The Construction And Repair Of Balalaikas

Изготовление и Ремонт Щипковых Музыкальных Инструментов
This is a translation of pp. 19-22, 114-152 of the original Russian book which is © Издательство «Легкая промышленность и бытовое обслуживание», 1988

**Construction and repair of stringed musical instruments**, Authors: N. A. Komarov, S. N. Fedyunin

Year: 1988, Publisher: M. Legprombytizdat, ISBN: 5-7088-0195-6, Pages: 272

Approved by the Academic Council of the USSR State Committee for Vocational and Technical Education as a textbook for secondary vocational-technical schools

© 1988 "Light Industry And Consumer Services" Publishers - Legprombytizdat

Translated from the Russian by Boston Balalaika Workshop as a service to the world-wide balalaika community. All rights are reserved by the publisher. This material may not be reproduced, displayed, modified or distributed without the express prior written permission of the copyright holder.
Technological Sequence of Basic Operations

Manufacturing stringed musical instruments in the modern enterprise is a complex manufacturing process, employing precise engineering calculations performed on numerous machines by a large number of skilled workers. At the same time, the production of musical instruments in a small workshop, and in cottage industries, is basically the same process as in the large enterprise. The difference is that the builder, in creating musical instruments, solves the technical difficulties himself, as sometimes both implementer and designer. He must clearly implement the entire instrument manufacturing process, correctly planning the course of technological processes of manufacturing individual parts, assemblies, and finishing of the instruments.

In the example of producing a balalaika-prima we will consider the processes in industrial and home workshop situations. First of all, we should define the main stages of production.

The production process is understood to be a series of collaborative human actions and the means of production, resulting from raw materials, billets and component parts to produce a single purpose item of the quality required. Thus, the manufacturing process includes the supply of business materials, energy supply, the design of new products and improvements to previously made products, transportation problems, and much more, and most importantly - the main production itself.

The manufacturing process is a complete part of the main production, which yields changes in shape, size, position, status, and properties of materials, or billets, or serial connection of component parts in accordance with the technical documentation.

The manufacturing process of a musical instrument involves the production of its parts, their assembly, and final processing of the entire instrument.

The manufacturing process of each part of a musical instrument is separated into a number of stages. They differ from each other by the nature of processing (e.g., cutting, gluing, lacquering, etc.), or the different goals set at this stage (e.g., cutting, machining, etc.).

The manufacture of musical instruments is concerned mainly with wood, for which, as is known, is characterized by specific humidity problems. Therefore, initial drying and final drying of wood, before we go to work, is one of the first stages of the process of any timber company. By itself, the drying of the wood is also considered an independent process. The second stage of the process, after drying, is cutting of the wood. Resonant spruce planks are cut out at a thickness of 4-5 mm for instrument soundboards and 9-10 mm for balalaika bases and so forth. Valuable building woods for balalaika staves, guitar sides and other parts are sawn out or planed on special machines into 3.5-4 mm thick billets.
Mechanical machining of workpieces is typically done in two stages. The first stage - the processing of rough billets - is to give them the correct geometry. For this machining process all four sides are worked in cross section and in length. The result is a finished workpiece (billet). In the second stage the finished piece is worked in detail, contours are cut in the billet, the necessary holes are drilled, sanding done, etc. For example, the headstock in the form of plates is cut with a pattern from the finished billet and the pocket under the tuning machines is prepared. These operations are the second stage of the manufacturing process of making the headstock.

Assembly of the balalaika from the finished parts is divided into several stages. The first of them is the assembly of parts into assembly units. Thus, several boards are collected for the instrument’s soundboard, 3-4 parts are collected to make the neck, etc. Assembly units are pre-treated (the soundboard is planed, the neck is glued, etc.), and then they go into the assembly of the entire instrument. Some assembly units, such as fret wire, are installed only on the finished product.

The main stages of the process are shown in the example of making a balalaika, as shown in the diagram (Fig. 0.1). The next stage in the process of manufacturing the balalaika, after the drying stage is the rough work, and then the finishing of the body details: neck, base, body staves and base wedges, pin block, linings, etc. The body is made from the parts listed (I). The soundboard is glued up from several resonant boards (7). Manufacturing and processing the soundboard, the braces being glued to it, forming the sound hole - all of this represents the process of manufacturing the soundboard. The result of this process is an assembly unit – the balalaika soundboard, which makes up the overall process. The process of gluing the soundboard to the body is called ‘zakubrovka’ (II). Joining the soundboard to the body is completed with the installation of the bindings (thin dark colored strips) and the decorative corners (III). The headstock, after the rough and finish machining stages is glued to the neck (IV). Finishing the top with the application of lacquer and then polishing (V) is the next stage of the process of manufacturing a balalaika. Making and gluing on the fingerboard (VI), shaping and leveling the frets (VII), making the bridge, the pickguard and gluing it to instrument (VIII) are crucial final stages of the manufacturing process. Next, the instrument enters the finishing process. The last stage is installing the tuning machines, the strings, stretching the strings and testing of the finished instrument.

Manufacturing processes for individual assembly units (neck blanks, soundboards, headstocks, etc.) are independent of the overall process of building instruments, so they can be done in parallel and in advance, that is, parts can be produced for future use. In practice, this is often done by the cottage-industry builder (or master).

Most stages of the process of manufacturing musical instruments include the machining of wood. In addition to experience and the ability to master modern woodworking tools, you need to understand about wood as a construction material, about the drying of wood, its decoration, etc.
Fig. 0.1. Manufacturing process of balalaika construction:

I – body assembly: 1 – neck; 2 – base; 3 – body staves; 4 – base wedges; 5 – linings; 6 – pin block cover;
II – Body top installed: 7 – balalaika soundboard; III – Body with bindings installed: 8 – binding; 9 – corners;
IV – Gluing the headstock: 10 – headstock; V – Finished soundboard; VI – Gluing the fingerboard: 11 – fingerboard;
VII – Installing frets: 12 – fret wire; VIII – Installing the pickguard: 13 – bridge; 14 – pickguard
Basic Construction Parameters and Instrument Structure

*Balalaika: - A Russian folk stringed musical instrument, designed for both solo play and playing in a string orchestra.*

The balalaika is a kind of historical body pattern, which is based on a triangular soundboard (Fig. 1). The body itself is a conical surface consisting of 5-10 staves and a flat base. The instrument neck has a traditional form for plucked instruments with tuning machines, which can be either closed or open backed.

The balalaika has three strings, two of which are synthetic (usually nylon), and the third, metal.

The balalaika-prima is used for solo playing, and the orchestral instruments are second (sekunda), alto, bass and contrabass (Table 1).

<table>
<thead>
<tr>
<th>Table 1. Basic parameters, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
</tr>
<tr>
<td>Vibrating Length of String L</td>
</tr>
<tr>
<td>Instrument Length A</td>
</tr>
<tr>
<td>Body Width at Base C</td>
</tr>
<tr>
<td>Body Height at Base H</td>
</tr>
<tr>
<td>Fingerboard width at Nut a</td>
</tr>
<tr>
<td>Fingerboard width at 12\textsuperscript{th} Fret b</td>
</tr>
<tr>
<td>Fingerboard thickness at 1\textsuperscript{st} Fret m</td>
</tr>
<tr>
<td>Fingerboard thickness at 12\textsuperscript{th} Fret k</td>
</tr>
<tr>
<td>Soundboard thickness h</td>
</tr>
<tr>
<td>Fret where neck meets body</td>
</tr>
<tr>
<td>Number of frets n</td>
</tr>
</tbody>
</table>

Mass-produced musical instruments usually adhere to the measurements shown under the part description and product specifications. Instruments of the highest quality, the so-called "custom" ones, are constructed in specialized workshops or by master, home-based builders (i.e. the cottage-industry). Therefore, in many of the sizes, instruments will have rather wide tolerances.
Fig. 1. Six-stave Balalaika:
The Construction and Repair of Balalaikas

Prima Balalaika is tuned:

Second (Sekunda) Balalaika is tuned:

Alto Balalaika is tuned and sounds one octave lower than written:

Bass Balalaika is tuned:

Bass Balalaika is tuned and sounds one octave lower than written:
Making the Neck Billet

The neck is made from hardwood: beech, walnut, mahogany, rosewood, ebony, etc.

Generally the heavier the wood species, the better the neck turns out. Neck preparation should start with well-seasoned wood.

The billet for the prima balalaika neck is a 300 x 60 x 25 mm block. After processing, the neck (1) (Fig. 2) has a small decrease in cross-section, from 17 down to 15 mm at the end. The heel (3) is attached to the neck with hide glue and a lamination (2), which is cut out of birch or walnut veneer to a thickness of 0.5-0.8 mm. If the material of the heel is the same as that of the neck, the lamination can be omitted (if desired). Arrangement of the lamination layers in the forms shown here is desirable, as seen in Fig. 2.

![Image of neck billet diagram]

Fig. 2. Making the Neck Billet:  
1 – neck; 2 – lamination; 3 – heel; 4 – set of 3 sheets of veneer

The billet is often decorated as follows: being cut along the center-line of the neck with the heel glued and the halves reversed. It is jointed with a plane before being glued. A set of three sheets of veneer (4) are inserted between the halves of the neck: two dark and one light, or two light and one dark. It may be limited to one sheet of veneer as desired. The color of the veneer selected depends on the color of the neck wood.
The Construction and Repair of Balalaikas

Fig. 3. Layout and sketch of neck block:

a – layout of heel under the neck block: 1-6 – cuts with fine toothed saw; 6 – sketch of the neck block; 1, 5-cheeks; 2-contour of the outer part of the neck block; 3 – contour of the inner part of the neck block; 4, 7 – cuts; 6 – upper part of the neck block; b – outer contour of the neck block

After the glued-up head block is dry, lay it out for further processing as shown in Fig. 3. At a distance of 17 mm from the edge of the heel draw the line on a contour. According to this line use a fine tooth saw to make cuts from 1 thru 6 at the depths shown in Fig. 3a. To the left and right of the heel, place 16 x 16 x 50 mm maple scraps (pads) (1) and (5) (Figure 3. 6). The layers are directed along the staves. The top of the neck block (6) is achieved, cutting off the heel to a depth of 3 mm. Working the neck block to contours (2) and (3) is done with a chisel, strictly maintaining the the outer contour (Fig. 3c). Try not to cut the inner contour (3). Cut (4) and (7) (see Fig. 3. 6) to a depth of 7 mm to complete the pre-processing of the neck block.

The billet for the headstock is preferably made from the same material as the neck. If this is not possible, then glue a billet 80 x 240 mm made of hardwood (beech, rosewood, etc.) 4 - 5 mm thick to the maple billet, planed down to 15 x 80 x 240 mm. You can use sliced veneer of the same thickness. After the glue has bonded, plane down until you reach a thickness of 15 mm. The thickness of the
bonded veneer should not be less than 2 mm. On the non-face side of the head are drawn the centerline and the main dimensions, as shown in Fig. 4, marking out the shape of the head. Marking with a 06.2 mm bit, drill a pilot hole at (1), establishing the first peg hole for the tuning machines and then find the other two centers. The holes should touch the strings of the guidelines at (2). After this insert the tuning machine pegs into the holes until they stop and draw an outline of the base as shown at (3). The tuning machine slot depth is cut first with an electric drill, and then cleaned up with a narrow chisel. Clutching the workpiece with a holdfast (clamp), the headstock is cut out around its outline. The recess for the metal gears is cut to the depth shown at b. The depth of cut is selected and customized for each type of mechanism. Tuning machines should sit tight in the socket and be recessed flush with the headstock. The builder is free to form a head, but the main considerations are ease of use, elegance of the design and reliability.

Fig. 4. Headstock billet layout:
1 – pilot hole, 2 – lines for string layout, 3 – channel under tuning machines, 4 – layout lines
Constructing the Body Parts

A stave billet should be 2.5 mm thick after finish planing. Many hardwoods are suitable for the construction of staves, but most craftsmen prefer maple. In addition, this species has good visual and acoustic properties. Any discrepancy in the figure of the wood is particularly noticeable in the two central staves, and this should be considered when selecting and matching a set of staves.

Fig. 5. Stave sizes for Prima Balalaika

A stave set is made from six pieces. One extra stave is kept in reserve, just in case a stave breaks. On the billets draw the outline of the pattern (Fig. 5) and work the contours with a chisel and a plane. Particular attention is paid to the precise preparation of the staves on the sides, to which a veneer strip will be glued. The same side of the stave is angled: for the first stave 20°, for the second 15° and for the third left 10°. The third right stave is worked only with a chisel (or small plane), leaving a reserve (extra) of 3 mm.

Veneer strips are glued to the lateral sides of the staves with the bevels, whose color depends on the color of the stave wood. Generally, the strips are cut from dyed birch veneer of 0.8 mm and a width of 3.5-4 mm. Glue is applied to the lateral side of the stave and veneer strip. The veneer strip is pressed in
with the nose of a metal hammer. If the veneer strip does not adhere, it can be tied in with thread or string.

Fig. 6. Dimensions of the base for the balalaika-prima

The base is made of two glued-up or one whole 10 mm thick fir billet (Fig. 6). It is permitted to have solid intergrown (included) knots up to 10 mm and located no closer than 20 mm to the edge of the base. The contour of the base is made from a template. Each of the six faces has a small beveled angle of about 10°, which is cut at the desired edge.

The lower edge also has an approximate 20° bevel, but in the opposite direction. The base should be well dried and thoroughly planed. All corners of the contour of the base should be checked for symmetry relative to the central axis.
Assembling the Balalaika on the Template and its Subsequent Processing

The assembly template (1) has a pair of clamps which hold the neck billet (2) with the prepared neck block (Fig. 7). Keep a distance of 280 mm from the beginning end of the neck block to the edge of the base (3), also to which two clamps are attached to the template. When you install the neck and base pay close attention to the alignment of the axes of the secured parts with the central axis of the template.

The assembly begins with the preparation of the first left stave (1) (Fig. 8). To simplify the figure the clamps are not shown.

![Fig. 7. Preparation of the template for balalaika assembly: 1 – template; 2 – neck billet; 3 – base](image1)

![Fig. 8. Fit the first left stave: 1 – the first left stave; 2 – veneer strip for first left stave; 3 – facets of the neck block; 4 – neck block; 5 – base; 6 – facets of the base; 7 – pencil line of temporary nail joints](image2)
The narrow end of the stave is attached at the appropriate facet of the neck block (4). For a snug fit to the end put a chamfer on the stave. From the width of the stave, customize it so that the veneer strip (2) that is bonded to the first stave passes beyond the length (3) of the neck block facet. Having attached the stave to the facet, press (bend) the stave to the edge of the base. The veneer strip must also pass through the facets of the base (6). Eliminate any gap that might appear between the end of the stave and the neck block with a chisel. Ensure that the stave is firmly fixed against the neck block, cleaning up with a rasp as needed. You want to maintain the contour of the inner part of the neck block. This operation is repeated in fitting the other staves. Then adjust the edge of the base beneath the surface of the adjacent stave with the rasp. Thus, the reliability of the installation of the first stave depends on quite a snug fit of the surface of the stave to the face of the neck block and the edge of the base. In this, the stave is curved (or bent) and the fitting is carried out, holding it firmly with your left hand. Having made sure of a good fit, run two pencil lines where the stave contacts the base. Turn the stave over (Fig. 9) and with an awl pierce four 1 to 1.5 mm holes through the stave. The angle of the hole should be 45°. After that, proceed to gluing.

![Diagram of stave attachment](image)

**Fig. 9. Piercing holes for temporary nail attachment**
1 – pencil line for temporary nail holes; 2 – awl; 3 – holes for the nails

Hide glue is applied to the part of the stave (Fig. 10), which comes in contact with the neck block (4), and on the facet of the neck block. The stave is attached to the facet. Hold the stave with two ‘shoe’ nails (tacks) through a pad made of birch veneer. It protects the stave from nail scratches. Drive an additional nail (5) into the template. It maintains the connection to the neck block. During the building process you should avoid making any dents and scratches on the body staves. Then glue is applied to the stave between the darkened pencil lines (7) (see Figs. 8 & 9), as well as on the edge of the base. Press the stave against the base with the left hand, and with the right hand (see Figure 9) insert four tacks into the predrilled holes in the stave and drive them through the stave into the base. Check the correctness of the clamping along the glued joint.
The first right stave is fitted and installed in the same sequence as the first left stave was. At the same time pay attention to the strict symmetry of the first pair of staves.

The narrow end of the second left stave is trimmed (shaved) with a chisel to the size of the facet on the neck block. Chamfer the end and install the second stave overlapping the first, joining it with the veneer strip onto the facet of the neck block and base. Pressing the stave with the left hand, with the right hand draw a pencil line along the inside edge of the body from the edge of the first stave. Removing the second stave, cut with a chisel along the line just drawn, leaving a margin of 1 mm extra. The last millimeter can be removed with a finishing plane. Test fit the stave to determine any error and repeat the same fitting process with the plane. If the veneer strip on the stave has descended from the face of the neck block or base, i.e. the stave has narrowed, it is trimmed along the length from the side of the narrow part. After this the stave is set and its width restored. To fit the second and third staves on their lateral sides make small adjustments to the bevel for a tight fit with the neighboring staves. When attaching the second and third staves, glue is applied to the veneer strip of the adjoining stave with the exception of the neck block and the base.

To secure the bond between the first and second staves, and the second and third, use brackets. Brackets suitable for this purpose can be made of soft copper wire with a diameter of 1.5-2 mm (Fig. 11). Crooking the end of the wire (1) around the first left stave (2), pull the wire and bend it around the other end of the left edge of the second stave (3). It should not make a deep dent in the second veneer strip of the stave (4). The bottom part of the wire can be moved in the direction of the base to strengthen the tie.

Fig. 10. Fixing the first left stave to the neck block:
1 – the first left stave; 2 – installation of the veneer strip; 3 – two tacks; 4 – neck block; 5 – additional tacks

Fig. 11. Installation of the bracket for tying first and second staves:
1 – annealed copper wire; 2 – the first left stave; 3 – the second left stave; 4 – second left veneer strip
The second right stave is installed in the same sequence as the second left.

When you install the third left stave assembly, the same sequence is followed. It should be noted that the veneer strip of the central stave should strictly follow the axis of the neck block and base, when positioning it in the fitting process. Before attaching the third left stave the contour of the rib is transferred to the third right stave.

Prepare the third stave based on the final contour on one side. From the other side extend a pencil line inside the body, as was done when processing the second stave. The prepared third right stave in the middle of its length should be one millimeter wider than the space between the third left and the second right staves. After applying the glue on all the contact surfaces the last stave is fixed to the neck block. Then, pushing from inside the body with the left hand, using the right hand with a little effort the last stave is pressed into place. After fixing the stave to the base with the nails, place a clip of copper wire across the entire body.

Wipe the liquid glue from inside the dried balalaika body along the seams of the staves. This is easier to do with the right index finger. Excess adhesive can be removed with a cloth dipped in hot water.

Fig. 12 Layout linings from template
a – layout on lining board; 1 – spruce board; 2 – cut lines; 3 – control line; b – a layout template for linings
If chips or cracks develop during the process of assembly to the neck block and base then fill them with shavings and hide glue.

After drying, the seams between the staves on the inside are then glued with dense fabric (such as calico). Smear hide glue on one side of 1 cm strips of cloth, and press them into the seams of the staves. The ends of the strips should overlap the neck block and base by one centimeter. At the end of this operation, it is recommended to use a cloth soaked in glue and draw it along the interior seams with your thumbnail.

While waiting for the body to dry (about 2-3 hours), start to prepare the linings. For this, a spruce billet (1) (Figure 12a), quarter-sawn with no knots, is marked with lines (2) and sawn with a narrow bow saw. For easy orientation at the top of a curved part, draw a pencil line (3). The template for the linings can be made based on the measurements in Figure 12, b. Cut along the lines so that the pencil lines remain to the left of the cut and is not crossed, i.e. “leave the line”.

The processing sequence of the right lining is next. The lining of the outer surface of the workpiece is cut with a chisel (supporting it on the workbench) so that the surface mirrors the inside of the first stave. This is difficult to perform the first time, as it requires practice and a good eye. The lining should be cut (maintained) as close as possible to the pencil line. A cross-section of the installed and clamped lining (1) is shown in Fig. 13.

A pocket, which was made in the neck block for the lining, cutting bit by bit, was completed earlier. A socket for the lining in the base is made along the cross-section contour at a depth of 1 to 1.5 mm.

Fig. 13 Installation of linings
1 – right lining; 2 – first stave; 3 – notching the lining into the base; 4 – skirting the nest neck block; 5 – clamp
The prepared lining, tightly seated in its sockets, is a model for producing the second lining. They are mirror images.

The surface of the lining is worked with a rasp, joining to the stave with tacks, dabbing with hide glue and putting into place. Clamping of the glued-up linings is accomplished with three clamps. (See Fig. 13)

After drying, the linings inside the body and the entire interior surface are sanded and covered with one or two layers of nitrocellulose lacquer.

Secure the body and use a fine tooth saw to cut the protruding ends of the staves flush with the base.

The strengthening of the body comes from creating a "domed" deck. There is a great amount tension in the balalaika from the strings stretched over the top. It is possible that that amount of force can bend or buckle the top. This is at first, ugly, and second, it can hardly be expected to improve the sound with such a deformed top. Work along the body with a plane and rasp correcting according to the diagram shown in Figure 14.

![Diagram of body strengthening]

With a pencil, mark out the locations of the wedges on the previously planed base. To do this, connect the vertices of the base with the center (A) (Figure 15a). The base wedges are made from the same material as the body staves, selecting from a thickness of 2.5-3 mm. Plane wedge № 1 perpendicular to the plate, adjusting it to the measurements on the base. Ensure the correctness, cutting the length of
the wedge flush along the glue seam between the edge of the base and the body stave. The surface of the base is treated with a rasp or scraper plane like the reverse side of a stave. The wedge coated with glue is pressed into place and secured with a few tacks. Fit a second wedge similarly to the first. When attaching the first and second wedges, install a veneer strip of the same color as in the body. The veneer strip is dipped in glue before installing. Remove the excess glue with the fingers of the left hand putting it back into the glue pot. Press the second wedge from both sides, as shown in Fig. 15. б. The fifth and sixth wedges are also secured from both sides (Fig. 15, в). In the area of the point (A), where the tops of the wedges converge, clean up this area with a plane or knife and seal it with glue.

Fig. 15. A set of wedges on the base
а – first wedge installation; 1 – wedge № 1; 2 – tack; 6 – setting second wedge; 1 – veneer between the first two staves; в – setting the sixth stave; 1 – site for pin block cover

\[ \alpha \times 90^\circ \]
Fig. 16. Gluing the bindings onto the base:
1 - 6 – binding strips; 7 – body stave; 8 – base; 9 – base wedge

If the base wedges are accurately fit, then there will be a point, narrow and straight between the ends of the wedges and the ends of the body staves. If the wedges of the base are not equidistant (about 3 mm) mirroring the body contour, then the defect can be corrected with a fine tooth saw, with which the wedges are sawn lengthwise.

It is recommended that the two-sided angle formed by the ends of the base wedges (9) and the body staves (7) (Fig. 16) be cleaned a few times with a heavy quadrangular knurled metal file. This is, so to speak, a socket under the face binding.

Bindings are custom fit in this order: 1, 2, 3, 4, 5 and 6. The binding ends are cut "like a mustache" with a chisel supported on the bench. Glue the bindings in this order: 1, 6, 2, 5, 4 and 3. The third is the "castle" that is, customized, when all the others are glued. The glued bindings are tied in with rope according to the diagram shown (see Fig. 16). For greater clarity, the base contour is distorted. For a better fit of the binding one of its faces is made out of square.

Fig. 17. Arrangement of the pin block cover on the base

Using a block plane, the dried binding is planed flush with the wedges from the base side, and from the side of the body staves this operation is performed with a metal file. Any cracks and defects discovered are filled with a mix of sawdust with the appropriate color of hide glue. After thoroughly drying, the base is planed and polished with emery paper.

A pin block cover is inlaid into the base (Fig. 17). At first the pin block cover, previously cut from 1.5 mm thick dyed birch veneer, is placed upon the base wedges and the contours are outlined with a sharpened pencil. The resulting outline is cut out with a cutter at a depth of 1-1.2 mm and then routed out. The pin block cover is glued (with hide glue) and set in with a hammer. We recommended that the
shape of the pin block cover be done to the dimensions shown in figure 17. The pin block cover form or shape may be of a different design.

**Preparation of the Soundboard and Gluing it to the Body**

Resonant spruce boards with thickness of 4 mm and a length of 300 mm can serve as billets for the creation of a balalaika top. The width of the boards is usually no less than 60-70 mm, although in principal the width does not matter. Much more important is to find billets with annual rings running width-wise (quarter sawn) from trees grown in shade. These parameters, to a certain extent, enhance the homogeneity of the potential top and its acoustic properties.

Boards are first selected and then planed down. This allows us not only to identify the structure of the material, but also to determine the direction of planing, which is shown by arrows (Fig. 18). There are two variants of selection for a balalaika top - the central fugue (matched plates or book-matched) or by a central board. Matched sounding boards are then labeled and the edges carefully jointed.

Glue up the resonant boards with casein glue, but in recent years people have increasingly used PVA (plasticized) for these purposes. Plates (1) (Fig. 19) are smeared on both side edges and clamped (2). Clamping plates to each other is supported with wedges (3). With additional wedges, you can adjust plates relative to each other in height.

![Fig. 18 Variations of top production](image)

1 – soundboard with a central fugue; 2 – soundboard with the central plate; 3 – arrow shows planing direction

![Fig. 19. Gluing resonant plates.](image)

1 – resonant plates; 2 – clamps; 3 – wedges for tightening; 4 – additional wedges

The dried top is planed on both sides, top and back, bringing it down to a thickness of 2.5 mm. Clamping support is produced by a thick wooden slab (a sheet plywood is suitable for this purpose). Screw heads protruding 1.5-2 mm out of the wooden surface can serve as (planing) stops. Before
planing, the direction to take shavings is determined by the previously established set of arrows. After planing it is recommended to sand the top.

The prepared top is joined to the balalaika body, strictly maintaining the center line, and following the body contour (1) (Fig. 20). Cut the top along this contour (with a overlapping margin of 5 mm) using a jigsaw, knife or a fine tooth saw.

Having defined the face side, specify the centerline and, indenting 110 mm from the edge of the top, mark the center of the future sound hole. Focusing on the center, set the rosette. An acceptable rosette for the balalaika is shown in Fig. 20. 6. The technique for fitting the rosette is the same as the example discussed for fitting the pin block cover. After the rosette is dry, it is scraped flush and any defects found are filled with sawdust and hide glue. Building the top requires a high degree of accuracy, since the thickness of 2-2.5 mm makes it very fragile.

Braces for the balalaika top, as well as for other musical instruments are made from resonant spruce. A radial cut board (Figure 21) is marked out on its end in 10 mm increments. At these marks use an ax (or froe) (See Fig. 21a), so that the gap formed by splitting the wood reaches a depth of 40-50 mm. Then insert a blade into the slit (Fig. 21b) and cleave a brace from the billet. This is done to ensure that cleavage occurs strictly in the tangential plane. Harvested braces (Fig. 21c) have dimensions of 10 x 20 x 300 mm. The size of 10 mm is adjusted with a plane to 4 mm. Then one of the two narrow edges is planed (Fig. 21d) on an arc of a special pattern, allowing the creation of the domed instrument top. (See also Fig. 14.) This template is easy to make from an ordinary wooden ruler. With a piece of string on one side of a wooden ruler draw an arc at a radius of 1820 mm. The derived arc line is the template. (See Fig. 23)
Fig. 20 Placement of the rosette on the balalaika top
a – position of the rosette on the top; 1 – contour of the balalaika body; 2 – center of the sound hole, 3 – center line of the top, 6 – dimensions of the rosette for the prima balalaika

Fig. 21 Preparing the braces
a – notching ax; 6 – cutting knife; a – measurements for preparing prima balalaika braces; r – brace, planed based on template

Fig. 22 Gluing the braces
1 – top, 2 – brace, 3 – clamp; 4 – clamping caul
Braces are glued with hide glue in a particular sequence. Thin pencil lines mark out the position of the future braces (2) on the inside of the top (Fig. 22). Begin by attaching brace number 1. Glue is applied to the arched edge of the brace and the brace is put in its place. From the face side of the top (1) install a clamping caul of spruce, sectioned 25 x 5 mm and place a clamp (3). For best clamp performance cut the edge of the braces before gluing "like a mustache." This should not leave gaps between the glued brace and the top. Any defect is eliminated with small wedges inserted between the clamping caul and the top. For best performance, slightly moisten the wedges before installing them.

After drying, the glued braces are shaped with a chisel to get to the appropriate sizes which are shown in Fig. 23. Sharp edges on the braces should be sanded smooth. The inside of the prepared top is covered with 1-2 layers of nitrocellulose lacquer, leaving a 15 mm wide bare strip along the contour (edge) of the top.

The top is tightly fixed to the body along the axis and notches are marked on the bindings with a pencil to determine the location for the sockets for the braces to fit into. Sockets are cut, using a chisel, knife and fine tooth hand saw. Sockets are established at a depth of 4 mm, but it is best to fit each brace individually. The balalaika top is then put onto the body to ensure that the braces fit snugly in their sockets. Then trim the top along the contour of the body leaving an excess margin of 2 - 2.5 mm.

A tool called "zakubrovka" (clamping bar) is used to attach the top to the body. For this operation prepare a clamping caul 10 x 20 x 500 mm, made of pine or spruce and a 20 x 40 mm birch plywood pad. You can pre-drive two tacks into the pad (See Fig. 24). Also prepare ~10 meter coil of rope or cordage (such as twill tape).
The balalaika body (6) is mounted on a workbench (Fig. 24) with a clamp (2). In order to ensure that the neck (3) does not slip on the bench (4), put a large piece of sand paper under it, folded in half, rough side out.

Glue is applied to the lining, neck block, brace pockets and base. The top is set into place. During this process, exercise the utmost caution regarding the soundboard corners. With the help of a pad press the upper part of the top to the neck block. Place the clamping caul (5) on the top, and press it down to the base with your left hand. Put your right hand on the nail driven into the neck block, and loop a 0.5 mm string around it, passing it under the body, and around the top to the second nail.

Having rounded the second nail, the rope protrudes from under the bottom of the body at the left corner and with two wraps secures the corner of body, the soundboard corner and the left end of the clamping caul. Then with the rope passed under the body, the right corner of the instrument is secured. Then continue to wrap the rope for several more turns, as shown in Fig. 24. The right hand continually stretches the rope and the left, holding the soundboard in the correct place, holds the body of the instrument. Sometimes it is necessary to hold the body with the knee. So that the rope does not slip on the clamping caul, it is possible to make small nicks in the zakubrovka with a round file. The glued-up soundboard, as if swaddled with the rope, should be checked along the edge of the glue line. If you notice any gaps, close them, pulling the rope tighter with wedges inserted under it from the sides of the body.

The process of attaching a top requires great skill, before the adhesive has time to set. Therefore, for the development of these skills this process should be repeated several times on a plywood top, of course, without glue.
After 4-5 hours, i.e., after the top is bonded and guaranteed to be dry, begin trimming along the outline of the top. Do this with a chisel or plane, and then clean up the edges with a metal file or rasp. The edge of the top should have a very smooth shape, without nicks or burrs.

On the marking guage (or purfling cutter) set the cutter to a width of 5.5-6 mm, with a 2.5 mm cutting depth and cut the corners of the top to a depth of 1 mm, as shown in Fig. 25, a. As outlined in this way the corners are decoratively inlaid, these are known simply as "corners". They may have different patterns or configurations. Three options are shown in Fig. 25, b. They are inlaid into the corners, like the rosette. The design of the corners is chosen based on the rosette.
Fig. 25. Inlaid corners: a – cutting of the top surface with a trim (purfling) cutter, and b – corner design options
Fig. 26. Gluing bindings:
a – binding cross section; 1 – strip of dark veneer; 2 – strip of light veneer; 3 – ‘rail’ of dark binding; 6 – laying rope: 1 – clamp; 2 – neck; 3 – bindings; 4 – rope

The top, with the corners dried, is then prepared for attaching the bindings. To do this, the width of the cutting surface gauge (purfling cutter) is increased by 0.5 mm. Cut through the soundboard with the purfling cutter along the edge to the lining, that is, the entire depth of the tool. Near the neck block, where the surface gauge (purfling cutter) does not work, cut through with a knife or cutter (chisel). A strip along the edge of the top is neatly cut with a chisel, enabling a place for a layer of glue. A heavily knurled quadrangular metal file is used to clean the resulting slot for the binding.

Glue 1-2 strips of dyed veneer to the binding (Fig. 26a). The length of the binding and veneer is determined by the measurements of the edge of the top plus an extra 20-30 mm. The binding, glued from the base side should have a break of 10-20 mm along the axis of the instrument.

First refine the fit of the bindings in the corners of the top. Medium viscosity hide glue is then applied to the two gluing surfaces of all of the bindings and put in their places in the corners of the top (see Figure 26. 6.). Tie a loop of rope on the left corner, with the bindings in place and pull on it. Then the rope is transferred across the top to the right corner where you make 1-2 turns, tightly clutching the bindings to the body and the top. Further, the rope crosses the base and leads out to the top and a loop of about 20-25 mm is placed on the left corner. Make 4 turns with the rope, as shown in Fig. 26, 6. With the final turns, tie the ends of the bindings into the rabbets at the neck block.

Once the bindings have dried out a little, they are scraped flush with the end wedges and base with a file from the body side. From the soundboard side the binding is planed with a block plane flush with the top.

Finishing the soundboard begins with filling all visible defects on the surface and all glued joints. After the filler is dry, scrape the top to level. The scraping direction is from the corners along the axis of the top, at an angle of 45°, and then in a direction parallel to the top. On a properly scraped top you should not feel any bumps with the fingers.

Polish the top with wet-dry sandpaper, using a felt pad backing, in the same direction and the same sequence as the leveling process. The soundboard is then rubbed with alcohol to raise the grain and then polished again (raising the grain with water is not recommended).

Prepare a “tampon” (muñeca) made from cotton jersey, and use it to apply two coats of nitro lacquer sealer to the soundboard. The operation is repeated two more times at intervals of 15-20 minutes.

The carefully dried, primed surface is fine sanded until a smooth matte finish is achieved. Sheets of sandpaper 60 X 80 mm, are folded in half and held with the thumb, index and middle fingers, with
slight pressure on the paper assisted by the other two fingers. Sanding the nitro lacquer should generate light dust, which suggests that it is well dried out.

Spirit varnish is used for the next coating of the top, done in the same sequence as the nitrocellulose lacquer finish. Any stains are extremely unacceptable in the appearance of the top, and drops of lacquer even more so. 10-12 layers of shellac varnish are applied and dried 1.5-2 hours in a warm well-ventilated room.

The dried surface of the top is sanded using fine sandpaper following the same method as the nitro lacquer primer. In this process use increased accuracy and attention to avoid sanding through the varnish surface. This leads to the appearance of whitish spots on the top, which can only be corrected by removing all the finish and starting again. A well-polished shellac varnish layer gives a deep matte finish with very rare and subtle glimpses of the grain.

The prepared surface is polished using pumice powder.

A ‘tampon’ (muñeca) of cotton is lightly moistened with lubricating oil, let it soak in and dip the ‘tampon’ (muñeca) into the pumice powder that has been poured out. After rubbing, wipe dry with a soft cloth. The top should have a dull matte finish without any shine.

After preparation proceed on to polish the top. On a prepared ‘tampon’ (muñeca) of white linen introduce the shellac polish and put it into a sealed container. For better impregnation the container is put in a warm place. After 15-20 minutes the ‘tampon’ (muñeca) is slightly pressed against the back of the hand, leaving a thin, fast drying layer of polish. Polish the top with the ‘tampon’ (muñeca) until movement of the ‘tampon’ (muñeca) becomes difficult. Finish the polish by brushing the ‘tampon’ (muñeca) with 2-3 drops of lubricating oil for easy movement. An hour later, the instrument is ready for the next coat.

**Preparing the Headstock**

The failure of the glue joint between the headstock and the neck is a rare phenomenon. There should be much attention paid, which the builder must give to this area, and obviously, a good design of the joint itself.

The headstock is connected to the neck of the balalaika with hide glue. For this, we first determine the position of the headstock on the neck. The headstock (Figure 27) is set on the neck, focusing on the location of the installation lines (4) (see Fig. 4). For control the approximate size is indicated - 86 mm, which corresponds to the interval between where the 3rd and 4th frets will be located, i.e. it is the ending position of the headstock in the plane of the neck. Saw along the line (6) (see Fig. 27) with a bow saw leaving a margin of 1-2 mm. This joint is worked with a smoothing plane with a chip breaker just along the line (6), and then tune up the surface a few times with a scraper plane. Check the fit of
The planed surface by placing the headstock portion against the area where it will be glued. The wedge that was sawn off from the neck (5) should be saved.

Before gluing, pre-heat the headstock by placing it on a hot stove. Glue is applied first to the neck in the glue-up area, and then on the heated headstock. Using a clamp (3) ensures the glued parts are well bonded (Fig. 28). So that the wedge (4), placed under the clamp, does not slip off the plane of the headstock (2), it is moistened. Observe careful alignment of the parts when gluing.

![Diagram](image)

Fig. 27. Diagram for determining the position of the head on the neck:
1 – the body of the prima balalaika; 2 – neck; 3 – headstock; 4 – Adjusting the line; 5 – saw off a wedge from the neck; 6 – saw line; 7 – balalaika-prima neck template

After the joint is dry, use a bow saw to cut away the part of the headstock protruding above the top plane of the neck. Then the surface of the neck is carefully planed with a smoothing plane (a plane with a chip breaker) and the fit is tested "by candling". Here, the soundboard surface lies in the same plane without refraction, as does the fingerboard that is glued to the neck and whose lower part is glued to the soundboard.

The connection of the balalaika body staves with the neck heel may have gaps. For this gap saw a slot to a depth of 2.5-3 mm and glue in a strip of dyed veneer. After the glue has dried, scrape off the excess with a knife, and clean up the veneer strip with a round rasp.

The fingerboard is made from a billet (6-7 mm in thickness) of ebony, stained beech or pear or other species resistant to wear. A fingerboard template for the balalaika-prima is shown in Fig. 29.

The template is placed on the neck, aligning the lateral edge of the triangular section with a line connecting the neck with the body, and then draw the outline of the contour of the lower part of the template on the soundboard. Completely remove any layers of lacquer with a knife or scraper from within the outlined area of the soundboard.
Roughen up the bottom surface of the fingerboard and the upper plane of the neck with a toothed plane. With an awl create two holes in the neck 50 mm from the beginning and the end along the axis of symmetry. Place cut off tacks into the holes so that their sharp ends protrude above the plane of the neck 1 to 1.5 mm. During the process of gluing these "teeth" will keep the fingerboard from sliding.

![Diagram of attaching the headstock to the neck](image)

**Fig. 28.** Attaching the headstock to the neck
1 – neck; 2 – headstock; 3 – clamp; 4 – wedge

Having set the fingerboard to heat up on a hot plate, the adhesive is first applied to the neck neck and soundboard area, and then on the heated fingerboard, connect them together, maintaining alignment. Clamping the glued joint is done with 2-3 clamps (Fig. 30). Pressure from the tightened clamps (1) is transmitted to the fingerboard (3) through the clamping caul (2). Excess adhesive protrudes from under the fingerboard around the entire perimiter. If there is a risk of a poor glue joint between the fingerboard and the soundboard, then between the clamping caul (2) and the fingerboard (3) you can easily insert a small wedge (6) to apply more pressure. Often the builder places a piece of walnut or birch veneer between the fingerboard and the neck. After the glue has dried the excess is removed with a knife or chisel.

The scale template is placed on the glued-up fingerboard (2) (Fig. 31). The axis of the template must be accurately directed along the axis of the instrument, and the 16th fret should stand above the veneer strip separating the neck (4) from the body (5). In this position, the template is pressed against the neck with a clamp (1).

Fret slots are laid out and cut with a fine tooth 1 mm saw to a depth of 1-1.5mm. The template is removed and the cuts are made to the required depth with a fretting saw. For better control of cut, depth-limiters in the form of two plates are attached to the saw blade on both sides. The depth and width of cut depends on the fret wire used. If the cutting depth is easily adjustable with limiters, the width can be increased by slightly swinging the blade from side to side during the process of cutting.
The technical sequence of processing the neck is shown in Fig. 32. To facilitate reading the diagram, the body and the headstock of the instrument are not shown. Begin by making three cuts in the heel with a bow saw (Fig. 32, a, b). Further treatment of the neck is done with a chisel, with all precautions and always with emphasis on using a rubber mat on the bench. It is most desirable to begin the process of carving the profile with a chisel (2) (Figure 32, b). This plane is the basis for further processing and exceeds the required final size of the neck by 1-1.5 mm in height. Then shave the sides, leaving the remaining 1-2 mm to be worked with the rasp. The profile and contours of the neck sections are shown in the figure at line (3). When processing the neck blanks you might encounter curly grain and the chisel will proceed "with defiance". Change the direction of cutting to avoid dangerous tear out of the wood.

Fig. 29. Balalaika-prima fingerboard drawing template

Fig. 30. Attaching fingerboard to the neck:
1 – clamps; 2 – clamping cauls; 3 – fingerboard; 4 – neck; 5 – body; 6 – wedge
Fig. 31. Fret slot preparation:
1 – clamp; 2 – scale template; 3 – fingerboard; 4 – neck; 5 – body

Fig. 32. Preparing neck blanks:
a, b – preliminary heel carving; b – processed heel and neck; 1 – original profile; 2 – profile after treatment with a chisel; 3 – the final neck profile and cross-sections
The Construction and Repair of Balalaikas

Fig. 33. Model for carving the neck heel and joining the neck with the headstock:

a – neck heel; b – joining the neck with the headstock

The most difficult areas are the transition zones in the neck and heel, and the neck and headstock. It is very difficult to identify any control points or apply any templates. In these places, neck treatment is entirely dependent on the experience and taste of the builder. The recommended heel model and headstock neck transitions are shown in Fig. 33, a, b.

Finish working the neck neck with a file (rasp) with various profiles and knurl patterns. The neck surface is then scraped and cleaned up with various grits of sandpaper.

Fig. 34. Fret Shaping

a – shaping the ends of fret wire: 1 – fret wire; 2 – fingerboard; 3 – neck; b – formation of the fret profile: 1, 2 – plane obtained from shaping with a file; 3 – plane obtained by spinning frets; 4 – final fret profile; 5 – fret wire; 6 – fingerboard; v – model for treating the ends of the fret wire
Fret markers on the fingerboard are installed after the 1st, 4th, 6th, 9th, 11th, 14th, 16th and 18th frets, with the final two made a smaller size. [Trans: This is another way of stating that the fret markers are installed at the 2nd, 5th, 7th, 10th, 12th, 15th, 17th and 19th frets.]

Hold a straightened piece of fret wire in the left hand. Lubricate the tang of the fret wire with liquid adhesive and hammer it into the slots. If the tang is difficult to insert, the slot can be easily expanded by sawing slightly. When the slot is too loose, resort to using a filler which can be made from sawdust and liquid adhesive. Excess wire can be nipped off with cutters. Particular caution should be exercised when driving frets into the lower part of the fingerboard, which is already glued to the soundboard. To avoid damaging the soundboard blows with a hammer must be light and easy.

The process of working the frets is called seaming or flanging (закатка in Russian - zakatka). Begin the flanging process by stripping the ends of the fret wire protruding from the sides of the neck. Do this with a heavily knurled metal file. The motion of the file should be such that the ends of the frets have no burrs, and the ends themselves become rounded (Fig. 34 a). Then all of the frets are leveled with a file to the same height. For this, a file is placed on the frets and, pressing down lightly with the hand, and is moved along the fretboard. This process continues until all traces of the file over their entire length are no longer noticeable and the frets are level. Usually this process is called leveling the frets. In this manner, the flattened area (or plateau) (3) is shown on the fret wire profile (Fig. 34. 6). Angles (1) and (2) are obtained by shaping the sides of each fret with a file. Round out the trapezoidal profile (4) of the frets with a special (fret) file. The ends of the fret wire, facing the sides of the neck are smoothed with needle files, seeking the form shown in the model in Fig. 34, b. Finish working the frets with abrasive sandpapers, lapping each fret separately and then all together. [Trans: Be sure to mask the fingerboard during this process to avoid any unnecessary scratches or dings.]

When viewed from the base along the surface of the fingerboard, the frets have to be merged into a single band with no light and dark spots. The frets should not have any sharp nicks or bumps to the touch.
Fabrication and Installation of the Nuts and the Pickguard

The first cut into the fingerboard (Fig. 35a) is made to the depth of the fingerboard. The resulting socket is cleaned with a chisel and a piece of ebony or other hardwood measuring 6 x 8 x 35 mm is glued into it. After drying, the upper nut is worked with a chisel to the profile shown in Fig. 35b.

![Fig. 35. Layout for the upper nut](image)

a – preparing the slot for the upper nut: 1 – fretboard; 2 – cut layout under nut; 6 – diagram of upper nut showing principal dimensions

The lower nut should also be made out of hardwood such as ebony, or bone. A rabbet under the nut is prepared, as shown in Fig. 36.

![Fig. 36. Layout for the lower nut](image)

1 – soundboard; 2 – binding; 3 – pin block cover; 4 – base wedges; 5 – base

The pickguard for a balalaika is made of polished billets of dyed beech or pear, 3-4 mm in thickness. For our purposes, we may use three-layer birch plywood without knots if beech or pear is not available. The first part of the pickguard contour (AGF) (Fig. 37) is cut with a jigsaw or a thin bow saw. Chamfering is done with rasps and files. The polygonal line shown in the figure, as ABCDEF, shows the second part
of the pickguard outline. Place the billet piece on top of the balalaika body, and trace the outline of the body and the fretboard end with a pencil. Cut out the pickguard billet BCDE under the fingerboard making it 2 mm narrower and 4 mm shorter (providing some allowance).

Fig. 37. Thumbnail of the pickguard billet (viewed from lower side)
1 – drawing of cutting the pickguard billet; 2 – pickguard cross-section; 3 – cross-section of glued veneer gakets

1.5-2 mm veneer gaskets or strips (3) are glued onto the bottom of the pickguard. [Trans: These gaskets hold the pickguard above the surface of the soundboard to allow the soundboard to freely vibrate.] The bevel angle is 15°, which is made along areas BC and DE, ensuring a tight fit of the
pickguard and the fingerboard. The site CD is connected to the fingerboard with the help of a shoulder pad (Figure 38). The pickguard is joined to the body with glue on the gasket (6) and several wooden nails (10). Notches under the nails were previously pricked with an awl or bored with a 1-1.5 mm diameter drill. Approximate nail installation locations are indicated in Fig. 37 by stars. Remove any lacquer from the soundboard at the area of attachment before installing the pickguard. Pay particular attention that the surface of the pickguard is level with the bottom of the fingerboard. Fill any slits or gaps between them.

Fig. 38. Diagram for strengthening the pickguard: а – placement of the cross-section, 6 and 8 – the transverse and longitudinal cross-sections:
1 – pickguard; 2 – fret wire; 3 – fingerboard; 4 – heel; 5 – soundboard; 6 – gasket under the pickguard; 7 – binding; 8 – lining; 9 – body staves; 10 – wooden nails

Fig. 39. Sketches of the bridge billet and finished bridge
а – bridge preparation; 6 – bridge
The bridge (usually called a podstavka, but sometimes called a kobylka) can be made from a maple or beech billet, less frequently from birch (Fig. 39, a). A shim or strip of ebony, rosewood or other very hard wood is glued to the top of the bridge. The final size of the bridge is shown in Fig. 39, б. The bridge height at the center is determined by the diagram shown in Fig. 40.
Finishing the Instrument

Finishing the instrument starts with a damp shop cleaning, as dust is the bitter enemy of the wood finishing process. You need to change your apron or gown and warm the room to 24-27°C. Then make a careful examination of the outside of the instrument. Any gaps or cracks found should be filled with a mix of sawdust and liquid hide glue. Fillers must be carefully applied, trying not to stain the soundboard. If this should happen, dampen a cloth to remove any uncured filler from the polished soundboard.

The dried body is scraped. The body of the instrument is supported in this case in the lap or between the knees, and the head and neck are pressed against a rubber strip on the edge of the bench. Scrape along each stave separately. On a properly scraped body the surface of the staves accurately shows the separate veneer strips (veins) in between.

The base is scraped far and wide across the entire surface, while avoiding being overly aggressive. Otherwise, change the direction of scraping.

Scrape the neck, beginning with the heel. In this, the scraper is worked smoothly through the strip (vein) separating the body from the heel. When scraping the neck, monitor so as not to have formed any ridges. These should be removed, working the scraper in a spiral or circular direction (Fig. 41). The headstock is scraped in the direction from the head toward the body, also avoiding any ridges or edges on the faces of the oval surfaces.

The body and neck are sanded with fine sandpaper in the same manner and direction as the scraping. It is recommended after sanding that the work surface be wiped with alcohol to raise the grain.

Before applying the lacquer to the body, the lacquered surfaces of the head and neck heel are primed with nitrocellulose lacquer NC-222 or similar. Priming the body and the neck is done with the same technique as priming the top. The part of the neck area where the musician slides the palm of his hand during playing should not be treated with lacquer (Fig. 42).

Lacquer the body and the neck with shellac varnish using a ‘tampon’ (muñeca) in the same sequence as was done with the soundboard. The same process or sequence is followed when sanding and pumice polishing the lacquer, as well as the subsequent polishing of the body.
Careful attention should be paid when sanding the lacquered surface of the body, as it is possible to sand through to the wood.

When pumicing the body and neck, also treat the neck. The same oily pumice powder gets into the pores of the unvarnished neck and soaks into it. This treatment to the neck is considered sufficient.

Quite often, the builder is not satisfied with the natural color of the body wood. In this case, you can make a body wash after the body is polished. The dye must be diluted in the correct proportions and always tested on a board of the same species as the body staves. To obtain good results the ‘tampon’ (muñeca) with dye is applied uniformly along the staves of the body, without runs and in even passes. The dyed/painted surface should not be too wet. After drying, rub the dyed/painted surface with a piece of felt to give a slight sheen. Then proceed to the primer and subsequent nitro lacquer finishing of the instrument. Remember that when sanding through the colored body, unpainted wood may emerge. Such a defect can only be completely eliminated by thoroughly scraping and repeating all of the subsequent operations.
Assembling the Finished Balalaika

Assembly of the finished balalaika begins with the tuning machines. Insert the mechanism into the slot prepared for it. Place two rubber gaskets between the gears of the tuning mechanism protruding above the headstock by 0.3-0.5 mm. The tuning machine cover will compress the gaskets by this amount and thus hold the tuning machines in place. The tuning machine cover is fixed to the headstock with 6-7 screws, in holes in the headstock made with an awl or small drill bit.

In the hole drilled into the base, insert a button (string pin) (Figure 43). The buttons (string pins) must be inserted into the holes tightly by hand. For the last 2-3 mm it is allowed to tap with light hammer blows.

![Fig. 43. Drawing of the string pin.](image)

For determining the location of the bridge you can use the diagram shown in Fig. 40. After determining the placement of the bridge at a distance of 2A from the upper nut, place a dot there, lightly pushing the pencil lead into the polished surface of the soundboard.

Make slots for the strings on the upper edge of the bridge and the upper nut (Fig. 44). The depth of these slots should not exceed half the diameter of the string being installed. Excessive deepening of the slots may cause buzzing of the strings.

Install three strings on the balalaika-prima. String (3) is metal 0.25mm (.010, but .011 and 0115 are common sizes), and two synthetic strings, usually nylon, 1mm (.039, but Classical Guitar G strings around .04 are commonly used). The strings should not stretch much. When transporting, it is recommended to put the bridge on its side.
Fig. 44. Layout of the strings on the nut and bridge-prima balalaika
1 – bridge; 2 – synthetic strings; 3 – metal string; 4 – upper nut
The Technological Process of Factory Production of Balalaikas

Serial production of the balalaika is based on the same basic technical methods and operations as that used in the manual production process. Industrial production differs only in the more general use of woodworking machines, using standard tools and templates. The balalaika body is gathered up from six staves, fixing them on the neck and the base. The body assembly is performed on a special device. This device is so constructed as to have fundamental differences from the patterns of improvised structures used in handmade balalaika construction. Techniques for working on such a structure also do not have any new elements compared to those already considered.

Braces are glued to the soundboard in pneumatic presses with resistance heating. Along with gluing the braces to the soundboard, the arching is created. The soundboard is glued to the body of the balalaika in pneumatic presses. The pockets for the braces under the soundboard are cut out on a milling machine. The soundboard is glued on with hide glue and kept in special fixtures for 4-6 hours.

The balalaika fretboard is glued on with adhesive M-70 or K-17 in pneumatic presses with low-voltage electrical contact heating. The heating temperature is 120-140° C. It is kept in a pressurized state 4-5 minutes, then clamped 2-4 hours afterward.

The slot in the end of the neck under the head is cut with a milling machine. The headstock is glued with hide glue. The headstock angle to the plane of the fingerboard is 12°.

After planing the fingerboard on the milling machine, fret slots are sawn into the fingerboard. This operation is performed on a scale cutting machine, which has several circular saw blades on a single shaft, the number of which corresponds to the number of fret slots required. The saw blades have a thickness of 0.7-0.8 mm. The working part of the saw blades is set to the height of the fret wire tang.

Sanding of the prepared balalaikas is done in two ways, on vertical disk sanding machines and with sanding rollers. Areas that the mechanical sanding cannot reach are then scraped and sanded by hand.

The prepared balalaika base and body are stained and the neck blackened. After the stain is dry, nitrocellulose lacquer is applied using conventional spraying. In recent years, it has become a widespread method to apply varnish electrostatically.

In order to save wood and increase productivity at the “Leningrad Lunacharsky Factory of Folk Musical Instruments”, they developed and put into production a method for making balalaika bodies from wood-pulp. From chips and waste paper, with the addition of phenol-formaldehyde resin and a special sizing agent they cast balalaika bodies. After pressing in the mold at 150-160° C and a surface pressure of 8 MPa (80 kg/cm2) you get a ready balalaika body, which goes to assembly using conventional wooden balalaika manufacturing techniques. Enhanced aesthetic and acoustic requirements for such instruments are not considered.
Balalaika Repair

Balalaikas coming in for repair, as other stringed musical instruments, may have pronounced defects that need to be addressed. Repairs are done in two ways: without opening the instrument, i.e. without separation of the soundboard from the body, and opening the body.

If the repair cannot be made from the outside, the balalaika is opened in the following sequence. Remove the strings, tuning machines, and buttons and then place them neatly aside. Using a thin, broad knife with a rounded blade, occasionally dipping it in hot water, separate the pickguard from the body and fingerboard. Having removed the pickguard, if you want to preserve it, clean the glue and residue from the mounting nails and set aside. Also clean the adhesive residue from the pickguard off the top.

If the repair once started does not require changing the fingerboard and together with it you wish to preserve the soundboard, take out the 16th fret, i.e. that fret, under which the body is joined to the neck. Fret kerfs can be deepened along the entire thickness of the fingerboard.

Using a rounded blade, warming it in hot water, carefully separate the top and soundboard from the body. Particular care should be used in the area of the soundboard corners. With the same knife carefully separate the soundboard from the lining and develop this gap along the lining. The points where the braces extend into the linings should be avoided. Having separated the soundboard from the lining, begin to separate it from the base. This is also done with the rounded knife. With a narrow chisel or cutter remove the braces from their pockets in the linings. It is very exacting and difficult work, and haste should not be tolerated. The last section of the top to be removed is where it is glued to the heel of the neck. The lower part of the fingerboard with frets remains on the soundboard.

If the fingerboard is of no value and you plan to change it, then in order to open the balalaika remove all of the frets and the nut and plane the fingerboard down. The soundboard is removed by the above method.

Significantly less common is opening the back of the balalaika body. To do this, cut out and carefully remove one of the staves. After making any repairs, such as replacing or restoring braces, the stave is glued back in place with the help of patches.
Crack Repair

Cracks can appear in any part of the instrument. If the crack is small, then pour hot hide glue into it and carefully wrap with rope. For greater confidence in tightly pressed parts, wooden wedges are slipped under the rope during gluing. Wedges can also be used to control the crack height. After gluing the crack area, sand and varnish.

The crack may have a rather large width – 0.5-1mm. In this case, use an insert as shown in Fig. 45. The edges of the crack (2) are cut "into the face", and the edges of the insert (1) are also cut "into the face". A clamp is then wound with rope.

When repairing cracks and crevices in the ornaments and the face of the bindings, use an adhesive filler of sifted sawdust of the desired color. Sometimes part or all of the trim is replaced or changed. Follow the same procedure as is done during the assembly of a new balalaika.

Corners of the soundboard that have fallen out or sound hole rosettes or pin block covers are repaired by replacing the lost items with new ones. Carelessly treated corners of balalaikas can be dyed. Any cracks and crevices that have appeared can be filled with adhesive filler, dyed to the appropriate color. For large areas of corner damage, the damage can be cut out and all damaged elements that converge at the corner can be restored.

Body Repair

There may be holes in the staves of the balalaika body. The preferred repair is to replace the stave. A broken stave can be neatly sawn and cut out with some kind of cutter. A new stave is prepared, chosen by wood type and grain. A patch (1) (Fig. 46) of spruce measuring 20 x 20 x 3 mm is glued from the inside on the sides of the stave (2). The new stave is shaped to provide a snug fit to the patch. Along the length of the stave take into account the veneer strip glued to it. After fitting and gluing the stave,
touch up the color and then varnish. Quality stave repairs adjacent to the soundboard/top, without removing the latter, are very difficult. With new inset staves, it is recommended to bend them along the body using the hot pipe or bending iron.

Fig. 46. Installation of patches when replacing a stave in the balalaika body:
1 – patch; 2 – staves of the balalaika body; 3 – pocket in the neck heel; 4 – bass binding; 5 – base; 6 – wedge on the balalaika base

There is rarely any need to change or do additional work on the top braces. Even more rarely, the builder may decide to replace the top. Both of these operations must be carried out by opening the balalaika body.

Neck Repair

The destruction of the balalaika’s neck heel rarely happens and usually means the death of the instrument, as well as compromising the integrity of the connection between the body and the neck. It is significantly more likely to have to correct a neck defect, like concavity or warping. Constant string tension can deform the neck and makes playing the instrument difficult. Repair begins by removing the pickguard, upper nut and frets. The fingerboard can either be planed off or removed with a semicircular knife. Before removing, place a rag soaked in hot water on the fingerboard for 10 minutes. This facilitates removing the fingerboard. Plane the neck flat and put on a new fingerboard. The thickness of the fingerboard is determined depending on the desired cross section size or thickness of the neck. Further treatment of the neck is not different from that previously described.
The most frequent repair is fretting. Under the first string, indentations will form, impeding the musician’s playing. If there is sufficient height left to the frets, then the repair can be confined to leveling all frets with a wide, coarse file. Then shape the frets by the usual methods. If the frets are worn out, then they are removed with nippers and replaced with new ones. It is best to remove the pickguard during these operations.

**Thoughts on Repair**

The main task of the builder during repair work is to preserve and, if possible, improve the sound of the instrument. Of great importance in this regard is the preservation of the sizes of the repairable parts and the relationships between these dimensions. For example, increasing the thickness of the fingerboard or incorrectly leveling raises or lowers the last frets. This in turn results in an increase or decrease in the height of the bridge. Increasing the height of the bridge increases the pressure on the top, and any reduction in the height prevents playing the instrument and makes it difficult for the formation of the pickguard. Therefore, when starting a repair of the instrument, the builder records and sketches the main elements of the instrument and their co-locations.

A musician may ask the builder to make changes in the design of the instrument, and the builder must know what options he has depending on these desired changes. If necessary, the builder must defend his opinion, as the quality of repair, as well as the sound quality of the repaired instrument, is entirely dependent on him.

Repair, done to musical instruments is very laborious and time-consuming work. Many believe that it is easier to build a new instrument than to repair an old one. But in repair work, the future master receives invaluable experience. He sees a variety of design solutions and can understand and learn new technical methods that were not previously known. Not for nothing, but the master builder and the master repairmen are both equally valued.
Questions and Problems

1. What are the main components of the balalaika? What material is required to construct these parts?
2. In what order are body staves of the balalaika installed?
3. At what fret is the fingerboard attached to the body of the balalaika?
4. What are the requirements for the material for braces?
5. Make 3-4 options for balalaika soundboard design.
6. How do you determine the placement of the bridge on the soundboard of the balalaika?
7. How do you open the body of the balalaika for repair?
8. How do you change frets on the balalaika?
9. How do you fix neck deformation?
Contents

The Construction and Repair of Balalaikas

Technological Sequence of Basic Operations

Basic Construction Parameters and Instrument Structure

Making the Neck Billet

Constructing the Body Parts

Assembling the Balalaika on the Template and its Subsequent Processing

Preparation of the Soundboard and Gluing it to the Body

Preparing the Headstock

Fabrication and Installation of the Nuts and the Pickguard

Finishing the Instrument

Assembling the Finished Balalaika

The Technological Process of Factory Production of Balalaikas

Balalaika Repair

Crack Repair

Body Repair

Neck Repair

Thoughts on Repair

Questions and Problems