Chapter 7

Repairs

"The repairman has to begin each job by getting outside his own head and noticing things; he has to look carefully and listen to the ailing machine."
—Matthew B. Crawford, author of *Shop Class as Soulcraft*

Various repairs may be needed during the life of a piano, such as repinning action parts, regluing them, replacing broken strings, etc. This chapter focuses on performing isolated repairs; Chapter 10, "Rebuilding," covers repairs of larger scope. For example, you will find instructions on replacing a broken string in this chapter, but a complete restringing procedure in "Rebuilding." For additional reading, see Stephen Brady, RPT, *A Piano Technician's Guide to Field Repairs*.

As most small repairs need to be performed on-site, you should always carry a well-organized tool kit and a set of frequently needed materials. Some repairs, however, must be done in a workshop (page 327).

When you work in a customer's home, remove all objects that could be damaged as a result of your work. When removing the action and/or the keyboard, be sure you have enough room to pull it out *and* carry it away from the piano. Protect the piano, the bench, surrounding furniture, and the floor as explained on page 135.

When working with glues, lubricants, or solvents, cover all work surfaces so that an accidental spill won't mar the piano, the floor, or the furniture. Always alert the owner if you intend to use solvents with heavy odors, such as a hammer hardener, CA glue, or even alcohol. Some people are sensitive or allergic to chemicals and dust—they will appreciate an advance warning.

If you work inside the action cavity or in a vertical piano, look for signs of rodent infestation. If you find any, decontaminate and clean the piano before proceeding (page 136).

Tool Kit

The tools and materials you carry with you depend on whether or not you have your own transportation. But even if you can drive a truck full of tools to every job, having a tool case that you *can* carry when you need to use public transportation, or have to walk some distance to a concert-hall stage or to a building on a college campus, is an advantage. The tool kit I describe strikes a balance between completeness and portability.

Case: I recommend keeping your tool kit in a case with dividers that have pouches for individual tools (Figure 383). Such cases can be purchased from piano-parts suppliers or well-stocked hardware stores. If you frequently need to walk with your tool kit, you may consider a case on wheels or a soft backpack. Keep your tools and materials rolled up in tool rolls.

Tools: The tool kit should include several screwdrivers, from a small flat-blade one for adjusting the hammer drop, to larger flat-blade and Phillips screwdrivers for end blocks and trapwork. The kit should also contain linesman pliers, needle-nose pliers, round-nose pliers, channel-lock pliers, tweezers, and a variety of specialized action- and keyboard-regulating tools, such as key-easing pliers, string-replacement tools, a string downbearing gauge, and a set of gram weights. An LED head light is a must for poorly lit spaces. A small long-bristle brush for dusting between tuning pins, and a larger one for the action and the key bed, will be handy on many occasions. Always have several pairs of light cotton inspection gloves on hand.

Lubricants: Various lubricants should be a permanent part of every piano technician's tool kit (Figure 384). Carry a small amount of at least one lubricant from each cate-

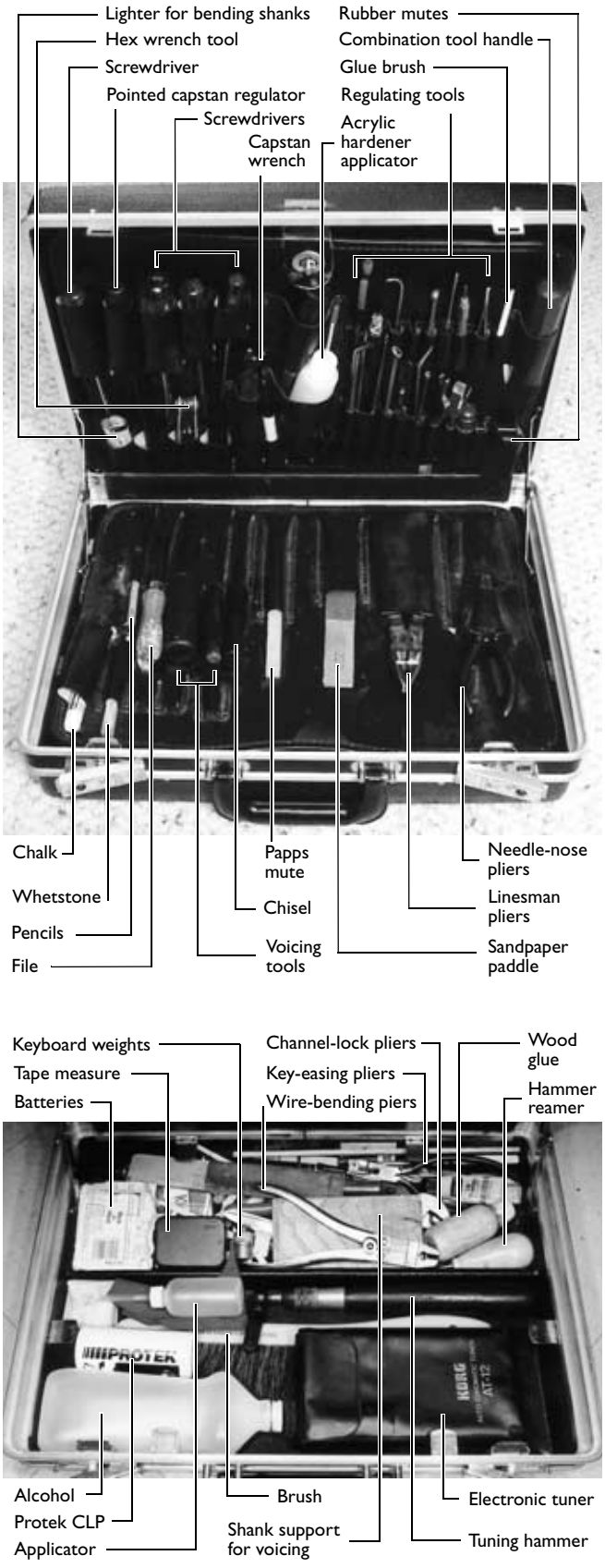

Figure 383 *Piano technician's tool case.*

gory on page 145. Also carry a 90% or stronger ethyl or isopropyl alcohol as a degreaser/cleaner. To fit more of them in your kit, carry chemicals in closable lens cases. Be sure to have dedicated applicators, such as blocks of felt, bottle brushes, and hypo-oilers.

Strings, tuning pins: To replace a broken string, you should have a tuning hammer and a mute, a medium flat-blade screwdriver, and linesman pliers for cutting the string and tightening the string becket. Carry replacement strings, pre-cut and clearly labeled, in a sealed pouch with silica gel to prevent rusting. Since it is relatively common for a treble string to break during a tuning, your tool kit should include replacement strings in half sizes at least between gauges #13 and #16.

Felts, cloth, leather: For regulating work, you will need bushing cloth in the three popular sizes, key frame cloths and felts, balance and front rail punchings in the most popular sizes, and an assortment of paper punchings. Carry replacement bridle straps, bridle cloth for muting strings, hammer rest cloth, and small amounts of cloth in various sizes and densities for emergency replacement of a missing key end felt, wippen heel felt, let off button felt, etc. Have a few strips of damper felt of each kind. A block of dense felt (or a felt eraser) is useful for applying powder lubricants. You should also have a few pieces of leather and thick buckskin for trapwork repairs.

Action parts: Tuning also challenges hammer shanks. For grands, carry several types of replacement shanks and flanges, assembled (my preference) or as individual parts (you will need to pin them yourself if purchased separately). For verticals, usually you need to have two sizes of special maple or hornbeam shanks, 7⁄32″ [5.5 mm] thick for uprights, and 3⁄16″ [4.75 mm] for consoles and spinets. It's useful to have a few wippens, backchecks, and underlevers or damper levers.

Repinning: To replace action parts' center pins, you should have flush-cutting pliers, a set of center pins in various sizes (pre-cut and supplied in a convenient dispenser box), and a tool for punching out and pressing in the center pins. You will also need a few strips of center pin bushing cloth to replace worn and contaminated bushings, when needed.

Voicing: An array of sanding paddles (page 202) will allow you to reshape worn hammers, as well as mate the hammers as part of your voicing work. Always carry a hammer-support board, and single- and three-needle voicing tools.

Materials: You need to have an assortment of hardwood dowels and plugs for repairing stripped screw holes. You should have a fresh supply of wood glue, a quick-drying epoxy, and some superglue gel. Some of these glues are affected by temperature extremes and should be replenished often if you keep them in your vehicle. Carry one or two sheets each of 60-, 100-, and 150-grit garnet (dry) sandpapers, silicon-carbide (wet) sandpapers from 180- to 600-grit, and a few steel-wool pads (you will need #000 and #0000 for most action work).

Figure 384 *An assortment of glues and lubricants in small containers.*

As you service more pianos, it will become clear what kinds of repairs you perform frequently, and your tool kit will become better "tuned" to your particular needs. If you always use the same vehicle, you may want to keep a larger selection of tools in it, including power tools, horses, action stands, etc.

Broken String

A broken string can be replaced or spliced. When a string breaks at the front termination, such as the agraffe or V bar, it's best to replace it. However, if it breaks at the tuning pin or the becket (where it enters the hole in the tuning pin), you can wind a piece of new string on the tuning pin and splice the old string to it. Be prepared to replace the string if the splice fails.

Pros and Cons of Splicing

Some technicians consider splicing a permanent repair and don't replace spliced strings. That may be acceptable if the owner doesn't mind the splices or the piano will be restrung soon. If you *do* plan to replace a string, however, replace it immediately to spare the tuning pin from needless turning and loosening. Splicing involves turning the tuning pin twice: once for the splicing, and the second time when replacing the string. Another negative is that a splice is more likely than a new string to damage the plate's gilding or felt.

Here are the cases in which splicing a string may be a genuinely better option than replacing it:

- **Sound quality and unison tuning:** If the owner is concerned about the new string sounding different and introducing false beats in unisons, splicing is the way to go.
- **A string breaks right before a concert** and there is no time to stretch and stabilize the new string. Some technicians would argue that if you have the time to splice, you can spend a few more minutes stretching the new string to last until the intermission, when you can retune it. This, however, is not always feasible.
- **A bass string breaks in a high-use or concert environment:** If you can afford it, keep a set of replacement bass strings for all important pianos you service. That way, you will be able to replace bass strings on the spot.[266] But even if you have a replacement string on hand, it will quickly go out of tune. Since you can't stretch a bass string because of its delicate copper windings, splicing the original will yield more stable results. Unfortunately, the bass section usually gives you very little space in which to position the splice, and if the splice ends up on the felt or the tuning pin, it may break.

When Strings Keep Breaking

If multiple strings break in the same section, check whether the gauge of the wire is correct for the note in question. Is the V bar grooved, making the strings bind on it? Lubricate the strings to reduce friction at their bearings (page 113). If that doesn't help, you may need to restring a whole section or even the whole piano (page 418). In that case, consider reaming and polishing the agraffes (page 436) and reshaping, polishing, and lubricating the V bar (step 6 on page 425). If the V bar is deeply grooved, heat-treating it may help.

TOOLS

- Protective gloves and goggles
- Tuning hammer
- Rubber mute, Papps mute for verticals
- Linesman or other pliers or nippers for cutting wire and tightening wire beckets
- Medium to large flat-head screwdriver
- Coil lifter (a screwdriver can be substituted in a pinch)
- Stringing hook (for grands, although it may also be useful in tightening string coils around tuning pins in all pianos)
- Dummy pin, preferably with a slot cut halfway through along the length and aligned with the string hole
- Bass string twisting tool
- Safety pin and/or string-threading device or narrow tube for installing under the over-strung section.
- Brass bar to tap down the string around bearings
- Optional: loop-making tool
- Optional: string-coil canisters

MATERIALS

- A selection of high-quality music wire graduated in half-gauges from #12 to #18, plus #19 through #23 in whole-gauge numbers, if necessary (premium unplated wire is recommended)
- A selection of tuning pins of each size/variation: sizes 2/0, 3/0, 4/0, and 5/0 in two lengths each, 2⅜″ [60 mm] and 2½″ [64 mm], nickel-plated or blued (it is recommended *not* to replace a tuning pin when replacing a broken string, if possible)

[266] Some technicians use hexagonal-core universal bass strings (Figure 83), but they don't blend well tonally.

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remove the key, and remove the lead. Hammer the lead oval and hammer it into the key, or push the lead back in and swage it (page 399). If there are any traces of oxidation on the leads, wear a good dust mask and protective gloves.

Replacing Oxidized Leads

Oxidized leads expand and should be replaced to prevent serious long-term damage to keys (Figure 203 on page 89). Replace such leads as explained on page 399.

Loose Balance Holes and Pulley Keys

Balance holes in keys enlarge from wear, climate changes, and over-reaming. Loose balance holes accelerate the wear of wippen heel felts, backchecks, key end felts, and key bushings. When a balance hole is elongated width-wise, the key will feel wobbly and the regulation may be inconsistent. If the hole is elongated from front to back, the key will shift from front to back, causing a condition known as "pulley key." This is distracting to the player and causes the regulation to be inconsistent: in a grand you won't be able to consistently regulate the backchecking and hammer height; in a vertical, the jack gap will be inconsistent. Tight balance holes, on the other hand, make the keyboard feel spongy and sluggish. To correct that, see "Reaming Balance Holes" on page 351.

The following are your repair options:

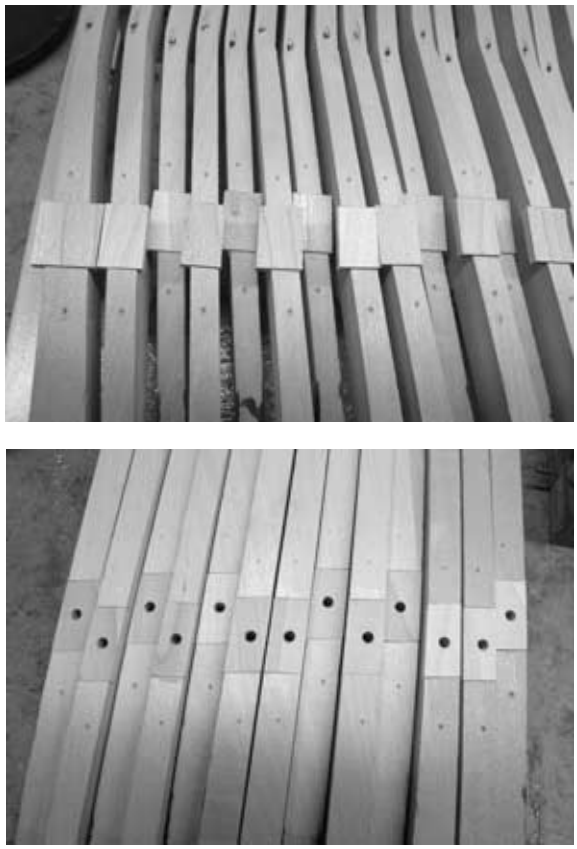
Alcohol/water: If the hole is slightly loose width-wise, apply a few drops of a 50% alcohol/water solution (add some water to the 70% rubbing alcohol). Wait until the water evaporates (a few minutes) and test the fit.

Glue sizing: If this doesn't help, you can glue-size the hole with a water solution of wood glue or hide glue.[267] The sizing should be fairly thin. Brush a small amount of sizing into the hole, let it dry completely, then ream the hole width-wise if necessary.

Hardwood strip: When glue sizing is not enough, you will need to rebuild the wood around the balance hole. To address the elongation along the length of the key, prepare a small piece of hardwood veneer (maple preferred) that is 1/16–1/8″ [1.5–3 mm] thick, 1/4″ [6 mm] wide, and somewhat longer than the width of the key. Cut a saw kerf across the underside of the key at the more distorted side of the hole (usually toward the front of the key) to depth of 1/8–5/32″ [3–4 mm]. Glue in the hardwood strip with wood glue (Figure 416). When the glue dries, trim the piece flush with the key. To make the hole round again, shape the strip with a thin Nicholson round file (rat-tail file) or a round needle file, then clean the hole with a drill bit slightly smaller than the balance pin. Put the bit in a pin vise, or run it in a power drill at very low speed (Figure 519 on page 351). Change the angle of the bit to widen the hole toward the mortise. Clean the mortise with the mortise tool, ream the hole widthwise from inside if necessary (Figure 518 on page 351), and coat/burnish it with a micropowder lubricant or a 5B pencil.

Photo by Allen Wright, RPT

Figure 416 *An elongated balance hole repaired with a hardwood strip.*



Photos by Mike Morvan of Blackstone Valley Piano

Figure 417 *Repairing elongated balance holes with hardwood blocks.*

Hardwood plug: If the hole is elongated widthwise or is too wide in all directions, plug it with a hornbeam or maple plug (Steinway-style let off buttons make good plugs for this repair), or a rectangular hardwood insert more

[267] Mix the glue with water for a fairly thin solution. Steinway & Sons recommends a 3:1 solution (*World-Wide Technical Reference Guide*, "Grand Preparation," p. 16). If you work with hot hide glue, heat the water a little (to no more than 150°F [50°C]) and stir it in gradually.

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Repairing a Cracked and Delaminated Pinblock with Epoxy

A cracked and delaminated pinblock ideally should be replaced, but if the piano doesn't justify the expense or the owner wants to preserve the authenticity of a historical instrument, you can treat the pinblock with epoxy. You may be tempted to apply a superthin, slow-drying epoxy with tuning pins in place, the way you would apply a CA glue, but that is unlikely to sufficiently restore tuning pin torque. The epoxy will seal the cracks in the top ply and prevent future applications, but will not address the delamination and cracking through the rest of the block.

Instead, you should remove the strings and tuning pins, seal the bottom of the pinblock (in grands), fill the tuning pin holes with the thinnest solids-only epoxy you can get, and redrill the holes.[289] The epoxy will strengthen the board by flowing into the cracks, and will restore tuning pin torque. However, is this effort justified? If you are ready to remove all strings and tuning pins, then drill the tuning pin holes inside the piano (do you have a drilling setup for this, or will you drill them by hand?), and restring the piano, why not replace the pinblock? The old block may develop new cracks, and tuning pin torque won't be as even as with a new pinblock. Aside from wanting to preserve the authenticity of the piano, the two cases where this approach may be justified are old upright pianos in which replacing a pinblock is difficult[290] and often economically unfeasible, and when removing the plate is out of the question.

You may be able to keep the old strings if you remove them carefully, with as little bending at the becket as possible. Label the strings and tape them to hitch pins before removing them from the tuning pins. Gently push the strings aside in the bass and middle sections. Don't kink the strings at agraffes.

For instructions on removing and installing strings, see "Restringing" on page 418.

Repairing Bridges

Here you can learn how to address loose bridge pins, and repair cracks and separations in bridge caps and bass bridges. For information on replacing bridge caps, setting the downbearing, notching the caps, and installing new bridge pins, see "Rebuilding Bridges" on page 472.

Warning: *Most bridge repairs involve infusing the bridge with a CA glue or epoxy. It is important to realize that you may have only one shot at this. Applying an insufficient amount of product or using a product that doesn't flow well or cures too quickly will not strengthen the bridge sufficiently, but will seal the cracks and prevent a future repair.*

Loose Bridge Pins

Loose bridge pins, which can cause false beats (page 132), can be repaired quickly with CA glue. This repair doesn't always work and may not last, but is worth performing when you're pressed for time. If you can afford to destabilize the tuning, loosen the string, push and hold the affected pin toward the string, and apply an ultrathin liquid CA glue (see "Treating the Pinblock with CA Glue" on page 255) around its base. If you can't loosen the string, simply apply the CA glue around the base of the pin away from the string. Repeat for each affected pin. If the CA glue doesn't help, perform the repair with epoxy (see "Cracks" below).

Don't apply the CA glue if the wood around the pins is cracked. The glue will seal the cracks and preclude a future repair with epoxy, which is much more effective as a filler.

Cracks

Cracks in bridges can cause false beats (page 132) and sympathetic vibrations. They can be repaired with epoxy. Normally you can just loosen the affected strings and pull out the affected bridge pins, but if you have to work around plate struts, you will have to remove the plate (and, obviously, the strings).

Your options for the repair are:

- **Quick repair:** Remove the pins, apply epoxy, and immediately install the pins, which will squeeze the epoxy into the cracks
- **Overnight repair:** Fill the holes with epoxy, let it cure, drill the holes, and install the pins

Each option is discussed below. If the cracks are wide, the cap is partially separated from the bridge, and/or the pins have lost their angle, you should replace the whole bridge cap (see "Rebuilding Bridges" on page 472).

Unless the relative humidity is low, dry the bridges for a day or two under heating lamps to expand the cracks. Remember, you have only one opportunity to infuse the cracks with glue.

Loosen the strings in the affected area and pull out the bridge pins with a pair of pliers (Figure 442). Keep the pins in order. If you have to install new pins, replace *all* the pins in each affected unison. Follow the instructions below.

Quick Repair

This technique is suitable only for minor surface cracks and to improve slightly loose bridge pins. If the cracks are extensive or you can see the gaps around the pins, perform the Overnight Repair instead. See below.

[289] See Kent Gallaway, RPT, "Epoxy Pinblock Consolidation in an Upright Piano: A Report"; and Ken Eschete, RPT, "Epoxy Consolidation: An Alternative Method for Restoring Piano Pinblocks."

[290] In many verticals, the top and side panels are glued to the case—removing them may involve sawing through their full width because prying them off usually causes too much damage. The pinblock itself is part of the frame and must be routed, planed, and/or chiseled out.

Coat each pin with a mold release or dry-film lubricant to prevent it from getting glued to the bridge. Mix a small amount of slow-drying epoxy glue and swab each hole with a thin pin or music wire. You need to apply enough epoxy for the pins to squeeze it into the cracks. If you apply too much, you may not be able to drive the pin as far down as you need to because it will press the epoxy under it like a piston. When you have swabbed about 10 holes, tap the pins all the way in with a hammer, and immediately wipe away *all* excess glue that has been squeezed out. Don't spread the epoxy around. Rotate the pins 15–20° clockwise from their original position, to make the strings touch them where they are not grooved. As the glue dries, occasionally turn the pins a little. When the epoxy cures (usually in 24 hours), chisel off any glue remaining around or on the pins (this is *very* important), file the pins' ends if necessary (don't let them get very hot), and clean everything. Reposition the strings around the bridge pins, and tune the piano.

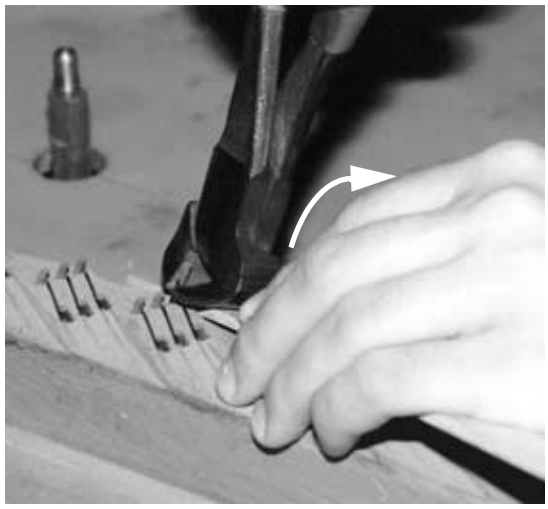

Figure 442 *Removing bridge pins with flush-cutting wire nippers. Note the wood strip that provides leverage and protects the bridge cap. Pull each pin in several short strokes.*

Overnight Repair

You can fill the cracks with epoxy either by injecting it with a syringe and hypodermic needle, or by applying it with a piece of wire. Injecting is recommended because you can work faster and fill the cracks more thoroughly. If you don't plan to remove the plate, make sure that plate struts won't prevent you from drilling the bridge pin holes at the original angles.

1 **Injecting epoxy:** Epoxy is a skin irritant—wear nitrile or latex gloves. Mix a small amount of slow-drying epoxy glue on a piece of cardboard, and inject the epoxy mixture into each hole using a 10 cc [10 ml] syringe and a thick (15 or 16 gauge, 1½″ [38 mm] long) hypodermic needle, as depicted in Figure 443. To repair more than a few holes you will need multiple syringes and needles (between 5 and 10 for all holes, if you work quickly and use a slow-drying epoxy). Strongly press the needle onto the syringe while they are both still dry—this way the needle won't slide off the syringe during the application. For a few holes, mix ca. 1 ml (1 cc) of resin and 1 ml of hardener; for a whole section, mix up to 3 ml of each. Mix the epoxy close to the edge of a cardboard sheet, bend the sheet to act like a funnel, and pour the epoxy into the syringe. Insert the plunger, turn the syringe upside down, and squeeze out the air. Quickly inject the glue into each hole from the bottom up. When you've used up the mixed epoxy (or if it starts to harden), *thoroughly* wipe its excess from the bridge. Top off the holes a few minutes later (with a new syringe and needle). Do not be surprised if the epoxy seems to vanish—it is infusing the cracks.

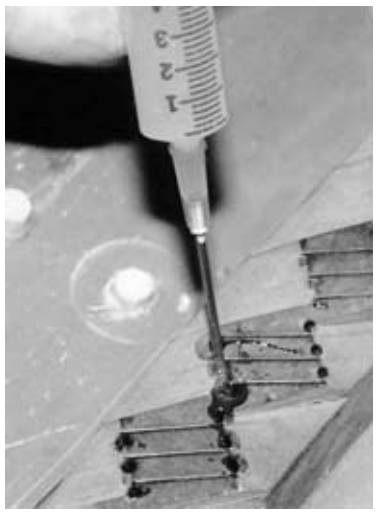

Figure 443 *Filling bridge pin holes with epoxy.*

2 **Applying epoxy with wire:** If you need to fill only a few holes, you can apply the epoxy with a thin pin or music wire. Work the pin in and out of the hole several times to push out the air. Stop using a mixed batch if it starts to thicken or it won't completely infuse the cracks. Reapply epoxy from fresh batches to top the holes.

Figure 444 *Drilling epoxy out of bridge pin holes.*

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Photos by Heinrich Koenig & Co. KG

Figure 452 *Applying König's Hard Wax (top) with their butane burn-in knife (bottom). The butane cartridge is shown removed.*

Repairing Chips and Scratches

The fastest and simplest way to conceal a chip or scratch is to rub across the scratch a **putty** product, such as König's Quick Filler, or a putty stick (Figure 451b). The repair will not blend in particularly well, will be clearly visible in reflected light, and will rub off if the surface is polished repeatedly, but is better than leaving the blemish as is.

The next level of repair is a **cold wax** or filler, such as König's Soft Wax, which doesn't require melting, and which can be sealed with a thin coat of lacquer (König's Special Repair Lacquer™ blends in particularly well). The sheen of the repair can be reduced with steel wool.

König's **Hard Wax** offers greater durability. It is applied with a burn-in knife (Figure 452) at a somewhat lower temperature than the traditional lacquer stick (see below). Hard Wax doesn't shrink, and can be leveled and scraped moments after it is applied.

The traditional product for repairing scratches on lacquer is the burn-in shellac stick, also called "**lacquer stick**" (Figure 451c). Lacquer stick creates a durable repair, but applying it requires skill and experience. Melt lacquer stick with a burn-in knife, and immediately apply the material to the scratch or gouge in various directions to avoid trapping air, which could cause pin holes or incomplete coverage. Smooth out the surface with the knife, moving it steadily to avoid creating ripples. Don't move too slowly or you may burn the repair and the surrounding finish. If the completed repair doesn't blend in well, you may need to wet-sand and rub it, then spray the surface with lacquer. Conventional lacquer (black or clear) will leave a halo unless you spray it over the whole surface, from edge to edge. König's Special Repair Lacquer™ may produce a more acceptable result.

König's alternative to lacquer stick is Hard Wax Plus, a synthetic product that is less brittle and tends to blend in better, due to its lower sheen.

Repairing Gouges and Deep Scratches

Lacquer stick and König's Hard Wax Plus can be used to repair relatively deep scratches, but if the wood is damaged, you should repair the void with a true wood filler (see Figure 752 on page 482), wood plug, veneer, or a block of wood if the damage is extensive.

To prepare the gouge, remove all finish, primer, and splinters from it, and chip off any loose or shattered finish around it. Grind its surface with a ball-shaped grinder bit in a high-speed rotary tool. Shape the gouge in a smooth, concave shape so that it will not retain air bubbles when filled. Apply the filler in thin coats, allowing each coat to dry thoroughly (or use a two-component filler, which will harden through a chemical reaction). Either fill the gouge to slightly below the surface and finish the repair with the products described above, or overfill the gouge slightly, then dry-sand the area flush with the surface, and spray the area with lacquer. If you decide to do the latter, reapply and sand the filler as necessary until perfectly smooth, with no pinholes. Vacuum and wipe away the dust, degrease the surface with alcohol, then spray several coats of lacquer sanding sealer, wet-sand it with 400- and 600-sandpaper blocks, and spray the whole area with multiple coats of top-coat lacquer. Wipe the surface clean and satinize it as explained in "Removing Swirl Marks and Light Scratches by Satinizing the Finish" below.

High-gloss Lacquer

Repair high-gloss lacquer as described above, but wet-sand the repair with sandpaper up to 1200-grit, and buff the surface as explained on page 483. Use liquid or paste buffing compounds suitable for lacquer, such as Meguiar's Mirror Glaze® No. 1, followed by No. 3 and No. 5. Don't use a buffing bar—it's too aggressive for lacquer and will damage and/or scorch the surface. If splatter is a problem (it always is on site), buff the surface with a soft sponge wheel at a very low speed, or buff by hand with a synthetic buffing sponge or soft flannel cloth.

Removing Swirl Marks and Light Scratches by Satinizing the Finish

A "satin" lacquer is just a regular, high-gloss nitrocellulose lacquer finish that is rubbed with the finest steel wool

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