March 30, 1965 M. KRAVKA 3,175,449

BRASS WIND INSTRUMENT

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Fig. 1

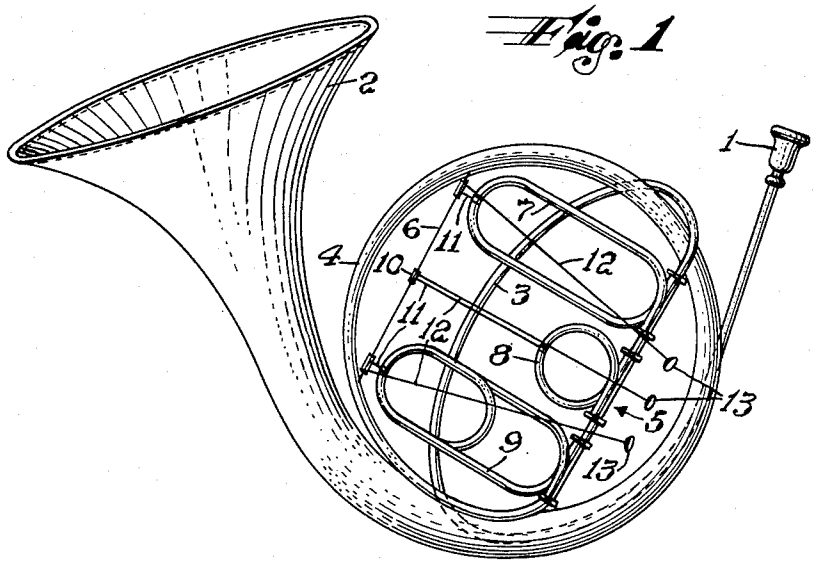
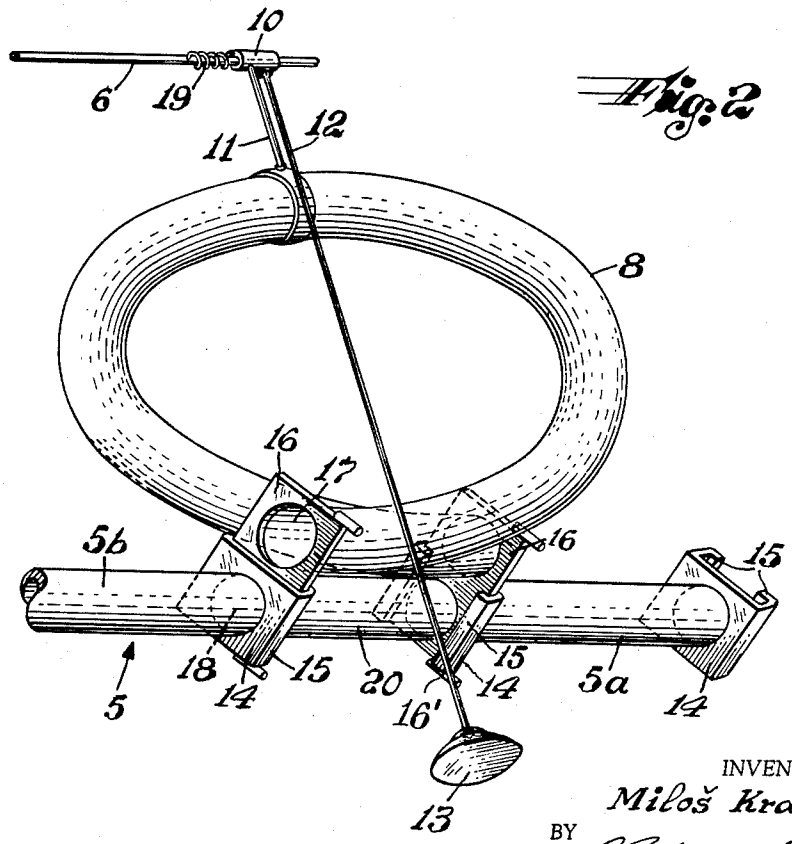


Fig. 2



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BRASS WIND INSTRUMENT

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Fig. 3

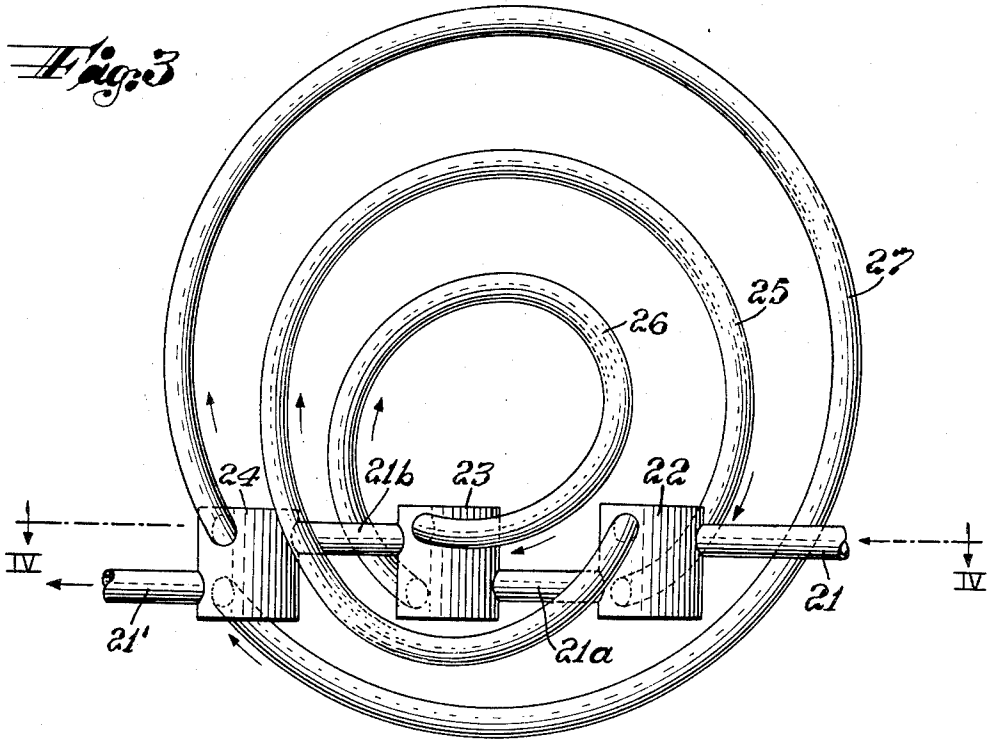
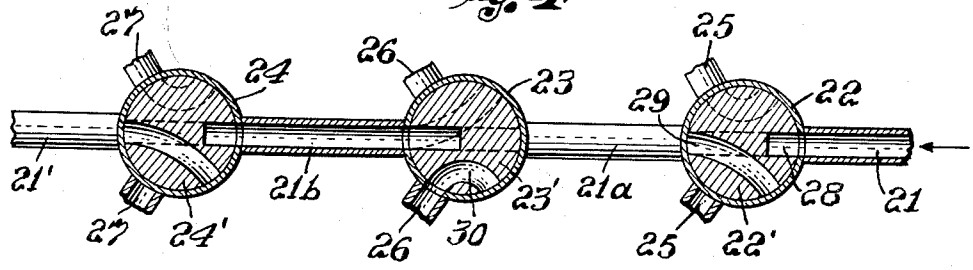


Fig. 4



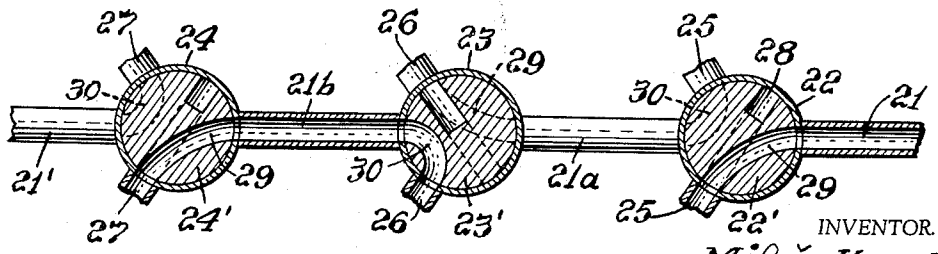


Fig. 5

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BRASS WIND INSTRUMENT

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This invention relates to wind instruments, and more particularly to brass instruments in which the length of a tube containing a vibrating air column, and thereby the fundamental pitch of the instrument, may be varied by the insertion of auxiliary lengths of tubing or crooks.

While the invention is generally applicable to brass instruments the fundamental pitch of which may be changed by the insertion of crooks into the path of air through the instrument, it will be described hereinafter in its specific application to the French horn. A brief review of the development of the modern orchestral horn will provide a better understanding of the invention.

The hand horn in its simplest aspects consists of a generally frusto-conical tube which is coiled in one or more circles. By varying the tension of his lips, the player can produce not only the fundamental tone determined by the length of the air column in the horn, but also a limited number of higher harmonics.

Supplemental coiled pieces of tubing of different length are interchangeably insertable in more elaborate hand horns to vary the length of the contained air column, and thereby to provide as many fundamental pitch levels as there are insertable crooks. With an adequate number of crooks, the hand horn can play a full chromatic scale, but the necessity of withdrawing one crook from its sockets on the instrument and of inserting another crook still limits the number of notes that can be played in reasonably fast succession.

The valve horn which is the standard instrument of the modern orchestra has permanently attached crooks which may be selectively or jointly inserted into the air channel of the horn by means of valves which may be either piston valves (slide valves) or rotary action valves. Each valve has twin bores by means of which the dependent crook may be either by-passed or added in.

It is a common feature of the known valve arrangements that they involve an abrupt reduction in the flow section of the instrument. The bore of the valve uses commonly only one third of the bore of adjoining fixed portions of the air channel. These changes in flow section have been found to be detrimental to the intonation and tone formation of the horn. The known valve arrangements also make it impossible to avoid a sharp angularity of the windways. The resultant resonant properties of the instrument make proper control difficult.

The general object of the invention is the provision of a French horn which maintains the advantages of the known valve horns yet avoids their shortcomings.

A more specific object is a horn of improved tonal quality.

Another object is a horn the fundamental pitch of which may be changed in the normally required manner without creating strictures in the windways of the instrument.

A further object is a horn in which air is permitted to flow in a continuous path without abrupt change of direction.

With these and other objects in view, the invention in one of its aspects resides in a brass wind instrument of the basically conventional type in which a mouthpiece and a bell or the like are connected by an interposed coiled main tube through which air flows in a main rotary path. The length of the path through the instrument may be increased by coiled crooks which define supplemental paths of air flow. Valves connected to the crooks and

the main tube are movable between an inoperative position in which they directly connect two portions of the main tube, and an operative position in which the main tube portions are connected through the crooks so that the air flows both through the main path and the supplemental paths of the operative crooks. The direction of rotation of the air flow in the brass wind instruments of the invention is the same in the main path and in the supplemental paths.

Other features and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 shows a French horn of the invention in the F key, the view being in elevation;

FIG. 2 illustrates a detail of the horn of FIG. 1 in an enlarged respective view;

FIG. 3 is a fragmentary elevational view of another horn of the invention equipped with rotary valves;

FIG. 4 shows a portion of the horn of FIG. 3 in section on the line IV—IV; and

FIG. 5 shows the device of FIG. 4 in its operative position.

Referring initially to FIG. 1, there is seen a French horn in F key of the invention. The main tube of the horn widens gradually from its narrowest portion adjacent the mouthpiece **1** to the conically flaring bell **2** in two consecutive coiled turns **3** and **4**. The turn **3** of narrower tubing begins adjacent the mouthpiece **1** and terminates in an approximately straight portion **5** adjacent the turn **4** of greater flow section. The latter turn is approximately circular. It provides rigidity to the horn and will be referred to hereinafter as the body portion. All other elements of the horn are attached to the body portion.

A pin **6** is mounted on the body portion **4** in spaced approximately parallel alignment with the straight portion **5** of the turn **3**. It pivotally supports three coiled crooks **7, 8, 9**. Crook **7** is constituted by an oblong turn of cylindrical tubing. Crook **8** is an approximately circular turn, and crook **9** has two consecutive elongated turns. The terminal portions of the crooks cross each other. Their orifices have a common axis, and are open in opposite directions. The terminal crook portions are parts of respective valve arrangements which will presently be described in more detail.

The three crooks **7, 8, 9** are rigidly connected to respective sleeves **10** by rods **11**. The sleeves are rotatable on the pin **6**, and are biased by key springs **19**, not seen in FIG. 1 to move the terminal portions of the respective crooks adjacent the mouthpiece **1** transversely of the straight main portion **5** toward the viewer. Three key mechanisms consisting of respective rods **12** attached to the sleeves **10** and of tabs **13** arranged adjacent each other on the rods permit the crooks **7, 8, 9** to be pivoted on the pin **6** against the urging of the key springs. The three tabs **13** are arranged in the usual location of the piston valve keys of a conventional valve horn, and serve the same purpose.

As shown on a larger scale in FIG. 2, the straight portion **5** of the main tube includes two short lengths of tubing **5*a*, 5*b*** which are secured on the body portion **4** by brackets, not illustrated in order not to crowd the drawing. Coupling flanges **14** on the two axial ends of each tubing length **5*a*, 5*b*** have turned-over edge portions **15** to provide guide grooves for slides **16** on respective terminal portions of the crooks **7, 8, 9**.

Only crook **8** is shown in FIG. 2, but it will be understood that the terminal portions of the crooks **7** and **9** are similarly equipped with coupling slides engaged in

guide grooves on the tubing lengths 5*a*, 5*b* and on other elements of the main tube turn 5 as is evident from FIG. 1. The two slides 16 of the crook 8 are substantially identical flat plates, each plate having two juxtaposed circular openings 17, 18 of a diameter equal to the diameter of the adjacent orifices of the tubing lengths 5*a*, 5*b*.

In the position illustrated in FIG. 2, the crook 8 is in its inoperative position in which it is being held by the coil spring 19 on the pin 6. Abutments 16′ are arranged on slides 16 for engagement with the guide edges 15 to limit pivoting movement of the crooks on the pin 6 to two terminal positions. In the illustrated inoperative position of the crook 8, a straight coupling tube 20 fixedly fastened to the slides 16 in alignment with the openings 18 provides direct sealing by-pass communication between the tube sections 5*a*, 5*b* to provide a continuous air channel the flow section of which increases gradually in a direction from the mouthpiece 1 toward the bell 2.

When one of the tabs 13 is depressed, the openings 17 in the corresponding slide 16 are sealingly aligned with the sections of the straight tube portion 5, and the crook is added into the air channel of the horn. In the specific embodiment illustrated, the main tube of the horn has a length of 365 centimeters, and the three crooks may respectively increase this length by 44, 21, and 74 centimeters.

FIG. 3 shows the valve and crook arrangement of a B flat alto horn of the invention. The major portions of the main tube with the mouthpiece and bell are analogous to those of the F horn of FIG. 1, and have been omitted from FIG. 3. The valves are shown without their valve bodies and key mechanism.

FIG. 3 shows two terminal portions 21, 21′ of the interrupted narrower turn of the horn. The terminal portion 21 is connected to the mouthpiece and the portion 21′ to the bell in a manner apparent from FIG. 1 so that air flows through the illustrated horn portion in the direction of the straight arrows when the horn is being played. Two short tube sections 21*a*, 21*b* and three identical tubular cylindrical valve housings or sleeves 22, 23, 24 are interposed between the two turn portions 21, 21′. Each valve housing has two pairs of radial openings, the members of each pair being arranged on two axial levels. One opening on one level is in a common axial plane with an opening on the other level. This pair of openings constitutes the intake opening and discharge opening of the valve. The other two openings are offset 60° in opposite directions from the axial plane passing through the discharge opening, and are on different axial levels.

The intake opening of the valve housing 22 is connected to the turn portion 21. The tube section 21*a* connects the discharge opening of the valve housing 22 to the intake opening of the valve housing 23. The tube section 21*b* similarly connects the valve housings 23 and 24, and the turn portion 21′ is fixed to the discharge opening of the valve housing 24.

The other pairs of radial openings in the valve housings 22, 23, 24 are respectively connected by three fixedly attached crooks 25, 26, 27. Each crook is of approximately circular shape. The three crooks are arranged in a common plane, and they define arcuate paths of air flow about respective axes which extend in a common direction and almost coincide. The longest crook 27 is attached to the valve housing 24 which is last in the direction of normal air flow through the horn, and envelops the other two crooks. The smallest crook 26 is attached to the middle valve housing 23 and is nearest the common center.

The valve housings 22, 23, 24 are shown with the corresponding cylindrical valve bodies 22′, 23′, 24′, the tube sections 21*a*, 21*b*, and the terminal orifice portions of the crooks 25, 26, 27 in the radially sectional views of FIGS. 4 and 5. Each valve body has three bores. The

first bore 28 extends in an axial plane and is obliquely inclined relative to the axis of the valve body. The second bore 29 extends in a common radial plane with a first aperture of the first bore 28 as is evident from FIG. 4. One orifice of the second bore 29 is offset 60° from that first aperture of the first bore. The other aperture of the second bore 29 is in the axial plane of the first bore 28 and axially spaced from the second aperture of the first bore. The third bore 30 extends in the radial plane of the second aperture of the first bore 28. The two apertures of the third bore 30 are spaced 60° from each other and from the axial plane of the first bore 28.

In the inoperative position of the valves illustrated in FIG. 4, the first bore 28 of the valve body 22′ constitutes a by-pass which connects the turn portion 21 to the tube section 21*a*. The latter is connected to the tube section 21*b* by the first bore of the valve body 23′, and the first bore of the valve body 24′ directly connects the last-mentioned tube section to the turn portion 21′. All crooks are by-passed, and the horn is set for operation in its fundamental pitch.

FIG. 5 shows the valve arrangement of FIG. 4 with all valve bodies 22′, 23′, 24′ in the operative position. Movement from the inoperative to the operative position requires 60° rotation of the valve bodies 22′, 24′, in a counterclockwise direction, and of the valve body 23′ in a clockwise direction. In the operative position of the valves, the second bore 29 of the first valve connects the turn portion 21 to one end of the crook 25 whereas the other crook end is connected to the tube section 21*a* by the third bore 30. Air is led to the second crook 26 through the second bore 29 of the valve body 23′, and discharged from the crook 26 to the tube section 21*b* through the third bore 30 of the second valve. The bores 29, 30 of the third valve body 24′ similarly cut the third crook 27 into the main tube of the horn. When the valves are in the operative position, air passes the corresponding crooks in the direction of the curved arrows in FIG. 3.

The operating mechanism of the valve bodies 22′, 23′, 24′ has not been illustrated since it may be entirely conventional, and of any type commonly employed in so-called "German" horns equipped with rotary action valves. It may consist of three levers, each having a tab at one end, and having its other end attached to a string wound around a pin coaxially attached to a valve body. When the tab is depressed, the string is unwound from the valve pin, thereby rotating the valve body from the inoperative to the operative position. A return spring permanently urges the valve body to rotate toward the inoperative position, and abutments prevent rotation beyond either position. The tabs may be located on the horn as the tabs 13 in FIG. 1.

It is a common feature of the two embodiments of the invention described so far that air passes through the crooks and the main tube in the same direction without reversal. As viewed in FIG. 1, air moves in the coiled main tube in a main path which turns clockwise twice. With each crook added, the number of turns is increased by the supplemental rotary path of each added crook, but the direction of rotary movement is clockwise in all portions of the path.

When the valve arrangement and the crooks illustrated in FIGS. 3 to 5 are substituted for the corresponding portions of the horn of FIG. 1, air movement in each added crook is rotary in a clockwise direction.

The second common feature of both embodiments is the smooth transition between the main tube and the valve bores. Contiguously connected portions of the straight tubular sections 5*a*, 5*b*, of the coupling tubes 20 and of the crooks 7, 8, 9 have identical flow sections and are precisely aligned to avoid any interference with smooth flow of the air. In the apparatus illustrated in FIGS. 3 to 5, the arrangement of the valve apertures on two axially spaced levels makes it possible to lead

the air consecutively through the several valves without restricting its flow, thus avoiding undesirable nodes and the associated resonance effects. The bores through the several valve bodies have the same flow section as the immediately adjacent terminal portions of the crooks 25, 26, 27. The crooks are of uniform cross section as is conventional.

A third feature which distinguishes both embodiments of the invention from most conventional valve horns is the small displacement of the valve actuators for insertion of a crook into the main tube of the instrument. In the F horn shown in FIGS. 1 and 2, the movement of the crooks between their operative and inoperative positions is approximately equal in length to their thickness, and thus very small. The movement of the tabs 13 may be made even smaller than that of the terminal crook portions by the use of well known mechanical linkages since the forces necessary for pivoting the crooks are very small. The arrangement illustrated, however, has been found to involve a sufficiently short stroke of the tabs 13 so that even rapid passages may be blown with ease. In the apparatus shown in FIGS. 3 to 5, the valve bodies rotate or pivot only 60° between their operative and inoperative positions. The best commercially available horns equipped with rotary action valves require a valve rotation of 90°. Even so, it has not been practical heretofore to avoid a constriction in the valve passage if the valve was to be limited to reasonable size and weight. The valves illustrated in FIGS. 4 and 5 solve the problem of short stroke operation without creating new problems that would arise from further constriction of the flow passage or from undue increase in weight or dimensions.

In practice it is advantageous to reduce the weight of the valve body furthermore by using a hollow cylinder supporting three short tubes, which take over the task of the bores of a solid valve body.

While the invention has been exemplified by single horns in F and B flat alto, it is evident that it is not limited to the specific embodiments shown. A double horn in F and B flat alto which is the French horn most commonly employed in symphony orchestras may be equipped with the pivotally mounted crooks or the rotary valves of the invention without departing from the spirit and scope of this invention. The valve arrangements illustrated and described may also readily be adapted to use in brass instruments other than the French horn to add supplemental length to a vibrating air column.

It should be understood, therefore, that the foregoing detailed disclosure relates to only preferred embodiments of the invention, and that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

What is claimed is:

1. In a brass wind instrument, in combination:
(*a*) mouthpiece means;
(*b*) bell means;
(*c*) main tube means connecting said mouthpiece means and said bell means, said main tube means having two consecutive portions and being coiled substantially in a plane for consecutive flow of air from said mouthpiece means through said portions toward said bell means in a rotary main path about an axis extending in a predetermined direction substantially perpendicular to said plane;
(*d*) coiled crook means defining a supplemental rotary path about an axis extending in said direction; and
(*e*) valve means operatively connected to said crook means and said two portions, said valve means being movable between an inoperative position in which said valve means directly connects said two portions, and an operative position in which said valve means connects said two portions through said crook means for sequential flow of air from said mouthpiece means through one of said portions, said crook means, and the other portion of said main tube means toward said bell means over said main path and said supplemental path, the direction of rotation of air flow in said main path about the axis thereof being the same as the direction of rotation of said air flow in said supplemental path about the axis of the latter.

2. In an instrument as set forth in claim 1, said main tube gradually tapering in flow section from said mouthpiece means toward said bell means, and the effective flow section of said valve means in the inoperative position and the operative position thereof being substantially equal to the flow section of respective parts of said two main tube portions adjacent said valve means.

3. In an instrument as set forth in claim 1, said crook means being movably secured to said main tube means and having two terminal portions, said valve means including coupling means attached to one of said terminal portions for movement with said crook means between an inoperative position in which said coupling means directly connect said main tube portions, and an operative position in which said coupling means respectively connect said terminal portions to said main tube portions.

4. In an instrument as set forth in claim 3, said coupling means including two coupling slides, each slide being formed with a first opening and a second opening, and a coupling tube connecting said slides and communicating with the respective first openings, said slides being respectively mounted on said terminal portions for communication of said second openings with said crook means, said main tube portion having respective orifices sealingly engaging said coupling slides respectively; and actuating means for actuating movement of said crook means between said inoperative position of said valve means in which said first openings are respectively aligned with said orifices, and said operative position of said valve means in which said second openings are respectively aligned with said orifices.

5. In an instrument as set forth in claim 4, said crook means being pivotably mounted on said main tube means, and said actuating means including means for pivotally moving said crook means on said main tube means.

6. In an instrument as set forth in claim 1, said valve means including a valve housing and a valve body rotatable in said housing about an axis, said housing being formed with a pair of axially and circumferentially spaced radial openings therein, said openings respectively communicating with said main tube portions and constituting the intake and discharge opening of said valve housing, and said valve body being formed with a first bore simultaneously alignable with said intake and discharge opening when said valve body is in the inoperative position thereof, said crook means having two terminal portions and said housing being formed with two other openings respectively communicating with said terminal portions, and said valve body being formed with a second bore and a third bore, said second and third bores respectively connecting said other openings with said intake and discharge openings when said valve body is in the operative position thereof, said operative position of said valve body being angularly offset from said inoperative position with respect to said axis.

7. In an instrument as set forth in claim 6, said second and third bores extending in respective axially spaced radial planes.

8. In an instrument as set forth in claim 7, said first bore having two orifices respectively located in said axially spaced radial planes.

9. In a brass wind instrument, in combination:
(*a*) mouthpiece means;
(*b*) bell means;

(c) main tube means connecting said mouthpiece means and said bell means, said main tube means having two consecutive portions and being coiled substantially in a plane for consecutive flow of air from said mouthpiece means through said portions toward said bell means in a rotary main path about an axis extending in a predetermined direction substantially perpendicular to said plane;

(d) a plurality of coiled crook means defining respective supplemental rotary paths about respective axes extending in said direction; and

(e) a plurality of valve means including respective by-pass means, said valve means being each operatively connected to respective associated crook means, to one of said two portions, and another one of said valve means, each valve means being movable between an inoperative position in which said bypass means thereof is open for connecting said main tube means portions, and an operative position in which said bypass means are closed and said valve means connects said two portions through the associated crook means for sequential flow of air from said mouthpiece means through one of said portions, said associated crook means, and the other portion of said main tube means toward said bell means over said main path and the supplemental path of the associated crook means, the direction of rotation of air flow in said main path about the axis of the same being the same as the direction of rotation of said air flow in the supplemental path of each crook means about the respective axis when the valve means associated with said crook means is in the operative position.

10. In a brass instrument, in combination:

(a) a tubular body portion having two ends and extending between said ends substantially in a plane in a continuous concave arc about an axis, said axis extending in a predetermined direction substantially perpendicular to said plane;

(b) a mouthpiece on one of said ends;

(c) a flaring bell on the other end;

(d) a plurality of valve means in respective consecutive parts of said body portion intermediate said ends, each valve means being movable between an operative and an inoperative position;

(e) a plurality of crooks, each crook having two end portions connected to a respective valve means and extending between said two end portions thereof in a substantially continuous concave arc about an axis extending in said direction,

(1) each valve means when in the inoperative position thereof by-passing the associated crook, and when in the operative position, connecting said ends of said body portion through said associated crook for rotary flow of air from said mouthpiece to said bell through said body portion and through said associated crook in a clockwise direction as viewed in the direction of said axes.

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