2 The development of the clarinet

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Introduction

The clarinet may be defined as a woodwind instrument with a predominantly cylindrical bore and a single reed that overblows at the twelfth. The term 'woodwind' does not preclude the instrument being made of a material other than wood; indeed, at least one of the few surviving very early clarinets is made of ivory. As regards overblowing at the twelfth, the assumption that one can use identical fingering in the chalumeau and clarinet registers has rather less validity on earlier clarinets than modern ones. With these reservations, the clarinet can be traced back to the beginning of the eighteenth century, when it is generally believed to have been invented by Johann Christoph Denner in Nuremberg, as outlined in Chapter 1. Instruction tutors for the clarinet go back more than 200 years, and almost from the beginning the tutor has normally opened with a brief history of the instrument. Originally this was not regarded as having much importance, nor are these brief histories very reliable. My presumption in this chapter is that it will be read by people interested in how the clarinet they know today evolved, or in playing or listening to earlier clarinets, and I will bypass aspects of the history of the instrument that seem to me less interesting from this point of view. This is a major restriction, because many of the fascinating and ingenious inventions that have been applied to the clarinet seem to have had no significant effect either at the time, or subsequently.

Despite the fact that one can learn something of the history of the clarinet from music written for the clarinet, from patents, from concert reviews and from other written sources, the primary resource from a playing point of view has to be surviving instruments. For that reason it is appropriate to pause and to consider how surviving instruments may bias one's impressions. If a twenty-first-century organologist were accurately to reconstruct the changing sounds of the English clarinet in the mid-twentieth century, it would be important

that he/she should find a good pair of Boosey and Hawkes 1010 clarinets and a good pair of Buffet R13s – yet the most abundant instruments to survive will probably be made of ebonite or plastic and may well show signs of severe maltreatment followed by neglect. The most abundant surviving early twentieth-century clarinets were probably used in military bands. Many Viennese instruments from the time of Mozart and Beethoven were in use for most of the nineteenth century with new keys added, broken keys removed and the holes blocked up, cracks glued, new mouthpieces added, as they were used successively in orchestras, town bands, dance bands and bars. I have attempted to discuss and illustrate instruments that I believe at least to be characteristic of what was being used by good professional orchestral players and soloists, on the basis that our primary objective in playing historic instruments is to gain a better feeling for what classical music actually sounded like when it was first heard in favourable circumstances.

The earliest clarinets

The earliest clarinets were nearly all built with two keys and pitched in C or D, although early two-keyed instruments in F and G also survive. The two keys of these instruments are equivalent to the A key and the speaker key of the modern clarinet. However, such a set-up would appear to leave no possibility of a $b\natural'$. The addition of a third key provided a low *e* and its twelfth $b\natural'$, but there is evidence that two-keyed clarinets may have been tuned so as to give a $b\natural'$ with the two keys at the top of the instrument open, rather than $b\flat'$ as on the modern instrument.

We really have very little idea what the very earliest clarinets were used for, although it is known that some were provided to monasteries. It is noteworthy that the majority have relatively large bores and wide mouthpieces and are probably better suited to the pieces by Vivaldi (for C clarinet) and for some of the other early literature rediscovered by Rice[1] than to the Molter concertos. Handel's piece for two clarinets in D with horn exemplifies the trumpet-like characteristics of these earliest instruments and comes off well when played on copies of the instrument by Jacob Denner that survives in Nuremberg (Fig. 1.2, page 7). The earliest good concertos we know are those by Johann Melchior Molter and are written for the D clarinet; all six use the clarinet and extreme registers almost to the total exclusion of the chalumeau register. There is a good two-keyed D clarinet by Zencker preserved in Nuremberg with its original mouthpiece (Fig. 2.1). The bore of the instrument is quite narrow, as is the mouthpiece; this seems to be among the best surviving instruments for Molter's concertos, since it is capable of playing the extreme register with fluency.

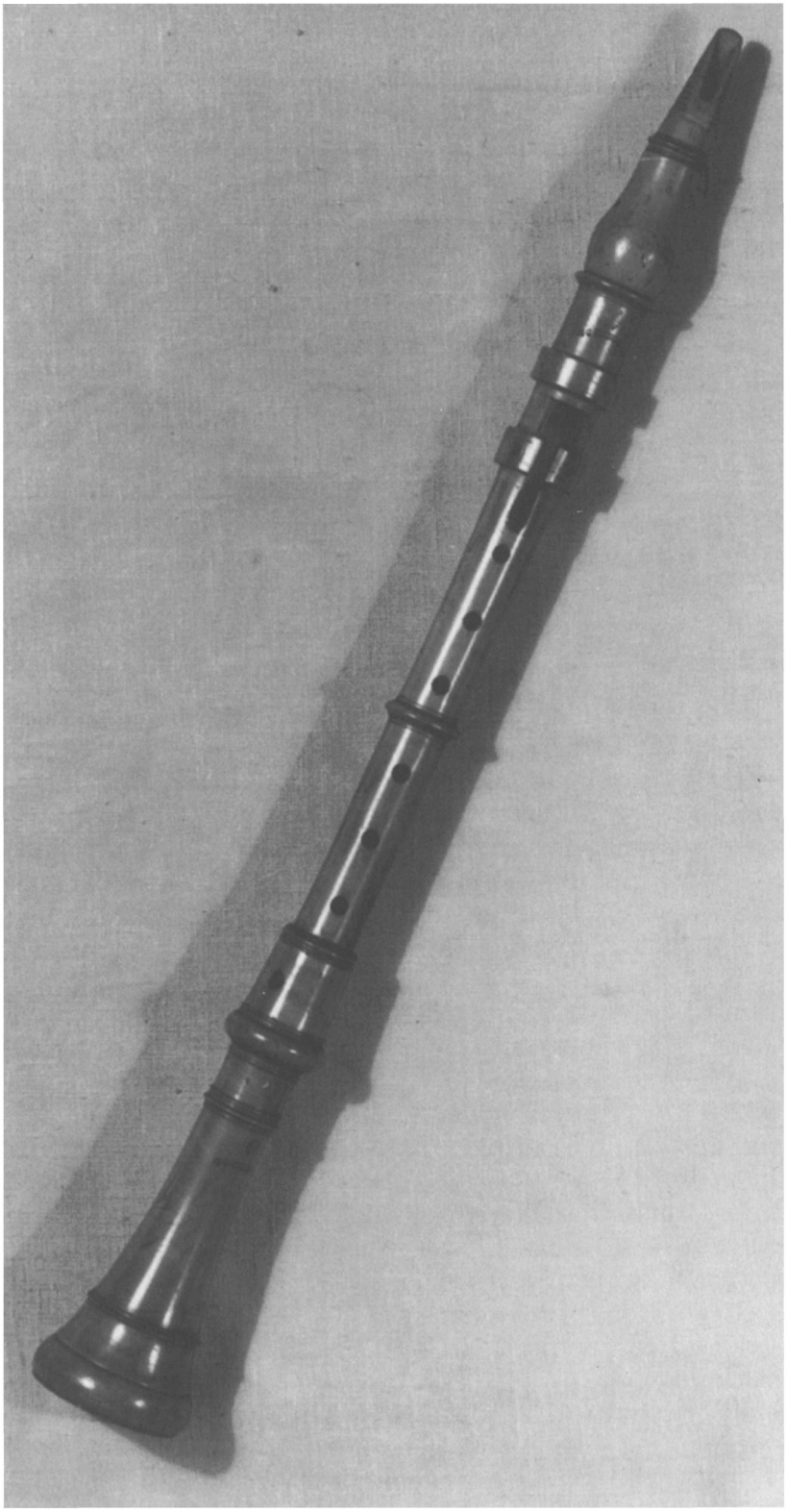

Figure 2.1 Two-keyed D clarinet by J. G. Zencker, Nuremberg, GN, No. R424

Early clarinets in B♭ and A

There are extremely few clarinets in B♭ or A known from before about 1770. A few exist with three keys (the third being the *e*/*b*♮′ key) and a handful more with four keys (the fourth being either the *a*♭/*e*♭″ key for R4, (e.g. Fig. 2.5*a*) or (in France) the *f*♯/*c*♯″ key for L4). The earliest identified English instrument is actually dated 1770 and has five keys;[2] several clarinets by distinguished makers after that date have fewer than five keys, but there is no surviving five-keyed instrument that shows evidence of being earlier than 1770. Thus if the concerto attributed to Johann Stamitz was indeed composed by him before his death in 1757,[3] it may have been intended for a three- or four-keyed clarinet. It is interesting to note that while on three-keyed clarinets the third key was usually an *e*/*b*′ key operated by the right thumb, several surviving instruments have been converted so that the key could be operated by L4 instead. In the clarinet register *f*″ is produced by closing R1 and R3, and *f*♯″ by closing R2 and R3. In the chalumeau register *b*♮ using R2 and R3 is very sharp, while using R1 alone is very flat. The Johann Stamitz concerto contains (once) the chalumeau register *b*♮ that gives so much trouble on early classical clarinets. It is curious that the only clarinet known to me that has a twin hole for R1 (as is found on some recorders and oboes in this position), producing a *b*♮ when only one of the pair is covered, is the much earlier but somewhat controversial instrument surviving in Berkeley, California (already mentioned on page 6) that was probably made by Johann Christoph Denner himself.[4] A few early basset horns have a twin hole in this position, perhaps implying that a well-tuned chalumeau register was regarded as being more important in relation to the basset horn than the clarinet.[5] It must, however, be said that oboists used the technique of half-holing (partially covering a tonehole) at this time, and it may be that this was the solution envisaged by Johann Stamitz, as well as by Carl Stamitz, Mozart and numerous others who used this note freely and unhesitatingly at a time when the majority of clarinets were not built to play it accurately.

The five-keyed clarinet (Fig. 2.2*a*) is the stage best regarded as the 'standard classical clarinet'. Despite the fact that there is ample evidence that some individual players chose to have additional keys on their instruments, these were chiefly regarded as being for trilling, rather than for improving the intonation of difficult notes. Thus several English B♭ instruments dating to the last decade of the eighteenth century have six keys, the sixth being a key for trilling on *a*′ and *b*♭′. The importance of the five-keyed instrument as the basic classical clarinet is suggested by an article by the celebrated maker Heinrich Grenser (1764–1813), who stressed that however many keys an instrument was built with, the maker's primary responsibility was ensuring

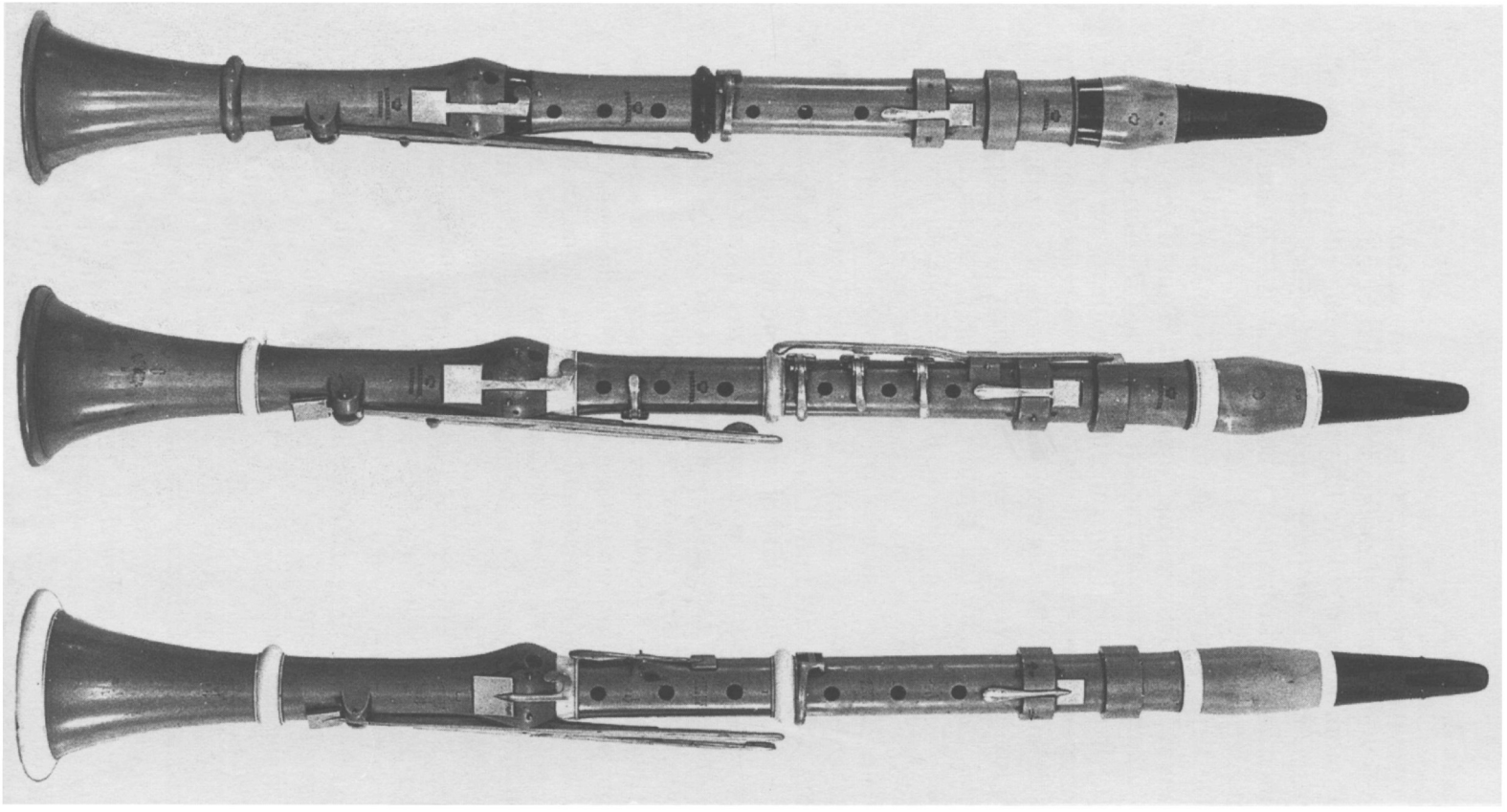

Figure 2.2 (a) Clarinet in C by Heinrich Grenser (Dresden, *c.* 1810). Boxwood, five brass keys.
(b) Clarinet in B♭ by Heinrich Grenser (Dresden, *c.* 1810). Boxwood, ten brass keys. This may be regarded as a five-keyed instrument with additional keys. The cross key for b♭/f′ (R1, R2, R3k) also produces an acceptable b♮ (R1, R3k) but is not well positioned for use in fast passages. The composer-clarinettist Bernhard Crusell used a similar clarinet by H. Grenser.
(c) Clarinet in B♭ by Jacques François Simiot (Lyons, *c.* 1815). Boxwood, seven brass keys. The side key for b♮/f♯′ (R1, R3k) is well placed for either the second joint of R3, or for R4. There is also a well-made c♯/g♯′ key for L4.

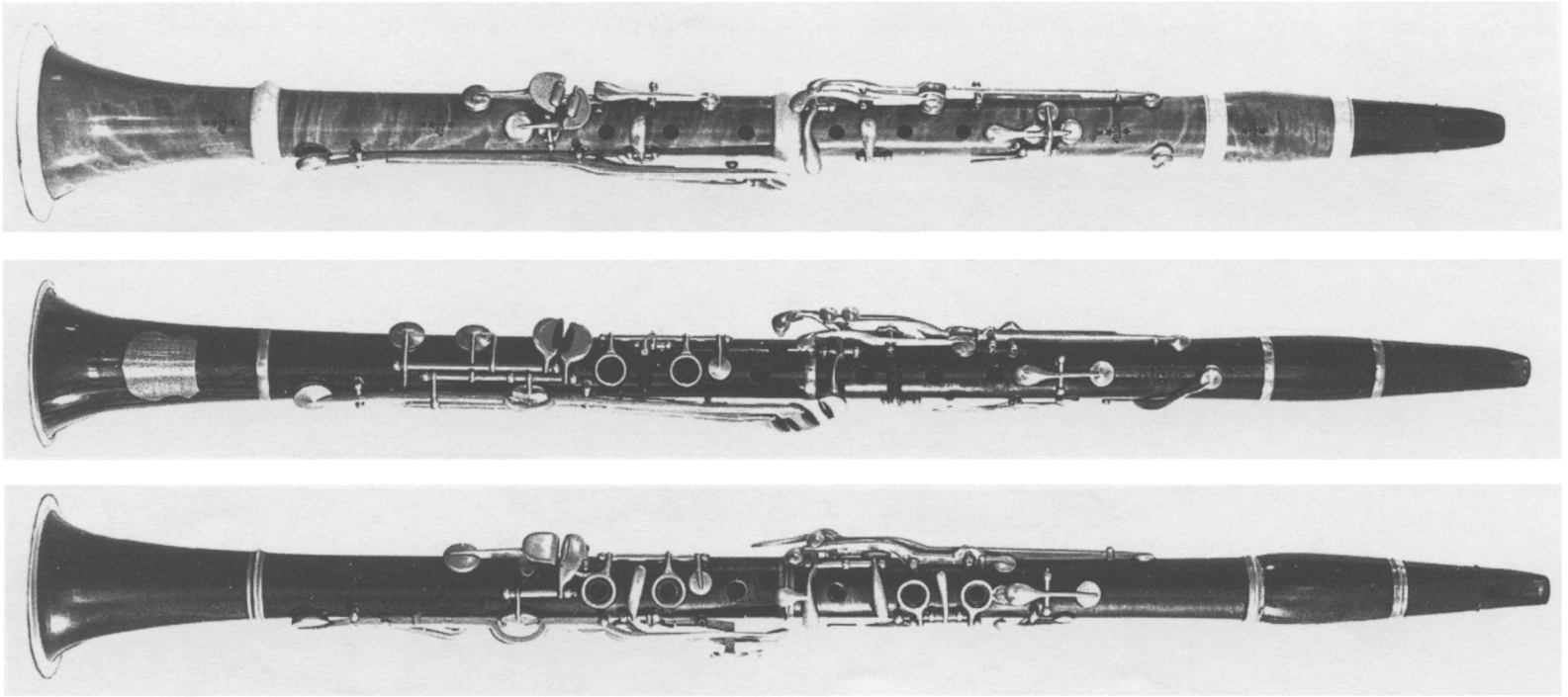

Figure 2.3 (a) Clarinet in B♭ by François Lefèvre (Paris, *c.* 1835). Boxwood, thirteen silver keys. Following Iwan Müller's proposals many makers produced thirteen-keyed clarinets despite the resistance of the Paris Conservatoire.
(b) Clarinet in A by Eugène Albert (Brussels, *c.* 1860). Rosewood, thirteen silver keys. Formerly the property of the celebrated English clarinettist Henry Lazarus (1815–95); instruments of this type were ubiquitous well into the twentieth century (popularly known as 'simple system' in Britain and as 'Albert system' in the USA).
(c) Clarinet in A by Wilhelm Hess junior (successor to Georg Ottensteiner) (Munich, *c.* 1870). Baermann system, virtually identical to the instruments played by Mühlfeld.

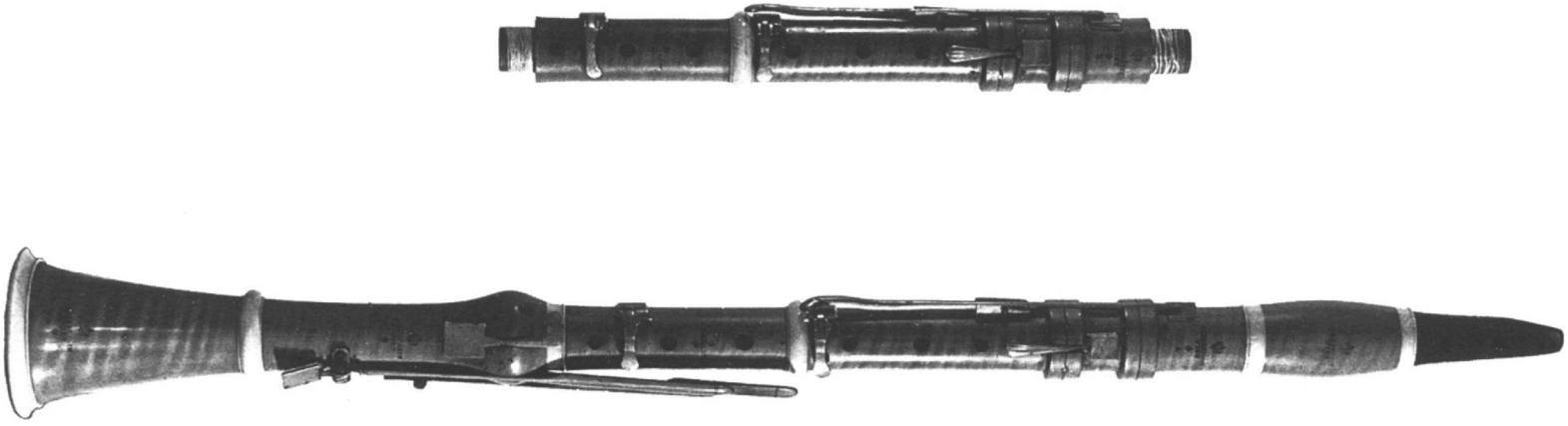

Figure 2.4 Clarinet in A with (left) alternative joint in B♭ by Johann Baptist Merklein (Vienna, *c.* 1810). Boxwood, eight brass keys. A typical classical Viennese clarinet with larger toneholes at the bottom of the instrument favouring the chalumeau register.

Figure 2.5 (a) Clarinet in A by Godfridus Adrianus Rottenburgh (Brussels, *c.* 1760). Stained boxwood, four brass keys. As on all early clarinets the small hole for R4 that sounds f/c″ is closer to the mouthpiece than the larger keyed hole that sounds a♭/e♭″; the maker has made no effort to shape the touchpiece.
(b) Clarinet in B♭ by Stephan Koch (Vienna, *c.* 1825). Ebony, twelve silver keys. An elegant Viennese Romantic instrument with delicate, well-designed keys. The relative positions of the R4 toneholes are unchanged but the a♭/e♭″ touchpiece is well designed so that R4 can slide from the tonehole to the touchpiece.
(c) Clarinet in B♭ by Richard Bilton (London, *c.* 1840). Boxwood, fourteen brass keys including the f/c″ for R4. Rollers on e/b′ and f♯/c♯″ touchpieces for L4. The touchpieces of the cross keys for b♮ (R1, R2k) and for b♭ (R1, R2, R3k) are carefully shaped so that it is possible for the fingers to slide on to them.
(d) Clarinet in A by Oskar Oehler (Berlin, *c.* 1935). The modern German clarinet follows Sax's fingering but has additional vents to render the tone more even but in consequence the interconnections in the keywork are much more complex than on the Boehm-system instrument.
(e) Clarinet in C by Auguste Buffet *jeune* (Paris, *c.* 1850). Following Theobald Boehm's approach to the flute, Klosé and Buffet revised the rings to provide b♭/f″ (R1) and b/f♯″ (R2) and devised a system of keywork that has survived almost unaltered to the present day.

the quality of the basic design.[6] Thus a good Grenser instrument (Fig. 2.2*b*) may be regarded as a classical five-keyed clarinet, with added keys that facilitate trilling and enable the player to produce certain notes with better intonation and tone-quality. However, the keys are

not designed for use at speed, and virtuoso passages would be performed using basic five-keyed clarinet techniques.

Generally clarinets pitched in C or lower were divided by a tenon and socket between the right and left hands, while the smaller instruments were usually not so divided. The right-hand section carrying three finger-holes was also divided from the lower section, known as the stock. Usually a player used the same stock and bell with alternative upper joints, or *corps de rechange* (Fig. 2.4) to convert the instrument from B♭ to A (and, less commonly, from C to B♮, and from E♭ to D). This practice came to an end with the increasing mechanisation in the nineteenth century. A standard set then comprised clarinets in A, B♭ and C in a fitted triple case, and it is only in the twentieth century that the C clarinet has fallen into relative disuse.

The earliest clarinets were invariably made with the bell and stock in one piece, and with the mouthpiece and barrel in one piece. In view of the fact that most owners (including museums) generally claim their instruments to be earlier than they truly are, it is worth remarking that as a general guide one should assume that no instrument with a separate bell was made before about 1800. That this is not the absolute cutoff is demonstrated by an instrument with a separate bell by Michel Amlingue (Paris), which is accompanied by a note from its original owner stating that it was purchased in 1794.[7] The motivation for the separation of the bell was probably entirely economic; good quality wood of sufficient diameter for the bell was (and is) scarce, and making the whole stock-bell from such a piece is wasteful.

The division of the mouthpiece from the barrel came one or two decades earlier. Eric Halfpenny demonstrated that in England this may first have arisen after makers were asked to repair mouthpieces with broken tips, and chose to reuse the original barrel.[8] However, the change undoubtedly had other benefits. First, it enabled the maker to use a more resistant wood for the mouthpiece (imported blackwood instead of local boxwood). Second, it enabled the maker to work on the interior of the mouthpiece from both ends, and made it more practical to modify the bore in the mouthpiece and the top of the barrel for tuning purposes. Lastly (in England and America), a long tenon on the mouthpiece was used for tuning.

The dimensions of the clarinet mouthpiece have changed considerably during its history. The very earliest clarinets have disproportionately broad mouthpieces, but from the mid-eighteenth century they were considerably narrower than they are today. On classical clarinets built around 1800 the mouthpieces were broadest in England and northern Germany, and narrowest in France (where they became broader from the early nineteenth century) and in Austria and adjoining areas (where very narrow mouthpieces survived longest). It is rather surprising that Viennese instruments, which were designed to

generate a good tone in the chalumeau register, did so with such a narrow mouthpiece. It goes without saying that the width of the reed was dictated by the width of the mouthpiece, but because few early reeds survive, there is not a great deal of information on changes in their design. As a general rule the lay on earlier mouthpieces was relatively long, and the tip opening relatively narrow, so that it resembled the modern German lay more closely than that usually associated with Boehm-system clarinets.

Keywork in the nineteenth century

The additions and modifications to the keywork of the clarinet that were made during the nineteenth century had several distinct purposes. First (starting in the late eighteenth century) keys were added solely to facilitate certain trills that were otherwise virtually impossible. Second, keys were added to enable complex chromatic passages to be played more fluently and/or with better intonation. Third, keywork was designed to render the tone of adjacent notes more even. Fourth, keywork was designed to enable the instrument to play more loudly.

A major objection to additional keys was the increased likelihood of unintended leakage. Until the 1830s the keys on the majority of clarinets sealed by means of a piece of soft leather attached with sealing wax to a square metal flap; this seated on a flattened area surrounding the tonehole. In London, James Wood patented (in 1800) an alternative whereby the tonehole was lined with a brass tube with a polished outer end, and the key carried a polished brass disc that sealed on the tube by close brass-to-brass contact. Aided with a drop of oil these keys seal well but make an aggravating clicking sound. In France the well-known flute-maker Clair Godefroy *aîné* used cork pads sealing on the end of a silver tube that lined the tonehole. However, the invention by Iwan Müller of the stuffed pad and the raised rim round the tonehole was the most significant improvement in the seating of the pads. At first the stuffed pad was almost spherical and fitted in a semicircular ('saltspoon') cover (Fig. 2.5*e*); towards the end of the nineteenth century this was replaced by the flatter card-based pad in a flatter cup that is in use today. To this day the pads of German clarinets are covered with white kid leather, while elsewhere the pads of the majority of clarinets are covered by thin fish bladder ('skin pads').

The majority of classical clarinets had springs of tempered brass riveted to the key and bearing directly on the wooden body. (On earlier instruments the spring was generally mounted on the body and bore on the metal of the touch-piece.) Well made, these springs can be extremely satisfactory, especially if the key is reasonably long; on very short cross keys they are generally less satisfactory. Early Viennese makers favoured blue-steel clock springs similar to those that are used

today. The needle spring was invented by Louis Auguste Buffet (his earliest version of the Boehm-system clarinet had only four needle springs, and one of the few changes that it has undergone is their gradual increase; a typical Boehm-system clarinet today has eleven needle springs). The last factor controlling the reliability of the keywork is the pivot. On early clarinets the keys were pivoted on a wire pin between blocks protruding from the body of the clarinet. Some makers mounted optional keys in brass saddles with somewhat thicker screwed pivots (e.g. Grenser, Fig. 2.2*b*) while others retained carefully sculpted wooden blocks (e.g. Simiot, Fig. 2.2*c*). Those keys on Grenser's instruments that were mounted across the body are generally more reliable than the equivalent keys on English instruments (Fig. 2.5*c*), because Grenser mounted each key in a brass saddle so constructed that the spring worked on the base of the saddle instead of abrading the wood as it moved. Generally the move to stuffed pads was associated with a change to an axle mounted between two pillars that were either mounted on a base plate, or screwed directly into the wood as is done today. A separate metal insert was provided to take the end of the spring. Point screws were introduced for longer pivots parallel to the body such as the low *e* and *f* keys on the Boehm-system clarinet.

The contrast between the keywork of the ten-keyed Heinrich Grenser clarinet and the twelve-keyed Stephan Koch clarinet (Figs 2.2*b*, 2.5*b*) exemplifies the contrast between keys that might be primarily conceived for trills and for occasional notes interpolated in a technique built around the five-keyed clarinet (Grenser) and keywork designed to be fully integrated in technique designed for the twelve-keyed clarinet (Koch). Instruments designed like the Koch instrument are very successful in Romantic music at a relatively low dynamic level. This particular instrument is part of a set comprising instruments in A, B♭ and C. The next major step was taken by Iwan Müller, whose main innovation was the addition of the key for *f*/*c*″ (Fig. 2.3*a*). The importance of this addition was that it gave the maker the flexibility to design an instrument with larger and more even-sized toneholes in the lower half of the instrument, whereas this was impossible so long as the open hole sounding *f*/*c*″ and controlled by R4 was closer to the mouthpiece than the keyed hole sounding *a*♭/*e*♭″, contrary to acoustical logic. Thus this single innovation heralded a general increase in tonehole diameter, giving a warmer sound at a louder dynamic level. Müller's other innovations, levers that enabled the right thumb to control the L4 *f*♯/*c*♯″ and the R4 *a*♭/*e*♭″ keys, were less popular, although they do draw attention to two areas where technical difficulties arise on this model of clarinet.

Müller promoted his clarinet as 'omnitonic' in the sense that it could play in all keys. In Paris his instrument was at first strenuously resisted on the grounds that it eliminated the desirable distinctions between

clarinets in different keys. In Paris at this time it was usual for serious players to have both an instrument with alternate joints in A and B♭, and a second one with joints in B♮ and C; at least three such sets survive.

The move to larger toneholes exacerbated acoustical problems on the right hand: in the chalumeau register separate keys were needed for *b*♭ and *b*, and even in the clarinet register the forked *f*♯″ (R2, R3) was less satisfactory than it had been on smaller-holed instruments. Thus the addition by Adolphe Sax[9] of rings that allowed the three fingers R1, R2 and R3 effectively to control four toneholes (Fig. 2.3*b*) was the step that freed makers to continue the trend towards even larger toneholes. During the rest of the century the only major change that was made to Sax's instrument outside the German areas was the so-called 'patent c♯' key, a device that provides an easy *e*–*f*♯ and *b*′–*c*♯″ transition. This invention was claimed in 1861 by the English player Joseph Tyler,[10] who sold the idea to S. A. Chappell for use by E. Albert, although Simon Lefèvre had patented an almost identical mechanism some years previously in Paris.[11] The importance of this device, which revolutionised the fluency of the clarinet in music with more than a single sharp in the key signature, is indicated both by its prominence in advertising material and by the fact that towards the end of the century a slightly different (and less reliable) mechanism was promoted by Chappell with 'new patent C♯' engraved on a key cover as a selling point.

Excellent instruments based on this model were manufactured by Eugène Albert and then by his sons in Brussels and were imported into England in large numbers first by the impresario Louis Jullien and then by S. A. Chappell. Boosey and Co., and Hawkes and Son also made similar instruments in London; they were very widely used until after the Second World War.

In Germany the instrument continued to develop. Mühlfeld, for whom Brahms composed his four clarinet works, used Baermann-system clarinets which were in essence Müller's model with a number of additions.[12] On the right hand the rings have the same function as Sax's, while the rings on the left hand improve both *f*♯′ and *c*♯‴. A lever for the right thumb opens the hole for *f*♯/*c*♯″, but the cover is articulated so that trills *e*–*f*♯ and *b*′–*c*♯″ can be made with L4. Two additional levers for L4 provide an alternative *a*♭/*e*♭″ and *b*♭/*f*♮″. On the left hand there are additional touch-pieces but no additional toneholes. It is notable that it is only recently that theoretical understanding has been gained of the disadvantages of designing an instrument with an excessive number of toneholes.

The modern German clarinet

During the early part of the twentieth century a number of further modifications were made by Oskar Oehler (1858–1936), a clarinettist

who in 1888 turned to instrument-making in Berlin. The Oehler-system clarinet that is used almost universally in Germany today (Fig. 2.5*d*) has only minor differences in fingering from the Baermann system, but has considerably more toneholes (twenty-nine as compared with twenty-four for the standard Boehm system) to provide a complex network of additional venting on both halves of the instrument. On the right hand there is the 'patent *c*♯' device discussed above, but with a movable lug so that the mechanism can be disconnected. A thumb key is fitted to full professional Oehler-system instruments; this controls additional vent holes that raise the pitch of low *e* and *f*♮. Although it is possible to design Boehm-system clarinets so as to bring the sound closer to that of the Oehler-system instrument, the differences between the two schools are perceived to be so important that advertisements for openings in German orchestras still (in 1994) almost invariably specify Oehler system.

The Boehm-system clarinet

The instrument that we know today as the Boehm system was devised by the clarinettist Hyacinthe Klosé with the maker Auguste Buffet *jeune*, and was first exhibited in 1843. The Boehm-system clarinet (like the Boehm-system flute) requires a major change in fingering, as the basic *c*″ major scale of the instrument is played by raising successive fingers whereas on instruments from the earliest times up to and including the Oehler system a forked *f*♮″ (R1, R3) is needed. The other important advance was the complex set of interlocking levers for L4 and R4 that greatly reduces the frequency with which it is necessary for these fingers to slide from one key to another.

Another radical change in fingering required by the Boehm-system clarinet is the elimination of the standard forked *e*♭′/*b*♭″ (L1, L3) and its replacement by the so-called 'long' fingering (L1, R1) which is a reflection of Boehm's desire to avoid the reduced venting that arises from forked notes. During the late nineteenth century at least three different methods were used to reinstate the true forked fingering without reducing the venting, of which one survives on the so-called 'full Boehm' clarinet as well as on the Schmidt Reform-Boehm instrument.

Bore and tonehole design

As mentioned at the outset, the clarinet is defined by having a bore that at least behaves acoustically as if it is cylindrical. In practice the acoustical ideal (each fundamental overblowing at a true twelfth) is achieved by means of several departures from a true cylinder. Since most deviations from a cylinder would be made by a craftsman by first making a cylindrical bore, and then enlarging parts of it, it is convenient to specify the diameter of the bore in terms of the diameter

Figure 2.6 *Bore characteristics of some representative clarinets*

maker	city, date	key	no. of keys	main bore	bore at f hole
Roberty	Bordeaux 1780	B♭	5	14.6	16.1
Bernard	Lyons 1790	C	5	13.8	15.8
Hale	London 1790	B♭	6	14.2	14.2
Hale	London 1790	C	5	13.6	13.6
Kusder	London 1780	D	5	12.9	12.9
H. Grenser	Dresden 1810	B♭	10	14.4	14.5
H. Grenser	Dresden 1810	C	6	13.7	13.75
Gentellet	Paris 1820	B♭	6	15.0	16.2
Gentellet	Paris 1820	C	6	14.3	16.3
Simiot	Lyons 1810	B♭	7	15.1	16.4
Simiot	Lyons 1810	C	7	14.2	16.9
Simiot	Lyons 1820	B♭	7	14.7	15.8
Milhouse	London 1820	B♭	5	14.5	15.2
Milhouse	London 1820	C	5	13.9	14.8
Lefèvre	Paris 1840	B♭	13	14.6	15.9
Lefèvre	Paris 1840	C	13	14.2	15.1
Koch	Vienna 1830	B♭	12	14.4	14.9
Koch	Vienna 1830	C	12	13.2	13.5
Hess	Munich 1840	B♭	12 2r	14.4	14.4
E. Albert	Brussels 1860	A	14 2r	15.0	17.6
Ottensteiner	Munich 1870	B♭	Baermann	15.0	15.3
Ottensteiner	Munich 1870	A	Baermann	14.8	15.0
Oehler	Berlin 1930	A	Oehler	14.8	14.8
F. Wurlitzer	Erlbach 1939	B♭	Schmidt-Kolbe	15.2	15.2
H. Selmer	Paris 1930	B♭	Boehm	15.0	17.5
B. & H. '1010'	London 1930	B♭	Boehm	15.2	17.2
B. & H. '926'	London 1950	B♭	Boehm	15.0	17.0
Buffet	Paris 1930	B♭	Boehm	14.9	18.7
F. Wurlitzer	Erlbach 1950	B♭	Ref. Boehm	14.65	14.7
Buffet	Paris 1960	D	Boehm	13.3	14.5

of the narrowest cylindrical portion (generally in the lower part of the upper joint). In poorly preserved instruments it is not easy to make this measurement without an appropriate tool because the tenons are usually found to have contracted noticeably (sometimes by more than 1 mm) as a result of continual pressure from the socket on the lower joint. A complete survey of the history of clarinet bores is beyond the scope of this chapter (and has never been attempted) but Figure 2.6 has been assembled to give an impression of the range encountered in important categories.

It may be seen from Figure 2.6 that there has not been a uniform trend in bore diameter. There was a rather rapid widening of the bore around 1800 in many areas; this was associated both with the separation of the bell, and with the insertion of a flare in the bottom of the instrument except in Germany. Subsequently, in the mid-nineteenth century, narrower instruments became more fashionable, after which nearly all regions saw a return to a bore close to 15 mm. In England the designer and acoustician David James Blaikley, working for Boosey and Co.,

promoted an even wider bore diameter, 15.2 mm, that became associated with the 'English School' of clarinet playing through the 1010 model that was made by Boosey and Hawkes from about 1930 and was used by the majority of the leading English players. In Germany Ernst Schmidt and Louis Kolbe developed the so-called Schmidt–Kolbe variant of the Oehler-system clarinet, also with a very wide bore of 15.2 mm. Excellent examples of this model were made by Fritz Wurlitzer in Erlbach, Vogtland, but today both of these large-bore variants have fallen from fashion.

There are four types of departure from the cylinder. First, not only does the bell have a wide flare, but the bore generally makes a transition that may be a gradual expansion starting several centimetres above the bell tenon (the so-called French bore) or may be much more sudden (the so-called German bore). Second, the maker may expand the bore at the barrel or in the upper part of the instrument using one or more conical reamers. Third, the bore may be made of two or more sections that are cylindrical but of different diameters ('poly-cylindrical bore'). Fourth, the maker may enlarge the bore at selected points ('chambering').

The purpose of the expansion at the lower end is to mitigate the otherwise very wide twelfths on *e* and *f*, but at a sacrifice in terms of the tone-colour of these notes. These notes may be up to 40 cents flat on an instrument with no flare; the magnitude of the difficulty is indicated by the provision of a vent key on modern Oehler-system clarinets to raise low *e* and *f*. This key raises the pitch of each of these notes by about 20 cents.

In general one observes that toneholes have become gradually larger as the mechanisation of the instrument increased. However, the design of the toneholes has also varied from minimal to very heavy undercutting. In general more undercutting will increase the flexibility of the instrument. Of the instruments listed in Figure 2.6 the most marked undercutting is on the narrow-bored romantic instruments by Stephan Koch (Vienna) and Wilhelm Hess senior (Munich); of the instruments from the 1930s the Buffet–Crampon is the most heavily undercut.

Clarinet designs for various uses

The development of the clarinet has been to a large extent driven by the demands of Western 'classical' music, but throughout most of its history a range of models has been available to suit a far wider range of players. In nineteenth-century Denmark the making of five-keyed clarinets by wheelwrights and other part-time makers, for popular music, is well documented. Although this practice must have existed elsewhere it is also the case that at least to the end of the nineteenth

century several major manufacturers and suppliers offered clarinets with only five or six keys for popular and dance music. The jazz era began at a time when the majority of available instruments in America were 'Albert system' with many variants that were inspired by French or German influences. Of these it was the simpler French models with fairly large toneholes and no extraneous keywork that proved to be most suited to jazz, and many players still favour these instruments. The same characteristics have made this the favoured model for twentieth-century popular music in most other regions where the clarinet has a special place (in B♭ and C in most regions; exceptionally in Turkey the clarinet in (low) G is used). It is only recently, as the commercial aspect of music has spread worldwide, that major manufacturers of the Boehm-system clarinet have set out to design different models for the jazz, wind-band, chamber and orchestral markets.

The basset clarinet and basset horn

The concept of using the right thumb to extend the lower range of an instrument is of course standard for the bassoon, where the tube is folded so that the right thumb covers a tonehole (and the left thumb, several keys). An early bass chalumeau using the same principle survives in the Salzburg museum; it was made by an undocumented maker named W. Kress, probably during the early part of the eighteenth century. The range of the basset horn is generally extended without a fully doubled-up bore; instead, the bore is extended by a section inside which the bore travels down, up and down again. The basset horn is generally believed to have been invented in Passau in 1770. Most early examples are in F or G but one example in D is known.

The basset clarinet can be regarded either as a basset horn in A or B♭, or as a clarinet with extended compass. Several surviving examples are constructed like basset horns and have only recently been recognised as basset clarinets; one is curved, some have angles in the barrel, some between right and left hands; one has the flat thrice-bored box typical of Viennese basset horns. On the well-known photograph of basset horns preserved in Hamburg,[13] the instrument with a globular bell by Strobach of Carlsbad is pitched in A and should be regarded as a basset clarinet, and two others in approximately this form are known. This instrument may have been made during the lifetime of Mozart's clarinettist and may be the closest we have to his own instrument.[14] On the other hand an instrument by Bischoff from the 1840s[15] (pitched in B♭) closely resembles a clarinet with a straight extension, as do basset clarinets made today. This instrument has a fully chromatic extension as did Anton Stadler's.

As regards the basset horn, we may be confident that during Mozart's lifetime, the parts he wrote for the instrument were generally played on

instruments made by Theodor Lotz or by Raymund Griesbacher, whose instruments are almost indistinguishable.[16] Surviving instruments by these Viennese makers have eight keys and are equivalent to five-keyed clarinets with a key in place of the small hole for R4, and with thumb keys for low *c* and *d*. Presumably Anton Stadler had additional keys on the basset extension, and perhaps elsewhere on the instrument. (The majority of the surviving basset horns by Lotz and Griesbacher have additional keys that were put on during the early nineteenth century, but the added keys do not include those for low *c*♯ or low *e*♭.)

The alto, bass and contrabass clarinet

Bass clarinets (an octave below the soprano in B♭ or C) were made from the 1770s onwards. The majority of early examples (before 1820) were extended to written low *C*, and several models were devised in bassoon form, probably for use in military bands. The American Catlin may have been the most prolific maker of the early bass clarinet. Alto and bass clarinets with the same range as the normal clarinet emerged in the 1820s; their design was dramatically improved by Adolphe Sax, who enlarged the bore, enlarged the toneholes, redesigned the keywork and enlarged the mouthpiece. Sax's instruments were pitched in E♭ and B♭ rather than in F and in C. It was the B♭ bass clarinet that became a member of the orchestra from the mid-nineteenth century; instruments in A were also in use at least in areas under the German influence.

The contrabass clarinet (in E♭ an octave below the alto, or in B♭ an octave below the bass) has only become widespread in the last fifty years. A few makers made examples in the late nineteenth and early twentieth centuries and certainly the model patented by Adolphe Fontaine Besson in 1891 had a measure of success.