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Practical Acoustics of Instruments of the Violin Family
(Bridging Science and Art)

First English Edition
7. The Bow

7.1 A short history

A stringed instrument without a bow is almost useless, on the other hand a bow without an instrument is also meaningless; the two belong together. There are no definitive indications that bowed instruments have always been preceded by plucked ones [67]; bowed instruments have existed long before the violin family appeared.

It is a curious fact that it is a relatively recent notion (since c. 1950) that the bow is of major significance for the sound quality and that there are large differences in character among different bows. This corresponds with a major rise in bow prices. Until the end of the 19th century the bow was considered to be an accessory of a certain, but secondary, significance. Nevertheless, the most distinguished soloists of that time (Joachim, Ysaye) played with the best bows of Tourte and his followers. It is typical that the firm Hill & Sons, who started making bows near the end of the 19th century, employed such specialized bow makers as S. Allen and W. C. Retford and that these bows were presented (with a case for the violin) to buyers of quality instruments. In that period around 1900 there was a buyers’ market for violins, a large supply and low prices, and certainly little interest in a new bow. The Hill firm later demanded high prices for their bows and the best Hill bows from the period 1890–1940 are now much sought after. The manufacture of bows by Hill and Sons gradually tailed off after 1960 and in 1992 the entire company ceased to exist [72].

For some reason France had become a centre of bow making producing a number of great names; Italy has played little or no part in the development of the modern bow. Germany has been important in the mass production of middle and lower grade bows, with one or two individuals making top class bows and England has had only a few excellent makers. Because of the lowly status of bows in the 17th and 18th centuries, very few have survived; a damaged or unsatisfactory bow for various reasons, was simply thrown away. Those who manufactured bows in this period (usually violin makers’ assistants) were held in low esteem. Not until late in the 18th century did bow making become a separate profession and the practice of stamping a bow with the real maker’s name only became widely established after 1800.

In contrast to the instruments of the violin family, the bow has undergone quite an extensive evolution in the period 1700-1800, of which only a few outlines are given here. The bows from the 17th and early 18th century, only a few of which have survived including one made by Stradivari [7], had the hair ribbon and stick parallel. Bows with outwardly curved sticks have been used in the vielle (the medieval precursor of the violin) and in folk music instruments (rebec, the Celtic crwth, and the Mongolian fiddle) but it can safely be relegated to the world of phantasy that such arched bows were used in the Bach period to facilitate the playing of chords.

These early bows, sometimes called Corelli bows, were mostly rather weak and had a high nut; they are very well suited to playing fast successive notes with a light tone, as often occurred in music of that period. Due to the construction of the bow (without an inward curve or camber) the playing of chords was easier than with later bows because the bow hairs had little tension and could be bent over the strings. The head had a more pointed end (pike’s head) than the more hammer-like shape of the present day bow; different types of wood (snakewood, iron wood) were used for the stick. The length was variable, for the violin between 60 and 70 cm and a weight of 50 g. Boydén [7] warns that the bows of before 1780 should not be regarded as primitive and crude; for much music from the 17th and 18th centuries they are clearly superior to the modern bow. Copies of these old bows have been made by modern bow makers for such music.
In the second half of the 18th century changes in music practice necessitated a bow which permitted the sustaining of long powerful notes. To meet this need bows had an inward curvature of the stick, the camber, giving the middle part of the bow greater stability. Bows from the period after 1770, with a light camber and a somewhat shorter head, called of the “transitional” type, are intermediary between the old Corelli type and the Tourte type at the end of the 18th century. A bow much used throughout Europe in the last quarter of the 18th century was the Cramer bow, named after a German violinist from around 1750 [54]. These bows were manufactured by anonymous workmen: Cramer himself had nothing to do with their production. In general, bow types were associated with players, not makers.

Shortly before the end of the 18th century, it was the great bowmaker François Tourte (1747-1835) who determined the present day form of the bow and the choice of materials for stick, frog and head, building on work of his father and other contemporaries. Since Tourte’s day the wood of choice has become pernambuco; after being cut to the right size the bow is then bent to the right shape by heating. It is said that Tourte used the pernambuco staves of South American rum barrels left on the Paris quay from which to cut his bows, but this does not seem to be a plausible story. This tropical wood was generally used in the 18th century to extract coloured products for textile dyeing. It is a nice detail that one of the earliest marked pernambuco bows carried the stamp “teinturier,” probably a pseudonym, pointing to this relation [41]. Originally, the sticks were only oiled; in the course of the 19th century the application of a shellac finish was adopted.

**7.2 Portrait of the present-day bow**

![Image](image_url)

Fig. 7.1 The nut of a violin bow on the stick. **a.** Slide of mother-of-pearl with behind it **b.** the metal silver plate which may or may not form a whole with the heel plate at the back of the nut. Other parts are shown in fig. 7.2

Fig. 7.2 The same nut as in fig. 7.1 detached from the stick to show some parts and the adjustment mechanism. **1.** Silver wrapping **2.** thumb grip **3.** lower part of the stick with the mortise **4.** nipple **5.** hair ribbon **6.** metal ferrule **7.** ebony frog with mother-of-pearl eye **8.** metal underslide which moves over the (octagonal) lower part of the stick **9.** screw-eye screwed into the ebony nut and which is moved in the mortise by means of the screw (10) **11.** button adjuster with metal rings over ebony.

Ignoring all details about the evolution of the nut, the head and the attachment of the hair ribbon [7, 67] the modern bow will be described here in some detail first. The figures 7.1-7.3 provide a general review of the bow, its parts, and the corresponding technical terms. The hair is retained in mortises in the head and nut with small wooden wedges; it is stretched by pulling the nut back along the stick by means of the screw adjuster. For this treatise, technical details about the exact fixation of the ends of the ribbon in head or frog and how to rehair a bow are of no importance [16, 50, 83].
The frog (also called nut or heel) is a fairly complicated construction of wood (mostly ebony, sometimes ivory or tortoiseshell), metal (gold, silver or nickel or gun-metal) and mother-of pearl, with an iron screw which fits into a screw mechanism fixed to the wood of the frog and which serves to move the frog to and fro for the adjustment of hair tension (fig. 7.2, 9). The frog is moved over the stick via an underslide liner of metal secured by tiny pins or screws to the frog (fig. 7.2, 8). The entire construction of the frog - although the measurements are more or less standardized - is characteristic of a maker or a school, and the materials used say something about the quality, at least in the eyes of the maker. The bow maker mounts his best work in gold, but in itself a gold-mounted bow does not mean an excellent bow; this depends on the standards of the maker. On the other hand a nickel mounted bow does not mean that the bow is inferior; quite a few of the “student type” bows from French ateliers can be excellent. The ferrule and the button of the adjuster are always made of the same metal, the button often with metal bands sandwiched in an ebony cap. For the players of old music, modern bow makers make copies of old bows of the Corelli or transitional type; they are however usually provided with a more comfortable adjustment of the hair tension than the “crémaillère” of older times, in which the frog was held in place by a series of iron indentations on the bow stick near its lower end [36].

It will be clear from the foregoing that the replacement of a frog by a new one (e.g. because of irreparable damage or wear) will reduce the authenticity of a bow and consequently its monetary value, although its playing qualities are not necessarily affected. To a lesser degree, this also holds for the button. In some cases, with a very valuable bow, wear and tear of the frog can be prevented by using a custom-made replacement frog for playing, keeping the original frog separate. In bygone days when money was scarce, materials expensive and labour cheap, many French bows were mounted in nickel to make them affordable for poor musicians. These bows have sometimes been re-mounted in silver to mark up the price.

Nickel mounted French bows are seen less often now, although they were made in large numbers.

The brand on the stick does not necessarily mention the name of the maker; often such a brand is only a shop or atelier stamp put on bows bought by the dozen from specialized bow making workshops. Stamps have often been faked to upgrade the value of the bow, in analogy with false labels in instruments; an expert is usually able to recognize these. Factory bows are routinely branded with the names of the makers of which they are copies. Apart from the stamp (if present, and not always reliable) and the characteristics of the frog, the model of the head and the way it is cut is of importance for the recognition of a maker or a school. The head plate (fig 7.3) is usually of ivory, sometimes of silver (especially with English bows) or of gold with bows with a gold-mounted frog.

Since 1800 most bows have been made of pernambuco wood (Caesalpinea echinata), a very dense and strong type of wood with the necessary resilience. It usually comes from northern Brazil, but not necessarily the Pernambuco region from
which the name is derived. Brazilwood, a lesser and more widespread variant of the genus Caesalpinea, originating from different regions in South-America and South-East Asia, is used for cheaper bows. Brazilwood can be recognized by its much coarser grain and more fibrous structure than pernambuco. Whereas bow sticks made from good pernambuco do not lose their elasticity and resilience even after 100-150 years, Brazilwood bows get exhausted after a certain period of time and become weak.

Bows are usually circular in cross section (or sometimes egg-shaped, slightly broader across the lower half) and decrease in diameter from the handle towards the head. Based on the bows of F. Tourte [67], J.B. Vuillaume has calculated the optimal decrease. It is questionable, however, whether even bows from the Vuillaume atelier always meet these requirements exactly; bow making is an artistic handicraft. There will be a great many bows which meet the criteria of Vuillaume precisely, but which are of no interest, whereas a number of great bows do not meet these specifications at all. At the thickest end of the bow, the so-called handle, all bows have a more or less octagonal cross section (fig.7.1) which enables the frog to be fixed with its underslide on the stick so that is laterally stable (very important for the player), and does not interfere with the to and fro movement of the frog for adjusting the tension of the hair ribbon. Many bows are octagonal over their entire length. Planta [61] has calculated that an octagonal stick, compared to a round stick of the same over-all diameter, would have 15% more stiffness. Apart from the round or octagonal shape, some bows have been made which could be called rounded octagonal or oval shaped.

Many experiments have been made with materials other than wood. J. B. Vuillaume had some success with hollow metal sticks. It did not become a real success with players, in spite of a laudatory letter from Paganini stating that it would be superior to a wooden bow [47a]. They tended to bend, buckle and rust and were less durable than wooden bows. They have become museum pieces.

More recently, after years of experiments and failures, bows have been produced with sticks made from synthetic materials, e.g. from polycarbonate fibres which have been made stable by resin impregnation. In view of the difficulty in obtaining good quality pernambuco wood, some young and adequately trained bow makers have recently produced bows which in terms of weight, elasticity and resistance approach the conventional bow, but have a stick made of such synthetic material [37]. The newest development is even a device enabling the resistance of such a stick to be regulated by a screw mechanism. Time will tell whether this is a viable development. In the past such developments have first created a furore which is forgotten later (e.g. the steel bow); so far this seems a serious novelty. In the rather conservative world of lutherie a certain resistance can be felt to sticks of synthetic material and it has happened that an enthusiast of the carbonate bow, when he brought it to his local shop for rehairing, was refused help.

To conclude this section on the anatomy of the bow, standard measurements of the present-day bow are shown in table 7.1. Different aspects such as weight, balance and other properties of the bow will be dealt with in the next sections.

Table 7.1 Standard measurements of the bow

<table>
<thead>
<tr>
<th>Bow Type</th>
<th>Length of Stick (cm)</th>
<th>Weight of Bow (grams)</th>
<th>Length of Nut (cm)</th>
<th>Ferrule Width (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violin</td>
<td>74.5</td>
<td>60 (57-63)</td>
<td>4.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Viola</td>
<td>74</td>
<td>70 (68-74)</td>
<td>4.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Cello</td>
<td>71.5</td>
<td>80 (74-84)</td>
<td>5.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Bass</td>
<td>72.5</td>
<td>125 (100-150)</td>
<td>6.8</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Note: The variations in length of the bow are, especially with older bows, considerable, e.g. for the violin the stick length may vary from 72.8 to 75.2 cm
7.3 The hair ribbon

The ribbon of a violin or viola bow contains 150-180 hairs, depending on the size of the ferrule, with a weight of 3½-4 g. A cello- or bass bow contains more hairs with a weight of 5-6 g. The hairs originate from the tails of horses all over the world and sometimes from their manes too if they are long enough. There are special dealers in horse hair, who clean it and select it on the basis of length, thickness, regularity etc.

Horsetail hairs (like the much thinner human hairs and all mammalian hairs in general) are covered on the surface with a layer of flat keratinized cells imbricated with their free edges all lying in the same direction, the cuticula of the hair shaft (fig.7.4). Rosin attaches to these minuscule surface irregularities, also by electrostatic interaction, causing the friction enabling the stick-and-slip movement when the string is bowed and resulting in the actual vibration of the string in a standing wave (see chapter 4).

It has been known for a long time that protrusions occur on bow hairs but, due to unfamiliarity with the actual aspect of the hair surface, these have been considered to be a kind of barb which would be responsible for the resistance of the hair on the string. Following the idea that should all the barbs point in one direction then the bow might only grip in this direction, it had become customary to lay new hairs in bundles of 10-15 in opposite directions. Although one glance at fig.7.4 reveals the obvious primitiveness of this concept, many industrious atelier assistants world wide still
alternate the bundles of hairs. Another misunderstanding is that the scales of the cuticula wear off easily causing a loss of ‘bite’ of the hairs. There is a certain degree of wear and tear but this does not occur in the short term, say up to a few hundred hours of playing. It is a layer of modified rosin overlying the cuticula scales which causes the loss of resistance. This accumulation of chemically modified rosin is partly due to the high temperatures developing at the hair/string contact point during vigorous bowing; this can be confirmed by an infrared camera [59]. This layer may be removed by cleaning the hairs with a 70% alcohol solution on a piece of cloth (taking care not to touch the stick), resulting in an increased ‘bite’ of the hairs when new rosin is applied [33]. This may be of importance for a travelling musician, who may distrust the abilities of the local craftsman to rehair his valuable bow. Even under other circumstances such a cleaning is better than a hasty rehair at a local shop with its risk of damage to the head. How often a rehair is really needed will vary; for professional players the average is about every six months or when the bow does not seem to hold the strings as it once did.

In spite of extensive experiments with various materials, it has so far not been possible to replace by a synthetic material the time-honoured horse hair which had been used for stringed instruments in the Arabic world even before the violin family came into being. In contrast, replacement of the classic catgut core for strings by synthetic materials has met with more success (chapter 8).

As a natural material, bow hair is susceptible to a particular parasite, the bow bug (museum bug, Anthrenus museorum), especially its larva. It is called a museum bug because the larva in question may eat the keratin from furs, wool and hairs as well as the protein skeleton of entire insects in a natural history museum. If many loose fragments of bow hair are found in all directions on opening a violin case that has been closed for a long time, then you can be certain a bow bug has been at work. The larvae have a preference for the dark and may stay for years in a closed case and feed on the keratin which forms the basic protein of the bow hairs [34]. The larva is a few millimeters long and has bristles all over its body (fig. 7.5). It does not show any interest in any other part of the bow but the hairs, nor for the violin or parts thereof. Wood is the speciality of the woodworm (Anobium punctatum), no relative of the bow bug. After metamorphosis the bow bug becomes a flying insect and feeds on the nectar of plants. Any such old violin case with broken hairs should be taken out into the open and treated with an insecticide spray.

Rosin is a subject which has often been neglected; it is, however, essential for the functioning of a stringed instrument. The best instrument with an excellent bow is unable to produce any sound without rosin. The way in which rosin is attached to the hairs and the stick-and-slip mechanism it causes has been dealt with in the previous paragraph and in chapter 4; the proper use of the right kind of rosin makes a difference to the playing quality of a bow and the tone it evokes from the instrument [67].

Rosin (called colophane in French and in German Kolophon after the region in Asia minor where good rosin used to be produced) is originally the residue left when turpentine has been distilled from the sap of resinous trees. New (semi-) synthetic procedures have since been developed to make rosin, and certain substances are sometimes added. The characteristic smell of rosin is attributable to certain volatile etheric oils; this is the reason why it is best to keep rosin in a closed box or envelope. The
colour of the rosin is related to the melting point: dark rosin has a lower melting point than light rosin. Dark rosin is soft and more tacky; light coloured rosin is somewhat harder, powders easily and, especially in cold surroundings such as churches, sometimes does not grip effectively causing non-response and whistling. In a hot climate hard, mostly light rosin is to be preferred. For the cello and especially the double bass, tacky rosin (which may or may not be dark) is best.

With violin and cello, the use of light or dark rosin is also dependent on the properties of the bow: if it has a very strong stick the chances are that light rosin might give insufficient grip, especially with stiff strings and in cold weather. On the other hand, with a flexible bow, a vigorous attack in a solo may be realized more easily with a hard rosin. Each player has to find out what is best for his playing and his equipment; it makes sense to have both light and dark rosin to hand, particularly in view of different atmospheric conditions. Apart from dark and light types, also rosin has been produced which contains a kind of lubricant which works satisfactorily for some players. The differences between the various brands of light and dark rosin are not very great.

Rosin should only be applied when necessary, i.e. when there is clearly a loss of grip on the string. It should be applied with long even strokes; short to and fro movements generate too much heat. For the first application after rehairsting a powdered rosin is advisable because it adheres more quickly to the scales of the cuticula of the hairs. Excess rosin is played off quickly, but it might cake onto the strings (thereby altering their mass) or onto the table. This can easily be wiped off, but sometimes the rosin on the strings is difficult to remove, causing them to sound false (because of the local mass increase). Moreover, a detrimental effect on the tone may occur when, during bowing, rosin slides over rosin. When the rosin cannot be wiped off easily, cleaning the strings with a minute drop of 70% alcohol (or eau de cologne) on a piece of cloth is indicated, taking care not to spill any alcohol on the varnish of the table. The cleansing towelettes provided with aircraft meals serve very well in this regard!

7.4 The bow as a tool for the player

The attitude of players towards the bow differs widely; some are quite indifferent, others are very critical. It has been well established that the characteristics and the quality of the bow are very important for the ultimate tonal result, and that the bow and the instrument should also match. There is no such thing as the ideal bow for everything and everybody, although good bows have much in common.

Any player handling a good bow for the first time is often surprised how easily all the different bow strokes can be executed, and even an unhappy “landing” on the strings seems to be effortlessly corrected due to an excellent response. The result with regard to tone production is also surprising. The experiment with a hidden player trying different quality bows on the same instrument is illustrative: the audience often thinks that different instruments are played. The difference between colourless mass-produced bows is usually inaudible. As with instruments, clear differences exist between various players who may draw entirely different sound colours from the same bow and the same instrument. Players usually agree on the response of a bow, i.e. the more or less rapid establishment of a Helmholtz vibration in a string.

A good sounding bow and one which is easy to play do not always run hand in hand; some bows, among which real Tourtes, have a beautiful tone but may be difficult to play for different reasons. It remains mysterious just what determines a beautiful tone. Far fewer investigations have been made in this respect than with violins. The tone is a product of response and damping of a bow in which the ribbon transmits certain vibration patterns to the wood of the stick, which plays the most important role in tone formation. The diameter of the ribbon determines the force which can be exerted on the string, but also the damping: the broader the ribbon, the more damping. The damping effects a
selection in the harmonic spectrum of the vibrating string. A good tone is produced when all parts of a bow combine harmoniously [21a].

Instruments differ in their demands on the bow; moreover there are differences between bows for various members of the violin family. The fact that violin and viola are played in a more or less horizontal position and cello and bass with the strings more upright, are of importance for the construction of the bow.

An important element in the adjustment of a bow is the curvature of the stick in both horizontal and vertical directions: there is no point in testing the qualities of a bow as long as these factors are not in order. As explained in 7.2, the modern bow (since c.1800) has a curve towards the hair ribbon, the camber. For setting the camber the shaft is heated thoroughly (yellow gas flame), equally and evenly on all sides and then bent while hot, using both hands. For mass production steam is used. If everything has been done optimally, the “belly” of the stick touches the hair about half-way. Many old bows have in the course of time lost some spring, causing insufficient tension on the hair and too weak a “feel” of the bow for the player in view of the strength of the stick; furthermore they may be curved laterally to the wrong side. A bow maker can easily correct this by re-springing the stick by heating as outlined above. This does not make a weak bow stronger, however, but its playing qualities can be improved. The desired result is not always obtained; pernambuco has a will of its own and warping may occur. The well known London bow maker James Tubbs always went to his workshop on Sundays to test the sticks he had bent on the preceding Saturday, thus avoiding surprises on Monday!

With regard to the hair tension, it should be noted that the climate may play a confusing role. Hairs are very hygroscopic and in humid and warm surroundings they may absorb water and stretch a few millimeters. It is known that in a humid tropical climate players sometimes cannot wind up their bows enough because the screw mechanism has reached its end before there is adequate hair tension.

Taking a gun barrel view from the handle to the head of a bow, it can be established whether the stick (apart from the camber) follows a straight course, and whether there are any irregularities in its thickness. In contrast to what many players think, this course is not always straight; some lateral deviation to the left for a violin or viola bow and to the right for a cello or bass bow (i.e. contrary to the direction in which force is exerted in playing) is favourable. Many quality bows are delivered this way, the bending being done after setting the camber. The lateral deviations just mentioned (when in the right direction) make the “feel” of a bow somewhat stronger; there are however also good bows which are totally straight, apart from the camber. A lateral deviation in the wrong direction however should always be corrected.

All this bending - adjustment - of bow sticks is the work of specialists and, if well performed, can have an amazing effect on the playing qualities of a bow. The suggestion of Rokos [70] to perform this at home on a rainy afternoon with a few heavy books and a central heating radiator is not worth following.

The wrapping which protects the stick from wear and tear, together with the leather thumb rest, give a more comfortable grip. Personal tastes play a role here: one may prefer a thinner or a thicker leather, and this may depend not only on the stick diameter but also on the manner in which the bow is held. Old bows (especially those from French ateliers) had a wrapping of silvered thread; whalebone wrapping has also been used, especially on English bows, and leather. Whalebone wrapping is no longer obtainable, but there is a quality plastic variant of alternating yellow and black threads. Plain plastic is usually mounted on the cheaper bows. Many master bows now have a silver wrapping, which (by varying the length of the wrapping or the thickness of the wire) enables a certain adjustment of the balance of the bow (see 7.5).
In choosing a bow, many players will consider the “feel” of the bow to be an important element, and not so much the weight, strength or balance. According to W.C. Retford, who worked for more than half a century in the bow workshop of Hill and Sons in London [72], this is not so bad an approach at all. In his book “Bows and bow makers” dating from 1964 [63] he has made a few sensible remarks about choosing a bow. These remarks, quoted below, remain valuable even after nearly forty years. The only remark to be made on these lines in the present time is that the sound of a bow has received little attention.

“When choosing a bow the selection should be from a number varying in weight, strength, etc. Attempts by a salesman to influence judgement should be discouraged. There may be instances where it might be well to have the opinion of another, but beware of the crank. The rule could be: if you dislike a bow, don’t buy it. Dislike entails unhappiness, a prime factor of success will be missing. For one who cannot play, the choice must be the teacher’s. For the player it should be entirely personal; the bow should feel a part of him, as comfortable and unobtrusive as old clothes to an old man who is contemptuous of fashion.

“Buy the best you can afford. Do not buy for the name. The possession of a Tourte will not provide a passport to fame.

“Gold is a better metal than silver. Silver is better than cheap, low carat gold. Many gold mounts have heavy, strong and unresponsive sticks scarcely providing the ideal combination with the sensitive Cremona.

“Do not make a hurried decision. We get the fiddle out; things don't go well; we put it away. As with the fighter who retreats, there may be another day when things go better and judgement may be more balanced.

“When buying an old bow a problem may arise. The practice, usually, is to take a gun barrel view; frequently, if the stick is not straight it will be condemned, a bargain may be lost. It may not be known, the straight line of the stick is artificially produced and skill can, without difficulty, restore its gun barrel accuracy.” [63]

7.5 Bow, instrument and player: a triad

After the general aspects dealt with above, a more detailed description will be given of the factors determining the properties of a bow: balance, weight, strength and elasticity.

Balance

The point of balance (the place where both halves of the complete bow have the same weight) is of utmost importance for the playing characteristics of a bow: if it is too close to the head, then playing near the frog is difficult: a player who is not aware of this will call it a heavy bow (and may reject it). On the other hand, a balance point too near the frog is also not pleasant, as such a bow has too little mass in its upper part, comes easily off the string and is therefore rejected as too light. One can get an impression of the balance of a bow by holding it in playing position and moving it around; it is better to measure this exactly. This is very simple and can be compared to the verification of “light” and “heavy” by weighing the bow on a letter scale, see fig.7.6.

According to Wunderlich [92] the following values are recommended for an optimal balance point in an average situation:

**violin and viola:** 24-25 cm from the end of the wooden shaft

**cello:** 23-24 cm

For **double bass** it is very variable, especially in view of the two types with high or low nut.

Sometimes the values for the balance point are given in cm from the thumb grip [82], but this is less accurate because the length and position of this may vary. It should be noted that the figures given above refer to a standard situation; some players prefer a bow that is somewhat top-heavy, corresponding to a balance point of, say, 26 cm for a violin bow.

The question may be raised whether all these details make sense, as one could say “good is good” and “bad is bad”. The answer is quite simple: an
optimal balance obviously does not increase the quality of a bow, but brings out its potential in playing. Many players complain about the quality of their bow, and something indeed might be wrong with it; often its adjustment is not optimal and its hidden qualities not revealed. On the other hand, there are thousands of well-balanced bows but which are totally uninteresting for the player.

One may change the balance of a bow e.g. by lengthening or reducing the silver wrapping or by using thicker or thinner silver thread. Such an intervention obviously influences the total weight of the bow and sometimes one has to compromise to reach an optimal solution. If it proves impossible to obtain a satisfactory balance due to insufficient weight of the head and the bow is sufficiently strong, it is sometimes possible to insert a small piece of lead in the cavity of the head if there is enough room. Some experts consider this as an unethical intervention, but nobody has difficulty in changing the wrapping for balance adjustment.

When the tension on the hairs is increased by turning the screw button, the frog approaches the head slightly. Even if this amounts to no more than half a centimeter it will affect the balance. From 1836 the versatile J.B. Vuillaume produced bows in his atelier with a fixed hollow frog with a piece of copper inside to which was attached the hank of hair. This piece was moved up and down in the slot through the action of a turning screw as in a normal bow [47a]. The specially-prepared hair ribbon with blocks at both ends was fixed in the head through a side opening; the other end was fixed inside the nut after taking off the pearl slide. The player could thus rehair his own bow without the need of a violin maker. The hanks were sold in small round boxes in the Vuillaume violin shop. In spite of the evident advantages of this system, it has not survived. These so-called self-rehairing bows from the Vuillaume atelier were made from quality wood by the best bow makers and they have later been converted to conventional bows (as by filling the hole in the head and replacement of the frog) and are used as such to the present day.

Weight

The notions ‘heavy’ and ‘light’ are often used carelessly by players. The reason for this, as explained before, is that the feel of the bow in the hand of a player may give a false impression of weight because of imbalance. This discussion can be cut short by weighing the bow: a letter scale will do; its electronic version is not necessarily better, although it can be read more precisely. The standard weights and ranges are given in Table 7.1. It should be emphasized that the importance of bow weight is often overestimated; except in extreme cases the balance is more important than the weight per se. Recently, there has been a tendency, to use slightly heavier bows; this is probably related to an increase in the use of strings with a core made from a synthetic material (chapter 9) which have a greater stiffness and require a somewhat heavier bow for ease in initiating a stable Helmholtz vibration pattern. Many splendid bows from the 19th century are now being laid aside because of insufficient mass; nothing can be done about this. Nor is too heavy a bow (assuming that any excess weight of silver etc. has been removed) easy to repair either. Weight reduction through shaving will also affect the strength of the bow. That this is a risky operation is illustrated by an event told by Wunderlich [92]. Near the end of the
19th century the Berlin violin maker Riechers had a beautiful Tourte bow which he had given on trial to the violinist Joachim. Although Joachim admired the bow for its tone, it was a little too heavy in his opinion. Riechers then worked on the shaft reducing its weight and presented it again to Joachim. To the astonishment of both, the bow appeared to have lost all its strength and elasticity and could barely be used. Such work with a knife and file on a priceless Tourte bow would nowadays be unthinkable, but in the 19th century there was less restraint in improving antique master works. In that period scores of violins and celli of the great masters have been made smaller or larger at a customer’s request.

Strength and elasticity

Weight is, up to a point, independent of strength (= resistance to bending). A bow can be light and strong, or vice versa, namely heavy and weak. It is possible to measure the resistance to bending under standard weights with an instrument, but this is less simple than determining the weight or the balance point. It is best tested by feeling the flexural strength with two hands, with the thumbs opposing inwards; an opinion of some value can only be given after extensive experience with various sticks. Fear of breaking the shaft is generally unfounded. Pressing the point of the bow on a surface to test the resistance (as is often done) is not to be recommended: in so doing the pressure is concentrated on the foremost part of the tip of the head plate (fig.7.3) and damage to it is far from imaginary. In many old bows the foremost part of this tip has been broken off (though not necessarily in this manner). The bowmaker can restore this, with the support of a new plate. The advantage of silver head plates is that they are usually stronger than the very thin ivory plates of the classic French school.

Traditionally, strong sticks are often mounted in gold; however a strong stick is not always preferred by the player. A weak bow with low resistance can sometimes produce a beautiful tone; in certain vigorous passages more resistance is required and then they fail. The famous English bow maker James Tubbs produced around 1880 a number of very weak “whippy” sticks, which appear now and then at auctions. They were probably made for the London happy few, where amateur music making was a favourite past-time, the whippy sticks helping to produce a beautiful tone, difficult passages being simply avoided. Tubbs also produced much stronger sticks for the professional musicians. A weak bow, lacking in hair tension, cannot be improved by further tightening by the screw mechanism, nor by restoration of the camber which would increase the amount of spring [63].

Elasticity, up to a point independent of strength, can be defined as the way a stick returns to its original state after bending. This is a property of the fibers in the wood [21a]. Elasticity may seem a good thing but excess of elasticity can make a bow too nervous.

Bows should be kept in the violin case with loosened hair tension, primarily for relieving the pull on the head; this is a considerable force which - according to the strength of the stick - may vary between 5 and 8 kilograms. Most players wind up any bow in the same way and this is often too much, perhaps because they once started with a weak bow. When the tension is tightened to the point of pulling the stick into a straight line, or “out of camber,” many strong bows perform poorly and most bows become laterally unsteady. A general rule is to wind up a bow until the distance between the belly of the stick and the hair ribbon is about the same as the thickness of the shaft in the middle [61]. A strong bow may need less tension, a weak bow more, depending on the bow strokes in the piece to be played.