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Flute

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Flute

[concert flute, cross flute, German flute, transverse flute]. (Fr. *flûte*, *flûte traversière*, *flûte allemande*, *flûte d'Allemagne*, *traversière*; Ger. *Flöte*, *Querflöte*; It. *flauto*, *flauto traverso*, *traversa*). Term used to refer to a vast number of wind instruments, from the modern orchestral woodwind to folk and art instruments of many different cultures.

See also ORGAN STOP.

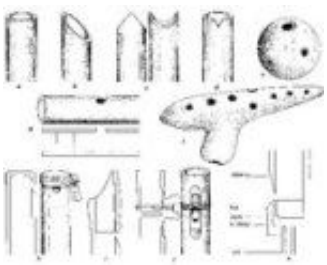
I. General

1. Acoustics.

Generically, a flute is any instrument having an air column confined in a hollow body – whether tubular or vessel – and activated by a stream of air striking against the edge of an opening, producing what acousticians call an 'edge tone' (see ACOUSTICS, §IV, 7); flutes are therefore often called edge-tone instruments. The edge is generally referred to as 'sharp', although sharpness is by no means necessary and may even be a disadvantage, as for example, on the modern orchestral flute – most makers prefer a slightly rounded edge. The opening is either at one end of a tube, or in the side of a tube or vessel. The air stream may be shaped and directed by the player's lips as on the modern orchestral flute; confined in a channel, or duct, which leads the air across the hole, as on the RECORDER or WHISTLE; or produced by the wind, as in the *bulu pārinda*, a large (up to 10 metres in length) aeolian pipe hung in treetops in Southeast Asia.

Where the air meets the edge it is divided, peeling off in vortices like miniature swiss rolls, alternately outside and inside the instrument. The pitch produced is determined mainly by the length of the tube or the volume of the vessel, although other factors such as the shape and diameter of the air body and the area of any open holes (including the embouchure hole) are also influential. If, with a tube, the distal end is closed, the length is effectively almost doubled, and the pitch produced is almost an octave lower; 'almost' because the true acoustic length of the open tube is slightly longer than the tube itself, a factor called end-correction. When the end is closed, the length of the tube is doubled but not this slight elongation of the air column, and thus the lower pitch is very slightly sharper than a true octave. If the uppermost range of an open tubular flute is to be playable and the octaves in tune, some conicity in the bore is necessary. This is one reason why the cylindrical Renaissance transverse flute and recorder had a more limited range than the Baroque forms, which had a conical body. When Theobald Boehm reinstated the cylindrical body on the transverse flute (see §4(iii) below), he introduced some conicity into the head joint ('Boehm's parabola'). A similar effect is produced on many other flutes by constricting the diameter of the distal end, often by boring a hole smaller than the diameter of the tube in the natural septum which closes the end of a tube of reed or cane.

2. Classification and distribution.



Examples of the variety of apertures and edges found in…

Flutes are classified in the Hornbostel and Sachs system by the way in which the sound is generated and then by a variety of other criteria. Flutes are:

4 *Aerophones*
42 *Wind instruments proper*
421 *Edge instruments or flutes*, and thereafter
421.1 *Flutes without duct*, either
421.11 *End-blown flutes* (**fig.1*a–d***), or
421.12 *Side-blown (transverse) flutes* (**fig.1*g***, or
421.13 *Vessel flutes* (only those without a duct) (**fig.1*e*)**.

These are followed by:

421.2 *Duct flutes*, either
421.21 *Flutes with external duct* (**fig.1*h* and *j***), or
421.22 *Flutes with internal duct* (**fig.1*f*, *i* and *k***)

Within these main categories, further numbers are provided to indicate: whether the instruments are single or multiple and if multiple how arranged (whether the tubes of **PANPIPES**, for example, are in a raft or a bundle); whether they are with or without fingerholes; or whether the distal ends are open, closed, a combination of both (as some panpipes are) or constricted, and if closed whether with a fixed stopper (as some organ pipes) or a movable stopper (such as a **PITCHPIPE** or a **SWANEE WHISTLE**). Suffixes preceded by a hyphen are available to indicate the presence of air reservoirs (on the organ, for example) and whether the reservoir is rigid or flexible; and whether there are keys, keyboards or mechanical drive. The suffixes can, of course, be used in combination, so that a barrel organ could be 421.222.11/.31–62–9 (*flutes* (421) *with internal duct* in sets (.222) *open ended without fingerholes* (.11)/also *closed ended without fingerholes* (.31) *with flexible bellows* (–62) *played mechanically* (–9)) whereas a Boehm-system flute would be 421.121.12–71 (*flutes* (421) *side-blown* and single (.121) *open-ended with fingerholes* (.12) *with keys* (–71)).

There are very few parts of the world where the flute is unknown. One is Australia, where the only Aboriginal wind instrument seems to be the didjeridu. Another is Greenland, where the only instrument of the Inuit is said to be the frame drum. Whistles were certainly known in palaeolithic Europe, for pierced animal phalanges have been found at Magdalenian sites in France, and it is improbable that bone antedated cane and reed, although of course bone survives far longer as a buried artefact (for further discussion, *see* **EUROPE, PRE- AND PROTOHISTORIC**). Equally, it is hard to credit the assertion that no such use existed among the Inuit or the Australian Aborigines.

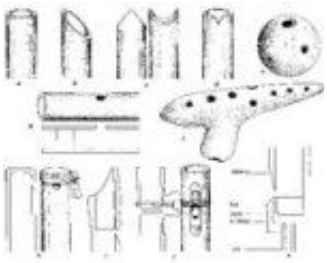
The most basic form of flute is a tube of reed or cane, stopped at one end and blown across the other. Such instruments, played in sets by a group of people (*see* **STOPPED FLUTE ENSEMBLE**), each playing a single note in turn in hocket style, are used in a number of areas, for example the *skudučiai* in Lithuania (*see* **LITHUANIA, §II**, [not available online]) and the *nanga* of the Venda of South Africa.

More complex forms, with the tubes combined into a single instrument, are known as **PANPIPES** and are found almost worldwide. The pipes may be arranged in a raft or a bundle, although the bundle, found mainly in Oceania, is much less common. The pipes are usually arranged in scalar order, although zigzag patterns that suit the musical needs of a particular culture are also used: the best known example is the *rondador* of Ecuador. Also common is an interlocking arrangement, either with half the scale in each of the left and right ends of one raft, as in China or Japan, or divided between two instruments, as is frequent in South America. Rafts are frequently doubled: the *sikus* of Bolivia and neighbouring areas have one rank half the length of the other or

one rank closed at the distal end and the other the same length but open. Both produce pitches in approximate octaves.

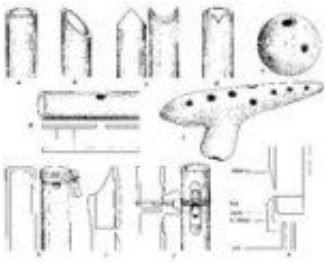
End-blown open-ended tubes with fingerholes are also widespread, especially throughout North Africa and the Middle East, most commonly under the name of NEY. The somewhat more elaborate KAVAL is found in Turkey and the Balkans. A characteristic of all flutes is that when blown harder the pitch becomes sharper, and when blown more gently, flatter. With an end-blown flute, the player can compensate for this by altering the angle of blowing and thus covering the open end more or less with the lip – the more covered, the flatter the pitch. Thus the *kaval* and the *ney* are capable of great subtlety in performance, with infinite gradation of tuning and pitch.

The end-blown flute (sometimes called a rim-flute) normally has the rim chamfered externally to produce a better edge and thus aid production of the sound. A variant form has the chamfer at one point only, at the base of a U-shaped or V-shaped notch; the sides of the notch help to focus the airstream (*see* NOTCHED FLUTE). Notched flutes are found in Africa, the Pacific Islands, Central and South America, and East Asia. Among them are the Andean KENA, the XIAO of China and the SHAKUHACHI of Japan. A lacuna in the Hornbostel and Sachs system is the lack of any separate provision for the notched flute.



Examples of the variety of apertures and edges found in…

The end- and notch-blown flutes require considerable skill to produce a sound, for it is essential to maintain the correct angle of blowing and speed of airstream. An instrument on which the sound is easier to produce has the notch further down the tube, usually in the form of a rectangular mouth, and a plug almost closing the blowing end (for example, the RECORDER). A narrow passage is left as a duct or windway to lead the air at the correct angle to the sharp edge at the base of the mouth (fig.1*i*). The player has only to blow, and a sound will always result. Thus the DUCT FLUTE is known almost everywhere; such instruments, however, lack the subtlety of tone control available on the end-blown flute.



Examples of the variety of apertures and edges found in…

Three variant forms of duct flute are more limited in distribution. The Indonesian SULING has an external duct, between a strip of leaf or bamboo and the head of the instrument (fig.1*h*), which is thinned in one section of its circumference to form the duct. In North and Central America, and in parts of East Asia, an internal plus external duct is found. The player blows into the end; a plug or a natural septum then forces the air out through a hole; and an external block, tied over the tube above the hole, channels the air along and then down into a mouth (fig.1*j*). Extremely elaborate blocks can be seen on flutes in pre-Columbian Mexican codices, and such flutes are still used in that area and in the southern USA. In another less common type, which appears in a number of areas, the player's tongue forms the duct.

The number of finger-holes on flutes varies according to the needs of the music and the preferences of the culture. The most common number is six, to which is added, where necessary, a thumb-hole to aid overblowing to an upper register: heptatonic scales of various forms are the most frequent throughout the world. Chinese and some Southeast Asian flutes have an extra hole between the mouth-hole and the uppermost finger-hole which is covered by a thin membrane (a MIRLITON) made from the inner lining of a piece of bamboo; this adds an enlivening buzz to the sound (*see* for example the DI of China). Chinese transverse flutes commonly have more holes than any others: a mouth-hole, a membrane hole, six finger-holes, two tuning vents and two holes for a decorative tassel which also functions as a suspension loop.

Some open-ended flutes have no holes at all. By opening or closing the far end with a finger, the player can produce the harmonics of either an open or a closed tube and, by interlocking these harmonics, can play melodically. An open tube would need to be a metre or more in length for this to be practicable, but a stopped tube which can also use some notes of the harmonic series of the open tube can be half that length or less. In the Highlands of Papua New Guinea one finds flutes 2 or 3 metres long but sounding only the overtones of the open flute; these are played in pairs, using hocketing techniques. In the Eastern Highlands, young men play shorter, very wide-bore flutes (often 10 cm or more in diameter) without finger-holes; pitch is varied by closing the

open end more or less with the hand. Rather narrower flutes in Suriname and Guyana have a large hole in the side which is similarly used.

Otherwise flutes without finger-holes are usually regarded as whistles (*see* WHISTLE). But some whistles can produce more than one note, for example the boatswain's pipe, on which the signals are varied by moving a hand over the airstream after it leaves the instrument (in Britain, in the Royal Navy, the instrument is the 'call' and the signals are the 'pipes'). Whistles sometimes have one or two finger-holes. The one-hole whistle is a very common children's toy, signal instrument, and bird-call imitator; the two-hole whistle is common in West and Central Africa, often with the holes in projections, one on each side near the top of the end- or notch-blown tube.

Whistles are blown in almost all the ways mentioned here, the most common being the end-blown and the duct. Many are more or less globular in shape, and vessel whistles and vessel flutes, sometimes called ocarinas (*see* OCARINA), are found in most parts of the world, made from natural seeds and gourds, or of pottery.

While most flutes are blown by mouth, a few, especially in Oceania and Southeast Asia, are blown by the nose. This is most commonly for cultic reasons, the breath of the mouth, which is used for eating and talking, being considered profane and the breath of the nose nearer to the soul (*see* NOSE FLUTE).

The least common flute worldwide is that best known in Western art music. The transverse flute is found in other cultures mainly in India, China, Korea, Japan and Papua New Guinea. Some other cultures in which it is well known today, for example that of the Indonesian island of Sulawesi, are known to have acquired it from European contact. In India it has been associated with Krishna, and, as the *vaṃśa*, is a favourite instrument for classical music. In the south it is quite a short instrument, around 30 cm in length, but in the north it may be twice that length or more. It is usually assumed that it was from India that the transverse flute migrated into Byzantium in the 10th century, at which period it began to appear in manuscript illuminations, and thus came into Europe.

In China the *di*, and before that the *chi*, were used. The latter was mainly a ritual instrument and the former was initially, as in Europe, a military flute eventually becoming an instrument for opera and later for all sorts of music. It is probable that the Korean transverse flutes derived from the Chinese, and it is certain that the Japanese instruments did, for Tang dynasty prototypes are preserved in the Shōsōin (the imperial treasury of Emperor Shōmu, *d* 756) in Nara.

In Japan the *ryūteki* and other transverse flutes are, with the cylindrical oboe *hichiriki*, the main melody instruments of the ritual court music, *gagaku*. The NŌKAN, which is thought to have derived from the *ryūteki*, is the most important melody instrument of the *nō* theatre and is also widely used in other genres.

It is clear that all the East Asian transverse flutes derived from the Chinese; whether there is any connection between the Chinese and the Indian is not known, although as with many other instruments, the *di* is thought to have come into China from western areas. Certainly, however, the 'sacred flutes' of Papua New Guinea are of independent origin. Some are short, 30–50 cm in length, and often played in groups; the most impressive are up to 3 metres long and are used in pairs, one a note higher than the other. They sound only natural harmonics, hocketing an interlocking series a tone apart.

There is no evidence of the transverse flute in ancient Egypt. The end-blown flute was common there, as in Mesopotamia, from the earliest times; because such instruments were held obliquely, as they almost invariably still are, they have often been misinterpreted as transverse instruments, for example the one on a slate palette in the Ashmolean Museum illustrated by Hickmann (1961). The transverse flute was unknown also in ancient Greece (a statue illustrated by Wegner (1963) is a fragmentary late Roman copy with a very small piece of something next to the figure's mouth; there is no evidence that this is the remains of a flute). One well-known late Etruscan relief of the late 2nd or early 1st century BCE, carved on an urn or sarcophagus in the tomb of the Volumnii family near Perugia, has been identified as the first European illustration of a transverse flute. There is no other evidence for the transverse flute in Etruria or Rome, whereas there is frequent evidence for the *plagiaulos*, a reed instrument played transversely; thus, while the Volumni relief does look much like a transverse flute, it should be regarded with some suspicion. The Roman bone tubes made in short sections, each with one or two holes in the

side, which have often been described as flutes – ignoring the difficulty of assembling such fragments into a single tube – have more recently been recognized as hinges.

Jeremy Montagu

II. The Western transverse flute

1. Terminology.

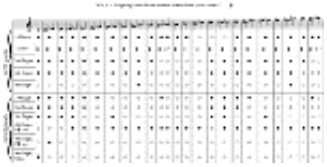
Before the late 18th century, the term 'flauto' or its equivalent, without a modifier, almost always referred to the RECORDER, evidently the dominant instrument of the two during much of their history, and sometimes specifically to the treble (alto) recorder, the most characteristic member of the family. Similarly 'flautino' or 'flauto piccolo' referred to a small recorder, a descant or even a sopranino. If, in earlier times, a transverse flute was intended, a modifier had to be added to the noun (e.g. cross, German, transverse, *traversière*, *traverso*).

2. The modern flute.

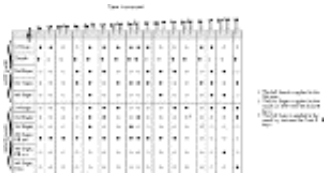
The modern flute is a tube of metal, more rarely of wood, about 67 cm in length and 1·9 cm in bore diameter (see fig.6*c* below). It is built in three sections fitted together with tenon-and-socket joints: a head joint with the mouth-hole or embouchure (raised in metal flutes to give the hole its proper depth); the middle joint with the principal keywork; and the foot joint with the keys for the right little finger. In the head joint the bore is terminated by a plug or stopper, usually threaded, which can be shifted to adjust intonation. The junction of the head joint with the body is also used as a tuning-slide, which can be pulled out to lower the instrument's pitch.

The sound is produced by blowing across the mouth-hole, activating the air in the tube. The basic scale of the flute begins on *d′*, but keys on the foot joint extend the compass down to *c′* and on some flutes to *b*. The instrument is functionally in C and thus non-transposing. It has an effective compass of just over three octaves, overblowing at the octave, so that the fingering of the first octave is duplicated in the second; the fingering of the third octave differs from the other two. Control of the sound is achieved principally by the player's lips, and thus the embouchure is an important part of the flautist's training.

The mechanism of the modern flute is based on Theobald Boehm's design of 1847, as modified by 19th-century French makers (see §4(iii)); there are a number of small variations between types. Practically all have a closed G♯ key, and they may be fitted with various trill keys, rollers and special mechanisms to enhance the instrument's playability. Flutes with keys having solid, airtight surfaces (as Boehm originally designed them) are called closed-hole flutes; on open-hole or 'French-model' flutes, five of the keys are perforated so that the finger forms part of the seal. Pitch levels of the later 20th century, higher than Boehm's, have compelled makers to devise adjustments to his specifications for internal tuning: several slightly different scales have been used, the best known of which is that devised by Albert Cooper (*b* 1924). Materials used for the tube and mechanism include nickel-silver, sterling silver, gold and platinum, while the springs are usually of tempered steel or phosphor bronze, occasionally of gold or another metal. The choice of material, especially for the head joint, influences the flute's tone: wooden flutes produce a rich tone with a very full *fortissimo* in the lower register; metal flutes produce a limpid, flexible tone with great carrying power and also allow the player very sensitive control over the tone-colour; gold produces a mellow sound while silver is more brilliant. To achieve a combination of these qualities a head joint of wood or gold is sometimes fitted to a tube of silver.



Fingering chart for the modern Boehm flute (with closed G♯)



The modern flautist is expected to be able to play a broad repertory. Distinct styles and techniques for playing Baroque, Classical, 19th-century, avant-garde music and jazz have all become part of the flautist's training, and the well-rounded orchestral flautist must also be an accomplished piccolo player. The flute is highly popular among young people, especially girls, although there is still a high proportion of male players in some countries such as Ireland and Italy.

3. Other members of the family.

The flute with *c′* or *b* as its lowest note (sometimes called the concert flute) is the most common representative of a family of instruments of different sizes and pitches. Other sizes were developed to play various parts in consort or band music or for other special uses, some of which no longer exist. Mechanically and acoustically these variants share the history and development of the concert flute. Only the principal members of the flute family that are employed in art music are discussed here, although other types, such as the G treble of the Irish flute bands, are well-known in particular places. Military band flutes are sometimes pitched in D♭ rather than C to match the B♭ and E♭ standards of brass instruments and clarinets, but these are not, strictly speaking, separate sizes.

(i) Piccolo

Piccolos: (a) with 4 keys, by John Köhler, London, 1800–10; …

(Fr. *petite flûte*; Ger. *kleine Flöte*, *Pickelflöte*, *Pikkoloflöte*, *Oktavflöte*; It. *ottavino* or, more rarely, *flauto piccolo*). A small flute pitched an octave higher than the concert flute. It is a transposing instrument, its music written an octave lower than sounding pitch. The piccolo is fingered like its larger relative but, as it has no separate foot joint, its range usually extends down only to *d″*, although Verdi in his Requiem and Mahler in his First Symphony wrote for it down to *c″*. 'Old-system' piccolos were used well into the 20th century even after the Boehm-system flute had displaced other types (fig.2). The most common model at the end of the century was a wooden, two-piece instrument with Boehm-system keywork, having a conical bore and either a wooden or a metal head and a range of *d″–c‴″*.

In the 18th-century 'petite flûte' or 'flautino' could indicate a flageolet or small recorder as well as the piccolo, and it is thus not always clear which instrument a composer had in mind. However, the transverse piccolo was used in 18th-century France: Michel Corrette mentioned it in his *Méthode* (1740), and Rameau (*Dardanus*, 1739) and Gluck (*Iphigénie en Tauride*, 1779) scored for it. Since Beethoven (*Egmont* Overture, Symphonies 5, 6 and 9) it has been an integral part of the symphony and opera orchestra, often used for special effects. Late 19th-century composers such as Richard Strauss and Mahler made the piccolo a full member of the orchestra, integrating its sound into the orchestral colour. As parts became increasingly difficult, piccolo playing became a speciality, and by the end of the 20th century most large orchestras had a principal piccolo player ranking with the other principals. The piccolo's brilliance is a feature of the military band repertory, and the military piccolo appears occasionally in the orchestra (as for example, in Berlioz's *Grand Symphonie funèbre et triomphale*, 1840, originally for military band, which also includes third flutes in F).

(ii) Third flute

[soprano flute, tierce flute] (Fr. *flûte à tierce*; Ger. *Terzflöte*). A soprano flute pitched a minor 3rd above the concert flute – hence its name. Its development followed that of the concert flute through the 18th, 19th and 20th centuries. 18th-century examples are usually in F (the lowest note of the contemporary flute was D), while later ones in E♭ also served in military bands to replace or double other instruments such as the E♭ clarinet. It has been used in the USA and Ireland in flute bands and choirs, together with flutes of all other sizes. It was used by Mozart in *Entführung aus dem Serail*, by Beethoven in the ninth symphony and by Tchaikovsky in the *Nutcracker* among others.

(iii) Flûte d'amour

(Ger. *Liebesflöte*; It. *flauto d'amore*). Flute usually pitched in A, a minor 3rd below the concert flute. J.M. Molter (1696–1765) wrote a concerto in B for *flûte d'amour* and Christoph Graupner (1683–1760) included the instrument in five cantatas and a triple concerto in G for *flûte d'amour*, *oboe d'amour* and *viola d'amour*. However, the repertory of the 18th and 19th centuries is small compared with the number of surviving instruments; perhaps they were used as transposing instruments, employing the same fingerings as concert flutes. Music written at concert pitch could be played on the flute in A by reading it as though written in French violin clef (*g'* on the bottom line), a procedure recommended by Quantz. Verdi scored for three *flûtes d'amour* in *Aida*; by then the instrument was so uncommon that some had to be specially made. The derivation of the instrument's name is not clear; it may have come from the soulful tone quality of the deeper pitched instrument, or it may merely be by analogy with the oboe d'amore in A (*see* OBOE, §III, 3(II)).

(iv) Alto flute

Modern orchestral flutes by Rudall, Carte & Co.: (a) bass…

(Fr. *flûte alto*, *flûte contralto en sol*; Ger. *Altflöte*; It. *flautone*). Flute pitched in G, a 4th below the concert flute (fig.3*b*). It was constructed by Theobald Boehm in about 1854 as a completely new instrument. Its mechanism differs slightly from that of the concert flute to allow the fingers to reach the keys and it has a powerful sonorous tone, which Boehm compared to that of a french horn. It is a transposing instrument, its music written a 4th higher than it actually sounds. Boehm promoted the instrument by performing on it a repertory of specially composed and arranged music. Its slightly melancholy, haunting tone attracted 20th-century composers such as Stravinsky (*Rite of Spring*), Ravel (*Daphnis et Chloé*) and Holst (*The Planets*), and it has been much used in avant-garde music. The *tiefe Quartflöte* mentioned by Quantz (1752) may have been an earlier instrument at this pitch. The alto flute has sometimes been called the bass flute, especially in Britain.

(v) Bass and sub-bass flutes.

Modern orchestral flutes by Rudall, Carte & Co.: (a) bass…

Flutes of several different kinds, used principally as the lowest members of flute ensembles. The most common is that in C (fig.3*a*), an octave below the concert flute. It is held transversely, with the head doubling back in a U-bend to reach the player's lips. Other types include a sub-bass flute in G, an octave below the alto flute, or a tone lower still, in F. A double bass flute in C, two octaves below the concert flute, has been made by Jaeger and by Kotato & Fukushima. The instrument is held vertically, the head bent twice like the letter P to bring the embouchure within reach. In 1910 a wide-bore bass flute in C, the *Albisiphon*, was made by Abelardo Albisi, principal flautist at La Scala, Milan; it was used in Mascagni's *Parisina* (1913). About 1925 Gino Bartoli introduced a U-shaped instrument with a narrower bore which he called a 'contrabass flute'. Rudall, Carte & Co. devised

another transverse type in 1932; it had a coiled head joint and a crutch to rest the instrument on the player's thigh. Ravel, Stravinsky and Shostakovich have scored for bass flutes, and various types have been used in avant-garde music and jazz. Several 18th-century bass flutes survive, including instruments by Beuker, Naust, Thomas Lot and Delusse; the latter has a U-shaped head joint.

4. History.

(i) To 1500.

The earliest undoubted representations of transverse flutes on the fringes of Europe come from Byzantium. Such instruments appear on 10th-century ivory caskets (Museo Nazionale, Florence, and Victoria and Albert Museum, London) and in a number of 11th-century manuscripts (listed in Braun). Thereafter, the transverse flute makes very occasional appearances, the earliest being on a Hungarian bronze water vessel of *c*1100, found in eastern Slovakia. The figure probably represents the centaur Chiron, here playing a drum, teaching the art of music to Achilles, who stands on the centaur's back playing the flute left-handed – the normal posture in the Middle Ages. Two 12th-century Benedictine manuscripts (an encyclopedia and a psalter) show figures playing transverse flutes, as does an illustration in the 13th-century Munich psalter (***D-Mu*** 24).

Music was not conceived for specific instruments in this period, and most references to flutes in written sources are ambiguous, possibly referring to duct flutes such as recorders or tabor pipes. Flutes of all kinds were often identified with mythical or spiritual figures, with pastoral life, and with death. Although depictions and descriptions of transverse flutes were rare compared with references to other instruments until the mid-16th century, in the most realistic of them certain customary uses can be identified. Adenés Le Roi's romance *Cléomadès* (*c*1285) mentions 'Flahutes d'argent traversaines' as part of the instrumentarium of a well-known minstrel: the word 'silver' [argent] may refer to their material or perhaps their tone. The *Niebelungenlied* of *c*1300 refers to the loud sound of the flute, comparing it to that of the trombone and trumpet, and in the *Roman d'Alexandre* (***GB-Ob***) illustrated by Jehan de Grise in 1344, transverse flutes are shown being played with large bells, drums, bagpipes and trumpets. A number of references to flutes in the hands of sentries and soldiers point to its use in outdoor military music as well as indoor courtly songs.

The first evidence to link the flute with a particular musical repertory is provided by two medieval illustrations. A manuscript of the *Cantigas de Santa María* (***E-E***; *c*1270–90) associated with the court of Alfonso, King of Castile and León, contains a depiction of two seated flautists playing left-handed on slightly different instruments, one with ornamental turning or binding. At this date flutes, like the other instruments, were probably made by the musicians themselves rather than by specialized instrument makers. The early 14th-century Manessische Liederhandschrift (***D-HEu***), one of the most important sources of Minnesang, includes a miniature, 'Der Kanzler', which presents a clear and elegant portrayal of three musicians: a fiddler playing a four-string instrument, a transverse flute player holding the instrument to his right, and a singer. As the music in these manuscripts is monophonic, it is not clear how the flute was used: perhaps it doubled the vocal line or played a drone, perhaps it provided improvised heterophony. Guillaume de Machaut gave instructions in *Le Livre dou Voir dit* (1363–5) that when instruments were used, his (polyphonic) ballades should be played without ornamentation or cuts, therefore this was probably not the normal practice. In *La Prise d'Alexandrie* (*c*1369), he distinguished between transverse flutes – 'flaüstes traverseinnes' – and duct flutes – 'flaüstes, dont droit joues quant tu flaüstes', that is, 'flutes you blow straight when you play them'. Other literary references, notably in the works of Eustache Deschamps (*c*1346–*c*1406), suggest that the flute still led a double life as both a soft, indoor instrument and a loud one with military connotations. No medieval flutes survive, but they were probably built in broadly the same way as surviving 16th-century examples: a basically cylindrical tube with six or more finger-holes and an embouchure hole, but perhaps with different ratios of bore and outer diameter to sounding length, which affected range, tone and carrying power.

Pictures and literary references involving flutes become rare for about 70 years after the second decade of the 15th century; Franco-Flemish, English and Italian polyphonic music of this period

may have provided few opportunities for the instrument. At the end of the 15th century the military flute became common again, particularly in the hands of Swiss mercenary troops and in combination with large side drums. The first use of the term FIFE occurs in a description of an occasion in 1489 in which drums, fifes and trumpets played together at a French feast. By 1494 the *grande écurie* of the French court was making payments to 'tambourins suisses', probably a corps of transverse flutes and side drums associated with Swiss mercenary troops who accompanied Charles VIII to Italy. In this period, as before, any technical distinction between the 'fife' and the 'flute' remained unstated. In fact, early 16th-century illustrations, such as the group of four Basle soldiers by Urs Graf, himself a mercenary, seem to indicate that, even if the instruments differed, the soldiers played both, perhaps performing four-part consort music on ordinary flutes and functional field calls and improvised marching music on military flutes.

(ii) 1500–1800.

Court inventories of the 16th century suggest that the flute was in high favour for playing the four-part consort repertory of that period. Henry VIII of England possessed 74 flutes, including examples in lacquered ivory and in glass (1547), Maria of Hungary had more than 50 (1555), Felipe II of Spain had 54 (1598) and the Stuttgart court (1589) no fewer than 220 transverse flutes, as opposed to 48 recorders, 113 cornetts and 39 viols. Multiple sets of a wide range of tuned instruments must have been necessary to play music in a wide range of modes. From the 1530s the flute emerged as a chamber instrument frequently played by amateur musicians of the aristocracy and the merchant class, a group that clearly included women.

The earliest printed instructions for flute playing confirm that the flute was made in several sizes in the 16th century (see, for example, fig.4 [not available online]). Like all Renaissance woodwind instruments it was fingered according to Guidonian theory (*see* HEXACHORD), which resulted in three sizes of instrument pitched a 5th apart. The recorder consort consisted of a bass which followed the flat hexachord (beginning on F *fa ut*), two tenors in the natural hexachord (C *fa ut*), and a descant in the hard hexachord (G *ut*). But on the transverse flute the scale began one note higher, so that the bass had G (*gamma ut*) as its lowest written note, the tenor and contratenor D *sol re*, and the descant A *la mi re*. Meylan (1974) has suggested that these flutes played an octave higher than written, so that in a mixed consort a D tenor flute could have played a descant or contratenor part. While most Renaissance wind instruments – cornetts, crumhorns, recorders, pommers, bagpipes and shawms – had almost identical fingering, that of the flute was unique, differing considerably in its upper register.

Information on the flute and on playing technique appears in 16th-century treatises by Virdung (1511), Agricola (1529 and 1545) and Jambe de Fer (1556) (essays by Gorlier, 1558, and Lengenbrunner, 1559, are lost). Virdung illustrated only one size of flute, which he called 'Zwerchpfeiff'. The first edition of Agricola's treatise, which was written for children, gives a rather unlikely range of three octaves, and mentions that the flute should be played 'with trembling breath'; other 16th-century sources reveal that vibrato was considered a characteristic feature of flute sound at this time (Hadden, forthcoming). Agricola's revised edition of 1545 contains 'transposed' scales for sets of instruments in D, A and E and in C, G and D as well as 'regular' scales for instruments in G, D and A, all with a more realistic range of two octaves and a 2nd or two octaves and a 6th. Three sizes of flute played four parts, the range of the instrument in D being wide enough to cover both inner parts, tenor and contratenor. Jambe de Fer, whose instructions were directed at amateurs, described only two instruments, a G bass with a range of 15 notes, and a D tenor with a range of 15 or 16 good notes, or up to 19 including some forced ones at the top. He directed that the highest part be taken by an instrument of the same size as those playing the tenor and contratenor, so that his consort would have consisted of a G bass and three D flutes, using principally the higher part of their range.

Collections of printed music for instruments gave occasional precise indications as to the use of flutes. In Paris, Attaingnant (1533) published arrangements of chansons by Claudin de Sermisy, Janequin, Josquin Des Prez, Gombert, Heurteur, Passereau and others, and, in Nuremberg, Forster (1539) printed music by himself, Senfl, Wolff and others. Attaingnant's *Chansons musicales* distinguished between pieces suitable for recorder consort and those for flute consort: they confirm the view expressed by Jambe de Fer, and later by Praetorius, that the flute of those times is best suited to playing in the flat modes, that is, scales with the natural notes of the gamut

as well as B♭, not in the scale of D major as is often assumed today.

Surviving instruments from the 16th century are predominantly D flutes, a high proportion of these and of the basses, according to Puglisi (1988), pitched at *a′* = 410, with a smaller group at *a′* = 435. Among surviving instruments the best represented makers are probably members of the families of Bassano (Venice and London) and Rafi (Lyons; see fig.14*a* below); they were performers and composers as well as makers of wind instruments. To ensure correct ensemble tuning, flutes were made in sets, as is made clear in a contract of 1542 between the maker Mathurin de La Noue and a French merchant, for 'ung jeu de flustes unyes, façon d'allement'. The term *flûte d'Allemagne* or 'German flute' remained common for the transverse flute until the late 18th century.

By the late 16th century military instruments were sometimes differentiated from indoor flutes. Arbeau's *Orchésographie* (Langres, 1588) noted that the military flute then used by the Germans and the Swiss had a narrow bore and a piercing sound, was played with a special hard articulation, and was used to improvise freely over a steady drum beat in marching. The distinction between flute and fife was mentioned again by Praetorius (2/1619) and Mersenne (1636–7), who gave different fingerings and a range of only a 12th for the fife. However, Puglisi (1988) points out that two surviving military flutes (from before 1674), contrary to Arbeau's description, have a larger bore than usual for their length, producing a more powerful first octave and less facility in the third.

The first surviving solo pieces for transverse flute date from the end of the 16th century and the beginning of the 17th. Giovanni Bassano's *Ricercate, passaggi et cadentie* (1585) is a collection of pieces exemplifying the Italian division style. Aurelio Virgiliano's *Il dolcimelo*, ii (*c*1600) contains *ricercate* in a similar style for cornetto, violin, transverse flute [*traversa*] or other instruments. Book iii contains a fingering chart for a D flute with a range of two and a half octaves. However, Lodovico Zacconi's *Prattica di musica* (1592) gives a range of only two octaves. The flute was a part of the peculiarly English mixed consort of treble viol, lute, flute, cittern, bandora and bass viol. Music for this combination by Thomas Morley (1599 and 1611), Philip Rosseter (1609) and others used a D flute on the tenor part, playing an octave higher than written.

The principal German source of the 17th century is Praetorius's *Syntagma musicum* (2/1619). His D flute had a range of 19 notes (*d′–a‴*), including four overblown ones, while his A flute could play only two octaves, its highest note being the same as that of the D flute. Praetorius noted that flat modes were the best for the flute, and specified the pitches in use in different situations and locations: in some places there was a choir pitch (*Chor Thon*) a whole tone lower than chamber pitch (*Cammer Thon*); and in England and the Netherlands there was another pitch a minor 3rd lower than chamber pitch, at which harpsichords and flutes sounded better – but this pitch was not used for large ensembles. From the Stuttgart court inventory of 1589, it appears that curved cornetts there were at chamber pitch (about *a′* = 450), while mute cornetts and flutes were at choir pitch (*a′* = 410). Thus chamber-pitch flutes were probably exceptional, a conclusion borne out by the pitches of surviving 17th-century flutes. Praetorius also mentioned two sizes of military *Schweizerpfeiff* or *Feldtpfeiff*, in D and high G, each with a range of an octave and a half.

Mersenne's *Harmonie Universelle* (1636–7) signalled a change in the design of the D flute, a prelude to the alterations that were to mark the emergence of the 'Baroque' flute. His two fingering charts, for G and D instruments, differed significantly from one another. Meylan has pointed out the similarities between Mersenne's chart for the D flute and that of Hotteterre (1707), and argued that Mersenne's flute must have had a conical bore if it functioned with the fingerings given, although unlike the true Baroque flute it was constructed in only one or perhaps two pieces and had no key. Mersenne mentioned that fifes were not used in consort, but that flutes, playing at choir pitch, were so employed, with the bass part taken by a sackbut, serpent or other bass instrument. As an example, he gave a 4-part *air de cour* for flute consort.

Although conical-bore instruments may have been made before the mid-17th century, cylindrical-bore transverse flutes continued in use. A two-piece flute by Lissieu with a cylindrical bore but proto-Baroque styling (Kunsthistorisches Museum, Vienna) was probably made in Lyons in the third quarter of the 17th century, and an instrument with similar characteristics (Germanisches Nationalmuseum, Nuremberg) may be from Augsburg or northern Italy. Jacob van Eyck's *Der Fluyten Lust-hof* (1646–9) is a Dutch collection of pieces and divisions for C recorder or flute in high G, the latter with a range of *g′–d‴″*.

The flute, like all the woodwind instruments, was transformed during the 17th century. The one-piece, keyless, cylindrical flute of the 16th century became a conical-bore instrument, divided into three sections, with a key for D♯/E♭. The new flute could produce hitherto difficult semitones more clearly, could play in more tonalities and in music which modulated, and had a more tractable and flexible tone, particularly useful for performing vocal music.

When and where these changes were first united in one instrument is uncertain. Most modern writers have assumed that the woodwinds were transformed at the French court, but the musical life of this period in the Netherlands, north Germany, southern France, Italy and England remains little studied by comparison. Probably the earliest surviving instruments with the new features are an anonymous D flute at *a′* = 395 (Biblioteca Comunale, Assisi) and a C flute at *a′* = 410 by Richard Haka (*fl* 1645/6–1705) (Ehrenfeld Collection, Utrecht). The musical connections between Italy and the Netherlands were strong in this period, and the city of Amsterdam, where Haka worked, reached its apex as a cultural centre at this time. The woodwind instrument makers of Amsterdam, themselves high in social status, supplied an extensive market of prosperous merchant amateurs. The flute held a favoured position in the domestic music-making that marked the lifestyle of the rising middle class, while the most favoured music and musical styles came from Italy.


Title-page of Marais' 'Pièces en trio' (Paris, 1692)

Nevertheless the first famous performers on the new transverse flute were those who emerged at the French court in the late 17th century. In France as elsewhere transverse flutes had been considered warlike instruments, but they were also thought suitable for soft and charming music of a more touching nature, especially that in which love was a theme. It was in the latter character that the flute playing of Philbert Rebillé (1639–1717) came to notice, not only in court music but in private concerts held in the apartments of the king and his principal courtiers. On such occasions the repertory probably consisted of simple brunettes, noëls and *airs*, in which flute and voice were accompanied by the lute and sometimes other instruments. R.P. Descoteaux (*c*1645–1728) was another famous player; he was known as a fine singer, and had an excellent tone on the flute, on which he was reported to have played 'scarcely anything but delicate airs'. Jacques Hotteterre's *Airs et Brunettes* (1721) is a rare printed collection of such music. A ritornello in G minor for two flutes and continuo appeared in Lully's *Le triomphe de l'amour* (1681), and the flute was used in Charpentier's *Médée* (1693) and Destouches' *Isée* (1697). The first French instrumental work to call specifically for the new flute may be the *Sonate* of about 1686 attributed to Charpentier, while the title-page of Marin Marais' *Pièces en trio* (1692; fig.5) depicts flutes of the new style.

According to Michel de La Barre (*c*1730), the transformation of the flute in France took place some time after that of the other woodwinds; it is not known whether the earliest surviving French new flutes were made earlier or later than the Dutch/Italian models. In Paris the woodwind instrument making workshops of Pierre Naust (*c*1660–1709) and J.-J. Rippert (*c*1668–1724) were active towards the end of the century, while at court members of the Hotteterre and Philidor families made flutes as well as playing them. Two original Hotteterre flutes survive (Landesmuseum Joanneum, Graz, and Musée de la Musique, Paris); they are probably the work of Martin Hotteterre (*c*1635–1712) or his son Jacques (ii) (1673–1763). Other examples in Berlin and St Petersburg previously thought to have been by Hotteterre are 19th-century copies of a lost original (Powell, 1996). Of the surviving flutes with Naust's stamp, one is at the same unusual pitch as the Haka instrument while three others are D flutes pitched at around *a′* = 395. P(eter) Bressan (1663–1731), active in London, was noted in the 1690s as a flute maker, but only one three-joint flute by him survives, at the higher London pitch of *a′* = 408.

During the first half of the 18th century in northern Europe male amateurs from merchants to princes adopted the flute as their favourite instrument. Professional players of the Baroque flute were principally oboists. In London they included foreigners such as Peter La Tour (*c*1705), and later Jean Baptiste Loeillet (1680–1730) and C.F. Weideman. London had excellent flute makers in Bressan, Thomas Stanesby (ii) (1692–1754) and, after his arrival from Germany about 1726, J.J. Schuchart (*c*1695–1758). Music for flute began to be published there at the beginning of the century; the first to appear was an aria for 'Flute D. Almagne' (1701) from John Eccles's *The Judgment of Paris*. Englishmen such as Thomas Roseingrave and M.C. Festing (whose father Michael and brother John were flautists) also published music in London, and Handel's sonatas op.1 were printed there about 1730. The first solo music for the new flute was published in Paris;

Michel de La Barre's *Pièces pour la flûte traversière avec la basse-continue* appeared there in 1702. In his preface the composer, one of the most eminent French flautists of the period, observed that the music was of a quite different character from the sighing tender airs of Philbert and Descoteaux hitherto considered suitable for the flute. Instead he modelled its dance-like movements on the viol pieces of Marais. Jacques Hotteterre (ii) published the first tutor for the Baroque flute, *Principes de la flûte traversière*, in 1707; he also published Italian-influenced solos and trios for flute and continuo.

Hotteterre's tutor described the flute as 'one of the most pleasant and one of the most fashionable' of instruments. The fingering chart gave different fingerings for flat and sharp versions of the same enharmonic note, although as Hotteterre observed, 'a number of people do not make this distinction at all'. His brief discussion of tonguing was limited to the two syllables 'tu' and 'ru', but he gave extensive instructions for playing the graces – trills, *ports-de-voix*, *accents*, *flattements* and *battements* – so integral to the successful performance of French music of this period. The first Dutch version of Hotteterre's flute tutor was published in 1729, and an English translation the following year – Hotteterre's prototype was also closely imitated by the only known Spanish Baroque flute tutor, Pablo Minguet y Yrol's *Reglas y avertencias generales* (Madrid, 1754).

The new flute became known in Germany around the second decade of the 18th century. In Hamburg, Reinhard Keiser scored for the flute in his opera *Heraclius* (1712), while the orchestra in Dresden employed the virtuosos P.-G. Buffardin (*c*1690–1768), his pupil J.J. Quantz (1697–1773), and J.M. Blockwitz (*fl* 1720–30). But according to Quantz, solo music for flute was rare at this time and flautists had to adapt pieces for violin or oboe. Three works by Keiser survive (1720) and a manuscript collection of 54 pieces (Brussels Conservatory) contains early solos by Blockwitz, Christoph Förster, J.H. Freytag, Handel, J.S. Weiss and Quantz. Pieces by Telemann and J.S. Bach are among the earliest German flute music to survive. Telemann's *Six Trio* (1718) includes a piece for violin, 'Flûte traverse' and basso continuo, and several manuscript trios, some from Dresden, dating from 1720 or before, contain parts for one or two flutes. Mattheson's *Der brauchbare Virtuoso* (1720) contained the first flute solos printed in Germany. Much of this music was in a 'violinistic' style characterized by constant semiquaver or quaver motion and arpeggiated passage-work, evidently influenced by the Italian style. The influence of Italian violin music and the Vivaldian concerto style is also apparent in Bach's solo sonata (Partita) in A minor, BWV1013, which is reminiscent of unaccompanied flute pieces originating in Dresden around 1720, and in his Sonata in E minor BWV1034, a 'sonata in the style of a concerto' written, according to Marshall (1989), about 1724.

Flutes from the 16th century to the 18th: (a) keyless…

Flutes of the first two decades of the 18th century were usually made of boxwood, ebony or ivory; they were constructed in three sections, with an essentially conical bore and a single key for D♯/E♭. However the instrument was by no means standardized: each maker developed an individual concept of tone and intonation, and devised original technical means to achieve it. Among the few surviving examples from this period, by Bressan, Chevalier, Jacob Denner, Hotteterre, J.N. Leclerc, Naust, Panon and Rippert (fig.6*b*), pitches range from *a′* = 395 to *a′* = 408, the bore taper (the difference between the largest and smallest points in the bore) can be as much as 6·5 mm or as little as 4 mm, and maximum bore diameters differ by up to 1·5 mm. Hence there are great differences in timbre, intonation, range and flexibility of tone. Around 1720 there was a brief vogue for flutes with an extension to low C, but although these were made by Bressan, Denner, Schuchart and Stanesby (ii), the idea did not become widespread.

About 1720 flutes began to be made in four sections instead of three, dividing the body between the two hands. Experimentation with the bore may have made the division expedient, but Quantz (1752) gave two further reasons: portability, and the prospect of supplying upper body sections of different lengths to adjust the pitch of the flute. Of the earliest four-joint flutes, by J.H. Eichentopf (1678–1769) (Musikinstrumenten-Museum, University of Leipzig), Scherer (Museum Vleechuis, Antwerp) and J.H. Rottenburgh (1672–1756) (Brussels Conservatory and Museo Clemente Rospigliosi, Pistoia), the flute in Pistoia has *corps de rechange* for *a′* = 392 and *a′* = 415. The first written mention of *corps de rechange* appears in a document of 30 December 1721 from the Naust workshop in Paris (Giannini). Flutes of different sizes, such as the *flûte d'amour* in B or A, the piccolo and the tierce flute in F (the same pitch as the treble recorder), were also made, but

their repertory, possibly including flute band and military music, remains largely unexplored. In 1726 Quantz added a separate key for D♯ to his flute to supplement the one for E♭; although this made the precise tuning of intervals easier and was retained by some later flautists, the idea never gained general acceptance.

In the second quarter of the 18th century, French composers for the flute turned from the French suite to the Italianate sonata, and the number of publications increased. Works by J.-C. Naudot, Michel Blavet and J.-M. Leclair may have been played by their composers in public concerts (the last as a violinist), in spaces much larger than those for the soft music of private performances at court. Such performers no longer relied on court appointments for their living, but were employed in the musical establishments of aristocrats and the bourgeoisie and gave lessons to wealthy amateurs. Buffardin returned to Paris occasionally to perform at the Concert Spirituel; Quantz visited Paris in 1726 (and became friends with Blavet). Composers such as J.B. de Boismortier and Michel Corrette supplied the growing demand for flute music and tutors, while the workshops of Charles Bizey, Louis Cornet (*c*1678–1745), Leclerc, Naust and Rippert made flutes available to anyone who could afford them.

In the Netherlands the flute was evidently already flourishing before 1730. Abraham van Aardenberg (1672–1717), J.B. Beuker (*b* 1691), Willem Beukers (1666–1750), Thomas Boekhout (1666–1715), Philip Borkens (1693–*c*1765), Frank Eerens (1694–1750), J.J. van Heerde (1638–91) and Engelbert Terton (1676–1752) were all established early as flute makers and made instruments that have survived. Italian composers such as Lotti, T.G. Albinoni, Vivaldi, Geminiani, Porpora, Tessarini, Leonardo Vinci, P.A. Locatelli and Sammartini published flute solos in Amsterdam and London beginning in the 1720s.

Flutes of the 1730s and 40s were just as diverse as earlier types. The workshop of Thomas Lot, successor to Naust, supplied large numbers of flutes to a widespread market and in 1744 August Grenser established a woodwind workshop in Dresden which went on to become one of the most famous in Europe. Ivory flutes from the Scherer workshop in Butzbach became popular with wealthy amateurs.

Telemann's *Sonate metodiche* (1728), *Continuation des sonates méthodiques* (1732) and *XII solos* (1734) added 36 superb solos to the repertory, while pieces composed by J.S. Bach include the sonatas in B minor BWV1030 and A major BWV1032 (*c*1736), as well as the Trio Sonata in G major BWV1039 (*c*1736–41) and probably the sonatas in C major BWV1033 and E♭ major BWV1031 (which Swack (1995) suggests was modelled on a piece by Quantz). In 1733 W.F. Bach, then organist in Dresden, became friends with Buffardin; between 1733 and 1746 W.F. Bach composed six challenging flute duets.

Frederick the Great became King of Prussia in 1740, appointing C.P.E. Bach as his keyboard player and his flute teacher Quantz as Music Director; C.P.E. Bach composed six flute sonatas, H552–6 and H548, in 1738–40, and three more, H560–62, in 1746–7. J.S. Bach's Sonata in E major BWV1035 may have been composed for Frederick's flute-playing valet, M.G. Fredersdorf, in 1741 or 1747, and the difficult trio sonata in the *Musical Offering* BWV1079 is a flattering comment on the king's own abilities as a flautist. Quantz supplied the king with flutes and with 300 concertos to play on them; his *Versuch einer Anweisung die Flöte traversiere zu spielen* (1752) codified the musical practices of the Prussian court and remained influential for at least 40 years. Quantz's flutes had keys for both D♯ and E♭, a head-joint tuning-slide, and a set of *corps de rechange*, of which only the lowest, pitched at about *a′* = 392, received much use.

Quantz's *Versuch* is less a tutor for the flute than a compendium covering musical taste and execution on all sorts of instruments. Because of its broad scope it became and has remained one of the most widely known instrumental method books of the 18th century. Its instructions on how to play the flute itself are tantalisingly brief. Although the tutor was written for the two-key flute that Quantz favoured, using separate fingerings for sharps and flats, he gave only brief hints on how to use these keys. His instructions on tonguing were by far the most sophisticated to date, using 'ti', 'di' and 'ri' for single tonguing, and 'did'll' for double tonguing, a technique which he was the first to mention (*see* **TONGUING**).

In London by the mid-18th century music shops supplied a growing middle class with flutes, tutors and music. Economic and artistic opportunities there attracted good players, such as P.G. Florio (before 1740–95) and Joseph Tacet, while makers included Thomas Cahusac (i) (1714–

98), Benjamin Hallet the elder (*b* 1713), Charles Schuchart (1719/20–65), Caleb Gedney (successor to Stanesby (ii)) (1729–69), and Richard Potter (1726–1806). Most of the music was by foreign composers, but Englishmen such as John Stanley (1712–86) were also represented. Sophisticated tutors like Granom's *Plain and Easy Instructions* (London, 4/1766) and Luke Heron's *A Treatise on the German Flute* (1771), and, later, Gunn's *Art of Playing the German-Flute* (*c*1793), were for sale alongside cheap anonymous method books.

Flutes from the 16th century to the 18th: (a) keyless…

Flutes with between three and seven *corps de rechange* were common by this period (fig.6*d*), and two devices were introduced to regularize the instrument's tuning, which varied with the length of the joint. These were the screw-cork, to make fine adjustments to the cork stopper in the head joint, and the index or 'register' foot joint, which had a telescoping tube to make it longer or shorter. Not many makers supplied these gadgets: flutes from the Grenser workshop are among the few from this period with registers, while in England Potter first used the device during experiments with a graduated head-joint tuning-slide in the 1780s. The most important mid-century development in England was the addition of keys for B♭, G♯ and F, with an extension of the range down to *c′*. The earliest surviving example of such a six-key flute was made about 1755 by J.J. Schuchart (Powell, 1996). The new keys facilitated the penetrating and even tone that was becoming fashionable, particularly in the lowest octave, among players developing a new bravura style. The Seven Years War in Europe made life more difficult than in England, thus the transmission of keyed flutes to the Continent occurred slowly.

In France, the flute was in decline in the mid-18th century while musical life focussed on opera. However a tutor by Charles de Lusse (Delusse) (*c*1761) showed the increasing virtuosity of flute playing by including brilliant studies and a piece using quarter-tones. In 1764 Buffardin wrote to the *Mercure de France* to say that Lusse's prescriptions for quarter tones were less advanced than his own. Later the Count of Guines commissioned Mozart, while in Paris, to write the Concerto for flute and harp (κ299/297*c*); that the flute part includes a low C probably indicates that the count had acquired an English flute during his earlier sojourn in London.

In Mannheim and Vienna Mozart wrote concertos in G major (κ313/285*c*) and D major (κ314/285*d*; an adaptation of an oboe concerto in C), and three quartets for flute and strings. Mozart's friend J.B. Wendling (1723–97), principal flute in Mannheim, may have played in Mozart's symphonies, perhaps on a flute by Parisian maker Thomas Lot. Other concertos and chamber works for flute include those by J.C. Bach, François Devienne (1759–1803), Carl Ditters von Dittersdorf, Michael Haydn and the Mannheim composers. The largest output, consisting mostly of printed solos, duets, quartets and concertos, was that of the Viennese composer and publisher F.A. Hoffmeister (1754–1812).

The most famous players of the late 18th century were travelling virtuosos. Those who performed in England, still a richly attractive destination for musical travel, included F.L. Dülon, Andrew Ashe and Tebaldo Monzani. Concepts of tone and performance style varied greatly between one virtuoso and another, and the varied acoustics, materials and key configurations of contemporary flutes tended to promote this diversity. In 1785 Richard Potter added to the numerous types of flute on the market a 'new-invented Patent German Flute', the first to be manufactured under patent protection; it had pewter instead of leather seals for the keys, a foot-register and a metal-lined head-joint with a tuning slide. The new flute was mass-produced and the pewter seals were soon imitated by other makers.

When the Paris Conservatoire was established in 1795 Devienne became professor of the flute. He encouraged his students to use flutes with only four keys (i.e. without the C-foot), a type institutionalized by the first official tutor written for the Conservatoire, by Antoine Hugot and J.-G. Wunderlich (1804). The Conservatoire's military-style regime introduced a new and more disciplined method of teaching, in which students were drilled in technical exercises.

The Leipzig virtuoso J.G. Tromlitz published his *Ausführlicher und gründlicher Unterricht die Flöte zu spielen* in 1791. Although he said less about musical style and ensemble playing than Quantz, he provided far more detailed instructions for playing the flute, including two chapters on single and double tonguing. As a performer Tromlitz was famous for his powerful tone and excellent intonation, qualities due in part to the flutes he made and played on. In 1785 he announced the invention of an instrument with seven keys (C for the left thumb, B , G , an F for each hand, D

and E♭). In 1796 he improved it by duplicating the B♭ key, and in 1800 he published a tutor with detailed instructions for playing it. Tromlitz's design of 1785 was the first important synthesis of existing elements, prefiguring developments of the following century. He combined his own thumb C key and the second F key invented by Dülon's father in 1783 with the basic English configuration of 30 years before, retaining on the foot joint Quantz's D♯/E♭ combination rather than extending the range down to C. His flute was the first on which every semitone was supplied with its own tone hole.

(iii) 1800 to the present.

While one-key instruments remained in use by beginners and amateurs, flutes with more keys were devised, modified and used in almost chaotic profusion according to the preference of individual players and makers. The most influential maker was Theobald Boehm (1794–1881), whose revolutionary design concepts provided the basis for the modern flute.

(a) Early 19th-century flutes.

Flute makers of the early 19th century modelled their instruments on those of the previous generation. Their flutes had a conical bore, a small embouchure-hole and six irregularly sized small tone holes, a key for D♯ and, usually, keys for F, G♯ and B♭, with eventually up to 12 further keys to supplant the fingerings inherited from the one-key flute; many have ivory ferrules or graduated tuning devices such as screw stoppers, registers or *corps de rechange*. Around 1820 a long *c″* lever for the right forefinger appeared; its invention has been attributed to both Claude Laurent (*fl* 1805–48) and J.N. Capeller (1776–1843). Capeller also devised a one-piece body joint to replace the separate joints for each hand. Instruments were made of boxwood, ebony or other woods, ivory or crystal, and keys of brass, silver or pewter.

Key systems developed along national lines. In France, Devienne and, for many years, the influential maker and player J.-L. Tulou persistently rejected the addition of a second F key and keys for *c′* and *c♯′*: most early 19th-century French flutes had four or five keys, with a separate joint for each hand. From 1805 French flutes had their keys suspended on rods and pillars attached to a plate screwed to the body of the instrument. Makers included Tulou, Laurent, who was especially noted among the post-Revolution upper classes for his crystal (glass) flutes, and Clair Godfroy *aîné*. German, Austrian and English makers continued to mount the keys on wooden protrusions called 'blocks', but their head-joints were now, after innovations by Richard Potter (1726–1806), often lined with metal. Keys for F and B♭ were sometimes supplied in dual form – either by fitting a second key or by adding a second touchpiece – to give the option of two different fingerings. A key for *d″* operated by the first finger of the right hand was added by Capeller about 1811; it served also to improve trills involving D, B♭ and B. Although variations persisted, by about 1820 the flute with eight or nine keys and *c′* or *b* as its lowest note was standard everywhere except France. Prominent English makers included James Wood (*fl* 1799–1832), Tebaldo Monzani, J.M. Rose (1794–1866) and Thomas Prowse (*fl* 1816–68), who made the large-hole flutes associated with the English virtuoso Charles Nicholson (1795–1837). The most important German maker was Wilhelm Liebel (1793–1871) of Dresden, whose instruments, along with those of Koch and Ziegler, were recommended by A.B. Fürstenau, the most influential German player, teacher and flute composer of the period.

Fürstenau toured as a virtuoso and served from 1820 as first flautist at the Hoftheater in Dresden, then under the direction of Weber. He wrote two methods for the flute: *Flöten-Schule* (1826) and *Die Kunst des Flötenspiels* (1844). He performed (on a flute by Koch) the Adagio (1819) from Weber's Trio op.63 for flute, cello and piano with the composer and the cellist J.J.F. Potzauer and was the dedicatee of Friedrich Kuhlau's Three Grand Duos op.39 (1821). After 1825 Fürstenau played a flute by Liebel. Kuhlau, who did not play the flute himself, but had an affinity for it, wrote a number of other chamber works for the instrument: his Grand Trio op.90 for three flutes (1826) was dedicated to the French flautist A.-T. Berbiguier and his Six Divertimentos op.68 (1825) to P.N. Petersen (1761–1830). Schubert's *Introduction and Variations on Trockne Blumen* (1824) was composed for Ferdinand Bogner, professor of the flute at the Vienna Conservatory. The most

prominent French players were Tulou and his rival Louis Drouet, who played Mendelssohn's Scherzo from *A Midsummer Night's Dream* in its first London performance (24 Jun 1829); both were prolific composers for the instrument. The most important English player was Nicholson, whose powerful tone, the result in part of his use of a flute with unusually large finger-holes and embouchure-hole, had both admirers and detractors. Drouet, in vain, tried to establish himself in London, but neither he nor his French flutes were accepted by the English public. Another important player was the Spaniard J.M. del Carmen Ribas (1796–1861), who served as first flute in the Gewandhaus Orchestra in Leipzig from 1838 to 1843 and played on an eight-key Nicholson flute.

(b) The Boehm flute.

Flutes featuring the concept, technology and acoustic principles devised by Theobald Boehm are called Boehm flutes. Boehm was trained in his father's trade as a goldsmith, but even as a child displayed an aptitude for music. As a young man he combined the careers of goldsmith, flute maker and professional flautist. In 1828 Boehm, then flautist in the Bavarian Hofkapelle, opened a flute factory in Munich. In 1829 he made an 'old-style' conical-bore flute with the keys suspended on pillars and axles, and right-hand levers on rods for *b♭′* and *c″*. On hearing Nicholson in London, Boehm was struck with the tone he produced on his large-hole flute and set out to design an instrument on which larger holes were spaced for good intonation and evenness of tone rather than according to the reach of the player's fingers. A prototype was made for him by Gerock & Wolf of London in 1831. Boehm's instrument broke new ground by employing ring keys, an idea patented in 1808 by the English inventor Frederick Nolan and also employed by J.C.G. Gordon. This device transferred the movement of a finger to keys outside its reach, allowing a single finger to stop two or more holes at the same time. On Boehm's new flute, a ring key allowed the right first finger to stop two holes, producing F♮ rather than the usual F♯ – an idea suggested by H.W.T. Pottgiesser in 1803, and F♯ was now produced with a second ring-key mechanism, for the right third finger: the basic scale of the instrument was now C rather than D.

Boehm's second model, which featured a combination of ring keys and rod axles (the 'ring key' flute), was made in his Munich shop in 1832. The hole for G was closed indirectly by the second or third finger of the right hand, the key for G♯ was open-standing and Tromlitz's open-standing C key for the left thumb was revived. As early as 1833 Boehm's pupil Eduard Heindl (1837–96) performed a *Fantasie* by Kuhlau on the new flute. Within a few years conical ring-key Boehm flutes were being made in Paris by the firm of Godfroy and by 1843 the instrument had become successful enough for Boehm to license its manufacture by Rudall & Rose in London (under the direction of Boehm's foreman, Rudolph Greve). In 1846–7 Boehm studied acoustics with his friend Carl von Schafhäutl with a view to improving his flute and developed his *Schema* (Munich, 1862, a plan for the relationship between the tube diameter and the placement and size of the tone holes, also published in his pamphlet *Die Flöte und das Flötenspiel in akustischer, technischer und artistischer Beziehung* of 1871). His next design, the 'Boehm-system' flute (1847), was a cylindrical-bore instrument of silver with a parabolic head, a rectangular embouchure-hole with rounded corners, and tone holes of the largest possible size, closed by padded keys interlinked with rod-axles and clutches; this instrument was the basis of the modern flute (*see* KEYWORK). After several experiments with a thumb key for B/B♭, in 1849 Boehm devised the version that has since been universally adopted. The invention of this key was incorrectly ascribed by R.S. Rockstro (1890) to Giulio Briccialdi and the key has since been known by his name. Boehm at first manufactured his flutes himself, later in partnership with his foreman Carl Mendler (1833–1914) under the name Boehm & Mendler. His pupils Emil Rittershausen (1852–1927) and Thomas Mollenhauer (1840–1914) also made flutes to his design, the latter making a piccolo to Boehm's specifications in 1862. Under Liszt's direction, between 1842 and 1862 Theodor Winkler (1834–1905), principal flute in the Weimar Hoforchester, was the first orchestral player in Germany to use the Boehm cylinder.

The practicality of the 1832 'ring key' flute was recognized early in France, and instruments were made and promoted by Godfroy, his son V.H. Godfroy and his son-in-law Louis Lot. Victor Coche (1806–81) and Auguste Buffet *jeune* (1830–85) modified the instrument, moving the rod-axles to the player's side of the tube and adopting needle springs instead of the flat ones used by Boehm.

In 1837–8 Vincent Dorus (1812–96) devised a G♯ key that remained open except when the ring key for the adjacent hole for A was pressed – a compromise between Boehm's closed G♯ key and the open G♯ of earlier flutes; this open key, although opposed by Boehm, has been generally adopted. Dorus adopted Godfroy's improved conical ring-key Boehm flute because 'it was, in essence, the keyed Godfroy flute he had used until 1838 except for its more functional mechanism'. In 1839 he played Berlioz's *Roméo et Juliette* on a conical ring-key Boehm flute by that maker. Dorus and P.H. Camus (*b* 1796) championed Boehm's flute and wrote the first tutors for it (1839); they introduced his cylinder flute at the Paris Conservatoire when Dorus succeeded Tulou as professor of the flute in 1860. But the conical ring-key Boehm flute remained in use: Saint-Saëns's *Romance* op.37 (1871) and Carl Reinecke's *Undine* (1882) were dedicated to A. de Vroye (1835–90), a student of Coche, who was then still playing one.

Boehm sold the rights to make his 1847 cylinder flute to Godfroy and Lot in France and Rudall & Rose in London. The French manufacturers replaced Boehm's G♯ key with Dorus's open one, arranged the keys in a straight line and perforated some of them as a compromise between the rings of the 1832 model and the closed keys of some non-French instruments. Buffet replaced the vaulted clutches used by Boehm and Godfroy with flat ones. After about 1850 the French Boehm cylindrical flutes were usually made of silver or nickel-silver, less often cocus or rosewood. The earliest methods for this, Boehm's second and final concept, were written by E. Krakamp, W. Popp, W. Barge and by Boehm himself.

(c) The flute after Boehm.

Fürstenau and most other German flautists rejected Boehm's designs; his new flutes, they felt, made superfluous the alternative fingerings that enhanced the tonal character and intonation of the instrument. Partisans of the old conical keyed flute – Wagner prominent among them – were not willing to relinquish the old instrument's wider variety of tone to gain the smoother technique, greater dynamic range and better intonation offered by Boehm's instruments. Wagner referred to the new instruments as 'Blunderbusses' (*Gewaltröhre*) and forced Moritz Fürstenau, one of the first to play the Boehm flute in Germany, to return to his old instrument. Boehm's pupil Rudolph Tillmetz (1847–1915), who was Wagner's principal flautist at Bayreuth, ordered an adapted ring-key flute from J.M. Bürger (*fl* 1881–1904) for the première of *Parsifal* in 1888. As late as 1898 Tillmetz claimed that 'the tone of the cylindrical flute was too assertive and lacking in flexibility', and the firms of Rittershausen (*fl* 1876–1927), Joseph Pöschl (1866–1947) and J.H. Zimmermann (1851–1922) offered hybrid conical ring-key flutes until 1920.

Beginning in 1853 H.F. Meyer of Hanover (1814–97) made flutes that reflected the requirements of German and Austrian symphony orchestras: they played easily in the high and low registers, produced greater volume and had better intonation than earlier 'old-system' flutes. Although his flutes were superficially similar to the nine-key instruments of the period, they differed in bore dimensions, placement and size of the tone holes and the size and form of the embouchure-hole; the keys and ferrules were generally made of nickel-silver or other metals. Flutes following his concept were known as 'Meyer' flutes or 'old-system flutes' to distinguish them from Boehm system flutes; they were immensely popular in the second half of the 19th century and played the flute parts in orchestral works by Schumann, Tchaikovsky, Brahms, Mahler and Richard Strauss. They remained standard in the symphony orchestra until about 1930 and in military bands even later. Important players of the Meyer flute included Franz and Karl Doppler and Jules Demerssmann (1833–66); Ernesto Koehler (1849–1907), Wilhelm Popp (1828–1903) and Adolf Terschak (1832–1901) wrote methods or studies for it.

By the late 19th century national preferences had given way to personal ones. Some players remained true to their first flutes while others switched to new models: in the Bilsesche Kapelle in Berlin in 1881 the Danish flautist Karl Andersen, who played a Meyer flute, sat next to the Frenchman Charles Molé, who played a silver Boehm-system instrument; later in New York Andersen sat next to Boehm's pupil Carl Wehner (1838–1912), who played a wooden Boehm flute with an open G♯ key. In the Leipzig Gewandhaus Orchestra, William Barge (1836–1925), playing a Meyer flute, sat next to Maximilian Schwedler, who played on a 'reform' flute of his own design (see below). Many hybrid instruments, combining features of both the Boehm flute and old conical flutes, appeared in the second half of the 19th century; such instruments may have been

developed as a result of reluctance among professional players to adopt an unfamiliar instrument, or sometimes in the belief that a new design represented a perfect compromise between the old system and the Boehm flute. Among the hybrids were Rudall, Rose and Carte's 'Council & Prize Medal' flute of 1851, Richard Carte's model of 1867, models designed by R.S. Rockstro and John Radcliff (1842–1917), Briccialdi's flute of 1870/71, 'Pratten's Perfected', made by R.S. Pratten (1814–62) and instruments by Thibouville, Abel Siccama (1810–65), John Clinton (1810–64), Tulou/Nonon and Giorgi. Of these, only the Carte model of 1867 and a version of it with a closed G♯ key known as the 'Guards' model' achieved popularity; in Great Britain and its colonies the Carte model of 1867 was the most widely used after Boehm's cylindrical flute until well into the 20th century. As well, makers including Clinton ('Equisonant' flute), Cornelius Ward and Siccama ('Diatonic flute') subjected Boehm's designs to various, sometimes eccentric, alterations and additions.

In 1885 Maximilian Schwedler (1853–1949) of Leipzig, an opponent of the Boehm flute, created the 'reform' flute – a conical-bore instrument based on Meyer's design. Like Meyer, he considered the conical bore and the combination of open and veiled notes as essential to the character of the flute. However, his instruments, mostly made for him by Carl Kruspe (1865–1929), took into account the demands of contemporary scores. The innovations he introduced from 1885 until his last reform of about 1916 were: the raised-side (*Seitenerhöhte*) embouchure-hole, a touchpiece for F, a Tulou-like cross F♯ mechanism, and, about 1900, a metal headjoint with ebonite embouchure plate to replace the metal-lined wooden one. Schwedler's best known models were those of 1889 and 1911. His last model, made in 1923 by M.M. Mönnig (1875–1949), was dubbed by Hindemith the 'six-cylinder flute' on account of its ample volume and advanced technology. His instruments never achieved the popularity of the Meyer flute and were played almost exclusively in Germany and the Balkans. In 1886 Brahms praised Schwedler's playing of the solo in the fourth movement of his Symphony no.4; other compositions written for the reform flute include Carl Reinecke's Concerto op.283 (*c*1908), dedicated to Schwedler, and probably the compositions of Sigfried Karg-Elert, dedicated to Tillmetz's pupil Carl Bartuzat (1882–1959). Schwedler took part in the first performance of Saint-Saëns's *Tarantelle* for flute, clarinet and orchestra (1893). He was one of the first to rediscover the forgotten repertory of the 18th century and the 19th: in 1901 he and Barge's pupil Oskar Fischer performed Bach's Brandenburg Concerto no.4 on reform flutes; for Peters of Leipzig he edited Bach's solo Partita (to which the organist Gustav Schreck (1849–1918) added a piano part in 1918) and six Sonatas (1910–24), and Mozart's Flute Quartets (1924).

By the end of World War I most Germans had overcome their reservations and were playing wooden Boehm-system flutes; English flautists played the Carte model of 1867, an instrument by Radcliff or a Boehm flute of silver, wood or ebonite. Most French players after 1860 used metal instruments of the modified Boehm system. Of these three 'national schools', the German and English players concentrated on tonal power while the French cultivated finesse in tone production and colour. Paul Taffanel and his student Louis Fleury gave new impetus to flute playing in France at the turn of the century by creating a new culture of pedagogy, playing style and repertory, which included the hitherto mostly unexplored flute music of the past 200 years. The flute methods written by Henri Altès (1906) and by Taffanel and his student Philippe Gaubert (1923) were still widely used at the end of the 20th century. Players of the French school favoured instruments by the firms of Lot, Claude Rive (*fl* 1877–95) and Auguste Bonneville (*fl* 1858–67). Outstanding solos from this period were Debussy's *Prélude à l'après midi d'un faune* (1892–4) and *Syrinx* (1913) for solo flute, the latter written for Fleury.

Around the turn of the century, German- and French-style flutes and flute playing were transmitted to North America. The French style became dominant, and the recordings, teaching and concert tours of French performers hastened the change from wooden Boehm-system flutes to silver flutes such as those made by Louis Lot. American firms founded by W.S. Haynes and V.Q. Powell began to make French-style flutes in the USA in the first decade of the century. These have set the standard both in the USA and, from the 1930s, in Japan, where Koichi Muramatsu began to make flutes inspired by Haynes and Powell. After World War II these and other American and Japanese makers added low-priced models to their lines while the few remaining French makers primarily made instruments for professional use.

(d) The modern Boehm flute.

After World War II players of the French-style flute cultivated a smooth, rich, penetrating and brilliant sound, to which vibrato was commonly added. This replaced the dark, dense, compact sound, without vibrato, that had been cultivated by English and German players for the past 150 years. Brahms and Mahler had desired a flute tone that merged with the other instruments, but this ideal became subordinate to an emphasis on the characteristic sound of each instrument; conductors such as Herbert von Karajan required a penetrating sound and a wide range in dynamics. Taffanel's axiom 'le volume est peu de chose et le timbre est tout' had been reversed.

The French Boehm-system flute best fulfilled all these requirements. The instrument is modelled after Lot's, with closed keys, five of them perforated; it is made of silver, silver alloy or gold, occasionally ebonite (predominantly in Great Britain), German silver or platinum. The bore is slightly wider than earlier models (19 mm) and a key for *b* is standard, as is a closed key for G♯. Since the late 1980s, occasionally the head joint is made of wood. Changing pitch levels and tone ideals led to larger embouchure-holes and a revision of Boehm's *Schema* by Albert Cooper (*b* 1924) and others. The resulting redefinition of the flute's sound through an increase in overtones differentiated it from earlier models. Such revisions led to the modern multi-purpose flute and a related playing style.

Following World War II, broadcasts and recordings made the polished and evocative playing of René le Roy (1898–1985) and J.-P. Rampal (1922–2000) available to a large international public. These players were exponents of the Taffanel school, passed down by his students Adolphe Hennebains (1862–1914), Gaubert and Marcel Moyse (1889–1984). Moyse's innovatory approach provided the foundation for a new French school: French flute playing and teaching were responsible for the almost complete disappearance of the German and English wooden flutes and related styles of playing.

Many outstanding works for the flute were composed for players of the French school. Ibert's Concerto (1932–3) was written for Marcel Moyse and Hindemith's Sonata (1936) for Gustav Scheck. Varèse's *Density 21·5*(1936) was written for a platinum flute (21·5 is the density of that metal) made by Powell for Georges Barrère, who had earlier played the first performance of the *Prélude à l'après-midi d'un faune*. Honegger's *Danse de la chèvre* (1926), Jean Rivier's *Oiseaux tendres* (1935) and Martinů's Trio for flute, cello and piano (1944) were composed for Le Roy and Poulenc's Sonata (1956) for Rampal. Prokofiev's Sonata (1943), however, was first performed by the Russian flautist N. Kharkovsky, who probably played a silver, closed-hole Boehm flute with an open G♯ key, the usual instrument in that region until late in the 20th century.

Especially since World War II players and composers have increasingly explored new techniques and expressive possibilities. Avant-garde techniques include multiphonics, whistle tones and whisper tones, humming and slap tones (created by slapping the keys without blowing through the instrument), and the electronic manipulation of sound. Pioneering works include Varèse's *Density 21·5*, Boulez's *Sonatine* (1946), written for Rampal, Messiaen's *Le merle noir* (1951) for flute and piano, Jolivet's *Cinq incantations* (1936) for solo flute and *Suite en concert* (1965), Maderna's *Musica su due dimensioni* (1952, rev. 1963) for flute and tape and Berio's *Sequenza I* (1958) for solo flute. Notable works of the late 20th century include Ferneyhough's *Unity Capsule* (1975–6) for solo flute, Cage's *Ryoanji* (1983–5) for small ensemble, written for Robert Aitken, and Boulez's *…explosante-fixe…* (1991–4). Flautists such as Severino Gazzeloni (*b* 1915), Aurèle Nicolet (*b* 1926), Istvan Matúz (*b* 1947), P.Y. Artaud (*b* 1946) and Robert Dick (*b* 1950) have played a major role in bringing the repertory up to date. Since the late 1930s the flute has been used as a jazz instrument by players such as Frank Wess, James Moody, Bobby Jaspar and Clement Barone. Bud Shank and others such as the more experimental Eric Dolphy, Roland Kirk and Mike Mower, have translated the advanced techniques of the avant garde to jazz.

Although a few women such as Cora Cardigan, Edith Penville and Winfred Gaskell (Liverpool PO) had played professionally in the early decades of the 20th century, the flute remained essentially a masculine instrument until the 1950s, when women began to occupy principal positions in orchestras and to make their mark as soloists. Among the first to achieve prominence were Doriot Anthony Dwyer (Boston SO) and Elaine Schaffer (Dallas SO); they were followed by many others. Prominent women soloists have included Susan Milan, Irena Grafenauer, Kirsten Spratt, Andrea Lieblenecht, Paula Robison and Carol Wincenc on the modern flute and Lisa Beznosiuk on historical flutes.

Makers have also been inspired to experiment with the instrument. As early as 1948 the British-

born flautist Alexander Murray began a series of experiments in collaboration with the makers Elmer Cole and Albert Cooper, and, in 1967, with Jack Moore. In 1972 Greta Vermeulen invented a *Flûte à coulisse*, which has a trombone-like slide instead of tone holes. Developments of the late 20th century include the Matúz-Nagy 'Multiflute' developed by Matúz, and the Oston-Brannen Kingma system 'Quarter-tone C flute' developed by Eva Kingma and Bickford Brannen, both for extended techniques such as multiphonics. A carbon-fibre flute with magnets instead of needle springs was developed in Finland by Matti Haekoenen and Matti Hellin and new alto, bass and lower flutes, such as the 'Grossbass' made in 1981 by Christian Jaeger for Max Hieber, have been introduced. The open-hole (perforated key) alto flute was the result of a collaboration between the Dutch player Jos Zwaanenburg and the makers Dick Kuiper and Eva Kingma; the latter also applied this idea to her bass flutes. At the end of the 20th century Kotato & Fukushima of Japan was making a range of flutes from the piccolo down to a sub-contra bass with a range to *C*.

(e) The historical revival.

In the late 1960s there was a revival of interest in early music and instruments. German teachers such as Scheck and H.-P. Schmitz reintroduced historical techniques while recordings by H.-M. Linde, Leopold Stasny, Frans Vester, Stephen Preston and Barthold Kuijken demonstrated that such effects were at their most convincing on period instruments. Around 1970 a modern school of 'Baroque flute' or 'Traverso' playing emerged, based on a selection from the mass of specific historical information. The all-purpose traverso, usually adapted from mid-18th-century models and pitched at the neo-Baroque standard of *a′* = 415, was used to play the music of Bach and Handel in a modern style loosely based on the instructions of Quantz; 'Hotteterre' flutes at *a′* = 392 were sometimes used for French repertory, and for music by Mozart, Haydn and Beethoven an early 19th-century keyed flute at *a′* = 430 became standard. The neo-Baroque style revived interest in 18th-century repertory among players of both the traverso and modern instruments; at the end of the 20th century the work of scholars, teachers and makers, and the development of an audience for early music, had provided a few young performers with the means to develop a personal yet 'historically informed' style, to investigate neglected music and to perform on instruments associated with specific repertories. At the same time, the revival influenced modern styles of flute playing. The flute repertory of the 16th, 17th and 19th centuries, however, was still viewed as more remote, and its techniques and instruments had been explored by only a few specialists.

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