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WRITE FOR PARTICULARS OF HIS WORK

VIOLIN MAKING AND REPAIRING

BY

ROBERT ALTON

With 61 *Illustrations*

CASSELL AND COMPANY, LTD

London, Toronto, Melbourne and Sydney

First published, January - - 1923
Second Impression - December, 1927

Printed in Great Britain

EDITOR'S PREFACE

A BOOK on the violin depends for its value almost entirely upon the qualifications of its author. In this case the author is a thoroughly practical fiddle-maker of lifelong experience, whose advice and instruction can be relied upon implicitly. He makes his appeal not only to people who wish to make violins, but to all who delight in using them. He describes, in great detail, the best methods of making a fiddle, and in the chapters on this subject and in those on repairing he gives the results of an unusually rich experience. A glance at the list of contents on the next page will show how fully the subject is covered.

THE EDITOR.

La Belle Sauvage,
London, E.C.4.

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VIOLIN MAKING AND REPAIRING

CHAPTER I

Suitable Woods: Making the Mould

THERE is no reason why the conscientious worker who is possessed of ordinary acquaintance with edge tools should not, with a little practice, become a skilled fiddle-maker. Provided his mould and patterns are correct, and that he is prepared to exercise due care in the working of the various parts of the instrument, the result is certain. It must be remembered, however, that from the first cut to the final polishing every precaution must be taken to execute the work as thoroughly as possible, and the principle of "that's near enough" will not do at all in violin construction.

Woods.—First of all, the question of wood must be considered. It is of vital importance that the best material possible be obtained, and the exercise of care in this respect will certainly save much disappointment at a later stage.

The violin is constructed from sycamore, maple (or sometimes pear wood) for the back, ribs, neck and head and scroll; and pine (preferably Swiss) for the top table or belly of the instrument, and also for the linings.

Sycamore is the wood generally used for the first-named portions, and although maple and bird's-eye maple, when well chosen, make handsome instruments, it will be better for the beginner to stick to sycamore. Bird's-eye maple is very tough and difficult to work, the " eyes " easily lifting out in gouging; and it is very difficult to work a plate satisfactorily when this happens.

The finer the figure of the wood, or " flame " as it is technically called, the more difficult the work, and it is as well in building a first instrument, at all events, to choose a piece of wood showing a fairly plain figure. Plain wood, generally speaking, makes the best-toned violins, and, after all, tone is the final object of the workmanship.

The material must be thoroughly dry and well seasoned, and the older it is the better. On no account must " green " wood be used, as it will twist and warp after construction, causing the workmanship, however fine, to go for nothing. Neither must wood be used which has been attacked by worms, for although it may appear on examination that the material is only slightly damaged, it is impossible to tell how far the damage extends. A crack or " shake " in a valuable piece of wood may be glued up, and the damage remedied, but worm-holes belong to a very different category.

To test wood for " faking," which is, unfortunately, occasionally used to give green wood a fictitious appearance of age, touch it with the tip of the tongue. Acid will at once make its presence known by means

of taste. Another method is to cut out a piece with a gouge, or a corner by means of a saw, when the centre of the "faked" piece will show white and green. Good, well-seasoned wood works smoothly and evenly with the tools, and the experienced woodworker will know almost instinctively by this characteristic whether or not his material is sound.

Fig. 1.—Slab-cut Log.

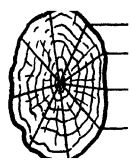


Fig. 2.—Quarter-cut Log.

Violin wood is generally sold in blocks or slabs cut to the size and thickness required, and in the case of the belly, is always cut "on the quarter." Figs. 1 and 2 illustrate the meaning of slab- and quarter-cutting, Fig. 1 representing the slab, and Fig 2 the quarter. In the case of the back, there is little difference in the resultant tone between violins built with slab-cut or quarter-cut backs. Perhaps the quarter-

cutting is preferable, and in sycamore the finest figure is obtained by the method of quarter-cutting.

Before commencing work on any piece of material it should be stored for a fortnight or so in a warm, dry, airy place, and during working kept, so far as possible, from damp or moist air. This will obviate or at least lessen variation from atmospheric changes.

In choosing wood for the plates of a violin (that is, the back and the belly), it is useful to consider the relative density of the material. For instance, a hard, close-grained back will give a sound more metallic in character when struck with the knuckles of the hand than will a soft, open-grained one. It will thus be seen that the choice of material must be guided to a large extent by the nature of the vibrations set in motion by the above means. If the back is hard and metallic in sound, it naturally follows that the belly must be chosen with a view to neutralising that metallic quality. So in the case of the belly. The fine-grained pine wedge with grain or growth lines close together will emit a sharper note than the wide-grained material, and in choosing a back to match a belly of this calibre, the worker should endeavour to obtain a tone in that back which will balance, so to speak, the hard metallic note of that particular piece. In violin building this precaution must be observed throughout the whole of the operations.

Endeavour to balance one piece against another, and so contribute to the fine, smooth tone so much in evidence in a good violin. Of course, much may be done by adjustment after the violin is built, yet

nothing, however slight it may seem, must be neglected in building a first-class instrument.

The character of the material of which the neck and scroll is to be made must also be studied with this end in view, for a heavy, clumsy, hard-grained neck and scroll placed in a light, delicately built instrument will do much to destroy tone.

Bear in mind also in this connection that hard, tough material is generally worked thinner (that is, the plates are not so thick) as in the case of softer wood, and also the thinner the plates the more thin and shrill the tone. Hence the importance of counteracting the effect of a hard back (worked thin in order to obtain freedom of vibration) by a soft, open-grained belly worked moderately thick, and vice-versa.

If possible, avoid extremes in choosing wood. Hard close-grained sycamore often gives the finest figure; but this very quality of hardness does not always produce the best tone, especially if allied to a hard close-grained belly. Too much importance cannot be attached to the choice of the wood for the plates, especially the belly, for they are the chief vibratory plates or surfaces of the instrument.

Moulds.—Violins are built on (or in) moulds, which are really supports round or into which the ribs and blocks are built. They vary with the pattern of the instrument. Most modern violin-makers follow one of the three Italian masters, Amati, Stradivarius, or Guarnerius; and drawings of outlines and archings for these various types may be obtained for a small sum from any of the chief violin warehouses in London.

Stradivarius is, of course, the master generally followed, as his pattern, if carefully constructed, cannot be excelled for gracefulness of line and beauty of arching or modelling. The Guarnerius violin is perhaps easier to copy than the Stradivarius, although in each case every care must be taken in the workmanship. An outline for a Stradivarius model is shown by Fig. 3.

A general view of an outside mould for a Stradivarius violin is shown by Fig. 4, and is constructed as follows : Obtain a sound well-seasoned block of pine or beech, thoroughly dry and free from knots, " shakes " or cracks. It will be found in practice that pine moulds are less liable to " start " or alter their shape than almost any other material (so far as wood is concerned), and the only disadvantage to their use is that, owing to the softness of the material, they are easily damaged. Beech, if well seasoned, also makes good moulds. Whichever wood is used, be sure that it is dry and thoroughly seasoned.

The size of the mould is as follows : Length 18 in., width 12 in., and thickness $1\frac{1}{2}$ in. Plane this piece perfectly true, and square it all round. Then place it in a moderately heated oven for an hour or so every day for a week. This will ensure thorough shrinkage and dryness. Then square it to the following dimensions : Length $17\frac{1}{2}$ in., width $11\frac{3}{4}$ in., and thickness $1\frac{1}{4}$ in. Now mark one end top and one side face, from which face all subsequent squaring must be executed.

The block must now be tapered from the bottom edge to the top (for all properly built violins are wider at the bottom edge than they are at the top), which is

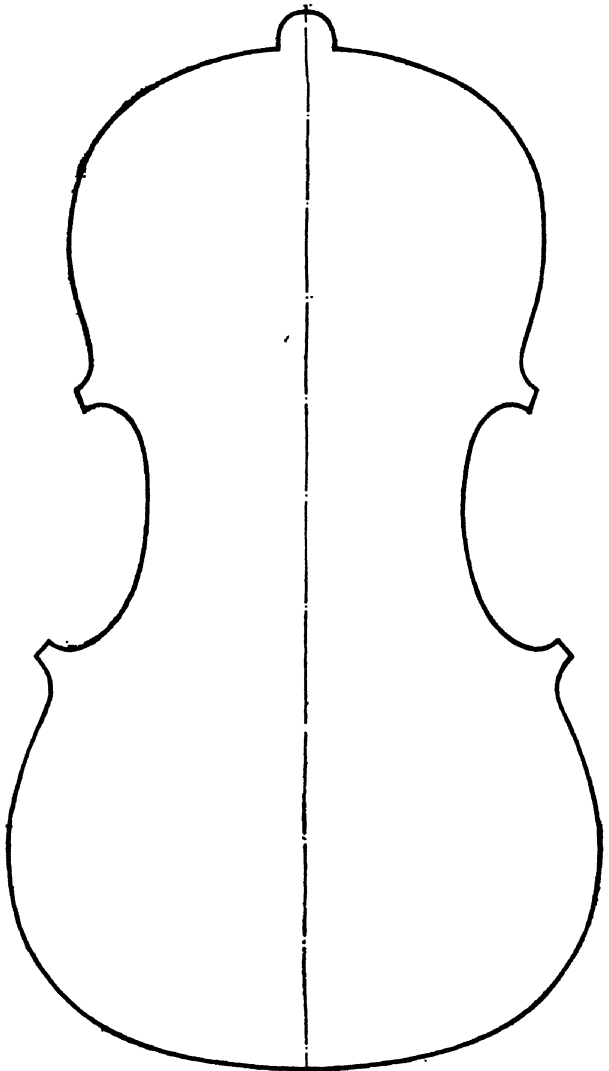


Fig. 3.—Outline of Stradivarius Violin.

marked out as follows: At the top end of the block measure down each corner from the face $1\frac{3}{16}$ in., and connect these two points with the bottom corners (back) along each side of the block, and also with each other along the top edge by means of a pencil mark (*see* Fig. 5). Then proceed to thickness the block from the

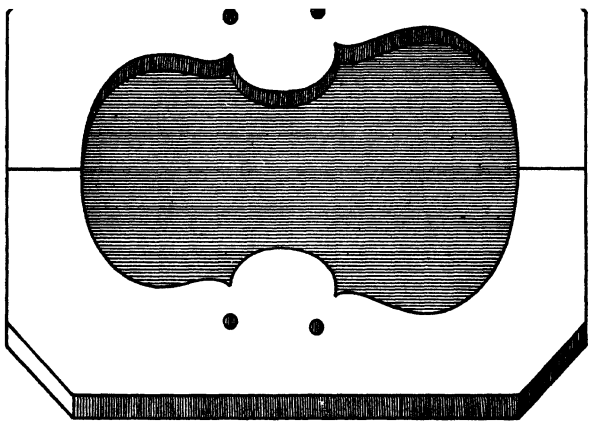


Fig. 4.—Outside Mould with Cut-out part shown Shaded.

back face exactly to these lines by means of the trying plane, finishing with smoothing plane, and finally glass-paper, exactly on the lines. Now rule a pencil line A A (Fig. 5) completely round the block from top to bottom in the exact centre of the material, and deepen this line by means of a steel marking-point. Use the square on the ends of the block to rule the lines from *the front to the back of the mould.*

Now take the paper half-outline of the violin back obtained from the dealer, and cut it out very carefully exact to the lines. Lay this down on a sheet of thin zinc plate (or three-ply wood), and mark the outline

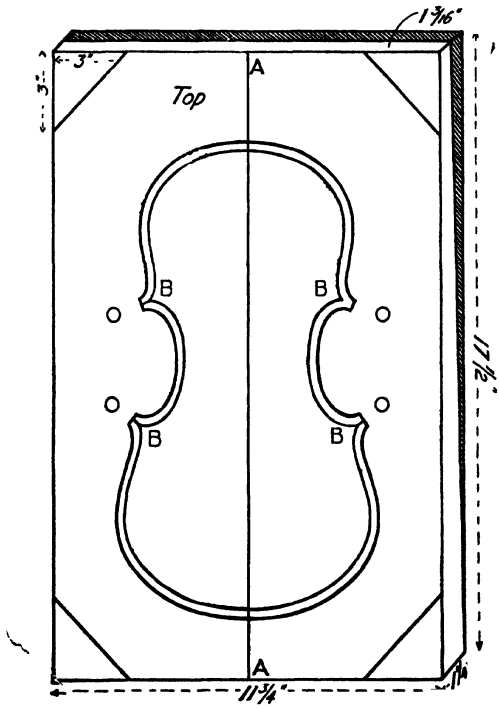


Fig. 5.—Mould Marked Out for Cutting.

exactly on the material (zinc is preferable to wood for all templates). Cut out this half-outline with a fretsaw exactly to the lines, filing up after cutting until a faultless outline is obtained. (Do not paste the paper outline down to the template; damp will stretch the

paper, and throw the outline out of truth.) This is the pattern for the outline of the violin plates, and no pains must be spared to render it as perfect as possible.

Now place the straight edge of this outline A A (Fig. 6) exactly along the centre line of the mould on the face side, allowing equal space to the edges, top and bottom, and go round the edge of the outline with a fine-pointed pencil and steel marking-point, leaving out the button B (Fig. 6). When complete, turn the half-outline over and exactly opposite the first half draw the other half, thus obtaining a facsimile of the complete outline of the violin on the face of the mould. Follow the sweep of the outline across the top instead of drawing in the button, which is not required in the mould.

Now, as the ribs of the violin fit against the plates inside the edges, a second outline must be drawn inside the first to obtain the correct line to which the mould is cut out. With a pair of compasses draw the second outline $\frac{5}{32}$ in. inside the first, jointing the lines in a point at the four corners B, as shown in the diagram (Fig. 5). The points should finish just at the edges of the corners and in the exact centre of each.

The mould must now be cut out to this inner line, and the edge squared exactly all round from the face side of the block. A band-saw or fretsaw can be used for taking out the inside piece, leaving sufficient room for squaring to the line, which must be executed as carefully as possible. Remember that the violin is built in this mould, and that any defect in the mould will infallibly be reproduced in the instrument.

When the mould is squared all round it must be shaped as in Fig. 5 for the convenience of applying cramps in building the ribs and blocks into it. From each corner measure off 3 in. along the edges, and connect the points with pencil lines, finally sawing the corners away. The circular holes opposite each corner must also be drilled with a brace and bit. The measurements are given in Fig. 5. Square all edges when finishing from the face side.

The mould is now complete, and every care must be taken of it. Keep it in a dry place and protect it from injury, for it is one of the most important appliances in the fiddle-maker's kit. Test it from time to time to see that it is true all over. As the violin-maker extends his experience, he will probably make several of these moulds, and can thus build several violins at

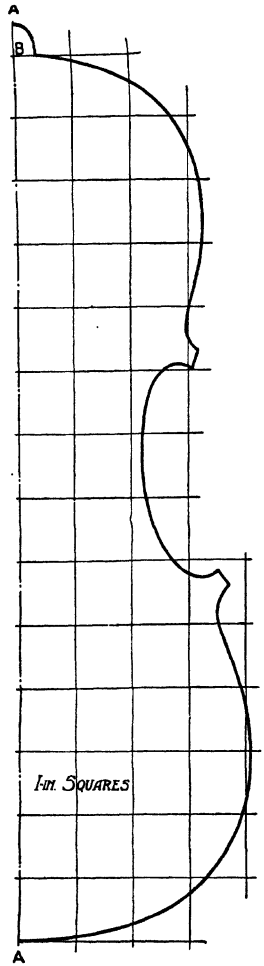


Fig. 6.—Half Outline of Violin Back.

the one time, in addition to varying his models. It is important that reliable outlines and archings be obtained, and the beginner cannot do better than study the various outlines and archings in any fine instruments he can obtain sight of, in order that he may train his eye to appreciate the subtle play and sweep of outline and arching in good fiddles, for there is a great difference in models, and the best pattern must always be striven after. Perfection of judgment is only to be expected by constant practice and observation, a good deal of which, however, will in many cases come naturally by working at the building of the instrument.

CHAPTER II

Making and Fitting the Ribs and Corner Blocks

THE materials now required will be a set of ribs, a back and belly, and a block for the scroll.

Endeavour, in choosing the various pieces, to balance one piece against another, in order to secure, as far as possible, a balance of parts. Choose the belly first, as it is the most important piece in the instrument. A medium-grained piece, not too hard, and with as much vibrating quality as possible, should be chosen. By driving in the thumb-nail between the growth lines, the strength and quality of the material may be judged. Good wood is firm and strong; poor quality material offers no resistance to the pressure of the nail. The figure of the ribs should match, so far as possible, the figure of the back, in order to produce in the finished instrument an even, homogeneous appearance.

The ribs of the violin are six in number, two for the top sweeps or "bouts," two for the middle bouts, and two for the lower bouts. In buying these, however, it will be found that three pieces go to the set, and the two pieces for the inner or central bouts are cut from the ends of two of these strips. They must be first of all planed smooth on each side. A small flat Stanley plane with a toothed iron is the best for the purpose.

The object is to remove the roughness of the surface, and the finishing is executed by means of steel scraper and glasspaper. The final thickness should be $\frac{1}{16}$ in. As sycamore is a very brittle material, every care must be taken to avoid breaking the strips during working.

When the three strips are ready they must be cut as follows: Cut from the ends of two of them pieces $5\frac{1}{2}$ in. long. The third piece must be cut into two at a distance of $7\frac{1}{2}$ in. from one end. The result will be a set of ribs of the following measurements: Two pieces $9\frac{1}{2}$ in. long (bottom bouts), two pieces $5\frac{1}{2}$ in. long (middle bouts), and two pieces $7\frac{1}{2}$ in. long (top bouts). The ends of all of these pieces must be squared from one edge of each, which edge must first of all be glass-papered perfectly straight and plane. Mark these plane edges, and work from them in all subsequent operations, in conjunction with the face side of the mould. That is, in inserting the ribs after bending, place these plane edges facing the face side of the mould.

Bending Iron.—A bending iron will now be required in order to bend the ribs, so that they will fit against the inside of the mould in their respective positions. The bending iron may be purchased, or if desired made as follows: Obtain a copper cylinder c 8 in. long by $1\frac{1}{2}$ in. in diameter (*see* Fig. 7). This must be mounted by the centre on an iron upright, which is secured at its lower end into a stand. Each end of the copper cylinder is split on its lower portion for a distance of 3 in. from each end, and narrow pieces cut away in order to take a couple of gas-jets on each

side. The copper cylinder is heated by this means. In the illustration A is the metal base, B the upright iron tube carrying the copper cylinder screwed into the cylinder and the base, C the bending iron, made from split copper cylinder as shown, D the iron pipe carrying gas-jets, F an ordinary incandescent turncock, and G a rubber tube carrying gas from stove or pipe.

It may be stated that the iron is much cheaper made in this form than one bought ready constructed

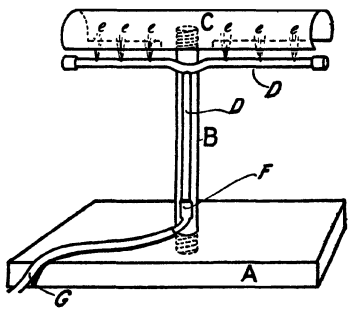


Fig. 7.—Improved Form of Bending Iron.

in the ordinary business way. The heat may be regulated by raising or lowering the flame *e*. The correct heat is such that a drop of water placed on the heated cylinder will " sizzle."

Bending.—In commencing this portion of the work of violin building, it must constantly be borne in mind that the thin sycamore or maple strip is extremely brittle, and will " fly " immediately any undue force is used. It is also necessary to note that too much heat in the bending iron is as bad as too little.

First of all fit the inner bouts. From each end of

the strip of sycamore a series of parallel lines about ¼ in. apart must be drawn, with square and pencil, across the inner surface, working from the plane edge of the strip. The outer surface (the side which fits against the mould) should show the finer figure, as sometimes one side of the strip shows a finer figure than the other. The squared lines are drawn across the ends to assist in fitting the blocks correctly into their position when that portion of the work is under construction.

Several text-books state that the wood should be bent with dry heat. A better plan, and one which will save endless trouble and breakage, is to dip the end of the strip into water before applying it to the heated iron. The moisture prevents burning of the strip, and also assists the bending.

Place the end of the strip on the heated iron, holding it in one hand by the other end. With the other hand place a small block of wood on the end of the strip, by this means holding it down on the hot iron. Apply gentle pressure on the free end of the strip, and gradually bend the material until a curve is produced, fitting closely into the corner of the mould at the top of the inner bout. When the fitment at the top is correct, take hold of each end of the strip and bend it in the centre slowly until a curve is produced in the rib, fitting the sweep of the mould at the inner bout. Heavy or sudden pressure must on no account be used. It is really a question of feeling the way round the iron in operations connected with the bending of the ribs, and if the above instructions are carefully

carried out there should be no question of breakage, no matter how brittle or pronounced in figure the wood may be.

Note the following points, which are very important. The ribs must not be too thick or clumsy. The iron must not be too hot. There must be no sudden or violent force used. The ribs must not be allowed to scorch or burn, and should remain damp until they are in position in the mould.

Now cut off the superfluous wood at the other end of the strip, using the pencil lines as a guide to keep the cut square with the edge. Then bend, and fit this end to the other corner of the inner bout. The ends must go right into the corners, and the rib must fit closely against the mould all over. Next with a file bevel each end of the strip on the inner side to an angle of 45°, in order that the top and bottom strip when bevelled likewise will make a close-mitred joint in each corner of the inner bouts.

Prop the rib just finished in position with a strip of wood placed across the mould inside, and proceed to bend the opposite inner bout in the same manner as the first. When complete prop that in position also. Then bend and fit the top and bottom bouts in the same way, squaring lines across each end as before. Each of the bottom and top bouts must be fitted so that their ends shall finish exactly on the centre line showing on the face of the mould, top and bottom. If one side of the violin is fitted first, the other side (so far as top and bottom bouts are concerned) may be sprung into position in the mould, cutting them of such a

length that the top and bottom end of the bouts fitted will, when pressed close against the mould, butt up against the ends of the ribs already in the mould, and so make a close joint.

In the case of the top bouts a close fit is not imperative, however, as the neck is fitted through the ribs at this point; but a close fit is necessary at the junction of the lower ribs, and by carefully measuring after bending and springing in the ribs, much trouble will be saved at this somewhat awkward part of the work.

In bending the top and bottom bouts a fine regular sweep may be given to the ribs by damping, and then bending round a tin vessel filled with boiling water. It is much more simple to obtain the sweep by this means than by using the bending iron. Of course, the corners at the junction with the inner bouts must be fitted with the aid of the bending iron.

Fitting Ribs and Blocks.—The ribs are now in their place in the mould, with their plane edges all facing and level with the face of the mould, the superfluous width of the ribs overlapping the back edge of the mould.

The corner blocks and top and bottom blocks now require fitting. These are of pine, chosen for fineness of grain, and free from knots or cracks. The grain should run from the belly to the back of the violin when the blocks are in position. Six blocks will be required, four for the corners and one each for the top and the bottom of the instrument. The rough measurements are: Four blocks $1\frac{1}{2}$ in. wide, 1 in. deep and $1\frac{3}{8}$ in. high, and two blocks 2 in. wide, 1 in. deep

and $1\frac{3}{8}$ in. high. The four corner blocks must be cut with gouges to fit the four inner-bout corners, using files and glasspaper to obtain a perfect fit. Figs. 8 and 9 show their shape before and after cutting. Fig. 8 shows a corner block before cutting, *a* representing the cutting lines. Fig. 9 shows a head and tail block, *a* representing the cutting lines and *b* the centre line. The parallel lines show the direction of the grain.

The lines drawn across the ribs will now be useful,

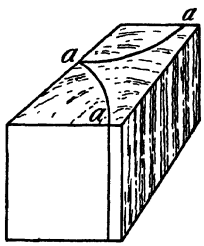


Fig. 8.—Corner Block previous to Cutting.

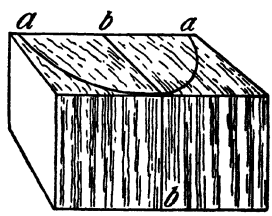


Fig. 9.—Head and Tail Blocks previous to Cutting.

inasmuch as they will enable the builder to fit the blocks perfectly upright in position. Top and bottom blocks must be fitted as follows: After squaring all over, lines must be drawn with square and pencil all round each block in the centre, that is, 1 in. from each end (*see* Fig. 9). This line is fitted exactly opposite the joint and the centre line of the mould, top and bottom, and so ensures the blocks being placed in the centre of the fiddle, a very important matter.

The sides of the blocks which fit against the ribs top and bottom must be shaped with chisels and files

until they fit exactly all over their surfaces, and no pains must be spared to fit both end and corner blocks exactly to the ribs. When they are thoroughly fitted glue them into position with violin glue, and cramp them against the ribs with steel cramps (Fig. 10).

In fitting corner blocks it will be seen how important it is to obtain correct fitting of the ribs first of all, as otherwise the pressure obtained by cramping the corner blocks into position will force the edges of the ribs where they are mitred apart, and so destroy the joint. Fig. 11 shows the ribs *e* in the mould *d*, with corner blocks *a* and head and tail blocks *b* cramped home. *c* is the centre line which runs round the mould and head and tail blocks. In every case wash away all superfluous glue with a brush dipped in hot water. When dry pare away the corner of the top and bottom blocks with a paring chisel, until the outside edges of the blocks show a nicely rounded sweep.

The corner blocks *a* require shaping to the sweep of the ribs, but first of all the linings should be fitted. To do this it will be necessary to pare the ribs and blocks down to the exact thickness of the mould, working from the back face only to carry this into effect. The face side, if the work has been properly done, will be practically level, and flush with the surface of the mould, and will only require glasspapering smooth, with a piece of glasspaper glued to a flat block. Prop the ribs firmly against the sides of the mould, by means of short lengths of wood, before commencing to plane them down to the correct depth, and in finishing endeavour to make them exactly the same depth as the

mould all round, and as flat as possible. Good work here is important, and will avoid trouble when fitting the plates, back and belly, to the ribs.

The linings are narrow strips of pine, which are bent and fitted to the edges of the ribs, back and front, all round the body of the instrument inside. They are intended to provide greater

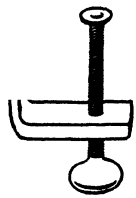


Fig. 10.—Steel Cramp.

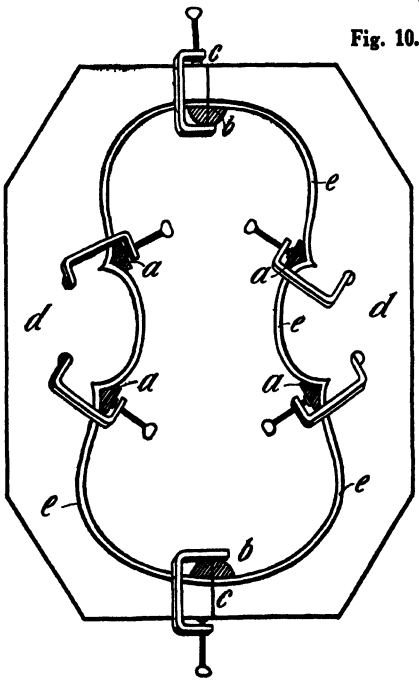


Fig. 11.—Mould with Blocks and Ribs Fitted.

gluing surface for the purpose of attaching belly and back than is afforded by the narrow edges of the ribs. They are bent on the bending iron and the heated kettle, and at each end are fitted into slots cut into the blocks.

First of all cut them to the correct lengths, approximately as follows: Four pieces $9\frac{1}{2}$ in. long, $\frac{5}{16}$ in. deep. and $\frac{3}{16}$ in. thick for the bottom bouts; four pieces $5\frac{1}{2}$ in. long, $\frac{5}{16}$ in. deep, and $\frac{3}{16}$ in. thick for the middle bouts; and four pieces $7\frac{1}{2}$ in. long, $\frac{5}{16}$ in. deep, and $\frac{3}{16}$ in. thick for the top bouts. With a $\frac{1}{16}$-in. chisel cut slots in the blocks at each side, top and bottom, all round, making them $\frac{5}{16}$ in. deep and about $\frac{1}{4}$ in. long (*see* Fig. 12).

In Fig. 12, which shows the slots cut in the block of the linings, *a* represents the ribs, *b* the block glued in position in the corner, and *c* the slots cut in the block for the reception of the linings. Now commence at one side of the ribs, pushing them slightly up out of the mould, in order to allow cramps to be placed on the edge after the linings are fitted. Clean up the linings all over with glasspaper and bend them, fitting each end well home in the slot cut to receive it.

Finally glue each lining into position, and apply spring clothes-pegs, which act as cramps, along the whole length of the rib and lining, clamping the lining close against the inside of the rib in each case. Fig. 13 shows one set of linings in position. These linings must be thoroughly fitted on both sides all round, allowing one side to dry, then pushing the ribs through the mould until the other side is out sufficiently far to

apply cramps in fitting the second set of linings. There should be no portion of lining sprung away from the ribs at any part of their surface, or trouble may come later in connection with the tone of the instrument. In Fig. 13 the shaded portion in the centre is, of course, hollow.

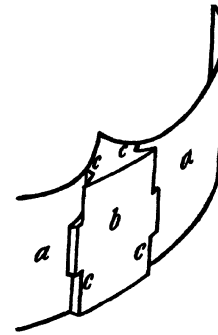


Fig. 12.—Slots Cut in Blocks for Linings.

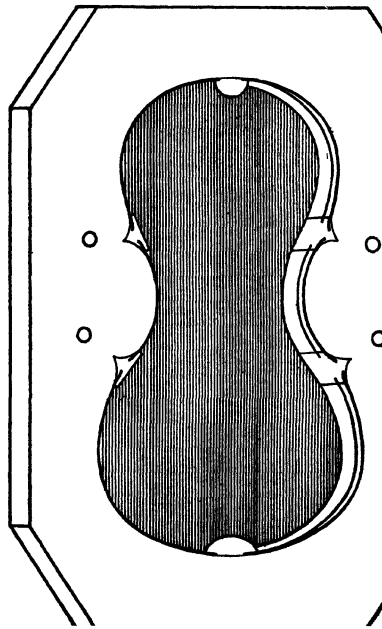


Fig. 13.—Fiddle Body with One Set of Linings Fitted.

When all is dry and firm, pare the lower edges of the linings all round to their junction with the ribs, making by this means the final shape of the linings as in Fig. 14, the broad edges level with the rib edges, and the feather edges opposite each other on the inside of

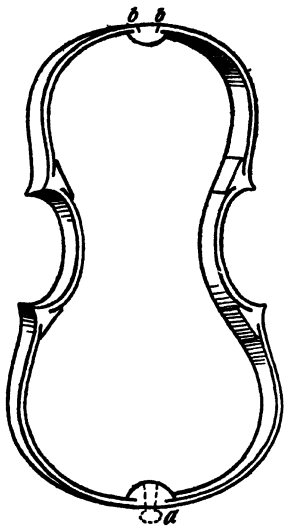


Fig. 14.—Plan of Shape of Linings.

Fig. 15.—Rib Linings and Blocks.

the fiddle body. Now with a flat gouge trim down the insides of the corner blocks until they form part of a guitar-shaped outline with the inside sweep of the fiddle (*see* Fig. 15, which shows the inside finally fitted); *a* shows the position of the tail pin in the bottom block, and *b* the saw-cuts in the top block for the insertion of the head and neck.

Before fitting the back and the belly it is as well to

make the two saw-cuts in the top block, and the hole for the tail pin in the bottom block. It is easier to do this now than after the body is together. At the junction of the lower ribs at the bottom of the fiddle body (which must now be removed from the mould), and half-way between the face and the back, a small hole must be carefully drilled through the block from the outside of the ribs. A woodworker's reamer must now be inserted and the hole cleaned out ready for the tail pin. If this fitment be obtained at this stage, the hole may be made the correct size and the tail pin fitted. When the fitting is complete, the pin may be put to one side until the violin is ready for stringing.

The two saw-cuts for the shoulder are made as follows: On the face side of the violin body, at the junction of the top ribs, measure off on each side of the joint $\frac{9}{16}$ in., and from the back edge at the central joint measure off on each side $\frac{5}{16}$ in. Join these points with pencil lines, and carefully saw down into the top block $\frac{1}{4}$ in. with a fine tenon saw. These are not the final measurements for the shoulder of the neck, but they serve to give an opening for the chisel when fitting the shoulder after the body is together, making the work much easier.

Now put the body of the fiddle back into the mould, prop it close against the inside with strips of wood, both longitudinally and transversely, and put it to one side in a dry place until the back and the belly are ready to be fixed to it.

CHAPTER III

The Back

VIOLIN backs and bellies are sold in blocks cut to the correct sizes, and sawn down the middle ready for splitting and jointing (*see* Fig. 16, the centre line on the edges showing the saw-cut ready for splitting). First of all the two halves must be separated (by driving in a wedge at the top of the saw-cut), and then the two halves must be jointed at their thick edges by means of a "rubbed joint." This joint must be as perfect as possible. Place one half of the back in the bench vice, and shoot the edge with a finely adjusted trying plane. Now shoot the edge of the second half in the same manner. The plane-iron must be ground perfectly flat to do the work properly, and the face of the plane must be perfectly true and straight. The condition of the trying plane will decide the character of the job.

By placing one edge on the other after shooting, and holding both to the light, any defect in the work will show by the light shining through the joint. There must be nothing of this kind in a jointed back if the work is to be considered satisfactory, and the process is not quite so easy as it seems. If, however, the plane is in good condition, and the wood is sound and dry, the job should be accomplished without serious

trouble. Glue both edges with thin hot violin glue, and rub the top half on the bottom, which is, of course, clamped in the bench vice. Leave the complete back in the vice until dry. The two inner sides of the block must form a flat plane, the two outer edges forming

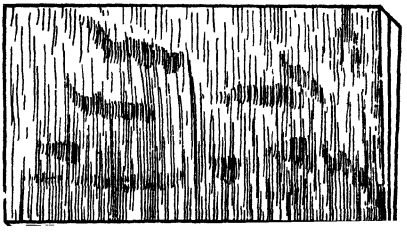
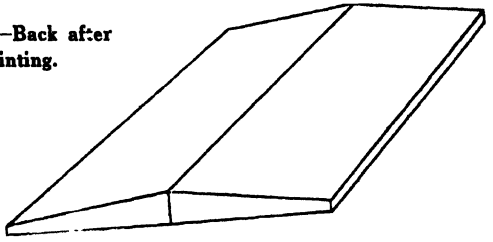


Fig. 16.—Belly or Back in the Rough.

Fig. 17.—Back after Jointing.



inclined planes from the centre joint similar to the roof of a house (*see* Fig. 17).

When dry the plane side must be planed flat all over and glasspapered. As the other side of the back is not a flat surface, some difficulty will be experienced in using the plane; but by gluing small strips of wood on the bevelled sides, steadiness may be obtained during the process of planing the flat side. These pieces may afterwards be cut away.

Marking-out.—The half-outline in zinc or three-ply wood must now be placed with its straight edge exactly along the centre joint of the back, and the half-outline of the violin drawn on the flat surface of the back with a steel point, exactly in the same way by which the mould was made ; but in this case the button is also drawn in. Turn the half-outline over, and draw the other half of the back exactly opposite the first. By this means a complete outline of the violin back will be transferred to the wood.

If the back is a slab back, a centre line will have to be drawn round it exactly as in the case of the mould, and the outline struck from this line. Be careful that the steel point does not deviate in any degree from the exact outline of the template. Nothing looks worse than an ill-balanced outline. For this reason it is perhaps preferable in all violin templates to use zinc rather than wood, because there is less risk of variation from the actual outline when using the pencil or steel point. Zinc templates are more troublesome to make, but they are worth the extra labour involved in their construction.

Cutting the Outline.—The back must now be cut out with a bow-saw or fret-saw. If the worker is doubtful of his ability to follow the line exactly, it will be better to cut a little outside of it, and finish up with fine files and glasspaper. In each case the line must be exactly on the finished edge, and any lumps or hollows will spoil the sweep of the curves.

Modelling.—The modelling must now be taken in hand. Perhaps as sure a method as any other in this

exacting work is as follows: Obtain a sheet of hand-made drawing-paper. Place the back on this, and draw a full-size outline with the pencil. Now mark both sides of the outline, as in Fig. 18, numbering the

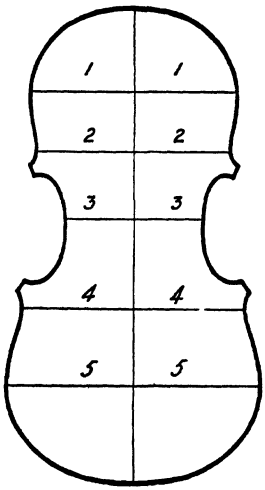


Fig. 18.—Working Outline Marked in to Show positions for placing Templates of Archings.

Fig. 19.—Rough Archings for Belly.

respective positions 1, 2, 3, 4 and 5. The various archings should be supplied on the sheet of archings and outline purchased from the fiddle dealer, but reduced archings in the rough are given in Fig. 19. They should be carefully cut out in zinc or thin sheet copper, and carefully kept in a case to protect them

from injury. If they can be stamped with steel number punches, it will facilitate the work of modelling.

Now, using inside-ground gouges, proceed to roughly model the outside of the back as follows: The correct thickness of the violin back must be gauged round the edge of the back from the flat side, using a carpenter's gauge, or one made as in Fig. 20, which shows one designed by the writer and found to be a very useful tool. The illustration is self-explanatory. This tool will be found extremely useful in purfling the violin, and its use for that purpose will be described in its proper place. The knife must be set to mark a line $\frac{3}{16}$ in. from the flat side of the back all round. Now place the back on the diagram marked on the drawing-paper, and mark the points on each side where the various archings fall. This gives the points to which the archings must be fitted in gouging down the back.

In conjunction with these cross archings, the violin must be modelled lengthwise by means of the long arching (Fig. 21). One end of this long arching must be marked (either top or bottom), and that end must be used at its proper end of the violin back, and not changed about from one end of the back to the other during gouging.

A long strip of wood should be screwed to the bench, against which the back is placed flat side down to serve as a stop, against which the gouging is executed.

Now proceed to fit long and cross archings exactly in their proper places, until a rough modelling of the back is worked out. When this part of the work is

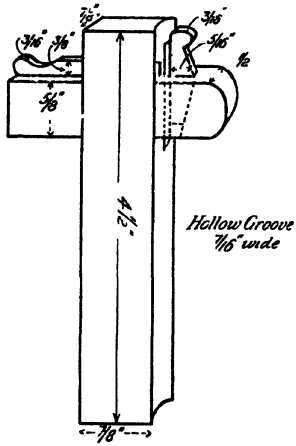


Fig. 20.—Purfling Tool and Gauge.

executed, violin planes will be required to finish the modelling.

These planes are extremely useful, and a set of them may be made as follows: Construct wooden patterns for the body of each plane, and the levers for same, as in Fig. 22. For these a square block of wood must be obtained, sound and free from knots, shakes, or other defects. If not truly square all over, it must be made so with plane, chisel and square, in the usual

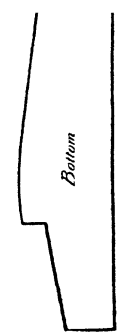


Fig. 21.—Long Arching for Back.

way. Now mark out on the top face to the size of the plane required. If an oval plane is required, of course the block will have to be cut to shape with chisel; if a square or oblong plane, the block itself will be dimensioned to the size required. This block must now be hollowed in order to take the iron, and the pattern given in Fig. 22 shows exactly the outside appearance of the template for a round plane when finally shaped.

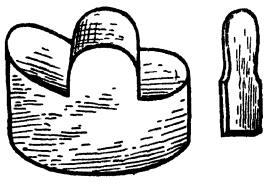


Fig. 22.—Pattern for Plane Body and Plane Iron.

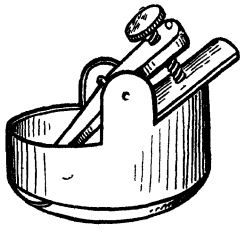


Fig. 23.—Plane Assembled.

The sides of the plane need not be more than ½ in. thick for small thumb-planes as used in fiddle-making. The back of the plane inside, behind the iron, is solid, and forms a support against which the blade is pressed by the action of the screw through the top of the lever (*see* Fig. 23). It is only the inside portion of the plane in front of the lever which is hollowed out. The bottom of the plane is rounded both sidewise and from back to front. The inside of the plane is hollow from the angle at which the iron will lie when the plane is finished, and this angle leads down inside the plane to

the mouth, which must be carefully cut through with a fine-bladed penknife, and made perfectly straight and square across the bottom and of the same width throughout. This width will, to some extent, be governed by the thickness of the iron and the position and working action of the lever, but in any case the mouth should not be too wide, otherwise the plane-iron will not act satisfactorily. It is best only to make a narrow slit in the template sufficient to be able to get a small file through the casting.

When the casting is obtained, the lever and iron may be fitted before the mouth is filed out to its final shape. This will enable the operator to make an exact fit of the plane-iron to the width of the mouth. There should just be clearance for the shaving in front of the cutting edge of the iron, and little or no more. The front of the plane inside must be smoothly cleaned out, and there must be plenty of room for the shavings to clear themselves from the mouth as they come through off the iron. Also the front of the plane must not be too deep; $\frac{1}{4}$ in. is sufficient for small planes. If this is not attended to, the plane may choke up with shavings and fail to act.

The lever is cast from a separate pattern, and must fit between the sides of the plane as shown in Fig. 23. It is swung on an axle, a thin steel rod, which is fitted through holes drilled through the lever and the sides of the plane body on each side, and is kept in position by riveting each end with a small hammer. The lever, of course, must work loosely on the axle. The top of the lever, as shown in Fig. 23, is drilled, tapped and

fitted with a thumb-screw, which screws down on to the iron and thus brings pressure to bear on the lower end of the iron by means of the front or bottom end of the lever, by this means binding the iron tightly into its place.

It must be noted, in cutting any patterns for brass casting, that no part of the inside must be "undercut," that is, the sides must be cut square down, and there must be no tendency to thin the sides by bearing in with the chisel when nearing the bottom of the inside. It is impossible for a moulder to work satisfactorily with an undercut pattern. There is no "slot" in a violin plane. The iron is kept in position by the pressure of the screw at one end of the lever acting on the axle as a fulcrum, and thus causing the other end of the lever to bite on the lower end of the iron inside the plate. Several of these planes may be made, with oval and flat bottoms. File up the castings before assembling, and polish with emery powder. The blades may be made from strip steel. If the worker desires he may purchase these planes ready-made; but they are somewhat expensive. Toothed irons for very tender or cross-grained material may be purchased to fit the planes, as the making of a toothed iron is beyond the average woodworker, and in any case is not worth the time involved.

When the back has been roughly modelled with the aid of the archings and gouges, the maker may proceed to finally model the back. Here it will be necessary to use the eye, and it is one of those points in violin construction which cannot be imparted by writing.

Get the shape of the model firmly fixed in the mind, and, cautiously using the planes, endeavour to make the back as graceful and well balanced as possible. Do not touch the edges in any circumstances, and leave the four corners thick.

When this process is satisfactorily accomplished a hollow groove must be carefully gouged round the violin about $\frac{1}{4}$ in. from the edge. First run a pencil line round, leaving the corners untouched. Go round the violin with a flat $\frac{1}{2}$-in. gouge, making the cut about $\frac{1}{8}$ in. deep. Then gradually soften away the edges of this cut, until a graceful sweep is formed $\frac{1}{8}$ in. from the edge to the highest part of the back. The object is to leave the edge of the violin raised up all round, and it is a most severe test of the fiddle-maker's capacity to do this properly. Wherever possible examine good violins carefully, and particularly note this part of the work. It is often a revelation in subtle flow of line.

The corners must be worked out all round with gouges, planes and glasspaper, until the hollow is carried out all round, and the edges of the corners gracefully raised to the same height as the rest of the edge of the fiddle. Do not make the rise sudden, especially at these four corners. The effect striven for should be an easy, graceful flow of line all over the fiddle back, without any lumps, hollows or interruption.

With coarse glasspaper rub all over, keeping a close watch to see that no part of that edge (which has been so difficult to obtain) is rubbed down. Damp the back all over, and go over it again when dry with finer-

grade glasspaper. Continue to damp and glasspaper, using finer grades of paper each time, until the back is as smooth as a piece of satin, without a single break or hollow to destroy the flowing curves. This will not be easy, but it must be done thoroughly if the violin is to look well and play well. The golden rule in fiddle-making is patience, and it will be well rewarded. Without it one may scarcely hope to become a fiddle-maker.

Hollowing-out.—The outside of the back is now modelled, and care must be taken during subsequent operations that the fine surface is not scratched or dented in any way. The hollowing out of this plate is now to be taken in hand. First of all it must be marked out. A pencil line is first of all drawn on the flat side of the back, $\frac{1}{4}$ in. from the edge of the back all round. At the top and bottom of the fiddle and at the four corners the blocks fit, and spaces must be left on the flat surface for these blocks, corresponding in superficial area to the actual blocks which are built into the mould. Perhaps the best way is to take out the ribs and place them in position on the back, marking the inside position with a pencil and keeping the margin even on the outside of the ribs all round the back.

When the outline of the ribs and blocks is in position on the flat side of the violin back, the hollowing out or thicknessing must be commenced. To do this satisfactorily, three guide lines should be marked with the pencil across the back, one at the widest part of the upper bouts, one at the narrowest part of the centre

bouts, and one at the widest part of the bottom bouts. Gouge out the wood at these points or along these lines until the thicknesses are $\frac{3}{16}$ in. A pair of double callipers will be required in order to arrive at these thicknesses. These callipers will register the thicknesses at one end as they mark at the other on the wood itself. There is a contrivance marketed which may be fixed to one leg of an ordinary pair of en-

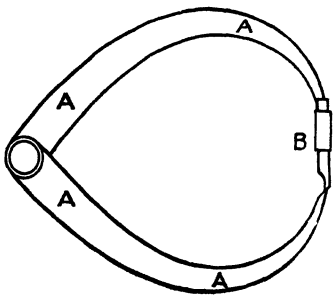


Fig. 24.—Thicknessing Callipers.

Fig. 25.—Measuring Device for Callipers.

gineer's callipers, and will register thicknesses on a dial plate up to $\frac{1}{1000}$ in., but it is somewhat expensive.

An alternative pattern is shown by Fig. 24, in which A represents the callipers (steel) and B the measuring fitment. An enlarged view of the measuring fitment is shown by Fig. 25, in which *a* is a metal box riveted to the end of the callipers, and *b* the measuring rod fitting closely inside *a* and marked in

thirty-seconds of an inch and showing No. 0 when closed. *c* is the spring to apply pressure on the measuring bar when in use, and *d* the point of the callipers. This tool can be made by any practical instrument-maker.

In gouging out these grooves, the back should be laid on a cushion or padded rest of cloth, which will form a firm base whilst the gouging is proceeding. The edge of the violin back may be pressed against the stay of wood screwed to the bench, exactly in the manner adopted in gouging the outside, except that in the latter case the violin back (outside) being finished is supported and prevented from injury by the cushion on which it rests. An alternative plan is to gouge out in a flat block a bed in which to rest the back, but it is a troublesome piece of work, and the writer has found the pad entirely satisfactory in use. A diagram of the back with guides gouged out is shown by Fig. 26.

The whole of the inside must now be gouged out to the same thickness, taking out the wood between these guide grooves first of all, and working the edges last, leaving the flat places marked for blocks untouched.

Thicknessing.—The final thicknessing of the back must now be taken in hand. The centre of the back is $\frac{5}{32}$ in. The centre of the top and bottom bouts is $\frac{1}{8}$ in., and the edges, just inside the places where the ribs and linings fit, $\frac{3}{32}$ in. These measurements are final, and the work of gouging, planing and glass-papering must be very carefully executed to these measurements.

The working of the violin plates is extremely im-

portant, and on this portion of the work depends in no small measure the final result of tone value. Do not suffer any lumps, roughness, or holes to have place on the finished surface of the inside. It should be as carefully glasspapered and finished as the outside, and

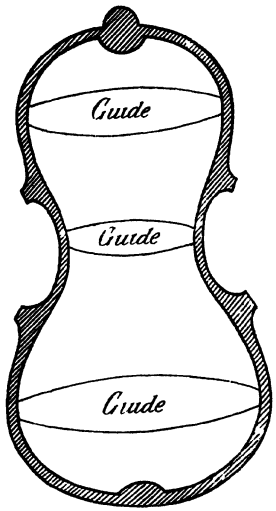


Fig. 26.—Back showing Guide Lines for Inside Gouging: Shaded parts Flat.

the callipers should show a gradual diminution of opening as they are drawn from the centre to the outside edges in every direction, without any sign of hollow or lump. If these are suffered to remain in the plate, the workmanship, however neat in other respects, will go for nothing.

When this work is satisfactorily accomplished, take a fine half-round file and carefully round over the inside

edges of the back, leaving the edges of the corners and the button untouched.

Attuning Plates.—The back, when finished, should answer to the note D. It will be found in practice that there are various notes emitted from the hollowed plates of a violin when tapped with the knuckle of the hand. The usual method of finding the note of the plate is as follows: Protecting the button of the violin from injury by two strips of wood, one on each side, clamp it firmly in the vice, allowing it to touch nothing except where the vice holds it. Now at the inner bout draw a well-resined fiddle-bow firmly along the edge. The plate will give out a sonorous note varying in pitch with its thickness and to some extent its density. The thicknesses given in the instructions on gouging the inside will be found, generally speaking, to produce the note D; but it is as well when thicknessing to test the plate from time to time by the bowing method, until the right note is obtained, always bearing in mind that the thickest part of the back must be left in the centre, gradually thinning out towards the edges, without any suspicion of a departure from even tapering. This must be proved, as stated above, by means of the callipers.

CHAPTER IV

The Belly and Bass-Bar: Assembling the Body

WHEN the back is satisfactorily finished put it carefully away until the belly is made. The archings and rises for this plate will be given on the purchased diagram. Rough templates reduced are given in Fig. 19.

Modelling the Belly.—The cutting and modelling of the belly is executed in the same manner as the back, but one precaution is necessary. The belly is constructed from very tender soft-grained stuff, and the tools must be ground and sharpened to a long, keen edge in every case. The toothed plane must be used frequently, and great care must be taken to avoid splitting off the corners, or going below the proper depth when gouging out the inside. Thickness to $\frac{1}{8}$ in. final all over obtaining the note C, and thickness slightly less from the centre of the belly to the edges, but only slightly

A few remarks must be made on this question of thicknessing the plate, which is an extremely important one in the art of violin building. If the position of the bridge and soundpost in the finished instrument is imagined as being the starting-points, so to speak (at any rate, so far as the plates are concerned), of vibration, it will be readily understood that vibration is strongest at these points.

As the vibrations travel outwards to the edges of

the instrument, they will gradually lose in force, exactly as the rings in water caused by throwing in a stone gradually decrease in force. These vibrations must therefore be helped by very gradually lessening the opposition offered to them on the way, but always remembering that the material must be of sufficient strength to carry them properly. Therefore very slightly taper the plates in every direction, but only with the minimum amount of taper. By hollowing out the cheeks of the plates, for instance, with the mistaken object of lessening resistance, it will be found that the wood is too weak to carry the vibrations in a proper manner, and the consequence, in violins of this character, is weakness of vibration and thinness of tone.

A still more serious defect is inability to wear well, and many of the violins of Vuillaume (a celebrated French maker) are spoiled through this practice of hollowing out the cheeks of back and belly.

Soundholes.—The next operation to be undertaken, after the belly is finished, is the cutting out of the soundholes. The shape of a Stradivari soundhole is given by Fig. 27, and its position on the belly is also indicated. A is the centre of the belly and B the corner. A full-sized tracing must be made of this, and it must be laid down on the outside of the belly exactly in the position indicated. It may be traced through carbon paper into its proper place. When it is traced on one side, turn the drawing over and trace it down on the other side of the belly from the centre joint of the belly and the curve of the edge,

These two soundholes must exactly match each other, and the correct cutting of them is a crucial test of the fiddle-maker's ability. The first process in cutting is to drill a hole through the bottom circle of

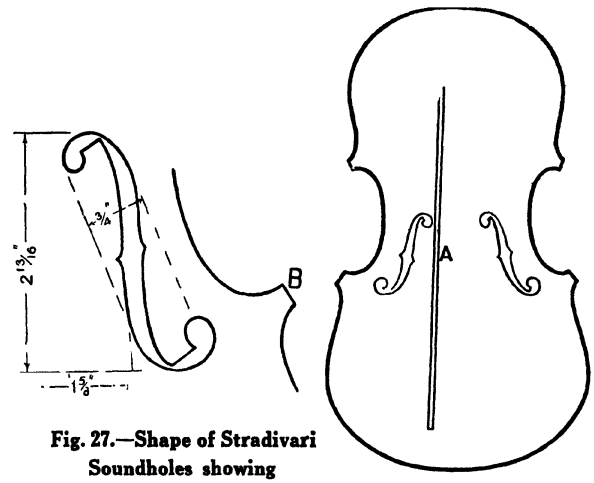


Fig. 27.—Shape of Stradivari Soundholes showing position on Belly.

Fig. 28.—Approximate position of Bass-bar.

each, and carefully cut them roughly out with a fine fretsaw, keeping inside the lines. When this is accomplished, the soundholes must be trimmed to the lines exactly with a keen-bladed knife. Be very careful in this operation to avoid breaking away the wings of the soundholes, the lower wings being especially liable to suffer this calamity. When the soundholes

are finished to the line, undercut them slightly in order to throw the edges into relief; but be very careful to avoid cutting beyond the line at any point. The slightest discrepancy will show, and spoil the symmetry of the work. The lines must present unbroken graceful curves without " dog-ears " or broken portions of line, and it will be found difficult in practice to obtain a correct well-balanced pair. But with caution in cutting and a careful finishing with file and fine glasspaper, a good job may be made of them. The nicks, inner and outer, may be cut last, and it is very important that the inner nicks be cut exactly in their proper positions, as they form a guide when setting up the bridge after the violin is finished.

Bass-bar.—The last operation in the making of the belly is the cutting and fitting of the bass-bar. Fig. 28 shows its position on the inside of the belly. A shows the highest part of the bar (opposite the soundhole nick). The object of this bass-bar is to govern the vibrations of the two lower strings, and its correct position, weight, and fitting are matters of considerable importance.

A piece of fine straight-grained Swiss pine 11 in. long, $\frac{5}{16}$ in. thick, and 1 in. deep must be obtained, and the grain of the wood must run from the belly side to the back edge, that is, the wood is cut plankwise and fitted to the belly of one edge. Consequently when fitted the direction of grain is the same as the belly. Plane it square and true all over, finally tapering it in thickness from $\frac{9}{32}$ in. at one end to $\frac{1}{4}$ in. at the other. It must be fitted to the inside of the belly exactly, and

its central point should be placed exactly opposite the central nick of the left soundhole, as shown in Fig. 28.

It must be remembered that the inside of the belly is shown in diagram, consequently the soundhole appears in this case as the right one. The bass-bar must be parallel with this soundhole, and should be directly under the left foot of the bridge when the violin is strung. The narrow or tapered end of the bass-bar must be at the top of the belly. The exact finished length is 10½ in. When this bar is an exact fit to the belly on its inside edge it may be glued into position. It must be exactly upright, and should be

Fig. 29.—Elevation and Section of Finished Shape of Bass-bar.

first of all roughly fitted with a chisel, finally obtaining fit by rubbing the belly with chalk at that portion of its inside surface where the bar is glued, and obtaining an exact fit by rubbing the bass-bar backwards and forwards in its proper place on this chalk. By this means the portions which are to be cut away will receive portions of the chalk, and so enable the maker to obtain an exact fit. This is a difficult piece of work, but the fit must be exact or the tone will suffer.

Some makers put the bass-bar in with a spring or tension, obtained by very slightly reducing the ends after the actual fit is obtained, and cramping down when gluing with long cramps.

When the bar is glued in and dry it must be shaped. Its final shape is shown by Fig. 29, the deepest part

being directly under the bridge, or in other words, directly between the nicks of the soundholes. A is the belly lever and B a section through the bar. In shaping this bar, which is done by the aid of the flat fiddle-plane, the tuning of the belly is brought exactly to the note D. Of course, when the soundholes were cut out the plate note was lowered, and the bass-bar must be trimmed until the note D is restored. It will be found in practice that the removal of wood from different parts of the bass-bar will affect the pitch of the tone differently, and this peculiarity must be looked for. Finally, the top edge of the bass-bar must be neatly rounded over, and the whole belly inside and outside finished as smooth as satin with No. 0 glasspaper. Do not suffer any roughness to remain anywhere inside or outside. Rough wood collects dust, and dust attracts damp, which is perhaps the greatest enemy the fiddle could have. Do not forget also in all operations connected with gluing to wash away all superfluous glue with hot water, for glue in its wrong place, for the same reason as that of roughness, is also a great enemy to tone.

Assembling the Body.—Take out the ribs from the mould, and prepare the edges of the blocks for gluing to the back. As most woodworkers know, end wood will not hold, and to overcome this difficulty, the end wood of the blocks must be coated with thick glue, which is burned with a hot iron and filed with an old rasp until a smooth, hard surface is obtained, taking care when using the iron to avoid burning the ribs themselves.

Violin cramps will be needed to cramp the ribs to the back, and these may be purchased or made as follows: Obtain an ash or other hard-wood rod about the thickness of a broom handle or slightly thicker in diameter. Cut this into small circular blocks 1 in. long, and drill each one with a fine steel drill exactly down the centre. Now fit 3-in. steel screws to these, one forming the bottom cramp, and the other, which revolves on the thread of the screw, forming the top cramp. The inside surfaces should be fitted with pads of leather in order to prevent damage to the edges of the tables when cramping up. The head of each screw should be countersunk to the level of the block surface, and fine pins driven in through the corners of the slot, in such a position that they will prevent the head of the cramp from turning on the axis of the screw, and thus preventing their proper use. One of these cramps is shown by Fig. 30. *a* represents the 3-in. screw, *b* and *c* circular pieces of wood drilled and screwed, and *d* and *e* leather pads glued to the pieces of wood. They are very cheap, easily made, and extremely useful.

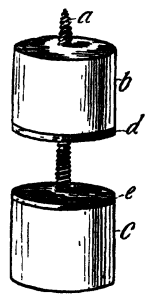


Fig. 30.—Easily-made Violin Cramp.

Now fit the head and tail block exactly in position with good hot glue, cramping down with steel cramps (Fig. 10). When these two blocks are glued into position, the rest of the corner blocks may be glued down and cramped in the same manner. Some makers glue

the whole of the edge down at one operation ; but this is liable to result in the back or parts of it springing away from the ribs at some subsequent period. It is better (as in all matters pertaining to violin building) to do the job thoroughly once and for all.

When the blocks are all glued into position, the edge may be glued down all round by dipping a table-knife into hot glue, inserting it between the loose edges of the ribs and the back, and by this means running the glue into its place, finally cramping up with the cramps (Fig. 30). Do not forget that every endeavour must be made to obtain even margins outside the ribs all round the edges, as this is one of those points an expert will scrutinise.

When the work is dry, clean up the whole of the inside as carefully as possible, leaving no roughness, scratch or dust.

The label may now be prepared, and put into its place under the left soundhole. By placing the belly roughly into position on the ribs, the correct place for the label may readily be found. The designing of the label is entirely a matter of taste. The writer had a facsimile of his own signature made, and labels were printed from it ; but, of course, everyone will use his own judgment in this particular. Many violin-makers give their creations names, and there is something in the idea. Take all measurements carefully before the belly goes into its place ; they will prove very useful when the second instrument is taken in hand, or as a check on the work for future guidance.

The belly is glued on in the same way as the back,

using glue of half strength only, for any internal repairs or alterations which are required are executed by removing the top table, and if full-strength glue is used, the tender wood will fracture when removing the table.

By the way, if the maker should require to remove this top table at any time, he must do so by carefully inserting a fine-bladed table-knife between the ribs and the table, guiding it very carefully round the instrument, until the table is loose all round. Especial care must be taken at the corners.

The violin body is now together, and should be carefully sponged clear of all glue, and rubbed with the finest grade glasspaper. Put it away in a place clear of all dust and dirt, if possible where the light and air may get at it.

CHAPTER V

Cutting the Neck and Scroll

If desired, partially finished necks and scrolls may be purchased, but the practical violin-maker will not rest content until he has cut his own, for there is a great deal of individuality to be seen in every hand-cut violin scroll, and it is frequently an important part in the judgment of the make of a violin. Again, the scroll should be chosen to " fit the fiddle," that is, the weight and character of the wood of this portion of the instrument must be taken into consideration when building the violin, and every violin requires individual treatment in this respect.

Marking-out.—Patterns for Stradivari scrolls (outline) may be obtained from the same source as the patterns of archings and outline. The first process is to make a zinc outline or template from this pattern, in exactly the same way as the templates were made for the back and archings. The utmost care must be taken to obtain sweep of line free from break or broken curve. A reduced facsimile of the scroll outline is given by Fig. 31. *a* are the notches for the nut, and *c* the finish of the volute.

A block of sycamore must now be procured. Length $10\frac{1}{2}$ in., width 2 in., and depth $2\frac{3}{4}$ in. Do not choose wood of a very pronounced " flame " or figure ;

these kinds of scrolls are extremely difficult to cut. A good, plain piece of wood is much better for the worker for a first attempt. When the first scroll has been finished, the maker will be better acquainted with the difficulties, and in a better position to estimate the chances of successfully executing this undoubtedly difficult part of the work in wood of high figure.

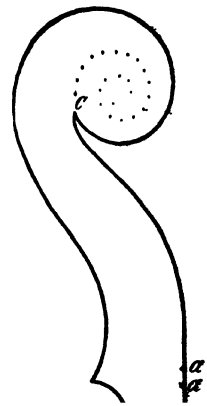


Fig. 31.—Outline of Violin Scroll.

This block must be squared perfectly true all over, reducing the measurements to, width $1\frac{3}{4}$ in. and depth $2\frac{1}{2}$ in. Mark the face and face edge respectively in the usual manner, and work from these faces throughout. The measurements given must be adhered to exactly, as the balance of parts must be rigorously preserved. Now lay the template in position on one side, from the top end of the block, which must be exactly square, and mark out the outline of the neck and scroll. The dotted lines in the central portion of the head or scroll itself are for the curls of the scroll, finishing at the "eye," and must be drilled through the template exactly in their position, as marked in the drawing. The two notches *a* must be

marked on the front edge of the block, and lines squared across the face from them as a guide for tracing the outline of the scroll on the other side, setting the notches in the template exactly to these lines, and testing the squareness of the block by observing whether or not the top of the template is exactly level with the top of the block. If it is not so, see to the square in use, for everything connected with scroll-cutting must be absolutely accurate.

Cutting.—When there is no doubt that the two outlines are exactly opposite each other on the two sides ($2\frac{1}{2}$ in.), the outline must be cut with a band-saw or bow-saw. It is best to get a skilled sawyer to do the work, and instructions should be given to him to saw just outside the outline. The block must then be squared from the face edge all over with the aid of square, paring chisel and files. Do not be impatient to get this part of the work finished; the object to be aimed at is correctness, for all measurements depend on the "squareness" of the outline. Templates must now be made for the shape of the head and the lines of the "volutes" or grooves which run over the front of the scroll. These are shown by Figs. 32 to 34, Fig. 32 being the front of the head, Fig. 33 the back from the chin of the scroll to the top of the head, and Fig. 34 the volute from the top of the head or scroll to the point *c* (Fig. 31).

The exact centre of the block across the face must now be found, and a line drawn right round the head and neck from end to end. This will serve as a guide on which to place the templates. Take the first

pattern and push the narrow end right into the angle of the cut at *c* (Fig. 31) centering it by means of the openings cut in the template (which must be absolutely central) and the centre line round the block.

Now carefully scratch in the outline with a steel point. The same method must be adopted with the

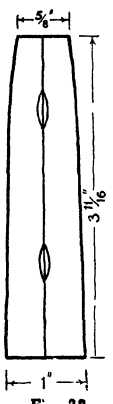


Fig. 32.

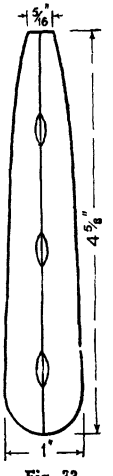


Fig. 33.

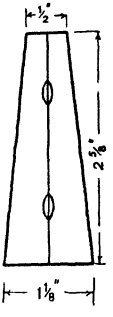


Fig. 34.

Figs. 32 to 34.—Templates for Scroll and Pegbox of Violin.

volute, the wide end being pushed into the angle at *c* (Fig. 31). The back is drawn by placing the narrow end on the top of the block where the narrow end of the volute finishes, centering down the back of the head by means of the openings and centre line as before, and scribing in with a steel point.

The next operation is cutting out the pegbox. Fig. 32 gives the outside measurement (1 in.), and the pegbox sides or cheeks must be measured off inside the

lines on each side. The cheeks of the pegbox should not be less than $\frac{5}{32}$ in. thick. They are made slightly narrower at the finger-board end, to allow string clearance, say $\frac{1}{8}$ in., not less. Do not use the chisel the way of the grain, but cut out the wood so far as possible across it, and be careful to avoid splitting the head.

The neck should be held in the bench vice during the operation. Another warning—do not go in so deeply that there is no room for the sinking of the volutes in the back of the scroll. Clean out the pegbox thoroughly, and do not leave any part of it in a rough state. It should be glasspapered as smooth as the rest of the instrument.

The neck must now be marked out for cutting down the sides. From the foot of the pegbox (that is, at the bottom end of Fig. 32 to the bottom of the neck) lines must be drawn on each side of the face as follows: Measure off from the centre line at the bottom of the face on each side $\frac{11}{16}$ in., and join these two points with the bottom ends of the front. On the back of the block at the bottom the same measurements are taken, and the lines drawn from these two points to a junction with the outside lines of the back of the scroll (Fig. 33).

Before cutting down these lines, two cross cuts will have to be made at *a a* (Fig. 35). Bear in mind that these cuts, one on each side of the head, must *not* go beyond the outside lines of the patterns of the front and back (Figs. 32 and 33), and also note that they are not the same distance from the edges on the front of the scroll as they are on the back. Any cutting below these lines will spoil the work.

Now fix the neck upside down in the vice, and carefully cut down from the bottom of the block on each side to the cross cuts made at *a* (Fig. 35). Do not on any account put undue strain on the head when this cutting is in progress, for the least lateral pressure will break the scroll in two pieces.

The head is now ready for carving. The superfluous wood from the outsides of the curls of the scroll,

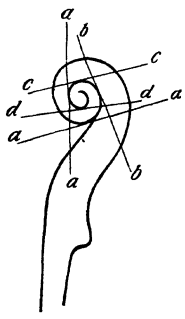


Fig. 35.—Head of Scroll.

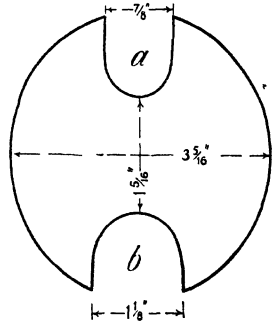


Fig. 36.—Pattern for Shapes of Top and Bottom Ends of Neck.

or wings as they are technically called, must be cut away. The dots which were marked in with the steel point when marking out the template for the outline show the position of these wings. Therefore make four cuts as shown at *aa*, *bb*, *cc* and *dd* in Fig. 35 on each side of the head, and be very careful to avoid cutting below the outside lines of front or back tracings (Figs. 32 and 33).

These pieces must now be carefully removed down to the outline of the head with a keen-edged chisel,

finally taking off the projecting corners, which will leave the scroll roughed out.

The wings and curls of the scroll must now be carved right round to the eye of the scroll on both sides, using fine keen-edged gouges. The clearing away of this superfluous wood is perhaps the most difficult part of the cutting of a scroll. If great care is not used, the pieces will split away and lift out parts of the curls of the scroll, totally ruining the work. Above all things the tools must cut, not lever out, the waste wood. It has been the experience of scroll cutters to find that in cutting away the superfluous wood, say from one side of *bb* (Fig. 35) to the other side, that the entry of the gouge will start a split which finishes inside the lines of the back, spoiling the appearance of the scroll when viewed from the back of the fiddle. The only way to avoid this is to use the gouge very cautiously, taking out a little at a time. In this way the wood does not get the opportunity to split, the slight shavings taken off obviating the risk of damage to the edges.

The spirals from the edge of the pegbox to the eyes of the scroll should be cut by " eating away " with a very sharp gouge, the superfluous wood. It is better to work from the outside of the spiral towards the centre of the scroll with the gouge than to attempt to chisel longitudinally. If the latter method be adopted, the wood may split or fly out right to the edge of the block, and so spoil the wings of the spiral. Use the gouge with a rocking motion, and keep it continually under control.

The depth of the cut from the outside of the spiral to the eye should vary in depth from a very shallow cut at the cheek of the pegbox where the sinking commences to a deep, well-pronounced cut at the eye. The object to be aimed at is to throw these curls into relief on their edges. Much care is required to do this correctly, and to see that the depth is the same on each side. It must be remembered that scroll-cutting is a fine art, and no pains must be spared if work is to pass criticism.

When this part of the work is finished, roughly shape up the neck with knives and files, but do not attempt any measurements as yet, merely taking care that the wood is not cut away to a less size than the diagram for the shape and size of the neck (bottom and top end) given in Fig. 36. *a* is the top end at the scroll, and *b* the bottom end at the shoulder. These show width of neck only. Cut out the chin of the scroll at the back of the head, taking care not to cut into the pegbox. The eye will show when there is any danger of this happening. The outline of the chin is shown in Fig. 31, and the maker should shape it with the aid of the knife, using the eye as a guide to balance.

Now take out the hollows on the back of the scroll, shaping them as in any ordinary violin scroll which must be taken as a pattern, for there are no measurements which can be given as a guide for this part of the work. A few minutes' examination of any violin will show exactly what is required. Do not cut so deep that the pegbox is cut into when cutting the grooves up the back, and do not in any circumstances cut away

the centre line. All cuts must finish at this line on each side right round the head, leaving about $\frac{1}{32}$ in. on the outside of the scroll edges all round, to allow for a slight bevelling with the file when finishing up.

When the cutting is finished, dip the whole head into water, dry instantly with a cloth, and file and glasspaper as smooth as possible all over. To get into the corners of the head and the hollows of the wings, use rolled-up pencils of glasspaper, alternately damping and glasspapering until every part of the work is smooth as the inside of the violin. It is tedious work, but it must be done if the head is to look well when varnished.

CHAPTER VI

Purfling the Instrument

The Necessity for Purfling.—Purfling is inserted not merely for the purpose of ornamentation, but with the object of the prevention of possible splitting of the edges. For this reason the work is necessary, and those instruments which are finished with lines only, scribed round the edges, cannot be said to be properly built violins. It is tedious and exacting work, and must be executed with the utmost care, or the appearance of the violin (to the eyes of a connoisseur) will be spoiled.

Some makers insert the purfling before the violin is put together, but this way (some very fine makers to the contrary notwithstanding) does not seem to have been the method adopted by Stradivarius. In genuine instruments by this master there is a peg of wood inserted through the back at the top and also at the bottom, about $\frac{3}{32}$ in. in diameter. The purfling is carried through half of this peg in its position as laid round the instrument. The pegs were inserted with the object of fastening the ribs and blocks to the back, and it will thus be seen that it is impossible to purfle a violin back before fixing the back by this method, and insert the peg afterwards, in such a manner that the purfling splits the end of the peg and overlays half of it. The peg must be inserted first, and half the

end cut away (with the rest of the groove round the back) after the ribs are glued on. The worker is therefore advised to put the body of his instrument together before purfling.

Purfling is made of three strips of wood, two outside strips black and the centre strip white. Sometimes variegated purfling is used, but this is very difficult to insert satisfactorily. A method of inserting this will be described later. First of all, however, the ordinary strip purfling will be dealt with.

Cutting the Grooves.—The distance from the edges to the outside cut of the purfling varies to a slight extent with different instruments. Some makers allow a wider margin than others, but $\frac{1}{8}$ in. will be found very satisfactory. The purfling tool shown by Fig. 20 will be found useful in marking the outside cut. Set the knife so that it will cut a groove $\frac{1}{8}$ in. from the edge, and keeping the stock or shank of the tool pressed firmly against both edges of the violin (back and belly), make the first groove right round the back. Do not be over anxious to get the first cut too deep. The important point is to see that a perfectly unbroken sweep of line is maintained the same distance from the edge at all points.

Now will be seen the importance of making this purfling tool the correct size. The hollow groove cut in the shank gives a double bearing on the edge of the instrument, and thus prevents the purfling tool from rocking out of its place. The length of the shank from top to bottom, by bearing on the edge of the belly as well as the back, prevents the tool from tipping forward

out of its proper distance from the edge as it cuts the groove. The length of the shank adjusts itself automatically to the various sweeps of the outline, and this narrowness prevents any discrepancy in the distance from the edge, which would speedily make its appearance if the groove in the shank of the tool were too wide.

There are few of the purfling tools on sale very satisfactory in use without considerable practice in the handling of them. This tool can be used by the tyro, provided ordinary care be taken. When the first groove is cut, the tool must be altered to the width of the purfling, and the inside cut made. Always make the outside cut first, in order to get the corners fitted nicely. These corners will have to be cut with a keen-edged knife, as the purfling tool will not go right into the bends of the corners. Follow the sweeps round until the various outside lines meet in the centres of the corners. The cut must now be prolonged as a single one, almost to the outside edge of the corner of the instrument. This single cut, when the purfling is completed, is called the "bee's-sting," and is one of the signs, when neatly inserted, of a good fiddle-maker.

The wood between the grooves must now be lifted out with a sharp-pointed narrow blade. The depth of the groove should not be more than half the thickness of the back, and must be cleaned out to the same depth all round, perfectly free from ragged edges or frayed ends. If this is not correctly done it will be impossible to insert the purfling cleanly, and the result will be unsatisfactory.

Inserting the Purfling.—The purfling must now be inserted without glue, being properly fitted at the four corners so that the white centres meet. This is a difficult matter, but the following precautions will help in the work. Insert the inner bouts first, bevelling the corners so that they will mitre neatly. The bottom and top bouts may be inserted in two complete pieces without a break, fitting one corner first and carrying the purfling right round until it meets the other corner, which must be fitted in the same way. Be careful in fitting this second corner to avoid making the length too short, which will necessitate a new piece being prepared.

To obtain a satisfactory "bee's-sting," make a long bevel on the end of the strip of purfling, and press it firmly into its place in the single groove cut into the corner, fitting the white to meet the white in the centre bout. Cut the groove deep and firm in the corner before pushing the purfling home, and the work will be considerably simplified. The purfling is extremely brittle, and the narrow sweeps will have to be bent by heat on the bending iron. The wider sweeps, with a little manipulation, may be fitted without heat.

When the whole of the purfling is fitted it is taken out, the groove is filled with good, hot white glue (which may be obtained from the warehouse), the purfling rapidly and accurately inserted and tapped gently down into the groove with the handle of a chisel or a small wooden mallet. Do not, in any circumstances, attempt to hammer the purfling down. This will flatten it out in the groove and destroy the sym-

metry of the black-and-white lines, and may also break away the edge of the back.

The purfling of the belly may be executed in the same manner, but in the case of the top and bottom bouts, two pieces may be used for each, as the purfling is afterwards cut away at the top for the neck, and at the bottom for the tail-rest, consequently a joint or open space without purfling does not matter here. The belly being of tender material is more difficult to cut than the back, and great care must be taken to keep the grooves at the correct distance from the edges, and the correct width when picking out the material between them.

When the glue is dry, the purfling of both back and belly may be pared down to the level of the wood with the gouge and violin plane, and glasspapered smooth all over.

Purfling may be made by gluing a sheet of white veneer between two sheets of black, and cutting into strips of the proper width, when dry, with the aid of a steel rule and knife. This method of making purfling is sometimes useful where a variation is required from the ordinary black-and-white purfling, as, of course, any colour of veneer may be used. The narrower the white centre the better the appearance of the finished work.

Variegated Purfling.—This is very difficult to manipulate, and is not often used. As a test of the maker's capacity in this direction, however, it may be occasionally inserted, though it must be stated that most people prefer the plain strip work. Variegated

purfling is composed of many pieces of material built up in strip form. It may be diamond black-and-white, square black-and-white, or lozenge and diamond pattern. Stradivarius on some few occasions used this kind of purfling, therefore it is as well for the maker to understand the method of inserting.

It will be readily seen that any attempt to bend a strip built up of so many separate pieces of material is at best a job which possesses its own difficulties. To overcome the tendency to fly which is characteristic of this purfling, the strip after careful fitting at the corners must be dipped in the glue, and while hot run over the bending iron, taking care that the glue is not singed. This will make the material pliable, whilst at the same time the glue will hold it together. It must be inserted at once before the glue cools, and an assistant who will fill the groove with glue whilst the material is being bent will prove very useful.

Get it into position quickly, making sure that the pattern at the four corners is a perfect match, according to the design of the strip. When dry it may be planed down and glasspapered, as described for the ordinary purfling.

Should the maker desire to imitate the split peg of Stradivarius (which looks extremely handsome when well done), he must drill a hole through the top and bottom of the back into the blocks on the centre joint, and in the position where the sweep of the purfling will just cut away half of the peg, the outside half in each case, so that when the groove is cut out and the purfling inserted, the half of the peg end appears as a

small half-moon on the inside of the purfling, top and bottom. The peg may be made of ebony or rosewood, and should not exceed $\frac{1}{8}$ in. in diameter, $\frac{1}{32}$ in. less being preferable. It is glued in and cut level with the back with a chisel, the groove for the purfling being cut through it after insertion. The pegs are not used in the belly at all.

CHAPTER VII

Fitting the Head and Neck to Body

Fitting the Pegs. — Before fitting the neck and shoulder to the body of the violin the pegs had better be fitted to the head, as it is easier to execute this work now than after the neck and head is fitted. A pattern is given by Fig. 37, and shows the position of the peg-holes in the cheeks of the peg-box. Mark these places accurately with a gimlet, and bore cautiously through both cheeks with a steel bit. Be sure that the holes are bored perfectly square with the head and horizontal. Now with a $\frac{1}{4}$-in. steel reamer (obtainable from any toolshop) bore out the holes from each side on their proper sides (violin facing the workman). The top hole and the third hole down are fitted with pegs on the right side, the second and bottom holes being fitted with pegs on the left side, four pegs in all. Be careful to avoid fitting the pegs to the wrong holes, which sometimes will happen if care is not taken.

The pegs must be accurately fitted, which is a somewhat trying operation, but which must be correctly executed, for on the correctness of fitting depends the ease and certainty of tuning. The pegs should be ebony, and must be filed and glasspapered to fit the holes bored in the head. Any projecting ends should

be cut off flush with the face of the cheek and the flat end rounded carefully with file and glasspaper.

The Tail-rest.—The tail-rest (also of ebony), over which the tail gut passes on its way to the tail-pin, must now be inserted in the bottom of the belly. Measure off from the centre joint on each side $\frac{3}{4}$ in., cut out the piece of the belly enclosed between these

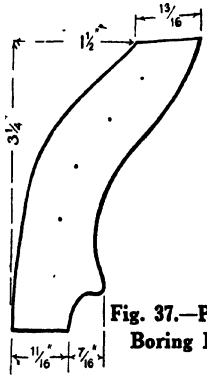


Fig. 37.—Pattern for Boring Peg-holes.

Fig. 38.—Shape of Tail-rest.

two points and the inside cut of the groove for purfling. The ebony tail-rest is cut as in Fig. 38, and must be fitted exactly into its place, its inside edge following the sweep of the purfling groove, and its outside edge following the sweep of the edge of the belly. Glue it home when filed and glasspapered, and leave to dry.

Fitting the Neck.—The neck and shoulder now demands attention. It will be remembered that two saw-cuts were made into the ribs before fitting the belly. With a chisel cut down from these saw-cuts to

the inside edge of the purfling on the belly, and remove the piece enclosed by these cuts right down through belly and block to the button on the back. Now, from the centre joint of the belly measure off on each side *slightly less* than $\frac{11}{16}$ in. Lines are drawn from these two points to two similar points against the button, that is on each side of the centre joint, exactly the same distance from that joint, and about $\frac{1}{16}$ in. inside the edges of the button. With a sharp chisel cut out the chamber to these two lines, keeping the bottom of the chamber square all over. The chamber should be $\frac{1}{4}$ in. deep when finished, from the top edges of the belly and back.

Now take the neck, and square a line across the bottom end $5\frac{1}{2}$ in. from the bottom notch on the outline of the scroll (Fig. 31). By placing this outline with its flat edge along the face edge of the scroll, the correct backward inclination of the neck and scroll will be found. Draw this line in with pencil from the squared line across the face, on each side of the shoulder, and join the two lines across the back. With a tenon-saw cut the superfluous wood at the end away, keeping the cut perfectly square and flat.

Fig. 39 gives a pattern for the shape of the shoulder from the front to the back. The centre line of this figure coincides with the centre line round the block. Draw this outline on the bottom end of the block, and roughly shape the shoulder with chisels to this measurement. The shoulder must now be finally fitted to the chamber with chisels and files, keeping the centre joint in each case exactly in the middle of the shoulder when

cutting, so that when finally fitted this centre line fits against the joint, back and belly. If this matter is not carefully attended to, the neck and scroll will not be in correct alignment with the body of the fiddle, and the instrument will consequently be thrown out of balance. In shaping the block at the shoulder, therefore, be careful to avoid taking off too much wood on one side. If the block is cut to correct measurements there will not be a great deal of cutting to be done.

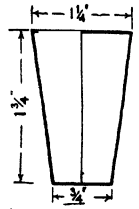


Fig. 39. — Pattern for Shape of Shoulder at End of Scroll Block.

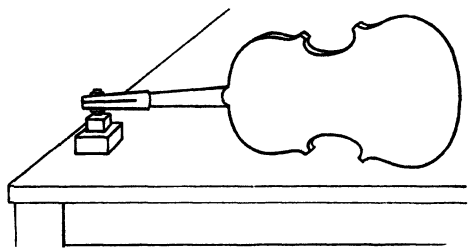


Fig. 40.—Method of Testing Neck Fitting.

The back of the shoulder which fits against the button will have to be shaped with chisels and files until it fits exactly against the button all over. When finally fitted, if the work has been correctly done, the body will hold to the shoulder without glue, and the fitting must be carried out to this degree of nicety if the work is to be considered satisfactory.

The correct backward angle will only be obtained by fitting and refitting the shoulder to the chamber. When finally at its correct inclination the *surface* of the fingerboard at its lower end (when placed on the neck in the position it will finally occupy) will be

exactly $\frac{2}{32}$ in. above the belly of the violin, and the fitting should be carried out to this degree by filing the end from front to back, keeping it square all over during the process. The face edge of the neck when finally fitted should rise $\frac{1}{4}$ in. above the belly at the chamber.

The correctness of this fitting may be tested first by laying the violin down on the bench on its edges, first on one side and then on the other, and placing a block of wood of suitable thickness under the eye of the scroll, until, whichever edge is laid on the bench, the scroll eyes are exactly the same distance from the top of the block (*see* Fig. 40). Secondly, by glancing along each of the back edges from the bottom of the instrument, when the eyes of the scroll should be exactly in line with these edges on both sides of the fiddle. Thirdly, by glancing along the joint of the back from the bottom of the instrument, when the centre line of the scroll at the back should be in line with the centre joint of the back.

When these various tests are all satisfactory the shoulder may be glued and cramped into the chamber, using plenty of good hot glue, both on the shoulder and in the chamber, and applying a cramp (Fig. 30), using waste pieces of wood to protect the button and shoulder from injury by the steel of the cramp. See that the shoulder is well home; finally test for correct balance as above, and leave to dry for a day.

The Fingerboard.—An ebony fingerboard must now be procured and fitted exactly to the face of the neck by means of plane and files. The nut, which must be

of ebony and $\frac{1}{4}$ in. thick, is glued into position at the top of the neck, fitting between the lines drawn across the face of the neck from the notches in the template (Fig. 31). The fingerboard should be temporarily held with a few spots of glue, and the nut filed round until it is of the same sweep as the surface of the fingerboard and standing about $\frac{1}{16}$ in. above it. It must be rounded over from front to back until the strings will lie evenly across its face.

The four grooves for the reception of the strings must be very shallow, otherwise the strings may rattle in them and cause an unpleasant buzzing sound when playing. The strings should be a sufficient distance above the fingerboard to allow a playing card to be inserted between them and the fingerboard, and no more. In other words, the G string should not be separated from the fingerboard by a greater distance than $\frac{1}{32}$ in.; the E string by a little less. The distance between each string at the nut is a matter of taste and convenience, some players (with broad fingers) requiring a greater space than others.

Seasoning.—The violin (if possible) should be played on for a few months in the white before finally varnishing. It will be improved by this means, as it will get seasoned. By keeping the instrument exposed to light and air, the wood will gradually develop a brown tint, and this tint will become an aid to the maker in obtaining a rich tone in the varnish. Most makers expose the instrument to a good light for several months before varnishing in order to obtain this brown tint.

To prevent the belly becoming soiled by the chin of the performer during the process of seasoning, a chin rest may be fitted to the instrument, but great care must be taken to avoid damage to the fine raised edge with this fitment, and if it can be avoided by the use of a silk handkerchief placed under the chin it is better to do without the rest altogether.

When finally fitting the fingerboard after varnishing, two blocks of wood, one shaped to the arch of the fingerboard and the other to the back of the neck, should be made for use in cramping. Use good hot thin glue, and see that a perfect fit is obtained all over, otherwise the fingerboard will work loose and create an unpleasant jarring noise when playing. The neck, shoulder and button must be carefully shaped with knife and files until the template (Fig. 36) fits exactly in position at the top and bottom of the neck respectively. Great care must be taken in shaping the button. It must form a perfect, well-balanced arch, rising equally from each side, a little broader at the base than its height. It is, simple though it looks, a very difficult matter to shape this button correctly, and every care must be exercised to obtain grace and symmetry.

The violin is now ready for varnishing and polishing.

CHAPTER VIII

Varnishing and Polishing

THERE is no doubt that this part of the work is difficult to execute satisfactorily, and the maker must neglect no portion, however slight it may seem. It is very annoying and also a great waste of time and energy to have the labour of removing a tenacious oil varnish from a violin on account of its unsatisfactory appearance; but close attention to the following instructions will contribute considerably to successful work.

Varnishes.—There are two kinds of varnish used in violin work, namely, oil and spirit. The latter is generally to be seen on the cheaper class of instrument, and is much the simpler to prepare and use. But the great drawback of spirit varnish is its liability to fracture. It does not wear in the same sense as that of a good oil varnish, and spirit-varnished instruments in a few years lose much of their beauty by reason of this chipping or "flying" of the brittle covering of gums and colour. There is nothing to bind them together once the spirit has evaporated, and consequently a jar or blow causes the varnish to fracture and chip off.

In oil varnish, which is prepared with oil of turpentine and linseed oil, the process which goes on after the

violin is varnished is not evaporation at all (as in the case of spirit), but oxidation. This process of oxidation lasts for years, and as the gummy residue of the oil is always present, and gradually solidifies into an extremely tough coat, the varnish never "chips," but wears, becoming more mellow and beautiful as time goes on. The maker is therefore strongly recommended to apply himself to the preparation of oil varnish, which, although very troublesome and uncertain at first, will give him in the end much more satisfaction in his work.

Several recipes are given later for both oil and spirit varnishes; but if the worker will accept well-meant advice he will avoid spirit varnishes altogether, excepting on the neck of the violin, where they are always used.

Oil varnishes are placed on the instrument to preserve the wood from dirt or atmospheric attacks and to bring into prominence the fine figure of the material. For this purpose they must be transparent, or as transparent as possible. To add to their lustre and brilliancy, and to still further enhance the beauty of the instrument, they are coloured with various substances; but this colouring matter must not in any circumstances interfere with the transparency of the varnish. The colouring matter for this reason must be but sparingly used.

To add to the coloured effect, and to aid the varnish in throwing into relief the beauty of the wood, a first wash is generally used, either of a yellow or red tint. This must also be transparent, and should be applied

by the aid of some medium other than water, which lifts the grain of the wood, thus necessitating glass-paper to smooth it again. This latter process affects transparency.

The violin-maker should get these facts firmly fixed in his mind, for on their thorough appreciation depends in a great measure the success of the work. Much time will be saved and useless expenditure in the purchase of unsuitable colour and material if it be thoroughly recognised at the outset that the colour, first wash and varnish are all to be applied for the express purpose of aiding the figure of the wood to display its beauty.

Oil varnish may be bought ready made, but owing to the lack of knowledge of the ingredients, the maker is recommended to prepare his own. First of all, however, he must prepare the first wash or washes according to the tint required. In this connection it must be borne in mind that any colour used in the varnish will be modified by this first wash shining through it; therefore, if a red varnish is required the yellow wash should be replaced by a red one, and so on.

It will be supposed that the varnish-maker is preparing yellow, red and brown washes in connection with his work. Obtain 1 oz. of gamboge (in the lump or powder) and 2 oz. of alkanet root. (The brown is not used as a wash, its place being taken by the red or yellow tint, which warms the brown colour used in the varnish, where that colour is employed.) Now obtain one pint of oil of turpentine, which should be sticky to the touch. Do not be satisfied with that "oil of

turpentine " which is in appearance similar to water, for it is of very little use. A varnish-maker's or carriage-builder's establishment is the proper place to apply for this oil ; the ordinary drysalters do not understand the fiddle-maker's requirements at all.

Make two solutions (one red, the other yellow) by boiling on a water-bath half the quantity of the oil of turpentine containing the powdered gamboge, and the other half containing the alkanet root. Do not fill the inner receptacle to more than half its capacity, and use a roomy pan for the outside water-bath. It is as well to perform these operations in the open air, in case of fire, although a gas stove, carefully used, is quite safe. If an open fire is used, be careful to see that there is no blaze which might set fire to the vapour from the turpentine.

When the colouring matter is firmly settled in the oil the mixture may be allowed to cool and should then be filtered. When the solutions are finally obtained clear and bright without any sediment or impurity, they should be bottled in coloured bottles (red glass) and labelled with the date of making and other particulars for future reference.

The varnishes must now be prepared, and there are many different substances used for this purpose, including copal, mastic, dammar, amber and sandarach. Without going into the merits of these various substances, it may be stated that a good hard-wearing, yet elastic and transparent, varnish may be made from copal, or dammar, and mastic (copal preferred). It will be found in practice that copal is extremely hard

gum resin, and heat is required to dissolve it in the turpentine.

A few additional remarks must be made at this point about this latter substance, for it is one of the rocks upon which the varnish-maker is often wrecked. There are several varieties of turpentine, from the genuine raw oil of turpentine, as it comes from the pine tree, to the distilled spirit of turpentine with most of the natural resin removed. This latter substance, spirit of turpentine as it is called, is of very little use for fiddle varnishes.

The turpentine required is of a yellow colour, oily in appearance and sticky to the touch. It forms a gummy residue round the rim of the bottle in which it is kept. This gummy residue is in effect exactly what is required on the fiddle. The turpentine when laid on the violin in the form of a varnish attracts oxygen from the atmosphere and gradually solidifies, forming a tough hard gummy film which will last for a hundred years or longer. Again, colour, generally speaking, will readily dissolve in this oil of turpentine, and on the contrary the spirit will frequently refuse to combine with colour in any circumstances.

When the violin-maker is perfectly sure that he has obtained this substance he may proceed to boil his gum resins in it, using ½ pt. of oil of turpentine, ¼ oz. of mastic, ⅛ oz. of copal. This is a long process, as the gums will only dissolve very slowly, and the boiling (on a water-bath) must be kept up until the gums are thoroughly incorporated with the turpentine.

A method sometimes adopted when the gums are

particularly obstinate is as follows: The oil of turpentine is heated on a separate water-bath, the gums are also heated separately, and when thoroughly melted the latter are slowly added to the hot oil, stirring with a pine stick until the whole is of the consistency required. If this method is adopted, every precaution must be taken to guard against fire, as all the substances are very inflammable. A bucket of wet sand, or some wet rags, should be at hand, and the work performed in the open air. The professional varnish-maker has special workshops constructed for the purpose, and the amateur should take necessary precautions in the absence of the professional's safeguards. A little at a time may be made, which, although it takes longer, is certainly safer.

When the turpentine is fully charged with the gums, the linseed or other oil may be added. It may be taken for granted that linseed oil is the best for the purpose, therefore that substance may be obtained from the same source as the oil of turpentine.

The important point in connection with the linseed oil is the quantity to be used. If too much is put into the turpentine the varnish will refuse to dry. Boiled linseed oil should be used, and it should be of the finest possible quality. To every pint of turpentine must be added not more than 1 oz. of linseed oil, and both liquids should be heated before mixing. Always add the linseed oil last to any preparation of varnish. The oil prevents cracking of the varnish, gives it a mellow appearance, and oxidises in exactly the same way as the turpentine, though not so rapidly. It is probable

that the fine mellow appearance of old well-worn oil varnish is due to the presence of linseed or similar oil.

The first washes and the varnish are now prepared. The latter must be filtered and every particle of sediment or undigested material removed. Bottle it in coloured glass or stone bottles, and store it where it will not be liable to be disturbed or shaken. The older it becomes, the better it will work; in fact, as a rule, new oil varnish does not work well at all. If it can be stored for a year or so before using, so much the better. The next operation is to prepare the colouring matter.

Colourings.—It is very necessary that these should be fast to light, and therefore when purchasing colouring matter the question should be asked, but in any case the material should be tested. Also inquire if the colouring matter is soluble in oil of turpentine or linseed oil. Many colouring materials are insoluble in both, and although some of these may be dissolved first of all in alcohol and then added to the varnish, the process is not always satisfactory.

Browns and golden yellows are the best in appearance on the finished instrument, and it is a difficult matter to obtain a satisfactory red varnish owing to the colour itself being somewhat garish and flaunting in character. Toning it down with yellow often gives a very beautiful orange, according to the shades of colour used.

Among colouring matters to be obtained may be mentioned alkanet root, madder, bismarck brown (cassell earth), and burnt sienna. It may be necessary to dissolve the bismarck brown in alcohol first; but the

other colouring matters are soluble in oil of turpentine or in the varnish itself.

Before mixing the colours with the stock solution of varnish they may be tested for permanency as follows: Coat long strips of maple or pine with the colour dissolved in a little varnish. When dry date them at each end, cut each into two pieces, and expose one half to bright sunlight, keeping the other half in a drawer away from the light. Comparison of the two pieces will show the extent of fading. Do not use any colour which is of a poor quality in this respect. The longer the colour stands in sunlight the better, of course, it is. Alkanet root may be found somewhat treacherous alone, but it gives depth and brilliancy when used in conjunction with other colouring matters, and it is for this reason included.

Varnish Recipes.—The following are recipes for suitable varnishes:

(1) Gum mastic 2 oz., gum copal 1 oz., and oil of turpentine 1 oz. Melt the mastic and copal together, warm the turpentine, and mix in with the melted gums, stirring with a piece of wood during operation. The addition of ¼ oz. of best boiled linseed oil will convert the above into an oil varnish. It may in each case be coloured by an alcoholic solution of red sanders wood, or dragon's blood and gamboge or turmeric.

(2) Shellac 2 oz., gum mastic 2 oz., gum dammar ½ oz., venice turpentine 1 tablespoonful in ½ pint of methylated spirits. Give the violin first of all two coats of the following mixture: copal varnish 4 oz. and oil of turpentine 1 oz.

(3) Shellac 2 oz., gum dammar 1 oz., oil of turpentine 1 oz. Colour with sandalwood and dragon's blood either together or separately, according to the shade required.

(4) An oil varnish may be made as follows: Melt together 3 oz. of copal and 1 oz. of mastic. Also mix together, in a separate vessel (after heating), ¼ pint of oil of turpentine and ⅛ pint of best pale drying oil. Now mix slowly together the copal and mastic solution with the turpentine and oil solution, stirring during mixing. The solution may be coloured by means of an alcoholic solution of sandalwood, dragon's blood, or madder root, according to the shade required.

In all cases the first coating must be gamboge in turps.

Varnishing.—Before applying any varnish to the instrument the peg-holes should be plugged up with pegs of wood or pieces of cork. This will prevent varnish entering and save much labour later, for it is difficult to remove from this awkward place when once firmly established.

Now the real work of varnishing must be taken in hand. Be perfectly sure that there are no scratches on the instrument left by the glasspaper. Everything must be as smooth and silky as satin. Before using new brushes wash them well with soap and water and make sure there are no loose hairs. Good fine hog-hair brushes are quite satisfactory. A brush which has been in use for some little time is better in working quality than a new one.

Begin with the ribs, giving a firm even coating of

the first wash, either red or yellow, as the case may be. In this connection do not forget that the resultant colour must be considered in relation to this wash, and it is of no use to use a yellow if a deep red is required in the finished instrument. The amount of colour which can be dissolved in oil varnish, at the same time preserving transparency, is so small that any underlying colour or tint will infallibly show through and modify the result. Consequently if red is required, and yellow is used as a ground tone, the result will not be a pure red, but orange—a very different thing.

Do not go over the same ground twice with the wash, or patchiness may result, although this depends in a great measure on the porosity of the wood and the nature of its growth. It will be found that the turpentine will bring into brilliant relief every shred of figure in the wood, and it must be the maker's unfailing object to preserve this brilliancy uninjured. If a deep brown is aimed at, this will not be found easy, as the more colour in a varnish the less transparent will it appear. However, beautiful effects may be obtained by the judicious use of colour.

When the first coating is dry give the violin a second coat of transparent oil varnish. Then proceed to lay on the coloured varnish, making sure that each coat is perfectly dry and free from tackiness before applying the next. Avoid all draughts playing on the work when in progress, for these will cause the surface to " bloom " or assume an unpleasant milky appearance. For this reason also no varnishing should be attempted in cold or wintry weather. The best time

for the work is the height of summer, when warm dry days may be reasonably expected. When the depth of colour required is reached the varnishing may be stopped and the varnish allowed to thoroughly dry and harden.

There is another method of varnishing which is sometimes preferable to the above, especially if deep colours are required. The colouring matter is mixed in a separate vessel with a little varnish, and the varnishing is carried out by alternately dipping the brush in varnish and colour, modifying the tint as proceeding and gradually increasing the transparent varnish and decreasing the colour on the brush as the coatings become more numerous, finally finishing off with clear varnish.

By this means the colour is diffused throughout the covering, and the light filtering through the varnish to the ground wash lights up the whole and imparts that fire which it is the aim of every fiddle maker to obtain. It is for this reason that an ordinary stain placed on the bare wood and covered with transparent varnish is so seldom satisfactory. The colour must be in the varnish as well as below it, and so long as this is obtained and transparency is not sacrificed it matters little which method is adopted.

Varnish the inner edges of the sound-holes, the head and scroll as far as the beginning of the neck, and including the inside of the peg-box and the shoulder of the neck, but not the neck itself. No varnish in any circumstances should be allowed to penetrate to the inside of the instrument.

During varnishing, the instrument should be protected from dust, and if possible air and light allowed to reach it, in order to assist oxidation of the oils.

Polishing.—When thoroughly dry, the surface of the varnish must be ground perfectly flat and smooth all over by the aid of pumice powder and water or No. o glasspaper dipped in water, using plenty of water, and making sure that there is no grit in the pumice to scratch the surface belly. When a final smooth, dull polish is obtained, the surface should be brought to a fine bright polish by rubbing with crocus or tripoli powder in oil or soap and water. This tripoli finishing will mellow the appearance of the varnish and improve it considerably; but it has a tendency towards softening the film, which must be allowed to dry hard again.

Finally, a mirror-like appearance may be imparted to the surface by rubbing briskly with the fleshy part of the thumb.

Some makers claim that this fine polish destroys the tone to some extent, but there does not seem to be any scientific ground for this, and probably in those cases where the tone has suffered after polishing there was some other undetected cause of the loss of tone. There is, however, a peculiar beauty about the appearance of the varnish before the final polishing which would no doubt appeal to many people, and the maker must use his own discretion as to the desirability of the final mirror polish.

Spirit varnishes are ground flat and polished in the same manner as the oil varnishes, and as they dry instantly (or practically so) the process of spirit

varnishing is much more rapid than that of oil. As before stated, however, the process is not recommended to the violin maker who is desirous of making a first-class instrument.

The neck of the violin is either finished with a rubbing of linseed oil, or is varnished with an ordinary white hard spirit varnish, then ground flat with pumice powder and polished with tripoli like the rest of the instrument.

CHAPTER IX

Fitting Up

THE violin is now made and varnished, with everything ready for stringing up and playing ; but there is a considerable amount of careful workmanship to be executed before the instrument is in a fit state to do its best. The adjusting of the violin is one of the most important processes connected with the instrument, and even a poorly built and defective violin may be made to sound tolerably well by careful adjustment. On the other hand, a beautifully constructed instrument will be quite spoiled by bad adjustment.

The Bridge.—A bridge is required, over which the strings pass from the tail-piece to the pegs. This bridge, although perhaps insignificant to look at, is the most important fitment (excepting only the sound-post) in the whole violin, and every care must be taken to secure the proper kind of bridge for the particular instrument under adjustment. Generally speaking, a heavy violin with plenty of wood in it, requires a moderately fine bridge, whilst a light instrument, meagre in material, will give the best result with a moderately heavy bridge.

Again, a violin shrill and hard in tone (generally found in company with a meagre allowance of wood) may be improved by the fitting of a bridge made of

soft wood (sycamore cut on the quarter is the material), whilst a soft woolly tone may be brightened up and added brilliancy imparted by the fitting of a fairly thin hard-grained bridge. The height of this bridge is governed by the height of the fingerboard, and should be just sufficiently tall to allow the strings to vibrate clearly *in playing* without touching the fingerboard. If the bridge is too high, difficulty will be experienced in obtaining good tone, especially in playing rapid passages, owing to the force required in pressing the strings down in fingering the instrument.

Setting-up the Bridge. — The position of the bridge-feet is exactly between the two nicks cut in the inner edges of the sound-holes, and a piece of thread drawn taut across the fiddle belly between these two points gives an imaginary line against which the *back* edges of the bridge-feet fit. Any deviation from this line will interfere with the tone. It will thus be seen how important it is to have the sound-holes in their correct positions and the nicks cut in the right places, because on their correctness depend not only the position of the bridge but also of the bass-bar, as previously explained. The joint of the belly when the bridge is standing in its correct position passes exactly between the right and left foot of the bridge.

These instructions must be followed in setting up the bridge. The feet of the bridge must be fitted exactly to the curve of the belly, both sidewise and longitudinally. The correct way to obtain this fit, which must be absolutely perfect over all surfaces, is as follows :

With a keen-edged penknife pare the feet of the bridge roughly down to the shape of the belly, leaving sufficient wood in them to stand firm without giving way to pressure on the strings, but not so much wood as to cause them to appear clumsy or to interfere with the maximum amount of vibration. Now place a strip of fine glasspaper across the belly, between the nicks of the sound-holes, and whilst holding the bridge firmly in an upright position between the finger and thumb of one hand, and the glasspaper with the finger and thumb of the other hand, rub the feet backwards and forwards between the nicks of the sound-holes until all roughness and inequality of wood are removed and the bridge stands in its proper position with every part of the bottom surfaces of its feet fitting the belly perfectly all over.

No pains must be spared to make this fitting perfect, for imperfect fitting will affect the tone in no inconsiderable degree.

Some makers scrape away the varnish under the bridge-feet to make junction exact with the belly wood itself, but it is doubtful if this is a wise procedure on every occasion. It will perhaps aid a dull-toned violin to increase its power, but the quality of tone seems to suffer by the process. A very valuable Strad. which came under the writer's notice some years ago was not scraped away at all at this point, and several expensive Italian instruments are also intact, so far as varnish is concerned, at this spot. The method seems to have been adopted by a later generation of makers than the classical Italians, and it is better to follow

them wherever possible, unless the violin demands a radical departure (such as this one) from their methods.

The right foot of the bridge should be in line with the sound-post (the fitting of which will be explained later), and the left foot must be directly over the centre of the bass-bar. By this arrangement both pairs of strings, the first and second, and the third and fourth, are directly in communication with the sound conductors of the instrument. This point is very important, and on no account must it be neglected. For this reason bridges made with more than two feet are unnecessary, and it will be found in practice that the ordinary one-piece bridge with two feet only is sufficient for every purpose of tone. It is in the fitting and position and weight of the bridge where the importance of judgment lies rather than in alteration of its form.

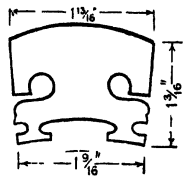


Fig. 41.—Arch and Pattern for Bridge.

The sweep of the top of the bridge is also important, as on the correct arch depends ease of bowing. An outline diagram is given by Fig. 41 showing this arching, and also for the purpose of cutting home-made bridges, if these are required.

It is not always possible to obtain a suitable bridge, especially with the correct *density* of wood. Therefore the maker will probably be required to construct his own. It should be cut out with a fret-saw, and carefully bevelled with a sharp chisel, files and glasspaper to the correct thickness and weight required by the in-

strument. It must, of course, taper on each side without any suspicion of hollows or lumps, and must in every case be cut on the quarter. It is often desirable to make them from the same piece of material as the back (when that is a sycamore one); also the pieces cut from the inner bouts often make capital bridges.

When a bridge is satisfactorily made and fitted, every care should be taken of it, as it adjusts itself to the instrument and grows in age with it. A new bridge is never so satisfactory as an old one, at any rate, for some time after it is fitted to the violin.

The Sound Post.—The sound-post is the most important fitment in the violin, and the slightest alteration in its thickness, position or nature of material will radically alter the tone of the instrument. It is made from pine, preferably from the same piece as the belly, and is set up inside the violin in a perfectly upright position about $\frac{1}{4}$ in. or less exactly behind the right foot of the bridge. An instrument made of iron, called a sound-post setter, is employed in the fitting and adjustment of the sound-post. The fitting of the top and bottom of the sound-post against the back and belly of the violin must be as conscientiously executed as the fitting of the bridge-feet.

First of all, with the callipers, obtain the rough outside measurement over the place where the sound-post will stand. Now split the pine until a stick is obtained $\frac{1}{4}$ in. thick and the same length as the callipered depth of the fiddle. Then bevel the two ends roughly to fit the sweep of back and belly at the proper place. Round the post with plane, files and

glasspaper, and inserting the sharp end of the setter into the lower portion of the side of the post in such a manner that the fibres of the post will be across the fibres of the belly, pass the post through the right sound-hole, and by manœuvring the setter try the fit.

It will take some little time to obtain a good fit, and by looking through the tail-pin hole in the bottom block any discrepancy in the fitting against back and belly will be noticeable. Continue to file the ends and test in the fiddle until the post is exactly fitted and perfectly upright in the instrument and just behind the right foot of the bridge. It may have to be moved a little backwards or forwards, or a little to the right or left, according to the build of the instrument, but it cannot be too strongly enforced that it must fit perfectly. Its diameter when finished should be $\frac{3}{16}$ in., but this will vary slightly in different instruments. Do not make it too thin ; it must carry plenty of vibration.

It must not be jammed into its place, or the belly will be damaged and the tone spoiled. When correctly fitted it will slide into its place without any force, and indeed force must not be used in any circumstances when fitting the sound-post.

If too tight, the tone will be tense and hard ; if too far forward, the tone will be loud and shrill without quality ; if too much to the right of the fiddle the E or first string will be loud and coarse, and the fourth or G string dull ; if too much towards the centre of the fiddle, the E string will suffer and the G become loud and strong.

The object to be aimed at is evenness of tone and

equal strength on all four strings. Do not be anxious to obtain power at first. If the violin is sweet and even in tone, power will come with use. No new violin (or at least very few) are both sweet and powerful, and if the former quality be present it is a subject for congratulation. There are many fiddles too loud, but not sweet, and there are not so many with the correct singing quality which should be the goal of every fiddle-maker.

The tone of the violin may also be modified by the use of a hard- or soft-grained post, as occasion demands. No circumstance must be neglected in order to obtain the maximum quality and quantity of tone from the violin. It will be found that careful adjustment of the sound-post plays a very considerable part in this matter.

CHAPTER X

Stringing

Fitting the Tail-piece.—The tail-piece now requires to be fitted. A piece of tail-piece gut will be required long enough to thread through both holes and form a loop with the loose ends inserted through these holes in the bottom of the tail-piece. The loop must be made of such a length that it will fit over the tail-pin inserted in the bottom block. The end of the tail-piece should project over the tail-rest, and there should be no part of the belly showing through between the bottom of the tail-piece and the edge of the fiddle. When the correct length of gut is found to allow the tail-piece to lie in the position indicated above, the ends should be knotted in a single knot, cut off, and the points burned with a lighted match. The heat will cause the ends to swell up into knobs and so prevent them (in conjunction with the single knot) from slipping through the holes in the tail-piece when the violin is strung.

Stringing.—A set of strings will now be required, E, A, D and G. The G string is wrapped with bell metal, copper or silver wire, and the latter, although somewhat expensive, is to be preferred on account of tone. The thickness of these strings varies with each fiddle, and the various gauges should be tried by means

of a string gauge until the set which best suits the violin is found. A note should be made of this for future reference.

Strings are made of gut or silk, and the former are to be preferred on account of their purity and strength of tone. Silk strings are liable to fray quickly, especially if the player's hands are moist.

String the E and G first, but do not tighten them up until the A and D are fitted. Each string should run direct to its own peg without crossing in the peg-box. The position of the holes in the pegs will affect this, and if the holes in the pegs are in their correct places no trouble will be found in adjusting the strings. Do not cut nicks in the top of the bridge; the strings will jam and break, or pull the bridge forward. The strings will make their own bed, and the most that is required is a shallow groove in the proper place made with a stroke of a fretworker's file. The violin is tuned to the second string—A—the first string, E $\frac{1}{5}$th above, and the third and fourth, D and G respectively $\frac{1}{5}$th below. The strings should *not* be tuned down when the violin is put away after playing, as the constant alteration of the tension of the strings does more damage to them than standing continually at full concert pitch.

Strings should be kept in an airtight tin box, and only a small stock should be bought at one time. Gut deteriorates, especially if subjected to the action of light, and unless great care be taken of the strings they soon become dry and brittle. This may be obviated to some extent by rubbing them before string-

ing with a rag soaked in almond oil, but care must be taken that none of this substance is allowed to get on the bow hair, or good tone will be impossible. Before fitting any strings they should be wiped clean and dry. Almond oil is the proper substance with which to clean the violin, and on no account should any variety of patent polish, or stuff of that nature, be allowed near fine oil varnish.

Do not buy fancy inlaid tail-pieces, pegs, etc. They may be very pretty to look at, but the inlay is liable to work loose and rattle, causing a mysterious buzzing sound which is often extremely difficult to trace. A loose finger-board, badly fitting peg, deep nicks in the bridge or in the nut, in which the strings rattle, badly fitting bridge or sound-post, are all liable to cause this buzzing sound, which is very annoying to a player. Loose linings, blocks, or a very dry G string will also cause it, especially the latter. In this case do not destroy the string, but give it a liberal coating of almond oil and allow it to stand for a day or so. The oil will penetrate into the gut, causing it to swell, and so tighten up the wrapping on itself, thus curing the buzzing. Do not forget to wipe away all trace of superfluous oil before refitting.

Chin-rests are often used, but although they protect the varnish from the friction of the chin, they often do much damage to that edge of the instrument which demanded much patient workmanship in its correct construction. For this reason it is better to do without the chin-rest if possible, although it may be necessary to fix one temporarily when using the violin in

the white to prevent the chin from soiling the belly of the instrument.

The choice of strings for the instrument requires some little experience as there is considerable variation in their quality. A good gut string is white, translucent, and free from spots or blemishes. Yellow or dirty-looking strings are seldom satisfactory. It should be borne in mind, however, that a string may be over-bleached, and very white strings should be viewed with suspicion. They are often nearly rotten, and will not stand concert-pitch strain.

A good string may generally be known by its regularity of vibration. Unroll the string and stretch it taut between the thumb and forefinger of each hand. If it be now set in vibration by twanging it, it will, if well made, form two regular lines of vibration, showing as two strings meeting at the fingers of each hand where it is held. If it shows irregular lines it has been badly spun, and should be rejected. German strings are white and clear; French strings somewhat similar, though not so well finished; English strings are generally dark-coloured. Sometimes they are good in spite of their colour. The Italian strings are the best, although they sometimes suffer from over-bleaching. There is an Italian string on the market made of red and white twisted gut which is found satisfactory.

It must not be forgotten that one bad string will upset the balance of the instrument and destroy the tone of the others so long as it is suffered to remain on the violin. If the tone of an instrument is faulty and

no defect can be found in making or fitting, look out for a cracked or faulty string. It is occasionally the unsuspected cause of trouble.

If the pegs should stick or jam rub them with a little blacklead, first of all making sure that they are perfectly fitted. If they show a tendency to slip, rub them with a little chalk. The application of these substances will cure the trouble in their respective cases. A first-class instrument is sometimes fitted with gold-mounted pegs! but the violin, generally speaking, needs no adventitious advertising of this kind. The workmanship if thoroughly performed is its own advertisement, and the fitting of gold-mounted pegs to a fine instrument seems somewhat in the nature of an attempt to paint the lily.

The maker who has persevered with the work and completed a violin will not need to be told to value it. The work of construction will be sufficient to cause him to do that. But it is well to know the right way to do it. First, keep the violin clean. Dust away all resin after playing, clean off any dirt by means of almond oil, and wipe dry, polishing with a silk cloth. The violin should be wrapped in flannel or soft material, and kept in a case. Do not hang it on a wall. Protect it as far as possible from changes of temperature, and finally, if it shows a variation or uncertainty of temper, have patience with it, for it is of delicate organisation and falls ill easily. And do not forget that it has been the constant friend and companion of many wise and great men, and it is well worthy of the respect which should be paid to it

CHAPTER XI

Repairing Violins

As the violin is an instrument of very delicate constitution, liable on the slightest cause to fall ill, it is necessary that the repairer should be in a position to diagnose the complaint and to prescribe or carry into effect the necessary remedies.

Tools.—For this purpose he, first of all, must provide himself with the necessary tools—sound, workmanlike articles. The violin-maker who has practised on the lines indicated in the previous chapters on the subject will already have most of the tools necessary for the repairer. Those who have not yet taken up the subject will require the following articles, most of which will be necessary for even simple repairs. Others which are not described will be illustrated during the progress of these notes.

First of all a good strong solid bench should be purchased. A local joiner is a good man to apply to for this article, and if a practical craftsman, will construct at a comparatively small cost a bench which will meet all requirements. It should not be less than 4 ft. in length and about 20 in. to 24 in. in width. It should be fitted with a good vice. A small steel vice, to screw on the bench when required, may be obtained at any tool shop, and will be found extremely useful where

pegs have to be bored, scrolls repaired, bass-bars shaped, home-made tools constructed, or the hundred and one operations of the kind necessary in violin making and repairing.

Gouges and chisels, inside and outside ground, are very necessary, and the violin doctor can hardly have too many. Violin cramps are extremely useful. A fine tenon saw, a small hand saw (about 6 in. in the blade length), a bow saw, and an ordinary crosscut saw (all of first-class make, bear in mind) will be wanted. Poor saws are anathema, so buy the best obtainable and keep them in first-class condition. They may be re-set and sharpened for a shilling or so at any tool-shop. The value of a saw may be fairly judged by the length of time it will remain effective without re-sharpening, and that saw which has to be taken round to the sharpener every few weeks should be scrapped.

Fiddle planes, round soled and flat, of several sizes should be obtained ; brass or gunmetal ones are best—they work better than steel and do not rust. A smoothing plane and trying plane are useful, but will not be required for simple repairing. A few good steel cramps will be wanted—different sizes, of course—and a fiddle-maker's set of callipers. For bow making and repairing a bow-maker's callipers set, a frog callipers and a bunsen flame had better be obtained.

The repairer will also require varnish and colours ; spirit varnishes and oil varnishes are both useful. Any reputable colour and varnish maker will supply, and the kinds and quality in every case must be the best possible obtainable. Crocus powder, pumice powder,

several grades of glasspaper, will all be wanted, and the operator may as well provide himself with small quantities of these, as he will find it impossible to carry the work to a successful conclusion without them. A stock of wood, sycamore and Swiss pine, the older the better, will also be necessary. Everything requisite for violin making and repairing—tools, wood, varnish and fittings—is supplied by Mr. Robert Alton, 35, Shakespeare Street, Bootle, Liverpool.

With this preliminary explanation, necessarily somewhat lengthy, the operations of the various repairs likely to be necessary will be dealt with. One warning is necessary, as in the case of good violin making calm, deliberate workmanship, carefully studied and well thought out, is a *sine qua non* in fine repair work, and poor repairing is almost worse than none—at any rate, in the case of a good violin. The owner of such an instrument will certainly resent it, and will not fail to voice that resentment; therefore, let the repair be of the best possible workmanship, and do not be beguiled into "rushing" the work either by the owner's plea of wanting the violin back "at once" or on any other consideration whatever. Besides, the fiddle will resent rushed work as well as the owner.

The largest class of repairing work which will fall to the amateur repairer is the various types of adjustment —fitting bridges, putting up soundposts, replacing pegs, gluing on fingerboards, and re-stringing. Although these repairs or adjustments on first glance may seem simple matters, there is a good deal of experience or knowledge required before they can satis-

factorily be carried out so that the violin will give of its best. This especially applies to stringing, bridge fitting, and soundpost adjustment.

Fitting New Bridge.—The main thing to be considered is the style and age of the instrument. A lightly constructed violin with the wood of the back and belly thinned out will generally be found to possess a thin, piercing tone, shrill under the ear, with little carrying power. This shrill tone must be modified by the use of a soft bridge of moderate thickness. The height of a bridge has also some effect on tone; but as the height of the bridge is governed by the set of the neck and the inclination of the fingerboard, little can be done in this direction without alteration to the neck, a somewhat difficult matter, and one not to be undertaken without the permission of the owner of the instrument. A low bridge (other things being equal) will modify, soften, and sweeten the tone; a high bridge often sharpens and sometimes strengthens the tone.

The taper of the bridge, methods of fitting, choice of strings, and position and size of soundpost are all matters which have been described in the series on violin making.

The repairs proper to the instrument may be divided under two headings, repairs to the head and neck, and repairs to the body, proceeding from the simpler or more easily executed repairs to those of a more difficult or complicated nature.

Neck and Head.—The neck and head are constructed of sycamore or (less commonly) bird's-eye

maple. It is hardly necessary to add that in repairing broken scrolls or damaged necks wood must be chosen of the same character as that of the portion under repair and as near as possible in both grain and colour. It is not permissible to repair a sycamore head with material other than sycamore, and the same thing applies to bird's-eye maple.

Re-fitting Pegs.—A simple repair to the head is the re-fitting of pegs. Old instruments which have been long in use sometimes become worn badly in the peg-holes, so much so that, without grave danger of splitting the cheeks of the pegbox they cannot be fitted with larger pegs ; but the holes must be filled up and rebored, fitting with correct sized pegs after the reboring is completed. This is accomplished in the following manner : A sound length of sycamore is obtained of a slightly larger diameter than the hole which requires " bushing," as the technical term is. This length is made perfectly circular and of taper to fit the hole exactly. With the aid of a steel tapered-reamer the hole is cleaned out perfectly circular, and the sycamore plug fitted right through from one side of the pegbox to the other, allowing the plug to project slightly on each side of the outer cheeks of the pegbox. This fitting or plugging must be cautiously carried out in order to avoid splitting the pegbox cheeks which latter calamity will necessitate a more complicated repair. The fitting of the plug must be perfect, and the easiest way to ensure this is to see that both pegholes (on each side or cheek of the pegbox) are made perfectly circular, and the tapered plug also. Small flat planes (obtain-

able for the purpose), files and glasspaper will all be used in order to effect this fitting.

When the fitting is satisfactory, the plug is glued into its place. White glue should be used, and it may be obtained from the London music warehouses. By using white glue the black line at the junction of the

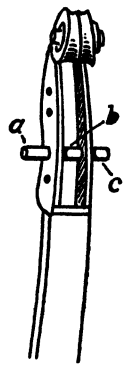


Fig. 42.—Pegbox with Glued-in Peg.

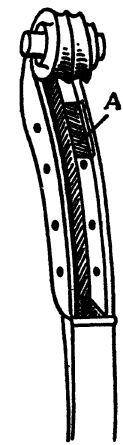


Fig 43.—Position of Peghole Centres.

old and new wood may be avoided, and in case the repair should not happen to be as well fitted as it might be, the use of white glue will minimise the glaring effect of faults. Every effort, however, should be made in all repairing work to obtain a first-class result.

When the plug is glued into its place and the glue is dry, the portion crossing the interior of the pegbox must be cut away with chisels and finished up against the pegbox cheeks smooth and flush. The same

applies to the portions projecting on each side of the outer pegbox surfaces. Fig. 42 shows the plug in position, *a*, *b* and *c* denoting the portions to be cut away. The edges of the plug, which are now flush with the inside and outside edges or surfaces of the pegbox, must be levelled and smoothed down with fine keen-edged chisels, taking care to avoid damaging the varnish on the outside cheeks of the pegbox.

If the old pegs have been fitted into the head in their correct positions, the exact centre of the plug will be the correct position to start reboring for the new peg. But it sometimes happens that owing to careless workmanship on the part of the original maker the pegholes are placed to one side, either too far to the back or too far to the front of the scroll. If too far to the front, there is danger of breaking away the side of the pegbox or cracking it longitudinally. This especially applies to the A peg, where there is always less room between the peghole and the front edge of the pegbox than in any of the other pegholes. Again, if the pegs are improperly placed, the strings will foul each other in the pegbox itself. This defect is, by the way, very unsightly and should be remedied where possible. In shifting the pegs, however, towards the back of the scroll the depth of the pegbox must always be examined to see whether the string will have clearance round the peg in its new position. Some scrolls are deeply cut in the grooves which run up the back of the scroll, and if the pegs are shifted too far back, it will be impossible to cut away the back of the pegbox inside to give string clearances without going through the back of the scroll.

These matters must be looked to before reboring for the new pegs. Fig. 45 is a pattern for an average Strad. scroll, showing the position of the centres of the four pegholes; but these will vary slightly with different models.

The correct positions of the peghole centres having been found, holes must be cautiously drilled through the pegbox cheeks from one side to the other. These holes must be of sufficient diameter to admit the point of the steel reamer, which follows through and cuts out the circular taper hole to the size necessary for the new peg. There is a tool used in violin-repairing workshops called a "lousse," which is very useful for the purpose of starting the holes through; but a spiral fluted steel reamer should always be used to cut out the tapered hole and to finish it ready for the peg. The "lousse," with careful management, will effect this work itself; but it needs more skill and care to finish up the peghole truly smooth and perfectly circular with the "lousse" than is necessary with the fluted reamer. Both tools should be obtained by the amateur. In Fig. 44 A shows the pattern of the "lousse," and B the fluted reamer.

When the holes are bored to a correct size and in their proper places, ebony pegs of the correct taper and size must be carefully fitted with the aid of files and glasspaper. The fit must be absolutely correct in order that tuning up may be carried out by the player without undue wrenching at the peg or jamming of the peg in the hole.

In boring for the pegs, two precautions must be

observed. One, that the holes are drilled perfectly parallel with the axis of the head and neck (that is, that they are at right angles with the scroll in both directions, looking at them from the front of the scroll and also from the top of the scroll), and, two, that the holes for the pegs are tapered from their proper sides—the A and E pegs from the right side of the pegbox, and the D and G pegs from the left side.

In plugging up the old holes some repairers use a parallel reamer, and plug each hole separately. This is a matter of choice. The parallel reamer takes out more of the pegbox cheek from the narrow end of the peghole; but it is easier to fit the new plug into the hole made by the parallel reamer than by the tapered reamer. In using a tapered reamer, of course the plug must go right through the pegbox—from the larger tapered end to the narrowest part of the tapered hole.

Scroll Cheek Cracked.—A frequent injury to the scroll, and one not particularly easy to remedy, is a cracked cheek. This may happen to any portion of either cheek, but is generally to be seen between the front edge of the pegbox cheek and the outer circle (or part circle) of the A peghole. Wherever the crack is found, however, the method of repair is the same so far as the pegbox cheeks are concerned. It will be supposed that the damage is in the position stated—in front of the A peghole. If the damage is not repaired there is grave danger of the split extending and a piece breaking away from the cheek altogether, and in this case, especially if the piece is lost, the work of repairing is troublesome and tedious.

The first operation (after removing strings and pegs) is to cut away a section of the pegbox cheek on the inside edge from the front to the back of the box. This segment should be wide enough to embrace the whole of the crack, and it should be about half the thickness of the pegbox cheek. The hole thus cut must be perfectly square and cleanly cut, parallel all the way down to the back of the box. A sound slip of

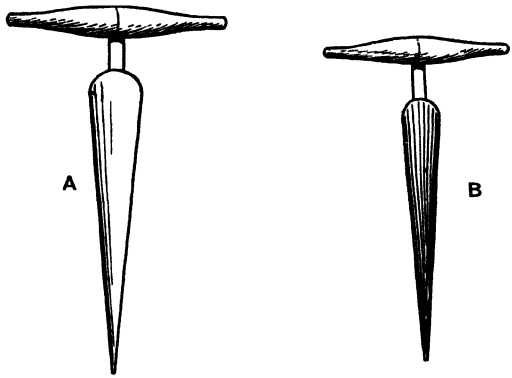


Fig. 44.—(A) Lousse or Peghole Bore, and (B) Cut Steel Reamer.

sycamore must be cut and filed to fit this hole perfectly. When this process is effected, the slip is glued into its place and cramped home, the varnish on the outer cheek of the pegbox being protected from injury by the cramp with a slip of cork or soft wood. Fig. 43 shows the slip in position, and the diagram will explain the method of procedure perfectly. The main thing to be watched in carrying out this repair is accuracy of fitting. When the piece is glued into its place and the glue is dry, the front edge of the slip is pared down

with a sharp chisel level with the sweep of the edge (front) of the cheek. If the crack is found in both cheeks, the fitting of the slips is effected in the usual way; but, in cramping up, a block of pine must be cut which will fit exactly into the pegbox between the slips on each side in order to obtain a purchase against which

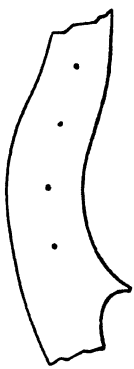


Fig. 45.—Repairing Crack in Cheek.

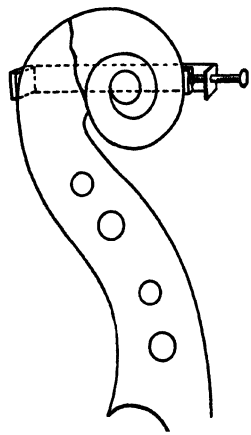


Fig. 46.—Repairing Broken Scroll.

the cramp will act, the cramp, of course, being applied across the outside cheeks of the pegbox. When dry, the block is removed, the front of the slips pared down, and the job finished. Should the varnish require matching, the method of doing this will be described later in the series.

Broken Scroll.—The repair of a broken scroll is more complicated, and requires exact workmanship, especially if the scroll be splintered or the fracture an

old one. In this repair it is presumed the scroll is still at hand.

There is probably no part of the fiddle more subject to slovenly repairing than a broken scroll. One occasionally sees a broken scroll screwed on with steel screws, and should there be any missing portion it seems to be a point of honour to fill up the space with wax, putty, glue or other quite unsuitable substances. A really fine repair (where this damage has occurred) is a masterly piece of workmanship, and on fine instruments which have been repaired at this portion of the structure by skilled craftsmen the workmanship is occasionally a treat to examine.

If the break is a clean, new one, the best remedy is immediately to glue the scroll into its place with good strong white glue, making sure that the joint is as close as possible. It is always difficult to apply cramps in repairing damage to the scroll itself, and the operator's ingenuity will sometimes be severely taxed in order to find an effective purchase for the application of the cramps. The fracture may lie in the direction of the axis of the head, or it may lie at right angles to it, and it also may take place at any other angle across the head or the cheeks of the pegbox between the right angle and the horizontal (or vertical). The application of cramps will depend on the direction of the break.

The scroll will almost certainly have to be fitted at some part of its surfaces with specially cut blocks, shaped to fit the required place, and sometimes the blocks, after cutting, may require temporarily gluing in position. The repairer must use his own judgment ;

every case varies, and no amount of printed directions will help him much in this particular species of repair. The main thing to be looked out for is to fit blocks truly in the position where the cramp will be able to obtain a firm purchase. The job must be deliberately considered, and the best means for the purpose of repair decided on, before commencing actual work. The inside of the pegbox may sometimes be used as a starting point for building up a purchase, and the advantage of commencing from this point (where possible) is that gluing operations (temporary) may be fearlessly indulged in, there being no need to worry over spoiled varnish. If the head is badly splintered, these splinters will have to be taken into account, because in all cases as much of the old wood as possible should be saved in preference to putting in new wood.

A typical break is shown by Fig. 46, with its method of repair illustrated. This is comparatively simple, but it serves to show the application of the cramp after gluing.

In spite of all precautions to preserve the old wood, it will probably be found, in the case of an old fracture, that portions of the old wood are missing, and that after the gluing up has been completed there are one or two places where the wood requires levelling up to the surrounding surface. Wax or patent stopping should not be used. It is extremely probable that wax will sooner or later fall out or will sink below the surrounding level, and, in addition, it is extremely difficult satisfactorily to colour these substances to match the adjacent varnish. The correct substance with which

to repair the damage and to fill up holes is wood. I the hole is of considerable extent, pieces may be cut, the hole squared (or rounded with a Cushman bit), and the pieces fitted (in this case the figure, grain and direction of grain of the surrounding material must be closely imitated); or, if the hole is small, the correct method is to fill it up with shredded pine and white glue, levelling down after the glue has set with a keen-edged chisel and fine glasspaper. The colouring of this and other repairs will be dealt with later.

Chipped Scrolls.—The curls of the scroll on each side are not infrequently broken or chipped away by careless handling, and occasionally one of the " eyes " of the scroll may be missing altogether. It is not permissible to alter the formation of the scroll on a good violin in any shape or form whatever, and in replacing lost or broken portions it must be borne in mind that any departure from the original pattern or alteration to the original maker's idea of form or flow of line must on no account be done. It may be that the repairer's idea of line and form is quite distinct from that of the violin under repair, and it is not impossible that his idea may be the superior one, but that in no way justifies interference with the flow of line in any particular scroll or modelling. Each violin stands on its own merits as a work of art (or otherwise), and another conception of form superimposed on the first reduces the whole to meaningless nonentity. Therefore, in all repair work, the design, modelling and flow of line must be strictly adhered to.

It is a comparatively simple repair to insert new

pieces of wood into the spaces caused in the curls of the volute, and this must always be done. No filing down or cutting away of adjacent portions (forming a new and altered flow of line) must in any circumstances be attempted. When the " eye " is broken away on one side, the other eye of the scroll is taken as a pattern. A piece of sycamore, roughly shaped to the pattern of the " eye " on the scroll, but slightly larger and wider, requires fitting into its place in the scroll. A Cushman bit of a diameter suitable for the work is used to drill a hole into the scroll, of a size exact to the base of the eye, the hole being deep enough to give a good hold to the new eye when inserted. It must be noted that this hole must be exactly opposite to the eye on the opposite side of the scroll, and that when the new eye is glued into place it must exactly balance with the other, no matter from which direction it is examined.

To obtain this desired result will not be an easy matter. Drilling must be carefully watched and cautiously carried out, the brace being held exactly at right angles to the scroll during the work. When the hole is drilled out, the new plug of wood is firmly glued home and left to dry. Then will come the modelling—the other eye must be matched exactly in size, shape, length and outline. Cut it carefully to pattern with sharp chisels and gouges, finishing with glasspaper. The colouring of the new wood and varnishing to match the rest of the varnish on the fiddle will be the final operation, and will be dealt with under the heading of varnishing.

Worm-eaten Violins.—Many old violins are badly worm-eaten, and in some cases the damage is so extensive as to ruin the instrument. Any sign of the ravages of this pest must at once be attended to, for worms, once they get into a fiddle, will pursue their work until the whole instrument is rendered useless. The head, neck and scroll being peculiarly liable to the attacks of these insects, the matter will be dealt with here.

These "worms" are really small beetles, varying from the size of a pin-head to $\frac{1}{8}$ in. in length. They are furnished with powerful jaws, by means of which they tunnel right into the heart of the wood and, moreover, make tortuous journeys in every direction. They are very difficult to destroy once they are firmly established. Creosote squirted into the holes is supposed to kill them—when it reaches them, but as a matter of fact it is almost impossible to get at them, buried as they are in the interior of the material. The best remedy, if the damage is not too large, is to cut away, when possible, the whole of the wood containing the holes and replace with new material. In very valuable instruments, in order to save as much of the original wood as possible and to preserve the contour and modelling, the holes are drilled and plugged with new wood. This is a troublesome, tedious and expensive process, and should not be undertaken unless the value of the fiddle warrants it. At the same time it is not desirable indiscriminately to cut away whole portions of the fiddle and insert new wood. Discretion must be exercised, or the tone of the violin may be seriously injured. This especially obtains where the repair is

required in the back or belly. Give the damage a thorough examination and think out the best and most suitable repair before commencing work at all. A thoughtful and deliberate examination will well repay the time spent on it, and the proper ways and means will in all probability suggest themselves to the repairer during his leisurely examination of the damage.

Fingerboards.—In the neck, shoulder and fingerboard will be found a great variety of repair work, varying from simple damage or faults to complicated and highly skilled repairing. The fingerboard is frequently found loose, especially at the lower end where it projects over the belly of the instrument, and this fault is often responsible for an unpleasant buzzing or jarring sound when the violin is played.

In refitting an old fingerboard or putting on a new one, the joint must be perfect, whilst at the same time it must be possible to remove it, if necessary, with a minimum of effort. Some violins are found with the fingerboards so firmly glued in position that it is a difficult matter to remove them without damage to the necks. The fingerboard must not be regarded as a permanent portion of the instrument. It frequently happens that it is required to be taken off for the purpose of "re-grafting," re-setting the neck, or repairing the belly. At the same time it is necessary that when the fingerboard is glued on it stays on until such time as removal is necessary. This is generally effected by reducing the glued area, the middle portion of the fingerboard, for that portion of its length which covers the face of the neck, being hollowed out down its

centre, thus enabling it to be glued home without the hold being permitted on the central portion of the glued length at all. The wood must be carefully gouged away of a depth sufficient to ensure this, whilst at the

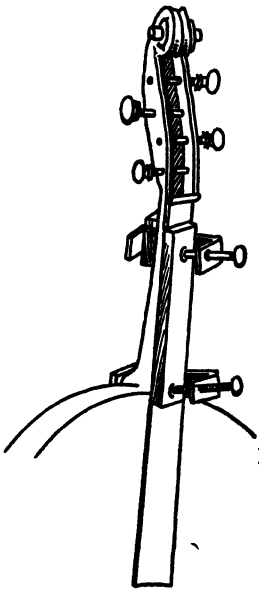


Fig. 47.—Gluing Fingerboard.

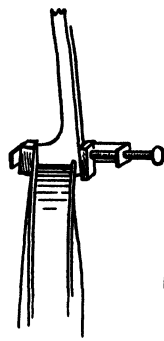


Fig. 48.—Cramping Neck into Position.

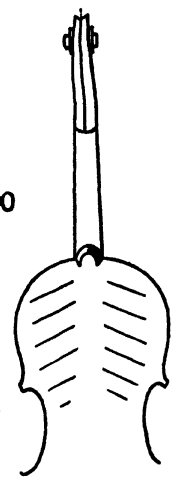


Fig. 49.—Diagram showing Ebony Half Circle Round Button.

same time the outside edges must fit perfectly along each side of the face of the neck. Steel scrapers are very useful for this purpose. It will be found in practice that planing either on the fingerboard or the neck will cause a rounding across the width of the material, which makes it impossible for a perfect fit to be obtained. The scraper must be quite sharp and its

edge perfectly flat, and in this condition it will take off fine shavings in any required direction, flattening the surface perfectly, and enabling the operator to obtain a good fit with a minimum of trouble.

Ebony is a cold wood, and in all gluing operations with this material the wood must be warmed before the glue is applied, otherwise it will chill the glue. Chilled or cold glue is useless, no matter how good the quality may be. In gluing on the fingerboard it should be used of the same consistency as olive oil, running finely from the brush without forming into drops. Coat the back of the fingerboard and the face of the neck, and bring the parts together, rubbing out all superfluous glue rapidly, and applying cramps as shown in Fig. 47. When the cramps are applied, additional glue will be forced out, and this must be washed away with the brush, previously soaking the brush in hot water. If the glue is allowed to harden on the neck it will be troublesome to remove, and should the operator attempt to cut or chisel it away he will possibly lift out pieces of the maple from the neck, causing serious damage. It is always necessary in gluing operations to wash away the superfluous glue whilst it is warm, and it will soon be found that it is much the easiest method.

Often it will be found that the fingerboard is deeply grooved under the strings by the practice of " vibrato." It is impossible to obtain good tone where these grooves are in evidence ; the remedy is to scrape them out with the steel scraper. There is only one precaution to be taken—the fingerboard must not be made hollow, or another defect, the " breaking " of the string against

the raised portions of the fingerboard during playing, will be caused, a defect quite as serious as that owing to the grooves. In scraping out these grooves a straight-edge laid along the fingerboard during the operation will enable the repairier to preserve the flatness of the fingerboard along its length. The cross arching must also be preserved, and this is simply a matter of care.

Loose Neck.—The neck where it is jointed into the top block of the body is sometimes found to be loose. It is, of course, impossible to play the fiddle in such a condition. Some repairers simply work in thin hot glue, cramp up, and leave to dry. This method is extremely unsatisfactory, as the joint is seldom, if ever, secure, and sooner or later, generally sooner, the neck works loose again. The neck should be taken out and re-set at the correct angle. To do this proceed as follows :

First of all work into the joint hot water, taking every care that the action of the water in softening the glue is confined to the joint of the neck, and not allowed to run down the joints of the tables with the ribs. By a little perseverance the glue holding the neck in position will be softened sufficiently to enable the repairer to pull out the neck altogether ; but force must on no account be used, or the ribs, tables or top block may be injured. When the neck is removed the parts must be thoroughly cleaned of all old glue by repeated washings with hot water. The brush is useful for this purpose. The instrument must now be laid on one side until thoroughly dry.

Refitting the Neck.—The next process is refitting the neck. The correct backward angle is found as follows: A long straight-edge is laid along the fingerboard when the neck is in position in the instrument. This straight-edge should project over the belly of the violin to the position of the bridge—that is, between the inner nicks of the soundholes. The distance between the lower edge of the straight-edge and the belly of the violin at this point should be $1\frac{3}{8}$ in. Another method is to measure the height from the surface of the belly to the top edge of the fingerboard end when in position; this distance should be $\frac{23}{32}$ in. These measurements, however, will only give the repairer the backward set of the neck; but it must also be set square in the fiddle. The fiddle is placed on a flat surface on its edges, and the distance between the eye of the scroll and the flat surface measured.

The violin is now turned over and laid on the edges of the opposite side. The distance between the opposite eye and the flat surface is now also measured, and the two measurements should agree. A small block of wood of sufficient depth to just slide in between the eye of the scroll and the flat surface on which the violin is resting is a useful means of measuring the distance, as several trials may be needed before the neck and scroll are square with the body of the instrument. A final test of truth is to glance along the back edges of the fiddle on each side, when the eyes of the scroll should be in perfect alignment with the edges of the back plate. If the neck answers correctly to these various tests, the work of gluing in the shoulder may

be proceeded with. The fitting of the shoulder into the block must be tight enough to hold the body without the aid of glue at all, because, should the fitting be loose, the joint will not hold. Cautious cutting will be necessary, and it must be noted that once the neck is cut too small it will be impossible to make a good job of the work.

When the fitting is finally satisfactory, coat the chamber in the block and the end and back of the shoulder with good hot glue, and press the neck home into its position, fixing a cramp as in Fig. 48, and washing away all superfluous glue. Before laying aside to dry, make final tests to see that the neck is truly set and that it has not shifted out of place during cramping operations.

Worn Button. — The button, against which the back of the shoulder of the neck is glued, is in old instruments frequently damaged, worn down or otherwise disfigured. It is important that this part of the violin should preserve its contour, as it is one of the first portions of the instrument to receive attention when in the hands of an expert. The button is often repaired by means of an outer lining of ebony, which, if well inlaid, looks very well and considerably improves the appearance of the back of the fiddle. It should be observed, however, that this lining must not be put in at the expense of strength, and the button in all cases must be left as large as possible in order to ensure a good grip or hold on the shoulder of the neck.

The first operation is to mark out the outside portion which is required to be cut away. The sweep of

the button, if not altogether destroyed, must be preserved on this inside marked half-circle, because, as in common with all repairing work, the marker's idea must not be interfered with. If the button outline is destroyed the repairer must carry out his drawing with regard to the best traditions on the subject and obtain, if possible, a fine violin which will give him the correct shape. Roughly speaking, the width is slightly greater at the base of the button than its height, and this proportion must be observed in inlaying the ebony rim.

When the half-circle is satisfactorily marked, a keen-edged chisel may be employed to cut away the outside wood to the level of the shoulder of the neck. The cutting must be perfectly at right angles to the face of the button all round, and must be a perfect sweep. When cut, take an outline of the edge by placing a blank piece of paper over it and rubbing the fingers along the edge. This pattern must be transferred down to a flat slip of ebony or rosewood of a thickness a little greater than the button and large enough to enable the repairer to trim round to the correct outline. Cut away the inside portion of the ebony, fit accurately and truly into its place round the edge of the button, and when everything is correct and the fit perfectly satisfactory, warm the ebony and glue home.

It may be necessary to use half-round files to fit the ebony truly into its place, and for taking out the inside piece a fretsaw is very useful. Take care when working the ebony to avoid splintering the wood, as it is very brittle and easily broken. When the ebony is

glued down into its place and dry, the trimming up may be proceeded with until the ebony lining is finally shown as a kind of parallel half-moon round the outside of the button. Fig. 49 shows the job when finished. The cramping down is carried out in the same manner as the cramping in of the neck (Fig. 47). protecting the fingerboard and button from injury by the cramp with slips of soft wood.

Grafting.—A somewhat complicated repair, which must be very carefully carried out if the work is to be successful, is the operation known as "grafting." Many old violins are short in the neck, and must be re-necked before the instrument is fit for modern use. The scroll and head being important parts of the instrument which reflect the individuality of the maker, and which are never in any circumstances destroyed or altered, must be re-grafted to a new neck of sufficient length to enable modern music to be performed on the instrument. All measurements used in this work must be carefully made and checked over before proceeding with the work, as a slight deviation from the truth in any part of the laying out will inevitably spoil the job.

There are several methods of carrying out the grafting operations, which vary in different countries. One of the best is that practised commonly in France, known as the "French graft," and it is this method that will be dealt with here.

The first operation is to cut off the head and scroll from the neck with a fine-toothed tenon saw. (See that the tools are all in first-class condition.) The cut is made across the neck on a level with the bottom edge

of the nut over which the strings pass into the pegbox. The head and scroll should now be carefully put on one side until the graft is ready. The old neck and shoulder must not be removed from the fiddle. (It is, of course, presumed that the fingerboard and nut are removed before commencing operations on the neck.) The shoulder where it is glued against the button of the back must be cut down with a fine-toothed tenon saw parallel with the button and as close to it as possible without injury to it. The saw-cut must be continued down through the shoulder until it is close to the ribs. Another saw-cut, made from the front to back of the neck as close to the top of the edge of the belly as possible, must now be made to meet the first, thus removing the neck and shoulder, all but the portion actually glued into the chamber of the top block and that glued against the button.

It may happen in very old fiddles that the neck is secured to the body by means of a long nail driven in through the top block and into the base of the neck. This must be looked out for in cutting downwards from the front to back of the shoulder, and on the first sign of the saw teeth coming in contact with the nail the operation must be stopped and the first cut made in front of this nail. The root of the neck must now be gradually cut away with a sharp chisel, taking care to cut, and not to lever, throughout the whole of the work. The nail may be gripped by its end with a pair of pliers and gradually forced back out of the way, until it is finally pushed right through the top block into the interior of the body, where it may be shaken out

through one of the soundholes. Be very careful in working this nail (where present) backwards not to split the top block, which is sure to be dry and very brittle.

Proceed with the cutting until the whole of the original shoulder and root are completely cut away. The exact centre of the fiddle must now be obtained and marked on the top block. The centre joint of the back and belly should give the actual centre, but it does not necessarily follow, and should the neck be fitted into the instrument to one side or the other, good tone will be impossible. The exact centre line of the belly may be found as follows: Measure the exact distance across the fiddle belly at the widest part of the upper portion, and place an ink dot at the exact centre. Another dot must be placed exactly between the nicks of the inside of the soundhole. A straight-edge placed along these two marks will give the spot at the chamber where the centre line of the neck must touch when in position.

The new neck graft must now be prepared. A nicely figured block of sycamore is required and is squared true to the following size: $7\frac{1}{4}$ in. long, $1\frac{3}{4}$ in. deep, and $1\frac{3}{8}$ in. or a little more across the fingerboard face. A line down the exact centre all round this block must now be marked with a blacklead pencil. Note that this block must be absolutely square on every face and also top and bottom, otherwise the work will be spoiled. The scroll and head now requires grafting into its place on one end of this block. First of all, prepare the scroll. The fronts of the pegbox cheeks

from the base of the pegbox must be marked as shown in Fig. 50, the distance from the base of the pegbox to the top edge of the marks being 1½ in. The dotted line in B shows the back of pegbox shell. C are the lines on the inside of the pegbox showing inside cuts for graft.

The wood between these lines on the inside (that is,

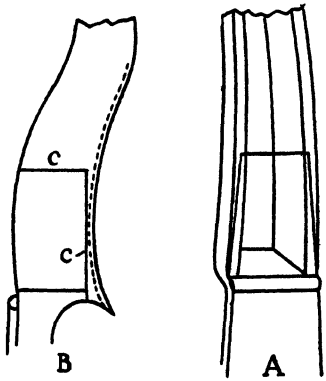


Fig. 50.—Pegbox Cheeks Marked Out for Grafting (A, Front View; B, Side View).

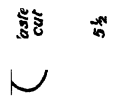


Fig. 51.—Neck Block Marked for Removal of Neck Portion.

nearest the pegbox centre) must now be chiselled carefully away, from front to back, including the floor of the pegbox, until the back of the box is reached. In fact, at the floor of the bar the chiselling is continued slightly farther in, in order to obtain a hold for the glue at the back face. These cuts must all be absolutely square, and perfectly flat, and the bottom edges of the pegbox must be finished up to a perfectly sharp edge in every case, or a good joint will be impossible. See that the chisels are razor-edged, and cut, do not lever. Now

take the sycamore block and measure from the bottom edge a distance of $5\frac{1}{2}$ in. Square a line round the block at this point B (Fig. 52). This line will give the position on the fingerboard face of the bottom edge of the nut; on the back edge it will give the position of the

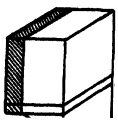


Fig. 52.—Neck Block Marked for Cutting in order to Fit Graft.

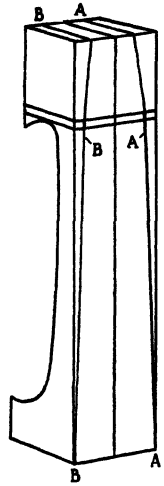


Fig. 53.—Block Marked for Cutting.

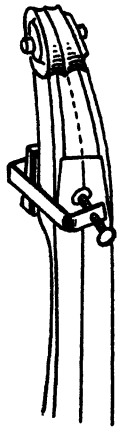


Fig. 54.—Scroll Glued in Position with Cramp on.

chin of the scroll, that is, the position of the chin of the scroll will be on a level with this line.

Now on the side of the block mark the portion which is to be cut out to form the neck proper, making allowance for trimming up after the neck and scroll is inserted in the fiddle. The thickness of the neck (approximately) may be taken from the old neck, and roughly lined out on the side of the block, giving plenty of room at the bottom end of the block for fitting against the button of the back. Fig. 51 shows the

block marked out. Then take the block to a bandsawyer and have the neck portion sawn roughly to shape. Square a line across front and down the sides $\frac{1}{4}$ in. above the former line, that is, $5\frac{3}{4}$ in. from the bottom end A (Fig. 52). Then on the side lines just marked, the same distance must be measured as the cut away portion of the pegbox floor. Take the spring compasses and find the exact depth from the pegbox front at the bottom to the inside edge of the back of the pegbox, and mark this distance on each side of the block on the lines just squared down the sides. From these points to the back of the block is superfluous wood, and must be cut away to the top of the block. The back face at this portion, bear in mind, must be perfectly parallel over its whole surface with the front or fingerboard face. Fig. 52 shows the lines and the superfluous portion shaded ready to cut away.

Fitting Block to Scroll and Head.—The front of the block must now be marked and cut for fitting into the scroll and head. From the top edge on each side, on the face of the scroll, measure downwards $1\frac{1}{2}$ in. Now with the callipers find the exact width of the pegbox at the base from the outer edges of each side. Divide this distance by half, and measure this half on each side of the central line running down the face of the block, along the top squared line across it A (Fig. 52). The two points just marked, $1\frac{1}{2}$ in. from the top down each edge of the face, should fall on the top line A (Fig. 52), but if they do not do so, the adjustment can easily be made when fitting the graft. In any case they will not be much out, and the superfluous

portion can be cut off the top of the block when fitting.

The distance across the pegbox at the top end of the graft must now be callipered, divided by half, and measured down, as before, this time along the top front edge of the block. Do not forget that the shoulders of the top of the graft (French style) must be taken into consideration, and the measurement taken right across from the corners of the chiselled-out pegbox cheeks.

The top of the block is now marked for cutting; but the width from the nut end to the bottom of the block should be marked out at the same time, by drawing lines from the outside bottom corners on the front of the block on each side to the two points marked for the width of the pegbox bottom on the line A (Fig. 52).

The complete block marked out for cutting is shown by Fig. 53. Cut down the lines A A A and B B B with a fine saw, keeping a little outside the marks to allow room for final fitting of the graft. Square the faces of the top, at the same time trying them in position in the pegbox until the joints of the graft slide into position closely and smoothly. There must be no force used or the cheeks of the pegbox will be split off; the joint must fit accurately. When correctly in position the central line of the volute of the scroll, back and front, will be in perfect alignment with the centre line of the block back and front. The dotted line in Fig. 54 shows the alignment of the centre line with centre front volute.

The graft must now be glued home with good strong hot glue. Cramps placed across the sides of the

pegbox will close the sides together; the back of the graft must be forced against the inside of the back of the pegbox to ensure a good joint. A cramp may be applied, but the pressure must not be applied near the chin of the scroll or damage will be inevitable. A shaped pad of soft cork-lined pine should be made to fit against the back hollow of the scroll, and the cramp cautiously applied against this. (*See* Fig. 54.)

The head and scroll are now in position on the neck, but part of the inside of the pegbox is still filled up with the solid end of the neck block. This must be cut away with keen-edged chisels, down to the back of the box and parallel with the cheeks down to the line A (Fig. 52), or, at any rate, very little above it. The base of the pegbox is always cut with an upward slant, to avoid going through into the box when sloping the chin and neck at the top, and this upward inclination should be followed when hollowing out the pegbox. Use the back of the chisel to scrape the back of the pegbox smooth after cutting is completed.

Fitting Neck and Scroll.—The neck and scroll must now be fitted into the fiddle. The centre of the fiddle has already been marked on the top of the chamber. The width of the chamber on each side of this mark should be equal; if they are not they must be made so. Now, with the spring dividers find the width of the button at the base. Divide this into two halves, and mark on each side of the centre line on the back face of the block. Then join these two marks on the bottom end of the block to the two outside front covers. This will give the shape of the bottom end approxi-

mately. Cut away all superfluous lines outside these lines, trying the neck in the chamber until a tight fit is obtained. The neck end must not extend above the fiddle belly for more than $\frac{1}{4}$ in., and the back face of the block must fit snugly against the button on the inside. In order to obtain this result the bottom of the block must be cut back to an angle, as shown by Fig. 55. The correct set of the neck backwards has already been described, and the method of gluing home has also been given ; also the fitting of the fingerboard.

There is nothing else to be described in connection with this part of the work, the method of testing for truth of setting is fully explained in the portion of this work already written for refitting the neck ; but the final shaping of the neck and shoulder still requires attending to. This must be carried out with the aid of sharp knives, files and glasspaper. At the top end of the neck (by the scroll chin) the shape and size of the neck will, of course, be guided to some extent by the width and shape of the pegbox cheeks and the scroll arch under the chin. The old neck will give the size and shape of the shoulder end. The main thing to be looked out for is that the neck at the shoulder and pegbox ends must be nicely shaped with an even flow of line all over, with no flat or angular spaces.

The varnish of the neck on the shoulder and under the scroll chin must be matched as closely as possible to the varnish on the rest of the fiddle. The neck proper should be soaked with linseed oil until a good polish is obtained. Some makers varnish the neck with spirit varnish ; linseed oil is preferable for the

following reasons: It will wear much longer than varnish, which quickly chips or rubs off, and does not penetrate into the wood to the same degree as oil. It is easily cleaned with a damp rag. It is impossible for it to stick to the hand, which some spirit varnishes do. It will amalgamate much better with the oil varnish at the top and bottom end of the neck than spirit varnish, and lastly, it brings up the figure in the wood where spirit varnish sometimes hides or obscures it. It is not advisable to thin out the neck too much, which is sometimes carried out to excess. A thin neck cripples the performer's hand, and it is very much to be doubted if a thin neck does not injure the tone. The neck should be strong enough to resist all strain.

In glasspapering down before finishing off see that all projecting portions of either fingerboard, nut or neck are made perfectly smooth and level. There must be no rough or projecting portions to annoy the player. The edges of the nut and fingerboard should be slightly rounded over. A little boiled oil rubbed well in to the ebony fingerboard is an improvement.

Body Ailments.—The body of the instrument suffers from many and various ailments. Perhaps the most frequent of these is a sprung table, that is, a space between the belly and ribs where the glue has given way and the table sprung off the ribs. It is impossible to play a violin which has this defect, as the loose portion will certainly vibrate in sympathy with certain notes, causing a jarring, buzzing or chattering sound, horrible to listen to. The first operation in all cases where glue has been used is to get rid of the old glue.

Wash the joint with hot water (a small brush is the best instrument) until the whole of the old glue is washed away. Fiddle cramps must now be procured, a little hot glue run into the joint on a table-knife blade, and the violin cramp applied across the ribs of the fiddle (the purchase being obtained from front and back plates), all superfluous glue being carefully brushed away. If the corners are sprung away it must be noted that on no account must cramps be applied to the corners themselves, but on each side of them only. Neglect of this precaution will assuredly lead to the breaking away of the corners altogether. Do not use too much force in applying the cramps; it is only necessary to bring the ribs and table together. The squeezed-out glue will give warning when to stop. Be careful also, in inserting the table-knife containing the film of glue, to see that none runs down inside the fiddle. Glue attracts dust, and dust attracts damp, and there is no worse enemy to any musical instrument built of wood than damp.

Cracked Corners. — Cracked or broken-away corners, if the broken portions are to hand, are best glued into position again and left to dry. If the corner is missing altogether, a more complicated job presents itself; but by carefully measuring the opposite corner, choosing sound wood of the same grain, and making a clean close joint, the work may easily be accomplished. Any modelling must be carried out in strict conformity with the rest of that portion of the instrument, and the flow of line in every direction must be continued.

Should the purfling be destroyed, this will have to be inserted in the new corner after it is in position on the instrument. The purfling is the strip (really it is three strips glued together) of wood which is inlaid round the back and belly about $\frac{1}{8}$ in. from the edges. It is composed of two outside black strips of sycamore (dyed) and one inside strip of white. At the corners these form a mitre with the other pieces which meet at

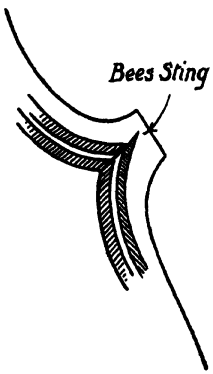


Fig. 55.—Angle for Neck-block End.

Fig. 56.—Mitring-in New Corner.

that point. The mitre must be perfect, that is, each black line must meet its corresponding black line, and the white centres of the strips must meet also exactly at the mitre. Further to this, the outside strip of black which meets that of the centre bout, is carried out beyond the mitre right into the corner of the fiddle forming what is known as the "bees-sting." This is a fine pointed black line which is not by any means easy to get into position. In inlaying the purfling, the sweep of the purfling already in the fiddle must be con-

tinued without break into the corners, the "bees-sting" marked, the grooves cut with a fine pointed knife, the central portion of the white wood picked out, and the new purfling fitted. The fit must be exact where old and new pieces meet. It is best to cut the old ends slightly on the angle; the fit of the new pieces will then be more exact.

Fig. 56 shows the whole process clearly on an enlarged scale. When the groove is cut out and the mitred corner fitted, take out the loose purfling, run in some hot, rather thin, white glue, and press the corners back home, paying special attention to the mitring and not attempting to trim down to the level of the table

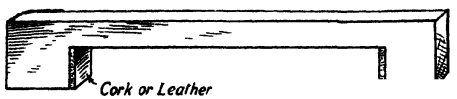


Fig. 57.—Cramp for Closing Cracks in Tables.

until the glue is dry. The purfling always sinks a little during the process of drying, and if it is cut flush with the table before the glue is dry, it will finally sink below the level of the plate and look very unsightly. When finally dry, it may be trimmed down to the sweep of the table with a flat gouge.

Cracks in the Tables.—These occur frequently. Providing they are not in the direct line of the sound-post, and are of no great length, it is only necessary to run in a little hot glue and close the crack. First of all spring the table backwards slightly and blow out all dust. If the crack is filled with dirt or grease, wash it out with hot water. Then run in the glue and apply a cramp across the table to close the crack. These

cramps may be cut out of a piece of hard wood of just sufficient width to grip the edges of the tables, and are sprung into position by simple pressure of the hand. A set of these might be cut from a $\frac{1}{2}$-in. plank of hard wood (oak or ash is useful) and kept for emergencies. Their shape is shown in Fig. 57, and the portions which grip the tables are lined with leather or cork.

If the cracks are of any length or along the belly over the soundpost, they must be glued up and studs placed across them to hold them together. These studs are made of pine (with hard grain threads in it), and are roughly the size of a farthing. They must be glued with the grain lying across the crack, and should be glasspapered very thin before gluing into position. In many cases it will be found possible to place them in position over the crack without opening the fiddle at all, a process always to be avoided if possible. A long pointed wire is inserted in the back of the stud, a spot of glue placed on it, and the stud manœuvred into position through the soundhole. If the stud is placed with its grain in the same direction as the crack, its holding capacity will be practically nil.

Opening the Violin.—Should it be found necessary to open the fiddle, the correct way to perform this operation is as follows: Obtain a thin table-knife, the finer it has been worn and the thinner the blade the better. Insert the end of this blade very cautiously between the top edge of the rib and the bottom edge of the belly, working the knife gently with a rocking motion until it forces its way through between the plate and the ribs. Now work the blade round the fiddle,

It may be necessary to pull out and reinsert the blade several times, working backwards or forwards as the case demands. Do not use more force than is absolutely necessary, as it is very easy to split the plate of an old tinder-dry violin. Be especially careful at the corners, as these will break away on the slightest provocation, and then there will be two repairs instead of one to undertake.

When the belly is off, it is a simple matter to apply studs on any part of the surface inside, but it must be noted that the fewer studs used the better. Every additional stud means so much lost power (interference with rhythmical vibrations), and as a rule two or three are ample for the purpose. If the crack to be repaired is in the direct line of the soundpost, the operator must be specially sparing with studs, and must not place them at all near that fitment; the glue alone must hold the crack together in that region.

The Bass-Bar.—While the fiddle is open it is as well to attend to the interior fittings, which are very important. First and foremost in importance is the bass-bar, a narrow-shaped strip of pine cut on the quarter which will be found glued to the belly, and extending down the inside of the table parallel with the left sound-hole. There are also four corner blocks, head and tail blocks and twelve strips of pine termed "linings," which are glued in position round the top and bottom of the ribs.

The exact functions of the bass-bar have long been in dispute. It governs the tone of the two lower strings of the violin, and when in its correct

place lies directly under the left foot of the bridge, the soundpost being in a line with the right one, although slightly behind it. It will occasionally be found that the linings, or bass-bar have sprung away from their places, and where this is so, the joint must immediately be made good again, because loose parts, wherever they may be, are productive of buzzing noises extremely irritating to the player.

Sometimes a new bass-bar is required, the old one being too small or too heavy as the case may be. The method of making and fitting a new one is as follows: A piece of straight-grained sound pine,

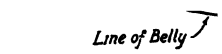


Fig. 58.—Shape of Bass-bar.

thoroughly dry and well seasoned, $10\frac{1}{2}$ in. long by about $\frac{2}{5}$ in. thick and 1 in. deep, is placed edgewise down in the position it will occupy, as follows: At the bottom end it should be $\frac{3}{4}$ in. away from the centre joint, measuring from the joint to the outer edge of the bar; at the top end it should be $\frac{1}{10}$ in. nearer to the centre joint. Above all things, however, its central portion should pass directly under the left foot of the bridge. Its approximate depth in the centre is $\frac{3}{8}$ in., but this varies with different instruments. Its shape is as shown in Fig. 58. To obtain the best results the bass-bar should be tentatively trimmed down to a little above the normal size after gluing into its place, the belly clamped on with fiddle clamps, the soundpost temporarily inserted, and the fiddle

sounded. By gradually reducing the bar and re-testing, the best tone will eventually be found. This is a somewhat troublesome process, but a good fiddle is worth the trouble.

Fitting Bass-bar.—The method of fitting after obtaining its correct position on the belly is as follows: Open a pair of compasses so that the pencil will just touch the lowest end of the bar when it is laid on its two ends (edgewise) on the inside of the belly. Now, keeping the compasses perfectly steady, pass the pencil point along the bottom edge of the bass-bar, the other leg of the compasses travelling parallel with the pencil along the inside of the belly, on the

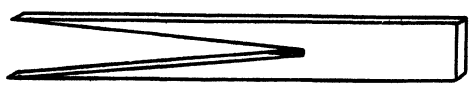


Fig. 59.—Cramp for Holding Bass-bar in Position.

line which will eventually be occupied by the bass-bar. Provided the compasses are not altered in their opening, and the point is kept directly under the pencil, the exact sweep of the inside of the belly will be reproduced on the bottom edge of the bar. Now trim down to this line with a sharp knife and fit to the belly with files and flat violin plane (small size). It will be found that the bass-bar will require bevelling across in places in order to obtain a correct fit, and a correct fit is imperative if the bar is to do its work thoroughly. There is nothing for it but to fit and refit until a close junction is effected. The top end of the bar might be thinned a little before fitting, as

there is less room for vibration at the top cheeks than at the lower cheeks.

The bar should be quite upright when correctly fitted. Glue into position. and push shaped cramps over the bar and belly to hold it firmly down until the glue is dry. Shaped cramps are shown by Fig. 59, and may be cut from sound ash or birch.

When the bass-bar is fitted and shaped the top edges should be nicely rounded over and glasspapered as smooth as satin, with varying degrees of glasspaper. It is important to remember that both the bass-bar and soundpost require the maximum of care in fitting and finish if the violin is to give of its best.

Linings.—If the linings be square, they should be bevelled on their inside edges to a feather-edge. The object of the linings is simply to obtain a greater surface for gluing on the back and belly, therefore there is no object in having them the same thickness throughout their depth ; vibration will only be impeded.

Wolf Notes and Thin Places.—In the case of obstinate wolf notes at any part of the register, it is possible that the plates have not been correctly worked, although a faulty bass-bar will sometimes create these discordant sounds. A wolf note briefly described is two notes, not in unison, vibrating together. Sometimes a defective string will cause them, or strings of obviously varying thickness on the one instrument. But it frequently happens that the cause is irregularities in the thicknessing of the back or belly. Go over the plates with the violin-maker's callipers and find out if there are any thin places, especially in the belly.

The thickness of a well-seasoned belly should be at least $\frac{1}{8}$ in. over the whole of the middle portion, extending half-way across the cheeks of top and bottom boats. From thence to the edges there should be a gradual and even taper to $\frac{3}{32}$ in. at the edge all round. But the thicknessing and tapering should be even all over the plates.

Thin Places.—Thin places must be veneered with sound, well-chosen pine (or sycamore in the case of the back), cut and shaped carefully to level up the thin place to the surrounding level of the table. This veneer must be cramped firmly down with wooden hand cramps, protected on each side by pieces of soft wood. See that the glue is thin and hot; the less glue left in the joint the better. Remember that the thin place should be levelled up with wood, not with glue. White glue, made thin, is advisable for the work. When the veneer is dry it must be glass-papered, absolutely to the sweep of the belly where it is placed, and finished as smoothly as possible.

Broken Plates or Ribs.—These, where the violin has received an injury resulting in an actual smash, and a piece is knocked bodily out of either back, belly or ribs, are the most serious of all injuries, and here the artistic skill of the repairer will find full scope for its display. To inlay a piece of new material in the surface of the belly, back or rib in such a manner that it will be next to impossible to detect it, is the severest test of the repairer's ability, and one may say that it almost amounts to a gift in some personalities when their work is examined. Great care must be

exercised and time taken reckoned of little or no account when working on an injury of this kind in a good violin. It consequently follows that the charge for good work of this character is always high when carried out by a skilled repairer.

It is important that the piece of wood chosen for the replacement of the lost portion be of the right character. If a hastily or ill-chosen piece is inserted it will be impossible, no matter how skilled the work, to hide the repair. The reflection of light from different pieces of material is totally different in character, and the piece chosen for the repair must have the same flash and reflective calibre as that of the table in which it is to be inserted. Moreover, it must be chosen for colour and grain line, and be inserted with the direction of the grain the same way as that of the table.

The first operation of the break in the tables is to square the hole. This is done in order to give a regular basis for working. It may be done with a fretsaw if care be used. When the repairer is perfectly sure that the hole is square, or at least that each corner forms a perfect right angle, he must file up the edges of the hole until they are quite smooth and bevelled slightly inwards on each side from the surface. Of course, if the break is an oblong one, the hole cut out with the fretsaw will also be oblong, but the thing to be striven for is to make the hole either perfectly square or perfectly oblong, with the edges bevelled inwards. Now a block of pine (sycamore or maple for the back) must be chosen as nearly

as possible identical with the table in figure, grain and colour. This block must be fitted exactly to the hole, with the aid of saw, chisels, files and scraper. The bevel given to the edges of the hole will enable the repairer to obtain a close fit, the block wedging itself into position. The grain lines of the table and the grain lines of the block must fit together as exactly as possible. When the fit has been accurately made, glue the block home into its place with white glue. When the glue is dry the modelling must be undertaken. The sweep of the table in every direction must be continued all over the block inside and outside. Chisels and gouges will, of course, be used for the purpose of reducing the block to its correct thickness in conformity with the table into which it is glued. When finally modelled, finish with several grades of glasspaper. It is better to glasspaper the varnish away irregularly round the edges of the repair, as by this method it is (when the job is finished) more difficult to see the joint.

Repairing Damaged Ribs.—With regard to damage to the ribs, it is not often necessary to fit a block. The usual method is to cut away the full depth of the rib of a width sufficient to take out the break. The edges are now bevelled inwards and a new piece of rib of approximate figure glued into its place. It is always advisable to keep by one old piece of pine, sycamore and maple, old ribs, tables and necks, as the repairer will find it much easier to effect a repair with a portion of an old fiddle than with new wood. The precaution of placing new wood with the grain

in the same direction as that of the table or rib must not be neglected, as the light which is reflected from wood held with the grain in one direction (especially maple) is not quite of the same character as that which is thrown off from the reversed piece.

Occasionally the joint of the back or belly springs apart, especially in the neighbourhood of the top or bottom blocks. It is not often necessary (or indeed desirable) to take off the tables for the purpose of effecting this repair. First of all clean out the opening with hot water, leave to dry, and then run in some thin fresh glue and cramp the joint together. Cramps (Fig. 57) are very useful for the purpose of this repair, and should the joint not go together quite flush on the surfaces, a small wedge driven under the cramp on the raised side of the table will press that half down to a level with the other.

Colouring and Matching the Varnish.—As regards the colouring and matching of varnish, a volume might be written on the subject. In fact, after the most skilful repair has been accomplished "in the white," it often happens that disregard or inability spoils the job. It is well to keep a record of all successful repairs, especially as to the method used to match the varnish. This record in process of time would be found very useful. Varnishes and varnishing are dealt with on pp. 73 to 85.

The repairer will no doubt make up alcoholic solutions of various tints for the purpose of matching repairs, but it is always safer to get the new wood toned down before applying any varnish. Liquorice

and permanganate of potash in water will be found very useful for this purpose. The new wood in all cases must be toned, otherwise a staring effect will certainly result. Do not use acids for the purpose of toning down a repair. Acid rots the fibres, creates an unpleasant smell, and generally does a lot more harm than good. Gamboge and dragon's blood, the rich colours subdued by the aid of liquorice or burnt sienna, are useful colours for matching repairs on violins. Where the varnish is red or golden, orange brown varnish may be imitated by liquorice, permanganate of potash, burnt sienna or logwood and bismarck brown. Experience will teach the experimenter more than any amount of writing on the subject.

CHAPTER XII

Making a Violin Bow

Woods Used. — Violin bows are made from Brazil wood, Pernambuco wood, snakewood, ironwood and lancewood. Greenheart is occasionally used, but the best sticks are undoubtedly constructed from carefully chosen sticks of Pernambuco wood, which is imported into the country for the purpose of extracting purple dyeing matter from it. The billets are carefully sorted out by experts, who pick out the straightest grained logs and retail them to the bow-makers. Pernambuco wood is extremely hard, cross-grained, and liable to be useless in many cases for the purpose of the bow-maker owing to this liability to cracks, shakes and knots. For this reason it is better to buy the sticks ready prepared (roughed out) than to buy the logs from a distance, as it is almost certain in the latter case that the majority of the consignment would be found useless on arrival. It is possible and, indeed, preferable to practice with cheap wood first of all, until a certain measure of dexterity is gained, when the Pernambuco sticks might be taken in hand. For the purpose of practice, lancewood, greenheart, or even good hard-grown straight-grained ash might be used. Snakewood is too stiff and unyielding to make good bows, and the same may be said of ironwood ; but one occasionally comes across fine lancewood bows.

Selecting the Wood.—The great thing to be looked for in choosing the wood is strength combined with lightness and flexibility. The stick must be sufficiently flexible to transmit every ounce of pressure to the hair without being so "whippy" that control is lost by the violinist. At the same time it must be light enough to come to the hand easily without tiring the player. In making a first-class bow all this is a

Fig. 60.—Template for Head of Bow.

Fig. 61.—Bow in the Rough.

matter of experience, and it must not be expected that the amateur will be able to make from the outset with the same certainty and precision that has been gained by another maker through years of practice. At the same time there are makers of quite limited experience who turn out very good bows; possibly in this latter case natural aptitude may play some part.

Marking the Peak.—The only part of the bow which can be actually measured from a template is the "peak" or head of the bow. This template is made to the pattern of Fig. 60, and may be copied from any modern bow by laying the head flat on a sheet of paper and tracing round it with a lead pencil. The template may be made in sheet zinc. This tem-

plate is laid on the upper face of the rough bow-stick (Fig. 61) and the pattern marked down with a steel point. The head is now roughly shaped out with keen-edged knives, and the neck or throat of the bow, along which the template has been marked down, rounded for about 4 in. downwards from the head. The stick throughout its length must be left thick (about twice as thick as the finished article is intended to be), and this must be looked to during the next operation of planing away the corners. Special planes may be obtained for this latter purpose.

Finishing the Stick.—Sometimes violin-bow sticks are made octagonal, and in this case the planing away of the corners of the stick is continued up to the head.

If the stick is intended to be rounded the rounding of the bow is left until after the setting, which must now be taken in hand. An upright bunsen flame mounted on a baseboard is very useful for this purpose.

Setting.—The spring and "life" of a bow depend greatly on the correctness of the setting. The bow must be passed backwards and forwards through the bunsen flame until the stick is heated thoroughly through, when it will bend in any required direction. But the job must not be hurried. If the stick is insufficiently heated, it will never keep its "set," but sooner or later it will straighten out, twist, or warp, making it useless for good work.

When the operator feels that the stick is thoroughly heated, he must bend it to the required sweep. This should be somewhere about ½ in. from the horizontal,

that is, when the stick is bent and laid bent side upwards on a flat surface, the rise from this flat surface at its highest point should be ½ in. or a little more. The length of the stick varies slightly with different makers, but 29½ in. is a good average. During the process of heating the stick will char, or even catch fire (hence the reason for leaving it thick); but this must not deter the operator from thoroughly heating the material. The bend of the stick is adjusted so that the hair of the bow when in position (before screwing up) touches the stick at the point where the bend is greatest. This point is not placed at any arbitrary distance from either one end of the stick or the other, but depends primarily on the quality of the stick itself. In bending the stick the operator can feel where the "give" is greatest, that is, where the resistance to the pressure is weakest, and it is at this point where he places the greatest amount of sweep. There is no royal road to the determination of this point; it is a matter which entirely depends on the experience of the bow-maker.

Should the stick be found palpably unequal, that is, if it gives rapidly or easily at any particular point, it is unsuitable for the purpose of making a first-class bow and should be discarded. Above all things the stick should be kept perfectly straight. One occasionally sees bows with the setting or "cambre" a little to one side of the longitudinal axis of the stick, and occasionally a player may be met who has submitted a fine bow to a maker for the purpose of putting in this side twist. The fact remains, however, that a fine

bow is dead level throughout its length, the taper being equal throughout on each side of the central axis.

Tapering.—When the bow is bent, the next operation is tapering. This also is a matter for the eye, although callipers are sometimes used to give the diameters at various portions of the stick. These callipers are built for average density sticks and are really approximate only, the final thicknesses being adjusted by the eye in conjunction with the maker's previous experience. If the bow is intended to be finished octagonal, care must be taken that the facets are the same width throughout.

The planing of the stick down to its proper thickness is carried out by means of small planes, with the blade set well forward in the body of the plane.

Finishing the Head.—The head must now be worked out with knives, files and glasspaper to its correct size and shape. In springing the bow the deviation from the flat stick must in all cases be sufficient to ensure a good and firm spring. It must be noted that it is not desirable to thin down the stick too far, because if this is done the weight of the head would cause the stick to be top heavy and the balance of the bow would be quite destroyed, besides losing the control of the spring. The head of the bow must be of a certain size and thickness, owing to the fact that a cavity is cut in the face of it of sufficient depth and width to take the waxed and wrapped end of the hair when rehairing. The tapering of the bow does not start at the butt end, which is left parallel for the space of about 4½ in., whence the taper to the

end or peak begins. When the head is shaped the top cavity is required to be cut; but before this is carried out the ivory face must be fitted to the front of the head. The ivory faces or tips lined with a thin face of ebony may be obtained from any firm of dealers in musical instruments and fittings.

Fitting the Ivory Face.—The fitting of the ivory face is a matter which must be carefully carried out. It is easy to split the ebony or ivory if undue force is used. The top is glued down into position and tied down with strong thread and set aside to dry. Sometimes metal tips are used, but in the best-class bows the face is invariably made of ivory.

Hair Cavity.—When the ivory face is fitted the cavity for the reception of the hair must be cut out. A hole of the right size is drilled through the face into the stick by means of a Morse twist drill. Do not use the ordinary wood-cutting bits; they will assuredly split the head. In all matters concerning the bow (this portion of it especially) it is imperative to bear in mind the force must be carefully controlled, and hurry must be avoided, otherwise damage is sure to result. When the hole is drilled out it is cut square by the aid of sharp chisels and files, the head of the bow being meanwhile locked or held in a small vice, the jaws of which are covered with leather-lined pieces of wood in order to protect the stick from injury.

Trench for the Frog.—The slot or trench in which the screw of the frog travels must now be taken out with keen-edged chisels. The hole in the end of the stick (in which the screw works) is now drilled out

and the frog fitted. There are ready-made frogs to be obtained from the dealers; some bow-makers make the frog for each bow as required, and for a first-class bow it is sometimes necessary in order that the requisite fineness of balance be maintained. The hole in the end of the stick should be drilled out in the lathe, although it is possible to take it out with a hand drill. The end of the stick is turned down for about $\frac{1}{8}$ in. to fit the head of the bow screw.

Polishing.—The stick may now be french-polished, or varnished with finest-quality oil varnish. Before polishing, the maker tests the bow for balance and spring, and there is generally some little adjustment to be made in order to correct minor faults in either spring or balance. The bow in use should be free from any suspicion of "top heaviness," which is fatal to fine or accurate playing. The maker who is also a player can readily test this matter for himself. For those who are not players it may be stated that the centre of gravity of an average bow is from 7 in. to $7\frac{1}{2}$ in. from the frog end of the stick.

"Lapping."—The "lapping" of the bow, that is, that portion of the stick which is grasped by the player and which is covered by the said lapping, is put on after the stick is polished. It may be constructed of rubber, which can be bought ready moulded to slip on the stick, or silver wire which is wound on the stick, the ends being finished off in the same way in which the wrappings or lashings are fastened on fishing-rods; or it may be made from leather strips.

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Wyman & Sons Ltd., Printers, London, Reading and Fakenham
36.1227