PHY-2464
Physical Basis of Music

Presentation 17

Brass Instruments

Adapted from Sam Matteson's
Unit 3 Session 29
Sam Trickey
Mar. 13, 2005

PHY-2464 Pres. 17 Brass Instruments

Brass instruments:

- ***Characterized by "buzzing" the lips in a mouth piece***

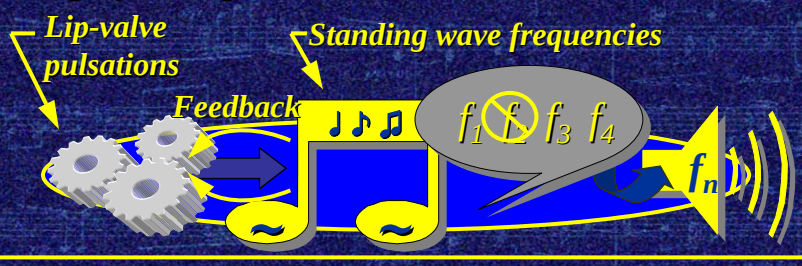
- ***KEY FACT –***
Pipe is closed at mouthpiece end to an excellent approximation

- ***There are valved and valveless brass instruments***
- ***There are "brasses" made with little or no metal.***

Brass Instruments of the Orchestra

Brass Instruments

- The lips produce a pulsation in the <u>pressure</u> admitted to the pipe. The pressure standing wave feeds back to control oscillations of the player's lips.



The Origins of Brass:

Ocleidex

Shofar

Sackbut

Serpent

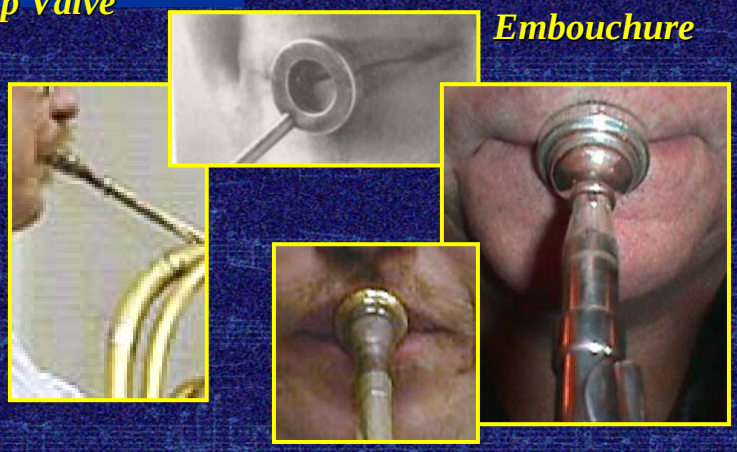
The Lip Valve

Brass instruments are played by the player's lips.

Breath pressure, muscle tension, and pressure feedback from the pipe determine the frequency of the opening and closing of the lips.

Louis Armstrong – trumpet (1901-1971)

Lip Valve



Embouchure

Lip Valve

- *The lips of the player act as a valve that admits pressure pulses into the pipe.*
- *The frequency is determined by the breath air pressure, the lip tension and the resonances of the pipe.*

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Brass Instruments are stopped pipes.

- *The player's lips produce a displacement node (pressure antinode) at the mouthpiece.*
- *A displacement anti-node (pressure node) exists at the bell.*

Winton Marsalis
Trumpet

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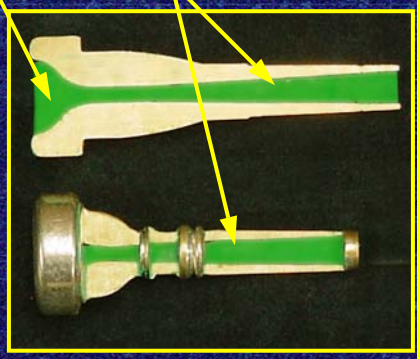
The elements of a valveless brass instrument are illustrated by the Hosaphone™

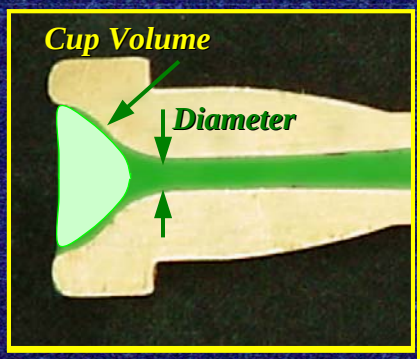
http://roth-music.com/hosaphone

The Mouthpiece

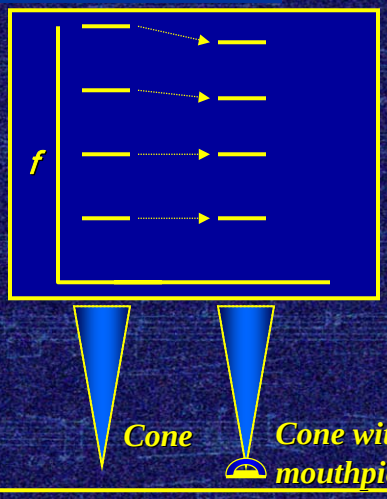


The Mouthpiece

The cup volume and the diameter of the constriction leading to the back bore are more important than the shape of the cavity.



Resonance for Combination Pipes



The Brass mouthpiece lowers the high frequency resonances.

The pitch is changed by pipe length and excitation of resonances.

By means of slides and valves the length is changed.

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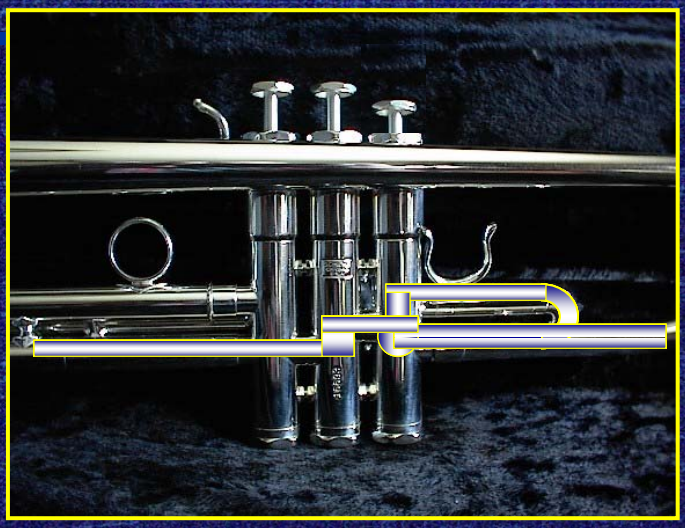


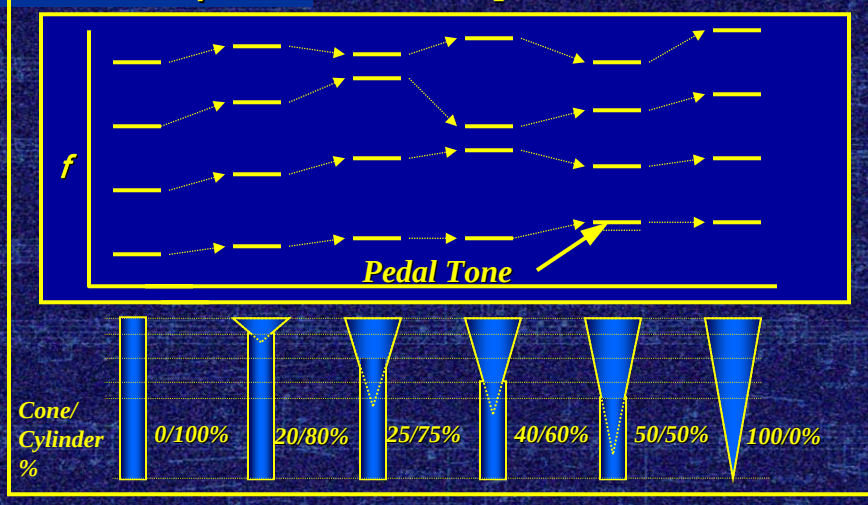
PHY-2464 *Pres. 17 Brass Instruments*

Horns can be played by exciting the resonances only.

The "Natural Horns"

No valves (a coiled hosaphone™)

Resonance for Combination Pipes

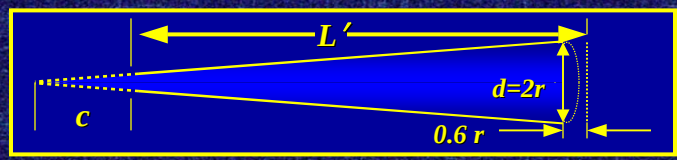


Recall Key FACT - For a stopped conical pipe

$$f_n \approx n\, v / 2(L' + c)$$

if $c << \lambda$

$$L' = L + 0.6\, r$$



Resonances for Combination Bores in Brass Instruments

Key FACT: A 50% cylindrical - 50% conical bore has a nearly harmonic series.

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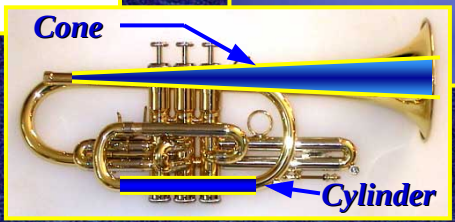
Cylindrical-Conical Instruments

French Horn

Trombone



Cornet

Trumpet-like Instruments

Various instruments have different lengths of cylindrical and of conical pipe.

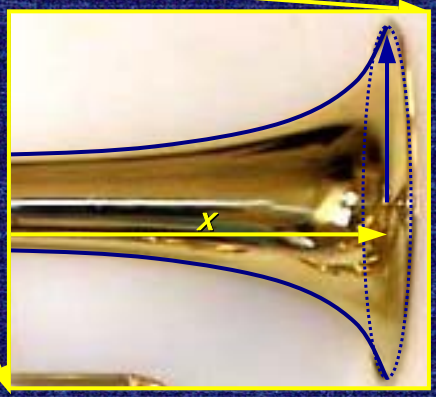
Cornet

Flügelhorn

Trumpet

The Bell

Exponential Horn



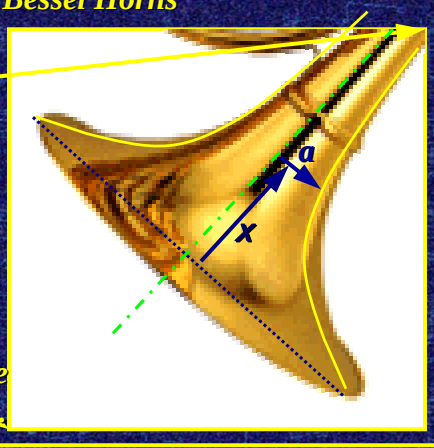
$a = a_o \exp(m\,x) + b$

"m" is called the "flare constant."

Larger m means more rapid flare.

The Bell

Bessel Horns



$a = a_o\, e^{-(\varepsilon x)} + b$

Called "Bessel Horns" because the standing wave follows a Bessel Function.

Summary

- Brass instruments are stopped pipes
- The pipe bore is a combination of cylindrical and conical or flared, designed to give resonances that are harmonic.
- Brass instruments are excited by lip-valves.
- The player's lips are a soft reed.
- The pitch is determined by feedback from the resonances of the pipe.
- The pitch is changed by exciting various overtones and by changing the length of the pipe.