A Manual Training Course.

The Selection and Arrangement of Exercises in Wood,

Forge, and Foundry Work.

by

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Outline and Index.

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Continued.

The general order and sequence of arrangement of these subjects and the exercises involved in each is of fundamental importance in the selection of manual training courses. It is the purpose of this treatise to show the relation between these different lessons, together with reasons for the sequence of exercises outlined.

Woodwork should naturally come first as it is simpler, involving the use of simpler tools and softer materials, and is thus a better subject in which to teach the mathematics of dimensions, and the interpretation of plans, than are the metals.

The forge work may not be so difficult if the student first masters woodwork. Also the philosophy of the behavior of iron and steel and the working conditions to be fulfilled in iron work, would place forging after the joinery course.

The joinery course should also precede the course in turning because (1) It is a good preliminary training in the interpretation of plans. (2) It forms a foundation for the turning course as the workman acquires the knowledge of the behavior of the grain of wood when muscular force is applied to it. (3) It teaches how to apply this force to the best advantage, and (4) The use of simple tools should be mastered before commencing the operating of machinery. In woodwork soft wood should be practiced on before hard wood and provision has been made for this in setting forth the following lists of exercises.

After joinery, turning, and forging, should come the foundry practice. Foundry work requires much care and still more knowledge of the action and reaction of materials and adaptation

of means to an end than blacksmithing.

In a general survey of the manual training field we may discover the aim of manual training and this aim will help to show the reasons for the breadth and scope of selection.

The course must teach utility and adaptability of materials to economical use, and the great dignity of labor; must be pursued for the purpose of the development of the students originality and skill. The mind and hand must be trained at the same time and the class of work done must conform to that end. The practical life work of the student body of the institution must be studied.

The different exercises of each course must involve proper combinations of useful processes in such a way that the simple shall precede the more complex operations. Each succeeding task should be not only a review of past work but should introduce some process new to the learner until the more important phases have been worked out. The student not only develops processes but acquires originality and love for industry. Manual training can also be made the window through which natural talent may be observed and thus the careful instructor may see avenues of usefulness for the student.

Joinery.

The beginner must first be given instruction in the care and use of tools and should make a special effort to learn the use of the apparatus and to acquire habits of neatness in the shop.

"Getting out stock" comes next and machinery such as the buzz saw, hand saw, and planer may be made use of. Blocks

must be cut large enough to allow for planing and "squaring to dimensions" and enough for each exercise for the whole class. The allowance should be at least one-quarter inch for each dimension of the block. The selection and "laying in" of stock are, of course, duties of the instructor.

Steps in "Squaring to Dimensions".

1. Plane lightly a broad face and mark it 1.
2. Plane lightly the best side edge ⊥ to 1 and mark it 2.
3. With gauge, mark width from 1, on 2 and 4, to proper dimensions and plane 3 to mark. Mark full for soft wood and exact for hard wood.
4. From 2, mark thickness on 1 and 3 and plane 4 to mark.
5. Measure length, placing rule on edge for accuracy.
6. With square and knife, mark off thin slab on one end and saw to knife line, leaving knife line on end of dressed piece.
7. With square and knife, mark the other end to length and saw to knife line.

Special Rules for Details.

1. For chamfers or curved lines, use pencil line as a guide.
2. For broad surfaces first plane crosswise and then lengthwise to make planes coincide.
3. In varnishing finished articles, use a thin coat and dry thoroughly. Apply two or three coats to useful article.
4. For making dowel pins, use dowel pin groove in chisel board. Plane from square prism to octagonal, then to cylinder and drive through hole, same size as dowel pin

hole, in waste hard wood block to round and shrink. Set with glue.

5. In boring holes of same depth, make strokes uniform and count, using same number in each succeeding stroke.

The following course in joinery will combine and apply all the principles of squaring and also the special rules above:

Ex. 1. Sawing to knife line. Soft wood, 2" x 2" x 7".

Ex. 2. Cross. Stock dressed to 1-1/4" x 1-1/2" x 5-1/2". Two pieces joined by middle lap joint and glued.

Ex. 3. Exercise in Sawing, Chiseling and Chamfering. Stock dressed to 1-1/4" x 1-5/8" x 10".

Ex. 4. Series of Mortises. Stock dressed to 1-1/2" x 2" x 7" with beveled corners.

Ex. 5. Mortise and Tenon Joint.

Ex. 6. Table leg joined with two rails, one rail with relish tenon.

Ex. 7. Dove-tailed middle lap joint. Two blocks dressed to 3/4" x 2", but one 4" and the other 5" in length.

Ex. 8. Bread Moulding Board - with end binders to strengthen the grain and avoid warping. Top to be highly polished.

Ex. 9. Bench Hook - stock dressed to 1-3/8" x 3-1/2" x 9". A sawing, chiseling, and smoothing exercise.

Ex. 10. T Square - stock walnut or oak - length 24" - crossbar 2-1/2" wide and 10" wide, stock dressed to 3/8" in thickness. Other details original.

Ex. 11. Series of Dovetails. Stock hard wood. Details, optional with instructor.

Ex. 12. Dovetailed Box 5" x 8-1/2" x 8-1/2" - with cover and carved handle. Three or four dovetails at each corner. Stock walnut.

Ex. 13. Oilstone Box. 1-3/8" x 1-3/4" x 9-1/4". Details optional with instructor.

Ex. 14. Drawer with carved front.

Dimensions:

Front, 1-1/4" x 3-1/2" x 6"

Sides, each, 3/8" x 3-1/2" x 11-1/4"

Back, 3/8" x 3-1/2" x 5-1/4"

Bottom, 3/8" x 5-1/4" x 10".

Ex. 15. Tool box with carved handle.

Dimensions of box 2-5/8" x 8-1/2" x 10-1/2"

End, each, 3/4" x 2-1/4" x 10-1/4"

Sides, each, 3/8" x 2-1/4" x 10-1/4"

Bottom, 3/8" x 9" x 11-1/4"

Ex. 16. Picture frame. Sawing Exercise. Stock walnut or (white pine, if pyrography designs are used for finish). Lids each 3/8" x 1-13/16" x 9-1/2".

Ex. 17. Footstool - stock, oak dressed to 3/4" x 7". Saw design on supports and top to be well polished.

Ex. 18. Easel - Rack form. Stock dressed to 3/4" x 1". Uprights to be fastened by cross bars with lap

joints. Uprights 8" apart at base and 5" apart at the top, outside measure, with upright mullion through the middle also fastened by lap joints.

Ex. 19. Carving Exercise, from original design.

Ex. 20. Practice in blueprint work.

Turning Course.

Ex. 1. Cylinder, 1-1/2" x 8". Stock white pine.

Ex. 2. Same with rounded beads.

Ex. 3. Cylinder with beading modified.

Ex. 4. Series of cylinders.

Ex. 5. Table leg. Stock, white pine.

Ex. 6. Rolling pin. 1-1/2" x 19-1/2" - middle 7-1/2"; handles, each, 2-1/2" long.

Ex. 7. Indian club. Stock, walnut or hedge.

Ex. 8. Darning ball. Stock walnut or hedge.

Ex. 9. Gavel head, 1-3/4" x 2-3/4"; handle, 8" long, allowing for setting in head, and 3/4" average diameter. Details original.

Ex. 10. Dumb bell. 3-1/4" x 10"; handle 1" in diameter.

Ex. 11. Table leg. Stock, any good hard wood.

Ex. 12. Cylindrical box with lid. Hedge. Box 2" x 2-3/4"; lid, 1" x 2"; sides 1/4" thick.

Ex. 13. Goblet - hedge or gum. 5" high; 3" in diameter at base, 2-5/8" at top, bowl to have a diameter 2-3/4"; neck ornamental.

Ex. 14. Goblet - hedge - 4-7/8" high, 3" across on top, tapering toward the bowl, 3" at base. Details original or optional.

Ex. 15. Card Tray - 3-1/2" high, 9" across top, 3" in diameter at base, 1-1/2" diameter of bowl of neck. Bowl tapering down to neck.

The above course in joinery presents a series of exercises gradually increasing in complexity of operation and it embodies also a great variety of processes arranged to give practice in interpretation of plans, and helping to fix technical names for parts of exercises and processes.

Among the operations which must be mastered in connection with these exercises, the most prominent ones are: In the first exercise given, marking with the gauge with the grain, with the knife across the grain, planing to the gauge lines, and sawing to the knife lines. Second, middle lap joint using also the steps in No. 1, and joining with glue. Next these processes are combined in the third exercise and are used in the cutting of mortises. This work also prepares for the mortise and tenon joint in the fourth. Chisel work is used in the bevel, mortise, tenon, and chamfer work. In No. 4, after marking with the gauge and knife on both sides, the mallet and chisel are used, first loosening a layer of wood and then digging it out and repeating until half way through the piece, taking precaution to keep the inside of the mortise level and turn it over and work from the other side. The tenon should be neither too large to split the mortise nor too small to fit it.

Sawing and chiseling are repeated in the fifth exercise with

the chamfer added in the bench hook of the sixth, boring in hard wood, and paring and beveling are introduced.

The mortise and tenon with relish make a firm and durable joint while a dowel pin joint on the same piece in No. 7, presents another kind of joint, while careful instruction in the manner of chamfering to the pencil line avoids much trouble, usually. The dovetail of the next exercise presents hard wood work and variation of the manner of execution of the lap joint.

Hard wood work will cause some difficulty in dressing stock to dimensions but will be used for most of the remainder of the course. The bread board consists of two pieces joined with dowel pins and polished on top and bound at the ends for firmness and to avoid warping. Pumice stone, shavings, hard oil etc, may be used for polishing.

The perfect joinery required in the construction of the T Square requires considerable skill as it must be true to 1/1000 of an inch.

The series of dovetails of the twelfth gives the preparatory practice for the dovetailed box which requires skilful work in joinery. From this point on through the course all the articles are useful and substantial and the student now comes to the more inspiring and helpful part of woodwork.

The oil-stone-box, tool-box, drawer, picture frame, footstool and easel are exercises the order of which matters very little as they give almost the same kind of training and practice in ordinary work, and in carving.

The elaborate original design should provide all possible

practice and training and it will help to develop the taste for the beautiful and useful and to prepare the mind for further original work.

The work in tracing and blueprinting should accompany or follow these exercises to give practice in drafting plans.

A careful investigation and comparison of the above arranged course will disclose a certain unity and variety of processes, that should train the young man how to do a few things well and give to the student a very good introduction to work in joinery.

Wood Turning. Correlation of operations.

The operation of machinery is the next problem in woodwork and the same principle holds true here as in other college work, i e, that the "hard knocks" will be inversely proportional to the care taken. The first awkwardness will be overcome if the operator of the lathe will carefully follow instructions. The oiling and adjustments are important. The rest, stocks, chisels, and gearing should all be studied. The "laying out" of work and taking of dimensions with the pencil, rule, and calipers are all useful arts to be learned.

The first few exercises should be done in soft wood or wood with a suitable grain. It will be notices that the first three exercises are in progressive steps and the fourth is also a modification of the first and may, for good reasons, be put second here. All the following work should be done with hard wood, walnut, oak, gum, hedge, and cypress for ordinary work and mahogany for special articles.

The beads in the third lesson, it will be noticed, are some-

what similar to those of the table-legs in Nos. 5 and 11. The rolling pin for same reasons should be placed second although the student has had too little previous practice to enable him to properly finish it if placed second. Darning balls, gavels, table legs, dumb bells, and Indian clubs, all require the same operations and hard wood is preferred in construction. Here the lathe and workman must do his best.

Boxes, goblets, etc., all come under that class of work called chuck work. The common Kansas hedge and walnut are good woods for this work as they both combine beauty and strength.

A "chuck" is a mechanical contrivance or machine fixed to the spindle of a lathe for holding a tool or the material to be operated upon. The stock is usually fastened to the chuck by means of screws or clamps or both and the head-stock and face plate are used but not the tail stock.

Chuck turning, as in Fig. 1, is used to good advantage for making patterns and wooden vessels of different kinds.

A logical, comprehensive and thorough course is the aim in the selection of a manual training course. It must combine utility, harmony, and breadth of arrangement and leave room for originality.

The joinery course should precede the course in turning because (1) It is a good preliminary training in interpretation of plans. (2) It forms a foundation for the turning course as the workman acquires the knowledge of the behavior of the grain of wood when force is applied to it. (3) It teaches how to apply this force to the best advantage, and (4) The use of tools should be mastered before the operating of machinery, just as

soft wood should precede the hard wood as stock for the course.

Course in Blacksmithing.

Ex. 1. Stock 3/4" x 6" Common round iron. First make square to 9" in length. Make octagonal all but 3-1/2" of length and increase length to 10". Round 4" of octagonal end. Reduce square end to pyramidal point using 1/2" of length. Reduce round end to conical point.

Note: heat to welding heat for drawing out and upsetting or iron will split. Smooth at orange heat. To make round point first make square point, then octagonal, then round.

To smooth strike straight and turn back and forth.

Ex. 2. Wedges. Stock, scrap iron, 1/8" x 5/8" x 7/8". Size of first wedge, 1/8" x 3/4" x 5/8". Other wedges of machine steel and larger in dimensions.

Ex. 3. Staple. Stock, 1/4" x 4" common round iron.

Note: the points of the staple should cut the grain of wood, not split it.

Ex. 4. Open Link. Stock, 5/16" x 5-1/2" common round iron.

Ex. 5. Ring 2-1/2" in diameter. Stock, 1/4" x 8-5/8" common round iron. "For amount of stock, add to inside diameter thickness of stock and multiply by (22/7 =)". Templeton's Rule.

The above rule gives the length along the neutral axis or through the middle. To bend, heat to dark orange. Avoid hammer marks by not striking work directly over anvil.

Ex. 6. Eye Bolt. Stock, 3/8" common round iron. Four inches for bolt and enough more to make an eye 1" inside diameter.

After heating, cool to eye before bending.

Ex. 7. Machine Bolt. Standard stock, round steel size of bolt. Note: For a square head, use 1" of stock plus two times thickness of bar. For hexagonal head, use 1" plus three times thickness of bar.

Heat to a light welding heat and upset forming a head on heading tool.

Sizes of heads: Square, thickness = $\frac{\text{1-1/2" x Diameter stock + 1/8"}}{2}$ Side, 2 x thickness of head.

Hexagonal head: Thickness = Diameter of stock; Diagonal = 2 x thickness of heat. May vary thickness, but not diameter.

Ex. 8. Fagot Weld. Stock, 3/8" x 3/4" x 30".

Ex. 9. Lap Weld in Flat stock. Stock 3/8" x 3/4" x 15" & 3/8" x 3/4" x 18" Norway iron. Note: For regular weld, allow 1/2 thickness of stock for waste but if weld is to be machined, allow 3/4" to full thickness. Beginners allow full thickness for regular weld. Before upsetting, mark each piece so that marks shall be 10" apart after welding. For upsetting, heat to welding heat. Make scarf convex, to avoid pocketing dirt. Work on horn and round corner of anvil, length of scrap to be 1-1/2 times, thickness of stock. Heat both pieces to same welding heat in clean fire scarf side down.

Ex. 10. Two Brace ends. Stock, 1/2" round Norway iron. Note: punch holes with punch size smaller than desired hole. Drive punch 3/4 through, then place over hole in anvil and punch through to proper dimensions, turn quickly and punch through from the other side.

Ex. 11. Weld in Round stock. Make scarf convex 3/4" long. Drill and counter-sink holes for No. 10 screw.

Ex. 12. Chain. Stock, 3/8" round machine steel. 31 links, 5/8" x 1-5/8" inside. Note: stock for links equals stock for half circles at ends + 2 x straight part of link + allowance for weld. Make 16 single links; join these to 8 three link chains; join these into 4 seven link chains and so on. Attach hook and ring to chain by links.

Ex. 13. Grab Chain Hook. Stock, 9/16" square Norway iron. Punch hole 3/8". Work eye on horn of anvil.

Ex. 14. Chain Hook. Stock, 1/2" round Norway iron. Punch 3/8" hole. Work eye on horn of anvil.

Ex. 15. Split Weld. (Iron to Tool steel) Stock, 1" x 6" round iron and 3/4" x 3" octagonal tool steel. Note: fasten steel firmly in fork before taking welding heat, having steel cold, iron red hot. Heat slowly at first to give time to heat through. When at orange heat, apply flux to protect steel from oxidation.

Having a clean fire for welding, heat steel red but not to sparkling heat. The higher the carbon content the lower the welding heat. Anneal for machining and for relieving strains.

Ex. 16. Center Punch. Stock, 3/8" x 3-3/4", octagonal tool steel. Scale full size. Note: Draw out head first. Draw out punch end square to straight taper, then make octagonal, finishing round with hammer.

This is high carbon steel, so in hardening, heat to dark orange for refining heat. Heat 1" of end, dip into the water

about 1/2" and take out as soon as water adheres to the surface. The part immediately above water should still show red. Scour point till colors show and draw temper over fire to light brown. When not red hot cool entirely.

Ex. 17. Cold Chisel. Stock, octagonal tool steel.

Chisel:	Stock	A	B	C	D	E	F	G
3/4"	3/4" x 6-3/4"	5/8"	2-1/2"	5/8"	3/4"	5/32"	13/16"	8-1/2"
5/8"	5/8" x 5-3/4"	1/2"	2-1/4"	1/2"	5/8"	1/8"	11/16"	8"
1/2"	1/2" x 5-3/4"	7/16	1-3/4"	7/16	9/16	3/32"	9/16"	7"

Note: Heat 1/2 blade; harden 2/3 length so heated; take out of water when it adheres to surface, and draw temper over fire.

For general work, temper 2/3 to 3/4 of hardened length to a brown tinged with purple. For wrought iron or mild steel, draw temper to a blue.

Ex. 18. Punch. Stock, octagonal tool steel. Use table as in No. _____. Temper to blue for iron.

Ex. 19. Cape Chisel. Octagonal tool steel. Note: Draw temper to brown or blue according to use to be made of chisel.

Supplementary Exercise:

Round nosed chisel - similar to cape chisel except the point which is finished like drawing.

In a brief explanation of the order of these lessons in forging we must concede that, in some cases, the length and purpose of course may change the order.

The first exercise given seems to meet the requirements of an introductory lesson. One of the most important things to learn here is that of keeping a good fire. All clinkers and

ashes should be removed and the firebox cleaned out. With a handful of shavings in the box, light the fire, use bellows, and cover the burning shavings with pieces of coke formed from the coal at the previous use of the forge.

While the iron is heating, the workman should plan his method of procedure, watching the iron to avoid overheating so that each stroke may be well directed when the hammering begins. The drawing out should be done at welding heat to avoid cracks, and smoothing should be done at orange heat.

The variety of processes and changes of the first exercise makes it a valuable practice work. As the iron is drawn out the form is changed from round to square then part of it to octagonal and then it is pointed. The exercise is simple, yet gives much training and these are good reasons for its value here.

A wedge can now be made in like manner by the drawing out process. Next, should come the staple and open link. The ring should be placed fifth in the course and the eye bolt, being the same class of work, sixth. These all require special care in bending to dimensions. The close calculation in the work of the bolt head might give it a place farther on in the course but the welding which follows is still more difficult. Here more than anywhere else, in the course, the work accomplished depends upon the conditions being exactly fulfilled and the workman will at least learn two things vividly impressed: (1) To heat iron to welding heat and (2) To strike while the iron is hot.

Next we teach the method of punching holes while making the

brace ends, closely related to former exercises in essential operations. Following this is the weld in round stock which requires much preparatory experience, and hence its place in the course.

Where much time may be devoted to forging, the chain exercise chiefly valued for the training and practice it requires, may be introduced near the begining of a course, but for a shorter course other work presenting important operations would tend to crowd the chain work into the supplementary list as special practice work for ambitious students. The grab hooks for the chain include drawing out, squaring, punching, upsetting, and bending, all used advantageously.

The split weld of iron to steel requires a flux to keep the steel from burning because steel burns much more quickly than iron and at a lower temperature on account of the carbon that it contains. Even with a flux, the steel must be closely watched to avoid burning. After the weld is finished, a useful tool like a screw driver may be made.

This leads up to the work in tempering which is the most essential thing to be learned in connection with tool making. The following suggestive list of tools will provide good practice in this work:

Center Punch

Cold Chisel

Heavy Punch

Cape Chisel

Round Nosed Chisel

Diamond Nose Chisel

Scraper

Scribe or Marker

Flat Springs

Clevises and pins

Hardy.

Foundry Course.

Founding is the art of forming moulds in loams or sands according to given designs or models. The moulds are then filled with molten metal and allowed to congeal. The casting obtained is a copy of the design or model used.

Foundries are classified according to the metals they employ as: gray iron, steel, brass, car-wheel, stove-plate, bell, statue and type foundries. In this paper we shall allude to the work in the iron foundry only.

For the manual training foundry, the following prescribed lessons will present the essential features of foundry practice.

1. Names and uses of tools such as flasks, rammers, vent-wires, gate-cutters.

11. Green Sand Moulding with Solid Pattern.

1. Setting up pattern
2. Ramming of the drag and venting.
3. Rolling drag over and ramming, tramping, and venting cope.
4. Separating cope from drag.
5. Swabbing of pattern
6. Revoving patterns by means of mallet and lifter or stripping plate and yoke to hold the pattern while the

flask is lowered by a lever.

7. Putting on parting sand and setting gate stick
8. Patching up model, if necessary, and cutting gate.
9. Putting finished mould together.
10. Set up same split patterns, and practice on the above exercises.

111. Cupola Practice - Pig Iron.

1. Cleaning slag from supola with hammer and chisel, if clogged.
2. Charging the cupola with alternate layers of iron and coke so that the first layer of iron shall be in the melting zone.
3. Light from the bottom, after applying the flux, and shut off tap hole with clay.
4. Turn on blast of air through the pipes and furnace.
5. When some iron is melted, open tap hole with bar and draw off molten metal into crucibles and pour into moulds, skimming surface of metal to avoid splashing, and light vents.
6. Stop tap-hole and charge more fuel, from the top as before, and ram it down.
7. Continue the "run" until all the iron is melted.
8. Take castings out and clean either with "Tumbling barrel, hand brush, pneumatic chisels or sand blast, or by picking with H_2SO_4.
9. Set up large moulds for wheels etc: by "bedding

in", using hole in floor for the drag.

10. Use of moulding machines, such as the Pridmore.

1V. Dry Sand moulds.

1. Make and set cores for mould in 111 - 10.

V. Preparation and tempering of moulding sand.

V1. Making of malleable iron castings.

V11. Repeat all these exercises for practice varying the methods where advisable.

The names and uses of foundry tools may be learned while ramming up the first few simple patterns. The difference in the ramming of the cope and the drag will accompany the method of "Rolling over" here. With these exercises, much practice is needed as there are so many things to learn which must be applied at once.

The proper venting of moulds has much to do with the quality of castings produced as the explosion of gases from the molten metal may cause much damage to the casting and injury to the moulder.

The next thing in order is the cutting of gates for the metal to run to the mould. Two kinds are shrink and common or skimming gates. (See sketch)

Some flasks or moulds may be set up by "bedding in". In this the sand is"tucked up" around the pattern or the pattern may be driven into the sand which is usually bad practice as it injures the pattern. For very large castings a hole in the floor may be used as the drag "tucking up" process of "bedding in".

When the beginner can successfully set up a plain solid pattern he may begin work with split patterns in green sand. One

part of the pattern is set up in the cope and the other in the drag and the two parts of the pattern join with dowel pins when brought together before ramming up the cope.

Next the moulder should take up core making which accompanies dry sand moulding. Cores are used to make holes through or recesses in such castings as wheels, forming the holes through the hubs. They are held in position by the use of chaplets.

A tapering core is called a "chill" made to exact diameter to avoid grinding of casting, and may be knocked out with a hammer. Loam cores are used in making large cylinders and must be well vented. Horizontal cores are strengthened by rods, and arbors or eyeholes are used in carrying them. The venting is sometimes accomplished by means of a string coated with parrafin or beeswax or core boxes and core machines. A hay rope will serve to vent a core for a large casting.

After a set of moulds have been made they are ready to be filled and the iron is usually heated in a cupola with coke. Where great strength of iron is needed the Reverberatory furnace is used but the cupola is used for ordinary work. (See sketch of Cupola)

The essential features of cupola practice are (1) The slag to be removed from the interior of the cupola before the run (2) The cupola is charged and rammed with coke and iron in alternate layers, so that a layer of iron will always lie in the melting zone.(1# coke to 5-1/2 to 15# of iron) with a layer of coke beneath it and alternate layers above it. (3) As each layer of iron is melted and runs down and is drawn off, another layer of iron comes into the melting zone and should be rammed from

the top. (4) As the iron is drawn off through the tap-hole and is carried to the moulds in crucibles and poured in while the vents are lighted and the surface of the molten metal is skimmed to avoid splashing while pouring, (5) Two or more openings are provided near the bottom of the cupola for the admission of air by force blast.

The ratio of coke to iron in the first charge of the cupola is about 1:3, but in succeeding charges about 1:10 is the average.

A flux of limestone, marble spalls, or oyster shells is distributed over the iron to produce a slag by chemical union with the impurities in the iron. The ratio of flux to iron is about 1:40. The amount of metal may be doubled by the use of a flux.

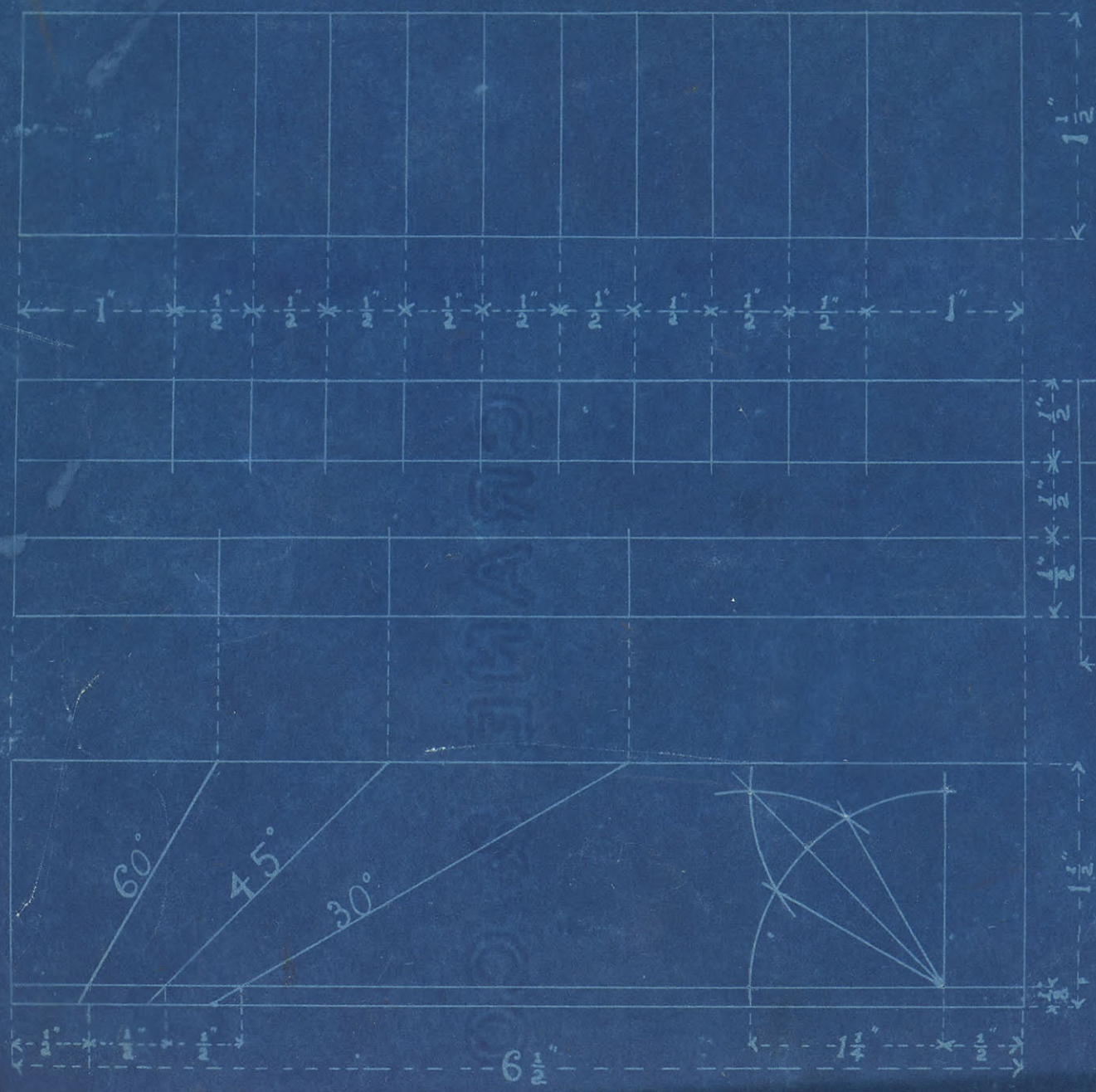
When the castings have congealed and cooled they may be taken out, cleaned, and ground smooth.

The manufacture of malleable castings may be done by the use of a mottled grade of pig iron between No. 2 and No. 3. The cupola or the reverberating furnace may be used but the latter is best, and impurities are not taken up by the iron as it comes in contact with the fuel.

The castings are molded in snap flasks in green sand and are placed in iron boxes and annealed (tempered or cooled slowly) at high temperature for from 3 to 5 days for small castings and a week for large castings. They are then covered with a film of iron oxide and cleaned in a tumbling barrel.

By the Open Hearth and Bessemer processes steel is made, but little of this is done in an ordinary foundry.

In the selection and arrangement of a college course of manual training, the student cannot be adapted to the course but the course must conform to the needs of the greatest number, remembering that the only article to be placed on the world's brain is the student prepared to place his skill on the world's market in practical life. "Training, not necessarily a trade except to the skilful", should be the motto in the manual training school.

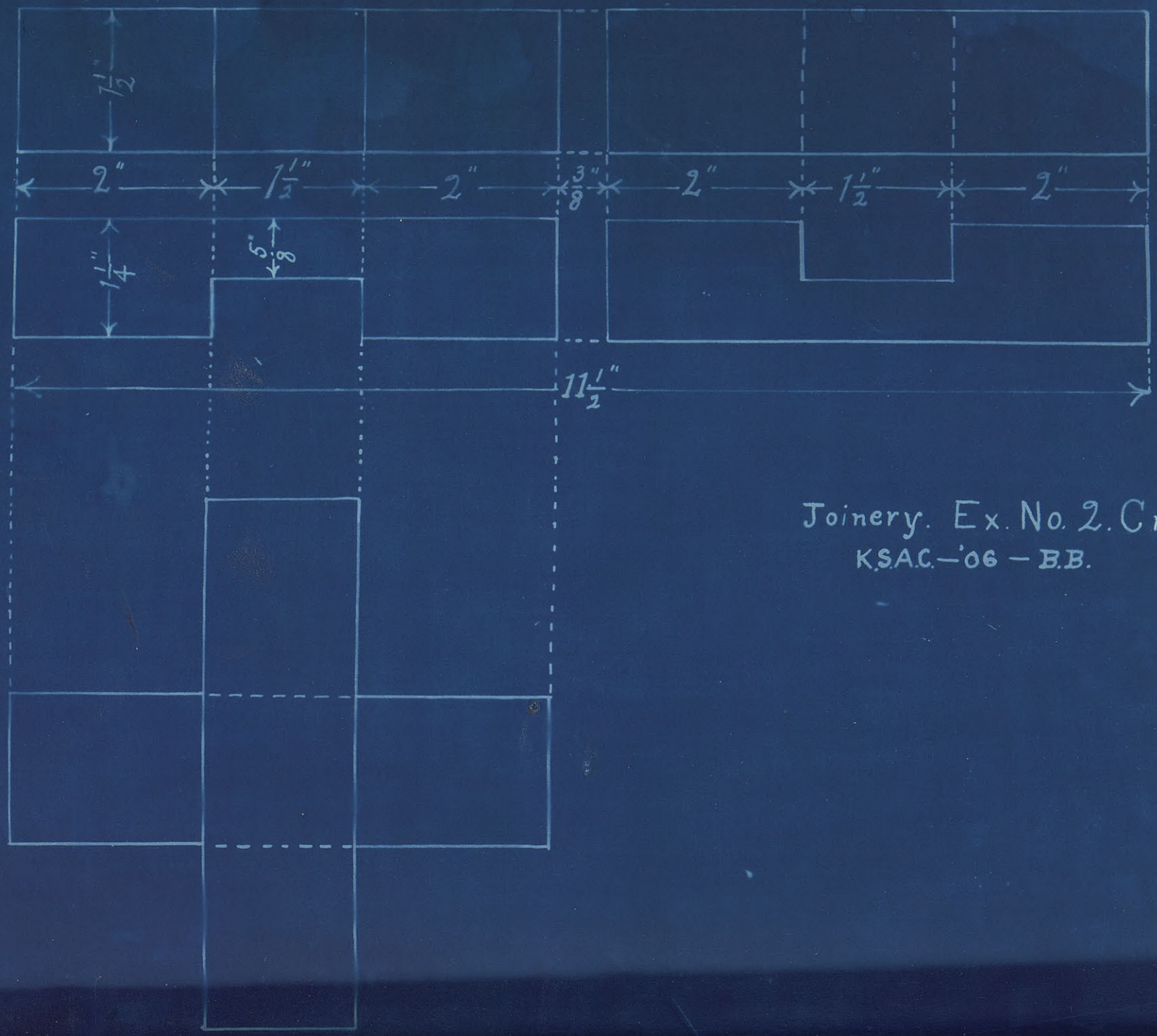


(a.) Square stock to 1½" x 1½" x 6½".
(b.) Laying out work - Knife, rule, marking-gauge.
(c.) Sawing to knife lines.
(d.) Laying out angles with compass and bevel.

RULE - All lines across the grain, make with knife, and all lines with the grain with marking-gauge.

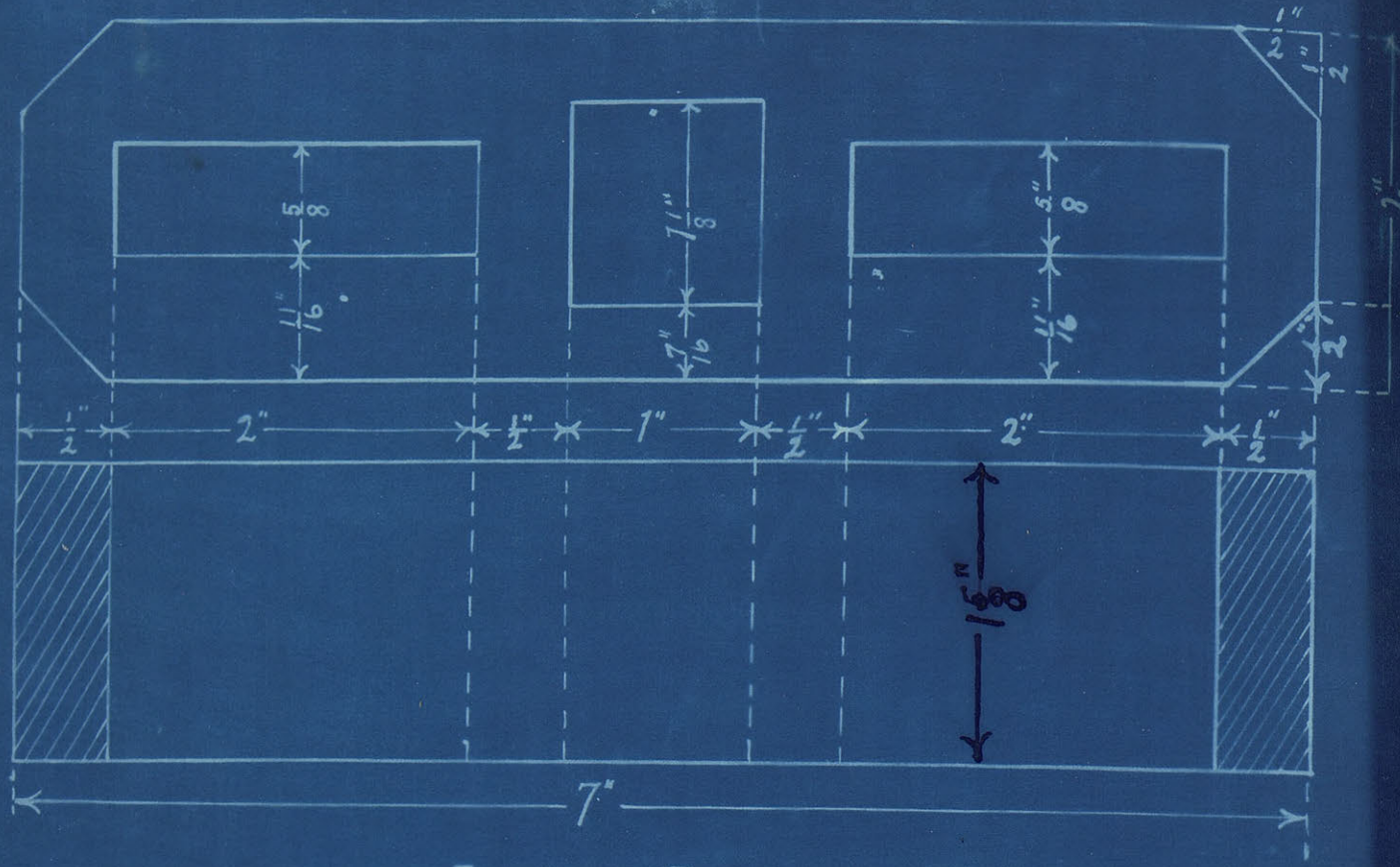
JOINERY Ex. No 1.

E. M.

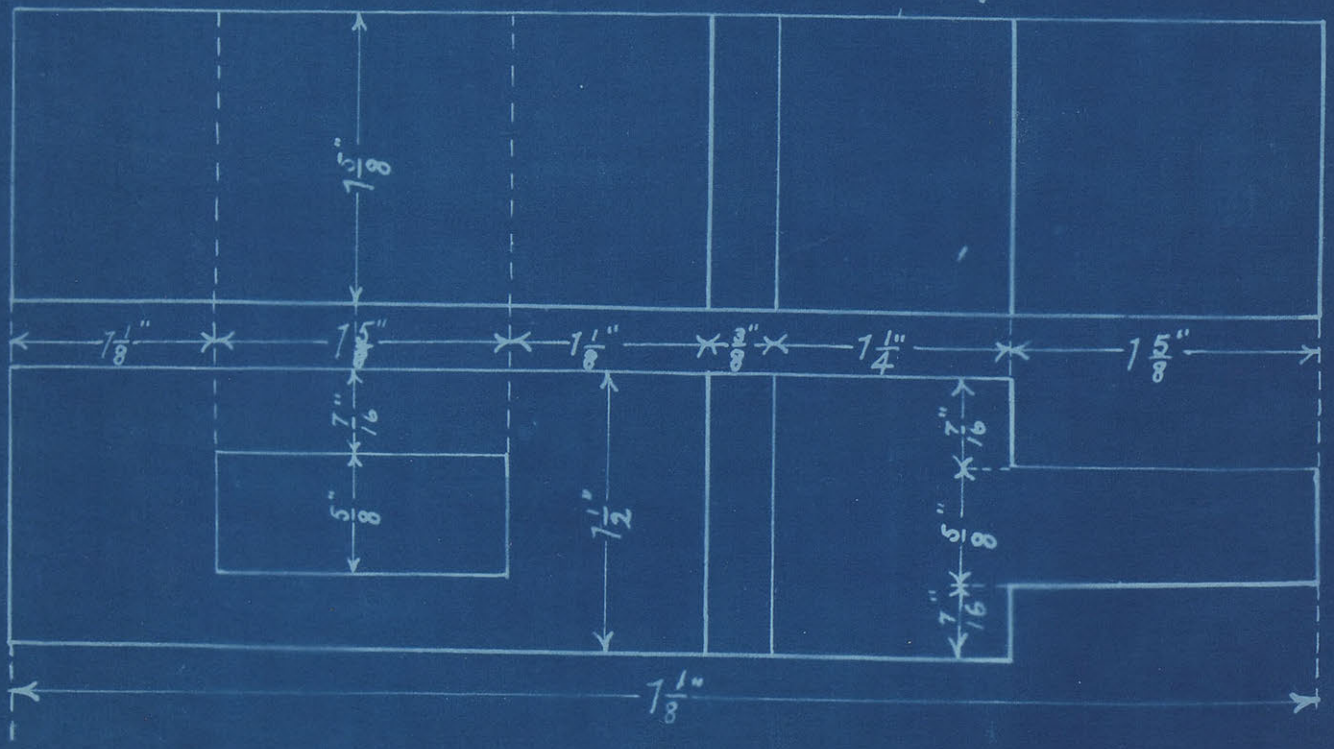


Joinery. Ex. No. 2. Cross.
K.S.A.C.—'06 — B.B.

JOINERY – No 3.

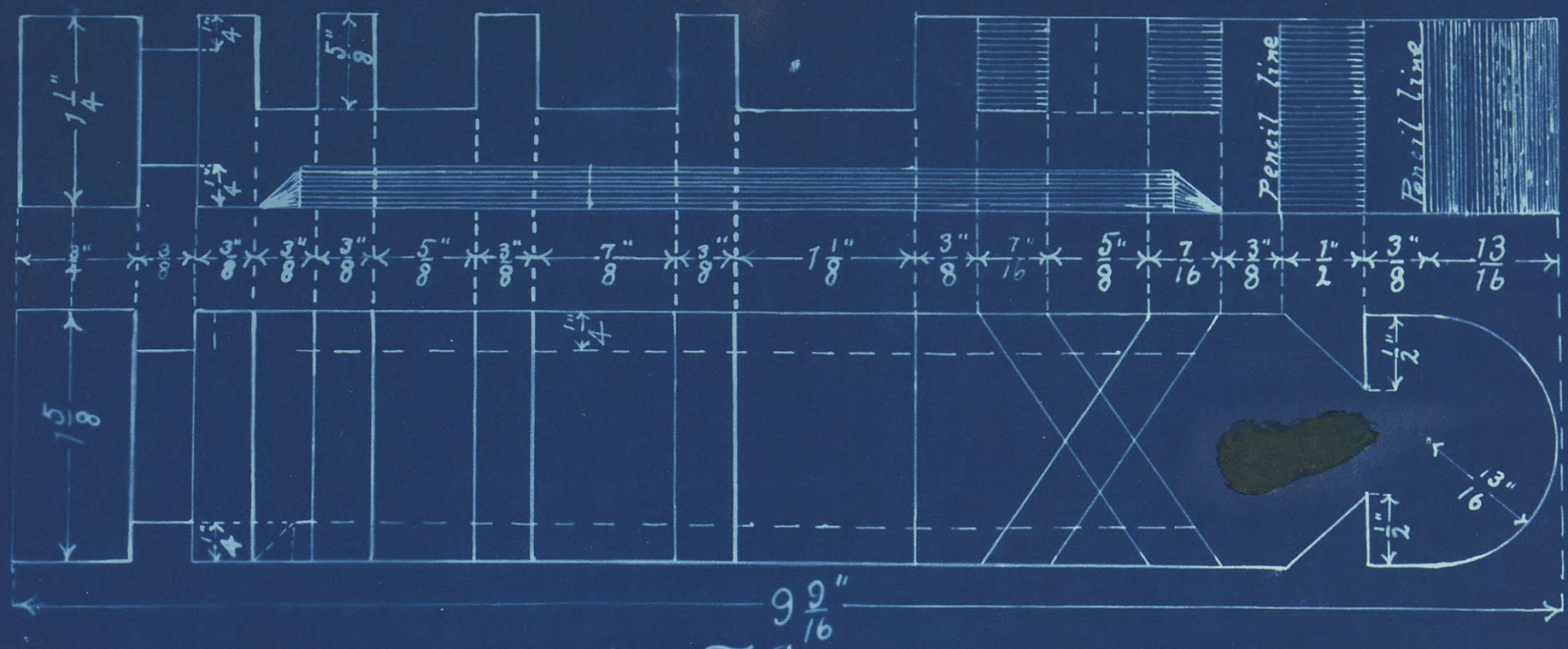


JOINERY EXERCISE No. 4.

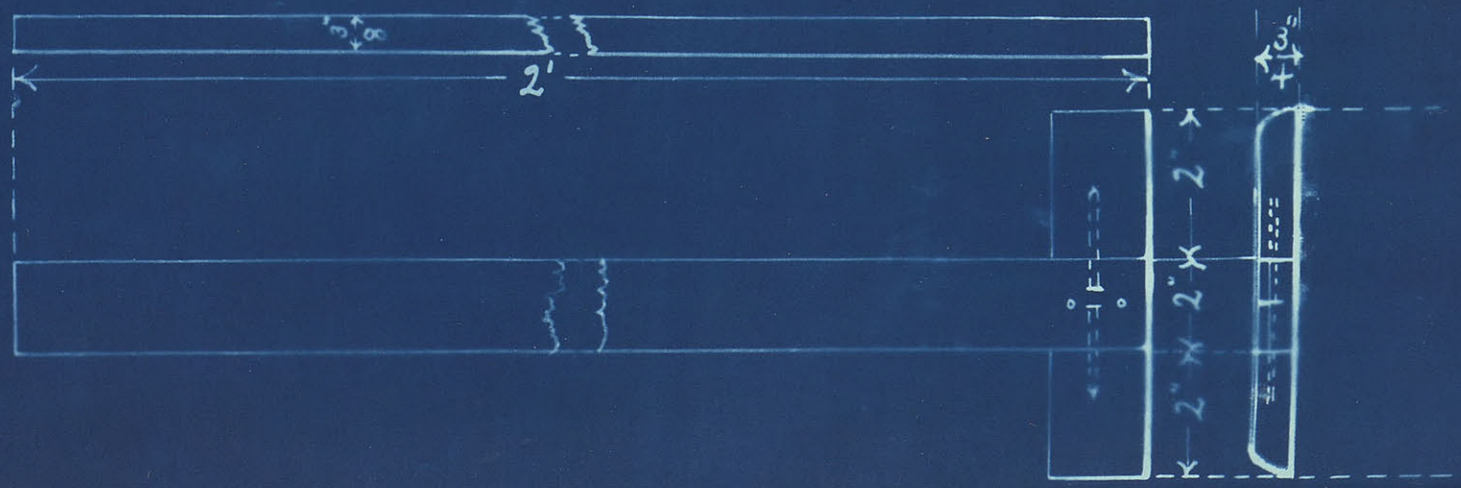


K.S.A.C. 06. B.B.

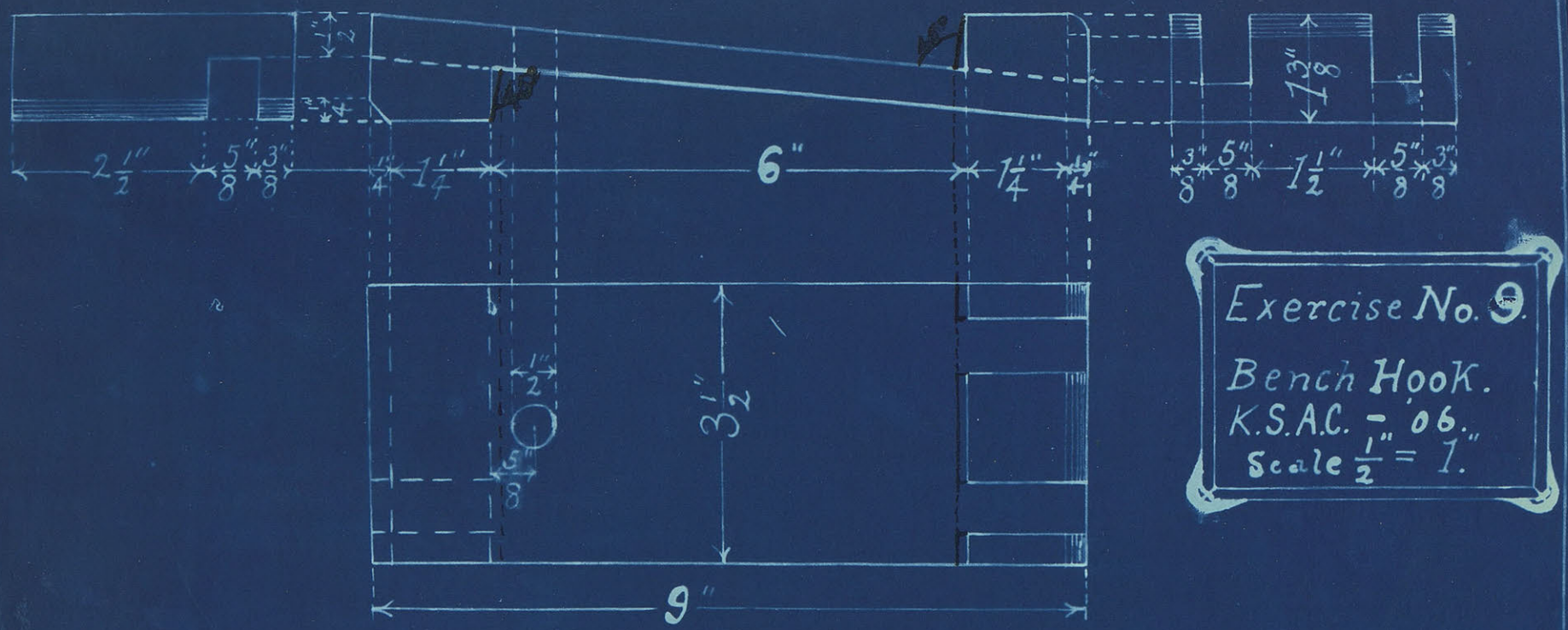
JOINERY EXERCISE No.5.



No.10. T. Square.



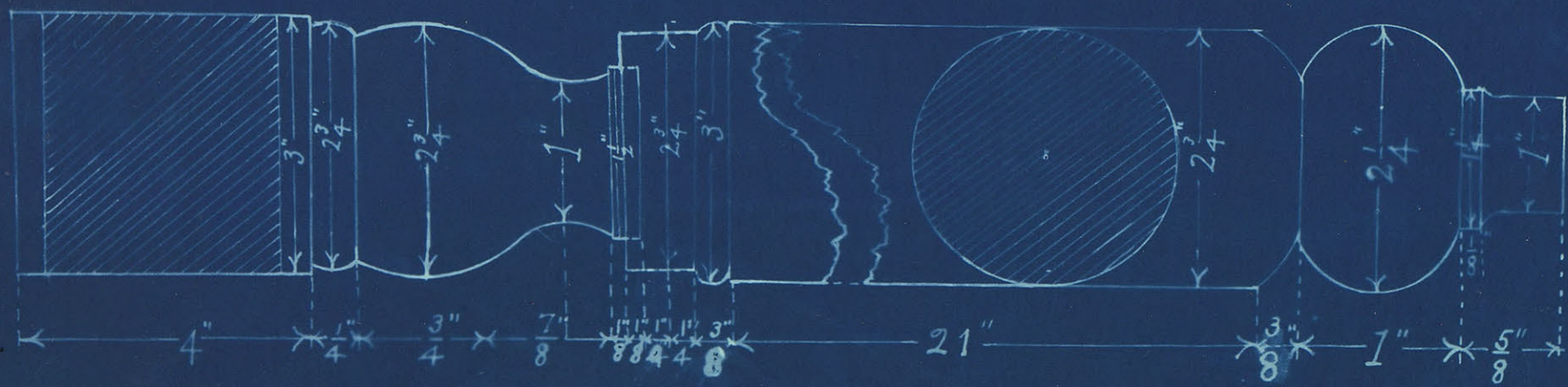
K.S.A.C. '06. B.B.



Exercise No. 9.

Bench Hook.
K.S.A.C. - '06.
Scale 1/2" = 1".

Table Leg. Turning Ex. No. 12.



B.B.

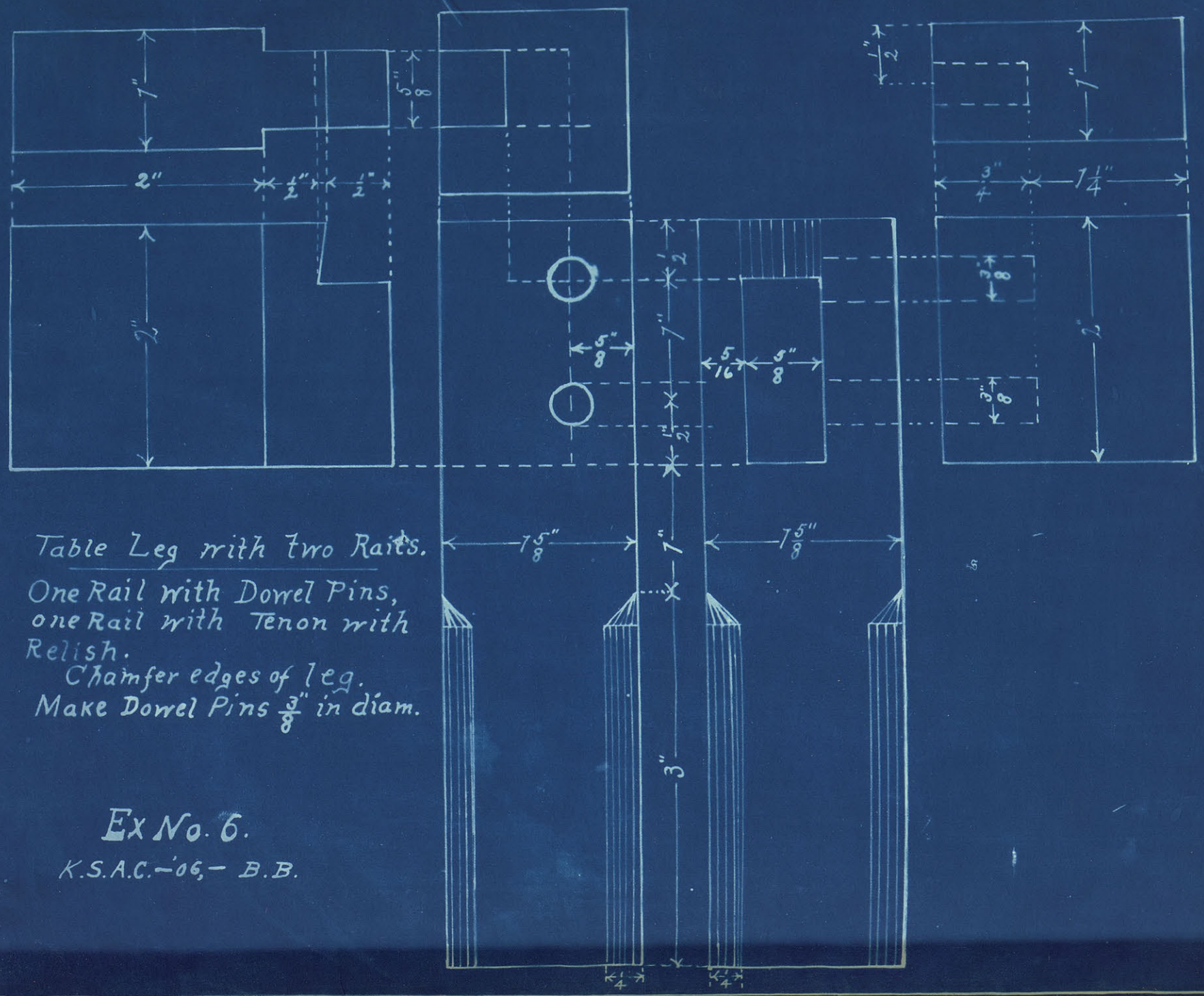


Table Leg with two Rails.

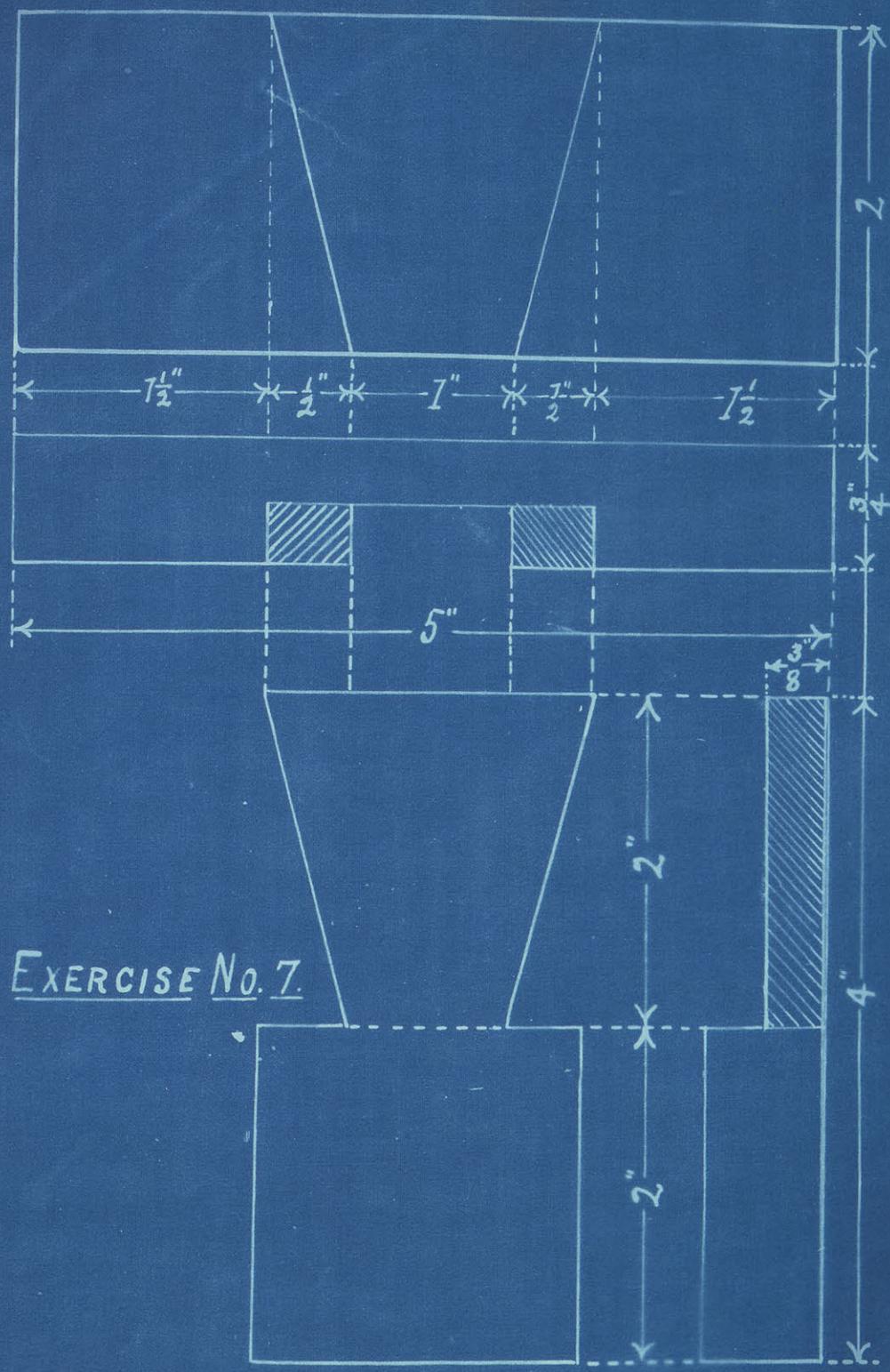
One Rail with Dowel Pins, one Rail with Tenon with Relish.

Chamfer edges of leg.

Make Dowel Pins $\frac{3}{8}$" in diam.

Ex No. 6.

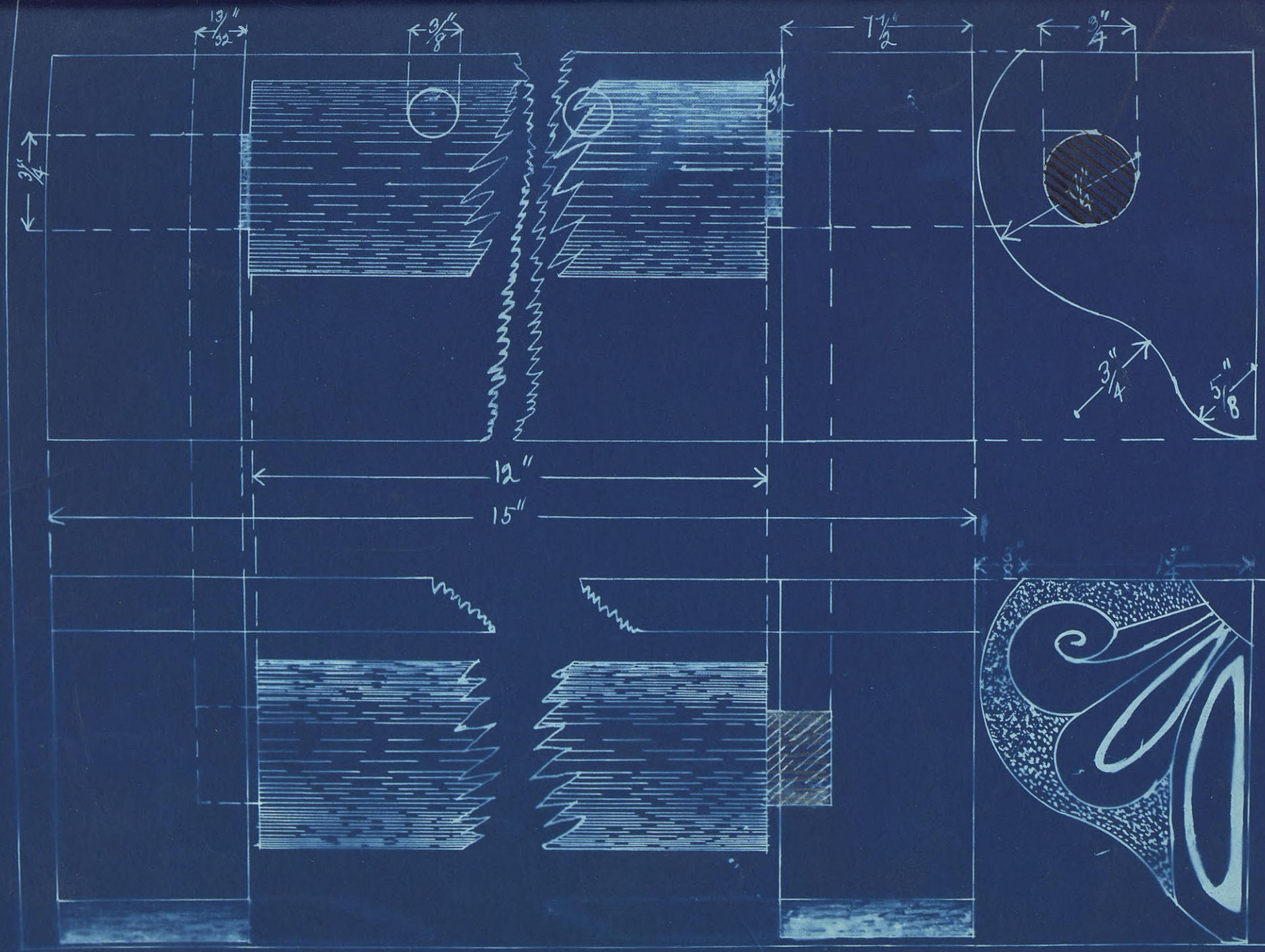
K.S.A.C.–06,– B.B.



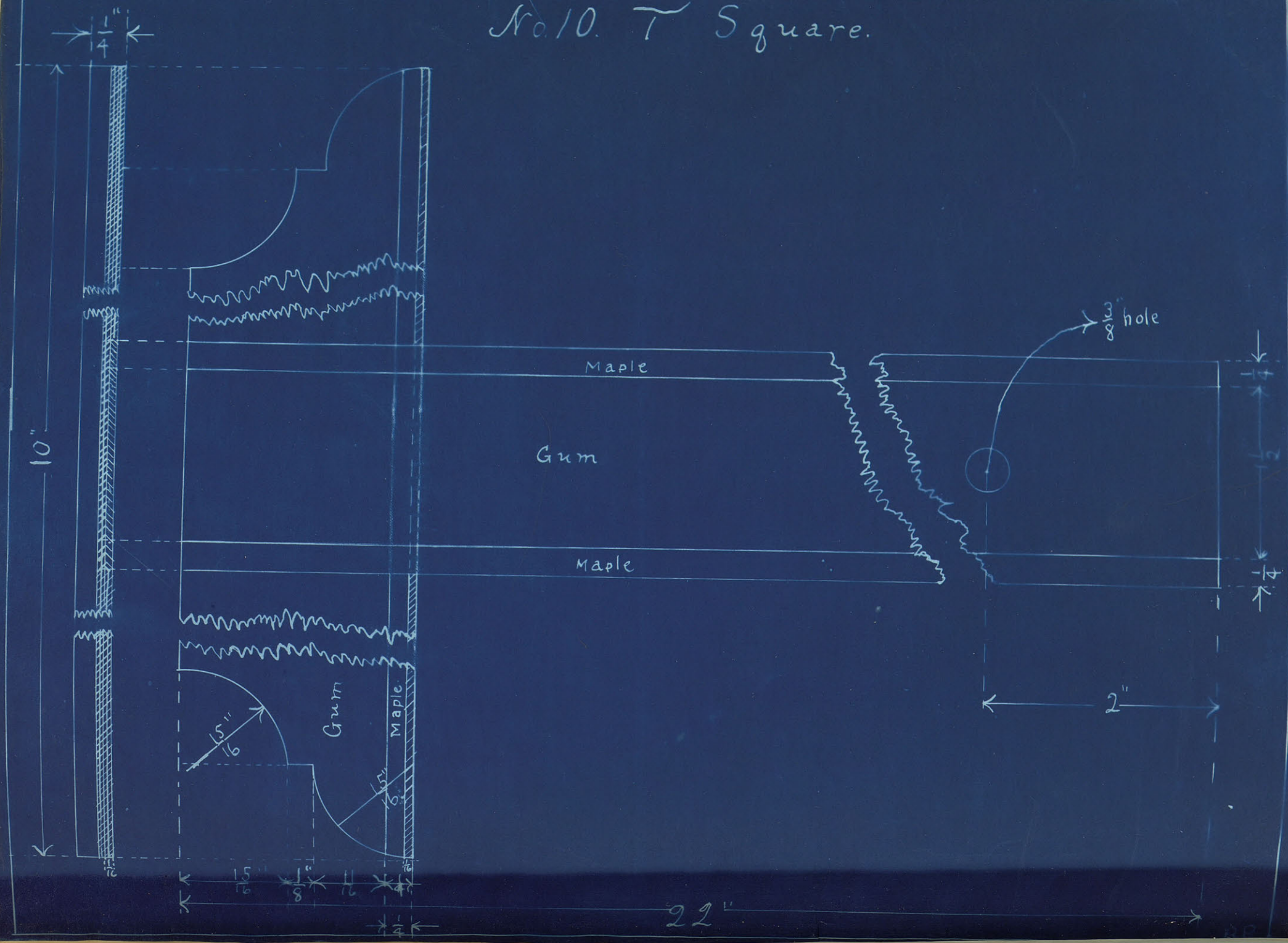
EXERCISE No. 7.

K.S.A.C. [illegible]

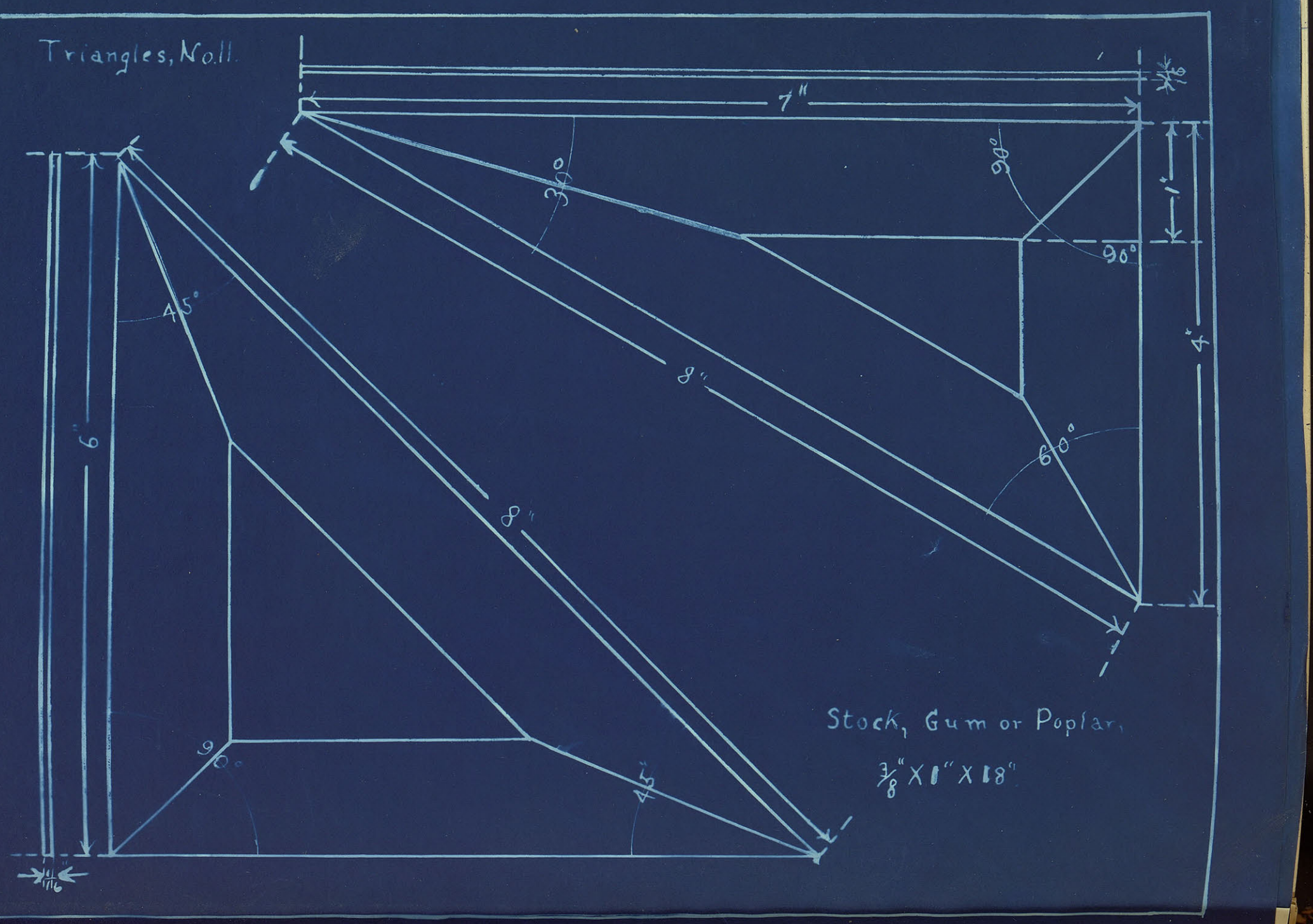
Junction City, High School.



No. 10. T Square.



Triangles, No. 11.



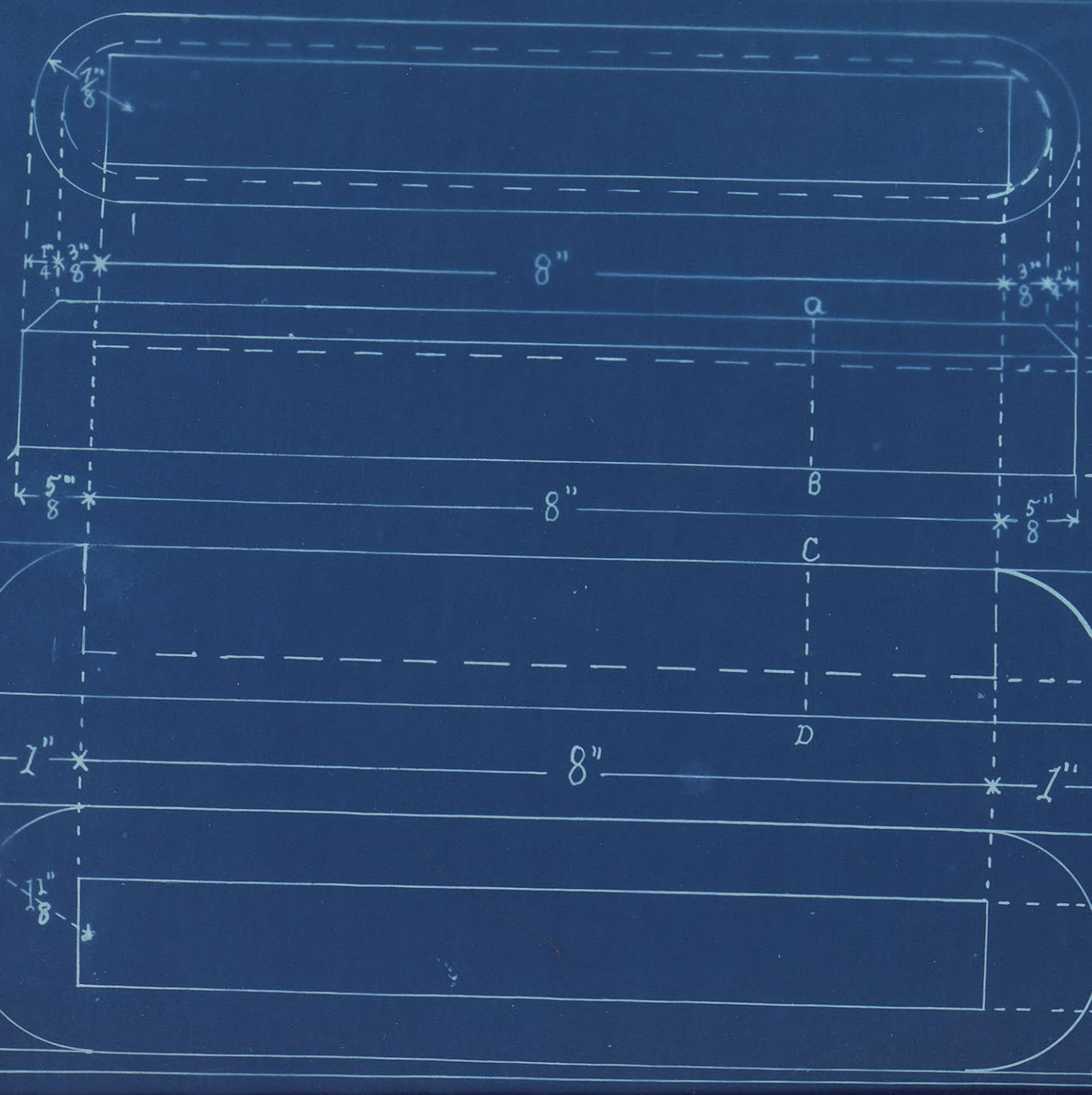
Stock, Gum or Poplar,

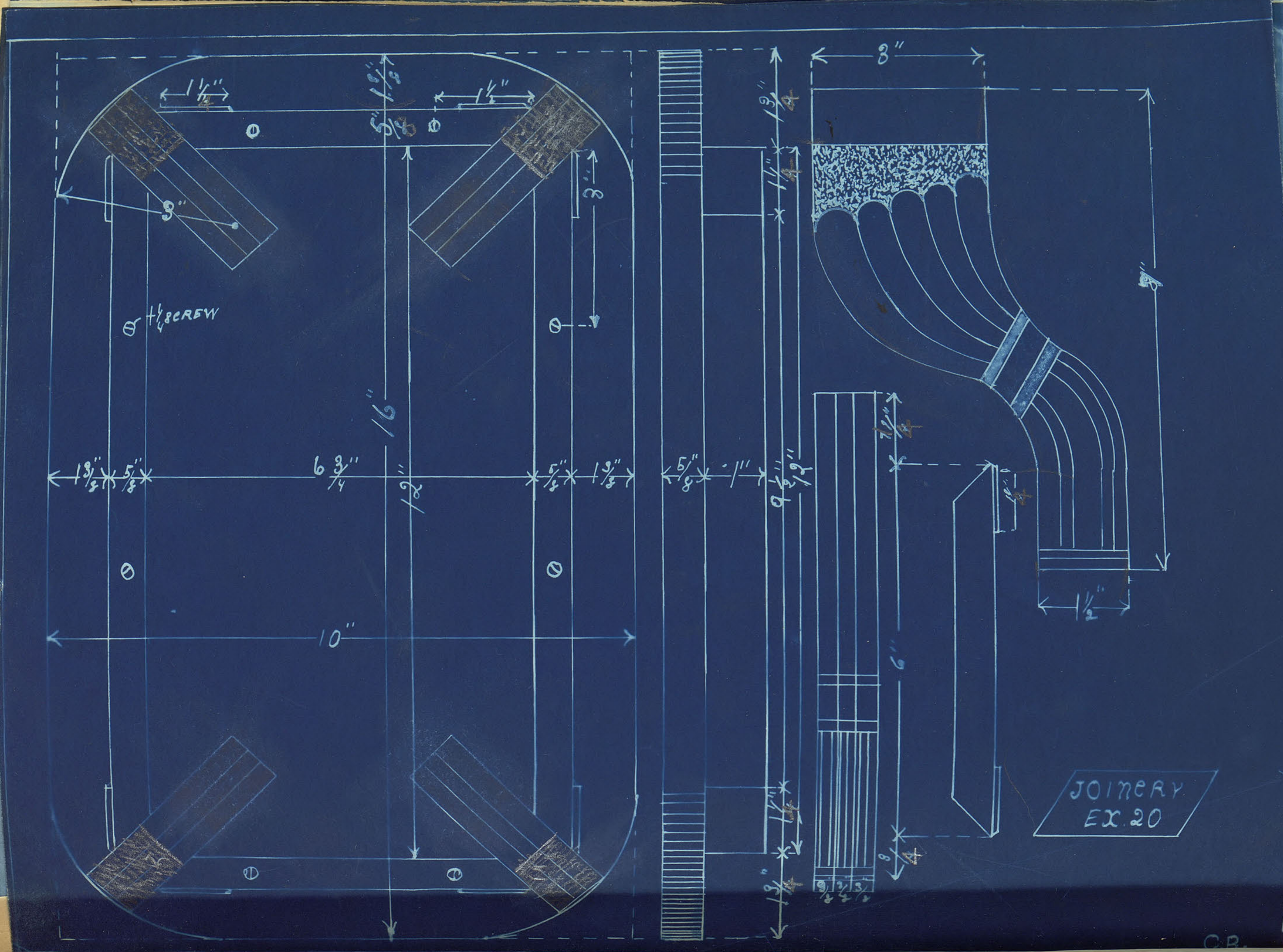
$\frac{7}{8}$" X 1" X 18"

EXERCISE No 14

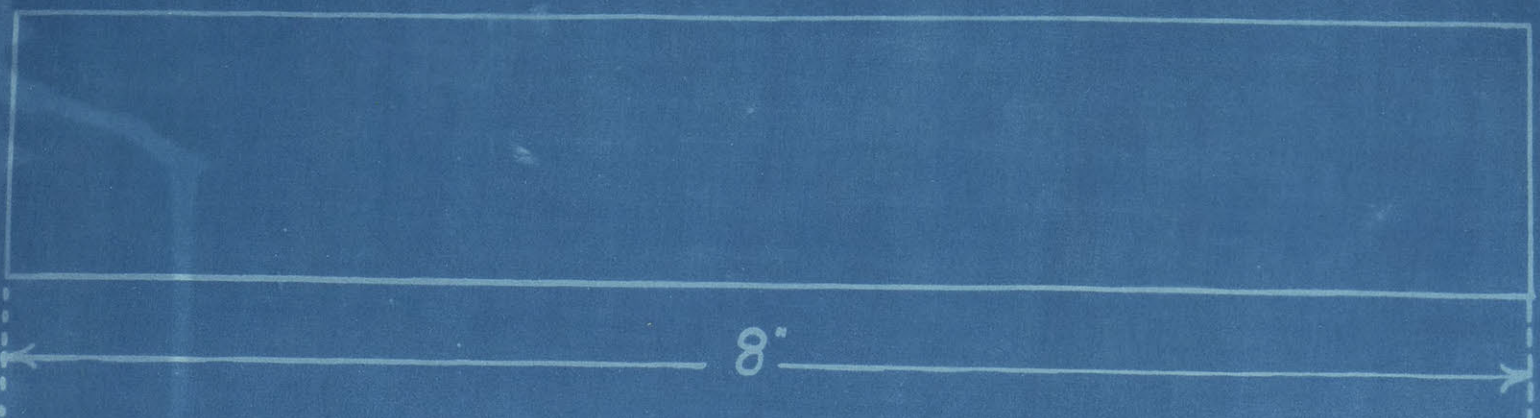
OILSTONE BOX

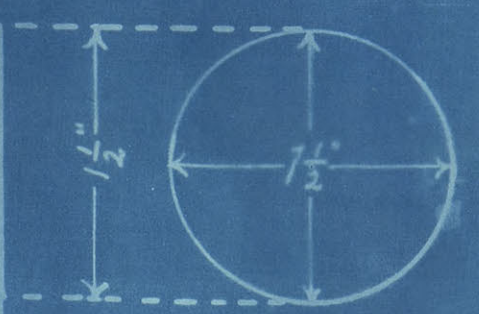
Scale $\frac{3}{4}$" = 1"

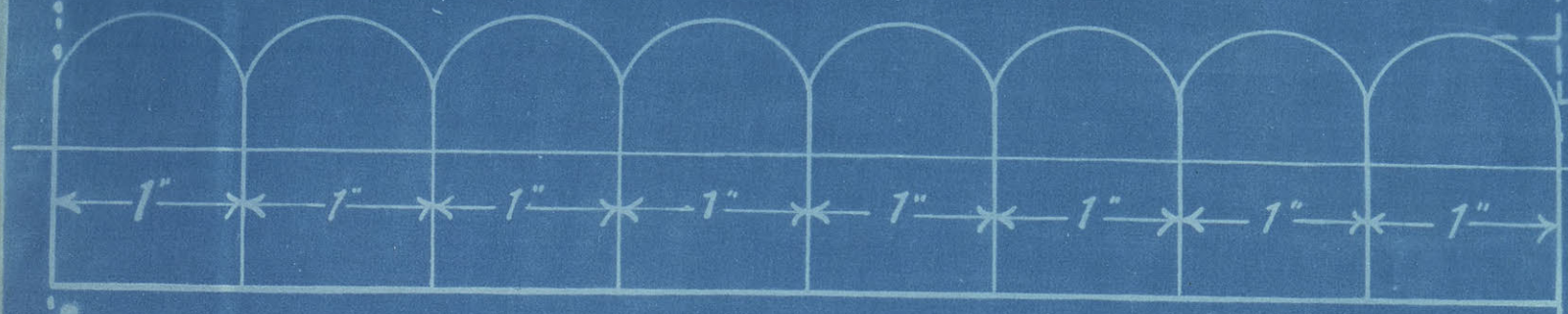


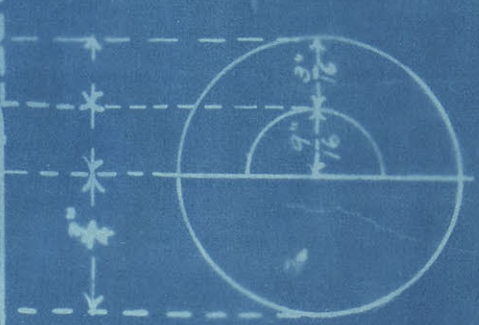

1/4 SCREW
10"
16"
3"
9"
6"
JOINERY
EX. 20

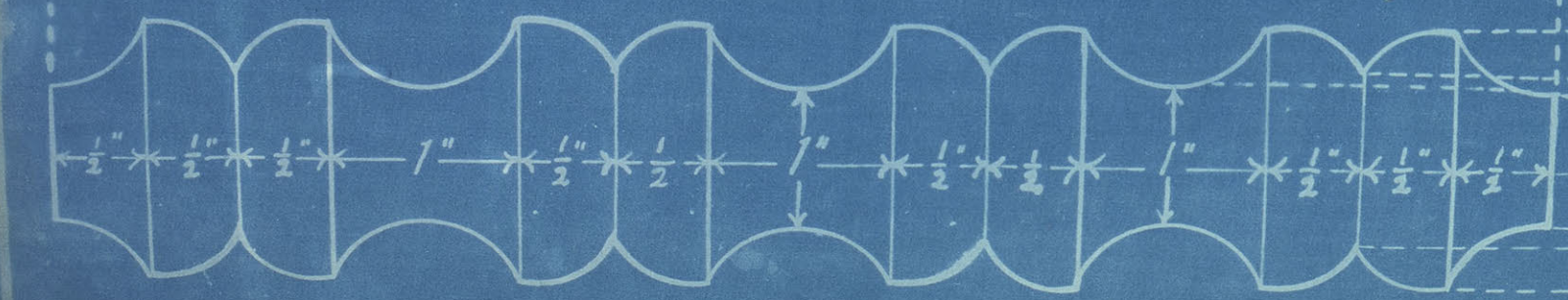
Exercises 1, 2, and 3. — Turning.

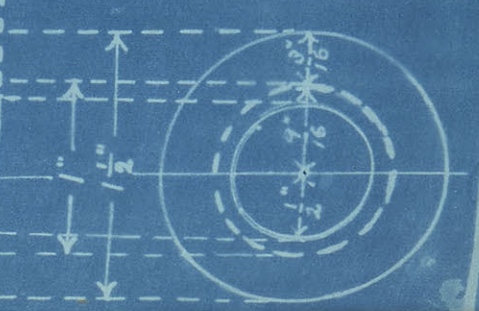






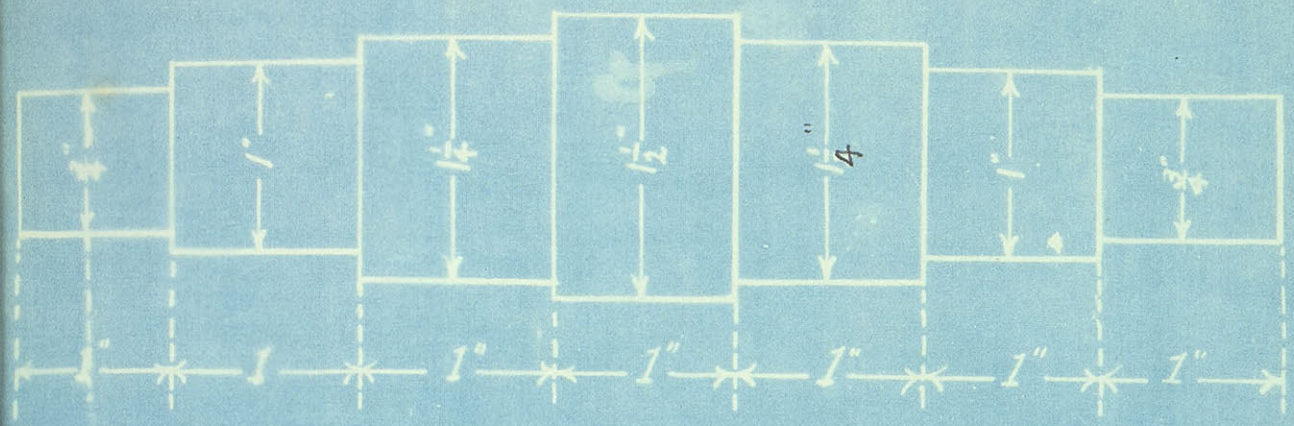




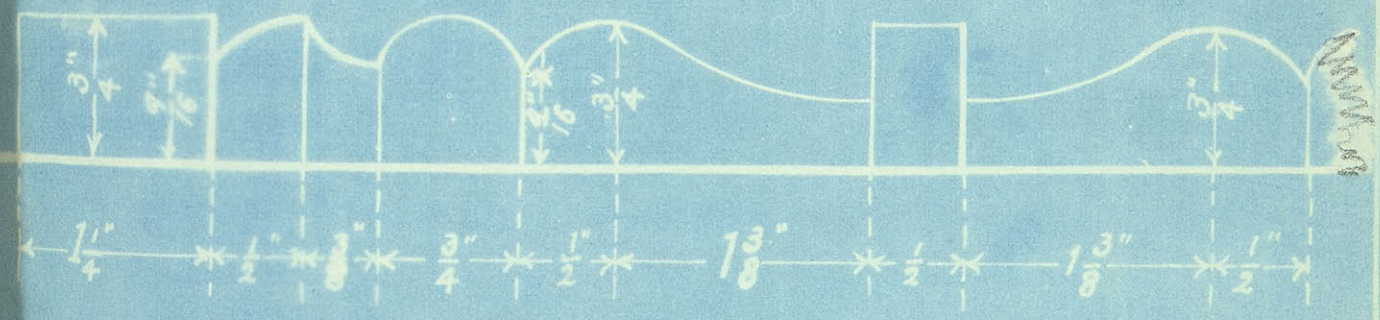


K.S.A.C. — B.B. 6-18-'06.

Turning Exercise No 4.



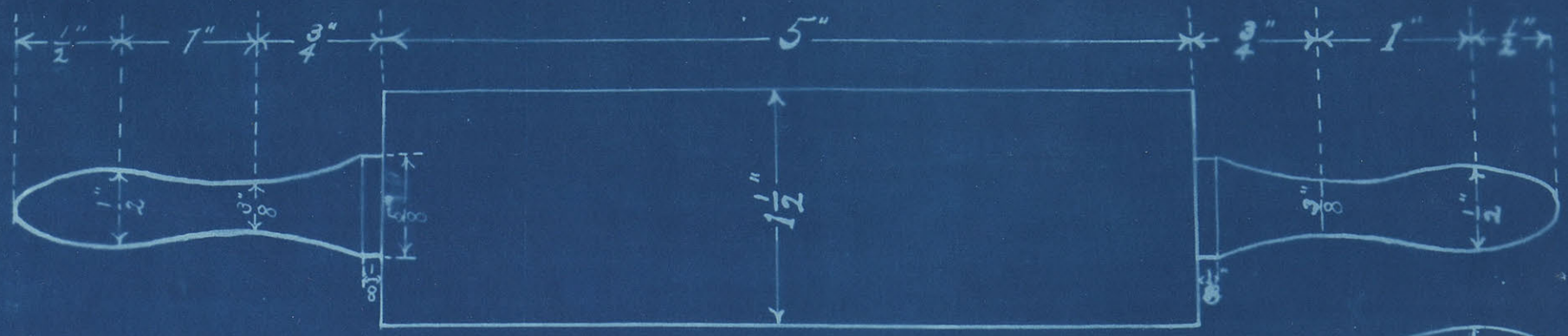
Turning No. 5.



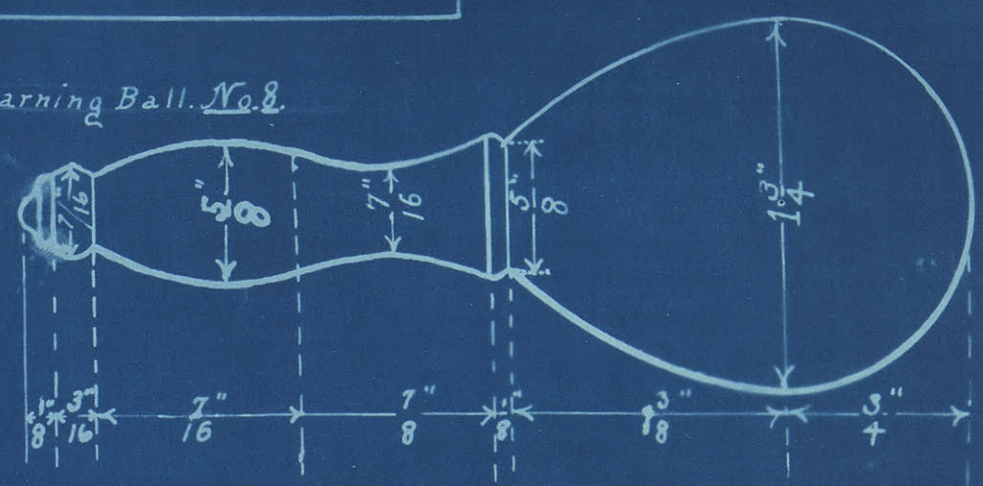
Turning Exercise No. 6.

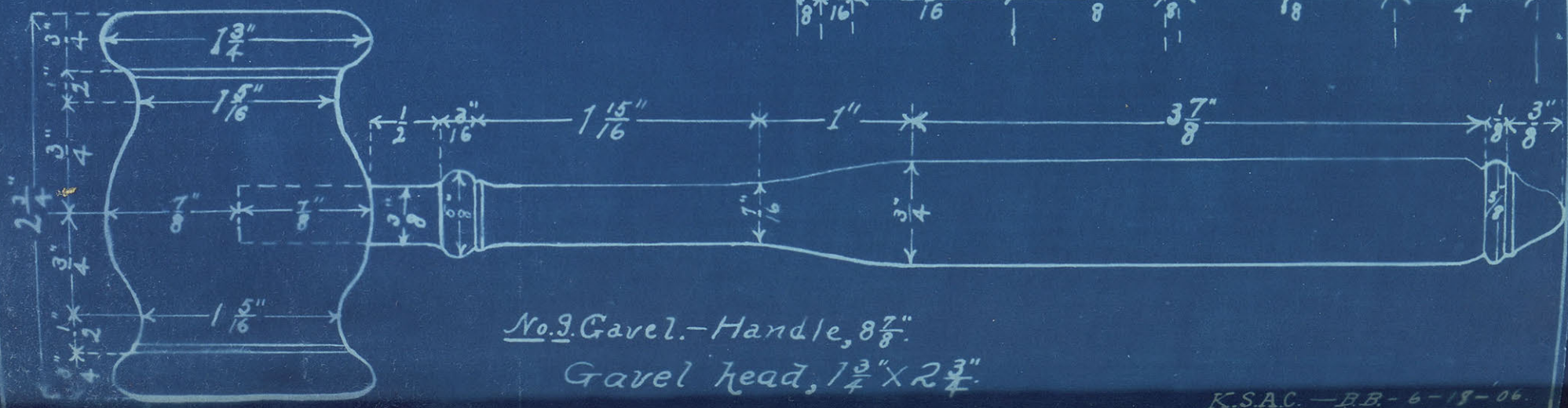
K.S.A.C.-B.B.-6-18-06.

Nº's 7, 8, and 9. — Turning.



Darning Ball. No. 8.



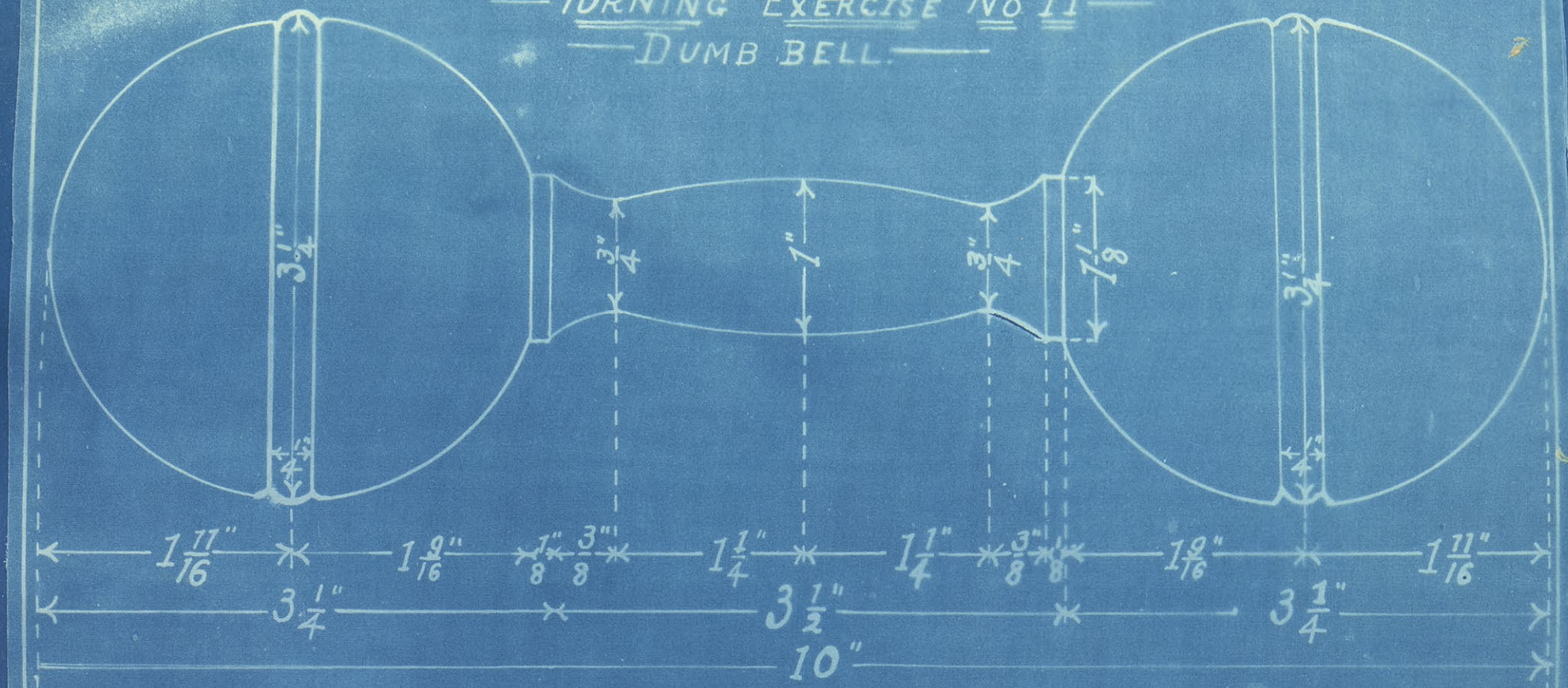


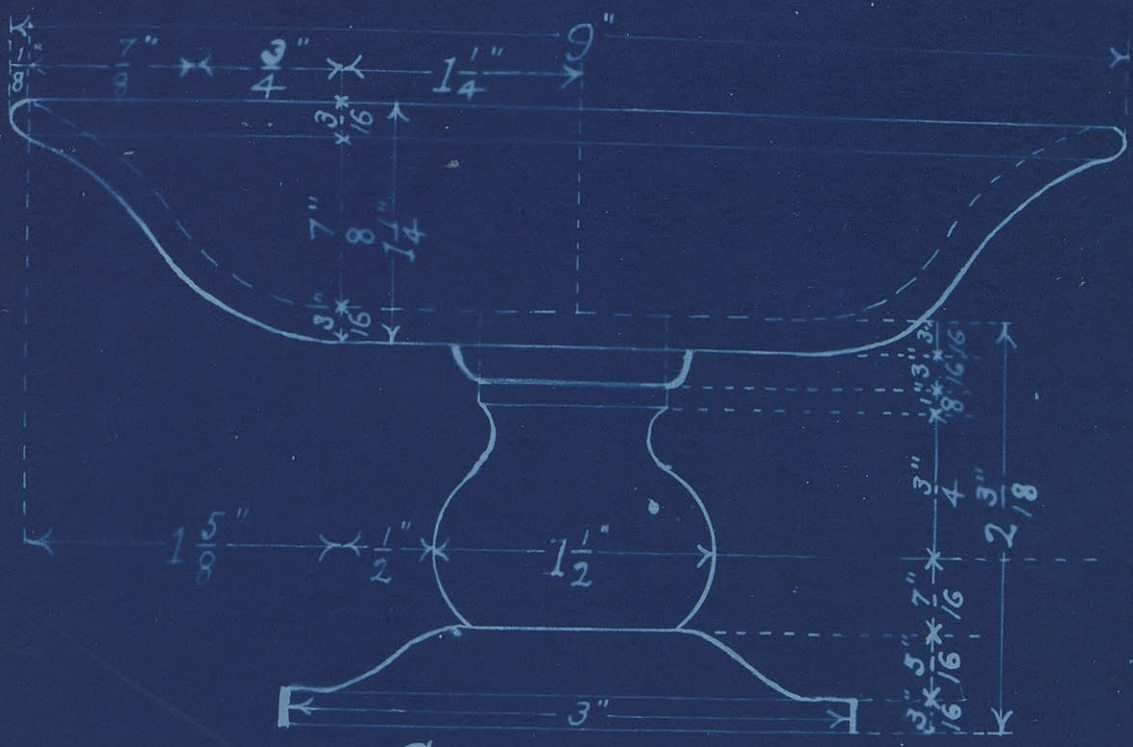
No. 9. Gavel. — Handle, 8 7/8".

Gavel Head, 1 3/4" × 2 3/4".

K.S.A.C. — B.B. - 6 - 18 - 06.

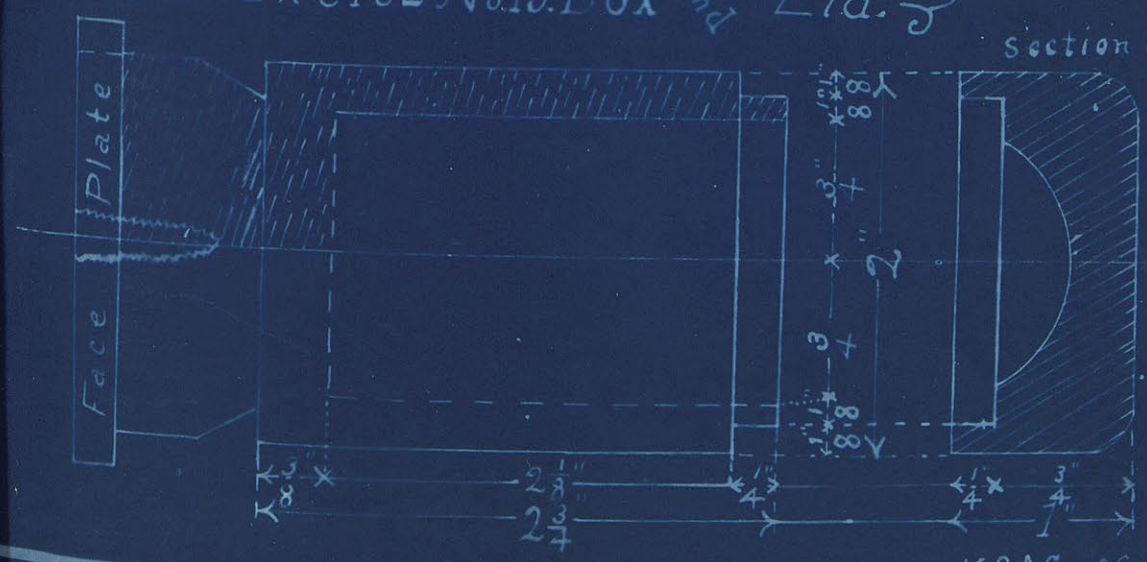
TURNING EXERCISE No 11
DUMB BELL.





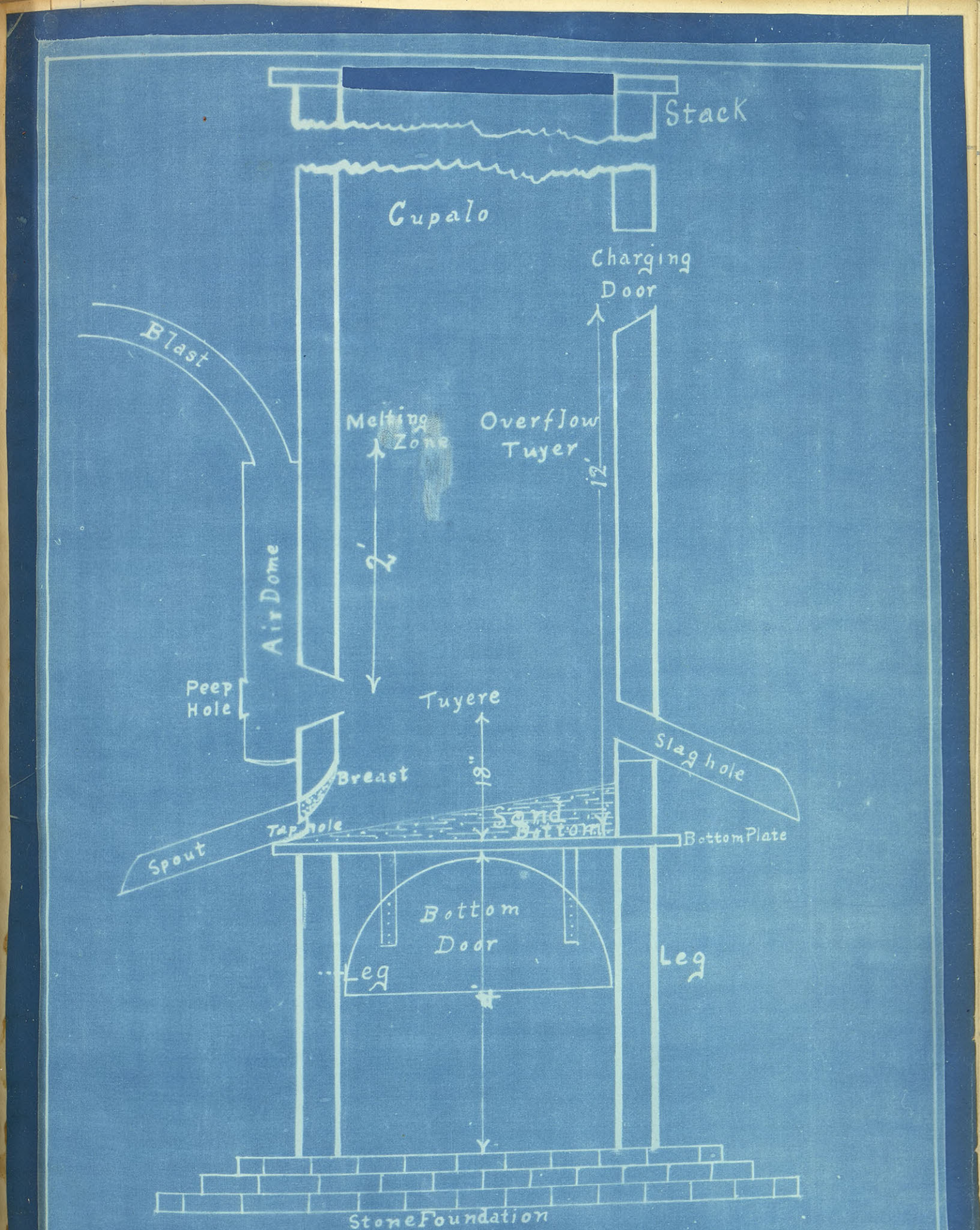
Card Tray. Turning No. 16.

K.S.A.C. '06. B.B.



EXERCISE No. 13. Box and Lid.

K.S.A.C. 06. B.B.



Foundry Cupalo.

K.S.A.C. '06. B.B.