



OXFORD JOURNALS
OXFORD UNIVERSITY PRESS

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Source: *Early Music*, Nov., 1986, Vol. 14, No. 4 (Nov., 1986), pp. 545-551

Published by: Oxford University Press

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DISCUSSION

Cary Karp

The early history of the clarinet and chalumeau

The histories of the clarinet¹ and the chalumeau² have received considerable attention both as far as organology and performance practice are concerned,³ and although a satisfactory account of the early development of the clarinet has yet to be written, the once enigmatic question of the identity of the chalumeau⁴ is now widely regarded as resolved.⁵

Within the surviving body of 18th-century two-keyed single-reed instruments (once all regarded as clarinets because of their mouthpieces),⁶ a distinction can be made between those with diametrically opposing keys⁷ and no bell,⁸ and those with non-opposing keys and a marked expanding bell. Since all later clarinets have bells and register keys,⁹ it may reasonably be assumed that any early 18th-century instrument with a register key and a bell is a clarinet, and one without either might then be correctly regarded as a chalumeau. The music specifically written for the two instruments supports this conclusion.¹⁰

Thus the instrument by Johann Christoph Denner¹¹ in Munich, previously regarded as the prototypical clarinet,¹² was reclassified as a chalumeau. The instruments made by Jakob Denner¹³ were regarded as proper clarinets of the type invented by his father J. C. Denner, despite the absence of similar instruments bearing the latter's name.

The importance with which J. C. Denner has traditionally been regarded in this context is based on the famous statement by the Nuremberg historian J. G. Doppelmayr:

Zuletzt trieb ihn sein Kunst-Belieben an noch dahin, wie er noch ein mehrers durch seine Erfindung und Verbesserung bey bemeldten Instrumenten dargeben mögte, diese gute Vorhaben erreichte auch würrklich einen erwünschten Effekt, indeme er zu Anfang dieses lauffenden Seculi, eine neue Arth von Pfeiffenwercken, die so genannte Clarinette, zu der Music-Liebenden grosen Vergnugen ausfande, ferner wiederum die vor alten Zeiten schon bekandte Stock- oder Racketten-Fagotte, endlich auch die Chalumeaux verbesserter darstellte.¹⁴

And finally he was driven by his affinity for the art yet further, as is repeatedly shown by his invention and

improvement of the forementioned instruments, this good intention really did attain a desired effect, in that at the beginning of this present century, he invented a new kind of wind instrument, the so-called clarinet, to the great delight of music lovers, furthermore he improved the stock- or rackett-bassoons which were already known in the olden days, and finally also presented improved chalumeaux.

It must be emphasized that Doppelmayr says nothing very specific about the order in which Denner's innovations were made. If anything, it is suggested that the invention of the clarinet preceded the improvement of the chalumeaux (instruments which, it should be noted, are referred to in the plural form).¹⁵

An examination of the two-keyed instrument by J. C. Denner mentioned above does not support the view that his 'improvements' to the chalumeaux consisted of fitting paired keys and heteroglot mouthpieces (that is, separate single-reed mouthpieces to which the reed is attached). These features are also to be found on other instruments, and until their dates of manufacture can be established,¹⁶ the maker of the earliest two-keyed heteroglot chalumeau cannot be identified.¹⁷ Doppelmayr's reference to chalumeaux in the plural form indicates that they may already have consisted of a group of different sized instruments before Denner's improvements. These are unlikely to have been idio-glot (that is, a single tube with a tongue cut into its side). Doppelmayr does not claim that Denner's improvements involved any basic structural modifications, and his chalumeaux may have been noteworthy simply for their qualitative superiority.

It is reasonable, nonetheless, to suppose that as the inventor of the clarinet, J. C. Denner would have incorporated into his chalumeaux at least some of the innovative techniques which he developed on the clarinet (or vice versa). It therefore remains very possible that he was the first to apply a heteroglot single-reed mouthpiece to a woodwind instrument, as well as the first to attach keys to a chalumeau.

The concept of the heteroglot reed was well known to contemporary organ builders, with whom any

interested recorder maker could at least have had discussions about the voicing of labial pipes.¹⁸ It is also worth noting that the tools needed to carve and voice a single-reed mouthpiece are substantially identical to those needed to carve and voice a recorder. The beak form usually encountered on single-reed mouthpieces is also a perfectly natural solution for the recorder maker to the problem of rendering such a device comfortable to hold in the mouth. Fitting a single-reed mouthpiece to a woodwind instrument was, therefore, something of which many recorder makers would have been capable. (In fact, a keyless chalumeau can be 'created' simply by replacing the recorder's tone generating mechanism with a single-reed mouthpiece.) The similarity between the early 18th-century chalumeau and the recorder is clearly demonstrated by their exterior profiles; the resemblance between the profiles of a two-keyed clarinet bell and the foot joint of a bass recorder is also worth noting.

It is usually assumed that the heteroglot mouthpiece was first developed for the chalumeau, and derived from the idioglot reed of a simpler type of chalumeau. Photographic and iconographic evidence exists of what may have been idioglot chalumeaux,¹⁹ but it cannot be proved that these developed into the heteroglot instruments. The organ reed pipe was significantly closer in design to the heteroglot mouthpiece, and the idioglot chalumeau (if it really existed) may at most have provided a source of inspiration for the experiments that led to the design of the heteroglot woodwind.²⁰

In any case, an idioglot reed of the type referred to above (see fn.19) cannot be controlled by the player's embouchure to anything like the same extent as a heteroglot reed. Furthermore, it is virtually impossible for the player's tongue to articulate an idioglot reed in the fashion required by all known specified chalumeau music. Indeed, the upward orientation of these reeds would seem to have been intended to prevent the tongue from interfering with their vibration.²¹ Thus the chalumeau, in the sense that the term is used here, must have been a heteroglot instrument, and its first builder an inventor. Among the makers known to us, J. C. Denner remains the likeliest candidate, though our reasons for honouring him are as much romantic as objective.²²

Doppelmayer's attribution of the invention of the clarinet to J. C. Denner was reconsidered²³ when it was noted that the only surviving of the three J. C. Denner

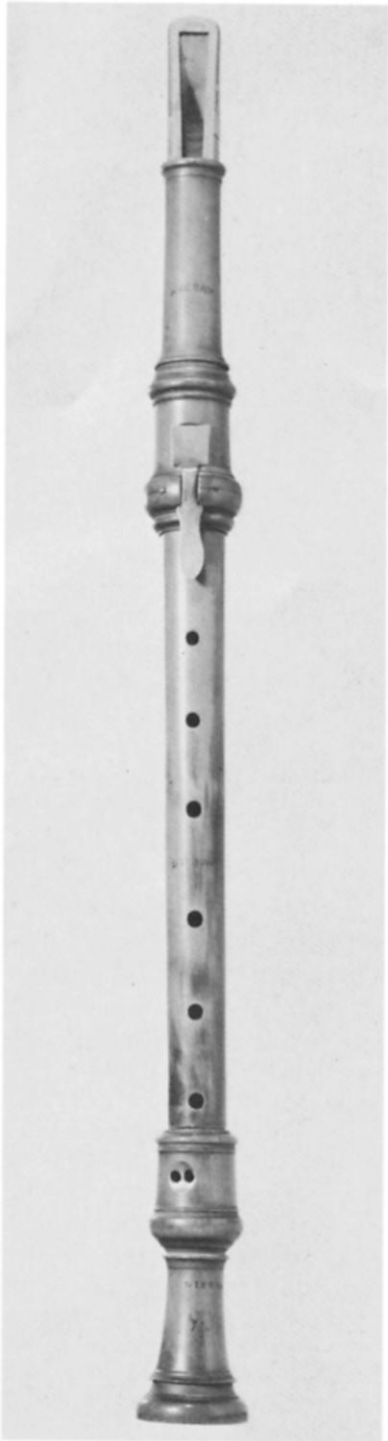
clarinets once thought to have been in Nuremberg²⁴ in fact bore the stamp of Jakob Denner. If the markings on the two missing instruments had also been misread it might be possible that Jakob Denner, and not Johann Christoph, was the inventor of the clarinet, but if so, a number of chronological inconsistencies and factual errors in Doppelmayer's statement would require explanation.²⁵

However, a clarinet has recently come to light in the University of California at Berkeley which bears J. C. Denner's stamp.²⁶ In addition to the two keys one would expect to find on such a clarinet, there is on its bell a third key; one more than was common decades later.²⁷ In the meantime, attention was drawn to an instrument that, but for its bulb-bell, would be regarded as a chalumeau, also fitted with a third key.²⁸ It is also of interest to consider a seven-keyed chalumeau now in Stockholm,²⁹ in addition to Diderot's keyless chalumeau³⁰ and, for the sake of completeness, two idioglot instruments: the one-keyed instrument illustrated by Reynvaan,³¹ and the keyless leather-covered instrument exhibited in London in 1902.³² Despite the fact that several of these instruments might be considered to lie outside the relevant field,³³ it is clear that to attempt to define a neat morphological distinction between the clarinet and the chalumeau is dangerous.

The mouthpiece of the J. C. Denner clarinet is missing and its bell, though unstamped, can reasonably be ascribed to Denner on stylistic grounds,³⁴ and well matches the stamped middle joint. Some important dimensions of the middle joint, such as the finger-hole positions, turned diameters and tenon sizes,³⁵ differ little from those of the middle joint of the J. C. Denner chalumeau. There is, however, one very important difference, in that the clarinet's keys are mounted directly on the middle joint, whereas the chalumeau's are not. The upper joint of the chalumeau consists both of the mouthpiece and a longer extension on to which the keys are mounted.

All known chalumeaux and two-keyed clarinets can be played with the reed pointing either upwards or downwards.³⁶ The reversal is accomplished by rotating the mouthpiece, or if the keys are attached to it, by interchanging them in their mounts and then rotating the mouthpiece.³⁷ Only symmetrically mounted keys can be interchanged in this fashion. It would therefore be expected that instruments with non-symmetrically mounted keys would have upper joints entirely free of keywork.

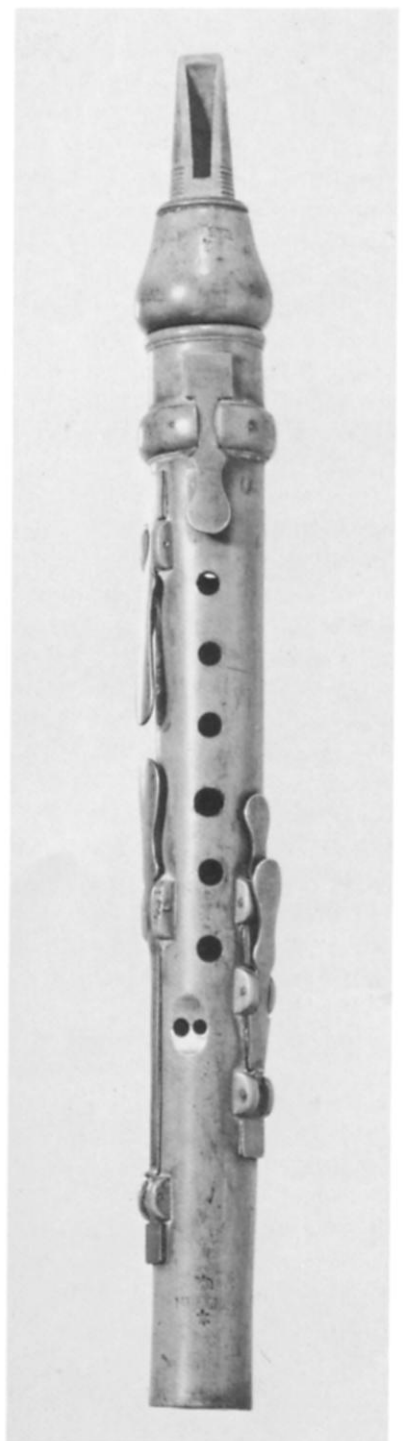
With this in mind, it can be seen that the essential



1 Chalumeau by Liebau (ex-Musikmuseet, Stockholm, cat.no.M143), early 18th century.



2 Chalumeau by Liebau (Musikmuseet, Stockholm, cat.no.M139). Note the interchangeable keys and the mouthpiece opening, which extends along the full length of the reed.



3 One of several instruments that cannot be defined unambiguously as either a chalumeau or a clarinet (Musikmuseet, Stockholm, cat.no.M140).

difference between the middle joints of the two J. C. Denner instruments is that one was intended for an instrument with diametrically opposing keys, and the other for an instrument with non-diametrically opposing keys—for an instrument with a register key. If we wish to question the authenticity of the unsigned bell of the three-keyed instrument, we can speculate as to whether it could originally have been fitted simply with a regular recorder-profile chalumeau foot joint; indeed, authenticating the keyed bell would not warrant ignoring the possibility. Despite the fact that this instrument incorporates both a register key and an expanding bell, it would be unwise to assume that these devices came into use on single-reed instruments simultaneously.

For those intent on demonstrating that J. C. Denner actually invented the clarinet, there is a good deal of justification in doing so by ascribing to him the invention of the register key.³⁸ In so doing, however, it will be realized that the chalumeau and the clarinet are not necessarily the altogether different morphological entities they are often made out to be. It is nonetheless useful to make a distinction between the two instruments based solely on the presence or absence of a register key. It remains to be seen if these definitions have historical precedence.

In passing, it is interesting to note that the only other Baroque woodwind with a register hole device was the recorder, whose thumbhole is partially opened to effect register shifts. Considering the recorder's probable role in the development of the chalumeau, it may be suggested that the clarinet, no less than the chalumeau, was an offspring of the recorder (whichever of them came first). More than the relatively short-lived chalumeau, the clarinet may be regarded as successor to the recorder, as the oboe, transverse flute, recorder and bassoon of the baroque yielded to the oboe, transverse flute, clarinet and bassoon of later periods. One could perhaps even suggest that the development of the clarinet should bear the ultimate responsibility for the recorder's demise.

Since the later part of the 18th century, the clarinet has been characterized by its very wide range, which is due in large part to overblowing by a 12th.³⁹ Of its three registers, the fundamental is known as the 'chalumeau', the first overblown as the 'clarinet' (or 'clarion'), and the second as the 'extreme'; the chalumeau itself was clearly the namesake of the clarinet's chalumeau register, and the chalumeaux for which Graupner and others composed were indeed used in their funda-

mental registers.⁴⁰ This is to be expected, since neither of the opposing keys on this type of instrument functions satisfactorily as a register key. Characteristic of the early clarinet is the restricted usefulness of its chalumeau register, as is confirmed both by composers' generally limited and cautious treatment of it,⁴¹ and by those who have examined the playing characteristics of older instruments. Thus, both the early clarinet and the concept of the clarinet register can be associated primarily with the use of overblowing. In this context the often-quoted comment that a clarinet 'klingt von ferne einer Trompete ziemlich ähnlich' ('sounds from a distance rather similar to a trumpet'),⁴² probably explains the origin of its name—an instrument with a clarion, or trumpet-like sound. The Graupnerian chalumeau, in contrast, sounds very much like a modern clarinet played softly in its chalumeau register.⁴³

Another instrument, known by name only, was that for which Walsh published *A Collection of Ayers fitted for the new instrument call'd the Mock Trumpet*.⁴⁴ It was said of mock trumpets that 'it is difficult to distinguish them from real trumpets'⁴⁵ and music for them was sold as being also 'very proper for ye Brazen Trumpet'.⁴⁶ Whatever it was, the mock trumpet must have sounded very much like a real trumpet. It appears to have been a leather-covered seven-holed reed instrument, played with no particular embouchure control over the reed. Sometimes simply called a 'trumpet', its published music and fingering system seem to imply that it was no more than an English name for chalumeau.⁴⁷ If so, here would be evidence of the existence of a keyless chalumeau which Denner could have improved, although, being 'new' in 1698, it was presumably only invented towards the end of the 17th century. Day may have illustrated such an instrument, but he describes it as sounding very much like a clarinet playing in its fundamental register, as is confirmed by his list of the tones produced by the instrument.⁴⁸

If the mock trumpet is indeed to be identified with the chalumeau, the latter's sound must be reconciled to that of a trumpet. In 1713, Mattheson wrote that:

*Den so genandten Chalumeaux mag vergönnet seyn dass sie sich mit ihrer etwas heulenden Symphonie des Abends im Junio oder Julio, niemals aber in Januario auff dem Wasser zum Ständchen und zwar von weitem hören lassen.*⁴⁹

The so-called chalumeaux may be permitted with their somewhat howling symphony of an evening in June or July, but never in January, to be heard from a distance in a serenade on the water.

*Applicatio
auf das
Clarinett.*

Clarinetto, ist ein zu Anfang dieses Seculi von einem Nürnberger erfundenes/ und einer langen Hautbois nicht ungleiches hölzernes Blas- Instrument, auffer daß ein breites Mundstück daran befestiget ist; es klingt dieses Instrument von ferne einer Trompete zimlich ähnlich/ und gehet von dem Tenor f. bis zum 2. gestrichenen a. auch zuweilen ins 3. gestrichene c.

4 Fingering chart for clarinet given in Majer's Museum Musicum (Nuremberg, 1732). The text reads 'Clarinetto, invented at the beginning of this century by a Nuremberger, is a wooden wind instrument not unlike a long oboe, except that a wide mouthpiece is attached to it; this instrument sounds from a distance rather similar to a trumpet, and goes from tenor f up to a double prime and sometimes up to c triple prime'.

In 1732, Majer reported that the chalumeaux 'sind absonderlich ratione des schweren Ansatzes sehr hart zu blasen'⁵⁰ (due especially to the difficult embouchure are very hard to play). It is likely from the dates and contexts of these comments that their authors were not merely describing raucous idioglot instruments, though they may have been referring to heteroglot chalumeaux played with poor or no embouchure control.

It is possible that the chalumeau also had a clarinet register, despite the fact that most of its repertoire was clearly intended for a non-overblowing instrument.⁵¹ The Stockholm instruments will easily speak in a trumpet-like register, by affixing the reeds to their mouthpieces so that air leaks between the base of the reed and the edge of the mouthpiece.⁵² Almost all

known early chalumeaux, including J. C. Denner's, were built in such a way that this was possible.⁵³ It can be demonstrated on the Stockholm instruments that with a little wax the reed seals tightly and the instrument is a well-behaved chalumeau, whereas without the wax it produces sounds as similar to a trumpet as does an overblown clarinet. What the earlier chalumeau cannot do is provide the player with both registers without continually adjusting the reed and mouthpiece. It must be emphasized, however, that these instruments normally function in the clarinet mode, and that the deliberate addition of wax is necessary for them to function as chalumeaux.

The stage may thus have been set for J. C. Denner (or whoever else it was) to transform one of the chalumeau's keys into a register key. It is not known whether

this was done in an attempt to allow unrestricted switching between the chalumeau and clarinet registers, or to permit the use of the clarinet register without alteration to the mouthpiece. In this case the mouthpieces could have been modified to achieve other musical goals. Since the extreme register did not come into being until the register key had been devised, there was considerable potential for experimentation, and much of the subsequent evolution of the clarinet can be understood in terms of the development of the mouthpiece.⁵⁴

The addition of a register key alone did not double the useful range of the instrument, for the 'bridge' between the chalumeau and clarinet registers caused by overblowing a 12th⁵⁵ presented its own problems (from which the clarinet has yet to be entirely freed). Tuning the instrument equally well throughout its expanded range must also have caused problems. Its subsequent development initially involved improving the quality of the clarinet and extreme registers, and then dealing with the problems of the bridge and chalumeau register, so that the whole range of the instrument was rendered fully effective. The original purpose of the key on the bell, which was abandoned but later replaced, was probably related to the problem with the bridge, though it may also have served to enhance the musical capabilities of the clarinet and extreme registers.⁵⁶

The chalumeau's existence as a separate instrument made it possible to ignore the clarinet's chalumeau register while experimenting with its overblown registers. Improvements to the chalumeau probably continued during the development of the clarinet, with some reciprocal influence between the two. Later chalumeaux, for example, have sophisticated mouthpieces that do not permit the alternate register use discussed above.

Whatever the sequence of the major innovations affecting the clarinet and chalumeau was, the clarinet ultimately assumed the musical roles which it had long shared with the chalumeau. Until then, however, the functional musical concepts of 'chalumeau' and 'clarinet' could not be coupled unambiguously to the instruments with the same names. If no such clear distinction was made during the 18th century, there is little reason to insist on one today.

This is a revised and annotated translation of an article which originally appeared under the title 'Zur Entstehungsgeschichte von Klarinette und Chalumeaux', in Studien zur

Aufführungspraxis und Interpretation von Instrumentalmusik des 18. Jahrhunderts, xix (1983), pp.34–9.

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¹The term clarinet is used here solely to denote the modern orchestral instrument and its immediate antecedents.

²The name chalumeau has been applied to a variety of instruments. It is used here to describe the single-reed instrument used in early 18th-century chamber and orchestral ensembles.

³See F. G. Rendall, *The Clarinet* (London, 1954, rev.3/1971 by P. Bate)

J. H. van der Meer, 'The Chalumeau Problem', *Galpin Society Journal* lbGSJ], xv (1962), pp.89–91

O. Kroll, *Die Klarinette* (Kassel, 1965, Eng. trans., 1968)

H. Becker, 'Das Chalumeau im 18. Jahrhundert', *Speculum Musicae Artis, Festgabe für Heinrich Husmann* (Munich, 1970), pp.23–47

E. Nickel, *Der Holzblasinstrumentenbau in der Freien Reichstadt Nürnberg* (Munich, 1969)

C. Lawson, 'The Chalumeau: Independent Voice or Poor Relation?', *EM*, vii (1979), pp.351–4

N. Shackelton, 'Clarinet' and 'Chalumeau', *New Grove*

C. Lawson, *The Chalumeau in 18th-century Music* (Ann Arbor, 1981)

⁴The question has generated much debate in organological literature, stemming from the widespread and erroneous assumption that the first single-reed instrument bearing J. C. Denner's stamp that came to light in modern times (Munich, Bayrisches Nationalmuseum, Mu 136) was a clarinet rather than a chalumeau.

⁵H. Becker, 'Historische und systematische Aspekte der Instrumentenkunde', *Studia instrumentorum musicae popularis*, ii (1972), pp.184–96

⁶These consist of two chalumeaux in the Bayrisches Nationalmuseum in Munich (Mu136, Mu137), and three in SMS-Musikmuseet in Stockholm (M139, M141, M142). (A fourth instrument once listed there (M143) is missing, but is documented both photographically and metrically.) A larger number of two-keyed clarinets survive, the earliest ones bearing the stamp of Jakob Denner; one of the most significant is the J. C. Denner chalumeau referred to above, fn.4.

⁷The holes covered by diametrically opposing keys are at the same distance from the end of the instrument and lie directly opposite each other across its diameter.

⁸The term bell is used here to denote a marked change in the profile of the bore at its lower end.

⁹Non-opposing keys cover holes that are not directly opposite each other, although the keys themselves are on opposite sides of the instrument. This is exemplified by the A-key and the register (or 'octave') key of the modern Boehm clarinet.

¹⁰See Shackelton (*NG*) and Lawson (1981), *op cit.*

¹¹The renowned and versatile Nuremberg woodwind instrument maker Johann Christoph Denner lived from 1655–1707.

¹²Rendall and Kroll, *op cit*

¹³Jakob Denner (1681–1735) may not have shared the inventive flair of his father, J. C. Denner, but he was a highly skilled instrument maker.

¹⁴J. G. Doppelmayr, *Historische Nachricht von den Nürnbergischen Mathematicis und Künstlern* (Nuremberg, 1730), from Nickel, *op cit*, pp.448–9

¹⁵Cf. J. F. B. C. Majer, *Museum Musicum* (Nuremberg, 1732), and J. G. Walther, *Musicalisches Lexikon* (Leipzig, 1732)

¹⁶The four Stockholm chalumeaux referred to in fn.6 were made

by Liebau and Klenig, both thought to have been active during the early 18th century.

¹⁷Several writers have suggested that the barrel-like shape of the mouthpieces on the two Klenig instruments in Stockholm implies a later date of manufacture than that of the Denner chalumeau. However, these mouthpieces are unlikely to be original, even though they were clearly made by a skilled 18th-century hand.

¹⁸The mouthpiece of the surviving Liebau chalumeau in Stockholm is not beak-shaped, but virtually identical to the shallot of an organ reed pipe (cf. *illus.2*).

¹⁹See V. Reynvaan, *Musijkaal Konst-Woordenboek* (Amsterdam, 1795), reproduced in A. Carse, *Musical Wind Instruments* (London, 1939), and C. R. Day, *Descriptive Catalogue of Musical Instruments at the Royal Military Exhibition, London 1890* (London, 1891), no.221.

²⁰It should, however, be noted that idioglot instruments become useless when their reeds tire or break, so they are less likely to endure than heteroglot instruments with their replaceable reeds.

²¹The tip of the heteroglot reed is accessible to the player's tongue regardless of the mouthpiece orientation, but an idioglot reed of the type under consideration can be reached by the tongue only if the reed lies downward in the player's mouth.

²²Doppelmayr himself has been accused of subjectivity, in Nickel, *op cit*.

²³Nickel, *op cit*

²⁴F. Jahn, 'Alte Muskinstrumente im Germanischen Nationalmuseum Nürnberg', undated typescript (GNM library)

²⁵Nickel, *op cit*

²⁶T. E. Hoepfich, 'A Three-Key Clarinet by J. C. Denner', *GSJ*, xxxiv (1981), pp.21-32

²⁷Two-keyed instruments were still being built as late as 1750. See, for example, the instrument by I. Scherer in the Musée Instrumental du Conservatoire de Paris (cat.no.E697).

²⁸K. Birsak, 'Das Dreiklappen-Chalumeau im Bayrischen Nationalmuseum in München', *Die Musikforschung*, xxvi (1973), pp.493-7

²⁹Stamped 'Muller', Musikmuseet, Stockholm, cat.no.M140 (see *illus.3*).

³⁰'Chalumeau' in D. Diderot and J. le R. d'Alembert, *Encyclopédie* (Paris, 1767). See also 'Lutherie', pl.4.

³¹*Op cit*

³²Day, *op cit*

³³Idioglot instruments have already been discounted. The bulb-belled and seven-keyed instruments, by virtue of their mouthpieces (with small, well-developed chamber and lay) are unlikely to be first generation chalumeaux. This objection may also apply to the small two-keyed instrument by Stuehnwal (Munich, Bayrisches Nationalmuseum, Mu 137).

³⁴The bell's profile is similar to those of J. C. Denner's bass recorders. See also Hoepfich, *op cit*.

³⁵I am indebted to Friedrich von Huene and Bruce Haynes for providing the respective measurements of the chalumeau and clarinet.

³⁶J. Eppelsheim, 'Das Denner-Chalumeau des Bayrischen Nationalmuseums', *Die Musikforschung*, xxvi (1973), pp.498-500, and C. Karp, 'Chalumeaux', *GSJ*, xxxi (1978), pp.144-6

³⁷Although the holes on the chalumeau lie opposite each other, the keys are not of the same length. The longer one may cover the thumbhole unless it is positioned to lie upwards. The interchangeability of the keys must have been intentional, for it would require far more precise craftsmanship than would occur by chance. The Eb keys on early 18th-century oboes are also mounted symmetrically but are not interchangeable.

³⁸See Shackelton (*NG*), *op cit*.

³⁹The clarinet functions acoustically as though it were a closed pipe. As such, it cannot easily produce even-numbered modes of vibration. It therefore overblows to the third mode of vibration, the 12th above the fundamental, rather than to the octave. If overblown again, it will jump to the fifth mode of vibration. It therefore has a

noticeably wider range than an instrument that overblows both to odd and even modes.

⁴⁰Lawson (1981), *op cit*

⁴¹Shackelton (*NG*), *op cit*

⁴²Cf. Majer, *op cit*

⁴³This is a reasonable description of the sound produced by the Stockholm instruments, and agrees with the impression given by various recordings made on reproduction instruments. Note also the description of the sound of the chalumeau, which '... gibt einen Klang von sich, als wenn ein Mensch durch die Zähne singet' (produces a sound as if a man were singing through his teeth), in J. Walther, *Praecepta der musicalischen Composition* (1708).

⁴⁴Newspaper advertisements for the first and second editions appeared in 1698 and 1699 respectively; a copy survives of the fourth edition (c1706). See Lawson (1981), *op cit*.

⁴⁵From a 1704 advertisement

⁴⁶Fourth edition, cf. fn.44.

⁴⁷T. Dart, 'The Mock Trumpet', *GSJ*, vi (1953), pp.35-40

⁴⁸Day, *op cit*

⁴⁹J. Mattheson, *Das neu-eröffnete Orchester* (Hamburg, 1713).

⁵⁰Majer, *op cit*

⁵¹Lawson (1981), *op cit*

⁵²On a modern clarinet mouthpiece the plane on which the table (that is, the flat part of the mouthpiece to which the reed is held in tight contact) lies extends unimpeded past the lower end of the mouthpiece, and the length of the reed is not limited in that direction. Older mouthpieces are carved with a clear lower end to the table past which the reed cannot project. If the edge (the lower edge of the mouthpiece cavity opening in the table) of the mouthpiece is not well above this barrier, the reed will not be able to seal tightly against it, and air will leak past the lower end of the reed.

⁵³On the Munich Denner, and all but one of the two-keyed Stockholm chalumeaux, the mouthpiece edge lies at the very end of the table. It is not entirely clear whether all the mouthpieces were originally made in this fashion, or whether the tables on some may have been lengthened. Since this type of modification would otherwise have had troublesome consequences, there must have been a good musical reason for doing it: presumably to facilitate reliable overblowing.

⁵⁴See A. H. Benade, *Fundamentals of Musical Acoustics* (New York, 1976), and C. Karp, 'Measuring Single-Reed Mouthpieces', *Musical Instrument Conservation and Technology Journal*, i (1978), pp.19-23.

⁵⁵The gap of a 5th between the upper end of the fundamental octave and the start of the first overblown octave is filled by the use of holes covered by keys. One of the holes also acts as the register hole, but there are difficulties in its dual role.

⁵⁶Holes in the bell of an instrument often have a considerable effect on its tone quality. This is particularly noticeable with the Deutsche Schalmey, which has a number of resonance holes in the bell and a small peg with which to plug one of them; its position has an astonishing effect on the tone quality and function of the entire instrument. Denner may have been trying to make use of this effect by placing a key on the bell hole.

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