THE *Musical Instrument* DESK REFERENCE

A Guide to How Band and Orchestral Instruments Work

MICHAEL PAGLIARO

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A Guide to How Band and Orchestral Instruments Work

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Foreword

Dr. Michael J. Pagliaro's *The Musical Instrument Desk Reference* appears at a time in the evolution musical instrument teaching and technology when, by virtue of the changes in the world's economy, more broad-based knowledge of instruments is required. In order to fill the needs of their personal ar school budget requirements, music teachers and technicians must now teach and service a great variety of instruments. These often include instruments completely foreign to those with which th practitioner might otherwise be most familiar.

Specializing in one instrument can seem a divine aspiration. The world will always need experts individual instruments. However, their restricted range necessarily limits the need for suc individuals, and a complete professional career based on expertise in one instrument is seldom viabl Those who choose to pursue a career in instrumental music have no choice but to expand the horizons to include a general knowledge of the more commonly used instruments. Notwithstandi the distinct advantages offered by specialization, few instrumentalists can survive on such narro expertise. The trend today is toward a more general practitioner form of professional involvement.

Dr. Pagliaro, a general practitioner with some sixty years of experience, has distilled his extensiv knowledge into a concise, reader-friendly document. Throughout the book, the various charts ar illustrations successfully underscore the written text, and each chapter begins with a quick sta section where the reader can easily glean any information necessary to begin work with a ne instrument. That quick start section is then followed by an in-depth discussion of the instrument or i family, allowing users to explore its operation in more detail.

Although other sources for this type of information exist in texts and method books, Dr. Pagliaro reference resource is the very first to combine all of the essential musical instrument material within single volume. Without question, it is the *sine qua non* of publications associated with the field musical instrument study.

Looking back over my thirty-five-year career as a music educator, I only wish at the time I cou have had in my possession this most essential book. It is an indispensable resource for mus educators and technicians, and should live as a permanent addition in the libraries of educators ar students at all academic institutions offering instrumental music and music education degr programs.

Dr. Earl Groner taught instrumental music in the Scarsdale School District of New York for thirty five years, has served as president of the Westchester County School Music Association in New Yor the New York State School Music Association (NYSSMA), and the Eastern Division president of MEN (now NAfME). Dr. Groner is also known for his work as music director and conductor of the Empir State Concert Productions and the Scarsdale Symphony Orchestra.

Preface

This manual provides important information for teachers, students, and technicians who work wi musical instruments on which they are *not* accomplished performers.

Instant, easy access is available to a simplified version of basic information common to the nee of the musical instrument practitioner, be he a teacher, teacher in training, technician, or student n proficient in the instrument under study. The operative words here are *easy access*. There will longer be a need to leaf through lesson books or boot up a computer to Google in the middle of a cla or project. Flip a page in the book on your desk and the answer will be there.

The manual is formatted with an Easy-Reference Quick-Start section (the first half of ma chapters) to provide users with immediate, easy access to illustrated, clearly and succinctly present information that may be needed during a lesson or for another immediate need. Basic fingering char assembly procedures, playing positions, embouchure hints, and other helpful facts are all instant available for those dealing with a non-major instrument.

Following the Easy-Reference Quick-Start sections are Expanded In-Depth Study sections, whi provide detailed, more extensive discussions on the topics covered in the Quick-Start sections.

It is worth noting that the study of music, like the study of medicine, is both an art and a scien Practitioners will sometimes have different opinions on procedures for practicing their trade. As y read through sections of this manual on which you, the reader, are an authority, you may be disagreement with matters or procedures stated in the text. Topics such as embouchure, alterna fingering, choice of equipment—and those topics that are not grounded in empirical scientific fact b that have more than one direction or process that has proven to be successful with particul individuals—can be open to challenge. The research used in preparation for writing this manual h directed the author to present such topics from a centrist articulation. The information proffered h been derived from a majority of historical successes in mainstream musical performance and stu throughout the ages. There is often more than one way to execute a musical experience. This manu presents the method that is most often used.

To avoid the necessity to look back for information previously mentioned that is relevant to a top under study, and because the manual can be used for specific references without reading it from cov to cover, some repetition will be present throughout the text.

Chapter 1

Introduction

Quick-Start Notes: Fingering

The traditional introduction to fingering for any instrument usually uses a chart illustrating, ascending order, all of the fingerings for all the notes in the range of the instrument being studied. I this manual, some fingering charts are written in descending order with illustrated fingering becau descending is the natural order by which many instruments—and especially brass instruments—arriv at their sounds. By studying the patterns apparent in the descending order, it is easier to visualiz reoccurring fingering patterns for all instruments of the choir under discussion. Understanding the fingering patterns greatly reduces the need to memorize each individual fingering chart.

This manual offers basic fingering charts for the instruments under study. Let it be clearly note that more extensive charts covering alternate fingerings and trill fingerings for all instruments exi and are available in publications that focus on a specific instrument or that deal with fingering char alone.

Understanding enhances knowledge. If you know how something works, it is a lot easier to work This manual helps practitioners understand the technology of all concert band and orchestral music instruments commonly in use.

The Anatomy of a Musical Instrument

Musical instruments are devices that have been developed to produce and manipulate sounds. The instruments achieve such a high degree of accuracy that they enable a player to perform an almo infinite variety of musical sounds. Although musical instruments are far from perfect, their inventor developers, and manufacturers have refined their products so as to challenge the ability of even th most gifted performer.

Musical instruments use three basic operating systems. These are: (1) a sound-generating system (2) a sound amplification system, and (3) a sound-manipulating or mechanical key system.

Sound Production

Sound production systems are different for each category of instrument, and are of five types: thre for woodwind instruments, one for brass instruments, and one for non-fretted string instruments.

Woodwind instruments generate sound by using (1) a single reed in conjunction with a mouthpiec (as in a clarinet or saxophone), (2) a double reed (as in an oboe or bassoon), or by using (3) a fla shelf-like surface positioned to allow a stream of air to undulate over and under the edge of the she (as in a flute or recorder).

Brass instruments generate sound by having the player's lips buzz within the confines of (4) a cu
shaped mouthpiece. This process is common to all brass instruments. It should be noted that there a
variations in embouchure and buzzing techniques that apply to the different brass instruments. Th
basic principle, however, is the same in all cases.

Non-fretted string instruments (violins, etc.) generate sound by (5) setting a string into motio (vibration) either by drawing a bow across the string's surface or by plucking the string with th fingers. There are some alternative methods of generating sound from strings but these are specific producing special effects and are not relevant to this work.

Amplification of Sound

Sounds produced by an instrument alone cannot provide sufficient volume and the timbre necessary satisfy the musical and aesthetic requirements of the listener. Therefore, a sound amplification syste is needed to complement the sound-generating processes.

These sounds require a support system to supply the amplitude necessary for the fundamentals an their overtones to attain the timbre desired. The support system is, in fact, the body of the instrumen It is the design and construction of the support system in conjunction with the sound-generatin system that ultimately produce the characteristic sound or timbre of an instrument.

Thus far, a device composed of a sound-producing mechanism coupled with a support system provide the amplitude and timbre desired for a specific sound effect has been described. This coupl acoustic system (i.e., the sound source and the associated structure or body of the instrument) sti cannot provide a musician with the equipment necessary to produce and manipulate sounds wi sufficient variety and versatility to perform music.

The coupled device is limited to producing only those sounds that are fundamental to the physic characteristics of the design. Consequently, a brass instrument–type construction would be capable producing only those pitches that are the product of the player's adjusting her lip tension embouchure; a woodwind design would produce essentially the same type of result; and a strin instrument would produce only those pitches to which the strings are tuned.

It is at this point in the design of an instrument that an additional system is necessary. That syste must alter the length of the vibrating column so that the pitches that exist between the fundamental namely, the chromatics, can be added to the fundamental or open tones.

Controlling Sound

Sound is controlled through mechanical systems such as valves and slides for brass instruments; ton holes, ring keys, and padded keys for woodwind instruments; and the shortening of strings through th use of fingers of the left hand on the non-fretted string instruments. These systems, added to the bas design of the instrument's body, and joined to a sound source, permit the player to lengthen or shorte the vibrating column of air or string by small degrees. In so doing, the player can produce the pitch that lie between the fundamentals in wind instruments and the tones that exist between the pitches which the open strings are tuned in the non-fretted string instruments.

As the vibrating column of air or the vibrating string is shortened, the pitch is raised. Conversely, the vibrating column of air or the vibrating string is lengthened, the pitch is lowered.

In the case of woodwind instruments, the altering devices take the form of holes in the body of th instrument. Some holes are open and some have padded, cup-shaped keys covering them. As the hol are covered, the sound-producing column of air within the instrument becomes longer. If the holes a open, the effective length of the instrument becomes as long as the distance between the sour generator and the first open hole.

Brass instruments have valves or slides that open sections of tubing to lengthen or shorten th vibrating column of air.

On string instruments, the length of the strings is shortened by pressing (stopping) the string to th fingerboard at any given point with the fingers of the left hand.

It is the combination of the sound generator coupled with the body of the instrument and th devices used to alter the length of the vibrating column or string that makes a wind or strir instrument capable of producing all of the notes that are within that particular instrument’s range.

The Science of Sound

Sound occurs when a force excites vibrations in the atmosphere. These vibrations are projected by series of compressed and released waves of air pressure. Molecules of air are pushed against eac other, acting as a train would when the last car is pushed and each car preceding the last one respond in turn in a chain reaction. Since one single molecule of air cannot travel very far on its own, th molecules must push against each other in order to permit the sound to travel.

When this action and reaction takes place in the air, a wavelike motion produces groupings o molecules positioned in alternating sequences. The first grouping of compressed molecules is referre to as *compression*. The grouping created by the void left behind the compression is in a more ope spatial relationship and is called *rarefaction*. It is the combined action of compression and rarefactio that results in one complete cycle (Fig. 1.1).

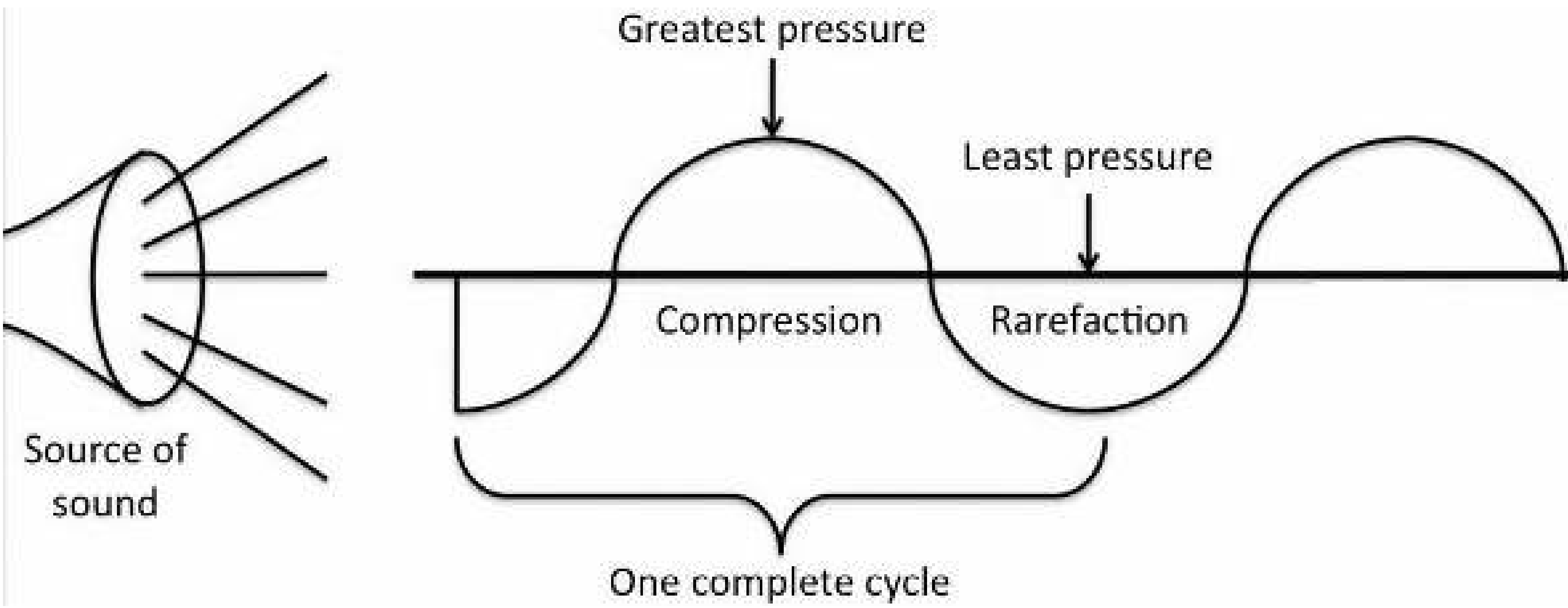

Figure 1.1. Complete cycle.

When vibration is initiated on a string, movement begins at the point of rest or equilibrium (Fi 1.2, point A). The movement proceeds to its upper limit (point B), begins a return trip traveling bac through the original point of rest or equilibrium (point A), and then continues on to the opposite lower limit (point C). The movement then travels back again returning to the point of equilibriu (point A). This entire voyage completes one cycle. Similarly, one cycle in sound consists of vibration passing by means of compression and rarefaction through every position that encompass its point of equilibrium (Fig. 1.2). This type of pure tone is called *sinusoidal* and its image is called sine wave.

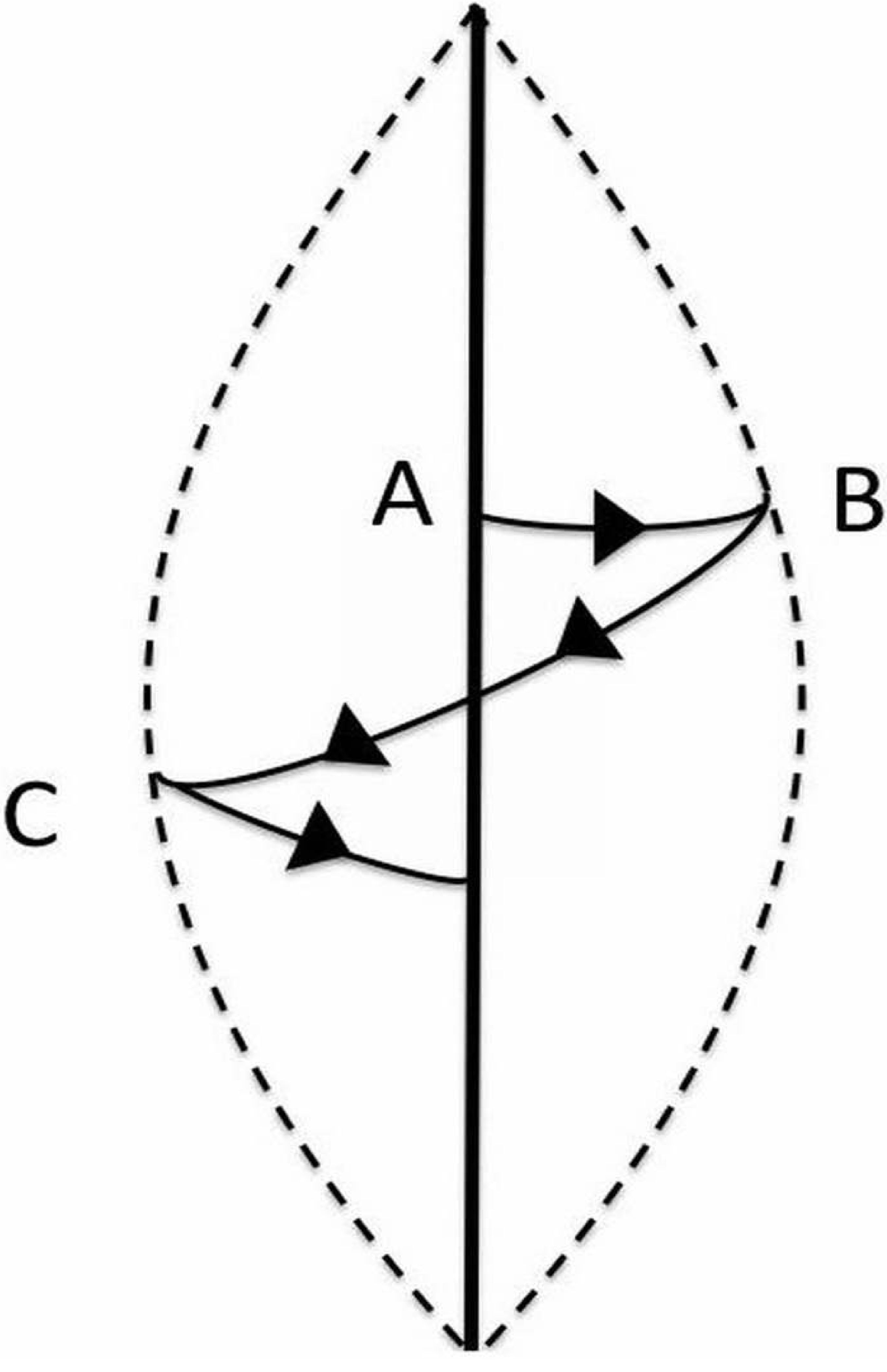
A
B
C

Figure 1.2. Equilibrium.

When sound is generated on a musical instrument, the sound presents itself in a symmetric pattern of vibrations. These vibrations include a fundamental note along with a number of oth related notes sounding in lesser degrees of amplitude or volume. The fundamental note alone is a pu tone and can be visualized as a simple wave, free from any accompanying vibrations or tones (Fi 1.3).

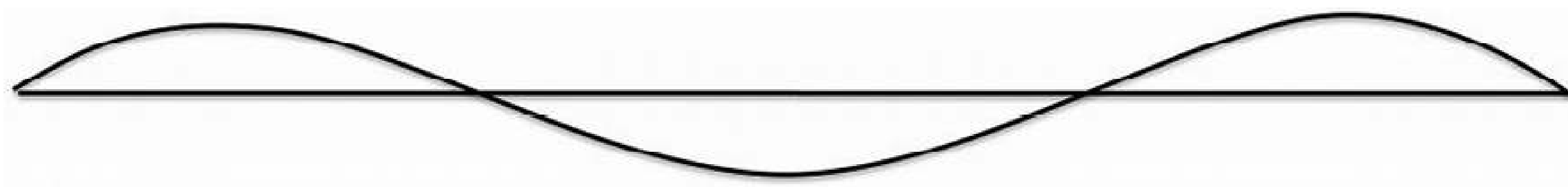

Figure 1.3. Sine wave.

Pure tones are best produced electronically and are generally considered to be musical uninteresting. When a tone is generated on a musical instrument, it is almost always accompanied by series of related sounds or tones called harmonics, overtones, or upper partials. These three terms ca be used interchangeably.

Harmonics (overtones, upper partials) are secondary vibrations occurring concurrently with th fundamental tone and consist of successive multiples of the whole vibrating body. The segmen occur, for example, as one half, one third, or one quarter of the original vibrating column and sour with less amplitude than the fundamental (Fig. 1.4).

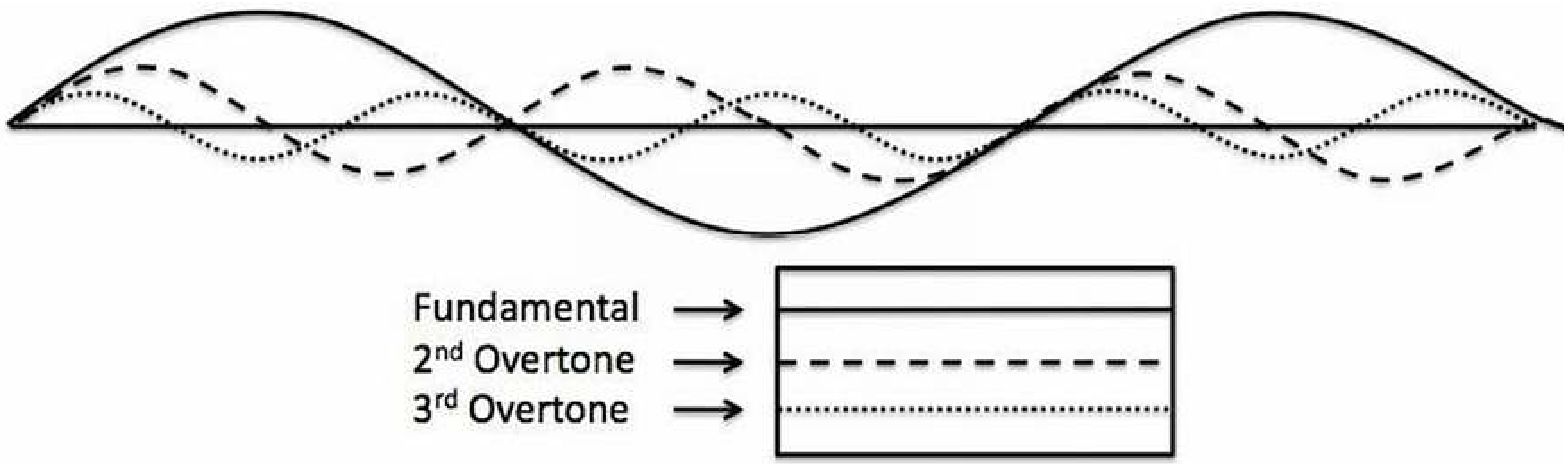

Figure 1.4. Harmonics.

Harmonics are embellishments of the fundamental tone. They are not distinguishable by the listen as entities in themselves but rather serve as ornamentation to the fundamental. As such, harmonic give a distinctive character to a pitch, allowing the listener to distinguish among the differe instruments or voices.

Vibrations per second are commonly referred to as cycles per second (cps) or Hertz (Hz), name after the physicist Heinrich Hertz. The number of Hz refers to a number of complete cycles p second, and so 30 Hz means 30 cycles per second. Any given tone is the product of the number vibrations or cycles that occur per second, for example, “A” 440 is the tone that is produced by sound generator producing 440 vibrations or cycles per second (Fig. 1.5).

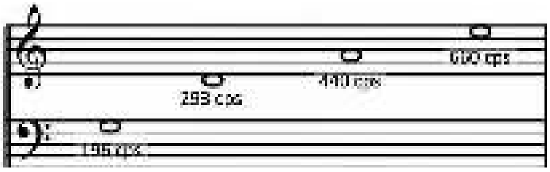

Figure 1.5. Cycles per second.

Although noise is sometimes used in musical performance, tone is more frequently utilized. It i therefore, necessary to understand those attributes of sound production that modify noise, thereb converting it into a tone. These attributes are pitch, amplitude, and timbre.

Pitch refers to the highness or lowness of tone. The notes of an ascending scale (do, re, mi, fa, so la, ti, do) go up in pitch or are successively higher (Fig. 1.6). Conversely, in a descending scale (do, t la, sol, fa, mi, re, do), the notes go down in pitch or are successively lower (Fig. 1.7). Any series notes can take one of only three possible directions in pitch. They can ascend (Fig. 1.8A), descen (Fig. 1.8B), or remain the same (Fig. 1.8C).

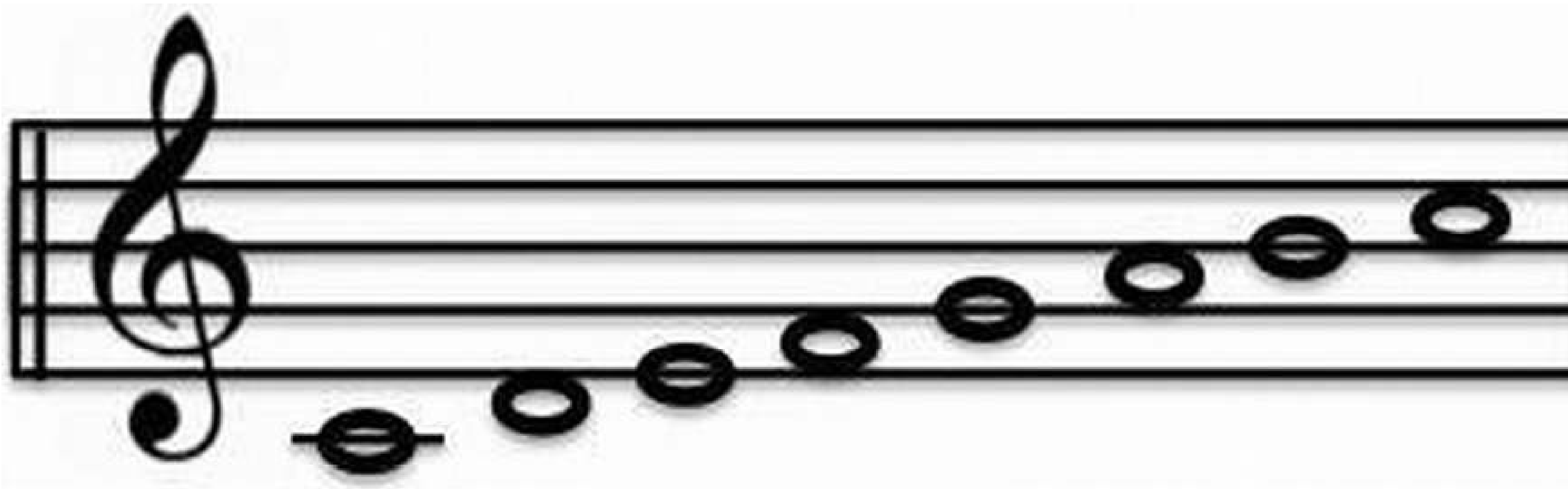

Figure 1.6. Ascending scale.

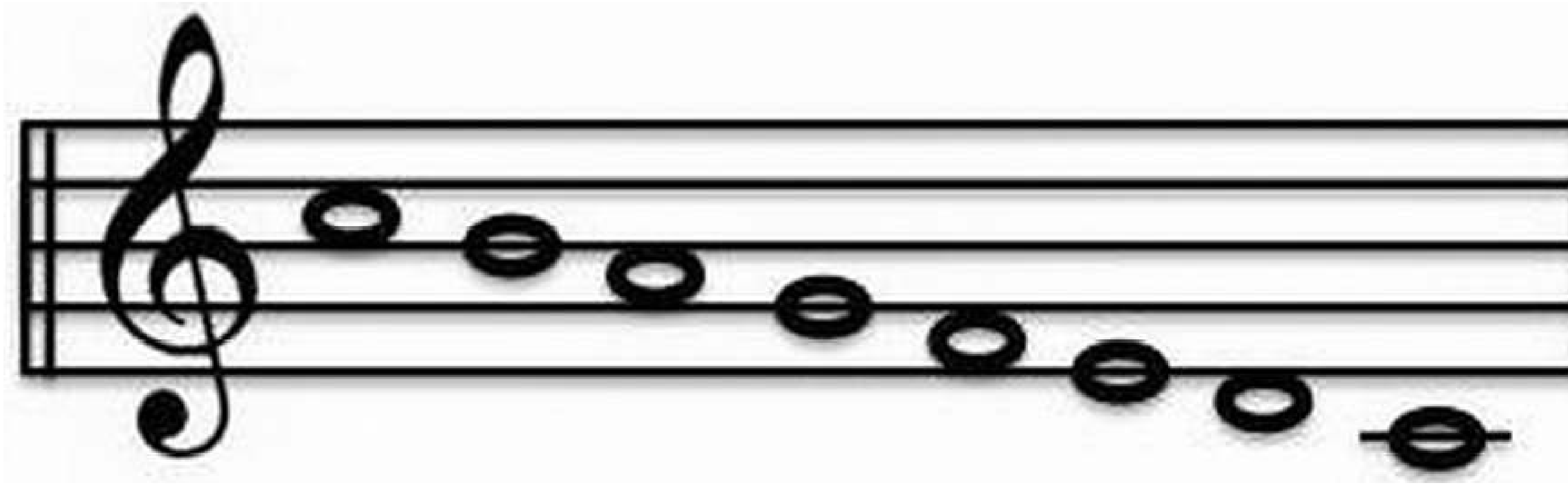

Figure 1.7. Descending scale.

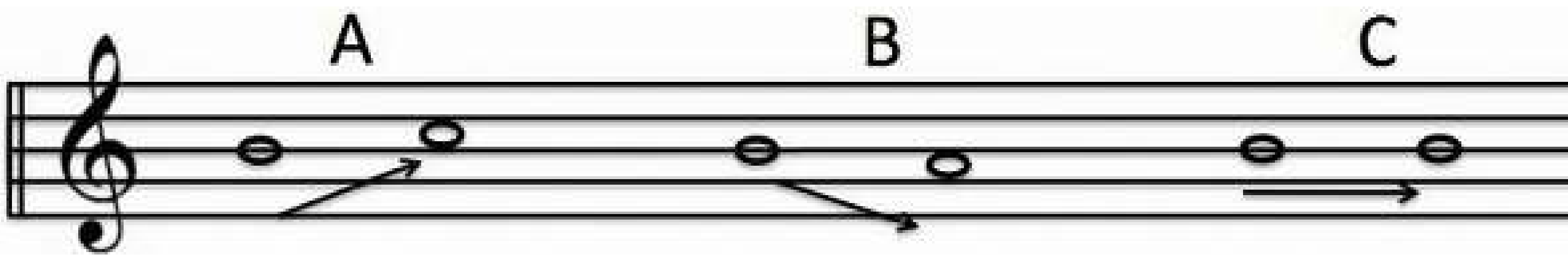

Figure 1.8. Pitch direction.

Amplitude, a form of energy, refers to the volume, or loudness of a sound. Greater amplituc produces louder sounds, whereas less amplitude produces softer sounds. A sine wave is a way c representing a single frequency with no harmonics. If a sine wave is used to measure the amplitude a tone, the amplitude is indicated by the distance from the point of equilibrium to the outermost lim of the sine curve (Fig. 1.9).

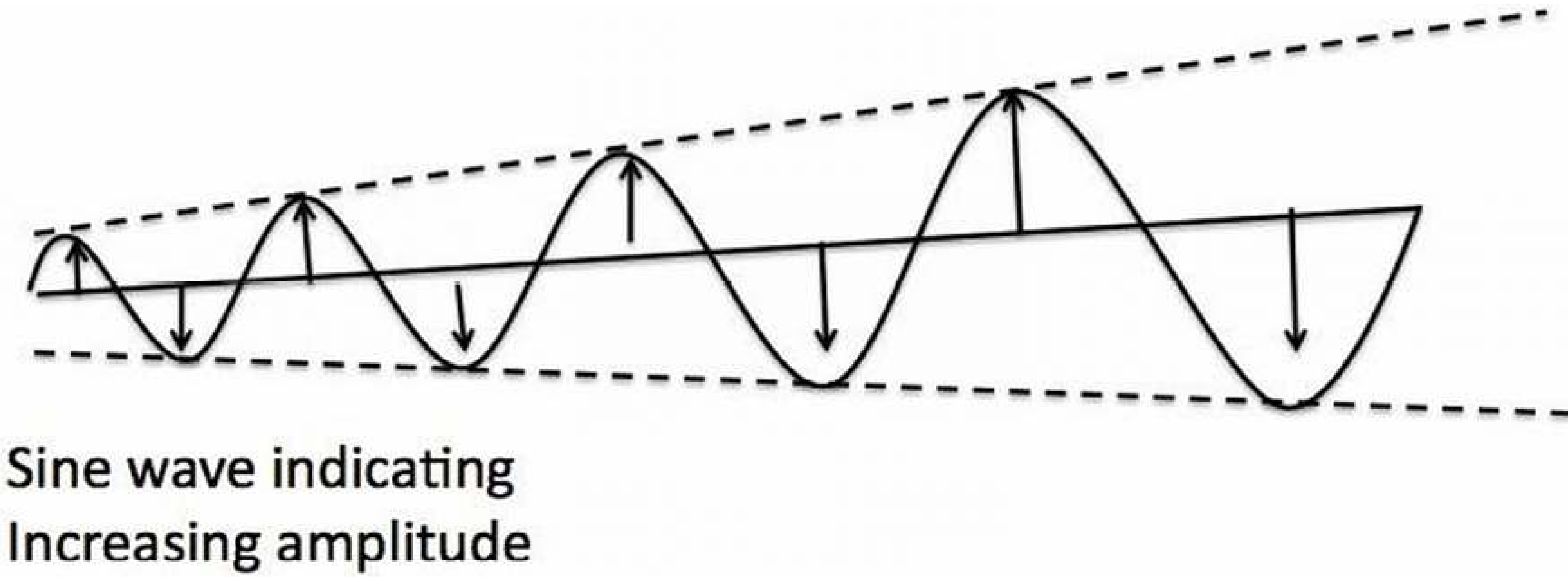

Figure 1.9. Amplitude.

As is the case with any force, there is a gradual diminution of the energy as it is confronted wi resistance such as friction, absorption, or dispersion. With this gradual decline in energy, the tone wi dissipate or fade away.

Amplitude (volume) is one of the several physical components that goes into the total character of musical tone. Amplitude is the force with which the sound is being produced and is common referred to as volume or loudness. The more forceful the vibrations per second, the louder the soun Conversely, the weaker the vibrations per second, the softer the sound. Amplitude does not affe pitch. Any pitch can be produced at any amplitude and, therefore, can sound at any volume.

Timbre is the product of the addition of harmonics to a fundamental sound. These additional soun referred to as harmonics (overtones or upper partials) (see Fig. 1.4) result from the inherent acoustic characteristics of the sound-producing mechanism (i.e., the instrument producing the sound).

For the note “C,” these sounds follow the harmonic sequence pictured in Figure 1.10 and are prese in most tones. The same interval pattern would occur for any note.

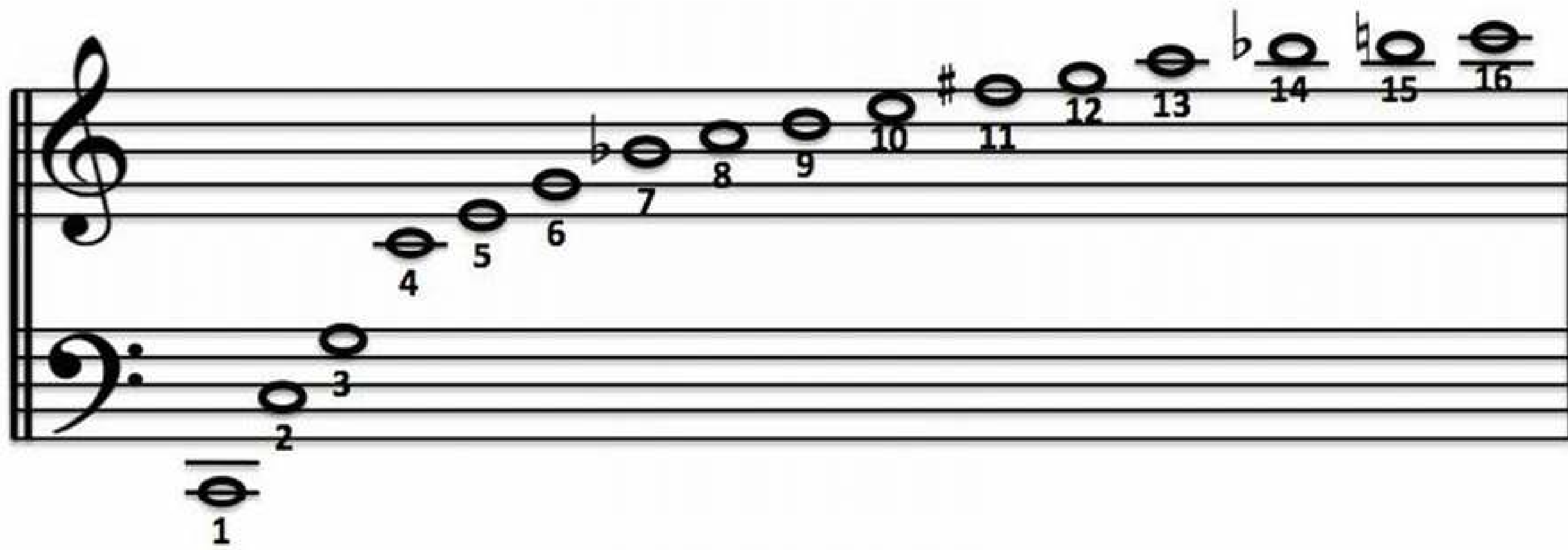

Figure 1.10. Harmonic sequence.

The difference in timbre that is sensed by the listener is the result of the streng (volume/amplitude) of the additional sounds (harmonics) and how they relate in volume to th fundamental. The greater the strength, volume, or amplitude of the additional sounds (harmonics) th more intense the nature or timbre of the sound of the instrument. The less th strength/volume/amplitude of the additional sounds (harmonics) the less intense the timbre. A example is the oboe. Tones played on an oboe have strong harmonics/upper partials producing a ton that can be identified as having an intense timbre. Conversely, the flute has a comparatively weak s of harmonics/upper partials and, therefore, produces a more mellow tone.

Summary

Brass instruments have valves or slides that open sections of tubing to lengthen or shorten th vibrating column of air.

Woodwind instruments have a series of holes in the body of the instrument, which the player ca open or close to lengthen or shorten the vibrating column of air in the instrument.

String instrument players lengthen or shorten the strings by pressing (stopping) the string to th fingerboard at any given point with the fingers of the left hand.

It is the combination of the sound generator coupled with the body of the instrument and th devices used to alter the length of the vibrating column or string that makes a wind or strin instrument capable of producing all of the notes that are within that particular instrument’s range.

Sound occurs when a force excites vibrations in the atmosphere. When a tone is generated on musical instrument, it is almost always accompanied by a series of related sounds or tones calle harmonics, overtones, or upper partials. These secondary vibrations embellish the fundamental ton giving it a distinctive sound quality or timbre.

Woodwind Instruments

Easy-Reference Quick Start

Sound Production

Woodwind instruments share many physical and operational characteristics. They produce soun using:

- a single reed (Fig. 2.1A) held on to a mouthpiece (Fig. 2.1B) by a ligature (Fig. 2.1C) as on clarinet or saxophone;

Figure 2.1. Reed/mouthpiece/ligature.

- a double reed (Fig. 2.2) as in an oboe, English horn, or bassoon;

Figure 2.2. Double reed.

- or a flat, shelf-like surface (Fig. 2.3) positioned so as to allow a stream of air to undulate ov and under the edge of the shelf as in a flute or recorder.

Figure 2.3. Flat shelf.

Intonation/Tuning: General Principles

The axiom is that bigger or longer instruments produce lower sounds and, conversely, smaller shorter instruments produce higher sounds.

The overall pitch of an instrument can be changed by adjusting its length. However, when tuning b using this process, not all notes adjust proportionately. Some become in tune while others the become out of tune.

This manual will cover tuning at its fundamental level. More advanced tuning procedures f particular notes on instruments is a study that requires the attention of an expert teacher experienced performer.

Fingering: General Principles

The traditional introduction to fingering on any instrument usually begins with a series of one-note-a a-time separate topics accompanied by a fingering chart of all the notes for that instrument. Using th approach, the student rarely realizes that every instrument has a simple, repetitious pattern that, whe understood in its totality, significantly facilitates determining fingering for all notes on all th instruments in that choir.

All woodwind instruments are constructed with a basic set of six tone holes on the front of the bod of the instrument. These six tone holes are covered by the index, middle, and third finger of each han (Fig. 2.4A). Tone holes in other locations on the body covered by keys complete the notes on th instrument (Fig. 2.4B).

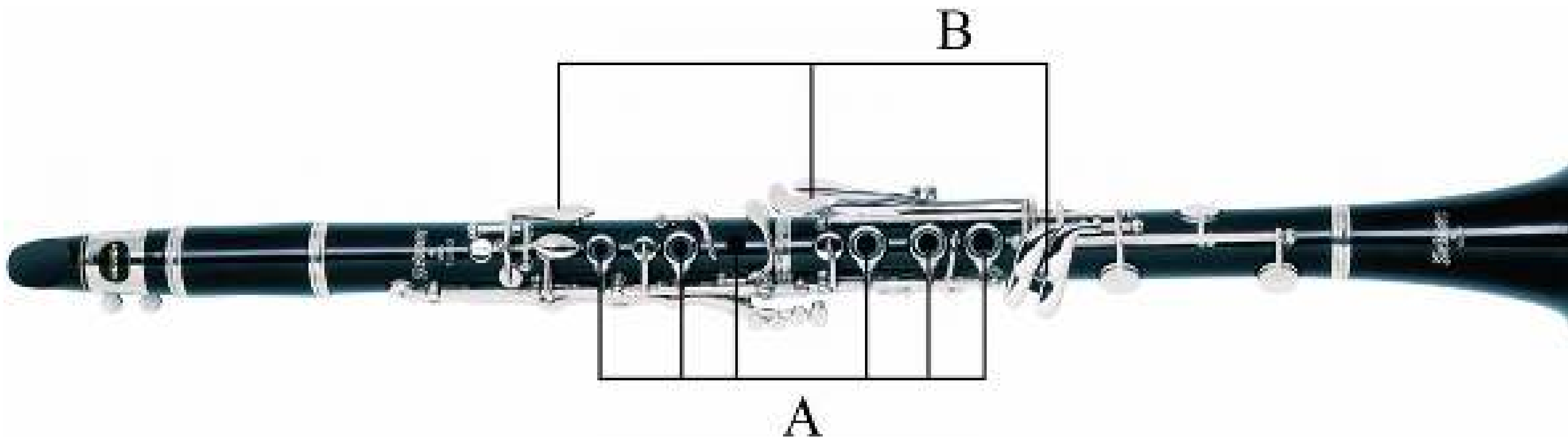

Figure 2.4. Six tone holes.

The fingerings for woodwind instruments are similar for many notes. The flute, oboe, an saxophone are very close, and the clarinet and bassoon also share patterns. An understanding of th patterns can be very helpful in determining fingering for the various instruments without having resort to a fingering chart. Also helpful is to be aware of and to apply the concept that the effectiv length (i.e., the vibrating column that produces the sound on an instrument) is as long as the distan between the mouthpiece and the first open hole (Fig. 2.5A). As the holes are covered, the instrume becomes longer and the sound lower (Fig. 2.5B).

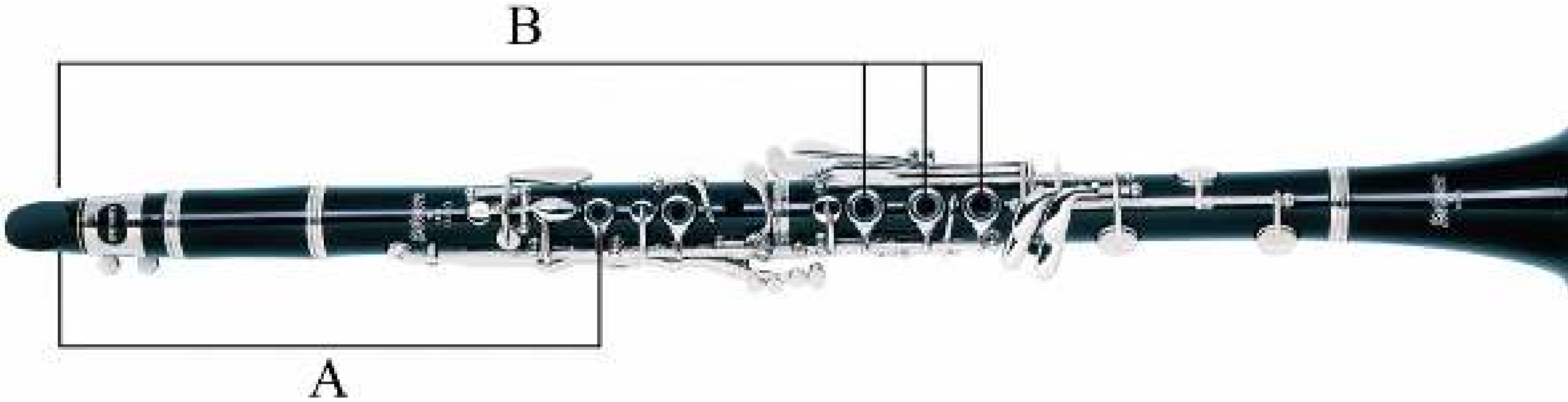

Figure 2.5. Clarinet effective length.

Covering the thumb hole (Fig. 2.6A) and then covering the six open holes one at a time descending order from the top down will produce a descending scale. Depressing the register key (Fi 2.6B) with the thumb hole covered will raise all notes on a clarinet a twelfth. On other woodwi instruments, the thumb key will raise the notes an octave. Pressing the side keys will alter the ton produced when any or all of the six open holes are covered (Fig. 2.7).

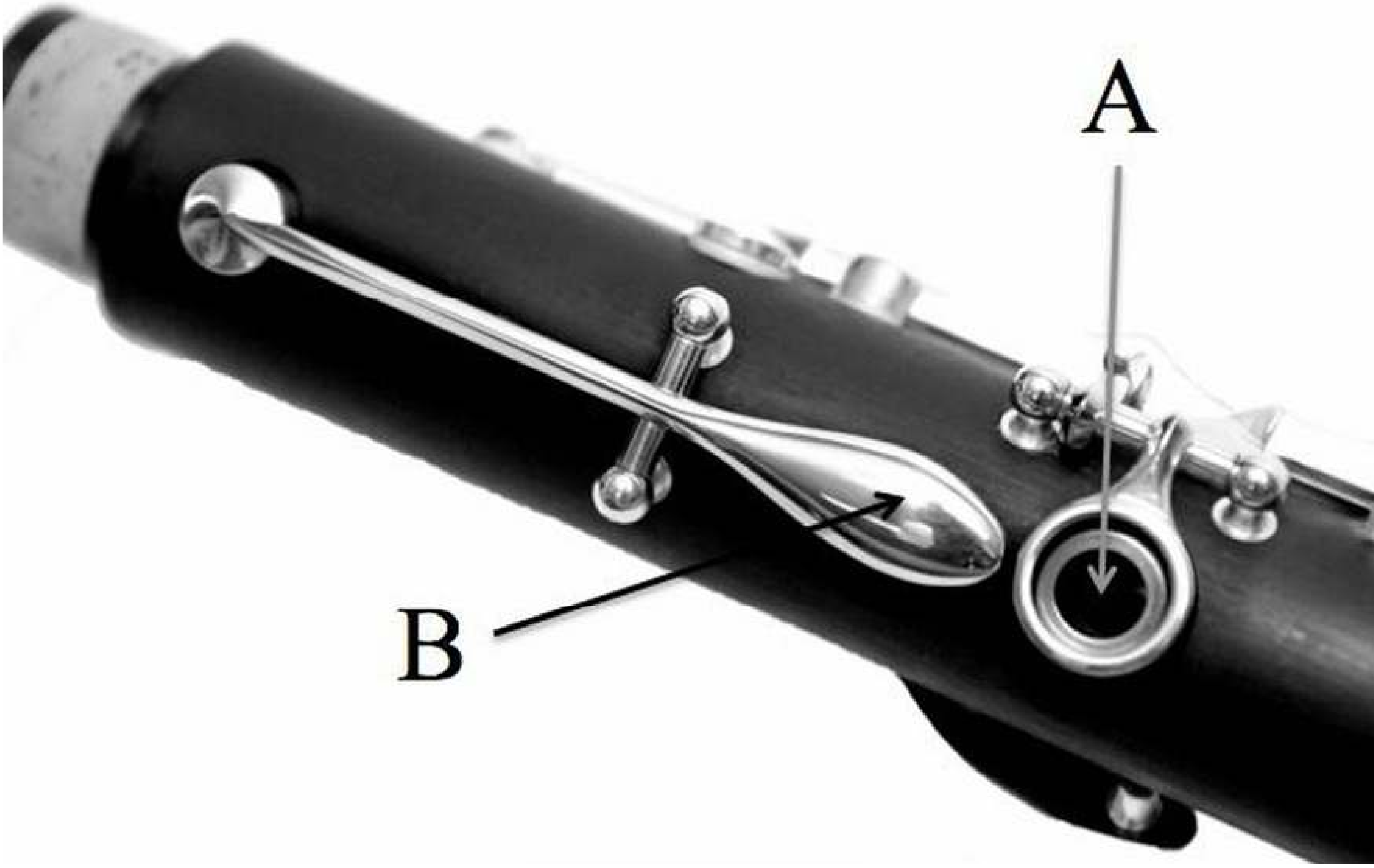

Figure 2.6. Thumb hole and register key.

Figure 2.7. Side keys.

The Flute

Easy-Reference Quick Start

Assembly

The flute (Fig. 3.1) consists of a head joint (A), body (B), and foot joint (C) joined together by tenor that interlock with each other. To assemble a flute, hold the body at the top in your right hand. Do no touch the keys (Fig. 3.2).

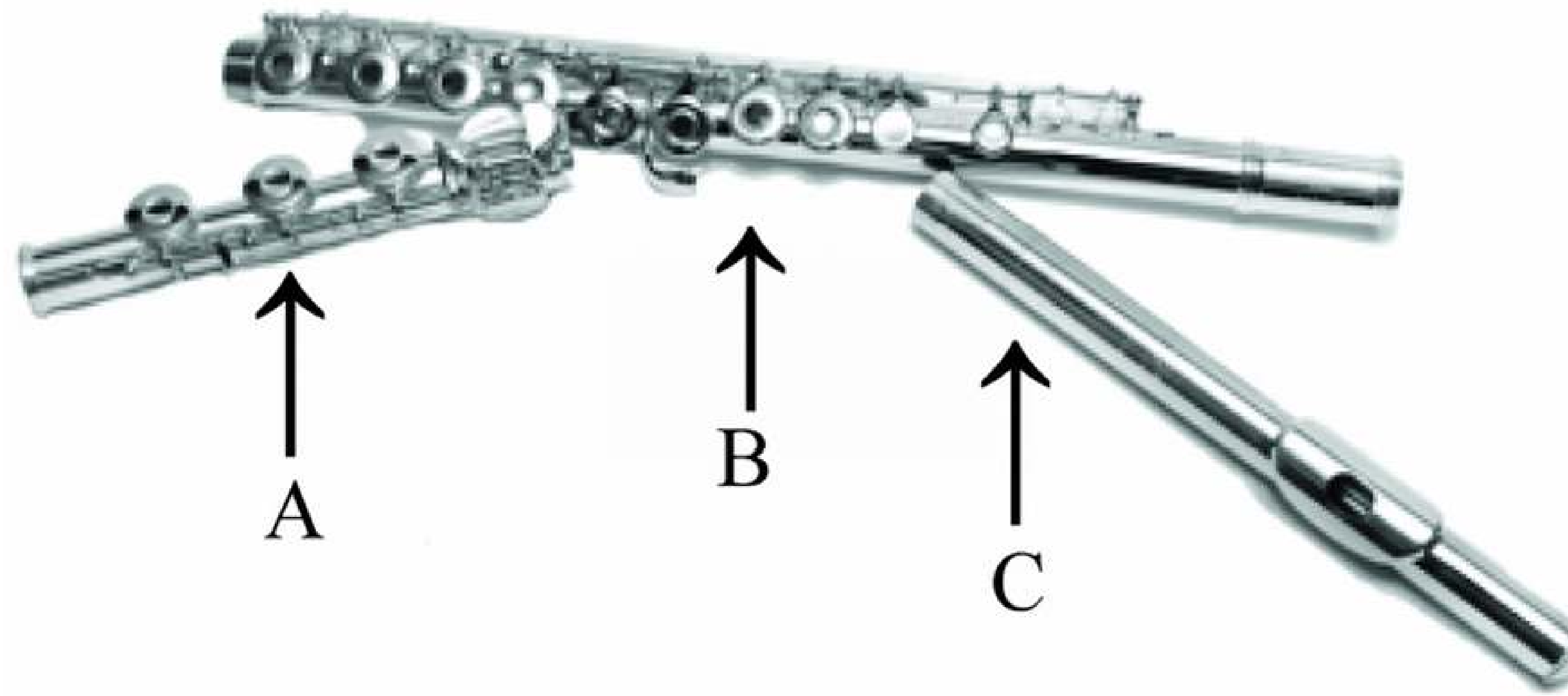

Figure 3.1. The flute.

Figure 3.2. Assembling the flute.

Take the head joint with your left hand and gently twist it into the top of the body so that th embouchure hole lines up with the keys. Holding the instrument by the head joint with your left han pick up the foot joint with your right hand holding down the two large keys. Twist the foot joint place so the key rod is centered on the keys on the body (Fig. 3.3).

Figure 3.3. The foot joint.

Sound Production: The Head Joint

To produce a sound on a flute, the player rests the lip plate against his chin, just below the lower li and directs a stream of air focused across the tone hole (Fig. 3.4). As the stream of air strikes the edg of the embouchure hole opposite the player's lip, the air stream undulates above and below the edg exciting a pattern of vibrations within the head joint (Fig. 3.5). These vibrations set the air containe within the body of the flute into motion. The body then acts as an amplifier for the sound generated the head joint.

sample content of The Musical Instrument Desk Reference: A Guide to How Band and Orchestral Instruments Work