. Part 1: Using detail representation draw the thread for a 1 1/8" X 3" semi-finished UNC bolt and castle nut. Start the thread at the crest shown. The thread length on the bolt is to be 2D + 1/4". ***Part 2:*** Using detailed representation draw the square thread on the vise screw. Thread data: 1 1/2" Dia., 7 threads per inch, right-hand. Draw three threads at each end of the screw and also at each end of the receiving portion. Draw ditto lines between finished threads. (§ 14.1-14.8, 14.10, 14.12-14.14, 14.36, Tables 10 and 15 Appendix)

No. 42. Draw a M76 X 6 thread on the adjusting plug illustrated. Start the thread at the crest shown, using detailed representation. Identify and locate the following: pitch, lead, major diameter, minor diameter. (§ 14.1, 14.5-14.8, 14.18-14.20, Tables 8 and 9 Appendix)

No. 43. Part 1: On indicated center lines draw 5/16" X 1 1/4" studs with semifinished hex nuts and "regular" lock washers. Studs enter threaded hole 1 1/2 D. ***Part 2:*** Draw 9/16" X 1 1/4" headless, slotted flat-point set screw with finished hex jam nut. ***Part 3:*** On appropriate center lines, draw 3/8" X 1 1/4" hex head cap screws with "regular" lock washers. ***Part 4:*** On proper center lines draw 1/4" X 1" hex head bolts and nuts with "regular" lock washers. (§ 14.22-14.28, 14.32, and Appendix)

No. 44. Part 1: On center line **B** draw a No. 304 Woodruff key assembled to the shaft and hand wheel; on center line **C** draw a 7/16" semifinished hex jam nut. Complete the end view. ***Part 2:*** On center line **E** draw a 3/16" American Standard small button-head rivet. Show six rivets equally spaced in the other view. On center line **F** draw a 1/4" X 3/4" American standard semifinished bolt and nut and "regular" lock washer. Show three bolts equally spaced in the other view. ***Part 3:*** On center lines **A** draw a 3/8" X 3/4" American Standard square-head set screw. ***Part 4:*** On center line **D** draw a No. 1 X 1 1/4" standard taper pin. (§ 14.22-14.34 and Appendix)

No. 45. Complete those parts of the following problem that are assigned by the instructor. On center line **A** draw a standard double worm thread engaged with worm gear. On the end of the shaft, draw a 3/4" finished hex jam nut with special thickness of 3/8". On center lines **B** draw 5/16" X 7/8" hex head cap screws with "regular" lock washers. On center lines **C** draw 5/16" X 1 1/2" studs with semifinished "regular" nuts and "regular" lock washers. On center line **D** draw a 1/4" X 1/2" fillister head cap screw and complete the top view. On center lines **E** draw 1/4" X 5/8" hex head cap screws with "regular" lock washers. The tap drill should not break the inside wall of the housing. On center line **F** draw a 1/8" American Standard pipe plug. On center line **G** draw a No. 406 Woodruff key assembled to the shaft and gear. Use simplified thread symbols on all fasteners and complete all views. (Chapters 14 and 24, Appendix)

Working Drawings

No. 46. Draw a view in section that will show the object most clearly. Indicate the cutting plane. Make a detail working drawing. (§ 7.1-7.11, 13.1-13.13, 14.1-14.20, 16.1-16.14, Table 9 Appendix)

No. 47. Select an appropriate scale and make a detail working drawing of the control guide. The part is formed from a flat steel strip. (§ 13.1-13.13, 16.1-16.14, 16.21)

No. 48. Make a detail working drawing of the fan spindle. Include the views, dimensions, notes, and a title. (§ 13.1-13.13, 16.1-16.14, 16.21)

No. 49. Select a suitable scale and make a detail working drawing of the cover–mixing machine. Add properly composed notes and a title. (§ 13.11-13.13, 16.1-16.14, 16.21)

No. 50. Add necessary dimensions, notes, and title to show a complete working drawing. The hub is made from a casting. Show finish marks for machined surfaces. Use an M8 X 1.25 thread for the threaded holes. The scale is full size. One required. (§ 13.11-13.13, 16.1-16.14, 16.21)

No. 51. The switch bracket is constructed by welding a piece of tubing to a piece of steel plate formed to the shape shown by the pictorial drawing. Select an appropriate scale and prepare a detail drawing of the bracket. Specify the weld using proper ANS symbols. (§ 13.11-13.14, 16.1-16.14, 16.19, Chap. 23)

No. 52. Make a complete working drawing of the adjustable bracket. The part is a casting with some finished surfaces which should be identified. The scale is full size. The inclined bracket face is circular in shape. There are six holes equally spaced on this face. Construct Section A–A as a two times size detail section. Construct an auxiliary view of the inclined surface in the front view. (§ 8.11-8.12, 13.1-13.14, 16.1-16.14)

No. 53. Show a full section view as indicated by the cutting plane. Make a complete working drawing. The housing cover is made from malleable iron, one per unit needed. The scale is full size. (§ 7.1-7.14, 13.11-13.13, 16.1-16.14)

No. 54. Select an appropriate scale and make a detail drawing of the rocker arm. Show a detail section taken through the ribs. (§ 13.11-13.13, 16.1-16.14.) Supplementary information not given on the picture is as follows:

(a) The distance from the center of the shaft to the center of the hole for the pin is 4.00". The distance from the shaft to the threaded hole is 4.50".
(b) The nominal diameter of the hole for the shaft is 1.875". The hole in the rocker arm is to be reamed for an accurate fit. The diameter of the pin is 0.969".
(c) The diameter of the boss with threaded hole is 2.00".
(d) The diameter of the roller is 2.25", and its length is 1.46". Total clearance between the roller and finished faces is 0.03".
(e) The inside faces of the arms are milled in toward the hub far enough to accommodate the roller.
(f) The rib is 0.62" thick.
(g) The lock nut has a 1.250-12UNF-2B thread.
(h) Fillets and rounds 0.12" R.

Assembly Drawing

No. 55-A. From the details shown, make a two-view assembly drawing of the roller rest. The instructor's requirements for a bill of material should be followed. (§ 7.16, 16.15-16.21)

No. 55-B. Prepare a bill of material for the roller rest (No. 55A). (§ 16.10, 16.18)

No. 56-A. Prepare a bill of material for the cup center (No. 56B). (§ 16.10, 16.18)

No. 56-B. The detail drawings on this sheet furnish the information needed to prepare an assembly drawing of the cup center (No. 56C).

No. 56-C. Make a two-view assembly drawing of the cup center using the detail drawings given on No. 56B. Use the simplified symbol for screw threads. Study the pictorial drawing carefully before starting the views. (§ 16.15-16.21)

Pictorial Drawings

No. 57. Make an oblique drawing of the object shown by the two-view dimensioned drawing. Select a suitable scale. Do not dimension the drawing. (§ 11.16-11.22)

No. 58. From the data given on the two-view drawing, make a full size isometric drawing. Do not dimension the drawing. (§ 11.1-11.9)

No. 59. From data given in the two-view drawing, make an isometric drawing of the object shown. Draw full size, and do not dimension the drawing. (§ 11.1-11.11)

No. 60. From the data on the two-view drawing, make an isometric drawing. Do not dimension the drawing. (§ 11.1-11.11)

Intersections and Developments

No. 61. Develop the lateral surfaces of the objects shown. In each case start with the edge or element indicated and unroll or unfold in the direction of the arrows. (§ 10.1-10.9)

No. 62. Develop the lateral surfaces of the objects shown. In each case start with the edge or element indicated and unfold or unroll in the direction of the arrows. (§ 10.1-10.22)

No. 63. Develop the lateral surface of the given transition piece. Start with the given line and construct the development in the direction indicated. (§ 10.1-10.21)

No. 64. Draw the line of intersection of the cylinder and cone. Show all construction used for finding points along the intersection and for transferring them from one view to the other. Develop the lateral surfaces of the cylinder and cone. (§ 10.8, 10.14-10.15, 10.24-10.40)

No. 65. Draw the line of intersection for the intersecting prisms and the two circular cylinders. (§ 10.24-10.39)

No. 66. Draw the line of intersection of the prism and pyramid. Show all invisible lines. Draw the development of the prism. (§ 10.6-10.7, 10.25-10.35)

Descriptive Geometry

No. 67. Part 1: (a) Using an auxiliary view determine the true length of the given oblique line **AB**, (b) Construct an **O**-view that will show a point projection of the line **AB**. *Part 2:* Locate the **H**- and **F**-views of **P**, the point where the line **FG** pierces the plane **CDE**. Use a view showing the plane as an edge. *Part 3:* Determine the true angle between the intersecting lines **AB** and **BC**. (§ 9.6-9.7, 9.10, 9.12-9.15, 9.18)

No. 68. Part 1: Draw the **F**- and **H**-views of the common perpendicular between the given lines **AB** and **CD**. Using a half-size scale determine the length of this perpendicular which is the shortest distance between these two nonintersecting lines. *Part 2:* Find the true size of the dihedral angle between the lateral surfaces having **AB** as their line of intersection. (§ 9.20-9.21)

No. 69. These problems can be solved within the space provided. Some problems may have more than one correct answer, merely complete the construction for a correct answer. Lines may be added to assist in solving some of the problems. Do not erase the light construction lines projected between views to assist in determining the visibility. These lines may assist in determining width, height or depth relationships within a specific problem. (§ 9.1-9.5, 9.12-9.13, 9.15, 10.24-10.26, 10.29)

1. Complete the **F**-view so that line **ST** intersects line **AB**.
2. Construct Line **JK** so that line is parallel to line **CD**.
3. Identify the point where line **GL** intersects the given plane. Show the visibility of line **GL** with the given plane.
4. Determine the point where line **EM** intersects the given plane. Show the visibility of the line **EM**.
5. The two planes have line **AB** in common. Complete the front view with visibility to satisfy the given representation.
6. Determine a segment of the line of intersection of the two given planes.

No. 70. These problems can be solved within the space provided. Some problems may have more than one correct answer, merely complete the construction for a correct answer. Lines may be added to assist in solving some of the problems. Do not erase the light construction lines projected between views to assist in determining the visibility. These lines may assist in the mental visualization process. The use of frontal or horizontal lines constructed within the given views may prove useful in solving some of the problems.

1. Construct a plane through point **A** parallel to the given plane. The new plane is to consist of two intersecting lines.
2. Construct a plane in triangular form parallel to the given plane. Point **M** is to be contained in the new plane.
3. Determine the angle formed by the two planes. Complete the front view, including the visibility.
4. Construct a plane making an angle of 30° with the given plane. Show the **F**- and **H**-views of the solution.
5. Construct a plane of two intersecting lines that is parallel to the given plane. Have the solution contain the point **S** and the given segment containing point **S** in the **H**-view.
6. Construct a plane containing the line **TU** that is perpendicular to the given plane. Point **T** is on the line **MS**. (§ 9.5, 9.8, 9.12-9.13, 9.19-9.20)

No. 71. This problem can be solved within the space provided. Lines may be added or extended to assist in the solutions. A hint for part (c): Construct a frontal and a horizontal line through the point **W** to assist with the positioning of a segment of line **QW** that is to be perpendicular to the plane **RST**. This segment may be shortened or lengthened to secure the precise value desired.

(a) Locate the **F**- and **H**-views of the points **A, B, C,** and **D** such that all points are in the plane **RST**.

(b) Locate line **RU** in plane **RST** with a bearing of North 65° East. Line RU is 52mm in length.
Locate line **SW** with a bearing of South 20° West. The point **W** is to lie on line **RT**. Show the **F**-views of both segments.

(c) Through the point **W** construct a line **WQ** that is 40mm long and perpendicular to the plane **RST**. Show the **F**- and **H**-views of the

line **WQ**. (§ 9.8-9.9, 9.12-9.13)

No. 72. Points **R**, **S**, and **T** have been geologically determined to lie in a plane (or stratum) which is a thermal source on the western slope of the Cascade range in the state of Washington. With equipment now available it is possible to bore in a selected direction toward the plane. The operation on the surface will start from the point **M**. The boring is directed toward the point **Q** which lies in the plane. The scale is 1 : 40,000.

(a) Locate the **F**-view of the point **Q**.
(b) Determine the slope of the line **MQ**. Slope is the angle the line makes with a horizontal plane.
(c) Determine the dip of the plane **RST**. Dip is the angle a plane makes with a horizontal plane.
(d) Determine the angle line **MQ** makes with plane **RST**. (§ 9.7, 9.9, 9.12-9.13, 9.16)

No. 73. Within the structure supporting a stadium scoreboard are elements represented by lines **AB** and **CB**. These members are rigidly supported by other members not shown, as they are not essential to this problem.

What angle does plane **ABC** make with a horizontal plane? Record your answer where it is measureable. The scale is 1 : 80.

A third element is to be located. Point **D** is 1.20m from point **B**. Element **DE** makes an angle of 60° with plane **ABC**. Element **DE** is 2.28m long and it is a frontal line. Locate the **F**- and **H**-views of element **DE**. (§ 9.6, 9.13, 9.16)

No. 74. Coplanar Vectors. Keep your pencil sharp and manipulate the triangles, the dividers, and the scale with care to achieve the desired graphical accuracy.

1. Graphically determine the resultant vector which represents the vector sum of the two given vectors. The scale is 1 : 800.
   Draw and identify the vector, **E**, the equilibrant, of the resultant.
2. Complete the necessary construction to secure the single vector which represents the sum of the vectors in array **A**. Do the same for set **B**. Note: the vector additions within each array or set may be in any order.
3. Determine the resultant of the three vectors. The scale is 1 : 100.
4. A 600 kg mass, **W**, is supported by two structural members represented by these elements. Assuming this view is a true frontal view, resolve and record the tension in each element. Select the scale to be used.
   The problem may be solved by resolving either acting or reacting forces. The magnitudes will be the same although the directions are opposite.
5. A small aircraft is going in the direction indicated at a corrected true ground speed of 150 km/h. There is a northwest wind of 20 km/h. Determine the bearing of the corrected heading and the indicated air speed which will produce the desired result of 150 km/h.
6. Reconstruct or transfer the three vectors to form a force polygon. The scale is 1 : 800. Note: the three vectors may be added in any order, the result will be the same. (§ 9.22-9.30, 9.35)

No. 75. Noncoplanar Vectors. These problems may be solved by using auxiliary projections. A graphical analysis may be made in each pair of principal projections. Select an appropriate scale for each problem. The problems may be solved by considering the acting forces or by using the reacting forces. The values will be the same although the directions are opposite.

1. The three line elements represent the three main members of one-half of a landing gear for a light plane. Each half is designed to accept a force of 1,500 **N**. Assume the impact is transmitted vertically. Determine the components in each of the three members. Select the scale. Record the values where they are measureable.
2. Graphically determine the force in each leg of the tripod-like structure. The mass hanging vertically downward from point **D** is 1,600 kg. Select the scale. Record the values where they are measureable. (§ 9.36-9.41)

No. 76. Arrange a conversion scale along a horizontal line about 1½" (38mm) below the upper border line. Relate degrees Celsius to degrees Fahrenheit. Graduate the degrees Celsius side from -40 to +100. Graduate the degrees Fahrenheit side from -40 to +212. This is probably the simplest form of an alignment chart.

Prepare a series of scales arranged vertically in the middle portion of the page. Arrange the left-hand scale as a Y-scale with values from 0 to 10. Make the scale 5" (128mm) long. Arrange a series of parallel scales to illustrate the following:

$$Y,\ 1/Y,\ Y^2,\ \sqrt{Y},\ Y^3,\ \sqrt[3]{Y},\ \log Y,\ Y$$

By placing a straight-edge from Y-scale to Y-scale,

intermediate values may be interpreted on any of the other scales.

Prepare another conversion scale from physics or economics (exclude dollars and cents). Arrange the scale in a horizontal position about 1″ (25mm) above the title block (§ 19.25-19.29)

No. 77. A natural *N*-chart is another form of alignment chart. Moment of inertia, *I*, for a rectangular cross-section fits this type of chart.

$$I = \frac{bh^3}{12}$$

I = moment of inertia, in.^{4}
b = width, 0 – 10″, in.
h = height, 0 – 12″, in.

The equation may be written in any of the following forms:

$$\frac{12I}{b} = h^3; \frac{I}{h^3} = \frac{b}{12}; \text{or} \frac{I}{b} = \frac{h^3}{12}$$

The maximum I value necessary for the range of b and h values is 1440 in.^{4}. Therefore, use a scale of 1″ = 200 in.^{4} units on the *I*-scale. Place the scale vertically about 1½″ from the left-hand margin. Graduate the scale reading downward from 0 to 1500. Caption this scale, *MOMENT OF INERTIA, I* (IN.^{4}).

Position the zero point on the *b*-scale in line horizontally with 1000 on the *I*-scale and about 1½″ from the right-hand margin. Arrange the *b*-scale reading vertically upward from this zero point. Arrange the graduations from 0-10″ uniformly along a five-inch vertical line. Caption this scale.

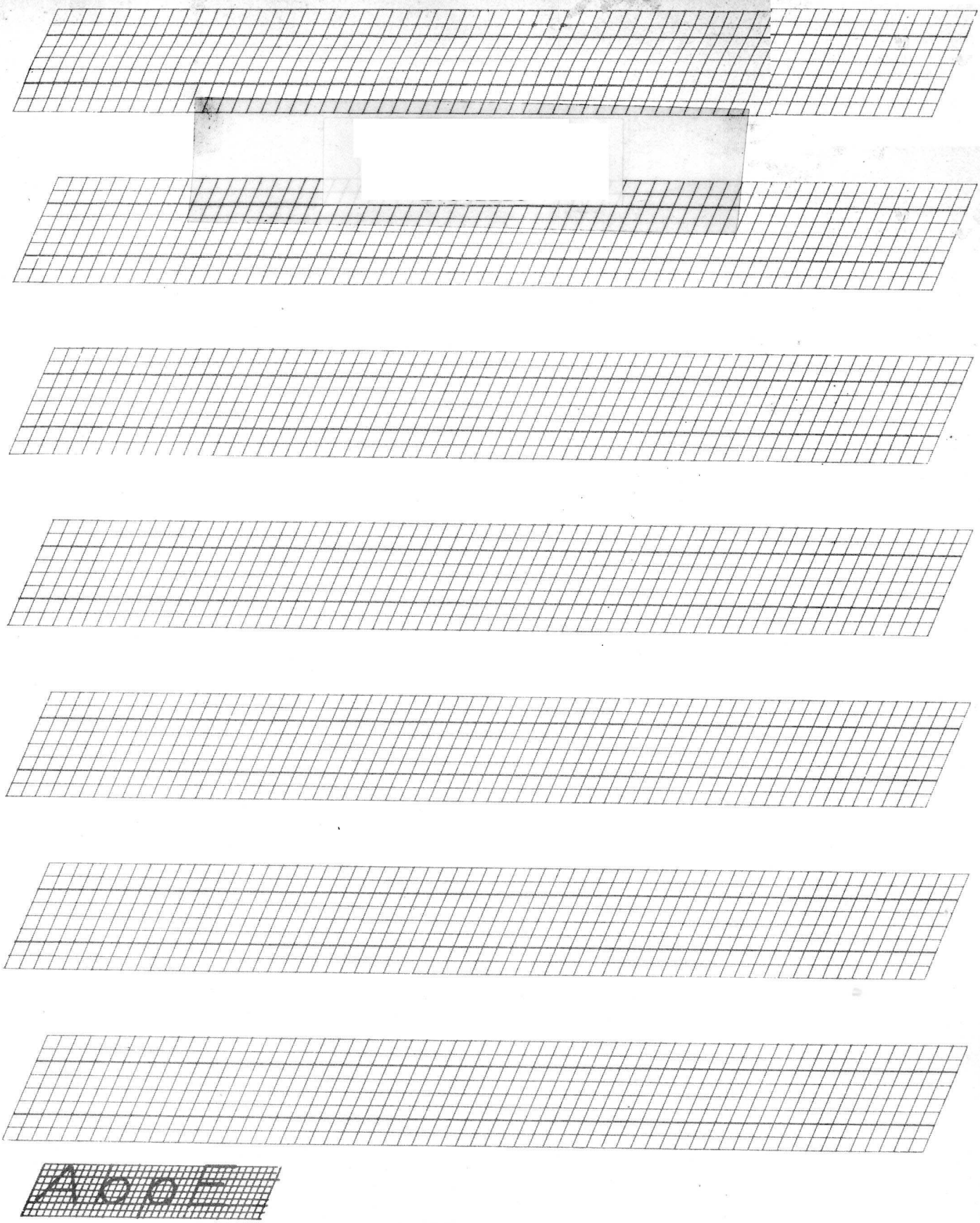
Connect the *N*-line from the zero point of the *I*-scale to the zero point on the *b*-scale.

The *h*-scale must be devised along the *N*-line. The zero point is common with the zero point on the *I*-scale. Select a point on the *b*-scale (use b = 6″) for the values of *h*, from 1″ to 12″. Determine and record a set of *I* values in a table. By placing an array of lines from b = 6″ to these several *I* values, the *h*-scale may be graduated. Caption the *h*-scale. (§ 19.25-19.29, 19.33)

No. 78. This layout may be used for a problem that may be assigned from a text.

Contents

Drawings



NEXT ASSY. NO.	NO. PER UNIT	PART NO.		NAME OF PART	STOCK		MATERIAL
SCALE	DATE	SECTION	CODE	DRAWN BY	CHECKED BY	APPROVED	DRAWING NO. 1