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ART AND EDUCATION IN WOOD-TURNING



WILLIAM W. KLENKE



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ART AND EDUCATION IN WOOD-TURNING

A TEXTBOOK AND PROBLEM BOOK
FOR THE USE OF STUDENTS

BY

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TO MY WIFE
EDITH ELIZABETH

FOREWORD

THIS book is intended primarily for the use of students in normal schools, high schools, colleges or similar institutions and for lovers of all things useful and beautiful in wood-turning. It aims by means of text and illustrations to give such facts about the art of wood-turning as are needed by students and teachers in the schools. In giving these facts, whenever there is a question between two methods of procedure, the one being the method of the factory expert in wood-turning, and the other the method of the art craftsman in the school, the latter has been employed. As a result it is sometimes true that a less direct method is recommended than is employed by the commercial turner, but this is justified on the ground of the purpose of the book, which is fundamentally educational.

Besides being a book of instruction on the process of wood-turning, it is a book of problems, in the designing of which the author has constantly aimed to recognize beauty of form. As indicated by the title of the book, the author's chief purpose has been to make a contribution to the teaching of art and to education, thru the fine old craft of wood-turning.

Acknowledgments are hereby given to my wife for her untiring assistance in compiling the text of the book.

I gratefully acknowledge, also, the willing attitude of my students in helping to work out the models, in posing for the photographic illustrations and in co-operating in the working out of a higher type of wood-turning. For the working out of the tea wagon wheel, acknowledgment is made to Samuel E. Wardell of the Central High School, Newark, N. J.

Acknowledgment is made to Charles F. Moore, head of my department, for his helpful attitude.

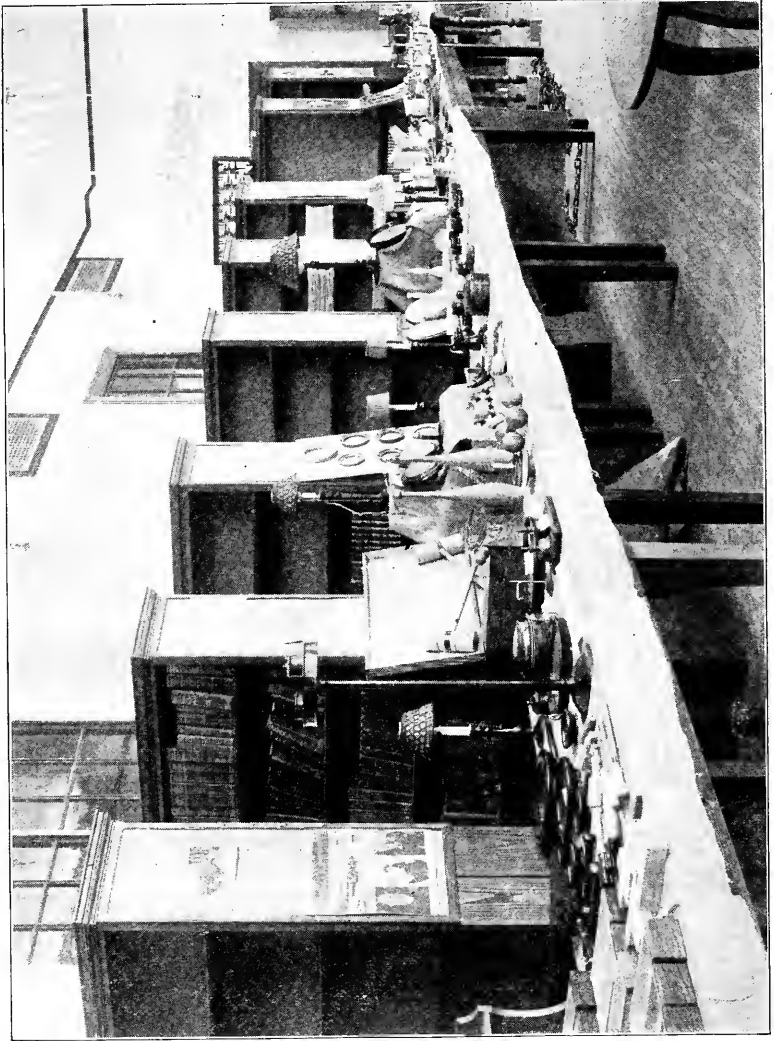
CONTENTS

	PAGE
THE SHOP	11
TOOLS AND EQUIPMENT	11
GRINDING AND SHARPENING	14
STARTING SPINDLE WORK	17
ROUGHING WITH A GOUGE	19
THE PARTING TOOL AND CALIPERS.	20
THE SKEW USED FOR SMOOTHING CYLINDERS	22
THE SKEW CHISEL FOR V'S AND BEADS	24
THE GOUGE USED FOR TURNING COVES	27
DESIGN	27
THE DARNING BALL	29
SANDPAPERING	30
FINISHING	33
THE POTATO MASHER.	36
INDIAN CLUBS	38
DUMB-BELLS	38
SCREWDRIVER HANDLES	40
THE MALLET.	44
GAVELS	47
THE ROLLING PIN	50
BOWLS.	54
THE NAPKIN RING	60
PICTURE FRAMES	68
BOXES	68
COMBINATION TURNING—CANDLESTICKS	70
LAMP STANDARD	76
LATHE BORING	76
SEGMENT WORK	78
SERVING TRAY	82
COLLAR BOX	84
BUTTON BOX	84
CHEESE AND CRACKER DISH.	86
SEWING SET	86
NUT SET.	86

	PAGE
CLOCK CASING	88
THE TEA WAGON WHEEL	92
CROQUET SET	94
LONG-PIECE TURNING — THE FOUR-POST BED	98
THE FLOOR LAMP.	98
WOODS USED IN TURNING	102
DON'TS	103
SHOP DISCIPLINE	104
THE EXHIBIT.	106

LIST OF PLATES

PLATE	PAGE
I. SHOULDERS, V'S AND BEADS, COVES	25
II. DARNING BALL	31
III. POTATO MASHER	37
IV. INDIAN CLUB	39
V. DUMB BELL	41
VI. SCREWDRIVER HANDLES	42
VII. TURNING TOOL HANDLES	43
VIII. MALLET	45
IX. GAVEL	48
X. GAVEL	49
XI. ROLLING PIN	52
XII. UMBRELLA HANDLES	53
XIII. NUT SETS	55
XIV. DRAWER KNOBS AND CASTER CUP	57
XV. MATCH BOX HOLDER	58
XVI. BATH ROOM STOOL	59
XVII. NAPKIN RINGS	61
XVIII. DRAWING SET	64
XIX. BREAD BOARD	65
XX. TEA POT STANDS	66
XXI. TRAY AND FRAME MOULDINGS	67
XXII. BOXES	69
XXIII. GIRL'S DRESSER SET	71
XXIV. CANDLESTICK	73
XXV. CANDLESTICK	74
XXVI. ELECTROLIER OR CANDLESTICK	75
XXVII. LAMP STANDARD	77
XXVIII. FLOWER HOLDER	79
XXIX. SMOKING STAND	81
XXX. COLLAR AND BUTTON BOX	83
XXXI. CHEESE AND CRACKER DISH	85
XXXII. SEWING SET	87
XXXIII. NUT BOWL	89
XXXIV. CLOCK CASING	90
XXXV. TEA WAGON WHEEL	91
XXXVI. CROQUET SET	93
XXXVII. FOUR POST BED	99
XXXVIII. FLOOR LAMP	100
XXXIX. FLOOR LAMP	101



A School Exhibit.—Note the Grouping of Objects to Form Separate Units.

THE SHOP

Fig. 1 shows the plan of a shop similar to one in use at the Central High School, Newark, N. J. The shop should be equipped with both benches and lathes so that it may serve a three-fold purpose—that of (a) wood-turning, (b) pattern making, and (c) joinery. The position of the lathes and benches in relation to the light is good, the light shining into the cone pulley. The distance between benches and lathes has been tried out, and should not be reduced.

The type of lathe to purchase will not be discussed further than to mention the author's preference for the style of lathe having the large step of the cone pulley to the outside, and the adjustments for holding the tee-rest and tail-stock worked with a hand wheel rather than a cam.

The band-saw, grinder and trimmer are almost indispensable in a well-ordered shop. A small drill press and 6" jointer save time, and make for accurate work. A small circular saw also is a fine addition to the shop.

The floor of all shops should be of maple—no cement floor being practical, as, in the first place, many tools are broken when dropped on the floor, and secondly, standing on a cement floor is harmful to the worker.

Lastly, allow plenty of light and air to enter; increase the number of windows indicated on the plan if the layout permits. The northern exposure is to be preferred.

TOOLS AND EQUIPMENT

Having decided upon the type of lathe to be used, the next step is the general arrangement of the shop equipment.

Fig. 1 shows the position of the lathes and benches, so as to get the maximum amount of light at each lathe, to allow ample room for the student to work and pass about the room, to have the grindstone and band-saw handy, and yet not waste any floor space.

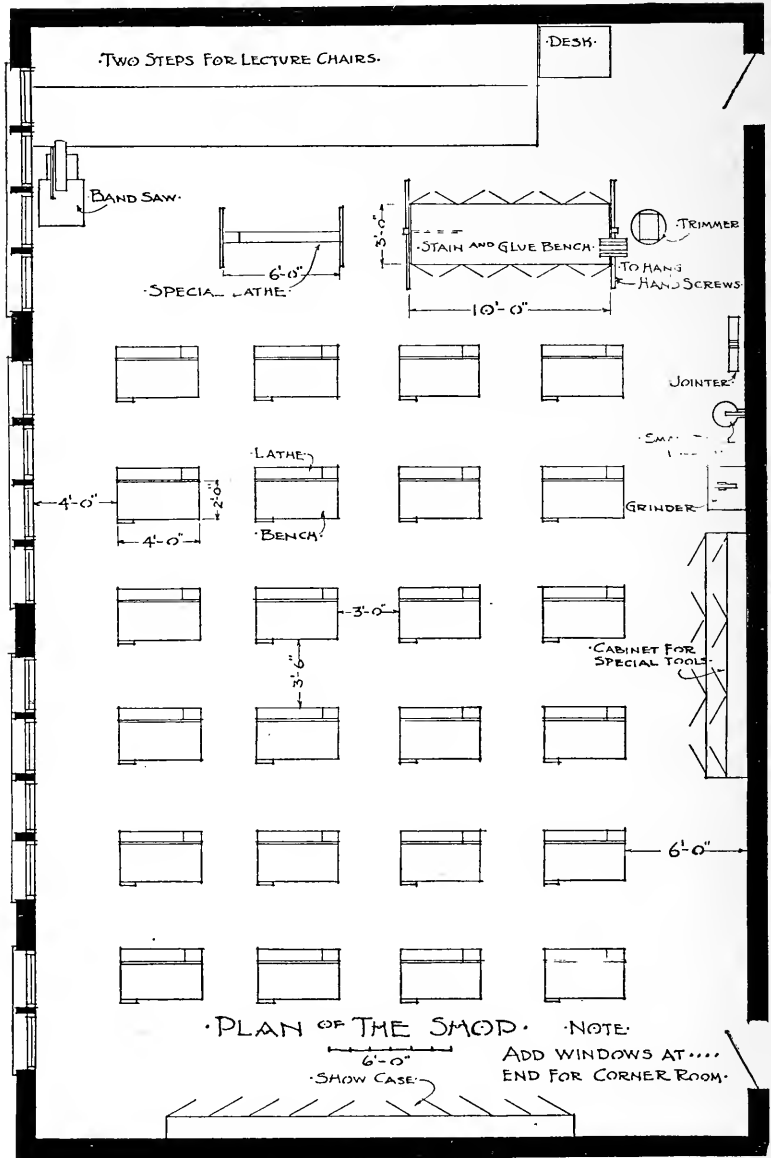


Fig. 1.

It is poor economy to equip a room with lathes alone, as such an arrangement can only be used as a wood-turning shop, whereas the plan suggested makes the room suitable for pattern making and joinery as well, or a combination of any of the two.

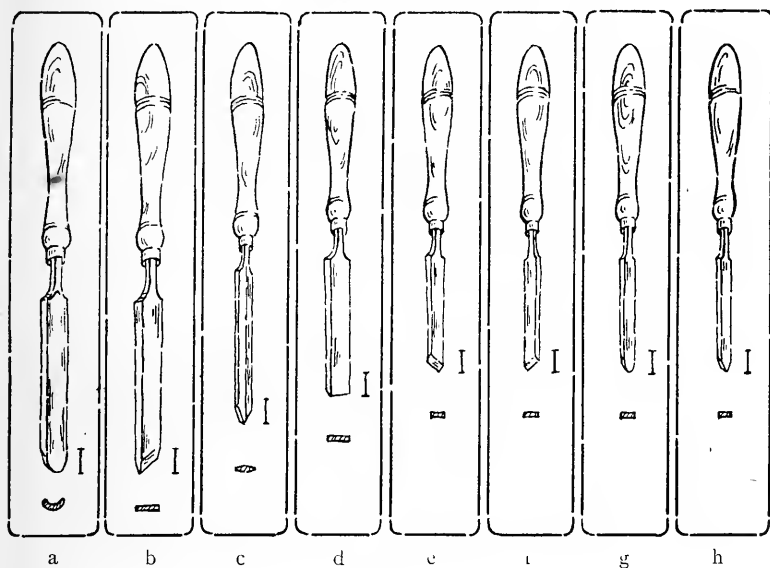


Fig. 2.

Each lathe should be equipped with:

- | | |
|--|----------------------------------|
| 1" gouge, Fig. 2, a. | 6" outside calipers, Fig. 3, c. |
| $\frac{1}{2}$ " gouge. | 6" inside calipers, Fig. 3, d. |
| 1" skew chisel, Fig. 2, b. | India oil stone slip, Fig. 3, f. |
| $\frac{1}{2}$ " skew chisel. | Copper oil can. |
| $\frac{1}{2}$ " parting tool, Fig. 2, c. | |

The bench should be equipped with the ordinary joinery tools.

The special tool rack should contain the following:

- 1 doz. $\frac{1}{8}$ " socket chisels, Fig. 3, a.
- 1 doz. $\frac{1}{4}$ " flat scrapers, Fig. 2, d.
- $\frac{1}{2}$ doz. $\frac{1}{2}$ " flat scrapers.
- 1 doz. 1" flat scrapers.
- $\frac{1}{2}$ doz. $\frac{1}{2}$ " right-hand skew scrapers, Fig. 2, e.
- $\frac{1}{2}$ doz. $\frac{1}{2}$ " left-hand skew scrapers, Fig. 2, f.
- $\frac{1}{2}$ doz. $\frac{1}{4}$ " left-hand skew scrapers.
- $\frac{1}{2}$ doz. $\frac{1}{4}$ " right-hand skew scrapers.
- $\frac{1}{2}$ doz. $\frac{1}{2}$ " round-nose scrapers, Fig. 2, g.

- $\frac{1}{2}$ doz. $\frac{1}{4}$ " round-nose scrapers.
- $\frac{1}{2}$ doz. $\frac{1}{2}$ " diamond-point scrapers, Fig. 2, h.
- $\frac{1}{2}$ doz. 6" dividers, Fig. 3, e.
- $\frac{1}{2}$ doz. 9" cabinet files.
- 2 file cards.
- $\frac{1}{2}$ doz. 9" screwdrivers.
- 1 set auger bits.
- 1 set from No. 5 to No. 12 twist drills.
- 2 Millers Falls Hand drills, No. 1.
- 2 turner's sizers (outside), Fig. 3, b.
- 1 pair of large calipers.

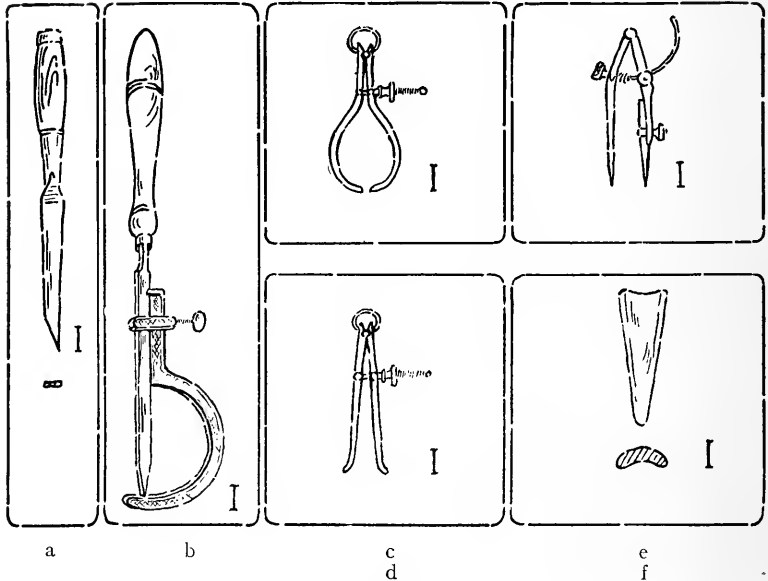


Fig. 3.

A staining and gluing bench is provided, with the necessary shelves for stains, shellacs, alcohol, fillers, turpentine, kerosene oil, sandpaper, waste, glue, handscrews, etc.

GRINDING AND SHARPENING

Generally speaking, turning tools may be divided into three groups, (a) the roughing-off tools, (the gouge), (b) the smoothing or cleaning-up tools, (the skew), and (c) the scraping tools, (the

flat skew, round-nose, diamond-point and other specially shaped tools used for scraping).

The grinding of all the above named tools is about the same, only differing in a few details. In every case the grindstone should

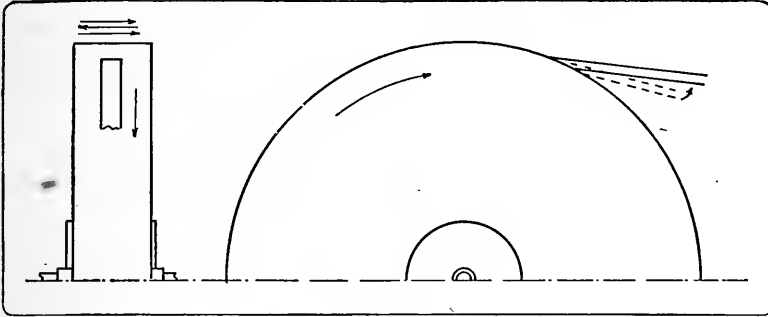


Fig. 4.

revolve towards the operator, Fig. 4. The tool to be ground is held low at the start, and gradually raised to a position so that the bevel will lie flat on the stone. This angle is then maintained thruout the grinding. In the case of the gouge, since the tool is



Fig. 5. Whetting a Gouge.

convex on the outside (and the bevel is on the outside), it will be necessary to roll the tool, and at the same time work it from one side of the stone to the other. The rolling motion makes it possible to grind all parts, and working it from side to side, prevents the wearing of a hollow in the stone.

To whet a gouge, the oilstone slip, Fig. 3, is used. Hold the slip in the right hand and the gouge in the left hand, Fig. 5. Two movements are necessary—one to work the stone back and forth, the other to roll the gouge from side to side. After some time, a burr

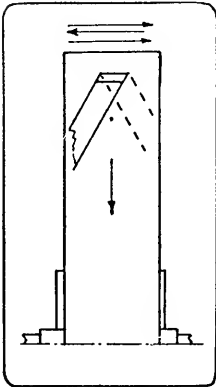


Fig. 6.

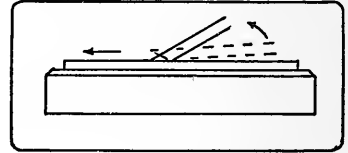


Fig. 7.

will be seen to form. To remove this burr, rub the slip on that side several times, then repeat the entire whetting operation until the gouge has been properly sharpened.

The grinding of the skew is somewhat different from that of the other tools, in that this tool has a bevel on both sides, and the cutting is *not* at right angles to the sides. Fig. 6 illustrates the cor-



Fig. 8. Whetting a Skew Chisel.

rect position of the skew while being ground; i.e. the cutting edge is kept parallel with the top of the stone. In whetting the skew the same principle is carried out, Figs. 7 and 8.

All scraping tools are ground only on one side. The foregoing instructions hold good for the grinding, but not for whetting. Since

the function of a scraper is to scrape and not to cut, it will be necessary to let the burr remain on the tool. This burr works as the burr on a cabinet or floor scraper.

If properly sharpened, with this burr, it is possible to work the wood down clean and quickly with any scraping tool.

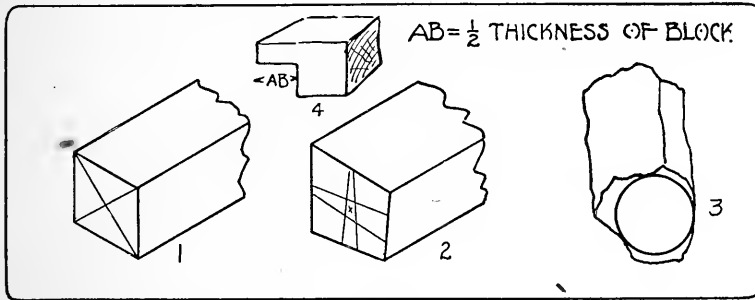


Fig. 9.

STARTING SPINDLE WORK

In order to get the most out of the stock given, and also to lessen vibration at the lathe, it is essential that one learn how to locate the center of the wood to be turned.

Fig. 9,1 illustrates a very simple and most commonly used method for locating the center. If the ends of the stock are square or nearly so, we know from geometry that the diagonals of the square bisect each other at the center.

Any straight edge will do for drawing the diagonals. Stand the wood on one of its ends and with the aid of a rule and pencil draw the required lines. The bed of the lathe or top of the tee-rest can be used to butt the wood against, to save looking for and handling a straight-edge.

Fig. 9,2 illustrates a method used on wood that is much out of square. Set a pair of dividers either a little greater or a little less than half the thickness of the wood, and, holding the block on something flat, scribe the four lines from the different sides. The center can thus be readily located. Instead of the dividers a parallel block or marking gauge can be used to obtain the same result.

Fig. 9,3 illustrates a rough piece of wood with no true shape. In order to get the desired diameter out of this stock it is necessary to draw the largest possible circle at each end.

In commercial turning, these methods are not generally used. The turner makes a guess at the center, starts the wood in motion

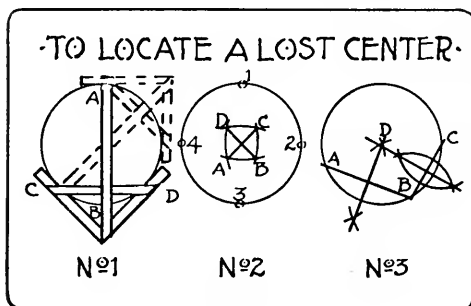


Fig. 10.

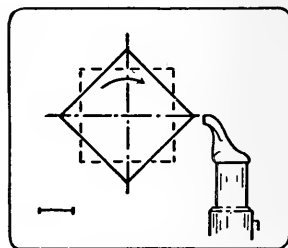


Fig. 11.

(by hand) and gently puts his gouge in contact with the wood, whereupon only the high corners will be hit. By lowering the wood with a tap or two of his mallet, hit on the high side, the wood is accurately centered. It must be understood, however, that the guess must be a good one, and this only comes with practice.

When a large number of pieces are to be turned, especially those of large dimensions, the turner often cuts a block as illustrated in Fig. 9,4, the distance AB being equal to exactly one-half the thickness of the stock. By using this as a gage and drawing two lines from adjacent sides, the center is accurately and quickly located.

The center having been found, the next step is to place the wood in the lathe. With the aid of the ramrod, drive out the live center of the lathe, then drive this center into one end of the wood (the end upon which the largest amount of turning is to be done). A mark, x, should be filed on one of the blades of the live center, and a corresponding mark put on the part of the wood this blade is to enter in order to indicate which blade was at that place. This is done so that the work may be removed and put back without shifting the center.

Place the live center and wood in the lathe, holding the latter with the left hand. With the right hand, turn the spindle of the tailstock out about 1", and then move the tailstock up to the work so that the dead center just comes in contact with the wood; then clamp the tailstock in place. Next, the dead center is forced into the wood by turning the spindle screw. At this point a drop or two of oil placed on the dead center where it comes in contact with the wood will ease the friction caused by the revolutions of the wood against the dead center. Now clamp the spindle securely to prevent it from working back while the piece of wood revolves.

Turn the wood so that one of the end diagonals will be horizontal, then move the tee-rest as close as possible to the work, having the top on a line with the edge of the wood, Fig. 11. Clamp the tee-rest in place. The height at which the tee-rest should be placed should be determined solely for the comfort of the student or worker.

Before starting to turn, try the various adjustments to make certain that all are secure, and revolve the wood by hand to make sure that it clears the tee-rest.

ROUGHING WITH A GOUGE

Fig. 12 illustrates a good position at the lathe. Put the weight of the body on the left foot; place the right foot one step forward. In this position the operator has freedom of motion to rock back and forth, thus obtaining the flexibility necessary at the lathe.

The left hand should slide along the tee-rest, gripping the tool as illustrated, Fig. 13. The right hand is held near the end of the handle and is kept against the hip bone.



Fig. 12. Position at the Lathe.

When possible work from the center out, to avoid hitting the corners and splitting the entire piece.



Fig. 13. Holding a Gouge.

The gouge, you will notice, Fig. 14, is tilted slightly so as to throw the shavings away from the face of the operator. In order to cut a shaving, care must be taken to hold the handle of the gouge low, Fig. 13 and 14; if held horizontally a

scraping cut will result, which will tear the fibres of the wood.

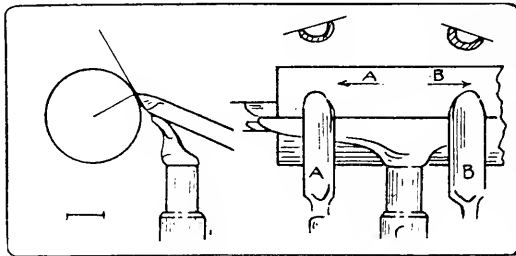


Fig. 14.

THE PARTING TOOL AND CALIPERS

In order that the wood-turner may have some quick and efficient method for obtaining a desired diameter, he resorts to the use of a parting tool and a pair of calipers, Fig. 15. Where, however, a number of pieces with the same diameter are to be turned, he often uses a combination of these tools, known as a turner's sizer, Fig. 3, b. If he has a sufficiently large number of articles to turn, each with several different diameters, it would be folly for him to set three or four turner's sizers, as this would necessitate handling too many

tools, and again there would be difficulty in keeping track of the diameter of each. Where such a problem confronts him, he works out



accurate gages, Fig. 16, with the diameters placed in the order he intends using them.

Fig. 15 illustrates the correct method for using the calipers and parting tool. Both are worked at one time, the calipers being held at right angles to the axis and resting gently in the groove cut by the parting tool, which is held high on the work and gradually lowered toward the center as the cut is being made. When the diameter, at which the calipers are set, has been cut, the calipers will drop.

In order that the calipers may work freely, it is advisable to round the ends with a file, otherwise there is danger of them catching in the fiber of the wood, and being thrown some distance.

To use the turner's sizer, it will first be necessary to have the work reasonably near the desired diameter, otherwise the tool can-

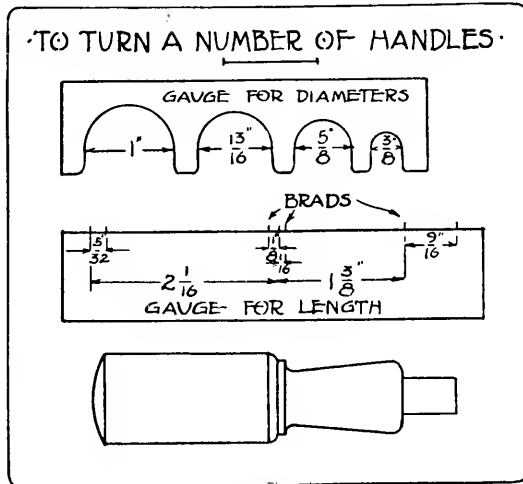


Fig. 16.

not be used. The use of this tool is similar to that of a parting tool in its cutting stroke, only it will be necessary to pull slightly on the handle so as to keep the caliper end in perfect contact with the cylinder.

The use of the gage is almost the same as that of the calipers.



Fig. 17. Setting Calipers over a Mandrel.

To set the calipers quickly and accurately it is a good idea to use a cylinder of known diameter and set the calipers to fit that, as indicated in Fig. 17.

THE SKEW USED FOR SMOOTHING CYLINDERS

Place the skew high up on the wood and draw downward, gradually, lifting on the handle, until the bevel clears the wood, allowing the tool to cut. Always keep the toe above the wood, Fig. 18, cutting with the center and lower part of the cutting edge. A great many turners work entirely with the toe forward, keeping the heel clear, but the author prefers working with the toe free, altho both ways give good results.

The height at which the handle of the skew is held must be governed by the bevel, Fig. 18. If held too high, the cut will be in ridges; and on the other hand, if held too low, the tool will not cut.

When cutting shoulders, part to the desired diameter first, rough off the wood with a small gouge, make the vertical cut with the toe, Fig. 19, No. 1, then clean out the shoulders with the heel, Fig. 19, No. 2. The consecutive steps for Problem No. 1; Plate I, shoulders, are illustrated in Fig. 20.

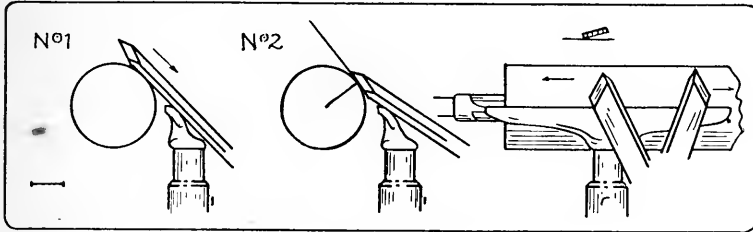


Fig. 18.

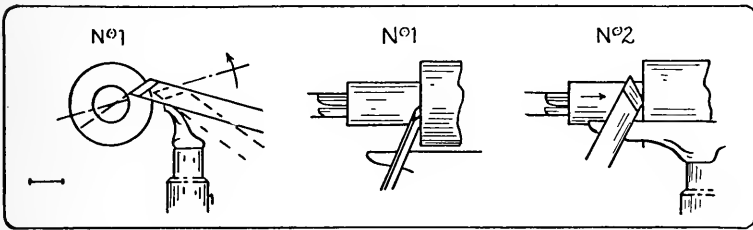


Fig. 19.

With all spindle turning always (a) turn to the large diameter, (b) cut to length, and (c) lay out the job with a sharp pencil and rule.

Before working exercise No. 1, the student should practice on a scrap piece of wood, (a) turning a straight cylinder with the large gouge, (b) parting to different diameters with the parting tool and calipers, and (c) smoothing cylinders with the skew chisel.

Almost any soft wood works well for the first three exercises, altho the author prefers using white wood. The rough stock for all three exercises should be 2"x2"x9½".

Fig. 20, a photographic reproduction of a model board in use in the author's classes, has been invaluable to the beginners in working out exercise No. 1. Besides this board, the student works from a blue print, Plate I, and is given a class demonstration.

It is never advisable to cut the work free in the lathe, if the best results are to be obtained, as the waste wood often breaks in the wrong place, taking more wood with it than is desired. It is therefore advisable to cut to about the size of a lead pencil, then remove the work from the lathe, and do the final cutting off with a sloyd knife. Even at this point, great care must be taken to use a sharp knife and try not to cut too rapidly.

It must be remembered, since the driving power is at the live center end, that this end should be weakened last, and never cut quite as small as the dead center end.

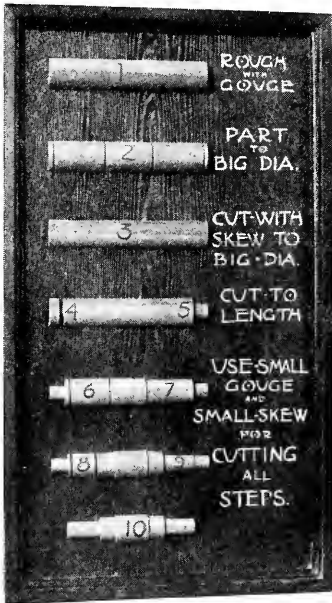


Fig. 20. Model Board for the 1st Exercise.

of the V, hold the $\frac{1}{2}$ " skew at the proper angle (that of the V) and with a slicing motion, using only the very point of heel or toe of the tool, lift on the handle, thus making one side of the cut, Fig. 21.

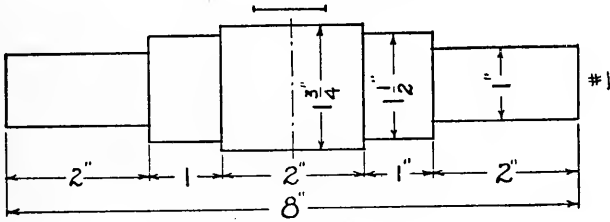
The other side is cut out in like manner. Notice that the tool is held high at the cutting edge when starting, and lowered in the direction of the axis when finishing. Some turners prefer to use the toe, while others find that the heel works a little easier. Either way is correct, and both work well, altho a very deep, narrow V is better made by using the toe.

The first steps in turning a bead are identical with those of the V, since V's are cut on either side of the bead, Fig. 22, to give clearance when making the final cuts.

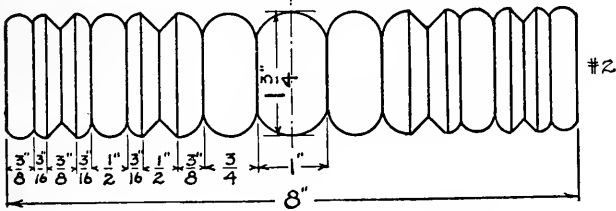
THE SKEW CHISEL FOR V'S AND BEADS

Having indicated, with a light pencil line, the location and width

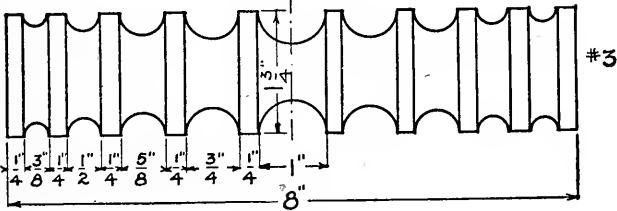
WOOD-TURNING PROBLEMS
SHOULDERS



V'S AND BEADS



COVES



NOTE

END VIEWS WILL ONLY
BE SHOWN WHEN NEED
ED- THESE PROBLEMS
ARE ROUND IN SECTION

To roll the bead, as it is sometimes called, start with the $\frac{1}{2}$ " skew held at right angles to the axis, the cutting edge high and the tool flat upon the tee-rest, Fig. 22.

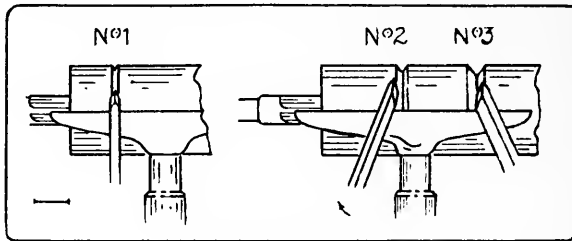


Fig. 21.

The point of the heel does all the cutting, and must therefore be very sharp in order to cut clean and with ease. Pivot the skew over from a horizontal to a vertical position, lowering the cutting edge gradually, and lifting on the handle, at the same time swinging

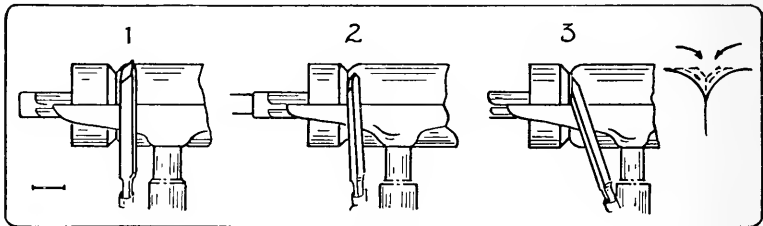


Fig. 22.

a little to one side. This completes one side, provided the cut is deep enough and of the proper curvature. The other side is turned in like manner.

It is a good idea for beginners, in order to insure symmetry, and to hold to the correct diameter, to mark a light pencil line on the center of each bead and cut to just a hair's breadth each side of this line.

THE GOUGE USED FOR TURNING COVES

The cove is generally recognized by turners to be the most difficult form to cut, and to some extent this difficulty is due to the fact that the gouge is the most difficult turning tool to sharpen properly.

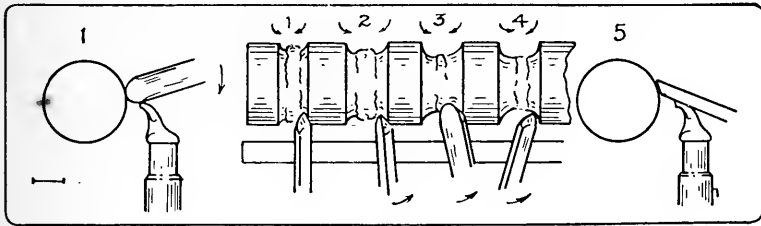


Fig. 23.

Fig. 23 illustrates the successive steps taken in turning a cove. The gouge in turning a cove makes three distinct movements: (a) rolling from a vertical to a horizontal position; (b) the handle is pried outward, forcing the cutting edge into the center; (c) the handle is held high when starting and lowered when finishing.

It must be remembered that the cutting stroke each time stops in the center of the cove, and the gouge should not be worked up on the other side; otherwise the fibers of the wood will be torn, leaving the cove in a rough condition.

When turning a symmetrical cove, such as in No. 3, Plate I, the beginner will find that it is desirable to test the cove by a gage, or treset; several pieces of dowel rod of suitable diameters will serve the purpose very well.

DESIGN

Before taking up our first completed problem, having acquired the necessary skill in turning beads, coves, etc., we must carefully consider the subject of design.

It is too obvious to need further mention, that the general standard of wood-turning design, whether in school or in the shop, is far from what it might be. This lack of good design is to some

extent due to the fact that we elaborate, or display our skill too much, believing that wood-turning is the cutting of a mass of beads and coves, all without a meaning.

The use to which we intend putting an article, will, to a great extent, govern the general outline, proportion, etc. The character of the wood, whether simple or complex in grain, all helps to add to, or detract from, the design. A wood rich in grain often needs only a graceful outline to make it beautiful, the grain being the decorative feature.

A good design must have the following qualities, (a) simplicity, (b) unity, (c) variety, (d) harmony and (e) good proportion.

Simplicity—Other things being equal, a simple article is the most beautiful. In working to this end, we must consider the profile—the general outline.

It must be remembered however, that simplicity can lead to weakness in our design. We must have a certain amount of snap and strength to our work, not merely flowing lines.

The kind of line to use is of great importance. Too many straight lines must be avoided; angular lines are ugly. The line of the circle is monotonous. The line of variety and grace only remains, and to this end we must work. Compare the line of a circle with that of a hen's egg. In the latter we have both grace and variety.

Unity—By unity we mean the holding together of all the parts to make the whole. Let there be a foundation line; to this all other parts are to be subordinated. With unity we get balance: the balance of equal and unequal parts. The balance of equal parts can be shown by a dumb-bell. Here we have equal sizes on both sides, hence perfect balance. Chair legs, candlesticks, and similar problems show unequal balance. Here we have a large mass above and a small one below. In order to obtain good balance, where many parts are to be considered, it is necessary to group the parts and consider unity.

Variety—The line, it has been shown elsewhere, may have variety by changing its direction and not having the same curvature. The flowing line, as that of a bead turning into a cove—a

compound curve, is continuous and often weak. In order to strengthen such a curve, the fillet is often used, Plate II. Where a line comes to an abrupt end, and almost returns upon its own direction, we speak of it as contrasted; this should be avoided as much as possible. See the top of the potato masher, Plate III.

Variety in decoration—When we add beads, coves and fillets, we must consider variety. All beads or all coves would be tiresome. Then, too, we must change the size of our beads and coves, not making all the same size.

Harmony—The design of the object must be in keeping with its use, and one part with the other. A candlestick, for example, suggests solemnity, and should be rather tall and small in diameter. Of course, the diameter of the top must be sufficient to support the socket, and the base large enough to prevent the candlestick from being top-heavy. The base and the shaft should have some curve in common. In turning a gavel, it would not be advisable to turn a number of beads on the head, and coves on the handle. One part should echo the other.

Proportion—Underlying the entire design we have the problem of proportion, and this to a large extent must be governed by common sense and use. In order to gain strength we must naturally increase the diameter and thickness. This is brought out to some extent by the napkin ring. Since wood is not as strong as metal, our napkin ring must be kept a little heavier, and so it can be seen with many other problems.

THE DARNING BALL

Our first complete problem, combining all the cuts of the three preceding exercises, is represented by the darning ball, Plate II.

In working out this problem, we not only make use of the various cuts just mastered, but we also introduce the use of sand-paper and polish.

The stock for the darning ball is maple, $2\frac{3}{8}$ " x $2\frac{3}{8}$ " x 9". Maple is used because it is a light-colored, tight-grained, hard wood, all

of which requirements are essential in the making of a good darning ball.

Fig. 24 illustrates the blocking-out of the wood so as to properly locate lengths and diameters at important points.

Having blocked out the work, turn the left-hand end of the ball, then the right-hand end, thus clearing away enough wood so that the small bead and cove can be turned, Fig. 25. Next the tapering part of the handle is shaped, and finally the rounded end.

It must be remembered, however, that this problem is to be sandpapered, oiled, and polished, therefore it is not advisable to

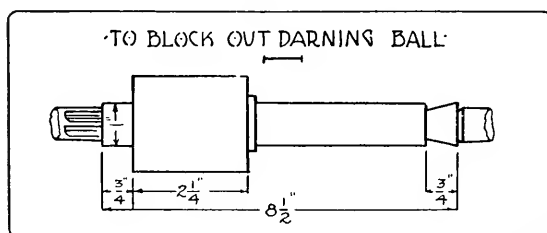


Fig. 24.

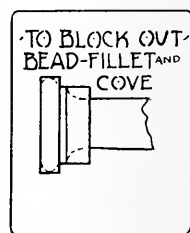


Fig. 25.

weaken the ends beyond $\frac{3}{8}$ " diameter; until all polishing has been completed.

The ends are to be cut clean with a knife, filed, and thoroly sandpapered, removing every scratch or mar. It may be necessary, while sandpapering, to take off some of the polish, but this can easily be refinished by hand.

SANDPAPERING

All turning must be completed before any sandpapering is attempted; otherwise the small particles of sand will work their way into the pores of the wood, and should it then be necessary to do any further turning, it will be found difficult to keep an edge on the tool.

For most work, numbers $1\frac{1}{2}$, $\frac{1}{2}$, 0 and 00 sandpaper, used in the order given, will be found to be sufficient. When the work has been

turned, instead of scraped, No. $\frac{1}{2}$ will be found to be coarse enough and very little sandpapering will be necessary.

It is a mistake to use too fine a grade of paper at the start, as much time is lost in getting all the irregularities out of the wood. If No. $1\frac{1}{2}$ sandpaper is used properly the wood can be brought to an even surface, all small nicks worked smooth, but it



Fig. 26. Sandpapering.

will be left with large scratches of the coarse sand, which in turn should be removed by the No. $\frac{1}{2}$ sandpaper, and so on with finer sandpaper until all scratches and imperfections have been entirely worn out of sight.

Many a well turned job is entirely ruined by the careless use of sandpaper. All the character can be worn from the work by taking the edges off corners, fillets, etc. It is just as necessary to shape a bead or cove with sandpaper as with your skew or gouge. On the other hand, it is quite possible to improve your poor turning by carefully sandpapering each part as a separate part, and not merely slurring over them, Fig. 26.

In working for a good finish, the first essential is to get the surface of the wood as nearly perfect as possible, and this fact can be emphasized by trying the following experiment:

Take a piece of maple and turn to a smooth form, sandpaper carefully, and then, instead of adding varnish or shellac in order to obtain a gloss, simply polish the piece of maple mentioned above by rubbing in the lathe with a smooth piece of soft wood, being care-

ful not to cause too much friction lest the wood become burnt. If this is worked carefully a high permanent gloss will result. This experiment will prove that good finishing is very much dependent on good sandpapering.

Where possible, it is advisable to sandpaper on the top of the turned piece, as this gives the turner a better chance to watch the work. Fig. 27 illustrates a quick method for truing up a cylinder. A long straight strip of cork or wood is held under the paper; the operator can bear down with the one hand and up with the other, giving twice the cutting capacity, and at the same time causing no spring to the work.-

When sandpapering the inside of a box (and this is doubly important for boxes with covers fitting on the inside), Plate XXII, great care must be taken not to allow the sandpaper to drag over the edge, thereby wearing away the entire neck of the box.



Fig. 27. Sandpapering with Both Hands.

Small fillets, V's, etc., are often left without any sandpapering, as it is next to impossible to work with paper on such small surfaces.

FINISHING

Three steps are taken in order to put a finish on most work: e. g., (a) staining, (b) filling and (c) varnishing. The first and second of these steps, that of staining and filling, are not always employed. Sometimes it is desired to keep the wood in its natural color, and in such cases the filler is the first to be applied. Then, again, close-grained woods, such as maple, need no filling of the pores; such woods are more often oiled, then polished.

Staining work on the lathe is quite the same as for cabinet work. The wood must be carefully sandpapered and free from all grease. Apply the stain to the work with a brush held in the right hand, while the left hand gently revolves the lathe, Fig. 28.

Do not allow the lathe to work at high speed; otherwise the stain will be driven in all directions by the centrifugal force, instead

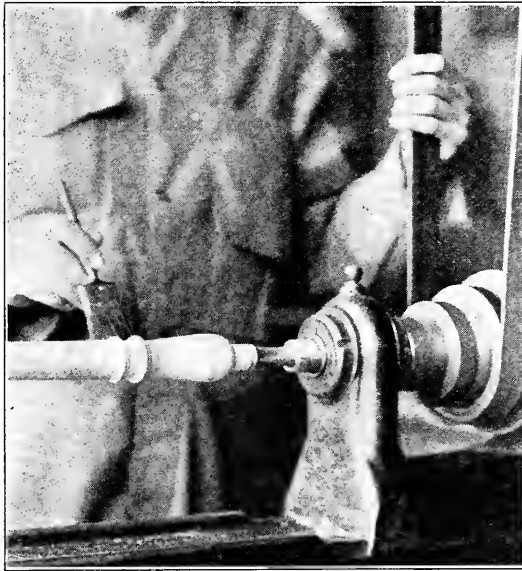


Fig. 28. Applying Stain.

of soaking into the wood as desired. All stained work should be allowed to dry about 8 or 10 hours; some stains require a longer time. When a water or spirit stain is used, it will be necessary to sandpaper the wood lightly after the stain is dry. If the wood requires filling, fill with the proper colored filler; allow another day for drying; then polish or varnish.

By polishing we mean French Polishing, Fig. 29; that is, using shellac as the polishing agent, and boiled linseed oil as a lubricating agent. The proportion of shellac to oil must be governed by experience. It is customary for the polisher to have two receptacles, one for shellac, the other for oil. A dab of shellac is put on the polishing cloth, one thickness of the cloth is folded over, and a few drops of oil added. The cloth is then brought in contact with the work



Fig. 29. French Polishing.

and as the lathe revolves, the cloth is run back and forth so as to cover all parts evenly. If too much shellac has been applied, the cloth will stick or pull rather hard. On the other hand, if too much oil has been added, the polish can be rubbed off entirely by passing a dry finger over the work while the lathe is stationary. In

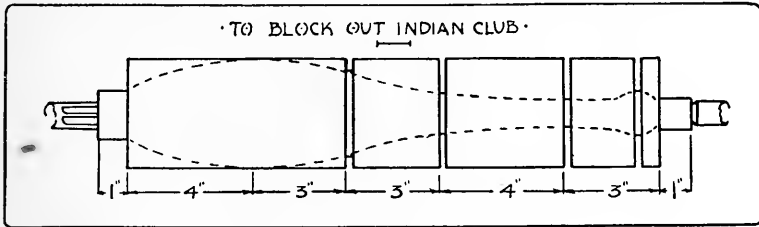


Fig. 30.

either case more of one or the other must be added. Should the polish be too thick and look streaky, simply take the same cloth and by a little friction burn the shellac and cause it to flow again so that it can be run off the work entirely or put on in a more even manner.

French polishing is by far the quickest way of finishing, but does not wear well and on large surfaces is difficult to get on evenly. For the best finish, after having stained and filled the wood, apply two coats of thin shellac, allowing 12 hours for each to harden, and then lightly sandpaper each coat. For a finish that is to be rubbed to a high gloss, apply not fewer than three coats of a good hard rubbing varnish, allowing three days for each coat to dry, and one week for the last one. Sandpaper lightly each coat. The final coat is rubbed with fine pumice stone powder and water, washed off, and followed with rottenstone powder and water, washed off clean and rubbed with the palm of the hand. This produces the highest possible polish if carried out carefully. For an egg shell gloss rub only with pumice stone powder and crude oil.

Varnishing must be done with the greatest of care, in a dustless room with a temperature of about 70 degrees Fahrenheit. In order to insure an even coat, it is advisable to flow the varnish on rather heavily, dabbing it into all corners; then immediately take up the superfluous varnish by brushing out thoroly and wiping the brush when heavy over the edge of the cup. Some varnishes require more

brushing out than others in order to make them lay evenly; this can be learned only by experience.

THE POTATO MASHER

The stock for the potato masher is maple, $2\frac{3}{4}'' \times 2\frac{3}{4}'' \times 12''$.

In working out this problem as with others, start at the large

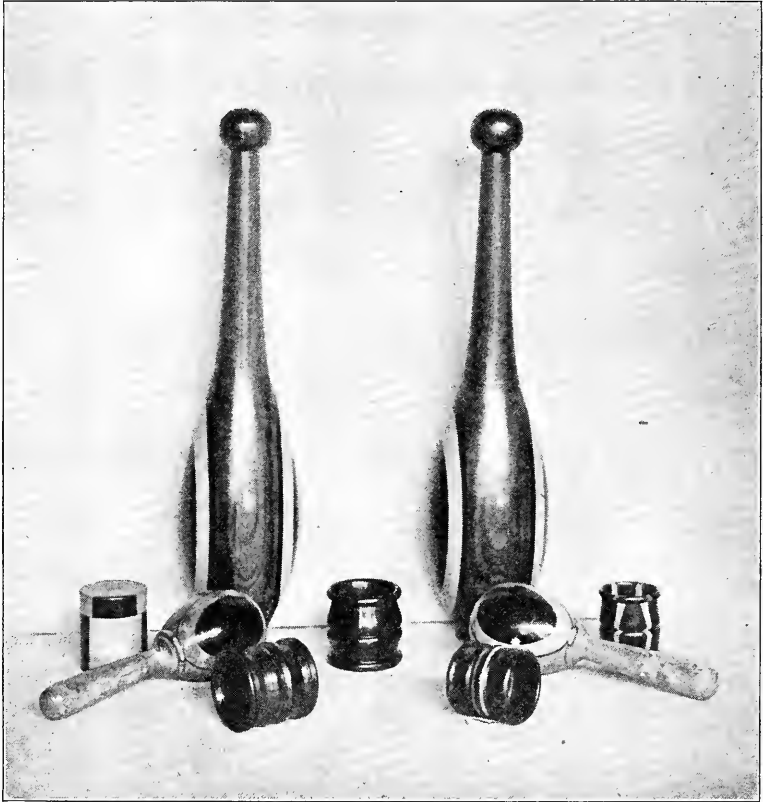


Fig. 31. Built Up Model.

end and work towards the small end. See Fig. 30 for method of locating the various diameters.

No finish is ever to be put on wooden kitchen utensils other than to sandpaper them thoroly.

INDIAN CLUBS

The commercial wood for the Indian club, Plate IV, is maple. Oak works well, and so do most hard woods. For those who like something a little out of the ordinary, stock for a pair of clubs can be built up, using many combinations of woods, Fig. 31.

The stock is $3\frac{3}{4}'' \times 3\frac{3}{4}'' \times 19''$.

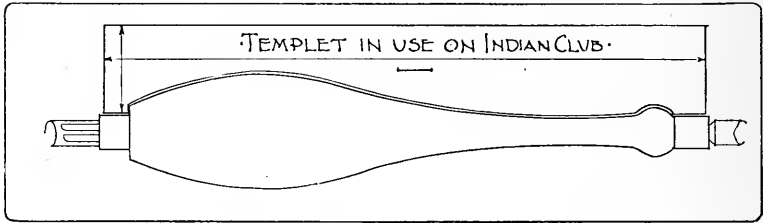


Fig. 32.

(a) Rough to $3\frac{9}{16}''$ in diameter, (b) cut to length, leaving a diameter of 1" at each end. Fig. 30 illustrates the method for locating the various diameters at the correct points. (c) Rough out the shape with a gouge, then (d) fit to the templet with a scraper, Fig. 32. The templet rests on each end of 1" diameter. Sandpaper and finish according to the wood used. (See Finishing, page 33.)

DUMB-BELLS

As with the Indian clubs, there is no special wood used for dumb-bells, Plate V, except that it is necessary to have a hardwood, such as maple, in order that it may stand rough usage. The stock is $3'' \times 3'' \times 10\frac{1}{4}''$.

Two methods may be employed with equal success in turning the balls at each end. The first method is similar to that of the Indian clubs, that is, by using a templet cut to a semicircle and resting it on a 1" diameter at either side of the ball. Shape to fit the templet. The second method is by geometry, Fig. 33. Turn to $2\frac{7}{8}''$ in diameter and cut to the same length, making the section a perfect square. Lay off an octagon; and so on, increasing the num-

WOOD-TURNING PROBLEM
INDIAN CLUB

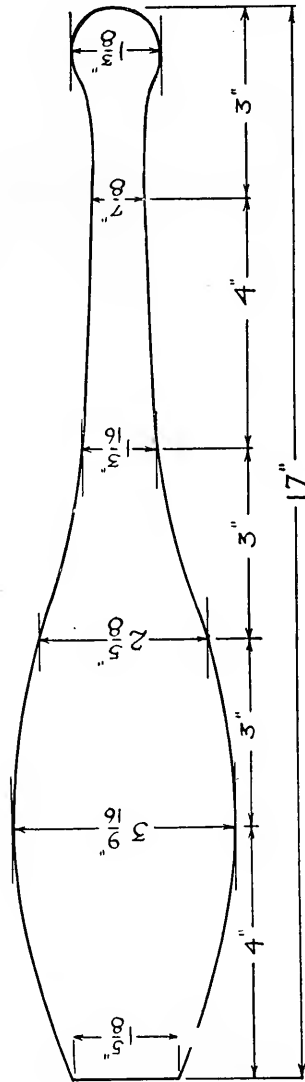


Plate IV.

WOOD-TURNING PROBLEM
DUMB-BELL

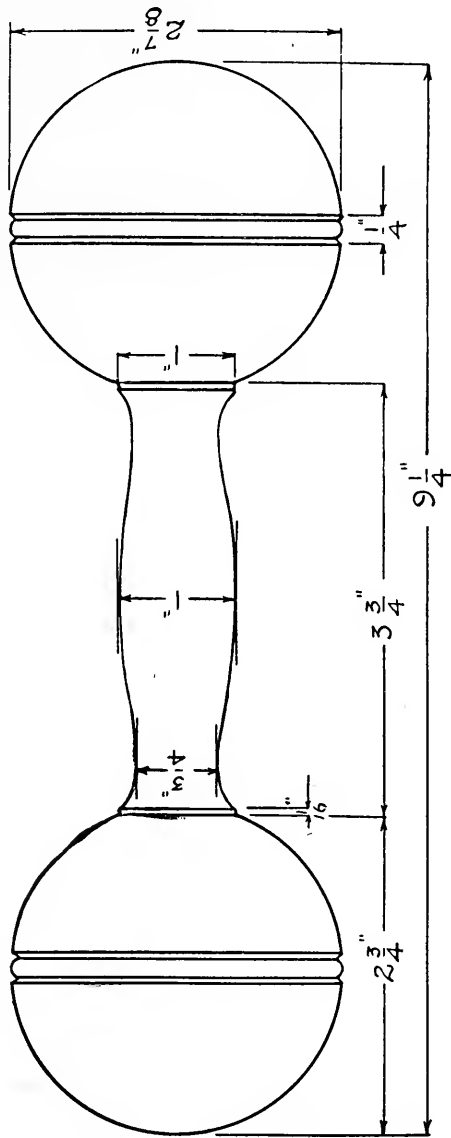


Plate V.

WOOD-TURNING PROBLEMS

SCREW DRIVER HANDLES

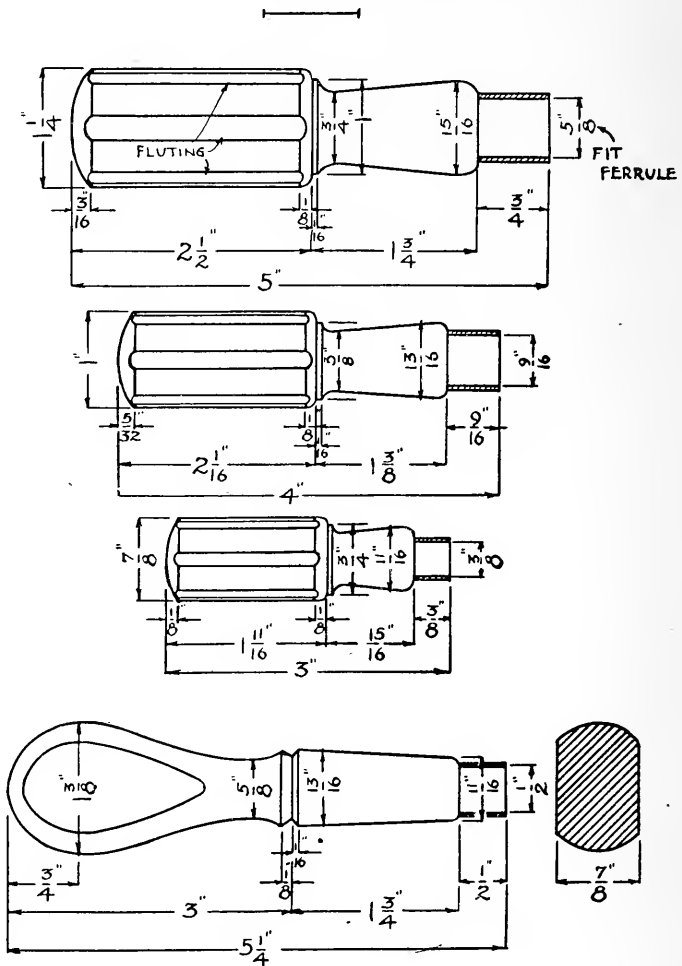


Plate VI.

WOOD-TURNING PROBLEMS
TURNING TOOL HANDLES

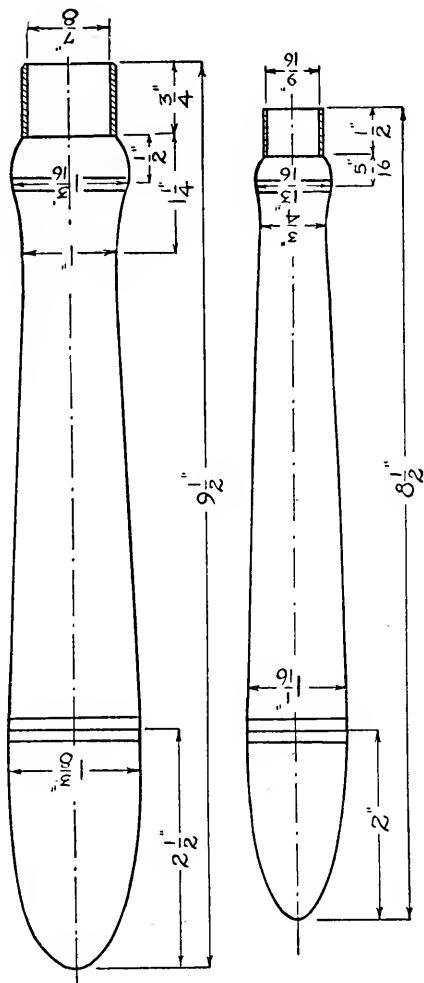


Plate VII.

hole can be bored, after which it is best to heat the end and make the fitting in that way. To prevent the shank from working loose, it is best to drill thru the ferrule, wood and shank; then insert a pin.



Fig. 34. Boring a Mallet Head.

For turning a large number of screwdriver handles see Fig. 16. The marker will indicate lengths and the calipering tool is used for obtaining the diameters.

THE MALLET

Lignum-vitæ is the best wood for a mallet head, Plate VIII, but in public schools where only the cheaper grades of wood are supplied, it is necessary to fall back on good hard maple.

The turning of a mallet is very simple; the only part needing great care and attention will be the boring of the hole in the head and then the fitting of the handle to that hole, Fig. 34.

In order that the hole in the head may be at right angles to the axis, and true in every direction, it will be necessary to locate this hole with the greatest accuracy.

WOOD-TURNING PROBLEM
 MALLET

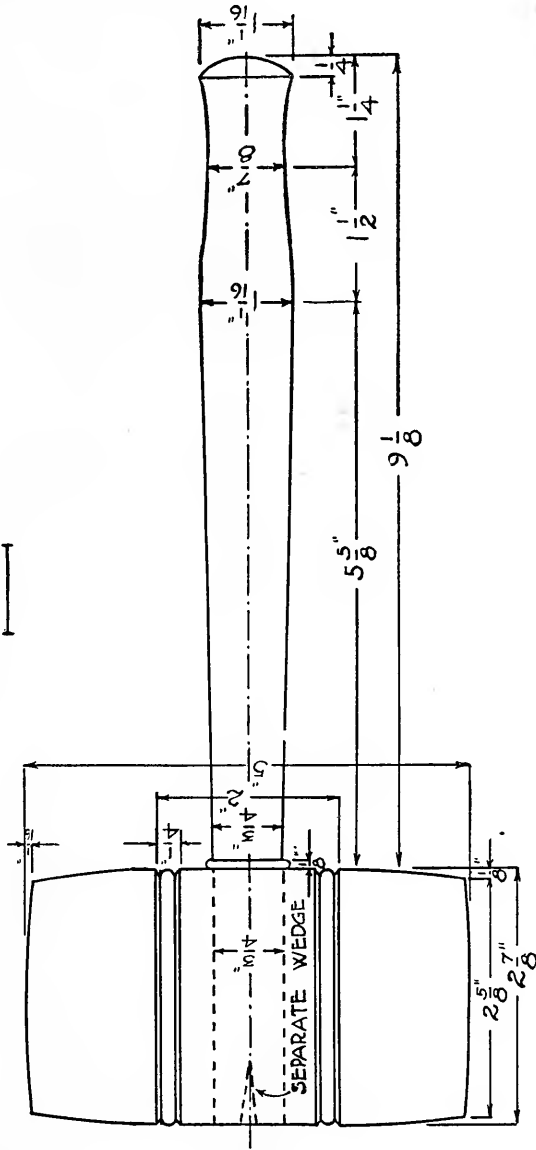


Plate VIII.

Fig. 35 illustrates one method for locating the hole in the head accurately. While the wood is in the lathe, and before sand-

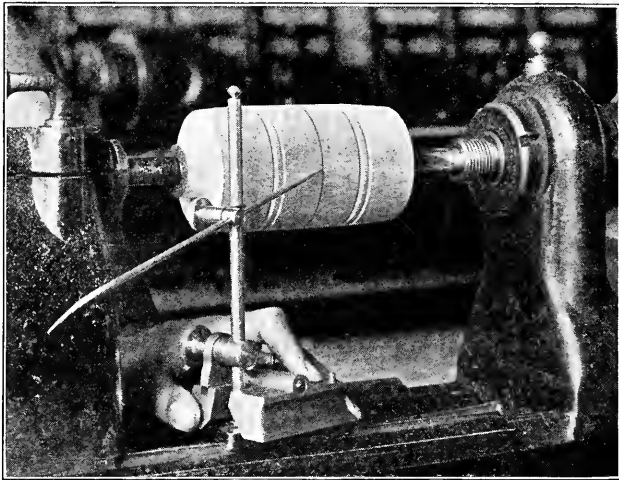


Fig. 35. The Surface Gage to Locate the Center for Boring.

papering, mark the center line around the head. The next step will be to cross this line in two places, so that a line passing thru these two points will be at right angles to the axis. Set the surface gage on the shoe of the tee-rest, and the point of the gage so as to coincide with the point of either the live or dead center (removing the wood, of course, in order to set the gage).

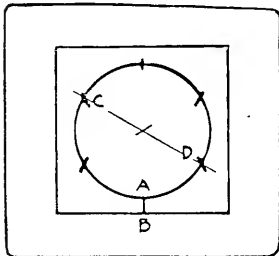


Fig. 36.

Place the wood back in the lathe, tightening on the hand-wheel of the tailstock so that the wood cannot turn. Hold the surface gage flat on the shoe of the tee-rest, being careful not to move

the adjustments on the gage; then mark the intersection. Place the gage on the opposite side of the head, not disturbing the position of the wood, and again mark the intersection. The two intersecting points obtained are the centers for the holes to be bored.

The second method, Fig. 36, illustrates a circle drawn on paper, equal to the diameter of the head of the mallet at the center line. Step the radius around the circumference six times, and any two opposite points, as connecting with a line passing thru the center of the circle, will be the points to use. Cut the paper from B to A and around the circle as indicated in Fig. 36, and place it over the head at the center line. Without moving the paper, mark the intersection of the center line in two places, C and D, Fig. 36.

After having carefully located the necessary points, make a deeper impression with a pair of dividers; then sandpaper and finish. If a chuck is available for boring in the lathe, place the point of the dead center into one of these holes (mentioned above), and the drill into the other. Fasten the tailstock to the bed of the lathe, and while the left hand holds the mallet head, let the right hand turn the hand-wheel and force the wood against the drill, thus boring the hole. Care must be taken not to use high speed, and not to force the hand-wheel too hard, otherwise the drill will become very hot. A metal drill works better in the lathe than an auger bit. When the hole is almost thru, remove the dead center, butting the head of the mallet against the spindle where the drill can bore into it without ruining the dead center pin.

By means of a V block and a drill press, it is also easy to bore the hole.

GAVELS

In designing a gavel, Plates IX and X, and in selecting wood for the same, there are a few requirements we have to meet. Since a gavel is used in somewhat the same manner as a mallet (in that we strike a blow with both), the first essential will be to use a hard wood. This stands the blow better, and hard woods being heavier, the blow is more easily delivered. The wood must be sonorous, so that sound is given forth. During periods of excitement, it is often necessary to use a gavel quickly, and little attention is paid to where the gavel strikes; hence the ends must be well rounded. To meet all these requirements, a wood such as rosewood, ebony, or cocobolo serves very well.

WOOD-TURNING PROBLEM
 GAVEL

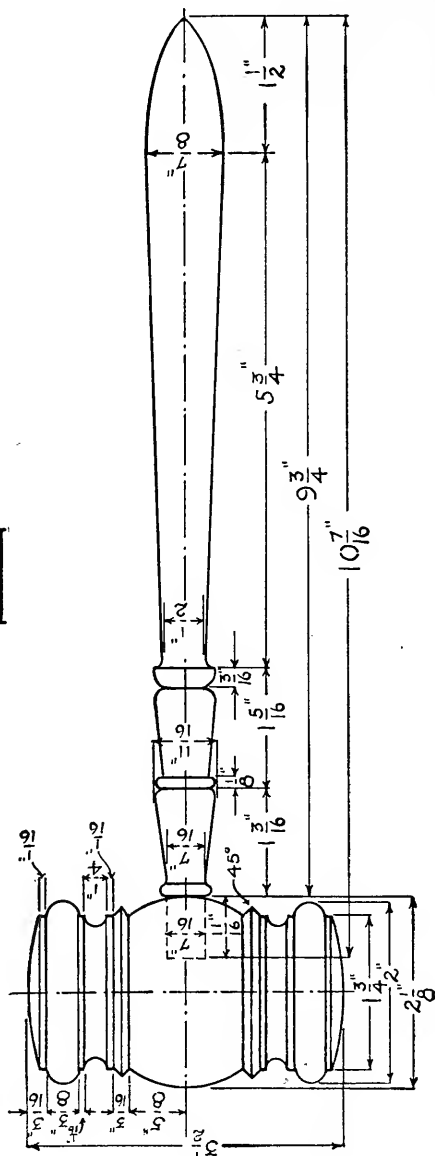


Plate IX.

WOOD-TURNING PROBLEM
GAVEL

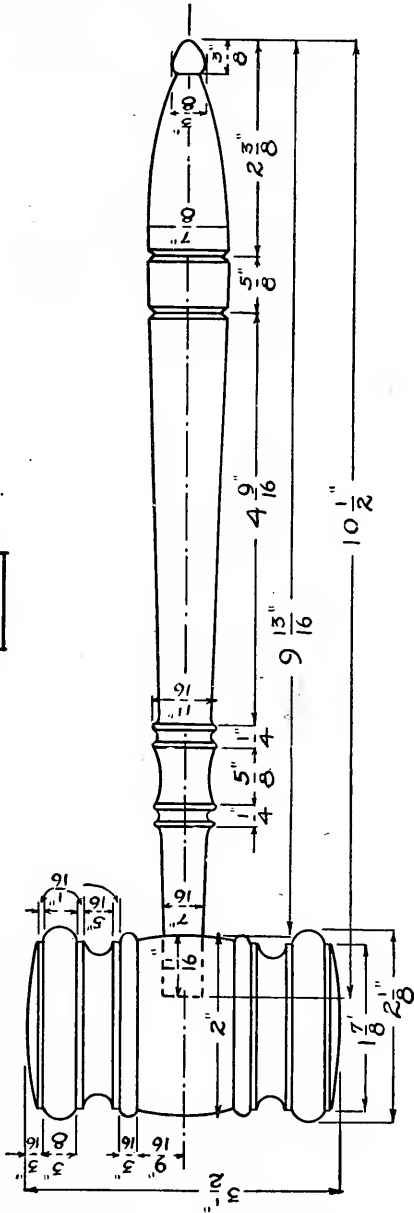


Plate X.

The stock for the head is $2\frac{1}{4}'' \times 2\frac{1}{4}'' \times 4\frac{1}{2}''$. (a) Rough down to the largest diameter, (b) cut to length, (leaving the same amount of waste wood at each end), (c) locate the center line and (d) lay off the work from both sides of this line. It is advisable, at the point (c), to make a small hole with the dividers, so that when boring the hole for the handle, it will be in the exact center.

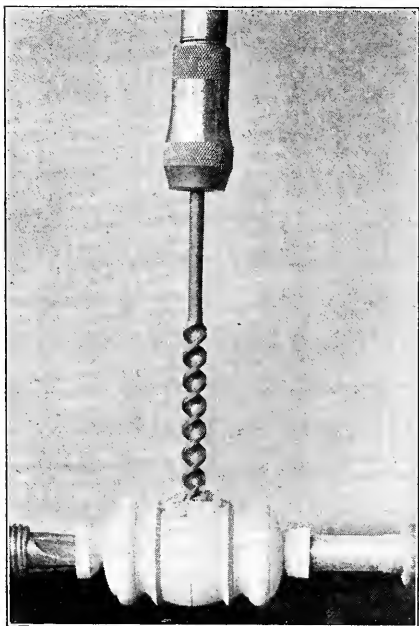


Fig. 37. Boring a Gavel Head.

When turning a cove, having a fillet at each side, it is advisable to ignore the cove entirely until the fillets are cut clean, then work out the cove.

Before cutting the work loose, bore the hole for the handle. This should be done in the lathe, the work being clamped tightly between centers, Fig. 37.

The handle should be turned with the small end at the dead center. All parts are finished before fitting the

handle into the head, so that no oil from the polish will reach that part. On all work, where one part fits into another, always cut the hole first, then fit the other part to that hole.

When all the ends have been cleaned off, Fig. 38, glue the handle into the head. Should the handle fit rather loosely, make a saw-kerf in the end, about $\frac{1}{2}''$ down the handle, and force a wedge into this cut. This method is often used in joinery.

THE ROLLING PIN

The rolling pin, Plate XI, like all wooden kitchen utensils, is made of maple, because maple does not splinter easily, is hard, and holds its shape fairly well.

To make it somewhat easier to understand, the rolling pin will be divided into two parts; the shaft and the handle.

The stock for the shaft is $2\frac{5}{8}'' \times 2\frac{5}{8}'' \times 12\frac{1}{4}''$. (a) Cut to $2\frac{1}{2}''$ in diameter; (b) cut to length, leaving the waste wood at each end 1" in diameter; (c) taper the ends, making a cut from $\frac{1}{8}''$ back

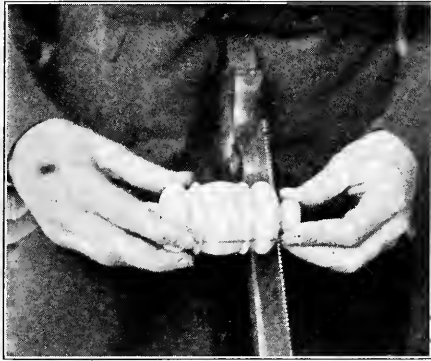


Fig. 38. Sawing off the Ends.

to the 1" diameter. After the wood is thoroughly sandpapered, (d) cut off the waste wood. At each end, the centers have left a small hole which locates the center for the holes to be bored.

Great care must be taken to bore the holes at each end absolutely true, otherwise the handle will not work well when glued in place.

In order to have the hole of the handle in the exact center, bore the hole first, and turn around the hole. To do this, turn a piece of maple to fit the hole just bored, leaving about $1\frac{1}{4}''$ of the waste wood 1" in diameter at one end, Fig. 39. The $1\frac{9}{16}''$ part is to be $5\frac{3}{8}''$ long. The reason for this length will be explained later. Glue $\frac{1}{4}''$ at each end, Fig. 39. When the glue has set, turn the

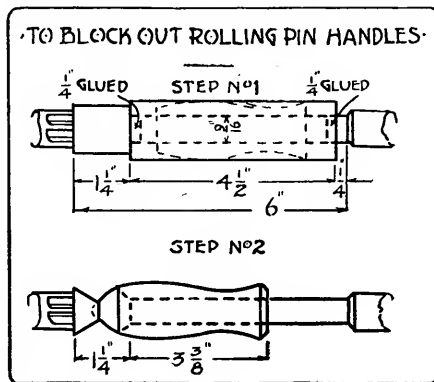


Fig. 39.

WOOD-TURNING PROBLEM
ROLLING PIN

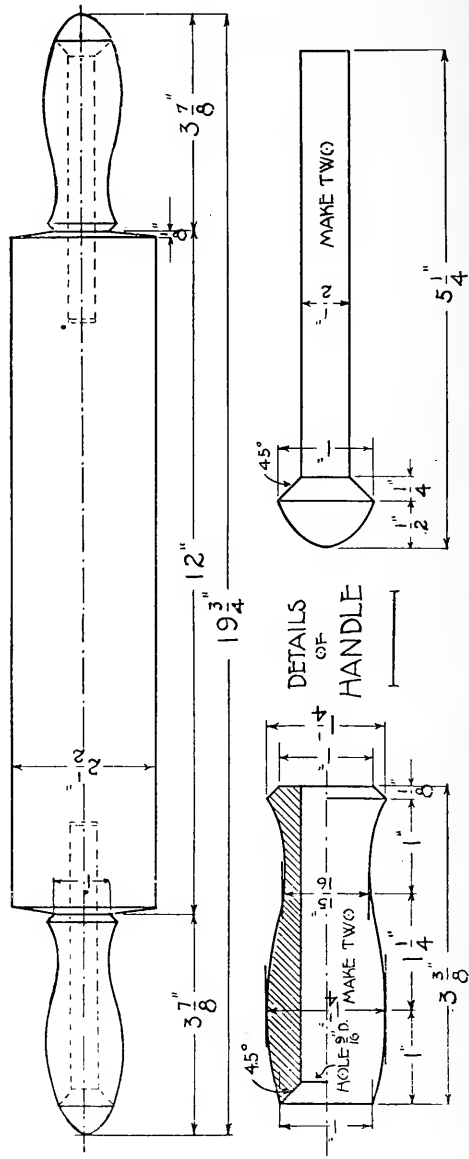


Plate XI.

WOOD-TURNING PROBLEMS
UMBRELLA HANDLES

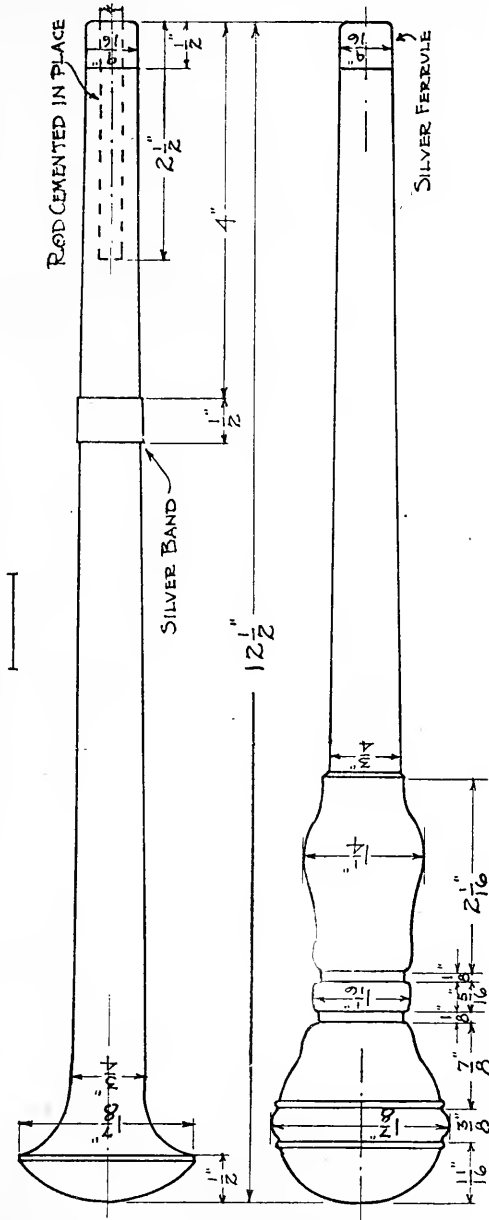


Plate XII.

handle, being careful not to turn the ends until everything is completed. Sandpaper carefully, and with an $\frac{1}{8}$ " chisel, cut the 45° at the one end; this makes that end free. Out of the remaining piece of maple, turn the spindle part of the handle, fitting the $1\frac{1}{2}$ " of the dead center end to a $\frac{1}{2}$ " hole. In order to make the curve of both handle and spindle continuous, place the handle over the spindle while turning the rounded end.

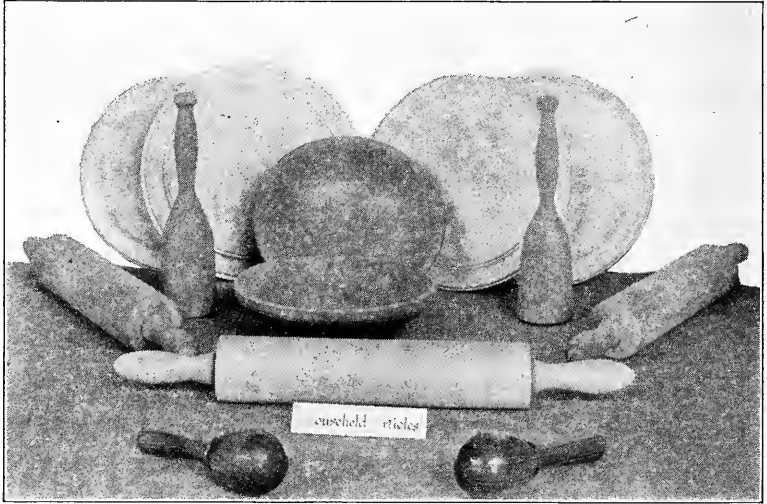


Fig. 40. Household Articles.

When gluing the spindle into the shaft, great care must be taken not to allow any glue to get into the hole of the handle, and not to force the handle up too tight against the shaft.

BOWLS

Bowls and solid trays, Plate XIII, come under the heading of face-plate work, and regardless of design, are all worked out in much the same manner. However to make the following description a little easier to follow, we will take one of the nut bowls as our example.

The rough stock should be $1\frac{3}{8}$ " \times $4\frac{3}{4}$ " \times $4\frac{3}{4}$ ", dressed on one face.
 (a) Cut out a $4\frac{3}{4}$ " circle on the band-saw. If no band-saw is avail-

WOOD-TURNING PROBLEMS NUT SETS

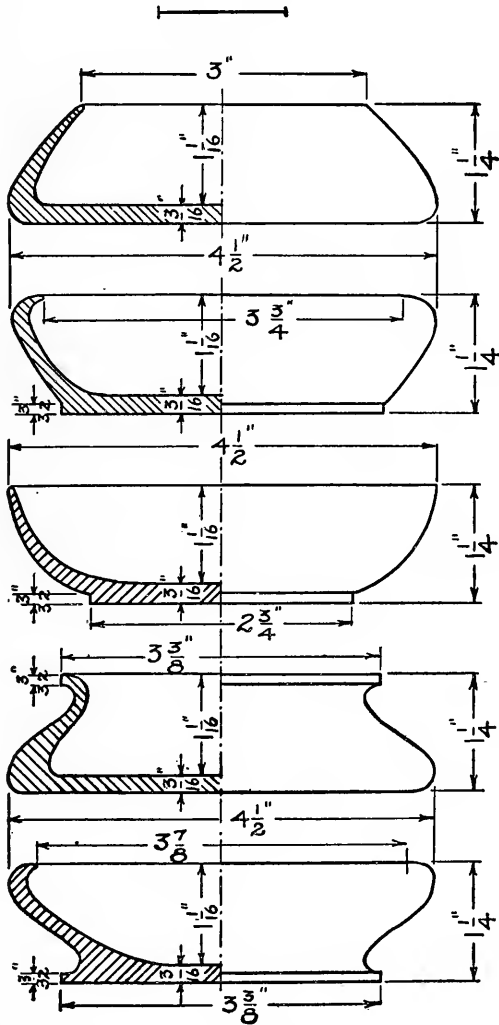


Plate XIII.

able, simply cut off the corners with a handsaw, (b) glue the dressed surface to a piece of whitewood of about the same diameter, with a piece of note paper between. The object of the paper is to separate

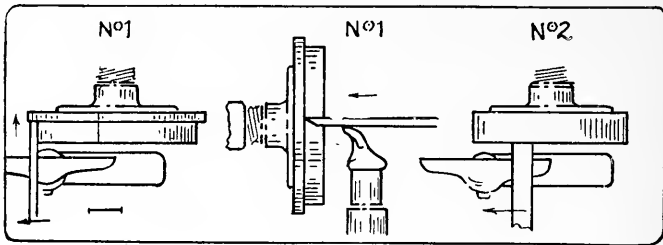


Fig. 41.

the fibers of the waste wood from the wood to be turned, so that a few light taps with a chisel and mallet will separate the two pieces when the work has been completed.

After the glue has set (use nothing but the best grade of hot glue on all problems); (c) screw the faceplate in place. (d) Start the lathe on slow speed, with the tee-rest parallel with the face of the work and a little below the center line. By means of the $\frac{1}{8}$ " mortising chisel, held horizontally and standing on its edge, (e) cut in the direction indicated in No. 1, Fig. 41. Do not cut the entire thickness, otherwise the wood on the opposite face will split off. Merely cut off enough wood to center the work. (f) Turn the tee-rest parallel with the edge, and with a gouge clean off the remaining wood.

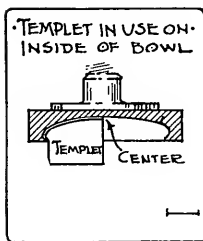


Fig. 42.

Having turned the wood to the largest possible diameter, (g) face off the surface with a 1" flat scraper, No. 2, Fig. 41, working from the center out, and to a thickness of $1\frac{1}{4}$ " (measuring from the glued joint).

(h) Trace on a scrap piece of paper, the inside outline of one-half of the bowl, as indicated in Fig. 42. (i) Transfer this to a piece of cardboard and cut with a sharp knife. This pattern is known as a templet, by the aid of which it is possible to obtain the correct shape of the inside of the bowl.

WOOD-TURNING PROBLEMS

DRAWER KNOBS AND CASTER CUP

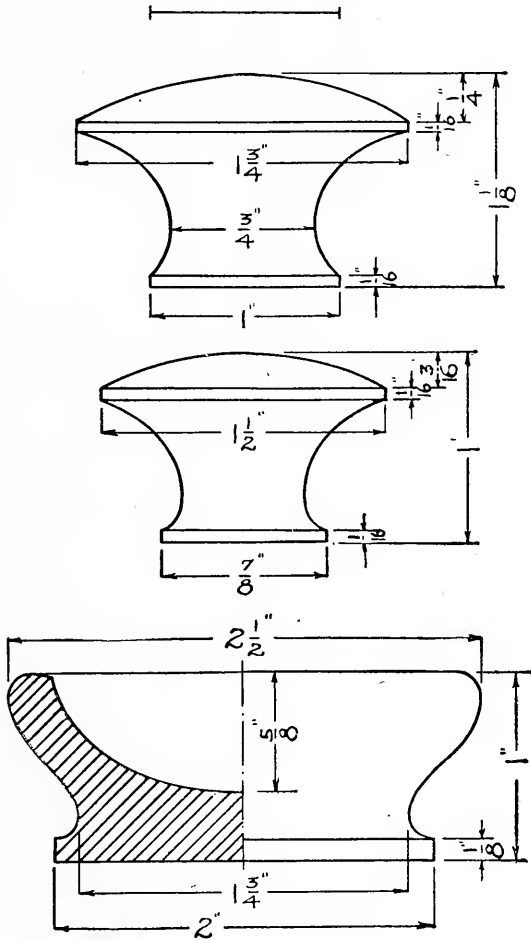


Plate XIV.

WOOD-TURNING PROBLEM
MATCH BOX HOLDER

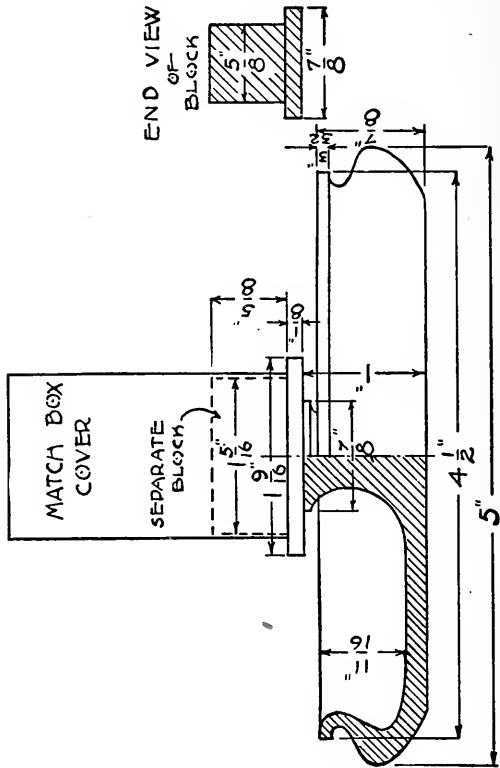


Plate XV.

WOOD-TURNING PROBLEM BATH ROOM STOOL

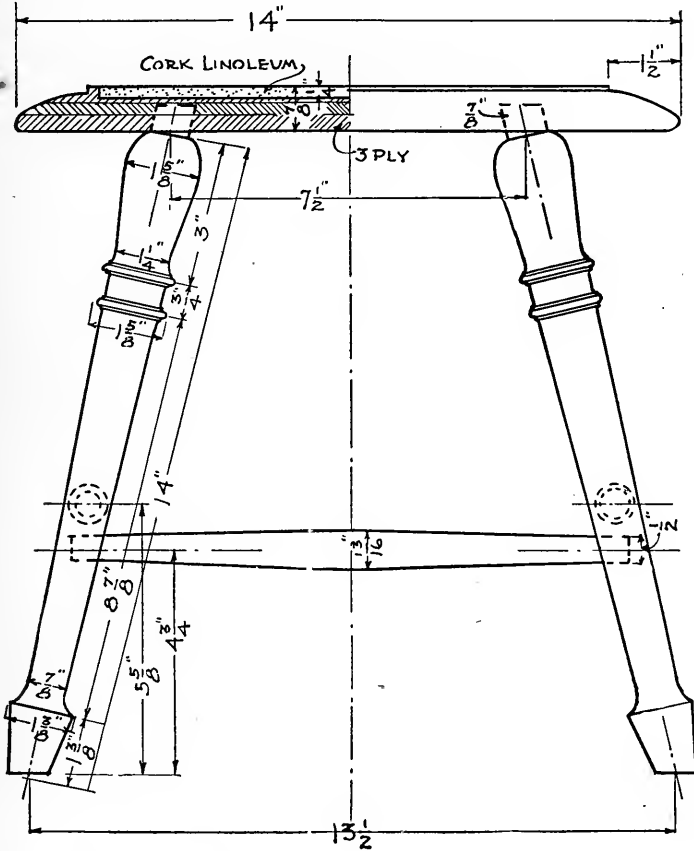


Plate XVI.

With a $\frac{1}{8}$ " chisel, (j) cut a diameter of about 1" and $1\frac{1}{16}$ " deep (scant measurement): measure the depth as indicated, Fig. 43. (k) Hollow out the inside with a round-nose scraper to conform



Fig. 43. Measuring the Depth of a Bowl.

with the templet. (l) Now sandpaper thoroly. (m) Shape the outside with flat, skew, and round-nosed scrapers, keeping a uniform thickness, Fig. 44. The thickness of the outside must be calipered with the fingers. Having performed all necessary turning, (n) sandpaper the work thoroly and polish. (See Finishing, page 33.)

To separate the bowl from the waste wood, place a 1" flat scraper in the glued joint (with the bevel against the waste wood), and tap gently with a mallet. Clean off the bottom and glue on a

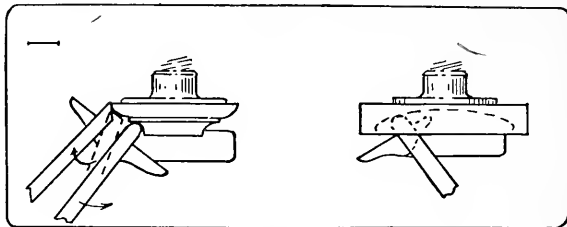


Fig. 44.

piece of felt. Since glue will not adhere to oily surfaces, and there is a great possibility of grease working its way on the bottom from polishing and handling, it is better to use shellac. Put on one coat and allow it to dry. A second coat is then applied, using rather thick shellac, and when "tacky," put the felt in place. Trim off the edge of the felt with a sharp knife when the shellac is dry.

THE NAPKIN RING

Napkin rings, Plate XVII. To bring into use built-up work, and at the same time to make the napkin ring more ornamental, it is a

WOOD-TURNING PROBLEMS
NAPKIN RINGS

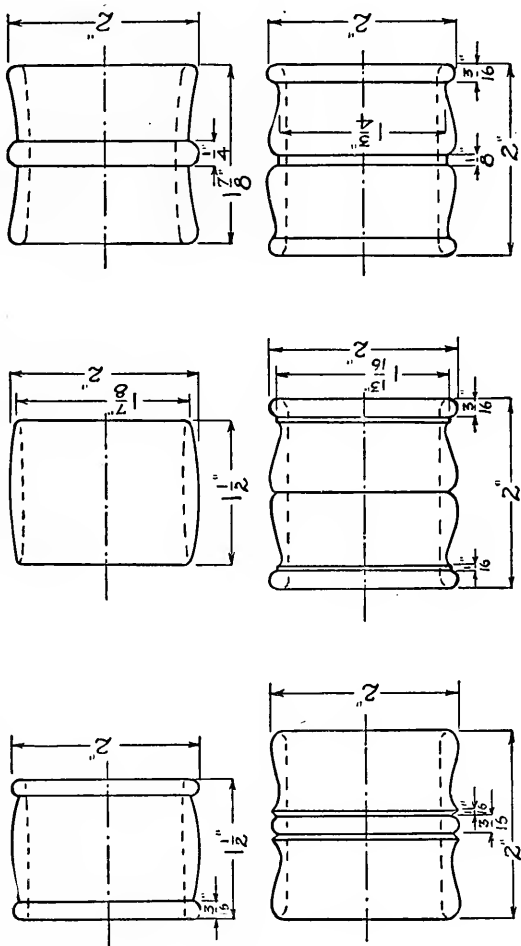


Plate XVII.

good idea to glue up all stock for this problem, Fig. 31. The best woods to use are those which are hard and have a fairly close grain, such as rosewood, ebony, cocobolo, East India mahogany, etc. The utmost care must be taken in planing up the stock, to

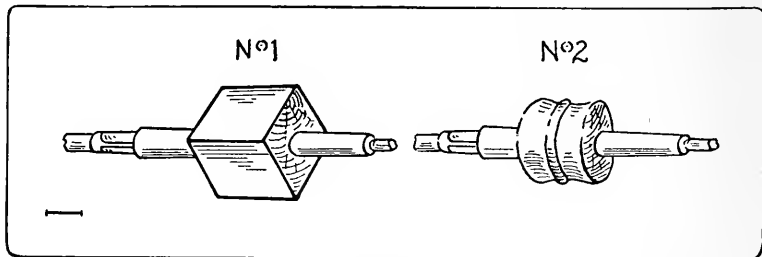


Fig. 45.

get each piece absolutely parallel, and where a symmetrical design is used, pieces of the same size should be exactly the same in thick-

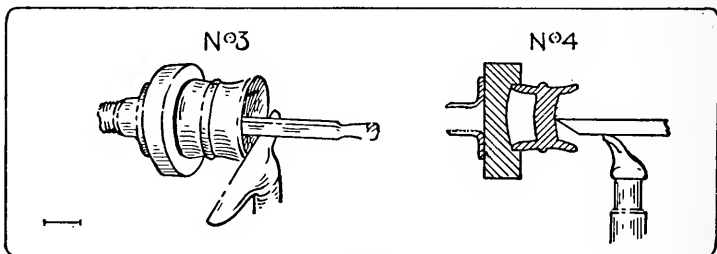


Fig. 46.

ness. Again, when starting to turn, the exact center must be located, otherwise the work will come out uneven.

Fig. 45 illustrates the turning of a napkin ring on an arbor. (a) Bore a $\frac{7}{8}$ " hole all the way thru the blank, and at right angles with the stock. (b) Turn a separate piece of wood between centers and about 5" long, to fit this hole snugly, having a *very* slight taper at the live center end. (c) Force the blank over this arbor and turn the design. (d) Sandpaper and finish. This will leave entirely too much wood around the hole. To cut this to the desired thickness, (e) a chuck must be turned to fit the outside of the napkin ring very

tightly, and should set in about $\frac{1}{4}$ " , Fig. 46. (f) Cut one end, (g) sandpaper and polish; then (h) rechuck the other end and finish.

When starting a napkin ring on a screw chuck, (a) bore a hole in

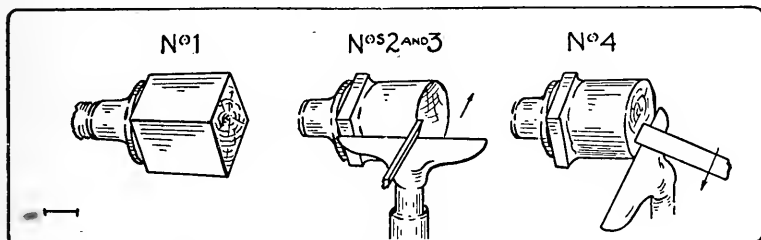


Fig. 47.

the wood a little smaller than the screw, so that when the chuck is screwed in place, the wood will not split, Fig. 47. (b) Turn the

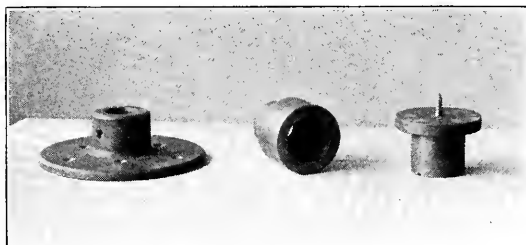


Fig. 48. Face Plate — Bell Chuck — Screw Chuck.

blank to the design, (c) clean out one end and rechuck the same as above.

In some schools, napkin rings are turned on a bell chuck, Fig. 48. The wood is first turned between centers to a diameter so that one end can be driven into the chuck. Held by this tight fit, the design is turned and one end hollowed out (as with the screw chuck), sanded and polished. The wood, in this case, must be long enough so that after cutting off the napkin ring, about $\frac{3}{4}$ " will remain for rechucking. It will be seen that in this case the rechucking is done from the inside, instead of the outside as with the other two methods. The greatest care must be taken to turn the chuck to fit the inside of the ring tight enough so that it will

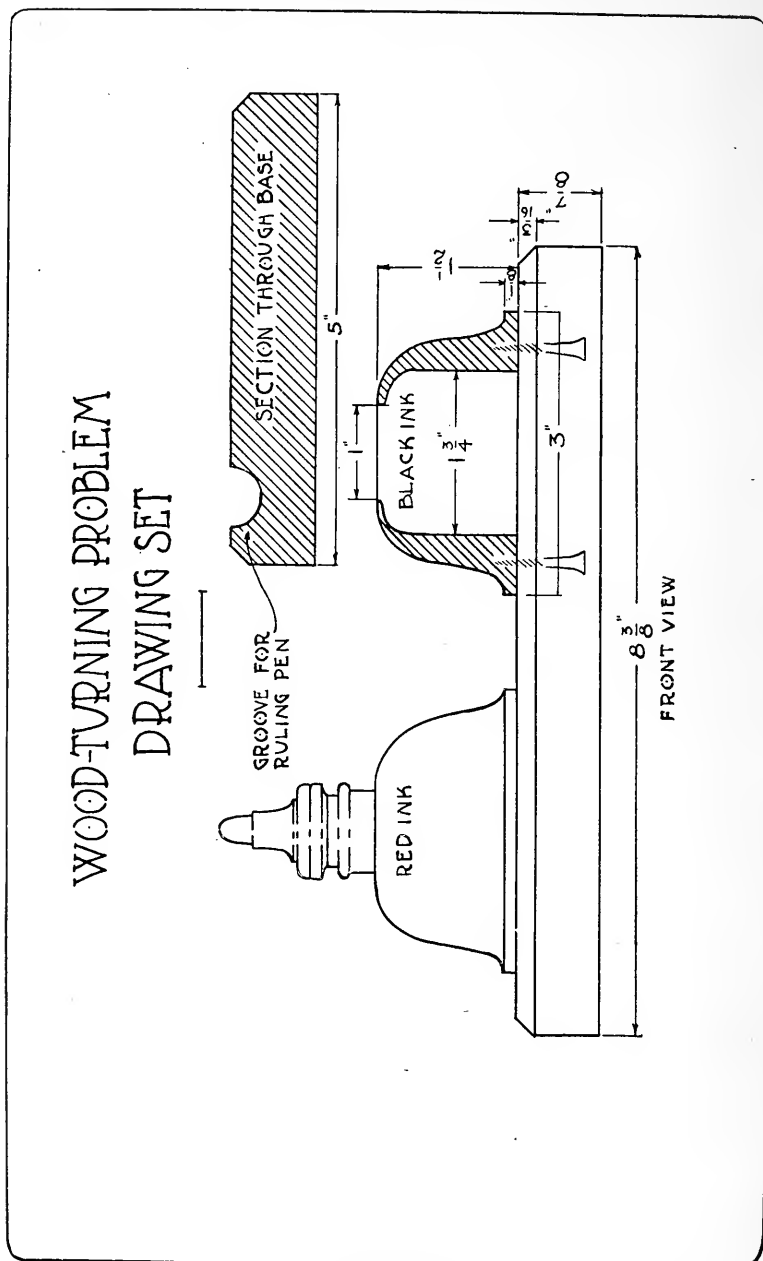


Plate XVIII.

WOOD-TURNING PROBLEM
BREAD BOARD

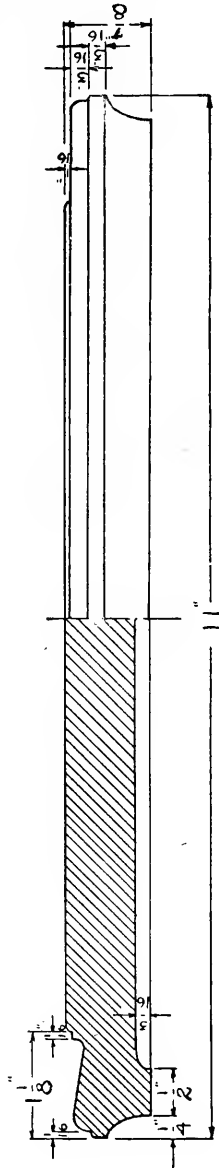


Plate XIX.

WOOD-TURNING PROBLEMS
TEA POT STANDS

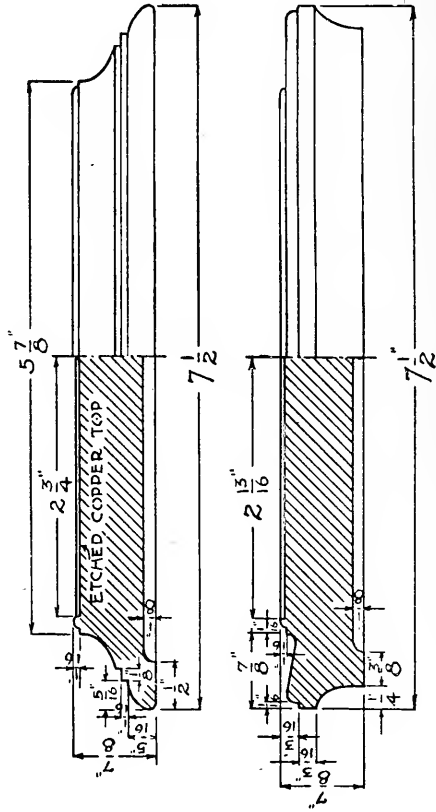
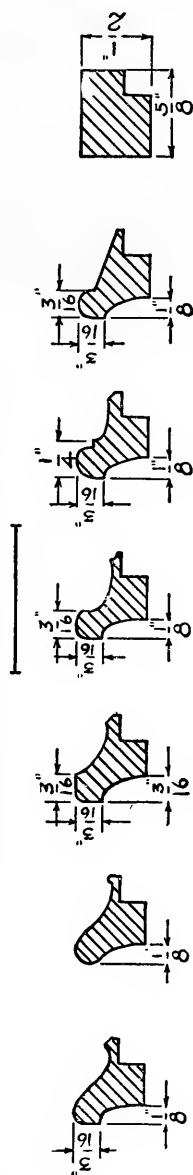
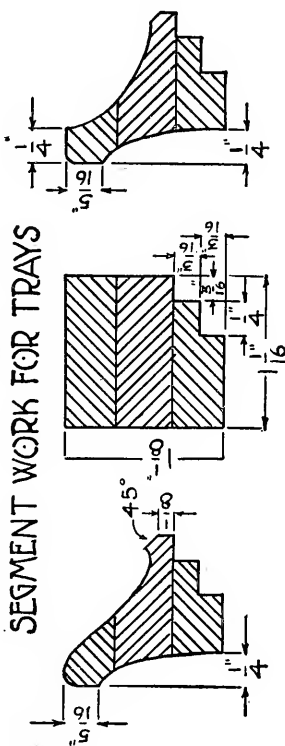


Plate XX.

WOOD-TURNING PROBLEMS
TRAY AND FRAME MOULDINGS



SEGMENT WORK FOR TRAYS



NOTE
ANY OF THE ABOVE
DESIGNS MAY BE
USED IN LARGE SIZE.

take hold, and yet not be a hair's breadth too large, otherwise the napkin ring will be split apart when forced in place. This method is not recommended by the author, as too often a napkin ring is split; besides it taking about 50% more valuable wood, whereas in the

other cases, whitewood or common pine is used for a chuck, and the same chuck, if made out of thick stock and fairly large in diameter, can be used many times for various problems.

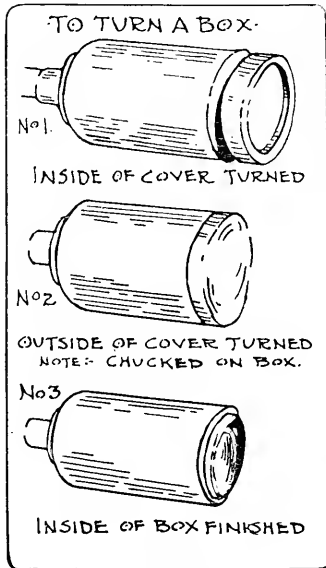


Fig. 49.

the wood apart with a few light taps of a chisel and mallet. The same scrap wood can then be used for rechucking. Big frames should be made of segments. (See Serving Tray, page 84)

PICTURE FRAMES

The method for turning a picture frame, Plate XXI, is quite the same as a napkin ring. In most cases, the screw-chuck method will be found to work satisfactorily, altho it is often advisable to glue the wood from which the frame is to be made to a piece of scrap wood, with paper between. Turn the front and side of the frame; when finished knock

BOXES

There are two general types of boxes to consider: those having the cover fitting on the inside, Plate XXII, and those having the cover fitting on the outside, Plate XXIII. Most boxes are of the latter type. There is, however, little difference in the turning.

All boxes should be turned standing on end grain. (a) Rough off the stock to approximately the largest diameter. (b) True up the end. (c) Now hollow out the inside of the cover, Fig. 49, No. 1, to

fit a templet, and (d) turn as much of the cover as can conveniently be handled; (e) sandpaper and polish. If the cover fits from the outside, (f) cut the collar of the box to fit the cover snugly. (g) Rechuck the cover on this collar and (h) finish the top. When this has been done (i) remove the cover and (j) hollow out the inside of the box to fit a templet (See Bowls). (k) Now sandpaper thoroly. (l) Turn the outside of the box to conform with the inside, easing upon the collar slightly, (m) sandpaper and finish. (n) Cut the waste wood at the bottom to about $\frac{1}{2}$ " in diameter, and slightly concave. The bottom is now ready to be cleaned with a knife and finished off with felt (See Bowls).

When the cover fits from the inside, great care must be taken when sandpapering the inside, not to drag the paper over the top, otherwise the cover will not fit.

It must be remembered in getting out stock for boxes, to allow at least $\frac{1}{4}$ " between the cover and box proper in order that there will be room for cutting off.

COMBINATION TURNING

CANDLESTICKS

Candlesticks, electroliers and all problems requiring both spindle and face-plate turning, come under this heading.

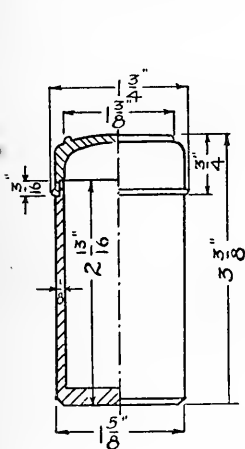
Our first example will be a candlestick, Plates XXIV, XXV, and XXVI, made of some hard wood, such as mahogany, walnut, oak, ebony, cocobolo, cherry, birds-eye, curly or plain maple, etc.

The Base—(a) Cut a piece of stock of sufficient thickness to allow $\frac{1}{8}$ " for facing upon both sides, and $\frac{1}{4}$ " larger in diameter than the design. (b) Screw this stock on a face-plate, using short screws and keeping them near the outside edge, so that no hole will remain when the work has been completed.

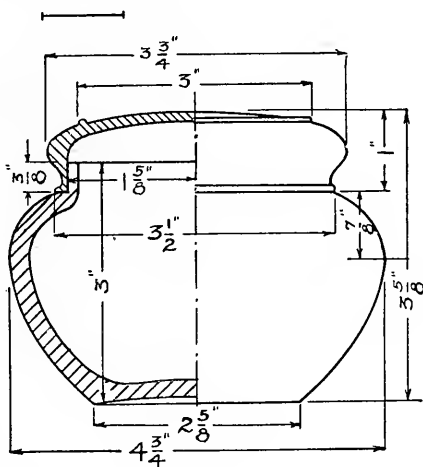
We are now ready to start on slow speed, and (c) cut in from the face along the edge to the required diameter. (d) Clean up the face until true, and (e) cut the opening which is to hold the lead. Note that the under side of the base is turned first. (f) Shape the edge up to the last fillet (where there is a fillet), (g) sandpaper and finish. (See Finishing, page 33.)

WOOD-TURNING PROBLEMS

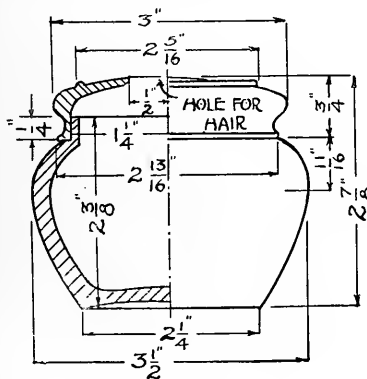
GIRL'S DRESSER SET



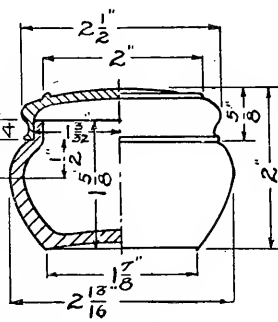
TALCUM POWDER BOX



PUFF BOX



HAIR RECEIVER



BUTTON BOX

Now (h) remove the wood from the face-plate, and rechunk. In turning the design shown in Plate XXIV, (i) cut the chuck $\frac{1}{4}$ " deep, the height of the edge, and true up the face to the required thickness, (k) boring the hole in the top, Fig. 50, with a $\frac{1}{2}$ " Forstner

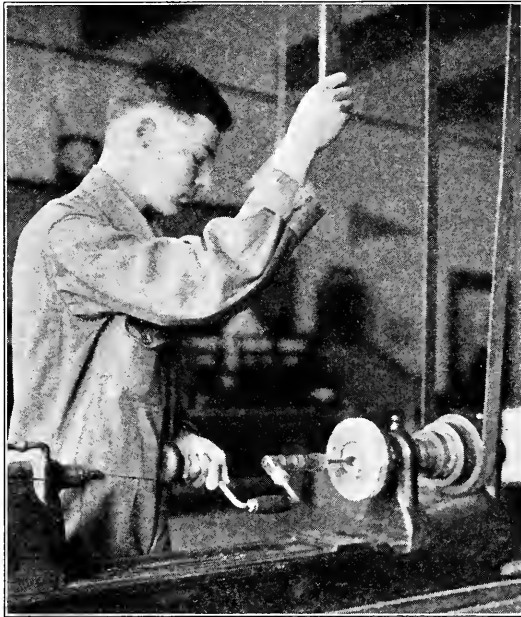


Fig. 50. Boring Face-plate Work.

bit. Since a Forstner bit has no spur to center it when boring, it is advisable to cut in a short distance with an $\frac{1}{8}$ " chisel to make sure of hitting the center. (See Lathe Boring, page 78.) (l) Shape the remaining part of the case, (m) sandpaper and finish. When polishing the base, great care must be taken not to allow any oil to work its way into the hole on top, otherwise the glue will not adhere. On account of danger of splitting the base, bore the hole first.

The Shaft—(a) Cut the rough stock $\frac{1}{8}$ " longer and $\frac{1}{8}$ " larger in section than the design. To make sure of having the hole in the center (on the top of the shaft), (b) bore a $\frac{7}{8}$ " hole first and turn around the hole. Bore $1\frac{3}{8}$ " deep to allow $\frac{1}{8}$ " for cleaning up the end, and (c) turn a plug between centers keeping the live center

WOOD-TURNING PROBLEM
CANDLESTICK.

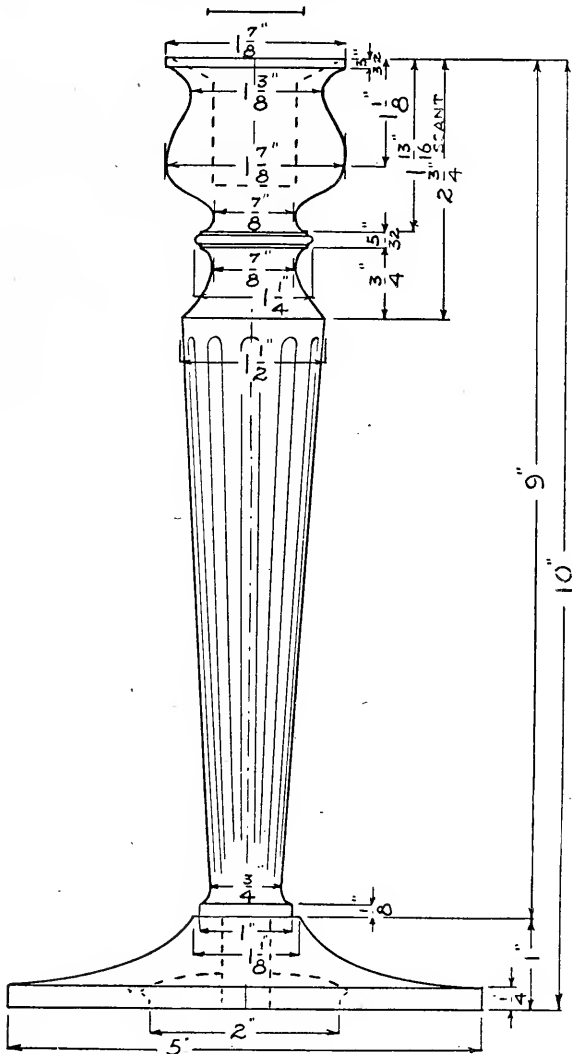


Plate XXIV.

impressions for future turning. (d) Now glue this plug in place as indicated, Fig. 51, and when the glue has set, (e) the shaft can be turned. (f) After all polishing has been completed, (g) fit the dowel into the base.

(a) Place the two parts of the candlestick together, and turn the bottom side up. Having done this, (b) pour enough molten lead

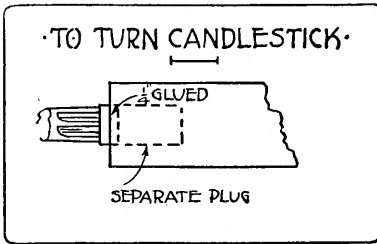


Fig. 51.

into the base to just come flush, and (c) cool immediately from the under side with a blower. If a high polish has been put on the base, it will be advisable to drop a small quantity of mercury into the lead—this alloy will melt at a lower temperature and therefore will not blister the polish.

When the lead has cooled off, (d) glue the base and shaft together, (e) finishing the bottom with felt. (See Bowls, page 54.)

LAMP STANDARD

Where it is desirable to have the wiring of the lamp standard start at the base and go thru the shaft, it becomes necessary to work out a hole about $\frac{3}{8}$ " in diameter the entire length of the shaft, joining the base at a suitable place. If good facilities are at hand for lathe boring, this will be one way of handling the problem. Bore the hole thru the rough stock, and plug both ends for turning. Where, however, the electrolier is too long, as in the case with a floor lamp, or where no available chuck is at hand for lathe boring, it will be found that the shaft will have to be grooved out of two pieces, half on each piece, glued together, plugged and turned.

The working out of the remaining part of the problem is much the same as that of a candlestick.

WOOD-TURNING PROBLEM LAMP STANDARD

GAS

ELECTRIC

NOTE
DIMENSIONS GIVEN ON
CUT ARE FOR TWO
LIGHT ELECTROLIER -
FOR ONE LIGHT SUBSTI-
TUTE THE FOLLOWING
MEASUREMENTS.

$$14\frac{1}{2} = 9\frac{1}{2}, 13\frac{1}{2} = 8\frac{7}{8}, 10 = 6\frac{1}{2}$$

$$9\frac{1}{4} = 6\frac{1}{16}, 2\frac{1}{4} = 1\frac{1}{2}, 1\frac{3}{4} = 1\frac{3}{8}$$

$$1\frac{1}{4} = \frac{27}{32}, 1 = \frac{21}{32}, \frac{1}{2} = \frac{5}{16}$$

$$\frac{3}{8} = \frac{1}{4}, \frac{1}{4} = \frac{5}{32}, \frac{3}{16} = \frac{1}{8}$$

MAKE TOP TO FIT
SOCKET-SAME AS
CANDLESTICK.

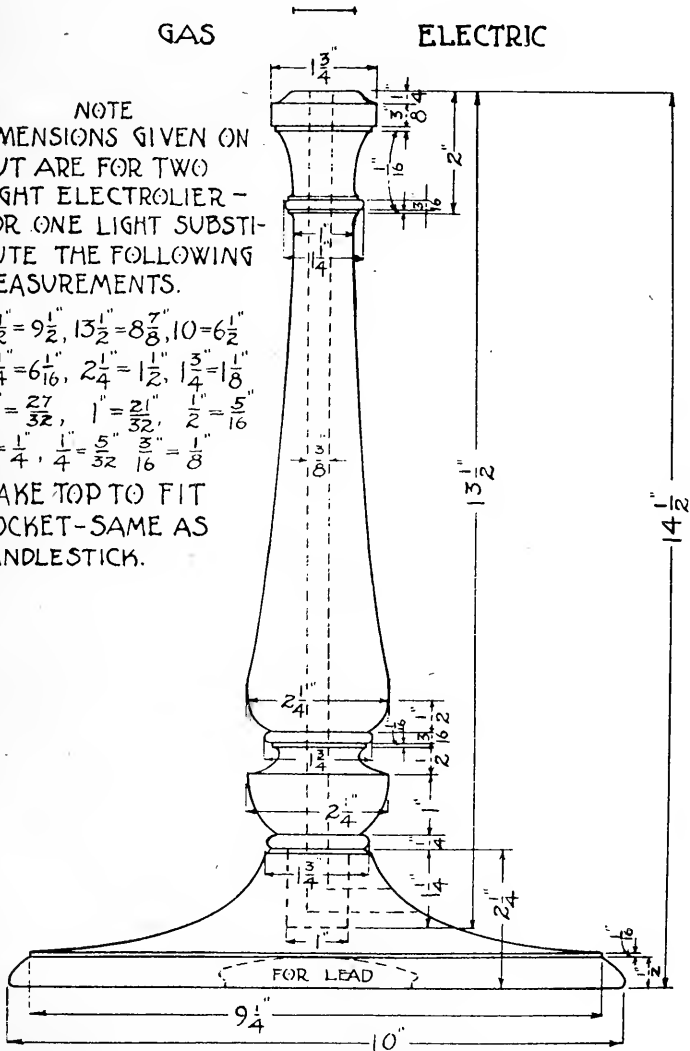


Plate XXVII.

LATHE BORING

For accuracy, speed and ease, there is no better way of boring a hole in wood, where the equipment is limited, than by using the lathe.

To bore a mallet head, (a) start the hole at the bench so as to center the drill; the point of the dead center takes care of the other

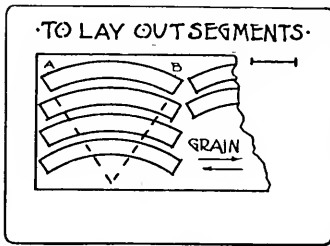


Fig. 52.

end. Having located the correct distance the tailstock should be from the drill, to allow for the size of the wood, (b) fasten the tailstock firmly, but leave the spindle free. Working at a medium speed, (c) force the wood against the drill by turning on the hand-wheel. When the hole is almost thru, (d) remove the dead center and (e) butt the spindle against the wood to allow the drill to go all the way thru without injury to the center. This method may be used on end grain boring, with such problems as the rolling pin handle and electrolier. Where a hole is to be bored longer than the length of the drill, reverse the ends and bore half way from each end. It will be found difficult to clean long holes of the shavings, and therefore it is not advisable to force the work too much; besides, the drill will become very hot, and must be cooled frequently by dipping in water.

For face-plate boring, where there is danger of splitting the wood, it is advisable to use a Forstner bit, as the screw on an auger bit is very apt to force the wood apart, and there is a great tendency for the bit to be pulled into the wood too rapidly. In order to center a Forstner bit, turn in a short distance with a chisel. Fig. 50 shows a center bit in use which works equally as well as the Forstner bit.

SEGMENT WORK

In order to turn large diameters so that there shall be practically no warping or changing of shape, and at the same time no sacrifice of strength, it will be necessary to use segments.

WOOD-TURNING PROBLEM
FLOWER HOLDER

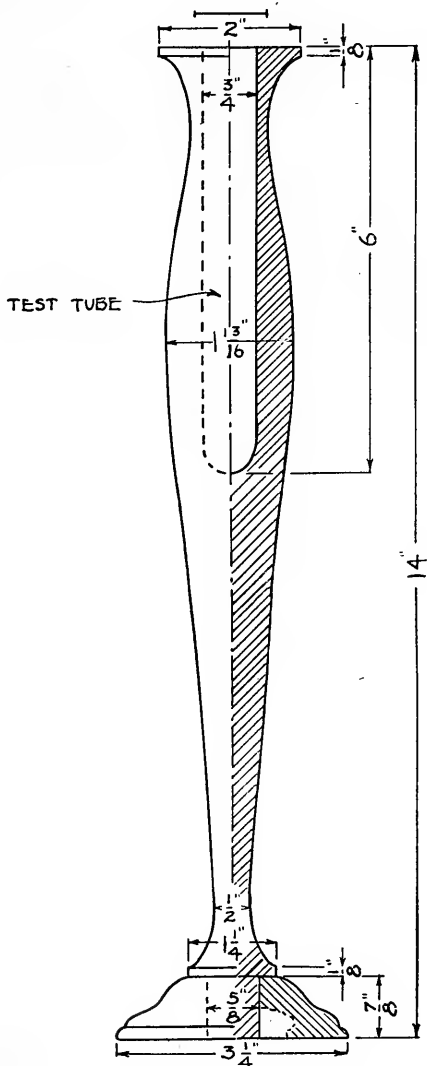


Plate XXVIII.

From Fig. 52 it will be noticed that the segments run with the grain of the wood, this, of course, being of the greatest importance, as otherwise no strength would be gained.

The theory of segment work is similar to that of a butt joint with a cleat fastened on each side. This form of joint is used every day in carpentry work. By "breaking the joints," as it is called, we have all parts of equal strength, and when thoroly glued together, the work is stronger than a solid piece. As will be shown, an odd number of courses always proves most efficient.

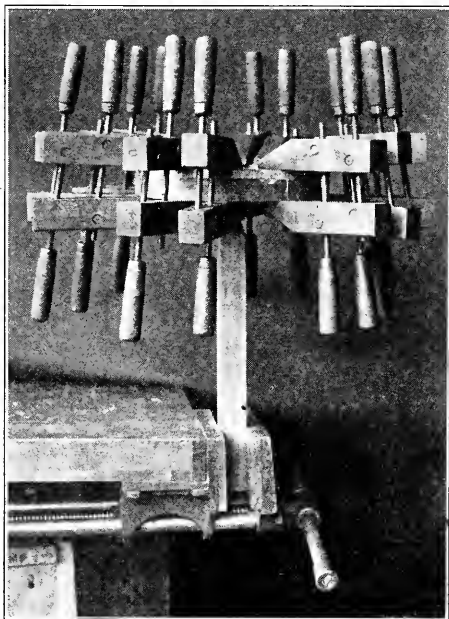


Fig. 53. Segment Work Being Glued.

There can be no set rule governing the correct number of segments for each course; small circles are usually made of three segments, whereas for about a 12" diameter, six segments will be necessary, and so on, always remembering that to avoid end grain, the segments will

need to be smaller. For the problems given in this book, six segments will suffice.

In starting segment work, it will first be necessary (a) to true up a piece of good white pine to the desired diameter. (b) Onto this pine the segments are glued and held in place until all turning and finishing have been completed. For six segments, (c) step the radius around the circumference six times and join these points with lines to the center. The lines just drawn will indicate the joints for the first, third and fifth courses, and so on according to the number of courses. (d) Divide each space in half, and again

WOOD-TURNING PROBLEM SMOKING STAND

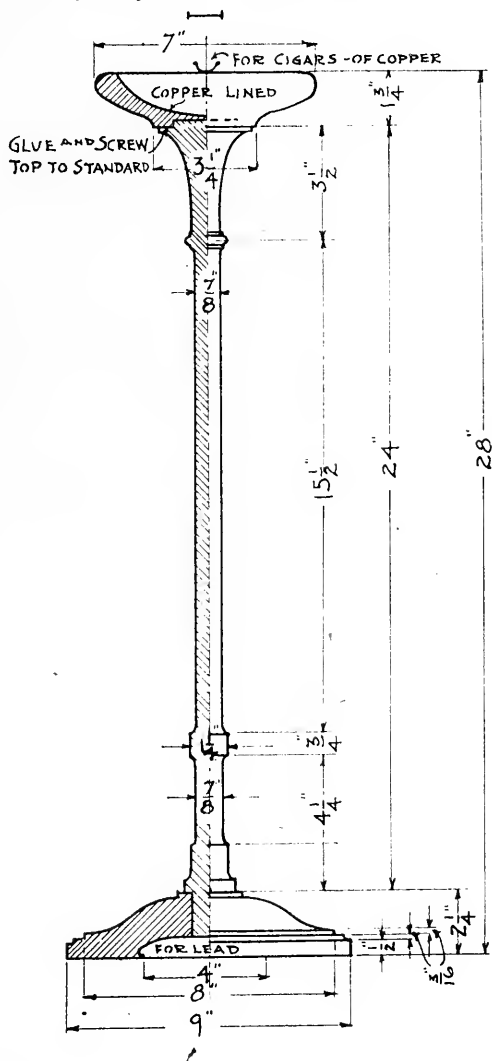


Plate XXIX.

draw lines to the center to indicate the joints for the second, fourth and sixth courses, etc.

Fig. 53 illustrates a good method for holding the work while gluing the segments in place. A piece of about 2" square stock is turned at one end to fit the thread part of the face-plate, leaving the square part for clamping in the vise.

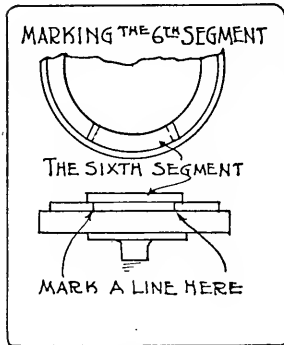


Fig. 54.

The greatest of care must be exercised to clamp the segments flat, making a tight joint all around. To do this, the shoulder spindle of the handscrew is tightened first, throwing the jaws slightly out of parallel, when a last turn or two on the end spindle will bring them to their correct position.

(a) The joints of segment No. 1 (segment No. 1 is the first segment to be put in place) are cut to correspond with the lines drawn on the pine stock and glued in place, cleaning away all glue from the end grain. (b) Fit segment No. 2 to make a tight joint with No. 1, at one end, and to correspond with the line on the other end. (c) Now size one end of No. 1 and No. 2 with the glue. After allowing the sizing to set for a few minutes, (d) glue No. 2 in place, forcing the joints together until absolutely tight. (e) Clean away the glue again on the other end of No. 2, and so on until the last segment is fitted. Fig. 54 illustrates the quickest and best method for getting a tight fit on No. 6 at both ends. After the necessary marks have been made, trim to the outside of the lines; if this is properly done, a tight joint will result.

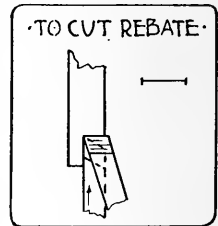


Fig. 55.

Allow not less than three hours for the glue to set before attempting to turn the work. Working on slow speed, (a) face up the first course of segments to the desired thickness and (b) clean up the outside and inside diameters just a little. (c) Now mark out the

WOOD-TURNING PROBLEM
COLLAR AND BUTTON BOX
SEGMENT WORK

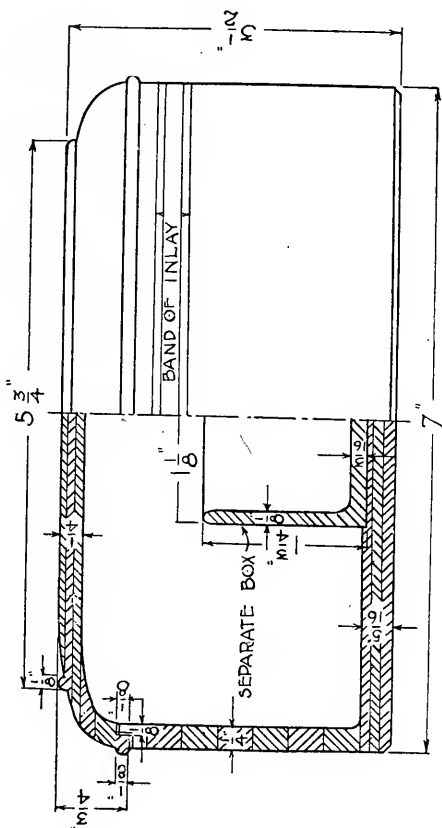


Plate XXX.

second course and continue as with the first. When all the courses have been glued in place, (d) do all necessary turning and finishing.

SERVING TRAY

Since a serving tray, Plate XXI, is nothing more than a large picture frame with two rebates on the back, Fig. 55, it will be necessary to rechuck the work. On account of the large diameter, and to avoid scratching the polish, it will be advisable to rechuck from the inside.

The first rebate will hold the glass and designed material for the bottom of the tray. (The latter is stretched over cardboard.) The second rebate is for the wooden bottom which is screwed in place, flush with the bottom of the molding. The handles are fitted to come flush and are firmly fastened from the under side of the mold. The entire bottom is covered with felt, previously stretched over cardboard, with the edges glued on the reverse side. Tack this felt covered cardboard to the tray mold with 2 oz. gimp tacks. Four small rubber bumpers are screwed in place, which completes the work.

By putting the tray together in this manner, should the glass break, it is a simple matter to take the necessary screws out and lift a few tacks without destroying any part of the tray.

COLLAR BOX

(a) Glue three pieces of stock together, Plate XXX, each a little over $\frac{1}{8}$ " in thickness, with the grain of the center piece running at right angles to the other two. When the glue has set, (b) cut out a circle approximately $7\frac{1}{4}$ " in diameter, which in turn (c) is glued to a pine core for turning. (d) Lay out for the segments and (e) build up to the top of the box proper. The segments should be about $\frac{1}{2}$ " wide to start with, to allow for turning.

The cover is built up in like manner and turned first on the inside, then rechucked. (See Boxes, page 68.) If a course of inlay is to be worked into the problem, it will first be necessary to glue up the

WOOD-TURNING PROBLEM
CHEESE AND CRACKER DISH

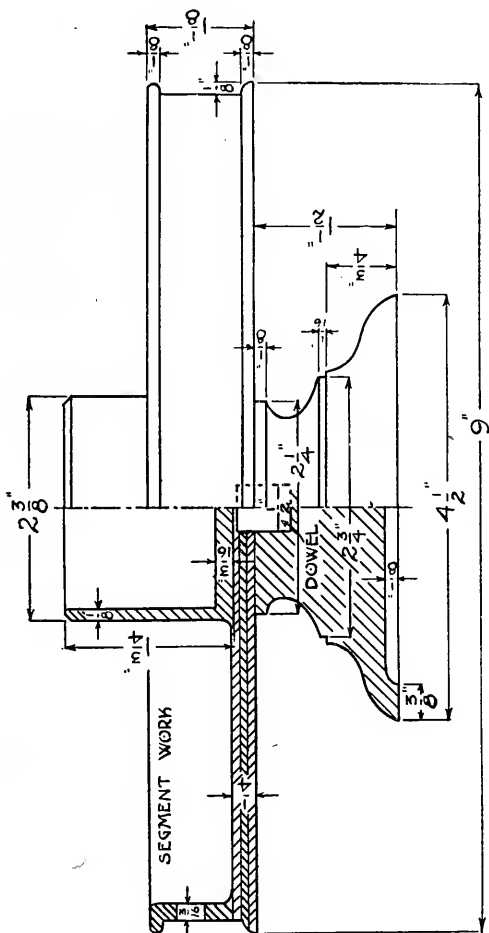


Plate XXXI.

vener for the inlay of suitable width and length so that when dry the six segments can be cut from same. These segments are handled in exactly the same manner as the others.

BUTTON BOX

The button box in the center, Plate XXX, is turned separately on a screw chuck, leaving $\frac{1}{4}$ " dowel on the bottom for gluing in place.

After all work has been completed, the felt is glued on the bottom, as in the case of the nut bowls.

As collar boxes are subjected to a great deal of wear, it is advisable to finish the work with three coats of good varnish and rub to an egg shell gloss on the lathe.

CHEESE AND CRACKER DISH

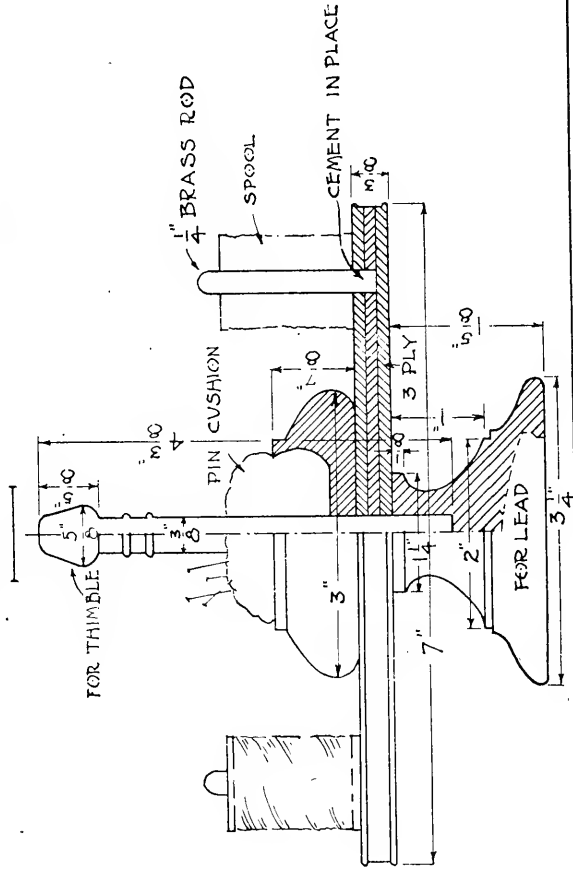
The working out of this problem, Plate XXXI, is merely a repetition of the foregoing problems. The stand is turned like the base of a candlestick, the top cup the same as the button box of the above problem, and the dish is the same as the collar box, except that it is rechucked to clean up the bottom side. To make the dish more beautiful, it is a good idea to build up the bottom of segments, all coming to a point, instead of building it of three pieces of wood as explained above.

SEWING SET

Like some of the other problems, the sewing set or stand, Plate XXXII, is simply a combination of several preceding problems. The base is turned in the same manner as that of the candlesticks; that is, the flat disk being turned from both sides. The pin cushion holder is nothing more than a bowl with a hole in the center, which in turning fits snugly around the spool spindle.

In gluing this problem together, be sure not to glue the flat disk, as it would then be impossible to revolve it. The brass dowels are $\frac{1}{4}$ " in diameter and set in place with Major's cement. The pin-cushion is made with a hole thru the center.

WOOD-TURNING PROBLEM
SEWING SET



NOTE:
THE DISK IS NOT
GLUED TO THE UPRIGHT.
GLUE IN BASE AND
PIN CUSHION HOLDER.

NUT SET

A nut set may include six small bowls of any one of the designs in Plate XIII and one large bowl of the same design as indicated in Plate XXXIII.

The large bowl differs from the small ones only in that it has a block left in the center to hold the upright and the nut picks.

As with the candlesticks, it is advisable to bore the hole in the base first, and then fit the shaft to that hole.

Because of the cross-lap joint on the spindle work, it will be necessary, on the upright piece, to turn to $\frac{7}{8}$ " diameter at the joint, step around the cylinder to make four equal sides, and pare off the wood with a sharp chisel, thus producing the joint part which is $\frac{5}{8}$ " square. On the cross piece it is possible to start with square stock $\frac{5}{8}$ ", and turn on each side of the center. When all sandpapering and turning have been completed, lay out the cross-lap joint, cut to fit snugly, and glue together. The ends will have to be rounded up by hand and the entire problem finished at one time when the work has been assembled.

Some people prefer to crack the nuts with a hammer made especially for that purpose; in that case, the upright portion is omitted, the block covered with heavy metal, and a small hammer turned with a metal head to be used in place of the nut-cracker.

When nut-crackers are used, it is more in keeping to turn down the metal handles to about $\frac{1}{4}$ " in diameter and turn wooden handles to be fitted over them.

CLOCK CASING

When time permits, and a fine job is wanted, the clock casing, Plate XXXIV, is included under the heading of segment work. It is handled in the same manner as the serving trays, except that, being of smaller diameter, four segments are used instead of six.

After building up the segments to the proper height, turn the cylinder to $3\frac{1}{2}$ " in diameter, hollow out the inside, sandpaper and finish. (See Finishing, page 33.) Now rechuck and turn the mold

WOOD-TURNING PROBLEM NUT BOWL

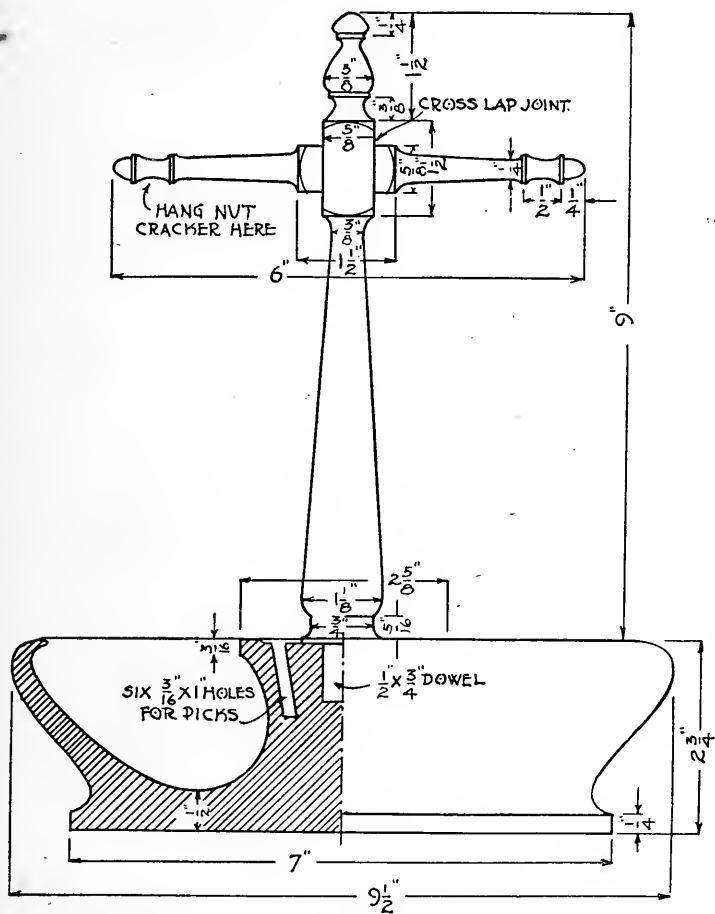
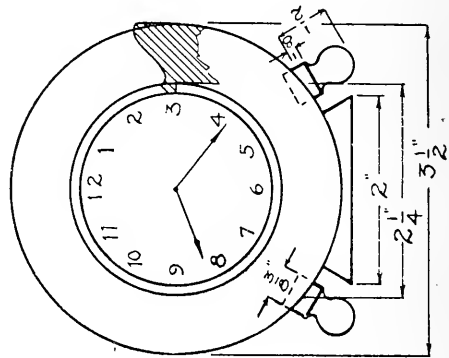


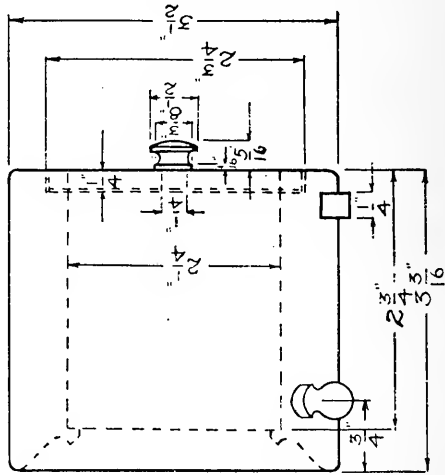
Plate XXXIII.

WOOD-TURNING PROBLEM CLOCK CASING

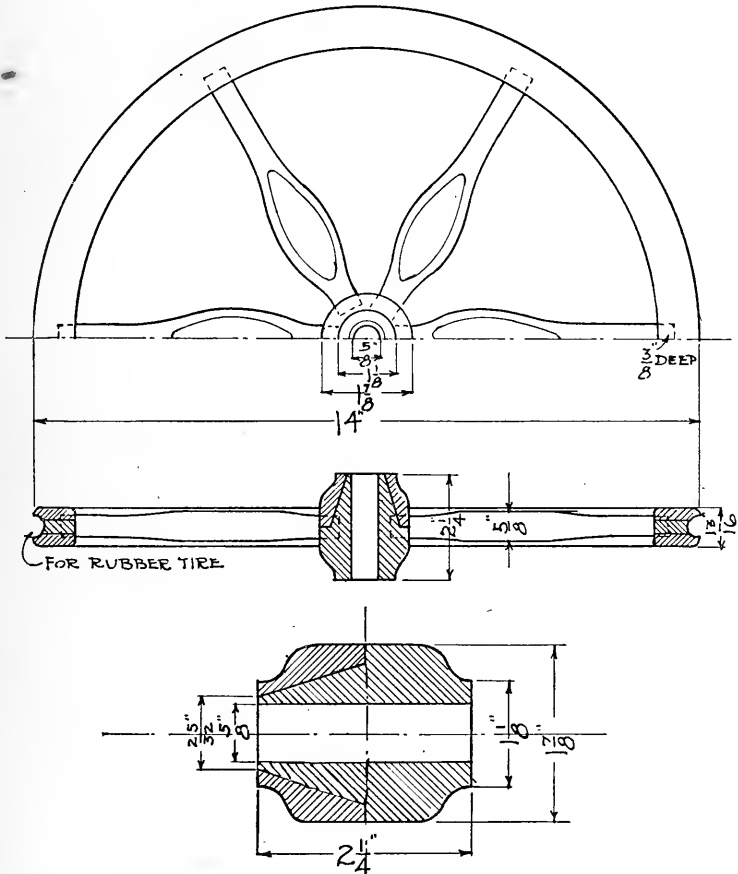
FRONT VIEW



SIDE VIEW



WOOD-TURNING PROBLEM
TEA WAGON WHEEL



• FULL SIZE SECTION THROUGH HUB.
MADE OF TWO PIECES

on the front. The cover is turned on the face and rechucked, after which the knob and two legs are turned between centers.

The cover is hung with a small brass hinge, and the knob glued in place. Bore the hole for the knob with a Forstner bit, and bore the holes for the legs with an auger bit.

Where the problem is turned from a solid piece of wood, the

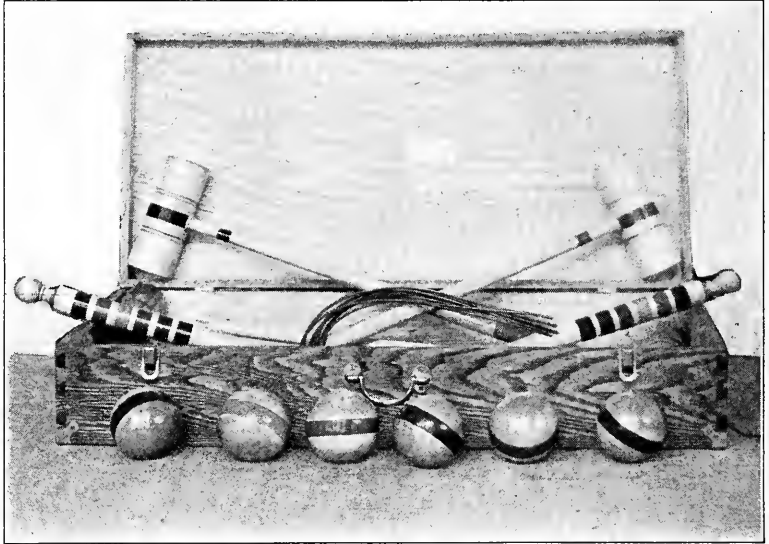


Fig. 56. The Croquet Set.

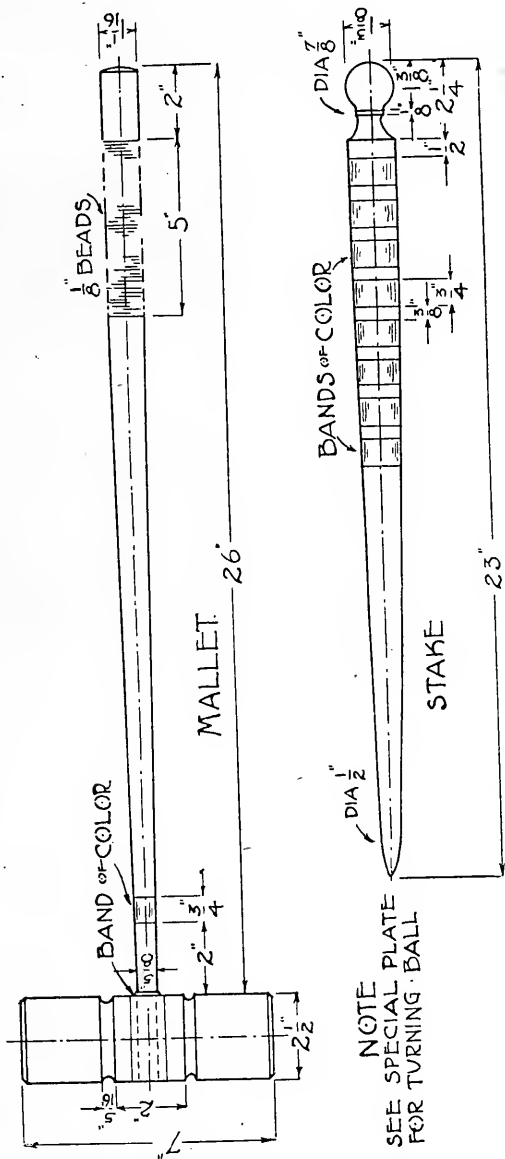
grain should run with the length; in other words, the face will show end grain.

On account of shrinkage, it will be necessary to make the inside diameter a little large, so that when the wood contracts, it will not bind around the clock and hold it fast. There is also danger of checking, should the wood shrink considerably.

THE TEA WAGON WHEEL

The tea wagon wheel presents no new problem from those having to do with segment and spindle work except in the making of the hub. From Plate XXXV it will be seen that the hub is turned in

WOOD-TURNING PROBLEM
CROQUET SET



NOTE
SEE SPECIAL PLATE
FOR TURNING BALL

Plate XXXVI.

two pieces. This is done for the reason that the spokes can be set in the rim, the lower portion of the hub set in place and the upper part fitted over that to make a complete wheel.

After the rim has been built up of segments and turned, holes are bored on the inside for the spokes; the hub is now clamped together in a vise, and holes to receive spokes bored in it. After this

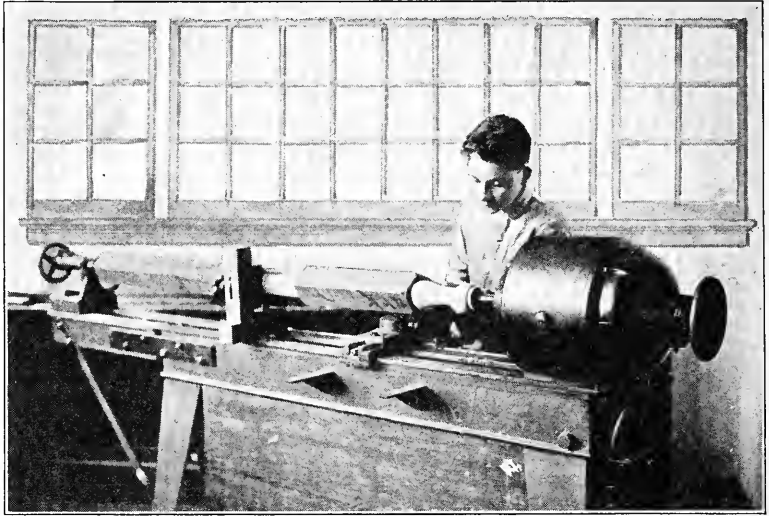


Fig. 57. Back Rest Used on a Bed Post.

has been done it is taken apart and the entire mass glued together. Great care, however, must be taken in gluing this problem to block up the spokes and rim from the under side to come level with the hub so that the spokes can be brought in line.

CROQUET SET

For a group problem, nothing works out so well and has more real educational value than the croquet set. Plate XXXVI and Fig. 56.

The Mallet—As with other problems worked in school, the price of material governs the kind to be used. For this reason hard maple will be chosen, altho boxwood, lignum vitae and rosewood are better for the head. Ash or hickory is satisfactory for the handle.

The principles involved in turning a croquet mallet are almost identical with those of a manual training mallet, Plate VIII, the only



Fig. 58. Turning with One Hand and Supporting the Work with the Other.

difference being found in turning so long a handle. Fig. 57 illustrates a back rest in use. To work this out successfully, first rough off in the center enough wood so that the support of the back rest can be brought in close contact with the handle. The diameter at this place should be as large as possible and the support can either be a semi-circle to correspond in diameter, or a block with a cut of 90° , the sides in the latter case acting as tangents to the cylinder. Now fasten all adjustments on the back rest firmly and grease the handle at the point of contact with a little tallow. Turn on both sides of this rest, starting at the headstock and working to the dead center. After doing this, remove the back rest and clean up the remaining wood. All such turning must be

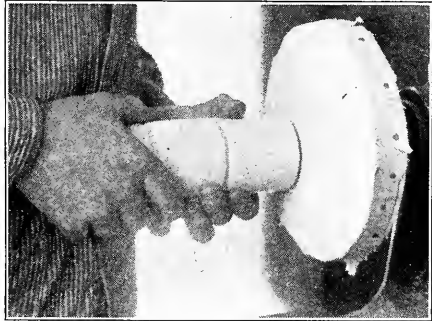


Fig. 59. The Sand Wheel Used to True Up the End of a Mallet Head.

done at slow speed. Fig. 58 shows a method of supporting the work with one hand while turning with the other.

Fig. 27 illustrates a quick and safe method for sandpapering long and weak spindle work. With sandpaper on each block, it is possible to work with great pressure, one hand supporting the strain on the other. The blocks should be of sufficient length to joint the

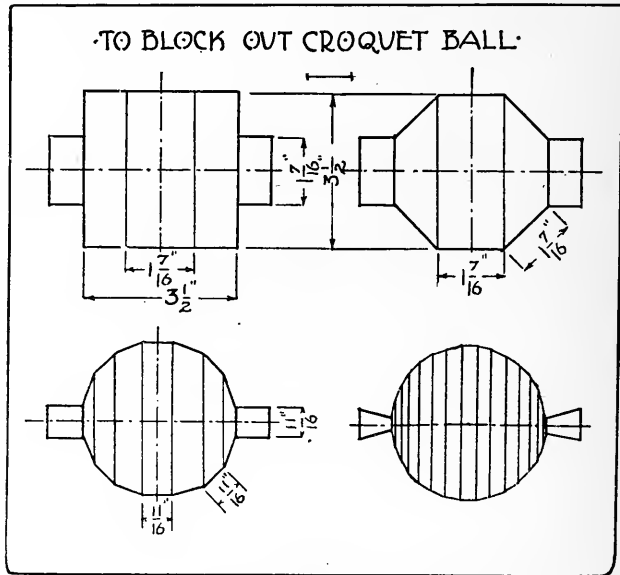


Fig. 60.

wood, working all small hollows and irregularities out of the cylinder. Fig. 59 shows how a sand wheel may be used to advantage in truing up the ends of a mallet head.

The Ball—It will be noticed in Fig. 60 that we first turn a cylinder of $3\frac{1}{2}$ " in diameter; then locate the center, and measure $1\frac{3}{4}$ " on each side of this line (a cross section thru the axis forms a perfect square; we intend, as it were, to inscribe an imaginary circle in this square). Our next step will be to cut so as to make the square section octagonal. Having reached this point we now cut so as to make the section a 16-sided figure; and so on until we attain 64 sides, when we have almost a round surface. Trim off the corners

and sandpaper thoroly. It will be observed that we do not cut the waste wood at either end below $\frac{3}{8}$ ", leaving the final cutting to be done with a knife and cleaned up with a file and sandpaper. If



Fig. 61. Illustrating Correlation in Advanced Work.—Note the Turned Legs on the Martha Washington Sewing Cabinet and Drawer Knobs and Bed Problem.

properly finished by hand no rechucking will be necessary. On account of wood shrinking in one direction only, it will be advisable to cut the end grain of the ball about $\frac{1}{32}$ " less in diameter than the width; when the wood has dried out thoroly, the ball will be as round as it is possible to turn one.

It will, therefore, be seen that we turn a ball by increasing the number of sides of a polyhedron. By diminishing each side in size, we approach a sphere for a limit. To succeed in getting a good round ball, it must therefore be remembered that the greatest care be taken to mark off the work accurately, and cut to the line. Each flat surface cut is a tangent to the imaginary sphere.

Before cleaning off the center line, cut a line $\frac{3}{8}$ " on each side of it with the toe of the skew. This band is made for a guide in painting the color on the ball.

The Stake—No instructions need be given on this part of the problem as it is simple spindle work. The lines are cut, as with the ball, to locate the bands of colors.

When all turning is completed, and the mallet glued together, cover all parts thoroly with linseed oil. Allow one day for drying, and give it two coats of white shellac. Lightly sandpaper each coat, and finish with two coats of spar varnish.

LONG-PIECE TURNING

THE FOUR-POST BED

The stock for the posts, Plate XXXVII, should be mahogany, joined true to $2\frac{7}{8}$ " x $2\frac{7}{8}$ ", so as to work out the square part, and also to make it easier to turn.

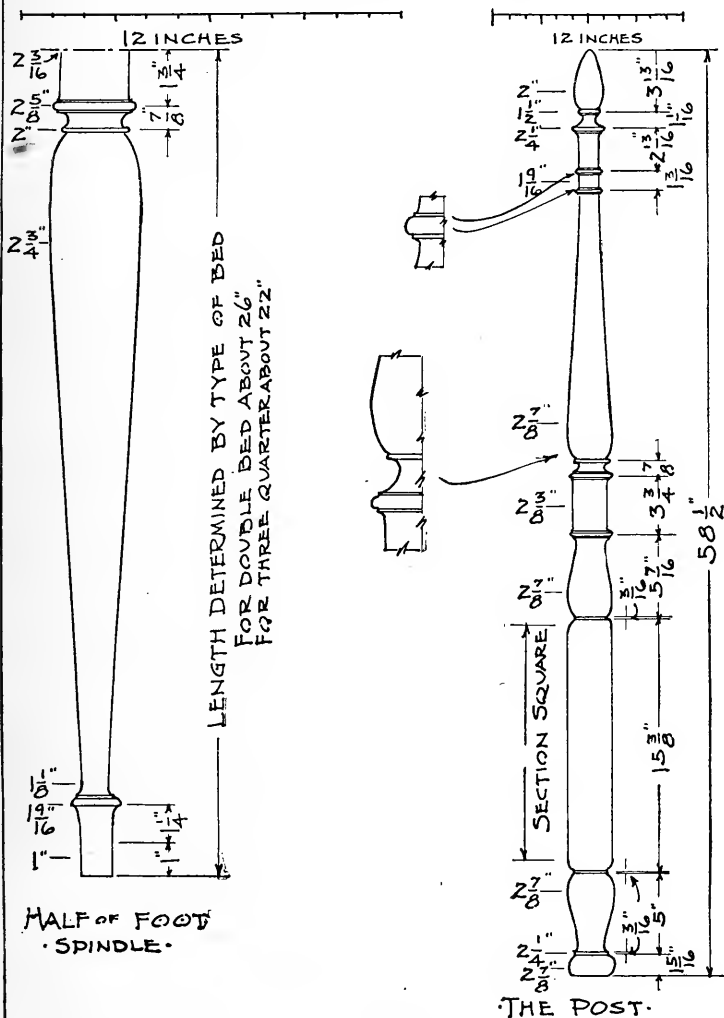
Great care must be exercised in centering the ends so as to show no uneven margin around the square part, when the post has been turned.

Start to round up the stock in that part of the post where the foot spindle is to join, Fig. 61; work the back rest in place and turn each half separately, Fig. 57. When all turning and sandpapering on these two parts is complete, remove the back rest and finish the remaining part, Fig. 58.

The turning of the foot spindle is identical with that of the posts.

WOOD-TURNING PROBLEMS

FOUR POST BED



WOOD-TURNING PROBLEM

FLOOR LAMP

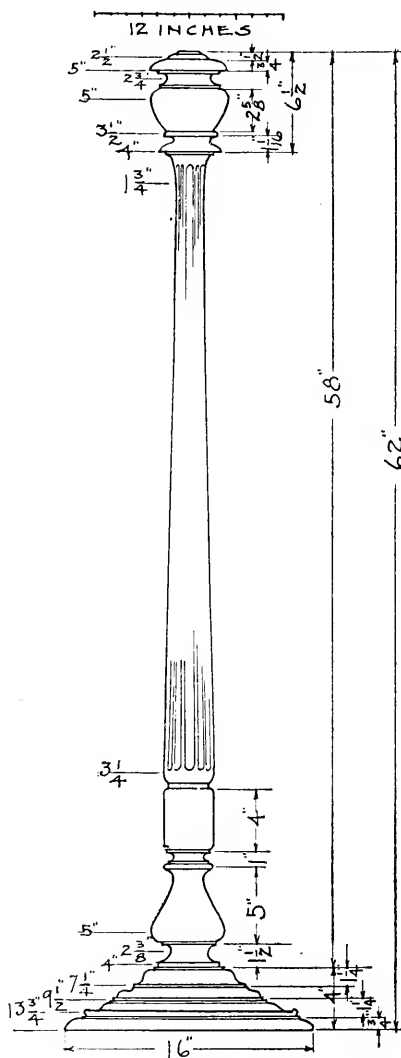


Plate XXXVIII.

WOOD-TURNING PROBLEM
FLOOR LAMP

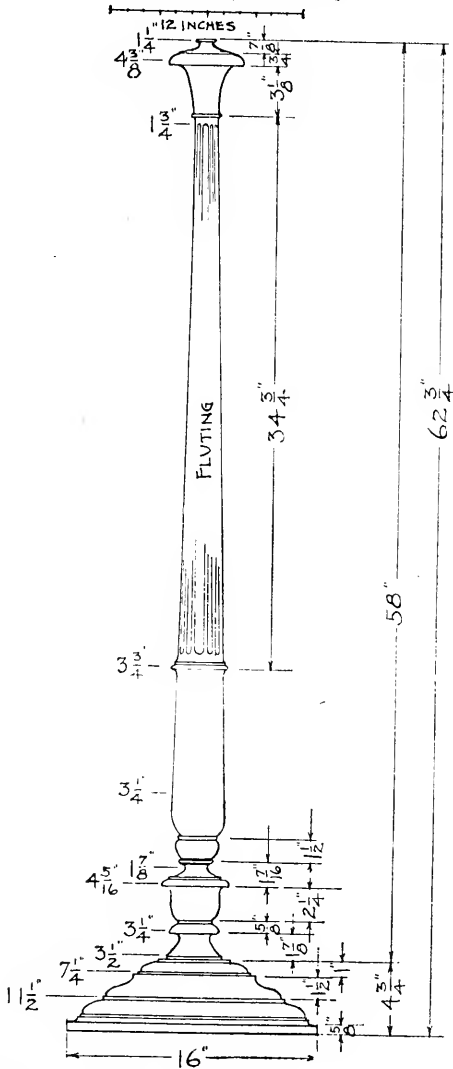


Plate XXXIX.

THE FLOOR LAMP

Where the floor lamp, Plates XXXVIII and XXXIX, is to be finished with stain, varnish, etc., mahogany, walnut or oak stock should be used. When a gold finish is desired, clear white pine serves very well.

The stock should be made up of two pieces, with a groove in each half to make a hole for the wiring. Before gluing this stock together, it is a good idea to run a few drops of oil in the groove so that the glue can readily be driven out when the lamp has been completed. This groove must be plugged while turning.

When the shaft is to be fluted, lay out for the correct number of flutes, marking each flute with the surface gage; see mallet head, Fig. 35. Rough out the grooves with a suitable gouge, smooth up even with a wooden round plane, run a rat-tail file up and down a few times to clean the rough places, and then finish with a piece of sandpaper wrapped around a dowel of proper diameter.

No new problem is presented by the base, and therefore no further mention will be made as to the method of procedure.

WOODS USED IN TURNING

It is possible to turn any wood on the lathe, provided the wood is firm enough to hold together. All sorts of odds and ends, otherwise useless on account of knots and gnarly places, are pleasing when turned. Plates XIV and XVII.

For the classroom, maple will probably be used for most turning as it adapts itself well for thin turning, is hard, takes a polish easily, can be stained in many beautiful ways, holds its shape fairly well and is reasonable in price. Oak is also a good wood, but on account of the porous grain, does not lend itself so well to all problems.

Where price of material is a secondary consideration, the following list of woods will be found to be all that is necessary to turn any problem, making it both serviceable and beautiful.

Maple—plain, curly and birds-eye.

Walnut—white, black, French and Circassian.

Oak—quarter-sawed white and red.

Cherry.

Sycamore—quarter-sawed.

Mahogany—bay wood, Mexican, East Indian and African.

Ebony—gray, black.

Cocobolo—Panama, Nicaragua.

Rosewood—African.

Snakewood.

Lignum-vitæ.

Myrtlewood.

Boxwood.

Holly.

Satinwood.

DON'TS

A few Don'ts are well worth remembering to help in avoiding both mistakes and accidents:

Don't start your lathe unless all adjustments are fastened; otherwise the work may be thrown out.

Don't leave the lathe running when no one is working at it.

Don't start any work on high speed; rough the corners on slow speed first.

Don't turn long, thin spindle work on high speed; it will spring too much.

Don't stop your spindle work or feel of its smoothness by holding your fingers near the tee-rest, as the motion of the wood is liable to draw your fingers or hand between the rest and the wood, causing injury.

Don't work your lathe on high speed while rechucking; there is danger of the work being thrown out of the chuck.

Don't stop your lathe without also stopping your work; otherwise when the lathe has come to a standstill, there is danger of the work winding its way off. This applies to face-plate work.

Don't apply stain, filler, etc., while the lathe is in motion; the centrifugal force will drive the moisture out of the wood instead of allowing it to penetrate.

Don't use cotton waste for polishing, or applying stain to your work, as the short threads may catch on to the fibers and draw the waste out of your hands, often causing injury.

Don't remove your wood from the lathe without first marking the center and the end of the wood so that both may be returned to the same place at a future time.

Don't cut your work free before being sure that all turning and finishing has been completed.

And finally, don't go ahead on any work if you are not sure what to do, or how to do it.

SHOP DISCIPLINE

With the exception of the machine shop, there is probably no shop in school where the discipline should be more carefully watched than in wood-turning. In the first place it is always more or less dangerous to work around machinery, and where we believe in Safety First, each student should be compelled to remain at his own lathe unless otherwise engaged. Permitting a reasonable amount of talking about the work in question is a good idea as one student gains knowledge from another, and it often saves the less apt student from accidents and mistakes by having suggestions made at the right time.

Secondly, if students are permitted to move about the room without a good reason, there is danger of one boy pushing another and ruining an otherwise good piece of work. When the order is given to shut off the lathes, it must be obeyed at once, and it is advisable to do this, should anything go wrong with the work or the machines. The work is not to be removed from the lathe more often than necessary, the instructor going to the lathe to inspect it rather than the student bringing the work to him.

Ample time is to be given at the end of each period for cleaning the lathes and putting all tools in their correct places. It is not enough to brush off the machines with a counter brush, but it is advisable to remove the grease, stains, dirt, etc., from all corners, and at the same time keep the lathes shining as they should. Kerosene and waste will be found to be the quickest and best method of accomplishing this. A metal receptacle is hung at each machine to contain the waste.

All tools should be numbered to correspond with a similar number on the lathe, and it is important that each boy put the correct tools at his lathe, thus making it easy to check up on missing or broken tools.

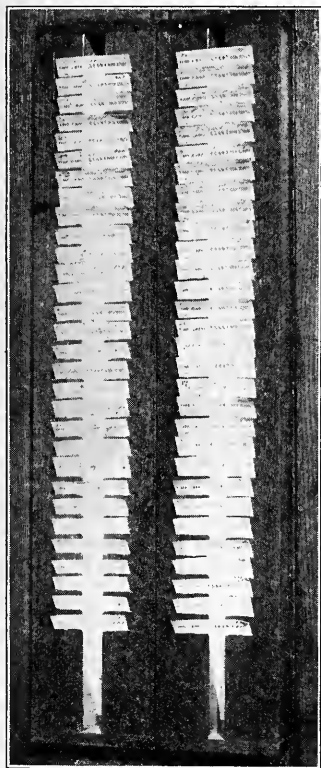


Fig. 62. Card Rack.

Each week one student is to be appointed, for a given length of time, to straighten out the general tool cabinet in the rear of the room, Fig. 1. This boy should see that all stain cans are closed, everything put in order, and the sandpaper box kept filled. A mark is to be given for this tool work and at least five minutes extra time for attending to everything.

In the bench each boy has a locker to contain all unfinished work, also his jumper. Pieces of unfinished work too large for this are kept in a special locker, one of which is put aside for each class.

Ratings—Fig. 62 illustrates a rack for the individual cards of the students, arranged in alphabetical order. As indicated by Fig. 63 each card will contain all the necessary information needed about each boy. His name (the last name being written first), his home, room number, and a

space for each problem. When a boy starts a job, he puts down the name of the problem and the date of starting. At the time his work has been passed upon and a rating given, he puts down the date of completion. In this way each boy knows where he stands and the instructor is better able to judge in the future how long it requires for the average student to do a certain problem. If at any time there is a question about a piece of work, the number on the card will indicate at what locker it may be found.

At the end of every month, a line is drawn under the last figure, indicating where the next month starts. The final rating of each month is kept in a separate book for this purpose.

As a part of the training and at the same time to keep up the condition of the tools, each boy is assigned, at the end of the term, the task of grinding and sharpening certain tools, for which work he is rated.

· RECORD CARD ·			
NAME: <i>Smith, John</i>			
DRAWER NO 46		HR. 312	
LATHE NO 2			
<i>Shoulders</i>	<i>2/5/16</i>	<i>2/11/16</i>	<i>7</i>
<i>V's + beads</i>	<i>2/11/16</i>	<i>2/17/16</i>	<i>8</i>
<i>Cove</i>	<i>2/19/16</i>	<i>3/</i>	
<i>Burning Out</i>			

Fig. 63.

THE EXHIBIT

There is great satisfaction to both student and instructor, after having worked along a certain course for several months, to be able to actually see what has been accomplished and to

compare the work of one student with that of another.

In addition to this the exhibit gives the student a goal to work for, and in the prospective student it stirs up enthusiasm and a desire to do the best possible work.

The manner in which the models are displayed is almost as important as the quality of the work. Too often the mistake is made of trying to exhibit a mass of work rather than a few choice models. When the show case is crowded, the visitor's mind is unable to concentrate on any one object, hence there is no lasting impression made. It is well to bear in mind how frequently we find, in the better shops, simply one or two carefully selected articles displayed. By isolating an object, we have full power to judge of its merits, with nothing to add to, or detract from its qualities. When objects are grouped together, it is always advisable to mass them according to color so as to have harmony. Again, such models as household articles would not look well with polished models.

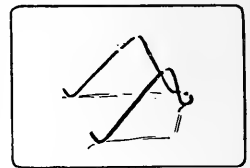


Fig. 65.

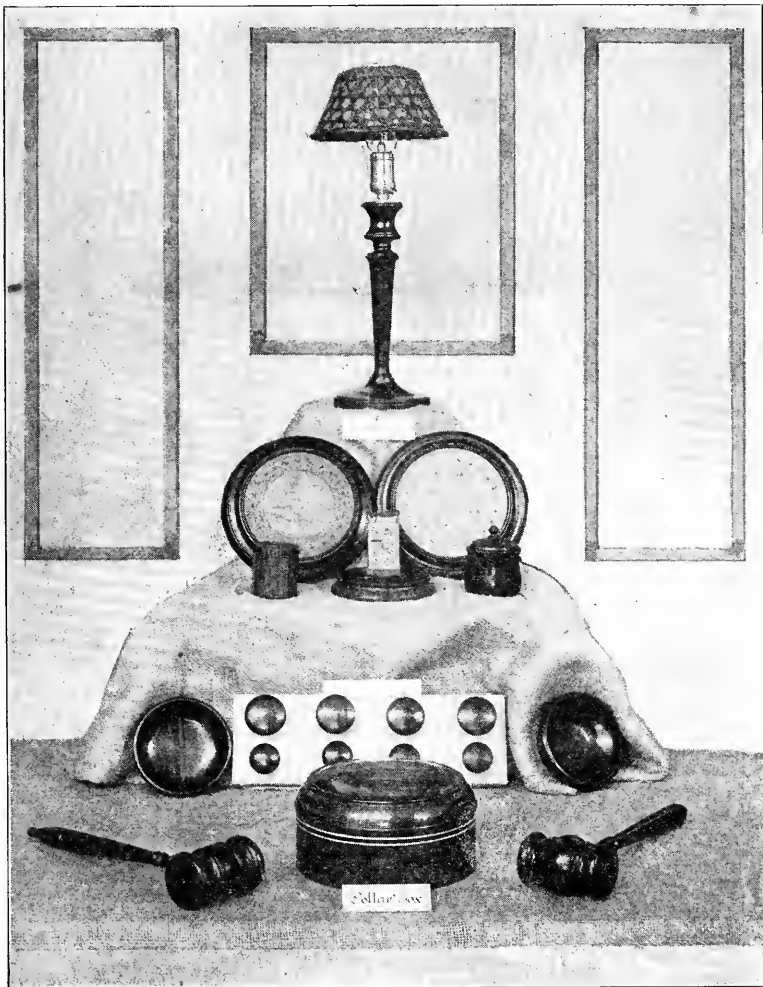


Fig. 64. Small Group Arranged for Exhibition.

Unless an attendant is always on guard, to see that no object is stolen or handled, it will be essential to have all work in a show case, and for wood-turning, a vertical case with a gray or any neutral colored back, glass shelves and glass on the front and two sides, will be found most satisfactory. Where, however, the work is displayed on tables, it will add very much to the exhibit to first cover the tables with burlap and use small boxes covered with like material to help in the grouping of the work and to relieve the flat appearance, see frontispiece. When the space permits, it will be found helpful to string a rope a little way in front of the tables to keep the visitors the proper distance from the models.

Neatly lettered cards, similar to those shown on the illustrations, will help in answering many questions, besides adding to the general appearance. The old English text script is most pleasing, the first letter of each word being capitalized in red ink. By bending an ordinary hair pin as indicated in Fig. 65, a quick and inexpensive tripod can be made to hold the cards.

INDEX

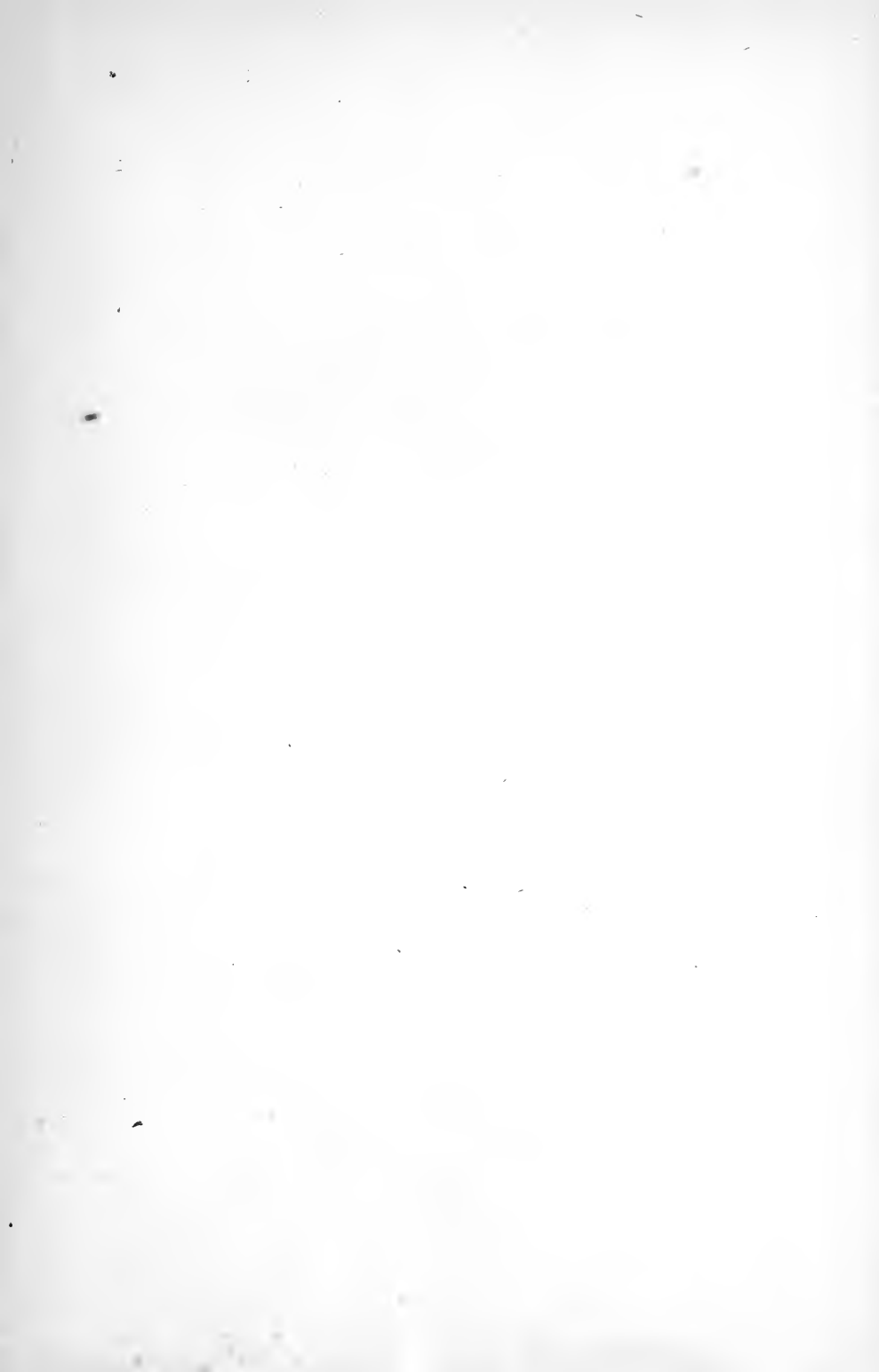
	PAGE		PAGE
Back rest.....	94	Croquet Set, Turning.....	95, 96, 98
Turning with.....	94, 98	Sandpapering.....	96
Balls.....	96, 97, 98	Stake.....	98
Bed posts.....	98	Finishing set.....	98
Stock.....	98	Darning ball.....	29
Turning.....	98	Stock.....	29
Back rest.....	98	Blocking out.....	30
Boring.....	72	Polishing and sandpapering.....	30
Lathe.....	72, 78	Design.....	27
Gavels.....	50	Lack of.....	27, 28
Mallet head.....	40, 46, 47	Governed by material and use of object.....	28
Bowls.....	54	Necessary qualities.....	28, 29
Stock.....	54	Dont's.....	103, 104
Gluing.....	56	Dumb-bells.....	38
Turning.....	54, 56, 60	Stock.....	38
Templet.....	56	Two methods of turning.....	38, 40
Finishing.....	60	Blocking.....	40
Nut set.....	86	Exhibit.....	10, 106
Boxes.....	68	School.....	10
General types.....	68	Grouping and arrangement.....	12, 106
Method of turning.....	68, 70	Correlation work.....	97
Fitting the cover.....	70	Display.....	106, 108
Collar box.....	84	Lettered show card holder.....	106
Button box for collar box.....	86	Finishing.....	33
Calipers.....	22	Applying stain.....	33, 34
Setting.....	22	French polishing.....	34, 35
Candle sticks.....	70	Varnishing.....	35, 36
Material.....	70	Gage.....	22
The base.....	70	Use of.....	22
The shaft.....	72	Gavel.....	47
Turning.....	70, 72, 76	Material used in making.....	47, 50
Plugging the end.....	76	Design.....	47
Gluing base and shaft together.....	76	Boring a hole in head for handle.....	50
Cheese and cracker dish.....	86	Turning the handle.....	50
Method of turning.....	86	Putting together.....	50
Chucks.....	63	Gouge.....	19
Bell.....	63	Roughing off.....	19
Screw.....	63	Turning coves.....	27
Clock casing.....	88, 92	Grinding and sharpening.....	14, 15, 16
Turning.....	88, 92	See Tools.....	12
Shrinkage of wood.....	92	Handles, screwdriver.....	40, 42
Collar box.....	84	Material used.....	40
Building up.....	84, 86	Method of procedure.....	40, 44
Inlay.....	84, 86	Indian clubs.....	35, 38, 39
Button box.....	86	Material.....	38
Combination turning.....	70	Blocking out.....	35
Candle sticks.....	70	Templet in use.....	38
Lamp standard.....	76	Instruction model board.....	23
Croquet Set.....	94	Lamp standard.....	76
Mallet.....	94, 95	Grooving out center hole.....	76
Balls, blocking out.....	96, 97		

	PAGE		PAGE
Lamp standard, Floor lamp	102	Segment work, when to use segments	78
Stock used	102	Gluing up	80, 82
Fluting standard	102	Theory of	80
Finishing	102	Number of segments used	80
Lathe boring	78	The sixth or last segment	82
Boring holes	78	Turning	82, 84
Face-plate boring	78	Sewing set	86
Long piece turning	98	Turning	86
Four-post bed	98	Gluing together	86
Mallet	44	Shop	11
Material used	44	Equipment	11, 13, 14
Two methods of boring hole in		Plan arrangement	11 12
head	40, 46, 47	Discipline	104, 105
Removing from lathe	47	System	105, 106
Napkin rings	60	Skew chisel for smoothing cylinders	
Material used	62	Position	22, 23
Planing stock	62	Cutting off	24
Turning on arbor	62	Stock	23
Re-chucking	62, 63	Turning	23
Screw chuck work	63	Model board	23
Bell chuck turning	63, 68	Skew chisel for V's and beads	24
Nut set	88	Method of procedure	24, 26
Design of	88	Position of tools	24, 26
Assembling and finishing	88	To insure symmetry and correct	
See Bowls	54	diameter	26
Parting tool and calipers	20, 21	Spindle turning	17
Use of	20, 21	Starting	17
Turner's sizer	20, 21, 22	Re-centering	17, 18
Obtaining diameters	21	Placing in lathe	18, 19
Working freely with calipers	21	Position at lathe	19
Accurate setting of calipers	22	Roughing off	20
Picture frame	68	Long turning	95, 98
Gluing	68	Tools	12
Segments	68	Equipment of each lathe	13
Potato masher	36	Various kinds of tools	13
Material used	36	Equipment of each bench	13
Method of procedure	36	Grinding and sharpening	14, 15,
Locating diameters	36	16, 17	
Finishing	36	Use of parting tool	20, 21
Rebate	82	Use of turner's sizer	20, 21, 22
Cutting	82	Use of gage	22
Rolling pin	51	Use of skew chisel	22, 23, 24, 26
Material used	51	Contents of tool rack	13
Shaft and handles	51	Trays, serving	84
Blocking handles	51	First and second rebates	84
Turning	51, 54	Finishing the bottom	84
Gluing together	54	Wheels	92
Sandpapering	30, 32, 33	For tea wagon	92, 94
Quality to use	30, 32, 33	Making of hub	92, 94
Obtaining a good finish	32	Method of building up	94
Spindle work	33	Method of gluing	94
End grain work	95	Woods used in turning	102
Segment work	78	Varieties of wood	102, 103
Laying out	78		









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