United States Patent [19]

Veneklasen

[11] **3,886,837**

[45] **June 3, 1975**

[54] **MUSICAL HORN ACOUSTIC PATH MODIFICATIONS**

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[21] Appl. No.: **371,126**

[52] **U.S. Cl.** **84/388;** 84/397

[51] **Int. Cl.** **G10d 7/10**

[58] **Field of Search** 84/388, 397, 392–394, 84/387, 390, 391

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Primary Examiner—Stephen J. Tomsky
Assistant Examiner—John F. Gonzales
Attorney, Agent, or Firm—White, Haefliger & Bachand

[57] **ABSTRACT**

A wind instrument wherein the strength of acoustical resonances is made more nearly uniform and independent of the length of tubing, or specifically independent of the use or choice of one or more valves.

29 Claims, 42 Drawing Figures

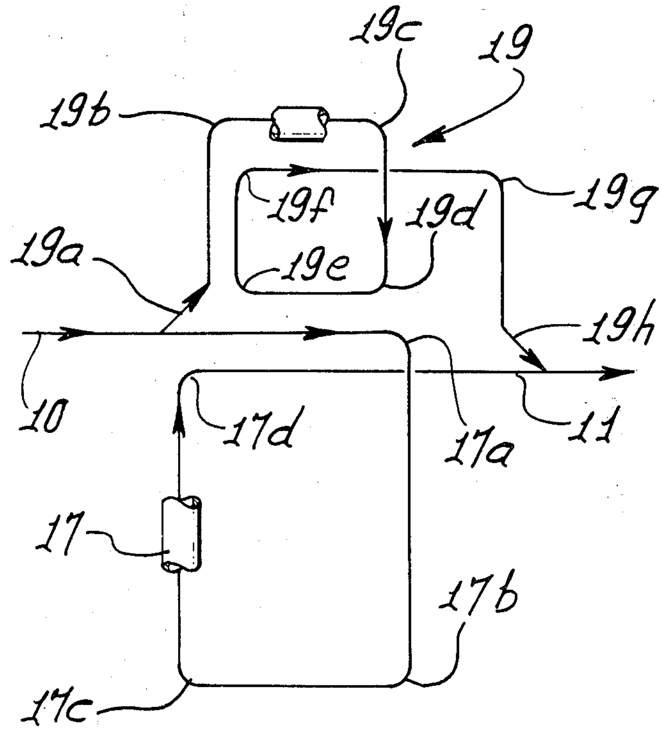


FIG. 1.
PROIR ART

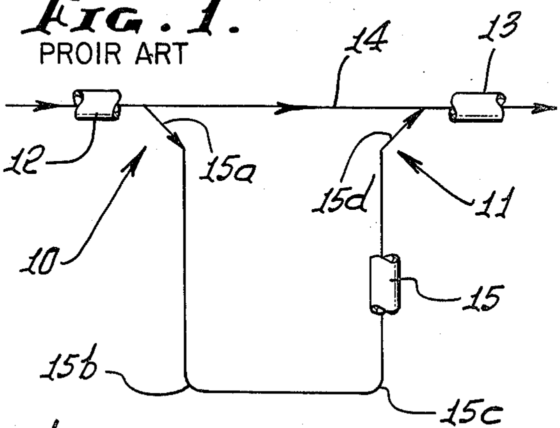


FIG. 2.

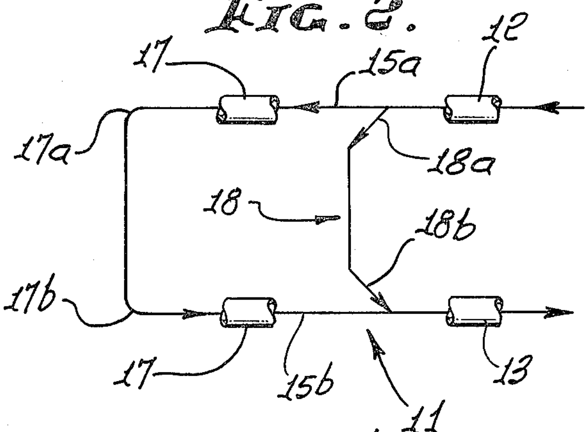


FIG. 3.

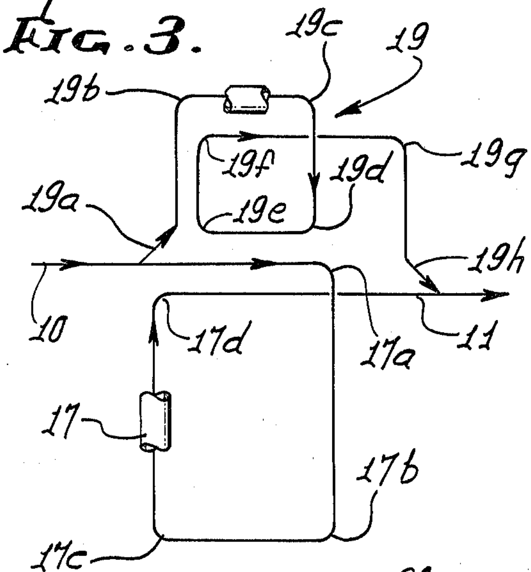


FIG. 4a.

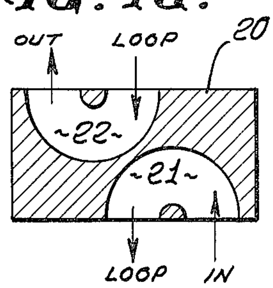


FIG. 4b.

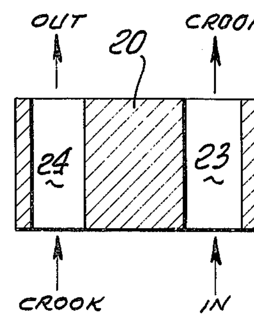


FIG. 4c.

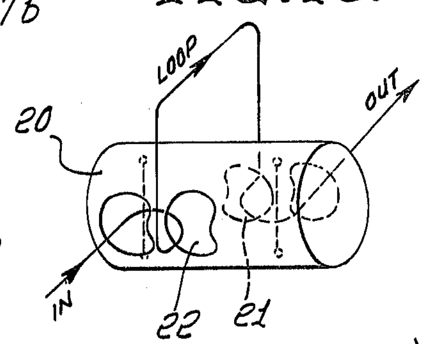


FIG. 4d.

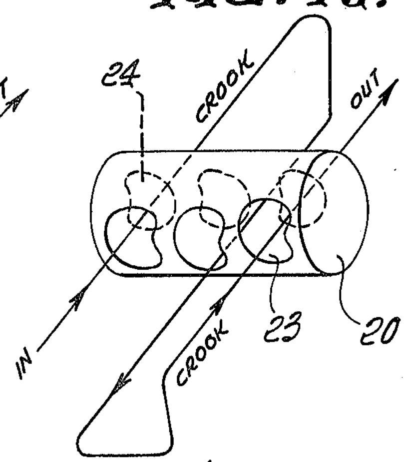


FIG. 6a.

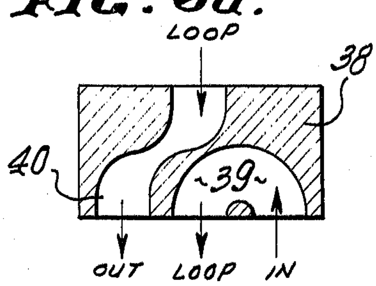


FIG. 6b.

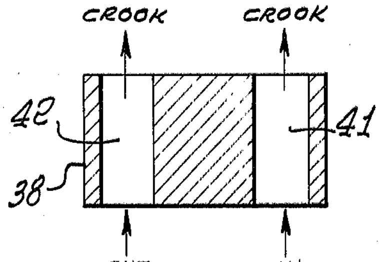


FIG. 5a.

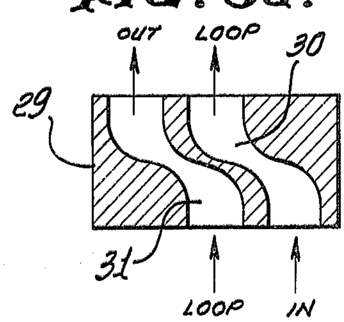


FIG. 5b.

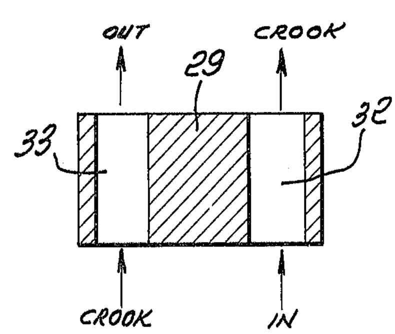


FIG. 7a.

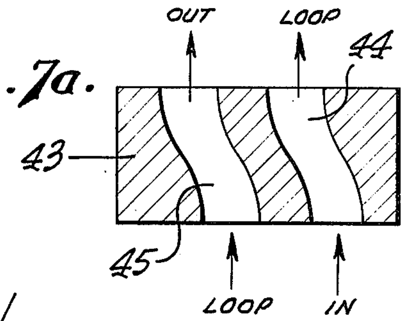


FIG. 7b.

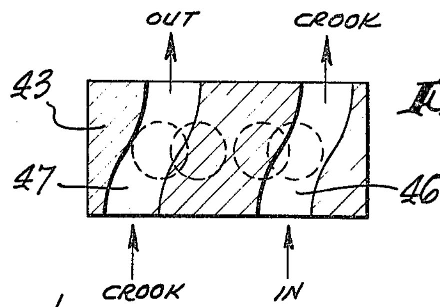


FIG. 8a.

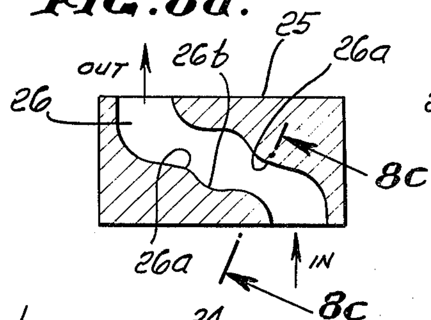


FIG. 8b.

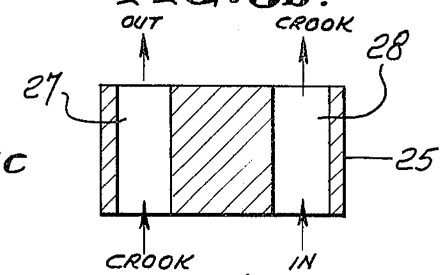


FIG. 8c.

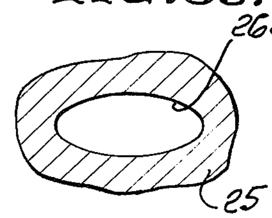


FIG. 9a.

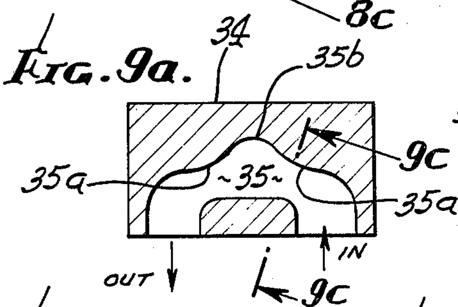


FIG. 9b.

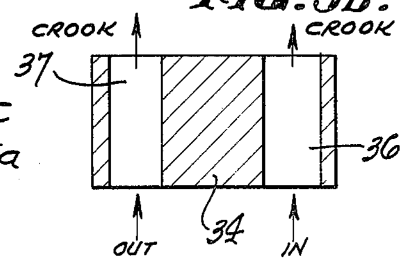


FIG. 9c.

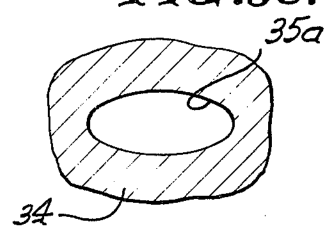


FIG. 10b.

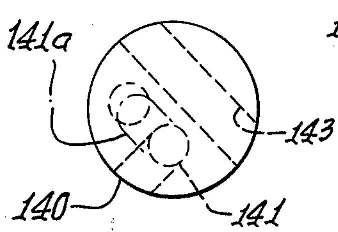


FIG. 10d.

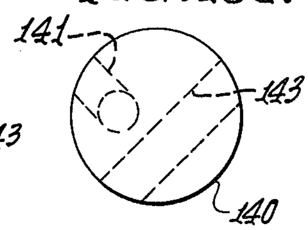


FIG. 11b.

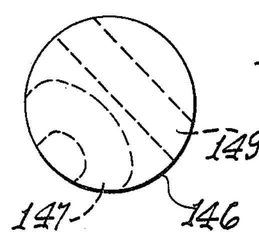


FIG. 11d.

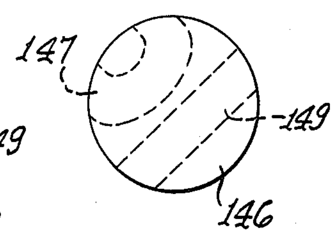


FIG. 10a.

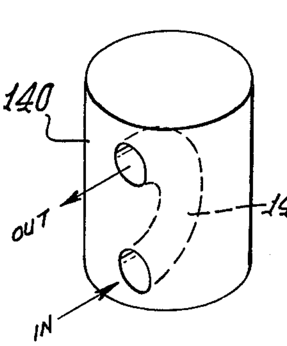


FIG. 10c.

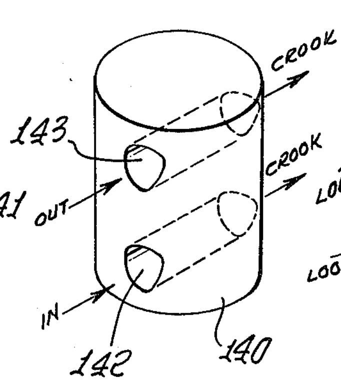


FIG. 11a.

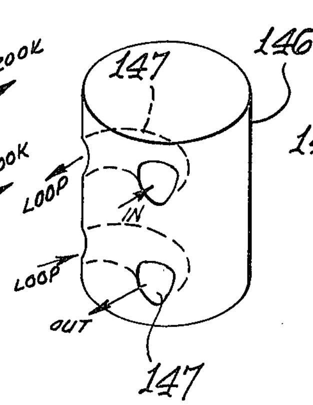


FIG. 11c.

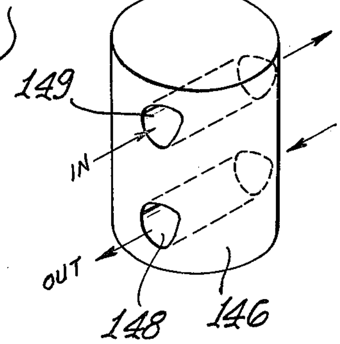


FIG. 12b.

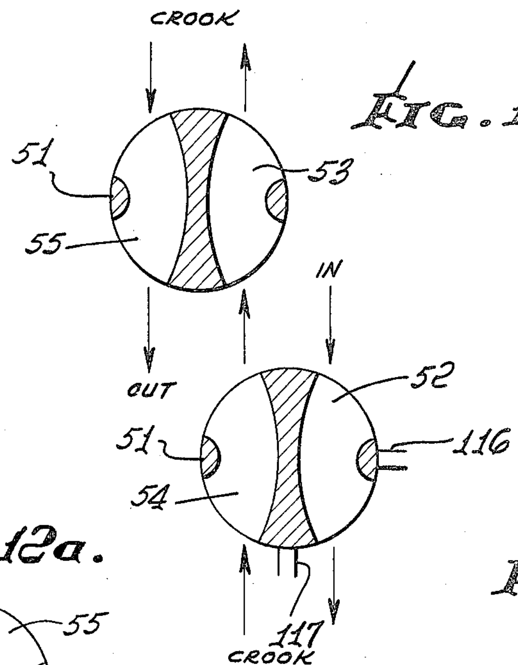


FIG. 12a.

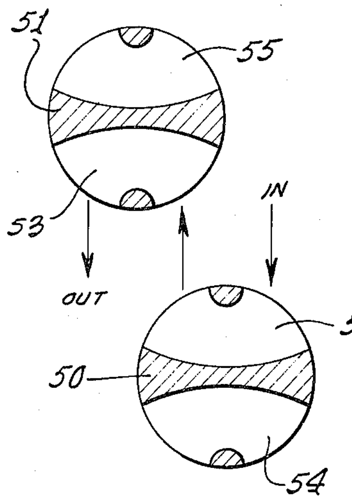


FIG. 13a.

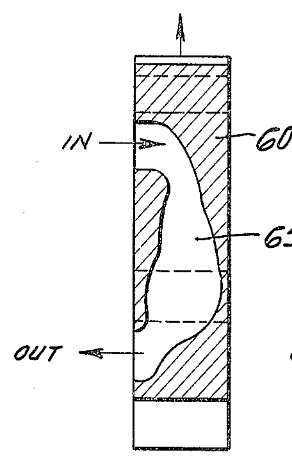


FIG. 13b.

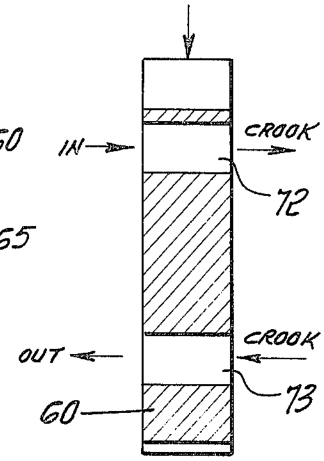


FIG. 14a.

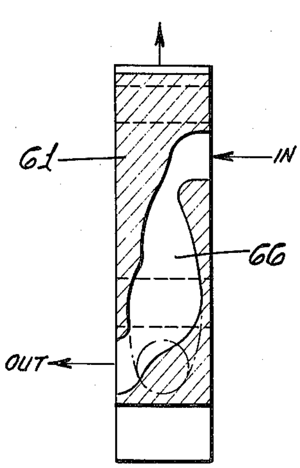


FIG. 14b.

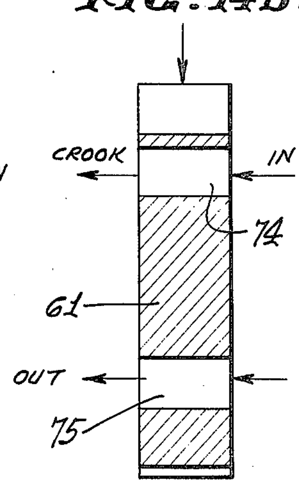


FIG. 15a.

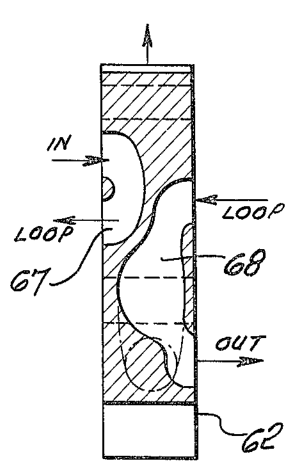


FIG. 15b.

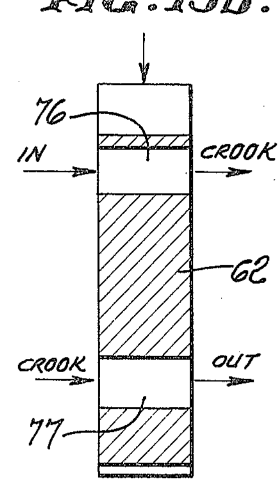


FIG. 16a.

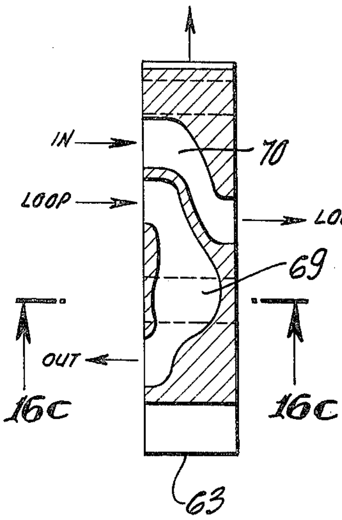


FIG. 16b.

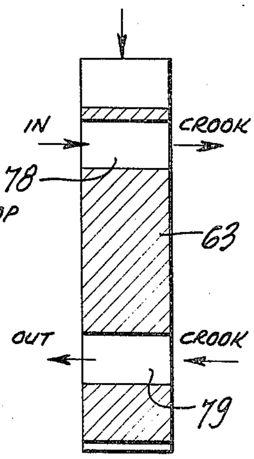


FIG. 17a.

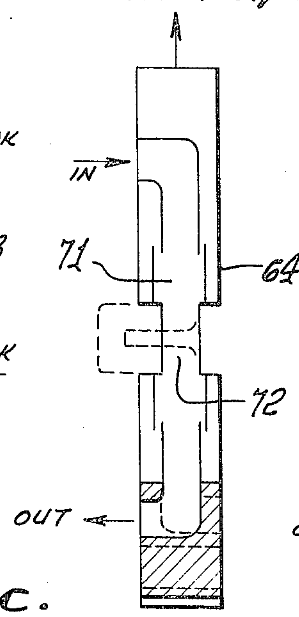


FIG. 17b

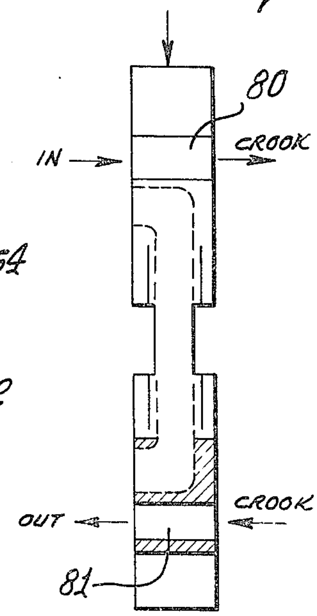


FIG. 19.

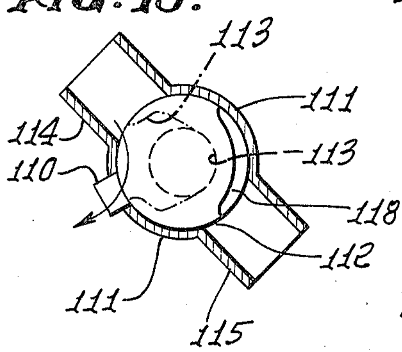


FIG. 16c.

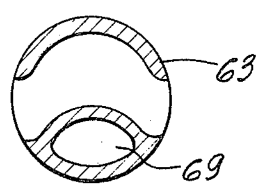
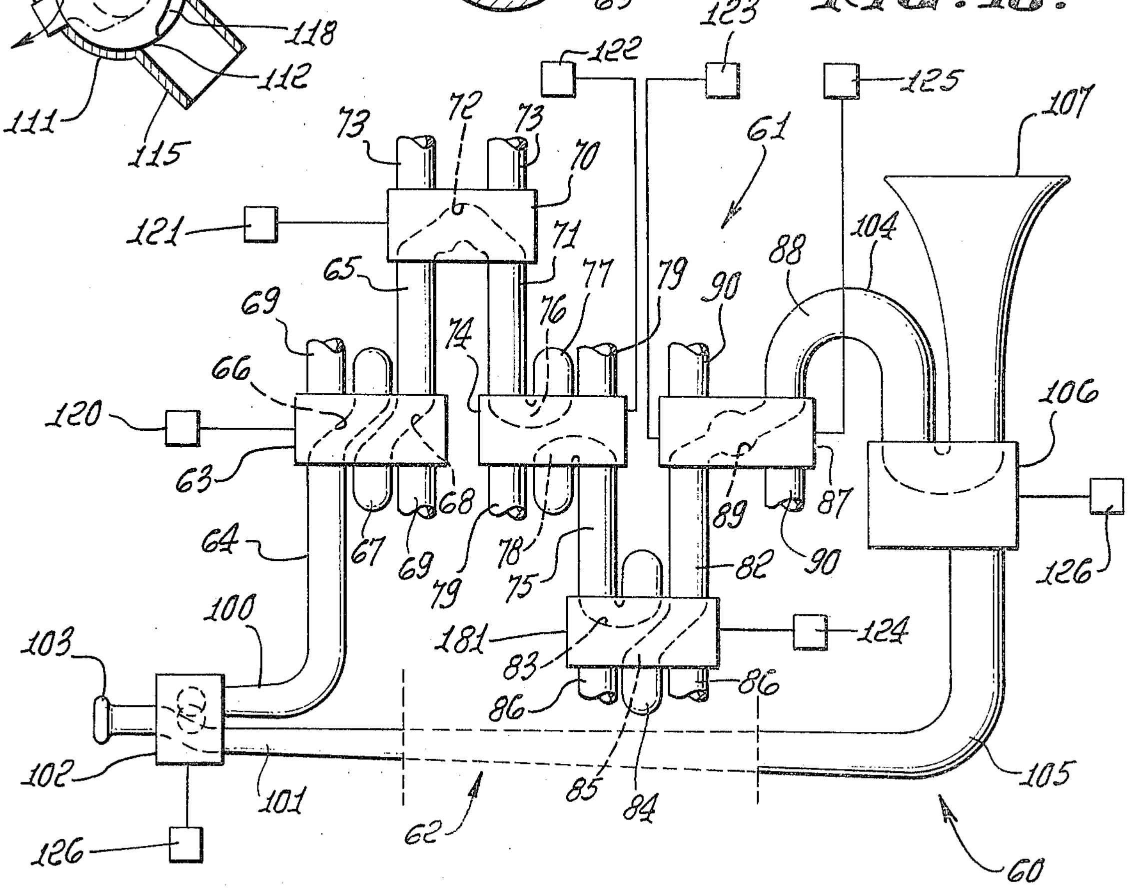


FIG. 18.



MUSICAL HORN ACOUSTIC PATH MODIFICATIONS

BACKGROUND OF THE INVENTION

This invention relates generally to the construction and operation of wind instruments, and more particularly concerns the solutions to age-old problems of playability and tonal production of such instruments, employing various air column configurations.

The instruments of the brass family are characterized by the following physical elements and acoustical system: the player's lips contact the rim of a mouthpiece; the mouthpiece has a bowl-shaped cavity and a constricted opening leading into an expanding tubular section; the tubular section of the mouthpiece continues into an expanding section of the instrument; the tubing of the instrument continues and may be expanding in area or remain of constant bore for some length; at certain points along the length valves may be inserted which permit selective insertion of additional lengths of tubing; beyond the valves the tubing continues and generally expands in area, finally terminating in a more abrupt expansion forming the bell. The player's breath is forced through pursed lips, creating a buzzing sound resulting from periodic bursts of air which pass down the tubing and are reflected back and forth through the tubing by acoustic resonance in tune with and counterreacting upon the breath pulses from the lips. The instruments of this family are all generically known as horns, and more specifically as trumpets, cornet, French horn, Baritone horn, trombone, tuba, Sousaphone, and many others. The slide trombone is uniquely different in that changes of tubing length are accomplished by continuous sliding tubing instead of switched discrete lengths of tubing.

The functioning of this type of instrument musically is dependent upon the series of acoustical resonances of the lip/mouthpiece/tubing/bell system. Simply described: any given length of tubing system is capable of resonating at a series of frequencies that are harmonically related to the fundamental pitch being elicited; for example, if the note played is pitched at the third harmonic of the basic pipe length, then in addition to the third harmonic, the tone will contain the 6th, 9th, 12th, 15th, etc., harmonics of the fundamental pipe, which in turn are the 2nd, 3rd, 4th, 5th, etc., harmonics of the tone; these harmonics and their individual strengths determine the distinguishing tonal color of the tone being played; another length of tubing will provide another series of resonances whose frequencies will fall between those of the first series; by choosing a number of appropriate lengths, the aggregate of the series of frequencies may be made to match with the needed frequencies for the chromatic musical scale over a range of several octaves. In general, i.e., for the simplest instruments, three valves inserting three additional tube lengths, known as crooks, used either individually or in combination, will provide eight lengths of tubing and sufficient numbers of resonant frequencies to match with the frequencies of the musical scale.

There are many problems with such instruments; and the present invention is concerned with solutions to such problems as are described below.

The first type problem is as follows: when the length of the tubing is changed, the series of harmonics does not behave in quite the same way; in general, a longer length of tubing produces harmonic resonances that are less strong or sharp than the resonances of a shorter tube length, i.e., particularly lacking strength in the higher partials of tone color; if, in making the tube longer, additional turns or bends are introduced along the length, as from passing through valves or around the turns of an added crook, these resonances will be still weaker than those of a straight tube of the same length. If these bends are sharp, though this contention is unsubstantiated in the laboratory. This effect is thought to be minimal on the lower of these partials and increasingly pronounced on the higher partials. Thru the evolution of brass design, convenient location of valves for finger actuation and other practical considerations of shape have tended to be dominant factors in layout of the necessary range of tube lengths. But design so prejudiced can result in many possible combinations wherein the effects of length and bends compound, act interchangeably, or are minimal at the same time. As the instruments have increased in desirable features and complexity, they have at the same time acquired increasingly non-homogeneous playing qualities as an unwelcome parasite. Notes one step apart musically, when played respectively on a short, straight tube and a long, twisted one vary somewhat in wound, while varying noticeably in feel to the player.

The practical result of this circumstance is that the instruments are treacherous to play, especially the French horn, which is a long-pipe instrument utilizing higher order harmonic resonances which are closely spaced in frequency. Therefore, when a player aims for one note, it is too easy to momentarily hit the wrong not and bounce to the correct one. As a result, the mastery of these instruments is too largely a mastery of demon technical problems, rather than, and to the distraction from, the mastery of musical performance.

Another problem involves condensation of moisture in the instrument. The player's breath contains water vapor as a product of metabolism. Entering the metallic tubing which is cooler, the moisture condenses and accumulates in increasing quantity. It collects in the gravitational sumps of the tubing, i.e., the lowest level of crooks and bends. Eventually, depending on the continuity of playing enough water accumulates so that the passage through the tubing is obstructed, and tone production is impaired or garbled. Therefore, the player must stop from time to time, quickly withdraw specific crooks and empty out the water before he can continue playing. This necessity is an inconvenience, to say the least, and a disagreeable spectacle to the observer.

Additional problems include intonation and other homogeneity discrepancies arising from differences in acoustical properties of parallel horn sections, as for example in French horns. Provision of such multiple basic pitches greatly expands the total range of tubing lengths available to the player, but also exaggerates the compromise imposed by the conventional practice of using the same tapered tubing at the ends of cylindrical sections wherein the length change takes place. Tapers of differing length and profile are necessary to match intonation and other qualities of notes played interchangeably or in sequence on different lengths.

SUMMARY OF THE INVENTION

It is a major object of the invention to provide solutions to the above described problems as well as others encountered in this field.

Addressing the first discussed problem, the objective is to make the strength of acoustical resonances more nearly uniform and independent of the length of tubing or specifically independent of the use or choice of one or more valves. This is accomplished in the following manner: when a valve is opened, the acoustic path is diverted through a given crook, and when the valve is closed, the path is direct, i.e., bypassing the crook. The length of the acoustic path is always greater through the crook, and therefore the resonances of sounded notes tend to be less strong, and conspicuously lacking in the higher partials of tone color. However, as explained previously, bends also tend to suppress resonance. Therefore, length or bends may be used interchangeably, i.e., a shorter path with more bends may resonate with similar strength to a longer length having fewer bends. Therefore, one aspect of the invention is to construct the horn with its valving and crook configuration so that the shorter direct path contains means for attenuating or weakening harmonic resonances, but particularly in the higher, assumed to be less afficient, partials of tone color, to approximate the resonance characteristic of the crook, where employment of bends has first been minimized and optimized to attenuate the higher resonances in preference to the lower. The latter are thought to be more efficient ones whose strength is being depleted by the crook's length. One example of this is to provide the direct path with bends intentionally introduced for these resonance matching purposes, thereby to achieve the intended more homogeneous behavior of the instrument and resulting relief technical playing technicalplaying problems.

Further, another aspect of the invention is considered to be a dividend of the above stated design feature. It is thought to accrue from the embodiment of a theory as yet unsubstantiated in the laboratory, but suggested by extensive field testing of instruments employing this feature whereon an otherwise difficult to explain free-blowing characteristic was encountered.

It is proposed that, in addition to the alleviation of tonal and playing discrepancies between notes, the feature's net effect is an instrument of enhanced free-blowing properties on all lengths. Where there is little or no improvement for the lowest notes played on a given length but a noticeable amount in the middle register and a considerable improvement in the highest register. Since air conduit lengths are provided either long and relatively straight or short and configured with many sharp bends, and because conduit length and sharp, tight bends are thought to have the parallel effect of attenuating the higher partials of tone color disproportionately, both long and short conduits are thus either long and straight enough or short and curved enough to resonate most readily in the lower partials of tone color. This last circumstance becomes a prime factor in the theory.

This is, however, contrary to the condition prevailing in the prior art wherein the longer conduits are increasingly tortuously curved and the shorter conduits are increasingly straight. This consensus the inventor believes is due largely to the great value placed upon obtaining the straightest "open" path. With the tubing so arranged, it is thought that attenuating effects are either sufficiently combined in the long paths or sufficiently absent in the short paths so that the effect is an essentially uniform attenuation of the tonal partials and is thus contrary to the feature of this invention. This uniformity of attenuation remains the case, and is not desirable as will be seen, whether its degree is great for the longer conduits or minimal for the shorter ones.

However, in accordance with the present invention describing the principle of length and bends employed in inverse ratio, a condition of enhanced free-blowing characteristics is thought to accrue from its alleged property of favoring resonances in the lower partials of tone color on all length conduits. Such a condition is thought to shift the distribution of vibratory energy emanating from the pursed lips to a concentration more heavily in the lower partials, and away from the more uniform distribution thought to be characteristic of a corresponding instrument of conventional design. It has been proposed above that partials of lower harmonic number suffer less attenuation than for the same energy driving partials of higher number. Allowing this, more energy entering the horn in these lower partials and less in the higher would resolve into less total attenuation, or a net energy issueing from the horn in all frequencies greater than that from a source emitting more high and less low.

Thus, inherest in the above, is the proposed freer blowing dividend, above and beyond the more uniform playing and tonal properties previously ascribed to this general aspect of the invention. While this added contention opens a whole new dimension for the range and accuracy potential of these instruments, it has yet to be empirically or theoretically substantiated.

The second type of problem regarding moisture ejection is solved in the following manner. As a valve turns from one position to the other, its port must align exactly with the continuous tubing at both terminal positions. However, at some intermediate position, it is possible to have the port pass a vent opening through the casing of the valve, that vent opening to the outside space and situated to purge the passage as it moves past. Accordingly, certain valves are so placed in the layout of the instrument so that the water accumulates at the valve position where the passage is properly situated and otherwise formed to act as the gravitational sump for some portion of the instrument; thus, whenever that valve is cycled, any accumulated fluid will be discharged through the vent. In this matter, because of the frequent use of the valves, no large amount of fluid is permitted to accummulate and, instead, in unnoticeable and unobjectionable quantities, the instrument is being purged, in a manner not distracting to the player, or unsightly for an audience to watch.

Additional objects include the provision of formats and designs for types of valves employing the above principles; the provision of a horn incorporating at least two sections which are alternately played, as in a French horn, and wherein the shorter section contains turns or bends for equalization purposes as will be described; and the provision of complete inlet tapers and a large portion of the outlet tubing tapers exclusive to each such section, to improve intonation, uniformity and response.

These and other objects and advantages of the invention, as well as the details of illustrative embodiments, will be more fully understood from the following description and drawings, in which:

DRAWING DESCRIPTION

FIG. 1 is a schematic showing of a conventional valve and crook assembly;

FIG. 2 is a schematic showing of one form of valve, crook and loop assembly embodying a partial employment of the invention;

FIG. 3 is a schematic showing of another form of valve, crook and loop assembly fully embodying the invention;

FIGS. 4*a*, 4*b* —9*a*, 9*b* are schematic showings of rotary valves of new design, with independent passages for the different circuits, in non-rotated and rotated positions, FIGS. 4*c* and 4*d* are perspective showings of the FIG. 4 valve, with and without added crook; and FIGS. 8*c* and 9*c* are sections taken respectively on lines 8*c*—8*c* in FIGS. 8*a* and on lines 9*c*—9*c* in FIG. 9*a;*

FIGS. 10*a* and 10*b*, 11*a* and 11*b* are side and top plan views of other types of rotary valves with independent passages in non-rotated position;

FIGS. 10*c* and 10*d*, 11*c* and 11*d*, are side and top plan views of the FIG. 10*a* and 11*a* valves, in rotated position;

FIGS. 12*a* and 12*b* are sections through other rotary valve pairs in non-rotated and rotated position, situated back to back;

FIGS. 13*a*, 13*b*—17*a*, 17*b* are schematic showings of piston valves in alternate linear positions; section 16*c* being taken on FIG. 16*a*.

FIG. 18 is a side elevation of a schematic horn embodying the invention; and

FIG. 19 is a section through a playing valve incorporating a further feature of the invention.

DETAILED DESCRIPTION

Referring first to FIG. 1, a conventional valve and crook arrangement includes valve elements 10 and 11 interconnecting tubing portions 12 and 13, a direct acoustic path through the valve internal section 14 and a crook section 15 of the tubing. The arrows at the valves indicate the alternate directions of the acoustical path. When the valve elements are positioned so that short, direct path section 14 interconnects tubing portions 12 and 13, there are no turns in the acoustic path; however, when the valve elements are positioned so that crook section 15 interconnects tubing portions 12 and 13, there are at least four turns in the longer acoustic path, i.e., at 15*a*, 15*b*, 15*c*, and 15*d* typically. Accordingly, the resonances are weaker than the diverted path through the crook section is used.

In accordance with one important aspect of the invention, both the direct acoustic path section and the crook section are provided with multiple bends, the number of bends in the relatively shorter direct path section exceeding the number of bends in the relatively longer crook section. In the FIG. 2 example, the diverted path 17 through the crook is made the necessary length and given the minimum number of turns, i.e., in this case two, at 17*a*, 17*b*. The direct path 18, while shorter, is provided with two turns, i.e., at 18*a*—18*b*, which, due to tubing portions 12 and 13 approaching in line with the diverted path section 17, are now added to path 18 at 18*a* and 18*b* instead of the diverted path of the conventional arrangement at 15*a* and 15*d*. While not compensating for the increased length of the diverted path in this first arrangement, the bends of the diverted path have been reduced and bends have been added to the direct path, thereby accommodating to the above principle. FIG. 3 shows another alternative wherein the relatively shorter length direct path section 19 contains eight turns, i.e., at 19*a*–19*h*, to the four turns of the crook section at 17*a*–17*d*. Using this principle, it is possible to produce horn configurations having much more uniform resonances, and more nearly uniform playing and tonal characteristics from note to note.

FIGS. 4*a*, 4*b*–9*a*, 9*b* show various form of rotary valve bodies of unusually advantageous construction, which may be employed to perform the functions analogous to those of the aforementioned valve elements 10 and 11. In each of these examples, the body defines first through passage means movable into series communication with the tubing direct (loop) path section, and second through passage means movable into series communication with the tubing crook section. FIG. 4*c* shows a complete circuit of variation 4 and is typical. These are summarized in accordance with the following table, it being understood that the valve body is rotatable (as through 90°) between its two illustrated positions in each figure:

TABLE I

Figures	Body	First Passage Means (to external loop)	Second Passage Means (to crook)
4*a* & 4*b*	20	21, 22	23, 24
5*a* & 5*b*	29	30, 31	32, 33
6*a* & 6*b*	38	39, 40	41, 42
7*a* & 7*b*	43	44, 45	46, 47

In the above table and drawings it will be noted that through passages 21, 22, and 39 are generally U-shaped, that passages 23, 24, 32, 33, 41 and 42 are generally linear, and that passages 30, 31, 40, 44, 45, 46 and 47 are generally S-shaped.

FIGS. 8*a*, 8*b*, 9*a* and 9*b* show various form of rotary valve bodies which may alternatively be employed to perform function analogous to those of the described valve elements 10 and 11. In each of these examples, the body defines first through passage means movable into communication with external tubing, and second through passage means movable into series communication with the external tubing crook section. These are summarized in accordance with the following table, it being understood that the valve body is rotatable (as through 90°) between its two illustrated positions in each Figure.

TABLE II

Figures	Body	First Passage Means (internal loop)	Second Passage Means (to crook)
8*a* & 8*b*	25	26	27, 28
9*a* & 9*b*	34	35	36, 37

In the above table and drawings, it will be noted that through passage 35 is generally U-shaped, through passage 26 is generally S-shaped, and passages 27, 28, 36 and 37 are generally straight. Certain passages 26 and 35 each have cross-sections which vary from being substantially circular at their ends (which meet the external circular cross-section tubing) to substantially oval at locations 26*a* and 35*a* intermediate those ends.

At intermediate location 35*b* (between two locations 35*a*) passage 35 is also circular in cross section, and at intermediate location 26*b* (between locations 26*a*) passage 26 is also circular. FIGS. 8*c* and 9*c* show the laterally elongated oval shape of passage 26 and 35 at locations 26*a* and 35*a*, and which act to attenuate or weaken the harmonic resonances within the valve passages.

FIGS. **10**a, **10**b, **10**c and **10**d show a modified rotary valve body **140** having a U-shaped first passage **141** providing an internal loop connected with the horn tubing in one body position (FIGS. **10**a and **10**b), and generally straight through second passage means **142** and **143** providing communication with an external crook in a rotated position of the body. If desired, two extra bends may be provided in passage **141**, as indicated at **141**a in FIG. **10**b, and the internal U-shaped loop **141** may have non-circular cross sectional configuration intermediate its circular end ports. FIGS. **11**a—**11**d show another modified rotary valve body **146** having U-shaped first passages **147** connectable with an external tubing loop (direct path) in one body position (FIGS. **11**a and **11**b), and generally straight through second passage means **148** and **149** providing communication with an external crook in a rotated position of the body. FIGS. **12**a and **12**b show rotary valves **50** and **51** modified with inlet and outlet tubing portions entering the casings in line with the crook section outlet and inlet. These are located back to back, so that the long path (crook) has no more bends than the short path, since it is thought that the approximately one-half diameter joggles through the valves in the long path nearly cancel their effect by having immediate and equal reverses in direction. In FIG. **12**a, the valve bodies are located so that first passages **52** and **53** are in series communication (direct path); and in FIG. **12**b, the valve bodies are rotated so that second passages **54** and **55** are also in series communication with the first passages via external crooks, as indicated (long path).

FIGS. **13**a, **13**b–**17**a, **17**b show various forms of linear or double piston (Vienna) valve bodies of unusually advantageous construction, which may be employed to perform the functions of the aforementioned valve elements **10** and **11**. In each of FIGS. **13**a, **14**a, **15**a, **16**a and **17**a, the valve bodies **60, 61, 62, 63** and **64** have been moved relatively endwise upwardly to connected the first passages **65–71**, as shown, with external tubing, which may or may not include external loops, as indicated (short paths); whereas, in each of FIGS. **13**b, **14**b, **15**b, **16**b and **17**b, the valve bodies have been moved relatively endwise downwardly to connect the second passages **72–81** in series with external crooks, as indicated (long paths). Note the U-shaped configurations of passages **65, 68,** and **69**, and the S-shaped configurations of passages **66** and **70,** these also having optional oval shaped cross sections at some points intermediate their circular cross section end ports. Passage **71** (short path) may be augmented, as shown, with tubing containing multiple bends and or oval cross sectional changes, these additions being made between the operatively interconnected sections of the body **64.**

When the above principles are applied to a "double" or "triple" type French horn, or other instrument of similar principle, still greater benefit is derived. Such instruments are really two (or three) horns in one: in the case of the standard double French horn the lower pitched horn is generally tuned in F (also Bb), and the higher pitched is generally tuned in B-flat (also F alto, etc.). Both horns share the same initial portion of pipe, and the same terminal pipe leading to and including the bell. Switching from one horn to the other is accomplished by a pair of valves which interchange the entire central section of the two instruments, each of which has its own playing valves and crooks. The problem is that the B-flat horn, having a shorter length, has stronger resonances particularly in the higher partials of tone color, and therefore plays differently and more brilliantly. In accordance with the invention, the B-flat horn is constructed so that its acoustical path entails many more turns than the longer F horn. As a result, the added acoustic dissipation of the turns, most effective at the higher tonal partials, can so compensate that when switching from one horn section to the other, there is relatively little change in tone quality and the playing characteristics are similar (excepting changes in the proximity of adjacent partials). The result of the equalization from one horn to the other, plus the equalization of the crooks for both horns, is a much more homogeneous behavior of the instrument and accordingly, a moderation of technical playing problems.

FIG. **18** illustrates a horn **60** which includes multiple sections **61** and **62** and which may be considered to schematically represent a French horn with horn longer section **61** tuned in F barione (lower pitch) and horn shorter section **62** tuned in F alto (higher pitch). Both sections may also be considered to employ multiple loops and crooks, as illustrated only with respect to section **61.** In the latter, rotary valve body **63** in one position (as shown) connects tubing point **64** with tubing point **65** via a "short" path including valve body passage **66,** loop **67** and valve body passage **68** (see FIG. **5** for example), whereas in another (rotated) body position, point **64** is connected with point **65** via a "long" path including through passages shown rotated 90° and crook **69.** Rotary valve body **70** in the position shown connects tubing point **65** with tubing point **71** via a short path including valve body U-shaped passage **72** (similar to passage **36** in FIG. **9**), whereas in another (rotated) position of body **70** the points **65** and **71** are interconnected via essentially straight through passages shown rotated 90° and crook **73.** Rotary valve body **74** in the position shown connects tubing points **71** and **75** via a short path including body U-shaped passage **76,** loop **77** and U-shaped body passage **78,** (similar to passages **21** and **22** in FIG. **4**), whereas in body rotated position, the points **71** and **75** are interconnected via substantially straight through passages (shown rotated 90°, but like passages **23** and **24** in FIG. **4**) and crook **79.** Rotary valve body **181** in the position shown connects tubing point **75** with point **82** via a short path including body U-shaped passage **83,** loop **84** and body S-shaped passage **85** (see for example passages **39** and **40** in FIG. **6**), whereas in body rotated position, the points **75** and **82** are interconnected via substantially straight through passages shown rotated 90° and crook **86.** Finally, rotary valve body **87** in the position shown interconnects tubing points **82** and **88** via a short path including body S-shaped passage **89** (like passage **26** in FIG. **8**), whereas in body rotated position, the points **82** and **88** are interconnected via essentially straight through passages (shown rotated 90°) and crook **90.** Accordingly, the paired loop (short path) and crook (long path) combinations are equalized, as previously described. Further, the horn shorter section **62** is constructed to contain more turns that the horn longer section **61,** so that when switching between the sections there is relatively little change in tone quality and the playing characteristics are similar (excepting changes in the proximity of adjacent partials). Such extra tubing turns in section **62** may be introduced at the tubing locations between the rotary valves, or in the case of multiple horns where only tubing of like diameter is exchanged between sides, by selecting the configuration of "change" valves according to the equalizing effect desired.

Keys to rotate the valve bodies in FIG. **18** are schematically indicated at **120 – 126.** Keys **120 – 125** would generally operate their respective valve bodies **63, 70,** 74, 81, and **87** in parallel with valve bodies of similar musical function located in section **62** (and a third section if present). Key **126** operates valve body **102** and **106** in parallel.

A further feature of the invention concerns the fact that the amount of tubing shared by the sections **61** and **62** is minimized in order to counteract playing problems and difficulties manifested by poor intonation and unequal tone quality and response. For this purpose terminal inlet tubing tapers **100** and **101** extend from a change valve **102** proximate the mouthpiece **103** toward the valving sections, and terminal outlet tapers **104** and **105** extend after the valving sections to a junction, change valve **106,** proximate the bell **107.** Merely as an example, tapers **100** and **101** may be about **23** and **12** inches respectively in length for an F octave F pitched French horn.

Finally, another aspect of the invention concerns the provision of means for automatically discharging water or saliva accumulation within the horn in response to operation of playing valves, thereby theoretically making "water keys" and grotesque rotations of the entire horn un-necessary, and greatly extending the intervals wherein removable crooks need by emptied.

As seen in FIG. **19,** a bleed port **110** is provided in the housing or enclosure **111** for the rotary valve body **112,** and at a location to be traversed by a port of a transfer passage **113** (see **35** in FIG. **9***a* or **22** in FIG. **4***a* for example) in the body as the body is rotated between positions in which the passage is connected with either the crook or the short path as described. The enclosure **111** is so situated in the structure of the horn that passage **113,** in its counterclockwise position, is a sump for all fluid draining from all tubing inclusive of tubing section **114.** Accumulated fluid will thus flow out automatically each time the valve is rotated; however, the passage **113** does not communicate with the port in playing position of the body during which the passage is in the acoustic transmission path. Tubing sections **114** and **115** are shown as connected with the valve body housing. Passage **118** is analagous in this example to **36** in FIG. **9***b*. Bleed port locations **116** and **117** noted on FIG. **12***b*, together with proper physical orientation, provide alternatives in application of this principle to conventional style rotary valves.

I claim:

1. In a horn having a mouthpiece and a bell, the combination comprising;

a. tubing and valving providing a direct relatively shorter acoustic path between said mouthpiece and said bell and including a loop section, and an alternate acoustic path longer than the direct path and including a crook section, both of said acoustic paths having multiple bends,

b. the valving movable to control which of said sections is connected in the acoustic path between said mouthpiece and bell,

c. the relatively shorter acoustic path including said loop section having at least as many bends as the relatively longer acoustic path including said crook section, and wherein

d. said valving has separate loop and crook passages for the shorter and longer acoustic paths respectively, the loop passages being substantially tortuous and the crook passages being substantially straight.

2. The combination of claim **1** wherein said valving loop passages and the loop section in the shorter acoustic path filter transmitted harmonic resonances tending to match the harmonic resonance attenuation imposed by the associated crook section.

3. The combination of claim **1** together with a second like set of tubing and valving tuned to a different musical key, and control valves for connecting either of said sets of tubing and valving into operative communication between said mouthpiece and said bell.

4. The combination of claim **2** wherein each valving loop passage has a cross section progressing from substantially circular at the interfaces with the adjacent tubing to substantially non-circular within said valving mediate said interfaces.

5. The combination of claim **1** wherein said valving comprises a movable valve body containing said separate passages.

6. The combination of claim **5** wherein said loop passage is substantially U-shaped.

7. The combination of claim **5** wherein said loop passage is substantially S-shaped.

8. The combination of claim **5** wherein said loop passage itself is the entire loop section for the shorter acoustic path.

9. The combination of claim **5** wherein said valve body contains a pair of loop passages that connect a loop section external to said valve body into the shorter acoustic path.

10. The combination of claim **1** wherein the valving includes a valve having a movable body containing a first tortuous passage means movable into series communication with the main horn tubing, and a second non-tortuous passage means movable into series communication with said crook section.

11. The combination of claim **10** wherein said loop section consists of said first tortuous passage means.

12. The combination of claim **10** wherein said first tortuous passage means includes a pair of through passages each of which is generally U-shaped lengthwise thereof.

13. The combination of claim **10** wherein said first tortuous passage means includes a through passage which is generally S-shaped lengthwise thereof.

14. In a horn having multiple sections, a mouthpiece, playing valves and crooks, and a bell,

a. a switching valve immediately adjacent the mouthpiece terminus and initiating entirely separate leadpipe tapers communicating with the respective passages of the valve, and joining with the respective horn sections,

b. separate terminal tapered tubing branches leading from the respective horn sections toward the horn bell, and communicating with the bell via another switching valve.

15. The embodiment of any horn, wherein at least one playing valve includes a valve body and a housing therefor relative to which the body is movable, wherein

a. the body contains at least one acoustical passage located in one or more of its playing positions, relative to the normal orientation of the instrument for playing, to act as a reservoir for condensation in adjacent tubing,

b. the housing containing a bleed port traversed by the aforementioned passage during valve body movement in the course of playing.

16. In a horn-type musical instrument wherein notes are selected by valves that insert additional crooksections into series with the tubing that forms an acoustic path between the horn mouthpiece and bell, the improvement comprising:

configuring the note selection valves so that when not depressed the shorter length acoustic path includes plural convolutions that attenuate higher harmonic components, and so that when depressed, the inserted crook sections form a longer acoustic path with fewer convolutions, said longer path attenuating approximately equally the same harmonic components that are attenuated by the plural convolutions in the shorter path, whereby uniform tonal quality and playing characteristics are achieved for all notes.

17. A horn according to claim **16** wherein said note selection valves each include an internal tortuous passageway that is within the acoustic path only when that note selection valve is not depressed.

18. A horn according to claim **16** including a pair of note selection valves, each valve having a rotatable body containing a pair of generally straight parallel through passageways, said valves being mounted in offset relationship to each other so that when either valve body is in a first orientation the acoustic path includes a generally U-shaped passage of which the tubing to the inlet and outlet of the valve comprises the legs of the U-shaped passage and one of the through passageways in the valve body comprises the base of the U-shaped passage, and that when the valve body is in a second orientation approximately at a right angle to said first orientation a crook is inserted into the acoustic path via both parallel through passageways of said valve body.

19. A horn comprising:

tubing and valve means together forming a convoluted acoustic path of minimum length,

additional crook sections of tubing,

said valve means, when actuated, operatively inserting said crook sections into said acoustic path to increase the effective length thereof to produce notes of lower fundamental frequency while decreasing the total number of bends in the acoustic path, so that generally equal harmonic content of all notes results.

20. A horn according to claim **19** wherein each of said valve means comprises a valve having an inlet and an outlet and having a movable valve body, said volve body having a first internal passageway of tortuous configuration, said first passageway interconnecting said inlet and outlet so as to be inserting in said acoustic path when said valve body is in a first orientation, said valve body also having a pair of direct, non-tortuous passageways that interconnect one of said crooks into said acoustic path via said inlet and outlet when said valve means is actuated to place said valve body in a second orientation.

21. A horn according to claim **20** wherein said tortuous first internal passageway is generally S-shaped.

22. A horn according to claim **20** wherein said tortuous first internal passageway is generally U-shaped.

23. A horn according to claim **20** wherein said tortuous first internal passageway is of non-uniform crosssection lengthwise thereof.

24. A horn according to claim **20** wherein said tortuous first internal passageway includes a completely interior generally U-shaped loop, the ends of said loop being connected to first and second passageway sections leading respectively to said inlet and outlet and forming extra bends with the legs of said loop, so that said internal passageway includes in the following order a first extra bend between said inlet and the loop, the bends of the loop, and a second extra bend between the loop and said outlet.

25. A horn according to claim **20** wherein said valve is of the Vienna double piston type and wherein said valve body consists of two pistons that move in unison, each of said pistons containing a respective one of said pair of direct, non-tortuous passageways, each of said two pistons also containing a generally L-shaped passageway, said two L-shaped passageways being connected together to form said tortuous first internal passageway.

26. In a brass musical instrument of the type in which the fundamental frequency of the note being played is established by the length of the tubing in the acoustic path, and wherein notes are selected by valved insertion of loop or crook sections or tubing, the improvement for obtaining more uniform tonal quality and easier excitation of all notes, comprising:

tubing forming a path between the horn mouthpiece and bell, and

valves for alternately inserting a loop or a crook into said path, insertion of a loop providing a relatively shorter but more convoluted acoustic path, insertion of a crook providing a relatively longer but less convoluted path, the harmonic attentuation of either path being approximately equal.

27. A musical instrument according to claim **26** wherein each of said valves includes a movable valve body having a pair of convoluted through passages via which said loop is inserted into said acoustic path when said valve body is in a first orientation, and having a pair of straight passages via which said crook is inserted into said acoustic path when said valve body is in a second orientation.

28. In a horn having multiple sections each including its own playing valves and crooks, said sections sharing the same mouthpiece and bell, the improvement comprising;

a switching valve immediately adjacent the mouthpiece terminus, and

entirely separate tapered leadpipes connecting the outlets of said switching valve with the respective horn sections.

29. In a horn of the type in which the fundamental frequency of the note being played is established by the length of the tubing in the acoustic path, and wherein the tonal quality and playing characteristics are established by the relative amplitude of the harmonics also excited in said tubing, the improvement comprising:

at least one note selection valve,

tubing sections forming a direct acoustic path of shorter length between the mouthpiece and the bell of said horn, said tubing sections including an inlet and an outlet to each note-selection valve,

a crook section of tubing associated with each valve, and inserted by depression of the associated valve into series with the direct acoustic path formed by the tubing sections,

each valve having alternate passageways therethrough, a first tortuous passageway connecting said tubing inlet to said outlet when the valve is released, so that the acoustic path of shorter length includes plural convolutions, each valve having a less tortuous second passageway, depression of said valve inserting the associated crook section in series with said inlet and outlet via said second pas-

sageway to form a longer, but less convoluted acoustic path for production of a note of lower fundamental frequency, the convolutions of said shorter length acoustic path effectively, similarly attenuating the corresponding higher harmonics that are attenuated by said longer acoustic path, so that the harmonic content of all notes is approximately equal.

* * * * *