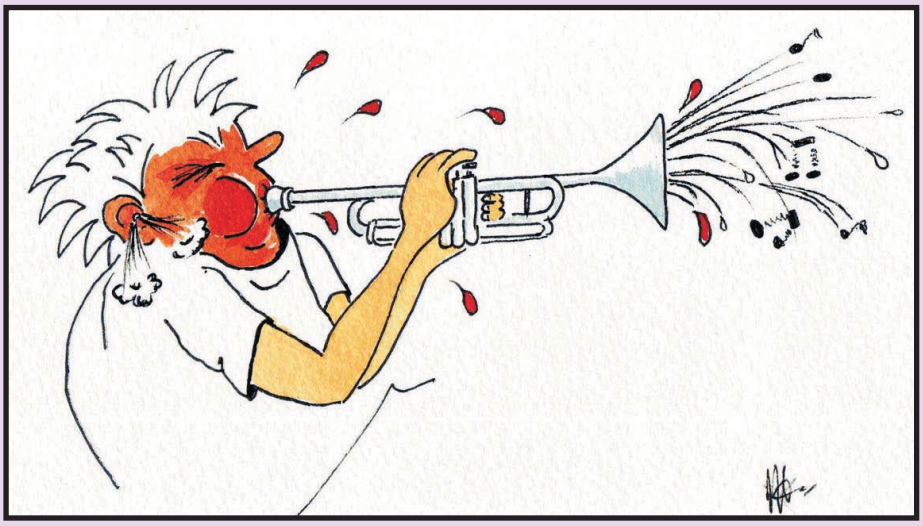
GETTING TECHNICAL

You don't have to blow to make a note!

Dr Richard Smith



Brass players usually believe, quite mistakenly, that they must literally blow the sounds out of their instrument. This is a natural and very common misconception. Fred Fox, 1974[1].

Without any evidence, instrument (and mouthpiece) manufacturers go overboard in describing how their specially designed tubes can improve *air-flow,* presumably on the assumption that this is an essential feature of instrument design. Nothing could be further from the truth. Examples found on the web pages of one manufacturer include:

'Perfectly rounded tubing (which is pressure formed) results in less turbulence and a smoother air flow, thus allowing for an excellent scale and reduced resistance.'

Other manufacturers, for example, refer to the Venturi in the mouthpipe and how the airstream in a mouthpiece forms vortexes. This is pseudo-scientific "fluid-dynamic-speak" normally used in a branch of engineering which studies the flow of gases or liquids through a tube from point A to point B. If it was just a matter of a blast of air going from the mouthpiece to the bell (as shown in the cartoon above), this description might have some validity. However, in reality, the creation and transmission of sound in a brass instrument is much more subtle. This article will show with some simple demonstrations how these erroneous beliefs can be dispelled.

What are the facts?

1. The mouthpiece

When playing a note normally, the air from the player's lungs is modulated by the vibrating lips. Apart from the player's air control, the ease of creating this vibration is largely dependent on the dimensions of the mouthpiece throat which acts as an 'air spring' for the lips to vibrate against. These dimensions are very specific and personal for each individual player. This is the main reason why Smith-Watkins offer a series of leadpipes to balance the instrument to the player's chosen mouthpiece. It is sufficient to say that many players know to their cost the consequences of tampering with the throat size. However, at the end of this article I will show that under special conditions it is possible to remove the conventional throat of a mouthpiece, and the notes can still be played!

2. The two types of airflow

Figure 2 shows the two components of air leaving a standard mouthpiece.

The direct component (shown as 'd.c.' in the diagram) moves in only one direction. Once it has made the lips vibrate, d.c. plays no further part in the sound production. I recall seeing a Renold Schilke demonstration showing that if smoke is exhaled during note playing, only a trickle of smoke comes out of the bell. This is the spent d.c. flow.

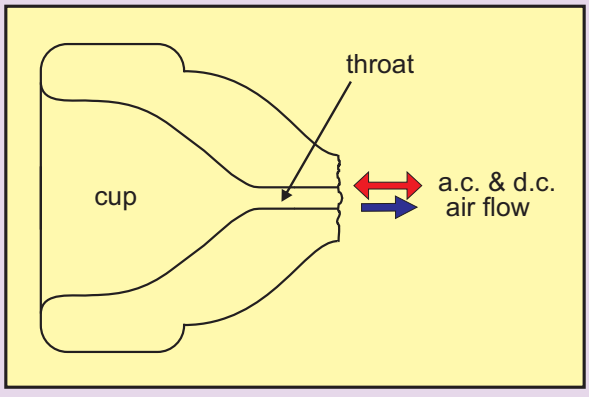


Figure 2. Section through a brass instrument mouthpiece.

The alternating component (shown as 'a.c.') moves the air particles backwards and forwards, creating a wave which travels through the length of the instrument at the speed of sound (that is faster than a jumbo jet). Air does not rush from one end of the instrument to the other - indeed if it did, a brass section would be quite draughty! Schilke, in his Brass Clinic[2], succinctly states: *It is not necessary for the air to move through the instrument any more than an energy impulse created by dropping a stone in water causes the water to actually move.*

Another analogy is in the 'Mexican' wave, in which the human 'particles' move very short distances vertically whilst the wave travels round a stadium faster than anyone can run. In a real brass instrument, this is a longitudinal wave of energy that is travelling at the speed of sound (350 m/s or 780 miles per hour) - far faster than any air particles you can blow into the instrument! In fact, the air particles in a trombone move only 1mm side to side when played *fortissimo*.

3. Are you a sucker?

Another simple demonstration showing that air need not go into and through an instrument is that many people can whistle by inhaling, giving a sound which is no different to that generated from exhalation. This idea can be extended to a brass instrument in which it is possible to create lip buzz by inhalation. After demonstrating this effect during one of my talks, I now know of many players, after years of practice, who can play music perfectly in tune and with all dynamics by sucking instead of blowing, using their normal instrument and mouthpiece!

Warning: if you were to try this at home, be aware of the fumes from valve oil and other debris inside your instrument!

The Ultimate Experiment

So far we have mentioned two ways in which a standard instrument and mouthpiece can be played. By blowing and sucking. In both cases, a similar sound wave is created which is independent of the direction of the d.c. air flow.

A third way to play a note is the

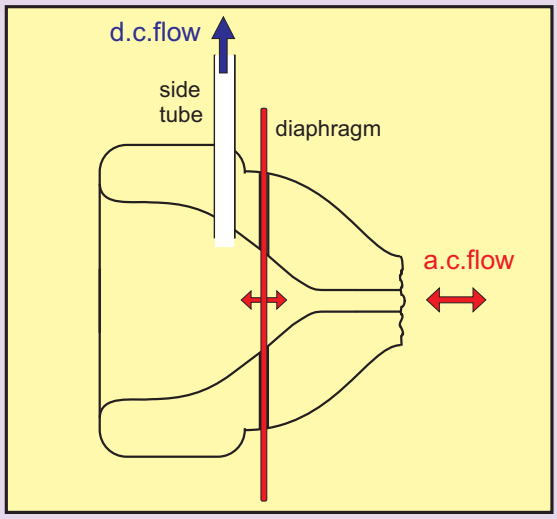


Figure 3 Mouthpiece with a diaphragm across the bore.

ultimate experiment devised to show that NO air needs to go in or out of the instrument to play that note.

I have described how the air through the mouthpiece is a combination of two components, a.c. and d.c. Readers familiar with electronic circuits will appreciate that it is theoretically possible to de-couple or separate these two components. Acoustically, this seemed to be a difficult challenge until I realised that the a.c. part of the air could be transmitted through a membrane - as for example with the ear drum, but at the same time would be impervious to the d.c. air flow.

Figure 3 shows a trombone mouthpiece which is cut into two parts with a membrane inserted between them. After trying various materials, condoms proved to be the most reliable material available for this purpose!

The d.c. component could then be directed through a side hole where it played no further part in the sound production but allowed the player to breathe. This sounded good in theory, but in practice it did not work. The side hole on its own did not give enough resistance to help the lips vibrate and reducing the size of the hole made the airflow difficult. The answer was to solder a tube similar to a 'throat ' onto the side hole. This device now worked well and notes of the correct pitch could be played. It was also apparent that the original throat in the mouthpiece was now redundant so it was drilled out to the instrument's bore size (0.5 inch) as shown in Figure 4.

When blown, the modified mouthpiece showed no adverse change. If anything, the output from the instrument was greatly improved. Although the player could still tongue notes in the normal way, the air coming out of the side tube could now be stopped and opened with a finger to simulate the effect of tonguing, and to impress the audience even further, an electrically operated air valve (e.g. a rotary valve on an electric drill) could be arranged to give the world's fastest possible repeating note!

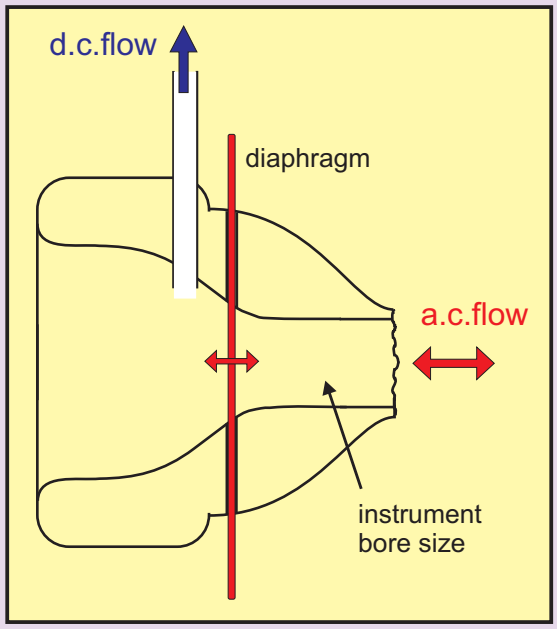


Figure 4. The same mouthpiece with enlarged throat.

Conclusions

These demonstrations give us some insight into the important factors affecting the way we play our instruments.

1. The lips vibrate because there is a flow of air from the lungs and an 'air-spring' in the mouthpiece throat for them to bounce against.

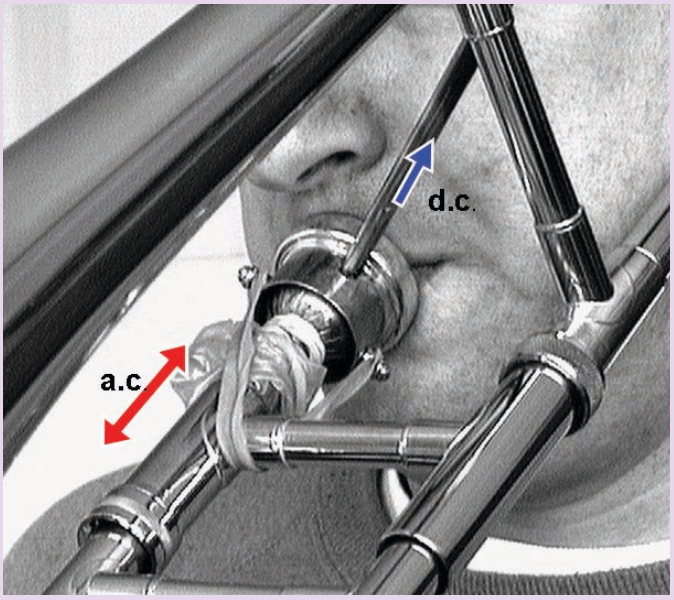
2. There is an optimum throat volume for each player. Deviating from this will make note production harder.

3. The air in the mouthpiece has two components, direct and alternating, which can be separated with a special mouthpiece.

4. The d.c. component only serves to keep the lips vibrating and does not need to enter the instrument. Also it does not matter in which direction it flows. An instrument can be 'blown' or 'sucked'.

5. The a.c. component is the source of the wave which travels down the instrument bore at the speed of sound. The wave is reflected at the bell and returns to the lips, and if the conditions are right, a standing wave or note will be produced.

6. The air particles only move 1mm for a *fortissimo* note and unlike the wave, do not travel down the instrument.



Separating the a.c. and the d.c. components.

Footnotes

After some recent correspondence, Ben Peterson (a trumpet teacher from Illinois) has been able to make a similar demonstration on the much smaller trumpet mouthpiece.

Thanks to John Clarke for drawing the cartoon.

References

[1]Essentials of Brass Playing

by Fred Fox. *Alfred Publishing Co. ISBN 0-913650-03-X*

I gain much of my inspiration from the work and teachings of Fred Fox. Apart from teaching some of our most eminent players, he was formerly the Solo French Horn of the National and Minneapolis Symphony orchestras and the Los Angeles Philharmonic. Fred is not only an outstanding practitioner of his instrument, but also able to give an explicit and logical approach to the basic factors that contribute to superior brass instrument performance. Highly recommended.

[2] Schilke Brass Clinic by Renold Schilke. http://www.dallasmusic.org/schilke/Brass%20Clinic.html