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Systematics of the Brasswind Valve

This lecture was presented in Berlin in 2014, when it was the first attempt to treat this subject. At that time, the complete study was still unfinished. This paper is more complete, showing all the final criteria with some examples (though not all of the detailed descriptions). The complete *Classification des pistons et valves des instruments de musique à vent* has now been published in French by the Association des Collectionneurs d'Instruments de Musique à Vent (A.C.I.M.V) in a *Larigot* journal special issue. It gives a complete detailed description of the subject with many examples, and can be accessed on the ACIMV site.[1]

Introduction

Why a classification of valves?

Many systems of classification for musical instruments exist – those invented by Hornbostel and Sachs being the most used – but a classification for the pistons and valves of wind instruments has never been proposed until now. Nevertheless, since the first trials of Blühmel and Stölzel at the beginning of the 19th century, many systems were indeed invented, giving rise to countless patents. Most of these systems remained in the status of prototypes or had only an ephemeral existence, a fact which does not stop new systems from appearing on the market even today. It might well be of scholarly interest to determine whether their basic ideas were new or not. Some valves are also more efficient than others, and it is important to explain why.

At present, the Périnet piston and the rotary valve share nearly all of the market between them. The variety of invented systems makes their precise description difficult, and most museum and private collection catalogues rarely yield reliable information. A universal classification system seems necessary, but this system, to be usable by non-specialist collectors and curators, needs to be simple, clear, and based on unambiguous and non-debatable criteria. Subsequently, the generic term

1 *Larigot spécial*, No. 31, December 2023, 100 pages.

»valve« will be used for descriptions. The aim of this systematic treatment is to propose a rational classification of valves based on geometrical properties (such as rotation or translation), that is both easy to use and unambiguous.

The classification follows three stages:

1. Description of the physical characteristics of an isolated valve, regardless of its use. Unless extra details are given, a valve is presumed to have two positions.
2. Description of valve effect and valve combinations, with the resulting cumulative effects on the airflow
3. Examples of use of the systematics

First Part: Description of the physical and functional characteristics of a valve

To allow a strictly unambiguous classification, certain criteria based on geometric properties have been favoured: translation, rotation, number of connected tubes, etc. Other interesting, though secondary criteria will be also taken into account and described, as well as their properties.

Physical characteristics of the valve

A Nature of movement of the moving part

If we consider a system of orthonormal X, Y and Z axes, we find five possible classes of motion, which will be divided into subclasses. If necessary, new subclasses may be added later.

A.1 *Translation perpendicular to the main air column (at least on one side)*

- **A.1.1** A cylinder of the same diameter as the bore, with air passing through one end
- **A.1.2** A cylinder of the same diameter as the bore, with air not passing through one end
- **A.1.3** Cylinder slightly larger in diameter than the bore
- **A.1.4** Cylinder with a diameter much larger than that of the bore, with all additional tubes located in the same plane perpendicular to translation
- **A.1.5** Cylinder with a diameter much larger than that of the bore, with the additional tubes located in different planes perpendicular to the translation
- **A.1.6** Cylinder with a diameter much larger than that of the bore, with all additional tubes located inside the piston itself
- **A.1.7** Cylinder with a diameter much larger than that of the bore, with some of the additional tubes located inside the piston itself
- **A.1.8** Parallelepiped with a diameter much larger than that of the bore
- **A.1.9** Two coupled cylinders of the same diameter as the bore, with air passing through one end

A.1.10 Two coupled cylinders with a diameter greater than that of the bore
A.1.11 Two valves (parallel round plates) coupled

A.2 *Translation in the axis of the main air column*
A.2.1 Cylinder of the same diameter as the bore, with air passing through both ends
A.2.2 Cylinder of the same diameter as the bore, located between two other concentric fixed cylinders, with air passing through both ends

A.3 *Rotation perpendicular to the axis of the main air column*
A.3.1 Cylinder of the same diameter as the bore
A.3.2 Cylinder with a diameter slightly larger than that of the bore
A.3.3 Two cylinders slightly larger in diameter than the bore
A.3.4 Cylinder with a diameter moderately larger than that of the bore
A.3.5 Cylinder with a diameter much larger than that of the bore and two positions
A.3.6 Cylinder with a diameter much larger than that of the bore and three positions
A.3.7 Cylinder with a diameter much larger than that of the bore and four (or more) positions
A.3.8 Cylinder with a diameter much larger than that of the bore and some additional tubes located on the valve cap, not in the plane of rotation
A.3.9 Two coupled movable flaps connected to an additional loop
A.3.10 Two coupled movable flaps connected to two additional loops
A.3.11 Three (or more) cylinders with a diameter greater than that of the bore

A.4 *Rotation in the axis of the main air column*
A.4.1 Conical valve
A.4.2 Rotary circular plate valve
A.4.3 Rotary valve for mouthpiece shank change

A.5 *Combination of translation(s) and / or rotation(s)*
A.5.1 Helical valve, translation + rotation

B Nature of movement of the control system

When the position of the valve is changed, the movement can also be broken down into translations and / or rotations, in the same plane or in a plane different from that of the valves. If we describe a system of orthonormal X, Y and Z axes, there are seven possible classes of motion. These will be divided into subclasses, because we must consider the case of a rotational translation and vice versa. If needed, more subclasses may be added later.

B.1 *Translation parallel to valve translation*
B.1.1 Direct action. The control knob is located directly on the piston.
B.1.2 Control located in an external piston and parallel to the controlled piston
B.1.3 Dual control: a control knob is located directly on the piston and an engagement also allows the piston to be operated by means of another, with both pistons then operated simultaneously.

B.2 *Translation not parallel to valve translation*

- **B.2.1** Control located in an external piston and not parallel to the controlled piston

B.3 *Translation acting with a rotary valve*

- **B.3.1** Control located in an external piston and transmission to the rotary valve by means of metal rods
- **B.3.2** Control located in an external piston and transmission to the rotary valve by means of cords

B.4 *Rotation parallel to valve rotation*

- **B.4.1** Direct control of the rotary valve
- **B.4.2** Rigid transmission, key located on the outside of the articulation
- **B.4.3** String transmission, key located on the outside of the articulation
- **B.4.4** Rigid transmission, key located on the inside of the articulation
- **B.4.5** String transmission, key located on the inside of the articulation

B.5 *Rotation not parallel to valve rotation*

- **B.5.1** Rigid transmission, key located on the outside of the articulation
- **B.5.2** Rope transmission, key located on the outside of the articulation
- **B.5.3** Rigid transmission, key located on the inside of the articulation
- **B.5.4** String transmission, key located on the inside of the articulation

B.6 *Rotation controlling a travel valve*

- **B.6.1** Transmission in the same plane as the piston
- **B.6.2** Transmission in a plane perpendicular to that of the piston
- **B.6.3** Blade connected to the piston and acting as a return spring

B.7 *Combination of multiple translation(s) and/or rotation(s)*

- **B.7.1** Combination of two perpendicular rotations

C Number of connected tubes and internal coquilles

Description: C. »number of tubes« / »number of coquilles«. In the case of a dual valve, the number will be given for only one of the two components of the valve.

A valve piston or rotor usually uses coquilles (tubes that guide air through the valve) that align with the external tubes. The number of these devices is an important criterion to assess the complexity of the valve, regardless of its type. There is no firm boundary between a coquille and an outer tube. Indeed, in some compensating valves, we can say that the coquille juts outside the piston, making a bump – or also, that the additional tube turns back inside before being fully separated. Should this ›hernia‹ be considered a coquille or an external loop? The most rational way to solve the problem is to use topology. This ›hernia‹ is similar to a ball, but not to a torus, since there is no hole in the surface. Therefore, in my opinion, a ›hernia‹ should be counted as a coquille and not as an external loop.

Movable shutters will not be treated as coquilles. For pistons where the air column passes through the axis (such as Stölzel pistons), each passage of air in the axis and its 90° connection with an outer tube will not be considered a coquille. This arbitrary choice makes it easier to separate the pistons of the bore diameter from the others in the classification.

The number of connected tubes ranges from 2 to 24. It is always even unless there are multiple bells, multiple mouthpieces, or coupling with another similar piston. Of the odd numbers, only 3 seems to have been realized.

The number of coquilles found ranges from 0 to 12. It is more or less proportional to the number of tubes connected (an average of 3–4), but there is no calculable formula, as some valves do not have coquilles and some coquilles are in use for in several positions of the valve.

The following table gives the combinations »number of additional tubes / number of coquilles« actually encountered (**C** = coquilles, **T** = tubes connected).

C / T	2	3	4	6	8	10	12	14	16	18	20	22	24
0			×	×									
1		×	×										
2	×	×	×	×									
3			×	×									
4				×	×								
5				×	×	×							
6					×		×						
7					×	×	×						
8							×		×				×
9							×						
10													
11													
12									×				

More than 99 % of the valves currently manufactured today are single Périnet pistons (4 tubes and 3 coquilles) or single rotary barrels (4 tubes and 2 coquilles).

D Additional slides

Each additional tube of the valves can be fitted with slides, allowing one to tune the length of tube. The slide is U-shaped and fits into two parallel tubes.

D.0 *No additional tube on the valve, no slide*

D.1 *Additional tube(s) of fixed length, not adjustable*

D.2 *A single tuning slide per additional loop; general case*

D.3 *Tuning slides on some of the additional tubes only*

D.4 *Device connected to a finger for changing the length of the slide during play, without a return device*

D.5 *Device connected to a finger for changing the length of the slide during play, with a return device*

D.6 *Device for automatically adjusting the length of the slide in the event of a change in the pitch of the instrument*

D.7 *Slide possibly modified or replaced*

D.8 *Multiple single tuning slides on the same tube*

D.9 *Slide adjustable with a screw*

E Valve return system

A valve has at least two positions. Either it must remain in the chosen position, or it must automatically return to its resting position. The return mechanism is a secondary criterion that is not a priority for the main classification, but which is nevertheless useful to describe.

E.0 *No return system*

E.1 *Permanent locking system in the actuated position*

E.2 *Effect of gravity*

E.3 *Elastic or rubber*

E.4 *Flat spring*

E.5 *Needle spring*

E.6 *Spiral spring (watchmaking type) working in rotation*

E.7 *Coil spring internal to the piston working in compression*

E.8 *Coil spring external to the piston working in compression*

E.9 *Internal coil spring working in extension*

E.10 *External coil spring working in extension*

E.11 *Coil spring working in rotation*

E.12 *Magnet or electromagnet*

F System to prevent the piston from rotating on its axis

If cylindrical pistons with longitudinal movement can rotate on their axis, the coquilles are no longer aligned with their outer tubes. It was therefore necessary to invent a guidance system to avoid this effect. This is not an issue for rotary valves, as they are designed to rotate between two stops.

F.0 *Not applicable for this valve*

F.1 *Long screw through the case and the piston from one side to the other*

F.2 *Small screw passing through the case on one side only and sliding into a groove in the piston*

F.3 *Fixed lug on the piston, sliding in a groove inside the valve casing*

F.4 *Movable rod or crown with a lug inside the valve casing*

F.5 *Movable rod or crown with two lugs inside the valve casing*

F.6 *Crown with at least three lugs inside the valve casing*

F.7 *Non-circular piston control rod*

Functional characteristics of the valve

G Valve function

Regardless of its technical characteristics, the valve has a function that alters the sound.

G.0 *Change of pitch*

G.1 *Change of bell without change of pitch*

G.2 *Change of bell with change of pitch*

G.3 *Plain descending*

G.4 *Plain ascending*

G.5 *Interchangeable (descending or ascending)*

G.6 *Multifunction: change of bell or descending*

G.7 *Master*

G.8 *Alternative slave*

G.9 *Additional slave*

G.10 *Alternative master/slave*

G.11 *Additional master/slave*

G.12 *Pitch correction with mute*

H Valve effect

The value is given in semitones: H.»n«, if *lower*. H.»–n«, if *raised*. H.»0«, if the valve does not change the pitch of the note (e.g. a bell change). If the value is related to the action of another valve (in the case of double and compensating systems), the value of the other master valve is given in parentheses H.(»m«)»n«. If more than one effect is possible, the values are given successively, separated by an »&«.

I Finger used

The finger normally operating each valve can be indicated according to the code:

I.0 *Right hand thumb*
I.1 *Right hand index finger*
I.2 *Right hand middle finger*
I.3 *Right hand ring finger*
I.4 *Right hand little finger*
I.5 *Left hand thumb*
I.6 *Left hand index finger*
I.7 *Left hand middle finger*
I.8 *Left hand ring finger*
I.9 *Left hand little finger*
I.10 *No designated finger*

J Other criteria not used for classification

After testing, the following secondary criteria were not included in this classification, as they were too complex to describe simply, or not of sufficient interest.

J.1 *Valve sound quality* This is, you might say, by far the most important criterion! The musician does not care how the valve works, he simply does not want it to alter the sound produced. However, it is not easy to quantify. Historically, the earliest valves aroused the suspicion of musicians, who feared that the sound would be distorted. The war between the natural horn and the piston horn raged in France throughout the 19th century.

STRUCTURAL CAUSES

Sudden curvature of the air column A sudden change of direction disturbs the airflow and alters the sound. This effect is difficult to quantify and rather subjective: for example, many professional musicians, who commonly use vintage Stölzel valve cornets for the Romantic repertoire, are very satisfied with the sound quality of their instrument.
Deformation of the bore The bore cross-section is usually a circle. The smaller the piston or rotor, the more deformed and twisted the coquilles need to be to fit inside. If the cross-section remains constant, the airflow speed does not vary, which is preferable. This is the case with oval coquille pistons, such as Allen Valves. If the

cross-section changes, as with twisted coquilles, turbulence appears, altering the harmonic spectrum.

CAUSES RELATED TO USE

Poor sealing of the moving part Air leaks alter the sound and should be strictly avoided. Each coquille passed through is a potential source of leakage, which is why compensating systems are so tricky to maintain. However, when the valve is leaking, it is possible to have it refilled with metal by specialized repairers – but this is relatively expensive.

Misalignment of the bore The movable part must allow a perfect alignment between the coquille and the outer tube to avoid a sudden reduction of the bore, which is a source of turbulence. As the metal-on-metal impact is very noisy, the valve is cushioned with a buffer, which is quite thick, and made of cork or felt. Over time, repeated shocks eventually crush this shock absorber, and the bore loses its alignment. The solution is a simple and economic one: the buffer must be changed regularly.

J.2 *Coquille shape* While most of the coquilles are cylindrical or toric, there are also oval, helical coquilles, ›herniated‹ coquilles, etc. Since a piston can have different coquilles and it is not easy to describe unambiguously, this criterion has been abandoned.

J.3 *Mounting and disassembling for lubrication of valves* This criterion, although important for players, is difficult to explain. There are two main issues:

- Pistons are usually very easy to disassemble: one simply unscrews the top cap. However, they are poorly insulated from the outside and quickly become dirty, so they need to be cleaned and lubricated regularly. In addition, the direct finger control can exert a parasitic lateral force that preferentially wears down one side of the piston, making it progressively less sealed.
- Rotating barrels are complex to disassemble: it is usually necessary to detach the control, unscrew the cap and remove the metal disc serving as a cap, which is not easy. However, they are well insulated from the outside and do not get dirty, so it is rarely necessary to maintain them. In addition, the external mechanism control always exerts the same action on the rotor, minimalizing wear.

J.4 *Valve manufacturing cost* It would be interesting to know if the valve is expensive to manufacture or not. The cost, however, depends very much on the technological means available. A workshop with hydraulic presses and modern lathes will produce faster than if everything is done by hand, but the tools must be amortized. Obviously, the more coquilles and external control mechanisms are present, the more expensive the valve will be. Depending on the criteria described above and the time of manufacture, one can get an idea of the cost, but it is not easy to quantify.

J.5 *Materials used* It would also be interesting to list all the materials that can be used to make a valve. However, since it is almost always the same ones that come up for each part, this criterion is not useful for classifying. Examples include brass, which is the base material of most valves and can be used for all its components. As an alternative, hard and low-friction alloys, like nickel silver, have been frequently proposed by various manufacturers. Boosey, for example, used an alloy called »solbron« for the manufacture of pistons. Stainless steel is also found.

- In addition, the springs and screws are made of steel (not stainless in ancient instruments) or bronze.
- The coquilles of the first Stölzel pistons are made of wax.
- The piston knobs may be made of ivory, bone, mother-of-pearl or plastic.
- The stops and shock absorbers are made of felt or cork.

Second Part: Use and combination of valves

1. *Valves used alone* By allowing a single pitch change, for a two-position valve, they are used mainly on signal instruments.

2. *Valves combined with another device* It is possible to combine the valves with another pitch-changing device: with a slide (trombones) or with keys, like some Adolphe Sax saxhorns (no longer used).

3. *Valve combinations* A two-position valve provides only two different tube lengths, but n valves give 2n combinations, and can allow the instrument to be chromatic. In a tempered scale using 12 semitones, the length of additional tube to be added per semitone is exponential, as 21/12 valve combinations add an insufficiently short tube length, and the sound is too sharp to be in tune. For automatically correcting valve combinations, compensating or double principle valves were invented later.

3.1 Combinations of 2 valves They provide 4 sets of notes, which makes the instrument fully chromatic only from the fourth harmonic of the overtone series.

3.2 Combinations of 3 valves In general, 1 tone + 1 semitone + 1½ tones give 7 pitches, enough to make the instrument fully chromatic from the second harmonic of the overtone series.

3.3 Combinations of 4 valves In general, 1 tone + 1 semitone + 1½ tones + 2½ tones gives 11 pitches, making the instrument fully chromatic except for one note, from the first harmonic, but multiple valve combinations are not in tune.

3.4 Combinations of more than 4 valves The addition of more valves allows one to play some notes in tune without the use of compensating systems. Mainly used for tubas.

4. *Possible combinations of valves*

4.1 Simple dependent valves The valves are placed successively on the tube and can be used simultaneously.

4.2 Single independent valves The valves are placed on the additional slide of the previous valve and are therefore without effect if this other valve is not played.

4.3 Compensating systems The goal is to automatically add an additional loop when several valves are used together, to correct the length. In a compensating system, this is done by adding a small extra loop to the main loop, with the air passing successively through both loops. There are two ways to achieve this system:

- The conventional compensating system requires only one master valve. For this valve, the tube crosses twice at least one other slave valve.
- The register system requires a single slave valve called a »register«. This valve is crossed by the main tube and by the additional tube of each master valve. The additional tube length of each master valve is modified by the action of the register.

4.4 Double principle systems In a double principle system, the additional loop in a slave valve is replaced by a longer one, with the air passing through only one of the two loops. Compared to the compensating system, it has the advantage of having fewer coquilles to pass through, so there is less risk of leakage and turbulence in the air column. The downside is that there are more tubes to add, so the instrument is heavier. The double system requires a master valve connected to 6 tubes. The slave valves are crossed by the main tube and by the additional loop of a valve, with the two lengths being always used independently.

Third Part: Examples of applications of the classification and diagrams showing the passage of the air in instruments

The valves are described in the order in which they are first passed through by the air column from the mouthpiece, without operating a valve. All the criteria are detailed according to the hierarchy chosen – though since they are independent, it is possible to use only the ones you need. While not exhaustive, these examples nevertheless illustrate some common systems as well as particularly complex creations, which have had no future.

Schematic color code:
green = Valves and controls
orange = Air passage when the valve is not actuated
blue = Air column
purple = Air passage when the valve is operated

Standard 4 piston Périnet echo cornet Standard design plus bell change valve

A.1.3	B.1.1	C.4.3	D.2	E.7	F.3	G.3	H.3	I.3
A.1.3	B.1.1	C.4.3	D.2	E.7	F.3	G.3	H.1	I.2
A.1.3	B.1.1	C.4.3	D.2	E.7	F.3	G.3	H.2	I.1
A.1.3	B.1.1	C.3.2	D.1	E.7	F.3	G.1	H.0	I.6

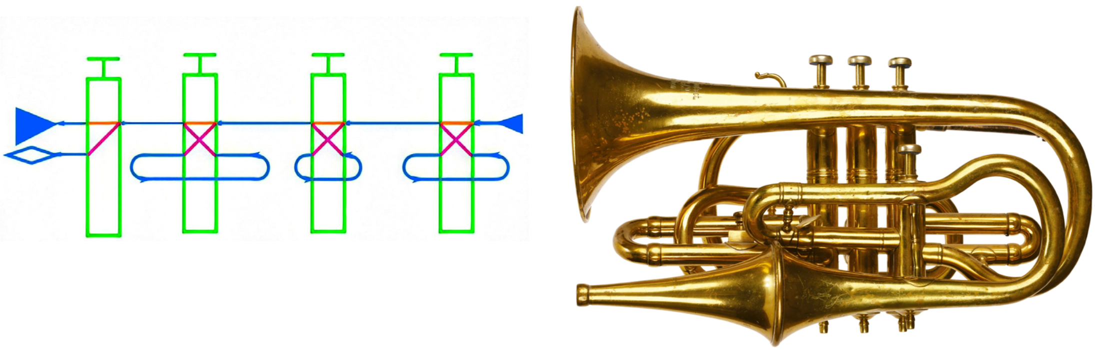

Figure 1 Echo cornet in B♭ by Schuster & Co., Markneukirchen, Germany, around 1900, Bruno Kampmann collection, No. 687 and schema. All photos by Lionel Renoux, all schemas by Patrice Rouxel

Wohlrab 3 piston cornet without additional tubes Example of a valve without additional outer loops, with the additional length accommodated in the piston

A.1.7	B.1.1	C.2.2	D.0	E.7	F.3	G.3	H.3	I.3
A.1.7	B.1.1	C.2.2	D.0	E.7	F.3	G.3	H.1	I.2
A.1.7	B.1.1	C.2.2	D.0	E.7	F.3	G.3	H.2	I.1

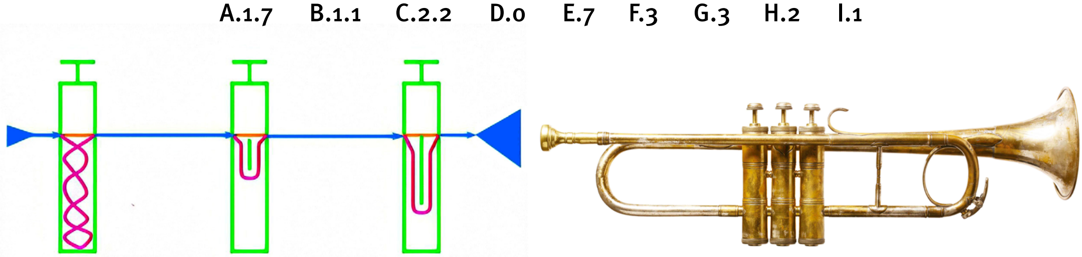

Figure 2 Trumpet in B♭ without external loops by Curt Wohlrab, Germany, 1950 patent, Bruno Kampmann collection, No. 840 and schema

Stölzel 3 piston Guichard cornet There are many ways to connect the Stölzel pistons to each other.

A.1.1	**B.1.1**	**C.4.1**	**D.2**	**E.7**	**F.1**	**G.3**	**H.3**	**I.3**
A.1.1	**B.1.1**	**C.4.1**	**D.2**	**E.7**	**F.1**	**G.3**	**H.1**	**I.2**
A.1.1	**B.1.1**	**C.4.1**	**D.2**	**E.7**	**F.1**	**G.3**	**H.2**	**I.1**

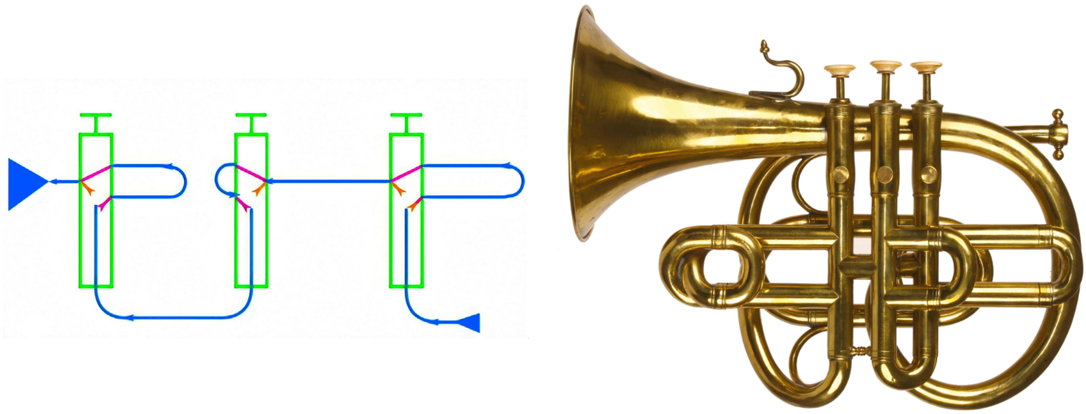

Figure 3 3 cornet with 7 crooks and 3 Stölzel valves by Jean-Auguste Guichard, Paris, before 1840, Bruno Kampmann collection, No. 1062 and schema

Rudall, Rose & Carte vocal horn in C with 3 »finger slide« by Samson The air column passing through the piston at both ends requires an external control piston (not shown on the diagram).

A.2.1	**B.1.2**	**C.4.0**	**D.2**	**E.8**	**F.0**	**G.3**	**H.2**	**I.1**
A.2.1	**B.1.2**	**C.4.0**	**D.2**	**E.8**	**F.0**	**G.3**	**H.3**	**I.3**
A.2.1	**B.1.2**	**C.4.0**	**D.2**	**E.8**	**F.0**	**G.3**	**H.1**	**I.2**

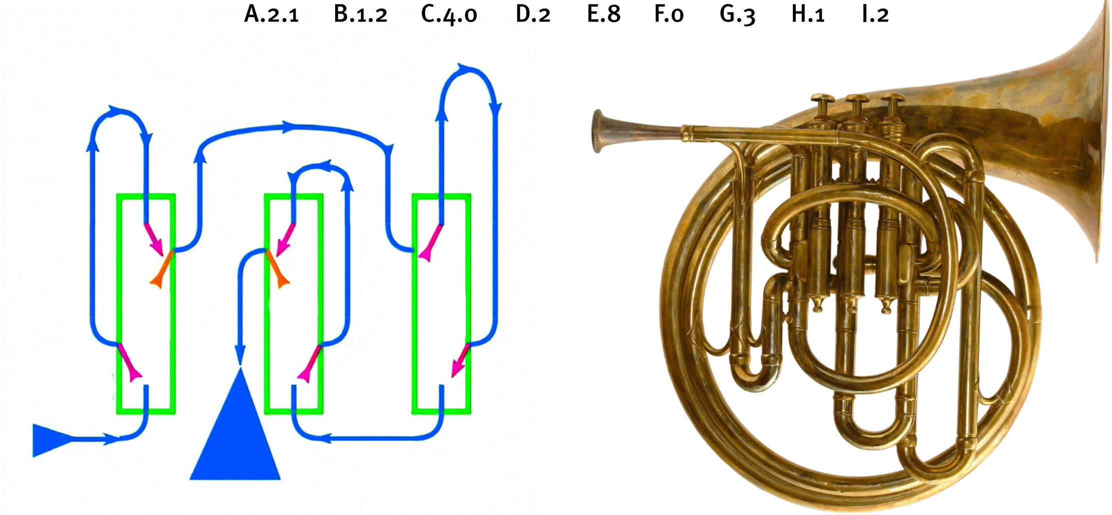

Figure 4 Vocal horn in C with 3 »finger slide« by Samson, Rudall, Rose & Carte, London, 1862 patent, Bruno Kampmann collection, No. 179 and schema

Lidl Alto flugelhorn with two mouthpiece tubes, connected by an axial rotation valve In one position, it is a natural instrument in F. In the other, a set of 3 rotary valves tuned in E can be added.

A.3.4	B.5.1	C.4.2	D.2	E.6	F.0	G.1	H.3	I.1
A.3.4	B.5.1	C.4.2	D.2	E.6	F.0	G.2	H.1	I.2
A.3.4	B.5.1	C.4.2	D.2	E.6	F.0	G.3	H.3	I.3
A.4.3	B.4.1	C.3.0	D.1	E.0	F.0	G.13	H.2	I.10

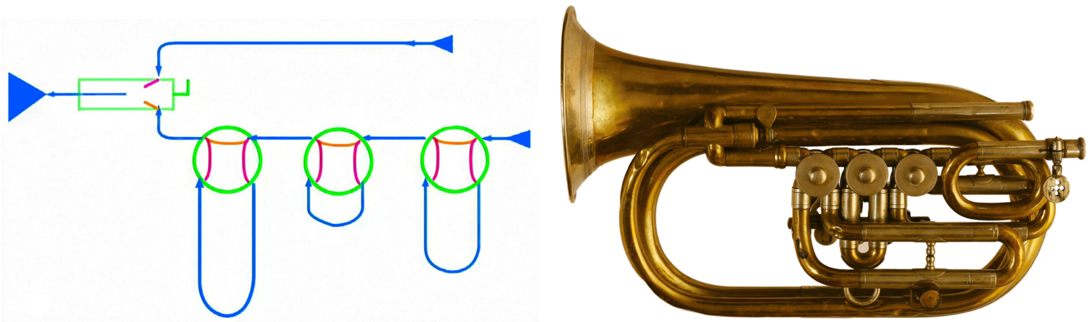

Figure 5 Alto flugelhorn in E♭ with two mouthpiece tubes by Josef Lidl, Brno, Czech, after 1900, Bruno Kampmann collection, No. 1075 and schema

Trombone with 6 independent valves In this system developed by Adolphe Sax, each ascending piston is on the slide of the previous one, and gives the right length because it is used alone. This compact system has been used in Belgium in the twentieth century for trombones, before disappearing.

A.1.2	B.1.1	C.6.4	D.2	E.7	F.3	G.4	H.–6	I.1
A.1.2	B.1.1	C.6.4	D.2	E.7	F.3	G.4	H.–5	I.2
A.1.2	B.1.1	C.6.4	D.2	E.7	F.3	G.4	H.–4	I.3
A.1.2	B.1.1	C.6.4	D.1	E.7	F.3	G.4	H.–3	I.6
A.1.2	B.1.1	C.6.4	D.2	E.7	F.3	G.4	H.–2	I.7
A.1.2	B.1.1	C.6.4	D.2	E.7	F.3	G.4	H.–1	I.8

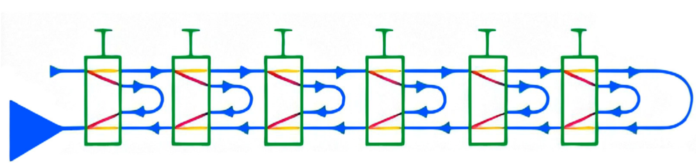

Figure 6 Trombone in B♭ with 6 independent valves by Adolphe Sax, Paris, 1863, Bruno Kampmann collection, No. 201 and schema

Boosey compensating cornet, Blaikley System, with 3 Périnet valves (third master valve, first and second slave valve) In this system, the additional tubes are very short and the coquilles herniate through the casing, and are not counted as additional tubes. Slaves have only 5 coquilles, with one being used twice.

A.1.3	B.1.1	C.4.3	D.2	E.7	F.3	G.7	H.3	I.3
A.1.3	B.1.1	C.6.5	D.3	E.7	F.3	G.9	H.1&(3)1	I.2
A.1.3	B.1.1	C.6.5	D.3	E.7	F.3	G.9	H.2&(3)2	I.1

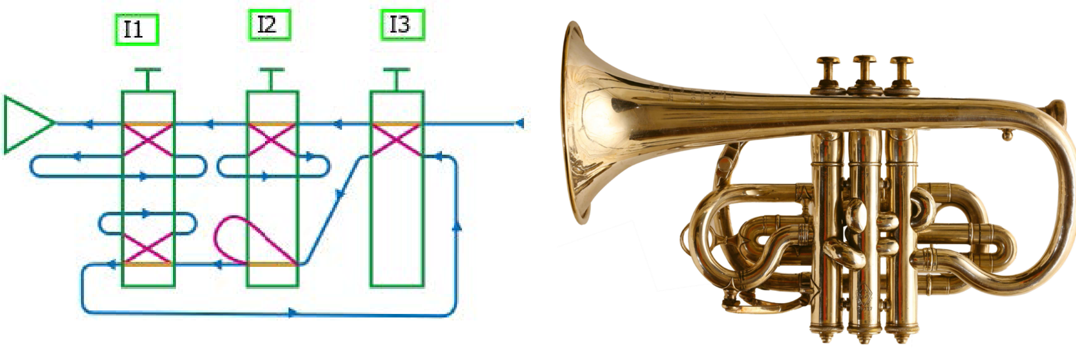

Figure 7 Boosey compensating cornet in B♭, Blaikley System, by Boosey & Co., London, 1904, Bruno Kampmann collection, No. 919 and schema

Lidl register horn The main tube and the additional slides of the three master pistons pass through the register, a long rotating valve, which automatically adds a loop to each tube. A compact and efficient system.

A.3.4	B.5.1	C.16.8	D.3	E.11	F.0	G.9	H.−5	I.5
A.3.4	B.5.2	C.4.2	D.2	E.11	F.0	G.7	H.2&(−5)2	I.6
A.3.4	B.5.2	C.4.2	D.2	E.11	F.0	G.7	H.1&(−5)1	I.7
A.3.4	B.5.2	C.4.2	D.2	E.11	F.0	G.7	H.3&(−5)3	I.8

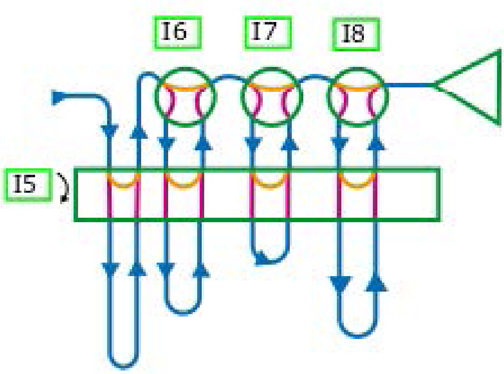

Figure 8 Register horn in B♭/F by Josef Lidl, Brno, Czech, around 1950, Bruno Kampmann collection, No. 224 and schema

Wunderlich register horn Device invented by Otto Tiedt, Hagen, 1909. The main tube and the additional slides of the three master valves pass through the register, a long rotating valve. In one position, the register sends the air column through a short loop. In the other, it sends the air column in a longer loop.

A.3.4	B.5.2	C.24.8	D.2	E.11	F.0	G.9	H.–5	I.5
A.3.4	B.5.2	C.4.2	D.2	E.11	F.0	G.7	H.2&S(–5)2	I.6
A.3.4	B.5.2	C.4.2	D.2	E.11	F.0	G.7	H.1&T(–5)1	I.7
A.3.4	B.5.2	C.4.2	D.2	E.11	F.0	G.7	H.3&T(–5)3	I.8

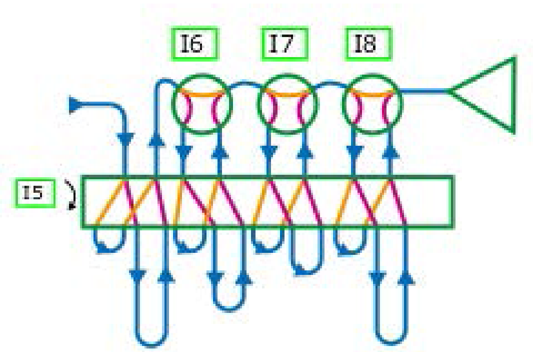

Figure 9 Register horn in B♭/F, Otto Tiedt patent, by Richard Wunderlich, Chicago, USA, around 1930, Bruno Kampmann collection, No. 113 and schema

Arban-Bouvet system double principle C trumpet with 4 Périnet valves (Fourth master valve, others slave valves) This instrument has a very unusual fingering. With the fourth piston raised, the first three pistons lower the instrument by one tone, one semitone and two tones respectively (this is the »ministerial« fingering). The fourth piston, operated by the thumb or forefinger of the left hand, lowers by one and a half tones, like the third piston of a standard trumpet. In this position, the first three pistons lower the instrument by an additional tone, a semitone, and one tone and half, respectively. The third piston this time is tuned as per standard fingering and no longer as ministerial fingering. Criterion H of the classification makes this peculiarity clearly visible.

A.1.3	B.1.1	C.6.4	D.2	E.7	F.3	G.7	H.3	I.6
A.1.3	B.1.1	C.8.6	D.2	E.7	F.3	G.8	H.2&(3)2	I.1
A.1.3	B.1.1	C.8.6	D.2	E.7	F.3	G.8	H.1&(3)1	I.2
A.1.3	B.1.1	C.8.6	D.2	E.7	F.3	G.8	H.4&(3)3	I.3

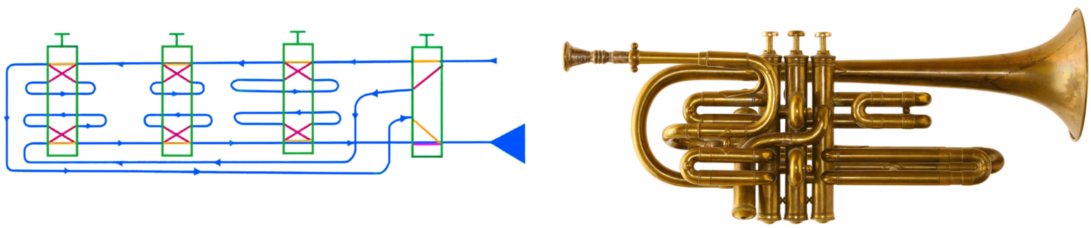

Figure 10 Trumpet in C with 4 Périnet double principle valves, Arban-Bouvet system, by Jean-Baptiste Arban, Paris, 1883 patent, Bruno Kampmann collection, No. 271 and schema

Double principle horn, Schmelzer Kravka system with twin barrels The air enters in the two-stage master barrel, and passes through the F or Bb circuit, before returning in the master before to enter in the bell. The 3 slave valves are twin two-stage barrels coupled, allowing an air deflection of only 120° instead of 90°.

A.3.2	B.4.2	C.6.2	D.2	E.11	F.0	G.7	H.–5	I.5
A.3.3	B.5.2	C.6.2	D.2	E.11	F.0	G.8	H.3&(–5)3	I.8
A.3.3	B.5.2	C.6.2	D.2	E.11	F.0	G.8	H.1&(–5)1	I.7
A.3.3	B.5.2	C.6.2	D.2	E.11	F.0	G.8	H.2&(–5)2	I.6

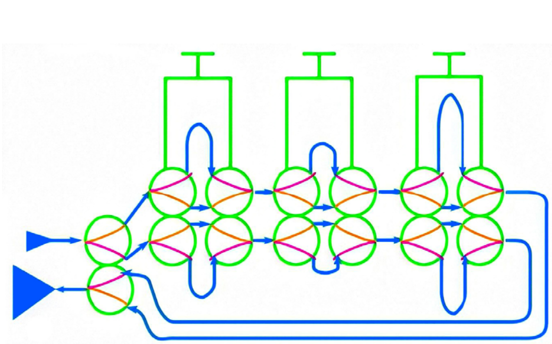

Figure 11 Double principle horn in B♭/F, Schmelzer Kravka system with twin barrels, by Amati, Kraslice, Czech, 1965 patent, Bruno Kampmann collection, No. 944 and schema

Besson double principle and compensating euphonium, ›enharmonic‹ model The third piston, master, and controls follow the double principle of the first and second slave pistons, but also control the additional slave compensated fourth to achieve a low E only with the I.3+I.6 fingering.

A.1.3	B.1.1	C.6.4	D.2	E.7	F.3	G.7	H.3	I.3
A.1.3	B.1.1	C.8.6	D.2	E.7	F.3	G.8	H.1&(3)1	I.2
A.1.3	B.1.1	C.8.6	D.2	E.7	F.3	G.8	H.2&(3)2	I.1
A.1.3	B.1.1	C.8.6	D.2	E.7	F.3	G.9	H.5&(3)3	I.6

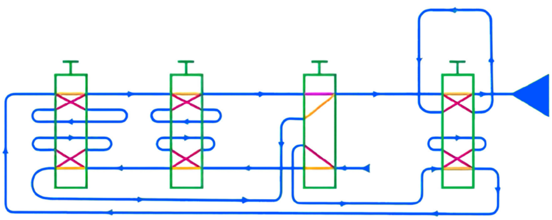

Figure 12 Double principle and compensating euphonium in B♭ by Besson & Co., London, 1908, Bruno Kampmann collection, No. 197 and schema

Conclusion

In the first part, several independent criteria are clearly defined to describe each valve, and these criteria are based on geometric properties (translation, rotation, etc.). They can be used unambiguously by curators or non-specialist collectors alike. These are supplemented by functional criteria for the use of the valve. In the second part there is the description of the use and combinations of valves. In the third part, concrete examples are given. If we refer to the various criteria described above, we get the complete description of any valve system in a concise form.

Abstract

Systematics of the Brasswind Valve
If many systems of classification for musical instruments exist, a classification for the pistons and valves of wind instruments has never been proposed until now. However, many systems were invented subsequently, giving rise to countless patents. Most systems remained in the status of prototypes or had only an ephemeral existence, a fact which does not stop new systems from appearing on the market. It might be interesting to determine whether their basic ideas are new or not. Some valves are also more efficient than others, and it is important to explain why.

A universal classification system is necessary, but this system, to be usable by non-specialist collectors and curators, needs to be simple, clear and based on unambiguous and non-debatable criteria. The classification follows three stages:

1. Description of the physical characteristics of an isolated valve, regardless of its use. To allow a strictly unambiguous classification, certain criteria based on geometric properties have been favoured: translation, rotation, number of connected tubes, etc. Other interesting, but secondary, criteria will be also taken into account, and described, as well as their properties.

2. Description of valve effect, with the resulting cumulative effects on the air flow. This part describes valves used alone, combinations of valves, dependent or independent, and also compensation and double principle systems to correct the pitch.

3. Samples of use of the systematics. All the criteria are detailed, according to the hierarchy chosen, but because they are independent, it is possible to use only the ones one needs.

Systematik der Ventile bei Blechblasinstrumenten
Es gibt zwar viele Klassifizierungssysteme für Musikinstrumente, aber eine Klassifizierung für die Kolben und Ventile von Blasinstrumenten wurde bisher noch nie vorgeschlagen. Allerdings wurden in der Folge viele Systeme erfunden, die zu unzähligen Patenten führten. Die meisten Systeme verblieben im Status von Prototypen oder hatten nur eine kurzlebige Existenz, was jedoch nicht verhindert, dass neue Systeme auf den Markt kommen. Es könnte interessant sein festzustellen, ob ihre Grundideen neu sind oder nicht. Manche Ventile sind auch effizienter als andere, und es ist wichtig zu erklären, warum.

Ein universelles Klassifizierungssystem ist notwendig, aber dieses System muss einfach und klar sein und auf eindeutigen und unstrittigen Kriterien beruhen, damit es auch von nicht spezialisierten Sammlern und Kuratoren genutzt werden kann. Die Klassifizierung erfolgt in drei Stufen:

1. Beschreibung der physikalischen Eigenschaften eines isolierten Ventils, unabhängig von seiner Verwendung. Um eine eindeutige Klassifizierung zu ermöglichen, wurden bestimmte Kriterien, die auf geometrischen Eigenschaften beruhen, bevorzugt: Translation, Rotation, Anzahl der angeschlossenen Rohre, usw. Andere interessante, aber sekundäre Kriterien werden ebenfalls berücksichtigt und beschrieben, ebenso wie ihre Eigenschaften.

2. Beschreibung der Wirkung der Ventile und der sich daraus ergebenden kumulativen Auswirkungen auf den Luftstrom. Dieser Teil beschreibt Ventile, die allein verwendet werden, Kombinationen von Ventilen, abhängig oder unabhängig, sowie Kompensations- und Doppelprinzip-Systeme zur Korrektur der Tonhöhe.

3. Beispiele für die Anwendung der Systematik. Alle Kriterien sind entsprechend der gewählten Hierarchie detailliert aufgeführt, aber da sie unabhängig voneinander sind, ist es möglich, nur diejenigen zu verwenden, die man braucht.

Autor

Bruno Kampmann graduated as an engineer from the »École Centrale Paris« and was always fascinated by the complexity and the variety of wind instruments which he has collected extensively for more than fifty years, owning now 700 instruments. He also plays euphonium and serpent in amateur bands. His special interests are Adolphe Sax, the unusual valve systems and compensating devices, and more generally all the inventions and patents that flourished during the 19th century.

In 1988 he founded the ACIMV (Association des Collectionneurs d'Instruments de Musique à Vent [Association of Musical Wind Instruments Collectors]) while editing and publishing the journal *Larigot*. In this journal, he wrote many papers about wind instruments and published several catalogues of private collections. He regularly gives lectures during the Galpin Society, American Musical Instrument Society, or Historic Brass Society congress.

He is now an expert in musical instruments, working mainly with the Vichy auction house. In 2010, he was awarded the Clifford Bevan Award, attributed by the International Tuba Euphonium Association, and in 2019, the Anthony Baines Memorial Prize, attributed by the Galpin Society.

Bruno Kampmann hat sein Ingenieurstudium an der École Centrale Paris abgeschlossen und war schon immer von der Komplexität und Vielfalt der Blasinstrumente fasziniert, die er seit mehr als fünfzig Jahren ausgiebig sammelt; mittlerweile besitzt er 700 Instrumente. Er spielt auch Euphonium und Serpent in Amateurbands. Sein besonderes Interesse gilt Adolphe Sax, ungewöhnlichen Ventil- und Kompensationssystemen und ganz allgemein allen Erfindungen und Patenten, die im 19. Jahrhundert ihre Blütezeit erlebten.

1988 gründete er die ACIMV (Association des Collectionneurs d'Instruments de Musique à Vent) und war gleichzeitig Redakteur und Herausgeber der Zeitschrift *Larigot*. Für diese Zeitschrift hat er zahlreiche Artikel über Blasinstrumente verfasst und mehrere Kataloge von Privatsammlungen veröffentlicht. Er hält regelmäßig Vorträge auf den Kongressen der Galpin Society, der American Musical Instrument Society oder der Historic Brass Society.

Als Experte für Musikinstrumente arbeitet er hauptsächlich mit dem Auktionshaus Vichy zusammen. Im Jahr 2010 wurde er mit dem Clifford Bevan Award der International Tuba Euphonium Association und 2019 mit dem Anthony Baines Memorial Prize der Galpin Society ausgezeichnet.