

- [54] **END BLOWN FREE AIR-REED FLUTE**
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- [52] **U.S. Cl.** **84/384**
- [51] **Int. Cl.** **G10d 7/02**
- [58] **Field of Search**..... 84/330, 380, 384

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Attorney, Agent, or Firm—Phillips, Moore,
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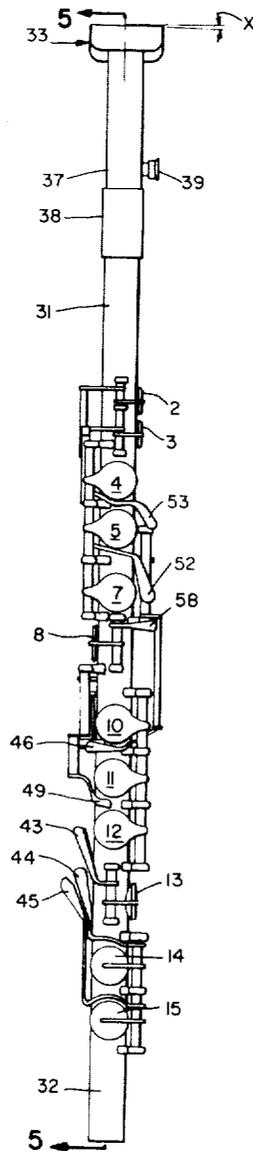
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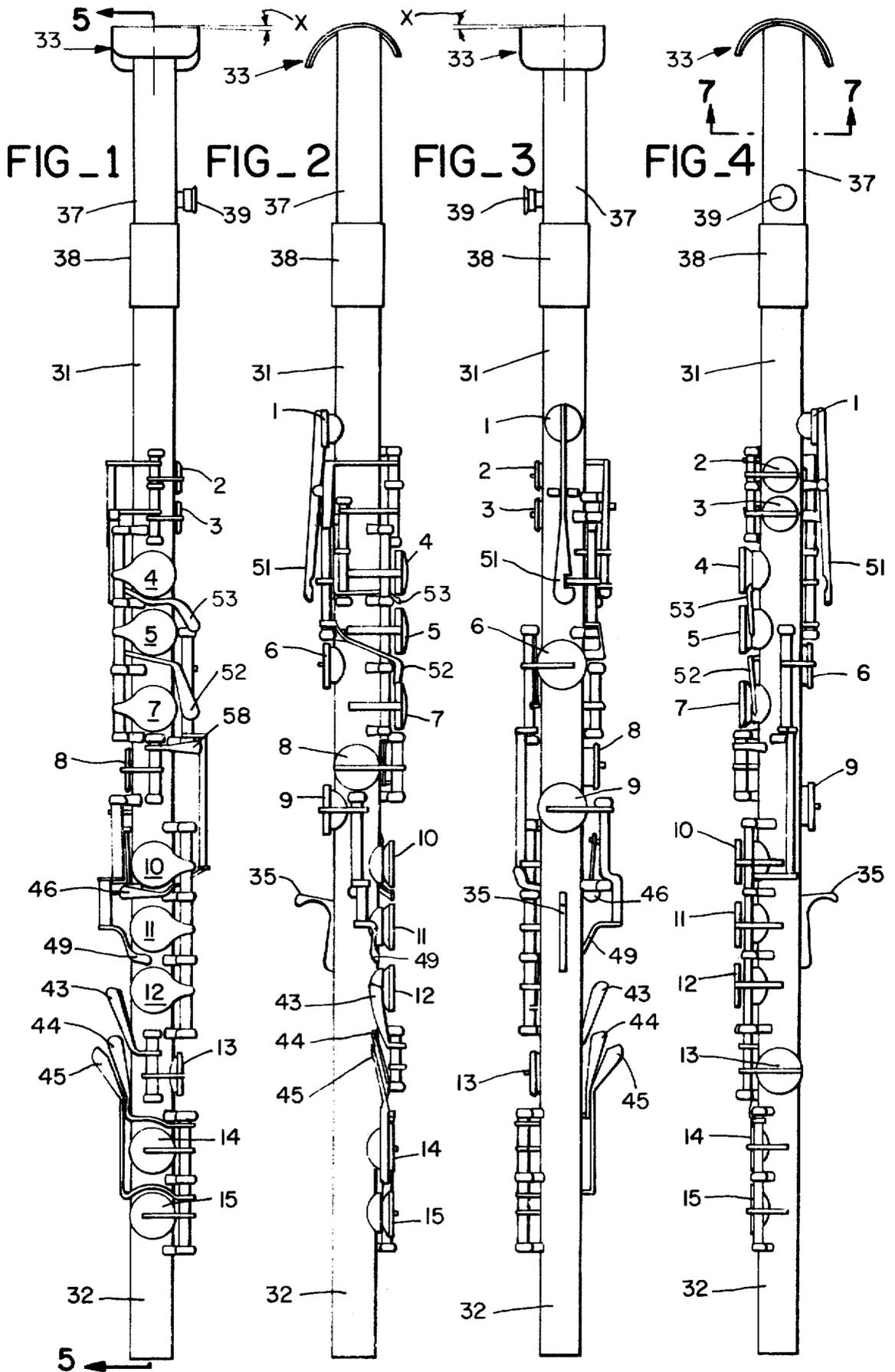
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[57] **ABSTRACT**

A free air-reed flute open at both ends, adapted to be played in a vertical position and blown by means of an embouchure at one end is disclosed. Embodiments of the flute comprising a cylindrical body with 15 holes and capable of providing all tones and semitones of at least one octave in a single register are described. A fingering system including both open and closed keys for mechanizing the flute is disclosed.

9 Claims, 11 Drawing Figures





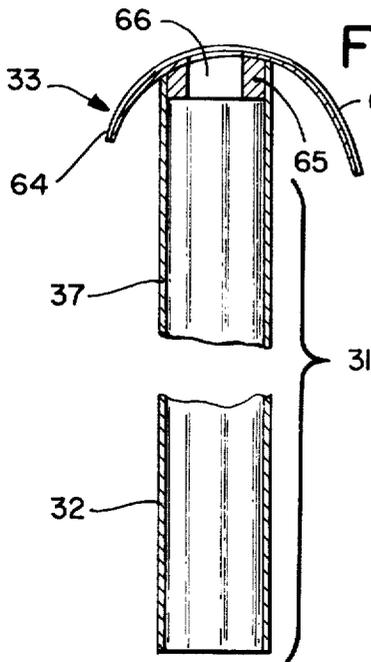


FIG. 5

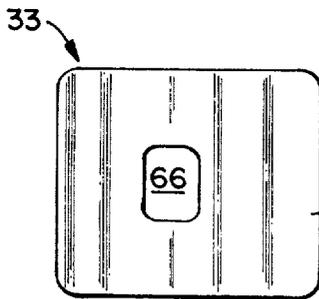


FIG. 6

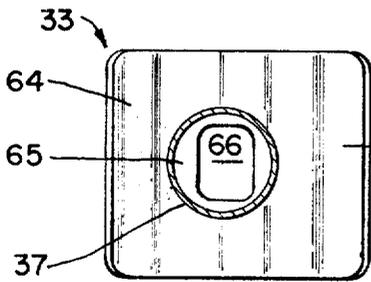


FIG. 7

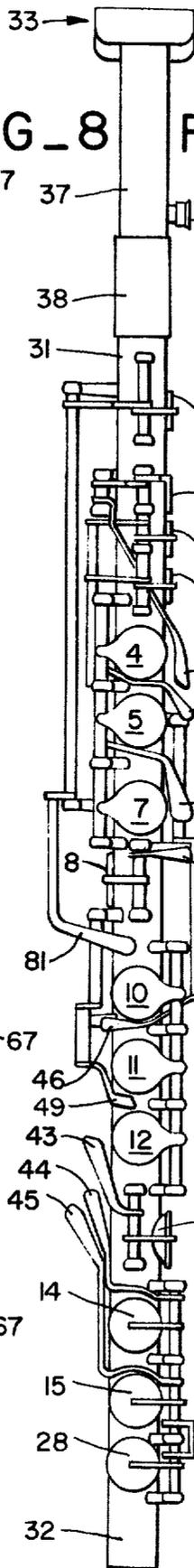


FIG. 8

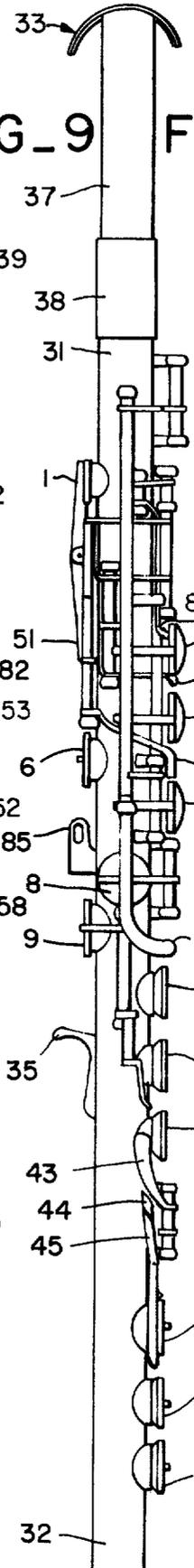


FIG. 9

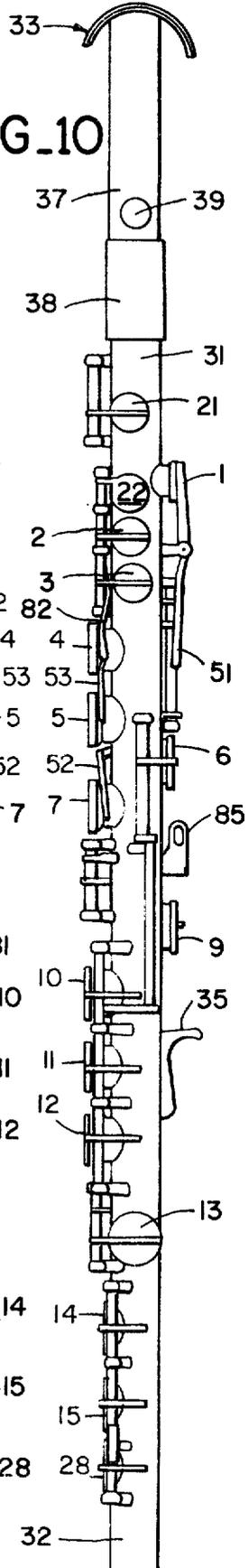


FIG. 10

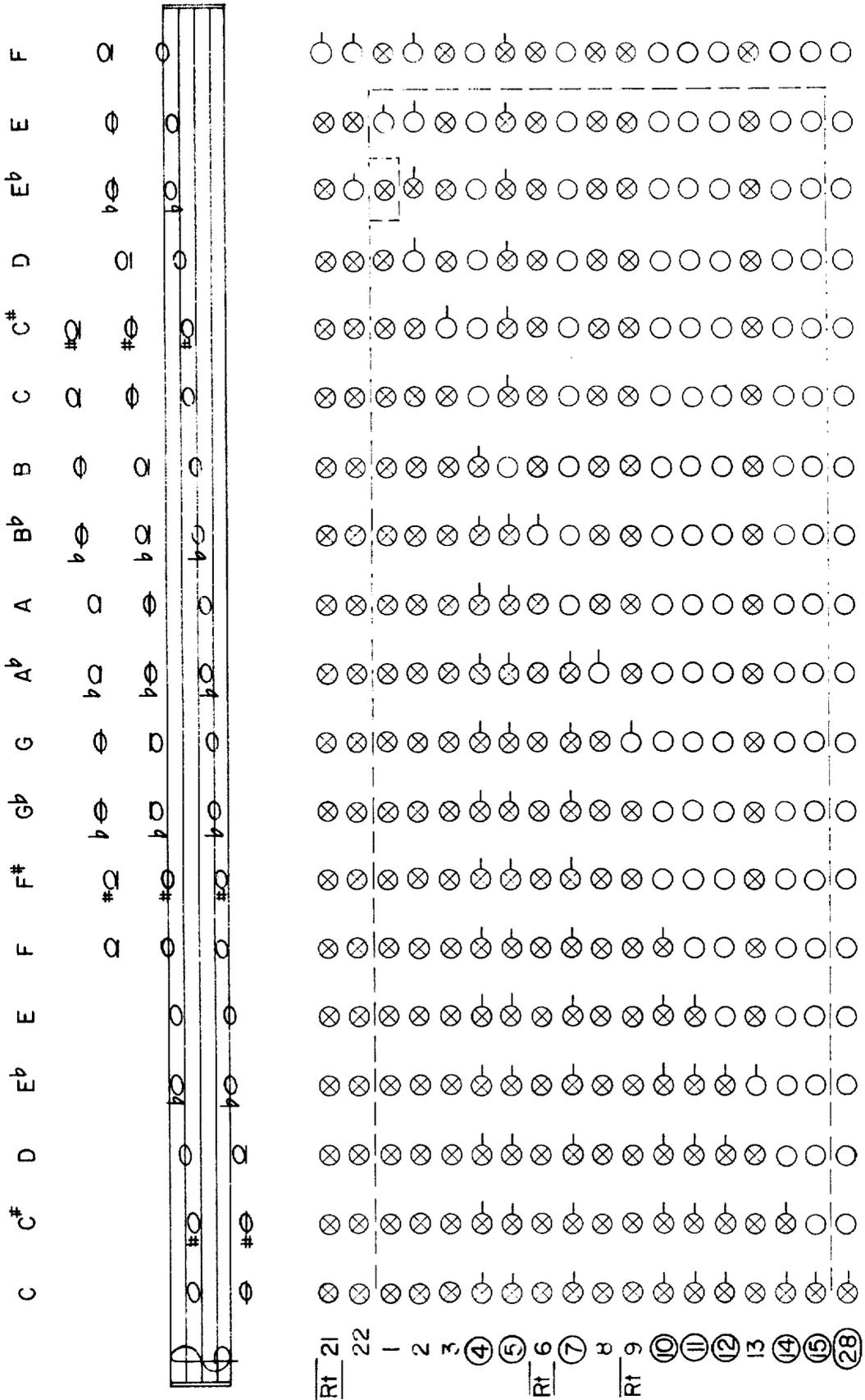


FIG - 11

END BLOWN FREE AIR-REED FLUTE

BACKGROUND OF THE INVENTION

This invention relates to true flutes based on free air-reed operation and having a body which is open at both ends and more particularly to such a flute which is designed to be end blown and played in a vertical position.

As used in this application the word "flute" does not include any of the many types of musical instruments such as "recorders" etc., which although they do not include an actual reed, rely on a confined air passage and "fipple" for operation in the manner of a whistle. Neither does the word flute include any of the many musical instruments such as ocarinas, etc., which, although they utilize a free air-reed, comprise a body which is not tubular and does not enclose a generally cylindrical air column. Finally, as used in this application, the word flute does not include any of the musical instruments such as pan-pipes which may be generally tubular and may use a free air-reed but are closed or stopped at one end in the manner of organ pipes.

Instead, the word flute as used in this application is intended to designate musical instruments such as the so-called "transverse flute", which is widely used in the United States and Europe for entertainment, orchestral and recital purposes, and the *nāy* or *quasāsba*, which are used throughout the Islamic world and North Africa, respectively, for similar purposes. Historically the flute as defined herein, although acoustically simpler, is believed to be of much later origin than musical instruments of the "whistle" or "stopped" type. Furthermore, it is an historical fact that the transverse flute has undergone extensive development whereas the *nāy* or *quasāsba* of today is surprisingly similar to the end blown flutes shown in ancient Egyptian stele and comprises a simple straight tube about 3 feet long with from 4 to 6 holes towards the lower end held in a position slanting obliquely across the body for blowing across the end thereof.

In the 1890's an attempt was made to introduce a flute similar to the *nāy* or *quasāsba* to the Western world by one Carlo Tomasso Giorgi. The Giorgi flute was designed to be played in a vertical position, being provided with a free air-reed embouchure at one of its open ends, and was essentially keyless although one to four keys were added in some examples in an attempt to extend its range and at a later date a fully keyed version known as the "Giorgi-Schaffner" flute was proposed as part of universal woodwind fingering scheme intended to be competitive with the well established "Boehm" system. However, both the Giorgi flute and the Giorgi-Schaffner flute are today a collector's curiosity as pointed out in the book entitled "The Flute" by Philip Bate first published in 1969 by Ernest Benn, London, England, and W. W. Norton Co., New York, N.Y. This fact is believed to be the result of the limited range of the Giorgi type flute, as well as playing and fingering difficulties. (See also U.S. Pat. No. 594,735).

It is an object of this invention to provide a flute adapted to be played in a vertical position and end blown.

It is a further object of this invention to provide a flute which is played in a vertical position and end blown capable of providing all tones and semitones of at least one octave in a single register.

It is another object of this invention to provide a flute which is played in a vertical position, end blown, and fully mechanized for ease of fingering in providing all tones and semitones of at least one octave in a single register.

SUMMARY OF THE INVENTION

Briefly, a flute according to this invention comprises a hollow cylindrical body less than about 2 inches in diameter and about 3 feet long open at both ends and having an embouchure providing a free air-reed at one of its ends. A plurality of holes are provided through the side wall of the body for the production of various tones and semitones by selective stopping of said holes. According to one aspect of this invention, the embouchure comprises a lip plate providing a surface which is smoothly curved in a first plane containing the cylindrical axis of the body and rectilinear in a second plane perpendicular to the first and also containing the cylindrical axis of the body, the surface in the second plane defining a line which intersects the cylindrical axis at an angle differing from the perpendicular by at least one and not more than 5°.

According to another aspect of this invention, the plurality of holes include at least 15 holes dimensioned and spaced from each other to enable production of all tones and semitones of at least one octave in a single register. According to a further aspect of this invention, the flute includes means for supporting the body with the cylindrical axis extending generally vertically and with the embouchure at the top.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing and other objects and features of this invention will be more fully understood from the following detailed description when read in conjunction with the appended drawing wherein:

FIG. 1 is a front view in elevation of a flute in accordance with one embodiment of this invention.

FIG. 2 is a view in elevation of the left side of the flute shown in FIG. 1.

FIG. 3 is a view in elevation of the rear of the flute shown in FIG. 1.

FIG. 4 is a view in elevation of the right side of the flute shown in FIG. 1.

FIG. 5 is a cross-sectional view taken along lines 5-5 of FIG. 1 with the central portion of the flute broken away.

FIG. 6 is a top view of the flute as shown in FIG. 4.

FIG. 7 is a cross-sectional view taken along lines 7-7 of FIG. 4.

FIG. 8 is a front view in elevation of a flute according to another embodiment of this invention.

FIG. 9 is a view in elevation of the left side of the flute shown in FIG. 8.

FIG. 10 is a view in elevation of the right side of the flute shown in FIG. 9.

FIG. 11 is a combined fingering chart both for the flute according to the embodiment of this invention shown in FIGS. 1-7 and for the flute according to the embodiment of this invention shown in FIGS. 8-10.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment of a flute in accordance with the teaching of this invention is shown in FIGS. 1 through 4. FIGS. 5, 6, and 7 show details of the

embouchure and flute body which are common to all embodiments of the flute according to the teaching of this invention, and FIGS. 8 through 10 show a second preferred embodiment of the flute according to the teaching of this invention.

Referring first to FIG. 5, it will be seen that a flute according to the teaching of this invention comprises a hollow, cylindrical body 31 of constant internal diameter throughout its length having a foot 32 end and a head 37 end. The body is essentially open at both ends although as shown in FIG. 5, an embouchure 33 or mouthpiece which will be more fully described hereinafter is provided at the head 37 end of the body 31.

The flute may be constructed of any of the conventional materials used in fabricating musical instruments. In embodiments of the flute as actually constructed, the body and embouchure were made of metal and the keys or pad cups were of the type conventionally used on saxophones, including pads of resilient material for stopping the holes in the body of the flute.

It will be understood that the embodiments of the flute shown in the drawing and specifically described herein were designed for use by a right handed player. However, the design may be reversed for the convenience of the left handed player if and as desired without departing from the teaching of this invention. Thus, it will be understood that the terms right hand and left hand as used herein include the reverse relationship and are to be considered limiting only in that sense.

Considering first the embodiment of this invention shown in FIGS. 1 through 4, it will be seen that the flute comprises a body 31 having a plurality of holes, each with an associated key, spaced along its length. Each hole and its associated key is consecutively numbered from 1 through 15 in FIGS. 1 to 4, with the hole and key numbered 15 at the bottom or foot 32 of the flute.

An embouchure 33 comprising a lip plate and plug which will be more fully described in connection with FIG. 5 is provided at the upper end of the body 31. The embouchure 33 is preferably mounted at the end of a relatively short section of the flute body to form a head 37 which is joined to the main body portion 31 by a joint 38 which may include socket and tenon means (not shown) to enable tuning of the flute. As shown in FIGS. 1 to 4, an amplifier tap 39 may be provided in the head 37 to facilitate the coupling of the flute to an electronic amplifier, as desired.

As best shown in FIGS. 2, 3 and 4, a thumb hook 35, for engagement by the thumb of the lower hand of the player to support the flute in use, projects from the rear of the flute body 31 directly opposite the space between the holes and keys numbered 10 and 11, respectively. In the embodiment of this invention shown in FIGS. 1 through 4, the lower hand of the player would be his right hand and thus, the hook 35 is properly located to facilitate manipulation of the holes and keys assigned to the right hand of the player.

It has been found that the inner diameter of the body 31 of the flute should be less than 2 inches in order to enable the flute to be comfortably played by persons of ordinary lung capacity. It has also been found that a range in excess of an octave in a single register may be obtained where the length of the flute body is less than 3 ft. from the embouchure 33 to the foot 32. Finally, it has been found that the size and spacing of the holes 1 through 15 in order to provide all tones and semi-

tones of at least one octave in a single register can be made convenient for manipulation by the fingers of the hands of an average player through the use of appropriate keys and lever arms.

Thus, the index, middle, and ring fingers of the left hand of the average player will comfortably rest on the keys and holes numbered 4, 5, and 7, respectively, whereas, the index, middle, and ring fingers of the right hand of the average player, will normally rest on the keys and holes numbered 10, 11, and 12, respectively, with such fingers in a more or less relaxed position when the body of the flute is held in a vertical position with the embouchure 33 at the mouth of the player and with the thumb of the left hand engaging the rear of the body 31 adjacent the key associated with hole numbered 6, and the thumb of the right hand engaging the hook 35.

It will be understood that the keys associated with holes numbered 4, 5, 7, 10, 11, and 12 are mounted on appropriate independent axles located to facilitate engagement of the fingers of the hands of the player with such keys and have an upper surface designed to accommodate the finger tips. According to the teaching of this invention, the keys associated with holes numbered 4, 5, 7, 10, 11, and 12 are spring biased to stand in an open position when not engaged by the fingers of the hands of the player. Thus, the normal grip of the flute by the hands of the player will depress keys 4, 5, 7, 10, 11, and 12 causing them to stop the holes associated therewith.

Similarly, the keys associated with holes numbered 14 and 15 are mounted on independent axles and biased to normally stand in their open position. In order to enable these keys to be easily closed by the little finger of the right hand of the player, appropriate lever arms 44 and 45 are mechanically coupled to the keys 14 and 15, respectively, which levers extend upwardly along the axis of the flute into proximity with the normal location of the little finger of the right hand of the player when the index, middle and ring fingers are resting on the keys associated with holes numbered 10, 11, and 12. The key associated with the hole numbered 13 is also manipulated by the little finger of the right hand of the player. However, according to the teaching of this invention, this key is spring biased to normally assume its closed position. Thus, the key associated with the hole numbered 13 is mounted on an independent axle and an appropriate lever arm 43 is mechanically coupled thereto and extends upwardly along the axis of the flute in spaced relation to the lever arms 44 and 45 to a point convenient for engagement by the little finger of the right hand of the player without simultaneously engaging lever arms 44 and 45. Lever arms 44 and 45 are specifically located to enable them to be conveniently manipulated either individually or simultaneously by the little finger of the right hand of the player.

The keys associated with the holes numbered 9 and 6 are also adapted to be normally closed and manipulated to their open position by the right hand of the player. Thus, the key associated with the hole 9 is mounted on an independent axle and spring loaded to its closed position. A lever arm 49 is mechanically coupled to such key and extends to a point between the keys associated with holes 11 and 12. Thus, the key associated with hole 9 may be easily manipulated by either the middle finger or the ring finger of the right

hand of the player. Similarly, the key associated with the hole numbered 6 is mounted on an independent axle and spring biased to its closed position. An appropriate lever arm 46 is mechanically coupled to such key and extends to a point in the space between the keys associated with the holes 10 and 11, respectively. Thus, the key associated with hole 6 may be easily manipulated by either the index finger or the middle finger of the right hand of the player.

The keys associated with the holes 2, 3, and 8, respectively, are each mounted on an independent axle and spring biased to their closed position. The key associated with the hole 3 is provided with a lever arm 53 extending to the space between the keys associated with holes 4 and 5 in order to facilitate manipulation of such key by either the index finger or the middle finger of the left hand of the player. The key associated with the hole 2 is provided with an appropriate lever arm 53 extending to a point in the space between the keys associated with holes 5 and 7 in order to facilitate manipulation of such key by the middle or ring finger of the left hand of the player. Finally, the key associated with the hole 8 is provided with an appropriate lever arm 58 to facilitate manipulation of such key by the ring or little finger of the left hand of the player.

The key associated with the hole 1 is manipulated by the thumb of the left hand of the player. Thus, such key is mounted on an independent axle and spring biased to its closed position. It is provided with an appropriate lever arm 51 which extends to a point between the keys associated with the holes 4 and 5, respectively, but on the opposite side of the body therefrom. Thus, it will be seen that a comfortable grip for the left hand of the player is provided and one which will enable him to easily manipulate the lever arm 51.

According to the teaching of this invention, the keys associated with the holes 4, 5, 7, 10, 11, 12, 14, and 15 are all located in a common line along the front of the flute body 31. The holes 1, 6, and 9 are located along a common line on the rear of the flute body 31. The holes 2, 3, and 13 are located along a common line on the right side of the flute body 31 and the hole 8 is located on the left side of the flute body 31. It will be understood that the embouchure 33 is positioned to enable the flute to be played with the rear side thereof facing the player.

Referring to FIGS. 5, 6, and 7, the structural details of the embouchure 33 are shown. It will be seen that the embouchure 33 comprises an apertured lip plate 64 and an apertured plug 65 aligned to form an aperture 66 of constant internal cross-section and mounted in the end of the flute so that the aperture 66 is located symmetrically about the axis of the flute. As most clearly shown in FIGS. 2, 4, and 5, the lip plate 64 has a smoothly curved upper surface in a first plane passing from the front to the rear through the axis of the flute as well as in all planes parallel thereto. However, as shown in FIGS. 1 and 3, the upper surface of the lip plate 64 is rectilinear in a second plane passing from left to right through the axis of the flute perpendicular to the first plane as well as in all planes parallel to such second plane.

It will be understood that in playing the flute, the curved surface at the rearward portion 67 of the lip plate 64 is rested against the chin and lower lip of the player in order to facilitate the orientation of the aperture 66 with respect to the lips of the player. As best

shown in FIGS. 6 and 7, the forward edge 69 of the aperture 66 or, in other words, the edge of the aperture 66 opposite the rearward portion 67 of the lip plate is rectilinear in order to provide an appropriate edge against which the breath of the player is directed in order to produce the free air-reed effect responsible for the acoustic output of the flute. Thus, in the specific embodiment shown, the aperture 66 is generally rectangular as will be more fully discussed hereinafter.

It has been found that in order to produce consistency in the playing of the flute, it is necessary for the lip plate 64 to have a slight tilt with respect to the perpendicular axis of the flute. Thus, as best shown in FIGS. 1 and 3, the line formed by the lip plate 64 in the second plane, mentioned above as passing from left to right through the axis of the flute, differs from the perpendicular to the axis of the flute by a few degrees as indicated by the angle X in FIGS. 1 and 3. It has been found that the angle X must be at least 1° and not more than 5° in order to provide consistency in the playing of the flute. Although the tilt representing by the angle X in FIGS. 1 and 3, is shown extending downwardly to the right and upwardly to the left, the direction of such tilt may be reversed to suit the individual preference of the player as where the player is left handed rather than right handed.

Considering now the design of a specific flute according to the teaching of this invention having middle C as its lowest note, the body of the flute is made of metal tubing having a constant internal diameter of eleven-sixteenths of an inch. The length of the flute is 24¼ in. from the embouchure 33 to the foot 32 thereof. The lip plate 64 of the embouchure was made of a rectangular metal plate 2½ by 1½ in. curved along its long dimension to provide the desired chin rest 67 as discussed hereinabove. The aperture 66 through the lip plate 64 is a rectangular opening six-sixteenths of an inch along its short dimension and one-half in. along its long dimension with the long dimension of the aperture 66 parallel to the short dimension of the lip plate 64. A plug member 65 extends from the concave surface of the lip plate 64 and has outer dimensions adapted to fit into the internal dimensions of the body of the flute in an air-tight manner for mounting the embouchure thereon. The aperture through the plug member 65 is of course identical to and aligned with the aperture through the lip plate as discussed hereinabove. The axial length of the plug member 65 should be less than one-half inch and no longer than necessary to provide adequate mechanical strength in the mounting of the embouchure in the end of the body of the flute.

According to the teaching of this invention, all of the tone holes with the exception of tone holes 1, 2 and 3, are circular holes nine-sixteenths of an inch in diameter. Tone holes 1, 2, and 3 are circular holes seven-sixteenths of an inch in diameter. In this specific embodiment of the flute, the centers of the various holes are located at the distance along the axis of the flute shown in the following chart:

Hole No.	Inches from Embouchure	Hole No.	Inches from Embouchure
1	3-3/16	9	15
2	9/4	10	15-13/16
3	9-15/16	11	17
4	10-13/16	12	18
5	11/4	13	19/4

-Continued

Hole No.	Inches from Embouchure	Hole No.	Inches from Embouchure
6	12½	14	20¾
7	13-1/16	15	21¾
8	14¼		

Referring now to FIG. 11 and particularly to the portion thereof contained within the dotted lines, it will be seen that a fingering chart for the embodiment of this invention shown in FIGS. 1 through 4 is displayed. The numbers of the tone holes from 1 through 15 are arranged in vertically descending order along the left hand boundary of the chart with the tones and semitones obtainable in three different registers of a flute according to this invention shown on a musical staff extending across the top of the chart. Symbols representing the condition of the key associated with each of the holes are arranged in vertical columns under each of the notes. Such symbols comprising a circle showing that the particular key is open and a circle with an X inscribed therein to show that the particular key is closed in producing the tone or tones represented by the notes directly above the particular column of symbols.

As pointed out hereinabove, certain of the keys associated with certain of the holes are spring biased to cause them to normally stand open whereas other keys associated with other holes are spring biased to cause them to normally assume their closed position. Thus, the keys associated with holes 4, 5, 7, 10, 11, 12, 14 and 15 are all spring biased to normally stand open and for ease in understanding the fingering chart a circle is circumscribed about these numbers at the left hand side of the chart. Thus, it will be seen that in order to sound middle C on a flute in accordance with the teaching of this invention all of the tone holes must be closed as indicated in the first column of symbols at the left hand side of the chart in which an X appears in each of the circles associated with each of the numbers 1 through 15. It will be understood that the keys associated with tone holes 4, 5, 7, 10, 11, 12, 14 and 15 must all be manipulated to their closed position and the manipulation of these keys is indicated in the left hand column of the fingering chart by the short horizontal line extending to the right from the symbols associated with these holes. As mentioned hereinabove, the keys associated with tone holes 4, 5, and 7 are manipulated by the first, middle and ring finger, respectively, of the left hand of the player, whereas the keys associated with tone holes 10, 11, and 12 are manipulated by the first, middle, and ring finger, respectively, of the right hand of the player. The keys associated with tone holes 14 and 15 are both manipulated by the little finger of the right hand of the player by means of lever arms 44 and 45 as discussed hereinabove.

As shown in the second column at the left hand side of the fingering chart in order to sound middle C sharp, the little finger of the right hand of the player is removed from lever arm 45 allowing the key associated with tone hole 15 to open while all of the other tone holes remained closed. Similarly, as indicated by the third column at the left hand side of the fingering chart in order to sound the D note immediately above middle C, the little finger of the right hand of the player is also removed from lever arm 44 connected to the key associated with tone hole 14 thereby allowing tone holes 14

and 15 to both stand open while all of the other tone holes remain closed.

In order to sound E flat as indicated in the fourth column from the left hand side of the fingering chart, it is necessary to manipulate the key associated with tone hole 13 by bringing the little finger of the right hand into contact with the lever arm 43 thereby opening tone hole 13 which is normally closed. Such manipulation of the key associated with tone hole 13 is also indicated by a short horizontal line extending to the right of the now blank circle in the fourth column to the right of the horizontal row associated with the number 13 in the fingering chart.

In order to sound the E, the little finger of the right hand of the player is removed from the lever arm 43 and the ring finger of the right hand is removed from the key associated with tone hole 12 thereby allowing tone holes 12, 14 and 15 to stand open, whereas the key associated with tone hole 13 returns to its normally closed position. Similarly, to sound the F, the middle finger, ring finger, and little finger of the right hand of the player are removed from contact with the keys associated therewith thereby allowing tone holes 11, 12, 14 and 15 to stand open while the key associated with tone hole 13 remains in its normally closed position.

It will be noted that both F sharp and G flat are shown in the next two columns of the fingering chart and that these are merely two different musical notations for the same note which is obtained by the player's complete removal of his right hand from manipulative contact with the flute, thus allowing the keys associated with tone holes 10, 11, 12, 14 and 15 to stand open with the key associated with tone hole 13 in its normally closed position. It will also be understood that the thumb of the right hand of the player remains in supporting contact with the thumb hook 35 at the rear of the flute body.

In order to sound the G, the index finger of the right hand of the player is brought into contact with the lever arm 49 thereby lifting the key associated with tone hole 9 from its normally closed position as indicated on the fingering chart. In order to sound the A flat, the right hand of the player is again removed from manipulative contact with the flute and the little finger of the left hand is brought into contact with the lever arm 58 to open the normally closed key associated with tone hole 8. In order to sound the A natural, the right hand of the player is allowed to remain out of manipulative contact with the flute and the ring and middle fingers of the left hand of the player are removed from the keys associated with tone hole 7 and the lever arm 58, respectively. In order to sound the B flat, the left hand of the player is allowed to remain in the position previously described for the A natural and the index finger of the right hand is brought into engagement with the lever arm 46 to open the normally closed key associated with tone hole 6. In order to sound the B, all of the fingers of both hands of the player are removed from manipulative contact with the flute, except for the index finger of the left hand which remains in operative engagement with the key associated with tone hole 4.

In order to sound the octave C, all of the fingers of both hands of the player are removed from manipulative contact with the flute. However, the middle finger of the left hand of the player may be in operative contact with the key associated with tone hole 5 as indicated on the fingering chart. This optional fingering is

preferred since it will enable the player to maintain a firm grip on the flute and insure physical control of the flute.

At this point, it should be remembered that the octave C can also be sounded in the second register of the flute using the same fingering as for middle C. The second register of the flute is obtained by changing the position of the lips in forming the jet of air directed into the embouchure of the flute, as is well known in the musical art. In other words, the lips tighten and the jet of air formed thereby is directed in a more downwardly direction into the flute. It has been found that the second register of the flute according to this invention is much easier to achieve and maintain than in conventional flutes. This enables a more relaxed playing of the flute and it is believed to be due to the orientation in which the flute is played and the particular acoustics resulting from the embouchure and its relationship to the flute body.

As shown in the fingering chart of FIG. 11, the second register of the flute in accordance with the teaching of this invention covers a full octave above the range of the first register thus providing substantially more than two full octaves, with more than one octave being obtainable in each of such registers. As also indicated in the fingering chart of FIG. 11, a third register is provided extending from the third F above middle C through C sharp of the fourth octave above middle C. The third register is, of course, achieved by a further tightening of the lips and reorientation of the jet of air as described hereinabove.

In order to sound the C sharp in any of the octaves above middle C, the index finger of the left hand of the player is brought into contact with the lever arm 53 thereby opening the normally closed key associated with tone hole 3 while the middle finger of the left hand of the player is brought into contact with the normally open key associated with tone hole 5 thereby closing it. In order to sound the D in either of the octaves above the octave of middle C, the index finger of the left hand of the player is removed from lever arm 53 while the middle finger of the left hand of the player remains in contact with the key associated with tone hole 5 and the ring finger of the left hand of the player is brought into engagement with the lever arm 52 thereby opening the normally closed key associated with tone hole 2.

As shown in the last two columns within the dotted lines at the right hand side of the fingering chart of FIG. 11, the fingering is for the second embodiment of this invention which will be described hereinafter. However, E flat may be obtained in the embodiment of the invention shown in FIGS. 1 through 4 by reversing the condition of the key associated with tone hole 1 in the E flat column and as indicated by the dotted line box about the symbol for hole 1 in the E flat column of the chart. Thus, in order to sound the E flat on the embodiment of this invention shown in FIGS. 1 through 4, the middle finger of the left hand of the player remains in contact with the key associated with tone hole 5 and the thumb of the left hand of the player is brought into contact with lever arm 51 to open the key associated with tone hole 1 while all of the remaining fingers of both hands of the player remain out of manipulative contact with the flute. In order to sound the E in the octaves above the octave of middle C on the flute according to the embodiment of this invention shown in FIGS. 1 through 4, the middle finger of the left hand of the

player remains in contact with the key associated with tone hole 5 and the thumb of the left hand of the player remains in contact with the lever arm 51 to open the key associated with tone hole 1 and the ring finger of the left hand of the player is brought into contact with the lever arm 52 thereby opening the key associated with tone hole 2.

By studying the fingering chart within the dotted lines of FIG. 11, paying particular attention to the short horizontal lines extending to the right of the symbols in the various columns, it will be seen that the fingering system for the flute of the invention shown in FIGS. 1 through 4 is simple and straightforward. In addition, the fingering system is relaxing in that it enables the flute to be comfortably and reliably supported throughout the entire range which effect is heightened by the inclusion of the thumb hook 35. The fingering system is logical and simple to learn since it fits more or less normally into the usual manipulative pattern of the fingers of the human hand.

It will also be seen that the flute according to this invention has an usually broad range of well over an octave in each of at least two different registers in spite of its comparatively short length and simple fingering system. The fact that more than one octave may be achieved in either of two registers with a large part of an octave being achievable in a third register adds greatly to the flexibility of the flute according to this invention.

Referring to FIGS. 8 through 10, a second embodiment of this invention is shown which is identical to the embodiment of FIGS. 1 through 4, except for the addition of three tone holes, one of which is optional for providing a more "reedy" tone and two of which are required to extend the range of the flute to the second and third F above middle C in the first two registers of the flute.

Thus, a tone hole 28 is added at the foot of the flute, together with a normally open key ganged with the key associated with tone hole 15. Tone hole 28 is not important with regard to range but may be included to provide a tone quality more like that of a saxophone if desired.

Tone hole 22 is added between tone holes 1 and 2 and a tone hole 21 is added above tone hole 1. A normally closed key is associated with tone hole 22 and is mounted on an independent axle together with a lever arm 81 extending to a point adjacent tone hole 4 to enable it to be opened by the index finger of the left hand. Similarly, the key associated with tone hole 21 is mounted on an independent axle together with a lever arm 81 extending to a point adjacent tone hole 10 to enable it to be manipulated by the index finger of the right hand.

In an actual flute constructed according to the embodiment of FIGS. 8 through 10, tone holes 21 and 22 have a diameter of 7/16 in. and are spaced 7¼ and 8½ in., respectively, from the embouchure. Tone hole 28 has a diameter of 9/16 in. and is spaced 22 13/16 in. from the embouchure.

Referring to the fingering chart of FIG. 11, it will be seen that the keys associated with tone holes 21 and 22 remain closed throughout the range of the flute except for the second and third E flat and the second and third F above the octave of middle C. Similarly, the key associated with tone hole 28 remains open throughout the range of the flute, except when actuated together with

the key associated with tone hole 15 in order to sound middle C. Thus, in order to sound E above the octave of middle C, the middle finger of the left hand of the player engages the key associated with tone hole 5, the ring finger of the left hand of the player engages the lever arm 52 to open the key associated with tone hole 2 and the thumb of the left hand of the player engages the lever arm 51 to open the key associated with tone hole 1. In order to sound the E flat of the second and third octaves above middle C, the middle finger of the left hand remains in contact with the key associated with tone hole 5 while the thumb of the left hand of the player is removed from lever arm 51 allowing the key associated with tone hole 1 to close and the index finger of the left hand of the player is caused to contact lever arm 82 thereby opening the key associated with tone hole 22. Finally, in order to sound the F of the second and third octaves above middle C, the index finger of the right hand is brought into engagement with the lever arm 81 to open the key associated with tone hole 21 while the index and ring fingers of the left hand of the player remain as described in sounding the E flat.

It will of course be possible to alter the fingering discussed hereinabove to suit the particular desires and style of the flautist and it is believed that skilled flautists will devise their own modifications in the fingering described hereinabove for the flute constructed in accordance with the teaching of this invention. The fingering system is unusually simple and therefore provides unusual flexibility.

The flexibility of the flute according to the embodiment of this invention, shown in FIGS. 8 through 10, is further enhanced by the inclusion of a neck strap support hook 85 located on the rear of the body of the flute at substantially the mid point of the length thereof. The inclusion of the hook means 85 enables the flute to be supported in a balanced manner from a strap or cord about the neck of the player. Where a neck support hook 85 is used, it may be possible to dispense with the thumb hook 35, however, the use of both the thumb hook 35 and the neck strap hook 85 will provide a more stable and reliable support for the flute during a performance and may add greatly to the flexibility with which the flute may be played.

The tone of a flute in accordance with the various embodiments of this invention is unusually pleasing and versatile. It has been found that a flute in accordance with the teaching of this invention can simulate a saxophone in tone and phrasing particularly where tone hole 28 is included depending on the skill of the player in blowing the flute. The fact that the flute is played in a vertical position makes it less awkward and enables greater flexibility in fingering and phrasing. The flute is easier to play both due to its vertical position in use and due to the embouchure which requires less tightening of the lips in normal ranges.

Finally, the flute in accordance with the teaching of this invention is less expensive to manufacture. It will be seen that with the exception of the key associated with hole 28 in the embodiment of this invention, shown in FIGS. 8 through 9, none of the keys are ganged together. Thus, there is less adjustment required and the pad cups of the keys may in fact be substantially identical to those used on saxophones. Thus, the flute according to the teaching of this invention might be aptly described as a cross between a flute and

a saxophone at least in terms of its tone and mechanical construction.

It is believed that those skilled in the art will make obvious modifications in the flute according to the teaching of this invention to suit their individual preferences and needs.

For example, it may be possible to construct the flute according to this invention with a tapered or conical bore rather than a cylindrical bore in order to change the relative spacing between the tone holes as desired. It will also be possible to make obvious changes in the location and specific mounting of the various keys and lever arms without departing from the teaching of this invention.

What is claimed is:

1. A flute comprising a hollow tubular body less than 2 inches in diameter and open at both ends, said body having a plurality of holes through the side wall thereof and spaced from each other along the length thereof, and one of said open ends of said body being provided with an embouchure comprising a lip plate providing an aperture for establishing a free air-reed at said one end of said body, said lip plate providing a surface extending transversely to the cylindrical axis of said body, said surface being smoothly curved in a first plane containing said cylindrical axis of said body and rectilinear in a second plane containing said cylindrical axis of said body perpendicular to said first plane, said surface in said second plane defining a line which intersects said cylindrical axis at an angle which differs from the perpendicular by at least 1° and not more than 5°.

2. A flute as claimed in claim 1 wherein said plurality of holes comprises at least 15 holes through the side wall of said flute body.

3. A flute as claimed in claim 1 wherein a plurality of keys each associated with a different one of said holes are mounted on said flute body for manipulation by the hands of the player to selectively stop the hole associated therewith.

4. A flute as claimed in claim 1 wherein said embouchure includes an apertured plug mounted on said lip plate and mechanically engaging the inner surface of said flute body at the end thereof, said aperture of said apertured plug being aligned and coextensive with said aperture provided by said lip plate and said plug extending less than 1/2 inch along the axis of said flute body.

5. A flute comprising a hollow tubular body less than two inches in diameter and about 3 feet long open at both ends and having an embouchure providing an end blown, free air-reed at one of said ends; said body having at least 15 holes through the side wall thereof dimensioned and spaced from each other along the axis of said flute body to enable production of all tones and semitones of at least one octave in a single register by selective stopping of said holes; and a plurality of keys each associated with a different one of said plurality of holes mounted on said flute body for manipulation by the hands of the player of said flute to selectively stop the holes associated therewith; said keys associated with the first, second, third, sixth, eighth, ninth and 13 holes as spaced along the axis of said body of said flute from said embouchure are biased to their closed position with the remaining ones of said keys being biased to their open position.

6. A flute as claimed in claim 5 including means for supporting said body with the tubular axis thereof ex-

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tending generally vertically and with said one end thereof at the top comprising a projection extending transversely from said body toward said player from a point spaced at least half way along said body from said one end thereof toward the other end thereof.

7. A flute as claimed in claim 5 wherein said keys associated with said sixth, ninth, 10, 11, 12, 13, 14 and 15 holes as spaced along the axis of said body of said flute are manipulated by one of the hands of said player and said keys associated with the remaining holes as spaced along said body of said flute are manipulated by the other hand of said player.

8. A flute as claimed in claim 7 wherein said plurality of holes includes two additional holes and two keys, each associated with a different one of said two additional holes, one of said additional holes being located between said embouchure and said first hole along said

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axis of said body of said flute and the other of said additional holes being located between said first hole and said second hole along said axis of said body of said flute, said key associated with said one additional hole being adapted to be manipulated by said one hand of said player and said key associated with said other of said additional holes being adapted to be manipulated by said other hand of said player.

9. A flute as claimed in claim 8 wherein said plurality of holes includes a third additional hole and a key associated with said third additional hole, said third additional hole being located between said 15 hole and the foot of said body of said flute, said key associated with said third additional hole being ganged for manipulation with the key associated with said 15 hole by said one hand of said player.

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