III

THE

BRASSES

GENERAL CONSIDERATIONS

Organologically, brass instruments belong to the category of *lip-vibrated aerophones*, a term that correctly emphasizes the way in which the air column is set in motion rather than the material of which the instrument is made. Although most "brasses" are in fact made of brass, they may be constructed of some other soft-metal alloy, and some cheap instruments are even made of fiberglass. The sound of all these instruments is produced by the vibration of the player's lips when air is forced between them, and it is this that gives them their "brassy" tone quality.

ACOUSTICS AND MECHANISM

Acoustically the brass are very similar to woodwinds. All behave as stopped, conical pipes, and thus share many tonal properties with the saxophone, oboe, and bassoon. They are all, however, built to a much narrower scale than any woodwind; this property enables the player to overblow (by tightening the lips to a greater or lesser extent) a great many more partials than are available on a woodwind, while simultaneously making the fundamental (called "pedal" by brass players) difficult to produce. Figure 35 shows the various partials that may theoretically be used by an alto or tenor brass instrument pitched in C. For instruments built in other pitches, this pattern should be transposed up or down by the appropriate interval.

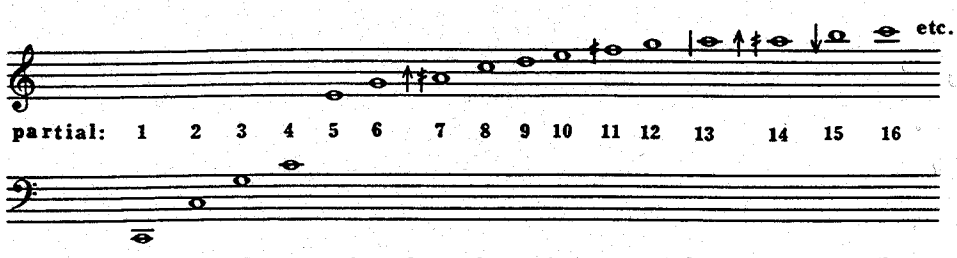


FIGURE 35. *Notes produced on a brass instrument by overblowing* C_0.

In reality, only the horn makes regular use of all of these partials,* but even on the relatively inflexible trumpet all partials from the second to the ninth are used in the normal course of play.

Note that *all* these notes are produced by the lips alone. If one ignores the fundamental, the largest gap between any two adjacent partials is only a fifth, and all that is necessary to give a brass instrument a completely chromatic range from the second partial up is some means of producing the six tones between the second and third partials; these six tones can themselves then be overblown to fill in the other gaps. The trombone's movable slide fills the gap with elegant simplicity: by pushing out the sliding portion of tube, the instrument as a whole is lengthened by the extent necessary to lower the pitch any amount up to six semitones. Thus, with the slide drawn all the way in, the notes $B\flat_1$, $B\flat_0$, f^0, $b\flat^0$, etc., can be produced with the lips alone; while with the slide slightly extended the pitches A_1, A_0, e^0, a^0, etc., can be produced, and so forth.

Brasses other than the trombone effect a similar lengthening of the tube by means of a system of **valves**. These valves operate so that when a lever is depressed, the windway, rather than running straight through the valve, is shunted through an extra length of tubing. This is accomplished by one of two rather different mechanisms. The **rotary valves** usually found on horns (Fig. 36) are internally simpler than the **piston valves** (Fig. 37) usual in trumpets, but rotary valves require a complicated and delicate mechanism for converting the linear motion of the valve spatula into the rotary motion of the valve itself. Both types of valve are returned to their "off" position by a spring when the spatula (rotary valve) or button (piston valve) is released. The **valve tubing** added to the windway when the valve is depressed is fitted with a movable section (like the slide of a trombone) by means of which the pitch of the valve can be adjusted. A similar **tuning slide** in the main part of the instrument enables the player to tune the instrument as a whole.

Typically there are three valves, arranged in a row and placed so as to be operated by the middle three fingers of the right hand (the horn is played left-handed). Of these three valves, the first (operated by the index finger) lowers the pitch of the instrument by a major second, the second valve lowers the pitch by a minor second, and the third lowers the pitch by a minor third. The valves can be used either alone or in combination; when all three are depressed together, the pitch is lowered a minor third plus a minor second plus a major second, i.e., a tritone. However, since the length of tubing needed to lower the pitch by a given amount is a function of the length of tubing already in use, a valve that is perfectly in tune when used by itself will be slightly sharp when added to a tube already slightly lengthened by the depressing

* Even on the horn the quarter-tone seventh, eleventh, thirteenth, and fourteenth partials are usually avoided.

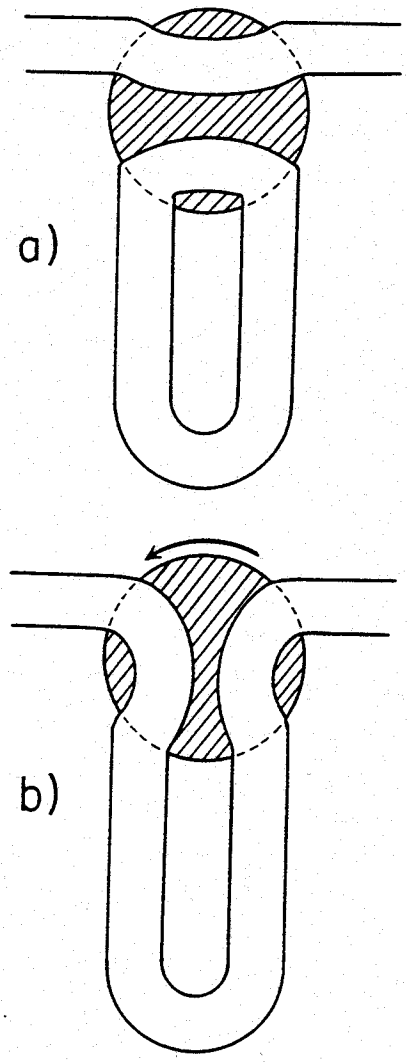


FIGURE 36. *Diagrammatic cross-section of a rotary valve: (a) closed; (b) open.*

of another valve. This discrepancy is not important when only two valves are considered, but when all three are depressed the combined sharpness is severe. To solve this problem, the third valve is tuned so as to be perfectly in tune when combined with the first valve. This results in acceptable intonation for the combinations 2 + 3 and 1 + 2 + 3, but leaves the third valve badly flat when used alone. Thus the fingering system shown in Figure 38 is produced. Where absolutely necessary the third valve *can* be used by itself to replace the combination 1 + 2—for instance, if in the example in Figure 38 one were to trill from g^0 to a^0. In trumpets a ring or (less commonly) a lever attached to the third-valve slide and operated by a finger of the left hand allows for instantaneous adjustment of the third valve in all combinations. Sometimes this mechanism is attached to the first valve as well or instead. Partials above the third are separated from each other by smaller and smaller intervals, so that as the scale is ascended, more and more notes have alternative fingerings. The third valve is not used at all when it can be avoided. Notes produced without depressing any valves are called **open** notes, and by analogy notes produced on the trombone with the slide pulled all the way

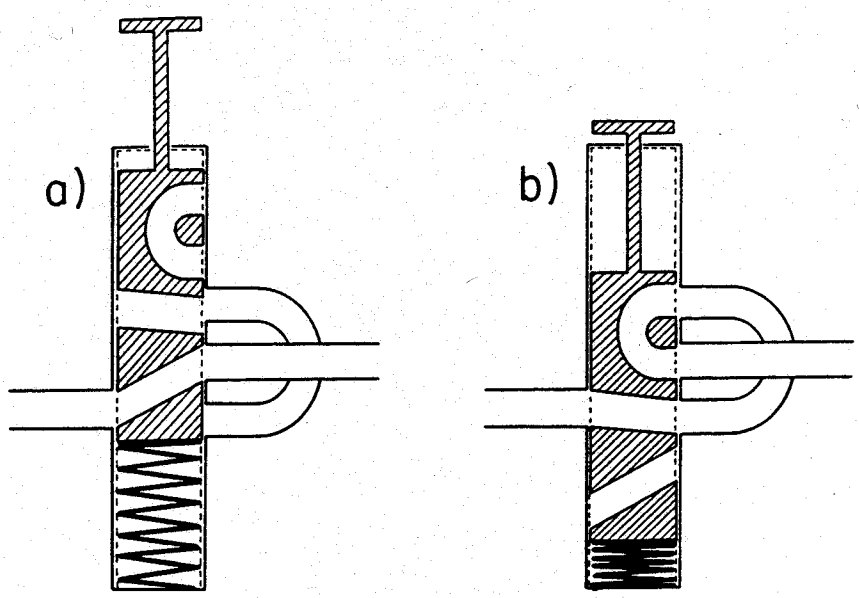


FIGURE 37. *Diagrammatic cross-section of a piston valve: (a) up; (b) down.*

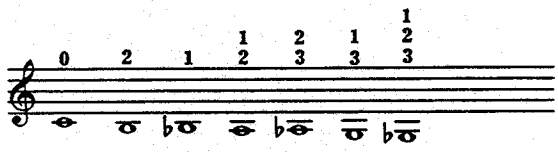


FIGURE 38. *Normal fingering system of three-valve brass instruments.*

in are also called open. Exceptions to this basic three-valve fingering system (and they are numerous) will be covered as they arise in the discussion of the various instruments.

A brass instrument that normally reads in the treble clef will be written for as a transposing instrument if its open fundamental is any note other than C. Those whose parts are usually written in the bass clef are invariably non-transposing.

TIMBRE AND ARTICULATION

The brasses are timbrally a much more homogeneous group than the woodwinds, differing no more among themselves than do the various conical reed instruments. The tone is affected mostly by the bore, which may be narrowly conical (horn), mostly cylindrical (trumpets and trombones), or broadly conical (tubas). Trumpet and trombone differ only in that the one has valves, the other a slide. Another factor affecting the timbre is the internal contour of the mouthpiece (Fig. 39). Funnel-shaped mouthpieces give a smooth, mellow tone, while cup-shaped mouthpieces produce a more brilliant and cutting sound. In practice, all modern brass mouthpieces are compromises between these extremes, with horn mouthpieces tending to be funnel-shaped, trumpet mouthpieces cup-shaped, and tuba mouthpieces somewhere in between. Most players own several different mouthpieces with slightly differing contours for use in different musical circumstances.

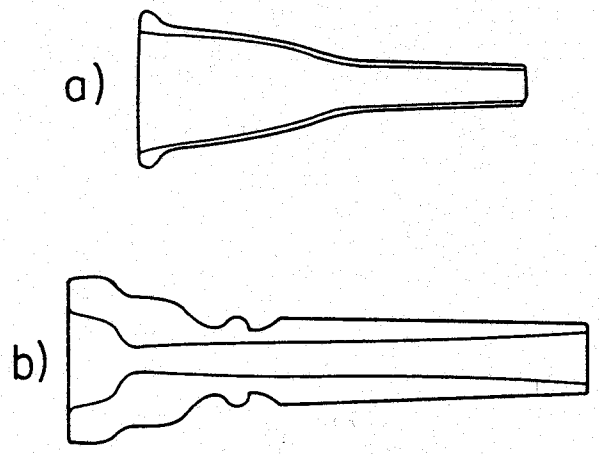


FIGURE 39. *Extremes of brass-instrument mouthpiece shape: (a) funnel-shaped; (b) cup-shaped.*

	PLAYER CAN USUALLY DOUBLE						
player's main instrument	piccolo trumpet	flügel-horn	tenor trumpet	alto horn	bass trumpet	baritone horn	contrabass trombone
trumpet	●	●	●	●	●		
horn				●		●	
trombone					●	●	●
tuba						●	●

FIGURE 40. *Common brass doublings.*

The more unusual brass instruments are usually handled by players of an instrument of similar size (depth of pitch), regardless of whether the instrument is of the trumpet, horn, or tuba type. The most common doublings are given in Figure 40. One should allow at least ten seconds for a player to switch instruments, and preferably thirty seconds or more to allow him or her to warm up the new instrument before playing it.

Articulation in brass instruments is very similar to that of the flute: notes are tongued by forming the consonant "d" or "t"; double-tonguing ("tktktk") is used for rapid detached notes, and fluttertonguing is available as a special texture. As with woodwinds, care should be taken to differentiate notationally between slurred fluttertongue notes ( ) and detached ones ( ). In addition to these articulations, brasses can start a tone with the sound "p." Tones are cut off as with woodwinds, by simply stopping the breath; in addition, they can be cut off with the tongue as a special effect.

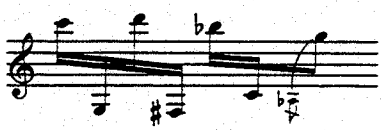
A brass instrument requires slightly more air to produce the tone at a given dynamic level than does a woodwind of similar pitch, so the player must breathe somewhat more frequently. The horn is the most acoustically efficient in this regard, comparing favorably to the

various tenor woodwinds; the contrabass tuba, on the other hand, requires more air than any other wind instrument, but a single soft, mid-range note can be held for twenty seconds or more. Cyclic breathing is as much of a possibility on brass instruments as on woodwinds. Remember that few players have mastered this difficult technique. It is also possible to play a brass instrument on the inhale, but the tone will be a bit coarse, and the highest and lowest notes of the range cannot be played thus.

Although brass instruments have broad dynamic ranges, they are most comfortably played *forte* and must be carefully scored when combined with strings or woodwinds. If the absolute maximum loudness is desired, one may instruct the player to direct the sound upward and outward with the instruction "bell in the air" or "campana in aria." At the highest dynamic levels (*ff*, *fff*) a special blaring quality can be obtained from the brass. The instruction for this is the word "brassy" or "cuivré." This technique is discussed in more detail in the section on the horn.

Brass players normally use a vibrato only when playing solo passages of a lyric character. If the presence or absence of vibrato is particularly desired, an indication to that effect should be written into the part. As with woodwinds, the speed and amplitude of the vibrato are variable.

The pitch ranges of brass instruments are not sharply delineated at either end. It is probably not much of an exaggeration to say that on any one of the brass instruments it is *possible* to play any pitch from the highest note of the piccolo trumpet to the lowest note of the contrabass tuba. One does, however, reach a point of diminishing returns: at the high end of an instrument's range, the partials begin to lie so close together that the player cannot be certain of pinpointing the correct one with the lips, and at the other end of the scale the tube exercises so little control over the player's lips that "any note can be played from any fingering," and intonation becomes extremely problematic. Even in the middle of the range the lips exercise tremendous control over the pitch, both through lipping notes up and down (particularly low ones) and through selecting the precise partial to overblow. Because of this, brass players must, like singers, have a good idea of what the note is *before* an attempt is made to play it; and because this is most crucial at the ends of the range, sudden leaps from one extreme to the other are likely to result in cracked or burbled notes. A passage such as:



is impossible to play on any brass instrument.

Because of the great control exerted by the lips over the pitch, a brass instrument can easily produce quarter-tones throughout its range.

A trill executed on a brass instrument is one of the fiercest sounds imaginable. Trills can be produced with the regular valve fingerings, with the special third-valve fingerings mentioned above, or, in a few cases, with the lips. These **lip trills** can only be executed between partials, such as the eighth and ninth, that lie a second apart.

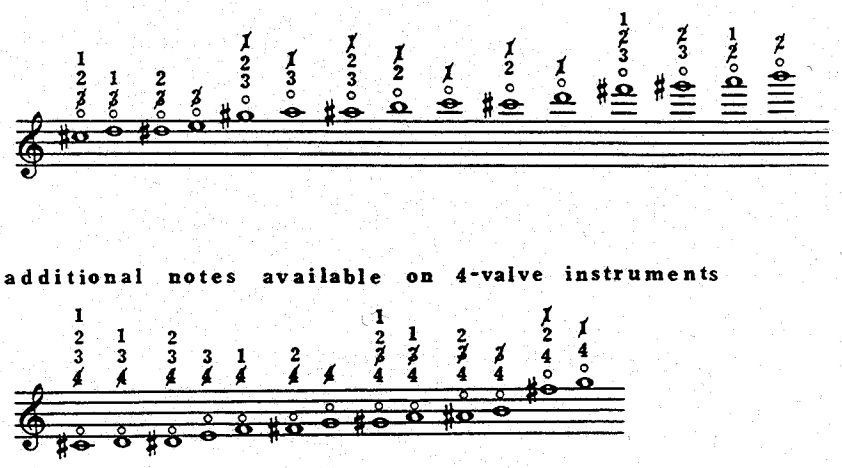
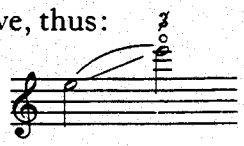


FIGURE 41. *Fingering chart of half-valve octaves, calculated for an instrument whose open fundamental is C_0. A slash through a number indicates that the valve in question is to be half-valved.*

SPECIAL EFFECTS

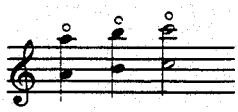
By depressing one or more valves only halfway, a peculiar strangled sound can be produced. This **half-valve technique** is most useful in the production of glissandos and microtones but can of course be used simply as a special timbral effect. Curiously, the greater the amount of valve tubing involved, the more normal the instrument will sound; thus, if the second valve alone is used to create the effect the sound will be extremely weak, thin, and pinched, while if all three valves are used together the tone will be only slightly muffled. Half-valving depresses the maximum dynamic level that can be attained, and in the most extreme case (when only the second valve is half-valved) the player cannot exceed *mezzo-piano*.

Under certain conditions, the depressing of a valve *exactly* halfway will cause the pitch of the instrument to leap exactly an octave. This occurs wherever a note can be produced either with a valve up or (on a neighboring partial) with the same valve down. When the valve is depressed only halfway the higher octave is produced, because the acoustically ambiguous state into which the windway has been thrown suppresses all the odd-numbered partials of the specific pitch being produced; in effect, a second-partial "harmonic" of that pitch is generated. Those who are by now utterly confused may avail themselves of the fingering chart in Figure 41, which is based on a hypothetical instrument whose open fundamental is C_0 but which is of course transposable up and down the scale. Despite their extreme altitude, these half-valve notes can be played on any given instrument with *exactly as much effort* as the normal note an octave lower. In fact, since the removal of the odd partials occurs *after* the tone has been created by the lips, the player may not even be aware that the octave has been leapt. These *half-valve octaves* are tricky to produce on cue and are best avoided altogether on instruments whose open fundamental is higher than C_0. The best way to ensure that the octave will be produced is to start with the lower note, then have the player adjust the valve while playing to bring out the upper octave, thus:



If the player starts with the valve up, half-valving will cause the pitch of the note to drop slightly before leaping the octave. If, however, she or he starts with the valve down and raises it in order to half-valve, the pitch will *rise* slightly before the leap, thus giving the effect of a quick glissando or portamento between the notes.

There is no standard notation yet for half-valve octaves, but the "harmonic" symbol (a small circle over the note) used here seems logical. Because the portion of the instrument between the valve system and the player's lips continues to vibrate at the lower pitch, both notes will be heard (at about equal volume), and the notation



may therefore be preferred. Whatever notation is used must be explained to the player, and it would be wise also to provide fingerings.

Multiphonics can be produced on brass instruments in two ways. One way involves setting the lips exactly halfway between two adjacent partials, both of which will then sound, producing a smooth and mellifluous multiphonic. Unfortunately, this is a very narrow fence to sit on, and such multiphonics are difficult to produce reliably. The player should be given plenty of time to produce the sound, which can best be arrived at by playing one of the two notes and then bringing in the other. These multiphonics are best notated by the two pitches being written together as a chord.

The other type of brass multiphonic, easier to produce but less predictable in effect, involves setting one side of the mouth to produce one note while the other side is set to produce a different one. The result is an aggressive but not particularly harsh growling or whining sound. This type of multiphonic is also best produced by slur from one of the notes it contains; but if the exact sound produced is not critical, a brass player can come up with such a multiphonic on cue without slurring. These multiphonics are probably best notated simply by writing the instruction "multiphonic" and indicating the general pitch-level desired.

Multiphonics of both types can only be produced between the second and eighth partials, except on the horn, where the limits are the third and tenth partials.

As a special effect a brass instrument can be played with a double reed or with a single-reed mouthpiece. The double reed (bassoon reed for trombone, bass trumpet, tuba, and baritone horn; oboe reed for all others) can be inserted into the brass mouthpiece or replace it at the end of the instrument, the former procedure being preferable because the player can store the reed in the cheek until it is needed, then insert it with the tongue in less than a second. When the reed is used, the instrument will sound harsh and nasal and will have the dynamic range of a woodwind. The reed can be used to produce high-pitched squeals at and just above the top of the instrument's normal range, and, lower down, to produce some harsh, woodwind-type multiphonics. The instrument *cannot* be played normally with the reed.

The single-reed mouthpiece is a somewhat different proposition. Here, the brass instrument's mouthpiece must be replaced by a saxophone or clarinet mouthpiece of appropriate dimensions (the saxophone mouthpiece being tonally the more flexible). Two sounds can be produced with such a mouthpiece. One is a low rattle in the instrument's pedal range; the exact pitch produced depends on the mouthpiece, reed, and embouchure, but it can be varied across approximately a tritone by using various valve combinations or slide positions. The

other sound is a high-pitched squeal on approximately the pitch the mouthpiece would produce if it were unattached to the instrument. This squeal can be modulated across a number of the instrument's high partials (all sounding out of tune) so that a number of higher pitches can (not very securely) be produced; this must be done with the lips, since the valves have little effect on the sound. The squeal and the rattle can be combined as a multiphonic.

A number of other special effects common to all brass instruments should be mentioned here. **Popping the mouthpiece** involves striking the opening of the mouthpiece with the palm of the hand. The resulting pop has a clearly audible pitch, and when the various valve combinations are fingered the seven pitches of the instrument's fundamental can be produced by this means. This effect can be performed as loudly as *mezzo-piano*. The **valve flutter** is produced by very rapidly and unsystematically alternating the valves while controlling the pitch with the lips. The sound produced is an odd, fluttery burble, only vaguely pitched but quite strong in timbre. **Playing on the mouthpiece alone** produces a thin buzz with only slightly more character than the sound of the lips by themselves. The range of pitches that can be produced is the same as that producible by the lips without the mouthpiece. **Singing into the instrument while playing** is particularly effective on brass instruments, since the sound of the voice coming through the instrument is very similar to that of the instrument itself. Combination tones generated by the conflict of the two vibrating mechanisms may create the illusion that three- or four-part chords are being played. Simultaneous singing and playing is somewhat easier to do on low-pitched instruments, and is easiest to control when the sung and played notes have frequencies in simple harmonic ratio.

THE HORN

THE INSTRUMENT

The horn (now called "French horn" only when some ambiguity might arise from simply calling the instrument "horn") is the most smooth and mellow-sounding of the brasses. Its role has traditionally been to mediate timbrally between the woodwinds and the other brass, and to add unobtrusive body to the sound of the full orchestra. The mellow tone arises from the instrument's very narrow bore and funnel-shaped mouthpiece, and in the normal course of play is enhanced even more by the player's right hand being held in the bell of the instrument, where it muffles and dampens the sound. The position of the bell also assures that the sound is directed backward and to the right, i.e., away from the audience, and this too helps to "gentle" the sound. The instrument is designed to be played with the hand in the bell, and when the hand is removed the sound is not only coarse and trombone-like but very sharp in pitch.

The horn's extremely narrow bore emphasizes the production of very high partials, and the horn is easiest to play and sounds most characteristic in the upper two-thirds of its range. Parts for the instrument are therefore normally written in the treble clef, the bass clef being used only when the instrument dips into the lowest part of its range. Horn players are used to seeing notes as low as c^0 written in the treble clef, but are accustomed to reading in the bass clef up to written c^1 if necessary.

The horn is a transposing instrument, sounding a fifth lower than written in both treble and bass clefs. Prior to the beginning of the twentieth century it was, for no very good reason,

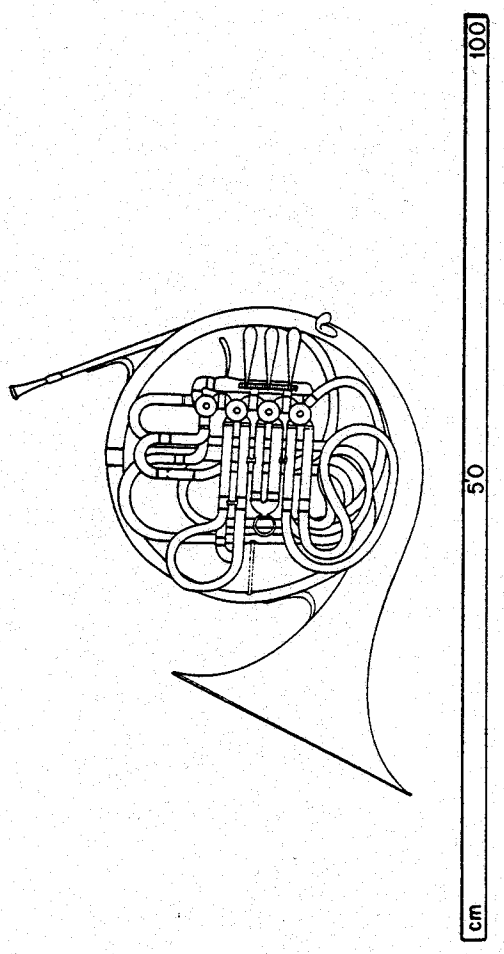


FIGURE 42. *The horn.*

name of instrument	*abbreviations*	*written range*	*sounds*	*open fundamental (actual pitch)*	*availability*
horn in f[0]	hrn. hr. hn.	loudest: *mf* — *f* — *ff* — *fff* softest: *pp* — *p*	a perfect 5th lower		common

FIGURE 43. *The horn—vital statistics.*

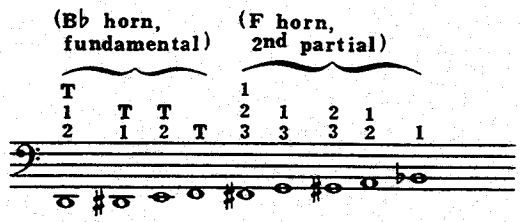


FIGURE 44. *Valve combinations for the lowest notes of the horn. T = thumb valve. Pitches are given as notated for the horn.*

universal practice when writing for the horn in the bass clef to notate the part an octave too low, i.e., a fourth down rather than a fifth up. Since the more logical modern practice did not become universal until quite recently, many twentieth-century horn parts are notated in the old system, and horn players are occasionally uncertain as to which system is intended even in brand-new works.

Except for some student instruments, all modern horns are **duplex instruments**: two horns, pitched a fourth apart, are placed side by side and share only mouthpiece, bell, and valves—even the valve tubing is duplicated. The switch from one of the two halves of the **double horn** to the other is negotiated by a valve operated by the left thumb: when this valve is depressed the shorter, B♭-horn side of the instrument is engaged and the pitch of the instrument is raised a fourth; when the valve is released the longer, F-horn side of the instrument takes over. It should be understood that parts for the horn are notated in f^0 for both sides of the horn; the additional transposition for B♭ horn is handled by the player.

The double horn was originally invented to help the intonation of certain notes and to make the highest notes more secure. Paradoxically, the addition of the B♭ horn to the simplex instrument in F also extends the effective range downward, since a number of pedal tones (= fundamental pitches) that can only be "faked" on the F horn can be produced clearly on the B♭ horn. The fingerings used for the lowest notes of the double horn are shown in Figure 44. All notes above the written $B♭_0$ can be played on either the F or B♭ side of the instrument. It should be emphasized that the use of the B♭ horn does not extend the range of the instrument upward: the highest notes can be played on both the F and B♭ sides of the horn—they are simply somewhat more secure on the B♭ horn.

PERFORMANCE CHARACTERISTICS

The lowest notes of the horn (up to written $B♭_0$) sound weak and flabby if they are forced, if they are played rapidly, or if they are dropped upon suddenly from above. But if well-prepared and played softly and slowly they can sound peaceful and serene, secure and in tune. Because of the very weak control exerted by the valves in this range, rapid runs or trills sound like so much mud—the player simply executing a valve flutter would achieve the same effect. By the same token, a sharp staccato is impossible in this range.

Between approximately written B_0 and c^1 the player has much more control, although rapid runs and trills still sound rather blurred. The sound of notes in this range is warm and vocal when they are played softly, but when they are played loudly their quality becomes covered, dark, and menacing.

The most characteristic timbre of the horn is that produced in the two octaves between written c^1 and c^3. This is one of the most physically beautiful of all timbres, beloved of many otherwise totally unmusical people, and is the subject of much Romantic hyperbole. Such blatant and easy gorgeousness has lately been out of fashion, and the mid-twentieth-century horn literature is accordingly rather small. One consequence of the horn's smooth, rounded timbre is that rapid legato leaps in either direction tend to sound like portamentos. This can be heard very clearly, for instance, in the "Market-place at Limoges" movement of Ravel's orchestration of *Pictures at an Exhibition*.

When the instrument is played *triple-forte*, the metal of the instrument begins to vibrate in sympathy with the air column and the sound becomes ringing, fierce, and clangorous. This effect, called by the French term **cuivré**, can also be forced by the player at a slightly lower (*ff*) dynamic level. The not infrequent demand for this effect at *all* dynamic levels by various (mostly French) composers does not reflect acoustic reality.

The notes above written c^3 (which not all players can produce) sound forced, strained, and thin at any dynamic level. The British firm of Paxman offers horns in F/high F and even a **triple horn** in F/B♭/high F to make these notes more accessible.

A special timbre, available only on the horn,* is that of **stopped** notes. By placing the right hand so that it almost completely blocks the windway, the acoustic characteristics of the instrument are altered so that (1) the pitches of all notes on the F horn are raised one half-step; and (2) the timbre becomes thin, buzzy, nasal, stuffy, and distant—in short, totally unhornlike. This effect sounds most distinctive when played *cuivré*. Stopping is notated with a plus-sign above each note affected, or by the word "stopped" (or its Italian equivalent, "chiuso") at the beginning of a stopped passage. It is canceled by a large "O" above the note (not the small "o" used to indicate harmonics) or by the word "open" or "aperto." Stopped tones should be written in f^0, like ordinary notes; the extra half-step transposition will be made automatically by the player. On the B♭ horn, stopped notes are raised by three-quarters of a step rather than a half-step, so quarter-tone stopped notes are easily produced. The pedal tones of the B♭ horn (which are not duplicated on the F horn) can be lipped the quarter-step into tune. Stopping lowers the maximum loudness of the horn by one dynamic level throughout its range; the minimum loudness also drops one dynamic level. Below about written $b♭^0$, stopped tones become increasingly uncertain in speech and intonation, particularly at the highest and lowest dynamic levels, and the stopped pedal tones are only barely negotiable. Low stopped notes can be produced more securely when a **stopping mute** is used instead of the hand. This mute seals off the windway and raises the pitch just as hand-stopping does, but has the disadvantage of requiring at least half a second of rest for its insertion or removal.

The ordinary horn mute (equivalent to the **straight mute** of trumpets and trombones) does not entirely block the windway. It is held in place by cork wedges on its sides, allowing the passage of some air between the sides of the bell and the sides of the mute. This mute changes the timbre of the instrument but has no effect on the pitch or dynamic range. The

* But see the discussion of Renaissance mutes in Part Two, and that of the plunger mute in the section on the trumpet.

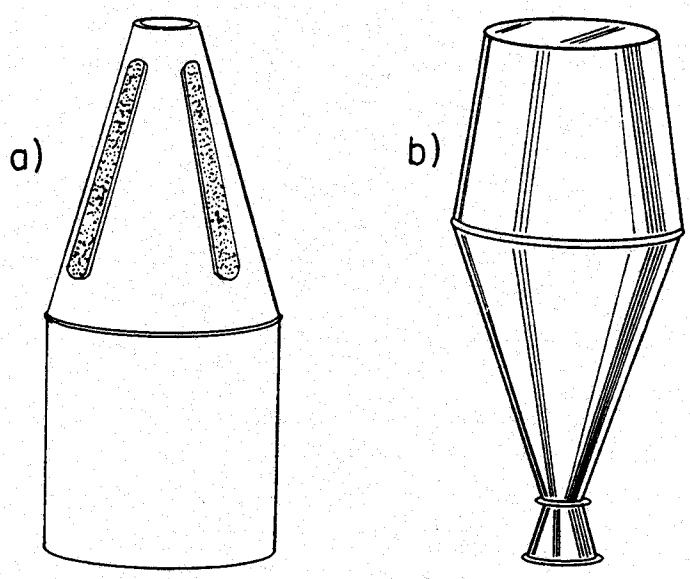


FIGURE 45. *Horn mutes: (a) regular mute; (b) stopping mute.*

sound of the muted horn is nasal and distant, without the thin stuffiness of the stopped horn sound (the right hand is of course not held in the bell while the mute is in place). Normally a couple of seconds of rest must be allowed to give the player time to pick up the mute with the right hand and insert it, and another couple of seconds, later, to remove it and put it down. If necessary, the mute can be held on a strap around the wrist, in which case it can be inserted or removed in as little as half a second. The instruction for muting is the indication "with mute" or the Italian abbreviation "con sord."; removal of the mute may be indicated by the instruction "via sord." at the spot where this occurs, but the indication "senza sord." immediately before the first unmuted note is more usual.

Subtle inflections of pitch can be performed on the horn not only with the lips but with the right hand as well. By the technique of **half-stopping**, in which the windway is closed off more than usual, but not completely as in full stopping, the pitch can be dropped any amount up to a half-step without affecting the timbre. This technique can be used to produce quarter-tones and half-step glissandos. Note that half-stopping *lowers* the pitch, while full stopping raises it. If the right hand is moved so as to gradually block the windway while a note is held, the pitch will slowly drop a half-step, then suddenly leap up a whole step, simultaneously acquiring the "stopped" timbre. True glissandos larger than a half-step can only be negotiated by the use of half-valve technique (the **valve smear**), in which one or more valves are partially depressed: the glissando is executed while the instrument is in this acoustically ambiguous condition. The resultant glissando will sound somewhat weaker in both volume and timbre than the notes that begin and end it.

For large upward glissandos, at least, a much more satisfactory sound can be obtained by means of the **lip gliss**, or **rip**. This is an upward slur across a number of partials, executed by the lips with or without any shift of valve configuration. It should be notated as a slurred group of notes, optionally with the added indication "gliss." to tell the player that the passage is meant to sound like a glissando. There are many such lip glisses notated very clearly in Stravinsky's *Sacre du printemps*. The lip gliss, valve smear, and half-stop may be combined.

Musical Examples

HORN:

Mahler, Symphony No. 4
Stravinsky, *Le Sacre du printemps*
Hindemith, Sonata for 4 horns
Varèse, *Octandre*
Nono, *Polifonica-Monodia-Ritmica*
Xenakis, *Anaktoria*

TRUMPETS

THE INSTRUMENTS

The trumpet family is not the tidy affair that Figure 47 would make it seem. Rather than five discrete sizes of trumpet, it would perhaps be more accurate to speak of an uninterrupted continuum of trumpets, built in a wide variety of pitches, ranging between the extremes represented by the piccolo trumpet and the bass trumpet. For any given trumpet part, the player may use an instrument in c^2, $b\flat^1$, g^1, f^1, $e\flat^1$, d^1, c^1, $b\flat^0$, f^0, $e\flat^0$, d^0, c^0, or $B\flat_0$, and his or her choice will be governed not so much by the composer's wishes in the matter as by how high or low the part lies, what instruments happen to be available, and any prejudices the player may have against one or another of them. This state of affairs is due to the indecision, confusion, and apathy of composers, the opportunism of instrument manufacturers, and, above all, to the fact that transposition on brass instruments is so easy that a part written for an instrument in, say, F can be played with little difficulty on an instrument in, say, E♭, if that's what happens to be available. The following discussion attempts to untangle this mess in terms of the existing reality, the choices realistically available to composers, and a hypothetical ideal.

Let us start with the ideal, for it is the easiest to describe. The main point of having a family of like instruments in different sizes is to extend to its limits the range of pitches in which the basic timbre of the instrument will be available; this condition can be satisfied by the piccolo and bass trumpets alone, for between the two of them the entire range of the trumpet family is covered without a gap. There is, however, another reason for instruments to be built in families. Instruments of sufficiently different size will have significantly different timbres even if they are constructed identically, and each of these timbres is valuable in its own right. For there to be such a consistently perceptible difference in their timbre, two like instruments must be pitched a fourth or more apart. Thus, it makes no sense to write, as many composers do, for trumpets in c^1 and d^1 in the same piece, for the sounds of these two instruments can only be distinguished by trumpet players. Two trumpets in $b\flat^0$ and d^1 *can* be told apart, barely, but if the higher instrument is pitched in $e\flat^1$ instead of d^1, the difference between it and the $b\flat^0$ instrument will be clearly and consistently audible.

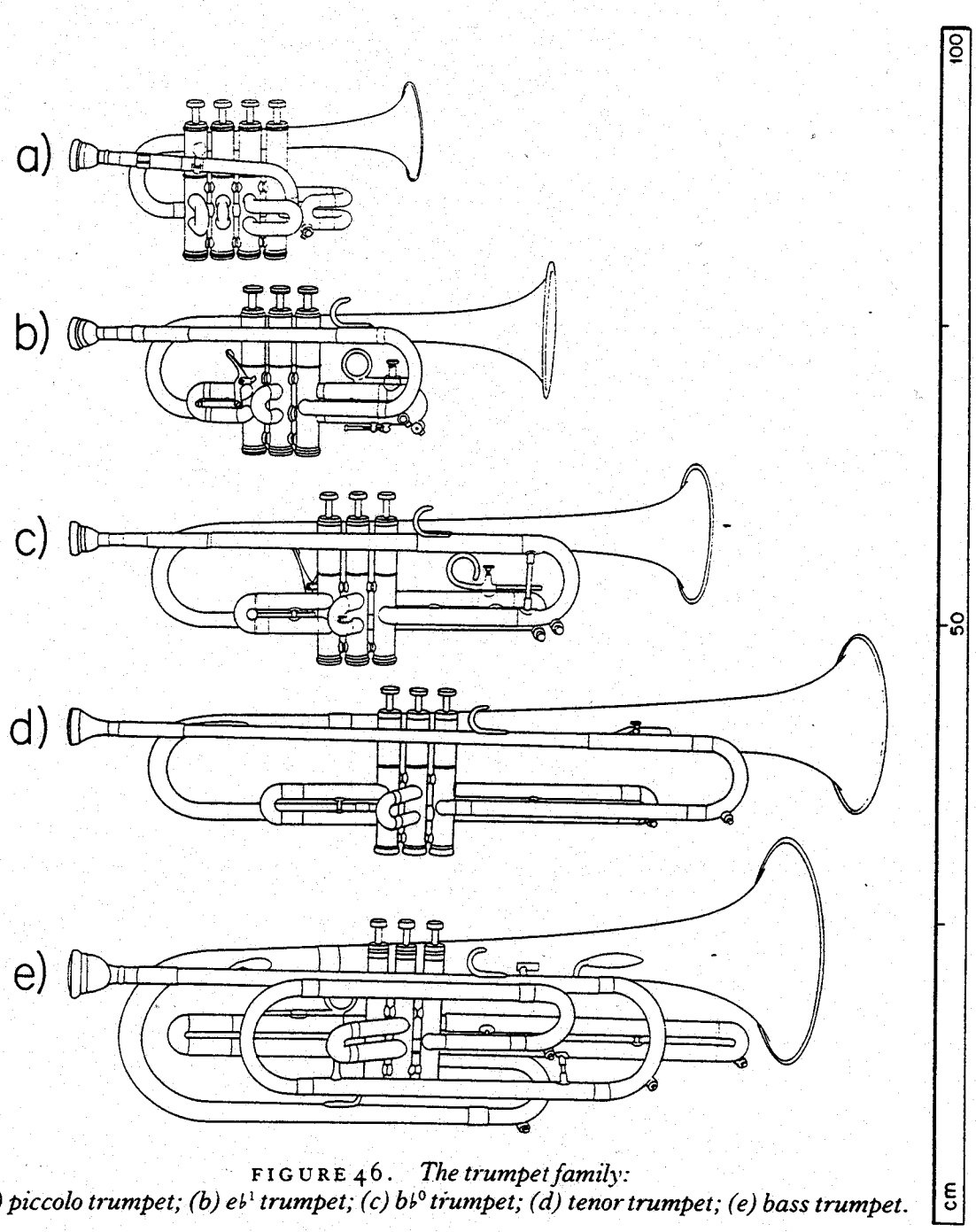


FIGURE 46. *The trumpet family: (a) piccolo trumpet; (b) e♭¹ trumpet; (c) b♭⁰ trumpet; (d) tenor trumpet; (e) bass trumpet.*

If, then, we were to choose from among the existing trumpets an ideal family of trumpets with the maximum pitch range and the maximum number of clearly distinguishable timbres, we would come up with something like the following:

piccolo trumpet in $b\flat^1$ or c^2
"soprano" trumpet in $e\flat^1$ or f^1
"alto" trumpet in $b\flat^0$ or c^1
tenor trumpet in $e\flat^0$ or f^0
bass trumpet in $B\flat_0$ or c^0.

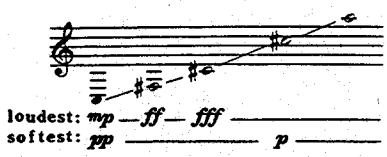
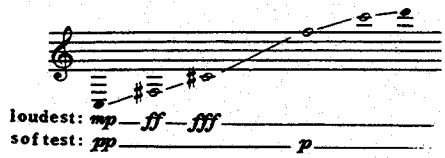
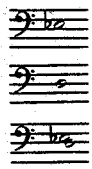
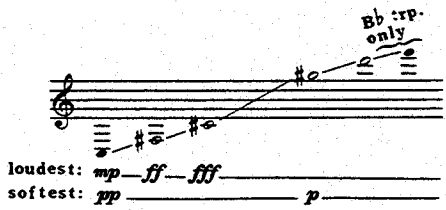
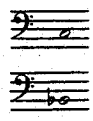
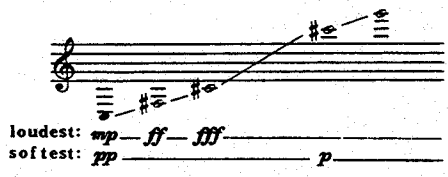
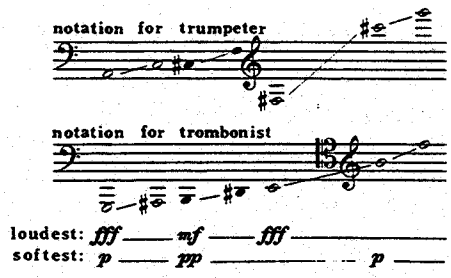
name of instrument	*abbreviations*	*written range*	*sounds*	*open fundamental (actual pitch)*	*availability*
piccolo trumpet in $b\flat^1$	picc. tr. picc. trp. picc. trpt.		a minor 7th higher		rare
trumpet in $e\flat^1$, d^1, $e\flat^1/d^1$	E♭ tr. (trp., trpt.) D tr. (trp., trpt.)		a minor 3rd higher, or a major 2nd higher, or either one		usually available common usually available
trumpet in c^1, $b\flat^0$	(B♭) tr. (B♭) trp. (B♭) trpt.		as written, or a major 2nd lower		common ubiquitous
tenor trumpet in $e\flat^0$	ttr. ttrp. ten. trp. ten. trpt.		a major 6th lower		very rare
bass trumpet in $B\flat_0$	btr. bs. trp. bs. trpt.		a major 9th lower as written		rare

FIGURE 47. *The trumpet family—vital statistics.*

In this family we have a piccolo trumpet which sounds thin and piercing, a brilliant and piercing "soprano," an "alto," also brilliant but somewhat more mellow, a tenor that is somber and somewhat dark, and a rich and powerful bass. If one is interested in the differentiation of a variety of trumpet timbres, one should write for these five alone and ignore the others. Even accepting this restriction, however, we still have ten trumpets to choose from where only five are needed. In this regard it should be pointed out that the various F and C trumpets are all less readily available than the equivalent B♭ and E♭ instruments, as Figure 48 shows, so the best bet would be to write only for the B♭/E♭ series.

	In F or C	*In B♭ or E♭*
Piccolo	very rare	rare
"Soprano"	very rare	usually available
"Alto"	common	ubiquitous
Tenor	very rare	very rare
Bass	very rare	rare

FIGURE 48. *Relative availability of trumpet in C, B♭, F, and E♭.*

In the real world, as we have seen, thirteen or more sizes of trumpet are jostling for attention by composers. Let us start at the top and work our way down through the heap. The **piccolo trumpet in b♭¹** was invented to play the trumpet part in Bach's second Brandenburg Concerto—which was originally conceived for a narrow-bore, valveless instrument three times as long as this trumpet—and it is to this piece and a handful of other extremely high Baroque trumpet parts that the instrument owes its continued existence. Since 1960 composers have written a number of important parts for the piccolo trumpet. Recently, increasing numbers of piccolo trumpets have been built with a fourth valve (to extend the range downward, thus making the instrument more generally useful). This fourth valve lowers the pitch of the instrument a perfect fourth, and is combined with the other three valves just as the fourth valve of the tuba is. The severe pitch discrepancies arising from the use of the fourth valve in combination are corrected with the third-valve slide. Other trumpets invented to play the second Brandenburg are the **piccolo trumpets in c², f¹ and g¹**. The f¹ instrument is extremely rare, as is the one in c²; the g¹ trumpet is slightly more common, but nowhere near as frequently available as the b♭¹ trumpet—which is also a more useful instrument. For all four instruments g³ (actual pitch) is the highest reliably obtainable note.

The **trumpets in e♭¹ and d¹** were invented for the performance of Baroque and early Classical trumpet parts written for valveless instruments twice their length, but the d¹ trumpet has since acquired a secure place in the modern repertoire. The best instruments of this type can be switched between e♭¹ and d¹ by means of a special lever or by adjusting the tuning slides. The trumpet in d¹ has been much more frequently called for by modern composers than the one in e♭¹, but the higher instrument is much commoner than one would suspect from this fact. As mentioned above, if an instrument genuinely different in sound from the standard trumpet in c¹ or b♭⁰ is desired, the e♭¹ trumpet is superior to the one in d¹.

The term "trumpet," unmodified, refers to the instrument in c¹ or b♭⁰. Of these, the **b♭⁰ trumpet** is both more common and more useful, since it is timbrally more flexible and has a potentially greater range. Nonetheless, composers have increasingly preferred the **trumpet in c¹**—probably because it doesn't transpose—and this instrument is gaining in popularity. Most players own both.

The **tenor trumpet in e♭⁰** is one of the most underexploited of all instruments. It has a huge range and a unique and beautiful timbre, but has seldom been written for, and is unfortunately quite rare. Rarer still is the virtually identical **tenor trumpet in f⁰**. A very few e♭⁰ tenor trumpets have a special valve that drops the pitch of the instrument to d⁰. Tenor trumpets are often erroneously called bass trumpets, and the two are frequently confused.

The **bass trumpet in B♭₀** is identical to the trombone in every respect save that it has valves instead of a slide. Since it is a much rarer instrument than the trombone, one should

write for it only when its unique capabilities—trills and rapid legato runs not possible on the trombone—are needed. There is also a much rarer **bass trumpet in c^0**. B♭$_0$ bass trumpets shaped like a trombone are called **valve trombones**; those shaped like tubas are called **tromboniums**. Since the bass trumpet is usually played by a trombonist rather than a trumpet player, it may be notated as written rather than as a transposing instrument a ninth higher.

PERFORMANCE CHARACTERISTICS

The characteristic brilliant, blaring sound of the trumpet is that of the notes from about written c♯^{1} upward. The notes between written f♯^{0} and c^1 are weaker and sound somewhat flabby and growling except in the bass trumpet, which retains full power in this range. The extension tones below f♯^{0} are the so-called pedal tones—extremely weak, flabby, covered-sounding notes which many trumpet players do not bother to master and which are seldom called for by composers. These notes are uniformly slow of speech and uncertain of intonation, and if written they must be well prepared, moving slowly if at all.

The reader may have noticed that only notes from written c^0 down are "true" pedal tones using the instrument's first partial; the production of the notes between c♯^{0} and f^0 appears to be an acoustic impossibility. That these notes *are* producible is due to a phenomenon not previously discussed in this book, that of **privileged frequencies**. On a wind instrument such as the trumpet (or any other brass instrument) where the column of air is dominated by the massiveness of the vibrating mechanism (the lips), the air column can be forced to vibrate not only at whole-number multiples of its fundamental frequency (the various partials), but also at such fractional multiples as 4/3, 3/2, or 5/3, and thus notes between the first partial (1/1) and the second partial (2/1) can be produced, with difficulty. These fractional "partials" are, together with the true partials, called "privileged frequencies."* The intonation of all trumpet "pedal tones" of whatever provenance is so highly influenced by the lips that the valve combination used makes little difference in the production of the note. The "true" pedal tones of the bass trumpet are much more secure than those of other trumpets, with the same powerful, blatty sound as the equivalent notes of the trombone. The notes between written c♯^{0} and f^0 are just as weak and insecure as they are on the smaller trumpets.

If desired, the note f^0 written can be obtained in the second partial of any size trumpet by putting the instrument into **German cavalry fingering**. This alternative (and generally inferior) system of valve tuning involves pulling out the third valve slide far enough to lower the pitch an additional semitone. The fingerings shown in Figure 49 are then used. Note that the starred fingerings will be out of tune and must be lipped to pitch. On most trumpets the third-valve slide is (by means of an attached ring) directly under the control of a finger of the left hand, and such instruments can be put into German cavalry fingering in a fraction of a second. Where this is not the case, at least five seconds must be allowed for the operation. If an f^0 is written with no further explanation of the composer's intent, the player will almost certainly use German cavalry fingering rather than attempt the clumsy and uncertain pedal-

* The situation is actually even more complicated. The construction of brass instruments is such that the fundamental is displaced acoustically to a much lower pitch than the one it should theoretically hold. The "fundamental" actually used by brasses is in fact one of these fractional privileged frequencies, itself displaced to lie where the real fundamental belongs.

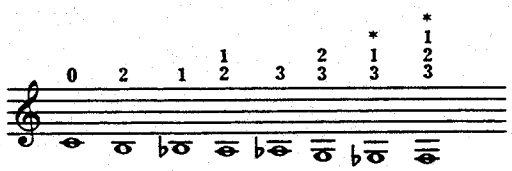


FIGURE 49. *German cavalry fingering. The intonation of the valve combinations marked by asterisks must be corrected with the lips.*

tone. Those piccolo trumpets with four valves can play in the second partial down to written c♯⁰, and the notes thus obtained can be played as loudly (*ff*) and clearly as the "ordinary" second-partial notes.

By means of a rather awkward contortion of the left hand, half-stopping similar to that of the horn can be managed on the trumpet, lowering the pitch any amount up to a half-step. This technique (which must be explained to the player, since it is by no means traditional) is most useful in the production of microtones and slow glissandos of a half-step or less. Larger glissandos can be produced by means of valve smears (half-valving) and lip glisses, subject to the same limitations as on the horn. Of these two techniques, the valve smear is somewhat more effective on the trumpet than the horn, the lip gliss somewhat less so.

MUTES

A wide variety of mutes are available for the trumpet. Longitudinal sections of the most common types are shown in Figure 50; mutes other than these are rare or very rare and are either synonyms or minor variants of these eight basic types. The standard trumpet mute is the **straight mute**. If the general instruction "with mute" or "con sord." is used without any further specification, the straight mute will be used. This is the oldest of the modern trumpet mutes and is entirely analogous to the mutes of the horn and tuba and to the straight mute of the trombone. It is a hollow cone, made of metal, plastic, or pasteboard, with an opening at the top. On the outside near the top of the cone are three or four longitudinal strips or wedges of cork that enable the mute to be wedged into the bell without blocking it off entirely. The sound of the instrument resonates inside the cone but must exit via the narrow channel between the mute and the bell of the instrument. The resulting sound is thin, nasal, and somewhat distant. The material of which a straight mute is made has a slight effect on its sound, metal mutes being generally somewhat harsher and more cutting in timbre than cardboard ones; plastic mutes fall somewhere between these. Some composers specify the exact type of straight mute they desire, but the differences in effect are actually quite small and may safely be ignored. Straight mutes of whatever type have no effect upon the dynamic range or response of the trumpet, but except for the very best they do affect the intonation slightly, requiring correction of some notes by the lips and/or third-valve slide, or an adjustment of the main tuning slide.

The other mutes fall into two general categories: mutes that make the tone harsh and thin and those that make it muffled and sweet. In the first category are the harmon, solotone, and practice mutes. All these mutes differ from the straight mute in having a complete ring of cork around the top of the mute, which prevents any air from escaping past the sides of the mute and forces all the sound to travel into the mute itself, escaping finally by some sort of

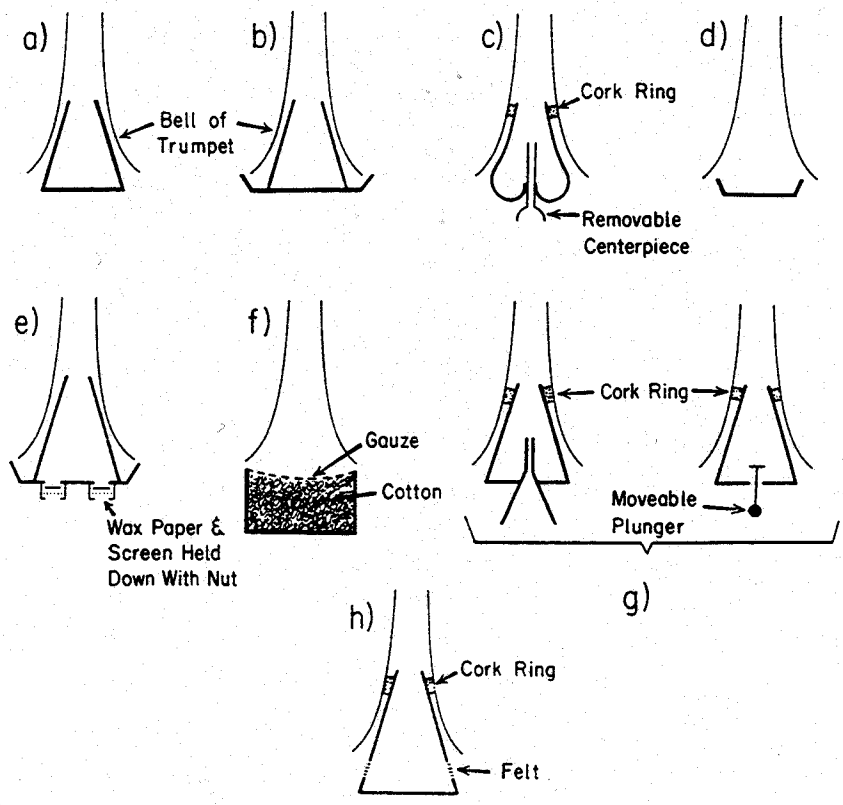


FIGURE 50. *Schematic longitudinal sections of various trumpet mutes in place: (a) straight mute (ubiquitous); (b) cup mute (common); (c) harmon mute (common); (d) plunger mute (usually available); (e) buzz mute (rare); (f) bucket mute (rare); (g) two types of solotone mute (rare); (h) practice mute (usually available).*

restricted opening in the base of the mute. With all these mutes the second-partial notes are weak and uncertain, and pedal tones are impossible.

In the **harmon mute** the opening at the end takes the form of a single hole about a centimeter in diameter, into which is normally inserted a snugly fitting but movable tube only a bit shorter than the mute itself. Thus, although the body of the mute acts as a resonating chamber, the sound must exit through the long, narrow tube. The tube (called the **stem**) ends in a tiny "bell" that helps to project the severely pinched sound once it has left the mute. The stem, as has already been mentioned, is movable, and variations of the basic harmon timbre can be obtained by either pulling out the stem to a greater or lesser extent without actually removing it or by removing it altogether. The normal sound of the harmon mute (with the stem inserted all the way up to its bell) is very thin, pinched, and distant. When played loudly a *cuivré* effect begins and the tone becomes extremely harsh and cutting. As the stem is extended the tone becomes increasingly more distant and pinched but somewhat less thin and nasal, the *cuivré* effect becoming less unpleasant. With the stem removed, the sound becomes gentler, covered and even cavernous, and the *cuivré* effect disappears. All three of these timbres can be varied by loosely covering the bell of the stem (or the hole into which it inserts, if it has been removed) with the palm of the left hand; this gives the tone a covered quality and makes it less metallic. Though one might guess otherwise, the vowel sounds obtainable with the plunger mute (see below) cannot be duplicated with the har-

mon—only the sounds [wɑ] and [ɑu] will have any vocal quality. This effect has led to the harmon sometimes being called the *wawa mute*, a familiar term unfortunately also used for the plunger mute. Muffling with the hand is indicated by  and canceled by  or the word "aperto" or "open."

The **solotone mute** is a modification of the harmon mute designed to project the tone forward while retaining the basic harmon timbre. The sound produced is somehow unsettling—one would almost say "distressing" or "irritating"—and can quickly get on one's nerves. This mute exists in two rather different forms (Fig. 50g). In one the sound, after emerging from a small hole at the end of an immovable tube within the mute, is projected forward with a megaphone-like extension of the mute. In the other, the sound emerges from an extremely tiny hole in the bottom of the mute, and there is no internal tube; because of this, the thin bottom wall of the mute acts as a diaphragm and vibrates sympathetically with the air column, producing a sort of "cardboard *cuivré*" very similar in sound to the megaphone-type mute. This second type of solotone mute has a further refinement in the form of a movable metal rod with a brass disk at one end and a knob at the other that fits loosely through the hole from which the sound emerges. By pulling the rod (called the *plunger*) out so that the brass disk inside the mute covers the hole, a sound is produced analogous to that made by muffling the harmon mute with the hand; pushing the rod in restores the normal sound. On the megaphone type of solotone mute, harmon-like "wawa" effects can be produced more naturally by covering the end of the megaphone with the left hand. The notation for this effect on either type of mute is the same as for the harmon mute.

The **practice mute**, as its name implies, was devised to enable players to practice without disturbing the neighbors. Here the sound is forced into the mute, from which it must exit via a number of small "windows" in the outer rim of the mute, each of which is stuffed with felt. The sound of this mute is very similar to that of the straight mute, but very tiny and distant, and it reduces the instrument's dynamic level to the range between *ppp* and *p*. This mute, sometimes referred to by the brand name "**Whispa mute**," must be used if a true *ppp* is desired from the trumpet.

The remaining varieties of trumpet mute are designed to make the tone sweet and gentle. All have in common a dish- or bowl-shaped component that lies flat across the very end of the bell of the trumpet, forcing the air (and the sound) to exit around the rim of the bell.

The simplest and most versatile of these mutes is the **plunger mute**, so called because in its oldest form it consists of nothing more than the business end of a plumber's helper—nowadays a pie-plate-like affair with a strap on the back for the player's hand is more common. This mute is also called "wawa mute" because of the vocal effects of which it is capable (unfortunately this name is also used for the harmon mute). The beauty of the plunger mute is that it remains in the player's left hand at all times and can be quickly and easily manipulated so as to mute the instrument to a greater or lesser extent. By this manipulation the sounds of the vowels [ɑ], [ɔ], [o], and [u] can be very closely approximated (for the meaning of these phonetic symbols see Chapter IV). The consonants [m], [w], and [β] can also be produced, and such word-like combinations as [βɑ̃ũmɔwo] can easily be done. Remember in this regard that the additional consonants [t], [p], [k], and [ʔ] can be made by the player with the mouth while playing. Traditionally, the notation for plunger mute has been  = bell closed by mute,

and  = bell open (by analogy with the notation for stopped notes on the horn); but composers are now beginning to use the phonetic symbols instead, since these indicate more precisely than the older notation the exact degree to which the bell is to be blocked. If the phonetic symbols are used, they should be bracketed, as here. [ɑ] represents the open position, [u] the usual closed position, and [m̟] the most closed normal position. Note that before either form of notation is used, the player must be instructed that the mute is going to be needed. By using the mute to block the bell altogether, a stopped sound like that of the horn can be obtained. The pitch of open notes so produced is raised a half-step, while notes requiring all three valves will be raised only a quarter-step, the other valve combinations showing intermediate raising. If phonetic symbols are used to represent the usual plunger-mute sounds, a + over the note can be used to indicate stopping.

A variant of the plunger mute, called simply "the hat" (because early jazz players used their hats for this purpose), differs from the plunger in that the bell of the instrument fits into the rim of the mute rather than vice versa. It sounds exactly like the plunger but cannot make as many different sounds. It should be mentioned at this point that the hand can be used without a mute to muffle the sound of the instrument. The effect, though quite clear, is much less strong than it is when one of the "wawa" mutes is used. The notation for this effect is the usual  and , together with the indication "muffle with hand."

Closely related to the plunger mute is the **cup mute**. This resembles a pie plate with a straight mute welded to its center, and sounds almost exactly the same as a plunger mute in closed ([u]) position. Some players prefer an [m̟] sound from the cup mute; they file down the cork wedges to make the mute fit more tightly. Some mutes are adjustable with a set screw, but the adjustment is time-consuming and requires removal of the mute. The advantage of the cup mute is that when this typical timbre is desired for an extended period of time, without any fancy vocalisms or rapid alternation between closed and open sounds, the mute will stay in place, freeing the player's left hand for supporting the instrument and turning pages. The sound of the cup mute is very gentle and sweet—almost woodwind-like—and does not become less so when the instrument is played loudly. With the cup mute in place the trumpet can be played no louder than *fortissimo*.

The **buzz mute** is a specialized variant of the cup mute: the bottom of the mute is pierced by three small, round "windows," each of which is covered by wax paper and a piece of brass screening. The wax paper and screen are held loosely in place by an adjustable hex-nut; whenever the instrument is played the paper vibrates sympathetically against the screen, producing a rattling buzz that sounds exactly as if the instrument were being played into a kazoo—which in fact it is. By obscuring the "windows" with the left hand, simple "wawa" effects can be produced like those of the harmon mute.

Finally, there is the **bucket mute**, a cylindrical metal pail filled almost to the brim with cotton and covered with gauze. This is attached to the trumpet with three prongs that grab the outer rim of the bell—in place, the mute bears an unfortunate resemblance to a horse's feedbag. In sound this mute corresponds almost exactly to the lay conception of what a mute does: the sound is muffled and deadened without its fundamental character being significantly altered.

As mentioned above, the basic instruction "with mute," "mute," or "con sord." is understood to call specifically for the straight mute. The best way to ask for some other mute is

simply to put the name of the mute immediately before the passage to be muted. For the removal of any mute the instruction "mute off" or "senza sord." is sufficient. To change from one mute to another without any intervening unmuted passage, the instruction "change to *x* mute" or "muta in *x* mute" should be used. Any mute can be inserted in a fraction of a second, but two or more seconds must be allotted somewhere for the player to *pick up* the mute. If the place in the music at which the mute is to be picked up is not immediately before the muted passage, the instruction "pick up *x* mute" should be written at the appropriate spot, followed by "mettere sord." or "mute on" when the mute is to be inserted.

Except for the straight mute, which is available for all sizes of trumpet, all these mutes are manufactured only for the ordinary trumpet in $b\flat^0$ or c^1. All the mutes can be used, albeit rather clumsily and imperfectly, on the d^1 and $e\flat^1$ trumpets, but the piccolo trumpet is restricted to the straight mute.* An identical series of mutes is available for the trombone, and the bass trumpet makes use of these; the tenor trumpet, by using some $b\flat^1$ trumpet mutes and some trombone mutes, can also employ the whole series.

Musical Examples

PICCOLO TRUMPET:

Xenakis, *Oresteia Suite*
Berio, *Allelujah II*

TRUMPET IN D/E♭:

Stravinsky, *Le Sacre du printemps*
Messiaen, *Et exspecto resurrectionem mortuorum*

TRUMPETS IN B♭, C:

Stravinsky, *Ebony Concerto*
Agon
Chavez, *Sinfonia de Antigona*
Varèse, *Octandre*
Xenakis, *Eonta*

TENOR TRUMPET:

Stravinsky, *Le Sacre du printemps* ("Action rituelle des ancêtres")
Schoenberg, *Gurrelieder*
Feldman, *Eleven Instruments*

BASS TRUMPET:

Janáček, *Sinfonietta* (1st mvt.)
Ruggles, *Men and Angels* (1922)

TROMBONES

THE INSTRUMENTS

As mentioned above, the trombone and trumpet families are virtually identical acoustically, differing only in that trombones have a slide mechanism rather than valves. The usual

* It should be fairly simple to jury-rig a plunger mute for this instrument.

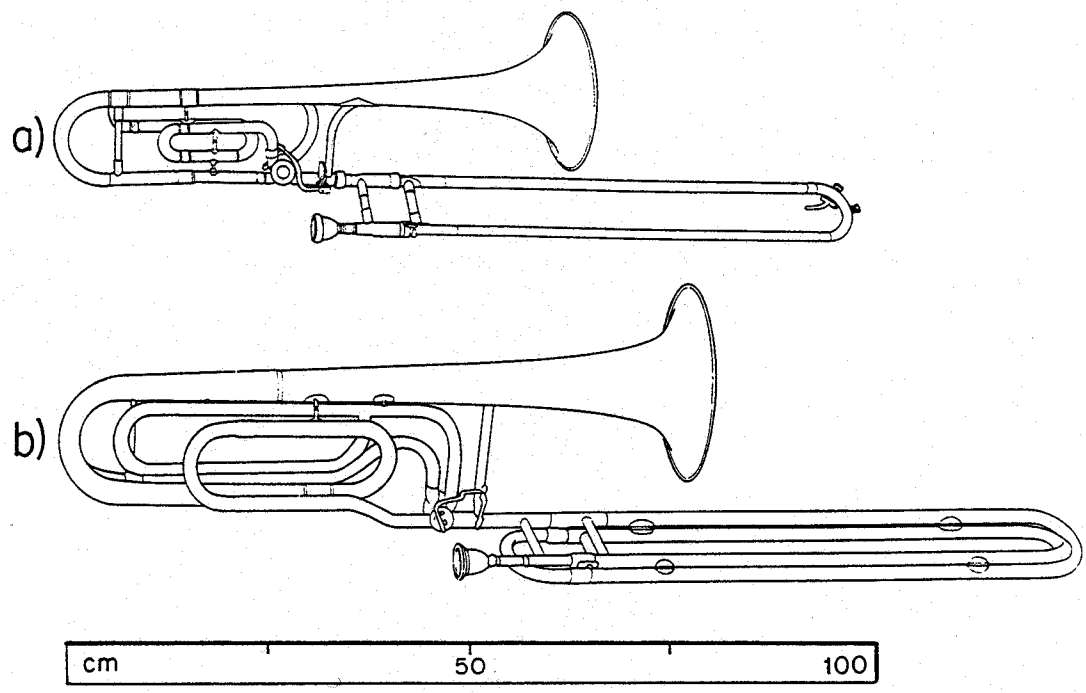


FIGURE 51. *The trombone family: (a) trombone; (b) contrabass trombone.*

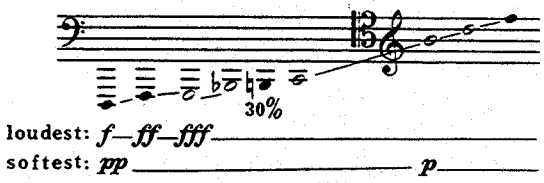
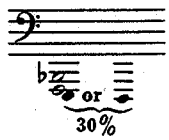
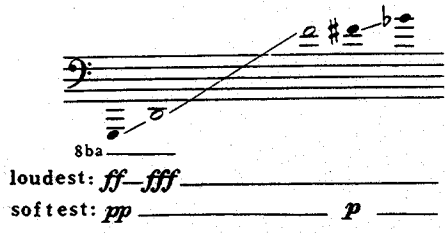
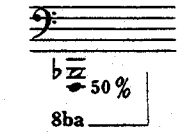
name of instrument	*abbreviations*	*written range*	*sounds*	*open fundamental (actual pitch)*	*availability*
trombone	trb. trbn.		as written		common
contrabass trombone	cb. trb. cbs. trbn.		as written		very rare

FIGURE 52. *The trombone family—vital statistics.*

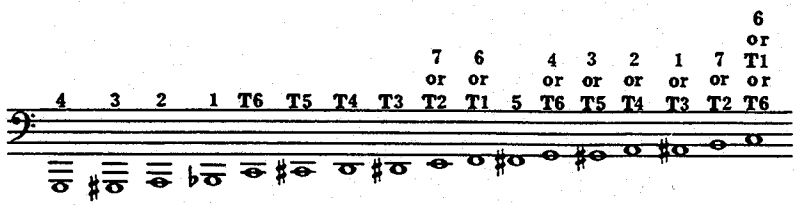
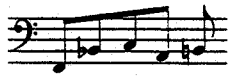
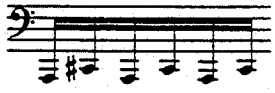


FIGURE 53. *Slide positions for the low register of the trombone (T = trigger depressed).*

modern trombone, however, is a duplex instrument like the horn, and thus possesses, in addition to the slide, a single valve designed to lower the pitch of the instrument a perfect fourth. This valve, called the "trigger" or "rotor," is operated by the left thumb; when depressed, it lowers the open fundamental from B♭ to F_1. The trombone is thus said to be "in B♭/F" even though it is not a transposing instrument. The original simplex intrument was in B♭, and the trombone is designed and played as a B♭ instrument with an F-attachment—the trigger is used only where necessary or particularly convenient.

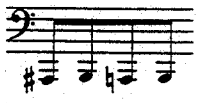
Trombonists speak of seven numbered "positions" of the slide, corresponding to the seven equal-tempered semitones on each partial. When drawn all the way in, the slide is in first position; when completely extended it is in seventh. When the trigger is depressed the instrument becomes longer, and the slide must be moved slightly further to achieve each semitone gradation in pitch. In this case there are only six slide positions, and the sixth position requires a greater extension of the slide than seventh position does on the unaltered instrument. The F-attachment is most often used in the lower register, where it fills a gap between the first and second partials and simplifies passages such as  that would be uncomfortably athletic to perform without it. Figure 53 should make this clear. Note that the pitch B♮$_1$ is not usually available on the trombone; it can be faked by lipping down the C above it or with a privileged frequency, but it will be weak, flabby, and uncertain of speech and intonation.* Note also that passages such as  that require rapid and extreme changes of slide position are impossible to play. Even  would be extremely difficult. Such awkward shifts of the slide are never required above G_0.

The usual sort of trombone, which we have been discussing so far, is more specifically called the **tenor-bass trombone**. Instruments of slightly different design are used by players for parts that lie unusually high or low. The old, simplex **tenor trombone** is used for the performance of music that lies consistently high in the range, such as nineteenth-century alto trombone parts. These instruments not only lack an F-attachment but generally have narrower bores, smaller bells, and shallower mouthpieces than tenor-bass trombones. No player is likely to use such an instrument for any part that descends below E_0; on the other hand,

* The tuning slide for the F-valve is marked so that it can be quickly and accurately lowered to E, thus making the low B_1 possible, but this is an emergency measure, requiring at least five seconds for the player to adjust the instrument both before and after the note is played.

attempts may be made to use a tenor trombone for a high-lying part that really demands the flexibility provided by an F-attachment, and in such cases composers should provide a cautionary instruction.*

Parts that mostly exploit the lower end of the trombone's range are often played on the **bass trombone**. Bass trombones have broad bores, large bells, and wide, deep mouthpieces, and usually have two triggers for the left thumb. The second trigger depressed simultaneously with the first lowers the instrument an additional half-step to E or minor third to D, enabling the player to produce a secure B♮$_1$. The D trigger is superior to the E trigger in that it gives this low B in fourth position rather than sixth, making passages such as



much easier to play.† Because of this advantage, the D trigger is now commoner on new instruments and seems likely to oust the E trigger entirely. In the meantime, some bass trombones have F, E, *and* D triggers. At any rate, all parts requiring frequent use of B_1 or $B|_1$ should be specifically labeled "bass trombone" rather than simply "trombone." Because bass trombones are designed to play low notes more easily than high ones, it is probably unwise to write for them above c^2.

While the tenor, bass, and tenor-bass trombones are only slightly different varieties of what is essentially the same instrument, the **contrabass trombone** is distinctive in tone, range, and appearance. Its distinguishing characteristic is its double-barreled slide, two equal and parallel U-shaped tubes that are attached to each other and move in and out together. Because of this doubling the slide has the same seven positions as that of the tenor-bass trombone. The instrument is usually built in B♭, an octave below the tenor-bass trombone, and most have an F-attachment as well, sounding an additional fourth down. With the trigger depressed the slide has six positions, again as for the tenor-bass trombone. Because a great deal can be done with the lips at such low pitches, the notes B_2–E♭$_1$ can be produced even on a simplex instrument but, needless to say, they are (except for the B_2 itself) much more secure and better in tune when there is an F-attachment. Some contrabass trombones are provided with valves rather than a slide—presumably to enable a tuba player to double on the contra trombone. While this may be fine for Wagner's *Ring* operas, more recent parts not infrequently call for glissandos impossible to play adequately on these "contrabass trumpets." Unfortunately, the contra trombone in any form is so rare that one is unlikely to have any choice in the matter. Valved contras have four rotary valves, the fourth replacing the F-attachment. Strangely enough, no octave transposition is used in notating for contrabass trombone.

PERFORMANCE CHARACTERISTICS

Both trombone and contrabass trombone normally read in the bass clef. Traditionally the tenor clef has been used for high notes, but the treble clef has gradually been replacing it.

* In early-twentieth-century scores the term "tenor trombone" refers indifferently to both the tenor-bass and true tenor trombones.

† There is also the quarter-tone $B|_1$, which must be lipped from B♮$_1$ on an instrument with an E trigger but is easily played in 4½ position with a D trigger.

Trombonists are used to reading in the bass clef up to about $b\flat^1$, in the tenor clef from about $B\flat_0$ to d^2, in the alto clef (for old alto trombone parts) from c^0 to f^2, and in the treble clef from e^1 up.

The tone of the trombone is powerful, resonant, and somewhat vocal, blaring at high dynamic levels, rich and velvety at low ones. Notes below E_0 tend to sound somewhat blatty, even flatulent, especially when played loudly. The extension pitches at the bottom of the range sound increasingly weak, flabby, and uncertain. The bass trombone has a somewhat smoother, fuller tone in the low register than does the tenor-bass instrument. The timbre of the contrabass trombone is considerably darker, fuller, and less blaring than that of the ordinary trombone; it is intermediate in quality between that instrument and the tuba.

Mutes are available for the trombone in all the types described above for the trumpet. These mutes are identical to the equivalent trumpet mutes in design, timbre, technique, and availability. With the plunger mute the trombone can imitate human speech to an uncanny degree: its timbre is more voice-like than that of the trumpet, and it can reproduce with its slide the variable, fluctuating pitches of actual speech. Only a straight mute is available for the contrabass trombone; however, the instrument can use the baritone-horn bucket mute, and a plunger mute can be jury-rigged.

Normally, legato passages are executed on the trombone by performing the smoothest possible tenuto and moving the slide during the almost imperceptible break in the tone. In many cases the legato so produced rivals that of other brasses. Even fairly large shifts of the slide can be covered in this way, provided they are accompanied (as they usually are) by a shift of partial. Only the following slurs may be called impossible, and even they can be faked:

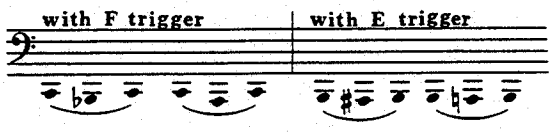


FIGURE 54. *Awkward trombone slurs.*

Note that a bass trombone equipped with a D trigger would have no trouble with any of these. Because of the large arm motions required in moving the slide, passages such as

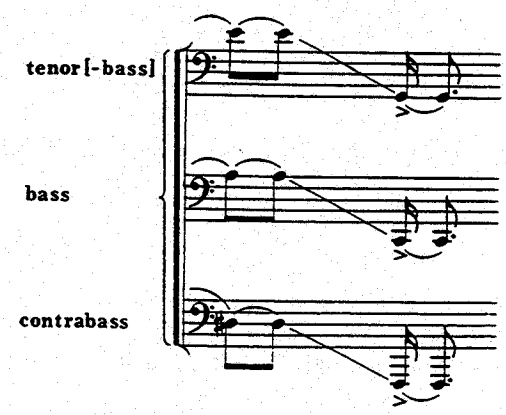
while technically possible, are not idiomatic for the trombone and will sound much better (and be much more easily played) on the bass trumpet.

Trills are possible on the trombone provided that the two notes of the trill are from adjacent partials and that the slide is not required to move more than one position back and forth. Trills that involve the trigger and/or the slide are of necessity somewhat slower and more awkward than those executed with the lips alone.

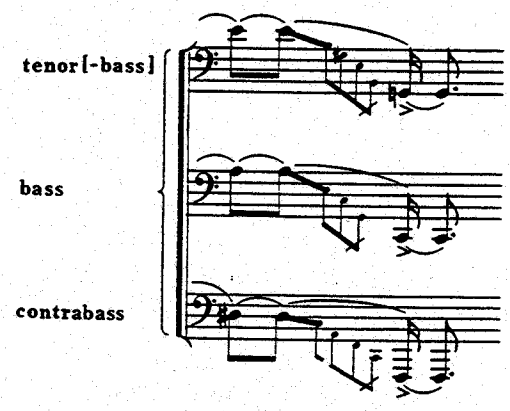
The trombone glissando is so famous that many composers assume that a smooth glissando can be executed between any two notes. In reality, the trombone cannot produce a true glissando in excess of a tritone in width, and the tritone can only be reached where the end tones of the glissando lie in first and seventh positions on the slide. A little thought will make

it clear that any trombone glissando must lie on a single partial, entirely between the two extreme positions of the slide, with the trigger(s) either engaged or disengaged for the entire duration of the glissando.

Glissandos that do not meet these rules are usually executed as combined slide and lip glissandos. Such combination glissandos can be quite effective if performed rapidly, but they will have perceptible breaks or rough spots. Composers should be aware of the distinction and notate the "true" and "false" glissandos differently. For example, the huge glissandos in the last bar of Varèse's *Intégrales*, which are written thus:



must be performed:



and should have been so notated. The various half-valve effects are possible from the trigger but have not been widely exploited.

Musical Examples

TROMBONE:

Hovhaness, Symphony No. 4 (3rd mvt.)
Stravinsky, *L'Histoire du soldat*
Bartók, *The Miraculous Mandarin*
Berio, *Sequenza V*
Xanakis, *Eonta*

CONTRABASS TROMBONE:

Varèse, *Intégrales*
Ligeti, *Requiem*

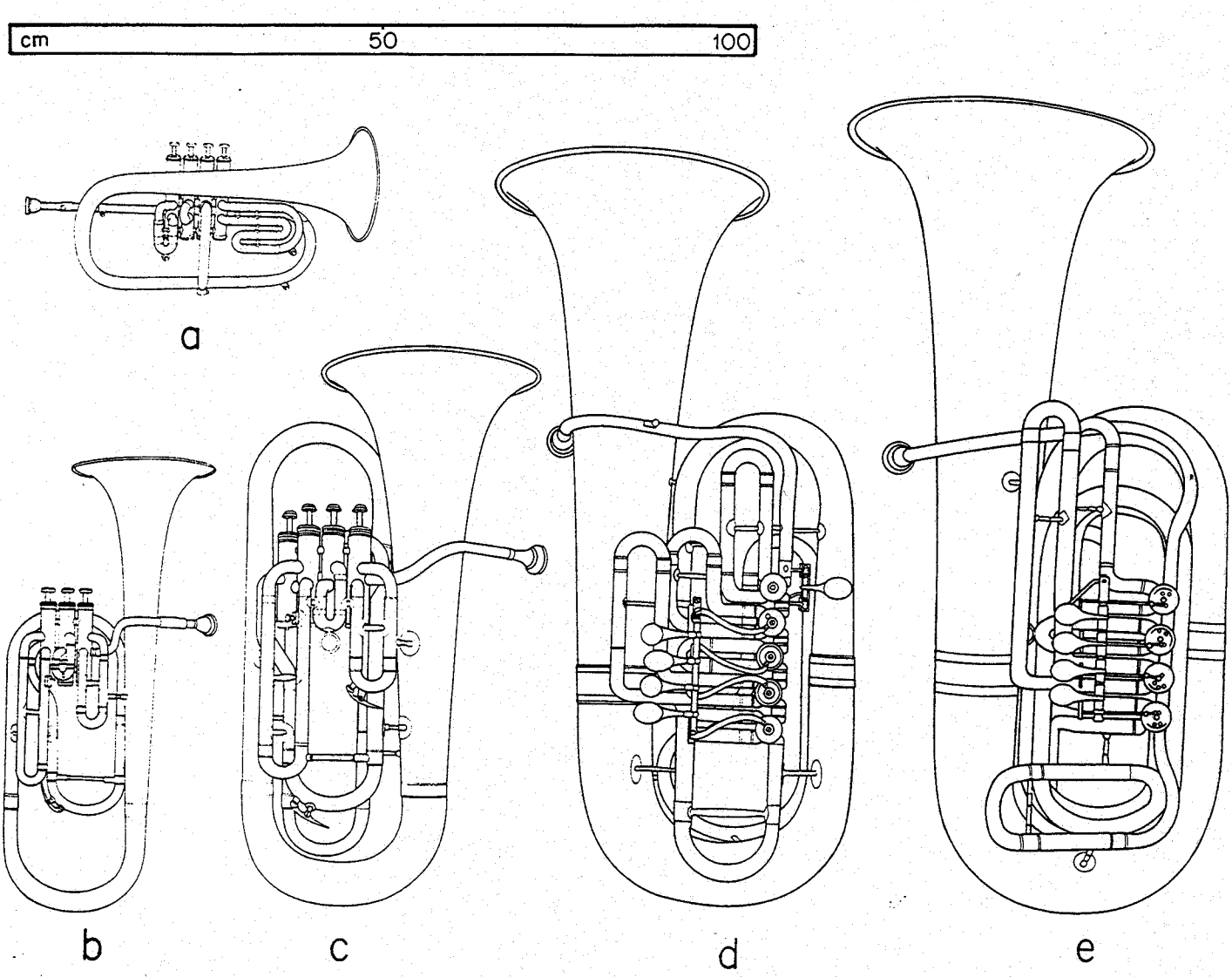


FIGURE 55. *The tuba family: (a) flügelhorn; (b) alto horn; (c) baritone horn; (d) bass tuba; (e) contrabass tuba.*

TUBAS

The tuba family arose from the addition of valves to the valveless military bugle. This basic idea was hit upon and/or pirated so many times in the course of the nineteenth century that half a dozen or more "different" families of tubas are still in competition with each other, and most musicians (including composers) remain unaware of the essential similarity of them all. All instruments of the valved-bugle type, whether called "tuba," "saxhorn," "flügelhorn," or what-have-you, are characterized by a broadly expanding conical bore, which gives them a coarse, full, somewhat mellow tone with a tremendous amount of **presence**—the quality of filling a room with sound even at low dynamic levels.

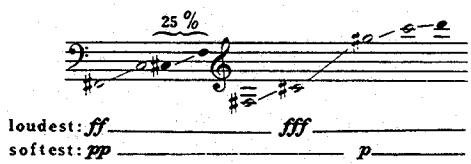
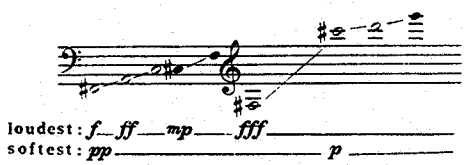
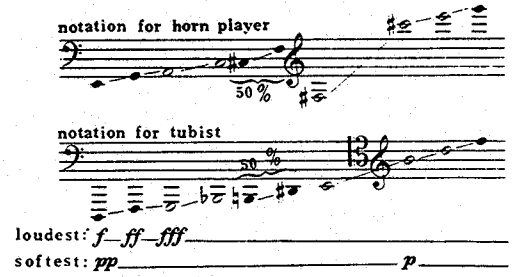
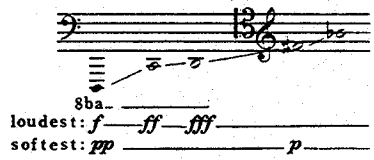
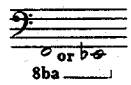
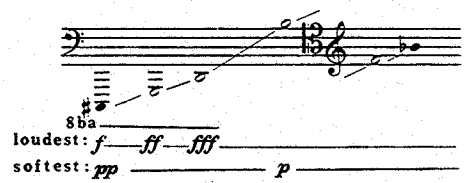
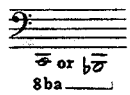
name of instrument	*abbreviations*	*synonyms & close relatives*	*written range*	*sounds*	*open fundamental (actual pitch)*	*availability*
flügelhorn in B♭	flug. flghn.	soprano saxhorn *cornet à pistons* (valve-)bugle		a major 2nd lower		usually available
alto horn in E♭	alt. hn. ahn. alt.	alto saxhorn alto flügelhorn altonium alto bugle tenor horn		a major 6th lower		usually available
baritone horn	bart. bt. hn.	euphonium tenor saxhorn tenor tuba Wagner tuba in B♭		a major 9th lower as written		common
bass tuba	b.t. btb. bs. tb. bs. tub.	bass saxhorn Wagner tuba in F bass		as written		common
contrabass tuba	cb. tub. cbt. cb. tb.	contrabass saxhorn bass sousaphone		as written		common

FIGURE 56. *The tuba family—vital statistics.*

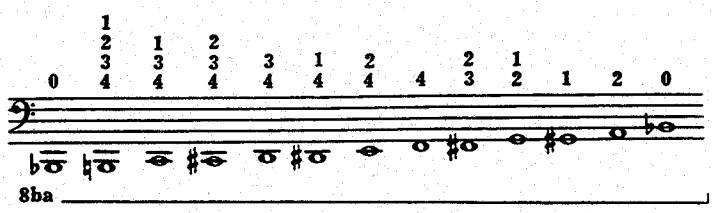


FIGURE 57. *Valve combinations for the lower register of the contrabass tuba in B♭.*

THE INSTRUMENTS

The "different kinds" of tubas are for the most part different in name only, being identical to each other in sound and virtually identical in construction. The only variants with some claim to an independent existence are the Wagner tubas and the old *cornet à pistons*. Wagner tubas (nowadays increasingly called simply **tubens**) are designed to be played by horn players (they have deep, funnel-shaped mouthpieces and are built left-handed) and are usually erroneously described as bass members of the horn family. The funnel-shaped mouthpiece gives these instruments a *very* slightly mellower and gentler tone than the ordinary tenor and bass tubas; it is doubtful that even the most confirmed Wagnerite would notice if the ordinary instruments were substituted for Wagner's invention, especially if appropriate mouthpieces were used. The *cornet à pistons* of the nineteenth century was essentially a soprano Wagner tuba, for it too had a basically funnel-shaped mouthpiece. The modern cornet, its direct descendant, is utterly indistinguishable from the trumpet. A handful of modern cornets are still built with bores wide enough to qualify them as tubas, and these, not surprisingly, sound much like flügelhorns; the cornet, in short, no longer has any truly independent existence.

The names used here for the five different sizes of modern tuba are those most commonly in use in North America. Ideally, of course, one ought simply to speak of soprano, alto, tenor, bass, and contrabass tubas and have done with the mess forever; unfortunately, at least as of this writing, no one would understand a reference to "soprano tuba" as indicating the flügelhorn.

The term "tuba" used alone refers to either the bass or contrabass instrument. Most tuba players play all their music on one or the other, regardless of which is specified by the composer, but the two instruments are somewhat different in both range and timbre. In *Et exspecto resurrectionem mortuorum*, for example, Messiaen makes good use of both bass and contrabass tubas in parts of differing character. Bass tubas may be built in F or E♭, contrabasses in C or B♭; since neither is a transposing instrument, this is no problem for the composer. All good contrabass tubas have *at least* four valves, the fourth extending the range downward and compensating for the intonation problems of the third valve. The severe intonation problems of the fourth valve (more than a half-step sharp when combined with the other three) are corrected by the addition of a fifth valve and/or by means of tuning slides that adjust either manually (with the player's free left hand) or automatically. The way the fourth valve is combined with the other three is shown in Figure 57. Professional-quality bass tubas are now made with a minimum of *five* valves; the fifth valve lowers the pitch either a major third or a major second, depending on the instrument.

The baritone horn ("baritone," for short) appears only occasionally in orchestral scores, but it is a standard member of the concert band. There it is traditionally considered both as a

transposing instrument in $B\flat_0$ and as a non-transposing instrument, and duplicate parts are provided by publishers. This reflects the fact that most players of the instrument have come to it from the trumpet, and beginners who have not yet mastered the bass clef use the (treble-clef) transposing parts. In orchestral scores the baritone is frequently written for doubling by a horn player rather than a tuba player or trombonist, and here too the transposing notation is used;* in all other cases the instrument should be notated at pitch.

Of those baritones used by professionals and first-rank amateurs, about half have four valves rather than three. Without the fourth valve the notes B_1 to $E\flat_0$ can be played only weakly and uncertainly as privileged-frequency pedals, and should thus be avoided; with four valves these notes are readily available. In band use the three-valve instruments are sometimes called "baritones" and the four-valve ones "euphoniums," but this is by no means standard.

The alto horn in $e\flat^0$ is almost exclusively a band instrument, used on the marching field to replace the "French" horn. Like the alto clarinet, the alto horn has a bad reputation which is largely undeserved: Hindemith's sonata for the instrument barely scratches the surface of its capabilities. All alto horns have three valves. The "false" pedal tones (from written f^0 to $c\sharp^0$) are as weak and uncertain as the corresponding tones of the tenor trumpet, but the "true" pedals (from written c^0 down) are quite strong.

The flügelhorn in $b\flat^0$ is shaped like a trumpet and played by trumpeters, but it is a true tuba. In North America it appears only occasionally in the concert band. Its primary use is by jazz musicians, who appreciate its muffled, vocal tone. Traditionally the instrument has been built with three valves; it is now occasionally (and increasingly) seen with four. Four-valve flügelhorns can descend to written $c\sharp^0$ on the second partial—three-valve instruments have only weak and uncertain "false" pedal tones from f^0 to $c\sharp^0$—but both four- and three-valve instruments have a surprisingly good set of "true" pedals below this.

All the trumpet mutes exist in variants usable on the flügelhorn. The harmon and solotone mutes destroy the instrument's presence, however; when these mutes are used the flügelhorn sounds essentially the same as a trumpet similarly muted.

For tubas other than the flügelhorn only straight and bucket mutes are available, and the bucket mutes are very rare. The straight mute for the bass or contrabass tuba comes in a wide variety of sizes and shapes, only about half of which perform their proper function of rendering the timbre thin, nasal, and distant. With either the straight or bucket mute the quality of presence that distinguishes all members of the tuba family is unaffected. A good straight mute will make a tuba of any size sound simultaneously very close and very distant. The mutes of the deeper tubas (from baritone horn down) are large, ponderous affairs that cannot be inserted or removed unobtrusively. While one need not go as far as the composer who said, "The only excuse for a tuba mute is theater," the theatrical aspects of its use should be taken into account.

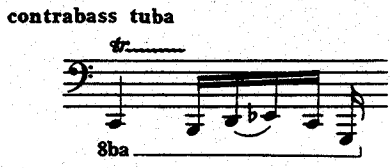
PERFORMANCE CHARACTERISTICS

Even compared to other brass instruments, tubas are remarkably even in timbre from one end of the range to the other. As mentioned above, the most distinctive quality of all these

* In *Le Sacre du printemps* Stravinsky writes the tenor-tuba parts an octave too low.

instruments is the room-filling character of their tone. Aside from this presence, the tone of the various tubas is best described by reference to other brass instruments: the flügelhorn sounds like a particularly coarse, dark, mellow trumpet; the alto horn has a tone halfway between trumpet and "French" horn; and the baritone sound is halfway between horn and trombone. The bass and contrabass tubas sound almost as if they could be low-pitched members of the horn family, with the bass tuba being more obviously coarse and powerful in a typically tuba-like fashion; the contrabass sounds thick and muffled even in its high register.

Although tubas *sound* ponderous, they are in fact as agile as trumpets, and one need not fear to write rapid runs, trills, valve-smears, and lip glisses as readily as one would for trumpets of equivalent size. Only below D_1 is any caution required, and even there, a passage such as



while it might raise some eyebrows, is possible (if difficult) to play. A truly sharp staccato is, however, impossible below D_1.

Musical Examples

FLÜGELHORN:

Stravinsky, *Threni*
Schoenberg, Theme and Variations, Op. 43a

ALTO HORN:

Hindemith, Sonata for alto horn and piano
Berlioz, *Les Troyens* ("Royal Hunt and Storm")*

BARITONE HORN:

Janáček, *Capriccio* for piano (left hand) and winds
Schoenberg, Theme and Variations, Op. 43a
Stravinsky, *Le Sacre du printemps* (Part I)

BASS TUBA:

Revueltas, *Sensemayá*
Stravinsky, *Le Sacre du printemps*
Varèse, *Déserts*
Messiaen, *Et exspecto resurrectionem mortuorum*

CONTRABASS TUBA:

Varèse, *Déserts*
Messiaen, *Et exspecto resurrectionem mortuorum*

* Most instruments—including the alto horn—have changed quite a bit since Berlioz's time. One must bear in mind when studying this score that it documents an historical practice—even if modern instruments are used to play the piece. Compare this book with Berlioz's orchestration treatise.

TUBA (BASS OR CONTRABASS):

L. Hiller, *Malta*

Additional Examples

BRASS IN LARGE GROUPS:

Stravinsky, *Ebony Concerto*
Schoenberg, Theme and Variations, Op. 43a
Hindemith, Symphony in B♭ for concert band
Grainger, *A Lincolnshire Posy*
Varèse, *Ecuatorial*
Messiaen, *Et exspecto resurrectionem mortuorum*
Xenakis, *Akrata*