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## Carte's Flute Patents of the Mid-Nineteenth Century And Related Systems

STUART-MORGAN VANCE

**B**OEHM'S NEW FLUTE OF 1832 produced responses that varied from one country to another. In his own Germany it was enthusiastically adopted by a small group of his own students, but it was either ignored or actively opposed by the majority. It was readily accepted in France, largely because of the improvement in fingering. But the most interesting response was that of the English, whose enthusiasm was not so much for the fingering as for the tone of the new model (Boehm was inspired to begin his redesign when he heard the English flutist Nicholson in 1831).

Comparing a Boehm flute (not just the modern silver or gold cylindrical model, but even a cone-Boehm) with a typical eight-keyed flute, we see that everything is set up to produce a higher cutoff frequency, above which there are no more resonances (in brass instruments this is determined by the shape of the bell flare, in woodwinds by the size and spacing of the first two or three open tone holes).<sup>1</sup> Large tone holes, closely spaced, and shallow tone chimneys make for high cutoff frequencies; small tone holes, widely spaced, with deep tone chimneys make for low cutoff frequencies. On the Boehm, the tone holes are relatively large; on a cylindrical-bore Boehm the wood is faced down as close to the bore as possible, almost eliminating the chimney. The Boehm metal instruments have the same characteristics, sometimes even more pronounced; and on either bore, downstream from the first open hole, all the holes for a chromatic scale are open. On an eight-keyed flute, on the other hand, the tone holes are much smaller (often less than half the diameter of the Boehm flute tone holes) and bored through relatively thick wood; and downstream from the first open hole only the holes for a diatonic scale are open.

The nineteenth-century English evidently preferred the tone of a flute with a high cutoff frequency, though this concept was not explicitly formulated until this century. Modern flutists, while they may agree with Richard Carte's remarks about the superior tone of Boehm's flute, may be a bit puzzled by his statement about "the superior *facility of execution*

1. On cutoff frequency, see A. H. Benade, "Characterization of Woodwinds by Tone-hole Cutoff Frequency," *Journal of the Acoustical Society of America* 54 (1973): 310.

obtained with the old flute."<sup>2</sup> To some extent this was a question of familiarity with the old fingering; but in the case of the sharp keys, there may be some truth in the idea that the eight-keyed flute provided greater facility.

In any case, it was in England that newly-invented woodwind fingerings proliferated most luxuriantly. Among the families of new fingerings that were reasonably successful were the flute systems patented by Richard Carte and some systems derived from them.

Carte (the father of Richard d'Oyly Carte of Gilbert and Sullivan fame), who became a partner in the flute-making firm of Rudall, Rose and Company in 1850, was one of the first Boehm enthusiasts in England. Carte was not completely satisfied with the 1832 Boehm flute, which did not yet have the thumb B $\flat$  (invented in 1849 by Briccialdi), though he intended to adopt it if it could be produced with the same perfection of tone and tuning but in a form that allowed greater facility of execution. In 1850 he tried his own hand at producing just such a flute (fig. 1), and obtained a patent for his design on September 7, 1850.<sup>3</sup>

Carte kept the old F $\sharp$  fingering and cross F key, and obtained a forked F by moving the Boehm F $\sharp$  mechanism down a semitone. The actual realization of this consisted of mounting rings V and VI on the far side, as in the 1832 Boehm; the tail of that pair of rings worked a lengthwise first-class lever closing the F $\sharp$  hole. This pad could also be closed by a key for the left little finger, thus providing a new kind of left-hand F fingering. One can see that except for the forked F, all the holes below the note being produced are open.

Boehm's open G $\sharp$  was retained, but it was articulated from plate IV, thus freeing the left little finger from having to hold down any key except the one for its own note. Hole III was a simple open hole. The tail of ring II closed a lengthwise first-class lever that could also be directly closed by the left thumb to obtain B $\flat$ ; this was the only B $\flat$  fingering provided.

Ring I, around a duplicate B hole, closed the pad immediately upstream of it to produce B. Each of the three pads upstream of hole I (C, C $\sharp$ , and D holes) closed the next one upstream. A left thumb lever closed the two pads nearest the embouchure to produce C; in the original patent, these two

2. Richard Carte, *Sketch of the Successive Improvements Made in The Flute* (London: Rudall, Rose, Carte and Co., 1855), 27.

3. Great Britain, Public Records Office, London, Patent Rolls for 1850, no. 12,998, issued to Richard Carte, Sept. 7, 1850.

In the figures accompanying this article, the diagrams with each photograph are drawn approximately to scale lengthwise, but not in the crosswise (circumferential) dimension.

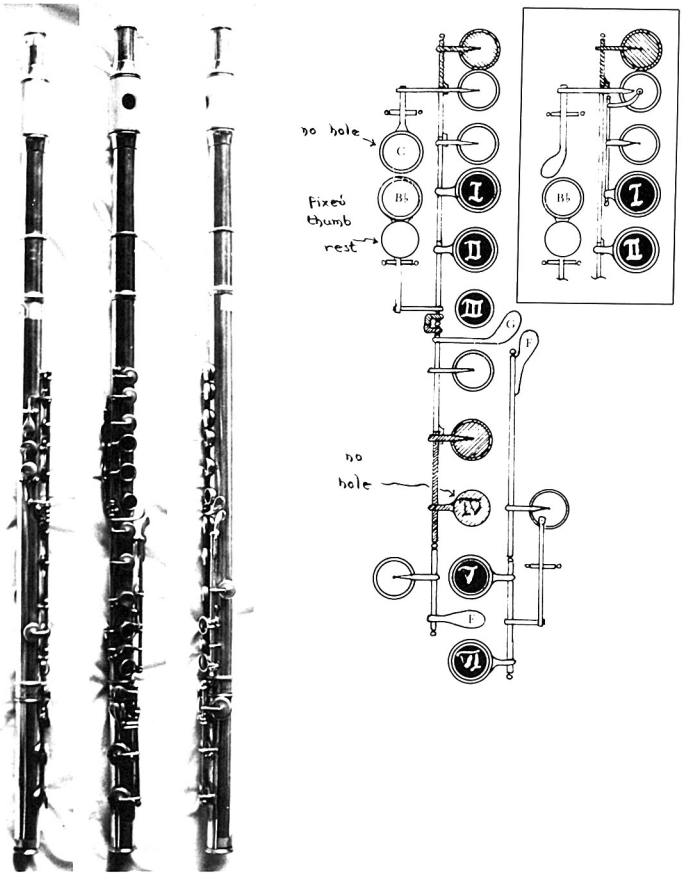


FIGURE 1. Richard Carte's flute patented in 1850. Rudall, Rose, Carte and Company, London. Collection of Glennis Stout, no. 26. The main drawing represents the mechanism of the body joint of the flute in the photograph. Inset: upper part of the mechanism of the body joint as described in the patent specification. All parts pinned to the rod that move rigidly together are indicated with diagonal hatching in the same direction. Open fingerholes are represented in solid black. Numbers I, II, and III are for the first (index), second and third fingers respectively of the left hand; numbers IV, V, and VI are for the first, second and third fingers of the right hand.

pads could also be closed by ring II, the principal fingering according to the patent (fig. 1, inset). Boehm had been unwilling to make his key system more complicated in order to include full-sized holes for C# and D, but Carte provided these (the two pads nearest the embouchure): the open note was D, with C# obtained by a connection from plate IV which closed the pad nearest the embouchure.

Carte revised the left-hand mechanism in 1851, making it more Boehm-like, while retaining the open D.<sup>4</sup> In this 1851 Carte system (fig. 2), the open thumb C hole of the Boehm system (to be closed for B) was adopted, replacing the C key of the patent. This open C also closed the D hole to produce C#. The two holes nearest the embouchure (C# and D) were made smaller and displaced upstream (to preserve the pitch) so that the C# hole could function as a register hole for D and Eb. The connection for C# was transferred from plate IV to plate III; this was already mentioned as an alternative in the 1850 patent specification, "though I prefer the mode I have above set out" (i.e., the connection from plate IV).<sup>5</sup> The connection from plate IV now closed the thumb B key (C hole). Since this in turn closed the D hole, the C# fingering from the 1850 patent was retained. A connection from the cross F key closed the thumb Bb key, and the articulation of the open G# from plate IV was retained. The right hand was essentially unchanged except for the connection to the Bb.

In his patent claims of 1850 Carte calls the system there described "the best mode of carrying out my Invention." Why then did he so soon change it, making it more like the system it was intended to replace? Let us look at some musical examples, using table 1, which shows the fingering charts for the patent of 1850, the 1851 system, the Boehm system, and the system of the old eight-keyed flute.<sup>6</sup>

Boehm-system flutists will immediately notice that the absence of an alternative to the thumb Bb will cause trouble in chromatic passages (example 1), though not as much as does Boehm's thumb B (C hole) key. In this passage, of course, with the ring model of 1850, the flutist could grab the ring-edge for A#, but this is not practical in a continuing chromatic scale.

4. Richard S. Rockstro, *A Treatise on the Construction, the History and the Practice of the Flute*, 2d ed. (London: Rudall, Carte, and Company, 1890), 379–80.

5. Patent application of 1850, p. 4, line 20.

6. To provide readers with an example of the use of the U. S. A. National Standards Institute system of pitch designations discussed and explained on pp. 130–32, this article has been printed using this system.

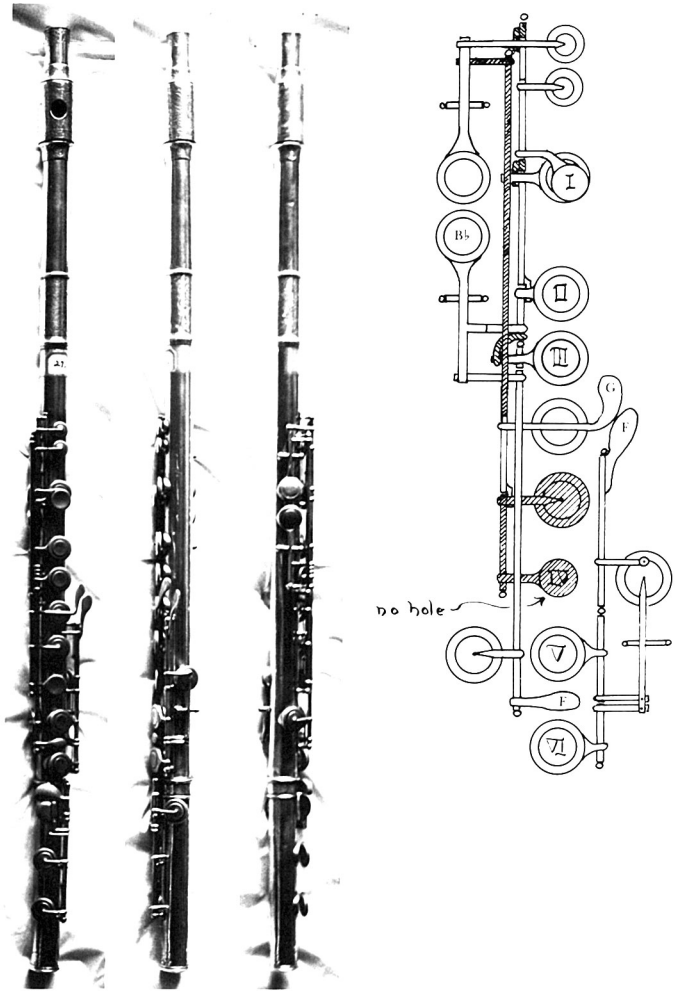


FIGURE 2. Carte's patented flute as improved in 1851. Rudall, Rose, Carte and Company, London. Collection of Glennis Stout, no. 27. All parts pinned to the rod that move rigidly together are indicated with diagonal hatching in the same direction.

TABLE I<sup>6</sup>  
Fingering Charts for Carte, Boehm, and Eight-keyed Flutes

Keys indicated by letters (G, F, D $\sharp$ , etc.) produce the pitches shown when the key is pressed. The fingering diagrams show them in their positions on the instrument.

Pitch	Carte Flutes		Boehm Flute	Eight-keyed Flute
	1850	1851	(open G $\sharp$ key, no thumb B $\flat$ key)	
C <sub>4</sub>	●●●G/●●●C	●●●G/●●●C	●●●G/●●●C	●●● / ●●●C
C <sub>4</sub> $\sharp$	●●●G/●●●C $\sharp$	●●●G/●●●C $\sharp$	●●●G/●●●C $\sharp$	●●● / ●●●C $\sharp$
D <sub>4</sub>	●●●G/●●●	●●●G/●●●	●●●G/●●●	●●● / ●●●
E <sub>4</sub> $\flat$	●●●G/●●●D $\sharp$	●●●G/●●●D $\sharp$	●●●G/●●●D $\sharp$	●●● / ●●●D $\sharp$
E <sub>4</sub>	●●●G/●●●○D $\sharp$	●●●G/●●●○D $\sharp$	●●●G/●●●○D $\sharp$	●●● / ●●●○D $\sharp$
F <sub>4</sub>	●●●G/●●●F <sub>○</sub> D $\sharp$	●●●G/●●●F <sub>○</sub> D $\sharp$	●●●G/●●●○D $\sharp$	●●● / F <sub>○</sub> ○D $\sharp$
or	●●●G/F <sub>○</sub> ○D $\sharp$	●●●G/F <sub>○</sub> ○D $\sharp$		●●● F <sub>○</sub> / ●●●○D $\sharp$
or	●●●G/●●●○D $\sharp$	●●●G/●●●○D $\sharp$		
F <sub>4</sub> $\sharp$	●●●G/●●●○D $\sharp$	●●●G/●●●○D $\sharp$	●●●G/●●●○D $\sharp$	●●● / ●●●○D $\sharp$
or			●●●G/○●●○D $\sharp$	
G <sub>4</sub>	●●●G/○○○○D $\sharp$	●●●G/○○○○D $\sharp$	●●●G/○○○○D $\sharp$	●●● / ○○○○D $\sharp$
G <sub>4</sub> $\sharp$	●●● / ○○○○D $\sharp$	●●● / ○○○○D $\sharp$	●●● / ○○○○D $\sharp$	●●● G $\sharp$ / ○○○○D $\sharp$
A <sub>4</sub>	●●○ / ○○○○D $\sharp$	●●○ / ○○○○D $\sharp$	●●○ / ○○○○D $\sharp$	●●○ / ○○○○D $\sharp$
B <sub>4</sub> $\flat$	●○○○ / ○○○○D $\sharp$	●○○ <sub>B<math>\flat</math></sub> / ○○○○D $\sharp$	●○○○ / ○○○○D $\sharp$	●○○○ / ○○○○D $\sharp$
or		●○○○ / ○○○ <sub>F<math>\flat</math></sub> D $\sharp$		
or		●○○○ / ●○○ <sub>F<math>\flat</math></sub> D $\sharp$		
or		●○○○ / ○○○ <sub>B<math>\flat</math></sub> D $\sharp$		
B <sub>4</sub>	●○○○ / ○○○○D $\sharp$	●○○○ / ○○○○D $\sharp$	●○○○ / ○○○○D $\sharp$	●○○○ / ○○○○D $\sharp$
or		●○○○ / ○○○○D $\sharp$		
C <sub>5</sub>	○○○ / ○○○○D $\sharp$	●○○○ / ○○○○D $\sharp$	●○○○ / ○○○○D $\sharp$	○○○ / ●●●D $\sharp$
or	○ <sub>c</sub> ○○○ / ○○○○D $\sharp$			●○○○ / <sub>c</sub> ○○○D $\sharp$
C <sub>5</sub> $\sharp$		○○○ / ○○○○D $\sharp$	○○○ / ○○○○D $\sharp$	○○○ / ○○○○D $\sharp$
or	○○○○ / ●○○○D $\sharp$	○○○ / ●○○○D $\sharp$		

a }  
b }  
c }  
d }

TABLE I (continued)

<i>or</i>	○ <sub>0</sub> ○ ● / ○ ○ ○ D $\sharp$			
D <sub>5</sub>	○ ○ ○ / ○ ○ ○ D $\sharp$	○ <sub>0</sub> ○ ○ / ○ ○ ○ D $\sharp$		
<i>or</i> (● ● ● G/ ● ● ●)	○ <sub>0</sub> ● ● G/ ● ● ●		○ <sub>0</sub> ● ● G/ ● ● ●	○ ● ● / ● ● ●
E <sub>5</sub> b	● ● ● G/ ● ● ● D $\sharp$	○ <sub>0</sub> ● ● G/ ● ● ● D $\sharp$	○ <sub>0</sub> ● ● G/ ● ● ● D $\sharp$	○ ● ● / ● ● ● D $\sharp$
		(E <sub>5</sub> - A <sub>5</sub> = E <sub>4</sub> - A <sub>4</sub> )		} a
B <sub>5</sub> b	= B <sub>4</sub> b	= B <sub>4</sub> b	= B <sub>4</sub> b	= B <sub>4</sub> b
<i>or</i>				● ● ○ / ● ● ● D $\sharp$
		(B <sub>5</sub> - C <sub>6</sub> $\sharp$ = B <sub>4</sub> - C <sub>5</sub> $\sharp$ )		
D <sub>6</sub>	○ ○ ○ / ○ ○ ○ D $\sharp$	○ <sub>0</sub> ○ ○ / ○ ○ ○ D $\sharp$		
<i>or</i>	○ <sub>0</sub> ● ● G/ ○ ○ ○ D $\sharp$		○ <sub>0</sub> ● ● G/ ○ ○ ○ D $\sharp$	○ ● ● / ○ ○ ○ D $\sharp$
E <sub>6</sub> b	● ● ● / ○ ● ● D $\sharp$	● ● ● / ○ ● ● D $\sharp$	● ● ● / ○ ● ● D $\sharp$	○ ● ● / ○ ● ● D $\sharp$
E <sub>6</sub>	● ● ○ G/ ● ● ○ D $\sharp$	● ● ○ G/ ● ● ○ D $\sharp$	● ● ○ G/ ● ● ○ D $\sharp$	● ● ○ / ○ ● ● D $\sharp$
F <sub>6</sub>	● ○ <sub>Bb</sub> G/ ● ● F <sub>0</sub> D $\sharp$	● ○ <sub>Bb</sub> G/ ● ● F <sub>0</sub> D $\sharp$	● ○ <sub>Bb</sub> G/ ● ● ○ D $\sharp$	● ○ <sub>Bb</sub> / ● ● ○ D $\sharp$
<i>or</i>	● ○ <sub>Bb</sub> G/F ● ○ ○ D $\sharp$	● ○ <sub>Bb</sub> G/F ● ○ ○ D $\sharp$		
F <sub>6</sub> $\sharp$	● ○ G/ ● ○ ○ D $\sharp$	● ○ G/ ● ○ ○ D $\sharp$	● ○ G/ ● ○ ○ D $\sharp$	● ● ● / ● ● ●
<i>or</i>			● ○ G/ ● ○ ○ D $\sharp$	
G <sub>6</sub>	○ <sub>c</sub> ● G/ ○ ○ ○ D $\sharp$	○ <sub>0</sub> ● G/ ○ ○ ○ D $\sharp$	○ <sub>0</sub> ● G/ ○ ○ ○ D $\sharp$	○ ● ● / ○ ○ ○
G <sub>6</sub> $\sharp$	○ ● ● / ○ ○ ○ D $\sharp$	○ <sub>0</sub> ● ● / ○ ○ ○ D $\sharp$	○ <sub>0</sub> ● ● / ○ ○ ○ D $\sharp$	○ ● ● / ○ ○ ○ D $\sharp$
A <sub>6</sub>	○ ● ● G/ ● ● ●	○ <sub>0</sub> ● ● G/ ● ● ●	○ <sub>0</sub> ● ● G/ ● ● ●	○ ● ● / ● ● ●
B <sub>6</sub> b	● ○ <sub>Bb</sub> ○ / ● ● F <sub>0</sub>	● ○ <sub>Bb</sub> ○ / ● ● F <sub>0</sub>	● ○ <sub>Bb</sub> ○ / ● ○ ○	○ ● ● / ● ● F <sub>0</sub>
<i>or</i>	● ○ <sub>Bb</sub> ○ F/ ○ ○ ○	● ○ <sub>Bb</sub> ○ F/ ○ ○ ○		
B <sub>6</sub>	● ○ G/ ○ ○ ○	● ○ G/ ○ ○ ○	● ○ G/ ○ ○ ○ <sup>d</sup>	● ○ <sub>Bb</sub> ○ <sup>g</sup> $\sharp$ / ● ○ ○ <sub>c</sub>
C <sub>7</sub>	○ <sub>c</sub> ● G/ ○ ● ●	○ <sub>0</sub> ● G/ ○ ● ●	○ <sub>0</sub> ● G/ ● ● ●	○ ● ● / ○ ● ○ <sub>c</sub>

<sup>a</sup>The G key and either or both thumb keys are optional for these groups of fingerings on either Carte system.

<sup>b</sup>The thumb B<sub>b</sub> key is optional on either Carte system for these fingerings; both thumb keys are optional on the 1850 system only.



<sup>c</sup>The thumb C key is optional for these fingerings on the 1850 system.

<sup>d</sup>The 1850-system flute in the collection of Glennis Stout (no. 26) lacks this C<sub>3</sub> fingering.

<sup>e</sup>The B $\flat$  key is optional on the 1851 system, and the G key on either Carte system.

<sup>f</sup>The upper thumb plate and G key are optional on both Carte systems for these fingerings.

<sup>g</sup>The 1850-system flute in the collection of Glennis Stout (no. 26) may require the thumb C key for these fingerings.

<sup>h</sup>The thumb key is optional for this fingering on 1851-system flutes; the G key is optional on Boehm flutes and those of either Carte system.

<sup>i</sup>The B $\flat$  key is optional for this fingering on 1851-system flutes; the upper thumb plate is optional on both Carte systems.

<sup>j</sup>The upper thumb plate is optional for this fingering.

The plate IV connection for C $\sharp$  (without alternative) presents the same problem in a D $\flat$  major arpeggio as does the Boehm flute without thumb B $\flat$  in an E $\flat$  major arpeggio (example 2). Example 3a illustrates this in a passage from a duet by Blavet, so simple to play on the one-keyed flute for which it was written! The answering phrase in the second flute part (example 3b) can be played with equal ease on instruments of either the 1850 or the 1851 design. Of course, some passages are somewhat easier using the 1850 design, as example 4 illustrates; the 1850 and 1851 fingerings are both immensely easier than those for the Boehm and eight-keyed flutes. The essentially “old system” right-hand fingering of the 1850–51 system facilitates the fingering of sharp keys, but the Boehm right-hand system is simpler in flat keys.

1850-system fingering

C	○	●	B $\flat$	●	●
○	○	○	○	○	○
○	○	○	○	○	○
○	○	○	○	○	○
○	○	○	○	○	○
○	○	○	○	○	○
D $\sharp$	D $\sharp$	D $\sharp$	D $\sharp$	D $\sharp$	D $\sharp$

1851-system fingering

○	●	●	●	●
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	○	○	○
○	○	F	○	○
D $\sharp$	D $\sharp$	D $\sharp$	D $\sharp$	D $\sharp$

EXAMPLE 1. *Duet in A Minor* by Johann Joachim Quantz, first flute part, measure 20 (repeated in the second flute part, measure 22).

1850 Boehm

EXAMPLE 2. Fingerings for a  $D\flat$ -Major arpeggio on the Carte 1850-system flute and an  $E\flat$ -Major arpeggio on the Boehm flute.

1850-system fingering 1851-system fingering

EXAMPLE 3a. *Duet in G Major* by Michel Blavet, second movement, first flute part, measure 16.

1850-system (or 1851-system) fingering 1851-system fingering

(or, alternately, exactly the same fingering as for the 1850 system)

EXAMPLE 3b. Answering phrase in the second flute part, measure 17.

Fingerings for the Carte systems of 1850 and 1851,  
and the Boehm and eight-keyed flutes

1850:

	○	●	○	●
	Bb ○	Bb ○	Bb ○	Bb ○
1850:	○	○	○	○
	○	○	○	○
	○	○	○	○
	○	○	○	○

1851:

	○	●	○	●
	○	Bb ○	○	Bb ○
1851:	○	○	○	○
	○	○	○	○
	○	○	○	○
	D# ○	D# ○	D# ○	D# ○

Boehm  
(without  
thumb Bb):

	○	●	○	●
	●	○	●	○
	○	●	○	●
	○	○	○	○
	○	○	○	○
	D# ○	D# ○	D# ○	D# ○

Eight-keyed  
Flute:

	○	●	○	●
	●	Bb ●	●	Bb ●
	●	○	●	○
	○	○	○	○
	○	○	○	○
	○	○	○	○
	D# ○	D# ○	D# ○	D# ○

EXAMPLE 4. *Concerto for Flute and Harp*, K. 299, by Wolfgang Amadeus Mozart, second movement, measure 93, flute part.

In December of 1866, Carte applied for a patent (granted the following June) for the system known as the “Carte and Boehm Systems Combined,” or simply the “1867 Patent System” (fig. 3).<sup>7</sup> The left-hand mechanism is

7. Patent Rolls for 1867, No. 3208, issued to Richard Carte on June 4, 1867.

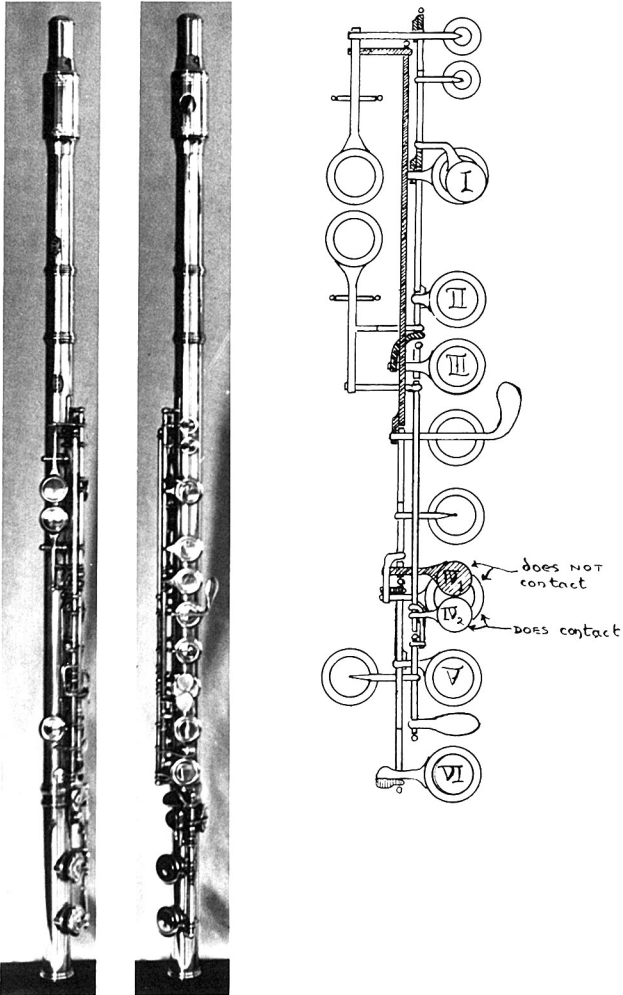


FIGURE 3. A Carte flute from the author's collection, of the type patented in 1867 with "Carte and Boehm Systems Combined," made by Rudall, Carte, and Company, London. All parts pinned to the rod that move rigidly together are indicated with hatching in the same direction.

identical with that of the 1851 model. (The 1851 left-hand system had already combined the Boehm and the Carte 1850 mechanisms.) It is in the right hand that a new combination of the Boehm and the old-style Carte mechanisms is made. Two plates are provided for the right forefinger, the one toward the embouchure ( $IV_1$  in fig. 3) functioning in the same way as in the 1851 system, the other ( $IV_2$  in fig. 3) closing the  $F\sharp$  pad to produce  $F$ . Plate  $IV_2$  works the  $B\flat$  connection in the same way as the cross  $F$  key, thus preserving the Boehm  $B\flat$  fingering:  $\bullet\circ\circ/\bullet\circ\circ D\sharp$ . This plate  $IV_2$  replaces the left-hand  $F$ , and the connection from plate VI provides the Boehm  $F\sharp$  instead of a forked  $F$ . This cured an acoustical flaw in the 1850–51 models, which have the same problem with  $E_6\flat$  that the closed  $G\sharp$  of the Boehm system (without “split  $E$ ”) does with  $E_6$ .

This system has been applied to all sizes of flute: a piccolo built in this way is illustrated in fig. 4, and fig. 5 shows an alto flute of this type.

Another derivative of Carte’s 1851 system is the Radcliffe model made by Rudall, Carte and Company (fig. 6). It retains the right-hand mechanism of 1851, but simplifies the left hand by eliminating the open  $D$ . The  $G\sharp$  is closed (the  $G\sharp$  articulation turns into a “split  $E$ ,” and the closed  $G\sharp$  is not articulated), and the left-hand fingerings are essentially the same as for the closed- $G\sharp$  Boehm system (except for the thumb-key arrangement). The same left hand, with the right hand from the 1867 system, is known as the “Guards” model.

Fig. 7 shows a flute mechanism that Boehm patented in 1854. The thumb-key arrangement is practically the same as that of Carte’s 1851 system, and the right hand is Carte’s 1850 mechanism moved up a semitone and brought around to the near side for the  $B\flat$  connection.<sup>8</sup> Carte’s 1850 right-hand system also shows up on Clinton’s “Equisonant” flute, but with the left-hand  $F$  omitted.<sup>9</sup> The version of this system made by Rudall, Carte, and Company (fig. 8) retained the left-hand  $F$ .

These ingenious flute mechanisms inspired by Boehm’s invention were intended to make the acoustical characteristics of the Boehm flute available to players of the pre-Boehm flute, who could use them without relearning as many fingerings. But since they offered no real advantages over the Boehm system, which has a fingering pattern significantly simpler than that of the pre-Boehm flute, the new generation of players did not adopt them.

8. Privilegium of March 18, 1854, granted to Theobald Boehm. Illustrated in Karl Ventzke, *Die Boehmflöte* (Frankfurt-am-Main: Verlag das Musikinstrument, 1966), fig. 12a.

9. See Nancy Toff, *The Development of the Modern Flute* (New York: Taplinger Publishing Co., 1979), p. 93, figs. 68, 69, for an illustration of this model.

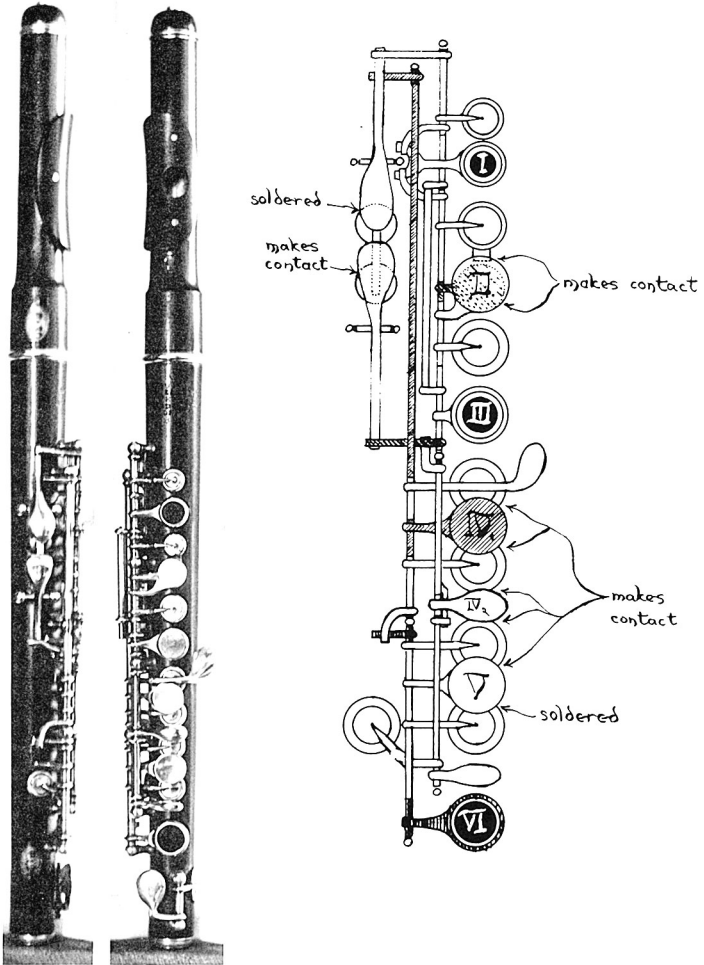


FIGURE 4. Piccolo from the author's collection using the same system as the flute in fig. 3. Rudall, Carte, and Company, London. Dotted lines indicate hidden parts; open fingerholes are represented in solid black; and all parts pinned to the rod that move rigidly together are indicated with hatching in the same direction. Plate III, perhaps originally a ring on this instrument, is shown as such on the diagram.

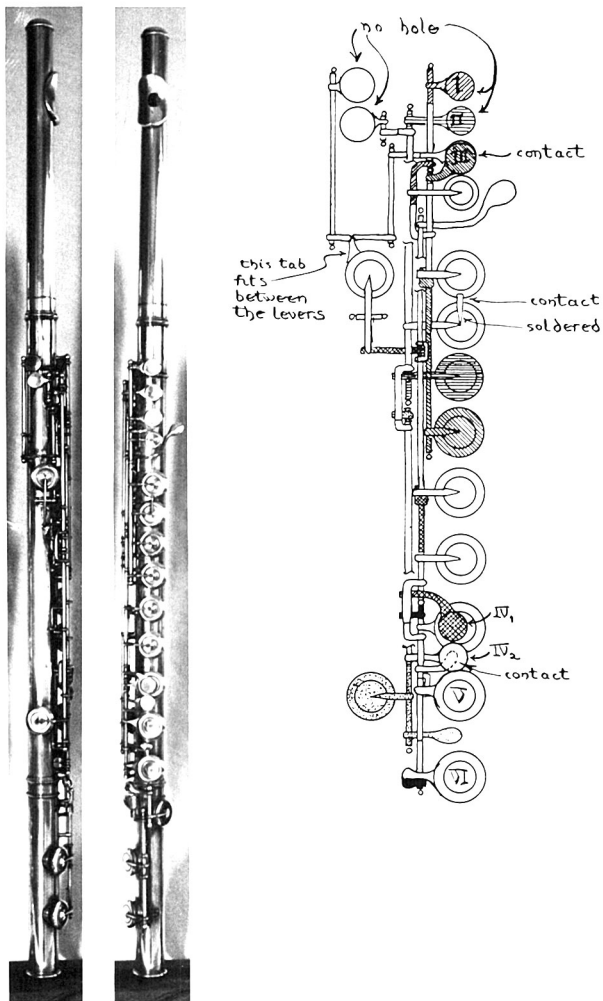


FIGURE 5. Alto flute from the author's collection with the same system as the flute shown in fig. 3. Rudall, Carte, and Company, London. Dotted lines indicate the hidden part; all parts pinned to the rod that move rigidly together are indicated in solid black or with hatching in the same direction.

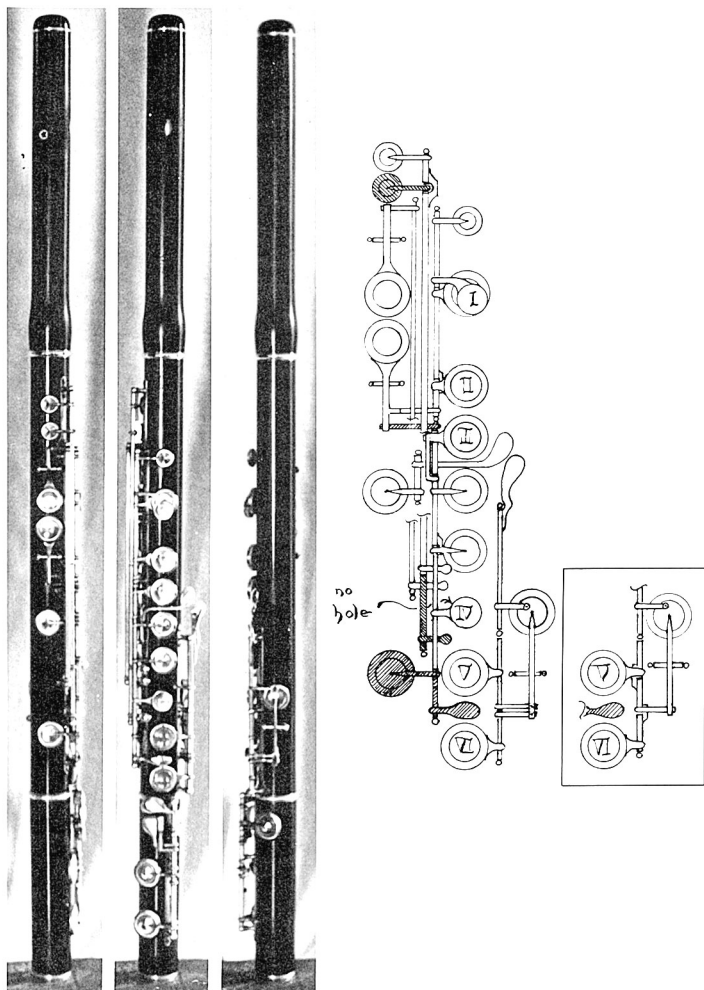


FIGURE 6. Radcliffe model flute in the author's collection. Rudall, Carte, and Company, London. Parts pinned to the rod that move rigidly together are indicated with hatching in the same direction. Inset: forked-F mechanism on a Radcliffe-model flute by Colonieu in the Dayton C. Miller Collection, no. 1132.



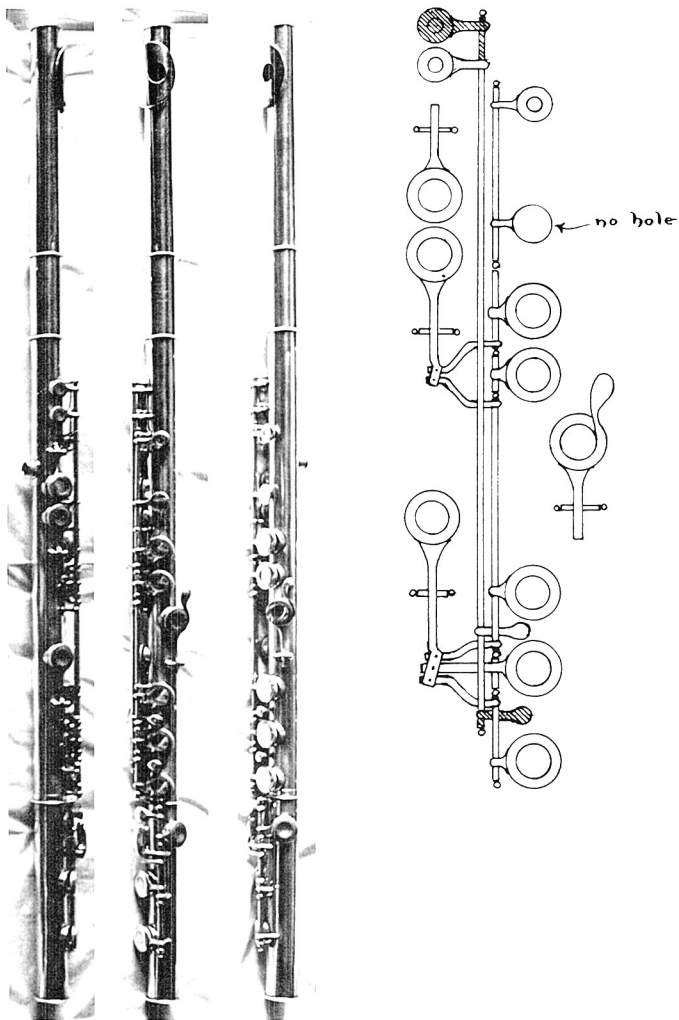


FIGURE 7. Flute by Theobald Boehm, patented in 1854. Boehm und Mendler, Munich. Collection of Glennis Stout, no. 25. Parts pinned to the rod that move rigidly together are indicated with hatching.

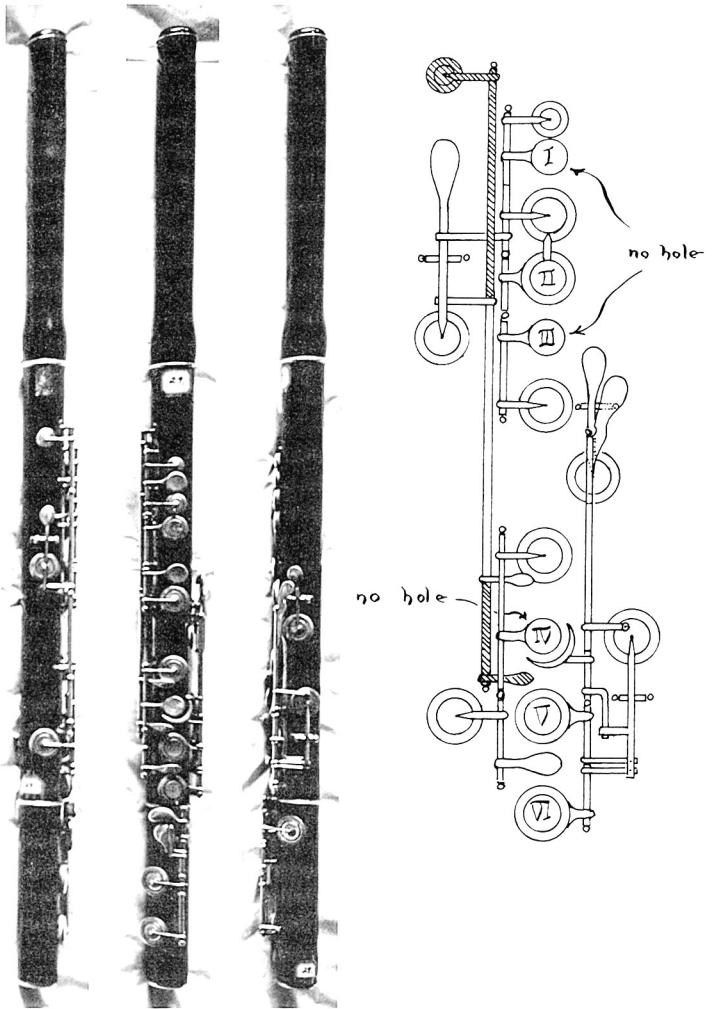


FIGURE 8. A version of the Clinton Equisonant flute made by Rudall, Carte, and Company, London. Collection of Glennis Stout, no. 29. Parts pinned to the rod that move rigidly together are indicated with diagonal hatching.

The author, however, uses the instruments shown in figs. 3, 4, and 5 regularly in performance. While systems such as the Carte designs of 1851 and 1867, the Radcliffe flute, and the “Guards” model, essentially unknown outside of Britain (where some makers will still supply 1867-system instruments on special order), have passed into oblivion elsewhere as far as flute makers are concerned, the existing instruments, particularly those built according to the 1867 system, continue to interest both collectors and performers.

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