

## Speaking of “air pushing” and “air blocking”\* in the vocal, wind instrument performing and singing -"Dynamic system" for reconstruction of performing and singing

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**Summary:** Air has become the driving force for vocal, wind instruments, and singing vocalization. It is based on the mutual cooperation of the "air pushing " and "air blocking ", which are of two major functional systems. Studies have shown that “air pushing” is the research category of hydrostatics, based on the Pascal principle; “air blocking” is the research category of fluid kinematics and is based on the resistance effect of the “transverse wall surface” at the entrance of the windpipe. The breath control is realized in the reasonable “pushing” and “blocking”, the “dynamic system” for the performing and singing vocalization is established.

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**Keywords:** vocal, wind instruments performing, singing, air pushing, air blocking, Pascal's principle, Lateral wall resistance

**Prospects:** This theory is a singing and playing control system based on the author's lateral wall resistance theory and Pascal's principle. It will become an important prerequisite for the development of international singing and playing theory in the future.

The dynamic system of vocal and wind instruments is built in the scope of human cavities. Through the regulation and control of human cavities, the air in the cavities flows outwards to form the force source for the vocal and wind instruments' vibration vocalization. The reason why we call it "dynamic system" is because this source of force does not come from a certain point or part of the human body, but it is the overall network of human bodies that are in contact with each other and restrict each other. The "dynamic system" is composed of two major components. One is the air-pushing function system, and the other is the air-blocking function system. Strictly speaking, the muscles and bones that form the lumen of the human body under the reeds belong to the “air pushing function system”; the voluntary muscles and bones (mouth cavity or throat cavity), which are mainly reeds and their surrounding control reeds, belong to the air blocking function system" (It should be noted that this part of the muscle tissue and bone has a dual function, both "air-blocking" function and "air pushing" function).The force of the "air pushing function system" is related to the air pressure. It belongs to the research category of hydrostatics. Pascal's principle reveals its inherent laws. The force of the “air

blocking function system” is related to the air flow, which belongs to the research category of fluid kinematics. The phenomenon of “necking” at the entrance segment of the windpipe due to the resistance of the “transverse wall surface”<sup>[1]</sup> reflects the inherent resistance feature. In the vocal, wind instruments performing and singing, the force of the cavity is based on the principle of “expansion” of the cavity in a steady progress; the “air blocking” at the exit of the cavity top is the change of the cavity in “expansion”. Through the interaction between “air pushing” and “air blocking”, a stable air column is formed, which becomes a precondition for rational performing and singing. We can't just emphasize “air pushing” and ignore “air blocking”, nor can we just emphasize “air blocking ” and ignore “gas pushing”, otherwise, it is not the inaccuracy of the force putting position, or the over-tightness or over looseness of the reed (vocal cord) mouth, thus losing control of the breath, affecting the pitch and timbre and other aspects of the performing and singing. In response to these problems, the author is to talk about personal opinions. First of all, it is to speak of the “air pushing”.

### I. Air pushing

#### 1. Pascal principle analysis

The cavity “air pushing” is used as a force source for performing and singing, and its force putting must be attributed to the research field of hydrostatics. The law of the famous French scientist Blaise Pascal 1623-1662 reveals the inherent laws: When the surface pressure of a stationary fluid in a closed container changes, the fluid will have an

equivalent transfer internally, and the pressure at any point in the fluid will change accordingly. When gravity is ignored, the pressure in a closed container is equal everywhere, and the acting force is inversely related to the area of action ( $P=F_1/A_1$ ) [2]. The following "schematic diagram of hydraulic press" can explain the Pascal principle:

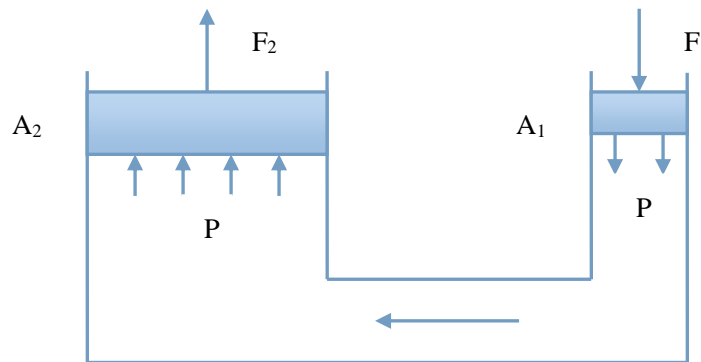


Figure 1 Pascal designed hydraulic press schematic diagram

As shown in the figure,  $F_1$  is an external force acting on the piston with an area of  $A_1$ , so that the liquid generates a pressure  $P$ , and is transmitted to the points in the container equivalently, including the piston  $A_2$ , so that it generates an external acting force  $F_2$ , and its expression is : Pressure intensity ( $P$ ) = acting force ( $F$ )/action area ( $A$ ). This expression shows that after the closed vessel wall surface is pressed, the changed pressure is transmitted in equal value inside the stationary fluid and is equal everywhere. However, due to the difference in the area and size of the vessel and the shape, the radius of the vessel is made different and the different lengths of pressure arms ultimately lead to differences in the ability of the wall surfaces at different positions of the vessel to withstand the pressure. The capacity of the small vessels to withstand the pressure is greater than that of the large vessels. Conversely, the effects of small vessels after the implementation of pressure are far greater than that of the large vessels. Practice has proved that if it is to face the vocal, the wind instrument performing, singing, the pressure on the human cavity wall surface and the force putting positions are constantly changing in the complex conditions, to maintain the equivalent transmission of pressure and maintain equal everywhere will become important technical requirements.

## 2.Inhaling

Pascal's principle tells us that air inhalation in performing and singing is different from the powerful air inhalation in life. Its purpose: Firstly, storage of air amount; Secondly, making the human body's lumen filled. Air inhalation is to overcome gravity through the external intercostal muscles (because of gravity, the gravity field is a common potential force field in life, its role in human motion is not negligible), the thorax is raised diagonally above, so that the lumen space expands upwards and around; the diaphragm muscles lower and contract and the lumen space expands downwards and around, establishing a stable confrontation relationship with the contraction of the abdominal muscles and other surrounding muscle tissue. However, medically speaking, the diaphragm muscle, as the involuntary muscle is closely connected to the voluntary muscular tissues such as 6 pairs of ribs at the lower rib position, thoracic xiphoid, the 2-3 lumbar vertebrae above the waist, the psoas muscles and the lumbar quadrate tendon, etc. Therefore, its movement is relatively complicated. It must deal with the rational pull of the surrounding, especially the relationship with the abdominal muscles. The abdominal cavity below the diaphragm muscle (including the diaphragm muscle) can be understood as the thickened part of the inner wall of the lumen.

Because the soft body in the abdominal cavity is like fluid, there is a lack of bone support around it. Only by coordinating the intrinsic in-situ contraction and descending diaphragm muscle in the abdomen, making diaphragm, abdominal, lumbar, and other muscles form a steady body and make them stabilized at the bottom of the human body's lumen, providing stable support for airflow. If the "pedestal" is ignored during air inhalation, the force putting for air exhalation (performing, singing) is out of the question. We call this passive filling of lumen due to expansion as "primary expansion," and the "primary expansion" of the lumen is a prerequisite for exhalation (performing, singing). However, the purpose of inhalation is to increase the cavity pressure boost, in addition to the storage of air amount. Excessive inhalation will increase the area of the lumen, reduce the control force, and also increase the burden of forced exhalation (performing and singing). Especially in the variable lumen (throat cavity to mouth cavity) changes, although the volume can not be too small (which will hinder the flow of air, causing sound tension), it can not be too large either (too much force putting will be wasted and lead to sound quality decline).

### 3.Exhalation (performing, sing)

The exhalation in performing and singing is the official launch of the "air pushing" function. The air pushing function system we talk about mainly consists of the human body's mouth cavity, throat cavity, thoracic cavity, abdominal cavity and surrounding body tissues, including the cavity around the exit of the reed (the mouth cavity for the performing of the wind instrument and the laryngeal cavity for the vocal music). The interaction between them has played a decisive role in the air pushing of performing and singing. From the aspect of human physiological structure, the power of this system mainly comes from the contraction of muscles such as intercostal muscles, abdominal pressure muscles, gluteus muscles, and the like. The contraction of the internal intercostal muscles is the initial source power of "air pushing". It is based on the premise that the gravity of the thorax falls, and continues to pull down the ribs to reduce the transverse and sagittal diameter of the thorax to achieve the purpose of exhalation. The abdominal pressure muscle is composed of diaphragm, rectus abdominis, transverse abdominis muscle, intra-abdominal, external oblique muscle, quadratus lumborum, pelvic muscles, due to the connection between rectus abdominis and 5-7th costal cartilage and xiphoid, external oblique muscle and the lower three ribs, the transverse abdominis muscles and the 7-12th ribs, and the quadratus lumborum and the 12th rib, their contraction has the effect of pulling down the ribs to help exhale. The

gluteal muscles belong to the lower limb muscles. They are located on the posterolateral side of the pelvis and belong to the edge zone of the waist and abdomen bottom. When performing and singing with greater force, their contraction will provide greater support. At the same time, for wind instruments, the relevant muscles around the mouth cavity are affected (the sphincter around the lips and upper lip levator of nosewing connected to it, the upper lip levator, levator anguli oris, the major and minor zygomaticus muscles, the buccal muscles, depressor anguli oris, depressor labii inferioris and the mentalis. and the lingual muscles of the mouth cavity, etc.) under the support of the bone such as the mandible, the teeth, the hyoid bone, the cheekbone, and the farther skull, etc., they act as the "air pushing" role top down the cavity; for vocal music, the relevant muscles around the laryngeal cavity are under the support of the bones such as the mandible, the hyoid, and the thyroid, and their contraction also acts as a "air pushing" effect top down the cavity. Under the joint action of the "air pushing function system", we have found that during the process of pushing out the air from the cavity: due to the effect of the air blocking function, only a very small amount of air is pushed out, and most of the air that has not been pushed out is returned to further pressurize the already filled cavity air, which has a strong reaction force against the muscle tissue in the air pushing function system. There is also a sense of "passiveness" in these active force putting muscles. "Initiative" lies in the subjective exertion of force for air pushing, and the "passiveness" lies in the counterforce of the air that makes them seem to be pushed back to their original position. There is a feeling of "sitting in", which is very stable and very surefooted. This is the "secondary expansion"<sup>[3]</sup> that continues to occur in the exhalation after the "primary expansion" of cavity generated due to air inhalation which was talked about in the past discussion. In the case where the amount of air is continuously reduced as the gas is constantly blown out, the overall muscle of the air pushing function system will also narrow the space of this cavity along with it, but in the process of narrowing, the space of the cavity is narrowed from the top to the bottom (also often referred to as "air going down"), the exhalation muscles in the air pushing function system must maintain a permanent confrontation with the air in the cavity, that is to say, in the performing and singing, whether it is a strong tone performing, singing or weak tone performing, sing or it is to "start blowing", "start singing" or a breath of "running" and "ending"<sup>[4]</sup>. It is necessary to maintain the expansion of the cavity. It is only that the expansion force is either big or small. Otherwise, because the human

body is tense, its surrounding muscle groups are forced upwards, which not only increases the force exertion burden of the muscle groups, but also increases the instability at the bottom of the lumen, causing the force to run out of control due to the floating of the breath. We should clearly realize that the human lumen is composed of complex-shaped curved surfaces, when static air acts on such wall surfaces, as the size of each air micro-element or the force at each point, the direction and the point of action are different, which have made the cavity form a complex spatial force system. Even for experts in theoretical deep fluid mechanics, it is intractable to obtain information on the acting force. What's more, what we are faced throughout the performing and singing are always the changing "living body" for the cavity shape. Pascal's principle tells us that the "expansion" pressure intensity in the human body cavity during the performing and singing is equivalent, and that under the action of external forces, the air must remain in equilibrium. The so-called "resting balance" refers that there is no relative displacement between the internal "micro-cluster" or "fluid layer" of the air, there is no relative displacement, as a whole it is like a rigid body. Therefore, fluid mechanics thinks that there is only normal stress inside the static fluid and the tangential stress is zero, so the stress everywhere is perpendicular<sup>[5]</sup> to the action surface, and the expansion of the cavity is holistic and omnidirectional. In order to meet this requirement, we must first base on Pascal's principle and implement the "change" to control the "change". In other words, through the regulatory function of the variable lumen, the use of complicated shape changes in the lumen, under the stable support of the force, it is to complete complex sound changes to keep it in our hands.

The human body lumen for the vocal, wind instruments performing and singing is a relatively closed and complex environment. When the "air pushing function system" implements its functions, the "balanced overall pressure" (equal pressure everywhere) becomes its force exertion characteristics. However, Pascal's "inverse relationship between acting force and area of action" tells us that grasping the interrelation between the adjustable lumen and the non-adjustable lumen is the root cause for the lasting stability in the change of air flow. We emphasize that the purpose of "air pushing" is to trigger the rise of air pressure inside the cavity and react upon the wall. This feature reflects the important principle of the system's force exertion. Let's talk about "air blocking" below.

## II. Air blocking

The so-called "air blocking" is to prevent the air

in the cavity from flowing out too quickly during the performing and singing, and maintain the expansion of the lumen, to ensure reasonable sound production and reasonable force exertion. The sound exciter for the vocal and wind instruments is located at the exit of the cavity. The air outlet of the control cavity is not only an important part for achieving "air-blocking", but also the key to achieve reasonable sound production. The "air blocking" is realized in the vocalization, and only the reasonable sound production can achieve reasonable "air-blocking". Therefore, the exploration of reasonable force exertion and reasonable vibration is the key to solving the "air-blocking" problem.

### 1. Windpipe entrance segment resistance analysis

The study finds that the cavity air outlets formed in performing and singing should belong to the research category of fluid kinematics, because the "short windpipe" through which the air flows is completely in line with the "entrance initial segment" condition<sup>[6]</sup> of fluid mechanics (for short the "entrance segment"), the entrance segment is one of the places<sup>[7]</sup> where the local resistance of the windpipe is generated. The definition for it by the fluid mechanics is as follows:

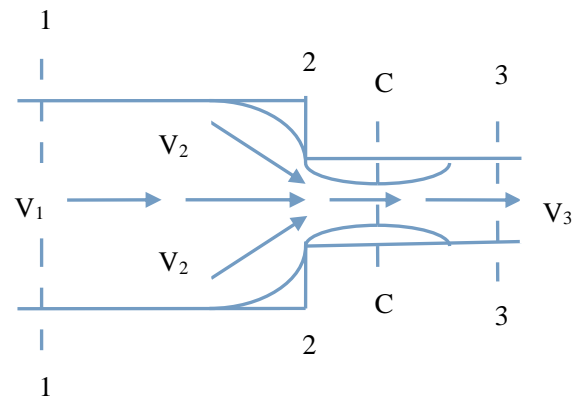


Fig. 2 Sudden narrowing phenomenon at the windpipe entrance segment

"The fluid has a sharp change in the motion morphology for the local obstacle zone, and then there is a force generated that impedes the fluid motion. This force is called local resistance"<sup>[8]</sup>. It has not only pointed out the characteristics of the air blocking, but also revealed the vibration rule of the reed, which is the relationship between the vibration vocalization of the reed and "air blocking." Next we analyze how the entrance segment produces resistance. As shown in Figure 2, the fluid flows from the large diameter 1-1 to the small diameter opening, the

fluid velocity is evenly distributed. When the fluid runs to the small diameter opening, the axial center The fluid at the centering area continues to move forward. Because the large windpipe diameter is at the 2-2 of small windpipe diameter opening, its cross-section suddenly shrinks and produces a transverse wall surface, which blocks the motion fluid around the large windpipe. The flow velocity and flow direction have undergone drastic changes, and the steering tube axial direction forms a "lateral flow" [9]. The intrinsic cause of lateral flow is that frictional resistance exists between the incoming flow and the transverse wall surface of the solid when the incoming flow near the side wall of the pipe encounters the transverse wall surface of the solid and turns around. Hydrodynamic studies indicate that frictional resistance can be expressed as a change in pressure, because the pressure is essentially the flow resistance of [10]. This shows that the relationship of "action and reaction" as stated in Newton's third law has been formed between fluid in the flow and the solid wall surface, it is the active pressure of the fluid on the solid wall surface that causes the solid wall surface to produce a reaction pressure, The pressure on both sides depends on the speed of the flow. The point where the flow velocity is the greatest (specifically at the centering of the pipe) is where the transverse plane pressure is the smallest, and the point where the flow velocity is the smallest (speed is zero) is the point where the transverse plane pressure is the biggest (specifically, the transverse wall surface of the solid), the narrowest high flow velocity zone is precisely the widest transverse plane high pressure zone, and the high pressure must move in the direction of low pressure. The author's point of view on "transverse wall surface" resistance has been indirectly confirmed in fluid mechanics. For example, the reason for producing resistance is that pipe "suddenly changes in shape, size, or direction" [11]. "The change in velocity distribution due to a sharp change in the solid boundary." [12], "The resistance is the tangential stress caused by the fluid flowing around the object" [13]. The resistance of the "entry start section" is the phenomenon of "necking" caused by the fluid deformation due to the sudden reduction of the cross section [14], etc.. These views are to illustrate the resistance brought about to the motion fluid by the solid "transverse wall surface" formation, but the resistance has not been summarized as the "transverse wall surface". The generation of "lateral flow" for the small pipe diameter opening further narrows the flow range of the fluid in the axial center area of the small pipe diameter, under the effect of "lateral flow," the pipe CC is the narrowest, and as the "lateral flow" force weakens, the flow cross section gradually increases from the pipe CC until the

flow rate of the pipe 3-3 fluid resumes uniform distribution. This is the whole process of local resistance produced at the initial section of the pipe entrance. The solid transverse wall surface around the small pipe diameter opening 2-2 becomes the source for the resistance of the entrance segment of the pipe. The transverse shear due to resistance is driven by the transverse shear, so that the force of the side wall moving toward the pipe axis is present at the pipe opening 2-2. The pipe wall is not deformed only due to the mutual support of the side wall structure of the round pipe.

## 2. "Air blocking" and reed vibration

Emphasizing that "air-blocking" is to reduce the air amount consumption, but also to obtain reasonable vibration of the reed, although the two tasks are different, they are all related to the internal operating rules of the "entrance segment" of the pipe, and the process of reed vibration is also the process of "air-blocking", the more reasonable the reed vibration is, the stronger the "air-blocking" function is. Reeds (including single reed, double reeds, double lips, and vocal cords) act as a sound exciter. It is an irregularly flat shaped short tube with a thin slit between the two walls of the short semi-axis. Compared with a round tube, it lacks a frame support. Therefore, when the air flow passes through the reed mouth, it is blocked by the lateral wall surface of the reed mouth, so that the air flow is turned to generate a transverse shear. The reed is driven by the transverse shear of the air flow, so that the reed overcomes its own elasticity and leaves the equilibrium position, forming a tendency to move from the high resistance area towards the lower resistance zone (tube axis), achieving reed closure (note here that although the "system of particles method" of Joseph-Louis Lagrange is rarely used in engineering fluid mechanics [15], the effect of individual fluid particles in motion cannot be ignored. The reason why reed can be pulled toward the tube axis. It is the result of continuous friction and pulling of each fluid particle in the lateral flow that passes through the reed mouth.) As the reed mouth shrinks, the airflow becomes thinner and slower, the lateral shear of the air begins to weaken, and the retracting force of the reed begins to increase. When the retracting force of the reed increases greater than the numerical value of the transverse shear generated by the steering airflow, due to tensile deformation, the reed produces an elastic force that is in situ. Under the action of elastic retraction force, the reed moves to the equilibrium position. Re-expansion of the reed mouth causes the air flow and flow rate to increase again, and the transverse shear again increases the tension on the reed, so that the cyclical reciprocation causes the reeds under the combined action of the

transverse shear stress of the airflow and the elasticity of the reeds to make its shape have the periodic changes and cause vibration vocalization (Prompt: the reed vibration speed is composed of a fast one and a slow one which are two parts, the action generated by the elastic force of the reed is slower, and the action of the air flow pulling the reeds is very Fast, so what really causes the reeds to vocalize is the result of the air flow pulling reeds for quickly flapping and compressing the air.) The intensive back-and-forth vibration of the reed forms a resistance to air flow. This resistance also becomes an important part of the air-blocking function system. However, in this process, the negative effects of the flow velocity and the cross section of passage on the “air blocking” cannot be ignored, the reed pipe is the only outlet of the air, but during the process of the air flowing through the reed pipe, due to the bottleneck effect at the “entrance segment”, which has made the “outlet” become an important “air blocking” function. In the case of reeds, the “lateral wall surface” is the external condition that restricts fluid flow, and the presence of the pressure function ( $P(x, y, z)$ ) in the fluid already shows the effect of pressure on the various orientations in the pipe <sup>[16]</sup>. The lateral pulsation (additional shear stress) in the motion fluid is an important factor for the pressure produced on the solid wall surface. The magnitude of the lateral pulsation is related to the flow velocity and is more related to the passage cross section (the diameter of the pipe is related to the air flow, and also related to the size of the damping. The larger the pipe diameter, the greater the flow and the smaller the damping; on the contrary, the smaller the flow, the greater the damping <sup>[17]</sup>). An increase in the passage cross section will reduce the side wall pull ratio by the lateral shear in the “lateral flow” produced due to the “transverse wall surface”, which will be detrimental to the closing of the reed and reduce the resistance to airflow; on the other hand, If the passage cross-section decreases, the side wall pull ratio by the lateral shear in the “lateral flow” caused by the “lateral wall surface” will be increased, which is beneficial to the closure of the wall surface and increases the resistance to airflow. Increasing the transverse shear at the pipe mouth and reducing the additional shear stress on the tube axis are the real reasons why the reed is made into a flat mouth <sup>[18]</sup>. At this time, people may be in doubt: The sound exciter for edge tone wind instrument is not a reed, but also to observe the reed vibration and “air blocking” principle? The answer is yes. First of all, the position for the “air blocking” function is exactly the same as that for the reed pipe instrument and there is no need to re-demonstrate. Although the external form of the edge tone wind instrument is different from that of

the reed wind instrument, its internal vibration principle is exactly the same. In order to remove doubts, we briefly describe the vibration process of the edge tone: when the air enters the blow hole, with the help of the “lateral wall surface” of the blow hole edge, it is to make the air flow turn to the tube axis to form a lateral flow. At this time, a low-pressure zone is instantaneously formed between the inner wall of the flute tube and lateral flow. Under the effect of low pressure, the lateral flow will quickly flow to the low pressure zone. When the pressure in the low pressure zone increases, the lateral flow will return to the original position, but at this time the low-pressure zone re-formed, again the lateral flow is turned to the low pressure zone, so that the cyclical beat of the lateral flow forms the “air reed vibration”, which is the vibration process of the edge tone. Under the effect of reasonable air flow angle, the relationship between “air reed vibration” and “air blocking” is exactly the same as the relationship between the above-mentioned reed vibration and “air blocking”, so in the discussion we can refer the sound exciter collectively to the reed. The air blocking function system we talk about, for vocal music, mainly consists of the relevant skeletons and muscle tissues that can control the tightening and closing of the vocal cords in and around the vocal cords. The closing of the glottis is closely related to the muscle groups of the air-blocking function system in the surrounding area. The purpose of opening and lowering the throat and opening the upper and lower throat channels during singing is to achieve a better closure of the reeds and a more reasonable vibration of the resonance tubes and cavity <sup>[19]</sup>. This fully realizes the function of the air blocking function system in breath control. For wind instruments, it mainly consists of the cavum laryngis, pharyngeal cavity, oral cavity, tongue, lip, mandible, and other parts of the human body in and around the reed, the control of the tongue body and the oral cavity in the blow, according to the difference in the high and low pitch wind instruments, is to appropriately control the changes in the size of the space, the mutual cooperation between these tissues have played a decisive role in the air blocking of the performing and singing. In vocal music singing, it is often emphasized that vocal cord closure is the reason. However, it should be noted that “closing” does not mean cutting off the air flow, but the relative flow is much less. Being too “closed” can cause problems such as sound nervousness, harshness, and suffocation. There is a complementary relationship between the vibration vocalization of the reeds and the “air blocking” function. Excessive airflow velocity in the reeds is not required for blowing performance, otherwise it will increase the hybrid

strength of the fluid particles in the reed pipes, making the reeds difficult to close during vibration, increasing the air volume and increasing the force. We must learn to use a slow airflow for the blowing performance. In order to make the vibration of the reed more reasonable, we must particularly emphasize the reasonable regulation and control of the muscle around the reed. The author believes that the muscle control around the reed is a process that conforms to the law of reed vibration rather than allowing the reed vibration to obey the manipulation of human muscles. In order to realize this control concept, the surrounding muscles must cooperate with the bones to both have the force to retract the reeds (vocal cords) and to make the reeds obtain space for sufficient vibration, so that there is always a "channel" existing in the reed mouth. When the air flow passes through the reed mouth, we do not rely on artificial pressure to narrow the air flow outlet, but rather to increase or decrease the air flow outlet according to the air flow velocity or pressure. If our muscles exert pressure on the reed more than the pressure of the airflow on the reed's mouth, it will result in "too tight" sound, making the reed unable to achieve the optimal vibration. On the other hand, because the muscles in the air-locking function system lack the effective pressure on the reeds, the reed mouth is made too large, which will cause the sound to be "over-scattered". The practice of performing and singing tells us that only a reasonable vibration of the reed will be consistent with the vibration variation law of the resonance tube and produce a good resonance, otherwise, the phenomenon of dullness, noise, inaccuracy, falseness, strenuous performing, and singing will occur. Acoustic studies have learned that: "If some of the resonance frequencies of the instrument match the higher harmonics produced by the vibration of the reed, the easier it is to blow, the better the control is." [20] Therefore, it is necessary to emphasize the best force exertion state of the muscles around the reeds in the performing and singing.

### III. "Pushing" and "blocking"

In the performing and singing of vocal and wind instruments, "pushing" and "blocking" are the combined effects of cavity expansion and cavity outlet compression. "Pushing" and "blocking" are like a pair of partners. Pushing is the source of force, "blocking" is reacting upon "pushing" and how much force is needed for the "pushing" will lead to the production of how much force for the "blocking", the "blocking" will never leave the "pushing" on its own. Conversely, the rationality of "pushing" completely depends on the effectiveness of "blocking". Once it loses the "blocking", "pushing" cannot be discussed. This fully explains the

reciprocal relationship between the "pushing" and "blocking" action and reaction, but because the "pushing" and "blocking" in performing and singing are based on the volume reduction of the cavity, that is to say, the reciprocal relationship between them is based on the stable output of airflow, which gradually reduces the volume of cavities in performing and singing, and this has become a natural phenomenon. However, in the process, whether the lack of expansion in the cavity or the cavity outlet being too large will cause the breath out of control. Therefore, reasonable "pushing" and "blocking" are the concrete embodiment for the establishment of the "dynamic system" in the performing and singing, and they are also the root for the reasonable vocalization of performing and singing.

### IV. Conclusions

The concept of "dynamic system" in vocal, wind instrumental performing and singing is not first proposed. It has been gradually developed and perfected by the author on the basis of long-term practice of blowing and theoretical research and drawing on previous experiences. This paper re-discusses "air pushing" and "air blocking" on the level of vocal, wind instruments and singing, and uses the basic principles of fluid mechanics to further clarify, summarize and sum up the force exertion characteristics of these two functional systems. Seen from the outside, it seems to be more "physical". In fact, it is the only way to achieve "natural"vocal, wind instruments performing, singing control force exertion and its vibration. The basic principle of fluid mechanics tells us that the so-called "control" is nothing more than conforming to the internal laws of the force exertion trend of cavities and the vibration vocalization of sound sources, eliminating one-sided factors in individual subjective consciousness and impeding the control for performing and singing, and making the control return to being "natural" and achieving the "natural" force exertion, the "natural" vocalization is the ultimate result of perfecting the performing and singing techniques. The reconstruction of the "dynamic system" not only lays an important theoretical foundation for the establishment of an overall view of control in vocal, wind instruments performing and singing, but it also has a new beginning for unveiling the mystery of the human body force exertion.

#### Note:

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