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Carl David Nyman
Utah State University

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I
HISTORY OF THE DEVELOPMENT OF THE VIOLIN

II
CONSTRUCTION OF THE VIOLIN

III
REPAIRS OF THE VIOLIN (STRING INSTRUMENTS)

by

Carl David Nyman

Submitted in partial fulfillment of the requirements for the degree

of

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in

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Carl David Nyman
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HISTORY OF THE DEVELOPMENT OF THE VIOLIN
The origin of all stringed instruments is lost in the midst of time, and despite the most patient and laborious research on the part of famous savants, no positive information has as yet been furnished regarding this point. Knowledge of the subject is more or less conjectural, and all that has been definitely established is the existence of the predecessors of the violin - the English crewth, a six stringed bowed instrument which is conspicuous for its rectangular shape, which is strongly reminiscent of the Greek kithara; the rebec, an instrument in the shape of an elongated pear having two strings tuned a fifth apart and played with a bow; the viol da Gamba, an instrument held on or between the legs and played with a bow and usually having six strings; the Arabian rebab, an instrument that is found in various shapes, e.g. elongated boat, halved pear, trapezoid, rectangle, and usually with three strings; the vielle played with the bow, having four strings and a drone string; and the organistrum, a medieval stringed instrument, shaped somewhat like a lute or viol, whose strings were put in vibration by a rotating rosined wheel. This instrument usually had four unfingered strings which produced a drone, and two fingered strings.

Caspar S. Duiffopruggar, named Tieffenbrucker, a Bavarian who became a nationalized Frenchman, was long reputed to be the first maker of violins, but according to Vidal, Bachmann (1925) all the so-called Duiffopruggar violins are spurious, having been made by Vuillaume, who in 1827, conceived the idea of making violins after the pattern of
a viola d'amour built by the former. Vidal estimates that Duiffopruggar worked in Paris from approximately 1515 to 1530, but in spite of the contentions that he was a wonderful artist at inlay work, there is absolutely no proof existing of the authenticity of the violins he is said to have made.

The creation of the violin as it is today concerning its shape is veiled in a mystery which the most ardent discussions on the part of specialists have not been able to solve. It is possible the paternity of the violin may be conceded to Gasparo da Salo, although it is more probable that Amati of Cremona and Maggini of Brescia may be considered the first to give the violin its present form; and in all events, the instruments made by the famous builders according to Bachmann (1925) are authentic in all their parts.

According to Farga (1940) it is with Gasparo da Salo that we enter for the first time the field of recorded history in violin-making. That da Salo made instruments at Brescia from 1560 to the year of his death, 1609, is indisputable. Whether the first violins were made by Maggini, da Salo, or by Andrea Amati, the fact remains that they originated during that period. The violins of da Salo were well built, although their appearance does not show the perfection of the later makers. His violins have backs of first class maple, low ribs, large F-holes, and a dark brown translucent varnish.

Giovanni Paolo Maggini was the most important of da Salo's pupils. Farga (1940) states that he took over da Salo's workshop after the latter's death. By that time, the name of Brescia had become famous all over the world owing to da Salo's instruments. Maggini never ceased experimenting, and improving over da Salo's models. Unfortunately, very few of Maggini's
instruments have survived, but those that have stand up to modern requirements. Their tone carries well and dominates even a large orchestra, yet in solo work they can produce a somewhat melancholy timbre.

Maggini's violins are large and wide, but their design lacks real beauty. The sound holes are a little too long and too pointed, and the scroll, though exquisitely carved, is too small for the size of the instrument. The curvature of the belly starts right from the ribs, which are a little too low. The edges are often lined with double purfling; the varnish is either brown or light yellow, but not as lucidly transparent as that of Gasparo da Salo's violins. It is well known that the Belgian virtuoso, Charles de Beriot, had two Maggini violins, one of which he bought in a junk shop in Paris for 18 francs. He preferred these instruments to those of any other maker.

Working at the same time as Maggini, Javiett Rodiani and Matteo Benti both contributed to Brescia's fame. Farga (1940) states that only toward the end of the seventeenth century did the Brescia school lose its influence; Cremona had by then become its great competitor.

Bachmann (1925) makes mention of the fact that it is evident that the actual form of the instrument is the fruit of a thousand and one successive changes, and that the present form has been in use for several hundred years. Innumerable experiments have been made with the object of varying the form, and of increasing the sonority of the violin as we know it; but none of those who would improve the violin has produced instruments which can equal in nobility of tone the instruments made by Stradivari, Guarnerius, Amati, and other great Italian masters.

With the assumed immigration of makers from Brescia--the emergence
of the Amati family and their final residence at Cremona--begins the classic period of the violin.

Wechsberg (1972) indicates that Andrea Amati was born in Cremona probably before 1510, and made violins from 1520-46. A good deal has been said about Andrea Amati and his violins. He was certainly the founder of the family, but not much is known about him except that he possibly acquired from Brescia the Maggini type, although his violins are somewhat smaller, arched in the belly, with a varnish that runs out of the Brescian brown into the mellow and brilliant gold and ruddy tints common to the Cremona Varnish. The F-holes of the Andrea Amati violins are quite wide and reminiscent of the Brescia school as are the sloping edges of his instruments.

For centuries violin historians have argued whether Gasparo da Salo or Andrea Amati "invented" the violin. It doesn't really matter, historically or geographically the distance between Brescia and Cremona is only thirty-one miles. If Andrea Amati was born around 1510 he would be older than da Salo. The oldest surviving Andrea Amati now in the United states was probably made in 1566.

Seniority alone won't establish the position of Andrea Amati in the violin world, but the Amati family according to Wechsberg (1972) did more than anyone else to establish and develop the Cremonese school of violin making, although this doesn't diminish the great contribution of the Brescians, Gaspara da Salo and Paola Maggini.

Nicolo Amati (the Great), son of Girolamo, was born in 1596. Haweis indicates that he did not trouble himself much with his grandfather Andrea, whom he probably regarded as a worthy old gentleman quite out of date. Nicolo the Great doubtless followed and imitated his father Girolamo,
but wishing to miss nothing and perhaps laboring under a sense of obligation or merely out of genuine affection, his labels embody an immortal acknowledgement of indebtedness to both masters. They run thus: "Nicolaus Amatus Cremonim Hieronymi Fil, 1677."

The grand Amati violin pattern runs some of the Stradivari violins very hard, and is evidently the model on which the 1700-35 strads are built. The side-grooving, generally held to interfere with the volume of tone, while supposed by some to add sweetness, has not disappeared as in the Stradivari grand model, but has become less pronounced.

Andrea Guarneri (Andrew Guarnerius) the apprentice to Nicolo Amati, worked with Amati until 1698. Many of the violins of Andrea Guarneri are of the small Nicolo pattern, but somewhat inferior, and not always well finished. Joseph, second son of Andrea struck out a freer line of work. Haweis describes his instruments as narrow-waisted boldly curved, with Brescian looking sound-holes set low down, the rich, almost too profusely rich, varnish and fine wood, give these violins quite a characteristic appearance, and in power and tone they are superior to his father's. But next to the great Joseph del Gesu, Pietro Guarneri is the flower of the family. The grain of his bellies is often wide, the distance between the F-holes is conspicuous, the F-holes themselves are rounder and less Brescian, the scrolls are beautifully cut and the varnish is superb, from its golden tints to its pale red.

We come now to the one man who with the exception of the great Nicolo Amati, who is worthy to measure swords (or bows) with Stradivari. He came from a side branch, and not in direct descent from Andrea Amati or any violin maker, being the son of one John Baptist Guarnerius, and
was born at Cremona in 1683. The great Joseph was a nephew of Andrea Guarnerius, just as the great Nicolo was the nephew of Andrea Amati, but a distinguishing fact separates Joseph from all his illustrious kinfolk: his father does not seem to have been a violin maker at all, so the young Joseph owed his teaching most probably according to Haweis to his uncle and cousins. Nothing about Joseph Guarneri del Gesu is more remarkable than the determined way in which, after examining the Amati type, he deliberately went back to the Brescian da Salo and Maggini models for inspiration. The time had come when powerful tone was wanted. The Amatis were sensitive and sweet and in the larger and more massive Brescians Joseph found the suggestion of what he was destined to make perfect. Strength, power, was what he wanted, and the sentiment was thrown off in the bulldog type of his head or scroll, in the thickness of his boards so much criticized, in the boldness rather than the grace and delicacy of his curves.

He tried many experiments; flat make, full make, F-holes cut almost perpendicularly, shortened, slanting, and sometime disproportionately long. He was watching the effect on the volume and quality of tone, and when he had in his own way conquered that secret of grand sonority, whether empirically or by calculation, then, and not until then, his workmanship improves.

A Joseph del Gesu is more difficult to find than a Strad--his output, as compared to Stradivari is one to six: his life was shorter, and his working career probably more erratic. Good instruments by both makers are difficult to locate today.

Antonio Stradivari and Andrea Guarneri were young apprentices together in the workshop of the great Nicolo Amati, sat on the same bench, used the same tools, and doubtless discussed the same problems.
When Nicolo Amati died, at the ripe old age of eighty-eight, he left all his tools and his plant not to his son Girolamo, then about thirty-five, but to Antonio Stradivari, just forty years old.

On the death of Amati, Stradivarius and the Guarneri family had the Cremona market to themselves. At this time Stradivari departs from the feminine Amati type and becomes a striking and independent builder, his F-holes recline more, his corners are pronounced, his middle bout curves are prolonged, his varnish almost fancifully varied from rich gold to soft velvety red. His wood is now invariably chosen with the utmost care, and as he made chiefly for the nobility, royalty, and other higher clerical dignitaries, he could afford to work just as he chose.

The one point of great general interest before the year 1700, when Stradivarius enters his golden period, as stated by Wechsberg (1972) is the deliberate manufacture of a certain number of violins on a pattern distinct from Amati, and from any patterns adopted by himself before 1686-94, or after 1700. These instruments are known as long strads, and they seem to be a sort of constructional or experimental link between the smaller Amati pattern and the grand Strad pattern of 1700-37; a model evidently suggested by the grand Nicolo Amati, but not adopted by the cautious Stradivari until some years after Nicolo's death.

From 1694 to 1700 Stradivari not only went out of his way to make long Strads, which not only looked longer because they were narrower and pinched in, but were 14 inches in body size, as compared with the 1690 13 inch Strad.

Stradivari violins are not all alike. He knew that the secret was not merely in the pattern or shape; Hill (1963) suggests that he could vary his curves, and yet produce masterpieces, because he knew all
about air column, the wood densities, and the proportions and quantities which should be combined for the requisite result, and he could mix them differently like a master colorist. The varnish used by Stradivari after 1690 is of a deeper richer color than that of previous years. He switched from the traditional Amati yellow to the warmer-tinted colors.

The achievements in violin-making up to the first quarter of the eighteenth century are clearly summed up in the names of Nicolo Amati, Antonio Stradivari, and Joseph (del Gesu) Guarneri.

Wechsberg (1972) states by by 1744, after the glorious trinity, (Nicolo Amati, Stradivari, Guarneri del Gesu) was gone there were still fine makers in Cremona: Francesco Ruggieri, Carlo Bergonzi, Lorenzo Storioni; elsewhere there were Comenico Montagnana, Santo Seraphin, Matteo Goffriller, the Guadagninis, Francesco Gabetti, Carlo Tononi, the Grancino and Gagliano families, but Cremona had reached the end of its glory.

The name of Carlo Bergonzi (1686-47) stands out as worthy, if not to be bracketed with that of the three mighty men. Carlo Bergonzi according to Bachmann (1966) was Stradivari's favorite pupil. He finished several of his master's late violins, and issued some others after his death collected from the debris of the great man's workshop; and Stradivari left him all his tools and plant.

Bergonzi's goals were a full bodied tone and great carrying power. These dominant ideas modified even his pattern. The instruments look bold and masculine. There is a larger breadth in the curve of the top, a certain bold angularity about the bouts, and a freer development of the lower part of the violin as well; the sound holes set lower and nearer to the purfling, and the flat model which Stradivari discovered
to be favorable to loudness. The whole build is massive. The varnish is laid on with a lavish hand, to allow for wear and tear and is of a red Cremona velvety brown.

There were five other Bergonzis, a son and grandsons; they all made violins but are listed as members of the declining period of the Cremona school.

The work of Lorenzo Guadagnini, (1695-1740) who was supposedly a pupil of Stradivari, cannot be overlooked. His make is bold, his model flat, and the varnish not so rich as Stradivari's. His son Giambattista made violins which are more highly esteemed than his father's. He imitated Stradivari perhaps more closely than his father.

There were seven Guadagninis who made violins between 1695 and 1881, but of these the first two, father and son, alone need to be taken account of. The Guadagnini family is the longest lived of all the violin making families the last one having died in 1942.

Attempts have been made to classify the various towns in which Italian violins were made during the Cremona period into school. Roughly speaking, there are but two influences - the Cremona, i.e. the Nicolo Amati, the Great Joseph Guarnerius and the greater Antonio Stradivari influence with its flat form, gentle curves, and red and yellow varnish; and the German influence, i.e. the Stainer model, with its elongated form, arched belly, deep side grooves, and brown-yellow varnish.

Some fine Venetian and Milanese makers like Montagnana and Serafino inclined to Stainer, while the Roman and Neapolitan adhered more to the Cremona type; but Stainer himself possibly learned at Cremona, and all the best men like Tecchler (Rome) and Gagliano (Naples) who went south copied either Stradivari or Joseph Guarnerius del Gesu.
Jacob Stainer or Steiner was undoubtedly born at Absam (Tirol). The argument against Stainer having received early instruction at Cremona seems to be that he affected the tubby raised bellies and deep side-grooves of the old German viols; but it must be remembered that, if as a boy he came under Nicolo Amati's influence, it was at a time when Amati himself approached far more nearly the raised viol form than he did later on when his own model improved. The Stainer pattern is therefore consistent with all these theories:--

First, that Stainer adopted the raised pattern which he found at Cremona and which was then common throughout the violin making world; that, returning to Absam, he adhered to it, and perhaps from motives of national pride, accentuated it to be more German.

Second, that he visited Cremona later, when his own model was already formed, and was too proud to alter it.

Third, that German he was and German he remained, and never went to Cremona at all.

The general look of a Stainer is so distinct from that of any maker except such as copied him, that it must arrest the attention of even a casual observer. The Stainer belly is much higher than the back, the rise is kept up through half its length; the varnish is yellow (or as in the Elector Stainers), with a sort of pale rose flush in it.

The best pupils and followers of Stainer were according to Haweis, Sebastian Klotz and Matthias Albani. Sebastian Klotz or Kloz (1675) and his son Mathias (1696-1708) made excellent violins, and some prefer the son's to the father's. It is certain that while the Klotz family lived and worked, a pretty steady stream of pseudo-Stainers poured forth from Mittenwald until about the year 1750.
The Albani family stands midway between the Cremona and Absam school. Albani's violins pass for Italian; they are varnished red, and rival the Amati tone, and the Joseph Albani's are more highly esteemed than the violins of Albani pere.

The golden age of French violin making dawned with Lupot (1736-58); was extended to Pique (1788-1822), also famous for bows; Vuillaume (1798-1875); Chanot (1801); Gand (1802); and Aldris (1792-1840), famous for his varnish; and Fent, an admirable copyist, whose violins often sell as Lupot's copies of Stradivarius.

Nicolas Lupot was a man who was enamoured with the Stradivari grand pattern, and his best violins are such good copies that many amateurs and some professional judges have been deceived by them. Lupot's violins are, however, covered with a glassy, hard and chip-able French varnish. One of Lupot's rivals was Pique who it is said was in the habit of buying Lupot's violins unvarnished, varnishing them, and labeling them as his own. Pique was considered second only to Lupot as a maker, which makes it surprising that he would stoop to this device. J. B. Vuillaume was also a great copier of Italian violins. His techniques not only enabled him to copy them accurately, but to counterfeit the wear and tear, even the cracks and worm-holes, the inlaying, the rubbed varnish and even the old wood. Vuillaume's copies were chiefly of Stradivari. Vuillaume was a great maker in his own right, a superb businessman who engaged countless artist bow-makers and developed the art of stringed instrument and bow making vastly in France.

The first two excellent English eighteenth-century makers were Panormo and Parker. It should be noted here that Panormo was not an Englishman but an Italian but did most of his work in England. According to Jalovek and Hamlyn (1958) as a boy Panormo may have been a pupil of
Carlo Bergonzi. In 1760 he worked in Paris and after 1772 in London. Panormo worked conscientiously on the patterns of Stradivari and Bergonzi. His instruments were made of fine wood, with tastefully cut sound holes and scrolls. He applied a wonderful orange-yellow or red-brown varnish. All genuine works of Panormo are of excellent tone, but not all of the instruments bearing his label are genuine. Many of his instruments that do not have his label have been sold as genuine works of other masters such as Stradivari. He either had several collaborators or some less skilled masters provided their instruments with his labels.

Farga (1969) states that Daniel Parker, a London maker who worked until about 1770, made violins that reproduced fairly accurately, the "Long Pattern" of Antonio Stradivari, even going so far as picking out the outline of the scroll in black. This craftsman has the distinction of being one of the earliest makers to consider the merit of the flatter Stradivari model.

Many writers and makers of the present century are often reserved in assessing the respective merits of violin makers, especially the modern ones. Many of them have yet to prove themselves and all modern instruments must stand the test of time. Many are slow to leave the ground of direct experience, but as each individual experience is necessarily limited one must rely on authorities. There are many great makers and experts in the violin field today. The Hill family have all been makers and collectors and authorities on the violin. They have been responsible for the preservation of many of the works of the masters as is indicated by their donation of the Hill Collection to the Ashmolean Museum in Oxford. The firm of Rembert Wurlitzer in the United States also has done much for the preservation of the instruments of the masters.
There are hundreds of violin makers in the world today, many of them experts in the field. There is not one particular country or city that could possibly stand out as the center of violin making as did the city of Cremona during the time of Stradivari, the Guarneris, and the Amatis.

In the present century, the instruments of the violin class have been perfectly established, the viol class being now obsolete, except as matters of curiosity. But with all the advances in practical skill, there have been no improvements in the models known three hundred years, unless it may be in some of the minor details.

Men have learned to split the atom and to transplant the human heart, but not to surpass the Cremonese violins. It is a bewildering thought. The enormous popularity of the violin has again and again fostered attempts at discovering the mathematical principles on which the structure of the instrument, its size and form, are founded. When the mathematical rules of their designs had been discovered, excellent instruments were built after the peak period of violin-making, but they never reached the quality of the old master violins, to say nothing of surpassing them.

It is only fair to say that mathematical rules are not everything in violin-making. In order to achieve the same results, the imitators would need the same material as that used by the old masters, the same choice wood and same inimitable varnish—quite apart from the genius of the old masters, which their imitators lacked.

From a statement by Farga (1940) it can be assumed that countless efficient violin-makers, slowly and laboriously, went to infinite pains
to discover the ideal measurements, and so paved the road to perfection for individual great masters.

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<tr>
<td>Giovanni Paolo Maggini</td>
<td>1590-1640</td>
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<td>Nicolo Amati</td>
<td>1596-1684</td>
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<td>Jacob Stainer</td>
<td>1621-1683</td>
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<td>Andrea Guarneri</td>
<td>1626-1698</td>
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<td>Antonio Stradivari</td>
<td>1644-1737</td>
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<tr>
<td>John Baptist Guarneri</td>
<td>1683-1740</td>
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<td>Carlo Bergonzi</td>
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BIBLIOGRAPHY


II

CONSTRUCTION OF THE VIOLIN
MATERIALS NEEDED FOR THE CONSTRUCTION OF THE VIOLIN

BACK: Old "loft seasoned" maple, either one-piece, at least 15" long, 8 1/2" wide, and having a minimum thickness of 1/4" at one edge and 1 3/8" at the thick edge. Or two-piece, at least 15" long, 4 1/4" wide, 3/4" thick at the thin edge and 1 5/8" at the thick edge when already split.

TOP: Old "loft seasoned" spruce, almost invariably two-piece. Same dimensions as two piece back.

SIDES: Three strips of maple, 15" long, 1 5/16" wide, and approximately 1/16" thick.

BLOCKS: Six inside blocks of spruce, two for the end blocks and four for the corner blocks. The end blocks are 3/4" x 2" to 2 1/4" x 1 5/16", and the corner blocks are 3/4" x 1 to 1 3/8" x 1 5/16".

LININGS: Twelve strip of spruce wood matching the blocks, 1/4" wide and 5/64" thick. Four strips 9 1/2" long for the lower bouts; four strips 5 1/2" long for center bouts; and four 7 1/2" long for the upper bouts.

BASS BAR: Old straight-grained spruce approximately 11" long, 1" wide and 3/8" thick, with the grain showing on the edge.

PURFLING OR INLAY: Furnished in readymade strips of suitable length.

NECK AND SCROLL: Maple, furnished either readymade or "stock", rough-sawed, 10 1/2" long, 2 1/4" wide, 1 3/4" thick.

FINGERBOARD, NUT, SADDLE: Ebony, furnished semi-finished.

PEGS, TAIL PIECE, END BUTTON: Furnished in ebony, rosewood or boxwood, usually matched. Sometimes elaborately carved and trimmed in gold, ivory, etc.

BRIDGE: Maple, furnished ready for final fitting and thinning.

SOUNDPOST: Spruce, round stick about 3" long, and about 1/4" in diameter.

GLUE: The best violin maker's, or cabinet maker's glue, furnished in flakes or ribbons.

FINISHING MATERIAL: Wood stain, sizing, color varnish, clear finishing varnish, rubbing oil, and powdered Italian pumice stone.
THE COMPONENT PARTS OF A VIOLIN

<table>
<thead>
<tr>
<th>Part</th>
<th>Number of Pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belly</td>
<td>2 (Sometimes 1)</td>
</tr>
<tr>
<td>Back</td>
<td>2 (Sometimes 1)</td>
</tr>
<tr>
<td>Ribs</td>
<td>6</td>
</tr>
<tr>
<td>Inside Blocks</td>
<td>6</td>
</tr>
<tr>
<td>Inside Linings</td>
<td>12</td>
</tr>
<tr>
<td>Inside Bass Bar</td>
<td>1</td>
</tr>
<tr>
<td>Purfling</td>
<td>24</td>
</tr>
<tr>
<td>Fingerboard</td>
<td>1</td>
</tr>
<tr>
<td>Neck and Scroll</td>
<td>1</td>
</tr>
<tr>
<td>Nut</td>
<td>1</td>
</tr>
<tr>
<td>Saddle or Lower nut</td>
<td>1</td>
</tr>
<tr>
<td>Tailpiece</td>
<td>1</td>
</tr>
<tr>
<td>Loop or tailpiece gut</td>
<td>1</td>
</tr>
<tr>
<td>Tailpiece Button</td>
<td>1</td>
</tr>
<tr>
<td>Pegs</td>
<td>4</td>
</tr>
<tr>
<td>Strings</td>
<td>4</td>
</tr>
<tr>
<td>Bridge</td>
<td>1</td>
</tr>
<tr>
<td>Sound Post</td>
<td>1</td>
</tr>
</tbody>
</table>

Total: 70
TOOLS NEEDED FOR CONSTRUCTION OF THE VIOLIN

Violin maker's knives
Gouges and chisels - assorted sizes
Violin maker's saw
Files - oval, half round, needle, flat, wood rasp
Garnet paper
Burnishing iron
Honing stones
Bending Iron
Arching guides
Violin clamps
Bass Bar Clamps
Lining Clamps
Registering Calipers
Purfling tools - groove marker, groove knife, groove cleaner
Peg Tools - reamer, shaper
Sound Post Setter
Violin maker's planes - 1/2" size is most essential
Scrapers - various sizes both flat and round
HOW THE MODELS OF VIOLIN PARTS ARE MADE

The surest way of tracing or copying a fine violin is to find an instrument that we will refer to as a "creators" instrument. This would be an instrument made two hundred years ago or more by Stradivari, Amati's, Stainers or Guarneri. Copies of these instruments can be purchased through such companies as Roth or Lewis. The models of the parts obtained from these companies are actual copies of the original "creators" instrument and are the models used by most violin makers. The models will be outlines of the belly and back, the curves of the belly and the back in respective lengths, the F-hole pattern, the cut and position of the F-holes, the curve of the neck and the pattern for cutting the scroll. All of these models are exact reproductions of the outlines of the various parts of the instrument of a famous "creator".
MAKING THE FORM

The form is a piece of wood cut to fit the inside of the ribs and with notches cut to receive the corner and end blocks. It is around this form the sides of the instrument are built and the linings installed. The form is usually copied from that of a famous instrument. In this instance the form is that of a 1704 Stradivari instrument.
FITTING THE CORNER BLOCKS AND END BLOCKS TO THE MOLD

The pieces of spruce that are to be used for the corner blocks and end blocks are cut to just exactly fit into their notches in the mold. The grain of these blocks will run toward the back and belly of the instrument. After the blocks have been fitted into their respective notches they are glued there with a small amount of glue so as to allow them to be removed later.

When the glue has dried the counter mold is placed on them and the outline is traced. This is the mold for the inside dimensions of the instrument. After the outline has been traced a chisel or gouge is used to remove the excess wood and give the blocks their final shape. The blocks will be completely finished with the knife and file.
Spruce linings along upper and lower ribs to which the top and back are glued.

End Block of Spruce that the neck fits into

Four solid corner blocks of straight grained and well seasoned spruce

End Block of spruce that end button fits into
FORMING THE SIDES OR RIBS

The violin maker of the olden times built the ribs on an inside type of assembly form. This is the type of form illustrated in the picture and the type of form that is used in the construction of this particular instrument. The wooden form has cutouts for holding the corner blocks and end blocks while the ribs are being given their proper shape.
BENDING

The ribs and linings are bent to their proper shape by using a bending iron. Using a wet cloth between the rib or lining and the iron, steam will be produced and allow the wood to be bent very easily. The ribs and linings will be bent to their approximate shape and allowed to dry and then attached to the assembly form.

Electronically heated bending iron and steel band
BUILDING THE BACK OF THE VIOLIN

If the back is made of one piece, a line should be drawn across from top to bottom on the level side making sure this line is absolutely parallel with the point on top. If a two piece back is used this line is not necessary because the line is formed by the joint.

The model is laid on the back of the slab and the entire model is traced on the wood. The back can now be cut out with a coping saw or a band saw. Do not cut too near the line as this wood is removed later with the knife and scraper.

A line is now drawn all the way around the edge of the cut out back to indicate the thickness which the edges should have. This will be 5 millimeters or 1/5 of an inch.

The arching can now be started by using gouges and planes. Be careful to remove only a small amount of wood at a time because a large splinter of wood removed can ruin the work. As you remove the wood check often with the arching guides and templates to make sure the arch is correct.
WOOD CUT ON THE QUARTER OR THE SLAB

Most of the wood that is used in the violins of today is cut on the quarter. This gives the nice flame look to the instruments back and ribs. The early Brescians used wood cut on the slab of the grain and you can see the growth ring markings. Most of the Cremonese instruments had backs that were cut on the quarter. This is a matter of individual taste and perhaps the Cremonese makers liked the looks of the quarter cut better. Wood cut on the quarter is used in both one and two piece backs, however we find most of the wood cut on the slab is found only in one piece backs.

Wood cut on the quarter or right way of the grain

Wood cut on the slab or across the grain
Back wood is well seasoned maple either in one or two pieces.

Top wood is imported spruce well seasoned and is usually in two pieces.
CUTTING THE GROOVE AND INLAYING THE PURFLING

If you are copying a model exactly set the groove marker to the same measurements as the model. Holding the groove marker exactly straight up from the back or belly move it completely around the border of the wood. After the guide lines have been well inscribed follow them around with the purfling knife cleaning out the channel periodically with the groove cleaning tool. You will continue this process until the groove or channel is approximately 1/16 of an inch deep.

The purfling comes in prefinished strips and all that needs to be done now is the purfling inserted. This is done by heating the strips and bending them to the desired position. Remember that the purfling strips join each other in the corners and form a nice point or "Bee Sting". When the glue of the purflings has dried the edges that are raised above the back or belly are removed with a plane or scraper.
Groove cut for the inlaying of the purfling.

"Bee Sting" effect is produced by extending the point at the tip of the miter.
THE SOUND BOARD OR BELLY OF THE VIOLIN

The arching of the sound board or belly is accomplished in the same manner as the back. Extreme care should be taken not to go too fast with the planes and gouges as the spruce is much softer and is removed much faster. It is very easy to take away too much wood when you are arching the front.

Be sure before you start the arching process to see that the heart of the wood is in the center of the sound board. The heart is that part of the spruce where the grain is the closest. Usually the only time you will need to check this is if you buy two pieces of wood that are not already joined.

After most of the arching is completed you can trace the design of the F-hole on the belly in its correct position. The F-holes are not pierced until the belly has been entirely completed. By means of gouges, scrapers and planes remove the wood from the inside of the belly until the proper thickness is obtained. Using registering calipers check as you remove the inner wood to make sure the graduation is exact. After you are sure of the graduation and the arch the F-holes can be cut using the F-hole saw. After the F-holes have been sawed out, clean them up with a small knife and make them exactly perfect and the same size as the design that you used.

Direction for cutting the F-holes
SIMPLIFIED THICKNESS CHART FOR TOP AND BACK

BACK

TOP
F Hole design - 1704 Stradivari violin
F HOLES DESIGNED BY FAMOUS MAKERS

Gasparo da Salo  Bergonzi  Guarnerius

Amati  Stainer  Stradivarius
MATCHING THE RIBS WITH THE BACK

Match the maple that you are using for the ribs with the maple in the back both in figure and grain. Notice that the grain of the ribs of a violin with a one piece back all runs the same direction where the grain of a violin with a two piece back runs in opposite directions. The strips for the ribs will always be put on the instrument with the slant of the figure matching that of the back.

After the ribs have been attached to the form install the linings on one side of the ribs only. After the linings have dried the form can be removed from the ribs, being careful not to loosen the blocks from the ribs. The ribs and blocks are now ready to be attached to the back.

After you have glued on the remaining linings lightly clamp the back to the ribs making sure you have an even edge all the way around. This edge should be approximately $\frac{7}{64}$ inches wide. When you are sure you have an even edge all around glue the back to the ribs by alternately removing the clamps and gluing the ribs in place. Be sure to remove all the excess glue from the surface of the instrument.

The curvature of the blocks and lining should now be finished off completely. Make sure that the linings are beveled toward the inside of the instrument and the corner blocks follow the curvature of the ribs.
One Piece Back

Two Piece Back
CONSTRUCTION AND POSITION OF THE BASS BAR

The construction of the interior of the violin is completed by the insertion of the bass bar. The bass bar is a piece of spruce about 1/3 of an inch in height, 1/5 of an inch thick and about 10 1/2 inches long. The bass bar is terminated at its two ends by bevels which stretch out on the sound board to which it is glued.

The bass bar is placed under the G string side of the instrument approximately 1 1/2 inches from the top and bottom of the instrument's belly. The top of the bass bar is approximately 5/8 of an inch from the center and the bottom is approximately 13/16 of an inch from the center.

The bass bar must be scraped and cut until all parts of it touch the belly when laid in. When the bass bar fits exactly it is glued in and clamped in place by means of the bass bar clamps.

The grain of the bass bar must be showing on the edge.
View of the inside of the belly.

Location of the bass bar in the belly of the violin from the underside of the belly.

Bass Bar goes under the G string
COMPONENT PARTS OF THE FINISHED BELLY.

- Neck Block
- Upper Bout
- Corner Block
- Middle Bout
- F Hole
- F Hole Notch
- Purfling
- Lower Bout
- Chin Rest
- Lower Block
- Saddle
THE COMPLETELY ASSEMBLED BODY

After the bass bar has been inserted into the belly of the violin the top is ready to be glued to the ribs. Here it is wise to dilute the glue to about one half its regular consistency to make the removal of the front easier for repairs that may be needed later. When clamping the top to the ribs again apply the clamps lightly so as not to damage the ribs or mar the back and belly.

After the body is completely dry and assembled the edges are rounded and finished with sandpaper and a felt block. There should be a well defined arch from the purfling up to the edge of the instrument. This is made by using the scrapers, special knife and sandpaper.

CROSS SECTION OF A FINISHED EDGE
THE CONSTRUCTION OF THE NECK

The scroll may be carved by the maker; however, it can be purchased with the scroll completely finished and the neck partly finished for fitting into the body and neck block of the violin. If the maker desires to carve his own scroll templates will be used for the outline. After the outline has been sawed from the block of maple the back saw, chisels and knife are used to complete the scroll. The final shaping is done with scrapers using those with rounded edges.

Templates for scroll (enlarged)
FITTING AND SETTING THE NECK

Make a template the exact size and shape of the end view of the neck. Trace the shape of the template on the ribs exactly centered on the button extension. Using a sharp knife start removing the wood from the ribs inside the lines that you have drawn. Work slowly trying the neck often for fit. Remove enough of the block to give you a string length of just under 13 inches. Before gluing the neck to the block check the alignment of the fingerboard with the joint down the belly. Also check the fingerboard height. The standard measurement for the distance from the top of the instrument to the top center edge of the fingerboard is 12/16 to 13/16 inches.
VARNISHING

Glue a piece of thin wood on to the neck where the fingerboard is going to be placed. Glue this lightly so that it can be easily removed. Fit the handle into the endpin hole. This is going to be your means of holding the instrument while you apply the various coats of varnish. After making sure the surface of the instrument is entirely free from dirt, glue, tool marks etc. dampen the entire surface of the instrument with water. While it is still damp apply the yellow stain over the entire surface of the instrument including the neck. This will raise the grain of the instrument and should not be sanded again. Hang the instrument to dry until all of the moisture has dried. Apply from four to six coats of varnish depending on the darkness that you desire. Let each coat dry completely before applying another. If you are using oil varnish it will take from four to six days for each coat to dry. Rub down each coat with pumice and oil making sure the surface is very smooth. After the last coat of color varnish has dried and been rubbed out apply a coat of colorless varnish. When this is dry polish again with pumice and oil. A high gloss can be obtained by combining the oil and a small amount of denatured alcohol on a cloth and polishing. Be careful not to use too much alcohol or you will remove the varnish.

Shading is done by removing some of the varnish using the denatured alcohol. Be very careful when trying this or it may be necessary to remove all of the varnish and start over. Most amateurs are content to leave the violin an even color. Much experience is needed before you will feel confident shading an instrument.
FITTING THE FINGERBOARD, THE NUT, AND THE SADDLE

The fingerboard is glued to the neck leaving an interval of 1/16 of an inch between the top of the fingerboard and the bottom of the peg box. This is the space that is to be filled by the nut. Take special care that the fingerboard does not slip out of line while you are clamping it into place.

After the fingerboard has dried the nut can be glued and clamped on. This is a piece of ebony about 1/3 of an inch high and 1/8 of an inch in breadth. This piece will project slightly beyond the sides of the violin neck and will be trimmed down to be even with the neck and peg box.

The saddle is a piece of ebony placed above the endpin of the instrument. It supports the piece of gut that is attached to the tailpiece. The nut is made from a piece of ebony and is a little over 1 inch long by 7/25 of an inch high. A cut is made into the soundboard and into the ribs about 7/25 of an inch just slightly larger than the saddle. The reason that the cut is made larger is due to the fact that the spruce in the belly swells and contracts much more than the ebony saddle. This will avoid cracking the top if the saddle is forced in too tight.
Location of the nut at the top of the fingerboard
The sound post is a cylindrical piece of spruce about 1/4 inch in diameter. The grain of the spruce of which the sound post is made should run in the direction contrary to the grain of the spruce which the belly or sound board is made. The length of the sound post is determined by measuring down through the upper end of the f-hole on the post side. This will give you the approximate length of the piece of spruce you are going to cut. Because the back and belly are not perfectly flat it is necessary that the sound post ends be cut on the bias so that all parts of the ends are in contact with the back and belly. The angle of the cut is about a 2 degree angle and will follow the direction of the grain in the post. The post is placed in position using either a blade type setter or a scissor type setter. The post is passed through the curve of the right hand f-hole to a position about 1/12 of an inch to the rear of the bridge and in line with the foot part of the bridge.

The bridge should be sufficiently solid to be able to withstand the tension of the strings; at the same time it should be as narrow as possible since this greatly augments the brilliance and purity of tone of the instrument. Begin by fitting the feet of the bridge to the instrument cutting them absolutely to the arching of the belly. The bridge should be cut to the correct height and will follow approximately the same arch as in the fingerboard. The height of the bridge should be approximately such that the height to the G string is about 1/4 of an inch above the fingerboard, the D string and A string a little less and finally the E string about 1/6 of an inch above the fingerboard.
The distance separating the G string from the E string will be about 1 and 1/3 inches.

The fitting of the pegs is a rather simple operation if you have the location of the holes marked properly. Most roughed out scrolls will come with small holes already drilled in them. Using a peg hole reamer open up the holes to fit the pegs that you are going to use. The holes must be made very round which is easy to do if you have a good reamer and one that is sharp enough to cut cleanly and without any effort. After the pegs are inserted cut off the end flush with the outside of the peg box and remove them and round off the end. On occasion it is necessary to cut down the size of the new peg as many of them are made large in order to fit them into holes that have been worn. Prepared peg dope is then applied to the peg which will prevent its slipping and sticking.

The end button is fitted into the end block somewhat forcefully so that it will be tight. When this is done all that is needed is for the tailpiece to be put in position and the instrument strung.
Position of the end of the tailpiece in relation to the saddle.
III

REPAIRS OF THE VIOLIN (STRING INSTRUMENTS)
REPLACING THE TAIL-GUT

Materials needed: Spool of heavy linen thread
                Piece of Rosin
                Tail-Gut of proper gauge

Tools needed: Sharp knife
              Alcohol lamp or matches

Procedure:

    Remove the strings from the tail-piece and then remove the old tail-gut. Cut off a piece of new tail-gut approximately 1 1/2 inches longer than the total length of the broken pieces. Hold the tip of one end close to a flame until the gut swells and a bell shaped end is formed. Press this against a hard surface until it cools so that it will retain its shape. (Do not burn the gut) Wrap about six to eight turns of thread around the gut next to the bell shape and tie. Coat the thread with melted rosin. Insert the gut down through the hole in the tail-piece and back up through the other hole and then check the amount of gut needed by replacing the tail-piece on the instrument and measuring. After you have measured the correct amount of gut you will need repeat the same process. Gut stretches so be sure that you make it tight enough. The tail-piece can now be put back on the instrument.

    The tail-gut can also be replaced with the very popular "Sacconi" adjustable tail-gut and you don't have to worry about the flame or the wrapping with the linen thread.

    The tail-piece gut for the string bass is actually specially designed wire that is twisted at the ends and fitted the same way as the gut for the other stringed instruments.
Bell end formed by heating tail gut.

Bell end wrapped with heavy thread to form a reinforced stop.
REPLACING A BROKEN STRING

Incorrectly wound strings can cause the peg to slip and not hold the string even though the peg is correctly fitted.

Always wind the string on the peg from the hole in the peg towards the head of the peg. This way the strings will never cross over each other in the peg box and will hold securely. You can secure the end of the string by pushing a small amount of the end of the string through the hole and on the first turn cross over the loose end. This will secure the string from slipping as you bring the string up to pitch.

The large end of the string is inserted into the notches in the tailpiece and usually will hold there caught by the knot. If the notches in the tailpiece are too large and allow the knot to slip through it will probably be necessary to loop the string around the tailpiece tying it in place.

Looping the string to the tailpiece.
No string should be wound against the peg box by succeeding laps. Such a procedure will damage the string and loosen the peg.

Right Way

Wrong Way
REMOVING AND REPLACING THE FINGERBOARD NUT

The fingerboard nut must be removed when the grooves have worn so that a buzzing or rattling sound is produced by the strings against the fingerboard.

Force hot water with a hot spatula into the joint where the fingerboard and nut are glued together. Most of the time the nut will pop off very easily. A new nut can be placed on the instrument, but the easiest thing to do is place a wedge or sliver under the old one to raise it up.

An ebony string-nut when purchased is oversize so it can be cut to fit the instrument. Cut off both ends of its length with a fine toothed saw so its length will be just slightly oversize. Then file and sand until the top edge extends above the fingerboard about 3/32 of an inch above the fingerboard. Now glue the nut in place and when the glue is dry carefully file the ends so they are flush with the neck. File the top surface of the nut until the edge next to the fingerboard extends about 1/16 of an inch above and slopes in a curved manner toward the shanks of the pegs in the peg box. Groove the nut for the strings being careful not to make the grooves too deep. The spacing of the grooves is a matter of personal taste but if the grooves on the old nut were satisfactory use it as a model.
Size of ebony string-nut before it is fit to the violin.

Approximate shape of the string-nut after it has been fitted.

Using a C clamp to hold the nut in place until the glue is dry.

Pad the clamp adequately so that it does not mar the instrument or the nut.
REPLACING THE SADDLE ON STRING INSTRUMENTS

The saddle at the tailpiece is a piece of ebony placed above the endpin of the instrument. The saddle on the violin is just a little over 1 inch long by 7/25 of an inch high. This supports the piece of gut string that attaches the tailpiece to the tailpin or end button. The only precaution which should be taken when making or shaping the saddle is to make it high enough above the belly to prevent the tailpiece from touching, and then to round it off at the angle which is to hold the loop of the tailpiece in such a way that it will not cut the gut. If the saddle fits very tightly file off a very small amount from both ends before gluing it. This will allow for expansion and contraction of the top during seasonal changes without danger of cracking the top. Clamps on each side of the saddle should be used when installing it. The saddle should be glued to the instrument with hot animal glue.
SADDLE

SADDLE IN INDENTATION
REGLUING A FINGERBOARD

Materials needed: Animal glue (hot)

Two strips of soft wood

Tools needed: Three C clamps

Rough sandpaper or a curved chisel

Sharp knife or a small saw

Procedure:

With a wet cloth, wash or soak off the old glue from the fingerboard and neck. Make two protective strips of soft wood as shown in the illustration, using the sandpaper, chisel, knife or saw. Apply hot glue to both the neck and fingerboard. Fit the fingerboard to the neck and place the protective strips in place and apply the C clamps alternating sides. If the clamps are put on from alternate sides, they will not have as much of a tendency to push the fingerboard out of place after the glue has been applied. Wipe off the excess glue with a cloth dampened in warm water. Allow to dry over night or at least for four or five hours.
SOFT WOOD STRIPS USED FOR REGLUING A FINGERBOARD

[Diagram showing wood strips with dimensions 1 5/16 " and 3/4 " in the middle]
REGLUING A FINGERBOARD

5 3/4" block

4 1/4" block
FITTING THE BRIDGE TO A STRING INSTRUMENT

The best bridges are made of "spotted" maple, selected so that the grain is horizontal and the wood of a medium degree of hardness. The bridge should be half as thick at the top where the strings are placed as at the feet. The fitting of the feet is of the utmost importance, as they must be curved exactly with the curve of the belly of the instrument.

If you have the pieces of the old bridge this can be used as a pattern for cutting the new one. If the old bridge is not available the feet should be scraped with a sharp knife using the curved center of the blade to prevent destroying the edges of the feet. The feet can then be shaped by placing a medium grained piece of sandpaper on the belly of the instrument with the rough side up. Place the bridge in the correct position and with slight pressure move it toward the fingerboard and backwards toward the tailpiece. This will make the feet fit the contour of the instrument. The bridge is now ready to be curved so that strings are at the proper height above the fingerboard. Following are the distances or string clearances between the strings and the top of the fingerboard and bridge end for full size instruments. Only the distance of the two outside strings are measured.

<table>
<thead>
<tr>
<th></th>
<th>Gut Strings</th>
<th>All Steel Strings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violin</td>
<td>E 1/8&quot; G 3/16&quot;</td>
<td>E 3/32&quot; G 5/32&quot;</td>
</tr>
<tr>
<td>Viola</td>
<td>A 3/16&quot; C 4/16&quot;</td>
<td>A 9/64&quot; C 3/16&quot;</td>
</tr>
<tr>
<td>Cello</td>
<td>A 1/4&quot; C 5/16&quot;</td>
<td>A 11/64&quot; C 1/4&quot;</td>
</tr>
<tr>
<td>Bass</td>
<td>G 7/16&quot; E 5/8&quot;</td>
<td>G 21/64&quot; E 7/16&quot;</td>
</tr>
</tbody>
</table>
Shape the top of the bridge using a sharp knife to make a nice curve. Be sure to always be checking your height as you cut.

When the bridge is at the approximate height using a round file make the notches for the strings. On a full size violin these will be approximately 7/16 inches apart. File the notches until the exact string height is attained. Finish the top of the bridge with a file or sandpaper until the notches are one half of the diameter of the respective string. Thin the bridge by laying it flat on a piece of sandpaper and sand off the excess wood until the top edge is slightly less than 1/16" and the lower edge is a little less than 3/16". With a small round file and knife cut down the top edges of the feet to form nice curves which make the outer edges of the feet 1/16" thick. Apply water to the feet of the bridge and place the bridge in its proper position on the instrument. This will warp the bridge fibers close to the top of the instrument curvature when allowed to dry and produce a much closer fit.

Fitting a bridge perfectly requires a great deal of skill and practice. A poorly fitted bridge will result in loss of volume and tonal qualities and often leads to damage to the instrument.

An easy way of getting the correct curvature of the bridge is to place a long pencil with a sharp point on the fingerboard with the tip extending over the end and trace the shape of the fingerboard on the bridge with the bridge in its correct position. On the side of the largest string add approximately 1/16" in height for the violin and adjust for the other instruments.
Inner F Hole Notch

Bridge Feet Markings

F Hole
REFITTING THE SOUNDPOST

If possible use the old soundpost for a model in cutting the length and curvature. If the old post is not available the approximate height is determined by measuring down through the upper curve of the right F-hole from the top to the back of the violin. Now with this measurement you are able to cut the post to the approximate length. Because of the curve in the back and belly it is necessary to cut the ends of the post on a bias. (This bias should be cut with and not against the grain) The grain of the soundpost must run in the opposite direction of the grain in the spruce belly. After you think you have the correct bias cut inset the blade part of the post-setter about one third of the way from the top of the post and insert the post into the instrument through the right F-hole. After the post is in the approximate position and is standing upright remove the blade of the setter and use the notched end to move it into a perfectly upright position. Usually you will be able to see the shiny spot on the inside of the instrument where the old soundpost was. The post can be moved around until the desired tone is produced.

Moving the post toward the bridge will give the instrument more power and more edge. Moving the post away or back from the bridge will take away power and edge. Moving the post to the outside of the instrument will favor the upper strings. Moving the post inside will favor the lower strings or even out the sound of all strings. Too far in gives a tubby sound.
Flat End

Sound Post Setter

Blade End of Sound Post Setter

↑ Notch in Post is located in the top third of the post.
REFITTING THE PEGS (USED AND NEW)

When the shiny pattern on the peg is continuous and forms a band the width of the peg box wall, the peg is fitting properly. This must be true for both the large and small end of the peg taper. If the pattern is not continuous this can sometimes be remedied by taking a piece of sandpaper and curling it around the peg and turning the peg in one direction only. If this doesn't work perhaps the peg hole is out of round and a peg hole reamer is used. When using the peg hole reamer to true up the peg holes be very careful that you do not take out too much wood.

When fitting new pegs to an instrument a peg shaper must be used as most new pegs are too large for the existing holes in the peg box. Cut the peg very carefully with the peg shaper inserting the peg into the hole in the peg box frequently to check the fitting. Adjust the shaper using the screws on the blade until the proper taper is produced. For final fitting curl fine sandpaper around the shaped peg and turn in one direction only. Cut off the end of the peg flush with the outside of the peg box wall and round off the end of the peg with fine sandpaper. Prepared peg dope is now applied to the peg so that it will turn freely and the finished peg is inserted into the peg box ready to receive the string.
Peg Hole Reamer →

Peg shaper
REGLUING OPEN EDGES

When an open edge is found on an instrument the old glue must be washed out with hot water and a spatula or small paint brush. After the old glue has been removed apply the new glue (using only hide glue) to the open edge. Clamp the edge back together using clamps that have a cork holding surface or another protective material so as not to mar the finish on the back and belly of the instrument.

Commercial clamps can be purchased for this use although they are quite expensive. A clamp that will serve the same purpose can be made from tinker toys or spools cut in half using a carriage bolt and wing nut to tighten them together.

When clamping open edges back together be sure that you do not put too much pressure on the clamps. Use a small brush or Q-tip and hot water behind the clamps to remove the excess glue from the varnish. The water must be wiped off at once in order to avoid any damage to the finish of the instrument.
Clamp in position for gluing an open edge.
Clamp made from Tinker Toy

Clamp made by cutting a spool in half
BOW REPAIRS (WEDGE AND SCREW)

When the wedge falls out of the ferrule in the frog this causes the hair to bunch up and not spread evenly at the frog. If you are still in possession of the old wedge and it is not broken it can be inserted using a drop of glue on the top side to hold it in place. Make sure that the hair is spread evenly as you insert the wedge. If you must make a new wedge a strip of well seasoned basswood about 3/4 of an inch wide and 1/8 inch thick is used. Wedges will be wider and thicker for the larger bows. With a sharp knife cut off both corners of one end of the strip. Cut off the top surface of the strip slanting it toward the end. Trim off the slanted corners and push the wedge into the frog with the flat side next to the hair and mark the wedge where you will need to cut it off the strip of wood. Remove the wedge and cut it to the correct size and force the wedge back into the ferrule until it fits flush making sure that the hair is spread evenly.

When the threads are worn in the brass eyelet so that the bow hair cannot be tightened it is best to replace both the bow screw and the brass eyelet in order to have a correct fit. Many screws and eyelets have different threads. Try to select a new eyelet that will fit the original hole in the frog. If the eyelet does not fit the hole in the frog you will either have to drill the hole or bush it up which should be avoided if possible. The eyelet and bow screw should be lubricated with hard soap and never with oil.
REPLACING THE SPREAD WEDGE

Wedge

Ferrule

Wedge in place above hair under tongue
PATCHING CRACKS IN THE BODY

For a crack in the top or belly of the violin you will want to remove the top. This is accomplished by taking a spatula and hot water and probe the edge between the top and the ribs until an opening is made. Now working gently and slowly with the spatula and hot water mover all the way around the violin or stringed instrument until you have loosened the entire top and it can be lifted off. You must of course remove the strings, bridge, chinrest, and knock the sound post over before you can do this. After you have cleaned out the crack with a brush and hot water apply hot animal glue and clamp the crack together using a special joining clamp designed to clamp the front or back of an instrument. Many times if the crack is a small one this much will suffice, however if the crack is a large one you will want to use some small patches over it as well. These patches are usually made from spruce and are attached to the underside of the back or belly with the grain running the opposite way from that of the back or belly. After the glue has dried on the patches sand them down very thin so that they are almost a part of the original shape. After you are sure that the glue has dried on the crack and patches the top may be replaced by using animal glue and several clamp screws spaced evenly around the instrument. A caution, do not over-tighten the clamps or you will possibly damage the ribs.
The grain of the patches must run opposite that of the grain in the instrument.
REGUING THE NECK

When regluing the neck the most important thing to remember is to get it in straight. The center of the fingerboard should be on a straight line with the center joint in the top or belly of the instrument. Before you glue in the neck check the neck block to see if it is broken and also check the ribs near the neck block to see if they have been separated from the block. If the ribs have separated force some glue into the separation and place a clamp across the rib and force a small wedge under the bolt part; this will force the rib against the block. After the glue has dried you are ready to insert the neck. Clean out all the old glue with water and a brush and apply fresh hot animal glue, insert the neck and fasten in place using a C-clamp padded with cork or another material so that you will not damage the fingerboard or the button of the instrument. Do not use very much pressure in tightening the C-clamp as you could cause very serious damage to the top, ribs or neck of the instrument. Wipe off any excess glue using hot water and then wipe dry and allow the instrument to set at least eight hours before stringing it up.
Cork or other material to protect the finger board from being marred by the C clamp.

Flat wood block for bracing. Block should be large enough to cover the neck block and part of the button.
REPAIRING THE VARNISH

All of the famous Italian and German violin makes, such as the Amati, the Stradivari, the Stainers, and others, have made use of the oil varnishes, which are far more beautiful and durable than the spirit varnishes. This varnish takes quite a long time to dry and if you are in a hurry to repair the nicks or scratches perhaps you will want to use the spirit varnish which dries almost immediately. The varnish should first be tested on a piece of wood to make sure you are using the right color. Remember that each successive coat of varnish darkens the color. After you are sure that the varnish is completely dry rub the repaired area with pumice stone and rubbing oil, making the surface perfectly smooth. Use only a high grade of mineral oil for rubbing the instrument. If a high gloss is desired, polish with a piece of cheese cloth folded into a pad and apply a drop of rubbing oil and a drop of alcohol to the rag and rub lightly in a circular motion. Be careful not to use too much alcohol as this will remove the finish. Use a good bristle varnish brush for oil varnish, the finer the brush the finer the results. A high grade thin ox or badger hair brush is best. For spirit varnish a camel hair or red sable flat artist's brush is best. The brushes must be perfectly clean and free from dirt, grit, or dust.
EPILOGUE

The information contained in part II and III is a result of personal study with violin luthier Ray Miller, owner of Ray's String Shop in Salt Lake City, Utah. Considerable time was spent with Mr. Miller working on instrument repair and construction of string instruments. Many of the repairs mentioned such as the patching of cracks that require the lifting of the front should only be done by a professional luthier. The amateur violin repairman should be cautioned to only attempt those repairs that are possible without the expert supervision of a skilled craftsman and not to attempt anything that could possibly impair the sound of the instrument.

GLOSSARY

BELLY: The upper covering of the body of a stringed instrument, over which the strings are stretched.

BRIDGE: The raised component through which the vibration of the strings is communicated to the belly or the soundboard of a stringed instrument.

FINGERBOARD: A strip of wood or other material laid upon the neck of a stringed instrument, against which the strings are stopped.

FROG: The block by which the hair is attached at the heel of a bow. Also called "nut".

NECK: The part of a stringed instrument which is grasped by the hand that stops the strings.

NUT: The fixed ridge that raises the strings of a stringed instrument above the fingerboard next to the tuning pins or pegs.

PEG: The pin that the string is attached to enabling the instrument to be tuned.

RIB: The sidewalls of a stringed instrument.

SADDLE: The piece of ebony that supports the piece of gut string that attaches the tailpiece to the end button.
SOUND POST: A cylindrical piece of spruce about 1/4 inch in diameter.
TAIL GUT: The piece of gut string that attaches the tailpiece to the end button.
TAIL PIECE: The piece to which the strings of a stringed instrument are attached at their opposite ends from the pegs.
TAIL PIN: The button inserted into the bottom block of a stringed instrument to which the tailpiece is attached by a gut loop.
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VITA
Carl David Nyman
Candidate for the Degree of
Master of Music


Major Field: Music Education.

Biographical Information:

Personal Data: Born at Logan, Utah, August 25, 1937, son of Carl N. and Jean Burrell Nyman; married Carol Ann Parry Jones; one child: Christa Lyn.

Education: Attended Cache County schools; graduated from South Cache High School in 1955; received Bachelor of Science degree in music education from Utah State University in 1959; attended the American University in 1960; completed requirements for the Master of Music degree in music education at Utah State University in 1975.

Professional Experience: Instrumental music teacher at Box Elder Junior High School, Brigham City, Utah, 1959-60; Member of 61st Army Band, Bremerhaven Germany, 1960-62; Orchestra Director, Box Elder County Schools, Brigham City, Utah, 1962-70; Conductor, Golden Spike Empire Youth Symphony, 1967-70; Orchestra Director and Assistant Professor of Music, Southern Utah State College, Cedar City, Utah, 1970-present.