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THE AMATEUR CARPENTER

By

A. HYATT VERRILL

Author of "The Boys' Outdoor Vacation Book,"
"An American Crusoe," etc.

WITH OVER 200 DIAGRAMS
BY THE AUTHOR



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INTRODUCTION

Of all branches of manual training there is none more generally useful than carpentry. A knowledge of how to use carpenter's tools properly and how to make simple articles from lumber will never come amiss, and there is scarcely a man, woman or boy who at one time or another has not had occasion to use some sort of carpenter's tool. It may seem a very simple matter to use a saw, hammer, screw-driver or other similar tool, but nine times out of ten the amateur does not use such tools properly.

The value of the "handy man about the house" is well recognised, and as a rule the handiest man is the man who possesses the best knowledge of simple carpentry; and it is to tell just how he may become handy in the use of tools, how he should care for them and what he may accomplish with them, that this book has been written.

It is a pleasure and a delight to use well-kept, keen-edged tools, and there is something absolutely fascinating in transforming plain pieces

of wood into various useful and ornamental articles.

There is no mystery about making wooden articles, nothing difficult; and no complicated principles are involved in simple carpentry. Once the use of the tools is thoroughly mastered any person can make neat, attractive, simple furniture or can even construct good-sized buildings.

During the long winter evenings carpentry work will provide a never-ending source of pleasure and one can while away hour after hour at the bench while constructing useful and attractive gifts, repairing furniture or making the various fixtures for an indoors gymnasium. Out-of-doors carpentry is also a fine field for the amateur carpenter, and in making rustic furniture, plant-stands and boxes, lawn seats, summer houses, pergolas or even garages and workshops, there is room for a great deal of inventiveness, originality and individual taste, as well as a splendid opportunity for the amateur carpenter to exhibit his skill as an artisan in an enjoyable manner.

Although this volume has been prepared primarily for boys, yet it will prove equally valuable for many "grown-ups" who are not familiar with

the use of carpenter's tools, and even those who know how to use the tools will find much of interest and many useful hints in its pages. It is always wise to commence at the very beginning, and in this book the author has endeavoured to start at the A B C of carpentry and to cover the subject step by step from the simple matter of sawing off a piece of board to the construction of furniture and small buildings.

The illustrations are so numerous and so comprehensive that even without the text the amateur carpenter should be able to construct nearly every article described, but in each and every case the cuts have been supplemented by full and detailed directions for each step of the work. The drawings are more or less diagrammatic and no attempt has been made to reduce them to uniform scale. Where some particular point is to be illustrated that portion of the work has been made more prominent than others and out of proportion to the rest, but as exact measurements are given in the text in every case, scale-plans or drawings are not deemed necessary.

Every effort has been made to avoid technicalities and trade terms and complicated or intricate

work and elaborate methods have been purposely omitted, the object being to produce a book so simple, so complete and so practical that any person may readily accomplish excellent results in carpentry with this volume as his sole guide and teacher.

THE AMATEUR CARPENTER

CHAPTER I

TOOLS AND THEIR CARE

EVERY one will find a knowledge of carpentering useful and entertaining. About the house, out-of-doors, on the farm, or when camping out, there are always opportunities for the amateur carpenter to show his skill and his handiness with tools and lumber. Although any one can "knock together" some sort of a bench, box or shelves, yet to make a well-finished and presentable job requires a familiarity with tools and their use, as well as a knowledge of how to use the materials to the best advantage and how to accomplish the end in view with the least possible waste of labour and material.

There is a right and a wrong way to do everything, and if you once learn the wrong way it will be very hard to overcome mistakes and do things right, so let's start right in the first place. The old motto, "Be sure you're right, then go ahead," is a splendid slogan for the amateur carpenter.

There is also another proverb which you will

do well to bear in mind, and that is, "A good carpenter is known by his tools," for without good tools no one can expect to do neat and workmanlike carpentry.

One does not require many nor expensive tools in order to do ordinary carpentering, and a really good carpenter or joiner can accomplish wonderful results with only a few tools, but it requires more skill to turn out good work with a poor kit of tools than with a proper equipment, and time and money will be saved by having proper tools to start out with.

On the other hand, too many tools are almost as bad as too few, for if you have a large assortment of saws, planes, chisels, etc., you will be confused and will often select the wrong tool for the work in hand, to say nothing of the trouble of looking after and caring for them.

The really essential tools for an amateur carpenter are as follows:

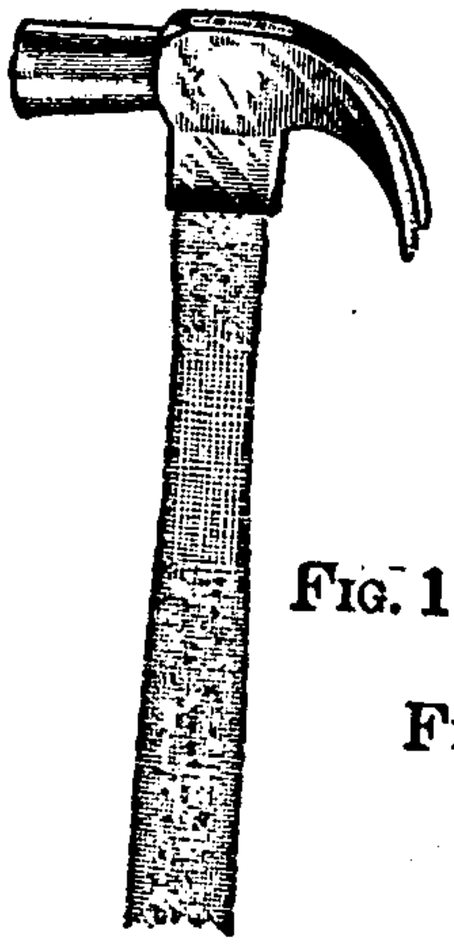
A claw-hammer
A cross-cut saw
A rip-saw
Two planes
A screw-driver
Gouges
A steel square
Rule or tape
A level
Sandpaper

A mallet
A brad-awl
A gimlet
A bit-brace
Bits
Augers
A countersink
Chisels
A keyhole- or compass-saw
A nail-set
An oil-stone
Cutting-pliers
Files
A carpenter's pencil

With these tools and an assortment of nails and screws one can make almost anything from a simple shelf to a house. There are many other useful tools which will greatly lighten your carpenter work and will add little to the expense, and among these are:

A saw-set
A carpenter's gauge
An expansion-bit
Clamps
A tack-hammer
A saw-vise
A bevel-square
A breast-drill
Dividers
A mitre-box
A hack-saw
A draw-knife
An iron vise
A plumb-bob and line
A mitre-saw

In selecting the tools it is poor economy to buy cheap or inferior things. The best carpenter in



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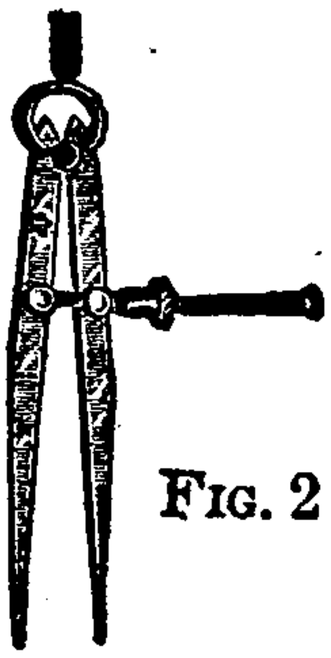

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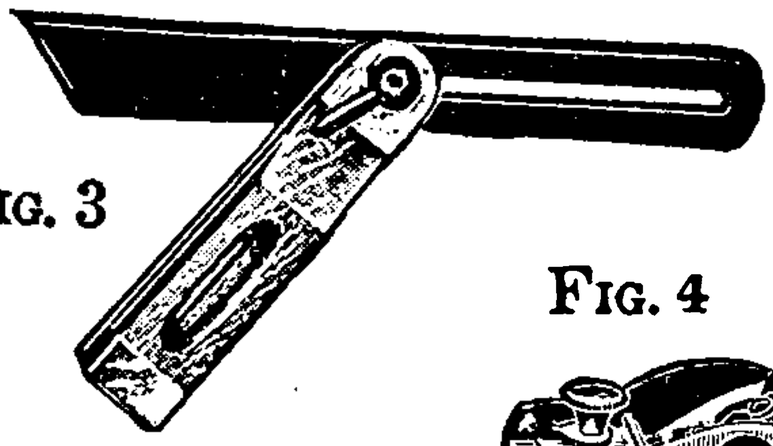

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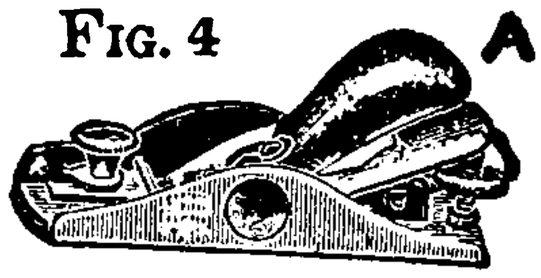

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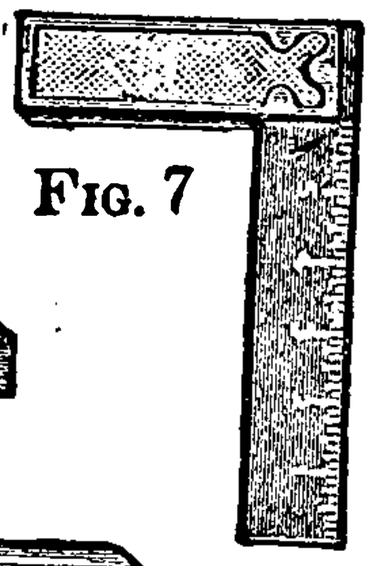

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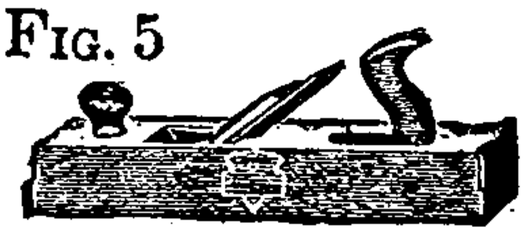

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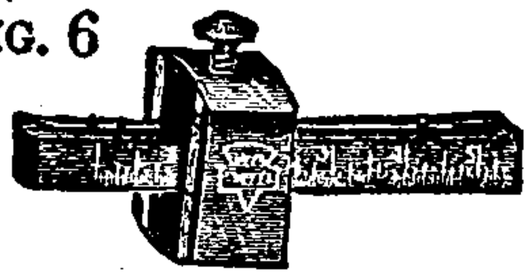

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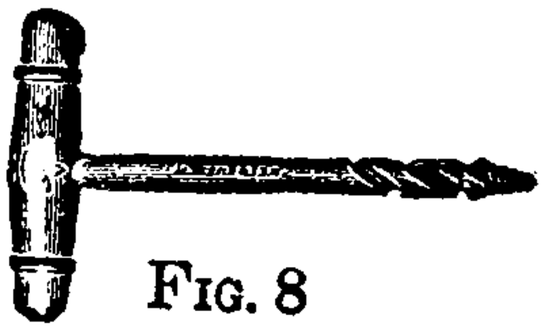

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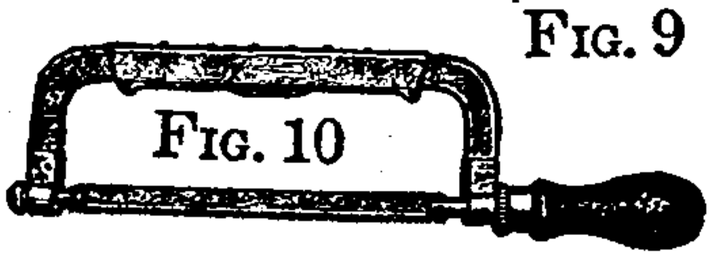

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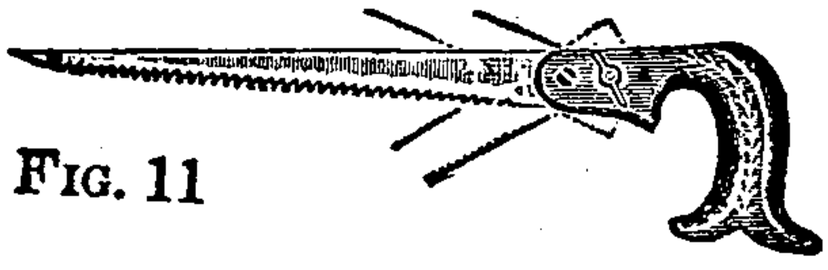

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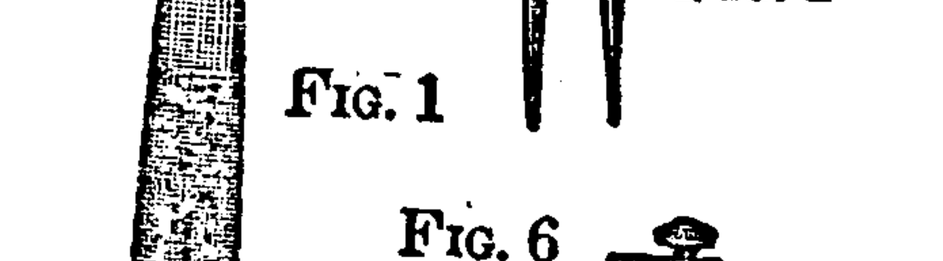

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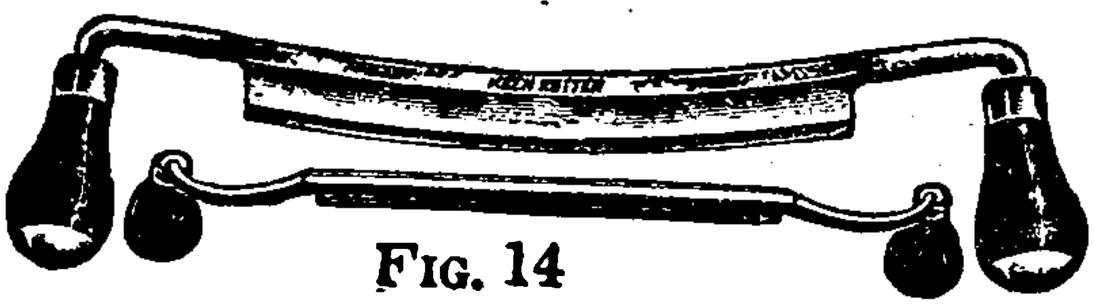

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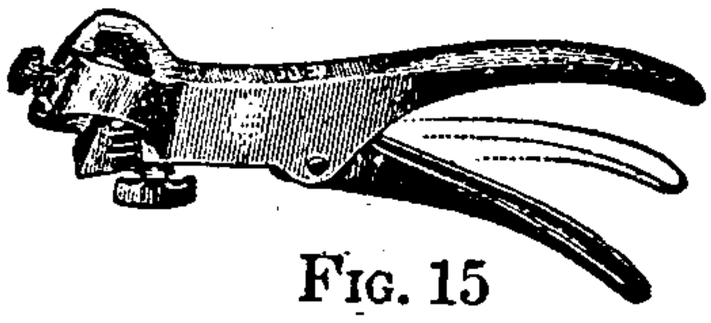

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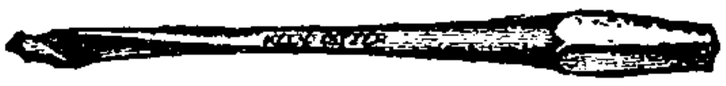

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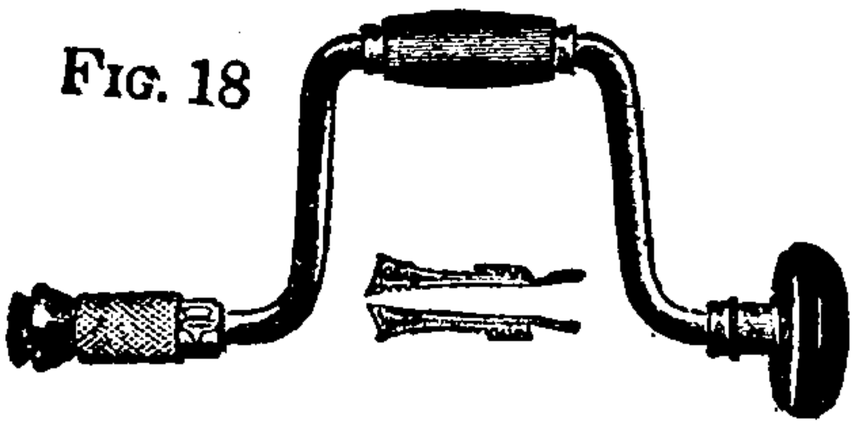

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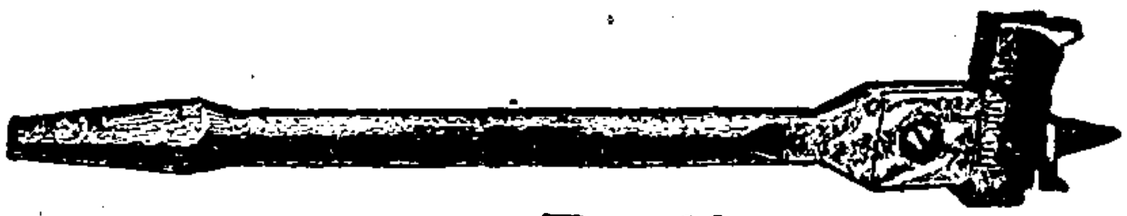

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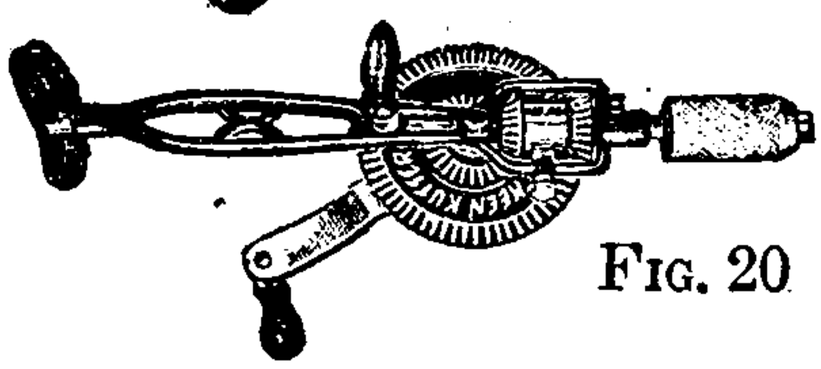


FIG. 20

the world cannot do good accurate work with tools bought in ten-cent stores or with the toy tools that come in boys' tool-chests. Now and then one may find excellent tools for sale at bargain prices at bankrupt sales, fire sales, second-hand stores, etc., and sometimes the five- and ten-cent stores have "seconds" for sale which will serve every purpose. In order to buy such tools intelligently one must be familiar with the makes and the quality and must be a really good judge of tools, and it is far wiser to go to some reliable dealer and purchase first-class, guaranteed tools, even if they do cost more in the first place.

The claw-hammer should be a strong, serviceable steel hammer; not a light tack-hammer and not too heavy. The cross-cut saw should be of medium size with fine teeth, of the kind known as a "panel saw," for if you are to have but one cross-cut saw it must be fine enough to cut thin wood and large enough to saw good-sized timbers. If possible secure two cross-cut saws, one large and fairly coarse, the other fine.

The rip-saw should be of good size and with medium teeth, suitable for ripping various kinds and sizes of boards, and until you are an expert and undertake heavy work one rip-saw will be all that you

will require. For the planes purchase a medium-sized jack-plane and a block-plane. Fore-planes, smoothing-planes, rabbet-planes and various other forms are very handy and useful for certain kinds of work, but with a good jack- and block-plane you can get along very well indeed.

The screw-driver should be of medium size, and if you can get one with extra interchangeable blades so much the better. The brad-awl should be small, and this is such a cheap tool that you will do well to have several or else purchase an awl with various-sized blades contained in the handle. Do not buy one of those combination affairs with miniature chisels, screw-drivers, gouges and what-not in the hollow handle. Most of these tiny tools are worthless and are merely a nuisance.

For the gimlet secure a real serviceable all-steel affair. One of $\frac{3}{16}$-in. size is about the best, but, as in the case of the awl, gimlets are so cheap you can afford two or three ranging from $\frac{3}{16}$ in. to $\frac{3}{8}$ in.

In selecting the bit-brace choose a really good one. A poor brace is an abomination, and as ratchet braces cost very little more than plain ones I advise you to buy one of this sort: you will find it

mighty handy many times. Plain bits will serve your purpose, but it is better to buy regular twist-drills with bit-stock shanks. With the drills you can bore holes without any danger of splitting the wood, and if you should strike a nail or screw the drill will go through it, whereas the ordinary bit would be ruined. The difference in the cost is slight and you will save money in the end by getting the drills. $\frac{1}{8}$ in., $\frac{3}{16}$ in., $\frac{1}{4}$ in., $\frac{3}{8}$ in. and $\frac{1}{2}$ in. are the most useful sizes. For holes larger than $\frac{1}{2}$ in. you will find augers most useful and you should add $\frac{5}{8}$-in., $\frac{3}{4}$-in., $\frac{7}{8}$-in. and 1-in. augers to your outfit. A single "rose" countersink will serve for all ordinary work. For the chisels select three, of say $\frac{1}{4}$-in., $\frac{1}{2}$-in. and 1-in. sizes, and be sure to buy the regular, straight-edged carpenter's style and not the slanting or diagonal-edged type used for special purposes, turning-lathes, etc. Three gouges of the same width as the chisels will be enough. The steel square should be of the 2-ft. size, for you will find the large square far more useful in general work than a small one. Either a folding pocket rule may be selected or a good strong tape, but personally I advise the rule, although it is an excellent plan to provide both.

The level may be of wood or steel and should

have both a horizontal and a vertical glass. The nail-set, sandpaper and pencil need no description, but in selecting the compass- or keyhole-saw be sure to get a really good one. A poor, soft tool of this sort is more trouble than it is worth, while one that is too stiff or too brittle will be almost as bad. Buy an oil-stone that is wide enough to take your widest chisels and plane-irons and select one that is of fine, keen grain. The so-called "India stones" are probably the best for all-round use. For pliers purchase either a pair of round-nosed, a pair of flat-nosed and a pair of regular cutting-pliers or else get a combination pair of flat-nosed and cutting-pliers and a separate round-nosed pair. For files you will require a half-round wood-rasp, a flat or half-round bastard, a rat-tail file and a three-cornered saw-file.

If you can afford the additional tools mentioned select them with equal care. The saw-set and saw-vise are very useful and will save a great deal of time and expense in sharpening saws, although they are not essential for some time to come. The expansion-bit is a mighty useful tool, for with it you can bore holes of various sizes, and as by its use you can do away with the augers, the additional expense will be nothing. A couple of small

iron clamps cost little and will prove very useful, and the tack-hammer, which is also inexpensive, will come handy in driving small nails, brads, etc. The bevel-square is almost a necessity in many kinds of work, as are the dividers or compasses, and both tools are cheap. The breast-drill will often be useful, especially for boring small holes in wood and sheet metal, and a small-sized, efficient drill of this sort costs very little. The same is true of the hack-saw. You will often have occasion to trim off small pieces of thin wood where your finest cross-cut saw would not serve, but where the hack-saw will be just the thing. In addition, if a nail, screw or other piece of metal must be cut the hack-saw will do the work readily, and as a good hack-saw frame and a dozen blades may be purchased for one dollar there is no reason why any amateur carpenter should do without them. The draw-knife will save heaps of time in "roughing out" work and in planing, for it is a useful tool, especially if you attempt large work. The iron vise will also prove valuable in straightening out bent nails, working pieces of metal, hinges, or other hardware and in a thousand-and-one other ways. Large vises are expensive, but for our purpose a cheap vise, with 2- or 3-inch jaws, will

answer very well. The plumb-bob and line will only be required if you attempt building work, for on ordinary carpentry the vertical level will serve every purpose. The mitre-saw, however, will prove a great help in combination with the mitre-box, but after you have learned a little about carpenter work you can make your own mitre-box and can even use your cross-cut saw at a pinch, although the mitre-saw will prove far more accurate and useful.

Almost as important as the tools themselves is their care. A good workman always thinks of his tools and keeps them clean, sharp and free from rust. If you throw your tools about, drop them on the floor, walk over them or use them for purposes other than those intended, your tools will soon be worthless and you will find that you cannot do good work and will become disgusted with carpentering. Unless you are willing to look after your tools, keep them sharp and put them away each time you are through with them, don't attempt to do any work and don't buy the tools:—it will merely be a waste of time and money.

You will not need an expensive tool-chest for your tools, and one of the first things you can make is a little carpenter's tray or box for carry-

ing your tools about as you work, but the most important thing, now that you have the tools, is a workbench. You can purchase benches already made, but this is not necessary, for it is a very simple matter to build one, and for a first lesson in carpentry a bench is an excellent subject. Even while constructing the bench you will require something upon which to work; and an old, stout table, some old chairs with planks across them, two saw-horses and a plank, or even the tub-bench from the laundry will serve your purpose temporarily.

Before you commence work you must find some place to put your tools, where they will be within easy reach, and you must also select the spot for your workshop and for your bench.

After the bench is made it will be an easy matter to arrange a place for everything, but while you are making it you will have to hang your saws, brace, square and similar tools on nails driven in the walls or timbers, and can arrange the planes, augers and other tools on shelves or boards. If you have a large, dry, clean cellar with plenty of light you may convert a part of it into a shop or you can use the garret, a vacant room or some outbuilding. Even a small carpenter's

shop is a noisy place at times and sawdust and shavings are sure to be tracked about; so avoid a garret or a room in the house, if possible, or your family will soon be sorry that you ever became interested in carpenter's work.

CHAPTER II

HOW TO MAKE A WORKBENCH

In order to construct your bench you will require some 2 x 3 scantling, either rough or finished, and some 6- or 8-in. planks. Although your bench will not have to be very large or heavy, still it must be strong and solid enough to be steady, and 2-in. planks should be used. If possible obtain planks that are finished, at least on one side, for it is a hard job to plane them until after the bench is completed, and the finished boards cost very little more than the rough ones.

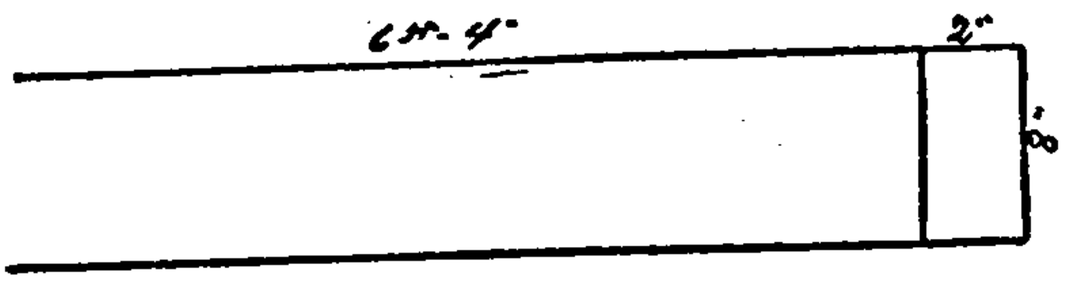
A good size for your bench will be 6 ft. 6 in. long by $2\frac{1}{2}$ ft. in height and 32 in. wide. This will be large enough for your present use, and later on when you undertake larger work you may easily build a bigger and better bench if you wish.

For the bench you will need about 30 running feet of the scantling and about 75 ft., board measure, of the planks. As the latter are to be 2 in. thick the boards will only cover about 38 sq. ft.

of surface, so do not be surprised at the amount you receive.

With your ruler measure off four spaces of 2 ft. 4 in. each on the scantling, and with the square mark lines across at each space on two sides of the timber. If you have never used a square before you will have to learn how, and this is a good place to begin. Place one edge of the square along the edge of the timber, as shown in Fig. 1, with the edge at right angles across the mark you have made on the wood, as shown in the cut, and with your pencil draw a straight line across the timber from side to side. This little detail is quite important and is all too often overlooked by amateur carpenters. You may *think* you can rule a line across a piece of wood so it is at right angles to the edge and you may *think* you can saw straight, but there is no one living who *can* draw a line at right angles to another by eye alone, and mighty few men who can saw a straight line without a mark to guide them. Unless you acquire the habit of always using a square and invariably making straight right angles where boards or timbers are to join to form a square corner you will never succeed at carpenter work. If even one board or timber is not squared up properly the whole work

will be skewed and slipshod, all of which may be easily avoided by using a little care and taking a little trouble to begin with. Get in the habit of being careful with little things and you will find that the results come out wonderfully well, but



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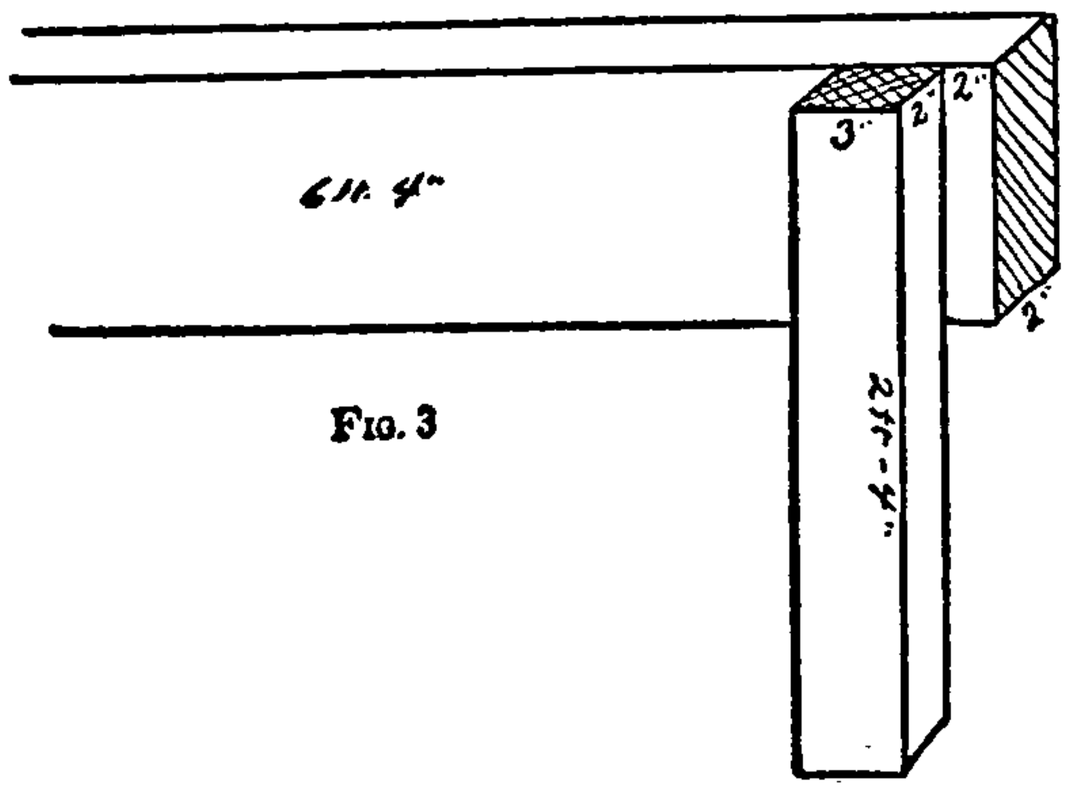

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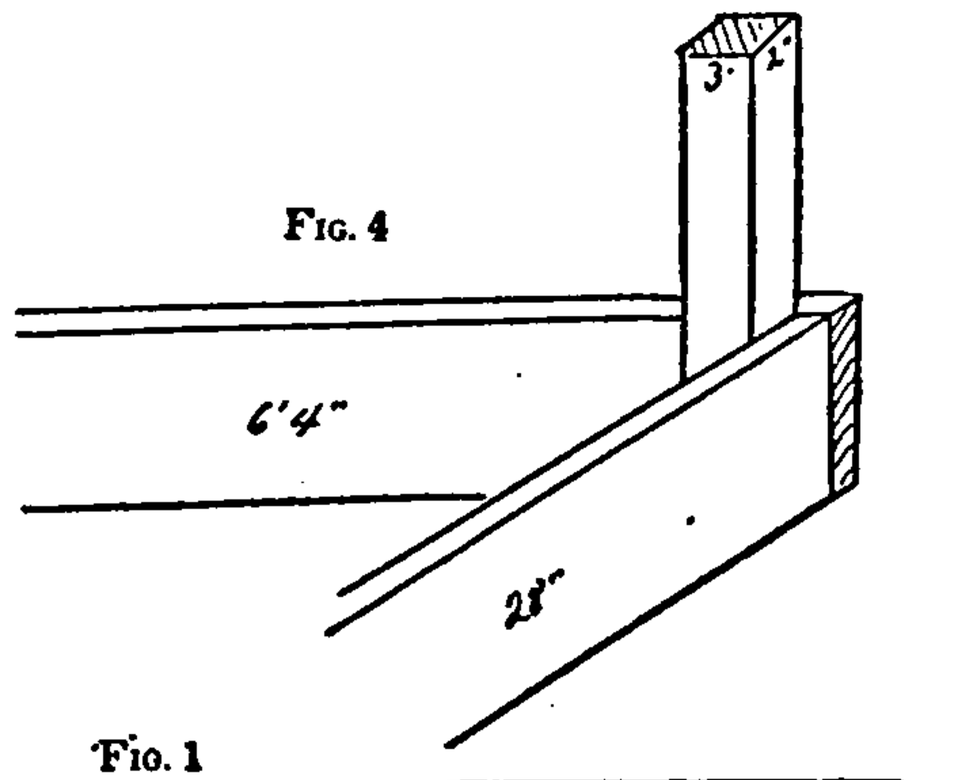
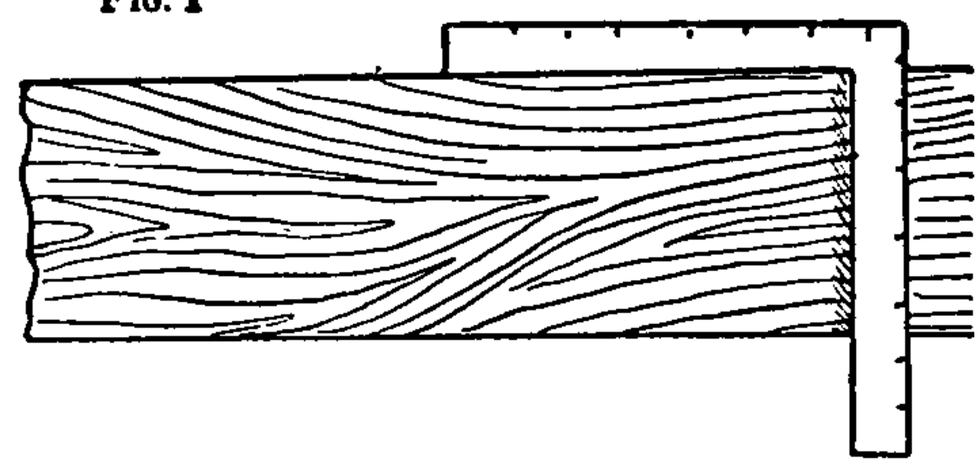


Fig. 4

Fig. 1



neglect the small details and you will never succeed.

Having marked off the four sections, place the timber across the saw-horses or chairs and arrange it so but one of the sections projects beyond the edge. Place your right knee on the timber above the end of the horse or chair, grasp your cross-cut saw in your right hand and starting it with short, gentle strokes across the pencil mark at an angle, begin to saw with long, steady strokes. You may laugh at such detailed directions for per-

forming such a simple feat as sawing off a piece of scantling, but not one person in a hundred knows how to use even a saw properly. Nine times out of ten they waste strength and energy by bearing too heavily on the saw or by working with short, quick strokes until they look like a steam pump going up and down, and when the saw is nearly through the wood the outer end sags, cracks and drops down with a big splintered piece hanging to it. Remember that only on the downward stroke is any work done by the saw; draw it up smoothly without bearing on and do not bear *too* hard as you push it down. The saw will bite through the wood almost as fast with a slight pressure, or none at all, as when you bear on hard, and the cut will be much straighter and better. When the saw is a little more than halfway through the timber place your left hand beneath the projecting end and support it slightly so it will not fall down and split the lower part of the wood.

After a little practice you will be able to follow a line very accurately and will also be able to keep your saw running true, and only one line will be required across the wood you are cutting. At first you should mark the lines on at least two sides of the timber and should watch the saw

carefully to be sure it is not running off at a slant or angle. Oftentimes a saw will stick and bind when sawing rough spruce timber. If this occurs rub some ordinary laundry soap on the sides of the saw; oil will soak into the wood and will do little good, but soap will make the saw run smoothly and easily.

The four short sections having been cut off, next mark and cut two pieces each 6 ft. long and two pieces each 32 in. long. Then from your planks cut two pieces each 6 ft. 4 in. long and two shorter pieces each 28 in. long. You may now lay aside the saw for a time and busy yourself with hammer and nails in putting the framework of your bench together. To join the various pieces you will need several pounds of nails. Wire nails are the best, and those you will require should be 4 in. long, or just a trifle less, with a few 5 or 6 in. in length. Select one of the pieces of plank 6 ft. 4 in. long, and at each end measure off exactly 2 in. and draw a line at right angles to the long edge and parallel with the ends by means of the square, as shown in Fig. 2. Take one of the pieces of timber 2 ft. 4 in. in length and place it on the board with the 3-in. side down and with one edge close against the line on the plank and with the

end flush and even with the edge of the plank (Fig. 3). Hold it in this position and tack it to the plank with a couple of nails. If you wish you can drive the nails almost through before placing the piece of timber, and you will probably find this the easiest method, for the timber is apt to jump about while you drive the nails, and unless you use care you will accidentally fasten it in the wrong place. After this first piece is nailed in position fasten a similar piece on the other end of the plank and then turn the plank over and drive two or three nails through the plank into the timber, using nails of the 4-in. size.

Lay the plank with the two legs aside for a few minutes and fasten two more of the 2-ft. 4-in. timbers to the other 6-ft. 4-in. plank. Now place one of the planks, with the legs, edge down on a level place and with the legs sticking up in the air, and nail one end of one of the 28-in. pieces of plank against the outer edge of the leg as shown in Fig. 4. Nail a similar piece to the other leg and also drive a few nails through the end of the long planks into the end of the short ones as shown in the cut. The long plank will now stand without your help, resting quite firmly on the two short planks. Bring the other long plank with the legs,

place it so that the free ends of the short planks bear against the outer edge of the legs and the ends of the long plank, and secure it with nails in this position. You will now have a rectangle of 2-in. planks with a leg sticking up at each corner like a low wooden fence with four posts. Mark off 6 in. from the free end of each of these projecting timbers and square a line across with the square. Across these lines nail the four remaining pieces of scantling, being very careful to have one edge straight and close to the lines you have marked, and when they are all in place the frame will be complete and will appear as in Fig. 5.

You will be surprised to find how stiff and rigid it is, provided the joints have all been made true and square, and you can turn it upside down, or rather right side up, and proceed to nail on the top.

Cut four pieces from your planks, each exactly 6 ft. 6 in. in length, and with the ends true and square. Place these on top of the frame with one end just even with the end of the framework and with the other projecting 2 in. beyond it. See that the end squares up with the end plank on the frame and with the edge of the long plank and nail it firmly in position, driving the nails

along the front edge as well as across the ends. After you are accustomed to carpenter work you will be able to judge distances so well that you can

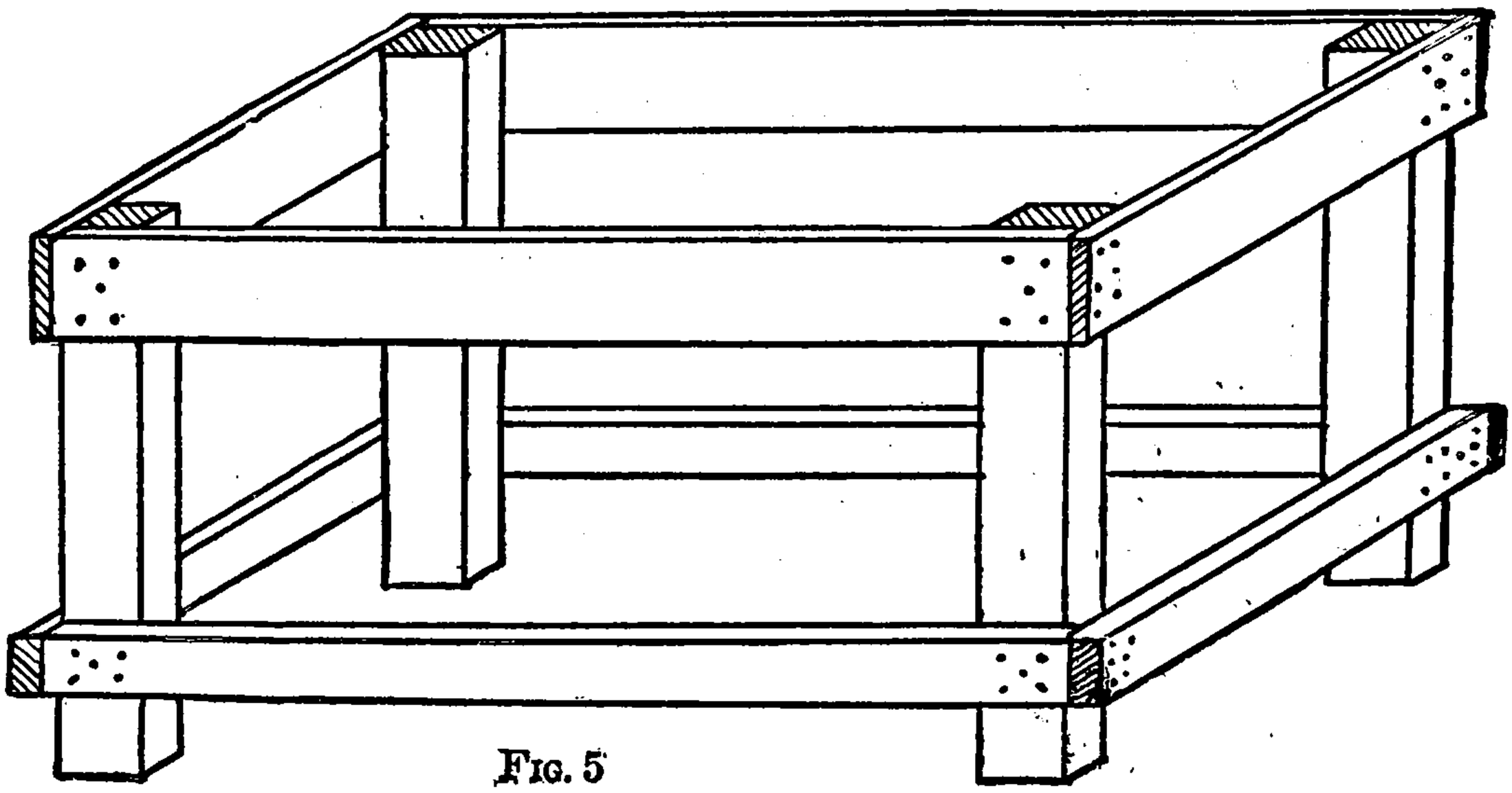
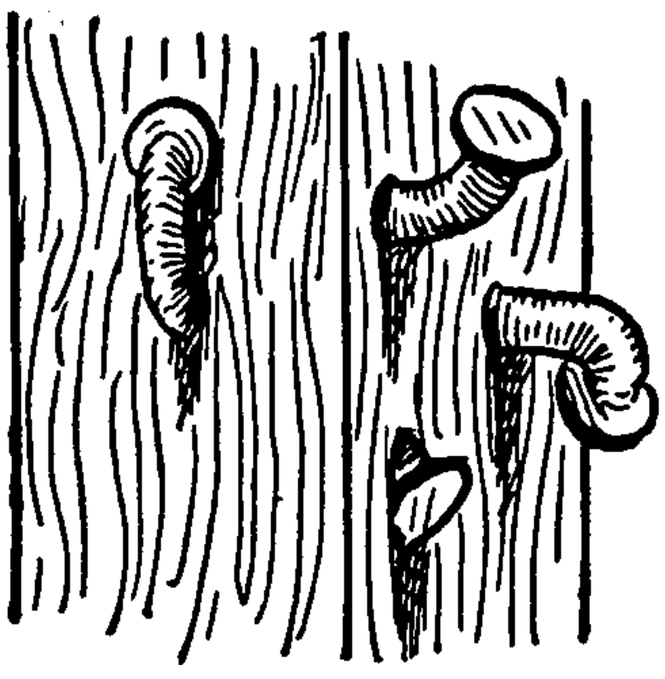


FIG. 5

FIG. 6



drive a nail down through a board into a board or timber out of sight, but at first you will not be able to strike the spot once in a dozen times. You must therefore measure off 2 in. from the end of the plank on the upper surface where it projects beyond the frame, and then drive the nails down

an inch beyond this line, thus making sure that they will enter the centre of the plank below. Nail all the top planks to the framework in this way, and then go over the nails with the nail-set and drive them down until the heads are well below the surface of the wood. Probably you know how to drive a nail, and I have taken this for granted, but even driving a nail properly requires some skill. Any one can hammer and whack away at a nail and finally get it into the wood. It may go straight and it may go crooked, and oftentimes it will buckle and bend and turn into a "Dutchman," as boat-builders call it, and will be driven into the wood with its head bent to one side and hammered down as shown in Fig. 6. Such a thing is an eyesore and a nuisance. If the nail starts to go crooked or to bend over, pull it out and try another. If the wood is hard, knotty or cross-grained, bore a hole smaller than the nail before driving it. In most cases, however, the fault lies with the man or boy or with the hammer rather than in the wood or the nail. A crooked, chipped, loose-headed or poor hammer will usually result in crooked nails, bruised fingers and loss of temper, but even with a perfect hammer some knack is required to drive a nail properly and

well. Start the nail by holding it between your finger and thumb and give it a few short taps of the hammer. As soon as it is firmly set in the wood strike hard, solid blows squarely on the head. Hold the hammer handle near the end, not near the head, and after the nail is flush with the wood give another tap to slightly sink it beneath the surface. On finished wood or delicate work this last blow should be omitted, but on rough, heavy work or unfinished wood, such as your bench, a good strong final whack will drive the head quite a bit beneath the surface of the wood.

After the top of the bench is secured in position and the nails are all set beneath the surface, go over the bench and add a few of the long nails where the lower timbers meet at the ends and where they cross the legs, and drive a few more down through the top planks into the upper ends of the legs. You do not need to fill the planks and timbers with nails or to drive them so close together that they split the wood, but a few of the large nails will greatly strengthen the bench if placed with a little judgment.

Before your bench is complete you should nail a piece of the 2 x 3 timber along one edge, and in doing this place the timber at the further edge

when the projecting end of the top is at your right hand. This little 3-in. rail along the rear of your bench will prove very useful, for without it things will be continually dropping down behind the bench and getting lost.

The bench proper is now complete, and if you have been careful to follow directions and to square up all the corners and cuts you will find that it is stiff, steady and firm. If it wiggles or tips, test the floor to see if it is truly level before you blame the bench or your work. This is easily done with your level. Set the level along the floor with the glass uppermost and see if the bubble swings back and forth and finally rests exactly in the centre of the tube at the line marked on the glass. Try the level first in one direction and then in another over the floor, and if you find the bubble ever rests at any other spot except the cross-line, you may be sure the floor is not level. In this case you will be obliged to nail a piece on the floor under the leg or legs of the bench to prevent it from tipping, but this is seldom necessary.

CHAPTER III

FITTING UP THE WORKSHOP

BEFORE your bench can be used to advantage it will require several fixtures. The most important of these is a carpenter's vise or bench-vise. This is a device consisting of a piece of strong wood extending from near the floor to the top of the bench and so arranged that it can be closed tightly like the jaw of a vise by means of a large screw and handle. The vise is used for holding boards, timber, etc., while working, and is a very useful and necessary appliance.

The jaw, screw and other parts may be purchased of any dealer in carpenter's tools, and can be attached to the bench in a few minutes. Another attachment which will prove of great value in holding wood while planing is a bench-plate. This is a small metal plate set flush with the top of the bench and with a notched or toothed movable centre, which can be raised or lowered and against which the end of a board is placed when planing it. A bench-plate is not by any means essential, however, for a strip of wood

tacked to the bench will do fully as well. If you have an iron vise it should be fastened near the outer corner of the projecting end of the bench top.

Many carpenter's benches are fitted with drawers and box-like ends in which tools, nails, etc., are kept, but this is objectionable, as the drawers and trays are always becoming littered with shavings and sawdust, and it is troublesome to find an article among the trash.

It is far better to keep your tools outside of the bench and to have your nails, screws and other small articles assorted in boxes on top of the bench or on shelves close at hand.

Now that your bench is complete you should prepare a place for all your tools and in doing this you will have occasion to use many of them and will thus have a good opportunity to become familiar with them.

After you have become a good carpenter you may amuse yourself making a splendid tool closet or chest, but for the present this is not at all necessary. The tools may be neatly and conveniently arranged on and about the bench, and for working outside of the shop a carpenter's tray may be made to hold the tools you wish to carry about.

If the shop has wooden walls or a partition behind the bench, it will be an easy matter to arrange the tools, but if not the first thing is to put up some boards behind the bench, as well as some shelves. Ordinary $\frac{7}{8}$-in. cheap lumber, known as "fence stuff," will do well enough for this work. It is very nice to work with clear, straight-grained, beautiful wood, but good clear wood is expensive and it is a shame to waste it for purposes where poor or cheap material will do just as well. Square off two or three boards, each 6 ft. 6 in. long; the number you will require depending upon the width of the boards. If they are 8 in. wide you will need three boards, while if but 6 in. wide you will want four, the idea being to have an aggregate width of 24 in. Nail these firmly to the wall behind the bench, placing the first and lowest board with its lower edge just even with the little ledge on the rear of the bench and with the boards above fitting close to one another, edge to edge. See that the ends all come even and flush. Now select a piece of board 8 in. wide by $\frac{7}{8}$ in. thick and cut it true and square, 24 in. long. With your rule and square, mark off 2 in. from one edge at one end and 2 in. from the opposite edge at the other end, and, with the long side of your square as a straight-

edge, draw a diagonal line from one of these marks to the other (Fig. 1). With your cross-cut saw, saw through this line, and to do this you will find that your bench-vise will come in handy, for the short board may be conveniently held in the vise when sawing. Let me call attention to one very important detail which you should always remember when planing, sawing, whittling or cutting wood, and that is cut *with* the grain. In Fig. 2 this is plainly illustrated by the sketch, which shows two pieces of wood with lines indicating the grain. If you saw or plane in the direction indicated by the arrows marked *right*, the tools as they pass along will have a tendency to hold or press the fibres of the wood together and prevent them from splitting or chipping up, whereas if the tools are moved in the opposite direction, as indicated by the arrows marked *wrong*, the tendency will be for the fibres of the wood to split, chip and spread apart; the plane will become choked, the saw will run crooked, and you will have no end of trouble. In most wood it is an easy matter to see which way the grain runs, but in some kinds of timber it is hard to determine it without trying. In such cases run a plane along the edge gently, and you can at once determine by the result which

way the grain runs. In many pieces of wood you will find that the grain runs in various directions on the different parts of the same piece of lumber. Such cross-grained or curly-grained wood is hard

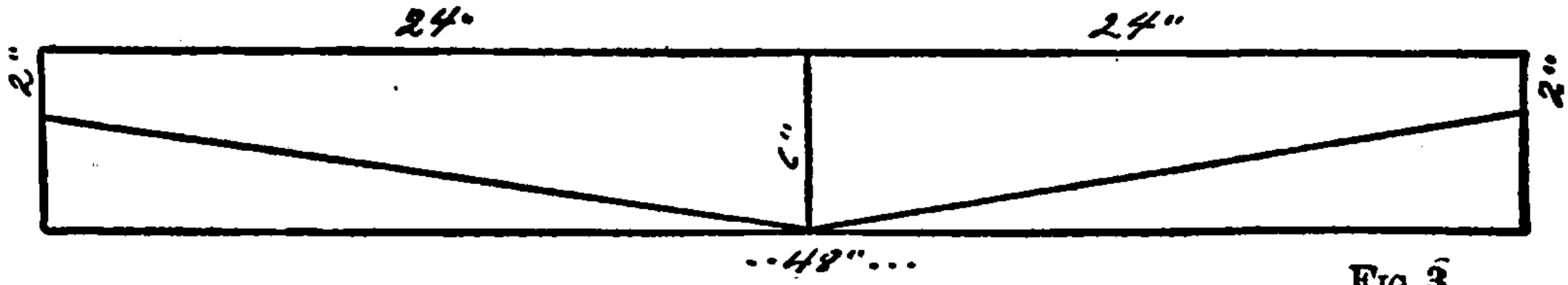


FIG. 3

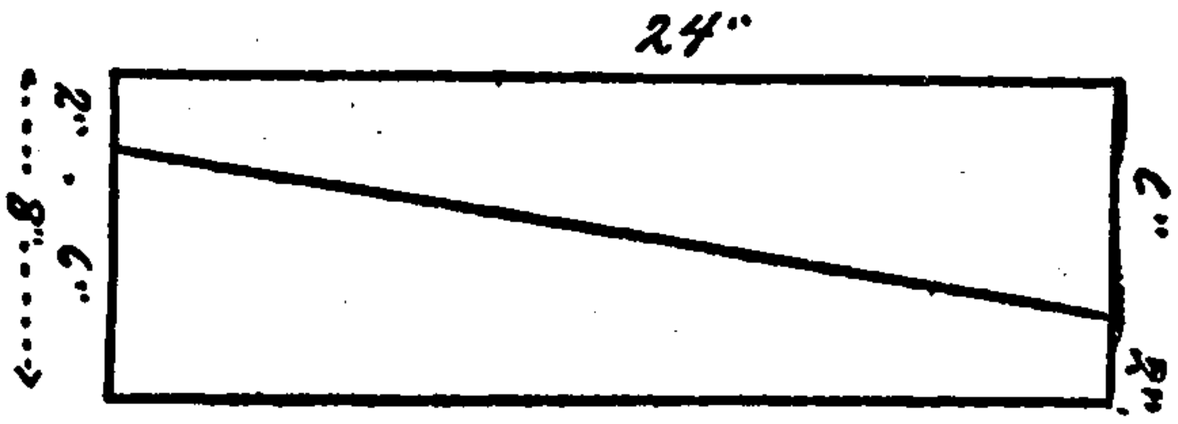


FIG. 1

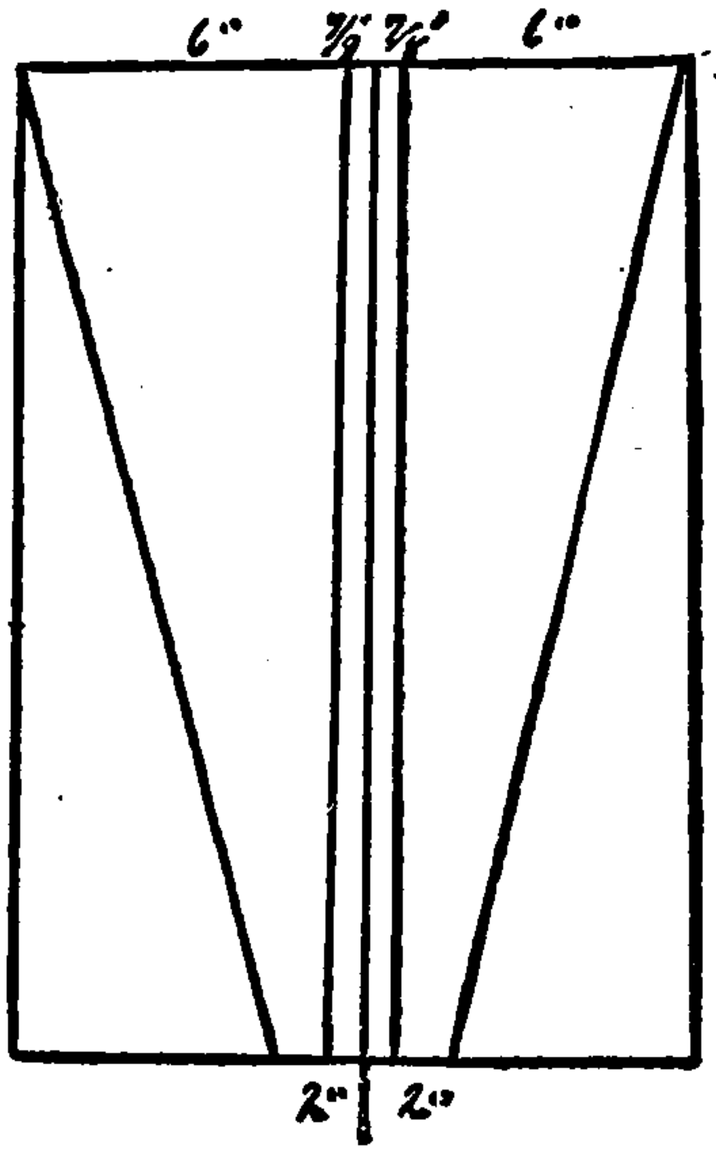


FIG. 5

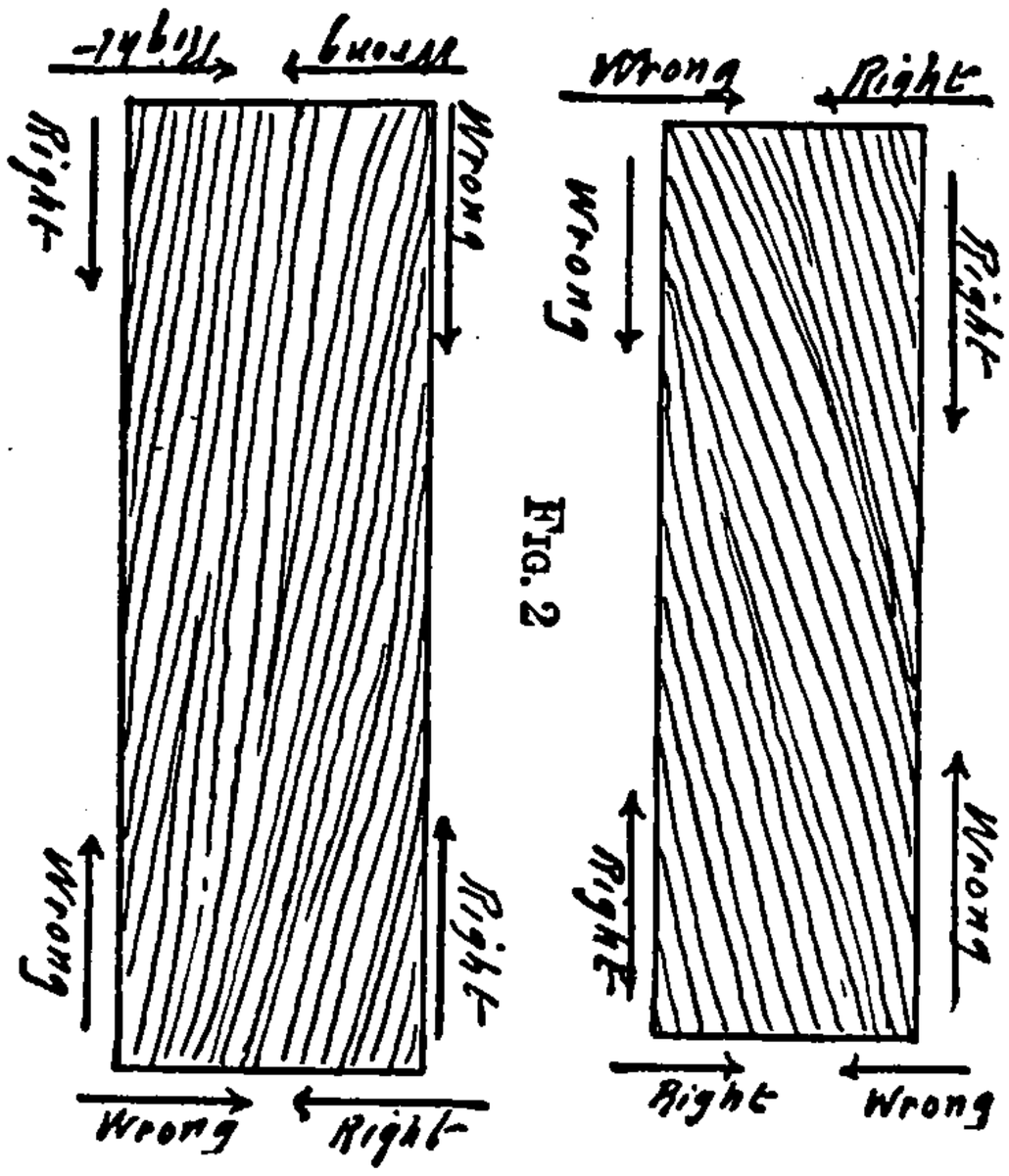


FIG. 2

to work and the only way to secure good results is to use very sharp tools, work slowly and carefully and take off small shavings each time.

But to return to our work. If you should not have a piece of board 8 in. wide you will have

to use 6-in. stuff for making the two pieces mentioned. To do this cut a piece 48 in. long, mark a line square across it exactly in the centre, mark off 2 in. at each end on the same edge and draw a line from each of these marks to the centre line at the opposite edge (Fig. 3) and saw along these two lines, and finally cut the board in two at the centre line.

Up to now you have not had occasion to use your planes, but this is a good time to begin. Select either one of the wedge-shaped boards you have cut, examine it to see which way the grain runs, and clamp it firmly in the bench-vise with the diagonal edge up and a few inches above the bench-top and with the grain *running away from you as you stand facing the end of the bench with your right side towards the vise.* Now take the block-plane in your right hand, clasping it firmly back of the projecting upper end of the blade and resting your left hand lightly on the forward end; place the plane squarely and evenly on the edge of the wood and push the plane forward, bearing down lightly on the wood. If, as the plane runs along, it takes off a clean, smooth, thin shaving your plane is set properly, but the chances are the blade will be either set too little or too much. If you ex-

amine the plane you will see a little lever or a thumb-screw under the blade (Chap. I, Fig. 4 A). By turning this slightly to left or right the blade will be drawn further in or pushed farther out from the plane and will consequently cut more or less at each stroke. Quite a little practice and experience is required in order to know just how much to set the blade, and it is a good plan to practise on some waste material before attempting to plane a piece of cut board that you intend to use. If the iron projects too far the plane will gouge into the wood, will stick, will cut big, thick chips and will soon become clogged. On the other hand, if the blade is not set enough the shavings will be small and very fine and thin, and your plane will have little effect on the wood. Moreover you will find it necessary to set the plane differently for different woods and for various kinds of work. The plane cannot be set as much when planing *across* the grain as along it, and for hard woods it must be set less than for soft woods. Having tried various adjustments of the plane on a piece of waste lumber, until the plane leaves a smooth even surface behind it and takes off a thin, curling, fine shaving, proceed to smooth off the rough saw marks from the edge of your wedge-

shaped boards. Endeavour to run the plane in long even strokes the whole length of the edge, for if you take short strokes and finish one part of the wood at a time the edge will be wavy and irregular. When the edge is smooth run the plane once or twice along each corner to take off the sharp square edges and to leave the edge slightly rounded, as shown in section in Fig. 4. Now place the two pieces with the diagonal sides opposite and the straight edges together, as in Fig. 5, and measure off a space $\frac{7}{8}$ in. from the straight side of each and draw a line from top to bottom, as shown in the cut. Lay the two pieces aside and from a piece of 2-in. plank cut two strips 1 in. wide and 24 in. long. To do this measure $2\frac{1}{8}$ in. from the edge of a 2-in. plank at frequent intervals and run a straight line through the marks with a ruler or the straight edge of your square. Then with your rip-saw, saw down this line, being sure to cut *with the grain*. In using the rip-saw, place the board to be cut with a foot or so projecting beyond the support, such as a bench, horse or other object; place your right knee on the board with your face towards the projecting end and with the mark to be sawed at your right. Start the saw slowly and carefully and then with long,

steady strokes, using scarcely any pressure, saw along the line. When nearly at the support move the board further forward and proceed until the desired length of cut has been made. It is far easier to make a true, straight cut with a rip-saw than to cut squarely with a cross-cut saw, and you will be delighted at the rapid, business-like manner in which your sharp new saw eats through the wood. If the cut is long you may find that the saw binds and sticks and in this case push little sticks or wedges into the cut behind the saw as you proceed. This will keep the two sides of the cut apart and prevent the saw from binding, but be careful not to use wedges that are too thick nor to push them in too far or hard or you will split the wood ahead of the saw or cause the saw to run off to one side. Also remember that the cut made by a rip-saw is quite a bit wider than that made by a cross-cut saw, and hence allow for this when laying out work and marking wood to be ripped. The two pieces you require may be cut out separately from a short plank or they may be cut as a single strip 4 ft. long and then sawed in two. If the plank from which the pieces are cut is but 2 ft. long or a trifle longer, it may be secured upright in the bench-vise and sawed in this posi-

tion, which will perhaps prove easier than sawing it supported on a bench or horse.

When the two strips are sawed out, clamp one of them in the vise with the grain running *away from you when your right hand is towards the bench*, and with your jack-plane smooth off the rough saw marks and splinters. In using your jack-plane you will have to adjust the blade exactly as you did that of your smoothing- or block-plane, but for the first smoothing with a jack, the blade can be set more than for the finishing with the block-plane. As soon as one edge of the strip is smoothed turn the next edge uppermost, being careful to examine the grain to see which way it runs, and thus smooth off each rough edge in turn. When this is done go over them again with the block-plane, but *do not* round the edges as on the diagonal piece described. Leave all but one edge sharp and square, but smooth one of the four corners off at an even, smooth slant or bevel, as shown in Fig. 6.

Now place these pieces side by side on the bench with the bevelled edges together and the 2-in. sides uppermost and the ends flush and even, and measure off three spaces, making the first mark 6 in. from the end, the next 6 in. from the first, the third

6 in. from the second, thus leaving a space of 6 in. at the other end (Fig. 7*a*). With the straight edge of the square or a rule, run a line down the centre of the sides of the pieces marked so that each piece appears as in Fig. 7*b*. Clamp one of the pieces in the bench-vise with the marks

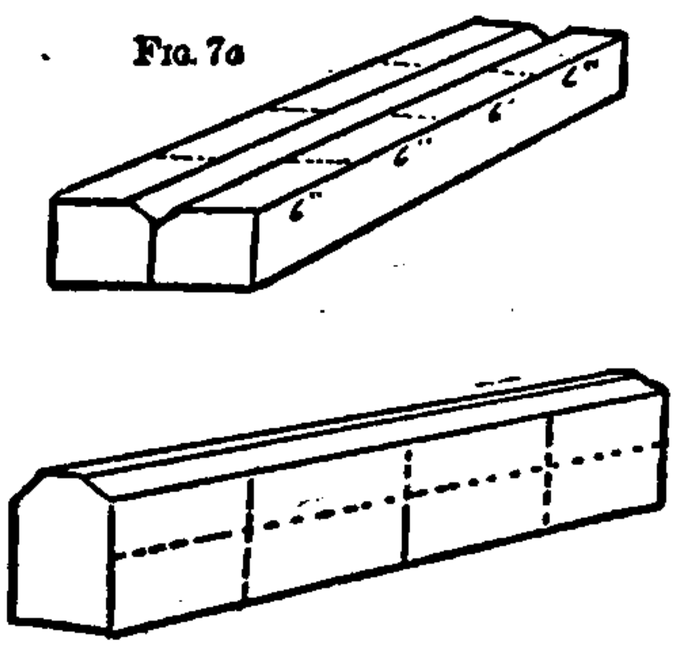


Fig. 7a

Fig. 7b

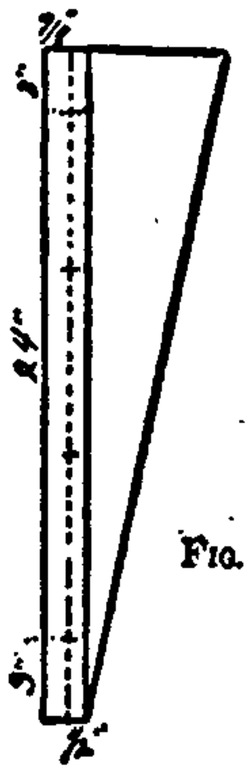


Fig. 8

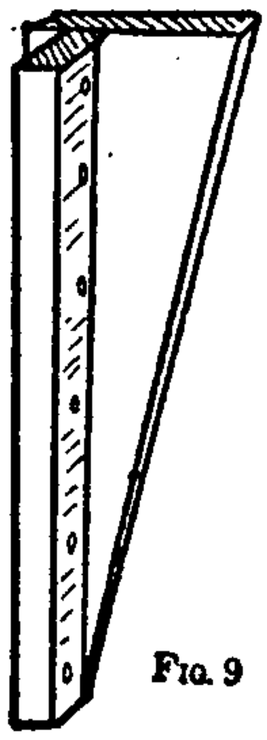


Fig. 9

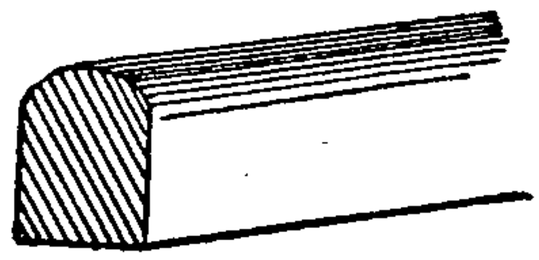


Fig. 4

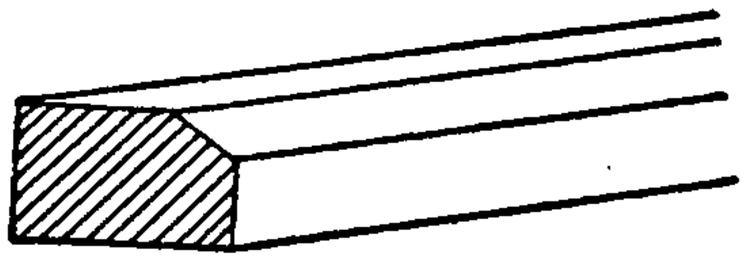


Fig. 6

towards you and just above the jaw of the vise. With a $\frac{1}{4}$-in. bit or drill bore through the strip at each of the intersecting lines, being careful to bore straight and true, and repeat the operation with the other strip.

Next place your countersink in the brace and ream out the holes *where they enter the marks, but not on the opposite side.* The next step is to mark a line along the wedge-shaped boards from top to bottom just $\frac{1}{2}$ in. from the line already made $\frac{7}{8}$ in. from the straight edge, and on this new line make four dots or crosses,

the first being 3 in. from the lower end of the board and the next three 6 in. apart, as shown in Fig. 8. Bore $\frac{1}{4}$-inch holes at each mark and ream out the ends at the marks with the countersink. With your square, mark across each end of the board from the line that is $\frac{7}{8}$ in. from the edge. Place one of the strips in the bench-vise with the bevelled edge down and the countersunk ends of the holes towards you. Place one of the wedge-shaped boards on the strip with the diagonal edge towards you and the countersunk holes uppermost and arrange it so that the *inner edge of the strip is true and flush with the marks across the ends of the board* (Fig. 9). Holding it in this position insert 2 in. x $\frac{1}{4}$ in. wood-screws in the holes of the board and screw them into the cleat beneath. In order that they may run true and straight and to make the work easier you should insert the brad-awl or one of the small gimlets in each hole before inserting the screws, and mark the spots in the strip in the vise. Then lay the board aside, and with the brad-awl, or a fine gimlet or drill, bore an inch or so into the strip at the marks made by the awl. It will then be an easy matter to start the screws. Repeat this operation with the other strip and board, and if

you have done the work correctly the two boards will have the two strips on the inner sides of the wedge-shaped pieces when placed side by side with the bevels together. The next thing is to put up these brackets, for that is what they are. This is an exceedingly easy and simple matter, for it is only necessary to place one at one end of the boards above your bench, with the straight rear edge fitting neatly over the ends of the boards, and screw the cleat firmly to the boards through the holes already provided. If you have put up the boards carefully the two brackets will be even and equidistant from the floor and bench, but it is a good plan to measure from the floor to the brackets to make sure before screwing the second one in position. The brackets in place, all that remains to do is to saw a board 6 ft. 8 in. long and 6 in. wide, plane off one edge and round the corners and fasten this on top of the brackets by screws or nails driven down through the top. As the upper ends of the brackets are even with the upper edge of the boards fastened to the wall, the shelf will cover these edges, and if a few nails or screws are driven through the back of the shelf into this board it will make it very strong and rigid. You may now arrange your tools, and in

doing this you must use your own judgment and ideas to a large extent. You will find the shelf very useful for small tools, papers, odds and ends, boxes of nails, etc. Beneath it, on the boards, nails may be driven for hanging up braces, squares and various other tools. On the sides of the brackets you may place nails or hooks to hold the saws. For your bits, drills and augers you may use a block of wood with holes drilled into it, but a better plan is to bore a number of holes through a long strip of wood and screw this to the boards back of the bench. Then arrange the varions drills and augers in this in regular order, and when they are all in position mark the size of each on the wood over the hole. This will be a great time-saver, for you can always tell just where each size drill is to be found, and if you always put them back in their proper places when done with them, they will not become mislaid and lost, and at a glance you can tell if one or more are missing, and if so, which ones. In arranging the tools hanging on the boards, mark around each one as it is placed in position. This will enable you to invariably put each tool back on its proper nails or hooks and will save confusion. For keeping the gouges and chisels, a few holes bored

through the projecting top board of the bench will serve very well. The planes may be kept on their sides on the bench or shelf, but a better plan is to make a little rack to hold them, by nailing strips to the bench so that the planes will just

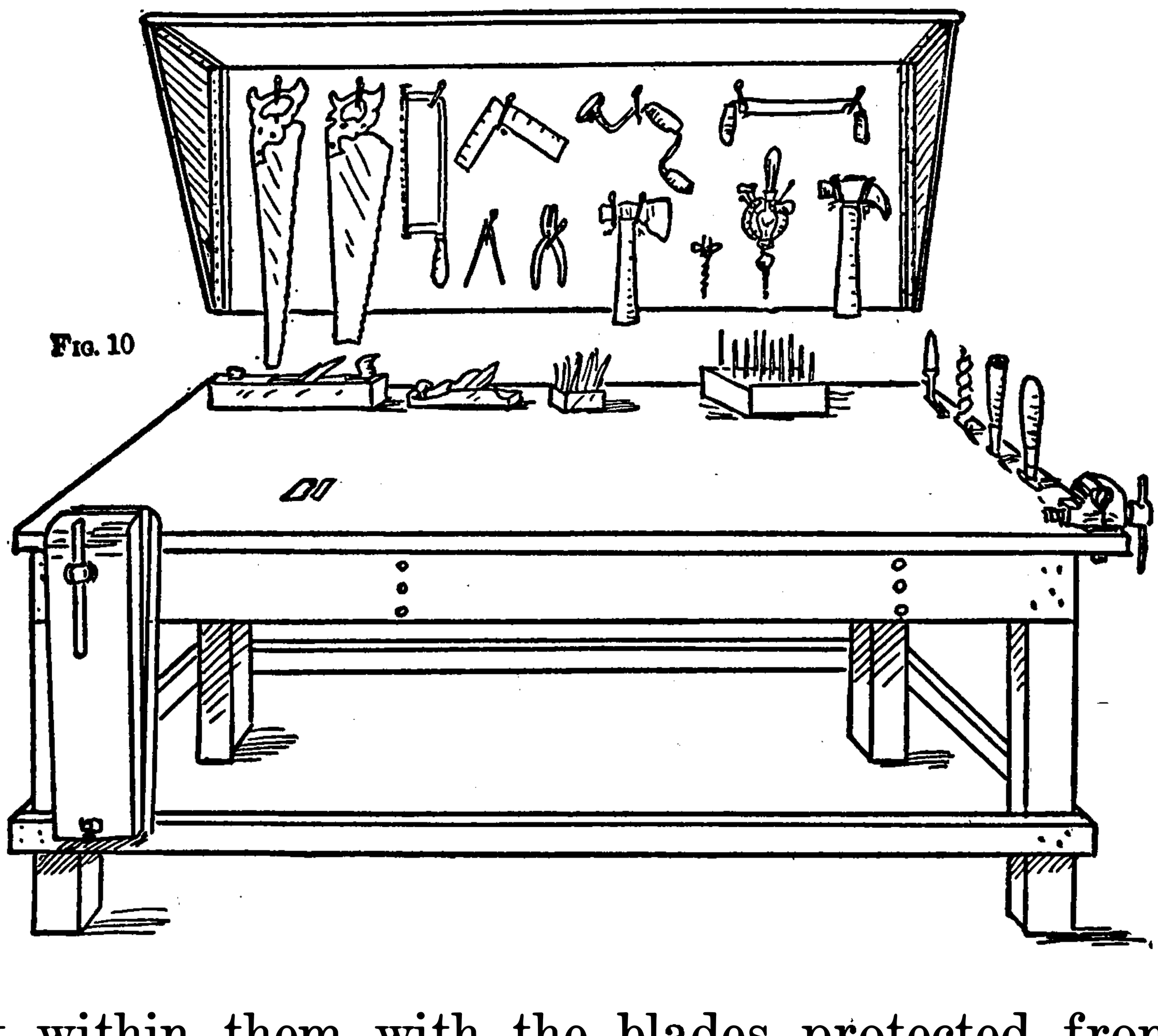


FIG. 10

fit within them with the blades protected from contact with the bench. Finally you should bore three $\frac{3}{4}$-in. holes in the front plank of the bench, each 2 in. apart and about 3 ft. from the bench-vise. A peg should be made to fit tightly in the holes and you will find this a most useful if simple device for supporting the end of a long board

when planing or working at it in the vise. When the tools are all arranged your bench and equipment will be ready for work and will be neat and orderly and will appear more or less as shown in Fig. 10.

As a great deal of your work will be outside of your shop and you will have to carry a number of tools, etc., about with you, you will need a carpenter's tool-tray. As this is a simple thing to make, your next lesson in carpentry may well be devoted to making this useful part of your outfit.

CHAPTER IV

HOW TO MAKE A TOOL-TRAY AND A MITRE-BOX

In making the workbench and the shelf for your tools the work has been rather heavy and rough, but in constructing a tool-tray you may obtain excellent practice in doing really accurate and careful work, and in addition will have an opportunity of using several tools you have not before employed.

For the tray you will require some $\frac{1}{2}$-in. wood, and if you wish you may use hard or fancy wood, such as walnut, mahogany, oak or cherry. A tray made of such materials will be very handsome, and such a small quantity of lumber is required that the additional expense of using fancy wood will be very little. Even if ordinary pine or whitewood is used the finished tray may be stained and varnished and will be very attractive. Whitewood is far superior to pine for work of this sort and it is easier to get good, clear whitewood than pine and it is also cheaper. Avoid using yellow-pine or cypress for light, small work;

they are both excellent woods for certain purposes, but they are apt to split unless care is used and they are harder to work than white-pine or whitewood.

The amount of material you will require for the tray will be about 10 sq. ft. of the $\frac{1}{2}$-in. stuff and a piece of $\frac{7}{8}$-in. material, 2 ft. long and 10 in. wide. If possible, obtain material of the full width, but if you cannot do this you can use boards 6 in. or more in width.

On one of the $\frac{1}{2}$-in. boards measure off and mark two rectangles each 20 in. long and $5\frac{1}{4}$ in. wide and two others each $11\frac{3}{4}$ in. x $5\frac{1}{4}$ in. with the grain running lengthwise in all. Cut these out carefully, being sure to get all corners square and all sides and ends parallel. Measure off $1\frac{1}{2}$ in. from each end on one edge of each of these pieces and draw a diagonal line to the opposite edge from each of these points (Fig. 1). Saw carefully across each of these diagonal lines so that you will have four pieces all $5\frac{1}{4}$ in. wide; two of them 20 in. on one edge and 17 in. on the other and the other two $11\frac{3}{4}$ in. on one edge and $11\frac{3}{4}$ on the other. Now on the piece of $\frac{7}{8}$-in. stuff measure off a rectangle 19 in. x $9\frac{5}{8}$ in. From one edge of this mark off $4\frac{1}{2}$ in. and draw a straight line

parallel with the edge but just $4\frac{1}{2}$ in. from it. From each end of this second line measure off $1\frac{1}{2}$ in. and draw a diagonal from each of these marks to the other edge, as shown in Fig. 2. Next measure off $9\frac{1}{2}$ in. from the extreme ends of the rectangle, thus finding the exact centre and draw a line across from edge to edge and square with the marks that designate the edges (Fig. 2 *A*). Two and one-half inches above the lower, lengthwise line and 2 in. below the outer line, make a mark (Fig. 2 *B*), and with your square mark a line at right angles across the mark *B*, and extending 2 in. on either side (Fig. 2 *D*, *D*). With the 1-in. auger bore two holes through the board, centring the auger at the marks *D*, *D*, and from the edges of these holes draw a curved line as indicated, with the upper point of the curve 1 in. above the point *B*, and the lower part $1\frac{1}{2}$ in. below *B*. Now from the intersection of the upper end of the diagonal marks and the line $4\frac{1}{2}$ in. from the edge *C*, *C*, mark a graceful curve extending to the extreme outer edge as shown at *F*, *F*. You may have difficulty in making this curve alike on both sides of the line *A*, but this is readily overcome by drawing the curve for one side on a piece of stiff paper, cutting out the

paper and laying it upside down, or reversed, on the opposite side of the line *A*. Then by tracing

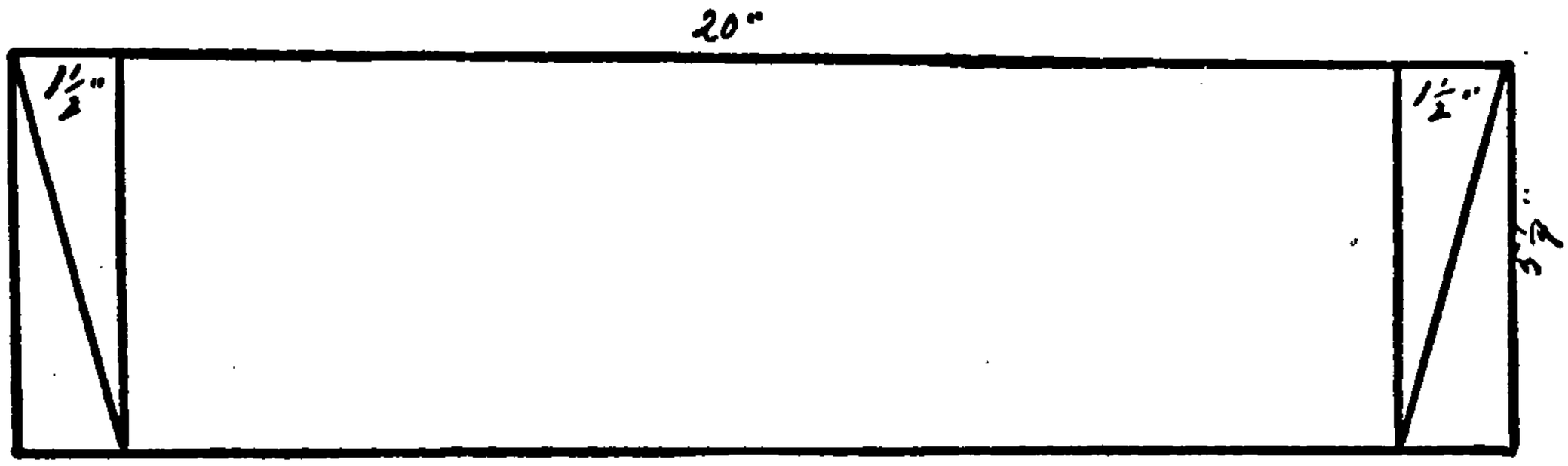


FIG. 1

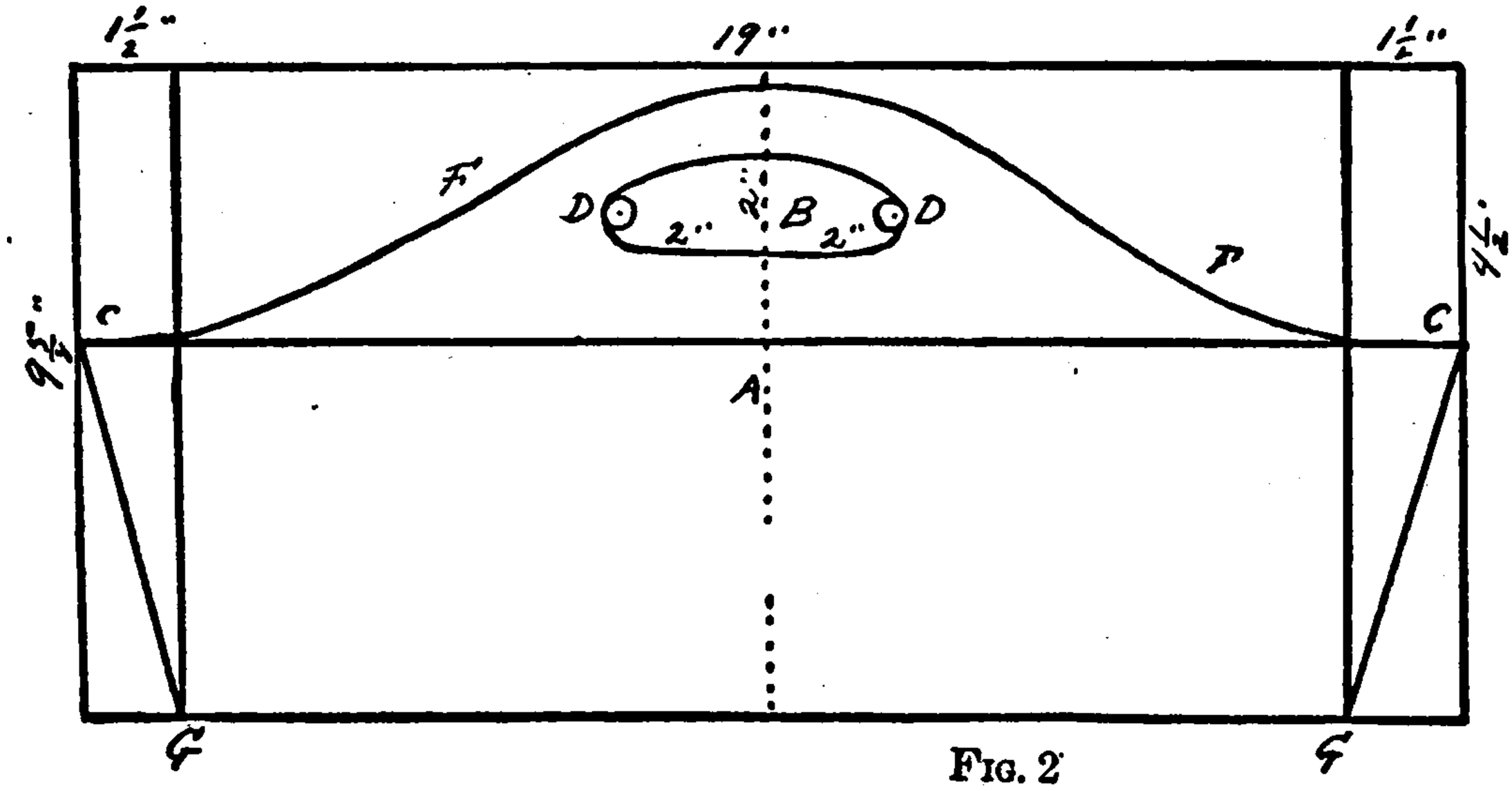
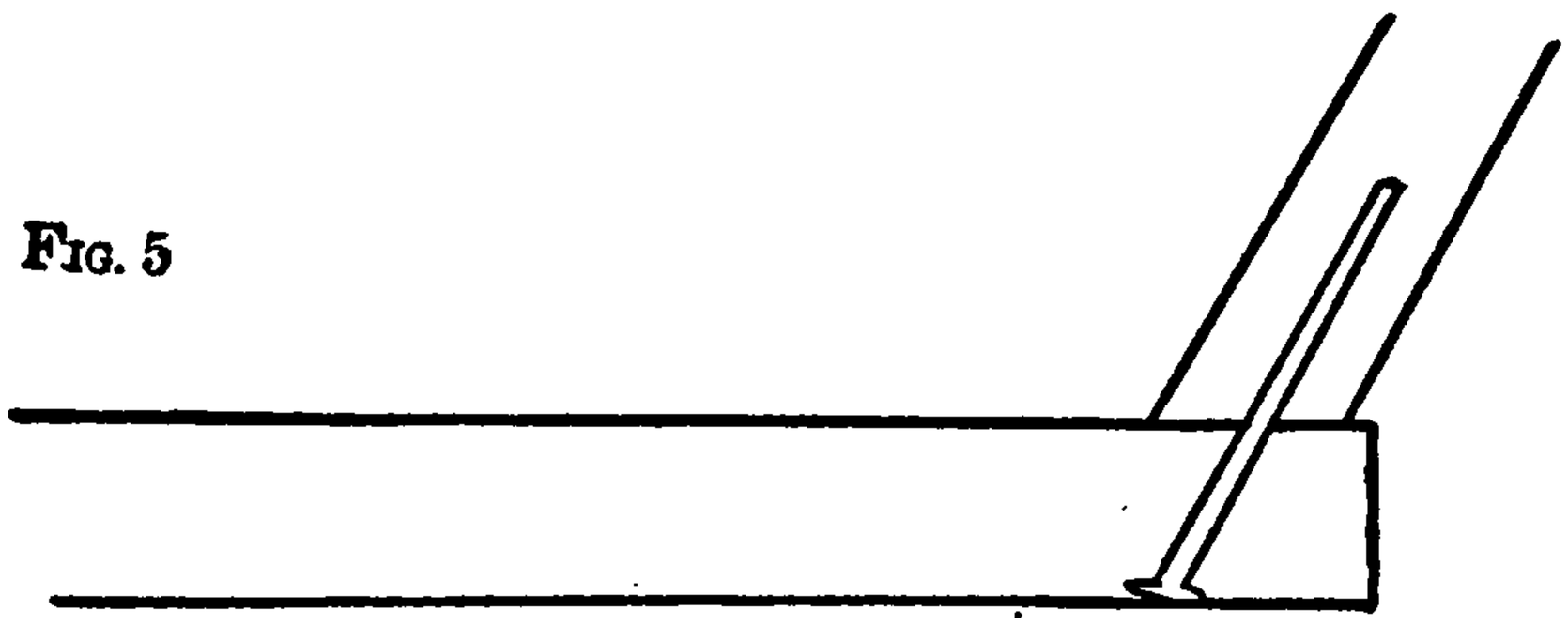


FIG. 2

FIG. 5



along the edge of the paper pattern both the curves will be identical.

In the above directions I have assumed that your $\frac{7}{8}$ board was 10 in. in width. In case you can not secure a board of that width you will be

obliged to fasten two narrower boards together, edge to edge. In order to make a good job of this the two edges that are to join must be planed smooth, true and even so they fit flush together. When this is done place them tightly edge to edge and tack two or three light cleats across the joint, and having the joint near the bottom edge, which is 16 in. long, instead of near the longer top edge. This is important, as the joint or seam if near the bottom will not matter at all, whereas if near the top it will show in the finished tray and will weaken the tray besides.

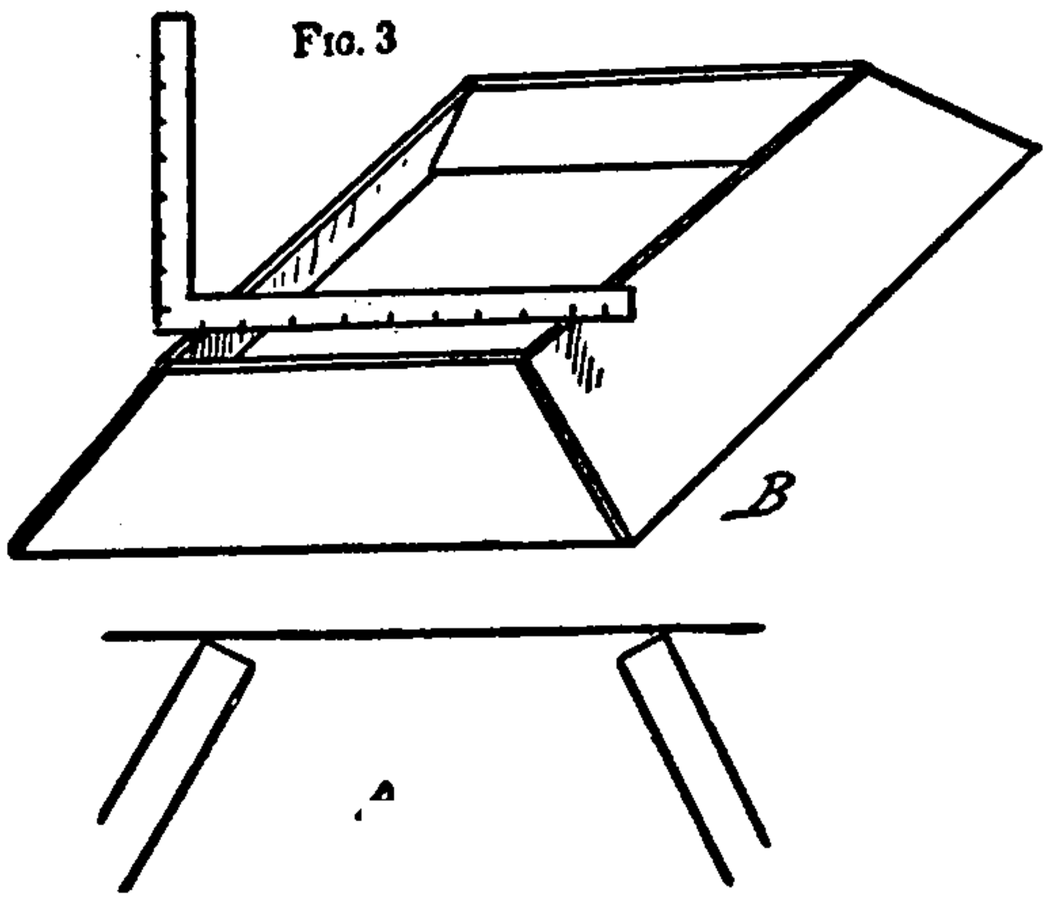
When all the marks on the piece are made as shown in Fig. 2 saw across the diagonal lines from *C* to *G*. Place the board in your bench-vise with one end uppermost and with your compass-saw cut along the line *F F* from *C* to *C*. With the compass-saw commence at the hole *D* and follow around the line to the other hole and then back along the other line to the opposite hole.

With the rasp and files smooth off the saw marks on the curved lines and finish the curved edges rounded and smooth with sandpaper. If you have sawed all the boards carefully the cut lines will be straight and smooth and free from chipped or split spots, and if you are to have

a neat tray this is important. The next step is to plane off the long edges on the other four boards and take a small shaving from their sharp corners so they are slightly rounded. They should not be appreciably rounded, however, but merely smoothed. Now place one of the smaller pieces in the bench-vise with the diagonal end up and in such a position that the diagonal cut is parallel with the top of the bench. With the brad-awl or a fine drill make several holes along both ends of the larger pieces and $\frac{1}{4}$ in. from the ends. Place one of these pieces so that the end is exactly flush with the end of the piece in the vise, and with small wire nails (about $1\frac{1}{2}$ in. long) inserted through the holes you have made, tack the long piece firmly to the shorter one. Place the other short piece in the vise and fasten the other end of the long piece to it in the same way. Then place the long piece on the bench with the two end pieces sticking up and fasten the other long piece to them in the same manner. You will now have a rectangular frame 20 in. long at the top, and 17 in. long at the bottom with a top width of $12\frac{3}{4}$ in. outside and a bottom width of $9\frac{3}{4}$ in. Place this frame with the largest, or top opening, upon the bench and secure it firmly by

tacking short cleats to the bench on all four sides close to the frame. Then with the block-plane cut down the edges of the frame until they are level or square across in all directions. This will be easier to understand by studying Fig. 3. As the edges of the four pieces are square and the

FIG. 3



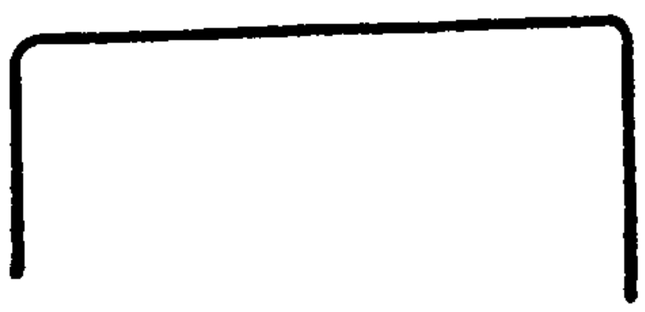


FIG. 4.

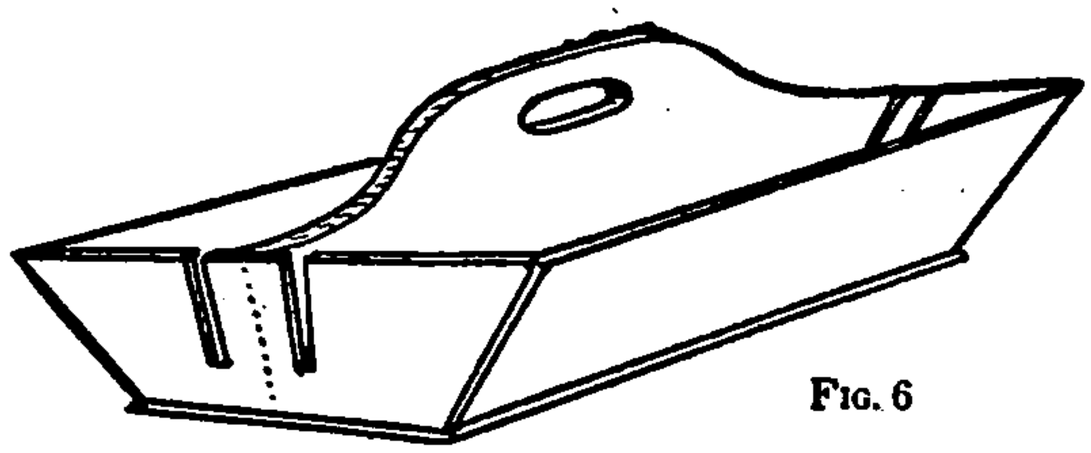


FIG. 6

pieces are fastened together at an angle the outer corners will be higher than those on the inside as indicated at *A*. Therefore these outer corners must all be planed off until the edge of your square, when placed across from side to side or from end to end, rests squarely upon the parallel surfaces of the edges as shown at *B*. By planing carefully and frequently trying the square you will find this an easy matter to accomplish. When this is done measure off at the upper and lower edges of the ends to find the exact centres and draw a line across from side to side. Along these

lines bore several holes with a drill or awl. Now turn the frame the other side up on the smooth surface of the bench and place the centre piece, cut from $\frac{7}{8}$-in. stuff, within it and with the ends *C*—*G* exactly in the centre of the end pieces of the frame. This is easily accomplished as you have the centre lines and holes already drilled in the ends. Insert nails through the holes, drive them into the ends of the $\frac{7}{8}$-in. centre piece and the tray will be ready for the bottom.

For this you will have to get out a piece of $\frac{1}{2}$-in. stuff $17\frac{1}{2}$ in. long and 10 in. wide. If you have no wood of 10-in. width fit two pieces together as already described. Saw the piece with all ends square and true and with your ruler and square mark a line completely around the bottom just $\frac{1}{8}$ in. from the extreme edges. Place the bottom piece in the bench-vise and with your block-plane round off all the edges, being careful not to carry the planing beyond the line marked around the edge. It is very easy to plane off the long edges with the grain, but when you come to the ends across the grain you will have to be very careful not to split or chip the corners. To avoid this, plane diagonally, rather than straight, across the grain and before planing across the ends round the cor-

ners slightly with a few strokes of the plane or a pocket knife (Fig. 4). Now clamp the centre piece, or handle, of the tray in the vise with the bottom of the tray uppermost. With the drill or awl make a number of holes around the edges of the bottom board, using care to bore them just $\frac{1}{8}$ in. within the line you have marked $\frac{1}{8}$ in. from the edge. Place the bottom board over the frame in the vise; move it about until the line $\frac{1}{8}$ in. from the edge is just flush with the outer edges of the frame and drive nails through the holes up into the frame. Use nails that are not over $1\frac{1}{4}$ in. long and drive them slightly outward at an angle, as shown in Fig. 5. Across the centre of the bottom from end to end drive nails into the centre piece and your tray will be complete, save for the finishing touches. If you have used two pieces to make the centre and bottom you may now remove the cleats that held them together. With the nail-set sink all the nail-heads well below the surface of the wood and with sandpaper go over the whole tray, smoothing off all edges, corners and the surface until no rough spots or pencil marks remain. About $\frac{1}{2}$ in. from each side of the centre piece and at both ends, saw straight slits about $2\frac{1}{2}$ in. deep, using care in sawing them so as not

to split the wood. In these you can put your saws when carrying them about. When the wood is smoothed to your satisfaction, putty up the depressions over the nail-heads and stain, oil or varnish the entire tray. When completed it will be a handy, useful article and should appear as in Fig. 6.

Another extremely useful adjunct to the carpenter shop is the mitre-box. Indeed for many kinds of work a mitre-box is absolutely necessary, and as you will soon require it in your work it is a good plan to make a mitre-box at once.

The material you will require for the box is $\frac{7}{8}$-in. stuff at least 6 in. in width and sufficient to make three pieces each 18 in. long. If possible use hard fine-grained wood, such as straight-grained birch, cherry, oak or beech. Although soft wood is easier to work with and will serve your purpose, yet a far more accurate and enduring box may be constructed from hard wood.

The first step is to mark off a rectangle 18 in. long and 6 in. wide on a piece of the board, and in doing this use the greatest care to get all the corners square and the lines parallel. The least inaccuracy in making the mitre-box will re-

sult in a finished box which is worthless and worse than none at all. On the rectangle you have marked out measure off 9 in. from one end and draw a smooth straight line across from one side to the other (Fig. 7 *A*—*A*). One inch from this draw another line across from side to side as at *B*—*B*, and exactly 6 in. from this draw another

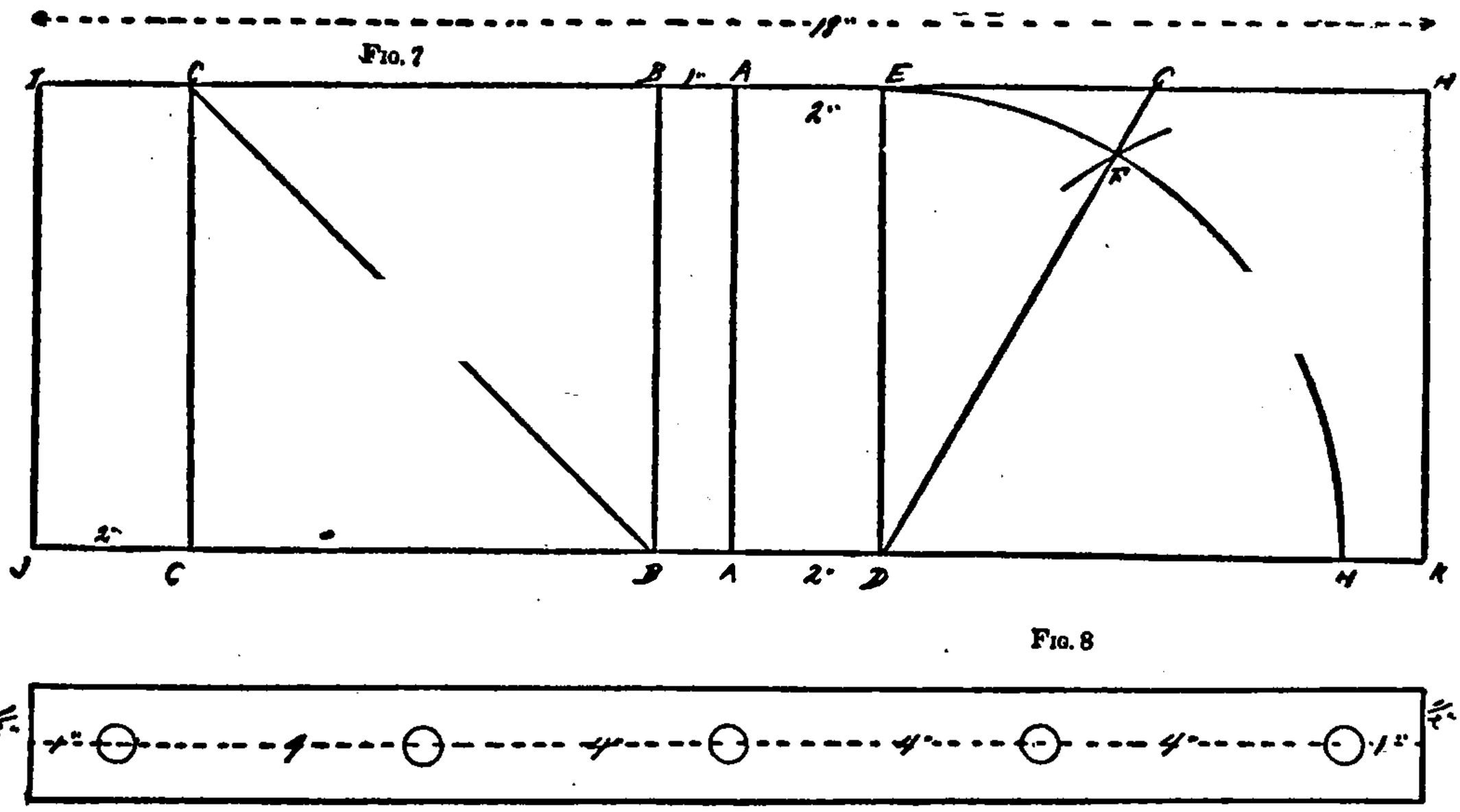


FIG. 7

FIG. 8

line as at *C*—*C*. Then with a straight-edge draw a heavier line diagonally from *C* to *B*. Two inches from the line *A*, towards the other end of the board, draw a line *D*—*E*. With a pair of dividers or compasses, or with a piece of string fastened to a nail and with a pencil at the other end, draw a quarter-circle as at *E*—*H*, the radius being exactly 6 in. and the centre of the circle being the point where the edge of the rectangle

intersects the line *D*—*E*, as indicated in the illustration. Without altering the adjustment of the dividers or the string, place the leg of the dividers, or the nail that holds the string, at the corner *H* and draw a section of a circle intersecting the first circle at the point *F*. Now with a straight-edge draw a diagonal line from *D* to *G so that it will pass through F*.

Then saw out the rectangle, following the lines from *I* to J, from *J* to *K*, from *K* to *H* and from *H* to *I*. Of course if the end and side of the board have been used for two of the edges, as *I*—*J*—*K* you will only have to saw the other two edges. Then get out two more pieces, each 6 in. wide by 18 in. long, using care to get all edges and ends square and parallel. Drill five $\frac{1}{4}$-in. holes through one edge of each of these pieces, making the holes $\frac{1}{2}$ in. from the extreme edge and placing one in the exact middle between the ends, others 1 in. from each end as shown in Fig. 8, and the others equidistant between them. Clamp the piece with the diagonal marks in the bench-vise and screw the sides to it, being careful to have the surface *without the marks absolutely flush and even with the lower edges of the sides*. You will thus have a rectangular trough 18 in. long with sides pro-

jecting $5\frac{1}{8}$ in. above the bottom and with the marks *A*—*A*, *B*—*C* and *D*—*E* in view between the sides. Place one edge of your square along the corner formed by one side and the bottom of the box and move it until the lower corner of the square is exactly even with the point where the diagonal line from *B* meets the line *C*, and with the pencil draw a line straight up the side of the box along the edge of the square. Do the same with the other end of the line where it joins *B* and repeat the operation at the points *D* and *G* and at both ends of the line *A*—*A*. Next place one edge of the square along the outside of one side of the box and with the other arm of the square across the edges of the sides and move it until the edge is in line with the line from *C* in the top of the box. Rule a straight line across the edge at this spot and treat each of the other marks on the sides of the box in the same manner. All this is plainly shown in Fig. 9.

With your cross-cut saw, cut straight down through the sides of the box across the lines marked on the edges of the box and carrying the cut down until the saw strikes the bottom of the box. If you use care and saw straight and true, guiding your saw by the lines on the inner

surfaces of the sides, the saw will cut across the bottom exactly on the lines *C*—*B*, *A*—*A* and *D*—*G*, and to accomplish this requires the greatest care and is the most difficult part of constructing the mitre-box.

The box will now be complete and ready to use, and to test it is an easy matter. Place a straight piece of wood in the box with one edge

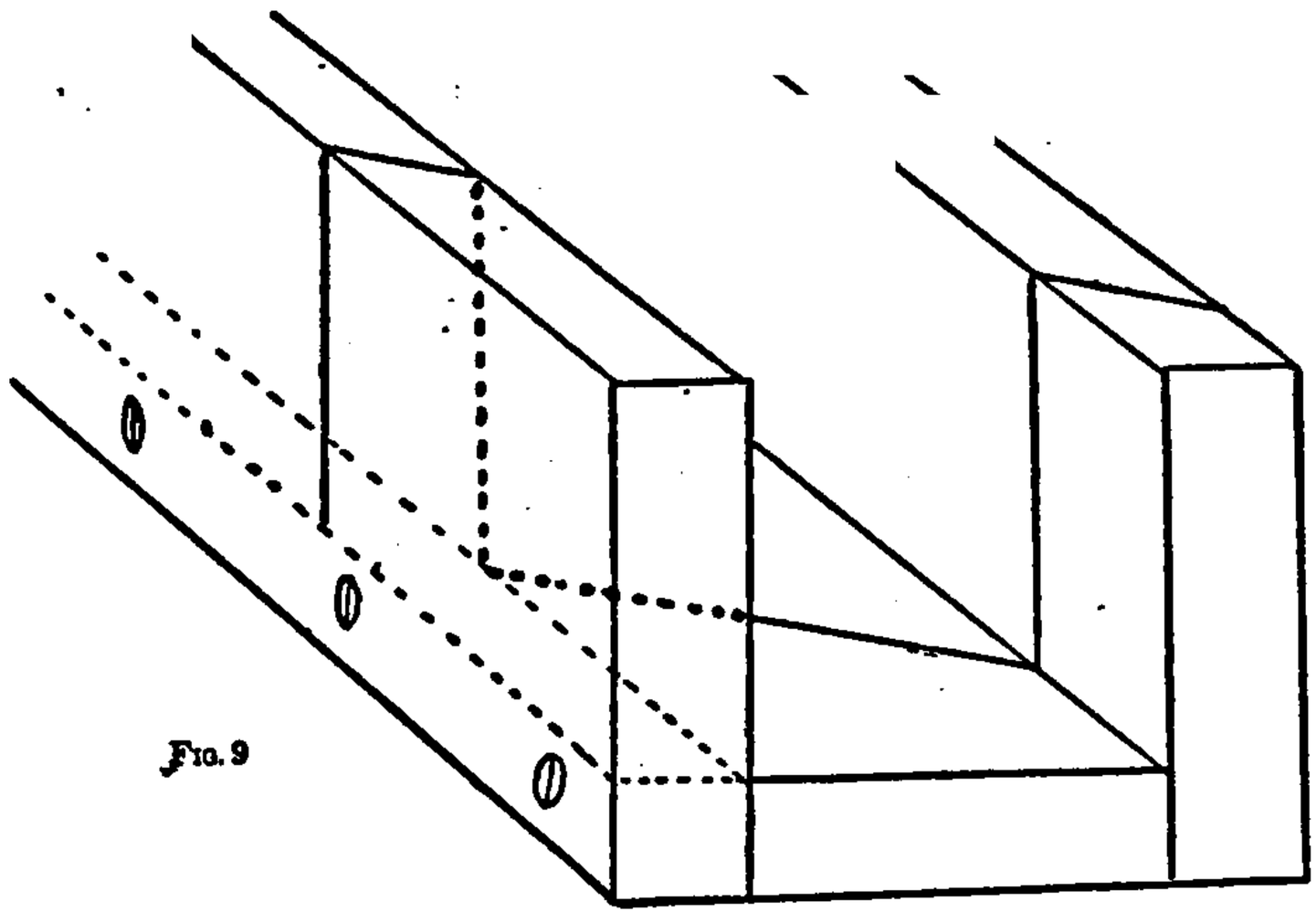


Fig. 9

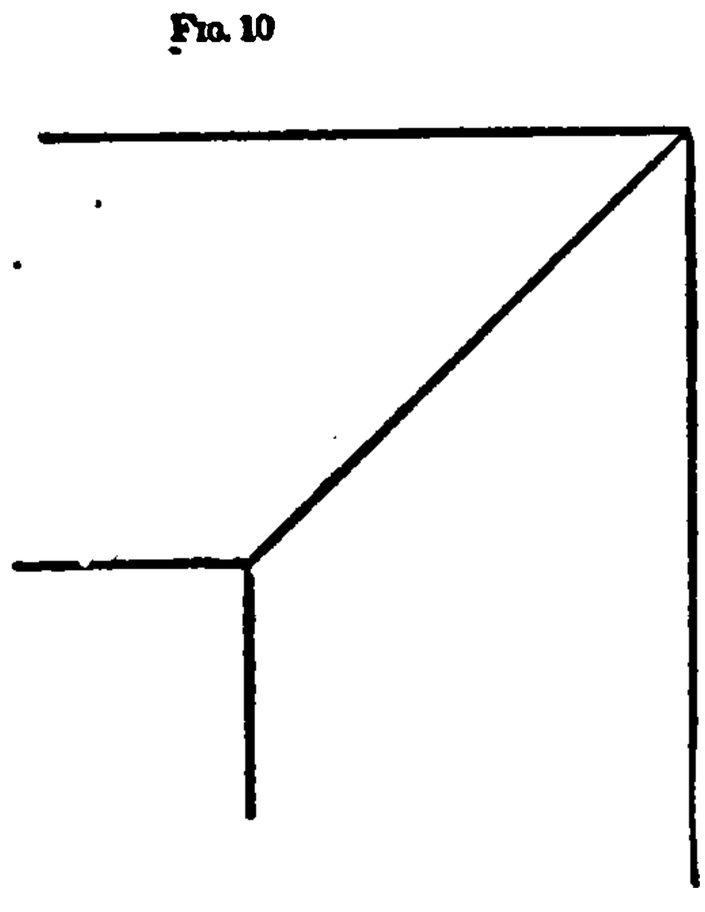


Fig. 10

resting against one of the sides on the bottom and placing your saw in the cut from *C* to *B*, saw through the piece of wood while holding it firmly in position with your thumb pressing it against the inside of the box. Do the same way with another piece and then lay the pieces on a flat surface with the two bevelled, or diagonal, ends together and with your square test them to see if their edges come true with the square as shown

in Fig. 10. If everything has been done carefully you will find the pieces form a perfect square, or right-angle, corner, for the line *B*—*C* is at a 45-degree angle. In making frames, joining corners of various objects and in numerous other ways this box will prove useful, for the line *B*—*C* will enable you to cut true corner-angles for square objects; the line *D*—*G* will guide you in cutting an angle for making six-sided objects, and the line *A*—*A* will be a guide for cutting square ends. With the cross-cut saw care must be used not to enlarge or mar the slits in the sides of the box, for if this is done the box will soon become worthless. A mitre-saw, which is a fine-toothed saw stiffened with a thick back, is far better, and if you intend to use a mitre-box to any extent you will do well to secure a mitre-saw as soon as possible.

CHAPTER V

LEARNING TO MAKE JOINTS

THERE are a great many methods of joining two pieces of wood together, and the particular kind of joint to be used depends a great deal upon the material, the strength required, the character of the work in hand and upon the skill of the carpenter.

In former times all joints were made by hand and carpenters became very expert in making accurately fitting and beautiful joints of all kinds. Doors, windows, chests, drawers, boxes and a thousand and one other articles were made by hand with beautifully-fitted tenons, dovetails or similar joints. Nowadays nearly every kind of joint can be made far more accurately and rapidly by machinery, and there are scores of excellent carpenters who do not know how to make a good dovetail or other complicated joint.

The simplest of all methods of joining two pieces of wood is to merely nail or screw the two pieces together as shown in Fig. 1. For very rough work this serves every purpose, but the

joint made in this way is clumsy and not very strong. A better way of joining two pieces of wood is by a half-and-half joint. This consists in cutting away half the material on each piece to be joined as shown in Fig. 2. This method is quite strong and if carefully done it makes a very serviceable and neat joint. This joint may be used either for pieces that join at right angles or for pieces joined with a mitre as shown in the figures. Ordinarily for mitre joints, however, it is merely necessary to nail the two pieces together edge to edge as shown in Fig. 3. A still stronger joint is the *Tenon Joint*, several forms of which are shown in Fig. 4. This is an excellent form of joint where neatness and strength are required and especially for joining the ends of timbers or for fastening uprights or cross-pieces in other timbers or scantling. It also makes an excellent joint for mitred work. For joining fine work such as furniture, drawers, cabinets, chests, etc., a form of joint known as the *Dovetail* is commonly employed. There are many varieties of dovetail joints, some of which are shown in Fig. 5. Most of the joints are very easy to make, but to fit a good dovetail requires great care, skill and practice. A form of dovetail which is just

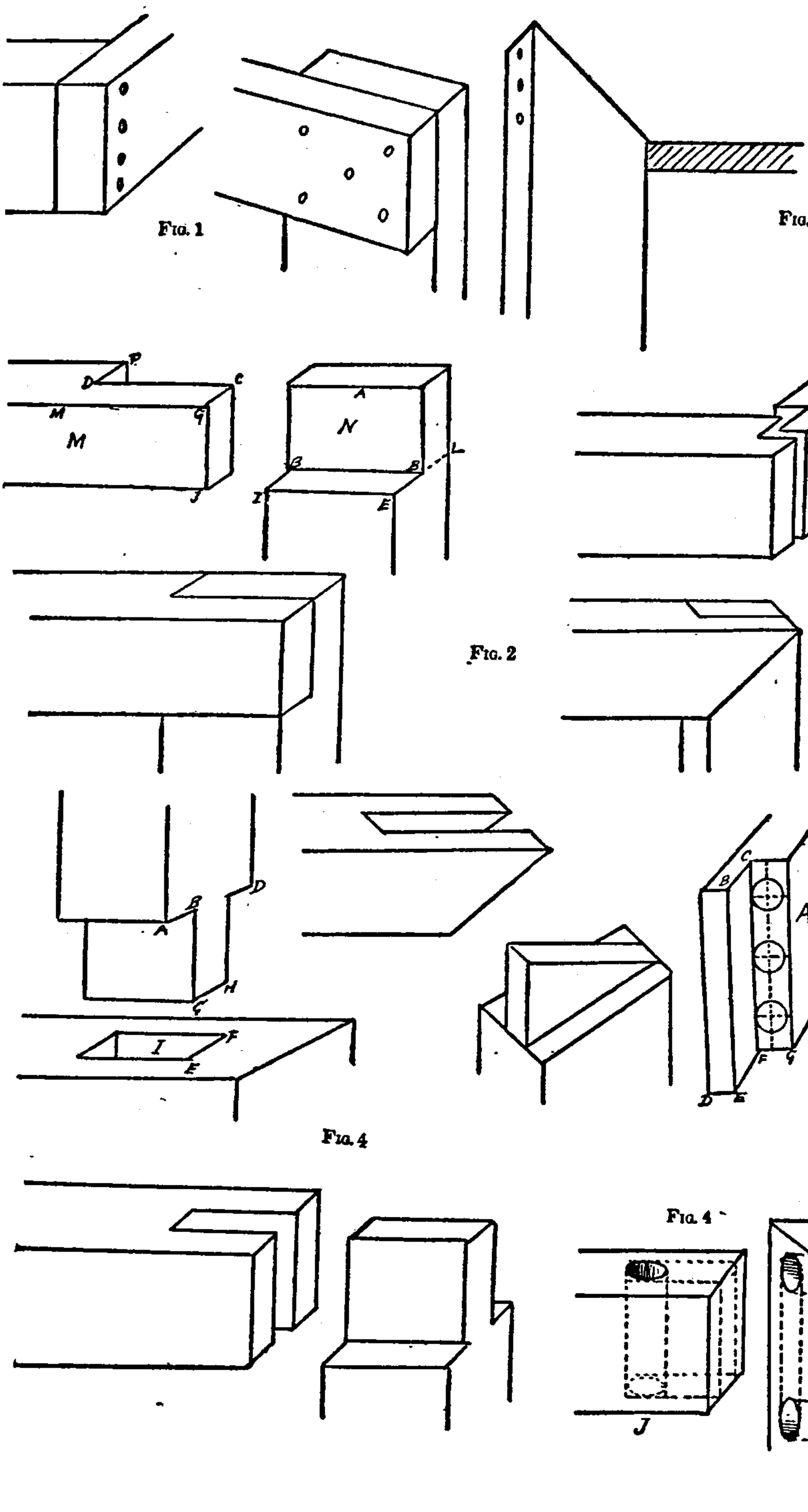


Fig. 1

Fig. 3

Fig. 2

Fig. 4

Fig. 7

Fig. 4

as neat and strong as any other is shown in Fig. 6, and this, moreover, is fairly easy to make, as it consists of holes bored in the piece *A* which are fitted over wooden pegs in the piece *B*. In making any of these so-called "mortised" joints you must use care and must work accurately if you expect good results. Before making a half-and-half joint, as shown in Fig. 2, lay off the measurements and mark the work carefully before starting to make any cuts. The distance from *A* to *B* and from *C* to *D* should be the same as from *G* to *J* and *E* to *I*. If the two pieces to be joined are of equal dimensions the measurements will all be equal, but if the two pieces are of different sizes each piece must be marked to correspond with the dimensions of the other. The cut *B* to *E* and the cut *D* to *F* should each be one-half the thickness from *E* to *L* or from *F* to *M*, or one-half the thickness of the pieces to be joined. The cuts should all be made smooth, square and true and the surfaces to be joined (*N*) should be smooth and even. In making a mitred halved-joint a little more care must be taken, but the principle is the same as in the plain halved-joint. The cuts *A*—*B*, *C*—*D* should be made in the mitre-box and while *A*—*B* should go but halfway

through the wood that from *C* to *D* should go clear through. On the piece *E* a cut at right angles to the edge *C*—*G* should be made half through the piece and when the two pieces are joined the junction will be scarcely visible. In making a tenon-joint as shown in Fig. 4 the cuts *A*—*B* and *C*—*D* should be equal, while *G*—*H* should be the same as *E*—*F*. There is no trouble in making this sort of joint, as it merely requires care in cutting and chiselling. In making the hole *I* it is often easiest to bore a hole through the wood first and saw from the end to this hole as indicated in Fig. 4 J, or else bore two holes and saw from one to the other with the keyhole-saw as shown in Fig. 4 *K*, afterwards smoothing the ends square with a chisel.

To make a dovetail joint lay off the piece *A* first and cut the recesses with a fine saw and sharp chisel. Then place the piece over *B* and with a sharp pencil mark around each of the "tails" and cut corresponding recesses in the piece *B*. For common work the distance from *C* to *D* must be the same as from *E* to *F*, but if particularly good work is desired and you plan to make a "blind" joint the distance must be the same from *C* to *D* as from *G* to *H*. The one great secret in

making dovetail joints is to work slowly and carefully and fit the pieces from time to time as you proceed until you are sure that they fit closely and accurately together. In making the form with holes and pegs, cut away a space on *A*, Fig. 7, with the distance from *B* to *C* equal to the thickness of the piece *D* and with only a very thin

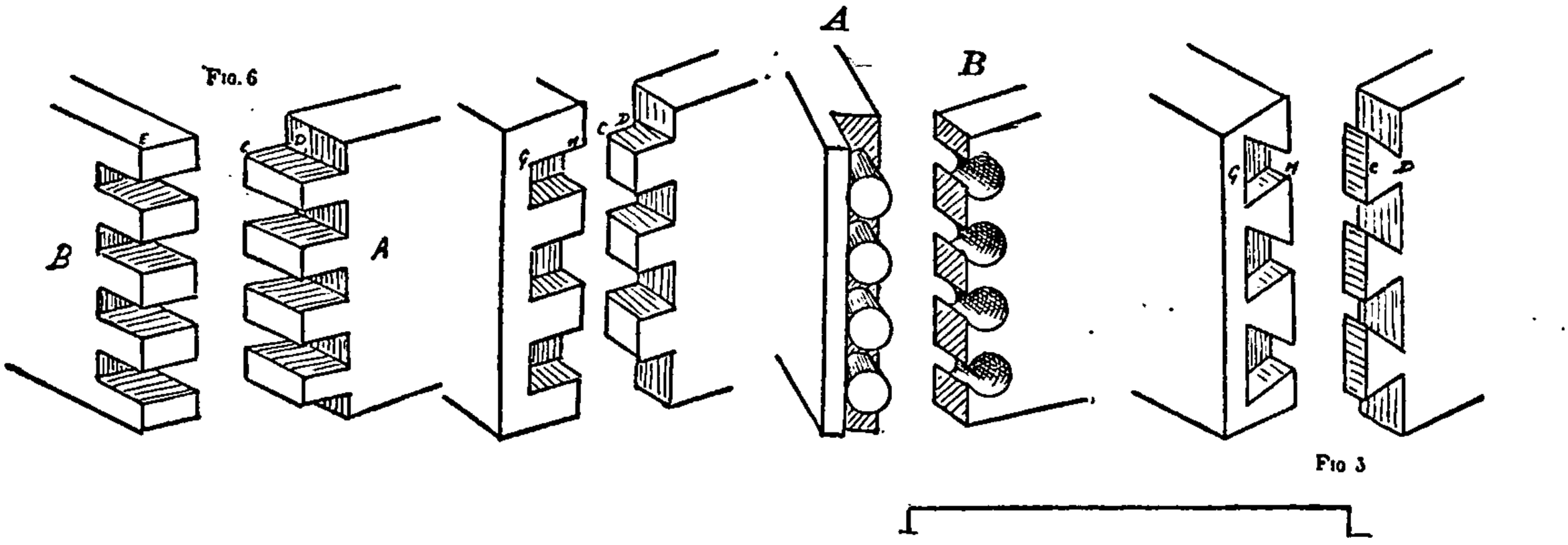


FIG. 6

FIG 3

portion left at *D*—*E*. Mark the distance from *F* to *G* on the piece *D* and draw a line parallel with the end at this distance from it, *G*—*H*. Along this line mark several points at equal distances and from these run lines to the edge as shown at *I*—*J*, *K*—*L*, *M*—*N*. Then with a twist-drill or sharp auger bore holes on each one of these lines. The holes should be of smaller diameter than the distance from *I* to J, etc., and the outer edge of the holes should just touch the extreme end of the piece *D* as shown in the figure by the dotted lines. Now place the two pieces *D* and *A* together in the position in which they are

to be joined and mark the places where the holes come on the piece *A*. With the bit or drill bore holes half an inch deep or so into *A*. Make a number of smooth, round, wooden pegs that will just fit smoothly into the holes and drive them into the holes in *A*, fastening them securely with glue. Slip the piece *D* over the pegs after coating all the surfaces with glue, and drive or press the pieces firmly together. After the glue is thoroughly dry trim off the projecting pegs and smooth the edges and you will have a joint that is exceedingly strong and very neat and which is invisible from the front, or *A*, side. Properly this is a dowel-joint rather than a dovetail, and you will find it a great convenience to buy dowel-pin stock already made rather than to try to make perfectly true, round pegs yourself.

All the joints described are particularly adapted to joining pieces of wood at right angles, but it is often necessary to join pieces end to end or edge to edge. The commonest way of joining wood or boards edge to edge is by the *Tongue-and-Groove* method (Fig. 8). This is a simple way and boards and timber may be purchased already cut or "matched" with tongues and grooves or the young carpenter may buy matching-planes with which

he can cut his own tongues and grooves as he requires them. Another method of joining boards edge to edge is by half-and-half joints as shown in Fig. 9, while still another method is to cut grooves in the edge of each board and drive a thin piece of wood into these as shown in Fig. 10. Where two timbers or scantlings are to be fastened end to end to obtain greater length there are several methods of joining which may be used. One way is to make a half-and-half joint as shown in Fig. 11, and after placing the two pieces together bore a hole through the timber and drive a peg in the hole as shown in Fig. 11*a*, which prevents the two pieces from pulling apart. In place of boring a hole and using a peg a square notch may be cut in each piece and a square dowel driven in as shown at Fig. 11*b*. A better method is to cut the timbers as shown in Fig. 12 and use either a peg or a square dowel as indicated at Fig. 12*a*. Still another method is shown at Figs. 13 and 13*a*; while by cutting the timbers as indicated in Fig. 14 the peg or dowel may be dispensed with.

In making mortised joints always try to have them fit so snugly that they must be driven together with light blows of a mallet or a piece of

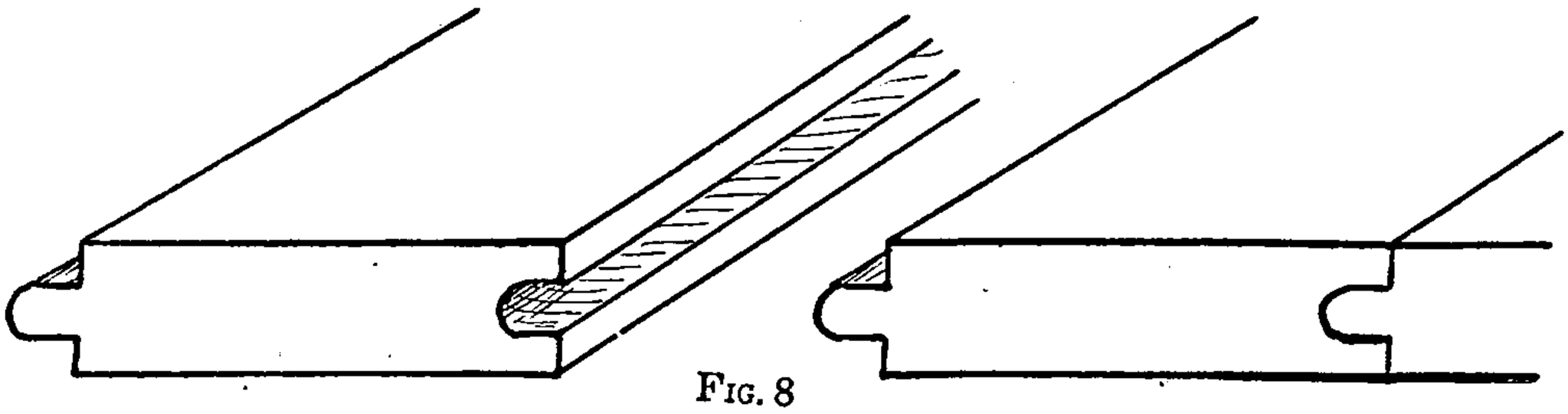
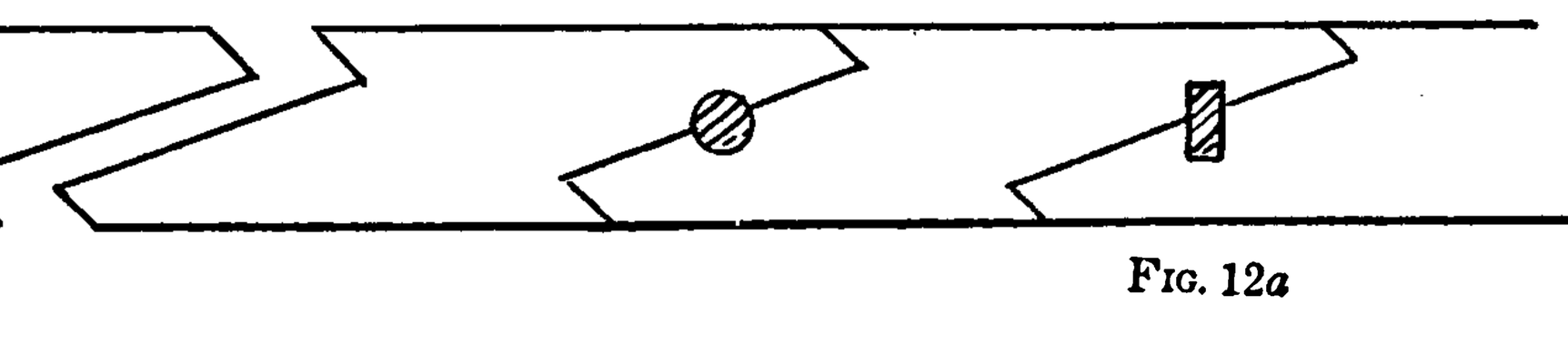


FIG. 8

FIG. 9

FIG. 10



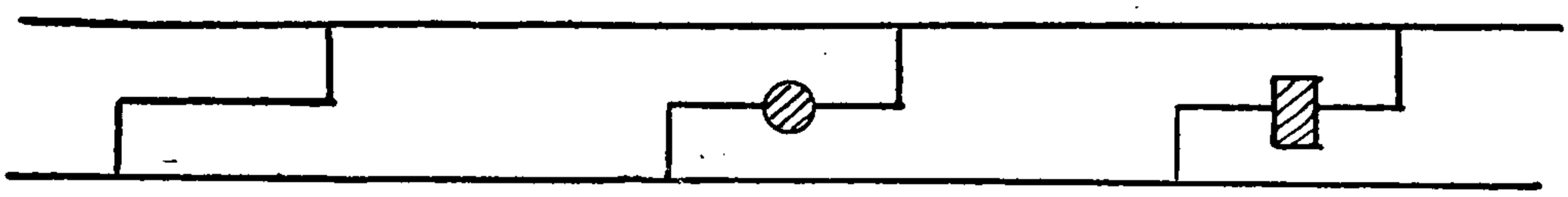


FIG 11 FIG 11*a* FIG. 11*b*

FIG 12 FIG. 12*a*

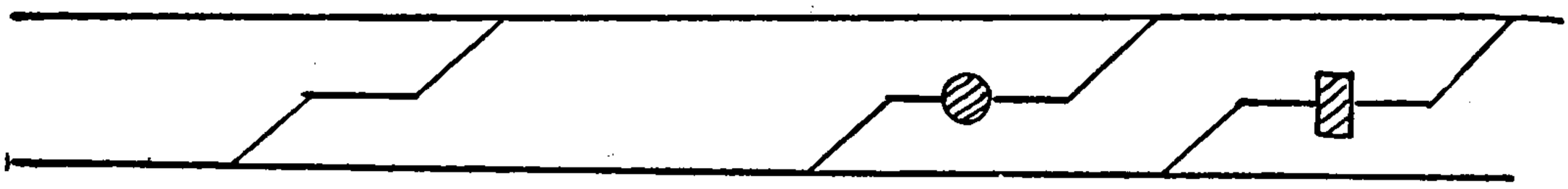


FIG. 13 FIG. 13*a*

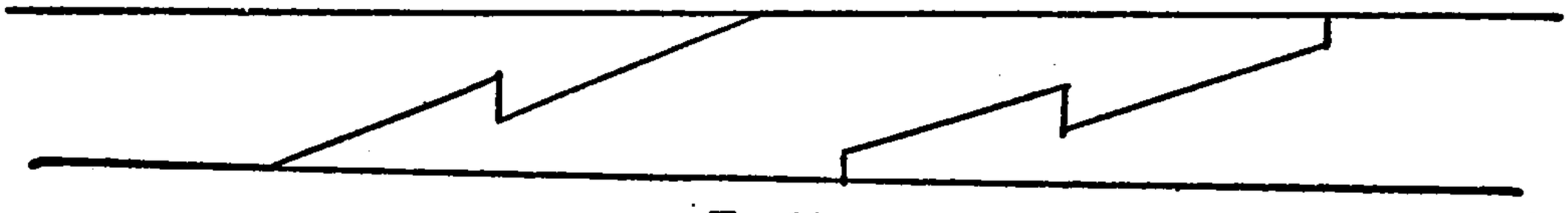


FIG. 14

wood and in all light, fine work, or where the wood will not be exposed to dampness or wet, make the joints with glue. Glue if well made is a great aid to the carpenter, but if poor in quality or carelessly made it is worthless and a nuisance and every amateur carpenter should know how to make and use glue properly.

If you are going to use glue you must have a double glue pot of some sort. Those sold for the purpose are the best and are not expensive, but an old saucepan and a smaller pot to set inside of it will answer every purpose. Use only the best sheet glue and place it in enough water to cover it and let it stand overnight. Drain off the superfluous water, place the pot in the larger pot or pan, which should be partly filled with water, and heat until the water boils. Let it continue to boil until the glue is thoroughly melted and soft and use it hot. Do not use too much glue; place a thin, even coating over the surfaces to be joined and press firmly together. If the weather or the material is cold warm the pieces slightly before applying the glue. If the wood is soft and porous give the surfaces a coating of thin glue (made by adding hot water to the glue) and allow this to harden before applying the glue for

fastening the parts together. Do not use prepared or liquid glues; they are all very well for mending broken dishes, ornaments and work about the house, but for good carpenter work the best freshly prepared glue is essential. Glue may be made waterproof by adding a strong solution of alum to the soft glue and stirring it thoroughly. No matter how well you prepare the glue or how excellent its quality the results will be unsatisfactory unless you use it properly. Good, common glue, if properly used, will unite two pieces of wood so firmly that the fibres will part from each other before the glue will break, and yet nine times out of ten amateurs cannot glue two pieces of wood together so they will withstand any strain whatever. The first point which must be attended to is to bring the cement or glue into perfect contact with the surfaces to be united. This seems very easy, but in reality it is quite difficult unless one goes about it properly. The great obstacles to the absolute contact of any two surfaces are dirt and air. The former is easily removed and a clean surface is readily obtained, but it is not so easy to remove the air which is universally present. All surfaces are coated with a thin adhering layer of air which bears, to the outer sur-

face of the bodies, a relation very different from that maintained by the ordinary atmosphere. Until this layer of air has been removed it prevents the absolute contact of the surfaces and consequently proper adhesion of the glue. This thin layer of air may best be observed by dipping a piece of metal or wood in water, when the air may be seen adhering to the object in the form of a silvery film or numerous tiny bubbles. A drop of glue allowed to fall upon a surface of dry wood will seldom adhere to it at all, but if the same drop is rubbed upon it, it will adhere firmly. Thus pressure and friction should be used in using glue. Another point to be remembered is to use just as little glue as possible. If the two pieces are separated by a large mass of glue the strength of the joint will only be that of the glue itself and will not depend upon the adhesion of the two surfaces. Most people make the mistake of thinking that the more glue they use the stronger will be the joint, but as a matter of fact just the opposite is the case and the less glue used the stronger the joint, providing the surfaces are covered evenly with the glue and a perfect contact is obtained. Cleanliness is also of great importance. Dirty, old, sour or spoiled

glue will not make a good joint and the best glue in the world will not hold on pieces of wood that are greasy, dirty, covered with old glue, paint or shellac, or that have fine sawdust or sandpaper-dust adhering to them. If two surfaces of wood that are dirty or coated with paint or old glue are glued together the joint will not be one of wood to wood but of dirt to dirt, or paint to paint, and the joint instead of having the strength of wood will have simply the strength of dirt or old paint. Even the mere rubbing of a wooden surface with dirty hands will prevent the glue from forming a strong joint. Finally remember that glue, being an animal substance, must be kept sweet, and to do this it is necessary to keep it cool after it is dissolved and before it is used. Keep the glue-pot clean and sweet by frequently cleaning out all old glue and replacing with fresh. Good glue requires more water than poor, and consequently you cannot dissolve five pounds of the best glue in the same quantity of water that would dissolve five pounds of poor glue. The best quality will require from one-half to more than double the water required for cheap, poor glue. The quality of glue can be readily ascertained by breaking a piece of the dry sheet. If good it will

break hard and tough and when broken will leave an irregular edge with cracks running from it. If poor it will break easily and will leave a smooth, almost even, edge.

When dissolving glue it is best to weigh the glue and measure the water. If this is not done you can seldom get two batches of glue alike and there is a liability of getting more glue than the water can possibly dissolve. When once the quantity of water that a sample of glue will take up has been ascertained, put the glue and water together at least six hours before heating and if it is not soft enough then let it remain until it is thoroughly soft, for there is no danger in letting really good glue remain in pure water for forty-eight hours. In cold weather you can save time in soaking by keeping your glue frozen. Glue that is frozen is very porous and will soften much quicker than when allowed to merely cool and harden and it is just as strong when heated and used. Good glue can be used very thin and if properly used the wood joint will be as strong as the material itself. There is no advantage in using white glue except in the case of white or light-coloured woods where dark glue would show. White glue is merely ordinary glue bleached.

CHAPTER VI

SHARPENING TOOLS

No matter how carefully you use your tools they are bound to become dull in time, and the most skilful carpenter in the world will fail to produce really good work if he is compelled to use dull tools. It takes a great deal of care and some practice to sharpen tools properly and a great many tools are ruined or made worse than dull by improper sharpening.

It is far better to sharpen tools a little at frequent intervals than to wait until they are very dull and then have to sharpen them a great deal. There is an old saying that a "Good workman never quarrels with his tools," and the reason that this is true is because the good workman keeps his tools sharp and in the best possible condition.

Every tool is designed both in shape, strength and the form of its cutting edge for some specific purpose, and to enable it to perform the work for which it is designed to the best advantage the

cutting edge and its shape must be maintained in its original form.

The most widely used and commonest of all tools is the common penknife, a tool that is used either to cut, split or scrape, but as its duty is primarily and mainly that of cutting, its edge is designed to that end and it should be sharpened for cutting, which will not prevent it from performing the other duties it is called upon to accomplish. If, however, the edge of the knife was sharpened for scraping or splitting it would not serve so well for cutting as a cutting edge would serve for splitting or scraping.

The edge of any cutting tool is in section like a wedge and the sharpness or keenness of the cutting edge depends upon the acuteness of the angle or wedge and upon how nearly we can make the two sides or facets at the thin edge of the wedge meet without danger of turning or bending the edge as well as upon the smoothness and evenness of the edge itself. The difficulty in doing this is due to the weakness of the steel, which if too soft will bend and turn and if too hard will chip and break. In a new tool the acuteness of the wedge or edge is fixed by the maker, and in resharpening the tools we must aim

to maintain this angle or wedge as nearly as possible. If we grind a tool or a knife upon a grindstone and then examine it under a microscope or a powerful lens we will find that it appears like an irregular saw, as shown in Fig. 1. This saw-

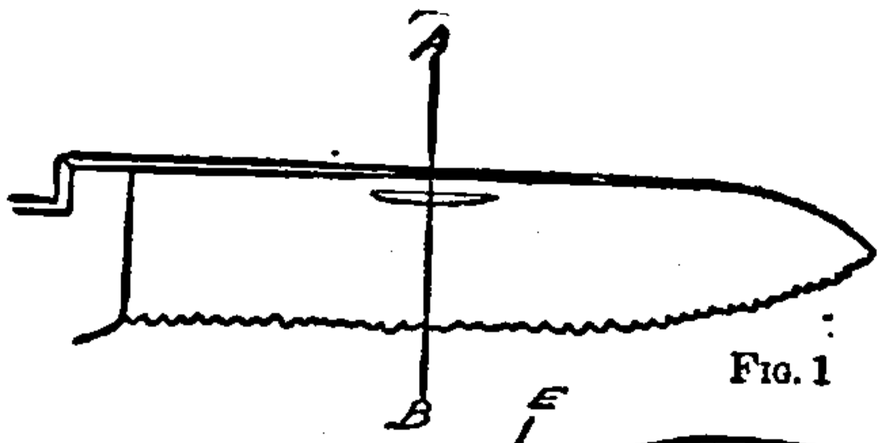


Fig. 1

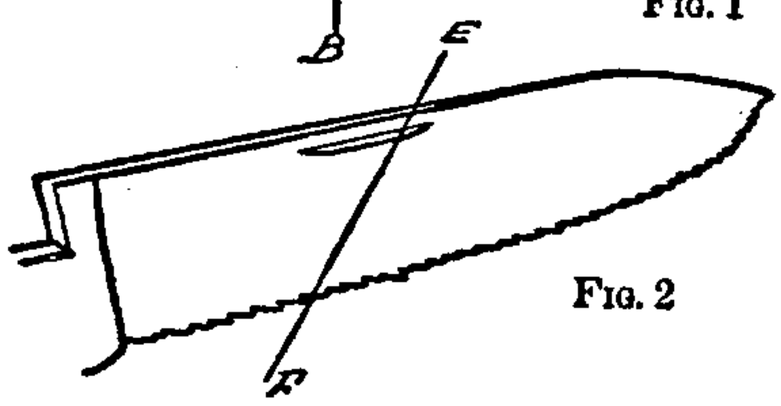


Fig. 2

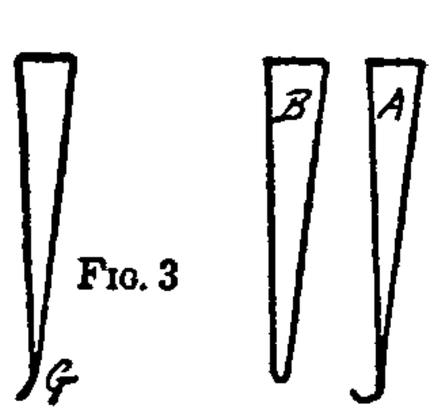


Fig. 3

Fig. 5

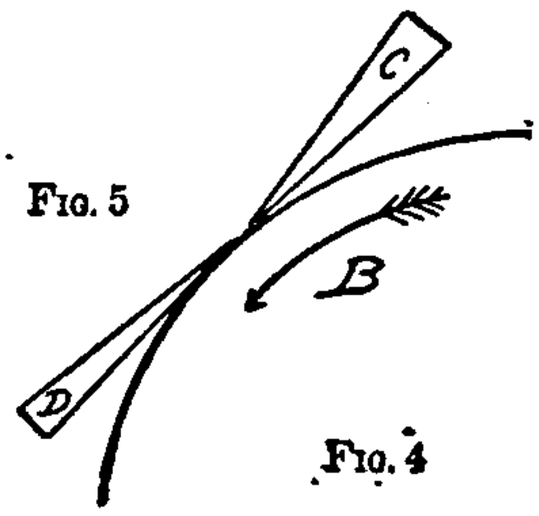


Fig. 4



Fig 6

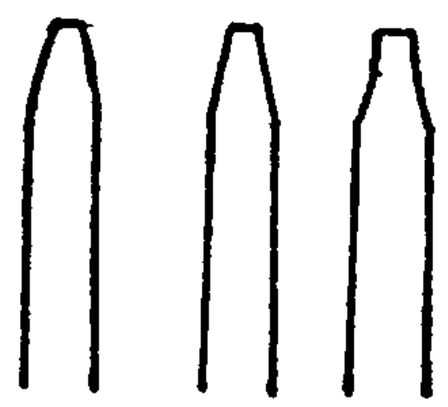


Fig. 10 Fig. 11 Fig. 12

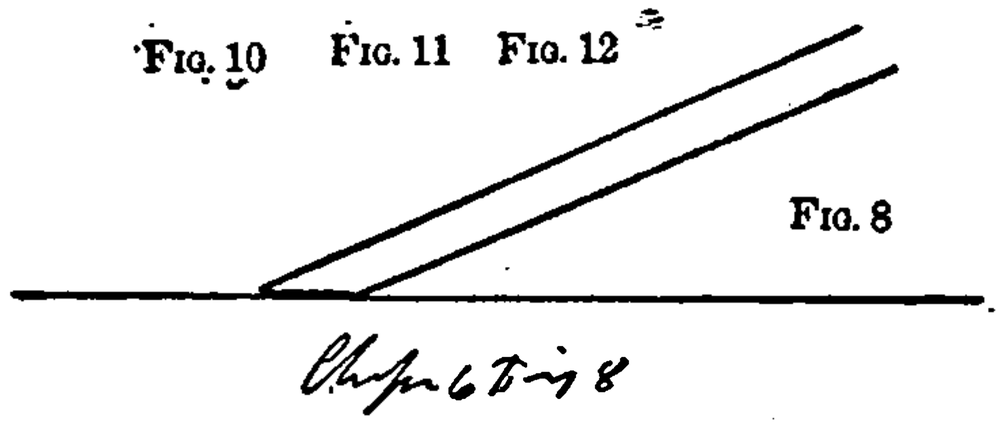


Fig. 8

Chapter 6 Fig 8

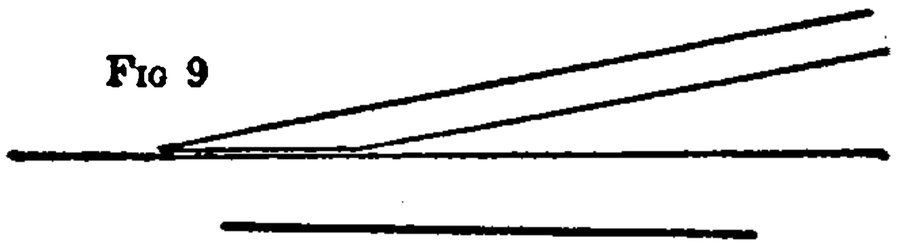


Fig 9

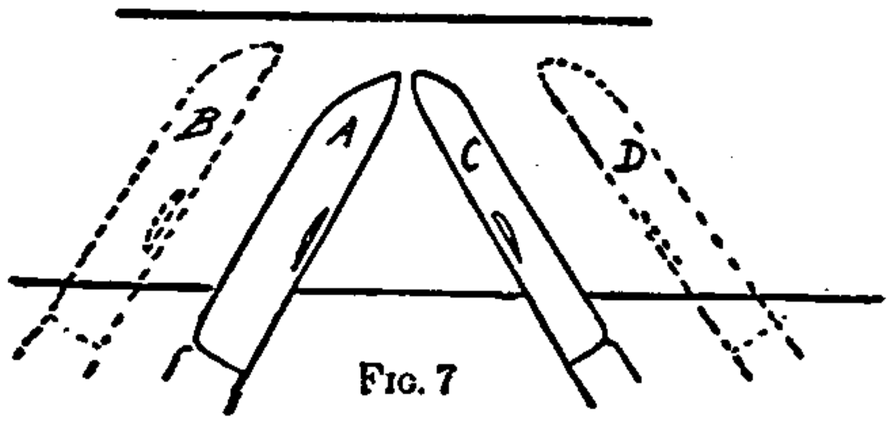


Fig. 7

edge is due to the fact that the surface of the grindstone is composed of innumerable grains, some harder and some coarser than others, and the larger and harder grains cut more rapidly and deeply into the steel than the smaller and softer ones, and within certain limits the harder the blade is pressed upon the stone the deeper and more irregular will be the cuts. In Fig. 1 the blade is shown as it would appear after being

held against a stone with the surface of the latter at right angles to the blade as indicated by the dotted line *A*—*B*, and hence the little teeth on the edge stand at right angles to the blade. If the blade is held at an angle to the stone, as indicated by the line *E*—*F* in Fig. 2, the teeth will be at an angle as shown. Suppose, then, that we hold one side of the blade against the stone in the position shown and the other side at a reversed angle, then the little teeth will cross one another, leaving it less irregular and sawlike than if both sides were ground as in Fig. 1 or Fig. 2, and as the smoother we can get the edge the better the results, we can realise that this is the best position in which to hold the blade. After we have ground both sides if we examine the edge of the blade again we will find that in section it appears as in Fig. 3, the edge being elongated into an extremely thin, curved extension. The reason for this is that the metal is so weak that it bends and gives to the pressure against the stone and the harder that it is pressed against the stone the greater will be this curved, bent elongation. It, therefore, follows that while we may press the blade firmly against the stone when we first commence to grind the blade, it should be

held lightly towards the finish to avoid this bent edge, which is known as a "feather-edge." As soon as we attempt to use a knife or other tool with such an edge the thin, bent portion breaks off, leaving a flat edge to the blade and thus making the tool dull. The amount of the edge that will break off depends upon the pressure applied to the tool and the direction and manner in which it is used, and as the greater the pressure and the harder the work the more will break off it is obvious that tools for light, easy work can stand a thinner edge than tools adapted to heavy, hard work. In order to remove the feather-edge of a knife it should be drawn lightly across a piece of soft wood, first lengthwise of the grain and then across it, after which the blade may be sharpened to keen edge on a fine oil-stone.

There is still another important item in regard to this feather-edge, and that is that the amount of feather-edge obtained depends a great deal upon whether the tool is held pointing toward the direction of rotation of the stone or with it. Thus in the diagram Fig. 4 the blade held against the stone in the direction of rotation as at *C* would have a long feather-edge, whereas the blade held against the rotation as at *D* would have

a very short feather-edge, and therefore the latter is the better position.

Unfortunately, if the stone has a soft spot in it or is at all out of true, the tool may catch and cannot be held steadily and true and a good edge becomes impossible. To obtain a finer cutting edge than is possible to obtain on the grindstone or emery wheel recourse is had to oil-stones. The action of an oil-stone is to smooth and polish the surfaces and thus remove the feather-edge and the sawlike indentations. Although the oil-stone does this, yet if not properly used it leaves another form of turned edge known as a *Wire-edge*, which is shown in section in Fig. 5. In holding the blade to the oil-stone it is necessary to keep the face of the blade as level as possible with the stone as at Fig. 6*B*, while at the same time exerting more pressure near the cutting edge than elsewhere. On the other hand if the blade has been frequently sharpened on an oil-stone without regrinding it may be held at a greater angle as at Fig. 6 *A*, which will result in a more durable and keener edge. No matter what the angle used that same angle must be maintained whenever the blade is sharpened, for otherwise a rounded, dull edge will result as shown in Fig. 5 *B*.

In sharpening a knife blade the motion necessary during the operation is shown in Fig. 7, the motion of one side of the blade being from *A* to *B* and the motion of the other side being shown at *C*—*D*, the blade being frequently turned over and the strokes being short and light to avoid forming a wire-edge.

The same general principles apply to various other tools, except that each tool requires being held at a different angle. Thus a chisel must be held at approximately the angle of its bevelled face as shown in Fig. 8 and must be sharpened only on one side, while a plane iron must be held at a different angle and sharpened on one surface only (Fig. 9). The great secret in sharpening tools is to preserve the original angle of the blade as first made, sharpen frequently, use plenty of oil on the oil-stone, keep the stone clean, use plenty of time and do *not* press too hard on the stone and thus form a wire-edge.

All these directions apply to edged, or cutting-tools, but to sharpen saws is quite a different matter.

If you look along the edge of a saw you will see that the little teeth project over each side of the blade and that the teeth alternate, one pro-

jecting one way and the next the other way and so on. This is known as the "*set*" and is a very important matter. Each kind of saw has a different set and a rip-saw has a much greater set than a cross-cut saw, while a mitre-saw has still less set. The more the saw is set the wider will be the cut it makes and the less accurate the work which can be done with it. If you get too much set on a cross-cut saw it will be difficult to use it, and it will stick and chip in the wood, whereas too little set on a rip-saw will cause it to bind and saw crookedly. Examining the teeth of the saw more carefully you will find that they are not all the same, but that the forward or cutting edges alternate, one tooth being sharpened at an angle on one side and the next on the opposite side. This is an important matter also, for in use each of the teeth acts as a tiny chisel and each tooth, as the saw is pushed against the wood, cuts away a little of the material. If all the teeth were sharpened on the same side the teeth would cut only on one side and the saw would make a crooked cut and in addition would bind and clog.

It is not at all difficult to sharpen a saw after you once know the principle, but in order to do it properly you must have a saw-clamp of some

sort and a three-cornered file for sharpening saws. The clamp may be a ready-made affair which costs less than one dollar or you may use a make-shift clamp by securing the saw in the vise between pieces of wood. In filing a saw it is only necessary to take a little care and follow the angle of the teeth as they have been sharpened in the first place. Always hold the file nearly level; file a few teeth and then turn the saw over and file the alternate teeth on the opposite side, and if they shape up evenly turn the saw back and work with the handle at your left and file all the teeth on that side,—that is, every other tooth. This side finished turn the saw with the handle at your right and file the teeth on this side, which will be the ones you did *not* touch when working at the other side. Be careful *not* to file too much. A single light rub of the file is sufficient if the saw is kept in good shape and filed as soon as dull. Be sure and hold the file at the same angle at every tooth and make a straight, smooth angle on the teeth,—not a curved or rounded edge. It is best to try filing on an old and poor saw until you are adept, for a little carelessness or improper filing will ruin a good saw. In order to set a saw you must have a saw-set,

which is not expensive and is a very handy tool. These are very simple to use, as the saw is merely inserted in the space between the jaws and the handle squeezed, thus bending the tooth to one side. The set is then moved along, skipping a tooth, and the next tooth set and so on with every alternate tooth on one side, when the saw is turned over and the operation repeated with the teeth that bend towards the other side. The only care necessary in setting a saw is to get the amount of set just right, and the only way to determine this is to experiment with an old saw or else ask some experienced person to adjust the set for you.

If you use your saws carefully and take care not to drop them, bang them around and avoid sawing against nails, grit, metal, etc., your saws will give good service for a very long time before they require setting at all.

Another tool which requires frequent sharpening, and which is frequently ruined by improper sharpening, is the screw-driver. It may sound funny to talk of sharpening a screw-driver, for a screw-driver is usually considered a very dull tool, but unless this useful instrument is kept properly sharpened it will perform very poor

work and you will injure many a screw-head by the driver slipping from the notch.

In driving a screw into wood the force used to press the screw-driver against the head of the screw tends to aid the latter in penetrating the wood, but when we attempt to extract a screw every pound of pressure we apply tends to render it more difficult to get the screw out. It therefore becomes very important that the screw-driver should be so formed that it will retain its position in the notch of the screw with the exertion of a very little pressure. If it has a tendency to slip out we can only keep it in position by applying more pressure, and each time it slips it mars the edges of the slot and its own edge and thus requires still more pressure to keep it in place. If we examine a screw-driver in the condition in which it is ordinarily found we will find that in section it appears somewhat as in Fig. 10, with the sides of the wedge-shaped end somewhat convex. Now the effect of this curve is to render the tip more obtuse, and when the driver is turned the tendency is for the screw-driver to slip from the slot and this tendency will increase in direct proportion to the amount of convexity that is found on the sides of the blade. This form, there-

fore, is the worst that can be used for a screw-driver and yet it is the commonest in drivers that have been used or sharpened frequently. In the hands of good carpenters we will find that the blades of their screw-drivers are perfectly straight as in Fig. 11. This is a great improvement over the other, but it is far from the best form, which is with concave sides as shown in Fig. 12. Now and then we will find a carpenter or a mechanic with screw-drivers sharpened to this form, and to use such a tool is a pleasure. Such a screw-driver will seldom or never slip from a good clean slot and screws can be extracted with scarcely any pressure being exerted to keep the tool in position. To sharpen a screw-driver in this form is almost impossible without a small grindstone or emery wheel, but the next best form with straight sides can be obtained on an ordinary grindstone or oil-stone.

CHAPTER VII

WOODS AND THEIR PROPERTIES

EVERY carpenter should know something of the properties and peculiarities of various woods. Only in this way can he know which wood is the best adapted to the work he has in hand. In a general way woods are divided into two classes, hard woods and soft woods, but many of the so-called soft woods are quite hard and several of the so-called hard woods are really quite soft. Pine, spruce, hemlock, cedar, cypress and similar woods are the commonest soft woods, while oak, beech, birch, maple, walnut, mahogany, rosewood, etc., are hard woods. In reality black-walnut is not very much harder than various soft woods, while mahogany and Spanish cedar are soft and easily worked. Each and every wood is particularly adapted to certain purposes, but in addition a great many woods are known as "cabinet" or "finishing" woods, as they are mainly used for the purpose of ornamental work or finishing. Each wood has some properties peculiar to it-

self, but many possess properties common to several varieties. In such cases it often makes very little difference which one of several woods is used, but in other cases some certain variety must be selected to fulfil all requirements. Among the most noteworthy properties of the commoner commercial woods and the purposes for which they are most widely used, are the following:

Elasticity: Ash, hickory, hazel, lancewood, chestnut, red-cedar, yew, snakewood, apple, orange, Oregon-spruce, spruce, fir.

Elasticity and toughness combined: Oak, beech, elm, lignum-vitæ, walnut, hickory, ash, hornbeam, apple.

Even grain for carving or engraving: Pear, pine, apple, box, orange, lime-tree, black-walnut, beech, birch, maple.

Durability in dry work: Cedar, oak, poplar, yellow-pine, chestnut, white-pine, cypress.

Ship and boat building: Cedar, white-pine, fir, elm, oak, locust, teak, mahogany, Spanish cedar, cypress.

Durability in contact with water: Oak, cypress, white-cedar, teak, mahogany, Spanish cedar, elm, alder, beech.

House building: Pine, oak, whitewood, chestnut, ash, spruce, sycamore, cypress.

Machinery and millwork: Ash, beech, birch, pine, elm, oak, hickory, maple.

Tools: Beech, birch, pear, maple, apple, box, elm, cherry, locust.

Rollers, etc.: Box, lignum-vitæ, hickory, oak, birch, maple, ash.

Foundry patterns: Alder, Spanish cedar, white-pine, mahogany, whitewood.

Furniture: Beech, birch, cedar, cherry, pine, black-walnut, whitewood, maple.

Cabinet work: Mahogany, black-walnut, tulip-wood, ebony, teak, walnut, oak, rosewood, satin-wood, cedar, Circassian walnut, bird's-eye-maple, curly-birch, etc.

By this it will be seen that certain woods are used for a great variety of purposes and are almost equally well fitted for all the uses, whereas others are so much better adapted to some particular purpose that they are seldom used for anything else. Hard woods and fancy or ornamental woods with crooked or curly grain are difficult to work and are very expensive and as a general rule it is far better to use the commoner softer and cheaper woods and either stain or finish

them to imitate other woods or else bring out their own natural beauties. Style and custom have a great deal to do with the woods used for ornamental or fancy work. At one time black-walnut was very stylish; mahogany and rosewood have had their days; light-coloured woods, such as bird's-eye-maple and curly-birch, came into vogue and Circassian walnut was all the rage at one time. From year to year the styles change, but all woods are beautiful if properly finished and even a piece of plain white-pine, if oiled and varnished, has a lovely appearance.

If woods are to be stained to imitate some other variety, the kind of wood to be used must be selected with reference to this, for it is impossible to stain a coarse-grained wood to imitate one with a fine grain or vice versa.

When staining wood it is not only important to know how to prepare and apply the staining solutions; the operator must have a knowledge of the properties of the various woods and their relation to the stains themselves, for with the same stain very different effects may be produced when applied to various kinds of wood.

This is partly due to the porosity of the wood, but more to the varying chemical composition of

the timber itself. The greatest factor is the presence or absence of tannin, which has a chemical action upon many stains and alters their colours. As an example, a piece of pine or fir, which contains but little tannin, when stained with a weak solution of chromate of potash becomes a pale yellow which will soon fade. The same solution, however, when used upon oak, which is rich in tannin, produces a beautiful brownish-yellow which is quite durable, for the tannin of the wood combines with the potassium chromate to form a brown dye in the wood-cells.

The same principle occurs in the case of other stains, such as sulphate of iron, which scarcely shows at all on pine or fir, but which in contact with the tannin in oak or walnut produces a light blue-grey.

The hardness or softness of wood or its porous quality also has a great influence upon the resulting effect of stains. Soft woods with large pores absorb more stain and the latter sinks deeper into the wood than in the case of hard, close-grained woods, and hence when staining soft woods you must use weaker stains to produce the same tint or shade than when treating hard woods, or else a stain of a less penetrating or greasier

character must be used or the wood must first be treated to prevent it from absorbing too much stain.

Even the same stain when applied to the same kind of wood does not always produce the same shade or effect. The wood varies as to the amount of sap or rosin it contains according to the soil in which the tree grew, its age and the season at which it was felled, and as rosin resists the penetration of the stain the colour may be lighter or darker according to the amount of resinous material in the cells of the wood. Moreover the colour of the wood itself varies and one may find all sorts of shades of pine, oak, walnut, etc. Each of these shades will appear different when stained, and if you wish to stain several pieces of wood to match up you must select pieces of the same shade and of the same quality as regards sap or rosin, porosity and chemical composition or else must adapt your stains to produce the desired result in pieces of varying character.

These facts all render it difficult to obtain exactly the desired colour or tint in a stain at the first attempt, and for this reason you should try the stains on sample or specimen pieces of the

wood before trying them on the finished article. In many cases also the final colour cannot be judged until some time after the stain is applied, for many stains develop their ultimate colours slowly under the action of the air and the chemicals in the wood and oftentimes the colour changes appreciably for forty-eight hours or more after applying. Hence wood that has been stained should be allowed fully forty-eight hours after being stained before the final varnish, oil or polish is applied. If any dampness is left in the wood when the varnish is used it will later manifest its presence by producing a dull or whitish spot on the finished surface. Moreover it is usually wiser to give several thin coats of stain to obtain a desired result rather than to attempt to obtain the full depth of colour with one application of a strong stain. In such cases each coating should be given ample time to dry thoroughly before applying the next coat. Another item also enters into the successful art of wood-staining. Many dyes which are widely used cannot be mixed or combined, and this is particularly the case with the aniline or coal-tar colours, and as many of them are apt to fade they should be avoided as far as possible and only true, fast, chemical,

mineral or vegetable colours should be used for durable work.

Many wood stains, especially those known as "water" or "spirit" stains, have a tendency to roughen the surface of the wood, but this can be remedied either by treatment of the wood before staining or by sandpapering afterwards. The latter process lightens the colour of the stain, but it brings out the grain well. The best method of preparing the wood beforehand is to dampen it thoroughly with warm water applied evenly with a sponge and after it is thoroughly dry sand-paper it smooth. Many stains are so rapidly and readily absorbed by the wood that it is difficult to stain the material evenly on a large surface. This may be overcome by rubbing the surface of the wood with raw linseed oil applied with a woollen rag and allowing it to thoroughly dry, after which the surface is sandpapered smooth. After this treatment the stain will spread evenly and will be less readily absorbed.

The following formulas will be found useful and reliable in producing stains of various shades or in imitating well-known woods, and the amateur carpenter will find a great deal of interest and pleasure in producing the colours and effects of

rare and expensive woods on plain pine, spruce, whitewood, etc. But you cannot get the desired effect unless you use care in selecting the wood in reference to the similarity of its grain to that of the wood you wish to imitate. For mahogany, plain whitewood, beech, birch, cherry and similar close-grained woods should be used. For black-walnut, whitewood or fine-grained pine; for ebony, use a hard, fine-grained wood or whitewood; for rosewood select ash, oak, cypress or coarse-grained pine, and so on with each particular wood you wish to counterfeit.

Ebony Stains

1. To one pint of boiling water add ¾ oz. of copperas and 1 oz. of logwood chips. Apply to wood when hot. When thoroughly dry wet the surface with a solution composed of 7 oz. of steel filings dissolved in ¼ pt. of vinegar.

2. Treat the wood with several applications of a strong decoction of logwood chips and when dry treat with vinegar in which rusty nails have been soaked for a week or more.

3. In 1 qt. of water boil ¼ lb. of logwood chips and add ½ oz. of pearl ash and apply the mixture hot. Then boil the same quantity of logwood in

the same amount of water, adding ¼ oz. of verdigris and ¼ oz. of copperas, after which strain and add ¼ lb. of rusty steel filings. With this latter mixture treat the wood already stained and repeat the application until the desired depth of black is obtained.

Rosewood

1. Boil ½ lb. of logwood in 3 pts. of water until the liquid is very dark and then add 1 oz. salt of tartar. When at the boiling point stain the wood with two or three coats, letting each coat partly dry before applying the next.

2. Treat as above and rub with asphaltum dissolved in alcohol or turpentine.

Walnut

1. Prepare a solution of 6 oz. of permanganate of potash and 6 oz. of sulphate of magnesia in 2 qts. of hot water. Apply the solution to the wood with a brush, allow it to dry and give a second coat.

2. Dissolve 1 part (by weight) of extract of walnut peel in 6 parts warm water, heat to boiling point and stir. Apply one or two coats of this to the wood while warm and when half dried brush over with a solution of 1 part (by weight) of

bichromate of potash in 5 parts of boiling water.

3. One part permanganate of potash dissolved in 30 parts clear water. Stain the wood with two coats and after five minutes rinse off with plain water, dry and finish. A fresh solution should be prepared each time.

4. Asphaltum dissolved in alcohol or turpentine and rubbed in until desired shade is produced.

Oak

1. Dark or antique oak effects may be produced on oak by the use of bichromate of potash dissolved in cold water and applied in repeated coats until the desired effect is obtained.

2. Very dark weathered oak effects may be obtained by the use of the following: 4 oz. of logwood chips and 3 oz. green copperas boiled together in 2 qts. of water for 40 minutes and applied hot. When dry wash with a solution of 4 oz. of steel filings dissolved in 1 pt. of strong vinegar.

3. Oak may be darkened by using the walnut stains already given, or other woods may be stained to imitate oak by using the walnut stains in thin solution.

4. Dissolve $\frac{1}{4}$ part of permanganate of potash in 1,000 parts of cold water and coat the wood with

the violet solution obtained. The tannin in the wood will alter the stain to a rich golden-brown. Sponges or glass-thread brushes should be used with this solution, as it destroys bristle-brushes.

5. Silver-grey or mission-grey is obtained by dissolving 1 part of pyrogallic acid in 25 parts of warm water and using this to coat the wood. When dry treat with a solution of 2 parts green vitriol in 50 parts of boiling water.

6. Grey is also obtainable on oak by using a solution of 20 parts of copperas dissolved in 1,000 parts of water.

7. Asphaltum dissolved in alcohol and applied thin will give a rich brown.

Mahogany

1. Dissolve powdered red sanders (obtainable in any drug store) in alcohol, using about 2 oz. of the sanders to 1 qt. of spirits. Strain and apply with a brush or rag. Thin the solution according to the colour you wish to obtain. A very dilute solution will produce the appearance of cherry or dark oak or Spanish cedar, while a browner tint may be obtained by adding a little asphaltum varnish or by rubbing with asphaltum in alcohol.

2. 1 oz. socotrine aloes; ½ oz. dragon's blood;

rectified or pure alcohol, 1 pt. Dissolve, strain and apply one or more coats according to shade desired.

3. Logwood, 2 oz.; madder, 8 oz.; fustic, 1 oz.; water, 1 gal. Boil for two hours and apply several coats while hot. When dry brush over with a solution of pearl-ash, 1 oz. in 1 qt. of water.

4. Rub the wood with a solution of nitrous acid and then with a brush apply the following: dragon's blood, 1 oz.; sodium carbonate, 6 dr.; alcohol, 20 oz. Strain and filter before use.

5. Rub the wood with a sclution of potassium carbonate in the proportion of 1 dr. to 1 pt. of water and then apply the following: Madder, 2 oz.; logwood chips, ½ oz.; water, 1 qt. boiled and strained.

Maple

1. Pale button-lac, 3 lbs.; Bismarck brown, ⅛ oz.; Vandyke brown, ½ oz.; gamboge, 4 oz.; methylated spirits, 1 gal.

2. One gal. methylated spirit; 4 oz. powdered gamboge; ½ oz. Vandyke brown; 1 dr. Bismarck brown; 3 lbs. shellac.

3. A weak solution of any of the walnut stains recommended.

Beech

See *Mahogany.*

Cherry

See *Mahogany.*

Spanish Cedar

Weak red sanders solution and thin solution of asphaltum varnish dissolved in alcohol.

Yellow of various shades may be obtained by the use of picric acid solutions or of gamboge dissolved in alcohol.

Browns of almost any tint may be obtained by using asphaltum dissolved in alcohol or turpentine and rubbed in with a rag.

Combinations of the red sanders and asphaltum stains will produce nearly any desired shade of red-brown, brown or deep red, and if used very dilute, almost any of the lighter-coloured reddish or brownish woods may be imitated.

Spirit Stains

Black

1. White shellac, 12 oz.; vegetable black, 6 oz.; methylated spirit, 3 pts.

2. Lampblack, 1 lb.; ground iron-scale, 5 lbs.; vinegar, 1 gal.

Brown

Alcohol, 2 pts.; burnt-umber, 3 oz.; Vandyke brown, 1 oz.; carbonate of soda, 1 oz.; potash, ½ oz.

Varnish Stains

Shellac is the chief basis of varnish stains, the colouring matter being either aniline dyes or dye-woods. A little elemi resin should be added to the mixture, as ordinary rosin is brittle and prevents the varnish from drying rapidly.

Water Stains

These may be made of chemicals, aniline dyes or vegetable dyes as already directed for several stains described above. In addition to these there are Cassel and nut brown in granules, while catechine is also good. For bright-coloured dyes the only things are aniline or coal-tar dyes such as *azine green, croceine scarlet, Parisian red, tartrazine, orange 'G,' water-soluble nigrosin, walnut and oak-brown.* For *blue* or *violet* use *methyl blue, naphthol-blue,* and *pure-violet* and when dry treat with a solution of nutgalls or tannin.

After the wood is stained and dry it should be smoothed with fine sandpaper, rubbed with oil, varnished or wax-finished, according to the purpose and style of finish desired.

Very beautiful mottled or grained effects may be obtained upon wood by the judicious application of heat. Fine sand heated almost red-hot and scattered irregularly upon light or dark woods will give splendid "curly" or mottled effects, while a piece of red-hot iron bar held here and there close to the surface of wood will make imitation "bird's eyes." The same effect may also be produced by using drops of acid, such as nitric or sulphuric acid, and when the proper depth of colour is obtained washing with strong soda solution. Pine and other woods may be made exceedingly ornamental by going over them with the flame from a common gasolene blow-torch such as plumbers use. If the flame is not held too long in one spot and is passed back and forth over the wood the grain will appear in rich brown on a golden background the depth of colour depending upon the heat applied.

There are various ways of finishing woods and each method has its advantages and is particularly suited for certain classes of work. Wood may be

painted, varnished, polished, oiled, waxed or shellacked, but as a rule the best method to follow is that which is the most durable and at the same time the most attractive. Where fancy or ornamental wood is used or where the wood is of good quality it is a pity to hide its natural beauties with paint, for even the commonest woods when well finished with oil or varnish are very beautiful. Paint is all very well in its place and for rough work or where poor wood is used or where it is exposed to weather there is no better finish, but for inside trimmings, cabinets and furniture, or wherever possible to do so, aim to finish the work with oil, varnish or wax, and thus bring out the natural beauty of the wood and its attractive grain. If you use a varnish use a good one. Cheap varnishes do not pay. The very best is the cheapest in the end. Remember that oiling wood darkens it and even if it does not darken it at once the wood will grow darker and darker with age. Shellac should never be used where wood is exposed to water or dampness, as water turns shellac white. A splendid finish may be obtained by merely rubbing with oil, and this gives a dull satiny surface which withstands hard wear and which may be readily touched up and refinished

at any time merely by rubbing with oil. Highly varnished or polished surfaces are easily scratched or marred and are hard to keep in good repair, but a rubbed-varnish surface is very durable. It is slow, hard work to produce a rubbed varnish surface, however, and few amateurs care to attempt it. If the wood is porous or the grain open it should be given a coat of some good filler before applying the varnish or oil.

When oiling wood use plenty of force and rub hard and when varnishing use a good soft brush with bristles which will *not* come out and do the work in a warm, dry room free from dust and do not touch it or disturb it until completely dry and hard. The great secret in varnishing is to use good varnish, good brushes, keep the work clean and free from dust and do not hurry the work. The best and most durable varnishes are slow-drying. If the first coat is not smooth or shiny enough rub it down with pumice stone and water and apply a second coat. This may be given a dull satiny surface by rubbing again and almost any degree of glassy smoothness or high gloss may be obtained by applying successive coats of varnish and rubbing down each one before applying the next. Nearly any dealer in paints, etc.,

can tell you the best varnish or oil to use for your work and can furnish you with detailed directions as to their use.

A great deal of the most expensive furniture is finished with a so-called French Polish. This is nothing but high-grade shellac rubbed down with a wad of cloth by hand. It is hard, slow work and requires an immense amount of skill and practice and is not worth the trouble for your amateur purposes. A good smooth varnish finish, if carefully laid on, will do just as well. Still another sort of finish is the "Rubbed Varnish," which gives a beautiful satiny, mirror-like surface often seen on pianos. This is obtained by giving the articles repeated coats of varnish and rubbing each down to a perfect surface with pumice or rotten-stone and water. Almost the same effect can be obtained much easier and more cheaply with some of the ready-prepared wax polishes, however, and for your purpose these will answer just as well.

CHAPTER VIII

CARPENTRY ABOUT THE HOUSE

I HAVE already told you how to put up a shelf for your workshop and while rough and ready shelves of this sort do very well for cellars, garrets, storerooms and other out-of-the-way places they would not serve in living-rooms, dining-rooms, kitchens or other places where shelves are frequently required. In such places shelves must be made neatly and must conform in style and finish to the rest of the room. If the room is in the Mission style the shelves should be in the same style, both in form and finish and so with every other style of room furnishings. Corner shelves are quite easy to make, as they are fitted snugly into a corner and may be easily and neatly secured in position, but even in putting up corner shelves you should aim to make the job as neat and artistic as possible and should have them in harmony with the other fittings. As a rule shelves should be made in units, so they may be readily taken down instead of being built into a room permanently. Where screws or nails are to be driven into a

plaster wall small holes should first be made and you should be careful to strike a lath or timber, for if merely driven into the plastering the support will not hold and moreover the plaster is likely to break and chip away. By using a light hammer or mallet and striking here and there on the wall a lath or timber may usually be located by the sound, but if this cannot be done a very fine brad-awl may be run carefully into the plaster here and there until a lath is located. The very small hole made by the awl may be readily plastered or filled up, and if in paper it will not be visible.

Wherever possible attach the shelves to other woodwork. Oftentimes at least one support may be screwed to a window-frame, a corner moulding, a mantel or some similar wooden object. Shelves should be fastened in such a way that the screws or nails and cleats are concealed or at least are not prominently in view.

Single shelves may be put up with ready-made iron brackets where appearances do not count for so much as utility, or brackets made of wood in conformity with the rest of the furnishings of the room may be used. Light shelves may often be hung to a wall, especially a wooden wall, with

hooks, or eyes over screws, driven into the wall. Such shelves are easily removable and in many cases are superior to any other form. Where shelves are placed one above another a very neat method is to let the ends of the shelves set into slots or recesses in the end pieces, which are held together either by fastening them directly to the

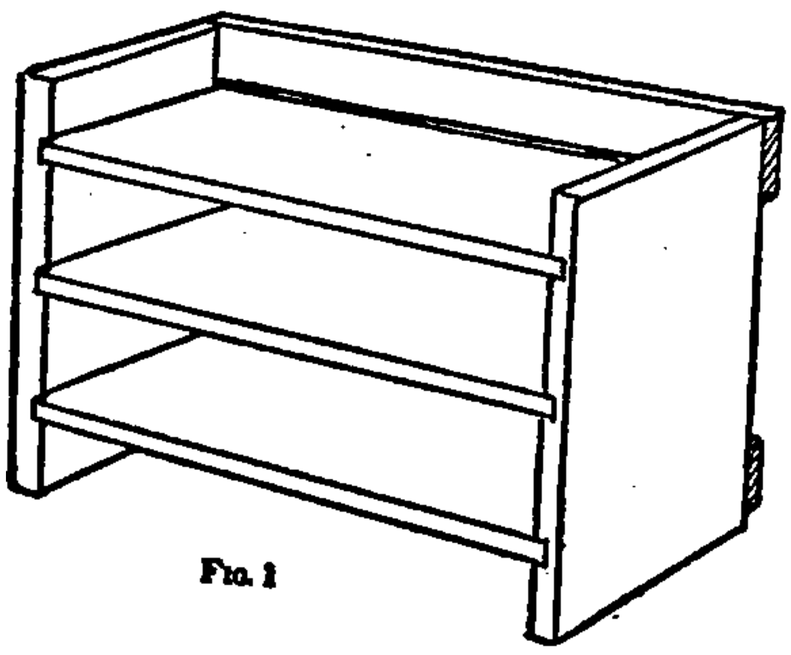


Fig. 1

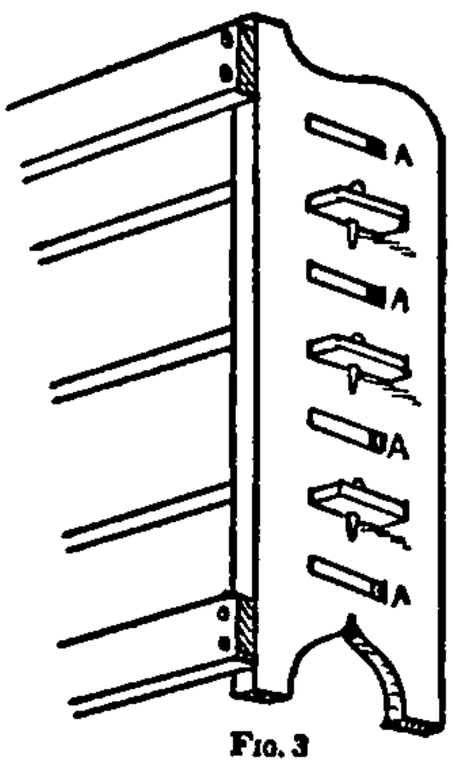


Fig. 3

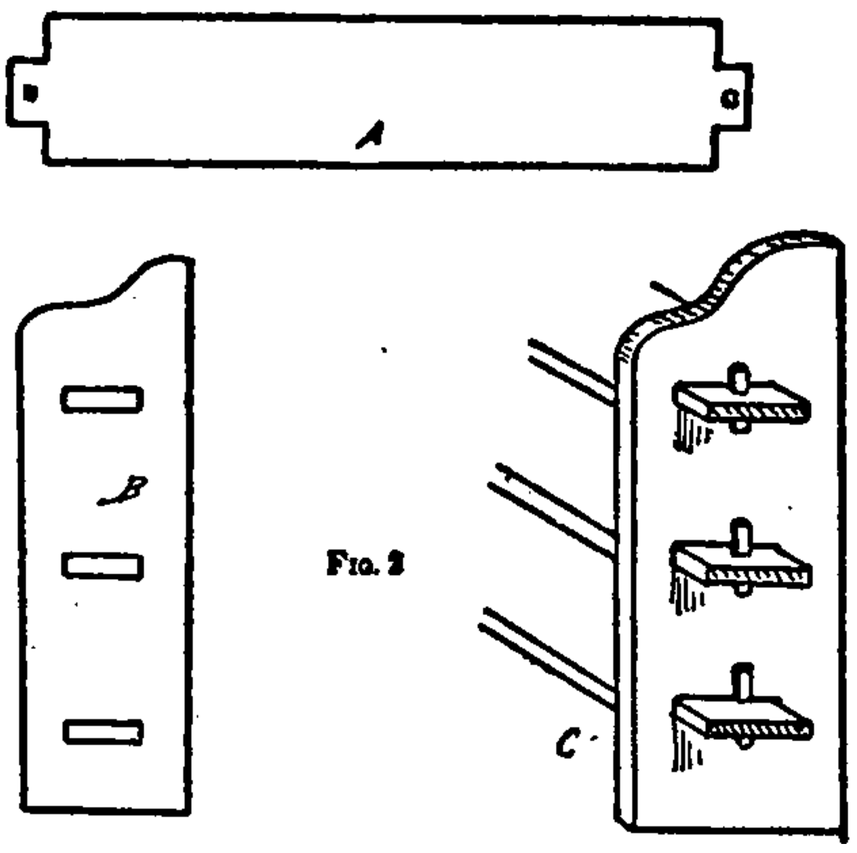


Fig. 2

shelves or by tie-pieces across the back and front edges (Fig. 1).

Shelves which may be readily taken down and packed flat may be constructed as illustrated in Fig. 2. In this case the ends of each shelf are cut away as shown in *A* and rectangular holes of the proper size are cut through the end pieces, *B*. Through the projecting ends of the shelves wooden wedges are thrust and thus the end pieces are kept securely locked in position (*C*). Such shelves may be hung with hooks to screws or may

be fastened to the wall through a back piece or cleat. The same method may be followed in constructing book-shelves or music-racks to stand on the floor but in this case rigidity must be obtained by a cross-piece at top and bottom which should be attached to the sides with screws (Fig. 3). By making a book-shelf in this way and cutting holes through the ends at frequent intervals (*A*), the shelves may be adjusted at varying distances apart to accommodate books of any size.

When shelves are protected by doors they become cupboards and if constructed with doors they must be more accurately and more carefully made than plain open shelves. Unless all joints are carefully made and all parts squared up true, doors will catch and bind or will sag and appear slovenly. Care is also necessary in fitting hinges and locks. There are a great many kinds of hinges in the world and they vary from crude pieces of leather nailed on the door to beautifully wrought ornamental metal affairs. Hinges may be divided into numerous classes some of which are made in two detachable parts. These are known as "loose butts" and are frequently used on doors, but for small cupboards, boxes, etc., they are not necessary. For cupboards, chests, boxes

and other household furnishings you may use either ornamental hinges which are fastened on the outside of the object where they will show well or plain metal hinges which are to be fastened on the inside of the articles where they are out of sight. Fig. 4 shows examples of both of these. In setting a hinge you should take care to place it so that it opens properly and in the direction intended by its construction. Thus in Fig. 5 the hinge will open but one way, as the ends of the leaves *AA* prevent the hinge from swinging in the opposite direction, as shown in *B*. Another style of small hinge is shown in Fig. 6 *A*. In this case, if the hinge is placed as illustrated, it will lie perfectly flat when the lid or door is closed whereas if placed wrongside up as in Fig. 6 *B*, the lid cannot close tightly and the hinge will be bent or injured. Where the lid of a large box or trunk is hinged some arrangement should be made to prevent the lid from swinging too far back and thus injuring the hinge or splitting off the wood. Light, metal pivoted pieces may be bought ready-made for this purpose, but strips of strong canvas or thin leather straps fastened neatly to the cover and the interior of the box will do just as well (Fig. 7). Unless hinges are set perfectly

parallel and true the door or lid will not open and shut properly and a little care in this matter will save a great deal of future trouble and annoyance.

Where hinges of the type illustrated in Fig. 8 are used, they should be set in flush with the wooden surface as in Fig. 8 *A*, for otherwise the door or lid when closed will have an opening between itself and the box or closet and the whole

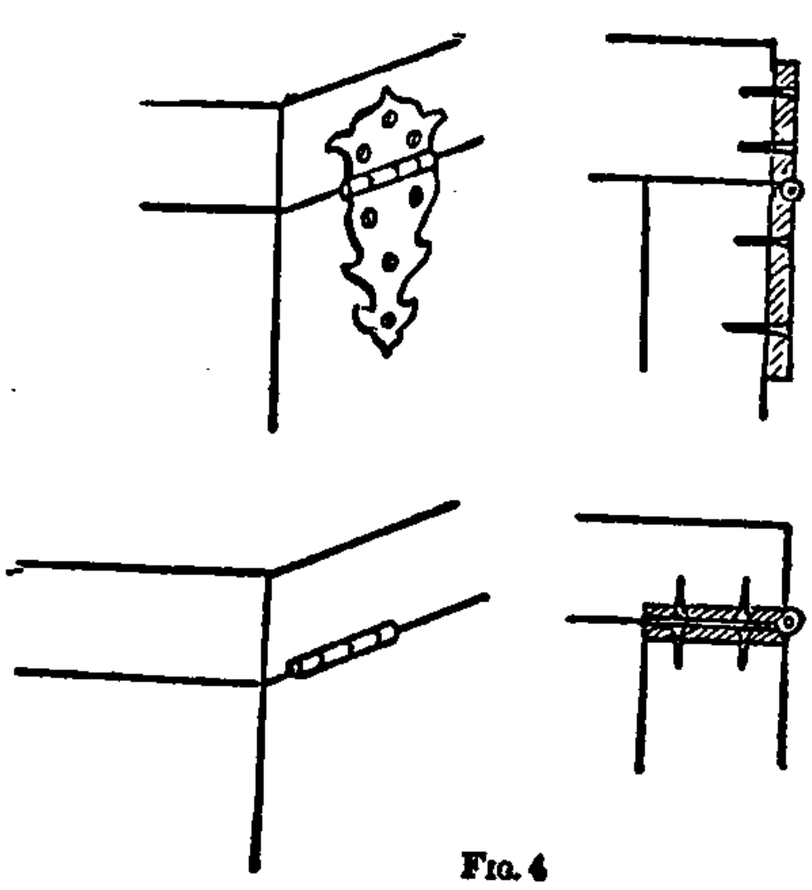


Fig. 4

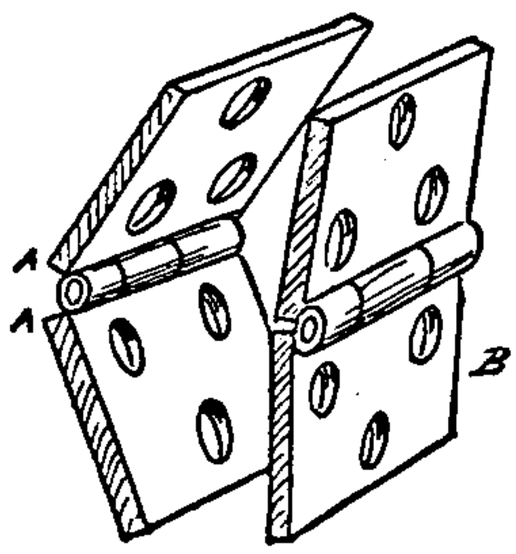


Fig. 5



Fig. 8

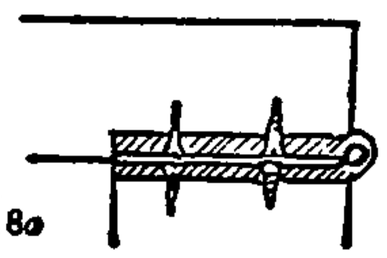


Fig. 8a



Fig. 6

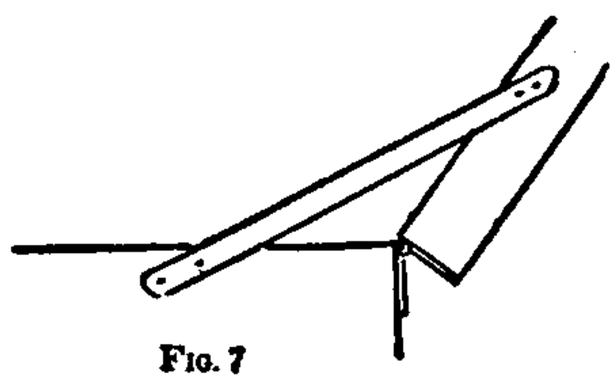


Fig. 7

job will appear slovenly and improperly made. Do not use hinges that are too light or too small and if the material is too thin or delicate to permit the use of good strong hinges, use several small ones.

In placing locks or fasteners on box covers, lids of chests or cupboard doors try to make the job as neat and workmanlike as possible. Ugly, rough locks screwed on the outside of an other-

wise neat and attractive object are eyesores. Wherever possible use a concealed lock and set it into the wood by mortising, and if this cannot be done use a lock which is attached to the inside of the chest or closet out of sight. Aim to have locks, hinges and handles in harmony. A chest or cupboard with ornamental brass hinges should have lock and handles of the same general style. Sometimes a very plain box or cupboard may be made quite artistic and attractive by using fancy metal work and as a rule this ornamental hardware is easier to attach than the kind which is mortised or let into the wood and is concealed. If you keep your eyes open and look carefully at various articles of furniture, closets, cupboards, chests, etc., you will soon see how professionals handle these little items and will obtain many useful and valuable hints in this way. It is the same with other branches of carpentry; notice how others have accomplished results and try to pattern your work after them.

In every household, furniture is constantly being injured and broken and while furniture repairing is an art in itself and to mend furniture of the higher grades calls for the services of an expert, yet there are many occasions when one

handy with carpenter's tools can mend broken chairs, tables, beds, etc., and save the expense of sending them out to a professional.

A great deal about furniture repairing may best be learned by a careful study of the furniture itself, and in a great many cases you will have to depend largely upon your own ingenuity and inventiveness in order to make strong and durable repairs that will be neat and practically invisible. As a rule do not attempt upholstery work; this is a special trade and can be better intrusted to the hands of some one who makes a specialty of it. In a great many instances, however, the upholstery must be wholly or partially removed in order to make repairs and when this is necessary the best method to follow is to note carefully how the upholstery was put on in the first place and replace it in the same way. For the present, however, we may confine ouselves to that class of repairing which depends wholly upon carpentry work, for this is what will interest the amateur carpenter and afford an opportunity for him to exhibit his skill and ingenuity.

Perhaps the most important item in successfully repairing furniture is to have good, strong, well-prepared glue. In mending furniture the great-

est dependence is placed on glued joints, which may be further reinforced by dowels, screws, etc., but nails should be used as little as possible. Many fractures of furniture are jagged, irregular and with small pieces broken off. If all these pieces are saved the fracture can usually be repaired so as to be almost invisible and very strong, but even when these are missing a good job can usually be done. All holes, cracks, uneven places and cavities left by missing chips may be filled with cement prepared by melting beeswax (cut into flakes) with crushed resin and adding dry pigment to match the wood. Use umber for walnut, Venetian red for mahogany, yellow ochre for birch, etc., and lampblack for ebony. The cement is dropped into the cavities when melted and is smoothed off when hard. If it is too brittle use more wax and if too soft more resin and only just enough colour to obtain the proper shade. You will also require one or two wooden carpenter's clamps (Fig. 9), and a few small iron clamps (Fig. 10).

One of the commonest injuries to household furniture is a broken rocker to a rocking-chair. In a great many cases it is cheaper to buy a new chair or a new rocker than to repair the old one, but it is good practice and a broken rocker can

be repaired so as to be as strong as new. The method to be followed is shown in Fig. 11. As the rocker is broken where the leg enters it, it is impossible to obtain a good strong joint at that spot, so the rocker is removed from the chair, the two pieces fitted together closely and the whole placed side down upon a piece of paper or cardboard.

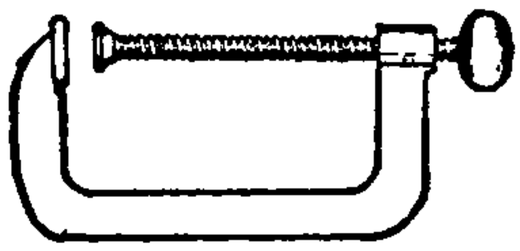


FIG. 10

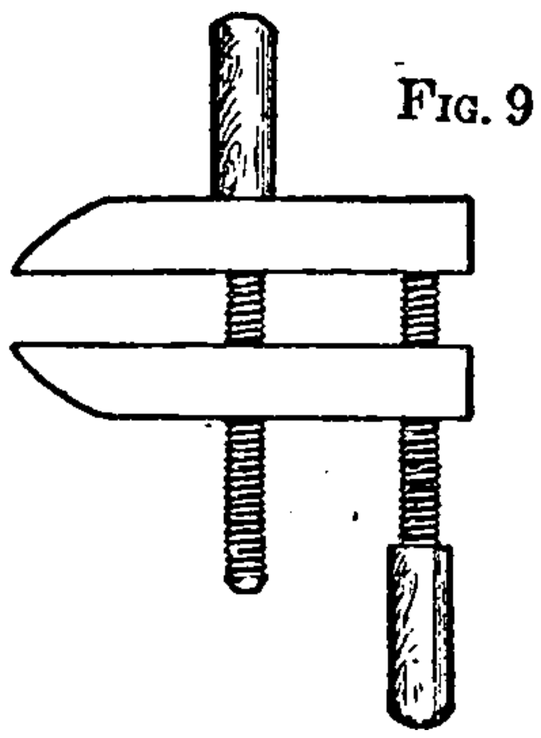


FIG. 9

An outline of the rocker is then traced on the card and the rocker is cut off at an angle in front of the broken spot (Fig. 11 *A*). The end is then cut into the form shown in Fig. 11 *B*, and a new piece is cut from hard wood using the cardboard pattern as a guide to replace the portion cut away as well as the broken end. This new piece is joined to the forward half with the halved-joint shown in Fig. 11 *C*, and is firmly glued and still further strengthened by a screw driven from the inner side and countersunk into the wood, the space over the head being filled with cement.

Oftentimes a chair may be unbroken and yet be so loose and rickety in all its joints that it is unfit for use. The only thing to do in such cases is to take the chair apart, clean off all old glue and re-glue all the joints. Where the joints are very loose they may be secured by fine finishing-nails driven through them, first making holes with a drill or brad-awl, while loose joints in uprights where they enter the seat may be expanded by driving small wedges into the lower sides as shown in Fig. 12.

Very often one or more of the posts or uprights of a chair become broken off in the holes in which they are fitted. This is a simple break to repair, although one often sees such fractures nailed or glued together in a most slovenly and slipshod manner. To repair such a break properly, first remove all particles of old glue and wood from the hole and saw off the broken end of the upright evenly. In the centre of the upright bore a straight hole for about an inch in depth and as nearly the same diameter as the end of the upright as possible (Fig. 13). Into this hole fit a round peg with the projecting end the diameter of the hole in the back of the chair and glue it firmly in both the upright and the back.

Still another common break in chairs is when a piece splits out of the seat where the uprights enter (Fig. 14). To repair such a break first trim the break smooth and even and secure the upright in the hole by means of glue and a screw

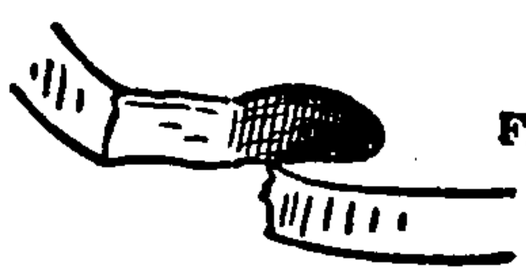


Fig. 14

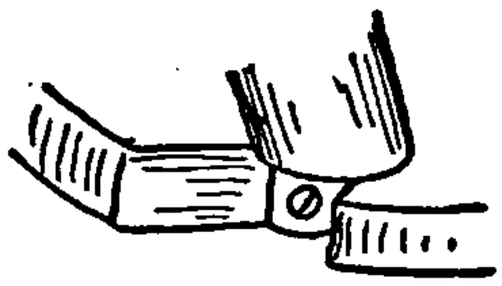


Fig. 15

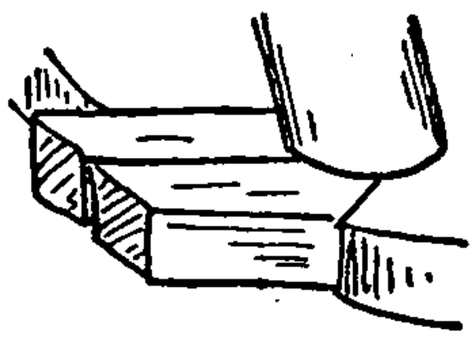


Fig. 16.

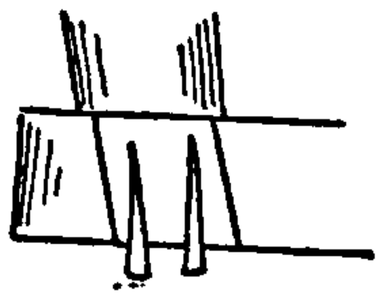


Fig. 12

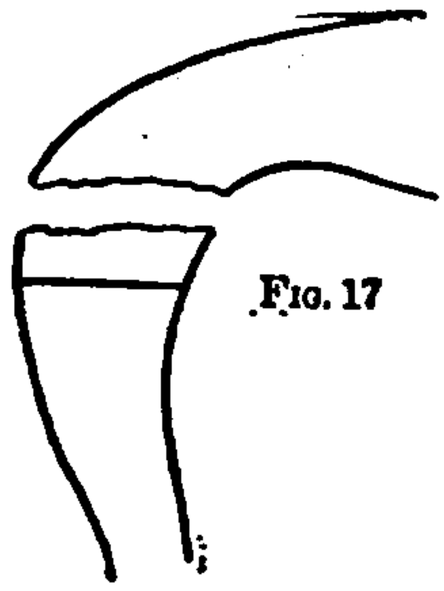


Fig. 17

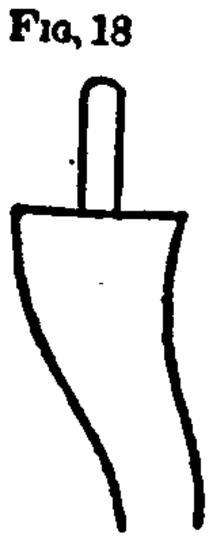


Fig. 18

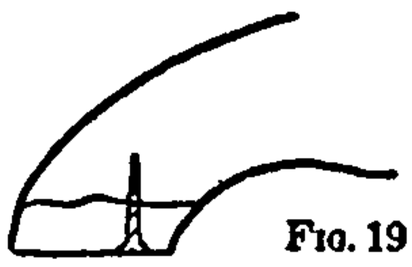


Fig. 19

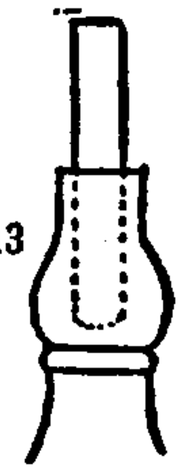


Fig. 13

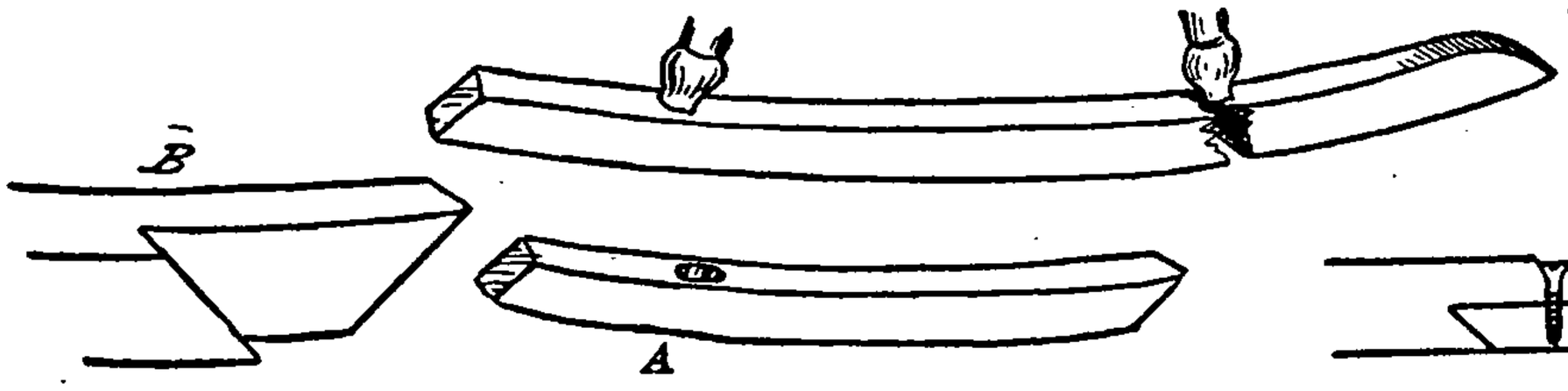
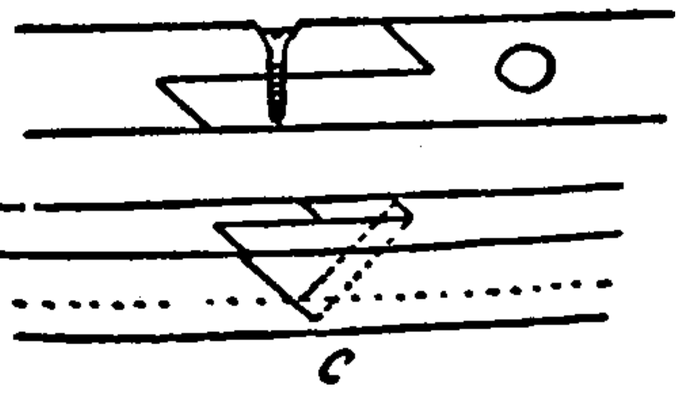


Fig. 11



as in Fig. 15, and then fit two pieces of wood into the space around it as shown in Fig. 16. These pieces should be glued in position and reinforced by fine finishing nails run through both pieces and into the seat of the chair beyond. When thoroughly dry the ends and edges should be smoothed off and finished.

Parlour chairs with light carved or ornamental backs quite frequently break where the dowels of the sides enter the rail at the top. To repair such a break (Fig. 17), remove all pieces of the old dowel and glue and bore a hole in the top of the upright. Into this fit a wooden dowel-pin, being careful to have it project far enough to reach clear through the loose piece and well into the solid back above (Fig. 18), and deepen the hole in the back sufficiently to accommodate the new dowel. Drill a small hole through the loose piece and screw it to the back as in Fig. 19, and also glue the pieces together. Place glue in the dowel-holes and drive or press the parts into place (Fig. 20). In order to hold the joints tightly together while drying, cramp the back to the uprights by strong string or light rope twisted taut with bits of stick and with pads of paper or cloth beneath the ropes to prevent scarring the varnish as shown in Fig. 21.

Chairs, tables or other furniture with round or turned legs or uprights often break in one or more places in the centre of these pieces as in Fig. 22. Such a break is very easy to repair as it is only necessary to dowel the joints together, but it is a very difficult, in fact almost impossible,

job to dowel an uneven broken joint, and hence the first step is to cut off the broken post near the fracture as shown in Fig. 22 *AA*. The broken pieces are then glued together with hot, strong, but rather thin glue and are brought into close contact by tapping with a mallet or hammer. They are then set aside to dry. A hole is then bored into both ends of the sawed cuts, taking care to exactly centre the drill or bit. While the hole bored into the whole end of the post may be but an inch or so in depth, the hole in the broken piece should extend well beyond the glued fracture (Fig. 22 *B*). Dowels of birch or other hard wood should then be fitted in the holes glued in place and driven in tight. In using dowels you should always cut a small groove along them in order to allow the air and surplus glue in the holes to escape. If this is not done it will be very difficult to bring the dowels and joints close together and if too much force is used the compressed air and glue will frequently split the wood. Even if this does not occur it may force the joints apart after you have set them aside to harden.

Chairs with loose, wobbly seat-frames may be strengthened by placing corner-braces of hard

wood in each corner of the frame and gluing and screwing them firmly into place.

Sometimes a chair, table or other piece of furniture will be very troublesome on account of the legs being uneven. To level up chair legs or legs

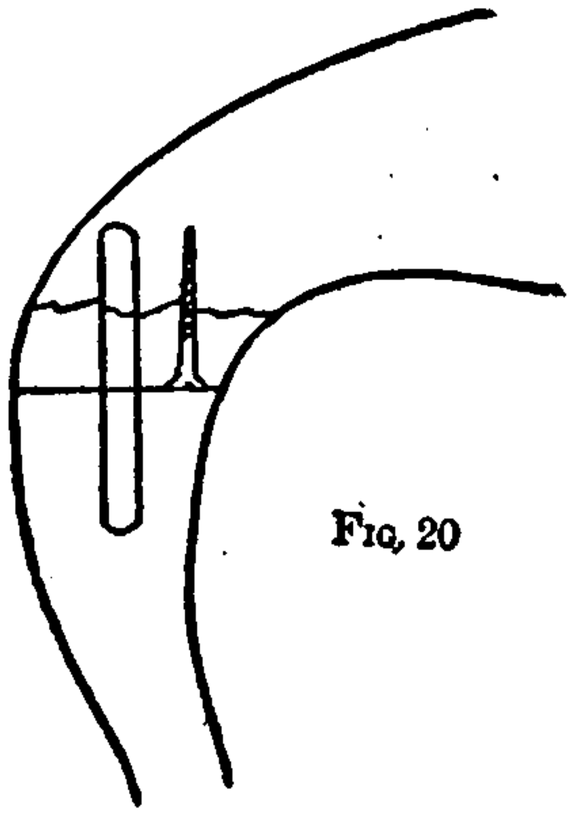


Fig. 20

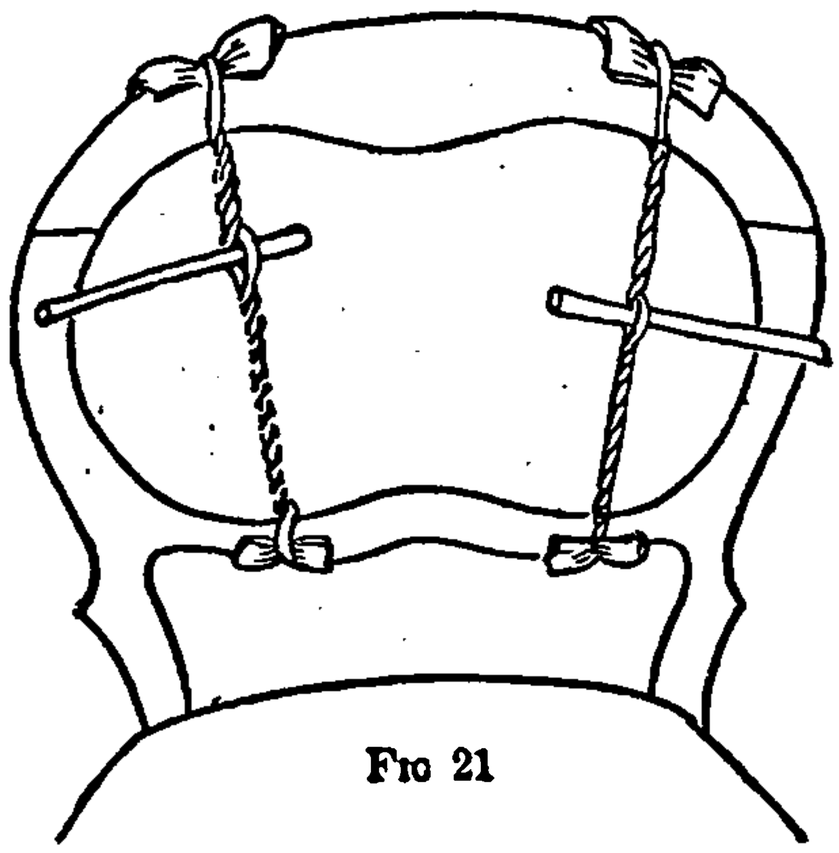


Fig 21

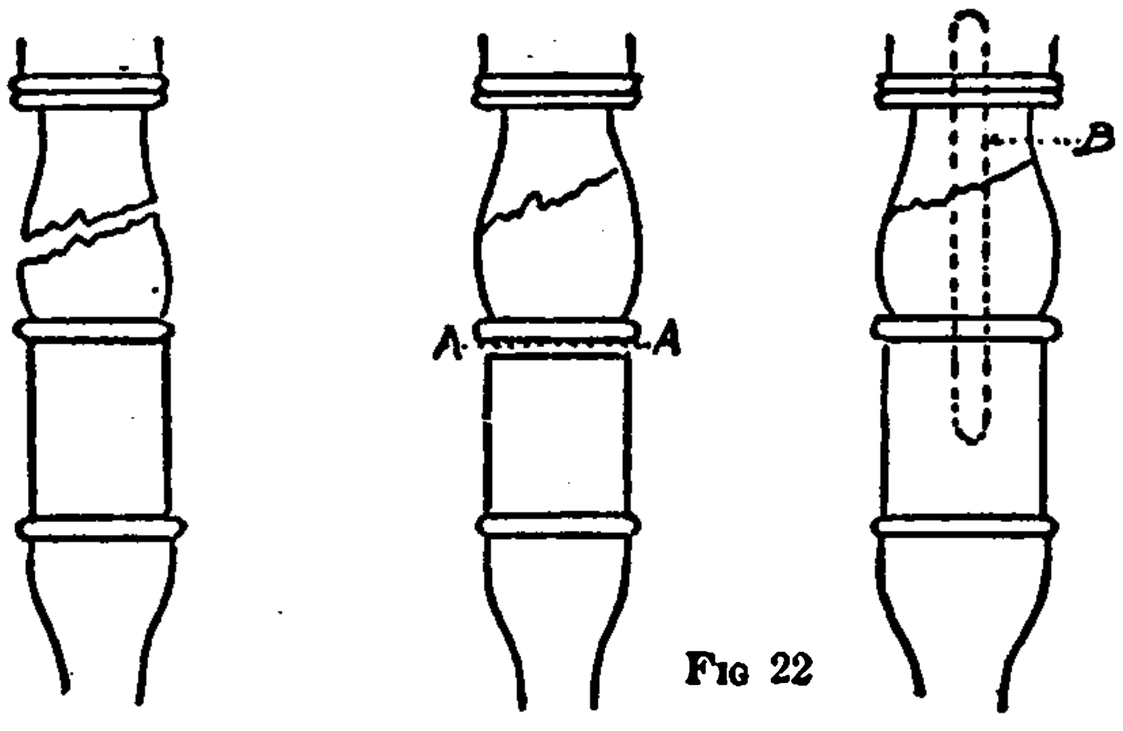


Fig 22

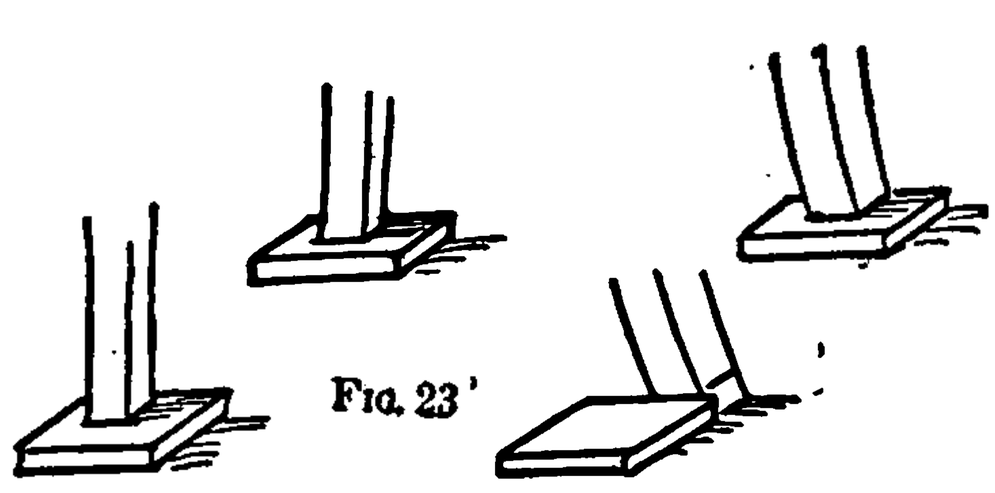


Fig. 23

of furniture which rest directly on the floor, secure four small blocks of wood of exactly the same thickness and place these upon a level smooth surface. Set the chair upon three of these and with the fourth as a gauge mark around the edge of the long leg as shown in Fig. 23, and saw off the amount indicated. Where one leg is too short instead of too long a small piece of wood may be

glued and nailed to the leg or the other legs may be trimmed off to correspond with the short one. Where castors are used you can level the legs in a different way. If the castors are merely screwed to the bottom of the legs with a plate, the one on the long leg may be removed, the leg cut off and the castor replaced; but if the castors are set into holes or sockets in the legs the hole must be deepened to shorten a leg or a bit of wood must be slipped in to make the castor project slightly further from the end of the leg when it is too short.

There is scarcely anything more annoying than drawers and doors that stick and bind and as such things are easily remedied there is no excuse for being troubled with them. Very often the reason that a drawer sticks is because the slides or runners or the back of the chest or bureau have warped or shrunk. When this is the case planing or cutting the drawer itself will do little good. If a drawer sticks badly, first roughen all the edges slightly with sandpaper or a file and then run the drawer in and out a few times and look it over for shiny spots and where these are seen plane or scrape off slightly. Avoid taking off any of the front edges as long as possible or

the drawer will be too small and will fit loosely. If planing and smoothing here and there does not remedy the matter, remove the drawer entirely and set it upon a level surface. If all four corners do not touch the surface the drawer is out of true or "winds," and you will be obliged to bring it back into shape, which is often a difficult job. If the higher parts are planed down sufficiently to bring it into shape the drawer will be too small, but if it is out of parallel or crooked from front to back or the sides bulge, a few light blows with a hammer may rectify the trouble. Sometimes the corner joints will be found out of true or loose and this should be remedied by either taking the drawer apart and re-gluing it or perfectly square cleats may be screwed and glued in each corner to bring the angles back into true.

If the drawer, after truing up, still sticks you should examine the runners (the wooden pieces against which the drawer slides), and see if they are parallel. They should be slightly wider apart at the back than the front and this may be determined by cutting a strip of wood the exact length of the opening of the front and sliding it back. If it binds as you push it along, or if it even touches at the rear end, the runners must

be reduced at the rear. Oftentimes a runner may be loose or entirely missing or a nail-head may protrude and bind somewhere. Sometimes the sides of the article itself may be warped or bulged, and when this occurs it must be remedied by cutting or planing the runners or springing or planing the sides until the runners are straight. Sometimes one runner will be higher than the other or one end may be further up or down than the other. This can be determined by sighting along them, but this requires practice, and an easier way is to test them with a level and square. When you have all the parts smoothed and adjusted until the drawer slides out and in with a little friction, rub the edges and the runners with spermaceti wax and a linen rag. If the wax crumbles warm it slightly before using. Common laundry or toilet soap will serve in place of the spermaceti, but is not so good.

Sometimes a drawer may be so jammed or stuck that you cannot pull it out without danger of breaking the handles or the front of the drawer. In such cases do not use chisels, screw-drivers or other tools to pry on it, but remove the back of the case or chest and while some one pulls on the handles tap the ends of the back of the drawer

with a hammer or mallet, taking care to strike the end furthest in first. If the drawer still refuses to budge remove the partition between the drawers by sliding it out and if necessary remove the runners or loosen them by prying them slightly from the sides of the case.

CHAPTER IX

MAKING SIMPLE FURNITURE

If you have ever had occasion to move a stove or a heavy trunk or box about, you know what a hard job it is, especially if you have no one to help you. If you have a truck to use you will find that it is an easy matter to move the largest stove or heaviest trunk or chest with ease, and as such a truck is a very easy thing to make, there is no reason why every household should not be provided with one or more of the handy utensils.

The material required is 2 x 4 scantling 36 in. long and some 1-in. boards—about 4 ft.—of 4-in. wide stuff. In addition you will require a good strong pivot-castor and two 3-in. iron wheels as well as a piece of iron rod or pipe for an axle.

Mark off 18 in. on the scantling and draw a diagonal line from one corner to the other as shown in Fig. 1 and saw along the line, thus obtaining two pieces 2 in. thick and 4 in. wide at one end and tapering down to a sharp point at the other. On one of these mark off 3 in. on

the wide end and draw a line parallel with the straight edge (Fig. 2), and saw along this line. Repeat the operation with the other piece.

Place these two pieces side by side, with the upper edges even (Fig. 3), and clamp them firmly in a vise. Then with a $\frac{3}{4}$-in. drill or auger bore a hole through both pieces, making the hole just over the corner *A*, and starting the centre of the

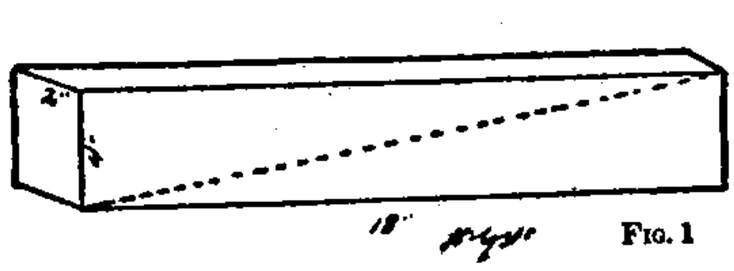


Fig. 1

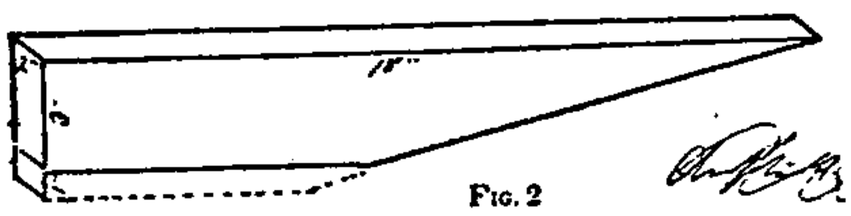
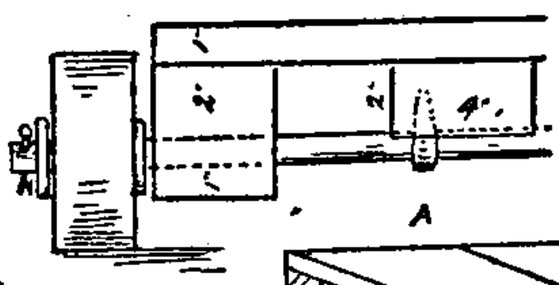


Fig. 2

Fig. 3

Fig. 6



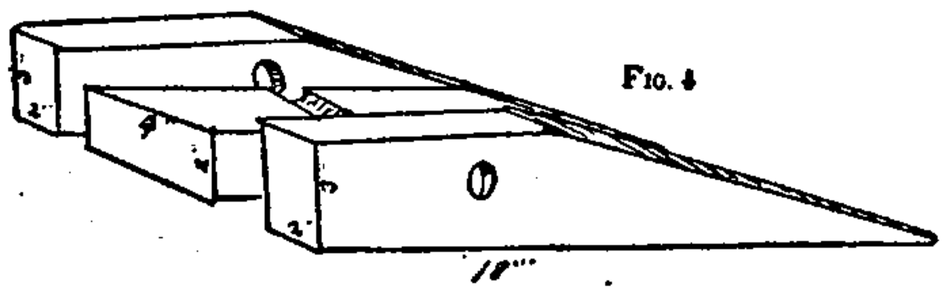


Fig. 4

Fig. 5

auger 2 in. from the straight upper edge and being careful to drill the hole straight so that it comes out in exactly the same position on the further side of the second piece.

Now place the piece of plain 2-in x 4-in. stuff between the two pieces with the ends even and *with the straight upper edges flat* on the bench and the plain piece edge on between the other pieces as shown in Fig. 4, and with a pencil mark at each edge where the holes are and draw a line across the plain piece. Saw $\frac{1}{2}$ in.

into the timber on these lines and split out the wood between the lines to leave a ½-in. deep groove across the 4-in. side of the plain piece. Place the two angular pieces with the outer edges 18 in. apart and to them firmly screw or nail pieces of the 1-in. board as shown in Fig. 5. In the centre, with each edge 5½ in. from the inner edges of the side pieces, fasten the 2-in. x 4-in. piece with the groove down. Now drive the ¾-in. piece of iron rod through the holes in the side pieces and leave enough projecting at each end to allow the wheels to slip over and allow a space for a washer and pin on the outer ends (Fig. 6). The holes for the pins may be drilled with a twist-drill in your breast-drill or any blacksmith will do the job for a few cents. The axle and rollers may be bought at any dealer in builders' hardware or may be picked up at some junk shop for a few cents. If you cannot get iron rollers you can use wheels of hard wood or even wooden sheaves from old pulley-blocks. Slip a washer over the axle, then slip on a wheel, place another washer over this and slip a pin (a cotter-pin is the best) through the hole as in Fig. 6. Then fasten the axle securely to the centre piece with staples, *A*. Now set the truck

on a level surface resting on the wheels and place blocks or bits of wood under the slanting ends until the top is level and measure the distance from *A* to *B* on the centre piece (Fig. 7),

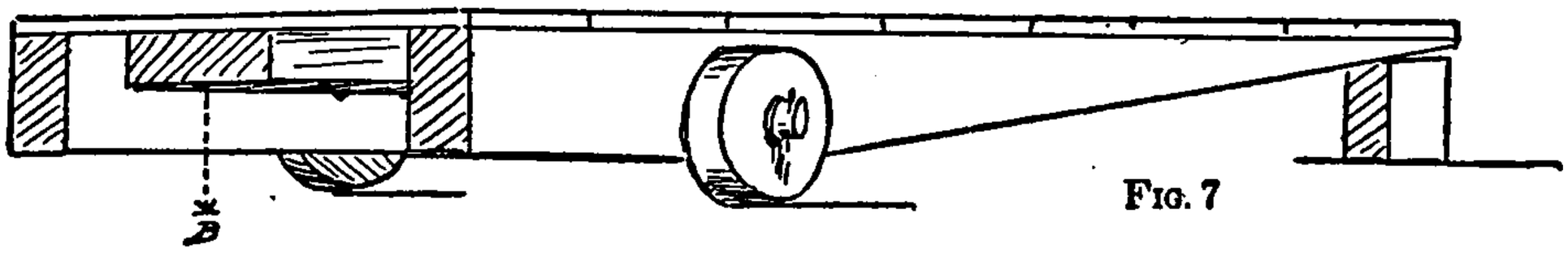


FIG. 7

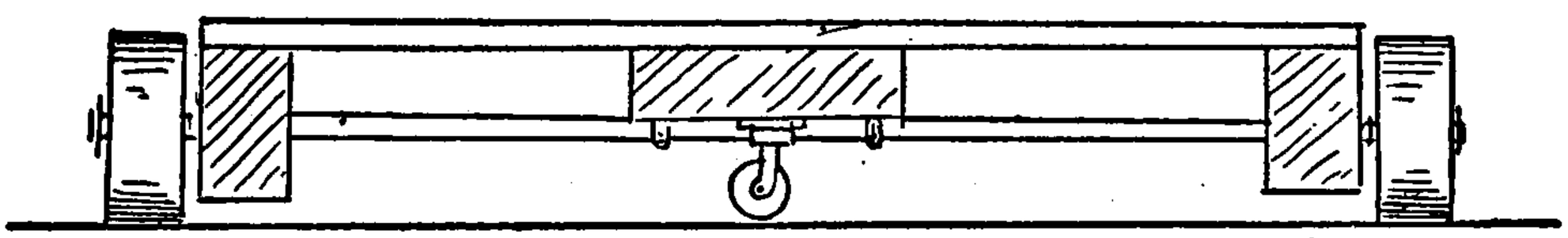


FIG. 8

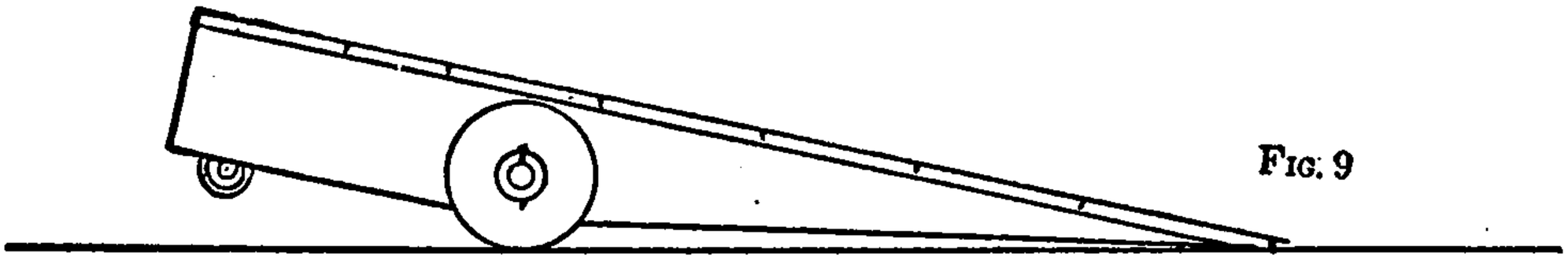


FIG. 9

and fasten the castor to this centre piece so it does not quite touch the floor (Fig. 8). The truck is now complete, and to use it you merely tip it down to the position shown in Fig. 9; tip up the box, trunk or stove, slip the truck under it, push forward, and the truck tips back to a level position and rolls readily.

Another useful and simple thing which the amateur carpenter can make for the house is a window ventilator.

To make the ventilator cut a piece of board—

pine or whitewood if desired, or if the window casing is finished in natural wood select the same kind of material—and fit it accurately to the width of the window. The board should be about 10 in. wide and the edges must be planed off to fit neatly against the sash and the sill, which slant. At equal distances from the centre cut rectangular holes, each 6 in. long by 3 in. wide, as shown in Fig. 10. Over each of these tack pieces of tin or sheet brass in the shape shown in Fig. 11, which will allow plenty of fresh air to enter the room but will prevent a direct draught. A better and neater job may be made by fastening cleats at the ends of the rectangular holes as shown in Fig. 12, and fastening the sheet metal over these, in the form shown in Fig. 13. By this method the air enters from the lower side and all danger of rain or snow finding its way in is obviated. By covering the lower opening, or the end openings, with wire netting insects or mice will be kept out, or the metal may be bent in either of the forms shown in Fig. 14 and the ends or bottom perforated, as illustrated.

Ash-sifters are used in a great many places, and while tin ash-sifters or galvanized iron affairs are fairly cheap and are in general use,

yet it is fun to make one yourself, and a home-made wooden sifter will do just as good work as a bought affair. Even if you do not want an ash-sifter you can make the arrangement de-

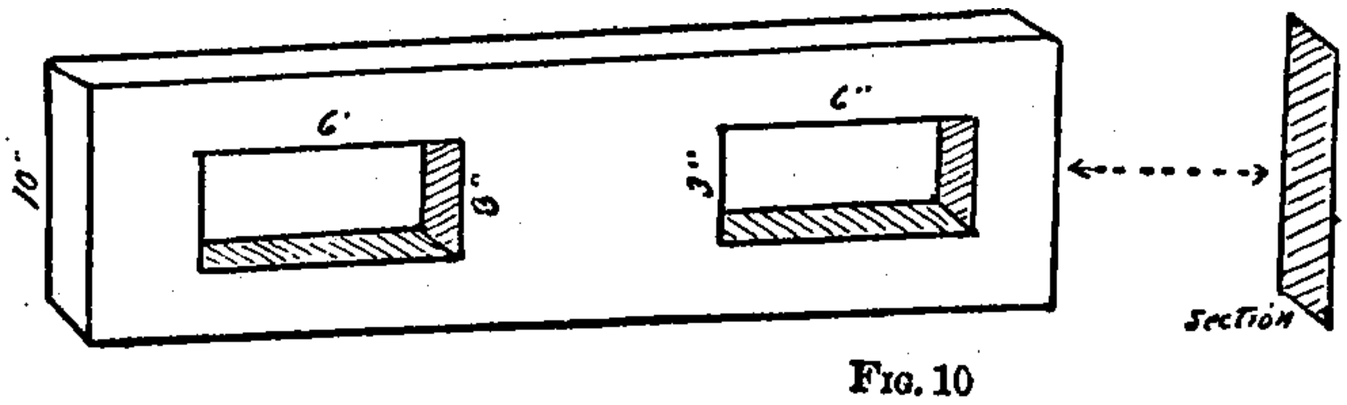


FIG. 10

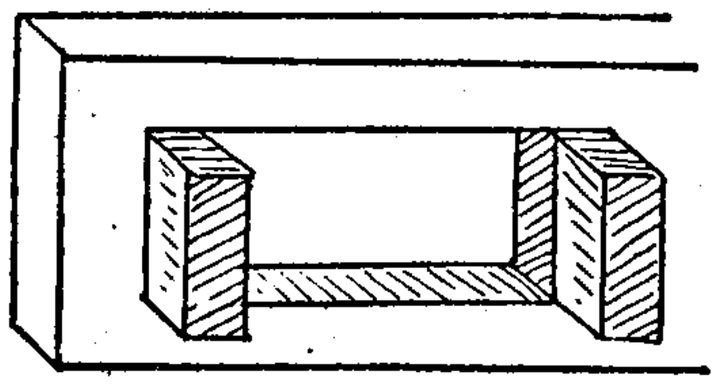


FIG. 12

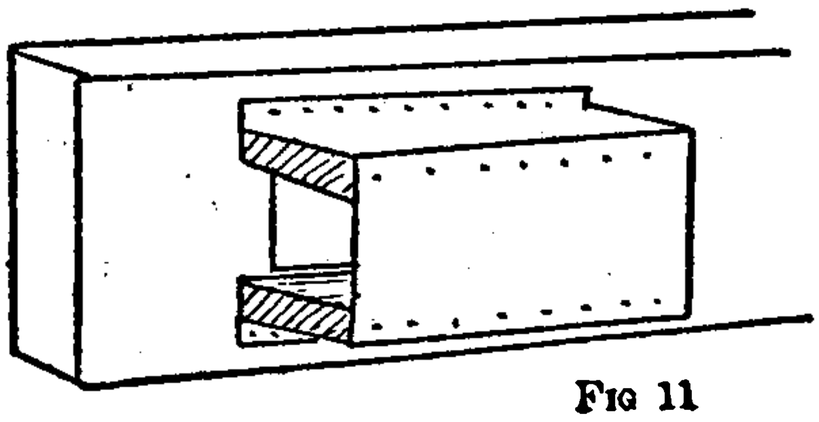


FIG 11

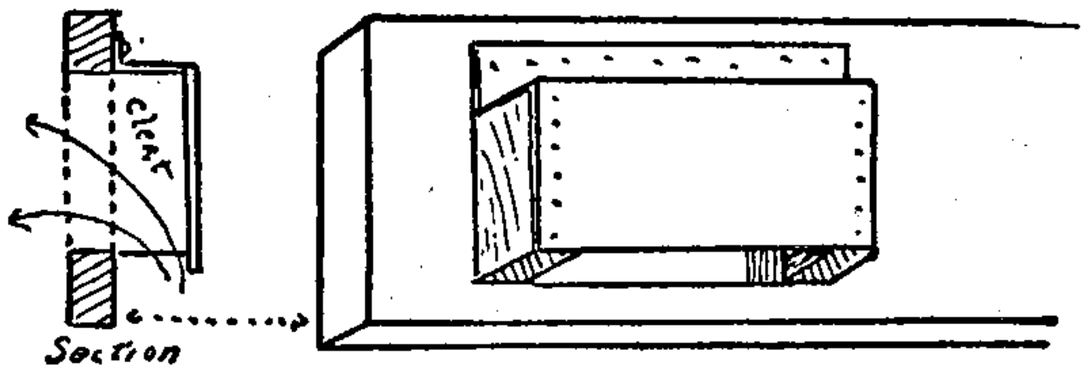


FIG 13

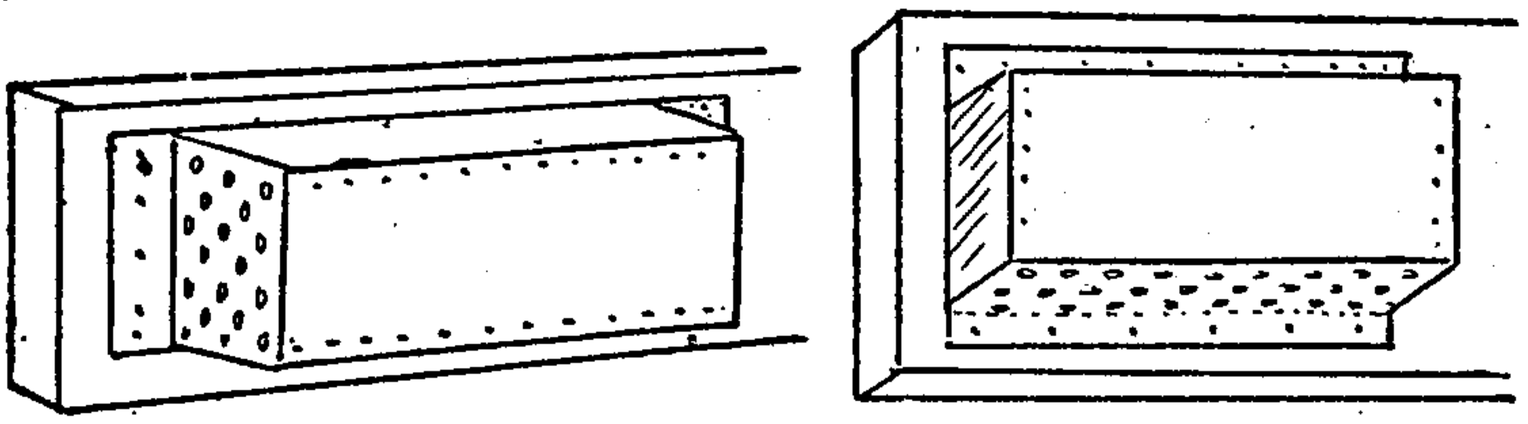


FIG 14

scribed for use in sifting earth for your flower garden or potted plants.

Saw six 21-in. lengths from 6-in. x 1-in. boards and place three of them edge to edge, and across them screw cleats 1 in. x 1 in., placing one cleat 6 in. from one end and the other 10 in. from the other end. Repeat the operation with the other three boards (Fig. 15). Now measure off from one side of one of these cleated pieces and find the exact centre, which should be 9 in. from either edge, and with a pair of compasses or a

string on a nail draw a half-circle, the centre being 9 in. from the end where the cleat is 10 in. from the end. This half-circle should just touch the lower end of the boards and the two edges as shown in Fig. 15. Repeat the operation with the other piece of cleated boards and with your compass-saw saw off around the marks made and trim even and smooth with a block-plane. You will now have two pieces each 18 in. wide and with one end of each cut in the form of a half-circle. Using these for ends, connect them by boards 20 in. long, making an open frame as shown in Fig. 16, with the cleats inside. On the side pieces fasten cleats exactly even with those on the ends that are 6 in. from the top. Make a neat wooden frame that will just fit snugly inside of the box-like affair, having the frame 6 in. wide (Fig. 17), and cover the bottom of this with wire netting. Bore two 1-in. holes in each end, as shown in the cut. Next fit a good strong cover to the whole and your sifter is complete. For use with earth for your garden this sifter will prove very handy, for it can be filled with earth, set down where desired and the earth sifted onto the beds or into boxes or pots as you wish to use it.

Another form of sifter may be made by fixing a box in a permanent frame and pivoting the sifter inside, but this form is harder to make and has no particular advantages over the other form described.

Although few amateur carpenters are able to make really fine furniture, yet there are a great

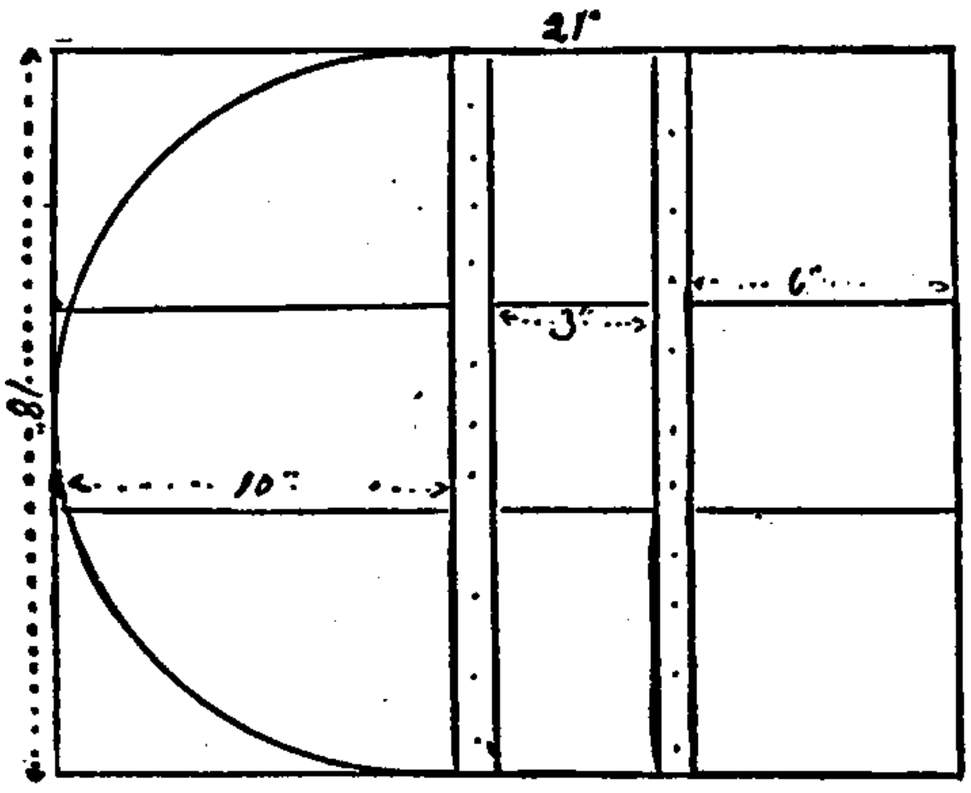


Fig 15

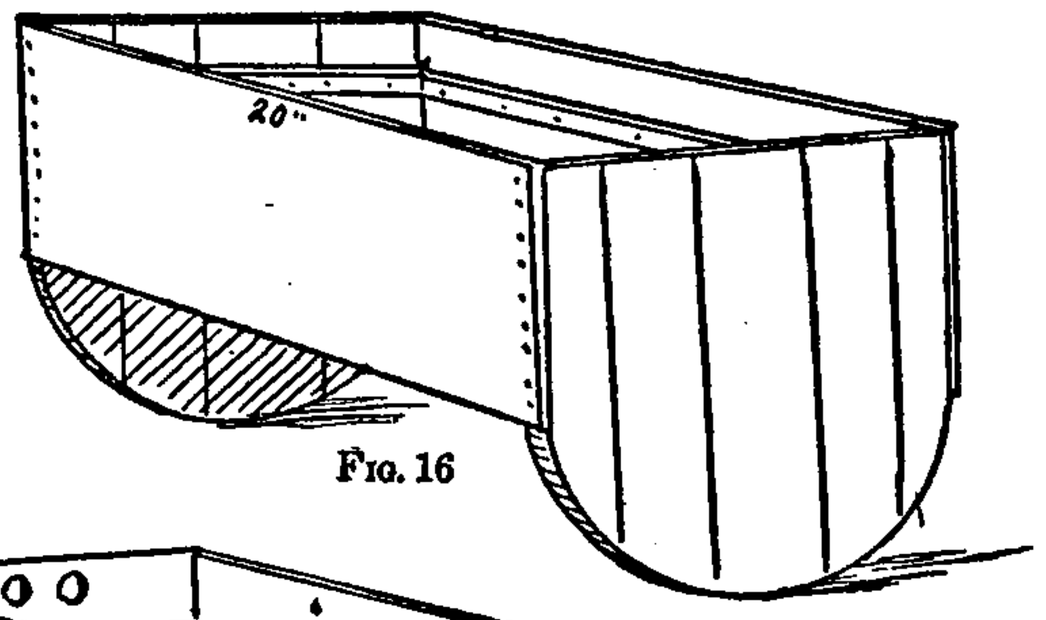


Fig. 16

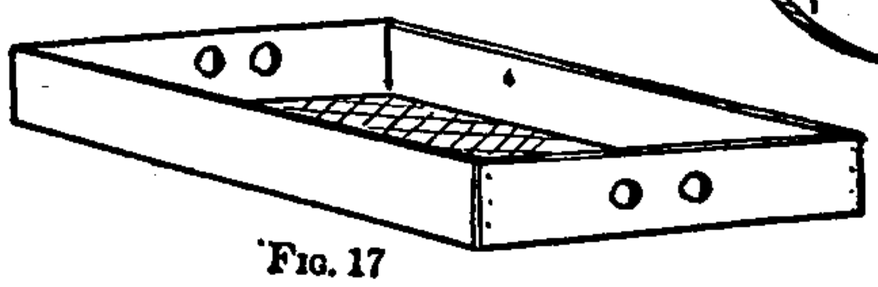


Fig. 17

many home furnishings and simple pieces of furniture which are easily made and will add greatly to the comfort and appearance of either a boy's own room or the home. You should aim to make the simplest things first, and as you become more and more familiar with the use of tools, the planning and designing of work, the methods of handling and working wood and the various styles of finishing, you will be able to undertake more and more intricate and difficult pieces.

One of the simplest things to make is a shoe-

brush holder and shoe-polishing bench, and, moreover, this is a most useful piece of furniture for any one's room. If you do not require a shoe-brush holder, the same design may be followed and the piece of furniture may be used to hold shoes, magazines, odds and ends, or in fact any articles that you desire to keep handy and out of sight. Select two pieces of wood 12 in. wide and 24 in. long and 1 in. thick, and if you cannot obtain pieces of this width cleat 6-in. pieces together. Four inches from one end of one of these pieces draw a light line from side to side. Draw another across 10 in. from the first and draw still another 2 in. from this. In the centre of the first line make a plain mark and a similar mark in the centre of the last line. On the first line, using the mark as a centre, draw a half-circle of 4-in. radius and on the last line draw a 4-in. circle. Measure off 2 in. from either corner of the board nearest this small circle and from these marks draw lines meeting exactly in the circle at the upper edge of the circle. From the extreme ends of the large half-circle draw straight lines at right angles to the cross-lines on the board to the second cross-line and thence to the outer corners, and the board will now ap-

pear marked as in Fig. 18. With your saws and compass-saw saw off all along these marks and in this way secure a board shaped as in Fig. 19. Repeat the operation with the other 12-in. x 24-in. board, and be sure that both are exactly alike. Now get out three boards each 10 in. wide by 24 in. long and one 24 in. x 8 in. and square the

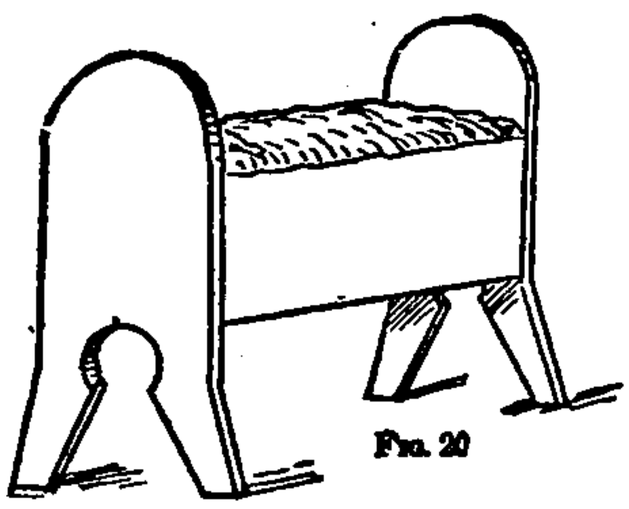


Fig. 20

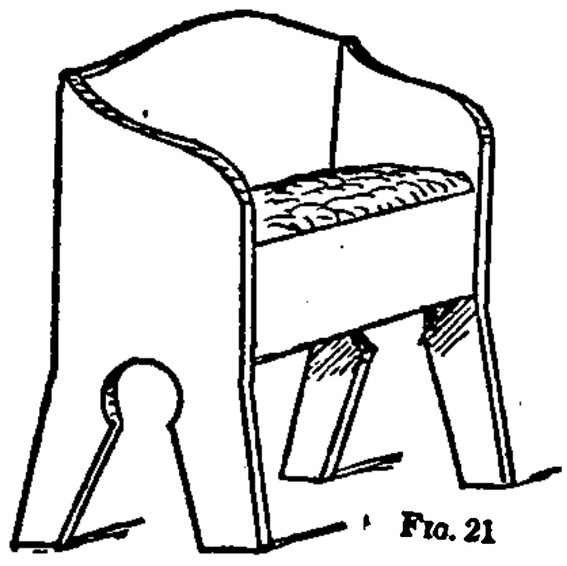


Fig. 21

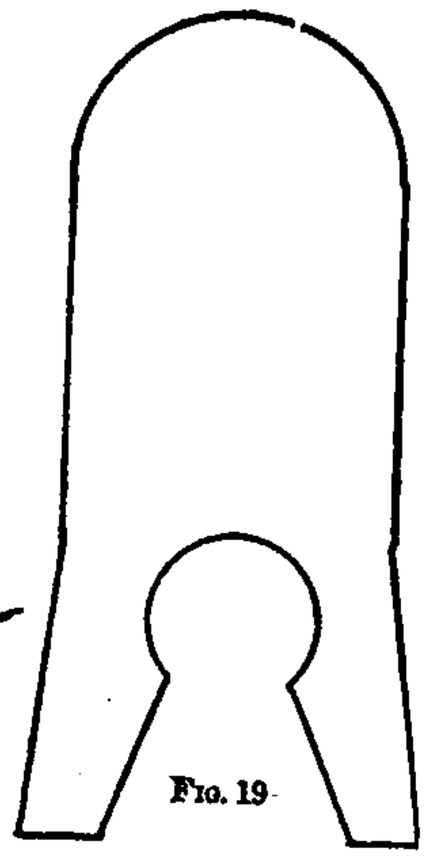


Fig. 19

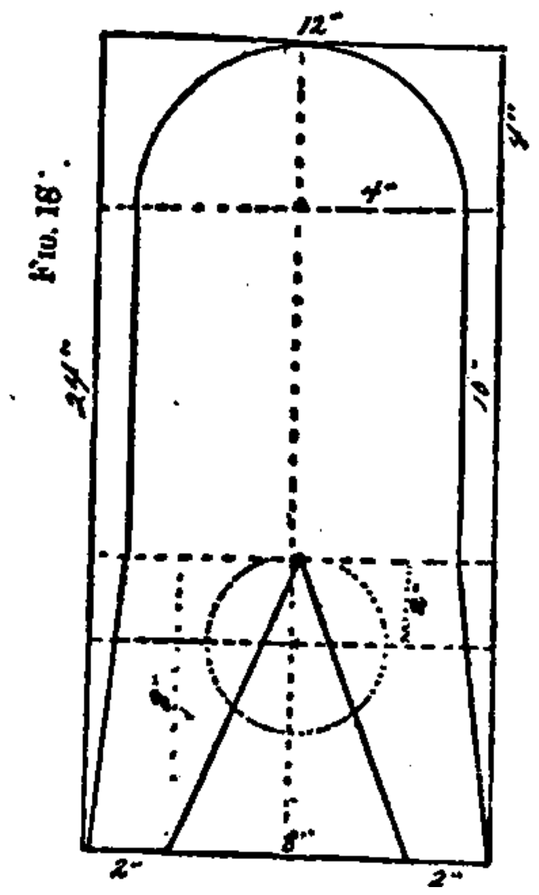


Fig. 18

ends and plane the ends and edges smooth and true. Fasten the 8-in. board to the end pieces by screws, placing the board with its lower edge on the line *B* (Fig. 18), and with a space of 1 in. on either side. To this board and the end pieces fasten the 10-in. boards, one on either side, thus forming an open box, and to one of these side boards hinge the third 10-in. board. See that the screws are all well countersunk and putty up the holes and finish the whole with stain and varnish or paint to suit your own taste. If the

affair is to be used as a shoe-polishing bench the top may be left as a plain board, but if you wish to use it as a seat it may be fitted with a cushion or may be upholstered in leather (Fig. 20). A variation in this little piece of furniture may be made by fastening the top securely and hinging the front, or the back may be carried up beyond the rest of the bench, the ends cut in the form shown in Fig. 21 and either the top or front hinged, thus forming a neat and comfortable bench with a receptacle under the seat.

Book shelves and racks are always useful and are among the easiest of furnishings to construct. For constructing the shelf described you will require $\frac{1}{2}$-in. material and you should use a wood which will appear well when finished with oil and varnish or which may be stained to imitate some fancy wood: oak, cherry, walnut, maple or other hard woods or whitewood are excellent.

The material should all be $\frac{1}{2}$ in. thick and care should be used not to split or chip the wood. The principal piece is the base, *A* (Fig. 22), which should be 7 in. wide and as long as you wish the shelf, say 24 in. Plane ends and edges smooth and half-round and at $2\frac{1}{2}$ in. from each end saw a straight line across the board about $\frac{1}{4}$ in. deep.

Saw another line on the inner side of each of these and ½ in. from them and cut away the wood between the lines with a chisel, thus leaving two grooves each ¼ in. deep and ½ in. wide as in Fig. 22 *B B*. Next get out the two upright end pieces, each 10 in. high and 6¾ in. wide, and with the upper ends neatly rounded or sawed into an ornamental form as in Fig. 23. Five inches from the square ends of these pieces make grooves ½ in. wide by ¼ in. deep, as described for the base piece. Then get out the shelf, which should be 18½ in. long and should have the edges but *not* the ends rounded and should be 7 in. wide. Sandpaper all these pieces until smooth and drill two holes through each of the grooves in the bottom piece and countersink the holes on the lower side opposite the grooves.

Now get out the pockets for the ends. These consist of three pieces for each pocket, two pieces 2½ in. x 4 in., with one end cut as shown in Fig. 24 *A*, with the third piece 6¾ in. x 3 in., as shown in Fig. 24 *B*. Bore holes from the bottom of the base piece close to the edges and ends and with glue and small screws fasten the pockets together and in position. Then set the end pieces in the grooves with glue and screw

them firmly in place with screws from the bottom, and lastly glue the shelf into the grooves in the end pieces (Fig. 25). If you intend to stain the

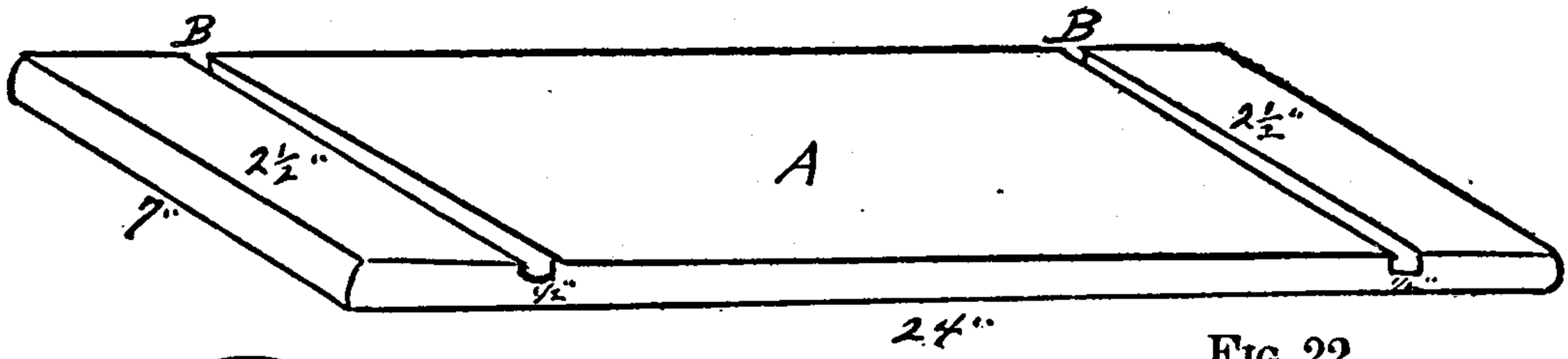


FIG. 22

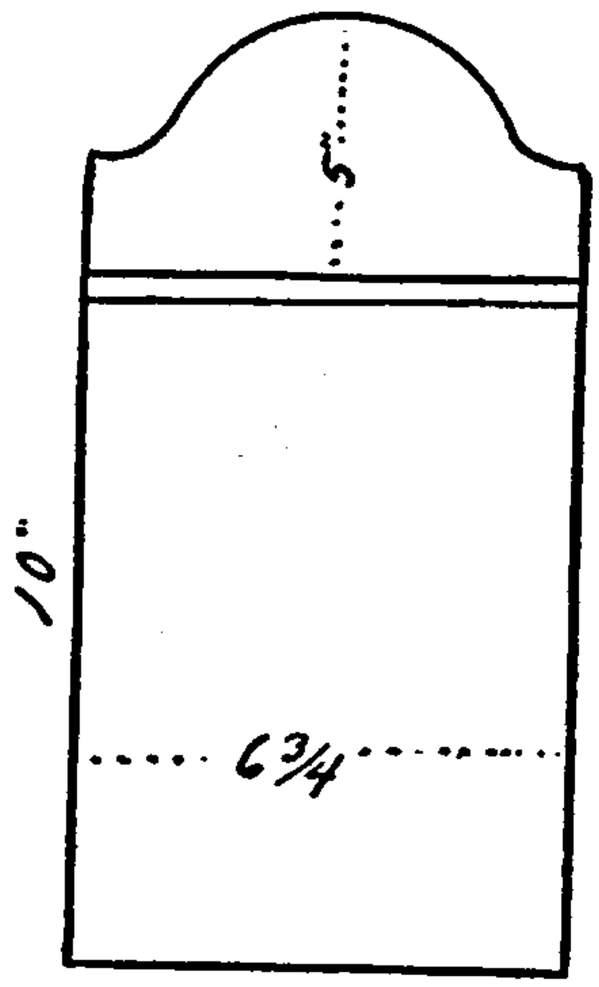


FIG. 23

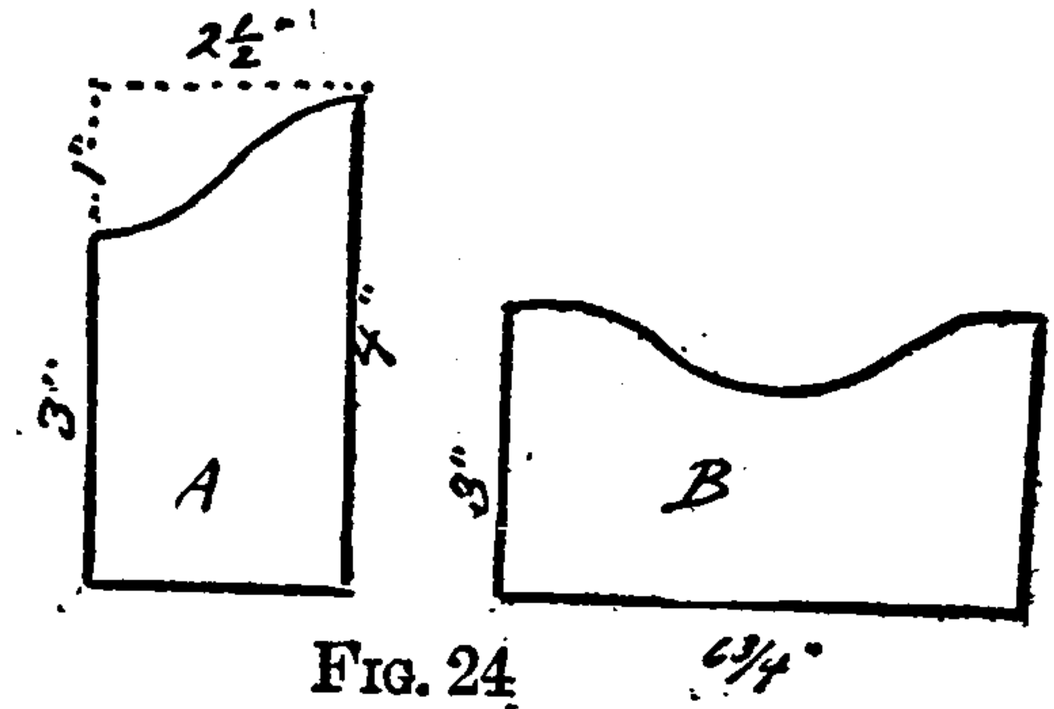


FIG. 24

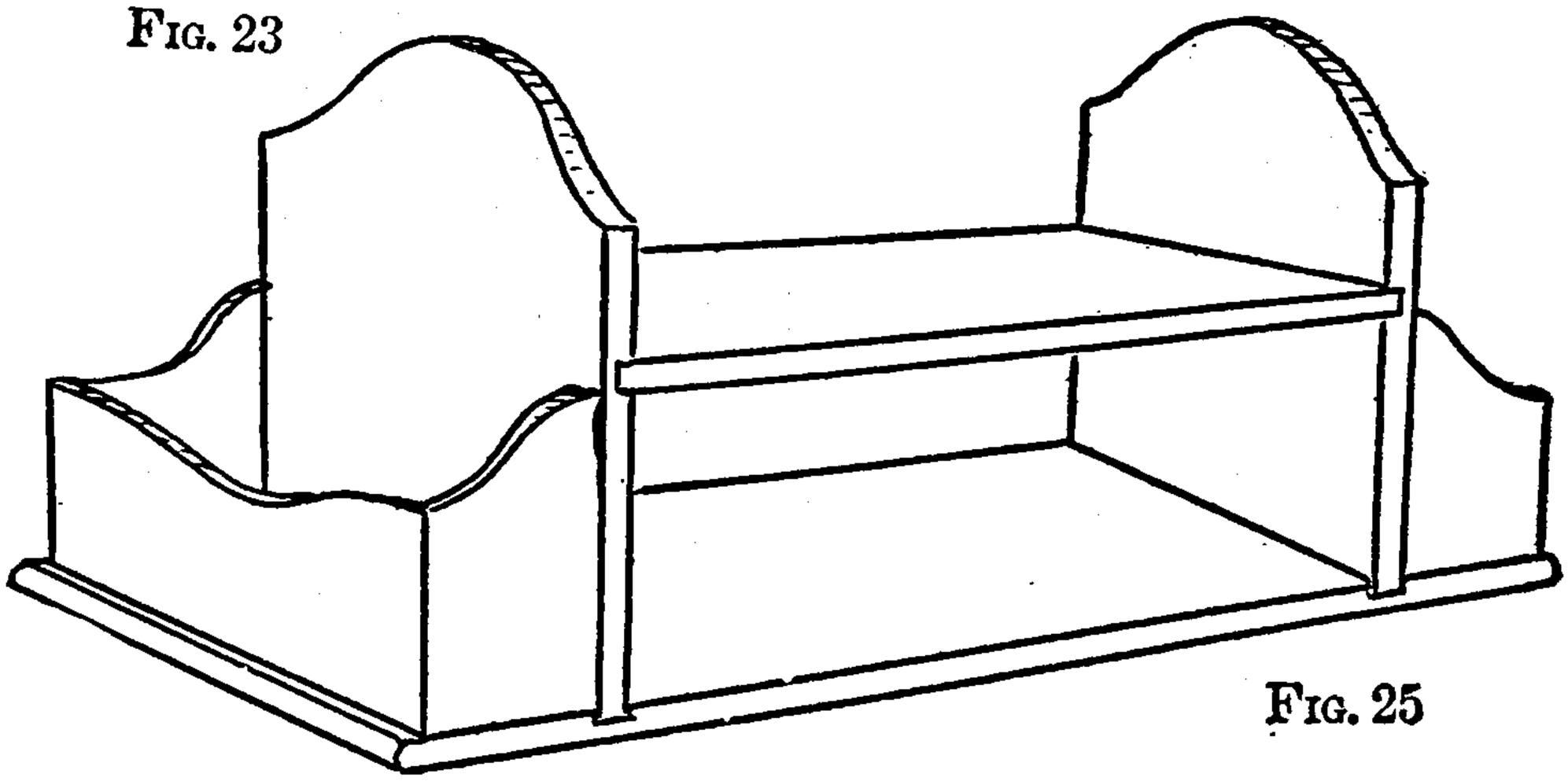


FIG. 25

shelf it is a good plan to give all the parts a coat before fastening together, as in this way there will be no danger of omitting some portions or getting too much stain on others, but the grooves

and the ends of the pieces to be set in them should not be stained, as the glue will adhere better to the plain natural wood.

Another very simple and useful piece of furniture is an umbrella-holder. The design given is quite attractive and is easy to work out, but it may be varied to suit your own ideas and the same dimensions adhered to. For the sides you will require four pieces of $\frac{3}{4}$-in. or $\frac{7}{8}$-in. board 25 in. long and 10 in. wide. Find the centre of one end of each board and measure off $3\frac{1}{2}$ in. on each side and from these marks draw straight lines to the outer corners at the other ends. Saw along these lines and thus obtain four pieces 25 in. long, 10 in. wide at one end and 7 in. wide at the other, as shown in Fig. 26. With your bits and compass-saw cut out the design illustrated or some similar pattern in each piece. Then plane off the edges of each piece to a 45-degree angle so that two pieces, when held together edge to edge, will form a right angle. Work slowly and carefully and when the pieces fit closely and true up with your square tack them together with fine wire nails. Then bore through the edges and countersink the holes for screws and fasten with brass screws sunk well below the sur-

face of the wood. If preferred the holes may be left without countersinking and round-headed brass or blue-finished screws may be used. At the bottom of the stand fasten a tin, zinc or

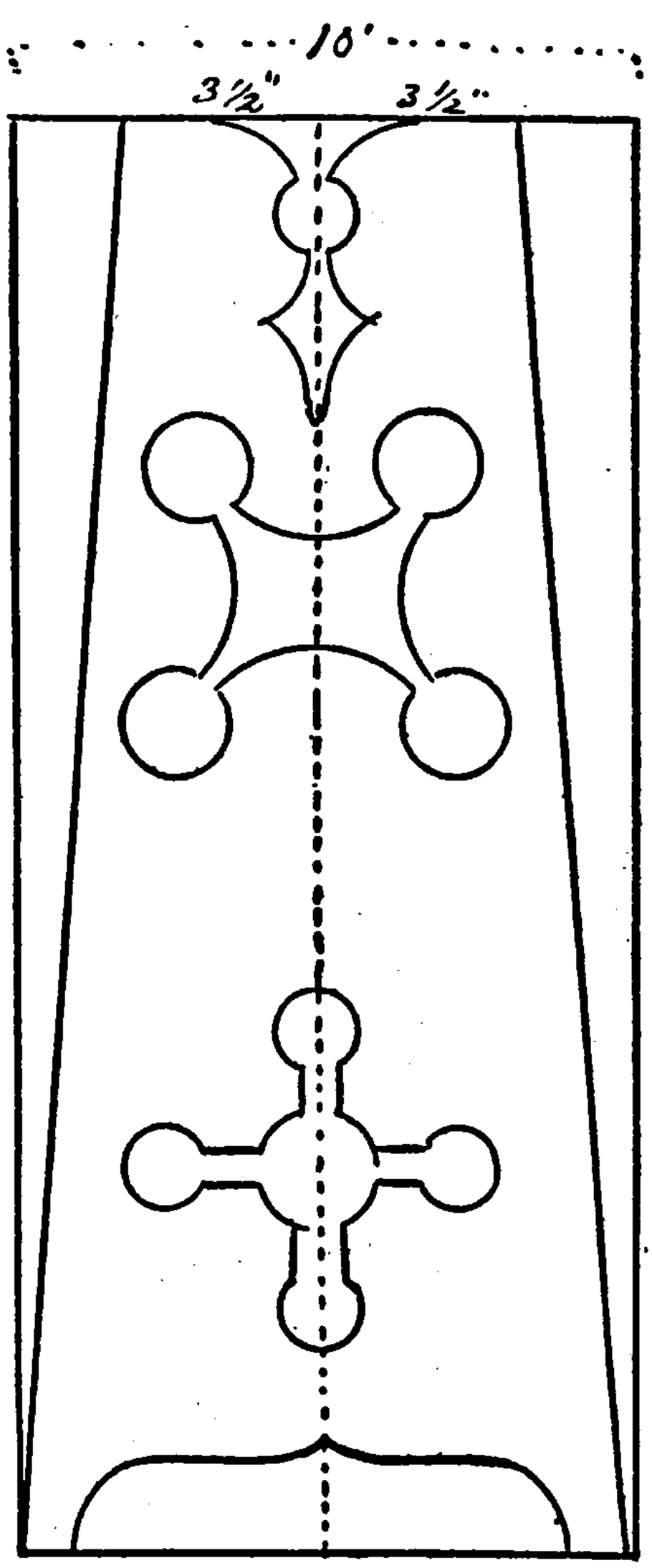
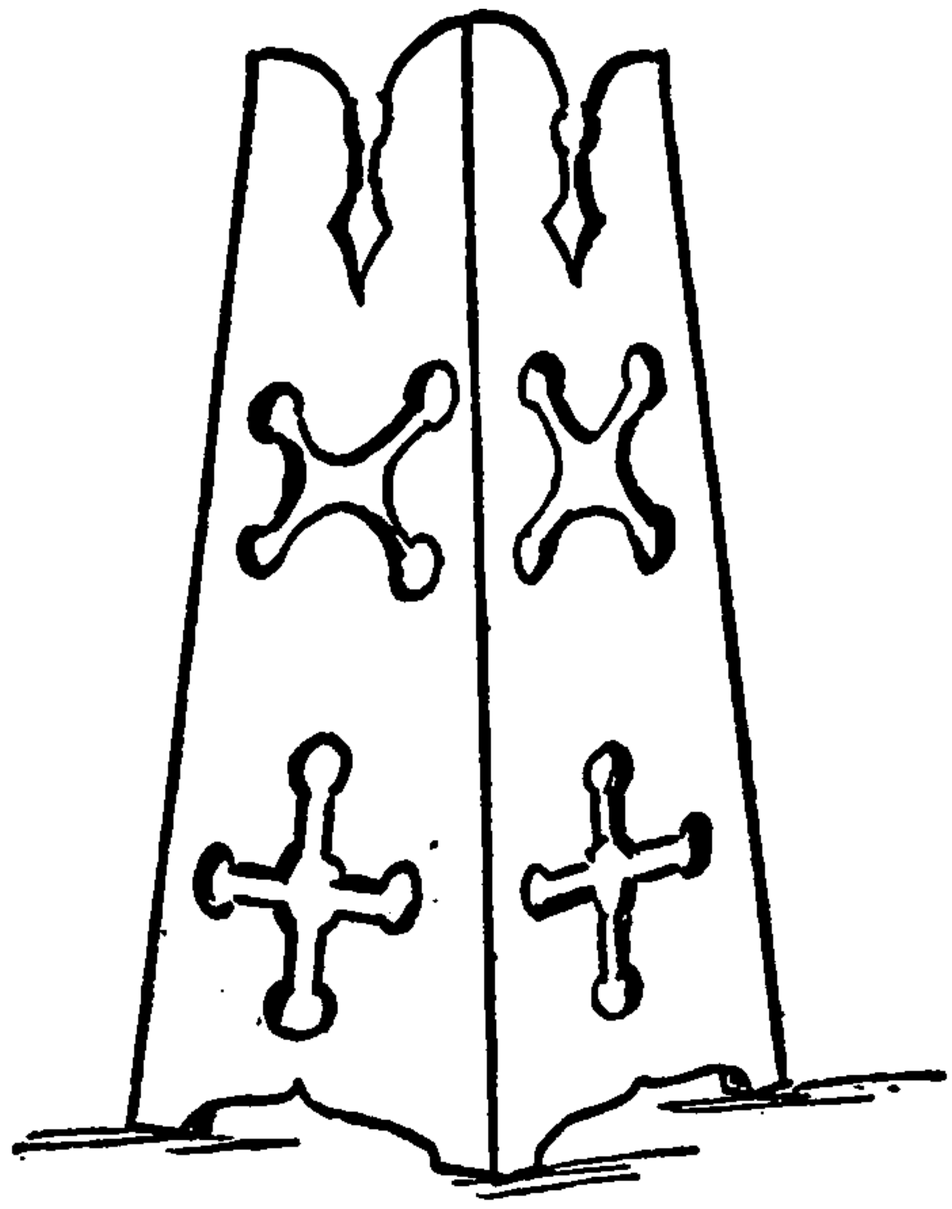


FIG. 26.



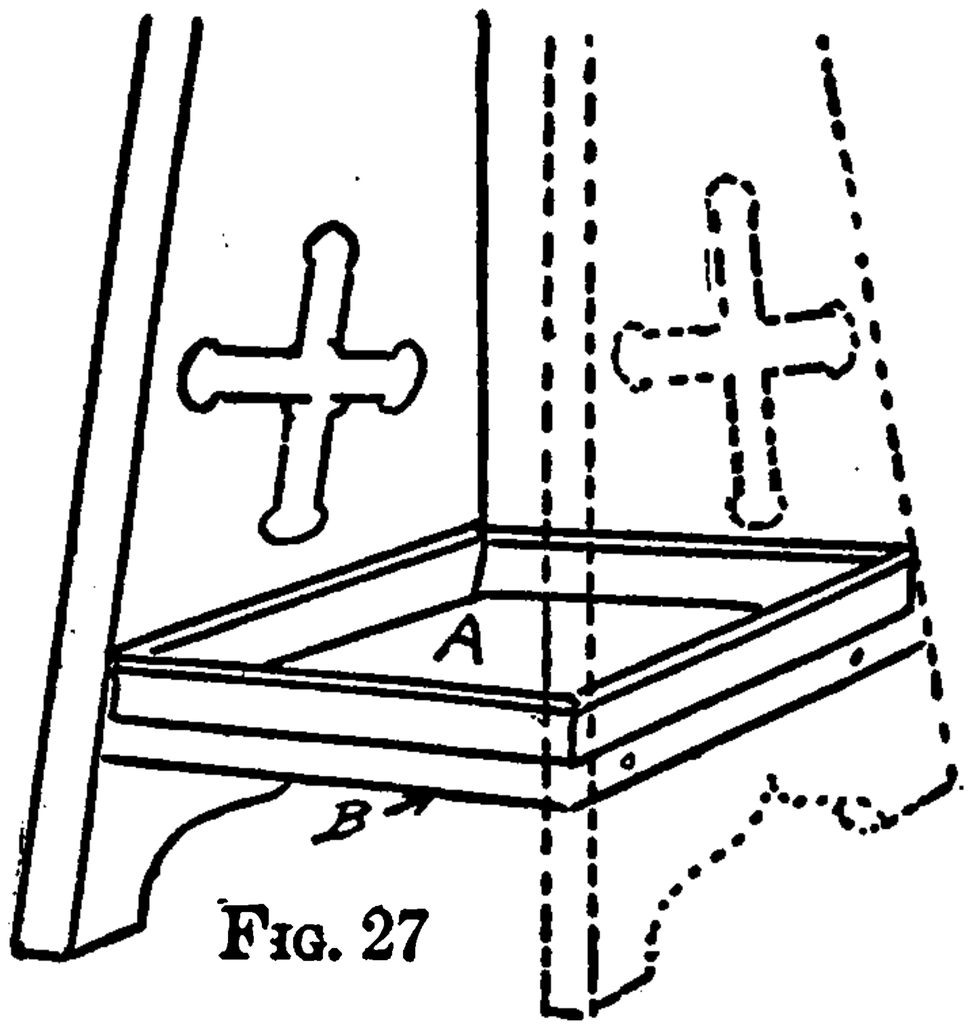


FIG. 27

brass tray (Fig. 27 *A*) which may be made by any tinsmith or which you can make yourself. Have the tray fit snugly inside of the stand and secure it in position by placing the piece Fig. 27 *B* under it and fasten this piece with round-

headed screws through the sides, two on each side. It is unwise to fasten the tray to the wood, for it may become punctured or leaky, then by merely removing the wooden bottom the tray may be renewed or repaired. If placed in the stand without the wood beneath it, it will soon be battered and filled with holes from umbrellas dropped into the stand. Finish the stand with stain, varnish, wax or any finish desired, taking care to putty up all nail and screw holes before finishing and remember when using putty for such purposes to colour the putty to match the finished wood.

Every boy loves a cosy-corner or a window-seat and such things are among the easiest of furnishings to construct.

In making a corner-seat, such as figured herewith, first fasten a good strong cleat of 2-in. x 2-in. stuff to the wall 16 in. from the floor. Be sure to get this level and run it along the entire length of the seats. Make the seats at least 18 in. wide, cleating two or more boards together with cross-pieces screwed in position, but be careful to leave 2 in. of the seat-board beyond the cleats so it can rest upon the wall cleats.

Get out several pieces of wood 2 in. square

for legs, making the pieces 16 in. long and fastening small triangular pieces or braces at one end of each leg as shown in Fig. 28. The number of legs you require will depend upon the size of the seat. There should be one at each end and one in the centre, and if they are spaced 3 ft. apart it will not be too close. If your seat is to be finished with a flounce and the legs are hidden these square pieces will serve every purpose, but if the seats are to be merely upholstered with cushions and the legs are visible they should be made somewhat ornamental. This may be done by using round, turned legs or they may be "chamfered" as shown in Fig. 29, or sawed into an ornamental shape as shown in Fig. 30. When the legs are done screw them firmly to the boards, set the boards on the wall-cleat and fasten them with stout screws. If the seat is in a corner a neat corner-cabinet or set of shelves may be constructed to hold books, magazines, etc. To make such a set of shelves get out four pieces as long as you wish the height of the shelves and in one corner of each cut grooves or slots as shown in Fig. 31, about 1 ft. apart. Screw one of the pieces in the corner of the room with the slot outward and screw two more to the walls in

the position shown in Fig. 32 and each the same distance from the first corner-piece as the length of the edge of the shelves from *A* to *B*. Set the shelves in these, gluing them in place and fasten

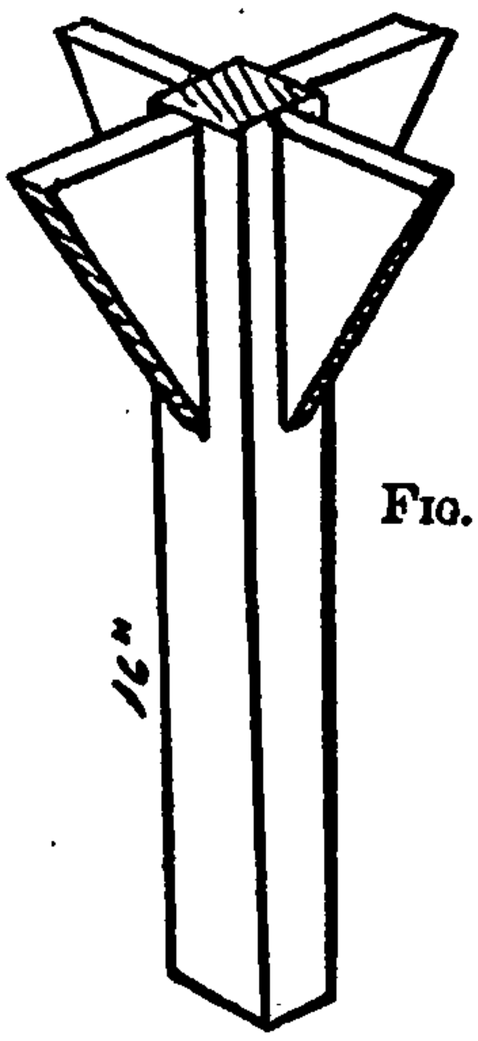


Fig. 28.



Fig. 29



Fig. 30

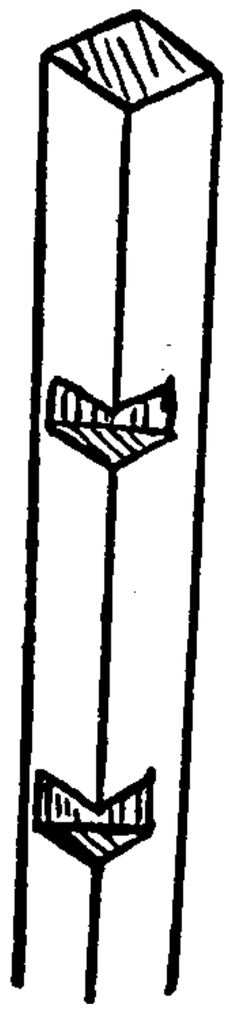


Fig. 31

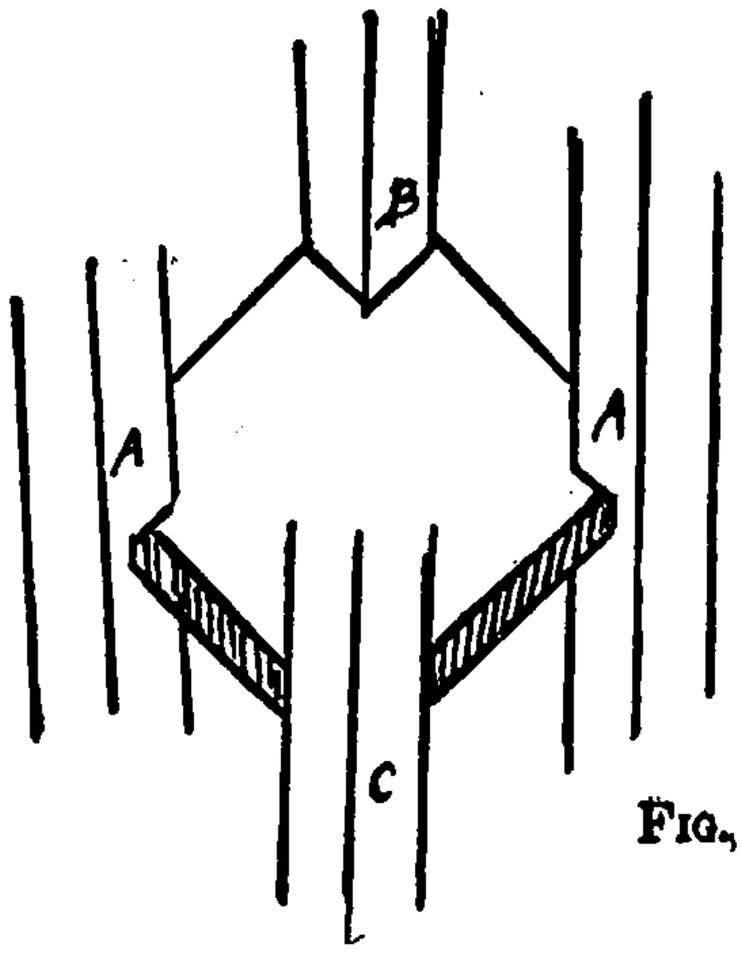


Fig. 32

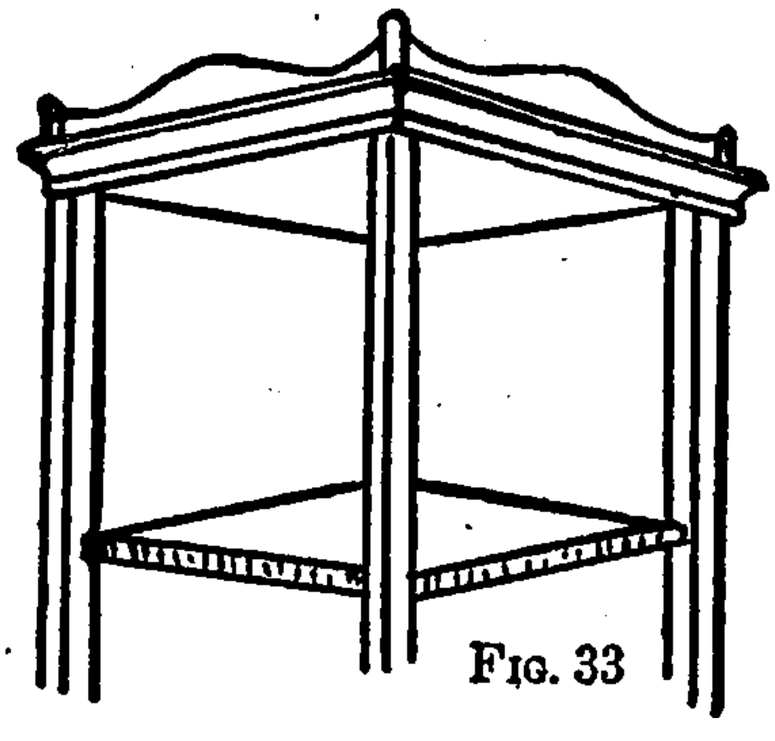


Fig. 33

the fourth piece at the outer corners as shown in Fig. 32 *C*. The top may be finished off by fastening a slightly larger piece with rounded edges on top of the uprights and a small neat rail may be placed around this or an ornamental moulding may be fastened around the edges as shown in Fig. 33.

Even without a seat such a corner-shelf is ornamental and useful, and it may be constructed with the lower part in the form of a cupboard or it may be entirely separated from the floor and placed at any desired height. A window-seat such as described may be still further improved by fitting back-rests at one or both ends. To do this get out smooth, well-finished pieces 18 in. long by 18 in. wide and with two of the corners neatly rounded. If obliged to cleat two or more pieces together,—as will probably be the case,—place one cleat close to the bottom or square end and the other close to the other end

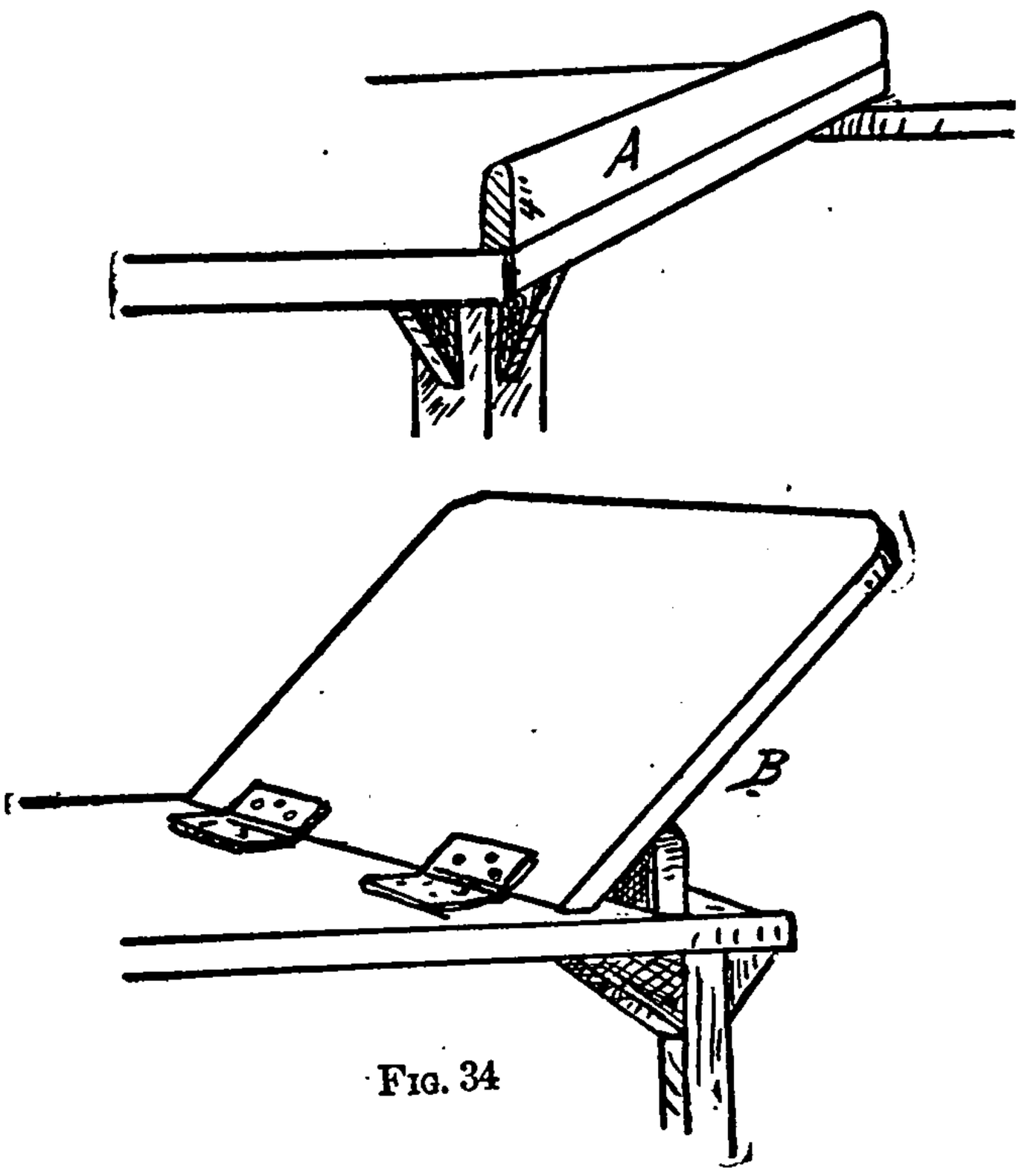


FIG. 34

and make the latter smooth and well finished with rounded corners and ends. Fasten a piece to the end of the seat so that it projects four inches above the seat and round off the edges and corners as shown in Fig. 34 *A*. Rest the backboard against this and when you have decided on the angle that seems best suited to your comfort mark across the seat where the lower edge of the backboard rests upon it. Fasten two or more hinges to the backboard and screw the other leaves of the hinges to the seat at the line marked. In this way the backboard may be folded flat on the seat and the cushions placed over it or it may be opened up and used as a back rest when desired (Fig. 34 *B*).

When you have succeeded with the various simple pieces of furniture already described you will probably wish to try your skill on something more elaborate. A good article is a stand or table, and to make a plain table is not at all difficult. In this stand 1-in. stuff is used throughout, and as all lines are straight a great deal of trouble and work is obviated.

For the top you will have to cleat two pieces together, for the top will be 12 in. square and you will have difficulty in finding a good smooth-

grained piece of wood of that width. Plane the two edges for the top—where the boards join—until smooth and even, and glue them firmly together. Then on one side fasten thin, neat cleats

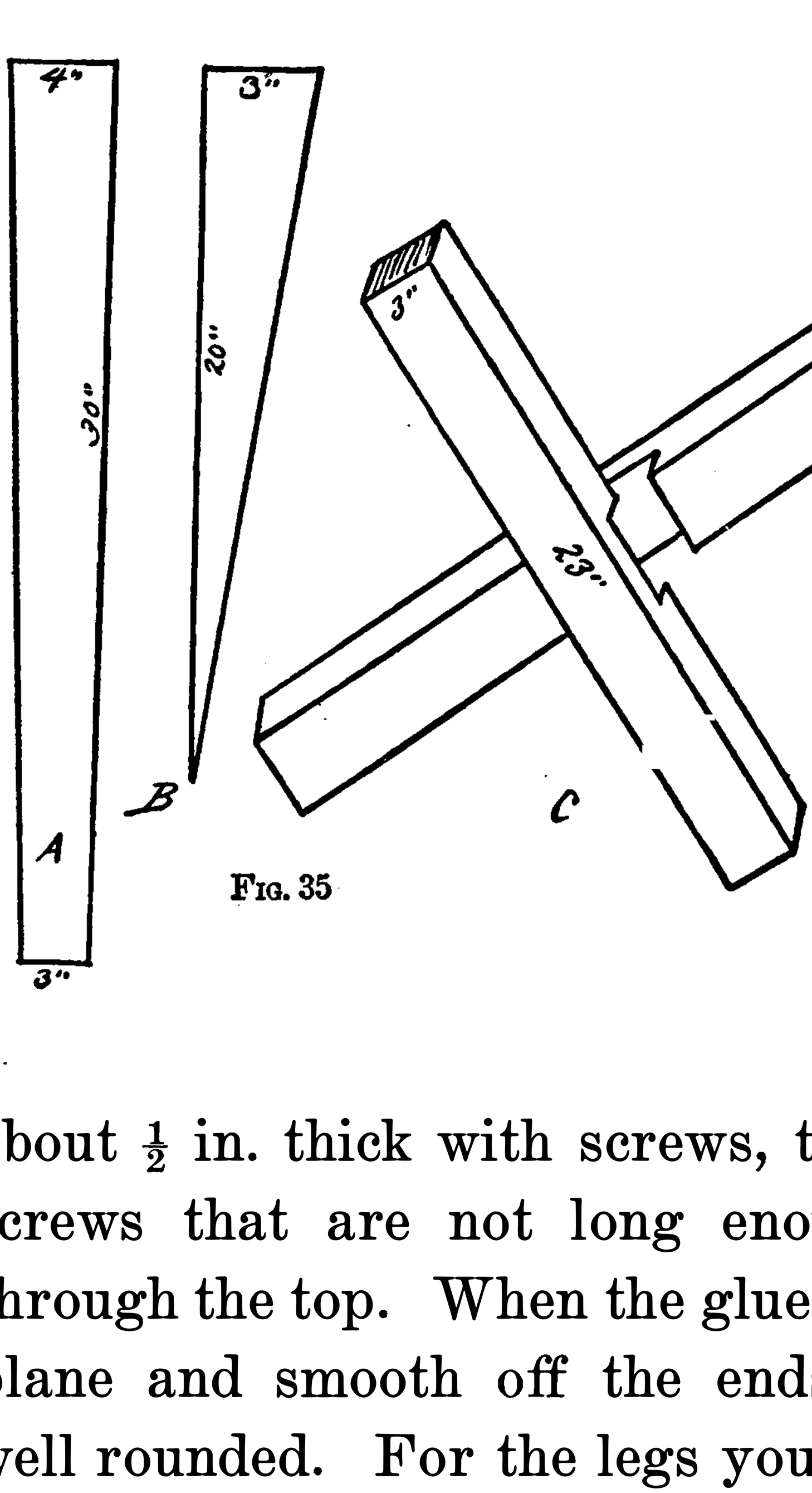


FIG. 35

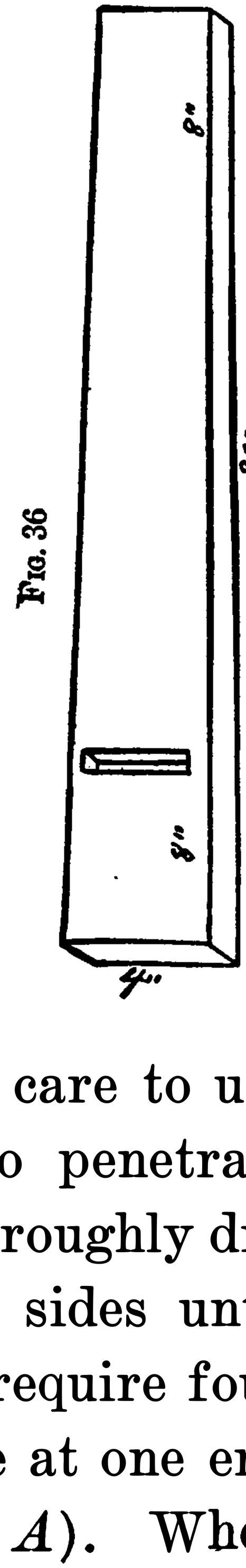


FIG. 36

about $\frac{1}{2}$ in. thick with screws, taking care to use screws that are not long enough to penetrate through the top. When the glue is thoroughly dry plane and smooth off the ends and sides until well rounded. For the legs you will require four pieces each 30 in. long and 4 in. wide at one end and 3 in. wide at the other (Fig. 35 *A*). When

the legs are roughly sawed out clamp them together in the vise and plane all together until they are all absolutely alike. Next get out four pieces each 20 in. long and 3 in. wide and tapering to a point at one end as shown in Fig. 35 *B*, and plane these so all are alike while clamped together in the vise. The next pieces to get out are the cross-pieces to support the shelf. These are each 3 in. wide and 23 in. long and should be half-and-half joined in the centre (Fig. 35 *C*). Eight inches from the bottom (4 in. end) of each leg-piece cut a recess 3 in. wide and $\frac{1}{4}$ in. deep (Fig. 36). On the lower side of the top draw lines from corner to corner and on each of these lines, $3\frac{1}{2}$ in. from the corners, mark off spaces 3 in. long and $\frac{1}{2}$ in. wide with the lines as centres, and with the chisel carefully cut out recesses $\frac{1}{4}$ in. deep as shown in Fig. 37. The bottom shelf is the next piece in order. This should be 18 in. square and on one side draw lines from corner to corner. With these lines as a guide mark lines at right angles to them (using your square for the purpose) and moving the square back and forth until the lines across the corners measure just 3 in. When this is determined draw the lines and saw off the corners as shown in Fig. 38. Next smooth and round

off all corners and edges on this piece, as well as the corner edges of the legs and the edges on the *slanting* side of the triangular pieces already described. Set the cross-piece, made by halving the two 3-in. x 3-in. pieces together, in the recesses in the lower part of the legs and place the top in position so the upper (3-in.) ends of the legs fit in the recesses made in the lower side of the top. If the top sets level and all parts fit well the next step will be to trim off a little on the inner sides of the legs so that they stand evenly on the floor.

To do this you will have to cut off a little piece of each leg, and the way to determine the amount is to place a piece of $\frac{1}{2}$-in. wood on the floor close to the leg until the desired result is obtained. When this is accomplished glue the cross-pieces in their recesses and glue the tops of the legs into the places in the top and through each leg, from the outside, drive a screw into the ends of the cross-pieces. The screws may be countersunk and puttied over or round-headed screws may be used, as your fancy dictates. Set the table aside until the glue is thoroughly dry, and then turn it upside down on a flat surface. Take one of the triangular pieces and place it on the outside of a leg

with the straight edge against the leg and the wide end against the lower side of the top.

You will find that if the straight edge is pressed evenly against the leg there will be a little open space between the inner edge of the end and the table top. Place a thin piece of wood or a rule along the lower side of the top and against the triangular piece and with a pencil draw a line parallel with the top. Saw carefully along this line, and if you have done the work properly you will now find that the end of the piece fits snugly against the top with the straight edge against the leg. Repeat this operation with the other three triangular pieces and then measure off from each side of each leg at the top and also at a point a foot lower down, and mark the exact centre of each leg from side to side. Measure $\frac{1}{4}$ in. from these centres on each side and draw a line from one centre mark along the legs to the other centre. Along this line drill two or three holes and countersink the openings on the opposite sides or inside of the legs. Coat the straight edge of a triangular piece with glue, and also the end, and place it against a leg, using the two little marks $\frac{1}{4}$ in. from the centre as guides and drive screws into it from the inside of the legs. With a fine

drill or bit bore a hole in each triangular piece and drive a slender, long screw through each of these into the lower side of the top. Bore a hole through each of the lower cross-braces, about 6 in. from the centre, and countersink the lower openings. Turn the table right side up, place the shelf on the cross-pieces and centre it so that the

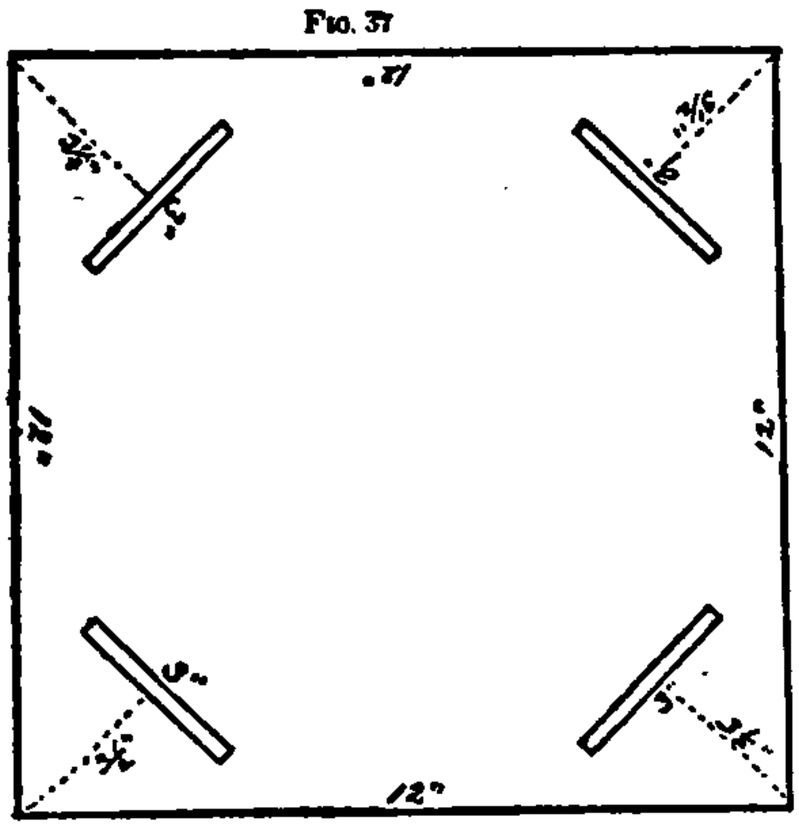


Fig. 37

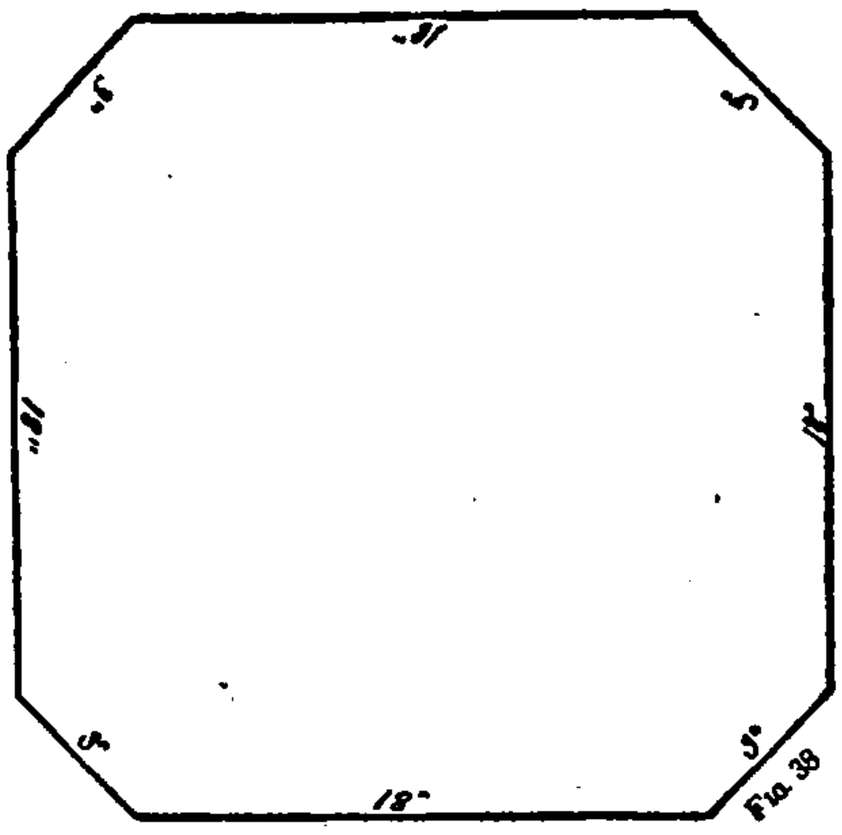


Fig. 38

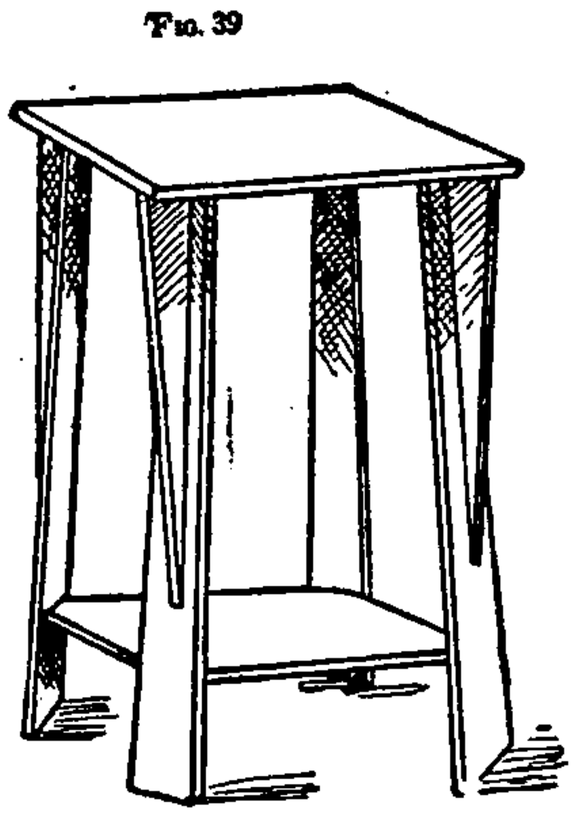


Fig. 39

corners are equidistant from all the legs and make light marks to indicate the position. Then fasten the shelf by screws driven up through the under side of the cross-braces and your table is complete, save for finishing with stain, varnish or wax as you prefer (Fig. 39).

Having constructed this stand to your satisfaction you can turn your attention to something more difficult and elaborate. The table described in the following paragraphs may be made of any size by altering the various measurements, but

the size given is very good. For this table you will require some $1\frac{1}{2}$-in. square stuff for the legs and bottom pieces as well as the regular 1-in. stuff for tops, rails, etc. In making this table there are several mortised or tenon joints which will afford excellent practice at this sort of work.

The top is 48 in. long by 24 in. wide and must of course be built up from several pieces glued neatly together and well cleated on one side, but in fastening on the cleats be sure to keep their ends at least 6 in. from the edges of the table top and do not place any of them nearer than 6 in. from the ends.

The legs should be 24 in. long and each corner of each should be chamfered for a space of 20 in., beginning the chamfers 2 in. from one end and carrying them to within 2 in. of the other (Fig. 40*A*). At one end of each leg cut away for a space of $\frac{1}{2}$ in. on two sides and $\frac{1}{4}$ in. on the other two sides for a depth of $\frac{1}{2}$ in., thus leaving a tongue or tenon $\frac{1}{2}$ in. by 1 in. and $\frac{1}{2}$ in. long (Fig. 40 *B*). From the 1-in. material get out two pieces each 39 in. long and 8 in. wide and shaped as in Fig. 41*a*, and two other pieces each 15 in. long and 8 in. wide formed as in Fig. 41*b*. On each end of each of these pieces cut away a space at top and bottom

½ in. deep and 1 in. wide. On each leg, on two sides and at the upper end, cut recesses ½ in. deep, 1 in. wide and 6 in. long, with one end of each recess just 1 in. from the top of the legs (Fig. 40 *C*). Then from 1½-in. material cut two pieces 26 in.

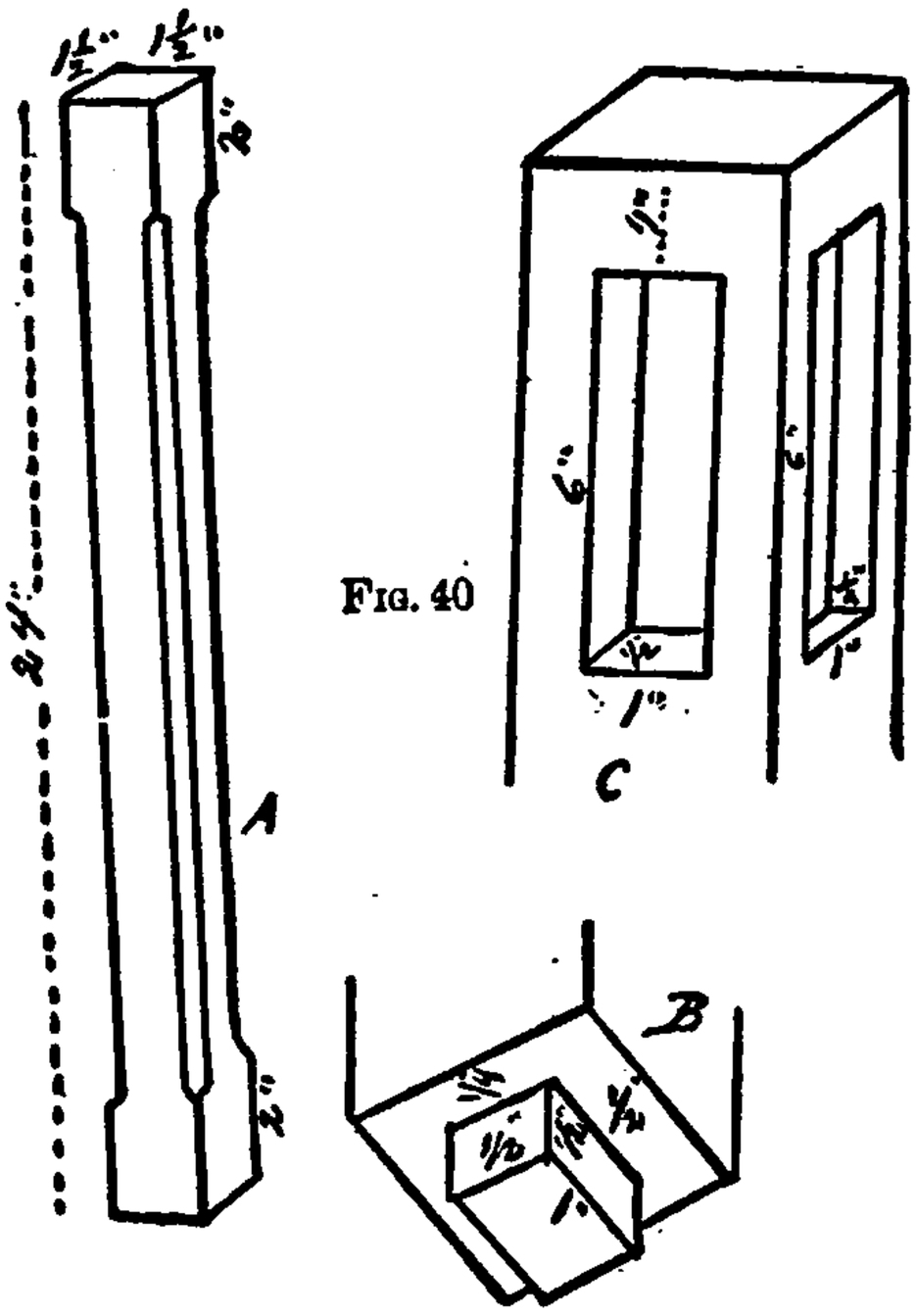


Fig. 40

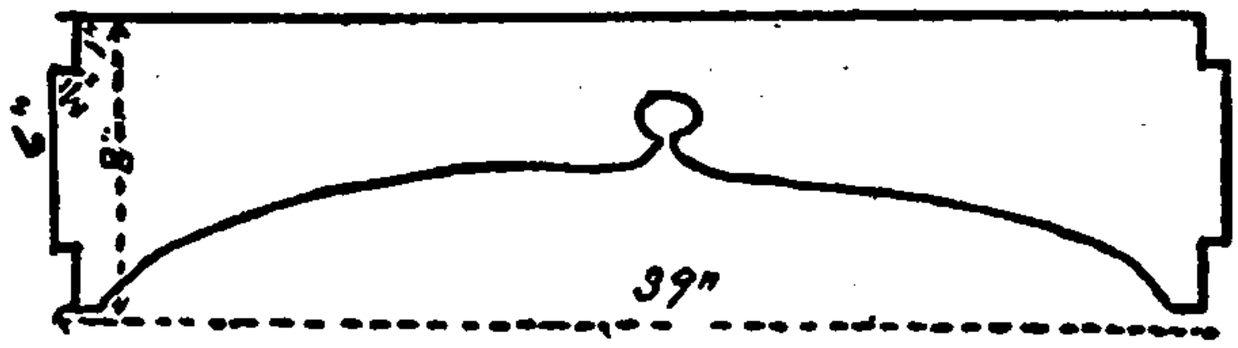


Fig. 41*a*

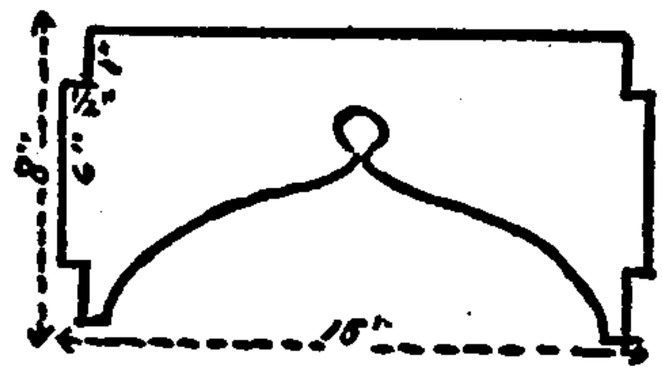


Fig. 41*b*

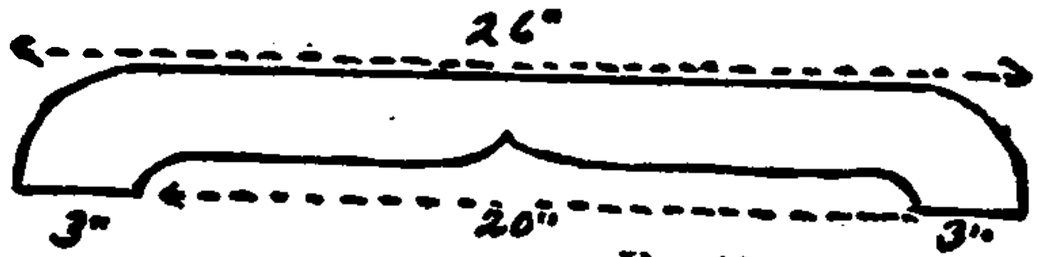


Fig. 41*c*

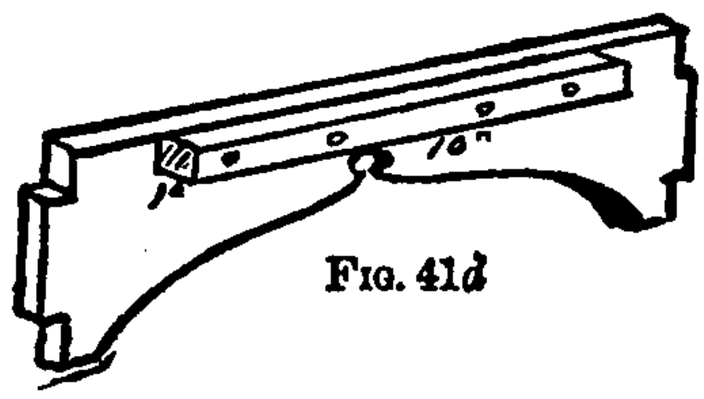


Fig. 41*d*

long and 3 in. wide shaped as in Fig. 41*c*. On each of the pieces Fig. 41*a* and Fig. 41*b* fasten pieces 1 in. square and about 10 in. long with one edge flush with the straight edge of the pieces (Fig. 41*d*). Screw these cleats in position with screws through the cleats and bore other holes at right angles to them as illustrated. On the pieces Fig. 41*c* find the centre from end to end and

from the centres measure off 7¼ in. in each direction and from these marks mark off rectangular spaces 1 in. long and ½ in. wide as indicated in Fig. 41*e*, and with a chisel cut these out ½ in. deep.

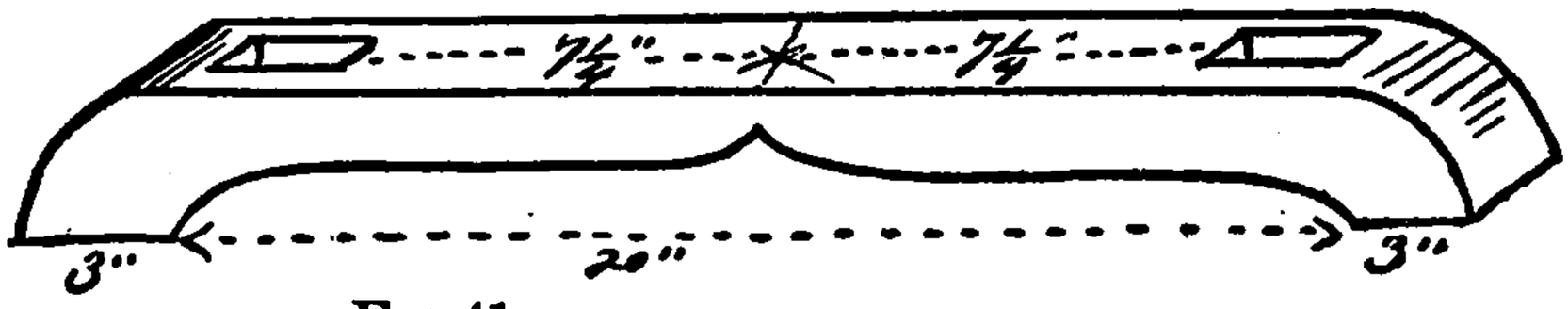


FIG. 41e

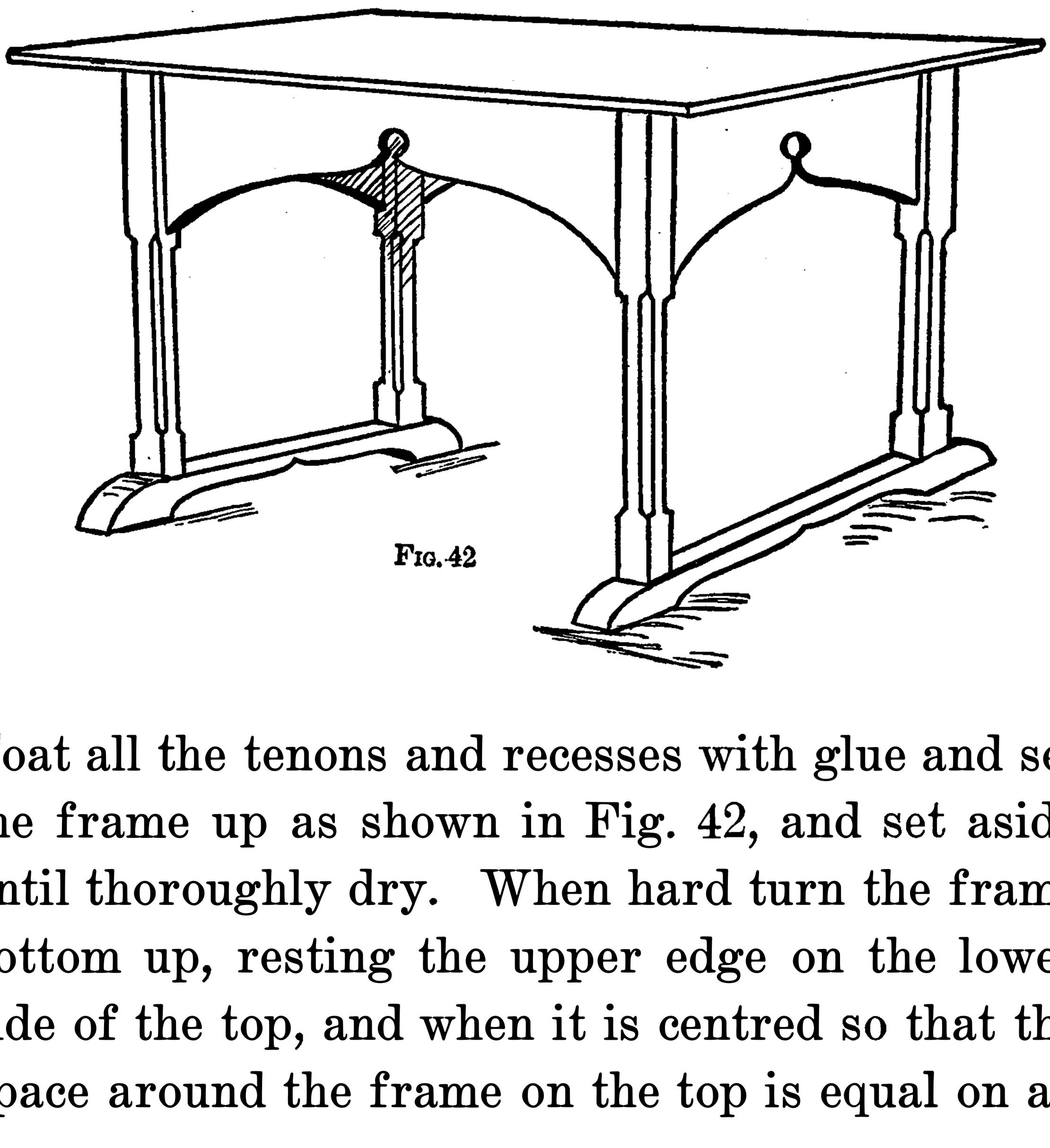


FIG. 42

Coat all the tenons and recesses with glue and set the frame up as shown in Fig. 42, and set aside until thoroughly dry. When hard turn the frame bottom up, resting the upper edge on the lower side of the top, and when it is centred so that the space around the frame on the top is equal on all

sides fasten the frame to the top with screws through the cleats fastened already to the side and end pieces, also placing glue between the edges of the side, the top of the legs and the lower sides of the cleats before driving the screws. Then through the lower side of the pieces at the bottom of the legs drive long screws up into the legs and your table will be complete save finishing, or if you desire, castors may be placed on the lower ends of the legs.

CHAPTER X

FITTING UP A GYMNASIUM

NEARLY every boy enjoys a gymnasium and the boy carpenter can easily fit up some garret room or loft to make a very satisfactory gymnasium at little expense. Many of the expensive fittings for a gymnasium can be made at home very cheaply by boys handy with tools, and the following descriptions will tell you how to construct some of these things.

Vaulting horses are always great favourites in a gym. and are among the simplest and easiest articles to construct. The material required will be 3-in. x 4-in. timber, some 1-in. boards and some 2 x 2 timber, as well as some heavy iron staple-bolts 6 in. high and 5 in. between centres of legs with the lower ends threaded for nuts as in Fig. 1. Any blacksmith can make these two staples of $\frac{1}{2}$-in. round iron for a few cents each. For the legs of the horse you should get out four pieces of the 3-in. x 4-in. stock each 43 in. long. Then on the floor, or bench, draw a straight line 48 in. long and at right angles a few inches from the

end of this line draw another line about 40 in. long. Measure off 16 in. from the upright line on each side of the last line and place two legs so that their outer ends just touch these marks and the upper ends cross the upright line as shown in Fig. 2*a* with the 4-in. side down. With a rule or your square mark across the timbers exactly in line with the mark on the floor and do the same where the line at the other end crosses them. Saw on these lines and the timbers will be shaped as in Fig. 2*b*. Using these for patterns repeat the operation with the other two timbers to be used as legs and on one end of each piece measure $1\frac{1}{2}$ in. from the diagonal surface as shown in Fig. 2*c* and draw a line parallel with this edge as shown. On this line measure 4 in. from the outer edge, as illustrated, and saw out the piece *A* so that the slanting ends of the legs will be the shape shown in Fig. 2*d*.

Cut another piece of 3-in. x 4-in. timber 5 ft. long and measure off 6 in. on each end. Fasten the legs to this timber with their outer edges at the spaces marked and securing them with screws in the position shown in Fig. 2*e*. Now get out two pieces of 3 x 4 timber each 38 in. long and place them upon the floor with their 4-in. sides

down and their inner edges just 4 ft. apart. Set the legs upon these pieces so that there is 3 in.



Fig. 2b

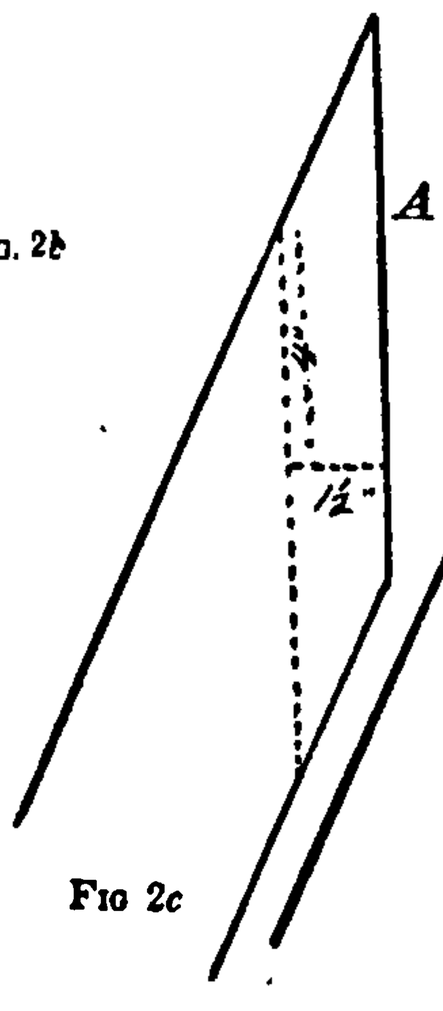


Fig 2c



Fig. 2d

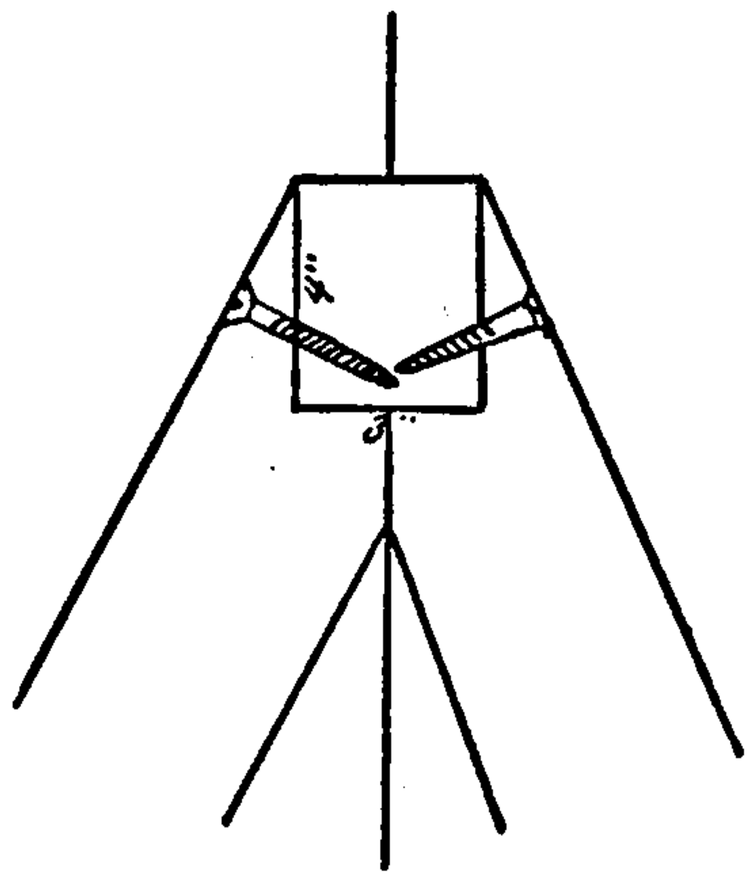


Fig. 2e

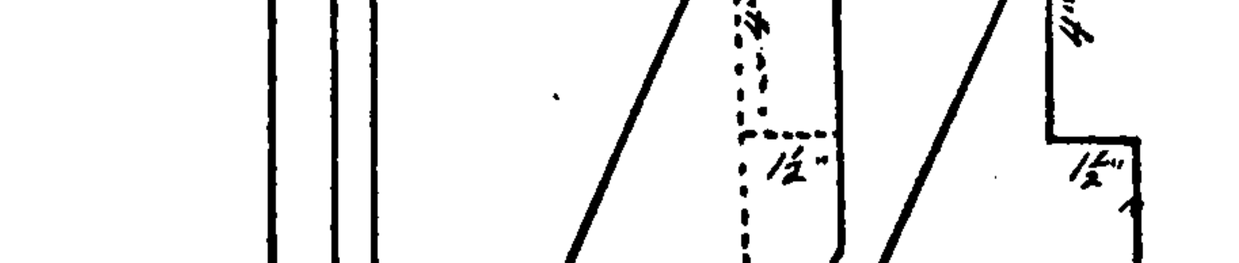


Fig 3a

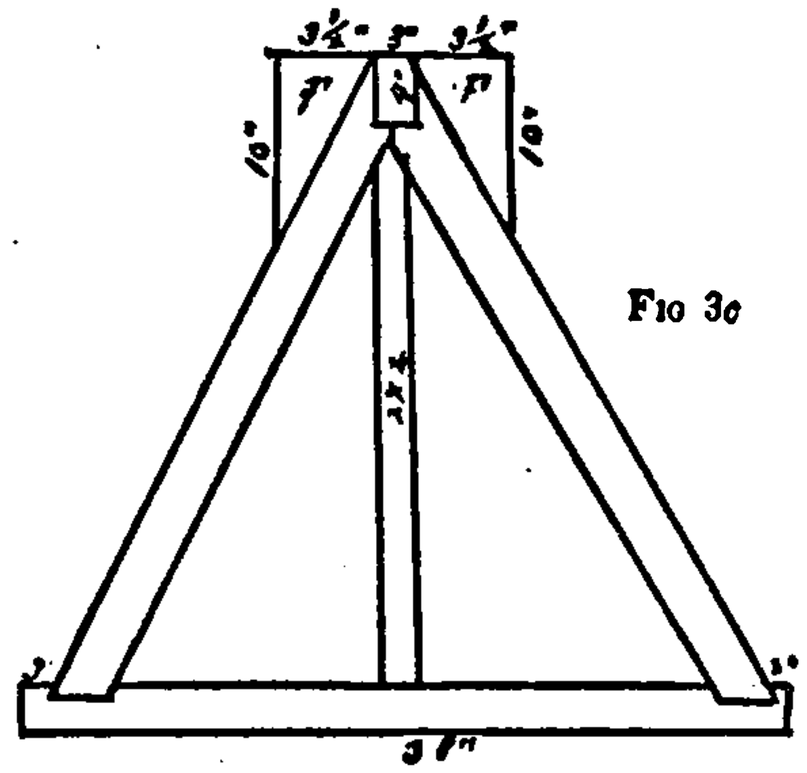


Fig 3c

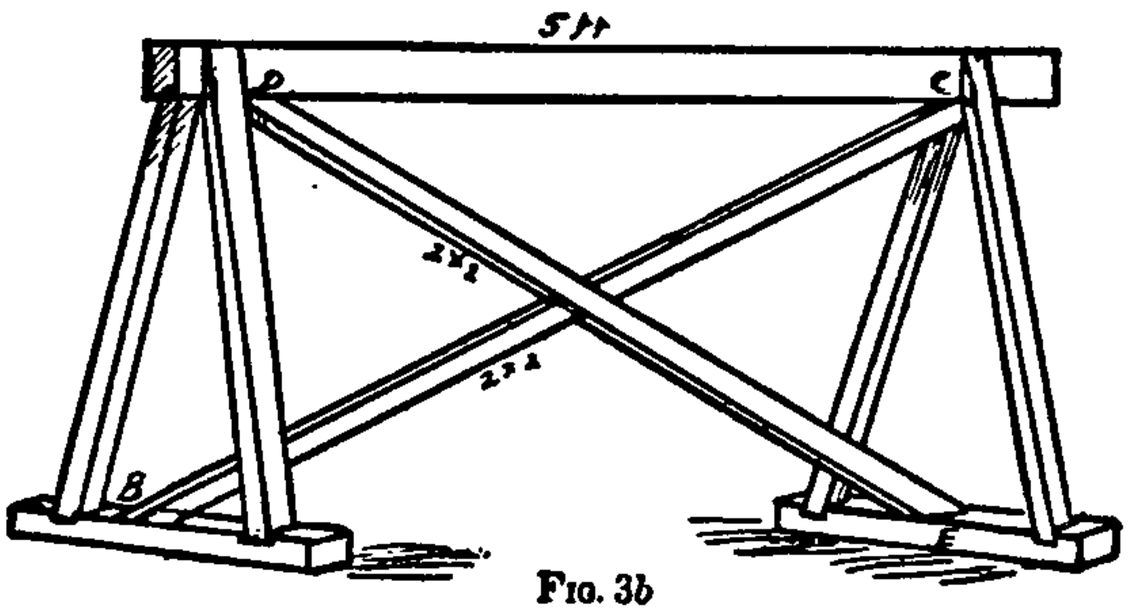


Fig. 3b

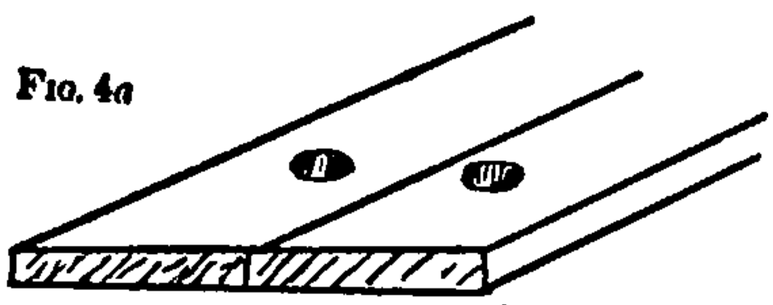


Fig. 4a

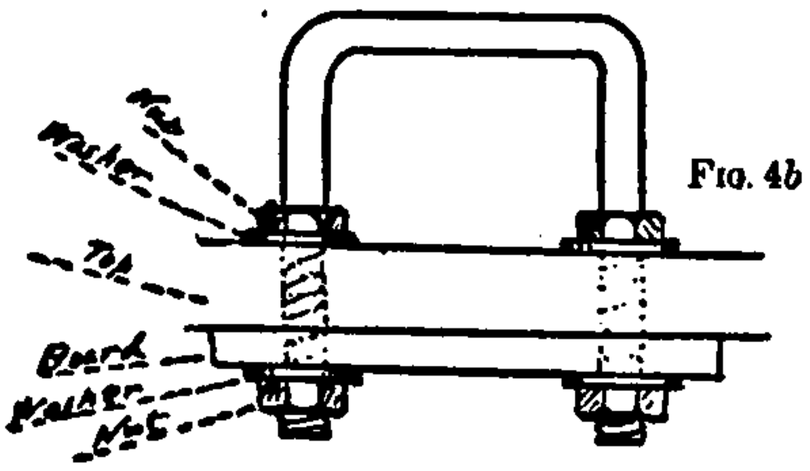


Fig. 4b

between the outer side of each leg and the end of the timber and with a pencil mark around each

leg. Cut out recesses where these marks indicate that the legs rest and fasten the ends of the legs in the mortises with stout screws driven through them (Fig. 3*a*). Now cut two pieces of the 2-in. x 2-in. stuff to fit diagonally across from the spot *B* to *C* and from *D* to *E* and where they cross in the centre half and half join them (Fig. 3*b*), and fasten the ends securely to the upper timber and the two cross-timbers on which the legs rest (Fig. 3*b*). Next from a piece of the 3 x 4 stuff get out four triangular pieces 10 in. long on the straight side by $3\frac{1}{2}$ in. wide and 3 in. thick. Fasten one of these pieces to the outer side of each leg as indicated at *F* (Fig. 3*c*), using either nails or screws in attaching them. Fasten a board 5 ft. long by 10 in. wide (or two narrower boards edge to edge) along these triangular pieces with the upper edges of the boards straight and flush with the tops of the angular pieces and the top of centre timber and nail or screw them firmly in position. Now on a piece of 1-in. board 12 in. wide and 5 ft. long, or two pieces placed edge to edge, mark the centre ($2\frac{1}{2}$ ft. from each end) and 5 in. from either side of this centre mark bore two $\frac{1}{2}$-in. holes 5 in. apart. If the piece consists

of two 6-in. boards let one hole of each pair come in each board as shown in Fig. 4*a*. Screw a nut on each end of the staples, slip the ends of the iron staples through these holes, place a cleat of 1-in. board over the projecting ends from side to side (Fig. 4*b*) and screw on the nuts with washers above and below the wood as shown in Fig. 4*b*. Now set the board with the staples in position on top of the horse and from the under side mark on the centre beam where the cleats rest upon it. Cut grooves into the top of the centre beam or "ridge" to receive these cleats and nail or screw the top board firmly to the centre timber and the triangular pieces on the legs. Then with a plane smooth off and round the outer sharp corners, where they join the side boards.

The next step is to cover the horse with several layers of old carpet and over this stretch a piece of strong canvas, tacking the edges under the edges of the side boards and upholstering it as neatly as possible and taking care that no nail or tack heads project to tear clothing or injure your hands and body. The horse is now complete and it may be set up wherever you desire by driving screws or bolts through the cross-pieces at the bottom of the legs (Fig. 5).

Such a horse will be strong and durable and will stand any amount of rough, hard use. It may be made much simpler by omitting the centre piece and doing away with the diagonal braces underneath, but such a horse will swing and sway and will last but a short time and may become dangerous to use. In making gymnastic appliances your aim should be to make the things just

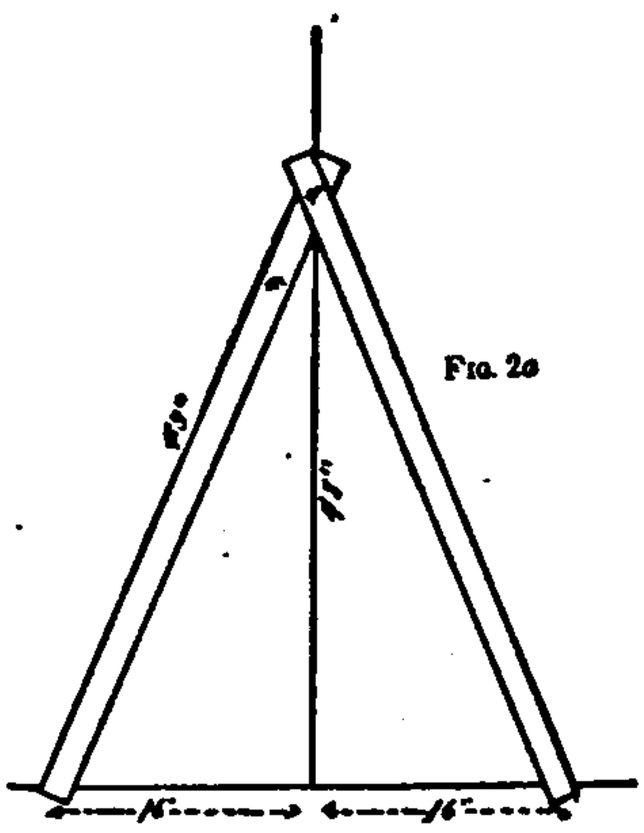


Fig. 20

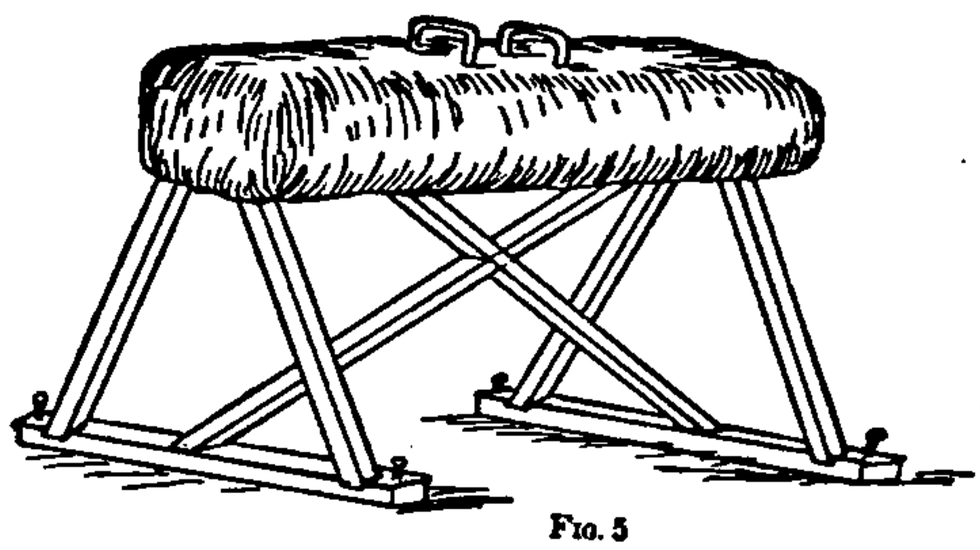


Fig. 5

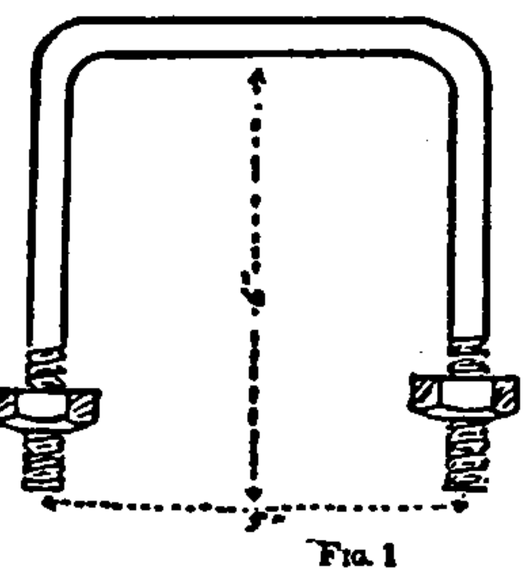


Fig. 1

as safe, strong and rigid as possible and only by using care and well-designed mortises, braces and joints can this be accomplished.

Every gymnasium must have a jumping hurdle, or several of them, and these are very easy affairs to make.

The first step is to get out two pieces of 3-in. stuff each 4 in. square. In the centre of each cut a recess $1\frac{1}{2}$ in. square and 2 in. deep. If easier you can cut the pieces from 2-in. material,

make the hole clear through and screw a piece of 1-in. material on one side over the hole. On each of the four sides of each of these pieces fasten 2-in. hinges 1 in. from the bottom as shown in Fig. 6, and to these fasten pieces 6 in. long and 4 in. wide of 1-in. material so that the bottom sides of the pieces are flush with the lower side of the 3-in. piece. Now get out two straight strips $1\frac{1}{2}$

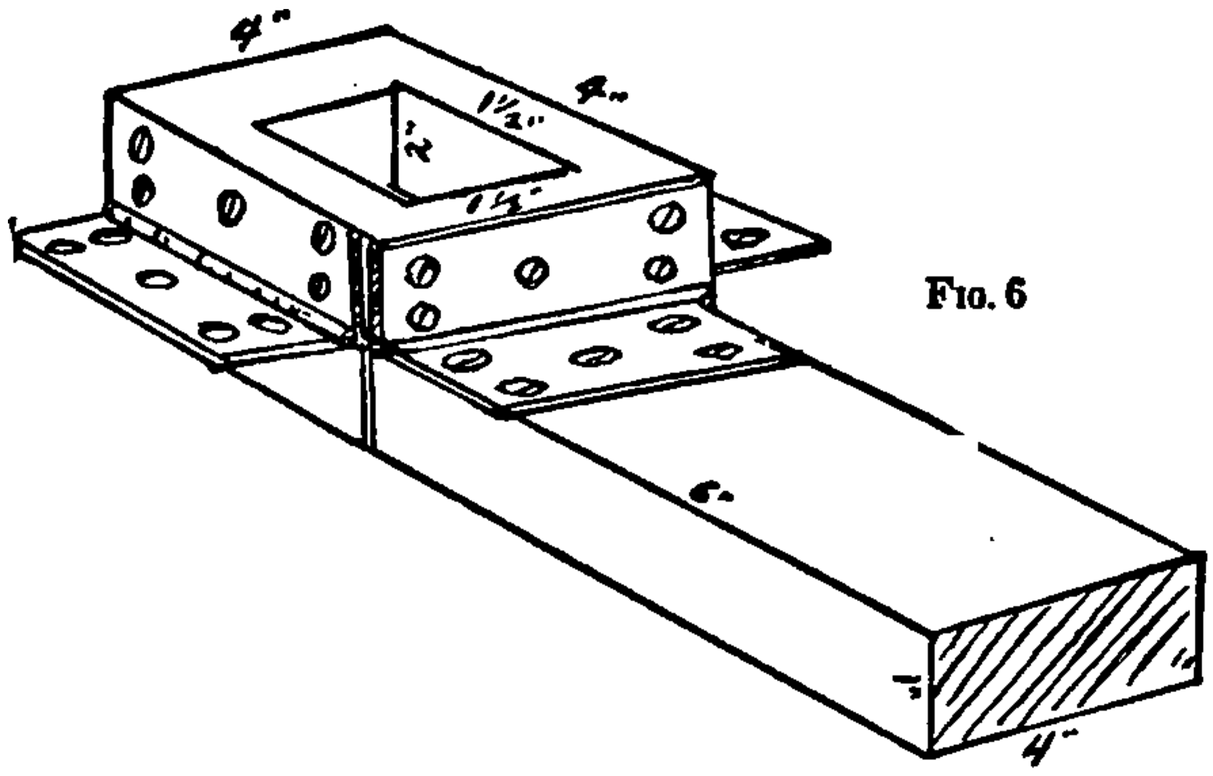
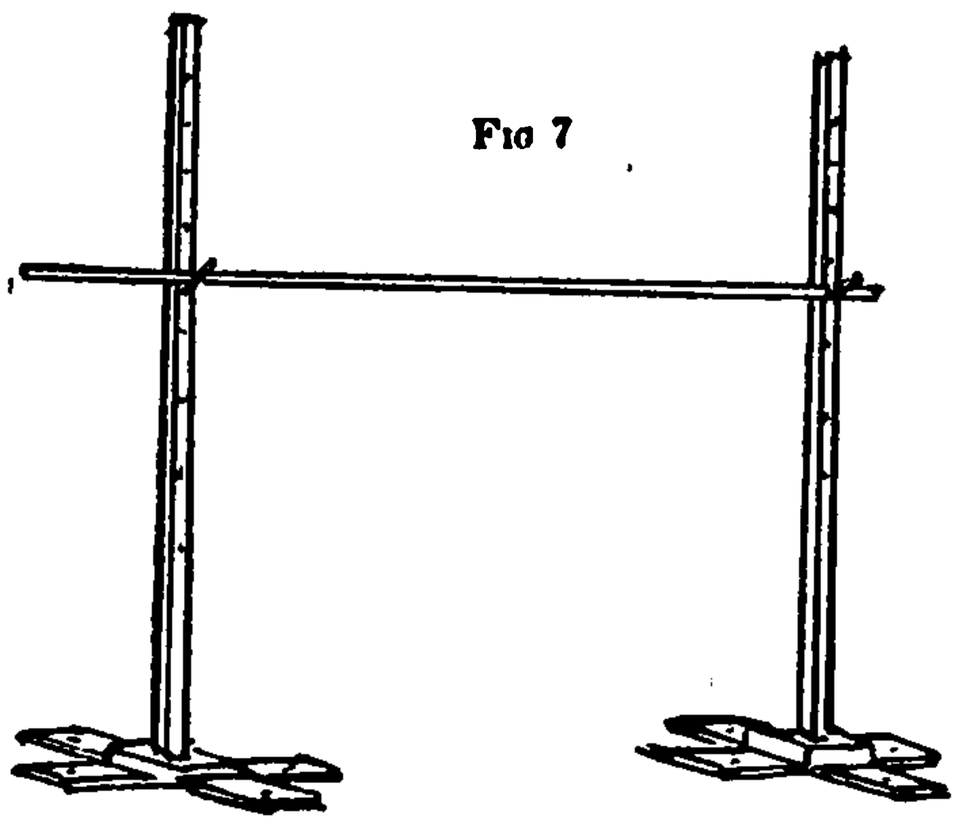


Fig. 6

Fig 7



in. square and 7 ft. long and bore $\frac{3}{8}$-in. holes through them, spacing the holes 1 in. apart for the first three or four feet and $\frac{1}{2}$ in. apart for the rest of the distance. In order to have the holes in line on both pieces clamp the two strips together in a vise with the ends even and bore the holes through both pieces at once. It is also a good plan to mark each hole on each strip neatly with the feet and inches from the ground, as in this way you will always know the height at which the hurdle is set and can always get the

cross-piece level without the bother of measuring. Set the two strips into the holes cut in the blocks with the hinged pieces and make some wooden or brass-rod pegs to fit the holes. For a cross-strip a light piece of wood or a slender bamboo pole will answer very well. When the hurdle is to be set up in the gym. it may be secured by screws through the hinged pieces, whereas out of doors pegs or long spikes may be pushed into the earth through the holes bored for these screws (Fig. 7). When not in use or when the hurdle is to be carried from one place to another the bottom pieces may be folded up out of the way and the uprights slipped out and tied together with the cross-piece.

PARALLEL BARS

These are useful appurtenances and several will not be too many for a gymnasium used by more than one or two boys. Parallel bars are very simple and easy to construct and only a small amount of material is required.

The wood should be mostly 3 x 4 material, preferably finished or planed, as to plane down rough scantling by hand is a slow and tedious job.

The length and height of the bars will depend entirely upon your own size, but for ordinary boys' use they should be about 2 ft. apart and 6 or 7 ft. in length with a height from the floor of about 3 ft.

The first step is to get out the two bars of 3 x 4 stuff and on these pieces plane off one edge (on the 3-in. side) until half-round. Six inches from each end of these cut a recess 4 in. long, 1½ in. deep and 2 in. high, as shown in Fig. 8*a*. For the legs or supports you will require four pieces of 3 x 4 timber of the length you have decided upon for the height of the bars from the floor. On one end of each of these pieces cut away a space 1½ in. deep on the 4-in. side and 2 in. from the end as shown in Fig. 8*b*. Set these in the recesses already cut in the bars and see that they fit snugly as in Fig. 8*c*. Next get out eight pieces of 2-in. x 3-in. timber each a little over 2 ft. long. Saw off one end of each of these pieces at an angle of 45 degrees and place them aside for the present. Take one of the leg-pieces and on the three-inch side mark a spot 2 ft. from the lower end and with your angle-square, or by placing the leg in the mitre-box, rule a 45-degree line across from this mark on the 4-in.

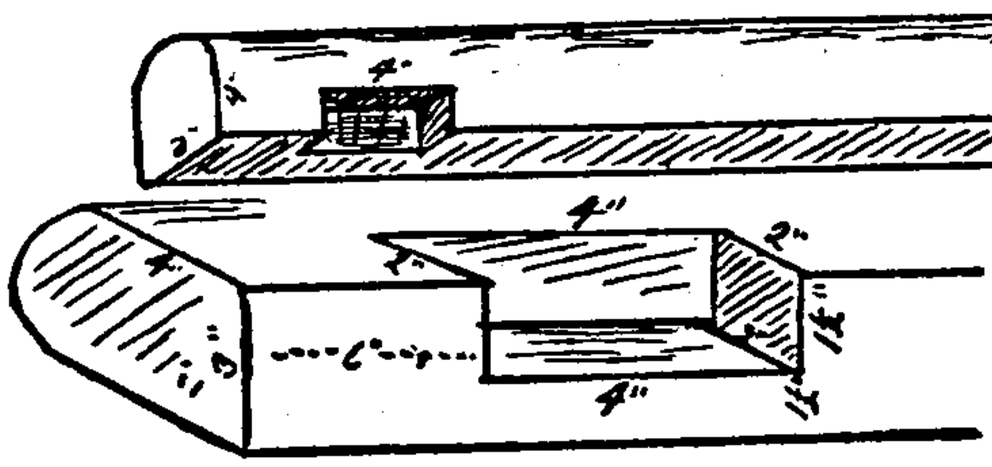


Fig. 8a

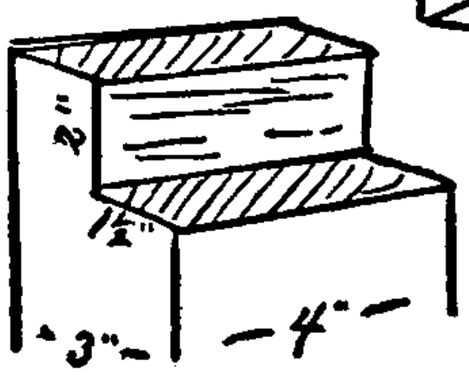


Fig. 8b

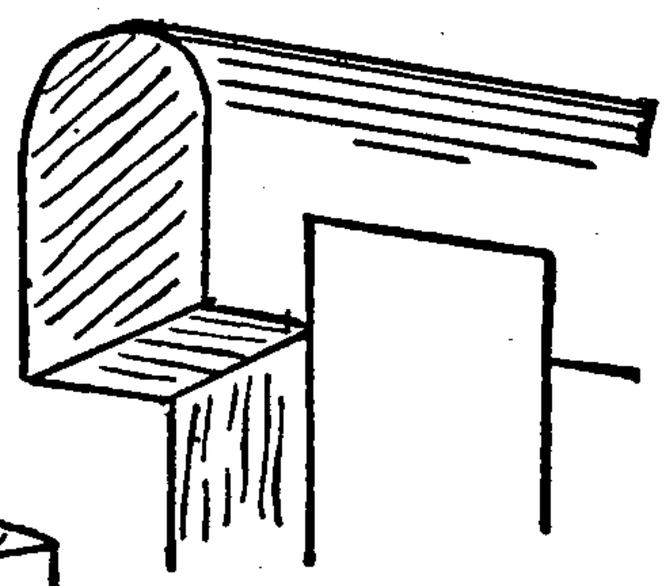


Fig. 8c

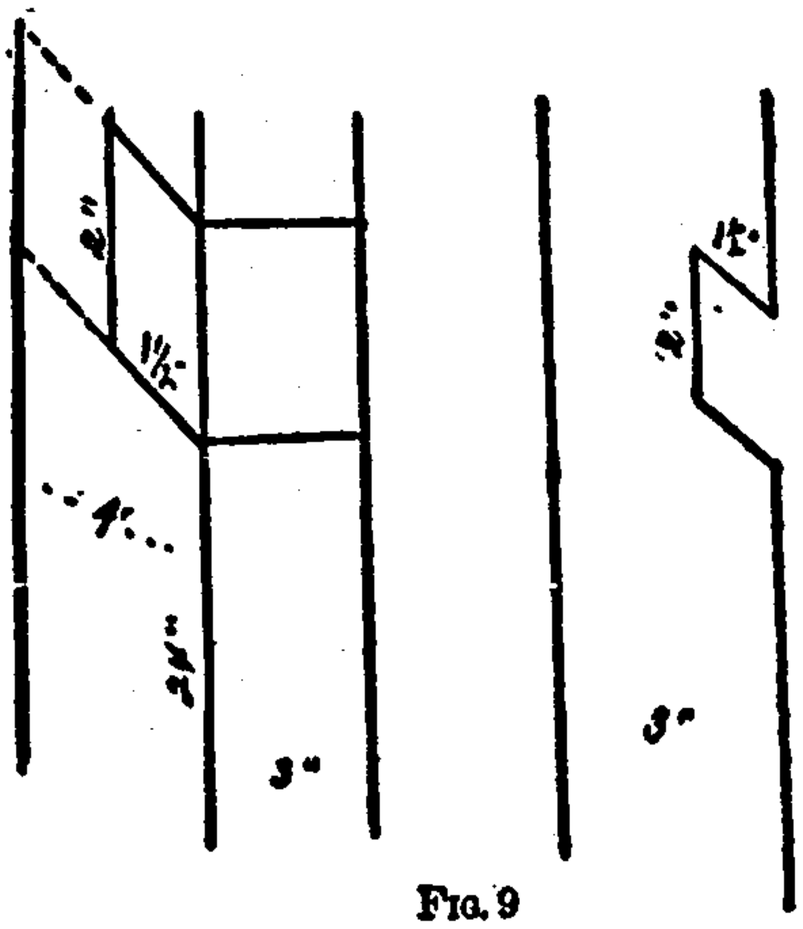


Fig. 9

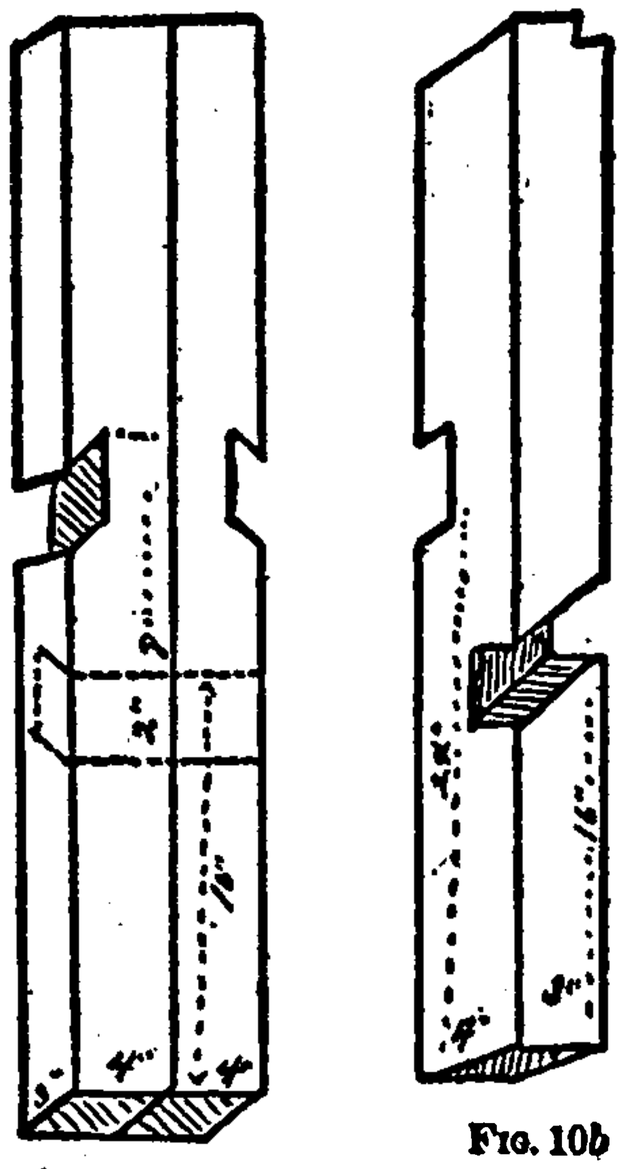


Fig. 10a

Fig. 10b



Fig. 11

Fig. 12

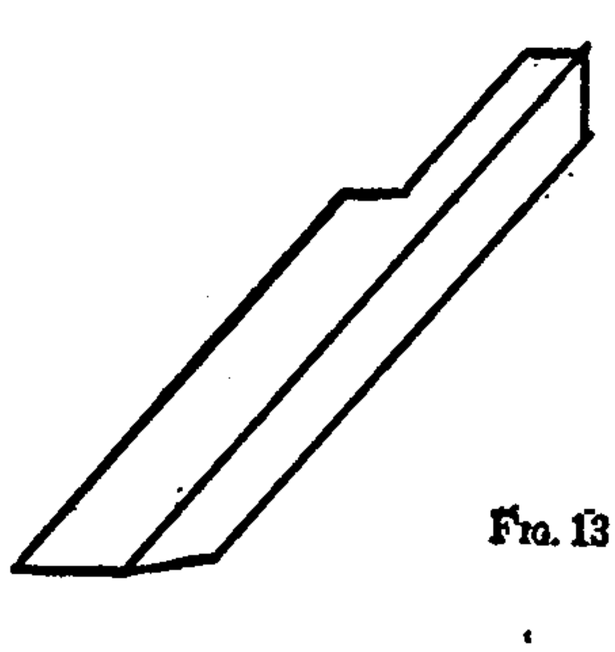


Fig. 13

side. Two inches below this draw a parallel line and connect the two by a straight line parallel with the edge of the leg and just 1½ in. from the edge. With these lines as guides cut out a piece, leaving a notch as shown in Fig. 9 on the 3-in. side of each leg. Now place the legs in pairs, with the unnotched sides together and the upper or notched ends down as in Fig. 10. On the 3-in. sides, opposite the notches already cut, make marks 16 in. from the lower (square) ends of the legs (Fig. 10*a*), and from these run lines at an angle of 45 degrees towards the upper ends of the legs. Two inches below these draw parallel lines and saw along these lines to a depth of 1½ in. and chisel away the wood to leave a diagonal groove across the legs as in Fig. 10*b*. Now set the angular end of one of the 2 x 3 pieces in the first notch cut in a leg (Fig. 11) and nail it firmly in position. Place your square along the side of the leg and mark across the projecting diagonal piece in line with the bottom of the leg (Fig. 11) and saw off the piece evenly on this line. Place the leg upright on the floor with the bottom of the diagonal resting on the floor also and tack both to the floor lightly with small nails. With square

and level move the leg slightly back and forth until plumb and straight on all sides before securing it. Select one of the remaining pieces of 2 x 3 stuff and placing the lower, angular end on the floor in line with the leg and with the outer edge just 16 in. from it, slip it into the recess already cut in the leg as shown in Fig. 12. With a pencil mark plainly where the edges of

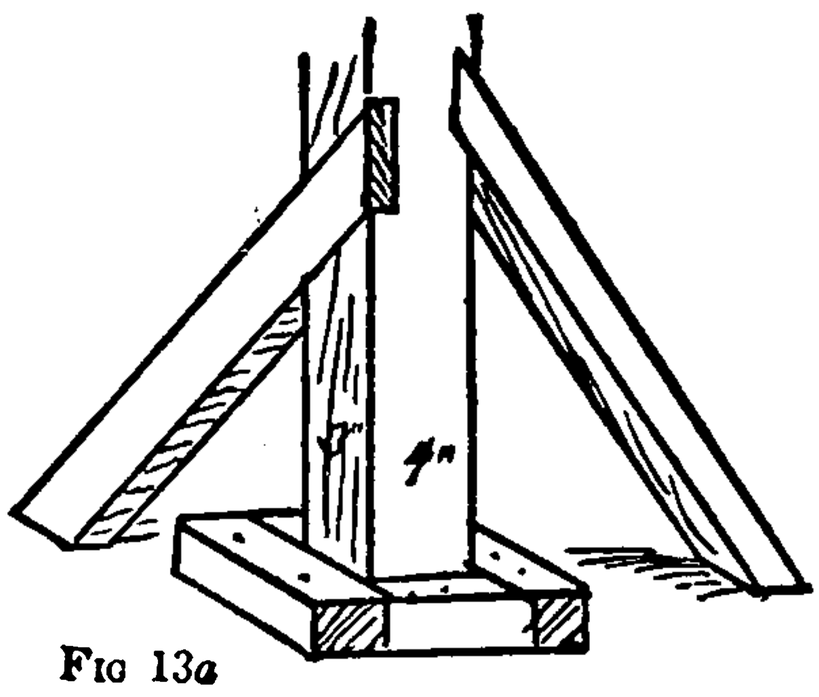


Fig 13a

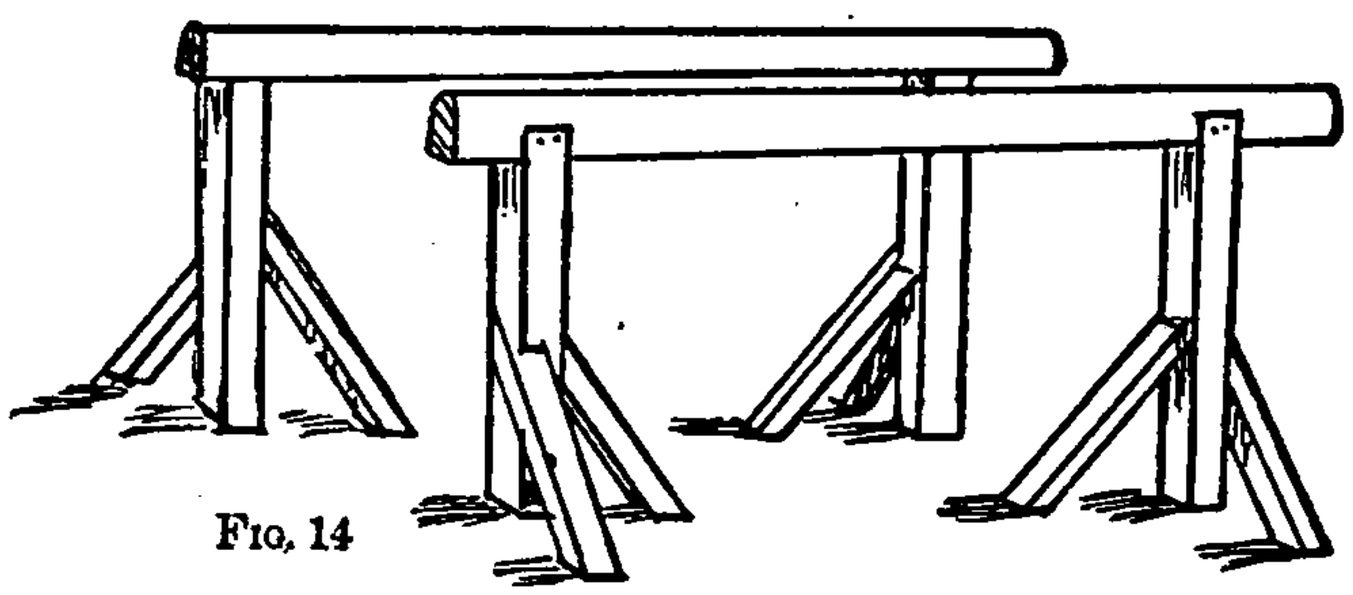


Fig. 14

the notch cross this piece (*A*, *B*, *C*, *D*, *E*, *F*) and saw along these lines to a depth of $1\frac{1}{2}$ in. on the lower mark and clear through the timber on the upper one and with a chisel cut away to leave a tongue as shown in Fig. 13. Repeat these operations with the other three legs and you will then be ready to set up the bars permanently. To do this fasten the notched ends of the legs into the recesses cut in the bars and then nail the legs and their braces to the floor the proper distance apart, being sure to keep the bars parallel. For

still greater rigidity and security place cleats of 2 x 3 material around the base of each leg (Fig. 13*a*) and your bars will be complete and will appear as in Fig. 14.

PUNCHING-BAG DISKS

Boys can get a lot of fun out of punching-bags. There is no better exercise indoors and, in addition, it is splendid practice in dodging blows and obtaining skill in using your fists.

The bags themselves are not very expensive, but the ready-made disks usually cost quite a good deal. There is no reason why any boy should not have a punching-bag, however, for the disks are easy to make and an old football may be used for the bag if you cannot afford a regular one.

Sometimes there is not enough space for a disk in the centre of the floor of a home gymnasium and I will therefore describe two forms, one for the centre of the room and the other to be placed near one of the walls. To construct the latter you will require some 1-in. lumber and some 2 x 2 scantling. The first step is to place three or four boards—aggregating 3 ft. in width—close together edge to edge on a smooth

surface. Tack them lightly in place to prevent their sliding or slipping about and with a string and a piece of chalk draw a circle with a radius of 18 in. on the boards (Fig. 15*a*). With your

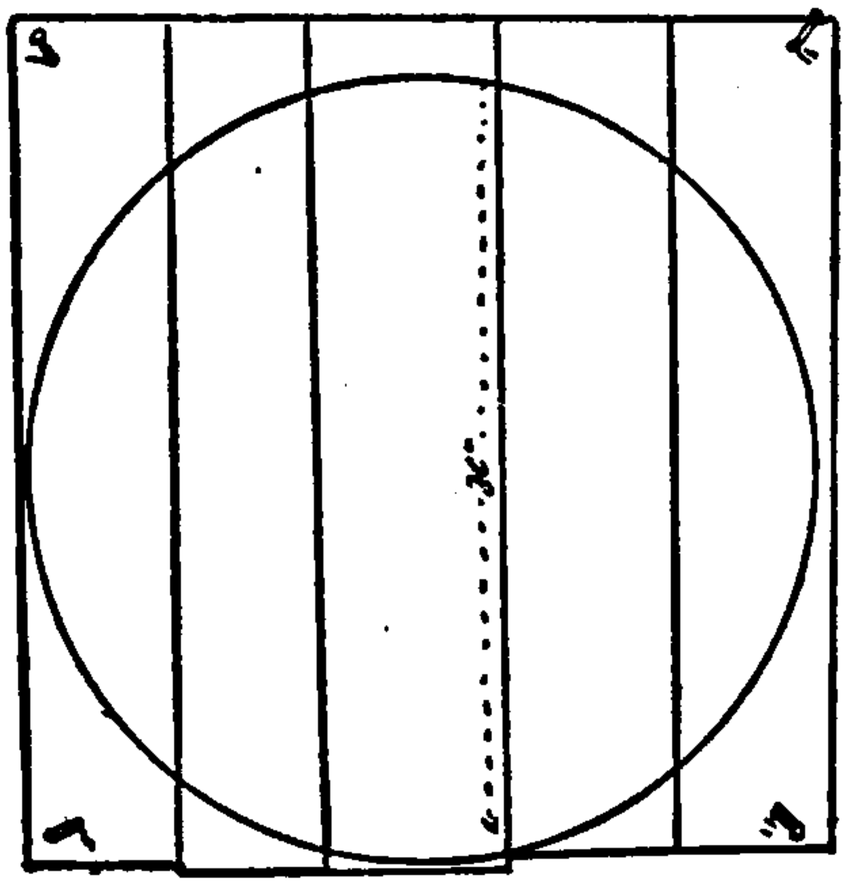


Fig. 15*a*

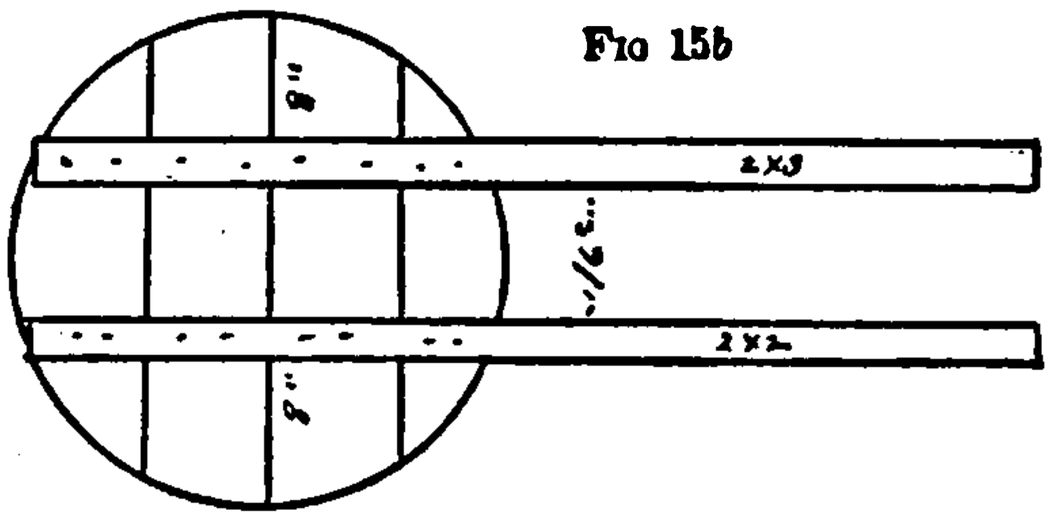


Fig 15*b*

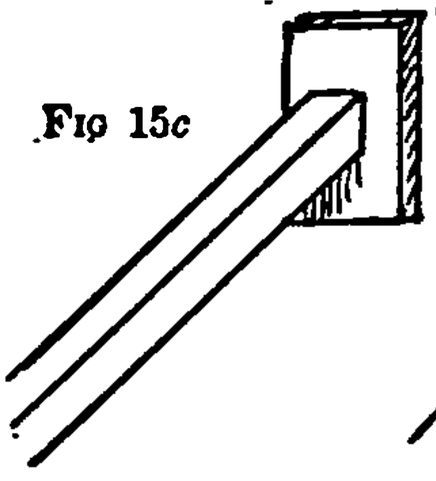


Fig 15*c*

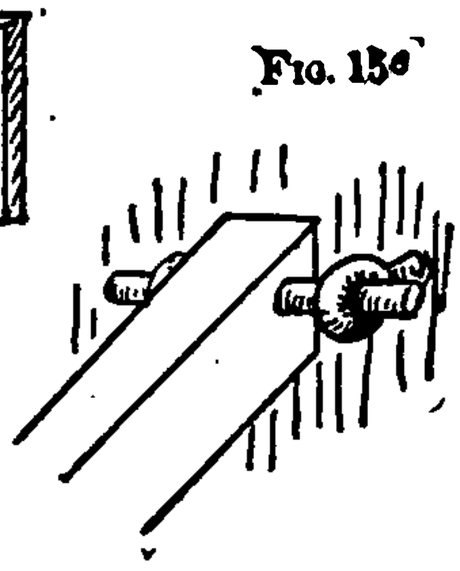


Fig. 15*c*

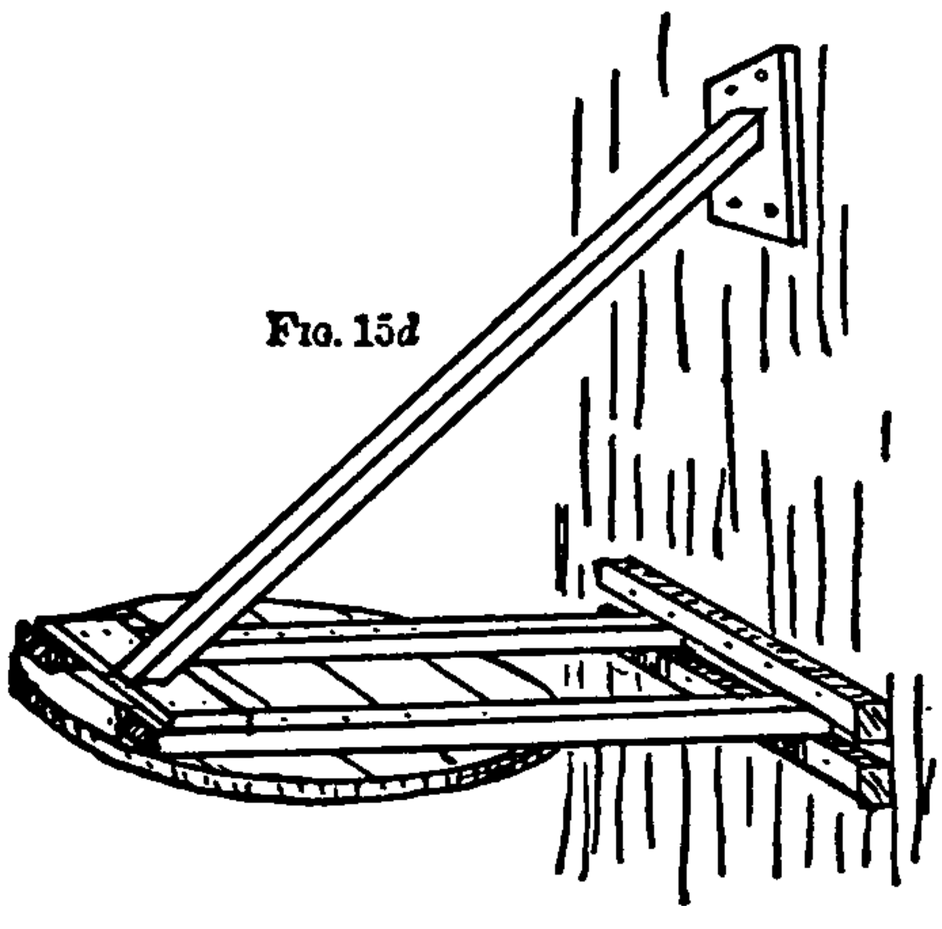


Fig. 15*d*

compass-saw cut around the circle and again place the boards side by side on the floor or bench. Get out two pieces of 2 x 2 material each 7 ft. in length and place them on the circle of boards at right angles to the joints and with one end just even with the edge of the circle

and with the two pieces 16 in. apart on their inner edges and with their outer edges 8 in. from the outer edge of the circle (Fig. 15*b*). Tack them in position, using nails that will not go clear through the boards, and then fasten each board securely to the two pieces by wood-screws driven down through the cross-pieces. Round and smooth off the edge of the circular piece and the ends of the cross-pieces that are even with it. On the wall selected for the disk screw a 2 x 2 cleat 24 in. long at the desired height of the disk and 2 in. above this place a second cleat, first boring holes from top to bottom of the cleats at about $2\frac{1}{2}$ and 3 in. from each end. Now select a piece of 2 x 2 stuff about 6 ft. long and saw off one end at an angle of 45 degrees and to this fasten a piece of 1-in. wood with screws (Fig. 15*c*). Tack this lightly to the wall about 4, 5 or 6 ft. above the upper cleat, the height depending upon the height of the room. If there is 6 ft. of space above the cleat place the piece as near the ceiling as possible and if the ceiling is only 4 ft. from the cleat tack the piece a shorter distance above the cleat to correspond and see that the piece is at one side of the end of the cleats, not in the centre over them. Place a piece of 1-in. board

across the cross-pieces on the disk, slip the cross-pieces between the cleats and with your level adjust it until it is perfectly level. Then slide the loose piece of 1-in. stuff along until it touches the slanting piece fastened to the wall and mark along this slanting piece where the upper side of the loose board crosses it. Take down the disk, pull the slanting piece from the wall and saw it off where you marked it. To this end screw the piece of 1-in. board, driving screws up from below and down from above as well and then screw the piece of board firmly to the cross-pieces on the disk so that the diagonal piece is exactly in the centre between the cross-pieces. Now once more place the disk in position between the cleats and screw the board at the end of the diagonal to the wall and then drive screws through the cleats into the projecting ends of the cross-pieces on the disk. The disk will then appear as in Fig. 15*d* and will be very firm and rigid. A disk made in this way will be just as useful and roomy as if in the centre of the floor, for the space of 4 ft. between it and the wall will enable you to jump around it on all sides. If, however, there is not enough space in the room to permit the disk to project so far from the wall you can

simply shorten up the projecting cross-pieces and bring it closer to the wall.

The disk may be arranged to fold down flat against the wall, and out of the way when not in use, by hinging the cross-pieces to the wall instead of fastening them to cleats as described. The diagonal brace may also be hinged to the disk and secured to the wall when in use by means of a pin or rod shoved through staples or screw-eyes and a hole in the diagonal as illustrated in Fig. 15*e*.

To construct the disk for the centre of a room you should first cut out the disk as already described and screw a piece of 1-in. board 2 in. wide across the centre (Fig. 16*a*), with one end projecting 3 in. beyond the edge. Mark off two other spaces equidistant from each other and from one end of the cross-piece, thus dividing the circumference into three equal parts. This is easily done, as the diameter (36 in.) will be practically one-third of the circumference. Screw two other pieces of 1-in. x 2-in. stuff on these marks with their inner ends neatly meeting the cross-piece (Fig. 16*a*) and their other ends extending 3 in. beyond the edge of the circle. One inch from the extreme outer ends of all three

pieces bore a couple of ¼-in. holes, each hole being ½ in. from the edge of the cleats. Now decide on the height you wish the disk from the floor and cut three pieces of 2-in. x 2-in. material 18 in. longer than this height and also bore a hole through the exact centre of the disk. Place the three pieces of 2 x 2 material, one piece under

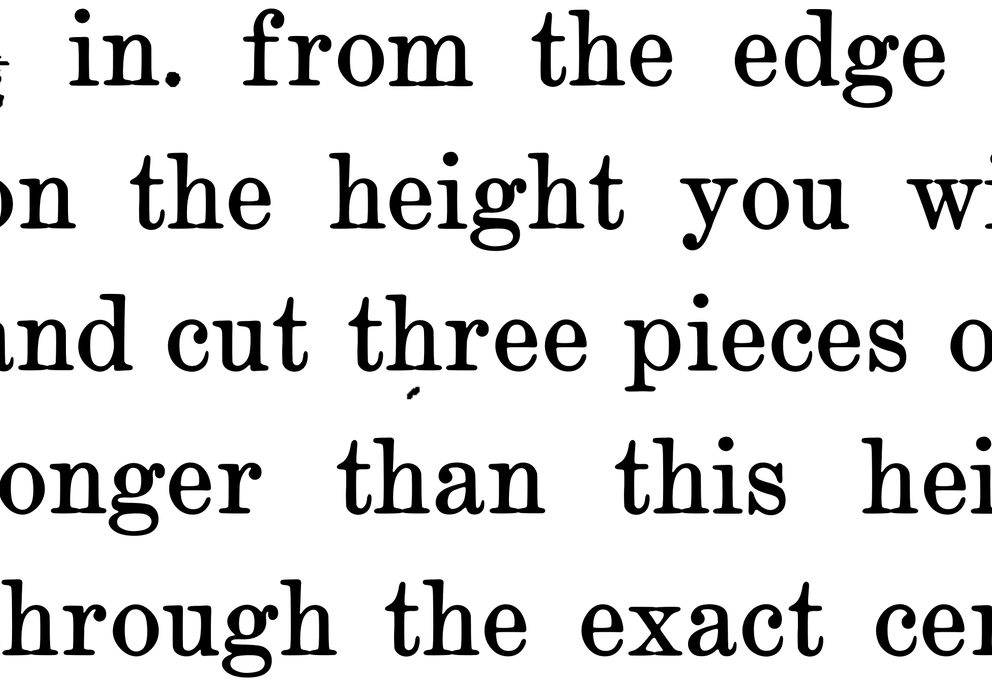


Fig. 16a



Fig. 17a

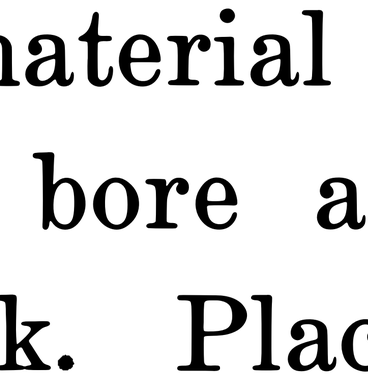


Fig. 17b

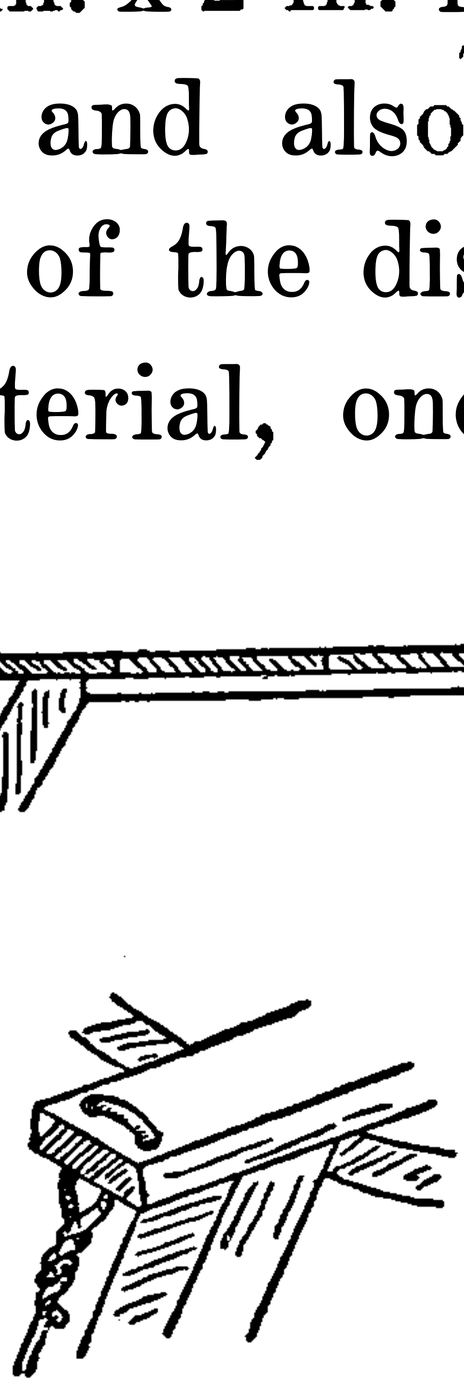


Fig. 17c

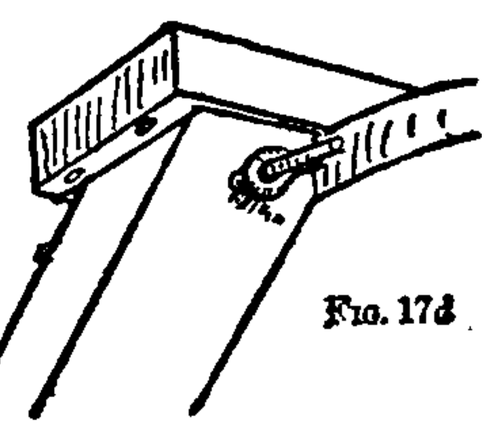


Fig. 17d

each cross-piece on the disk, thus forming a tripod with the disk resting on the ends of the legs. Through the hole in the centre of the disk drop a line with a weight on the end and mark the spot on the floor where it touches. With this for a centre move the legs out or in until each is equidistant from the centre mark and equidistant from one another, and when this is accomplished nail their outer ends lightly to the floor and screw them firmly to the pieces on the disk after cutting

off the upper ends slightly so they will fit snugly up under the cross-pieces as shown in Fig. 17*a*. A short cleat of 2 x 2 stuff should be screwed to the floor at the outer side of each leg and two other pieces should be screwed to the floor around the legs to form a socket for each (Fig. 17*b*). The disk will now be quite strong and rigid and will sustain a great deal of weight from above, but as all the strain of the punching-bag will come from below it is necessary to guy the disk in position with wires or small wire ropes. This is done by passing wires through the holes in the cross-pieces as shown in Fig. 17*c*, and attaching the other ends to screw-eyes in the floor a foot or so beyond the end of each leg. The wires may be drawn very tight by fastening them to the eyes before the latter are turned in tight and then turning the eye into the floor or they may be tightened by small turnbuckles, which may be bought for a few cents at any hardware store. This punching-bag disk may be made easily removable by cutting little notches in the floor for the legs instead of nailing them down with cleats around them and by securing the upper ends of the legs to the cross-pieces of the disk by means of pins and eyes (Fig. 17*d*). When set up in this

way and the wires are drawn taut the disk will be perfectly rigid. Until you have tried it yourself you cannot realise how strong and rigid any devices may be made by guys turned up tight. If you have ever seen acrobats on the stage, however, you may have noticed that all their appliances were erected with fastenings of this sort and were so constructed as to be easily taken down and moved about.

In addition to these various appliances you should erect horizontal bars, flying rings, trapezes, etc., none of which require any great amount of carpenter work; and, moreover, you should build cupboards or lockers, racks for foils, gloves, etc., and should have shelves for other odds and ends. You will find that in fitting up a gymnasium there is a great opportunity for exhibiting your skill as a carpenter and from time to time you will be able to add new appliances and fixtures.

CHAPTER XI

RUSTIC CARPENTRY

THE back yard or the grounds of a summer home offer great opportunities to amateur carpenters. Settees, ornamental fences and gates, lawn-swings, summer-houses, pergolas, arbours, trellises and many other useful and ornamental objects may be constructed.

Out-of-doors carpentry may be carried on with ordinary timber and boards, but rustic work in wood with its natural bark adhering, or in plain wood which is afterwards covered with bark or rough natural branches, is usually far more artistic and attractive. In England rustic carpentry is carried to extremes and most elaborate stables, garages, fences, gates, lodges and even dwelling-houses are built and finished in natural, bark-covered wood. In this country such objects are not so often seen, but many objects, such as summer-houses, pergolas, arbours, etc., are constructed of bark-covered wood and are to be seen in private and public grounds. The wood used in this country is mainly red or white cedar poles

and logs, for the cedar is very durable and the bark lasts a long time. Moreover, small, knotty cedars that are not fit for lumber are very abundant in many places and can be obtained very cheaply. Other woods will answer excellently and sassafras, hemlock, pine, scrub oak, hornbeam, maple, apple and many other trees will prove useful. Wild grapevines, as well as crooked, gnarled roots of grape and spruce, may be used to advantage in many places, while the rough half-round "slabs" from sawmills are most useful in out-of-doors carpentry. The boy who lives near the woods or who visits the forests often, may secure many interesting and odd formations which may be worked into the structures he builds. The gnarls of various trees, the limbs twisted and distorted by parasites and disease, the bent and crooked branches of wind-swept stunted trees and the crooked, tough roots of upturned trees are all useful and can be worked up into interesting features. By gathering such things whenever you see them you will soon accumulate a large assortment from which you will be able to select such as you require at any time.

In out-of-doors carpentry, as in other branches of the art, the simplest things should be under-

taken first and there is nothing much simpler than a rustic seat such as is shown in Fig. 1. For constructing the seat, poles or saplings about 4 in. in diameter and some smaller poles will be required. For the ends select four poles 36 in. long and in each one bore 1-in. holes, placing one hole exactly in the centre of each post and another 3 in. from each end (Fig. 2*a*). Then cut six pieces, each 28 in. long, and cut down each end of each of these to fit snugly into the 1-in. holes. Drive them into place and secure with nails through the posts. Lay one of the gate-like ends on the floor and drill two more 1-in. holes in the upper sides of the posts 15 in. from the lower ends and bore another hole in each post 6 in. from the lower end or 9 in. below the others (Fig. 2*b*). Repeat this operation with the other end and then cut four pieces, 6 or 7 ft. in length; trim down the ends to fit the holes, drive them in position and secure them with nails. Mark off a number of spaces along the upper sides of the upper lengthwise poles and parallel with the ends and about 2 in. apart. Remove the ends again and on each of these marks bore $\frac{3}{4}$-in. holes an inch in depth. Cut a number of light poles 28 in. long and trim the ends to fit in these holes and drive

them in place and fasten them with nails to form a ladder-like structure. Now replace the ends on the long poles, nail them securely and your frame-work will appear as in Fig. 2*c*. It will now be quite strong and rigid, but to make it still stronger diagonal pieces should be added between the cross-pieces of the ends and between the length-

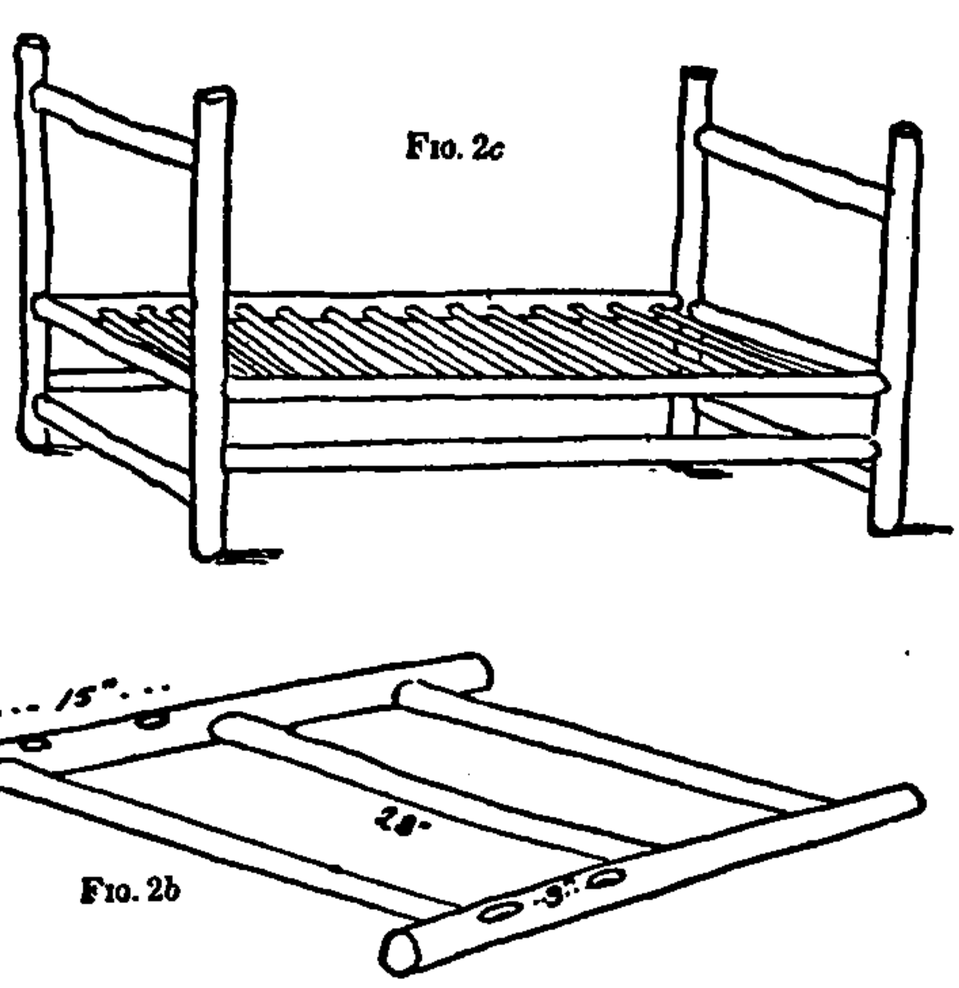


Fig. 2*b*



Fig. 2*a*

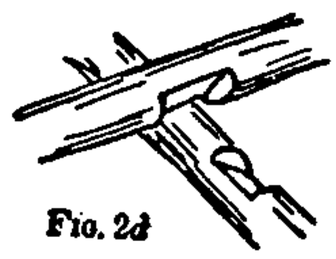


Fig. 2*d*

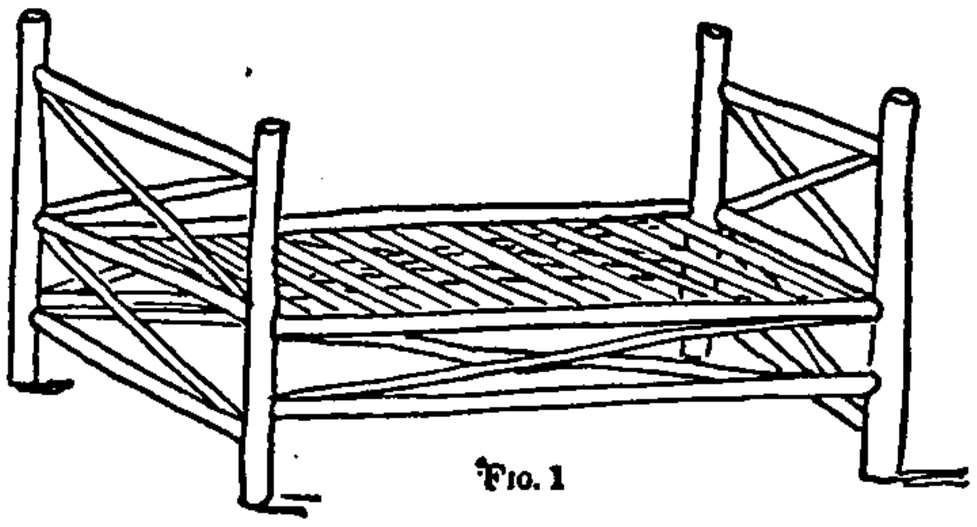


Fig. 1

wise pieces on back and front. These may be light poles with the ends trimmed at an angle and nailed in position and mortised together where they cross (Fig. 2*d*). If desired, the open spaces between the cross-pieces on the ends and between the lengthwise poles may be filled in with gnarled roots, grapevines, cedar branches, etc., and the diagonals omitted, as the ornamental work will strengthen the bench sufficiently (Fig. 3). The bench may be varied by making a back

by setting a pole from one end post to another and filling in the space with light poles set into holes in this piece and the upper lengthwise piece. In fact the bench may be formed in numerous designs while constructing it on the same general principles and the amateur carpenter may use his taste and ingenuity in making as many differ-

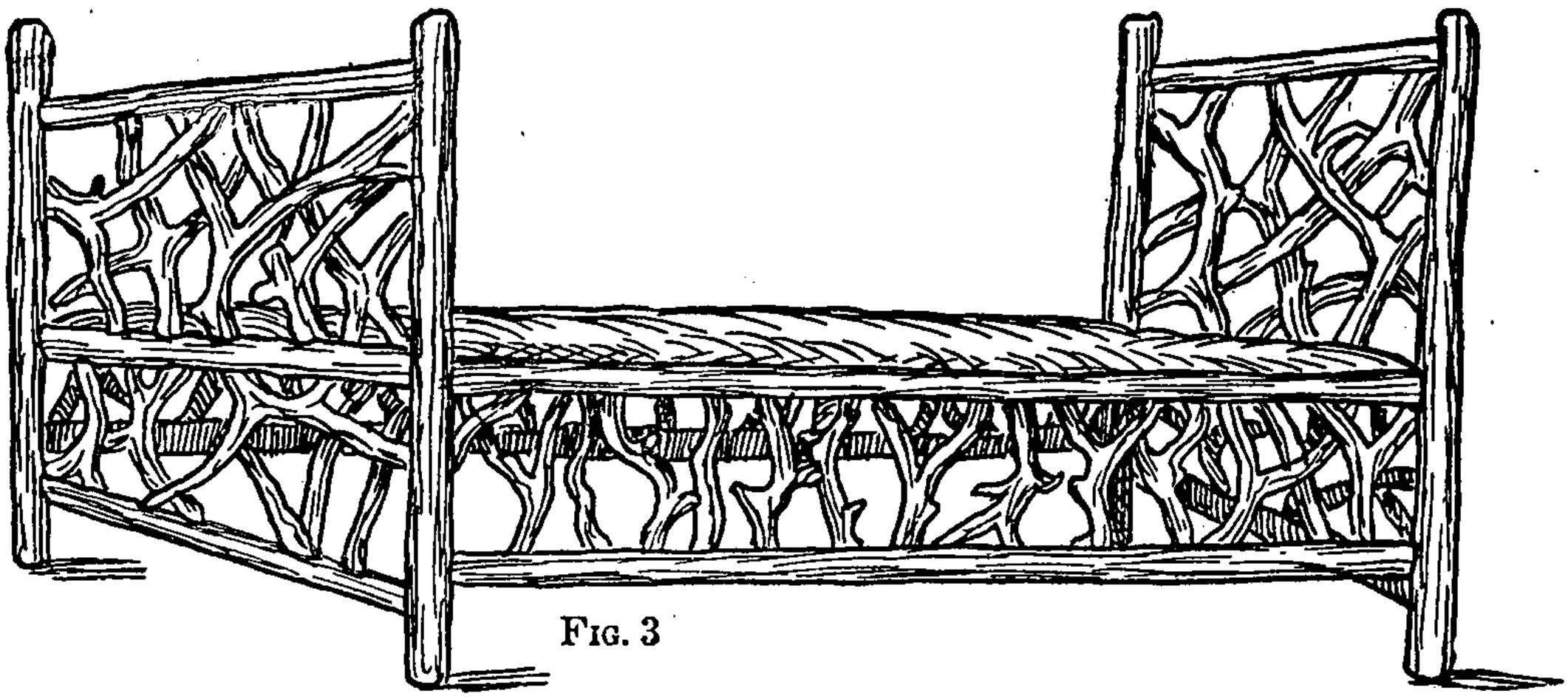


FIG. 3

ent styles and patterns of these benches as he desires.

In making rustic garden furniture, etc., you should aim to avoid abrupt angles, straight lines and square corners as far as possible and should try to make the various objects as artistic, rustic and unconventional as your taste and the materials permit. Rough, crooked and curved sticks, roots and branches may be built into very comfortable and durable settees, etc., but in accomplishing this you should always make the

various joints as neatly as you can and should use galvanized or copper or brass nails and brass screws, for plain iron fastenings soon rust and are unsightly. Cedar or other barks endure out of doors for some time without preparation or finish of any sort, but if given a coat of oil or waterproof spar-varnish they will last much longer. In using the varnish, where a dull surface is desired it may be thinned with turpentine until it dries without a gloss. Where the materials are stripped of the bark and left in natural wood a coat of either dull or glossy varnish may be given either with or without staining. Joints may be made by trimming the end of one piece of wood to fit snugly against another and then nailing as in Fig. 4*a*, or the end may be worked down round and set into holes as already described. Still another method is to mitre the ends of the pieces where they join others, as shown in Fig. 4*b*, while for small or especially good work tenon-joints like Fig. 4*c* may be employed. Sometimes lashed joints will be found very useful and will add greatly to the appearance of the article. The lashings may be made with strips of tough bark, rattan—such as is used in caning chairs—or raffia. Where no great

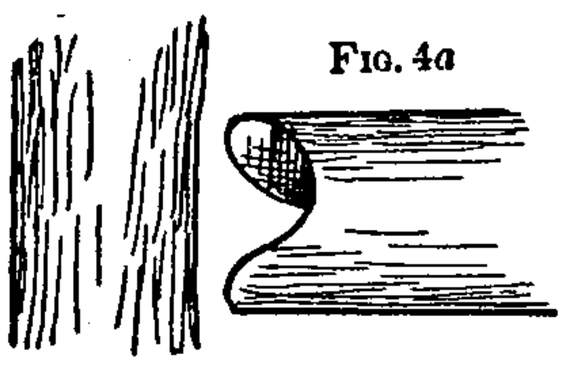


Fig. 4a

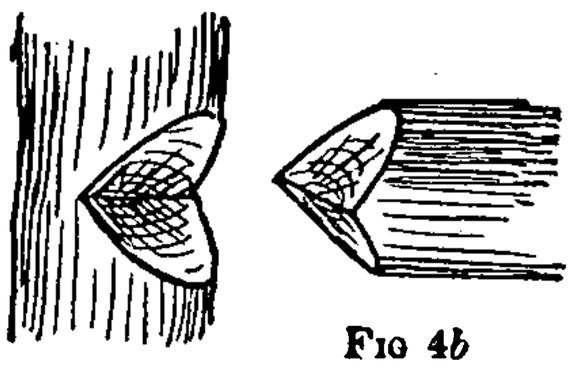


Fig 4b

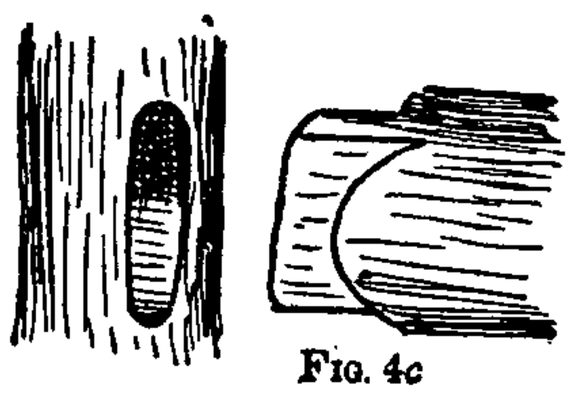


Fig. 4c

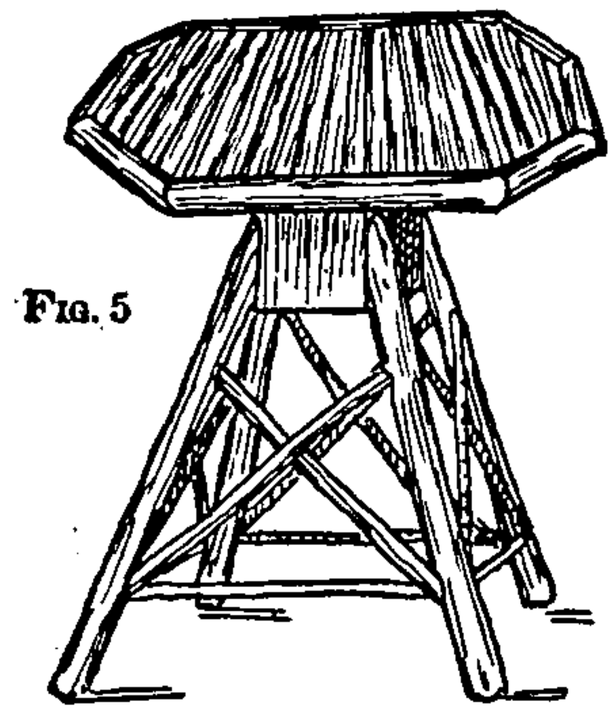


Fig. 5

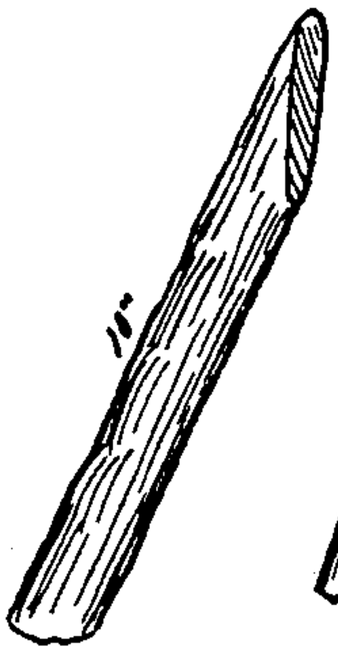


Fig 5a

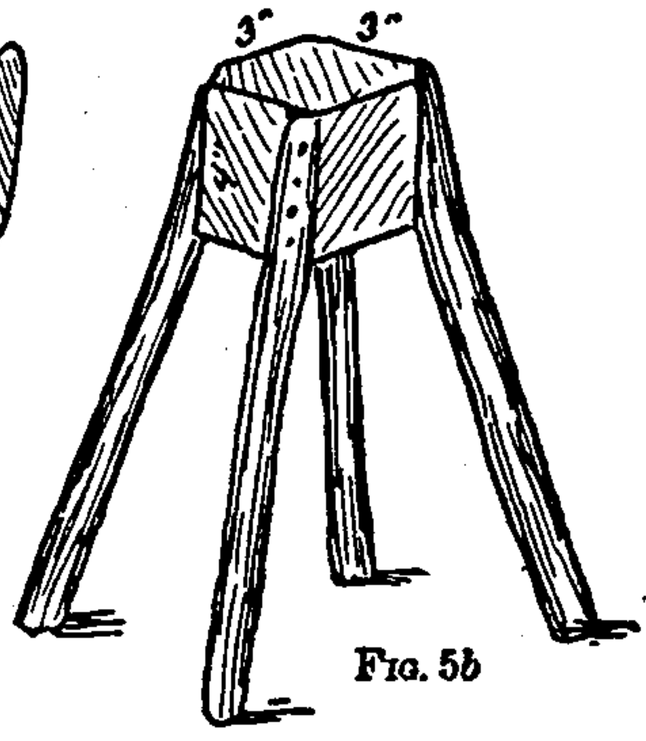


Fig. 5b

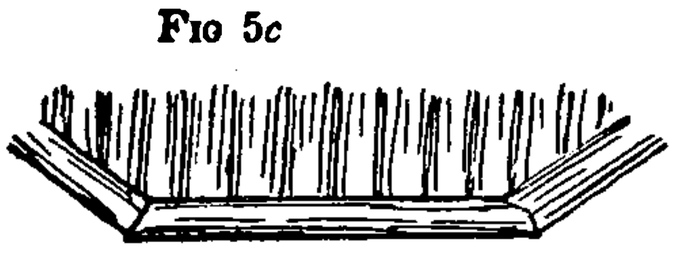


Fig 5c

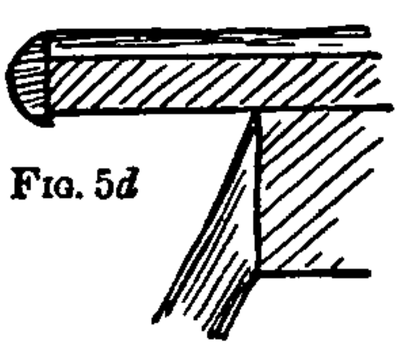


Fig. 5d

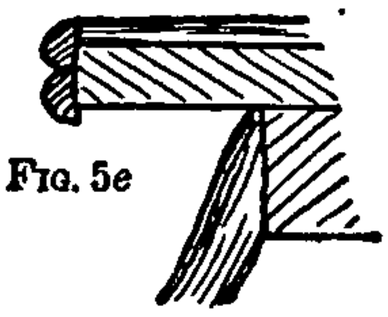


Fig. 5e

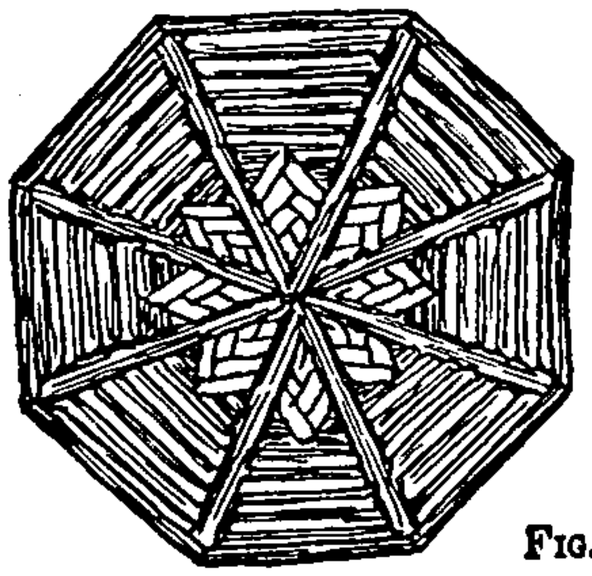


Fig. 5f

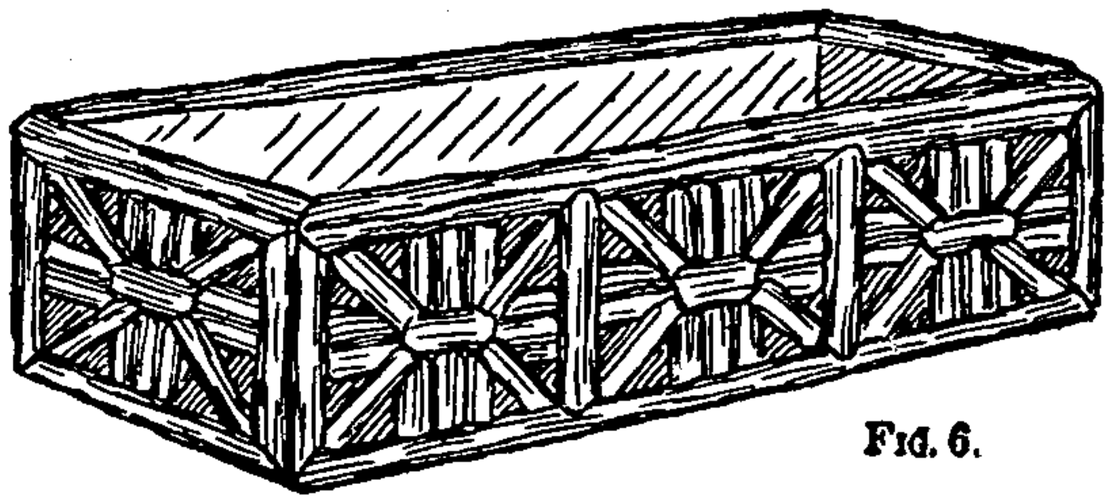


Fig. 6.



Fig. 6b

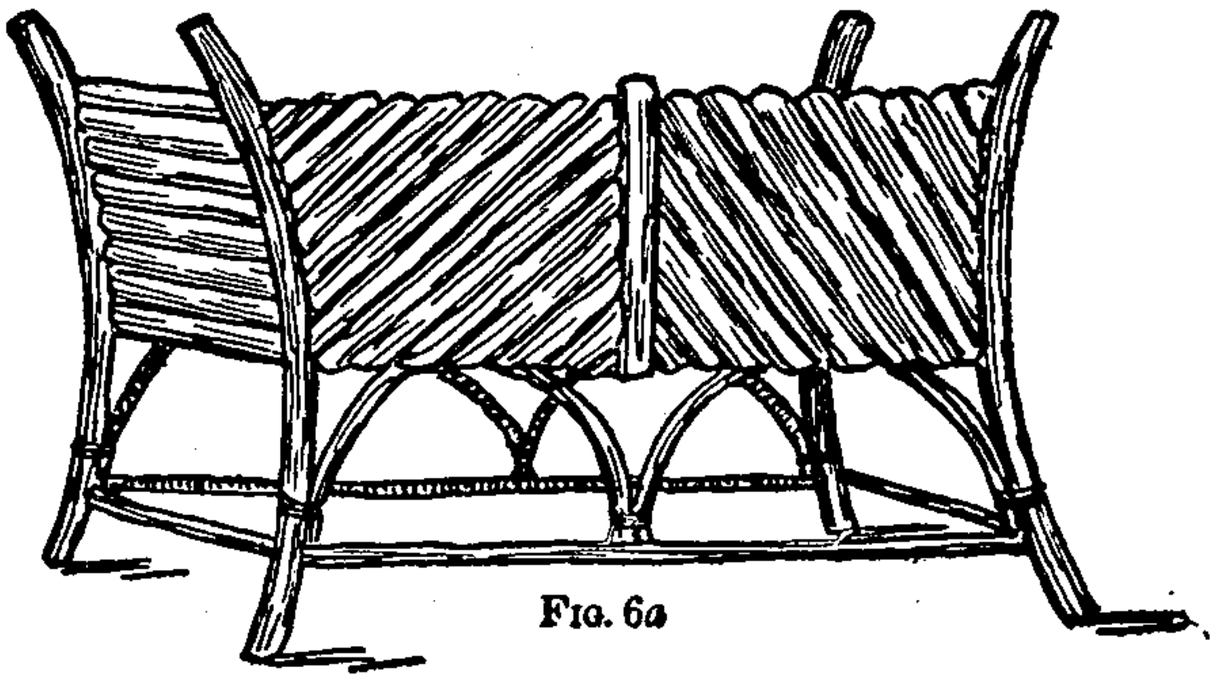


Fig. 6a



Fig. 6c

strain comes upon the joint entire reliance may be placed on lashings alone, but as a rule it is safer to nail or screw the parts together and add the lashings to reinforce the joints as well as to conceal the fastenings.

Plant stools, such as shown in Fig. 5, are pretty and useful objects either in the garden or the house and are easily made. The tops should be cut from common 1-in. boards or old packing cases. The legs are merely four straight pieces of apple, cedar or similar woods with the bark on and are 10 in. long and about 1 in. in diameter. One end of each leg is squared off at an angle on one side, as shown in Fig. 5*a*, for a distance of 4 in., and the legs are fastened to a block of wood 3 in. square and 4 in. long (Fig. 5*b*). The top is then screwed to the block by long screws driven down through the upper side. The wooden block and the top should be given a coat of thin asphaltum varnish or dull-grey or brown paint and when this is dry the top should be finished by placing thin, selected, straight pieces of smooth bark across it, with small wire brads for fastenings. Let the ends of the pieces project slightly and trim them off smooth and evenly with the edges of the top. Then nail pieces of

half-round wood, with bark on, around the edges, mitring the ends where they join (Fig. 5*c*), and allowing the upper edges to project enough to conceal the cut ends of the bark nailed on the top. The lower edges should also project about $\frac{1}{4}$ in. below the edge of the top (Fig. 5*d*). If you cannot procure pieces of just the right width to accomplish this you can use two or more narrower strips as shown in Fig. 5*e*. The exposed portions of the centre block, between the legs, are also covered with bark and cross-pieces of grapevine or slender, bark-covered branches are nailed diagonally across the legs. The top may be made still more attractive by arranging the strips of bark in ornamental patterns (Fig. 5*f*). Similar stools may be used as seats by making the tops round or square, while by making them higher and adding a lower shelf little reading or tea tables may be formed. Window or porch-boxes for growing plants may be easily constructed by lining old packing-boxes, or boxes made for the purpose, with zinc and covering the exterior with pieces of bark or half-round, bark-covered sticks as illustrated in Fig. 6. For flower stands in the yard or for holding a number of growing plants in pots a stand similar to that

in Fig. 6*a* may be constructed. The size will depend upon the number and size of the pots or the size of the box it is to contain, but for our description we can assume dimensions of 3 ft. long, 3 ft. high and 10 in. wide. The legs are slightly-curved branches, which may be natural, but as it is hard to find four pieces of equal size with the same curve it will usually be necessary to obtain the curve by artificial means. The best way to accomplish this is to select fresh, green sticks a little longer than the desired length of the legs and cut notches an inch from each end. Fasten flexible wire cord or stout hemp cord from notch to notch, like a double bowstring, and by means of a stick twist the cord until the desired curve is obtained (Fig. 6*b*). By twisting more or less the same curve may be obtained on all four pieces, when they should be set aside to dry. In a few weeks the cord may be removed and the saplings will retain the curve permanently. They will, however, spring back slightly, so the original bend given them should be greater than you desire in the finished uprights. The rails should be tenoned, or cut round and fitted into holes in the legs as in Fig. 6*c*, and across the lower rails pieces of flat wood or

narrow slats should be fastened for the box or pots to rest upon. The stand is then finished by nailing pieces of round or half-round, bark-covered wood from rail to rail, using your own taste for the pattern (Fig. 6*a*). Other forms of tub or pot stands are illustrated in Figs. 7, 8, 9. That shown in Fig. 9 is constructed from a half-barrel or tub supported on strong stout legs of oak, stripped of bark; on large apple limbs, or in fact on any gnarled, twisted or crooked natural wood. You may have to search some time before you can find pieces which have just the right curves to form a secure support for the half-barrel, but by cutting away on the inner sides and trying first one way and then another you can usually adjust them to hold the tub securely. The legs are then firmly fastened together by long bolts passed through from side to side (Fig. 9*a*), and a lashing of bark or rattan or strips of bark-covered wood are fastened around the supports to conceal the bolt-heads. The tub should be painted with grey or brown paint and covered with bark or half-round branches nailed upon it in ornamental patterns. An easier method, which will look almost as well when completed, is to support the tub upon a central, straight piece

with a table-like top and secure the legs to this as illustrated in Fig. 9*b*. This method has the advantage that the tub itself may be removed for placing indoors or elsewhere or other tubs

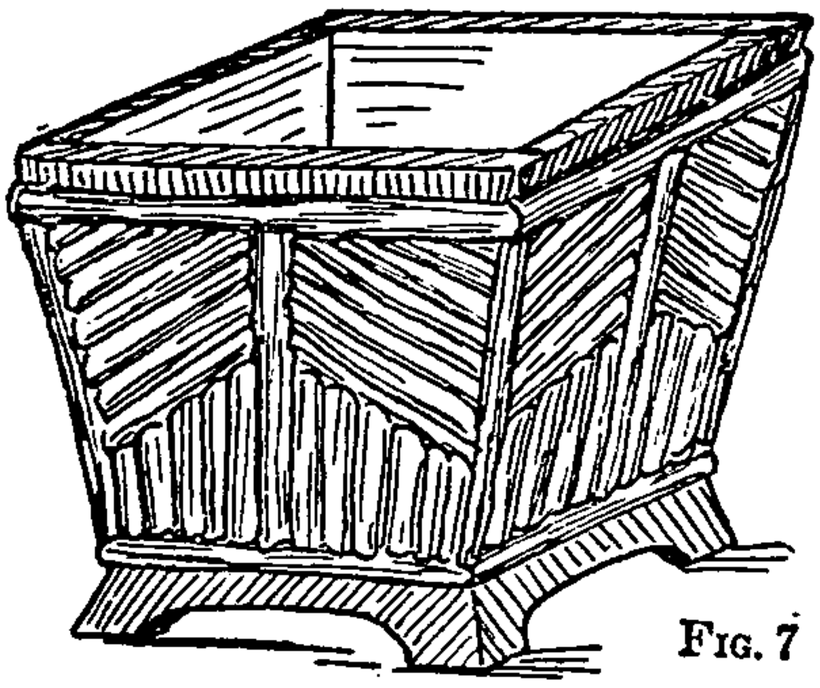


FIG. 7

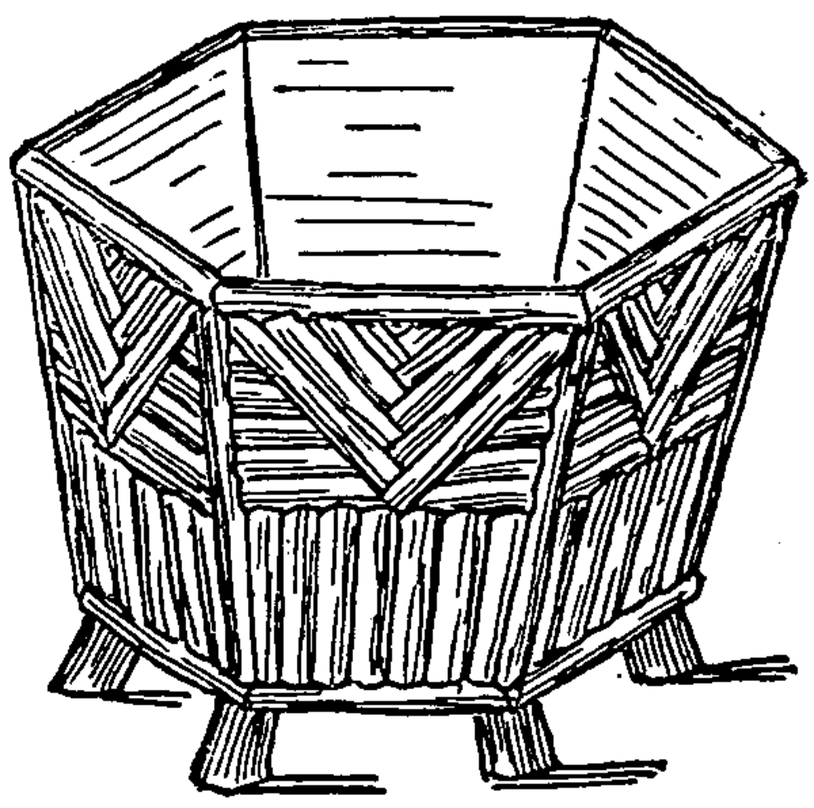


FIG. 8

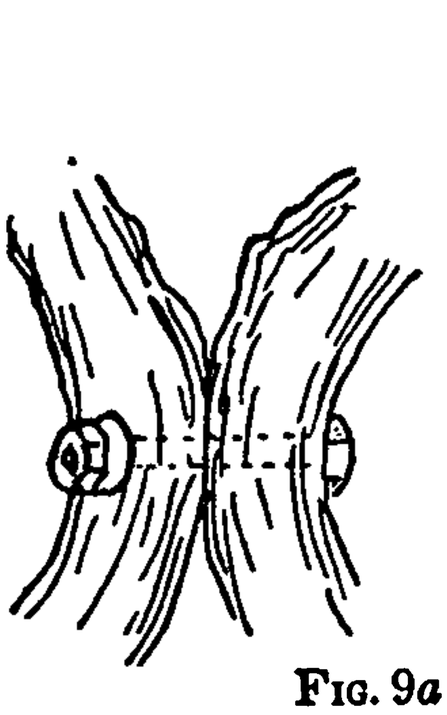


FIG. 9*a*

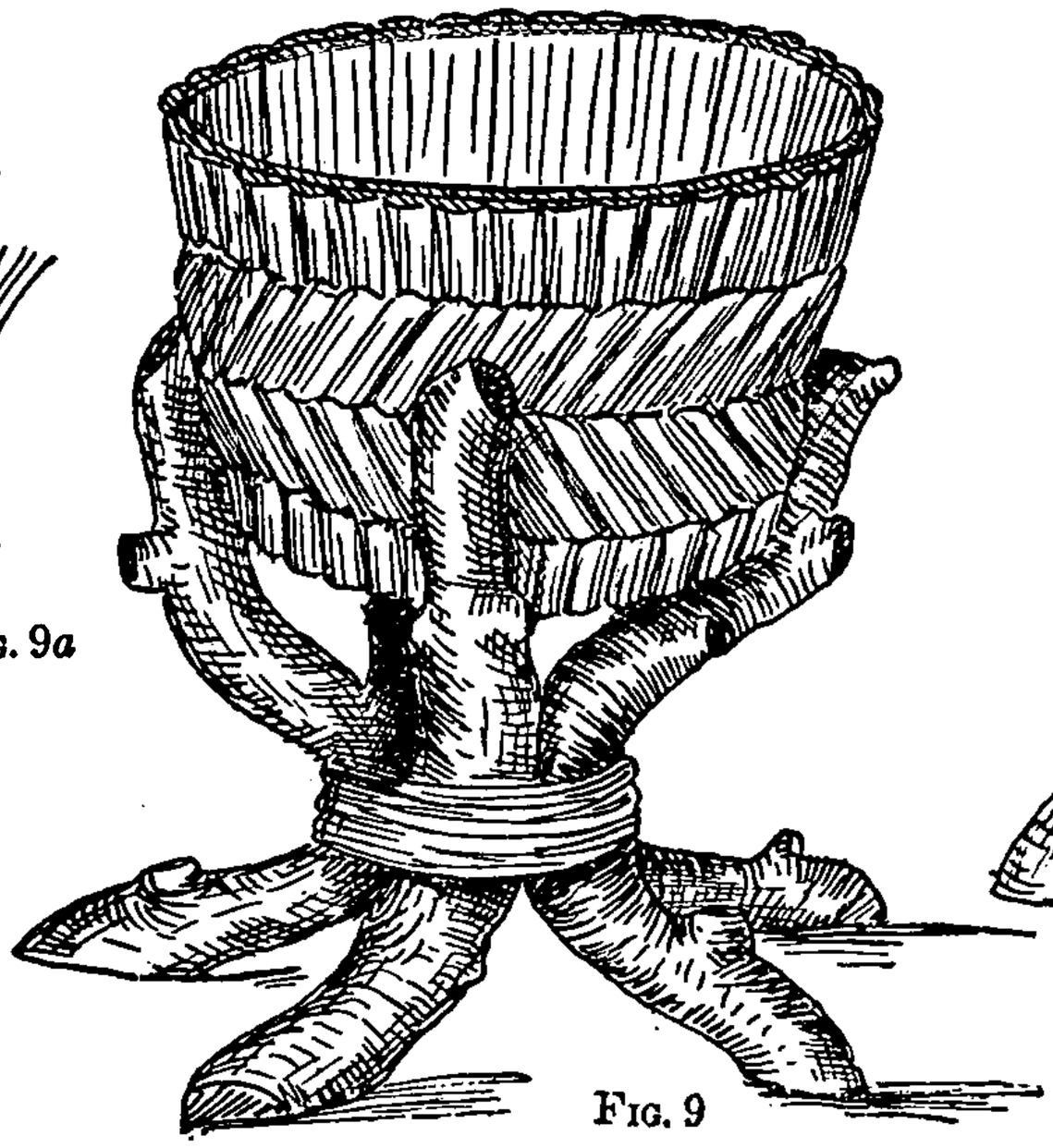


FIG. 9

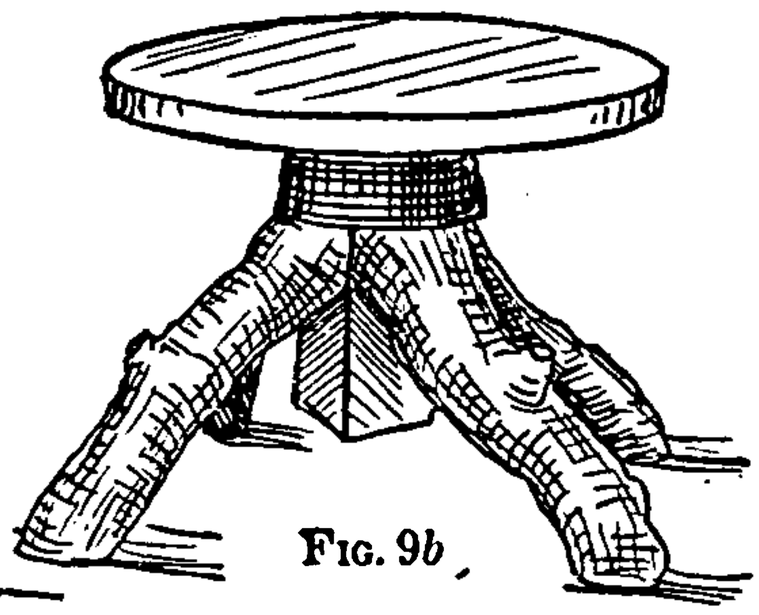


FIG. 9*b*

may be substituted for it on the standard. A very attractive form of plant-box is illustrated in Fig. 10. This is made from a square wooden box with corner legs cut away and fastened to the box as indicated in Fig. 10*a*. The sides and

ends are then covered with pieces of alternating light and dark wood as shown. Among the various common trees you will be able to find barks of various shades running all the way from the almost pure white of birch and young maple through greys and browns to almost black, and

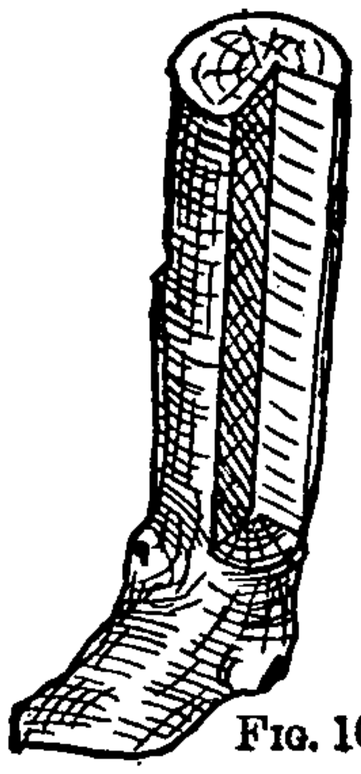


Fig. 10a

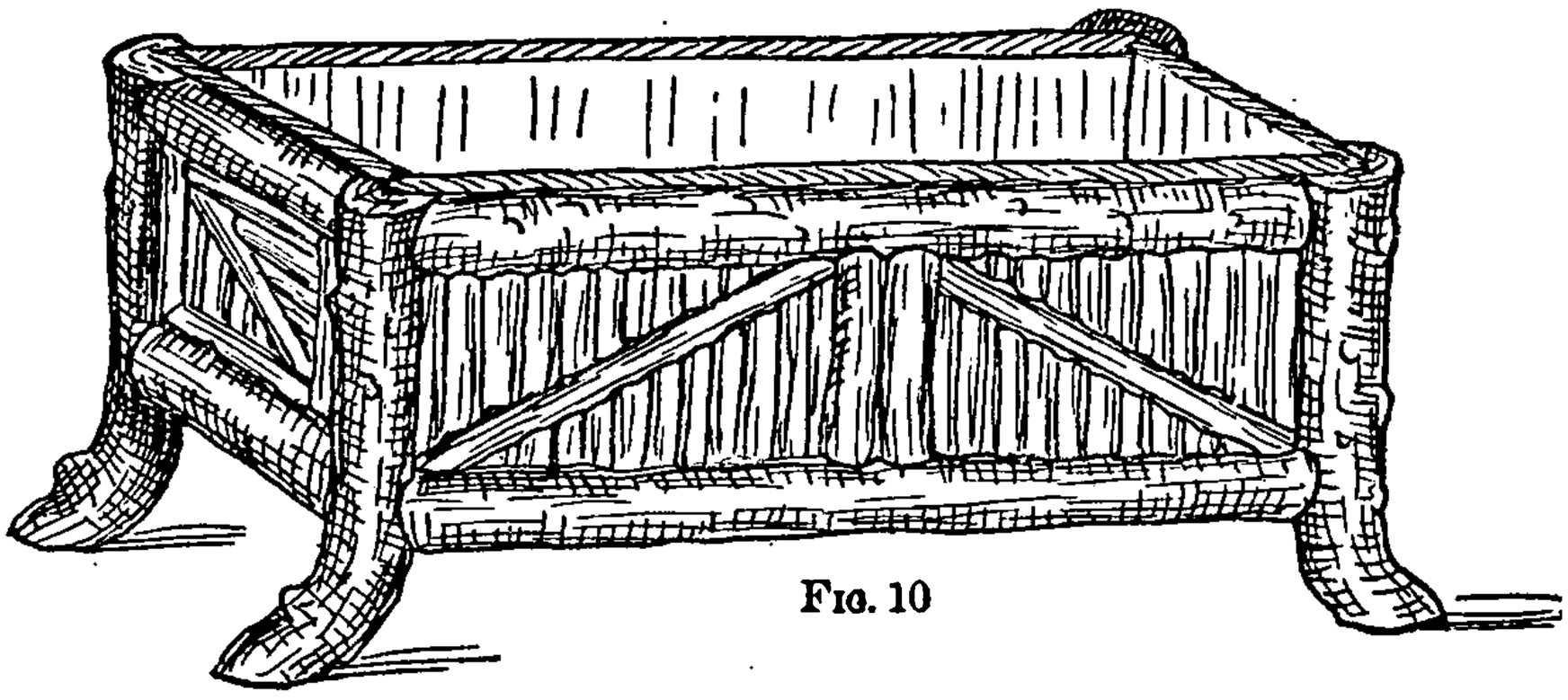


Fig. 10

by judiciously combining these very pretty designs may be accomplished. In cutting sticks for rustic work, where the bark is to remain on the wood, be sure to gather them in midwinter. At that season the sap is at rest and the bark adheres firmly to the wood, whereas the same woods cut in summer or spring would peel and flake off.

Chairs are perhaps the most difficult of all rustic furnishings to build, but still with a little care and trouble any amateur carpenter can make very useful, comfortable and durable chairs. In

Fig. 11 a large armchair is illustrated which is simple to construct. The legs are four evenly-curved pieces of saplings or limbs, those for the front being 2 ft. long and those for the rear 2 ft. 10 in. long and all about 2 in. to 3 in. in diameter, as strength in this chair is essential. The front rail of the seat is 1 ft. 2 in. long and about 2 in. in diameter and should be set into the legs by cutting the ends round and driving them into holes in the uprights. The rear seat-rail is 1 ft. long and 2 in. in diameter and the side rails are the same diameter and 1 ft. 3 in. in length, all secured to the uprights in the same manner. If you desire, the ends of the several rails may be tenoned and mortised into the legs, or they may be trimmed concave and fitted with dowel pins to be inserted in holes (Fig. 11*a*). In any event they should be driven together firmly and fastened with nails or screws passed through the legs and the inserted ends of the rails and a lashing of roots, rattan or raffia should be placed over and around them. On the inner sides of the legs cleats are fastened (Fig. 11*b*) to support the first front and back cross-pieces of the seat, the upper ends of the cleats being the same height as the centre of the rails. The cross-

pieces are fitted neatly to rest upon the round rails and should be secured with fine nails well sunk beneath the surface of the wood. The arms and back are composed of three pieces joined together, exactly over the ends of the rear legs, by means of lapped or scarfed joints (Fig. 11*c*). The diagonals for back and sides are then fitted

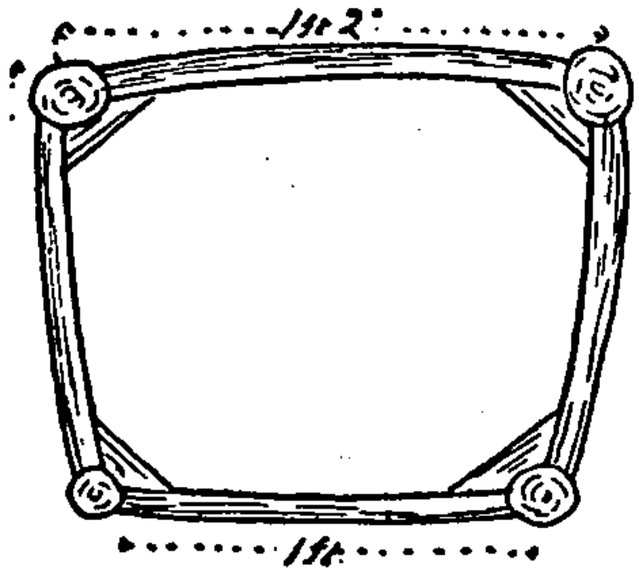


Fig. 11*b*



Fig. 11*c*

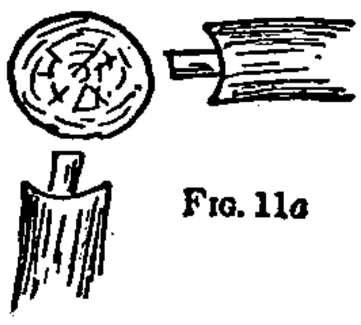


Fig. 11*a*

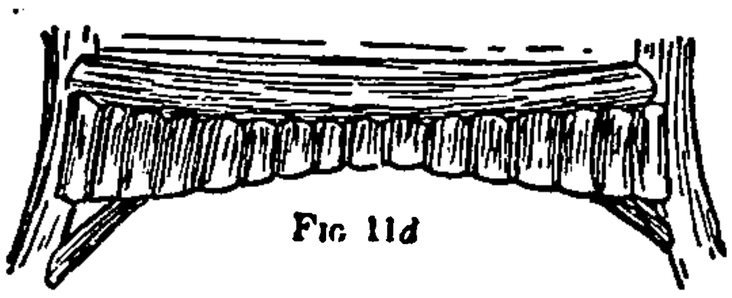


Fig. 11*d*

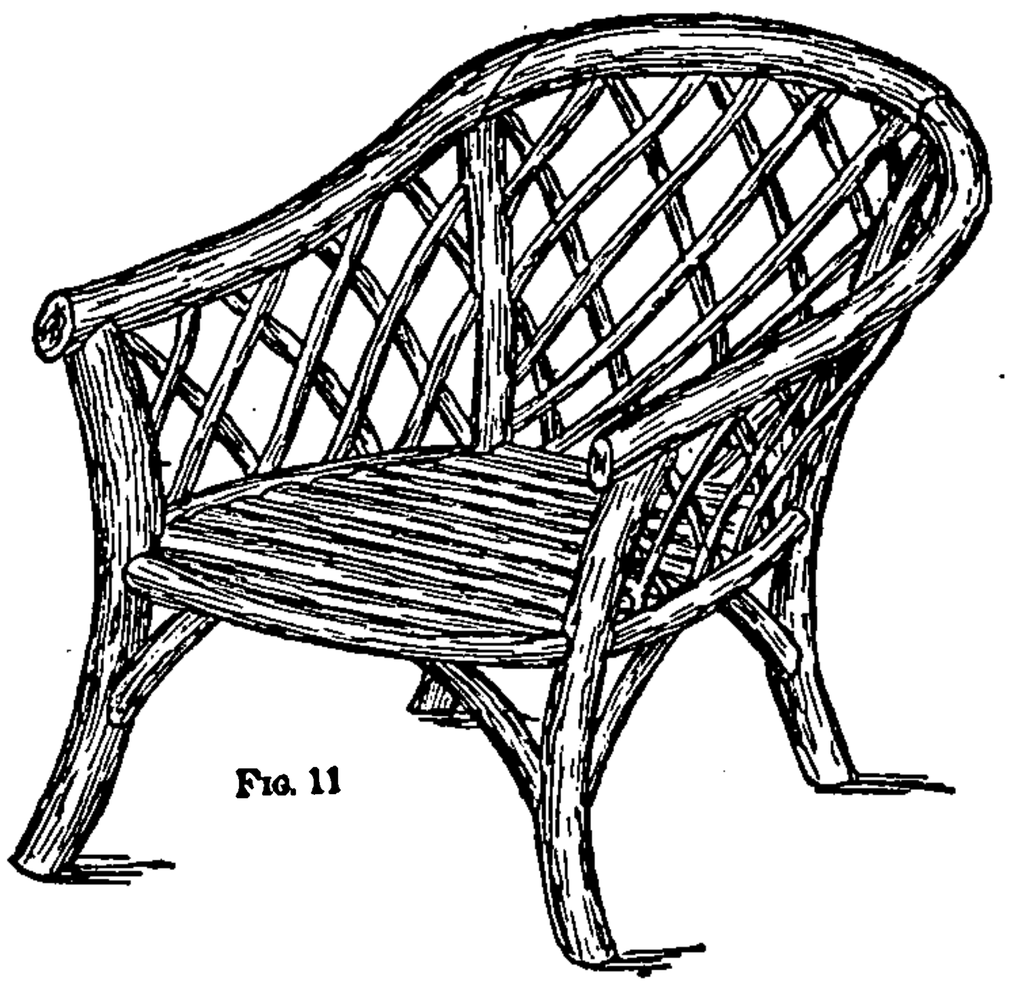


Fig. 11

in and the braces from legs to seat added. The edge of the seat may be left untouched, or if desired a little ornamental fringe of sticks may be added as shown in Fig. 11*d*. The chair may be constructed of peeled or unbarked wood, as desired, but as a rule the seat should be of peeled material, as the rough bark is liable to tear or wear clothing.

Sometimes a rough board-fence or gate is an unsightly and ugly object about an otherwise at-

tractive garden. The fence may of course be hidden by vines, shrubbery or tall plants, but the gate cannot be thus concealed. In such cases rustic carpentry may be brought into play with excellent results. By covering the gate, the posts and a few feet of the fence on either side with natural bark-covered sticks the ugly board-gate may be transformed into a very pretty and artistic object (Fig. 12). If the gate is square or angular an ornamental or curved superstructure may be added as in Fig. 13, or the natural branches used in covering it may be extended up on one side as in Fig. 14.

Where small saplings, odds and ends of brush and trimmed branches and similar material are abundant very pretty and useful fences may be formed. Such fences are so simple to build that no detailed description is necessary, the only care required being to set the posts firmly and plumb and to make the joints of the various pieces neat and strong. In Fig. 15 two rustic fence designs are illustrated, with designs for gates in Fig. 16. Such gates are best hung with rough, heavy, pivot-hinges driven into the wood as indicated in the diagram (Fig. 17).

Trellises and arbours may be constructed in a

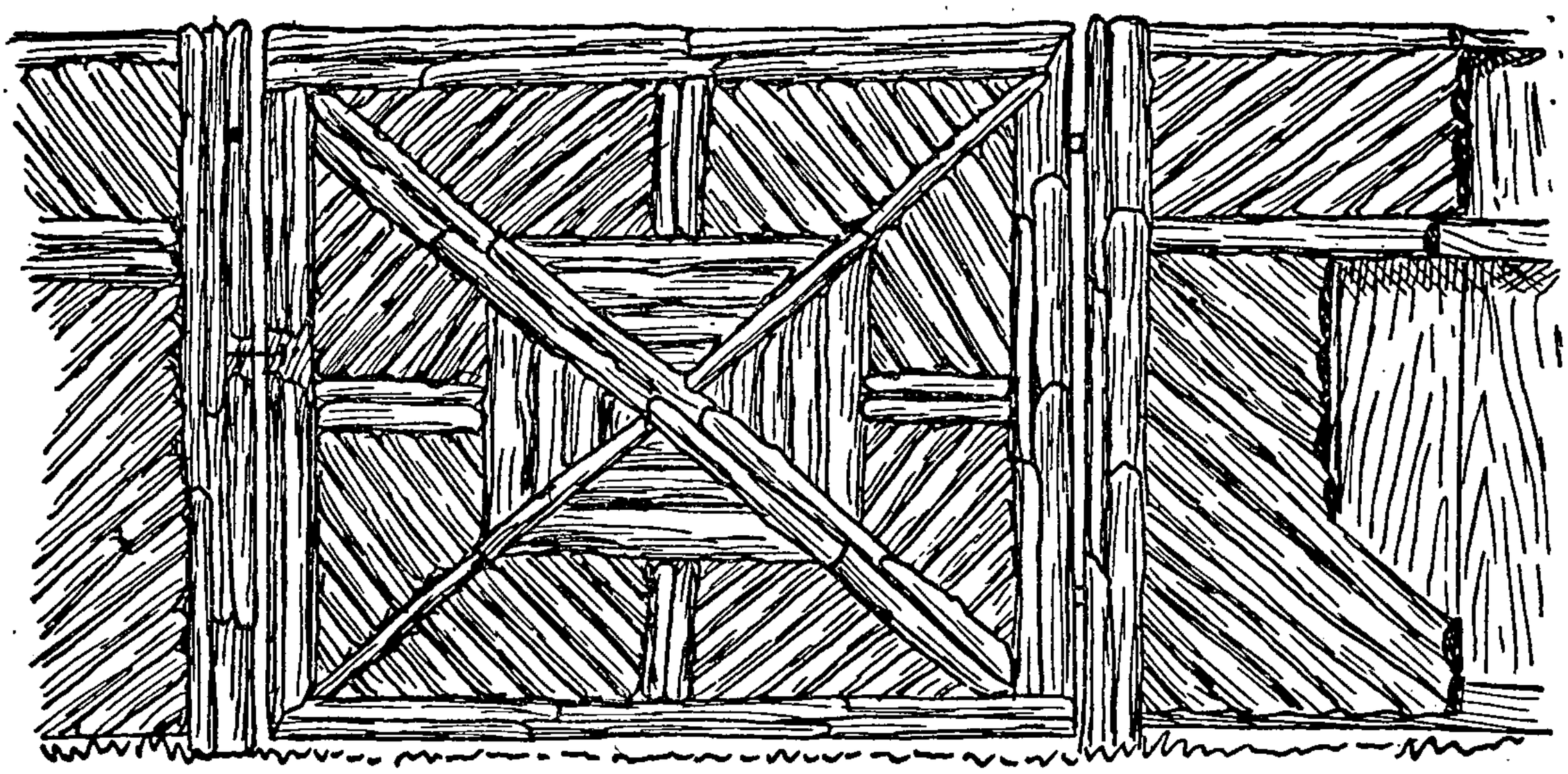


FIG. 12

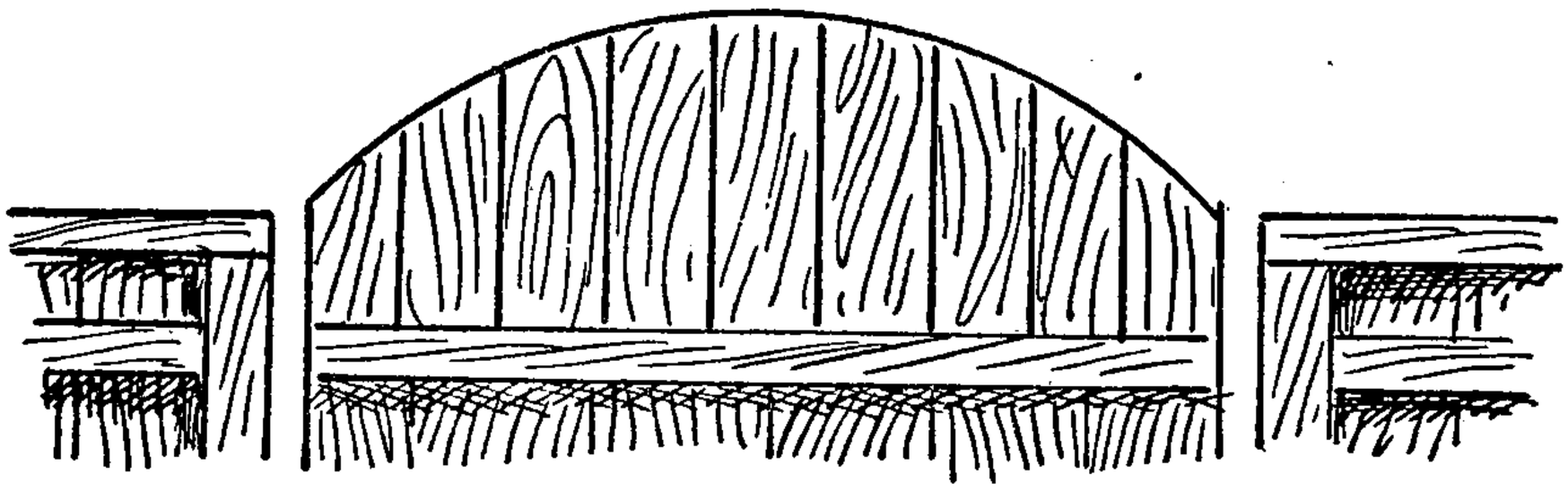


FIG. 13

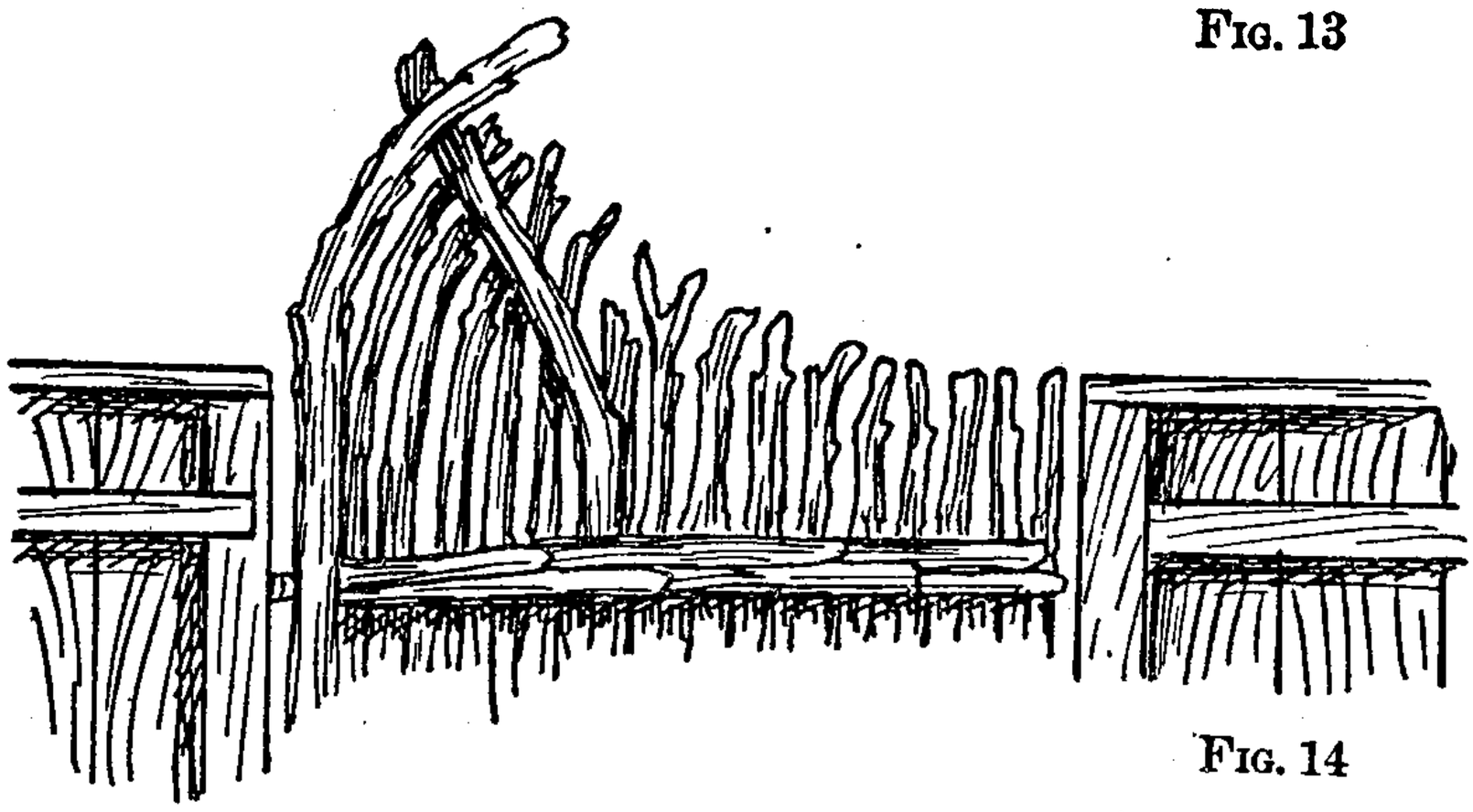


FIG. 14

similar manner, and such affairs will always appear much prettier in winter, when the covering foliage has fallen off, than the square board and timber affairs so often seen.

If you have a small stream, pond or water-

course on the grounds you can use your ingenuity and skill in constructing artistic bridges across it. Such a bridge may be made by simply placing good-sized posts or logs from one bank to the other, boarding it over and fitting natural bark-covered rails and sides, or it may be patterned after a Japanese design. In the former case the upright end-posts should be tongued or tenoned to the side-logs (Fig. 18), and the latter should be supported upon a firm foundation. A hole dug into the earth and filled with large stones, a stout post set into the ground, or some similar support, will prevent the ends of the timbers from settling and distorting or wracking the bridge. The hand-rails and struts should also be fastened securely to posts and girders by tenons or dowels and the ornamental pieces should all be hollowed at the ends to form neat joints where they are attached to the posts, rails, etc.

The Japanese bridge is just as simply made, but the girders are curved logs and the rails and other work are curved also. The details are fully shown in Fig. 19.

If you wish a pergola in the garden you will find that natural bark-covered material lends

itself very nicely to the work and is far less expensive and much more ornamental than the

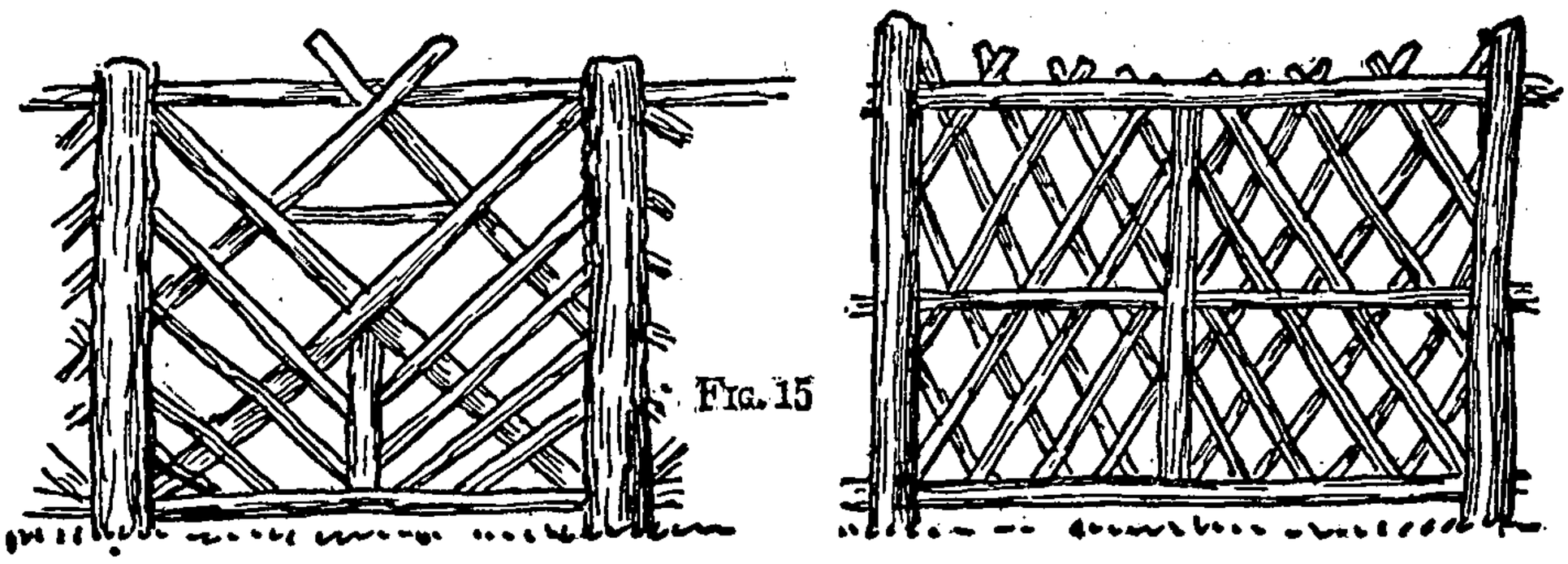


FIG. 15

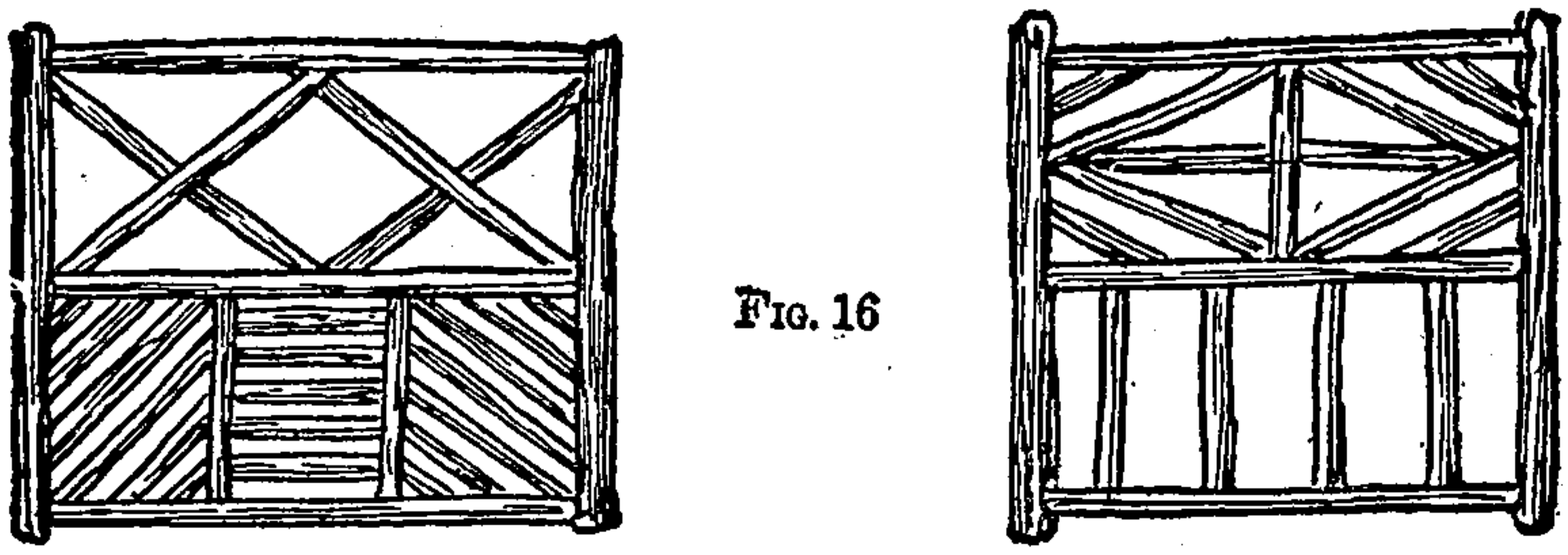


FIG. 16

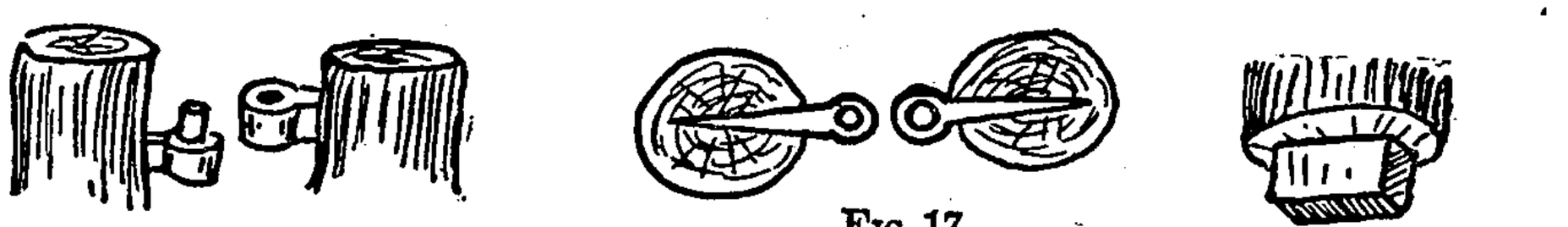


FIG. 17

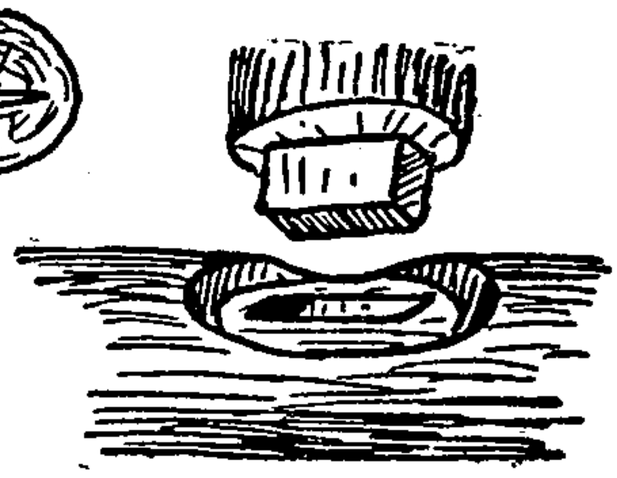
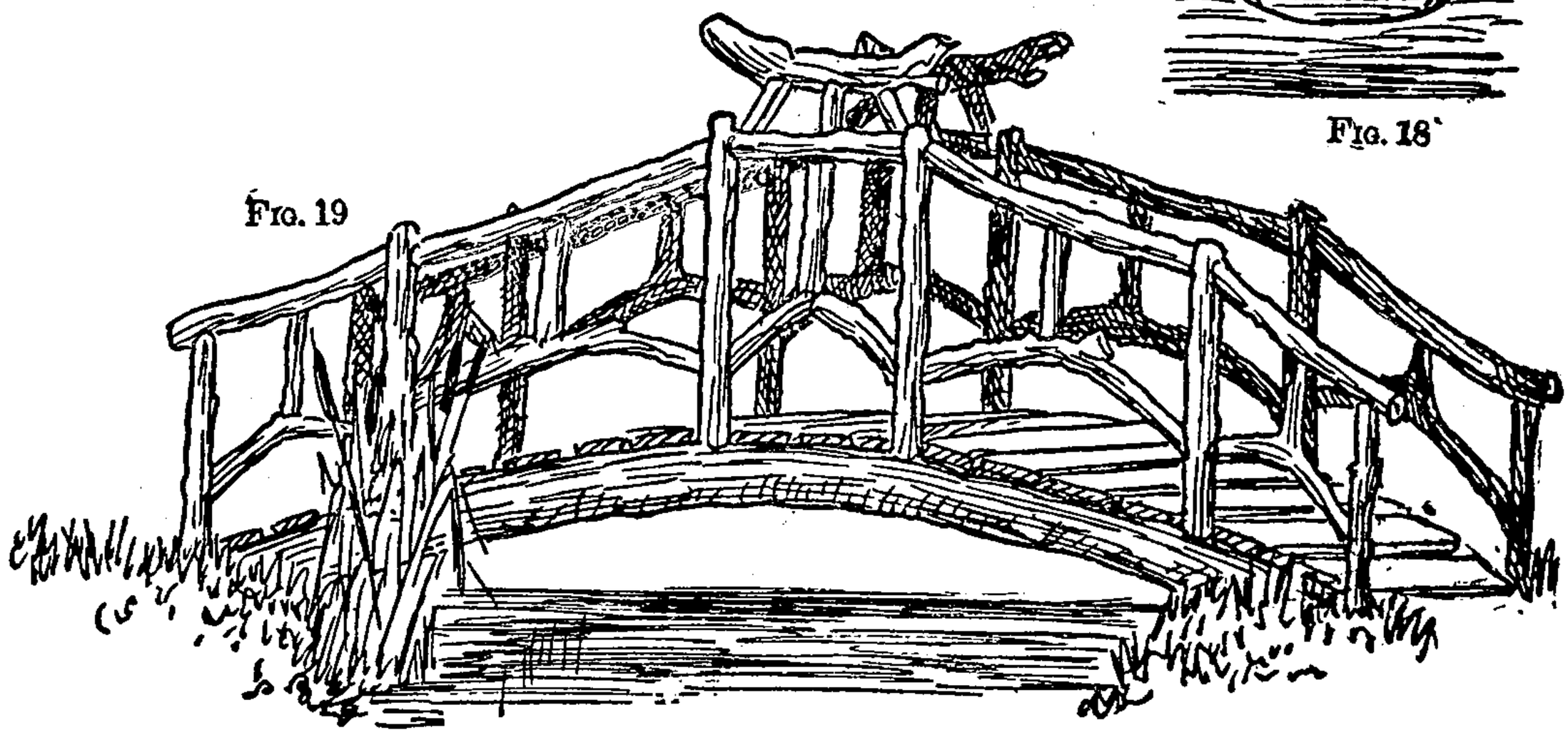


FIG. 18

FIG. 19



turned and sawed, white-painted conventional pergolas of formal gardens. Even a rustic summer-house is not difficult to construct from

natural, bark-covered saplings and a few good stout posts, and in fact a summer-house or shelter of this sort is much easier to build than a framed and timbered board building of the same size. The easiest way to build such a house is to erect a stout centre post, or if you have an old tree that is of no particular use you can use this, and from this central support run diagonal pieces to six or eight upright posts as shown in Fig. 20. It is not necessary to tenon or mortise these roof-beams to the uprights, for if attached by joints made as shown in Fig. 20*a* it will be strong enough. The lower rail is then fastened from post to post, roof battens are nailed across the diagonals and the ornamental work is placed in position. The roof may be finished by shingling or by strips of bark nailed over it, but the latter will be far from waterproof in heavy showers. The neatest and most attractive roof is a thatched roof, and it is regrettable that more of these common European roof coverings are not used in America.

Thatching is easy, simple work, and any boy can learn to thatch a roof that will serve every purpose for a summer-house, tool-house or out-of-doors building of small size, although to thatch

a large building or a dwelling-house so as to be weather- and rainproof is quite an undertaking and requires a great deal of skill and practice. Almost any material, such as rushes, straw, grass or cat-tails, may be used as thatch. The material should be tied into bundles of equal size, known technically as "yelvens," which are sewed to the battens of the roof by means of a long needle and tarred rope. For the amateur's purpose a long, heavy upholsterer's needle and tarred gardener's twine or "marline" will answer every purpose. Begin at the eaves and sew a number of bundles side by side for as wide a distance as you can conveniently reach on each side of the ladder on which you stand. This is known to a thatcher as a "stelch." When one stelch is done lay another over it with the new layer of bundles, covering the cords which secure the first layer to the roof (Fig. 20*b*), and continue to work upward, placing one layer over another until the ridge or apex of the roof is reached. In placing each new layer or stelch, however, you should take care to blend the edges of each bundle together and not make the layers "bunchy" or uneven. The quality and waterproof properties of the entire thatch depend very largely upon this little



Fig. 20c

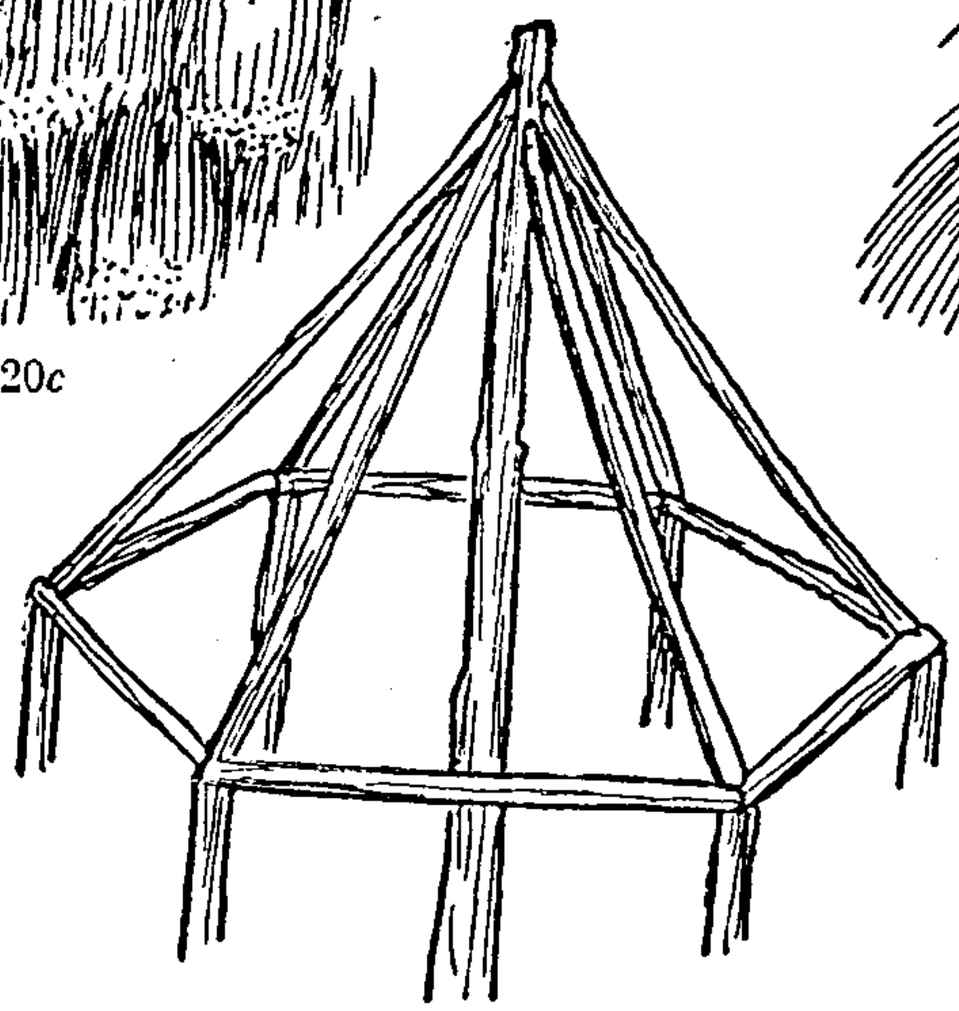


Fig. 20

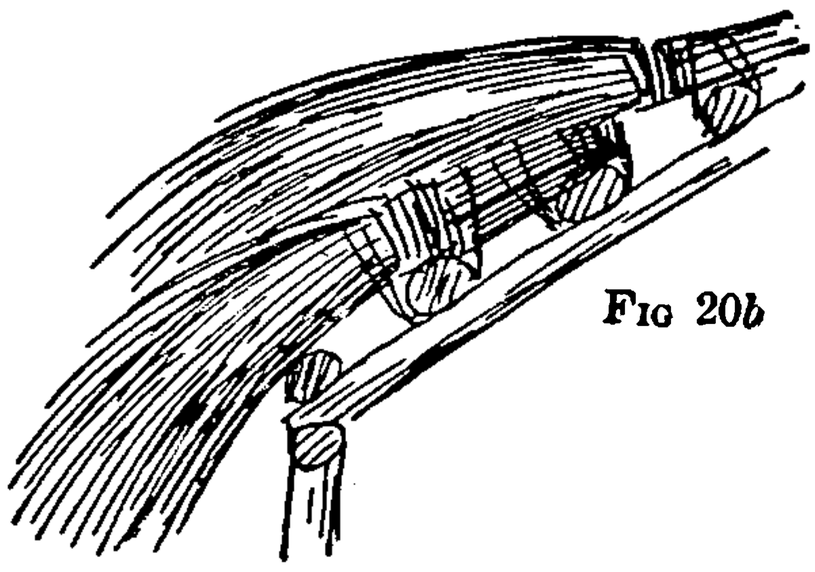


Fig 20b

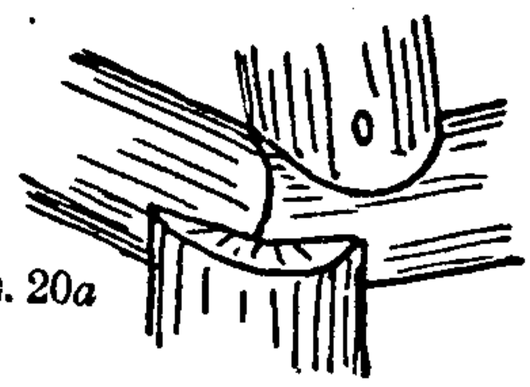


Fig. 20a

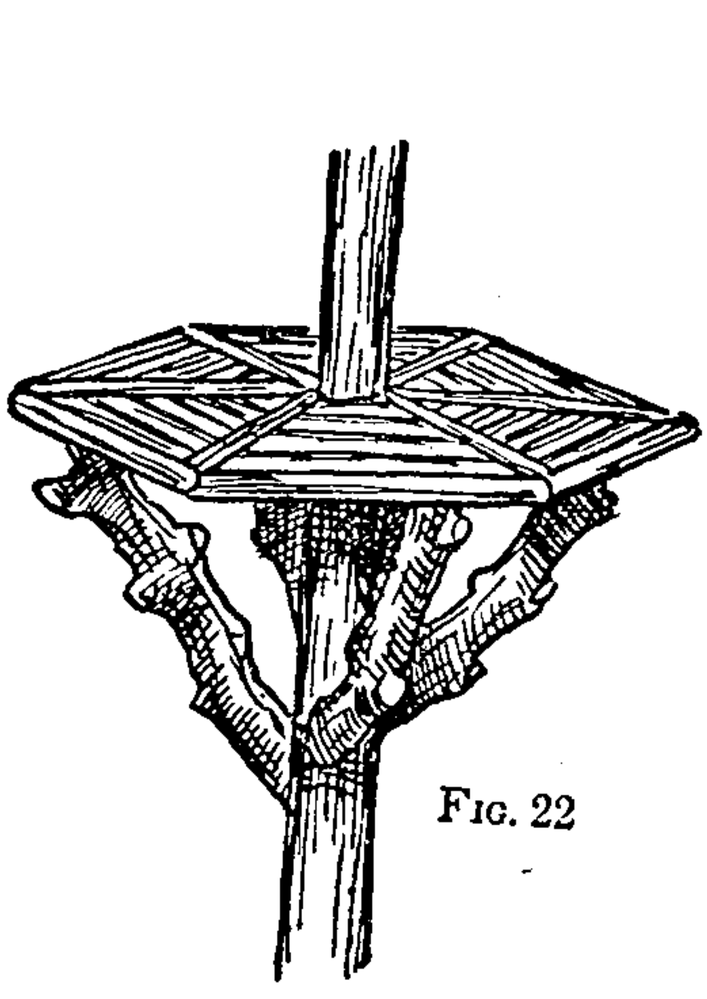


Fig. 22

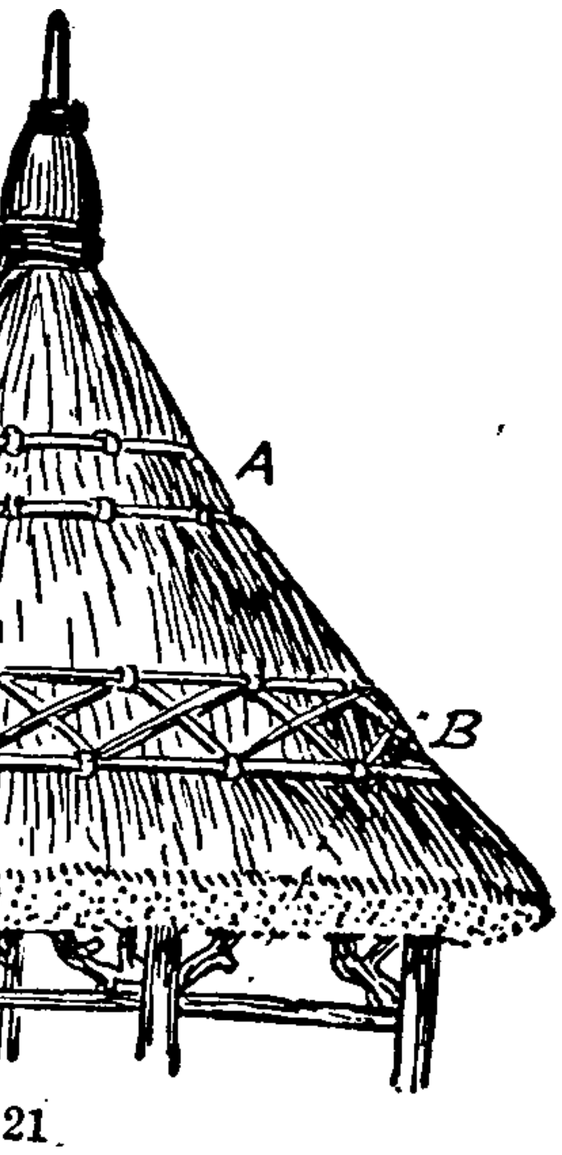


Fig. 21

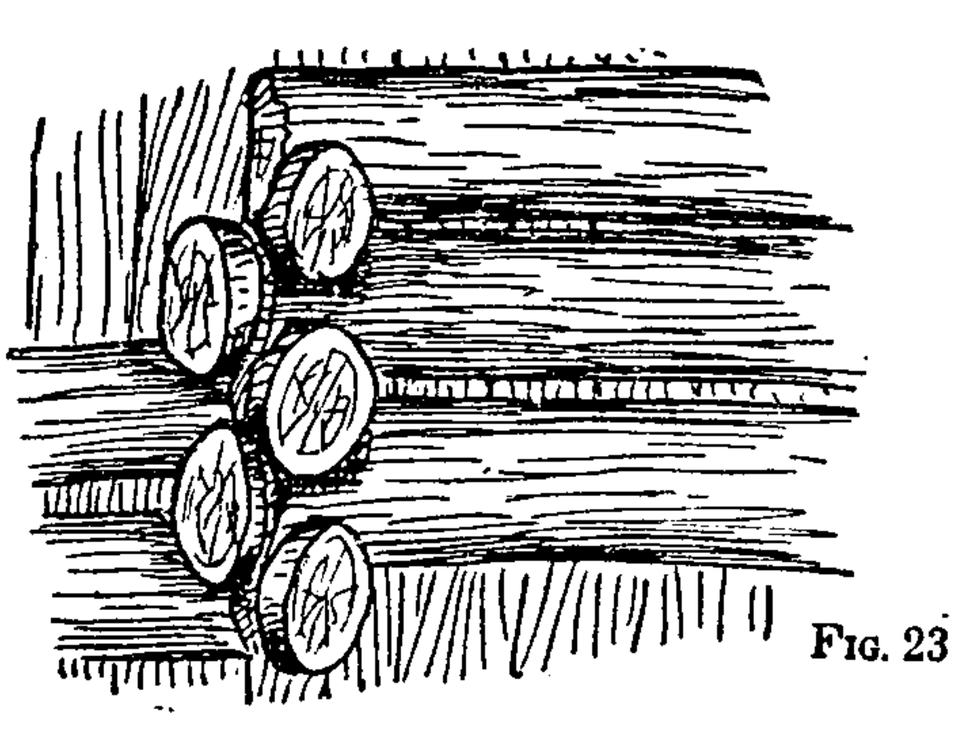


Fig. 23

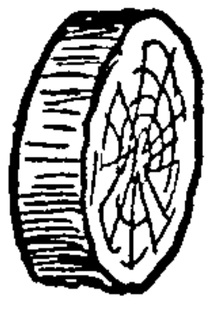


Fig 23a

matter. After carrying up the thatch to the top of the roof begin again at the eaves and lay another series of stelches, blending and combining the edges where they join and always "breaking joints" where one bundle overlaps another (Fig. 20*c*). When the roof is completely covered on all sides, finish the apex with a little bundle of thatch, which should be tightly bound to the central pole with several lashings of tarred twine. Then with a coarse wooden rake smooth down and straighten out the thatch and finish by binding it down with "buckles and runners." The buckles consist of pieces of willow or alder withes twisted and doubled and with pointed ends like gigantic hairpins. The "runners" are merely straight strips of light willow or alder and are laid across the thatch and are secured by the "buckles," which are shoved upwards instead of straight into the thatch, in order to prevent rain from entering around them. The buckles and runners may be plain, as in Fig. 21 *A*, or they may be made ornamental by placing diagonal pieces between the plain runners (Fig. 21 *B*). For most purposes, at least two belts of buckles and runners should be used. Lastly, the lower, projecting edges of the thatch should be trimmed off

evenly and smoothly with a heavy pair of grass-clipping shears. Within the summer-house a bench may be built around the sides, and if desired an ornamental rustic table may be constructed around the central post as illustrated in Fig. 22.

If you already have boarded buildings or out-buildings on the premises they may be made to resemble real log houses by the use of "slabs," which are the bark-covered, partly-rounded pieces cut from mill logs when being sawed into boards. As they are waste material and only fit for firewood, they are very cheap, but for the purposes of the rustic carpenter they are extremely useful. The slabs may be nailed to the buildings in a perpendicular position or they may be nailed horizontally. In the latter position they form a covering which closely resembles a real log cabin and by arranging them as in Fig. 23, and fastening sections of logs (Fig. 23*a*) to imitate the ends of the alternating logs, the deception can be carried to such perfection that at a distance of a few yards no one can distinguish the cheap, easily-constructed slab-covered building from the expensive and complicated building built of real logs.

CHAPTER XII

MAKING SMALL BUILDINGS

ALTHOUGH it is far beyond the province of this book to describe how to design and erect houses or other large buildings, yet any smart boy can easily build small, inexpensive sheds, workshops, garages or similar buildings, and a few hints as to how the work should be done will be of value.

In constructing large buildings accurate plans and scale-drawings are made and the timbers and other materials are cut, mortised and prepared before erecting them. In fact the frame of such a building is all worked out and made ready on the ground and is done so accurately and with so much system that the pieces fit together and form the skeleton of the building as if by magic when the various parts are raised into position. All this requires skill, practice and a knowledge of the builder's art, which is a distinct profession from that of the carpenter. Of course lots of carpenters are builders and most builders are carpenters, but there are many splendid wood-

workers and carpenters who could not by any possibility build a house and would not even understand what the blue-print plans meant.

In building small sheds, playhouses, workshops and similar structures one may proceed quite differently and may cut the various timbers and materials, fit them together and place them in position as the work proceeds. Moreover, in such small buildings mortised and tenoned joints are not essential, for ordinary half-and-half and lapped joints will serve every purpose and will save a lot of time and labour. If the boy carpenter wishes practice and desires to exhibit his knowledge and skill in carpenter work he can mortise, tenon and dowel every joint if he pleases, but the building will really be no better than one built with much simpler and more easily constructed joints.

A great mistake that many amateurs and professionals make when erecting small buildings is to use timbers which are too small or light. Although perfectly sound, clear timber is very strong and even a small scantling will support a great deal of weight and will withstand enormous strains, yet few scantlings are clear, straight-grained, free from imperfections, etc.

The strength of board or timber is only the strength of its weakest spot, just as the strength of a chain is the strength of its weakest link, and a timber which has a large knot or a crooked-grained weak spot in it is no stronger than that one weak portion. For this reason you should allow considerable excess strength, so that even the weakest portions of the timbers will be strong enough to support the weights and resist the strains imposed upon it.

Always bear in mind that upright pieces will support a greater weight than horizontal timbers of the same size, and also remember that timbers or planks set edgewise will support a far greater weight than if set sidewise. A 2-in. plank 6 in. wide will support an enormous load if set on edge, whereas the same plank, laid flat, would bend and break with a small part of the same load.

Don't overlook the fact that timbers and boards not only have to support the other timbers—the boards, shingles and all other parts of the building above them—but must also be strong enough to bear the added weight of snow and ice in winter time. Snow is very heavy, and many a flimsily-built building has collapsed under the

weight of ice and snow upon its roof. Moreover, the pressure of winds must be taken into consideration, for even a moderate gale will exert tremendous strains upon the sides, roof and timbers of a small building. Last of all, remember that upon the security and firmness of the foundation depends in large measure the durability of the building, and that a poor or weak foundation will soon settle and throw the building out of plumb and will wrack and strain every joint. Even a small shed weighs many hundred pounds and the entire weight rests upon the foundations. If the building is erected upon the bare earth it may seem solid and firm, but you must recollect that the consistency of this earth is never constant. In winter it may be frozen as hard as rock, in rainy weather it is soft and gives under the weight and in dry weather it shrinks and cracks or becomes loose and sandy. Before erecting even a small tool-house make the foundations secure and strong. The old Bible parable of the house built upon sand and the one built upon rocks is an excellent thing for the young builder to bear in mind. Let the corners of your building rest upon stones or stout posts driven or sunk several feet in the earth. If no large, firmly-

embedded rock can be found or used as a support, dig a good-sized hole and fill it with small rocks and place a flat rock on top of those beneath. Bricks may also be used if rocks are not at hand. Of all foundations nothing excels concrete, and, if possible, use this material. Cedar, cypress or chestnut posts sunk into the earth will last many years, and if given a good coating of asphalt, copper-paint, creosote or even ordinary paint they will endure much longer.

Having decided upon the dimensions and location of your building, which we will assume is to be 12 ft. x 10 ft., mark off the proper size on the earth by means of stakes and twine stretched between them and build your foundation or posts at the four corners. Then cut two pieces of 3 x 4 scantling, each 12 ft. long, and two more 10 ft. long, and make neat halved joints at the ends of all. Place these upon the corner foundations, squaring the corners true and levelling up on all sides until all these sills are perfectly level. If the foundation stone on one corner is too high cut away a little on the timber where it rests upon it or knock off a little of the support. If the foundation is slightly too low place a thin board or a small stone under the timber to bring it level

with the others. Herein lies the advantage of posts over stones, for the tops of the posts may be sawed off or the post driven a little deeper in the earth to level the sills.

Nail the four corner joints firmly with large wire nails and on each corner level off a smooth space on which to rest the uprights. These four corner posts are of 3 x 4 stuff, those for the front 9 ft. long and those for the rear 7 ft., for the little building is to have a "lean-to" roof, which is just as serviceable and far easier to make than a peaked or ridged roof.

Place a 9-ft. timber and a 7-ft. timber (4-in. side down) on a smooth surface 12 ft. apart from the outer edges and place a straight timber at right angles to them and just touching the ends, and with your square true them up until the two are equidistant apart and are square with the other timber. Now place a straight piece of board or strip of wood across from one of the posts to the other and with the upper edge just flush with the forward edge of the two (Fig. 1), and mark a diagonal line across the timbers where the straight edge crosses them (Fig. 1*a*). Saw off along these lines and cut the other two posts to correspond. Place the corner front post in posi-

tion with the square end resting on the corner of the sill and with the 4-in. side along the side sill and the 3-in. side flush with the front sill (Fig. 1*b*), and tack the post with one or two nails driven as in Fig. 1*c* to the sill. Tack two light pieces of boards diagonally from the side and front of the post to the sills and by means of these and your perpendicular level adjust the post until absolutely plumb (Fig. 1*d*). Repeat these operations with the other two posts (taking care that the sloping upper ends of the posts have the highest edges towards the front) and nail them all securely. Get out two pieces of 3 x 3 stuff 11 ft. 4 in. long and two pieces 9 ft. 6 in. long. Measure 6 ft. from the top of the sills on each of the four posts on the sides and back and 7 ft. from the sills on the front, and mark the posts at these spots. Place one of the 11-ft. 4-in. timbers between the front and back posts on one side with the lower edge just flush with the marks 6 ft. from the sills and nail it firmly to the posts by driving nails through as shown in Fig. 1*e*. Place the other 11 ft.-4-in. timber on the opposite side between the two posts, and place one of the 9-ft. 6-in. pieces across from one rear post to the other at the 6-ft. marks, and finally secure the

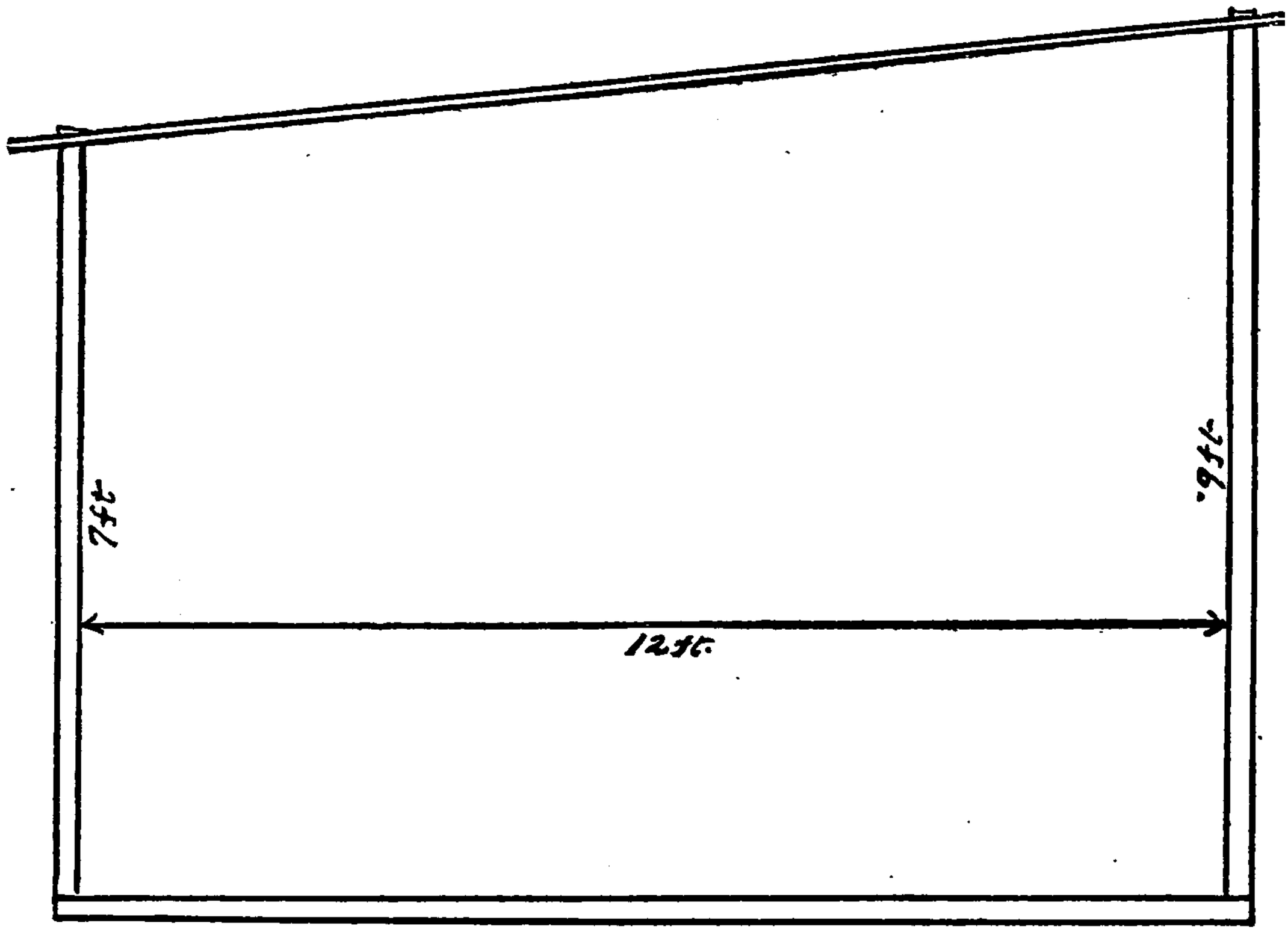


FIG. 1

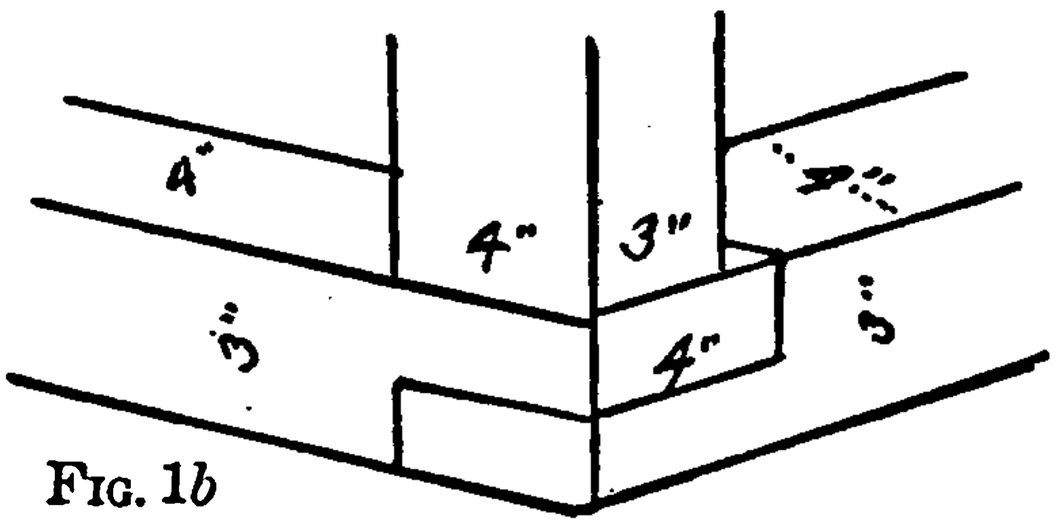


FIG. 1*b*

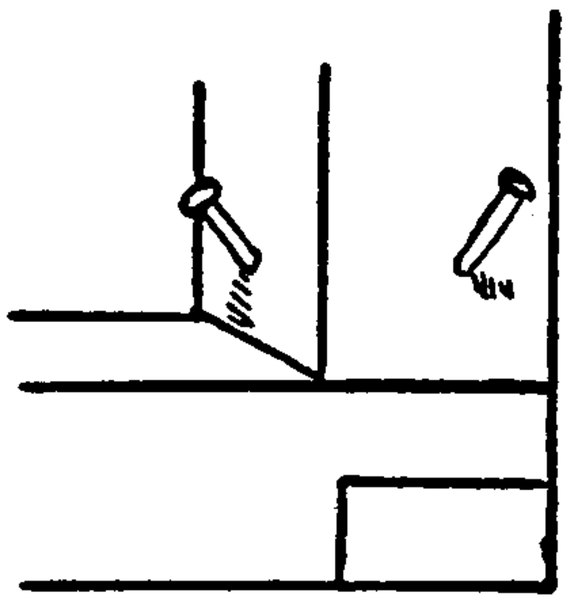


FIG. 1*c*

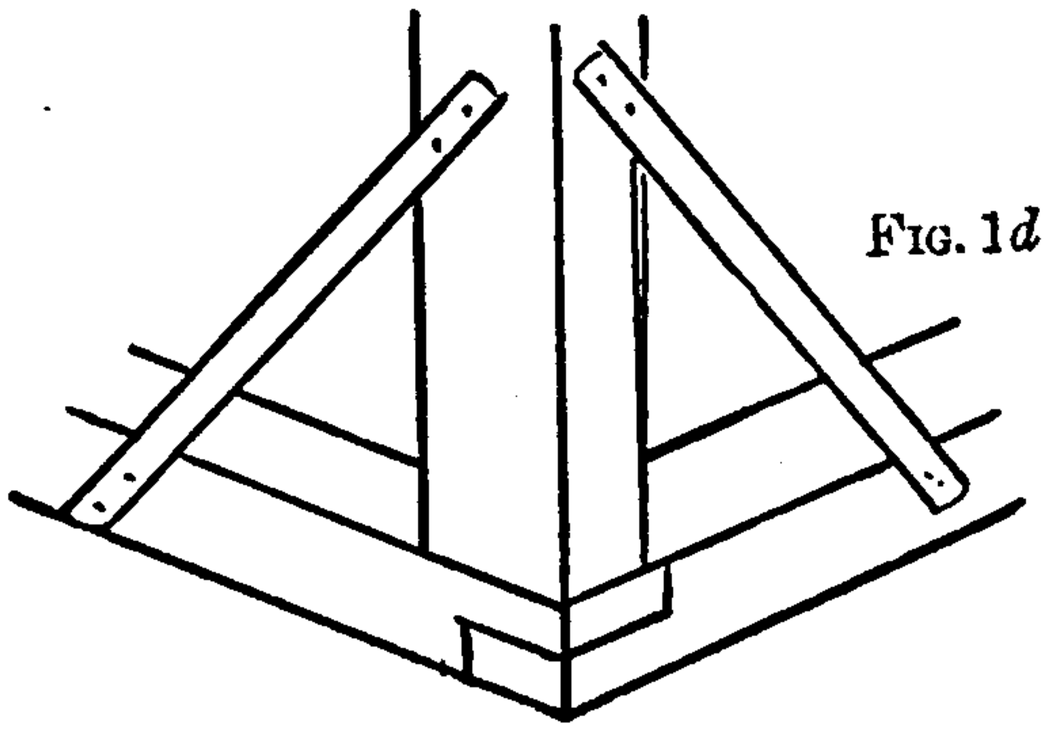


FIG. 1*d*

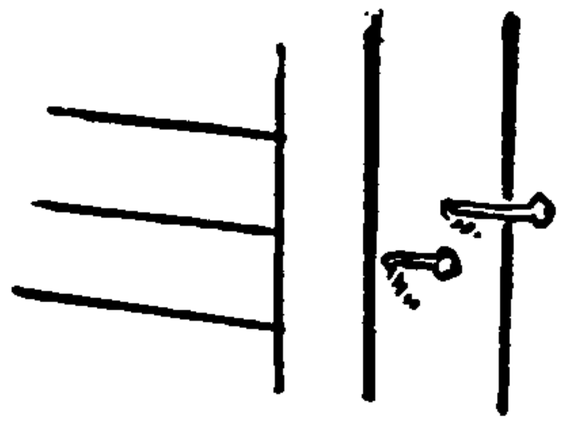


FIG. 1*e*

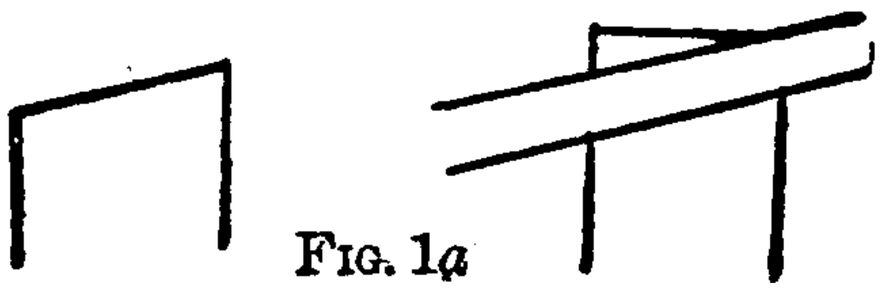
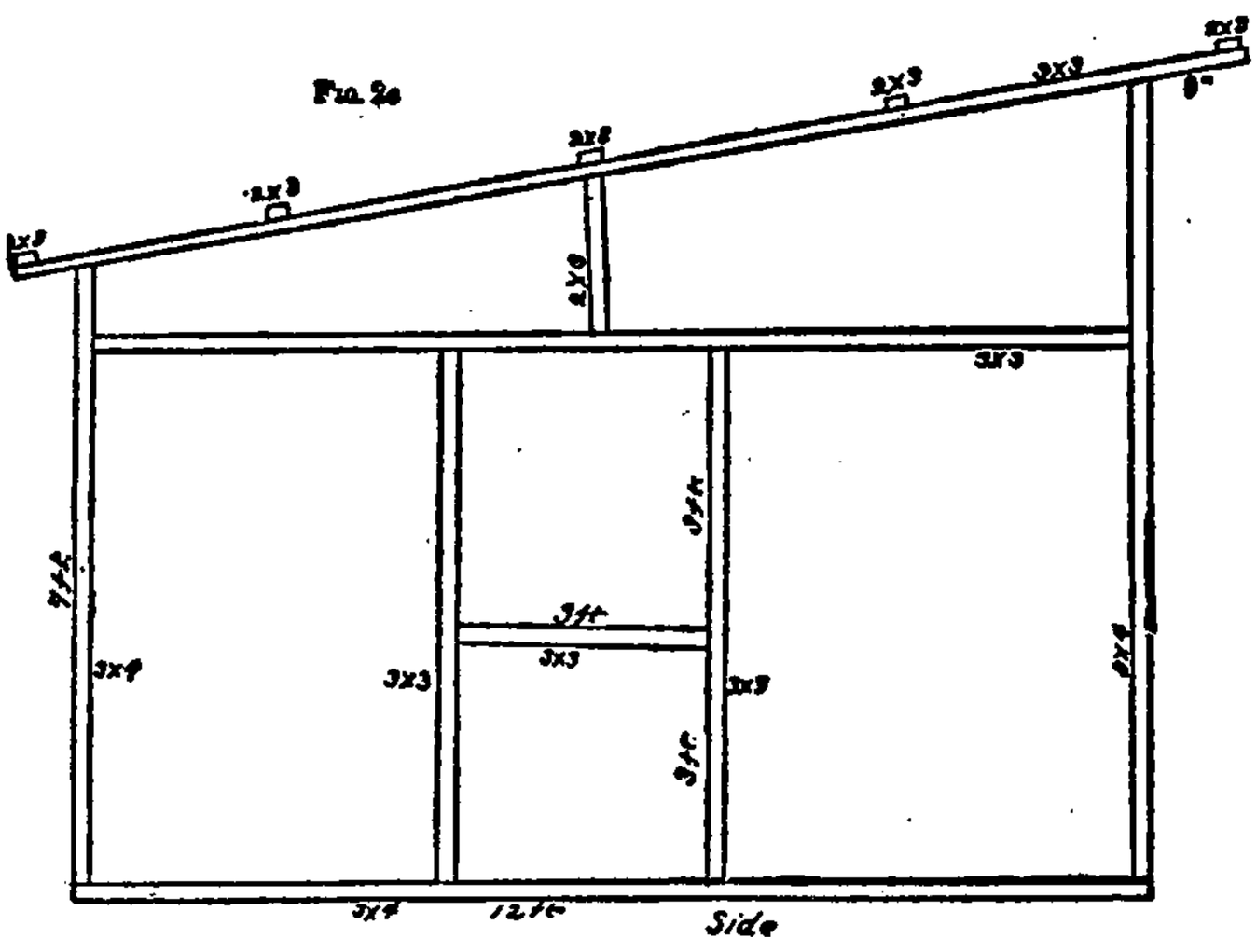


FIG. 1*a*

last 11-ft. 4-in. piece between the two front posts at the 7-ft. mark, being sure to keep the outer edges of the pieces flush with the outside edges of the uprights.

Now cut two pieces of 3 x 3 timber each 7 ft. long and four pieces 6 ft. in length. Fasten the two 7-ft. pieces in an upright position for door-posts, between the sills and the cross-piece 7 ft. from them, setting them 3 ft. apart and either in the centre or at one side, according to whether you wish the door in the centre or at one side of your shop. Fasten two of the 6-ft. pieces on each side between the cross-pieces and the sills for window-frame posts, placing them 3 ft. apart, and in all cases keeping the outer edges flush with the outer edges of the other timbers. Cut two pieces of 3 x 3 stuff 10 ft. long and fasten them, one between the two front posts and one between the two rear posts just even with the tops of the posts and with outer edges even with the outer edges of the posts, uniting them together as shown. Cut three timbers of 3 x 3 each 13½ ft. long, and place them from front to rear, placing one on each side from post to post and the other halfway between. Allow about 8 in. of these to project at the forward end, letting the rear ends

also project and nail them in position to the posts and upper cross-timbers. From side to side across these roof beams nail pieces of 2 x 3 scantling each 11 ft. long, and letting 6 in. on each end project beyond the sides of the frame and spacing the cross-pieces 3 ft. apart so that there is one at each extreme end of the sloping timbers and three between them (Fig. 2*a*). Di-



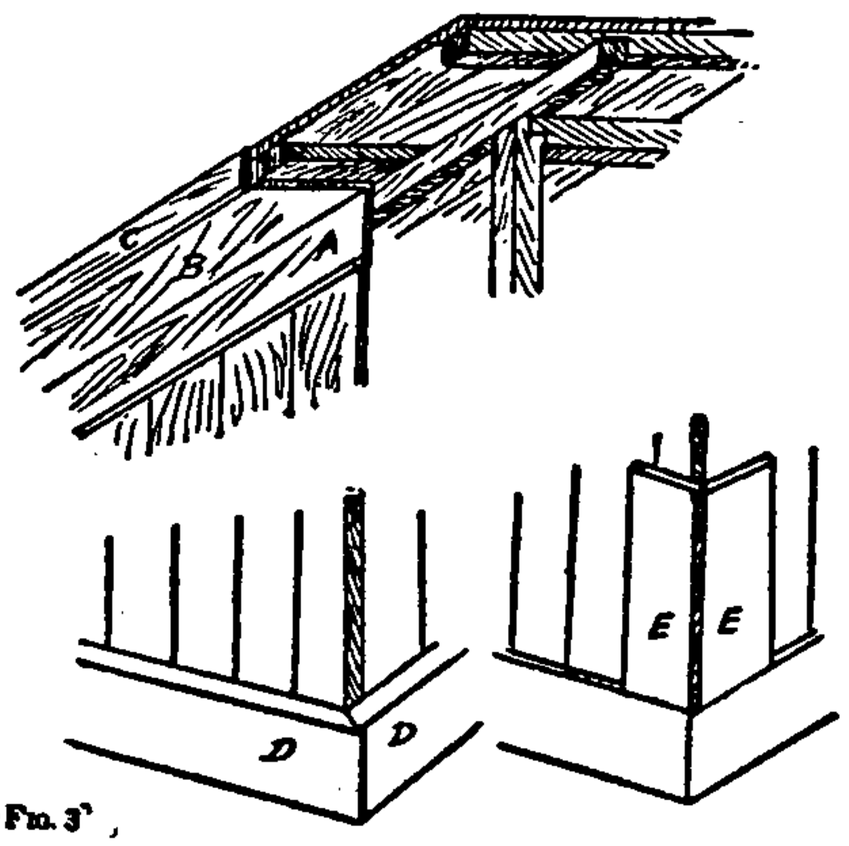


Fig. 3

rectly over the centre of each of the window spaces fit a piece of 2 x 3 timber between the sloping roof timbers and the cross-pieces 6 ft. from the sills, and place a similar piece between the roof timber and cross-piece 7 ft. from the sills over the door space as shown in the cut. At the rear fit another piece of the 2 x 3 material in the centre from sill to cross-piece and another over it between the cross-piece and roof timber.

Between the posts at the sides of the window fasten pieces of 3 x 3 timber 3 ft. from the sills, and your frame will be complete and will appear as in Fig. 2*ab*. The diagonal light pieces used to secure the corner posts while truing up may now be removed and you can proceed to board up the building.

Use matched boards of cheap, fairly clear wood and first cover the roof, so that if it rains you will have some protection from the weather while finishing the rest of the building. To sheath the roof place a piece of the board, from which the tongue has been planed off, with the planed edge flush with the outer ends of the roof timbers, and nail it in position. Place another board alongside, drive the matched edges tightly together, using a piece of board for the purpose (Fig. 2*c*), and nail this one to the various timbers it crosses. Continue in this way until the entire roof is covered and cut the last board to fit exactly even with the ends of the timbers on the opposite side from where you commenced. It is a waste of material to try and cut the boards to length before nailing in place, and you will save lots of time and trouble by selecting those nearest the proper length and trimming the uneven ends off

square after they are nailed in position. As the roof is to be covered with roofing paper or shingles the boards need not all extend the whole length from front to back but may be placed in pieces of any length, as long as the butt ends join over one or the other of the timbers.

To board the sides commence at one corner, with a board from which the tongue has been planed, and proceed around the side to the next corner. If a groove comes just even with the corner it will do no harm, but as a rule the last board will have to be marked and cut to fit. Let the boards extend from top to bottom of the shed wherever possible, and when pieces are too short save them for filling in about windows, doors and short spaces. Each board must be cut slanting at one end for the side sheathing, but the slant need not be exact, for weatherboards will be fitted over them at the upper ends before the building is complete. Above and below the window openings and above the doors let the boards come very even and flush with the timbers, but if they run down an inch or two below the sills it makes no difference. When the sides and ends are all sheathed nail a neatly fitting board along each side and across each end under the eaves (Fig.

3 *A*), thus covering the upper ends of the sheathing. On the lower sides of the roof timbers nail well-fitted boards to cover the open spaces between the timbers (Fig. 3 *B*), and nail other boards over the outer ends of the projecting timbers and the last boards as in Fig. 3 *C*. Along the lower edges of all the sheathing nail boards neatly fitted at the corners (Fig. 3 *D*), and nail two boards at each corner, breaking the joints with the sheathing as shown in Fig. 3 *E*. The next step is to finish the door and window frames. Fit smooth boards around the inner surfaces of the window frames, allowing the outer edges of the side and top pieces to come flush with the outer surface of the sheathing (Fig. 4 *A*), and letting the strip on the lower frame project an inch or more beyond the sheathing (Fig. 4 *B*). Around the frame on the sheathing, outside, nail four boards with the ends mitred and covering the edges of the liners on top and sides as in Fig. 4 *C*, and fitting snugly under the one at the bottom (Fig. 4 *D*). Above the window fasten two triangular brackets and on top of these nail a piece of 6 in. x $\frac{7}{8}$ in. board. Fasten a strip of zinc over this, tack it snugly to the wall with tar or cement behind it (Fig. 4 *E*), and the window frame will

be ready for the window sash or shutters. Treat the door frame in the same manner and then make a good, strong wooden door to fit it. To make a door place strips of the matched boards on the floor or bench and cleat them together in the desired form by two cleats straight across

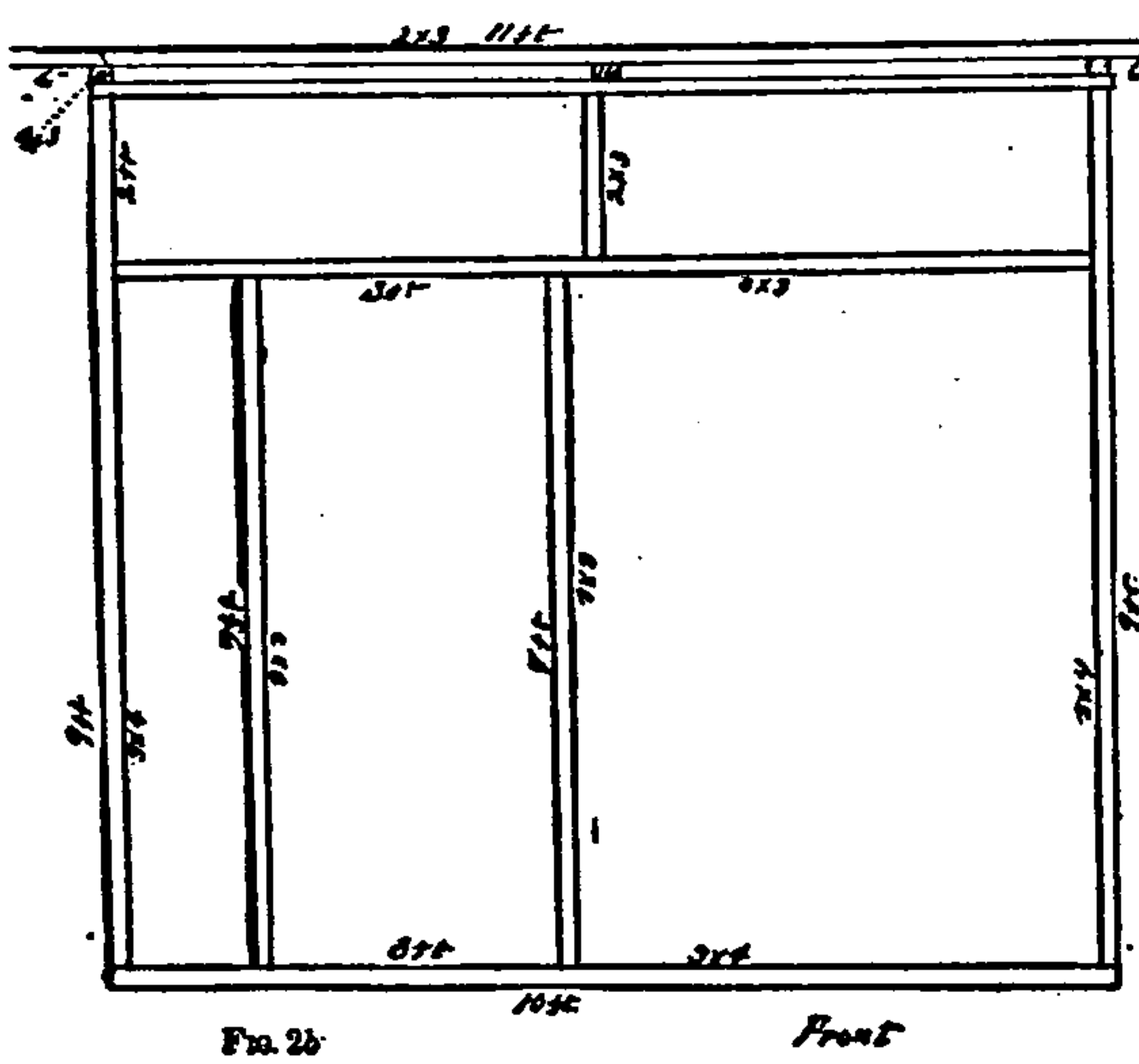


Fig. 2b

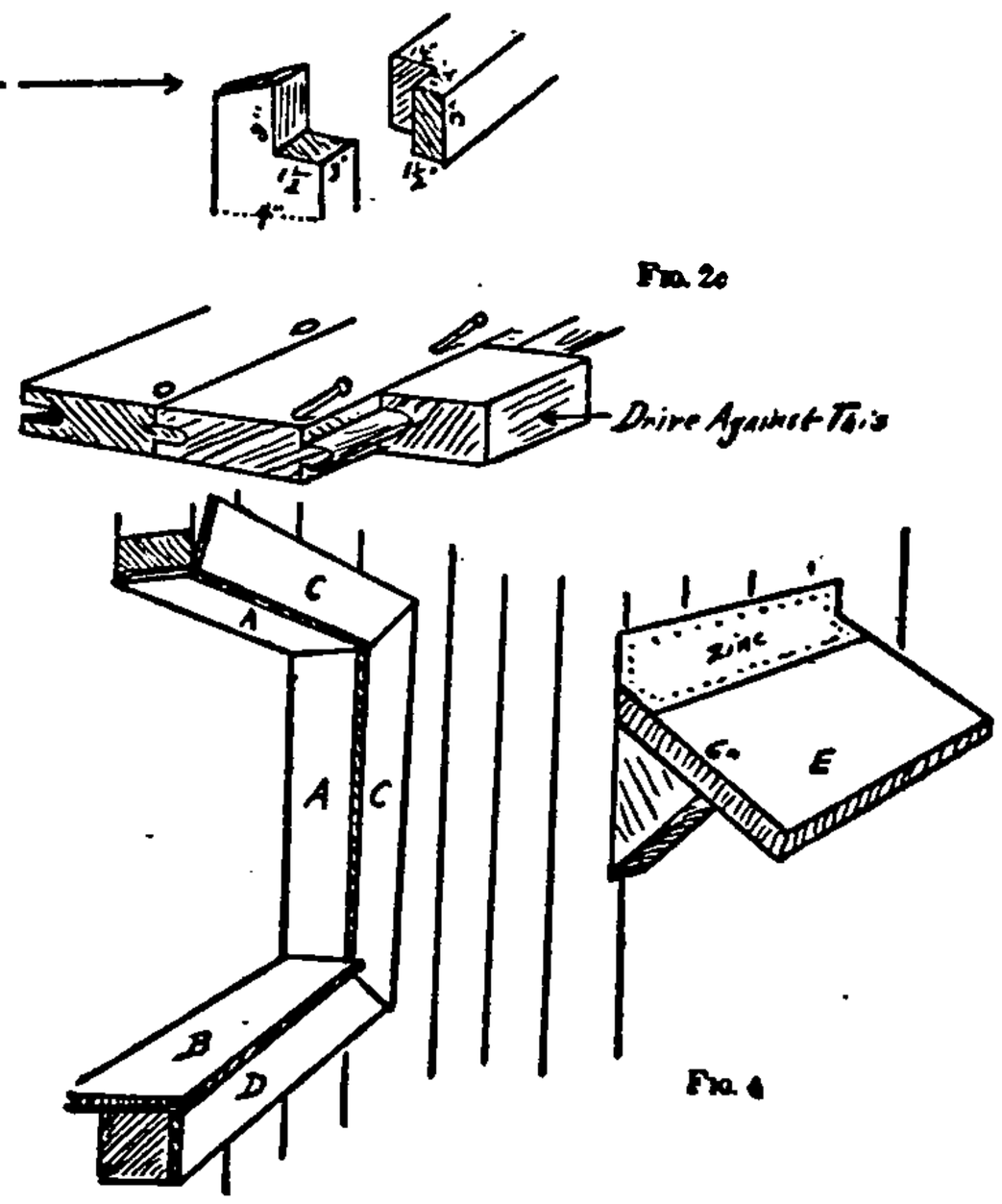


Fig. 4

and another diagonally between them, all being screwed firmly to every board. Hang the door on good, strong hinges so it swings easily in the frame and fit a strip all around inside for it to bear against when closed. In order to prevent any water from entering under the door the sill should be cut slightly slanting or a sloping sill-piece should be used.

A shutter for the window may be made like the

door or a sash with glass may be fitted and hinged. In case you intend to use sash, however, it is a good plan to secure the sashes first and build the window frames to fit them. The roof may be shingled or covered with rubberoid or tarred roofing paper, but the latter is cheaper and easier to use than shingles. In placing the roofing paper on the roof run the breadths across, laying the back or rear edge breadth first and lapping the others slightly over the upper edge of each preceding breadth as you proceed. Before roofing with the paper or rubberoid plane off all sharp edges of the sides and ends and turn the paper over the weatherboards all around and secure it neatly by narrow strips of wood nailed over the paper.

If you are to shingle the roof use good quality shingles and begin at the lower or rear end and be sure to run the shingles even. To obtain straight rows of shingles measure off equal distances on the edges of the roof, stretch strings across and use these guides for placing the shingles. If shingles are to be used you must give the roof a good slope or pitch and better results will be obtained if the forward end is made 10 ft. high instead of 9.

The floor should be laid from the sill on one side to the sill on the other, but as 10-ft. boards would spring and bend without some support a centre timber, or even two timbers, of 3 x 4 or 3 x 3 stuff should be placed between front and rear sills before nailing the floor, and at this time additional posts or stones should be piled under the sills.

When you have completed this little house you will be mighty proud of it, and if given a good coat of paint it will make a very attractive and neat little building. It may be greatly improved by the addition of a little porch or front steps or by some ornamental work around the eaves or over doors or windows, or, if you wish, you may cover it with rough bark-coated slabs and thus give it the appearance of a log cabin. The building is intended for use rather than ornament, however, and will prove a snug, comfortable little workshop for the amateur carpenter, and if vines and shrubs are planted about it, it will be very pretty in summer time. The same method of construction and practically the same dimensions may be used in building a garage, but for this purpose a concrete or heavy plank floor must be laid, wide sliding or folding doors must be

provided and the lower end must be high enough to accommodate the car and driver. With these directions for building a little workshop at hand the ingenious amateur carpenter can easily design and construct small buildings for any purpose.

CHAPTER XIII

VARIOUS USEFUL HINTS AND RECIPES

Finishing Floors

It often happens that hardwood floors become worn, discoloured or stained and it is necessary to refinish them. Quite frequently, too, a polished or hard-finished floor is desired and the expense of a real hardwood floor stands in one's way. Worn, discoloured or otherwise injured hardwood floors may be easily renewed and refinished and even ordinary soft wood floors may be finished to imitate genuine hardwood floors by the amateur carpenter, with little trouble and expense.

Before anything can be done the floor must first be prepared. The first thing is to have the floor perfectly level. If it is an old, common floor, pull up all nails and tacks, which have been used in fastening carpets, and drive all other nails at least $\frac{1}{8}$ in. below the surface with a nail-set. Putty all holes, small cracks and the spaces over the sunken nail heads. If there are knot-holes,

or similar imperfections in the floor, fill them with pegs or plugs of soft wood and fill wide cracks between the boards with strips of wood planed wedge-shape. Before driving in these wooden strips and pegs, coat them with good glue on all sides. Don't try to plane the floor

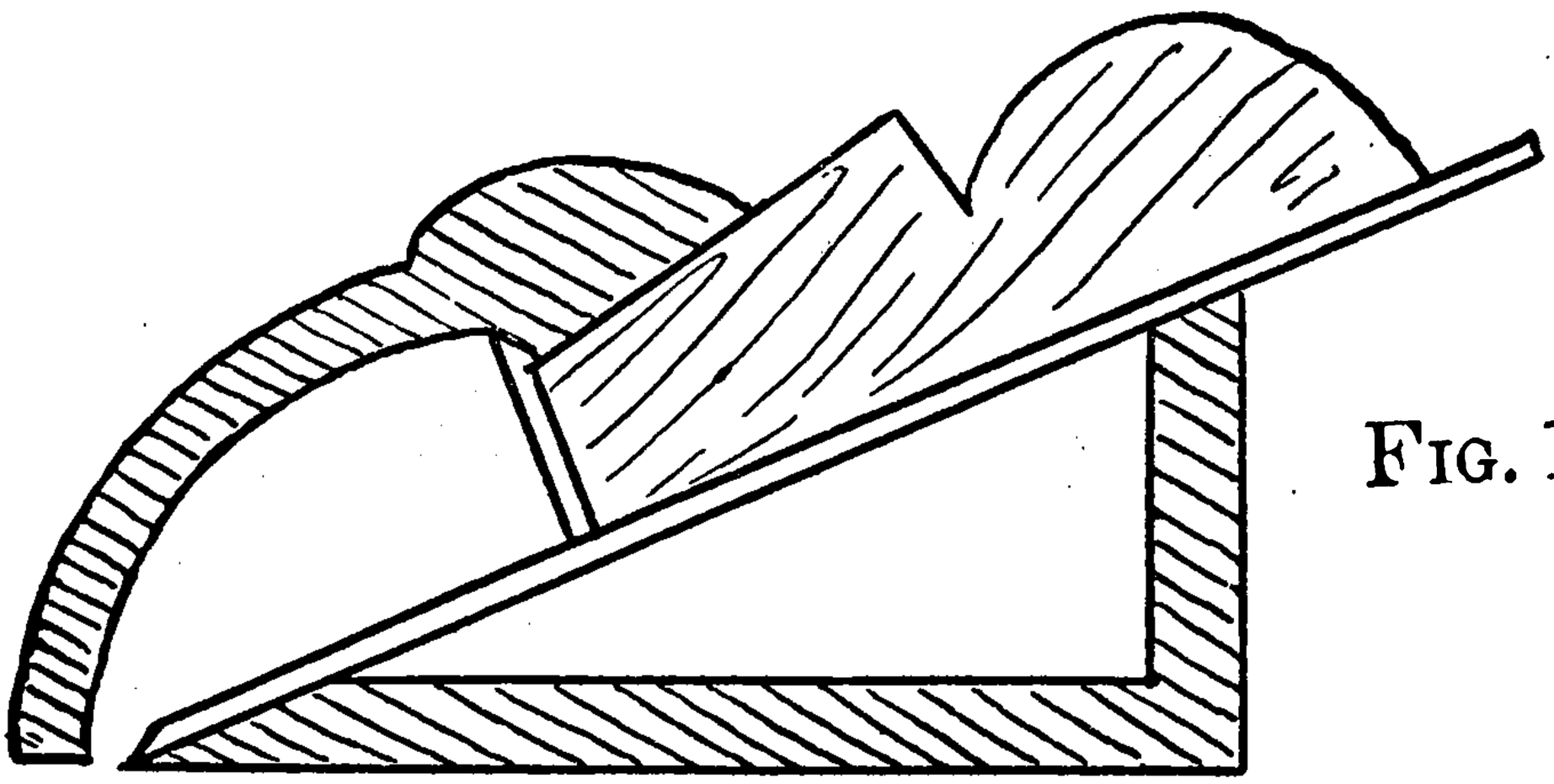


FIG. 1

until all the glued pieces, putty, etc., have thoroughly dried. In order to plane and level the floor a bull-nosed plane (Fig. 1) must be used, for it is impossible to plane close to the walls and into corners with a common plane.

The floor must be thoroughly cleansed with hot water and soda or some strong washing powder, rubbed in with pumice stone or Bath-brick, and when thoroughly dry it should be rubbed smooth with sandpaper. Having planed, cleaned and sandpapered the floor the next step is to stain it.

The floor may be stained all one colour to imitate some certain wood or it may be stained to imitate several woods or to imitate inlaid or parquetry work. A simple and effective way to stain a floor is to dissolve four ounces of shellac in one pint of denatured or plain alcohol with enough colour added to give the desired shade. Thus brown umber will give a walnut colour, Venetian red will imitate mahogany, etc. This should be brushed evenly on the boards and when dry it should be smoothed with fine sandpaper. A second coat should then be applied and smoothed and a third or fourth may be given if a darker stain is required. The floor may be kept clean and fresh by occasionally wiping with a rag, wet with linseed oil, or it may be given a couple of coats of good spar or floor varnish. If a wax or French polish is desired it may be applied directly over the shellac-stained floor.

If the entire floor is desired in one colour the stain may be applied over the whole surface, but quite frequently an ornamental design or a border of a different colour is preferable. The beauty of any such design, or border, will depend a great deal upon the neatness with which it is made and the clean, even lines or edges

where two colours meet. As it is often impossible to stain a board with two colours side by side without the tints running or spreading, the desired pattern should be marked on the floor and the outlines drawn in with some oil-paint or glue-sizing. This may be of the same tint as one of the stains used on the floor, or if paint is used it may be of some sharply-contrasting colour. The various stains may then be applied without danger of their running together. In some cases thick paint may be used for the designs, especially if it is desired to imitate tile, but as a rule better effects are obtained by using stains. You may draw the patterns with rule and dividers, or you may make paper or thin cardboard stencils and use these, which is much the easier and better method. A sample design may be applied to some old board and the stencils may thus be altered until the desired effect is obtained. Care should be taken to have the design of such size that it will come out even on the floor. Nothing looks worse than to see a broken or partial design at a corner or end of a floor, or to see two different portions of a design joining. If tiles are imitated the dimensions of the squares should correspond to the width of the boards,—that is,

if the boards are 6 in. wide the imitation tiles should be 6 in. square. Otherwise, when the boards shrink—as they inevitably will—the counterfeit tiles will appear cracked.

After the design is laid on and thoroughly dry the entire floor should be given a coat of sizing and it may then be varnished, shellacked or otherwise finished.

Veneering

In a great many cases the cost of fancy or ornamental woods is so great that the carpenter and cabinet-maker cannot afford to use them, and in order to obtain the same results at less expense veneering is resorted to. Veneering consists of gluing very thin layers of wood onto any object, and practically all the mahogany, rosewood and other fancy wood articles of furniture, pianos, etc., are veneered. The basis of veneered work should, by preference, be soft wood, such as whitewood or pine, for although hard wood *can* be veneered a great deal more skill is required to accomplish it and the wood is always liable to warp, twist and crack after the work is done. It is very easy to veneer if one goes about it properly, but a great many amateurs become dis-

gusted with trying to veneer, mainly because they do not understand the principles and requirements. The first step is to prepare the object to be veneered as well as the veneer itself. The veneer must have all rough spots, saw-marks, etc., removed and the surface to be veneered must be smooth—but not polished—and free from all grease, dirt, polish, varnish, paint, etc.

The veneer should be dampened, spread on a flat surface under weights and when dry should be planed and sandpapered smooth on one side and should be planed to an even, roughened surface with a toothing plane on the other side. If, while doing this, the veneer should be cracked or broken it may be easily repaired by gluing a piece of stiff paper on the smooth, or upper side. The veneer should be cut rather larger than the surface to be covered; if much twisted, it may be damped and placed under a board and weight overnight. This saves a great deal of trouble; but with veneers that are cheap it is not worth while taking much trouble about refractory pieces. The wood to be veneered must now be sized with thin glue; the ordinary glue-pot will supply this by dipping the brush first into the glue, then into

the boiling water in the outer vessel. This size must be allowed to dry before the veneer is laid.

We will suppose now that the veneering process is about to commence, and that the glue is in good condition and boiling hot, the bench cleared, a basin of hot water with the veneering hammer and a sponge in it, a cloth or two, and everything in such position that one will not interfere with or be in the way of another.

First, damp with hot water that side of the veneer which is not to be glued, then glue the other side. Second, go over, as quickly as possible, the wood itself, previously toothed and sized. Third, bring the veneer rapidly to it, pressing it down with the outspread hands, and taking care that the edges of the veneer overlap a little all round. Fourth, grasp the veneering hammer close to the head (shaking off the hot water from it) and the handle pointing away from you; wriggle it about, pressing it down firmly, and squeezing the glue from the centre out at the edges. If it is a large piece of stuff which is to be veneered, the assistance of a hot iron will be wanted to make the glue liquid again after it has set; but don't let it dry the wood underneath it, or it will burn the glue and scorch

the veneer, and ruin the work. Fifth, having pressed out all the glue possible, search the surface for blisters, which will at once be betrayed by the sound they give when tapped with the handle of the hammer. If present the hot iron (or the inner vessel of the glue-pot itself, which often answers the purpose) must be applied, and the process with the hammer repeated.

When the hammer is not in the hand, it should be in the hot water. The whole work may now be sponged over with hot water, and wiped as dry as can be. And observe, throughout the above process, never have any slop and wet about the work that you can avoid. Whenever you use the sponge, squeeze it well first. Damp and heat are wanted, not wet and heat. It is a good thing to have the sponge in the left hand nearly all the time, ready to take up any moisture or squeezed-out glue from the front of the hammer.

Wood-Carving Tools and Their Care

In a great many cases furniture and other objects are greatly improved by ornamental carvings. Wood carving is fascinating work and is very easily learned. Some branches of the art are very simple, requiring but a few hours' work

and the simplest of tools, while others require a great deal of skill, time and care. Oftentimes the simplest and easiest forms of carving are the most effective and in every case you should employ a design or pattern which is in harmony with the rest of the work. If you have the proper tools and keep them clean, sharp and in good condition you will find little trouble in doing any carving you may require. The best woods to use are close-grained, fairly soft varieties, such as whitewood, walnut, mahogany, Spanish cedar, birch, beech, etc. Oak is quite easy to carve, but the harder and coarser grained the wood the more difficult it is to work. Books and books have been written on wood-carving, but printed directions are of little use in learning the art. Practice and common sense are far more important. Don't try to work too fast, but cut away a little at a time and always cut *with* the grain, not *against* it. Oftentimes it is a great help to have a pattern, or model, to follow and a good model may be made of putty, clay or any similar material. It is far easier to copy such a model than to follow a flat drawing, no mattter how well shaded it may be.

Before commencing to carve, secure a block

of the wood you intend to use and test and try your various tools in order to learn just the best motions to use, the amount you must bear on them to make good clean cuts, and the length of strokes necessary to accomplish the desired results.

The first thing is to obtain the proper tools, and these are neither numerous nor expensive. The following will be found ample for the beginner, and as your skill increases and more complicated and difficult work is undertaken, you can add such as are needed.

Three chisels—$\frac{1}{8}$-, $\frac{1}{4}$- and $\frac{1}{2}$-in. sizes.

Three flat gouges of the same width as the chisels.

Three half-round gouges of the same sizes.

One "V" or parting tool.

One "skean" or corner chisel.

One small mallet.

Two cramps for holding the work to the bench.

One oil-stone.

One slip-stone.

One brace and bit or drill.

One star punch and one checker punch.

One tracing-point.

Files, sandpaper, gimlets, hammer, etc.

Of course several of these will already be

among the tools mentioned as carpenter's tools and some of them, such as the bit-stock, gimlets, sandpaper, files, oil-stone, bit and hammer—may be found in the tool-chests of most ingenious boys. In making the purchases, however, beware of what are called "boy's" tools. They are cheap and pretty, but the material and temper are not what is required. Go, therefore, to some reliable hardware store, and purchase such tools as are sold to mechanics—with good large handles, and finely though not fancifully finished—and you will have a set of really much more serviceable tools than any assortment that is usually put up for amateurs. A few of the tools—including the punches and the V or parting tools—can be had only from houses that deal in wood-carver's tools, but they may be ordered through any hardware merchant.

Any good stout table will answer for a work-bench; but if you can procure a bench as made in the engraving, Fig. 2, it will greatly facilitate your operations. It should be at least 40 in. long by 24 wide, with a bench-vise at one end and a tray at the further side to hold the tools. The thickness of the bench should be at least 2 in., and it should be as firm and as solid as it can be

made. It should be high enough for you to stand up to your work; and have holes bored through at convenient distances, in three rows, to insert the hold-fasts, of which a sketch is given (Fig. 3).

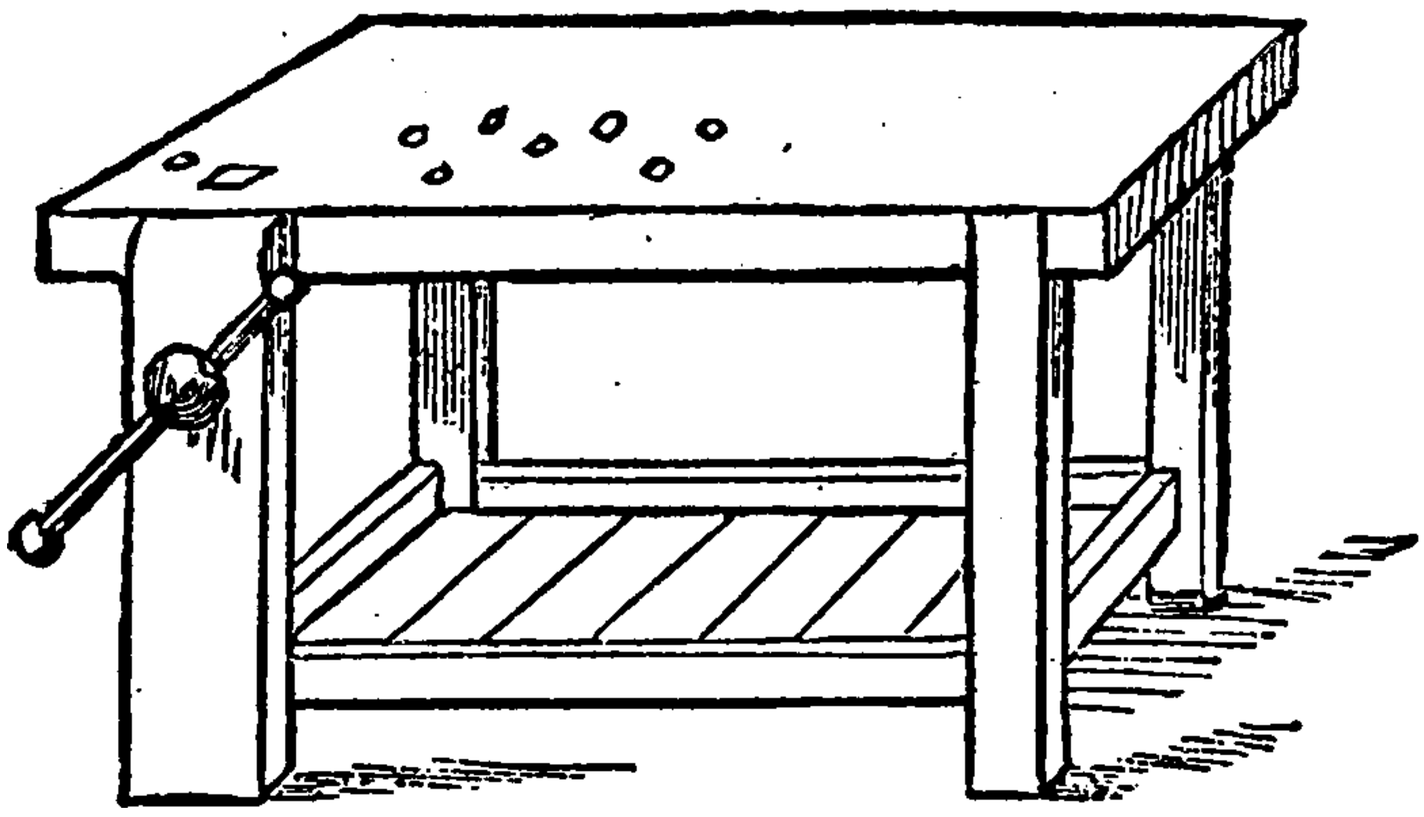


FIG. 2

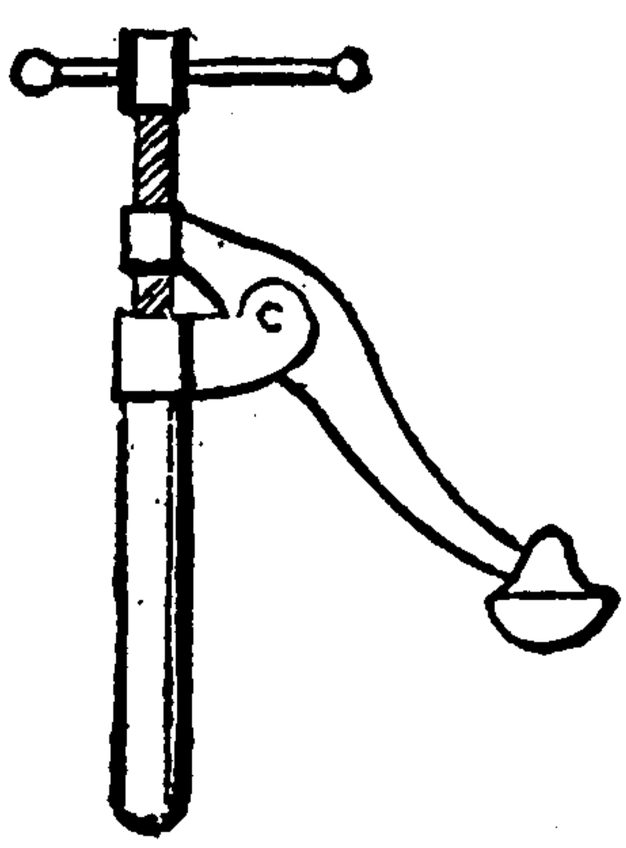


FIG. 3

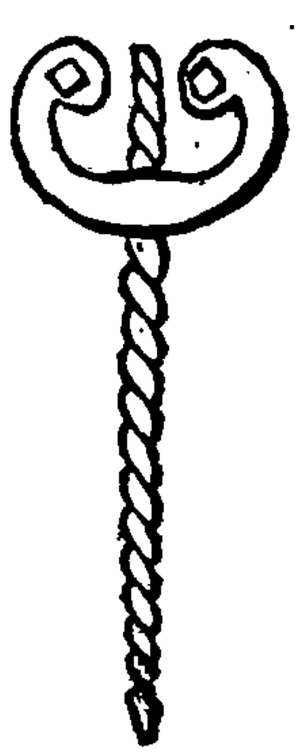


FIG. 4

The hold-fast is put into one of the holes, the work to be held is put under the pad, and the screw is turned until the work is firmly fixed. This hold-fast is used when the wood to be carved is too thin for the carver's screw to be inserted into it, and when it is not desirable to glue it

down on another board. In using this hold-fast, always put a piece of some soft wood between the pad and the wood that you are carving, so as to prevent the teeth of the pad from marking it. It is not difficult to see that a deep scratch might interfere sadly with the delicate part of some leaf. Instead of the hold-fast, the carver's screw, which is better, may be used. It all lies below the table, and there is nothing in the way of the carver. This screw, with its nut or clamp, is shown in Fig. 4. To use it, remove the clamp, grasp the screw in the bench-vise between two scraps of wood, so as to save the jaws of the vise; screw the upper or sharp point into the block to be carved; pass the screw down through the bench, and then, by means of the clamp or nut, make it fast. Where the block is very thin, it should be glued to a thick block, a thickness of paper being glued between the two to facilitate their separation.

The first thing to do is to learn to sharpen your tools. They generally come ready ground from the store, and merely require to be sharpened on an oil-stone. The oil-stone should be set in a block of wood, and fitted with a cover, so as to protect it from dust and dirt, and give it a

broad, firm basis on which to stand. A small particle of hard grit falling on the stone and remaining there while the tool is being sharpened, will often seriously injure a fine tool, and great care is therefore required in this respect. To keep an oil-stone in good condition, it must be kept clean and free from old gummed-up oil. When the oil becomes thick and gummy, the tool slides over it without being ground away, and your labour is lost. The best kind of oil, in my opinion, is good sweet oil. Some recommend kerosene, but I have found that it hardens the stone and injures it. It is also necessary that the stone for sharpening chisels, etc., should be kept perfectly flat. When it becomes irregular, the best method of making it true is to grind it down upon some flat gritty stone, with water, and afterwards smooth it off by rubbing it over with a flat slate charged with very fine emery. After having cleansed off the stone carefully, put a little oil on it, take one of your chisels, the handle in your right hand, put it on the stone, and holding it at the angle at which it has been ground, place the fingers of the left hand on the face, and with a moderate pressure rub it steadily backwards and forwards, looking at it frequently to see if

you do not get it down too much and make what is called a wire-edge. When it is sharp enough, raise your right hand a little, give the edge of the chisel a semicircular forward sweep or two on the stone; then turn the face down, give it two rubs with a semicircular forward sweep, and your chisel will be sharp. If you should get a wire-edge, draw the tool over the edge of a table or board, and it will come off. If this does not remove it, stick the tool upright on the table, and bend it backwards and forwards; then put it on the stone again, giving it, with the hand raised, the semicircular sweep before described. Sharpen your gouges in the same way, only you must keep turning your hand as you rub to and fro, so that each part of the edge of the gouge may come in contact with the stone. I sharpen my gouges in a manner different from most people; by holding the gouge across the stone and giving it a rocking motion by turns of the wrist, as I push it up and down the stone. To explain: bring the gouge close to you, holding it across your body; put the further corner of the gouge down on the stone, push from you, and at the same time turn your wrist, so that the upper or nearest corner comes down on

the stone; drawing it back, reverse the motion, and in this way every part of the edge of the gouge will be equally ground by the stone. I have found this by far the best plan, as the edge does not get rubbed away more in one place than in another. Then, as you can not sharpen the face, which is hollow, on the oil-stone, take the slip between the finger and thumb of your right hand, and holding the gouge firmly in the left, sharpen the inside of the tool. Take care not to rub away too much of the face of your tools, for it is the hardest and most precious part.

The V tool is the most difficult of all to sharpen. This must be done with the flat side of the slip, and take care that it is not rubbed more on one side than the other. It will require considerable practice and much patience to learn to sharpen this tool well; but in this, as in all other things, remember the old Spanish proverb: "With patience and perseverance the mulberry leaf becomes a silk gown." The final touches, which give to the tools the last degree of sharpness and smoothness of edge, are given on a piece of stout leather, about 1½ in. wide and 8 in. long, glued to a board, and rubbed over with the very finest emery paste, which is emery

made into a stiff paste with tallow. The emery must be perfectly free from grit; and, to obtain it in this condition, you must get some of the very finest flour of emery and mix it with water in a tall jar, such as a good-sized fruit jar. After stirring it up vigorously, allow it to settle for say a minute; pour off the liquid into another vessel, and allow the fine powder that remains in it to settle completely. Pour off the liquid, dry the powder, and keep it for use. The strop should be kept carefully covered, to protect it from dust; and, if the emery be good, it will impart to your tools an edge as keen as a razor. The leather should be hard, firm and of even texture. Some people recommend soft, buffed leather; but this is a mistake as it does not sharpen a tool nearly as well or as quickly as the hard leather. Moreover, the soft leather will curl up behind the tool as it is rubbed along and will thus round off the edges instead of leaving them with a true angular bevel.

Soldering

At first thought soldering may seem to have but little connection with carpentry, but as a matter of fact a knowledge of soldering will be

of great value to the amateur carpenter. Gutters to roofs, pipes, trays, linings to moth-proof boxes, the trays for umbrella-racks, ornamental metal work and hundreds of other accessories used in carpentry must be soldered, and aside from its value in this connection you will find soldering very useful. In a thousand and one places, on the farm, in the city home, in camp, when travelling and, in fact, under nearly all conditions and in nearly all places a knowledge of proper methods of soldering will come in very handy.

A boy who can solder well will find a surprising number of things which require his attention; dishes, utensils, instruments, tools, toys and a thousand other discarded objects may be made as "good as new" by judicious use of solder and, moreover, with some odds and ends of tin, brass, etc., a boy can make a great many things which he cannot possibly construct in any other way.

There are but three things necessary for soldering. The first and most expensive is the "soldering iron" or "soldering copper," a square or rounded piece of copper with a sharp point and a handle. The second essential is the

solder, a mixture of lead and tin, which may be bought in bars or strips, and the third necessity is the "flux," a compound or material used to cause the solder to stick.

A good soldering copper may be purchased for fifty to seventy-five cents, the price depending upon size and weight, as these tools are sold by weight, and a medium-sized, straight-pointed copper is best to begin with. A very small copper will lose its heat rapidly and is a nuisance, whereas a very large one will be clumsy and tiresome to use. The solder should be of the "half-and-half" mixture and ten cents' worth will last quite a long time. Now comes the flux, and in a way this is the most important item of all as well as the cheapest. There are a great many kinds of fluxes used and the particular one depends somewhat upon the character of the work, the materials to be soldered and the preference of the solderer. Resin works very well on bright tin, but is not good on most other metals and, to my mind, the best flux of all is chloride of zinc and sal ammoniac. The chloride of zinc is merely hydrochloric or muriatic acid in which zinc is dissolved until no more will be taken up. When all the zinc possible is dissolved, add sal

ammoniac in the proportions of about 2 oz. of the sal ammoniac to 1 qt. of liquid.

Pieces of old battery-zincs are the best material to use in making this compound, but clippings of sheet zinc do just as well; the important matter being to add zinc until no more will dissolve. The acid should be placed in a large jar or bottle and the zinc added slowly to prevent it from fizzing or boiling over.

When preparing the mixture, retain a few good-sized lumps of the sal ammoniac, as they will be useful later on, and, when all is ready, have a piece of old tin on a board, a woollen rag, some sandpaper and a file on hand. First of all the copper must be "tinned." This is accomplished by heating the copper hot enough to melt the solder readily, brightening it with a flat file and rubbing it on the sal ammoniac and solder on the piece of tin. The sal ammoniac will cause the solder to coat the brightened surface of the copper, and if well done the entire point of the copper should be bright and silvery. If at first you do not succeed in getting a good coat on the copper, heat it over again, rub with the file to remove oxide and rub again on the sal ammoniac and solder.

While the copper has been heating you should have thoroughly cleaned the parts to be soldered by scraping with an old knife and rubbing with sandpaper or emery cloth. If the place to be repaired is merely a crack or small hole it should be wet with the soldering flux (using a piece of stick with a swab on the end and not a piece of metal).

When the copper is well tinned, dip the point in the solder, rub the copper over the bright wet surface around the hole or crack and a coat of melted solder will at once flow onto the surface. If the hole is very small this thin coat will probably be sufficient to cover it, but if it is large you should gradually add more solder by rubbing the copper towards the hole from the edges and piling up the melted solder in a little ridge until the hole is hidden.

If the hole is very large, you will have to solder a small piece of metal over it. Use metal of the same kind as that of which the object is made, clean it thoroughly, wet it with the flux and coat it with solder by rubbing the copper over it until well coated. Then coat the space around the hole with solder, place the small piece of metal over the hole with the solder-coated surface against

the coated surface about the hole, and rest the hot copper against it until the solder runs together between the small piece and the surface around the hole. Now gently withdraw the copper and allow the soldered utensil to cool slowly. If the piece you solder on is very small, you will find it is easier to hold it in position by pressing a stick against it when removing the copper, as otherwise it may slip on the melted solder and get out of position.

If two pieces of metal are to be joined, they must be cleaned and brightened and each piece tinned by wetting with flux and rubbing the solder-coated copper over them. The two parts to be joined must then be tied or held firmly in position and the soldering copper run along and around the edges so that the solder melts and runs in between them.

The soldering copper *must* be kept quite hot while you are working, for a cool copper does rough work, but occasionally where a large mass of solder is required over a large hole or a weak spot, the solder may be more readily piled up if the copper is just hot enough to melt the solder and pick it up in a sort of "pasty" form.

The secret of strong soldered joints is to have just as little solder as possible between the parts soldered.

You will undoubtedly have some difficulty in making neat jobs at first, but you will soon get the "hang" of it and will be able to turn out work that would be a credit to a professional. Do not get the copper too hot; if it gets red-hot the solder will be burnt off, the copper oxidized, and you will have to tin it over again. Use a charcoal or coke fire if possible, but a blow torch or even a good coal fire will serve if the ashes are wiped from the copper with a woollen rag each time it is taken from the fire. A small gas stove is also an excellent method of heating the copper.

You will find that copper, tin and brass are very easy to solder, but you will have hard work with iron, steel and aluminum. For the latter you *must* use specially-prepared aluminum solder and a bare, untinned copper very hot and no flux at all. For soldering iron or steel you will find that pure muriatic acid works better than the flux, and that hard solder containing a lot of tin is superior to the half-and-half. Sometimes cast iron may be soldered more satisfactorily by first

pressing a piece of tinfoil against the surface and melting it on by heating the whole.

Whenever you wish to solder large pieces of metal the objects should be made quite hot, as otherwise the solder will refuse to stick or will be rough and uneven, while the heat from the copper will be drawn out by the cold metal and the copper will require frequent heatings.

In soldering zinc it is more satisfactory to use pure chloride of zine without the sal ammoniac, and if you wish to solder very fusible metals, such as lead, pewter, or britannia, you must use a very soft easily-melted solder.

By trying different metals and experimenting you will soon learn to know just how hot to keep the copper, just the kind or grade of solder best adapted to the work and the most satisfactory flux to use. Most amateurs fail by having the copper too cool, by failing to keep it clean and brightly tinned, by failing to thoroughly clean the parts to be soldered and by too much haste; a great deal of trouble is also encountered by forgetting the copper and allowing it to get too hot.

Use care and patience and remember that "practice makes perfect" in soldering as well as

in any other work, and in the end you will find that a knowledge of how to solder is a most valuable attainment.

Working Glass

Quite frequently the amateur carpenter will have occasion to use glass. A knowledge of how to cut, bore, and work glass is of great value, and while at first you may think glass a very hard and refractory material to handle, yet you will find it nearly as easy to work as wood, after you know how.

For cutting ordinary flat glass, such as window glass, or for cutting curved, round, oval, or irregularly-shaped pieces out of flat glass, the diamond is the best tool; and, if the operator has no diamond it will always pay to carry the job to a glazier rather than waste time and make a poor job by other and inferior means. When, however, it is required to cut off a very little from a circle or oval, the diamond is not available, except in very skilful hands. In this case a pair of pliers softened by heating, or very dull scissors, are the best tools, and the cutting is best performed under water. A little practice will enable the operator to shape a small round or

oval with great rapidity, ease and precision. When bottles or flasks are to be cut, the diamond is still the best tool in skilful hands; but ordinary operators will succeed best with pastilles, or a red-hot poker with a pointed end. The latter is preferable, as it is the most easily obtained and the most efficient, and I have never found any difficulty in cutting off broken bottles so as to make dishes, or even in cutting spirally around a long bottle or tube so as to form a sort of glass corkscrew. Strangely enough glass cut in this shape is quite elastic, and the spiral may be pulled out for some distance, like a spring.

The process is very simple. The line of the cut should be marked by chalk, or by pasting a thin strip of paper alongside of it; then make a file mark to commence the cut; apply the hot iron and a crack will start; and this crack will follow the iron wherever we choose to lead it. In this way jars are easily made out of old bottles, and broken vessels of different kinds may be cut up into new forms. Flat glass may also be cut into the most intricate and elegant forms. The red-hot iron is far superior to strings wet with turpentine, friction, etc.

For drilling holes in glass, a common steel

drill, well made and well tempered, is the best tool. The steel should be forged at a low temperature, so as to be sure not to burn it, and then tempered as hard as possible in a bath of salt water that has been well boiled. Such a drill will go through glass very rapidly if kept well moistened with turpentine in which some camphor has been dissolved. Dilute sulphuric acid is equally good, if not better. It is stated that, at Berlin, glass castings for pump barrels, etc., are drilled, planed, and bored, like iron ones, and in the same lathes and machines, by the aid of sulphuric acid. A little practice with these different plans will enable the operator to cut and work glass as easily as brass or iron.

Ornamental and Frosted Glass

Sometimes a pane of glass, especially in a cabinet or bookcase, will be more in harmony with the design if frosted or ornamented. Ornamental glass is quite expensive and is far more difficult to cut and work than plain glass. It is not necessary to use the prepared glass for such purposes, however, for the ordinary plain glass may be treated by a simple method and will be just as ornamental and ofter prettier than the commer-

cial article. A very good method to employ is the following: Mix a very concentrated cold solution of some salt with dextrine, and by means of a broad, soft brush, lay the thinnest possible coating of the fluid on the surface to be covered. After drying, the surface has a beautiful, bright mother-of-pearl appearance. To make the coating adhere to glass, it is only necessary to varnish it with an alcoholic solution of shellac. The following salts give the finest crystallisations: sulphate of magnesia, acetate of soda and sulphate of tin. Coloured glass thus prepared gives a good effect by transmitted light.

Sometimes plain, ground glass is desired and by using the following method ordinary window glass may be transformed into ground glass, which will withstand ordinary washing and will even be proof against steam, as in bathrooms, etc.

Put a piece of putty in muslin, twist the fabric tight, and tie it into the shape of a pad; thoroughly clean the glass first, and then putty it all over. The putty will exude sufficiently through the muslin to render the stain opaque. Let it dry hard, and then varnish. If a pattern is required, cut it out in paper as a stencil; place it so as not

to slip, and proceed as above, removing the stencil when finished. If there should be any objection to the existence of the clear spaces, cover with slightly opaque varnish. In this way very neat and cheap signs may be painted on glass doors.

Waterproofing Wood

Sometimes it is very convenient to be able to made wooden objects impervious to water. To do this, soak the wood in a solution of zinc chloride, or soak it in a mixture of boracic acid, 6 parts; ammonium chloride, 5 parts; sodium borate, 3 parts and water, 100 parts.

Fireproofing Wood

Strictly speaking, it is not possible to make wood really fireproof, but nevertheless there are several ways of treating wood so it will merely char and will not blaze or even glow, save under tremendous heat. The following are all good formulæ for rendering wood practically fireproof:

Coat the wood with a solution of 10 to 20 parts of potassium carbonate in 100 parts of water.

Immerse the wood in the following solution: Ammonium phosphate, 100 parts; boracic acid, 10 parts; water, 1,000 parts; or ammonium sulphate, 135 parts; boracic acid, 5 parts; sodium borate, 15 parts; water, 1,000 parts.

If the object is too large, or for any other reason cannot be soaked in the solution, two or three coats brushed on will serve all ordinary purposes.

Where the solution is to be applied with a brush the following formulæ are preferable:

Sodium silicate, hot, 100 parts; Spanish white, 50 parts; glue, 100 parts. Tungstate of soda solution thoroughly brushed into wood will prevent it from burning or blazing save under great heat.

Fastening Metal, etc., to Wood

Quite frequently it is necessary to attach metal, leather, celluloid or other substances to wood, and ordinary glue or cement will not prove adequate. The following formulæ will be found efficient:

Rubber to Wood.—Shellac, 1 oz.; gutta percha, 1 oz.; sulphur, 45 grs.; red lead, 45 grs.

Melt together the shellac and gutta percha and

then add and stir constantly the sulphur and red lead. Use while hot.

Celluloid to Wood.—Shellac, 1 part; spirits of camphor, 1 part; alcohol and camphor (90 per cent.), 3 to 5 parts.

Metal to Wood.—Dissolve 50 parts of acetate of lead and 5 parts of alum in a little water. Dissolve, in another receptacle, 75 parts of gum arabic in 2,000 parts of water. Into the latter pour 500 parts of flour, stirring constantly and heat gradually to the boiling point. Mix the two solutions.

To Prevent Wood from Warping

Wood may be prevented from warping, even when in very thin pieces, by immersing it in a concentrated bath of sea water for a week or so. After this treatment the material will resist the greatest changes of weather and temperature without warping or buckling.

CHAPTER XIV

WOOD-WORKING MACHINERY

WHILE a great deal of work may be accomplished solely with hand tools, yet many hours of time and much hard and difficult work may be saved if wood-working machines are within reach. Nearly every boy has seen or used "scroll-saws" or "jig-saws," and these are mighty useful machines in connection with carpentry work. The ordinary old-fashioned scroll-saws, with minute, easily-broken blades, and capable only of light work on thin wood are of little value for the amateur carpenter. For real utility the scroll-saw should be large and strong enough to handle wood at least $\frac{7}{8}$ in. in thickness without undue strain. In getting out shelves, brackets, furniture and a thousand and one other objects such a machine will prove of inestimable value and is perhaps the most useful of all simple wood-working machines. A turning-lathe is also most valuable, and as turning-lathes large enough for amateurs' use are fairly cheap every boy carpenter should save his spending money to pur-

chase a lathe if he cannot prevail upon his parents to get one for him.

Many books and magazine articles have described how to make home-made turning-lathes, but as a rule such things are merely makeshifts and in the end cost nearly as much as a well-built lathe. To be of any real value a lathe must run true and must be very rigid, and wooden, home-made affairs seldom do this. Although in former days nearly every carpenter built his own lathe and turned out good work, yet such lathes were far inferior to the cheapest ready-made lathes that to-day are within the reach of nearly every boy.

You can get a good lathe for the price you would pay for a gun or a good fishing-rod or even for a baseball or tennis outfit, and the lathe will prove far more instructive and useful and will furnish fully as much amusement as the gun or other articles.

On a lathe you can turn ornamental work of all kinds and can make chair, table and desk legs, round railings, spindles, and in fact anything which is round or cylindrical, and, moreover, you can use it for making tops and baseball bats and many other objects of sport and recreation. It

is very easy to use a lathe, for it is merely necessary to set the wood in position, place the tool-rest at the proper height and distance from the wood, hold the tool properly and turn out anything your fancy dictates. A great many beginners fail in their first attempts at using a lathe merely through not understanding the simplest

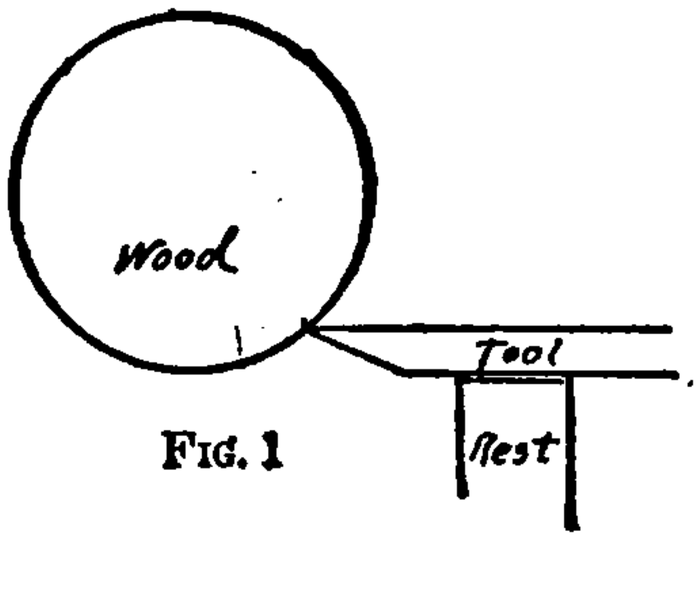


FIG. 1

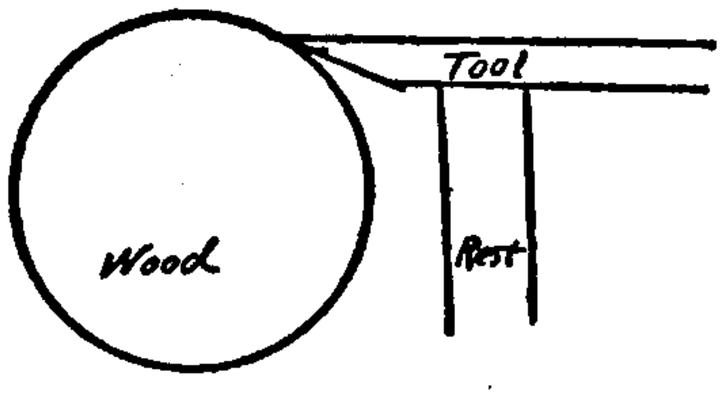


FIG. 2

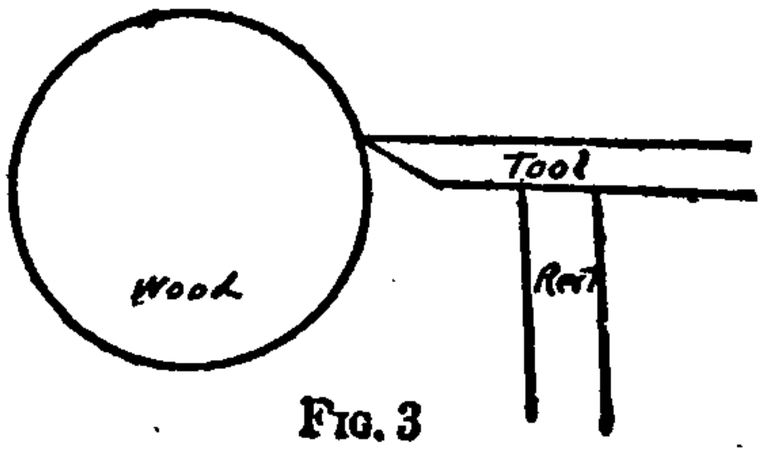


FIG. 3

principles of turning, but with a few hints and a little care any boy can produce excellent results after a few hours' practice.

In turning wood or other materials the object to be turned revolves towards the operator and the tool held against the revolving wood cuts shavings from its surface. If the tool is held too low, as in Fig. 1, you can readily see that the tendency is for the wood to bend down the tool and tear it from the operator's hand, whereas if held too high (Fig. 2), the pressure exerted against the tool will have a tendency to push it back and split off large pieces of wood. To secure

the best results and cut the wood without either wabbling or pushing the tool out of position and splitting the wood, the tool must be held slightly above the centre of the wood and slightly tilted up as in Fig. 3. The wood to be turned may be either round, roughly hewed into octagonal or hexagonal shape, or merely square, for with proper tools the rough, square edges will be rapidly taken off and the wood turned true and round. The first tool to be used depends very largely upon the form of the billet of wood and the kind of wood used. In turning hard wood the chips taken off must be smaller than for soft wood and a finer tool must usually be employed. In the same way when roughing out a square piece of wood you must use a coarser and heavier tool than for working on a piece which is already rounded. The roughing is usually done with a large turning gouge which is held firmly on the tool-rest and just touches the corners of the wood as it revolves. Do not try to hurry this part of the process, but run the gouge slowly back and forth along the rest, chipping off the corners gradually and from time to time setting the rest nearer the wood and pressing the gouge more firmly against it as the piece of timber assumes

a round form. A heavy turning-chisel is also useful in roughing out, and in using this the corner should be brought closer to the wood than the straight edge and should be run along the wood as the latter revolves. Never try to work a piece of wood down in one spot and then move along and work down in another. Rough the piece for the entire length until round and then proceed with the finer work. A few gouges and chisels, a few files and some sandpaper are all the tools required for turning, and a good workman can perform wonderful turning feats with one or two tools. You will soon find that each angle at which you hold the tool and the different corners or edges of the tools will produce various results, and you will be fascinated at the ease and rapidity with which you can transform a rough piece of cordwood into a smooth, round, highly-polished and beautifully turned object.

Beginners usually find quite a little difficulty in the use of wood-turning tools owing to the fact that they hold the tools in the wrong position with relation to the work. If a tool is not held correctly it is liable to dig, or run, into the material and at times may even be thrown from the hand of the operator. If the principles

governing the use of turning tools are once properly understood, any boy may handle them with confidence and safety and may secure good results.

The principal tool used in ordinary turning is the gouge (Fig. 4). It is used mainly for roughing-out work, turning uneven or square billets of wood into the size and general form desired and for turning rounded grooves, etc., but in the hands of an expert finely finished work may be produced by the use of this tool alone.

The proper way to hold the gouge is shown in Fig. 5, in which the cut of the tool is being taken from right to left, the face-plate of the lathe being on the left-hand side, and so by holding the hands as illustrated the arms and body are kept away from the plate and wheel. If the cut is to be taken from left to right, however, the position of the two hands must be transposed.

If the work is very much out of true or is square, or has corners upon it, the forefinger may be placed *under* the hand-rest with the thumb in the trough of the gouge pressing the tool firmly against the rest in order to steady it and prevent it from jumping or chattering. This is necessary to prevent the gouge from digging into the work

in many cases, as well as to obviate any danger of the tool forcing the wood from the lathe by suddenly moving forward and catching on a corner of the square wood. When the gouge is thus held the point of rest upon the lathe may be used as a fulcrum, the tool handle being moved laterally to feed it to the cut, which is a very simple and safe manner of using it, for beginners. The main point in the use of the gouge is to be particular as to the plane in which the trough lies.

Suppose, for example, that in Fig. 6 the piece of wood has three separate gouge cuts being taken on it, that on the right being taken in the direction of the arrow. If the gouge is held in the usual position it acts merely as a wedge and the whole of the pressure placed by the cut upon the trough-side, or face, of the gouge is tending to force the tool in the direction of the arrow and therefore to dig into its cut, rip the work and perhaps throw it from the lathe or break the tool. To avoid this the gouge should be canted or tipped so it lies as in *A* or *B*, in which position any pressure against the cut tends to force the gouge away and only a slight pressure is required to make the cut. In using the gouge

the trough should be almost horizontal and the cutting edge only slightly elevated.

The gouge for turning should be sharpened as shown in Fig. 4, where, by looking at the back

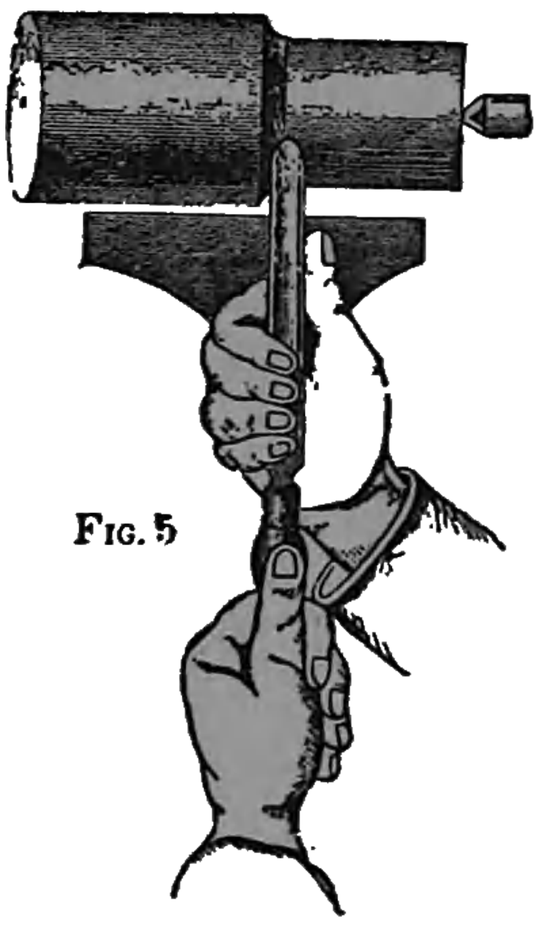


Fig. 5

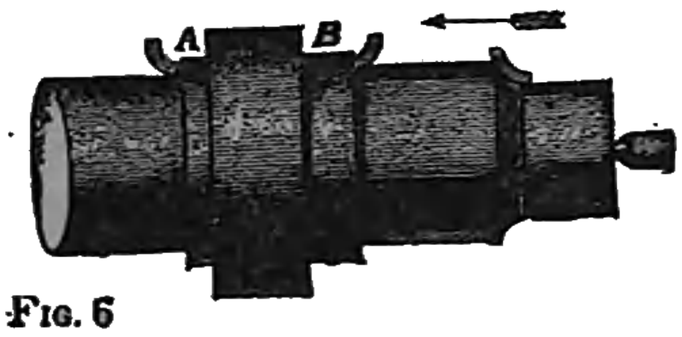
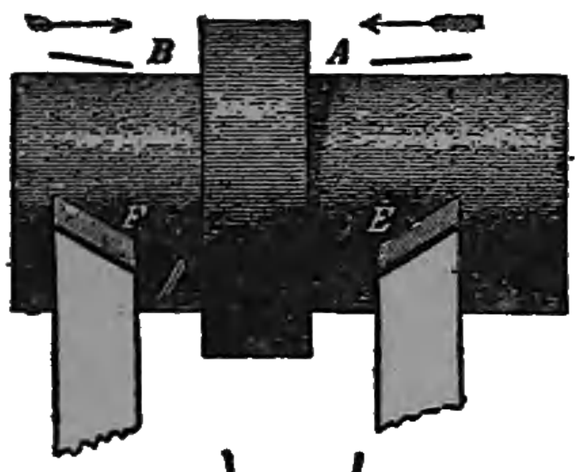


Fig. 6



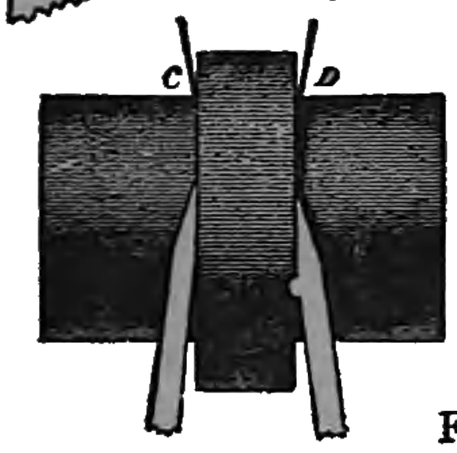


Fig. 9

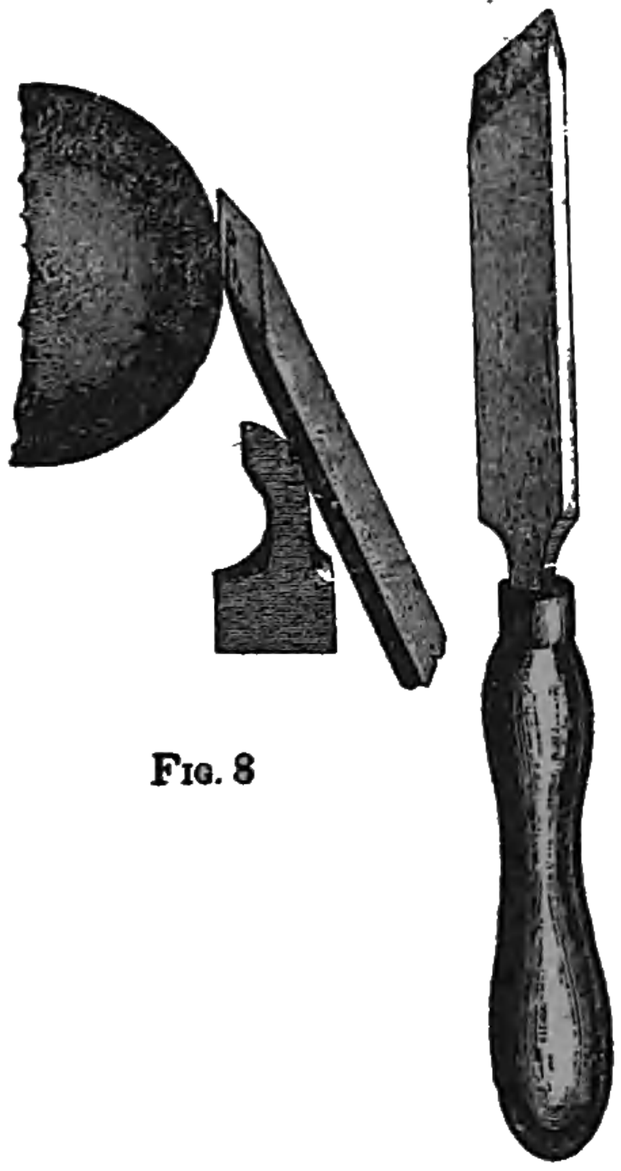


Fig. 8

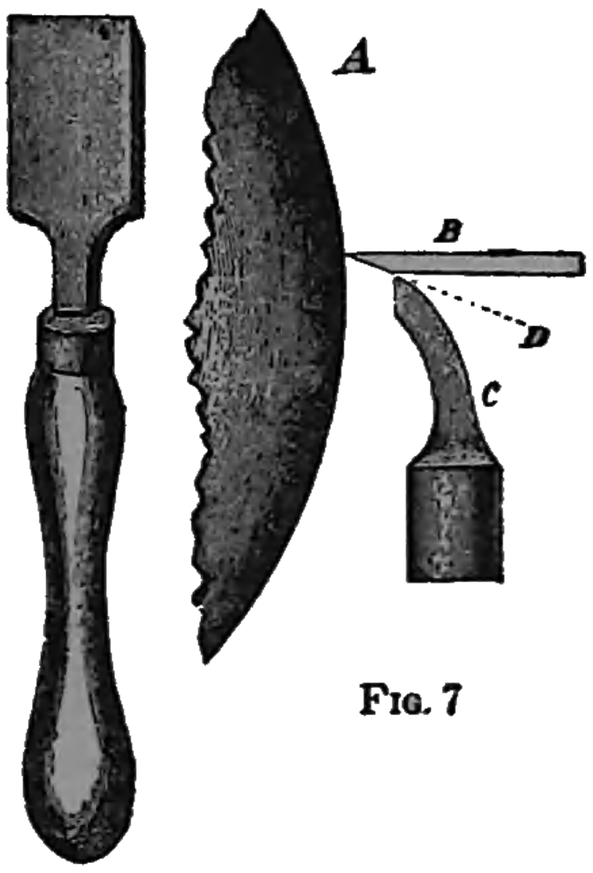


Fig. 7

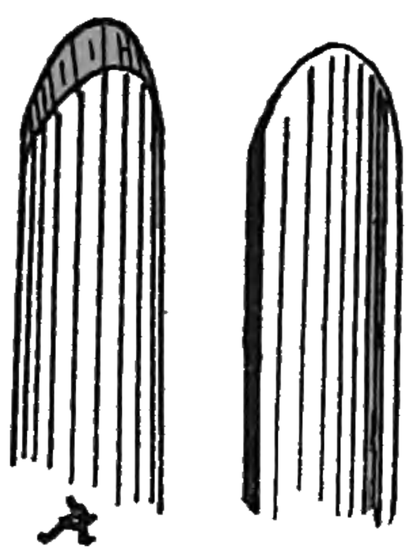


Fig. 4

view (*A*), it will be seen that the curve is well rounded or ground down on the sides in order to make the sides of the cutting edge keen and sharp.

Frequent oil-stoning of the gouge is essential, a small, round slip being used for the inside of the trough and a common flat stone for the other side.

For finishing long, even surfaces and in many other kinds of work a square-ended chisel is used. This should be stout, short and of the form shown in Fig. 7. It should be carefully ground and oil-stoned with the surfaces level with the stone. The position in which this tool should be used is shown in Fig. 7, *A* being the wood in the lathe, *B* the chisel and *C* the tool-rest. Some workmen who are expert hold this form of chisel at an angle, as indicated by the dotted line, *D*, and while this position makes the chisel cut very freely and rapidly it increases the liability to dig into the work and should not be attempted until you are quite familiar with wood-turning work.

Another tool of great importance is the skew-chisel, so called because its edge is at an angle or askew with the rest of the blade (Fig. 8). This chisel will cut very clean and smooth, leaving an almost polished surface on the work, and it has the advantage that its body may be kept out of the way of projecting flanges or radial work or by turning it on edge it may be used to finish radial surfaces with great precision. The position in which this tool should be held depends upon the character of the work. In Fig. 8 it is shown as used in turning a globe. Here it is

held so that the middle of the edge does the cutting and thus there is no tendency to dig into the work. The whole secret in using this important and valuable tool lies in giving it just the proper angle or slant in relation to the revolving wood. It is shown in Fig. 9 in the correct position for taking a cut from a flange; at *E* from right to left, and at *F* from left to right. The face of the tool lying on the work must be tilted over for *E* as shown by *A*, and for *F* as shown by *B*, the tilt being just sufficient to permit the edge to cut. If it is tilted too much it will dig into the work and if not tilted enough the edge will not meet the work and therefore cannot cut. For cutting down the ends of work or down a side face of a flange it should be tilted very little, as shown in *C*, *D*, the amount of the cant regulating the depth of the cut so that when the cutting edge has entered the wood to the desired depth the flat face of the tool will prevent the edge from going any deeper. In cutting down a radial face the acute corner of the tool leads the cut, whereas in plain cylindrical work the obtuse is the better corner to lead. For cutting down the ends, for getting into small corners and for all forms of small ornamental work this tool is far handier

than the ordinary chisel and leaves more highly finished work; but for good results it must be kept excessively sharp.

Remember to keep the tool-rest just as close to the surface of the revolving wood as possible and as you turn down the wood move the rest closer to it, for if a considerable space intervenes your tool will sway, wabble and "chatter," or may be broken, torn from your hand or may catch in the wood and throw it from the centre and out of true or may even tear it entirely from the lathe. When the piece of wood is nearing completion work very carefully; too much pressure may break some thin delicate portion and ruin the work. Keep the tools sharp; a dull, chipped, or poor tool cannot produce smooth, well-turned work. Oil the end of the wood which revolves on the centre spindle and see that the point of the centre is kept well turned up and tight in the wood. In placing the wood in the lathe first mark the approximate centres at each end. On square wood this is easily accomplished by drawing straight lines from corner to corner and the centre will be where they cross, and on round wood the approximate centre may be found either with a pair of dividers or compasses

or by measuring the diameter and marking half its distance in two or three directions on the end of the wood. This centring will save time, for while the wood may be turned true, even if placed out of centre on the lathe, a great deal of unnecessary material and considerable time will be wasted. Remember that no matter how carefully you centre the wood it will not be *absolutely* true when revolving in the lathe and a certain amount must be taken off before it becomes perfectly round and, therefore, make allowance for this and use a piece considerably larger than you wish the finished object. After the article is turned true and to the proper size and form with tools, go over it and smooth it with files while revolving it very rapidly and finish with sandpaper held against it. It may be stained, oiled or waxed in the lathe and if a shellac-moistened cloth is held against it a high polish may be imparted. Smooth pieces of hard wood, bone, ivory or other material, if held against the wood, will burnish it, and very attractive effects may be obtained by holding bits of smooth wood or other materials against the wood until it scorches or browns slightly.

A pair of calipers must be used in getting two

or more pieces turned alike, and as the piece becomes near the right size you should proceed carefully and make frequent measurements;—it's an easy matter to take off material but impossible to put it on, so be sure and do not get the piece too small before you realise it.

Band-saws and buzz-saws are useful wood-working machines, but the former has no advantage over the heavy-duty scroll-saw for ordinary work and a buzz-saw is mainly useful where a great deal of work is done. Moulding machines are very useful where cabinet or furniture work is being done or where it is difficult to purchase ready-made moulding, and some of these machines are so cheap and so handy that the boy carpenter will find them a great convenience and a source of much pleasure and recreation. Boring-machines are seldom worth while for amateurs' work, and planers have no place in the amateur's shop. Sanders are useful machines in large mills and shops, but it is seldom that the boy carpenter will find them of any great value. Mortising and matching machines, tenon-cutters and innumerable other wood-working machines are on the market and in fact nearly every sort of work may be accomplished by ma-

chinery, but the really important wood-working machines for boy carpenters' purposes are the lathe and the scroll-saw. Both of these machines may be operated satisfactorily by foot-power, but if you can arrange to have them driven by mechanical power you will find the work far easier. If you have electricity in the home you can readily drive the machines by a small electric motor, but motors—even small ones—are quite expensive. If you have a motorcycle or automobile you can easily rig the machine up to operate your wood-working machinery. By jacking up an automobile, removing a tire from one rear wheel and running a belt from the rim to your shop you will be able to operate any amount of machinery, and even a motorcycle used in the same way will drive all the wood-working machinery you require. If you have a motor-boat the motor may be taken out in winter and set up in the shop and may be used to operate your machines, or a small 1 or $1\frac{1}{2}$ H. P. motor may be purchased very cheaply and used as a stationary engine for the purpose. Every boy's carpenter shop should have a grindstone and an emery wheel, and if you have power of any sort these useful things may be operated by the same

power, but for all practical purposes the boy carpenter's own "elbow grease" or foot-power will prove amply sufficient to operate any wood-working machines that he may acquire.

Good, handy, willing carpenters are always in demand about a house, and the boy carpenter who desires to earn money with which to purchase his own tools and machines will have little difficulty in getting enough carpenter jobs around the neighbourhood to keep him busy during spare hours, afford him splendid practice and bring in enough odd dollars to keep himself well supplied with tools, materials and appliances of his trade.