THE BASSOON (DER FAGOTT)

by Wilhelm Hermann HECKEL, Biebrich am Rhein Wiesbaden Germany 1931.

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FOREWORD

This essay is a revision of the monograph, Der Fagott, published in 1899[1], and for several years out of print. The revision seems justified both by the demand for a reprinting, and by improvements in the manufacture of the bassoon since the monograph first appeared.

It is further justified perhaps by the many recent contributions to the history of woodwind instruments.[2] Most of the woodwinds were developed in Germany during the middle ages. In general the early instruments had a range of only little more than one octave. The tones were neither chromatic nor of pure intonation. It was thus customary to use several instruments of the same type, but of different sizes, to approximate the range of the modern instrument. The historical development of each member of each of the woodwind families, and their consolidation into fewer instruments of greater range, is thus a subject of lively interest both to the player and to the student of orchestration.

The evolution of each instrument explains why one cannot adapt the instruments of former centuries to modern key-work and still preserve the original tone. The requirements of the pure chromatic scale necessitate changes in the bore of the instrument which inevitably change the tone.

It is this intimate relation between the principles of acoustics and the efficiency of the given instrument in the modern symphony orchestra which justifies an account of the bassoon from the standpoint of the manufacturer. Acoustical theories do not tell the bassoonist why his instrument is built as it is. They tell merely what the instrument should do. But no woodwind with the range of the bassoon has yet reached its theoretical possibilities.

Acoustical principles can, however, be directly applied to an instrument of the organ type. It consists of many separate pipes. They differ in size and they involve several different means of producing sound. Each tone is produced separately and is independent of the other notes. With all woodwind instruments and particularly with the bassoon, the problem of construction is far more difficult. The problem consists in producing as long and as pure a chromatic scale as possible on a single pipe (in the case of the bassoon from Contra A or B^b to f).[2] The solution can be reached only by finer adjustments between the size of the bore (main air column) and the size and position of the finger holes. Each of the holes may be imagined to represent the end of a pipe, which "speaks" only in relation to all the other holes or pipes. The resulting difficulties are obvious.

Another set of problems no less difficult are those resulting from the physical limitations of the performer. Unfortunately for the manufacturer the performer has only two hands, ten fingers, and one mouth. Such limitations require a science of woodwind fingering which conforms to the laws of acoustics as closely as possible, but which in itself is limited by the facts of human anatomy. Moreover, the laws of acoustics, on the one hand, and the performer's capacities, on the other, must both be adapted to the demands of the composer. The widest differences in tempo and in volume of sounds must somehow be produced by the same instrument, and by the same double-reed. The manufacturer who confronts so many conflicting demands has thus no one set of principles to guide him. He must rely mainly on commonsense and on the wisdom born of endless experimentation.

THE EARLY WOODWINDS

The science of woodwind construction emerged from a wealth of tradition. The tradition, which constitutes the history of the woodwinds, has its roots in mythology. It is generally supposed that wind instruments were the first to appear. The very first was doubtless the flute, made many thousands of years ago from the hollow stem of a water plant or from the shinbone of same waterfowl, like the crane. The first flutes were doubtless held straight down from the mouth. The player used one end of the tube as the mouth hole, pressing it against his under lip and blowing across the hole an one can on an empty battle. Such use of a reed stem very probably flattened the end and split it sideways. When the player discovered how to make the split reed speak, with an excitingly different voice than that made by blowing across the round end, he invented the first reed pipe.[3] Such flutes and reed-pipes have been found by anthropologists in almost all primitive societies.

It is natural therefore that the flute should be the oldest orchestral instrument. The transition was apparently from the lip-flute, with an oval blow-hole, to the flute which was plugged with a wind-slit in the mouthpiece[4] (i.e. fipple flute) and then back to a refinement of the flute held across the mouth, which sounded like the modem orchestral flute.

The second oldest instrument in the orchestra is the bassoon. It developed from the doublereed bass instrument, the *Dulcian*, by stages later described.

The third oldest of the woodwinds is the oboe. It developed, toward the end of the 17th century in Germany, from the instrument known in the Middle Ages as the *Schalm*.[5] The oboe's forerunners also include the old German Zink,[6] a straight or slightly curved wooden horn with finger holes on one side, which was covered with leather and fitted with a cup-shaped mouth-piece. It sounded like the harsh tone of the old oboe, different though the two instruments were in type. The Zink was used for a long time, because of its chromatic scale. It took the place of the earlier natural trumpet, until the invention of the valve trumpet (c. 1830), which occurred during the last century. The larger sizes of the oboe are the *Oboe d'amore* (in A) and the *Oboe da caccia* (in F). The latter is an alto oboe, which later became the *English Horn*. For the baritone register, the *Baritone-Oboe* was added at the beginning of the 19th century, and a century later the *Heckelphone*.

Fourth and youngest of the woodwinds is the clarinet. It was probably created about 1690 by Johann Christoph Denner of Nurnberg from the single-reed *Chalumeau*. The first clarinets had a narrow bore to produce the effect of the high register of the trumpet during the 16th and 17th centuries. The most favored clarinet at the time of Mozart was the soft-toned *Bassethorn*,[7] a long alto clarinet in F. The clarinet family was later increased by the Bass and the Contra-Bass-Clarinets.

Returning to the bassoon, one finds more legends than facts concerning its origin.[8] Legend ascribes its invention to Canon Afranio of Ferrara in 1539, who is said to have cut the old *Bass Pommer* in half and placed the two pieces side by side. But that Afranio contributed little or nothing to the modern Bassoon is clear from the minute description of Afranio's *Phagotum* published in 1539 in Pavia by Afranio's nephew, Tesceo Ambrogio Albonesi. The description and the accompanying illustration show that Afranio's Phagotum was, in all essentials, a bag-pipe.

In point of fact, the bassoon probably evolved from the eight-foot Bass Pommer or *Bombard* which was in general use during the 16th century. The Pommer[9] was a long straight wooden tube with nine finger holes. Two of the holes could not be reached by the fingers and so were reached by keys.

Curt Sachs,[10] however, maintains that the bassoon family developed beside the Pommer from the Dulcian. Probably both views are correct. The Pommer contributed the pitch and range; the Dulcian gave the U-shaped bend of the double and conical tube which made the tone-color softer and more flexible. Both instruments carried the S-shaped tube to connect the reed with the horn itself. Both instruments, the Pommer and the Dulcian, although essentially distinct, have somewhat similar tone quality; as shown by comparison of existing specimens. Both may therefore be regarded as parents of the modern bassoon.

The characteristic tone of nearly all doublereed instruments, until about 1750, was a somewhat inflexible and monotonous buzz or hum, not unlike that of the muted saxophone or trumpet in the modern jazz band. The persistence, or the periodic reappearance, of instruments with this buzz implies that they meet a popular demand for rhythm and novelty perhaps, if not for their genuine musical tones. In large part, the noises of the American jazz band instruments which contribute the growls, buzzes, and hums, are much like those made by the old *Krummhorns*.

The Krummhorns[11] are of special interest because they well represent this less important type of instrument as it existed until the middle of the 17th century. The name refers to its shape, a very narrow cylindrical horn with a semi-circular curve at the lower end. The reed of the Krummhorn and kindred instruments was contained in a wooden or ivory wind-cap. This wind-cap operated somewhat like the leather wind-bag of the bagpipe. To make the reed speak the player had merely to blow into the wind-cap through a slit. This made the horn easy to blow, but prevented the player from modulating the tone and from over-blowing into the higher octave.[12]

Another curious member of the bassoon family is the Rackett or Ranket, also nicknamed Sausage-bassoon both in German and in French.[13] But the reed of the Rackett was like that of the modern bassoon and was placed between the lips. The largest Rackett had a crook or S to hold the reed; the smaller ones (and the Krummhorns as well) had a small, straight conical tube instead. The body of the instrument was a squat, jar-shaped block of wood with a cylindrical and very narrow bore, which turned nine times up and down inside the block.

Such ancestors and contemporaries of the bassoon, in fact almost all the old reed-blown instruments except the Dulcian, had a strident but inflexible and soulless tone. In this respect they differed sharply from the flutes[14] of the period, which were singing, tender, and melodious. The difference is explained by the fact that any cylindrically-bored instrument, when blown with a double reed, sounds about an octave lower than one would expect from its length. The lower pitch results from the wind-vibration peculiar to the double-reed. The vibration is caused by the rapid opening and closing of the reed, and the closing of the reed has the effect of a "stopped" pipe in an organ.

Table 1 shows the range of twelve instruments at the beginning of the seventeenth century, as described by Michael Praetorius, in 1619. It shows also that the upper and lower limits of the scale were not chromatic, yet the players may have managed to supply some of the missing notes by half-covering the holes, or by cross-fingering. Praetorius recommends a woodwind section containing five bassoons and seven kinds of Pommer, which is further evidence that the two were contemporary. In the high register the bass-pommer reached only $b^{\#}$ while the bassoon of the same period generally reached d^1 and some bassoons even reached g^1. The table shows the further noteworthy fact that both the *Chorist-Fagott* (or Dulcian) and the Bass-Pommer were in use at the same time and that both had about the same range. It was during this period of transition that several medieval instruments were gradually displaced by others that disappeared.

TABLE 1
COMPASS OF EARLY DOUBLE REED INSTRUMENTS
according to Michael Paetorius, *De Organographia Syntagma Musicum,* 1619. The black notes indicate pitches which could by produced with a suitable reed.

1. Exilent, or Gar Klein Schalmey
2. Diskant Schalmey (contemporary oboe)
3. Diskant Schalmey (contemporary oboe)
4. Diskant Fagott
5. Nicolo
6. Fagott Piccolo, or Einzel Corthal
7. Basset or Tenor Pommer (intermediate baritone oboe)
8. Bass Pommer
9. Dolcian or Chorist Faggott, or 1 Doppel Corthal (contemporary bassoon)
10. Quart Fagott or Fagott Grande
11. Gross Bass Pommer
12. Gross Bass Dolcian (Doppel or Quint Fagott) (contemporary double bassoon)

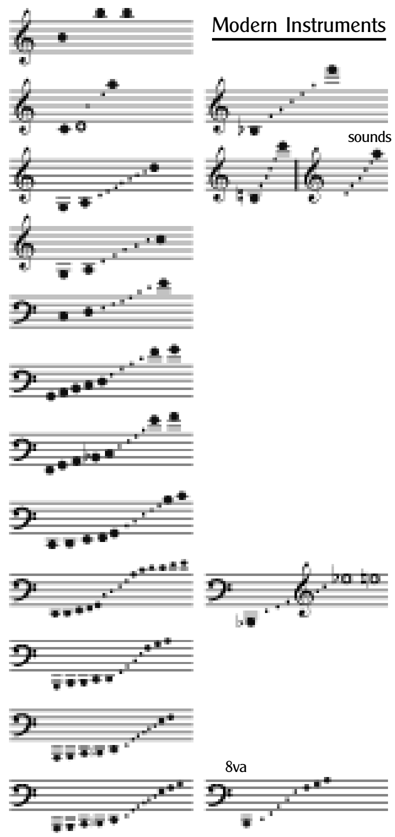


PLATE A

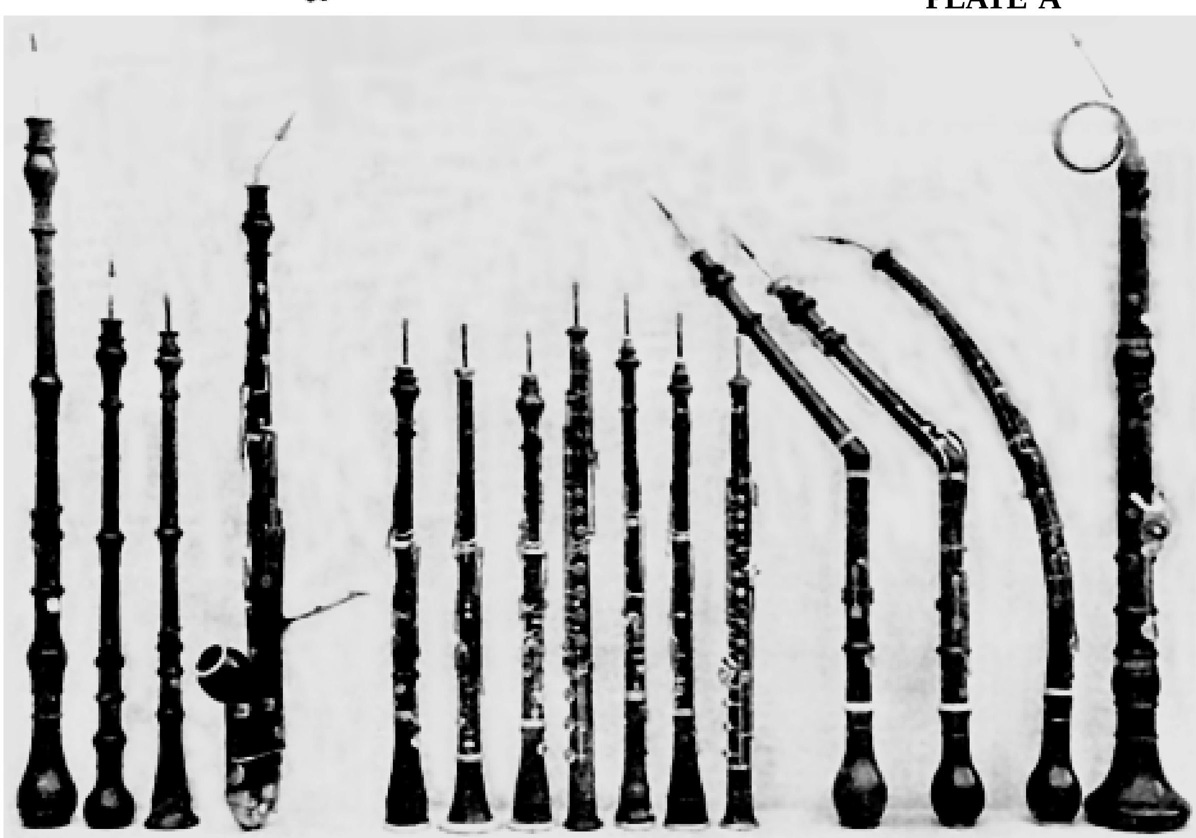


PLATE B

PLATE A - Double-reed instruments, 1500 to 1650, some with cylindrical, others with conical bore. (From Historical Music Museum of Wm. Heckel, Biebrich)

(A) Bass-Pommer (Bomhart, Bombard, Bombarda) came from Naumburg Church choir, now Berlin State Collection. Deepest note sounds C. Facsmile by Heckel 1550/1925.[1]

(B) Grosser Bass-Dulzian (double bass Dolcian, Doppel-Fagott). Heyer-Museum, Koln/Leipzig. The deepest note (C-key) sounds Contra-A^b. Facsimile by Heckel 1575/1925.

(C) Discant-Nicolo (Basset-Pommer). Heyer Museum, Koln/Leipzig. The deepest note sounds c.^{1}

(D) Fagott (Bassoon). Oldest original instrument in the Heckel Museum. Stamped: Joh. Georg Eisenmenger, 17th century. The instrument has five wooden keys; one of them has been added later. The lowest note is Contra-B.

(E) Bass Krummhorn (Krumphorn, Cromorne, Tournebout) Heyer Museum, Koln/Leipzig. If all fingerholes, keys and the two slide-keys are shut, E^b is produced. Facsmile by Heckel 1525/1925.

(F) Discant-Rackett (Ranket). Este Collection in the Historical State Museum, Wien. The lowest note is D. Facsimile by Heckel 1590/1925.

(G) Alto or Tenor-Rackett (Ranket, Wurst-fagott, Cervelas). State Collection, Berlin. Lowest note sounds C. Facsimile by Heckel 1600/1925.

In spite of their shortness, the *Racketts* are as low in pitch as the other Bass instruments. The *Discant-Rackett* has an open socket into which the reed is fitted. The *Nicolo* and the *Krummhorn* have so called closed caps (receptacle, windkapsel) for the reed. The above extreme notes stated to facilitate comparison, are approximately at the normal German pitch, a^{15}-438 vibrations per second.

PLATE B - Doublereed instruments with the register of the Oboe and English Horn, from about 1750 to 1850. (Likewise from the Heckel Museum).

(A) Oboe da caccia (Jagd-Oboe, Hautbois de chasse) in F, predecessor of the English Horn (Cor Anglais) Grundmann-Dresden. State Collection, Berlin. Facsimile by Heckel 1750/1930.

(B) Oboe d'amore (Liebes-Oboe, Hautbois d'amour) in A. Grundmann-Dresden. State Collection, Berlin. Facsimile by Heckel 1774/1930.

(C) Oboe in C. Hammig-Wien. Historical State Museum, Wien. Facsimile by Heckel 1740/1930.

(D) English Horn in F. Mark: Joh. Heinr. Gottl. Streitwolf, Goettingen. Fine specimen-bell bent upwards. Thumb keys for low B^b, A, and A^b. 1830.

(E) Oboe. Mark: C. Golde-Dresden. Silver keys. Grained boxwood, 1840.

(F) Oboe. Mark: Heckel-Biebrich. Fitted with a special keyhole for the middle finger for the forked F, two $F^{\#}$-keys. Body of boxwood with ivory rings and brass keys. 1850.

(G) Oboe. Mark: Heckel-Biebrich. Silver keys; bipartite $F^{\#}$-rings; low B key for left thumb, 1855.

(H) Oboe in C. Boehm-Muenchen. With fingerhole-plates.

(I) Oboe. Mark: Brod-Paris. This instrument has no octave-keys; the octave is produced entirely by lip-pressure; silver keys 1830.

(K) Mark: Triébert-Paris. Precursor of Conservatory model. Silver keys; 1845.

(L) Oboe. Mark: Triébert-Paris. Boehm Oboe with ring mechanism and a plate for left thumb. 1867.

(M) English-Horn in F. Original; bent at an obtuse angle; only C and E^b-keys. 1790.

(N) English-Horn in F. Original; bent at an obtuse angle; eleven brass keys. 1835.

(O) English-Horn in F. Mark: C. W. Roth-Strassburg. Bent in crescent shape; body covered with leather; brass keys. 1845.

(P) Basset-Oboe (Musetten-Bass, Basse de Musette) in C. J. J. Riedlocker-Paris. Facsimile by Heckel 1790/1909.

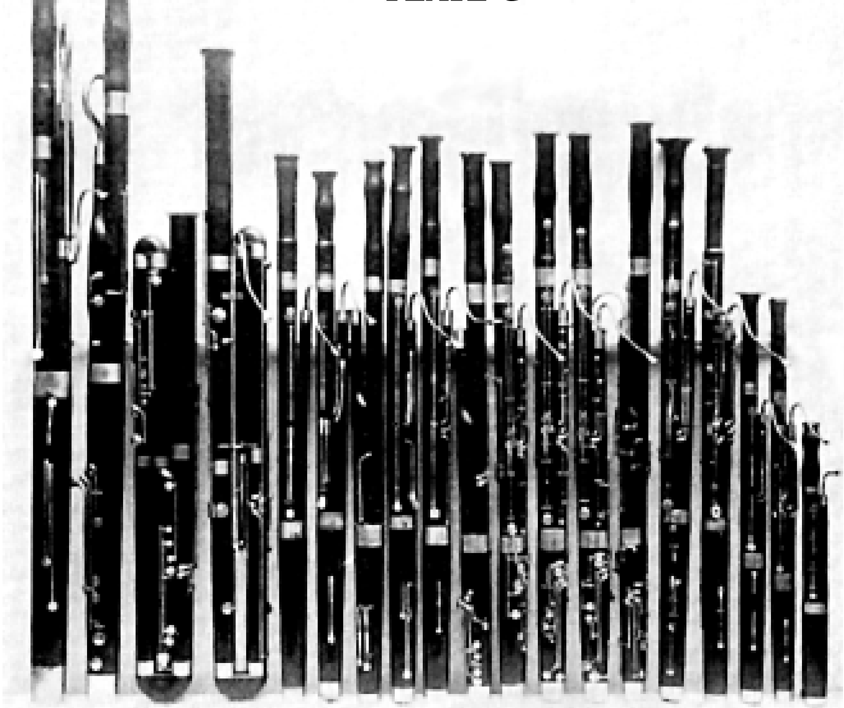
EVOLUTION OF THE BASSOON

One Siegmund Schmitzer of Nurnberg, who died in 1578, is said to have perfected a bassoon which he sold widely in Germany and elsewhere. But it is not likely that the bassoon was made in different places until about a century later– i. e., the close of the 17th century. Thereafter the "bundle of sticks," which the bassoon resembles when the joints are taken apart, well deserved the name fagott from the Italian "il fagotto," meaning bundle. It must be admitted however that the derivation of the word is a puzzle for etymologists.[16]

At the close of the 17 century, the bassoon came to have eleven lateral holes, three of them covered by keys. Its wale ranged from Contra-B^b to A^{b1}. During the next few decades its efficiency was much increased by the addition of new keys. The three original keys were Contra-B^b, D and F. The A^b was then added and soon afterward the E^b key and later the $F^{\#}$ key. By means of another new key the scale was extended upward to a^1 and b^{b1}. Still later the interlocking keys were invented to produce the notes $b^{\natural 1}$, c^2, $c^{\#2}$ d^2 and $d^{\#2}$. At the end of the 18th century, the notes middle $c^{\#}$ and $b^{\flat}$ were cleared by two more keys. By this time the bassoon had become well established in the minds of composers, and hence in the European orchestra.

The composers' increased attention to the instrument naturally made heavier demands upon the players who, in turn, called upon the manufacturers to remove the more important defects in sound and fingering. As of about 1800, the instrument-makers most active in their efforts to improve the bassoon included the Grensers – Karl Augustin (1720-1807) and his nephew Heinrich (1764-1813) - and their successor, Wiesner of Dresden, and later (about 1850) Haseneier of Coblenz. Two leading makers in France were J. N. Savary Fils and Frédéric Triébert. The latter attempted to make bassoons according to the Boehm system, but this construction did not prove satisfactory.

PLATE C



A B C D E F G H I K L M N O P Q R S T

PLATE C - A group of original Bassoons showing evolution from 1750 to 1900. (From the Historical Music Museum of Wilhelm Heckel, Biebrich).

(A) Contrafagott: Mark: B. Schott: but made by J. A. Heckel. Descends to Contra-D. About 1834.

(B) Contrafagott: Mark: Heckel-Biebrich. Descends chromatically to Contra-D. G-key (A-hole with two cups and pads) as on the old Heckel-Bassoon. About 1849.

(C) Contrafagott: Mark: Heckel-Biebrich. Left-handed type, with left hand below. Descends to Contra-C. About 1876.

(D) Contrafagott: Mark: Heckel-Biebrich. Original type of the modern Contra-Bassoon. Had as yet no $C^{\#}$-key on the Wing, and only one such for the right thumb; descends chromatically to Contra-C. This model was played before Richard Wagner in 1879.

(E) Bassoon: Mark: "Dresden." Five brass keys; about 1750.

(F) Bassoon: Mark: not legible. Eight brass keys; about 1820.

(G) Bassoon: Mark: A. Grenser-Dresden. $C^{\#}$-key on the wing for the little finger of the left hand; about 1770.

(H) Bassoon: Mark: W. Hess-Muenchen. The thumb-hole of the long joint is bushed with ivory. The hole for the $C^{\#}$-key on the wing passes through a raised portion of the wood 35 mm. thick; about 1820.

(I) Bassoon: Mark: B. Schott Fils a Mayence, a French mark, although of German production. Over the thumb-hole of the long-joint is a cover-key. This is an Almenraeder instrument; about 1824.

(K) Bassoon: Heckel-Almenraeder Bassoon. On the butt is the E-plate for the right thumb. The $B^{\flat}$-key lies in a waterfree position, and is also operated by the right ring finger by means of a "shank" passing through the partition wall. G-key (A-hole with two cups and pads); slide water-escape tube. Open low $B^{\flat}$-key, characteristic of the Heckel-Almenraeder Bassoon. $C^{\#}$-key an the long-joint; about 1835.

(L) Bassoon: Mark: Heckel-Biebrich Showing early arrangement of the $B^{\flat}$-key and the E-plate for the right thumb; about 1850.

(M) Bassoon: Mark. Heckel Biebrich. Improved E-plate and differently placed $B^{\flat}$-key for the right thumb; long-running $F^{\#}$ and $G^{\#}$ shake-key; $C^{\#}$-key on the butt. Besides the usual three thumb-keys on the wing a $D^{\#}$-key and a high D-key. The G-key (A-hole) lies in a water-free position.

(N) Bassoon: Mark: Heckel-Biebrich. Improved $B^{\flat}$-key and cross moving interlocked $F^{\#}$ and $G^{\#}$ shake-key. First style of $C^{\#}$ and $D^{\#}$ shake-keys on the wing. About 1882.

(O) Bassoon: Mark: Heckel-Biebrich. The G-key fixture of that time is visible. Showing improved $C^{\#}$ and $D^{\#}$ shake-mechanism connected with the C (Octave) key to obtain easier production of the high $b^{\natural 1}$ and c^{2} About 1884.

(P) Bassoon: Mark: J. Horak-Prag. Typical Austrian bell with large rim. Closed low $B^{\flat}$-key; low $B^{\natural}$ and $B^{\flat}$ fingered as usual on the Dresden Bassoons. In the middle of the wing is a tuning slide and both thumb-keys have a sliding adjustment. About 1850.

(Q) Bassoon: Mark: Buffet-Paris. Typical French bassoon in whole appearance and mechanism; in particular the bell shape is of interest. Closed low $B^{\flat}$-key with the characteristic Parisian key-mechanism for the low C, $b^{\natural}$, and $B^{\flat}$ keys. About 1850.

(R) Quartfagott: Mark: Kies-Wien. Bell with wide rim; nine bran keys; about 1800.

(S) Quartfagott: Mark: Savary jeune-Paris. With developed key-mechanism on the long-joint. Descends chromatically to $B^{\flat}$. About 1850.

(T) Piccolo-Bassoon. (Fagottino). Apparently Bohemian model; four brass keys; about 1780.

The Dresden bassoons were preferred for the softness and beauty of their tone. But they could be played easily only in F, $B^{\flat}$, C, and G major, and in g and c minor. These keys served well enough when the bassoons were used merely for accompaniment or for filling in. But as soon as composers began to require a smooth technique in all keys for solo work, the inequality of the different notes in these bassoons became so striking as to render the instrument far less efficient than the flute, oboe, or clarinet. Nor did the addition of a few keys serve to equalize the quality of the different tones. The tones made by means of keys sounded clear enough, but those made by stopping the original holes sounded muffled and foggy. The makers then recognized that the body of the bassoon was at fault and needed important structural changes.

Such structural changes were made by the joint efforts of Carl Almenraeder (1786-1843), a bassoonist, and later by J. A. Heckel (1812-1877), a young instrument-maker, during the decade 1824-1835. The two became friends in the factory of Messrs. B. Schott, Mainz, and on March 11, 1831, established the present house of Heckel in Biebrich on Rhine. Their essential achievements were two - the even strength and purity of notes produced by changes in the bore, and the extension of the practical range to almost four octaves.

Other improvements had less effect on tone and notes, but added much to the player's convenience and hence to the efficiency of the instrument. One such is the water-escape, formerly a cork-plug and now a brass elbow-tube, made fast by screws and packed with India rubber. Another was the $B^{\flat}$ key on the butt, which gave a good "keyed" $B^{\flat}$ instead of the false "forked" $B^{\flat}$. Other keys added for greater clarity of tone and greater facility in fingering were the Contra-$B^{\natural}$, the low $C^{\#}$, and E plate for the right thumb. The middle $c^{\#}$ key was improved to give both the $c^{\#}$ and the $d^{\#}$ without cross fingering. As the larger D-tone hole on the long piece was difficult to cover with the left thumb, the so-called C-plate was reconstructed. The bore of the instrument was also completely changed.

PLATE D - Selection of wind instruments (from the Historical Music Museum of Wilhelm Heckel, Biebrich).

PLATE D

A B C D E F G H I J K L M N O P Q U

(A) Contrabassoon of papier-maché. Very wide bore. Mark: Berthold-Speyer. 1888.

(B) Bass clarinet in $B^{\flat}$, bent at knee-shaped angle. Descends to low D. Mark: Heckel-Biebrich. 1850.

(C) O-Teki (Yoko Fuye). Japanese transverse flute. Original. 1900.

(D) Double flageolet. Mark: Bainbridge and Wood-London. 1830.

(E) Blockflote. (Flûte douce, Recorder) Heckel facsimile. 1600/1925.

(F) Giorgi flute. Mark: Maino e Orsi-Mailand. 1888.

(G) Flageolet-flute. Mark: Goulding and Company-London, with an original Patent Flageolet-head by Hastick-London.

(H) Transverse flute. Mark: Friedr. Gabriel A. Kirst-Potsdam. Heckel Facsimile. 1790/1930.

(I) Krummer Chorzing (Black Zink, curved cornet). Heckel facsimile. 1600/1925.

(J) Clarinet d'amore in G. Mark: Heckel-Biebrich. 1850.

(K) Bass Ophicleide. Mark: Labbaye-Paris. 1822.

(L) Clarinet in C. Heckel facsimile of a Denner instrument. 1700/1926.

(M) Piccolo-Clarinet in A^b. Mark: Heckel-Biebrich. 1850.

(N) Clarinet in C. Mark: H. Grenser-Dresden. 1805.

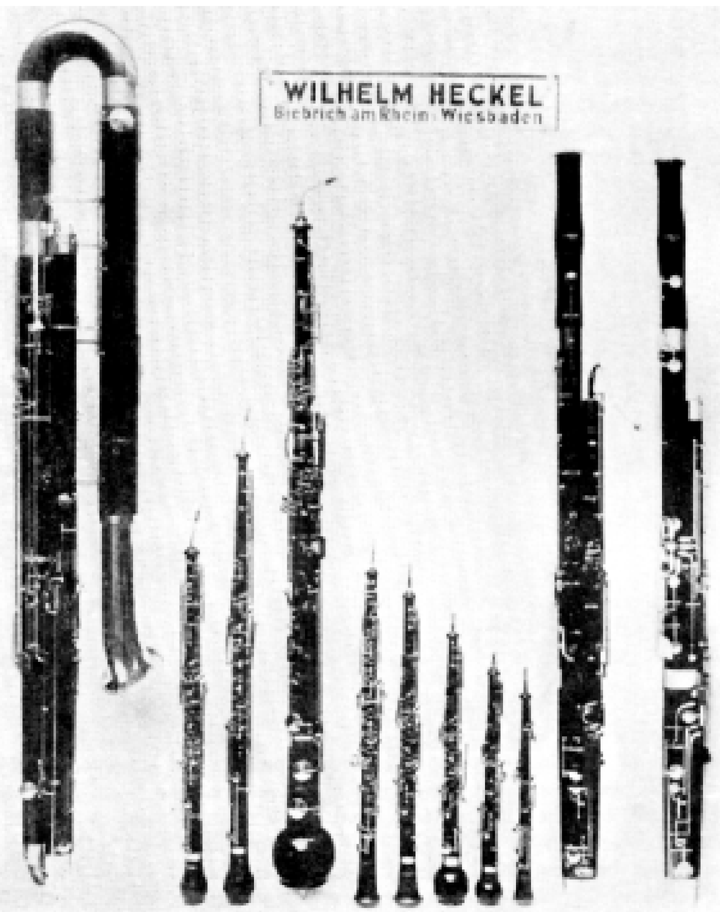
(O) Clarinet in E^b. Body made with double walls of brass. Choice piece. Mark: J. H. G. Streitwolf-Goettingen. 1825.

(P) Clarinet in B^b. Body of brass with raised finger-holes. Mark: Heckel-Biebrich. 1850.

(Q) English-Bass-Horn. (Serpent-fagott, Serpent-Anglais, Russian Bassoon). Original. 1810.

(R) Bass Sarrusophone. Mark: Gautrôt ainé-Paris. 1863.

(S) Klappenhorn (Key bugle, Kent bugle). Mark: J. C. Guender/J. G. G. Fischer-Leipzig. 1833.



A B C D E F G H I J^A J

PLATE E

Despite these improvements, which together served to produce a somewhat new instrument, the equality of notes and the far greater facility of performance had been secured at the expense of the "good old tone." The clear, hard tone and greater volume of the new bassoon was less pleasing than the delicate, soft tone-color of the old. These apparently conflicting virtues were not achieved by the same instrument until further experiments had shown the necessity for changing the size and taper of the bore in relation to the finger holes, and until the development of new tools permitted, more exact gradations in the conical bore and further improvement of the key mechanism. When these changes were made, the old singing quality was restored without loss of volume, clarity, and even strength of the tones, over the wide range of almost four octaves.

Evenness of tone is determined by the relation of the bore to the position of the finger holes. The even tone was not achieved until the principle was developed, somewhat in defiance of the laws of acoustics applicable to other instruments, that three sound holes, namely F, G, and A, determine the position of all the others. The "soul" of the instrument lies between the highest finger hole of the wing and the G-hole (F-key) of the butt. When the correct position of the top finger-hole had been established by repeated experiments with bores of different sizes and tapers, the position of the other finger holes could be determined by experiment.

The peculiar tone-quality of the bassoon is also conditioned by the thickness of the wood at the finger-holes, especially the three main holes at the wing and at the raised $C^\#$ hole. Each of these holes must be drilled obliquely, not only to give the proper pitch but also to give the proper tone. The wing tones, which do not vibrate through the whole instrument, will always sound thin and hard if the fingers come too close to the central air column. An exact thickness of wood is needed to give the wing tones a caressing quality.

PLATE E – Modern double-reed instruments. (from Music Museum of Wilhelm Heckel, Biebrich)

(A) Heckel-Contrabassoon. Shortened shape with the head-joint of wood turned downwards, with Subcontra-A as extreme lowest note. Tuning-slide on the Big-Crook; interlocked $F^\#$ and $G^\#$ shake-keys; threefold octave-key.

(B) Heckle Oboe d'amore in A.

(C) Heckel English-Horn in F.

(D) Heckelphone in C, descending to A. World model.

(E) Heckel-Oboe. Conservatoire model, descending to low b^b.

(F) Heckel-Oboe. Normal type, going down to $b^\#$.

(G) Terz-Heckelphon in E^b.

(H) Piccolo-Heckelphon in F.

(I) Heckel-Musette in F.

(J) Heckel-Bassoon. With $F^\#$ and $G^\#$, and $C^\#$ and $D^\#$ shake-mechanism, as also G-hole ring; also with mechanism to close the small Vent-hole in the Crook by an automatic connection with the E-plate. (Plate for the right thumb at the butt). Also additional key-lever for left thumb. World model.

THE CONTRA BASSOON

Most large orchestras and many military bands of the past century used a larger bassoon for the contra-bass, an octave lower than the tones of the ordinary bassoon. The older contrabassoons played no lower than Contra-D. The improved contrabassoon now reaches sub-Contra-A. It was first used by Wagner in Parsifal, as he said, "on account of its facility for legato in the deep register."

Until about the year 1875, the contrabassoon had the same shape as the bassoon. So it consisted of wing, butt, and long-joint; but besides the real crook or S-tube, it had an additional crook proportioned to the upper or thinner end of the wing. Another instrument of the bassoon type for the contra-bass register was made in 1849 by Haseneier in Coblenz and was called the contra-bassophon. It was produced by different makers for about ten years. Its bore was very wide; hence the instrument was too large to handle easily and few players had enough wind to control it. The tone was more like the blurting of the Ophicleide than the easy legato of the bassoon.

Some twenty-five years later, in 1876, J. A. Heckel began to remodel his contra-bassoon somewhat along the lines of the contra-bassophon. He changed it from the two parallel tubes of the regular bassoon into three parallel tubes, and changed the form of the large crook. Such changes made the instrument left handed, because the keys and finger plates of the wing lay on the under bend. The player's left hand was thus below his right, although the fingers of both hands had the same movements as on the regular bassoon.

In 1879 the instrument was made right handed by W. Heckel (1856-1909), who changed the length of the tubes. The next few years of experiment greatly improved the bore, which produced a full organlike tone and greatly economized the player's breath. The modern contrabassoon requires scarcely more breath than the ordinary bassoon. The large crook was changed to a metal tube which became part of the instrument itself, thus adding a parallel tube to make four in all. Two octave-keys in the metal tube made it possible to finger the notes above upper d as the same notes are fingered in the middle register, and also made the high notes easy to execute in quick passages.

The present contrabassoon, which reaches to Subcontra-A or B^{b}, is made either with an upright bell, or with a large bend. The bend tends to condense the tone somewhat. Because of the large wooden air chamber, the pitch varies considerably in different temperatures. Such variations in pitch are now controlled by a conical tuning slide in the metal tube. Other technical improvements in the contra-bassoon were much like those made in the ordinary bassoon.

The old "Fagott-Chor" or "Bassoon family" had at least five members in addition to the regular bassoon. The smallest was the "fagottino," a type of Discant-bassoon. It was pitched in C and sounded an octave higher than the regular bassoon. The piccolo-, alto-, or tenor-bassoon was pitched in G and stood a fifth above the regular bassoon. Notes blown on the piccolo-bassoon with the customary fingering sounded a fifth higher than the written notes. The quart-bassoon was pitched in F and played a fourth above the regular bassoon; that is, the fingered C sounded F. At the beginning of the 17th century, there was also a quart-bassoon in G which played a fourth lower than the regular bassoon and a fifth higher than the contra-bassoon. The fifth and largest of the family was the quint- or double-bassoon, in F. The old double-bassoon stood a fifth below the bassoon and a fourth above the modern contrabassoon. C sounded a fifth lower.

Praetorius in 1618 wrote that Hans Schreiber of Berlin was about to produce a large contrabassoon - which is proof that this instrument was contemplated at the outset of the 17th century though it had not been manufactured. The quint- or double-bassoon was the only one of the five which was much used by orchestras of the 18th and early 19th centuries. It apparently supported the early contra-bassoons, and for a time even displaced them, because the 18th century contrabassoon was not dependable in its higher register. The parts now given to the contra-bassoon were formerly carried by the bass-ophicleide, the serpent, the bass-zink (bass-cornet), the English bass-horn, the serpent-bassoon, and similar bass key-bugles.

A B C D E F G H I J

PLATE F

PLATE F – A group of modern woodwind instruments[17] with beak mouthpiece (single reed).

(A) Heckelphone-Clarinet..

(B) Bassethorn in F.

(C) Bass-Clarinet in B^b.

(D) Alto-Clarinet in F.

(E) Contrabass-Clarinet in B^b.

(F) Clarinet in A^b.

(G) Clarinet in E^b.

(H), (I) and (J) Clarinets in B^b.

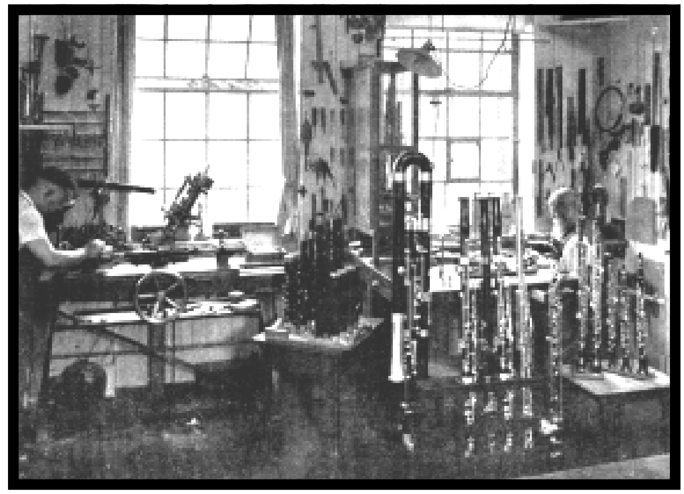


PLATE I. *- Views of Heckel turning shop, Biebrich am Rhein-Wiesbaden.*

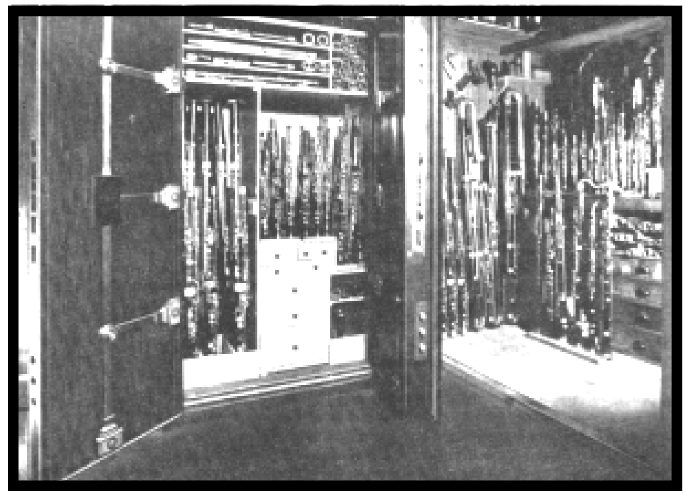


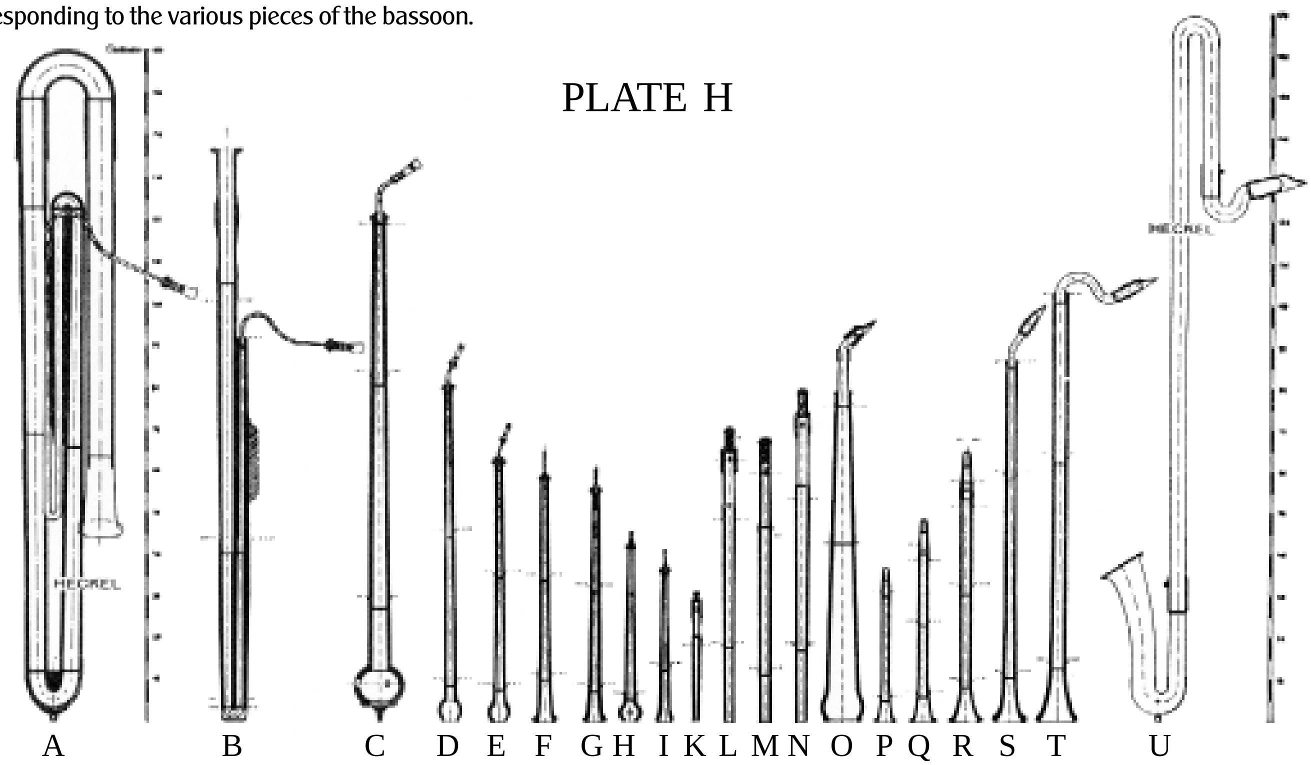
PLATE J. *- Collection of pattern instruments.*

MAKING BASSOONS[18]

The process of manufacture starts with the selection of wood. Maple wood has the important advantage of being easily shaped and of having just about the ideal weight. Maple has three other essential qualities: it can be bored smooth; it is tough enough to hold the threads of small and it absorbs oil. But not every maple tree will serve the purpose. The trees selected are those of most normal growth and of a specified weight.

Maple trees meeting these requirements are felled, sawed into thick sections, and slowly steamed to kill the cells. The sections are then allowed to dry for several years in the open air, but protected from the direct rays of the sun. Thereafter they are cut into square blocks corresponding to the various pieces of the bassoon.

PLATE H



The next step is to drill a narrow hole from which the bore is very gradually developed. As each section is brought by yearly stages to the exact diameter of the bore, it is very closely examined for any imperfections in the wood, and the imperfect sections are of course discarded.

The accompanying sketch (Plate H) shows the different types of bores used in both conical and cylindrical woodwinds.

PLATE H. - Diagram of different types of woodwind instruments shown in cross-section, for comparison of the proportions of length and bore.

The length in instruments with double-reed mouthpiece is measured from the mouthpiece to the end of the bell; in flutes from the middle of the embouchure to the bottom end; in clarinets from the top of the beak to the end of the bell. The following is the meaning of the letters:

KB - Conical bore
VKB - Reversed conical bore
ZB - Cylindrical bore

Instrument	Length	Type of bore	Type of bell
(a) Contrabassoon	593 cm.	KB	abruptly flared
(b) Bassoon	259 cm.	KB	increasing evenly throughout
(c) Heckelphon	138.5 cm.	KB	spherical
(d) English Horn	90 cm.	KB	pear-shaped
(e) Oboe d'amore	72.5 cm.	KB	pear-shaped
(f) Oboe-Conservatoire	66.5 cm.	KB	gently flared
(g) Oboe	64.5 cm.	KB	bell-shaped
(h) Piccolo-Heckelphon	45 cm.	KB	spherical
(i) Musette	42.5 cm.	KB	gently flared
(j) Piccolo-flute	25 cm.	VKB	(bore of head ZB)
(k) Flute	64 cm.	VKB	(bore of head ZB)
(1) Boehm-flute	60.5 cm.	ZB	(bore of head KB)
(m) Flute d'amore in A	71.5 cm.	VKB	(bore of head ZB)
(n) Heckelphon-Clarinet	102.5 cm.	KB	parabolic
(o) Piccolo-Clarinet in Ab	37.4 cm.	ZB	funnel-shaped
(p) Clarinet in Eb	48.6 cm.	ZB	funnel-shaped.
(q) Clarinet in Bb	67 cm.	ZB	funnel-shaped
(r) Basset Horn in F	106 cm.	ZB	funnel-shaped
(s) Bass Clarinet in Bb	134 cm.	ZB	funnel-shaped
(t) Contrabass Clarinet in Bb	276 cm.	ZB	gently flared

Pitch: A^1 = 875 vibrations per second
For comparison: 1 cm. = 0.394 inches
1 inch = 2.54 cms.

When the pieces have been sorted, according to weight and uniformity of fibre, the wing and butt sections are shaped. The shaping requires many tools, especially devised for accurate measuring, turning, and drilling. One of the many turning lathes gives the butt-joint its oval shape. Another lathe automatically turns the head or bell-joint. Drilling the sound-holes demands extreme precision, because each hole requires its own particular thickness of wood.

The first metal work is to insert the U-shaped water-cap at the end of the butt. This adjustment must be very exact to prevent air leaks without making the cap hard to remove. The semi-circular and conically-tapered bend of the water-cap is punched with a die from a single brass plate and then pressed into shape.

Each section of the bassoon is then treated to protect the wood from moisture and to improve its sounding qualities. This treatment consists first in attaching bands to the wing, butt, and bell to strengthen them; then in finishing each part in accordance with its exact patterns. The parts are then ground, stained, polished, and saturated with a suitable oil. The oil closes the pores of the wood and so protects it from moisture. The wing and the narrow tube of the butt, which are most exposed to moisture, are then lined by a special process with ebonite. Before the invention of this ebonite lining by Wilhelm Heckel in 1889, the constant moisture, in the wing-joint especially, had the effect of producing small fibres of wood, like hairs, on the inside surface of the bore, which gave the instrument a buzzing sound and eventually spoiled the pitch as the surface decomposed.

Next comes the highly important process of drilling the lateral toneholes and the screw-holes for the key posts in each section of the instrument. Such drilling is done in a copying machine, which must be used with great care. Any imperfection in the drilling of one hole renders the entire joint useless.

If the wood were exactly round, it would be sufficient to have a machine wherein the wood piece could be rotated about its axis and shifted lengthwise. However, due to the very irregular shape of the wing and butt, the machine is further complicated. In addition to rotation about its long axis and the motion lengthwise, a sidewise shift of the instrument axis is necessary in order that drilling may be perpendicular to the wood surface. Furthermore, in order to drill the slanting tone holes in the right direction, the drilling axis must be capable of being tilted and locked within almost 90 degrees either side of the vertical. Special bits are used for each size of tone holes and pad seat.

When the key posts have been screwed into place, the key mechanism is mounted by hand. The individual keys require somewhat different fitting on each instrument, according to the peculiarities of the wood. Leaf springs and pin springs are then applied, after which the entire metal work is polished.

The slanting holes are then drilled, and by the aid of reamers graduated in steps of a fraction of a millimeter all tone holes are brought accurately to size. The bore as well is similarly reamed.

The instrument is finally assembled and each part tested for accurate fit. The bore is again checked, reamed if necessary, varnished and polished smooth. Following the installation of the pads, the whole mechanism is tested for noiseless action and good regulation.

The last process of manufacture is the very difficult construction of the crook or S-tube. The problem lies in giving it the correct shape without altering the slope of the cone throughout the entire instrument. Such shaping is possible when a straight tube of the right conical slope is filled with a substance soft enough to bend but resistant enough to preserve the conical bore. When the tube has been properly bent, it is of course essential that no particles of the filler be left in the tube. The inner surface must be smooth as a mirror.

Every note of the instrument is finally tested for correct pitch and resonance. This process is rendered difficult by the great dependence of every bassoon upon the particular reed used to blow it. As a means of standardizing the performance of the testing reed, Heckel bassoons are tested by a "beak," somewhat like the mouthpiece of a clarinet though much smaller. The beak of ebonite or of silver contains a single reed of cane or of silver, which always blows the same. Following this test, each note is retested with several new reeds of the usual cane.

PERFORMANCE

The foregoing pages have indicated certain historical and scientific developments which have produced the bassoon, particularly the Heckel Bassoon, as we know it today. Each of such developments explains to some extent why the bassoon can so well combine an indefinite diversity of expression with a brilliant and melodious tone. The historical evolution of the instrument and the present methods of its construction thus combine to explain the peculiar uses of the bassoon to the modern orchestra. The present paper may thus appropriately close with some notes on the bassoon's present status, from the standpoint of the manufacturers.

The difference between a rich tone and a thin tone depends largely upon the number of harmonic overtones.[19] Each note of a good woodwind should be capable of variations such that the player's lips can make small and delicate differences in vibration and hence in sound and in pitch. The possibilities of such differences is what gives life to any instrument in the hands of a skilled player - for example, the subtleties of the violin as against the mechanics of the organ or piano.

Richard Strauss once remarked that the harmonics of the bassoon are vivid under certain conditions. He writes, "The sounding harmonics of the bassoon are specially strong. For example, in the A^b minor chord in my tone poem, 'Death and Transfiguration,' blown by the trombones, English horn, bassoon, and contra-bassoon, I could often hear a c, evidently a harmonic of the bassoon or contra-bassoon."[20]

The maker of a non-tunable instrument like the bassoon is, of course, particularly exasperated by official changes in pitch. The European "a^1" formerly represented 870 single vibrations per second at 19° Centigrade. Later the Berlin Hochschüle für Musik adopted the 11 "a^1" at 875 vibrations. England and America have used as many as 878 or 880 vibrations. An international group meeting May 11, 1939, approved the a^1 of 880 single or 440 double vibrations per second as the international standard. Such small changes are of no consequence to the makers of any but woodwind instruments, and they are of small importance to any but the makers of conical woodwinds - i. e., oboe, English horn, and bassoon.

But the bassoon maker can produce a new pitch only by very elaborate and expensive research. Pitch cannot be raised by merely shortening the instrument a few millimeters. The instrument must be rebuilt throughout, with the continuous testing of each note. But as a matter of fact and by way of recompense for the labor, the bassoon has a somewhat finer tone in the higher pitches than in the old 435 pitch.

An ardent wish of all instrument makers is to give each orchestral instrument a perfect uniformity of pitch. Perfect tuning is now greatly handicapped by the fact that the tuning rooms of most concert halls are dark, often without windows, and usually damp or dried by steam pipes - a bad place for the tuning and a worse place for the preservation of delicate instruments. Any woodwind should be allowed to dry in good air at an even temperature after it has been used. The tunable instruments of the orchestra should be tuned in an off-stage room where the acoustics are as nearly perfect as possible. The acoustics of most tuning rooms today are even worse than their ventilation.

It is an interesting fact that because of their excellent broadcasting qualities, all woodwinds, and especially those blown with a doublereed, have been much more widely used since the advent of the radio. Many tests have shown that string basses rattle on the radio, because the friction of the bow sometimes makes more noise than the tone itself. The contra-bassoon, however, comes out rich and full. Its strong vibrations combine with instruments of higher register to give the orchestral mass its maximum of volume. The radio orchestra has established the practice of increasing the bassoons to strengthen the cellos. Compositions for woodwind ensembles are also increasingly composed and performed. The double reed and the radio have thus proved mutually helpful.

The orchestral status of the bassoon is of course limited by its register and peculiar tone quality. But the popular demand of several centuries for its tone quality and the fundamental importance of its register both assure the bassoon a long life among coming generations of musicians.

Someone commented to Rudolph Bing, manager of the Metropolitan Opera, that "George Szell is his own worst enemy." "Not while I'm alive, he isn't!" said Bing.

Footnotes

1 By my father, Wilhelm Heckel, to record the family tradition of bassoon-making begun by his father, Johan Adam Heckel.
2 For example, "A Short History of the Bassoon," *Musical Progress and Mail,* London, England. June-September. 1939.
3 Shawn, Schalm, Schalmei, or Chalumeau.
4 Like the Recorder, Beak-flute, Blockfloete, or Flute-douce.
5 Also Discant-Pommer, or Schalmey.
6 Krummer Zink, Stiller Zink, straight cornet.
7 Also Corno-di-Bassetto.
8 But see L. G. Langwill's article on the "Curtal," "*Musical Times*," April 1937.
9 Other varieties of the same sort were called Gar-Klein-Schalmey, Discant-Schalmey.
10 In his *Real-Lexikon der Musikinstrumente*. 1913. Berlin.
11 Also known as Krumphorn, Cromorne, Tournebout.
12 See Dr. G. Kinsky, *Archiv für Musikwissenschaft*, 7th Jahrbuch, 1925.
13 German Wurst-Fagott and French Cervelas.
14 Querflóten, Schweizerpfeifen (cross flutes), Blockflóten (Recorders), and Grosspfeifen (Bass-pipes).

SHOP TIPS

These stackable clear plastic containers are threaded together and may be used to hold small parts conveniently. They may be purchased in sporting & hardware stores in the area displaying fishing accessories.

OCARINA FINGERING CHART