

Physics of Musical Sound

Brass Instruments II
Class 18
Read Chapter 11
Exam Friday

8/30/01

Physics 120

Changing the Note

- Have to alter length of tube. Two methods available
 - Slides/Valves change physical length of tube
 - Trumpet, French Horn, all the Cornet/Tuba family use valves.
 - Trombone and rare slide trumpet use a slide.
 - Sound always comes from complete tube so that tone color is quite constant.
 - Can only put into a straight section of tube!
 - Holes can shorten acoustic length of tube
 - Cornett (2 T's), Serpent use simple holes
 - Keyed bugle, Ophicleide use keywork
 - Tone color is much less even over range. Obsolete.

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Physics 120

Brass Instruments

- Two basic families with rather little difference in tone
- Straight tubes with some conical or flared sections
 - Trumpet, Trombone, American Baritone horn
 - Brighter sound. Used in orchestras where brightness is needed to cut through mass of other instruments.
- Conical tubes with some flared or otherwise slightly altered sections
 - Cornet, Flugel horn, alto horn, French Horn, Euphonium, Tubas
 - Mellow sound. Used in ensembles (brass bands, silver bands) where the sound blends better than trumpets etc. would.

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Physics 120

Open or Closed tube?

- Bugle calls show that the available notes from a fixed length tube form a complete harmonic series (missing the fundamental)
- Lip reed must operate into a high impedance, high pressure anti-node of the pipe and should give an incomplete series!
- Flaring bell alters the effective length of the tube for different frequencies and alters the pattern of partials.

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Brass Instruments

- Lip reed
 - Player can alter tension in lip over a very wide range. Gives the player control over natural frequency and over Q not available to other reed players.
- Mouthpiece
 - Surface to rest lips, resonator chamber with a sharply constricted opening, conical tube to match to bore of instrument
- Leader pipe on Trumpet
- Body tube
 - Basically straight or basically cylindrical according to family.
 - Length determines pitch of instrument. As usual, the longer the tube the larger the bore to allow low frequencies to get out.
- Bell
 - Couples tube to the outside world.

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The Bell

- Produces a high-frequency cut-off.
- Makes tube have different length for low frequencies, which reflect early in the bell, and high frequencies, than high, which travel somewhat further before reflecting.
- Effect is to raise lower partials relative to upper ones, altering the 1, 3, 5, 7, relationship.

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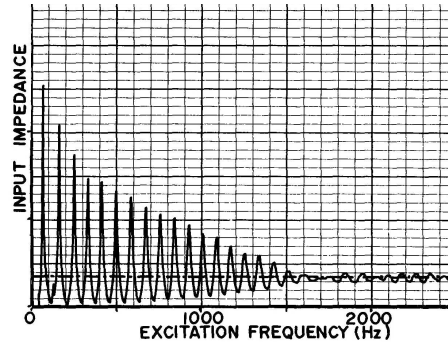
The Bell

- Varying tube diameter makes different frequencies reflect at different points in bell.
- Low frequencies reflect early in the bell.
- High frequencies travel somewhat further before reflecting.
- Effect is to lower higher frequency modes relative to upper ones, altering the 1, 3, 5, 7, relationship.

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Modes in Flared Tube



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Effect of Bell on Modes

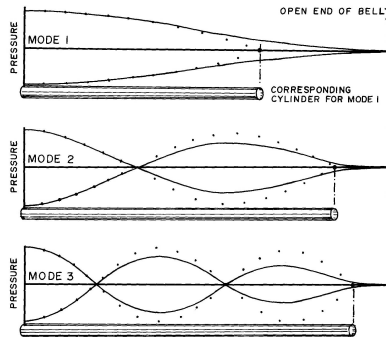


Fig. 20.8. First Three Characteristic Shapes of the Pressure Distribution in a Flaring Horn
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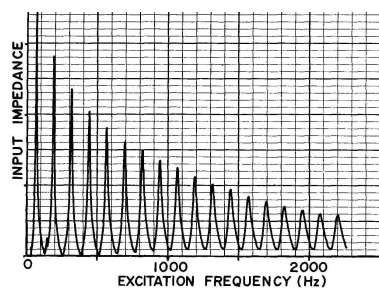
The Mouthpiece

- Has natural "popping" frequency around 850Hz. Broad resonance.
- Extra volume of mouthpiece pulls down some of the upper partials.
- By itself it does not strengthen the lower resonances enough to make them sharp, can still slide note around with the lip.

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Modes in Straight Half-Closed Tube



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Mouthpieces

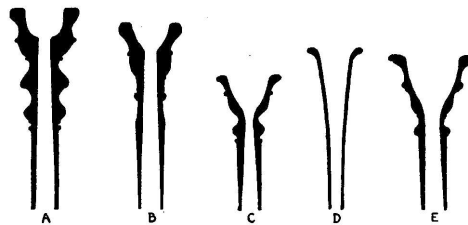


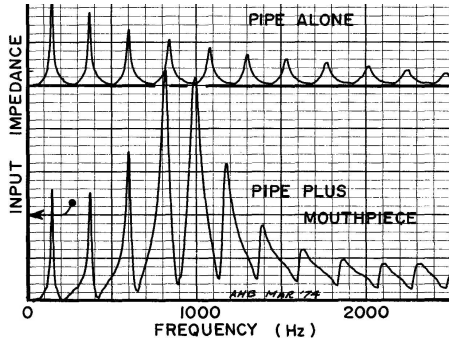
FIG. 2.—A. Old trumpet. B. Modern trumpet. C. Cornet. D. French horn. E. Trombone.

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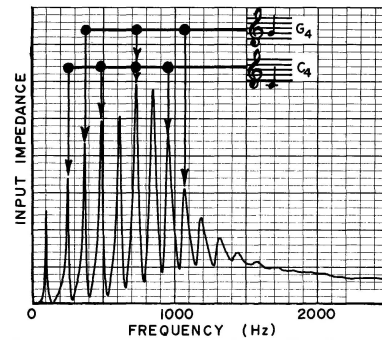
Fig. Carse, Musical Wind Instruments

Effect of Mouthpiece



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Low Trumpet Notes



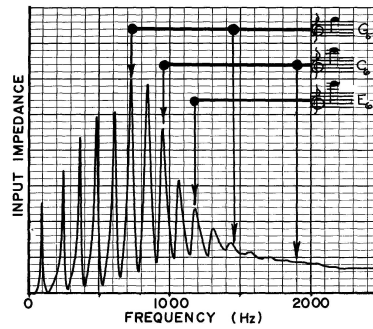
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Combined Effect

- Bell Raises lower modes
- Mouthpiece Lowers upper modes
- Result is nearly harmonic set of modes except for the lowest
- Lowest mode is significantly out of tune with others and does not give an easily playable note.

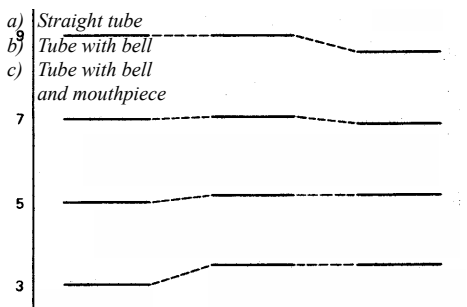
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Upper Trumpet Notes



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Resulting Brass Modes



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