AN ILLUSTRATED BASIC FLUTE REPAIR MANUAL FOR PROFESSIONALS

DOCTOR OF MUSICAL ARTS DOCUMENT

Presented in Partial Fulfillment of the Requirements for
The Degree Doctor of Musical Arts in the
Graduate School of The Ohio State University

By

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The Ohio State University
2008

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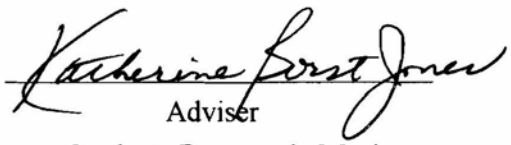

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ABSTRACT

This document is a comprehensive flute repair manual for the modern Boehm and Brögger flute mechanisms. Written for college professors and students, as opposed to professional repair technicians, this illustrated document offers step-by-step procedures to guide readers through standard repairs and maintenance. All chapters use four-color illustrations and offer practical repair techniques in a tight sequential order.

Easy, sequential instructions in this manual minimize the complexity of basic flute mechanism repairs. Brief textual explanations accompany hundreds of close-up photos that take readers from the gathering of simple tools and supplies to the sophisticated techniques needed for repairs generally performed by the professional technician. This manual offers literacy on two levels: the brevity of the written word and the unparalleled quality of images. This manual takes professors, students and flute aficionados to a whole new level of flute understanding and appreciation.

Evolutionary aspects of the modern flute mechanism are included. Building a historical perspective helps readers understand the painstaking and prolonged efforts of flute makers of the past and their unique contributions to the making of the modern flute mechanism, as we know it today. Such a profound appreciation of flute development helps flutists see the extraordinary relationship between the mechanics and the fine art of making music.

Dedicated to Father Robert Massé

ACKNOWLEDGMENTS

I wish to express my sincere gratitude and appreciation to my adviser, Professor Katherine Borst Jones, for her countless patience and valuable suggestions during the process of this document. I have learned a lot from her during the six years at The Ohio State University. I also wish to sincerely thank my document committee Dr. R. J. David Frego, Professor Robert Sorton and Professor James Pyne, for their insightful comments and constructive advice for the contents of this document. I am also grateful to Dr. Patrick Woliver, for his support and advice as the Graduate Studies Chair.

I would like to acknowledge my indebtedness to two Taiwanese flute makers, Mr. Geoffrey Guo and Mr. Cheng-Rong Wang, for their selfless teaching, wonderful ideas and technical support on flute repairing techniques. My gratitude also goes to Dr. Jo-Ann Triner, for her expertise on document writing, her insightful opinions on this document, and her assistance as my English tutor. I also wish to thank Ms. Karen Clausen of *Flute*

Arts, former Finishing Department Manager of Brannen Brothers Flute Company, for reviewing this document and providing constructive advice and suggestions.

I wish to especially thank Father Robert Massé, my first flute teacher, for taking me as the youngest student during my Secondary school study. His love and endless words of encouragement continue to help me.

I will forever be grateful to my parents and siblings for their unconditional love and understanding. I also owe a great debt to my parents-in-law, for their endless words of encouragement and prayers. In addition, my heartfelt gratitude goes to my wonderful family: my wife and the photographer of this document, Vivian, for her love, understanding, support, encouragement and prayers during the eight years of our marriage; and my two adorable sons, Austin and Justin, for their cute personalities that cheer my heart every day.

Finally, my deepest thankfulness goes to my Heavenly Father, for His endless love, blessings and promises. This document could not be done without the strength and wisdom He granted me.

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CHAPTER 1

A CONCISE EVOLUTION OF THE MODERN FLUTE MECHANISM

The Boehm Flute Mechanism

In 1660, Jacques Martin Hottetterre invented the one-key flute. Further refinements of this one-key system resulted in additional keys being added over the next several hundred years. This evolution resulted in an eight-key system developed by Rudall & Rose in 1827.[1]

When the first orchestra was formed in the later half of the 18th century, the flute was included but proved inadequate due to its low volume. However, the popularity of the flute continued to grow and became even more important due to the instrumental

[1] Nancy Toff. *The Development of the Modern Flute*. (New York: Taplinger Publishing Company), 1979, 27.

polyphony in Mozart's symphonies.[2] Because of increasing interests in the flute throughout the 19th century, people started to develop new key systems to meet the needs of the flutists and composers of that time.

Theobald Boehm (1794-1881) was one of the most important flute makers who applied the applications of science to the construction of the flute. Boehm was a goldsmith, engineer, composer and flutist. He began his study of the flute in 1810 with Johann Nepomuk Capeller (inventor of the d2 shake key), and later made a four-keyed flute for his own use and is thus recognized as both musician and inventor. In 1828, he established his own flute workshop in Munich, where he produced simple system flutes with the keys mounted on screwed-in pillars. Later on, Boehm experimented by connecting the keys with rod-axles, contributing to the evolution of the instrument[3] (Figure 1.1).

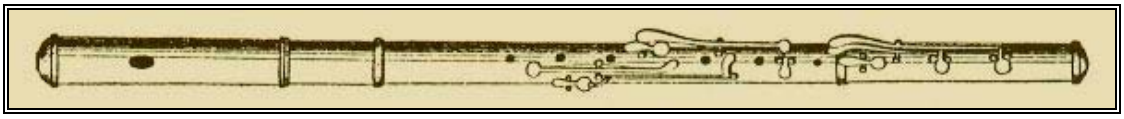

Figure 1.1: Boehm's 1829 Nine- Key Conical Bore Flute with small tone holes, rings, studs, flat gold spring and silver keys mounted in short silver pillars[4]

[2] Ibid.
[3] Ibid, 46.
[4] Ibid, 47.

Boehm's 1831 flute

Intonation was an inherent problem of the eight-keyed German flute. It was not dynamically powerful enough to compete with the brass section of the Romantic orchestras.[5] Boehm was bothered by the lack of volume on the old system German flute[6]. In 1831, Boehm made his first flute during his visit to London. While performing several concerts there, Boehm noticed the incomparable sound produced by English virtuoso flutist, Charles Nicholson. Nicholson's tone was significantly louder than Boehm's. In a letter (dated 1871) to J. S. Broadwood, Boehm wrote: "I did as well as any continental flutist could have done, in London, in 1831, but I could not match Nicholson in power of tone, wherefore I set to work to remodel my flute. Had I not heard him, probably the Boehm flute would never have been made."[7]

Nicholson used a seven or eight-key flute with large tone holes that made the sound powerful. The increased size of these tone holes, however, also required a powerful

[5] Ibid, 46.
[6] Rick Wilson. "The Bohem Flute in the 19th Century," *Rick Wilson's Historical Flute Page* (Accessed on March 5, 2007). <http://www.oldflutes.com/boehm.htm>
[7] Ibid.

embouchure to control the tone and intonation. This inspired Boehm to conclude that the German flute fingering system needed to be totally redesigned to improve the strength and volume of sound.

Boehm's 1831 flute model was never produced commercially because Boehm did not think this model had enough improvements to warrant the making of a prototype[8] (Figure 1.2)

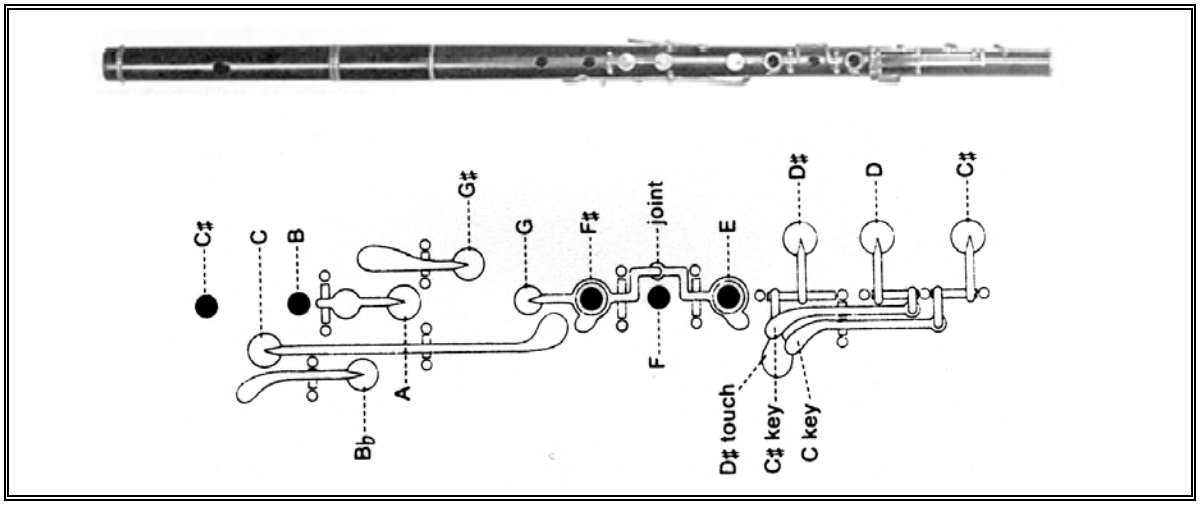

Figure 1.2: Boehm's 1831 Flute

Boehm's 1832 Flute

In 1832, Boehm re-measured the tone hole size believing that powerful tones could only be produced if the holes were placed in the acoustically correct positions.

[8] Toff, 53.

There were fourteen holes, one hole for the low C-sharp, one small hole for the upper trill key d" and d"', and the rest of the twelve holes for the chromatic scales starting from d'. Boehm made the size of the tone holes as large as possible, into equal-sized holes, to make the first two octaves in tune. The complete open-key system which requires that all keys except the D# key remain off their holes until being depressed by the player, was also adapted for the 1832 model to enhance the volume of the flute sound. Fourteen holes were controlled by nine fingers and twelve keys to make a chromatic scale functional. Two small holes for the trills were controlled by the long axles controlled by the right hand.[9]

Major changes of the Boehm flute after the 1831 model include:[10] (Figure 1.3):

1) The use of large finger-holes at the correct acoustical positions, allowing for equal temperament.
2) Covering the distant holes with keys and using the ring keys on the finger holes.
3) Changing the closed-key system to open-key system inspired by Captain Gordon, a military man and amateur flutist in London.

[9] Philip Bate. *The Flute:A Study if its History, Development and Construction.* (London: Ernest Benn Limited; New York: W. W. Norton & Company Inc.), 1969, p121.
[10] Toff, 49.

4) Left hand fingering remained the same as the German flute, only the A hole was repositioned down to its acoustically correct position to be depressed by the left hand third finger. Boehm did not enlarge the A tone hole size.[11]

5) The right hand holes were re-spaced down to the correct positions. Using ring keys to cover two holes at the same time, fingering was then changed.

6) Three ring keys are normally up, but when any of the F#, F, or E holes is covered, the F# ring key is automatically closed.[12]

7) Boehm used a key cup with a pad to cover the G key when the F# ring key was depressed by the F#, F or E key.

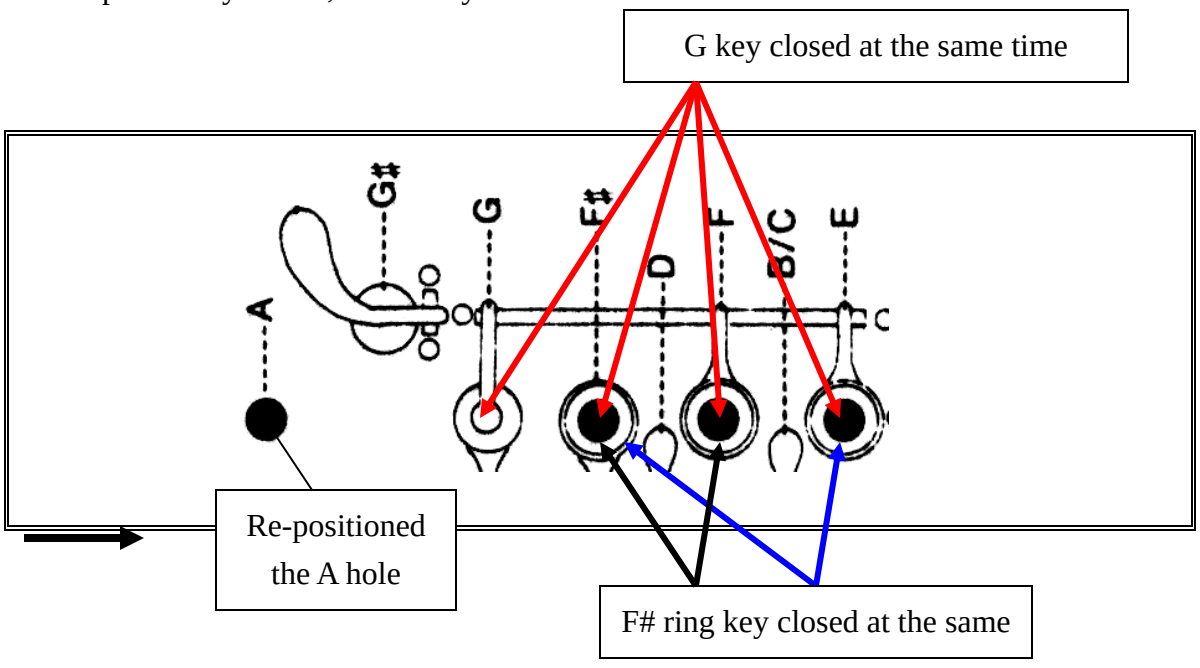

Figure 1.3: Two Major Changes on Boehm's 1832 Flute

[11] Ibid, 53.
[12] <http://www.oldflutes.com/boehm.htm>

In this 1832 flute model, Boehm simplified the key system to one fingering for each note. Simplicity was his goal for the mechanism. As we can see on the fingering chart (Figure 1.4), all the long axles are connected to one or two keys of the flute operated by the right hand.[13] Another new device used by Boehm was the crutch for the left-hand thumb (Figure 1.5). This wood crutch let the weight of the flute rest between the thumb and index finger, so the flutist could hold the flute steadily, thereby freeing the left hand. Because of its new revised fingering system, this model did not become popular in France until 1838.

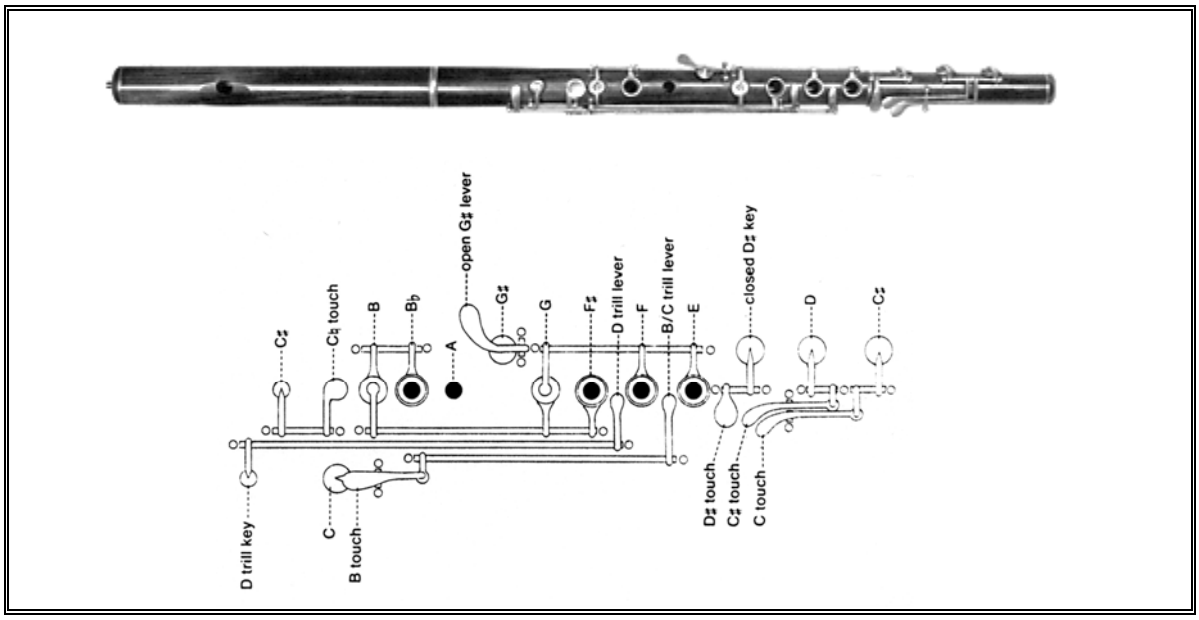

Figure 1.4: Boehm's 1832 Flute

[13] Ibid.

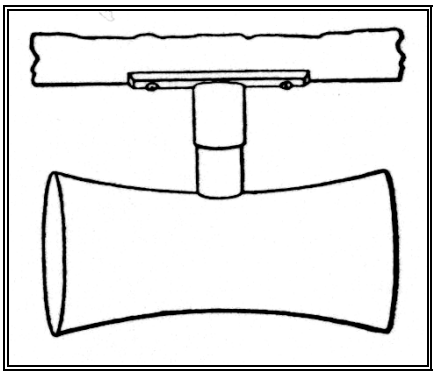

Figure 1.5: Wood Crutch

Boehm's 1847 Flute (Figure 1.6)

In 1846, Boehm began studying classical acoustics with Dr. Carl von Schafhäutl at the University of Munich where he proved wood tubes to be unstable. He then began to experiment with metal flutes. He discovered that metals like silver and brass, due to their higher densities, produced clearer and higher quality sounds than woods. Moreover, changing the tube from conical to cylindrical shape enabled the instrument to produce a full and clear sound. From this he concluded that a cylindrical tube was the best adaptation for the construction of a flute. On this subject, he stated that "the silver flute is the best choice for playing in a large room because of its greater ability for tone modulation and brilliancy.[14]

[14] Toff, 72.

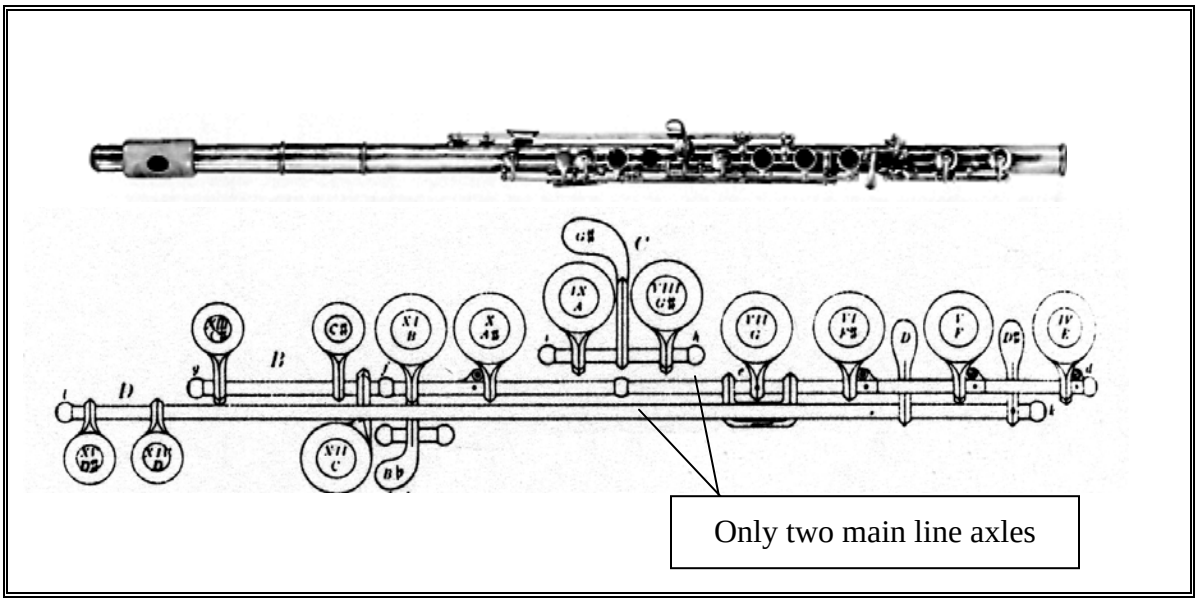

Figure 1.6: Boehm's 1847 Flute

Major changes of the Boehm flute after the 1832 model included:

1) Acoustical adjustment in the sizes and position of tone holes.

   Equally-sized holes now became varied in size: The smallest hole was C2 thumb key (12mm), the largest hole was C1# on the foot joint (15mm). A short axle was used to move the C2# to its correct position and make it smaller. The C2# also then served as a vent hole for the key D2, D2#, D3, G3# and A3.[15]

2) Use of key pads: The large tone holes could not be covered by fingers directly, so Boehm used the key pads that he invented to cover the holes.

[15] Ibid, 69.

3) Adaptation to sleeves and rods: Boehm adopted from the sleeves and rods of Buffet flute, which each key covered to its own sleeve and used a needle spring to open the key.

4) Reduction of axles: Vertical pins or overlapping lugs were used to connect the keys in order to move at the same time. This invention reduced the number of axles.[16]

The Briccialdi B flat thumb lever on the Boehm Flute Mechanism

In the modern flute mechanism, not all of the key designs are permanently affected by the 1847 Boehm model. Some variations were invented to make the mechanism become more playable. In 1849, an Italian flutist, Giulio Briccialdi invented a left-hand B flat lever controlled by the thumb. This was permanently adopted by modern flute makers. The Briccialdi B flat thumb lever (Figure 1.7) provides flutists an alternate fingering for B flat that is mechanically more convenient.[17] This B flat lever was positioned above the B key vertically to close B and B flat keys at the same time using only one finger. Later, Boehm invented a similar B flat thumb lever (Figure 1.8) that was

[16] Ibid, 70.
[17] Ibid, 73

located below the B key horizontally. However, not many flutists were using Boehm's distinctive design. In contrast, Briccialdi's design was generally preferred and has remained popular to the present day.

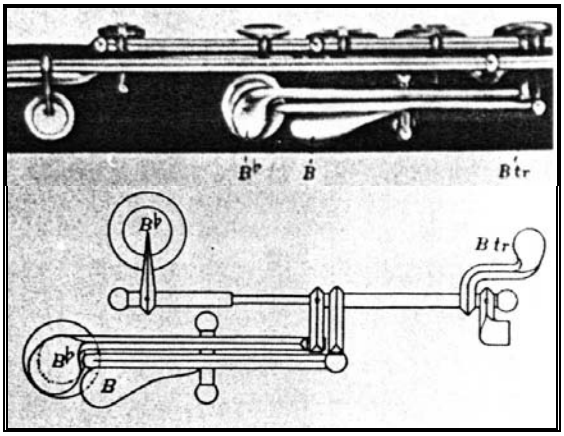

Figure 1.7: Briccialdi B Flat Thumb Lever

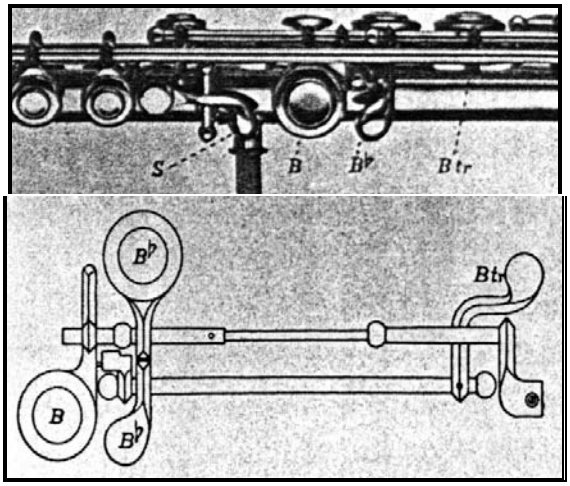

Figure 1.8: Boehm B Flat Thumb Lever

Variations of the Boehm Flute Mechanism on Modern Flutes

The Boehm flute mechanism lasted more than 150 years because of its outstanding design and excellent acoustic qualities. Most flute companies around the world continue to manufacture flutes based on the Boehm system. Despite the improvements of the Boehm system, modern-day flutists still seek flutes that are more reliable and playable.

Because of the improvement of technology and high quality production of metals, flute makers now build flutes with new materials and fine craftsmanship that were virtually impossible to achieve in the past. Many modern flute makers are developing new flute mechanisms.

Brögger Flute Mechanism

With the modern Boehm flute, imperfections still exist: The B flat key sticks when the flutist applies the G key at the same time on the inline flute. This binding

problem comes from the axle and pin which connect the B flat and G keys. Moreover, the F sharp key in the main line on the right hand has a maladjustment which causes the F sharp to respond slowly.[18]

Johan Brögger, a well-known Danish flute maker, was originally educated in medicine before he started to build the musical instruments such as the lutes and guitars. In 1973, he began to study gold and silver smithing with the famous Danish craftsman Jens Houvgaar in order to pursue his flute making business. Brögger persuaded the famous flute maker Le Fevre to teach him flute making of the Boehm system. In 1977, Brögger opened his own flute shop to repair and restore Boehm flutes.[19]

There are two well-designed flutes with new key systems that will be discussed in the following section: Brannen Brögger Mekanik and Miyazawa Brögger Mechanical System.

[18] Brannen Brothers Flutemaker Inc. *Brögger Flutes: Albert Cooper Orchestral Model.* (Accessed on March 6, 2007), <http://www.brannenflutes.com/brogger.html>, 2003.

[19] Mogens Friis. "Johan Brögger: Luthier, flutemaker, goldsmith, inventor & perfectionist," translated by Margif Schaeffer. (Accessed on March 6, 2007),<http://www.flutist.dk/eng.%20Johan%20B.htm>, 2005.

Brannen Brögger Mekanik

Brögger experienced some problems in the restoration and repair of the traditional Boehm flutes. This inspired him to improve the old key system and design a variation based upon the Boehm system. He implemented his new system in the 1980's. This new key system which was patented in Denmark and the United States, began production in 1986 by the flute company, Brannen Brothers in Boston with the name *Brögger Mekanik.*

Major Changes from the Boehm System to the Brögger Mekanik[20]

1) Two long screws from both end posts connect all the keys on the main line instead of pinning the key to the axle. This new invention made the mechanism stronger and the keys easier to assemble.

2) The friction problems of the B flat and F sharp keys were solved by using bridges and full-size back connectors. This "Bridge mechanism" also made the keys quieter and more responsive. Moreover, moving the connector to the back of the flute made minor adjustments easier (Figure 1.9).

[20] <http://www.brannenflutes.com/brogger.html>

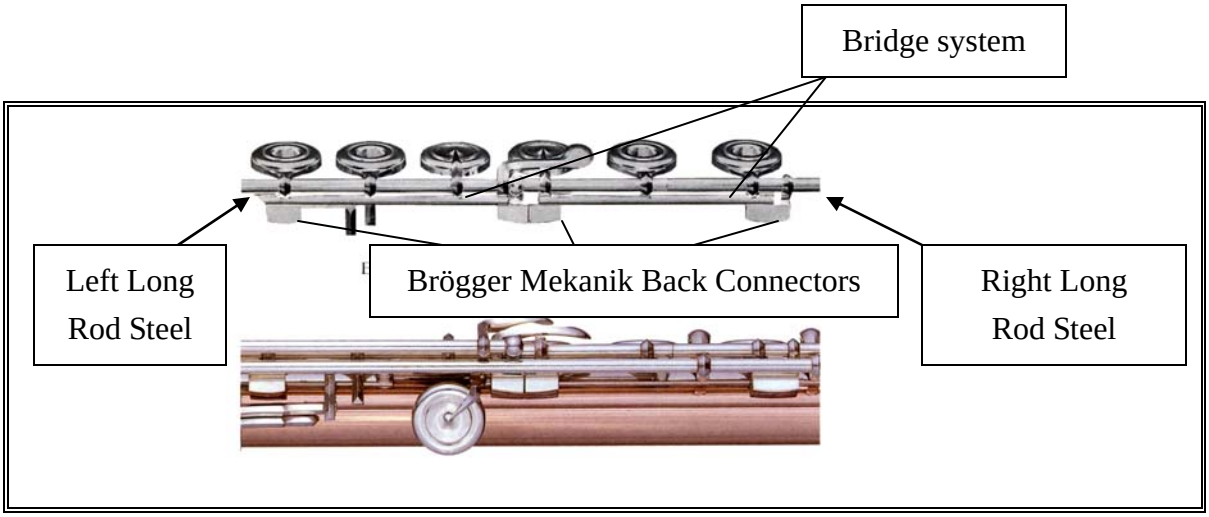

Figure 1.9: Brögger Bridge Mechanism
(Photos from Brannen Brothers Flute Company)

3) This bridge system allows the tension of the spring on each key to be adjusted independently. The key action is much more even throughout the mechanism.

Miyazawa Brögger Mechanical System

After the Brögger Mekanik was licensed to Brannen Brothers, Brögger continued to improve and develop his Brögger system. Improvements were based on the acoustical and mechanical aspects of the original design. In 1996, he redesigned his Brögger

Mekanik and combined all his new inventions to the new flute under the name of *Brögger Mechanical System*. This model was licensed to the Japanese Miyazawa flute company for production in 2005.[21]

Major Changes from the Brögger Mekanik to the Brögger Mechanical System:

1) One long screw was used to connect all the keys on the main axle. This made the mechanism stronger and more stable with less friction[22] (Figure 1.10).

Figure 1.10: Brögger Mechanical System
(Photo from Miyazawa Flute Company)

2) All keys on the main axle are pinless. This means that the keys respond faster, quieter and last longer[23] (Figure 1.11).

[21] <http://www.flutist.dk/eng.%20Johan%20B.htm>
[22] <http://homepage19.seed.net.tw/web@1/flute1217/003.htm>
[23] Miyazawa Mfg. Co. Ltd., Japan. "The Brögger System," *Miyazawa: The Elements of Perfection*. (Accessed on March 7, 2007), <http://www.miyazawa.co.uk/brogger.htm>, 2004-2005.

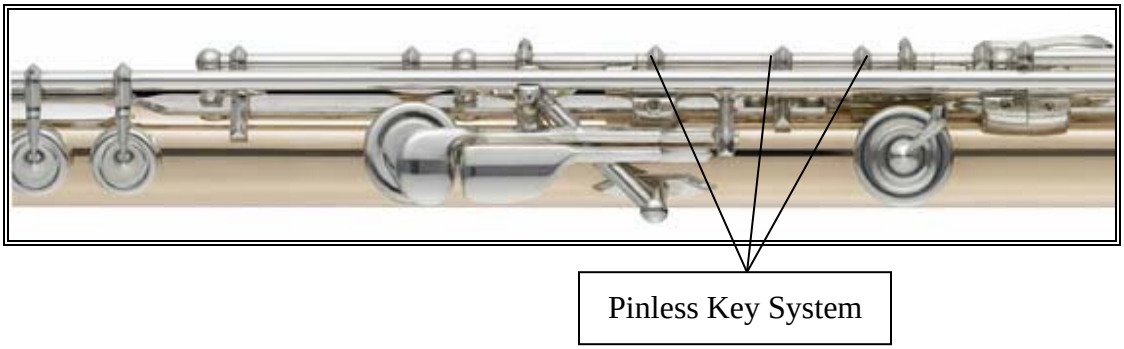

Figure 1.11: Pinless Key System
(Photo from Miyazawa Flute Company)

3) Adjustable screws on the back connectors make minor adjustments easier[24] (Figure 1.12).

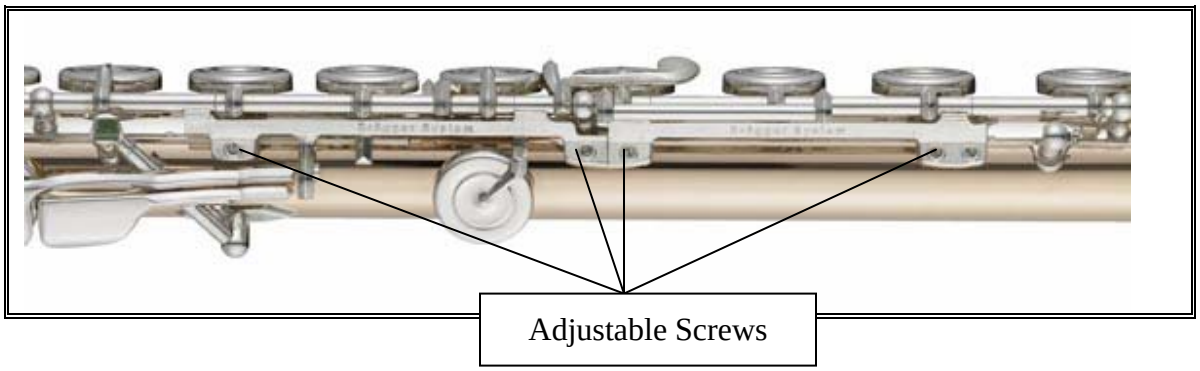

Figure 1.12: Adjustable Screws
(Photo from Miyazawa Flute Company)

4) The traditional Briccialdi B flat thumb key vertical axle was changed from a vertical direction to a 20° - 75° longitudinal axle. It gives the flutists a much smoother and

[24] <http://homepage19.seed.net.tw/web@1/flute1217/003.htm>

responsive feeling on the B and B flute thumb keys[25] (Figure 1.13). Furthermore, Brögger changed a flat spring between the body tubing and thumb key to a needle spring for the B and B flat keys. This prevents contact and friction between the thumb key and the body tubing[26] (Figure1.14).

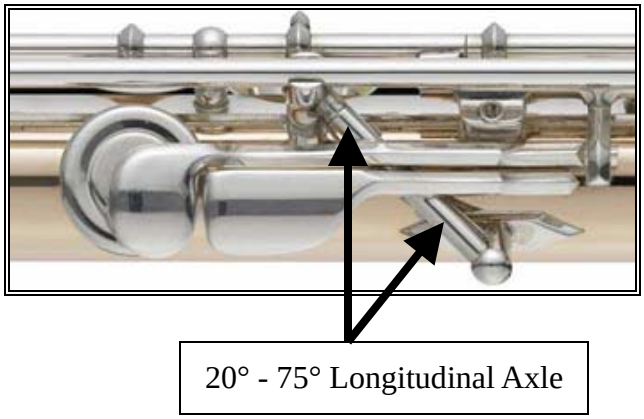

Figure1.13: 20° - 75° Longitudinal Axle
(Photos from Miyazawa Flute Company)

Figure 1.14: The Briccialdi B Flat Thumb Key
Photos from Miyazawa Flute Company

[25] <http://www.flutist.dk/eng.%20Johan%20B.htm>
[26] <http://www.miyazawa.co.uk/brogger.htm>

5) Brögger invented the double conical tone holes to improve response. This allows the flutist to project sound easily, apply tonguing easier and also improves the tone quality of the tonguing. Legato intervals are easier to produce in all octaves with better tone quality.[27]

6) Brögger designed the flat key bottom which provides the stability of the pad installation in the key cup. Therefore, there is no need to add any piece of cardboard or plastic stabilizer under the pad for support while operating the padding procedure (Figure 1.15 and Figure 1.16).

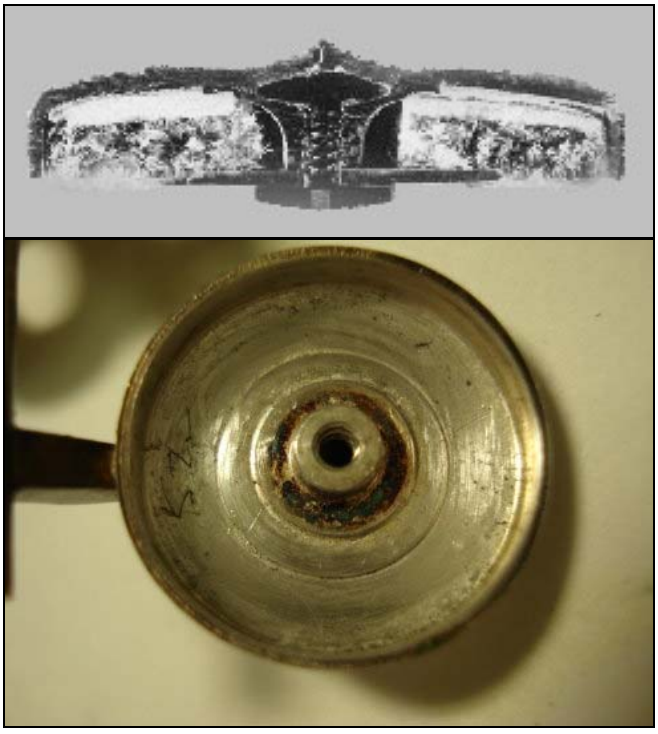

Figure 1.15 A Traditional Curved Shape Key Cup

[27] <http://www.flutist.dk/eng.%20Johan%20B.htm>

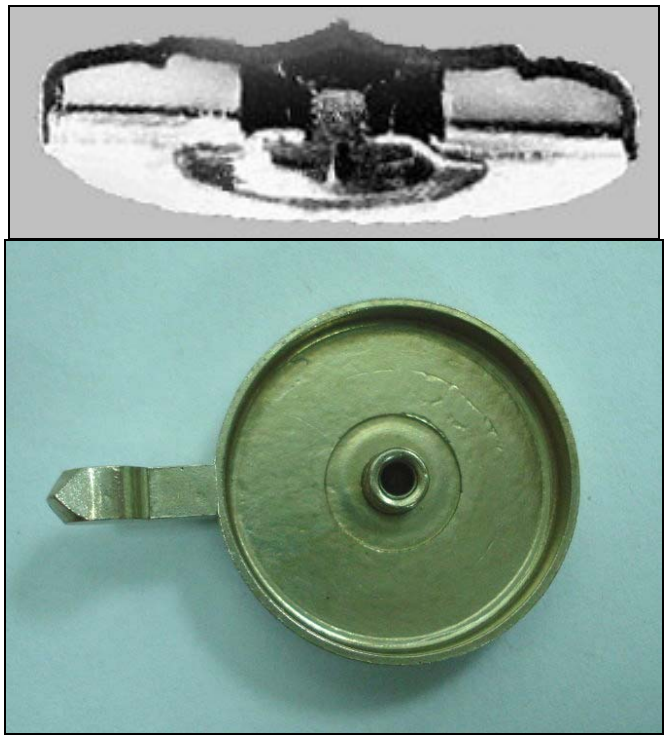

Figure 1.16 A Flat Bottom Key Cup

The Kingma System

The Kingma System is a new innovation design by Eva Kingma and Bickford Brannen at the Brannen Flute Company based on the key system of the Boehm 1947 model. The Kingma Company was originally established by Dirk Kuiper, who was a flutist in the Concertgebouw Orchestra of Amsterdam, in Holland in the early 1950's. Kuiper was well-known for producing wooden, silver and gold C-flutes. In 1975, Eva Kingma joined this flute company and by 1980 was appointed to be the head of the

company. The Kingma flute company specializes in making the alto, bass, contrabass and sub-contrabass flutes with the innovation of the “key on key” open-hole and quarter-tone system. Later, this innovation was applied to the C-flute and produced by the Brannen Brothers flute company in the United States.[28]

The Kingma system is built based on the Boehm French system with a C sharp trill key. Adding six extra keys (Figure 1.17) enables the flutist to play the full twelve quarter-tone scale which is impossible on the traditional French model flute. Six of the twelve quarter tones are played by using the extra six keys; the seventh quartertone is produced by using the C sharp trill key along with the C key; the rest of the five quartertones are played by using the French model open-hole keys (see Appendix A: The Kingma Fingering Chart) .[29]

[28] http://www.kingmaflutes.com/CMS/index.php?module=pagemaster&PAGE_user_op=view_page&PAGE id=8&MMN_position=59:59

[29] http://www.brannenflutes.com/kingma.html

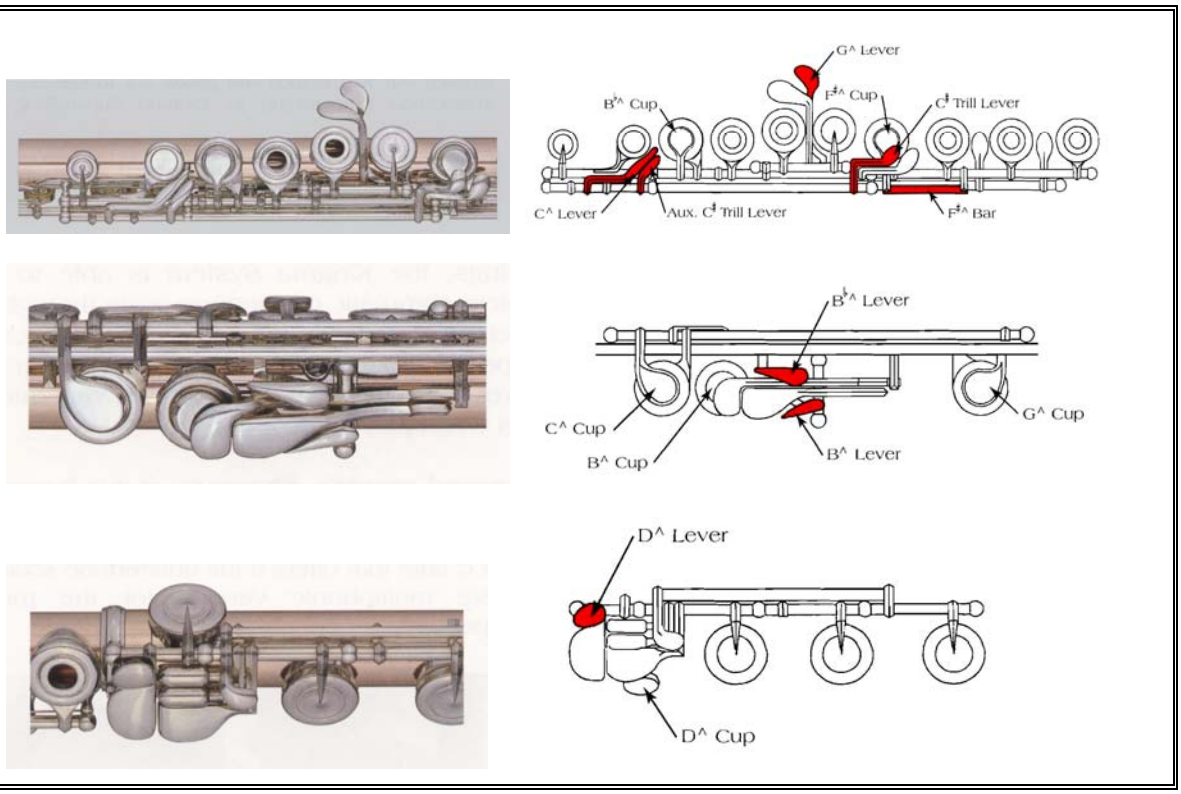

Figure 1.17: Photos from Brannen Brothers Flute Company

The extra keys available in the Kingma System are very useful to perform contemporary music as well as the traditional flute repertoire. In contemporary music, traditional open-hole flutes can produce quartertone effects with the use of alternate fingerings, but not with the quality of intonation allowed by the new system. Using the old system, flutists cover the portion of the hole, which is less than a half of the hole on the key cup to make it possible. This is done with such degree of difficulty that it is impossible to make it happen during fast passages. The Kingma System solves this

problem and flutists can easily play chromatic quartertone scales in all registers fluently. This significant innovation substantially extends flutists' techniques and which are used in modern compositions.

Moreover, the Kingma System allows flutists to adjust the intonation of pitches efficiently. Flutists now can play forte without going sharp and play piano without going flat. The only disadvantage is to memorize the complete fingerings (see Appendix A: The Kingma Fingering Chart).

The Grenaditte System

The Grenaditte System (Figure 1.18) is a brand new system that was introduced to the world in 2006. The system is designed by Taiwanese flute maker, Geoffrey F. Guo, who established his flute company (G. M. I. C.) in 1988 in Taichung, Taiwan (Figure 1.16), with a brand new material from Germany, called Grenaditte. Geoffrey F. Guo has been a pioneer researching innovative materials in making musical instruments including both the C flute and G flute (Figure 1.19). Gou's flute mechanism is similar to the "bridge system" that has been used by Brannan and Miyazawa with some improvements.

Figure 1.18: G. M. I. C. Flute Company in Taichung, Taiwan

Figure 1.19: Geoffrey Guo with his new C Flute and G Flute

The entire Guo flute, including the key system with the exception of the B flat shake key, is made of Grenaditte. The B flat shake key is still made of 925 sterling silver (Figure 1.20). The name “Grenaditte” comes from the color of the wood “grenadilla”. However, the elements of Grenaditte material are not actually made from wood. It is made from two major elements, fiber glass and industrial plastic, which increases the density of the flute tube and makes the mechanism unbreakable and unaffected by temperature.

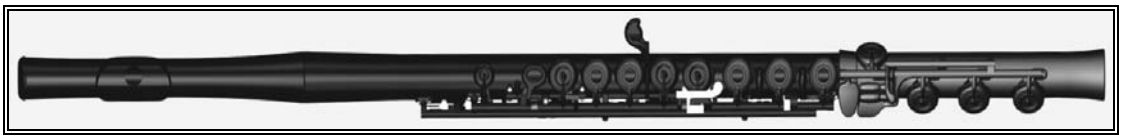

Figure 1.20: Grenaditte Flute (Photo from G. M. I. C.)

Keys respond subtly without the traditional G-B flat and F sharp key friction on the inline flute. The B flat shake key is repositioned to the right hand with the transmission to the individual B flat key allowing the B flat key to stay away from the left-hand mechanism. The F sharp key is also taken apart from the right-hand mechanism to prevent friction. (Figure 1.21)

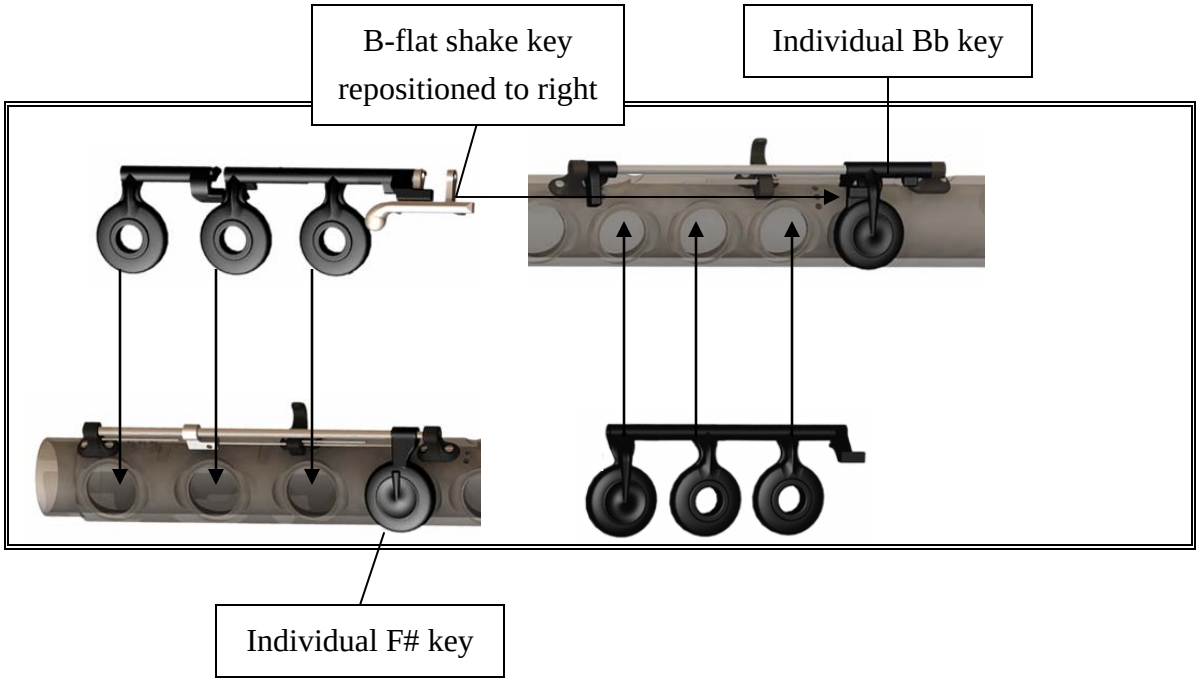

Figure 1.21: Mechanism of Grenaditte Flute (Photos from G. M. I. C.)

The key system is designed on computer graphic softwares, *Solidworks and Auto CAD*, by Mr. Guo's younger brother (Figure 1.22). The flute and its mechanism are manufactured by injecting Grenaditte material into the pre-made mold on a computer-controlled machine. The highest level of quality control for the mechanism on each flute is thus achieved.

Another remarkable design on the key is the metal washer which holds the pad in the key cup. The idea of curve-shaped washers comes from the shape of the human finger-tip. Guo believes that the curve-shaped washer improves the tone acoustically

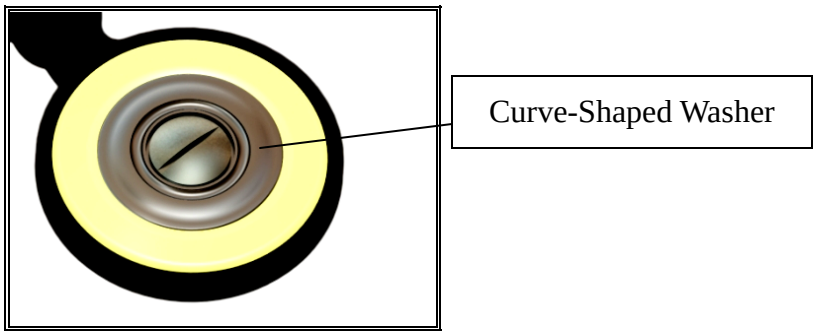

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Figure 1.22: A Curve-Shaped Washer (Photo from G. M. I. C.)

As technology evolves, flute makers continue to reinvent the mechanism to assist flutists. New materials and new strategies are employed contributing to the ongoing evolution of the flute. Flutists owe a debt of gratitude to those who spend their lives perfecting this instrument.

CHAPTER 2

FLUTE NOMENCLATURE

Head Joint

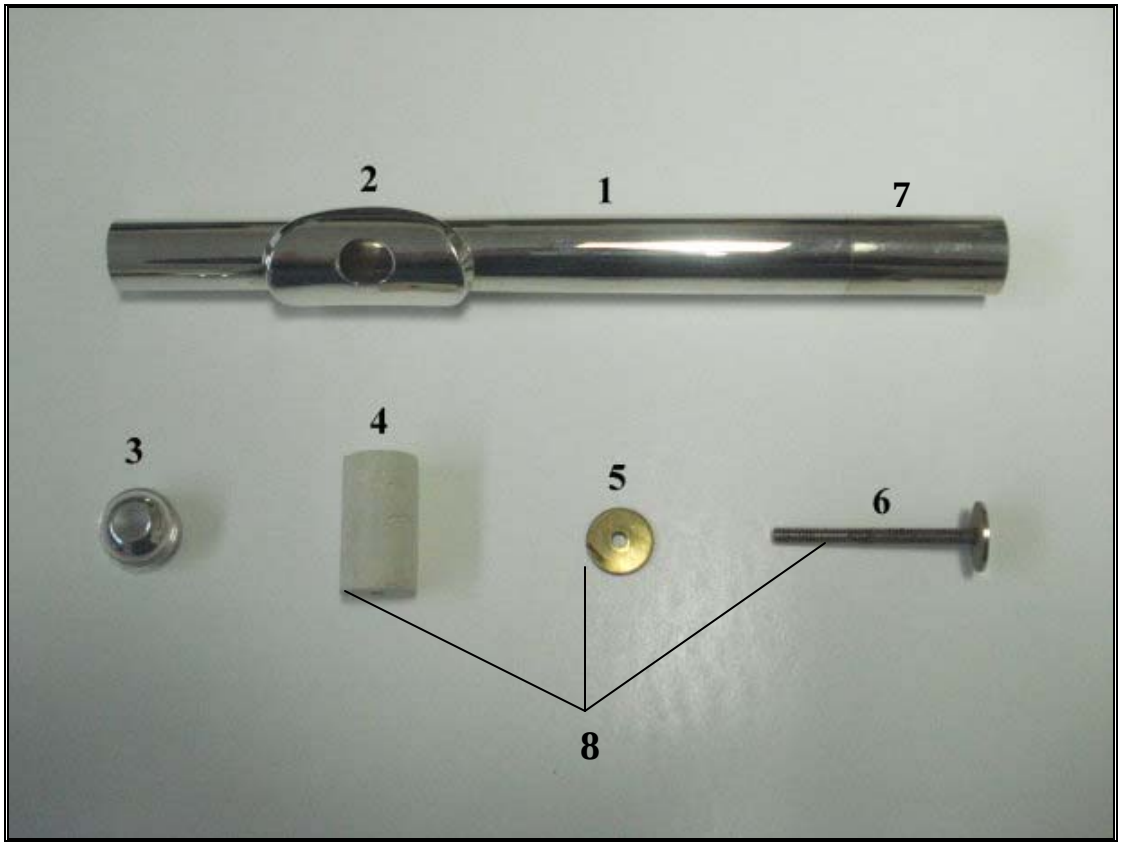


Figure 2.1: Head Joint Nomenclature

1. Head joint
2. Lip plate
3. Crown
4. Head cork
5. Upper metal disc
6. Bottom metal disc with screw
7. Tenon
8. Cork assembly

Main Body Joint

Traditional Boehm Flute Mechanism

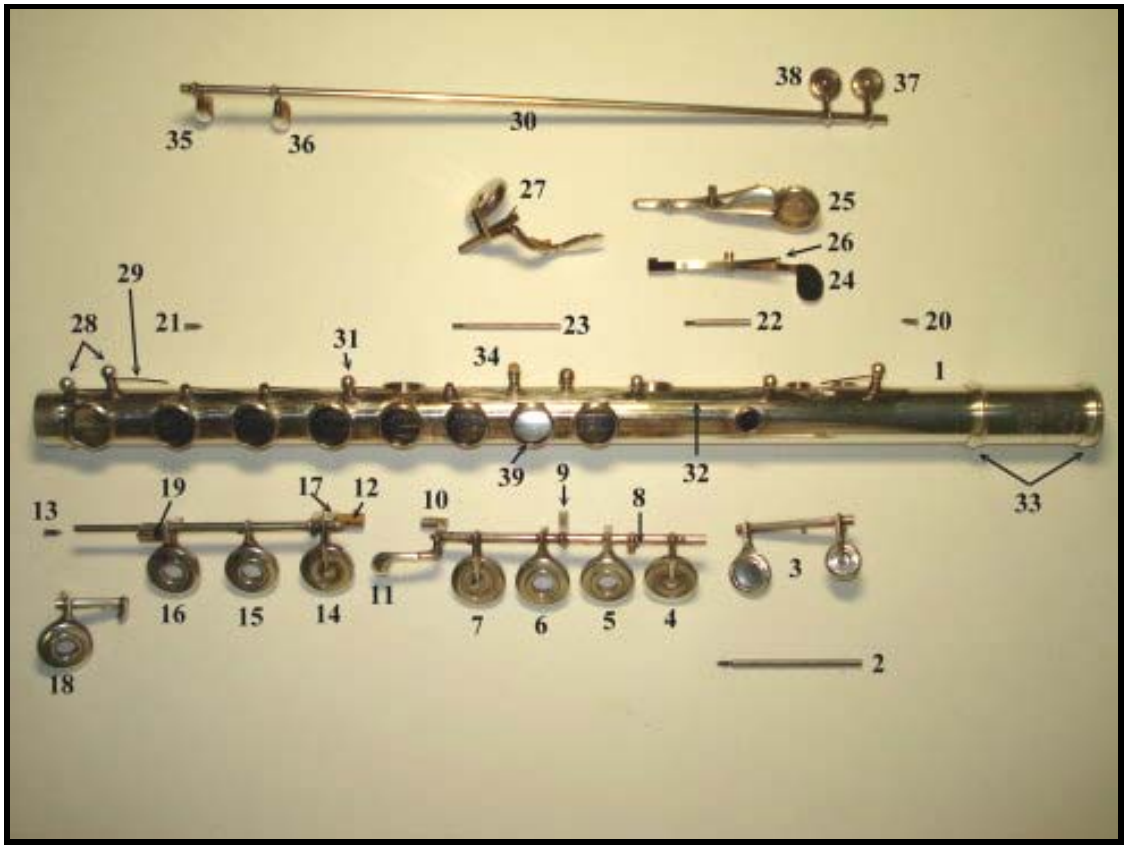


Figure 2.2: Traditional Boehm Flute Main Body Joint Nomenclature

1. Prima Sankyo SR Handmade 925 Sterling Silver main body joint
   French model, in-line G keys
2. Left-hand mechanism steel or C-sharp steel
3. C-sharp key and lever
4. B-flat key
5. A key
6. In-line G1 key
7. In-line G2 key
8. B-flat key and A key front connector

9. B-flat kicker
10. F/B-flat back connector
11. B-flat shake key
12. F key connector
13. Right-hand pivot screw
14. F-sharp key
15. F key
16. E key
17. F/F-sharp back connector
18. D key
19. E and D keys front connector with F-sharp key
20. Long trill rod left pivot screw
21. Long trill rod right pivot screw
22. Thumb key steel
23. G-sharp steel
24. B-flat thumb key
25. Thumb key
26. Thumb key flat spring
27. G-sharp key
28. key post
29. Spring
30. Long trill rod
31. Double pivot bearing (Center Post)
32. Rib
33. Ring
34. Trill key guide
35. Upper trill lever
36. Lower trill lever
37. Upper trill key
38. Lower trill key
39. Tone hole (soldered tone hole)

Brögger Flute Mechanism

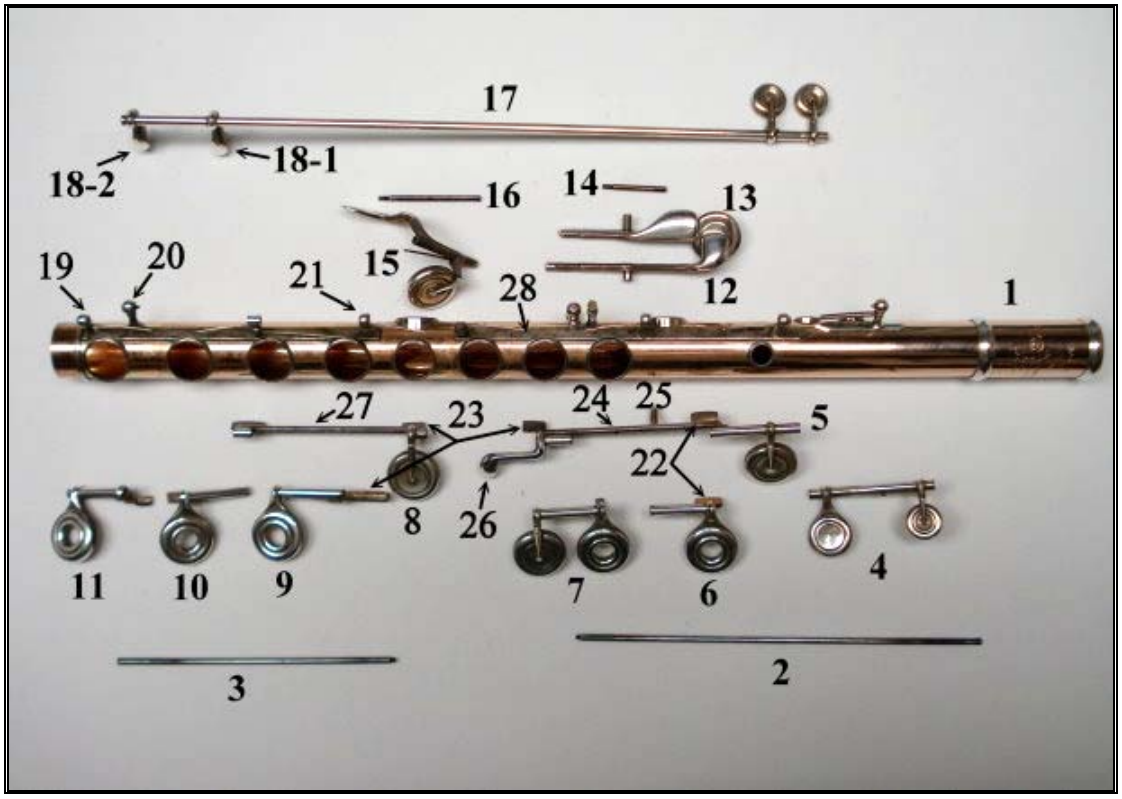


Figure 2.3: Brögger Flute Main Body Joint Nomenclature

1. Brannen Brögger system 14 karat rose gold flute main body joint
   French model, in-line G keys
2. Left-hand mechanism long pivot steel
3. Right-hand mechanism long pivot steel
4. C-sharp key and lever
5. B-flat key
6. A key
7. In-line G1 (open-hole) and G2 (close-hole) keys
8. F-sharp key
9. F key
10. E key
11. D key

12. B-flat thumb lever
13. B thumb key
14. Left-hand thumb key steel
15. G-sharp key
16. G-sharp key steel
17. C and C-sharp trill keys with long rod
18-1. Lower trill lever
18-2. Upper trill lever
19. Key post
20. Pivot screw in the post
21. Double pivot bearing (Center Post)
22. B-flat and A back connector
23. B-flat, F-sharp and F back connector
24. B-flat bridge rod
25. B-flat kicker
26. Alternate B-flat shake key
27. F-sharp bridge rod
28. Rib

Foot Joint

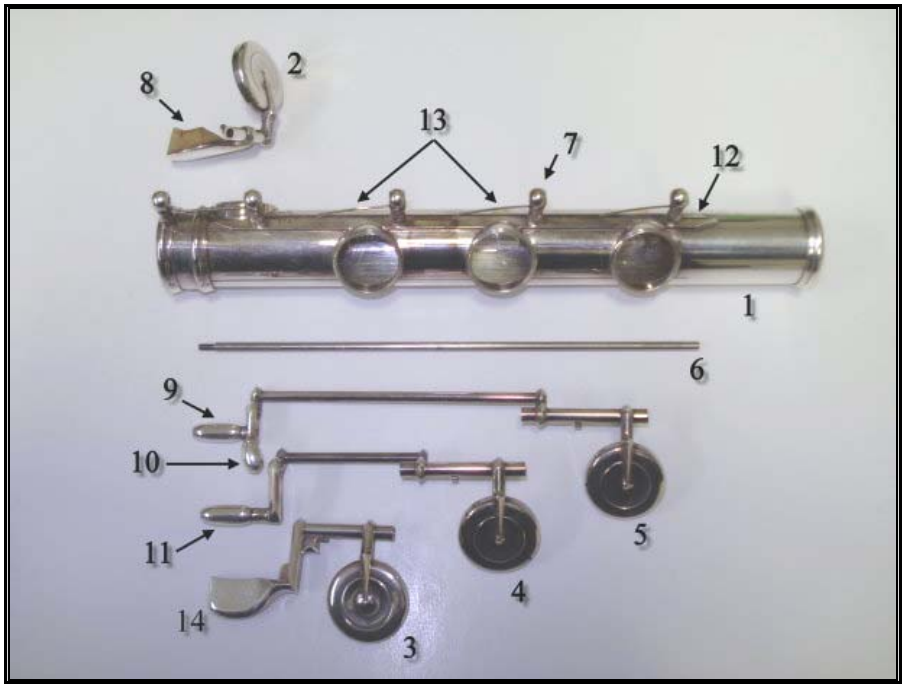


Figure 2.4: B-Foot Joint

Figure 2.5: C-Foot Joint

1. Foot joint tube
2. D-sharp or E-flat key
3. C-sharp key
4. C key
5. Low B key
6. Foot joint long steel
7. Key post
8. D-sharp or E-flat key cork
9. Low B key roller
10. Low B gizmo key
11. C key roller
12. Rib
13. Spring
14. C-sharp key lever

Key Nomenclature

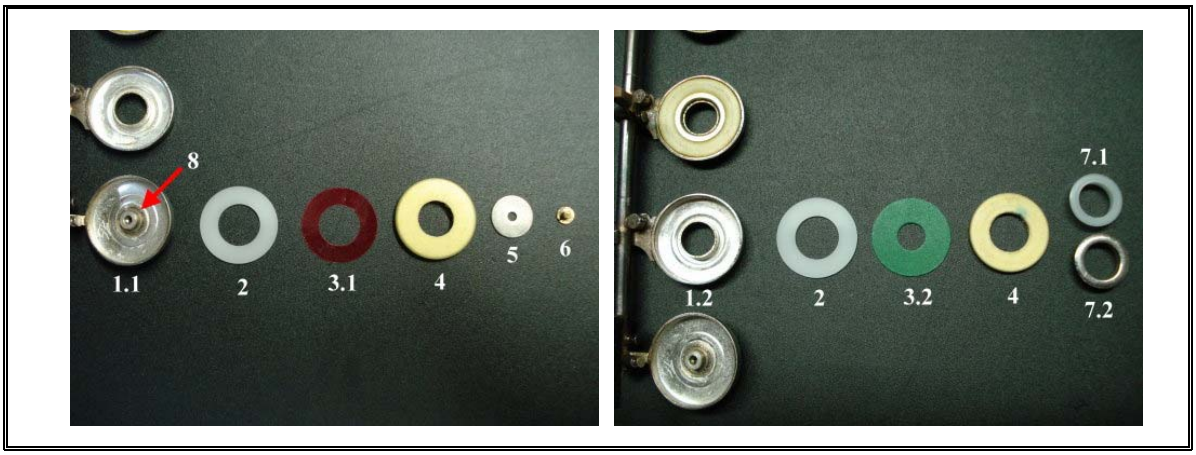


Figure 2.6: Key Nomenclature

1.1. Close-hole pad cup
1.2. Open-hole pad cup
2. Plastic Delrin stabilizer
3.1. Plastic shim
3.2 Paper shim
4. Pad
5. Metal washer
6. Screw
7.1 Plastic Delrin bushing
7.2 Metal bushing
8. Screw Thread

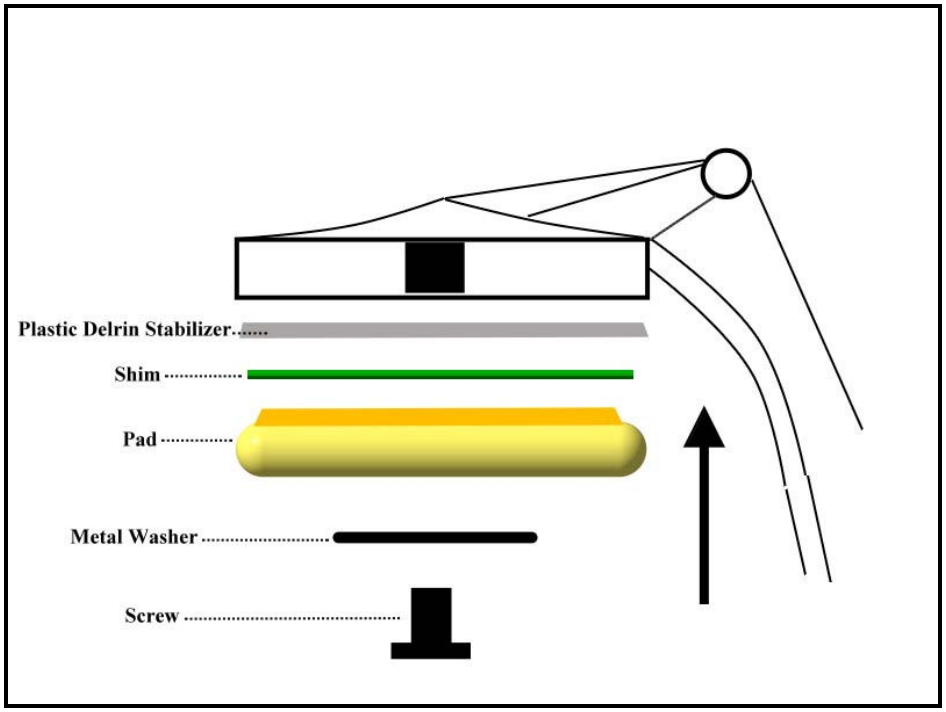


Figure 2.7: Close-Hole Key Nomenclature

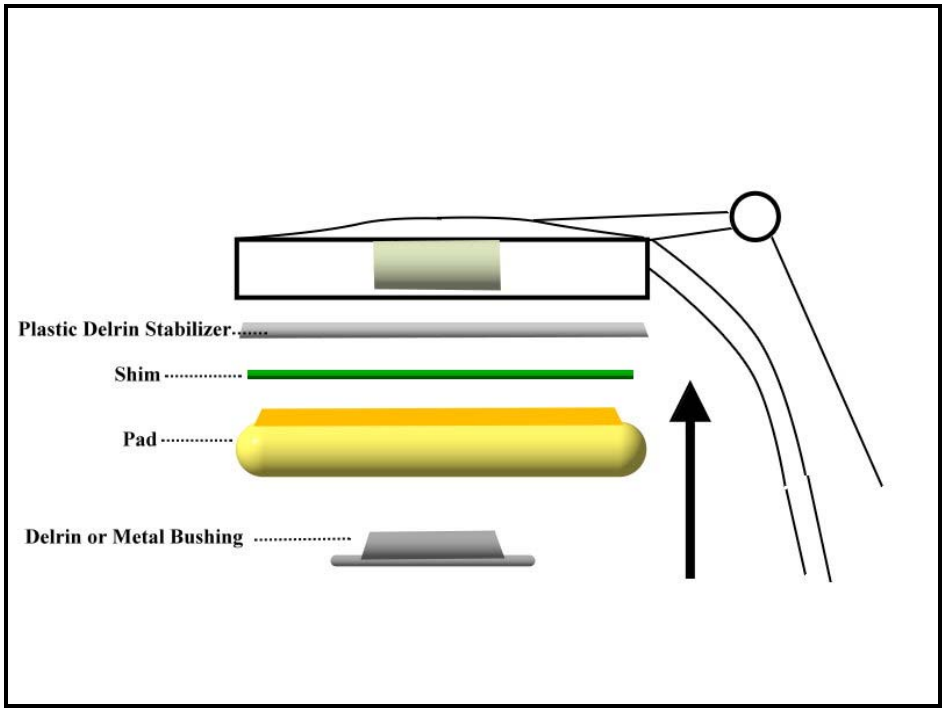


Figure 2.8: Open-Hole Key Nomenclature

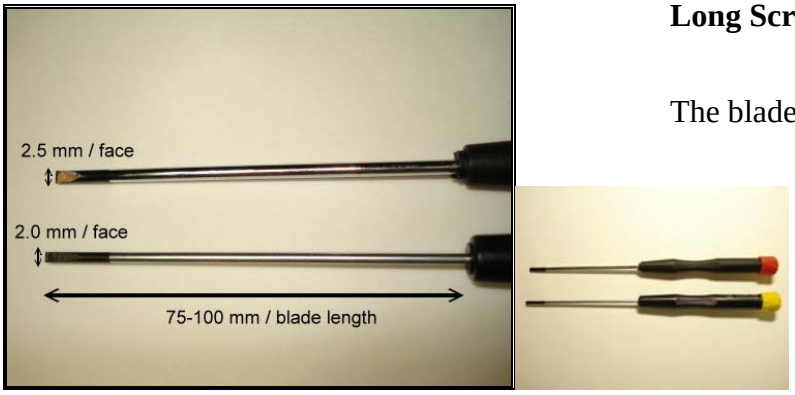
CHAPTER 3

AN INTRODUCTION TO REPAIR TOOLS AND REPAIR SUPPLIES

A Chinese idiom tells us that “good tools are a prerequisite to the successful execution of a job”. With the proper tools, flutists can complete the repair procedure efficiently and successfully with a basic knowledge of repair techniques. In 2008, one can purchase for under $500, all the necessary tools to perform the tasks included in this document. Purchase a cheap student flute to practice repair techniques.

Flutists can choose to perform basic repairs on the flute using a wide array of repair tools. Choosing the proper tools, however, is often bewildering and challenging. Some of the repair tools are sold by repair suppliers (see Appendix B) but many of these tools are more economically purchased at local hardware stores. (See Appendix X for a complete listing of these locations).

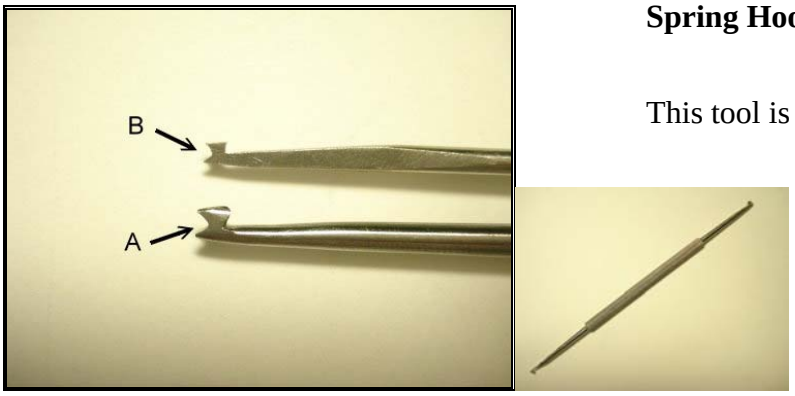
In this chapter, all the essential repair tools will be introduced with a mindset of affordability. The functions of these tools will be discussed as well.



Long Screwdrivers (Figure 3.1)

The blade face of the screwdriver should be between 2mm to2.5mm and the blade length between 75mm to100mm.

Figure 3.1: Long Screwdrivers



Spring Hook (Figure 3.2)

This tool is used for pulling or pushing the needle spring into place or off the spring catch.

Figure 3.2: Spring Hook

Needle Point Tweezers (Figure 3.3)

The tweezers are used for managing the flute pads, delrin stabilizers or shims.

Figure 3.3: Needle Point Tweezers

Figure 3.4: Needle Pin Vise

Needle Pin Vise (Figure 3.4)

This small pin vise is useful for removing the flute pads out of the pad cups.

Figure 3.5: Flat Nose Pliers

Flat Nose Pliers (Figure 3.5)

The pliers are used for removing the G-sharp key steel during flute disassembly. Insert small plastic rubber tubes onto the flat nose pliers. This will help to prevent scratches on the G-sharp key steel.

Figure 3.6: Digital and Dial Calipers

Digital and Dial Calipers (Figure 3.6)

The caliper is used for measuring the size of flute pad cup and pad.

Figure 3.7: Single Razor Blade

Single Razor Blade (Figure 3.7)

Razor blades are used for cutting corks, felts and papers.

Figure 3.8: Key Dusting Brush

Key Dusting Brush (Figure 3.8)

This paint brush can be used as a cleaning tool to brush dust off the flute mechanism. It also can be used to apply small amounts of mucilage onto fish skins during the re-skinning process.

Figure 3.9: Flute Pad Iron

Flute Pad Iron (Figure 3.9)

The pad skin needs to be ironed after pad installation. The pre-heated pad iron can make the pad skin smooth.

Figure 3.10: Flute Pad Assembly Die

Flute Pad Assembly Die (Figure 3.10)

This die set can hold the old Straubinger pad in place during the re-skinning process. There are four sizes of dies available (17mm, 17.5mm, 18mm and 18.5mm).

Figure 3.11: Chopstick cut in half or Wooden Cuticle Stick

Chopstick cut in half or Wooden Cuticle Stick (Figure 3.11)

A chopstick can be used during the re-skinning process for Straubinger pads.

Figure 3.12: Small Scissors

Small Scissors (Figure 3.12)

The scissors are used to trim flute pad shims or fish skin.

Figure 3.13: Alcohol Lamp

Alcohol Lamp (Figure 3.13)

An alcohol lamp can be used for heating the flute pad iron during pad installation.

Figure 3.14: Denatured Alcohol

Denatured Alcohol (Figure 3.14)

This kind of alcohol can be purchased in local hardware stores. It is added into an alcohol lamp as fuel. This kind of alcohol can also be used to clean some oil residue and debris inside the key tubing or steels.

Figure 3.15: Pipe Cleaner

Pipe Cleaner (Figure 3.15)

A pipe cleaner dipped in denatured alcohol can clean oil residue and debris inside the key tubing.

Figure 3.16: Pad and Cork Cement

Pad and Cork Cement (Figure 3.16)

Partial shims can be glued onto the base shim with this cement in the pad cup.

Figure 3.17: Contact Cement

Contact Cement (Figure 3.17)

Stabilizers can be glued in the pad cups with this kind of contact cement.

Figure 3.18: Flute Head Joint Cork Stick

Flute Head Joint Cork Stick (Figure 3.18)

A 5/8 inch diameter and 12” long craftwood dowel can be purchased in local hardware stores. This stick can be used to push out the head joint cork for cork replacement.

Figure 3.19: Key Oil

Key Oil (Figure 3.19)

Two different viscosities of key oil are used in flute repair: thick (heavy) oil and thin (medium) oil in bottles with small needles or in nail polish bottles with small brushes.

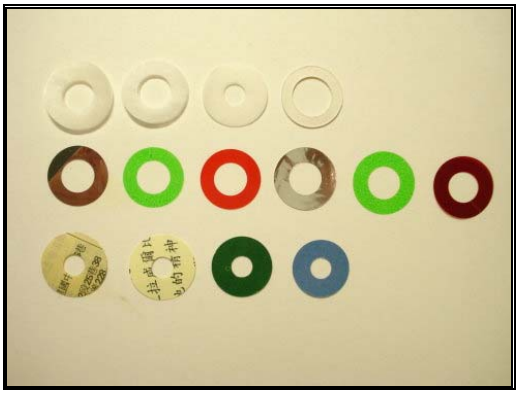


Figure 3.20: Paper and Plastic Pad Shims

Paper and Plastic Pad Shims (Figure 3.20)

Different sizes and thicknesses of flute shims are used during the shimming process.

Figure 3.21: New Head Joint Cork

New Head Joint Cork (Figure 3.21)

Standard sizes of head joint corks can be bought from repair suppliers. (11/16” diameter, 1 1/4” length, 9/64” center hole)

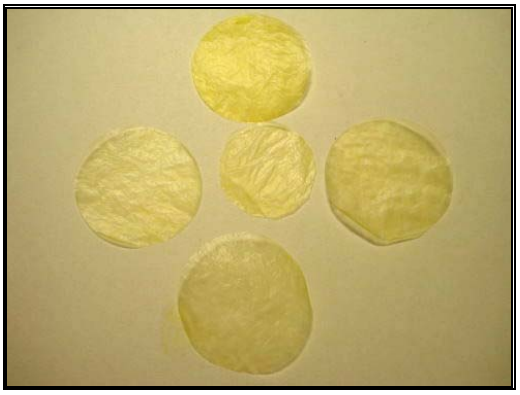


Figure 3.22: Pre-Cut Bladder Fish Skins

Pre-cut Bladder Fish Skins (Figure 3.22)

Bladder fish skins are used for recovering old Straubinger flute pads.

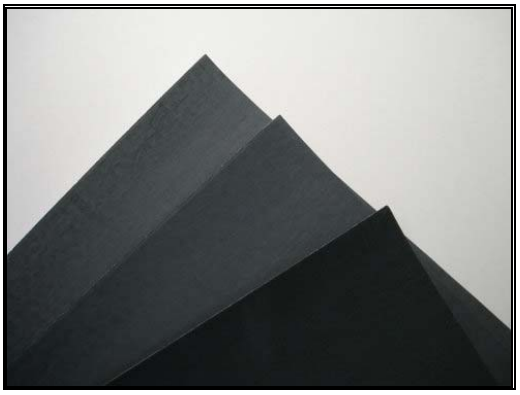
Figure 3.23: Flute Shim Container

Flute Shim Container (Figure 3.23)

Jewelry containers can be used to store different sizes of shims.

Figure 3.24: New Flute Pads

New Flute Pads (Figure 3.24)



Sandpapers (400 grit, 600grit and 1500 grit)
(Figure 3.25)

Figure 3.25: Sandpapers

Super Glue (Figure 3.26)

Super glue can be used to glue stabilizers in pad cups.

Figure 3.26: Super Glue

Mucilage (Figure 3.27)

Mucilage can be applied onto the fish skin during the re-skinning process of old Straubinger pads.

Figure 3.27: Mucilage

Figure 3.28: Flute Pad Bushing Remover

Flute Pad Bushing Remover (Figure 3.28)

Flute makers use this tool to remover bushings from open-hole pad cups.

CHAPTER 4

BASIC DISASSEMBLY AND ASSEMBLY OF THE FLUTE IN PREPARATION FOR REPAIRS AND COA (CLEAN, OIL, ADJUST)

The basic disassembly and assembly of the flute is the first technique that flutists will need to learn in order to better understand the flute. Disassembly will offer the flutist a thorough understanding of flute parts and how these parts work together to allow a flutist to produce quality sounds. The flutist will then be able to make basic repairs to the instrument including the following: padding, oiling, cleaning, adjusting and replacing corks and felts. Once a year, a COA (clean, oil, adjust) should be performed. The procedure should be first practiced on a student flute. Common repairs that a flutist may encounter that take less than an hour to fix include, cork replacement and minor adjustments. More complicated repairs that require more expertise include shimming and

changing pads. Two flute mechanisms dominate today's market. This chapter will cover both the Traditional Boehm mechanism and the Brögger mechanism. Each demands a slightly different disassembly and assembly technique.

The traditional Boehm mechanism is the standard flute mechanism in flute production of today. Because this mechanism uses several pins to connect the keys, it requires advanced techniques to disassemble the flute completely for the annual COA (clean, oil, adjust). This chapter will focus exclusively on basic disassembly which will leave all the pins in place on the traditional Boehm mechanism. In contrast, the Brögger mechanism improves the binding problem of the B flat and F sharp keys on the Boehm mechanism by the use of a bridge system. Pinless, it uses a long screw instead of pins.

It is recommended that the novice in flute repair practice repetitively in order to become proficient at this disassembly technique. It is advisable that the flutists practice on a student model or used flute. The following instructions will demonstrate the step-by-step disassembly with the proper repair tools. To re-assemble the flute, simply follow the instructions in reverse order.

Repair Tools Required

Figure 4.1: Repair Tools Required

Foot Joint Mechanism Disassembly

The foot joint mechanism is much less complicated than the main body joint mechanism. It serves as a good starting point in the study of flute assembly and disassembly.

Two distinct kinds of foot joint mechanisms are available from flute manufacturing companies: the C-foot joint and the low B-foot joint. Flutists use these interchangeably. For the purpose of this manual, we will focus exclusively on the B-foot joint, that is, by far, the more popular of the two.

Step by Step Disassembly Instruction:

Figure 4.2: Traditional Low B Foot Joint with Gizmo Key

(Figure 4.2) The complete assembled view of a traditional low B foot joint with gizmo key is featured in this photo.

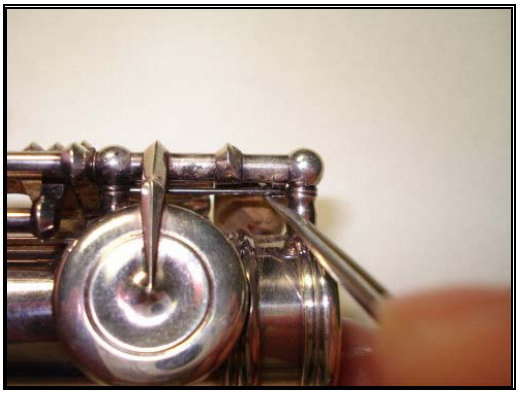


Figure 4.3: Unhooking D-Sharp or E-Flat Key

(Figure 4.3) Unhook the D-sharp or E-flat key spring off the spring catch by "pulling" it toward yourself.

Figure 4.4: Pushing the Spring Off the Spring Catch

(Figure 4.4) If the spring cannot be pulled off the spring catch, try to turn the foot joint 180 degrees and use the spring hook to "Push" the spring off the spring catch.

Figure 4.5: Unhooking the Spring of the C-Sharp Key

(Figure 4.5) Unhook the spring of the C-sharp key off the spring catch.

Figure 4.6: Unhooking the Spring of the C-Key

(Figure 4.6) Unhook the spring of the C key off the spring catch.

Figure 4.7: Unhooking the Spring of the Low B Key

(Figure 4.7) Unhook the spring of the low B key off the spring catch.

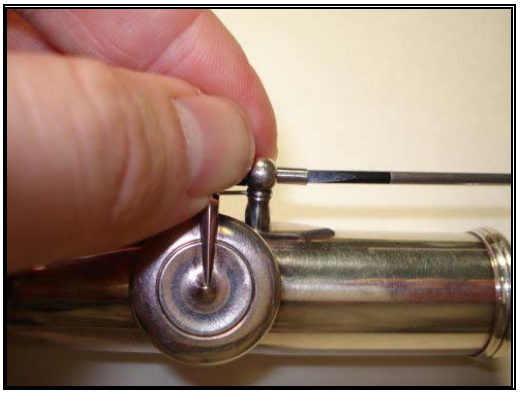


Figure 4.8: Unscrewing the Screw

(Figure 4.8) Use the left-hand thumb and index finger to guide the blade face to prevent slipping of the screw driver, as shown to the left. This will prevent scratching of the key post or keys. Unscrew the steel in a counter-clockwise direction until one hears a very faint “click” sound. The “click” sound means that the steel is fully unthreaded.

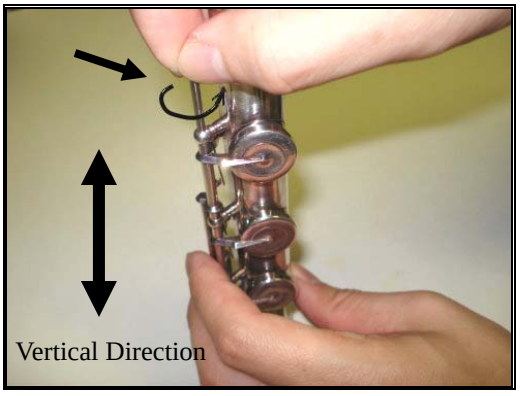


Figure 4.9: Vertical Direction and Twisting the Steel

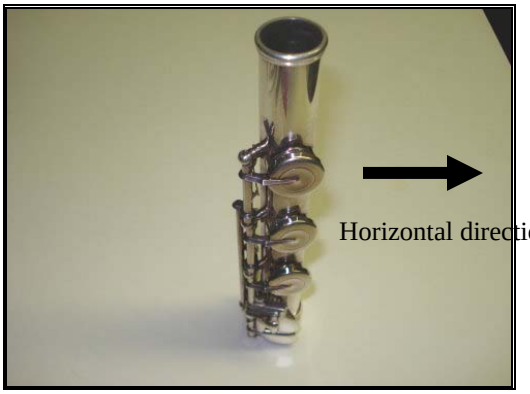
(Figure 4.9) Before pulling out the steel, be sure that the foot joint is in a vertical position with the end of the foot joint. Gravity will keep all the keys in their original positions which will allow the steel to be pulled out smoothly. Twist the steel counter-clockwise while pulling out the steel. This can prevent the steel from obtaining vertical scratches.

Figure 4.10: Pulling Out the Steel

(Figure 4.10) Completely pull out the steel. All the keys will remain in their original positions.

(Figure 4.11) Clean off the oil and any debris on the steel with a lint-free soft cloth or tissue.

Figure 4.11: Cleaning off the Oil and Debris



(Figure 4.12) Turn the foot joint from the vertical position to a horizontal position.

Figure 4.12: Positioning the Foot Joint

(Figure 4.13) Remove the D-sharp (or E-flat key) from the foot joint.

Figure 4.13: Removing the D-Sharp (or E-Flat Key)

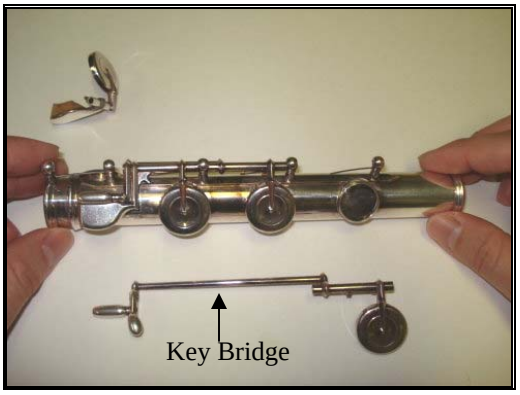


Figure 4.14: Removing the Low B Key

(Figure 4.14) Remove the low B key. Do not attempt to remove the C key before the low B key is removed because the C key bridge is under the low B key bridge. Sometimes, the C-sharp key is the first key to be removed. This makes it easier to remove the low B key, then the C key, without bending the bridges.

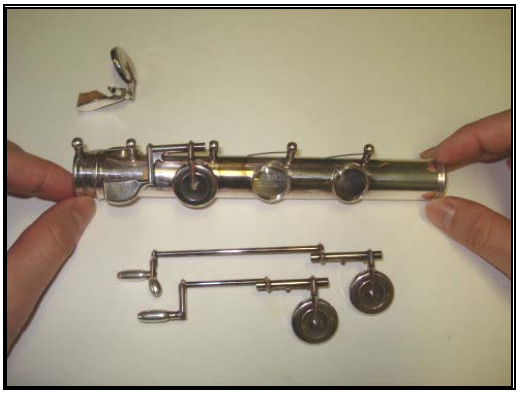


Figure 4.15: Removing the C Key

(Figure 4.15) Once the B key is removed, the C key can then be removed from the foot joint.

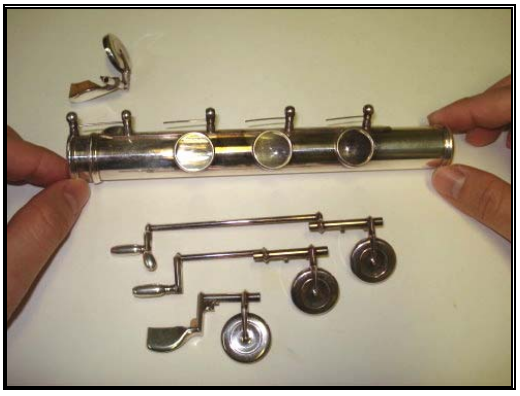


Figure 4.16: Removing the C-Sharp Key

(Figure 4.16) Remove the C-sharp key from the foot joint.

Figure 4.17: Complete Disassembly of The Foot Joint

(Figure 4.17) This photo is the complete disassembly of the foot joint.

Main Body Joint Mechanism Disassembly:

The Traditional Modern Boehm Flute Mechanism

Figure 4.18: Prima Sankyo SR Handmade Silver Flute

Step by Step Disassembly Instructions:

Figure 4.19: Unhooking the B Key Spring

(Figure 4.19) Use the spring hook to push the C-sharp key spring unhooking it from the spring catch. Pushing down the key spring releases the tension and frees the key. However, bending the spring with too much effort will distort the spring tension. Over exertion on the spring is not recommended. To prevent scratching the rod, turn the spring hook upside down.

(Figure 4.20) Unhook the B-Flat key spring by pushing the spring off the spring catch. Use the same technique as described in the figure above.

Figure 4.20: Unhooking the B-Flat Key Spring

(Figure 4.21) Unhook the A key spring from the spring catch by pushing the spring off the spring catch in the same way.

Figure 4.21: Unhooking the A Key Spring

(Figure 4.22) Leave the G1 and G2 key spring hooked, since sufficient space to unhook the spring. You will note that the G-sharp key rod blocks the space under the G key spring. Do not attempt to force the spring under the spring catch. Ignoring this step will result in a scratch to the G# key rod.

Figure 4.22: G Key Spring

Figure 4.23: Unhooking the F-Sharp Key Spring

(Figure 4.23) Unhook the lower spring which is the F-sharp key spring. If the B-flat shake key obstructs the view of the F-sharp spring, unhook the spring after removing the left-hand mechanism. Wait to do so later in the disassembly process. This will become clear only at that point of disassembly.

Figure 4.24: F Key Spring Cradle

(Figure 4.24) It may be difficult to unhook the F key spring catch because it is much larger than other catches. On mechanisms where the spring catch is thick, the spring will need to be bent in order to unhook from the spring catch completely. However, bending the spring with too much effort will distort the spring tension. Over exertion on the spring is not recommended. It is permissible to unhook the spring while removing the right-hand mechanism.

Figure 4.25: Unhooking E Key Spring

(Figure 4.25) Unhook the E key spring by pushing it off the spring catch. Continue the process as described in aforementioned directions.

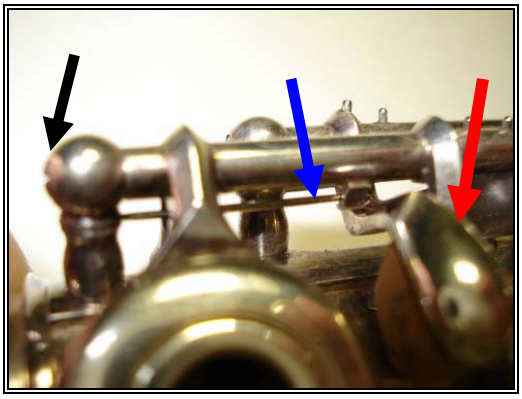


Figure 4.26: D Key Spring

(Figure 4.26) The D key spring is not easy to unhook if the lower trill key is under the spring. On some flutes, this spring can be unhooked easily if there is enough space between the spring catch and the lower trill key. If there is not enough space, then wait until after unscrewing the right-hand mechanism. Otherwise press down the trill key to increase the space, if the spring is not too long. The trill key is identified here with the red arrow.

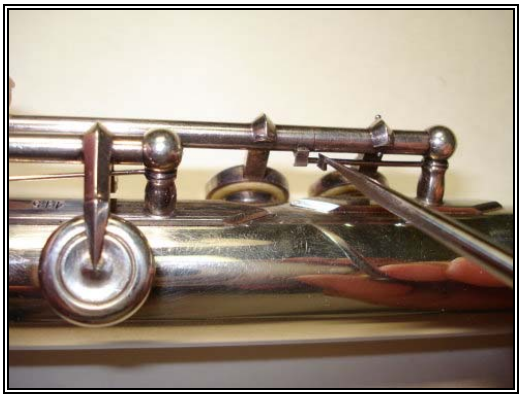


Figure 4.27: Unhooking the Upper Trill Key Spring

(Figure 4.27) Unhook the upper trill key spring by pushing it off the spring catch. This procedure is identical with aforementioned directions.

Figure 4.28: Unhooking the Lower Trill Key

(Figure 4.28) Locate the lower trill key by turning the mechanism 180 degrees around. This will align the instrument with the figure to the left. Now pull the lower trill key spring toward you in order to unhook it from the spring catch.

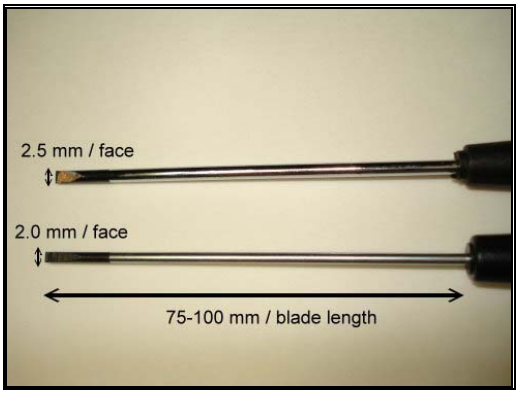


Figure 4.29: Screwdrivers

(Figure 4.29) The next step will entail unscrewing the screws from either end of the post. Choosing a proper size screwdriver is critical. The blade face of the screwdriver should be between 2-2.5mm and the blade length between 75-100mm. Using too small a blade face will damage the screw, and too large a blade face won't fit into the screw slot. It may also tend to scratch the inner key post. Using the longer blade length makes it easier to hold the screwdriver and is then not blocked by the trill key post.

Figure 4.30: Unscrewing the Steel

(Figure 4.30) Use the left-hand thumb and index finger to guide the blade face and prevent slipping of the screwdrivers as shown to the left. This will prevent scratching of the key post or keys. Unscrew the steel in a counter-clockwise direction near the C-sharp key until one hears a very faint "click" sound. The "click" sound means that the steel is fully unthreaded.

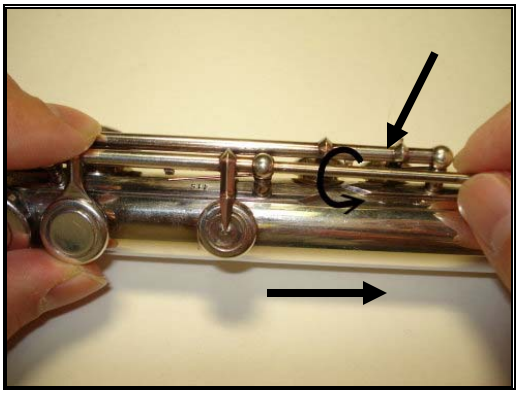


Figure 4.31: Pulling Out the Steel

(Figure 4.31) Twist the steel counter-clockwise. Holding the keys in place with the left hand, ease the steel out smoothly. This step is highly recommended to prevent horizontal scratches on the steel surface that can potentially affect the quality of the key action later. A vertical scratch does not affect the key action in the same way. Scratches may occur from normal use and present no real concern.

Figure 4.32: Cleaning

(Figure 4.32) After releasing the steel entirely from the key rod, clean the oil residue and any debris on the steel with a lint-free soft cloth or tissue.

Figure 4.33: C-Sharp Key Rod

(Figure 4.33) While in repair mode, insert the steel back into the C-sharp key rod. This is important since disassembly entails keeping track of many similar but distinctly different parts and pieces.

Figure 4.34: Left Hand Mechanism

(Figure 4.34) The previous disassembly step now allows the left hand mechanism to be lifted just high enough to unhook the G key spring that could not be mechanically reached heretofore. Removal takes a bit of patience. Use a gentle curve motion as opposed to a vertical motion.

Figure 4.35: Removing the Left Hand Mechanism

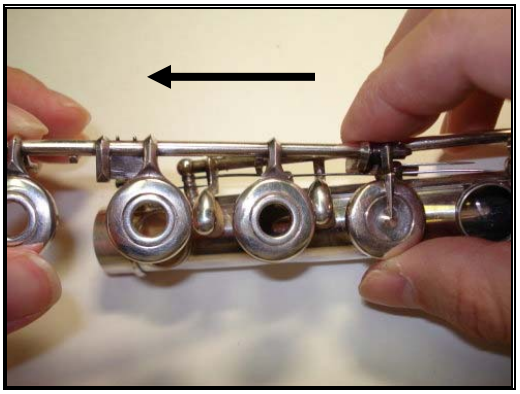
(Figure 4.35) Remove the left hand mechanism gently.

Figure 4.36: Unhooking the D Key Spring

(Figure 4.36) Lift up the right-hand mechanism slightly in order to unhook the D key spring which was previously blocked by the lower trill key lever.

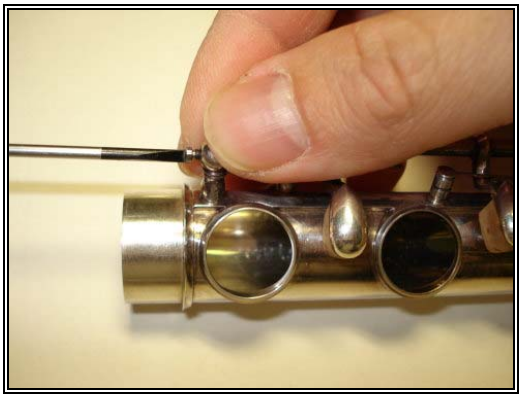
(Figure 4.37) Unhook the upper F key spring if it hasn't been unhooked already.

Figure 4.37: Unhooking Upper F Key Spring



(Figure 4.38) Remove the right hand mechanism gently.

Figure 4.38: Removing Right Hand Mechanism

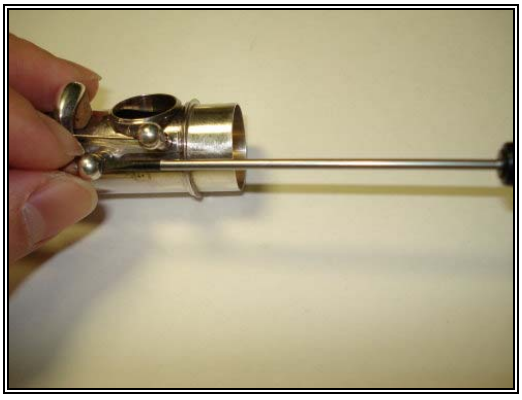


(Figure 4.39) To prevent scratching the key post or keys, use the right-hand thumb and index finger to guide the blade face of the screwdriver. This will prevent it from slipping. Screw the right-hand pivot screw back into its original position.

Figure 4.39: Right-Hand Pivot Screw

(Figure 4.40) Unscrew the left pivot screw of the trill key rod just to the end but not entirely out of the post. This is suggested because left and right pivot screws are not interchangeable and can easily become confused. Use the same technique as in the previous figure.

Figure 4.40: Unscrewing Left Pivot Screw



(Figure 4.41) Unscrew the right pivot screw of the trill key rod in the same way as shown in the figure above. Once again, be aware that the pivot screws are not interchangeable and are easily confused.

Figure 4.41: Unscrewing the Right Pivot Screw

(Figure 4.42) At this point in the disassembly process, the trill key comes apart from the main body joint almost effortlessly. Put it aside temporarily.

Figure 4.42: Trill Key Comes Apart

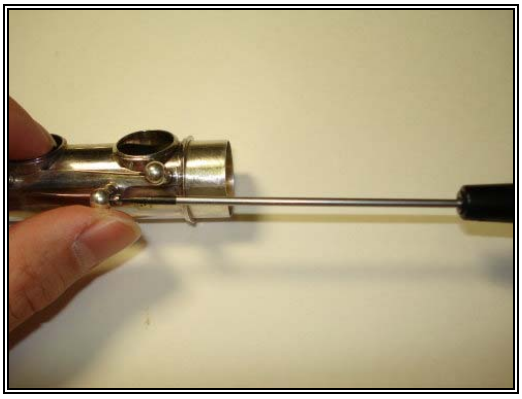


Figure 4.43: Right Trill Key Pivot Screw

(Figure 4.43) Screw the right trill key pivot screw back into the right-hand key post. Be aware that left and right pivot screws are NOT interchangeable as mentioned earlier. This means that the pivot screws need to be screwed back to their original places.

Figure 4.44: Screwing Back the Right Trill Key Pivot Screw

(Figure 4.44) Screw the right trill key pivot screw back to the left-hand key post.

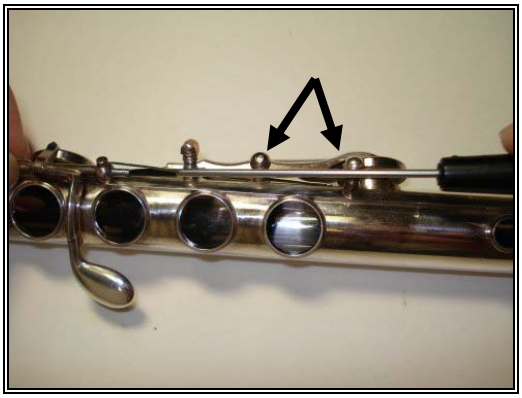


Figure 4.45: Unscrewing the G-Sharp Key

(Figure 4.45) Be sure to use the long screwdriver (75-100mm/blade length) to unscrew the G-sharp key steel. Using the long screwdriver, unscrew counter-clockwise until hearing the faint “click” sound. The “click” sound means the steel is fully unthreaded from the post.

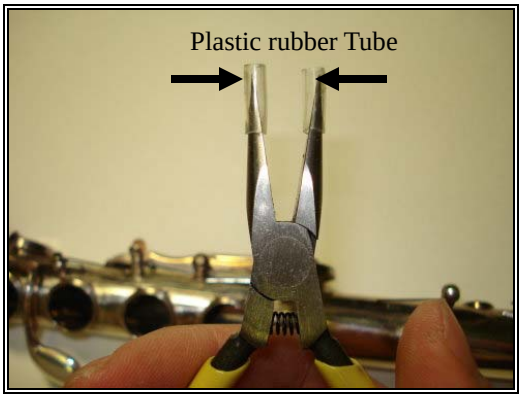


Figure 4.46: Small Plastic Rubber Tubes

(Figure 4.46) To prevent scratches on the G-sharp key screw, insert small plastic rubber tubes onto the flat nose pliers as shown in this figure.

Figure 4.47: Pulling Out the G-Sharp Key Screw

(Figure 4.47) Pull out the G-sharp key steel gently with the modified flat nose pliers. Place your left-hand thumb and index finger on the G-sharp key to prevent it from moving. Know that the spring tension of the G-sharp key is extremely strong. Pulling out the steel without holding the key will cause the key to get stuck between two key posts.

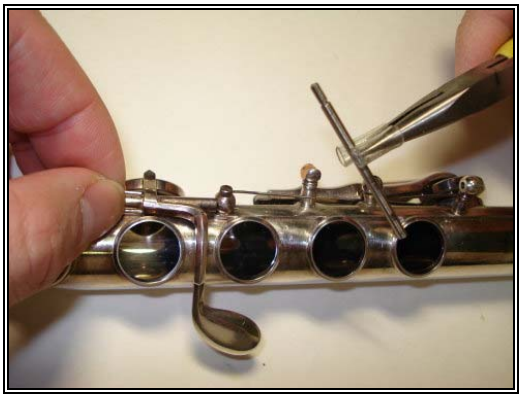


Figure 4.48: Pulling Out the Screw

(Figure 4.48) Pull out the steel completely, and place the steel onto a lint-free soft cloth or tissue. Keep holding the G-sharp key in place.

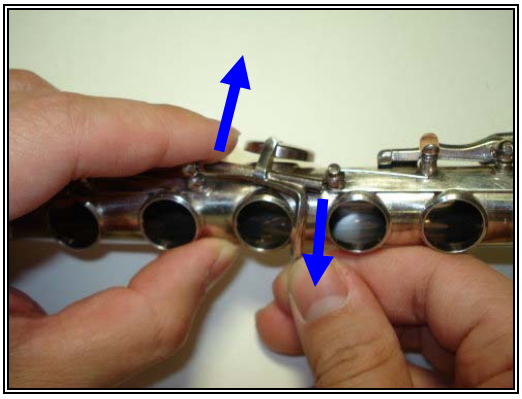


Figure 4.49: Removing and Releasing

(Figure 4.49) Gently remove the key out of the key posts as shown. Parallel moving makes it impossible to remove the key out of the posts. Exert an opposite motion on the key rod in order to release the tension of the spring as shown on the photo.

Figure 4.50: Cleaning

(Figure 4.50) Clean off the oil and impurities on the steel with a lint-free soft cloth or tissue.

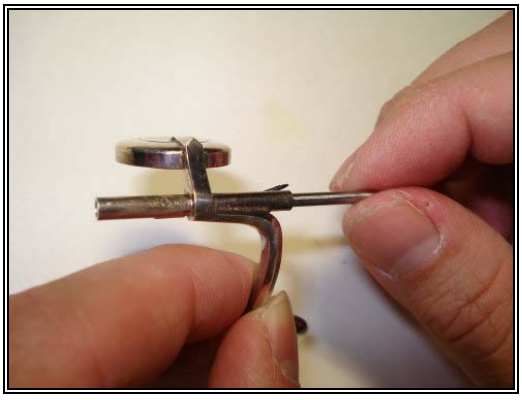


Figure 4.51: Inserting the Screw

(Figure 4.51) Insert the steel back into the G-sharp key rod.

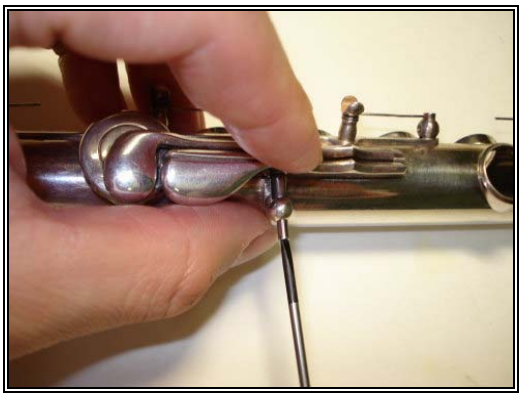


Figure 4.52: Unscrewing the Thumb Key Screw

(Figure 4.52) Use the right-hand thumb and index finger to guide the blade face of the screwdriver and prevent the screwdriver from slipping. Unscrew the thumb key steel.

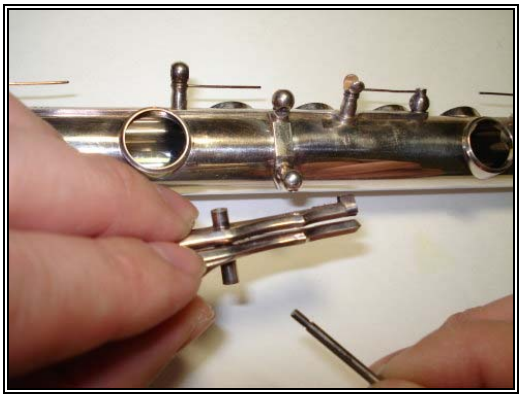


Figure 4.53: Removing the Thumb Keys

(Figure 4.53) Remove the thumb key and B-flat thumb key together or separately after pulling out the steel.

Figure 4.54: Inserting Back the Screw

(Figure 4.54) After cleaning off the oil from the steel, insert the steel back into the thumb key set.

(Figure 4.55) This photo is the view of all the disassembled components from the traditional Boehm mechanism. The keys on the main line are still bound together by several pins.

Figure 4.55: Disassembled the Boehm Mechanism

Main Body Joint Mechanism Disassembly:

Brögger Mechanism

Figure 4.56: Brannen 14 Karat Rose Gold Flute

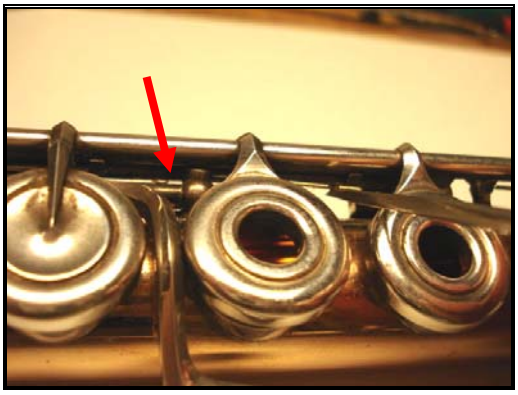
Step by Step Disassembly Instructions:

(Figure 4.57) Use the spring hook to push the C-sharp key spring, unhooking it from the spring catch. Pushing down the key spring releases the tension and frees the key. To prevent scratching the rod, turn the spring hook upside down.

Figure 4.57: Unhooking the B Key Spring

(Figure 4.58) Unhook the B-Flat key spring by pushing the spring off the spring catch. Use the same technique as described in the figure above.

Figure 4.58: Unhooking the B-Flat Key Spring



(Figure 4.59) Unhook the A key spring from the spring catch by pushing the spring off the spring catch in the same way. Leave the G1 and G2 key spring hooked, since there is not sufficient space to unhook the spring. You will note that the G-sharp key rod blocks the space under the G key spring. Do not attempt to force the spring under the spring catch. Ignoring this step will result in a scratch to the G-sharp key rod.

Figure 4.59: Unhooking the A Key Spring

(Figure 4.60) Unhook the F-sharp key spring from the spring catch. Leave the F key spring in place since it cannot be unhooked at this time.

Figure 4.60: Unhooking the F-Sharp Key Spring

Figure 4.61: Unhooking the E Key Spring

(Figure 4.61) Unhook the E key spring from the spring catch.

Figure 4.62: Unhooking the D Key Spring

(Figure 4.62) Unhook the D key spring from the spring catch. Sometimes the second trill key is very close to the D key spring. (This varies from flute maker to flute maker.) Pressing down the trill key creates a space that makes unhooking the spring easier. If not, wait until you have unscrewed the right hand long screw.

Figure 4.63: Unhooking the Trill Key Springs

(Figure 4.63) Unlike the traditional Boehm trill key springs, both springs on the Brögger mechanism are on the same side. Unhook the lower trill key spring first from the spring catch making more space to unhook the upper trill key spring.

Figure 4.64: Unhooking the Upper Trill Key Spring

(Figure 4.64) Unhook the upper trill key spring from the spring catch.

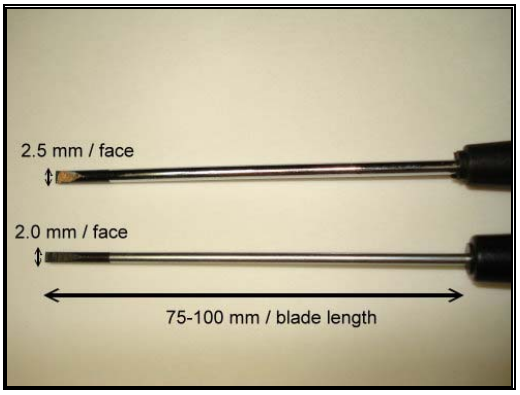


Figure 4.65: Screwdrivers

(Figure 4.65) The next step will entail unscrewing the screws from either end of the post. Choosing a proper size screwdriver is critical. The blade face of the screwdriver should be between 2-2.5mm and the blade length between 75-100mm. Using too small a blade face will damage the screw, and too large a blade face won't fit into the screw slot. It may also tend to scratch the inner key post. Using a longer blade length makes it easier to hold the screwdriver and is then not blocked by the trill key post.

Figure 4.66: Unscrewing the Screw

(Figure 4.66) Use the left-hand thumb and index finger to guide the blade face and prevent slipping of the screwdriver as shown to the left. This will prevent scratching of the key post or keys. Unscrew the steel in a counter-clockwise direction near the C-sharp key until hearing a very faint "click" sound. The "click" sound means the steel is fully unthreaded.

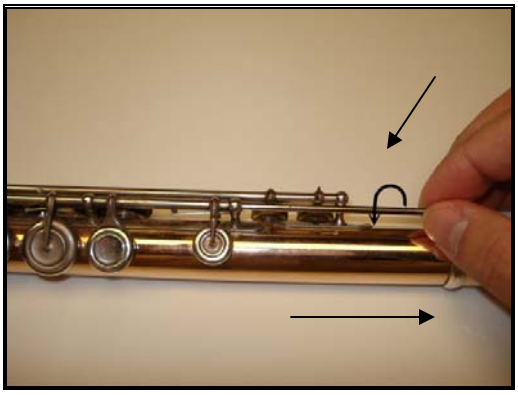


Figure 4.67: Twisting the Screw

(Figure 4.67) Twist the steel counter-clockwise. Holding the keys in place with the left hand will ease the steel out smoothly. This step will prevent the possibility of horizontal scratches on the steel surface that can later affect the quality of the key action. This detail should not be minimized. However, vertical scratch does not adversely affect the key action.

Figure 4.68: Pulling Out the Left-Hand Screw

(Figure 4.68) Use the left hand to hold the G1 and G2 keys while pulling out the left-hand steel. The G key spring has not yet been unhooked. Know that pulling out the steel too suddenly without holding the G keys might damage the mechanism.

Figure 4.69: Unhooking the G Key Spring

(Figure 4.69) Lift up the G keys slightly to unhook the G key spring.

Figure 4.70: Left-Hand Mechanism

(Figure 4.70) Once the long steel is released from the tubing, the complete left-hand mechanism will come apart from the main joint.

Figure 4.71: Pinless Keys

(Figure 4.71) Remember that the Brögger mechanism, unlike the Traditional Boehm mechanism, uses the long steel and bridge system to connect all the keys. There are no pins on the keys. All the keys operate as an individual section. Note that care must be taken not to bend the bridge. Bending of any kind will damage the mechanism.

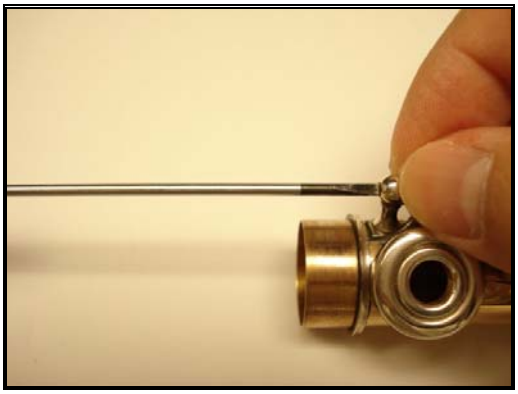


Figure 4.72: Unscrewing the Right Hand Key Steel

(Figure 4.72) Unscrew the right hand key mechanism counter-clockwise.

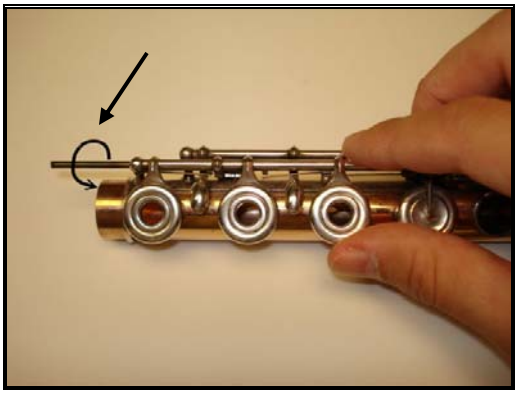


Figure 4.73: Pulling Out the Steel

(Figure 4.73) Twist the steel clockwise while pulling out the steel. Hold the F and F-sharp key in place with the right hand to help pull out the steel smoothly. The F key spring has not yet been unhooked and will bounce out suddenly if it is not held in place. If this step is not performed with caution, the key rod might be bent or scratched inside by the steel.

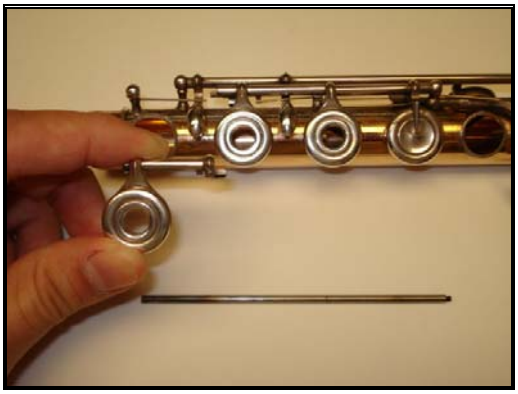


Figure: 4.74: Removing the D Key

(Figure 4.74) After taking out the right-hand long steel, the D key can be removed easily.

Figure 4.75: Removing the F Key

(Figure 4.75) Remove the F key as soon as possible to release tension on the spring.

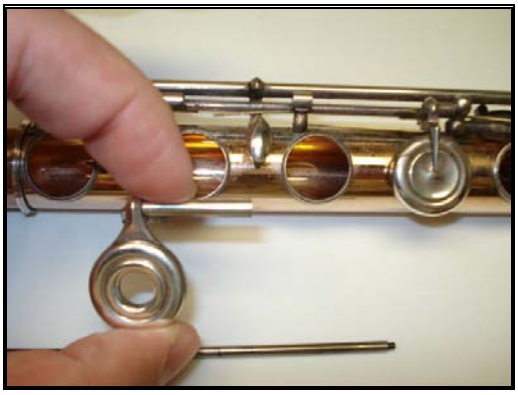


Figure 4.76: Removing the E Key

(Figure 4.76) Remove the E key effortlessly.

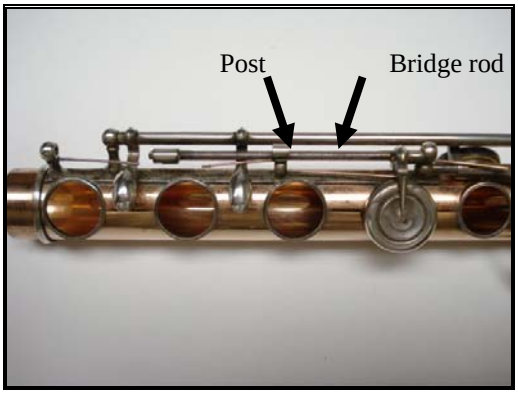


Figure 4.77: Leaving the F-Sharp Key

(Figure 4.77) Leave the F-sharp key in the original place. It cannot be removed now because the bridge rod is stuck between the key post and the trill key rod.

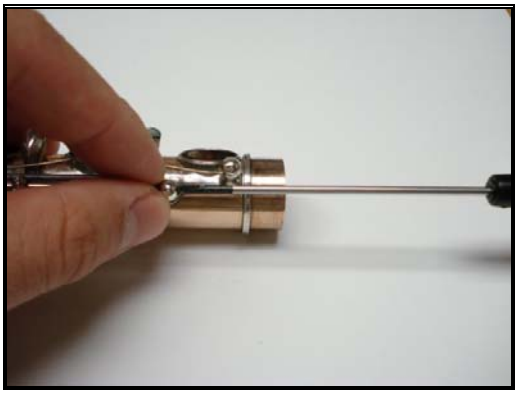


Figure 4.78: Unscrewing Right-Hand Pivot Screw

(Figure 4.78) Unscrew the right-hand pivot screw of the trill key rod just to the end but not entirely out of the post. This is suggested because left and right pivot screws are not interchangeable and can easily become confused. Use the same technique as in the previous figure.

Figure 4.79: Unscrewing the Left-Hand Pivot Screw

(Figure 4.79) Unscrew the left-hand trill key pivot screw.

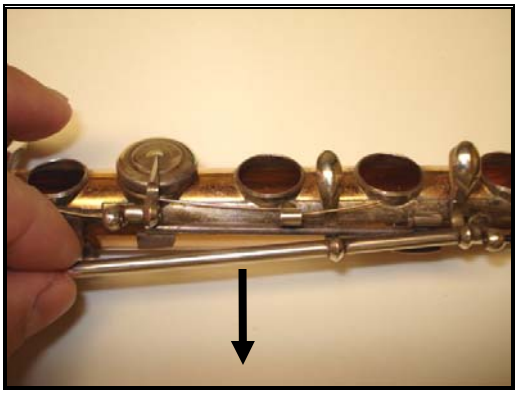


Figure 4.80: Removing the F-Sharp Key

(Figure 4.80) Move the trill key rod slightly away in order to remove the F-sharp key.

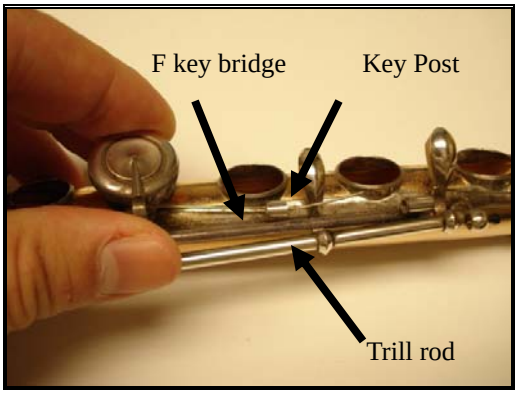


Figure 4.81: Removing the F Key Bridge

(Figure 4.81) Remove the F key bridge between the key post and trill rod.

(Figure 4.82) Remove the trill key rod.

Figure 4.82: Removing the Trill Key Rod

(Figure 4.83) Screw back the pivot screw to its original position to prevent loss.

Figure 4.83: Screwing Back the Pivot Screw

(Figure 4.84) This figure shows the complete right-hand mechanism with the long screw and trill keys apart from the main joint.

Figure 4.84: Complete Right-Hand Mechanism

Figure 4.85: Unscrewing the G-Sharp Key

(Figure 4.85) Use the long screwdriver (75-100mm/blade length) to unscrew the G-sharp key. Using the long screwdriver, unscrew in a counter-clockwise direction until hearing the faint “click” sound. The “click” sound means the steel is fully unthreaded from the rod.

Figure 4.86: Small Plastic Rubber Tubes

(Figure 4.86) To prevent scratches on the G-sharp key screw, insert small plastic rubber tubes onto the flat nose pliers as shown in this figure.

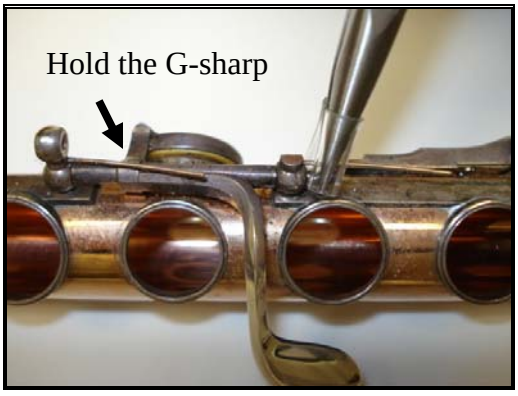


Figure 4.87: Pulling Out the G-Sharp Key Steel

(Figure 4.87) Pull out the G-sharp key steel gently with the modified flat nose pliers. Place the left-hand thumb and index finger on the G-sharp key to prevent it from moving. Know that the spring tension of the G-sharp key is extremely strong. Pulling out the steel without holding the key will cause the key to get stuck between two key posts.

Figure 4.88: Pulling Out the Steel Completely

(Figure 4.88) Pull out the steel completely, and place the oiled steel onto a lint-free soft cloth or tissue.

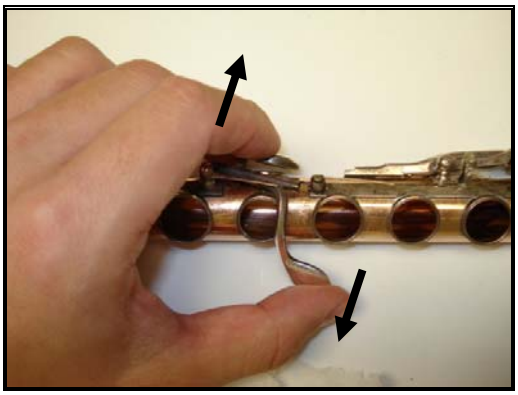


Figure 4.89: Removing the Key

(Figure 4.89) Gently remove the key out of the key posts as shown. Exert an opposite motion on the key rod in order to release the tension of the spring as shown in the photo.

Figure 4.90: G-Sharp Key and Steel

(Figure 4.90) This figure is a full view of the G-sharp key and the steel.

Figure 4.91: Unscrewing the Thumb Key Steel

(Figure 4.91) Use the right-hand thumb and index finger to guide the blade face of the long screwdriver to prevent the screwdriver from slipping. Unscrew the thumb key steel.

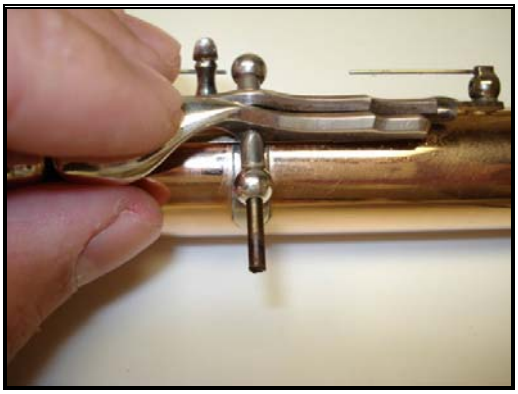


Figure 4.92: Pulling Out the Steel

(Figure 4.92) Hold the thumb key and B-flat thumb key while pulling out the steel.

Figure 4.93: Cleaning and Inserting Back the Steel

(Figure 4.93) After cleaning off the oil and any debris from the steel, insert the steel back into the thumb key set to prevent loss.

(Figure 4.94) This photo is a view of all the disassembled parts of the Brögger mechanism. The keys on the main line are completely taken apart since there are no pins used in this type of mechanism.

Figure 4.94: All the Disassembled Components of the Brögger mechanism

Head Joint Disassembly

The flute head joint plays an important role in the production of tone. Usually, the head joint has fewer problems compared to the main body joint and foot joint. However, if the head joint cork is misplaced inside the head joint, then flutists will experience problems with intonation. Theoretically, the distance from the center of the blowing hole to the bottom of the cork against the bottom metal disc should be 17.3 mm. Using the end of a cleaning rod, frequently check the cork position.

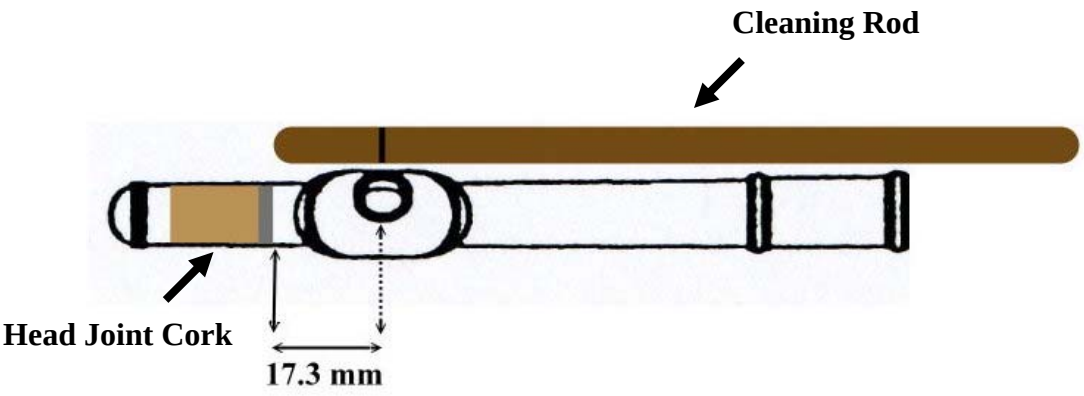


Figure 4.95: Head Joint Cork and Cleaning Rod

It is unnecessary to disassemble the head joint unless the cork becomes loosened and needs to be replaced with a new cork. Cork is a material that tends to shrink and becomes inflexible when it has been installed in the head joint for a period of time. Once the cork shrinks, the tone production becomes weak and stifled and flutists sometimes have the desire or habit to tie up the crown by twisting it clockwise. The position of the cork is gradually raised up closer to the crown which will cause intonation problems throughout the flute. In the following instruction of head joint disassembly, the replacement of the head joint cork procedure will also be demonstrated.

Repair Tools and Materials Required:

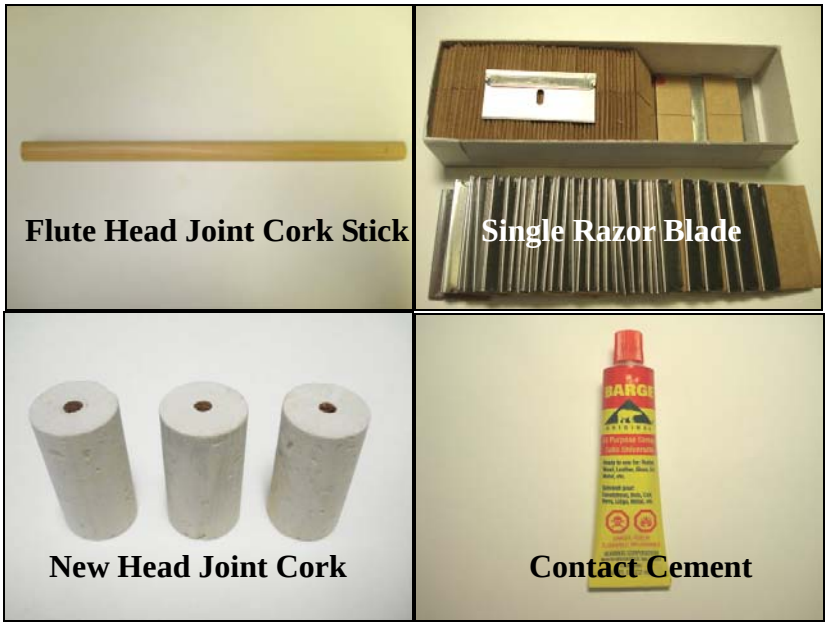


Figure 4.96: Repair Tools and Materials Required

Step by Step Disassembly Instruction:

Figure 4.97: Unscrewing the Head Joint Crown

(Figure 4.97) Unscrew the head joint crown by twisting in a counter-clockwise direction.

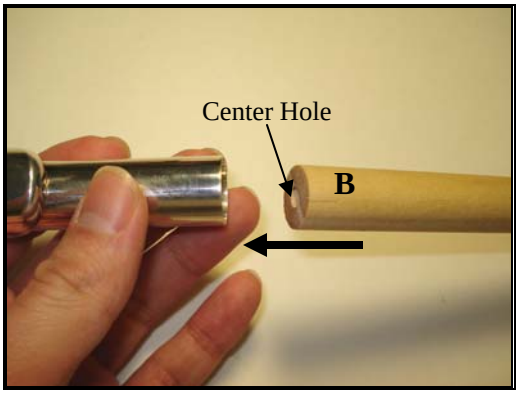


Figure 4.98: Inserting Side B

(Figure 4.98) Insert side B (with a center hole) of the head joint cork stick into the top of the head joint. The head joint cork screw can fit in the center hole which will guide the stick into the top of the flute.

Figure 4.99: Pushing Out the Cork

(Figure 4.99) Please note that the head joint is conical shape and the cork can only be pushed out from the tenon (or interlocking) side. Place the other side of the stick on a desk vertically and "push" the cork out from the tenon side of the head joint with both hands while holding onto the head joint. Make sure not to hold the head joint on the soldered lip plate because it may fall off easily if too much pressure is applied. Be sure to hold on either side of the head joint.

Figure 4.100: Keep Pushing the Cork

(Figure 4.100) Once the cork becomes loosened, keep pushing the cork until it comes out of the head joint.

Figure 4.101: Water Gets Into the Bottom of the Cork

(Figure 4.101) When water gets into the bottom of the cork it makes the cork become black and inflexible. As a result of moisture, tone production becomes weak and less responsive because of the shrinkage of the cork. This is the right time to replace the cork.

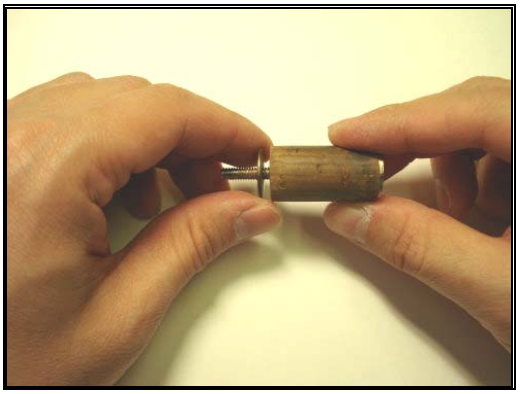


Figure 4.102: Unscrewing the Upper Metal Disc

(Figure 4.102) To replace the cork, simply unscrew the upper metal disc from the cork as shown in the figure. Sometimes, the upper metal disc is glued in place. It may need to be cut off with a blade razor.

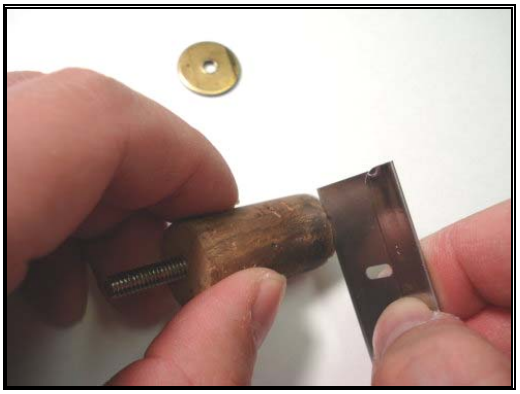


Figure 4.103: Cutting Off the Cork

(Figure 4.103) Use a single blade razor or knife to cut off the cork. The cork cannot be removed without the blade razor because of the shellac or contact cement applied between the cork and the bottom metal disc. Make sure not to cut through or damage the screw inside of the cork. Circular cutting around the cork can avoid damage.

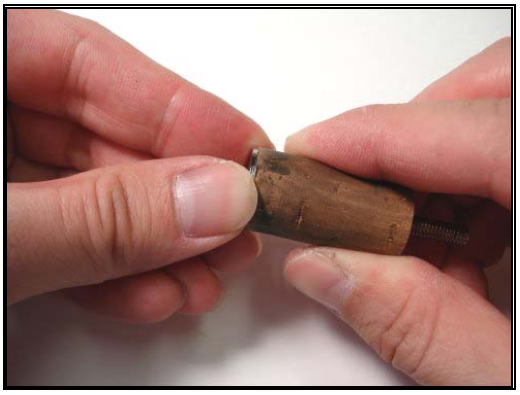


Figure 4.104: Twisting the Cork Off the Center Screw

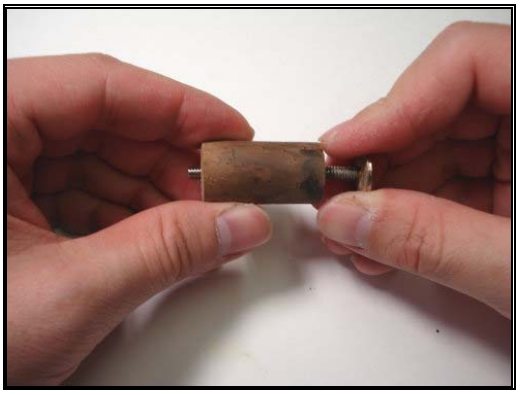
(Figure 4.104) After cutting the cork, try to twist the cork counter-clockwise off the center screw. Be careful not to bend or damage the screw and metal disc while twisting the cork.

Figure 4.105: Twisting Back the Crown

(Figure 4.105) If the cork is tight and cannot be twisted off the screw, the other option is to twist the crown back to the screw completely.

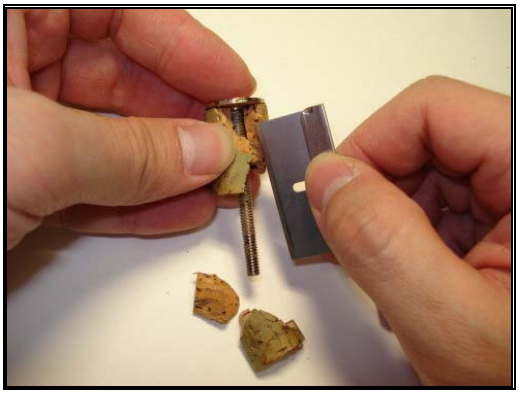
Figure 4.106: Separating the Cork From The Bottom Metal Disc

(Figure 4.106) Hold the crown and cork with both hands, and twist them in opposite directions (both clockwise). Usually, this method will separate the cork from the bottom metal disc.



(Figure 4.107) Unscrew the crown and keep twisting the cork off the screw by holding the cork and bottom metal disc.

Figure 4.107: Unscrewing the Crown



(Figure 4.108) If both methods do not succeed in separating the cork from the screw, the final option is to cut the cork vertically. Be careful not to mar or damage the thread of the screw or hurt the fingers.

Figure 4.108: Cutting the Cork Vertically

(Figure 4.109) Use both hands to peel off the rest of the cork as shown in the figure.

Figure 4.109: Peeling Off the Rest of the Cork

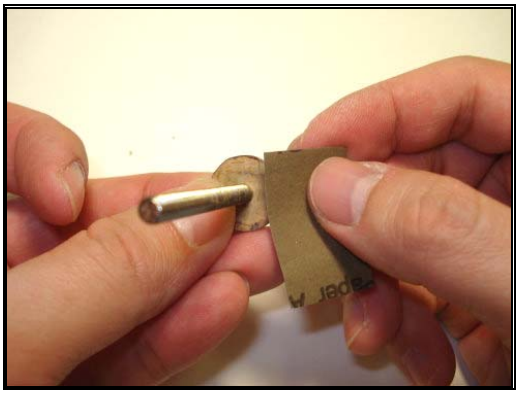


Figure 4.110: Sanding Off the Shellac and the Cork

(Figure 4.110) Use 400 grit sandpaper to sand off the shellac and the cork on the bottom metal disc.

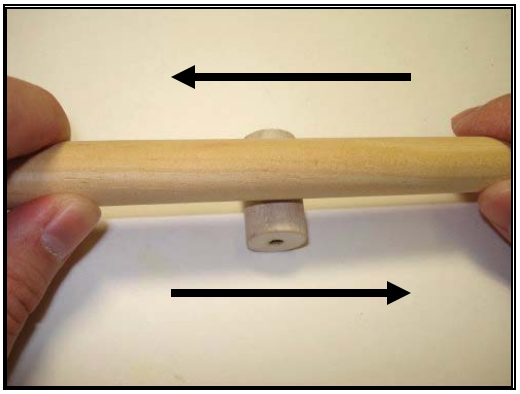


Figure 4.111: Rolling the Head Joint Cork Stick Across the Cork

(Figure 4.111) Some new head joint corks are slightly bigger than the standard head joint diameter. This may make the installation more difficult. If this is the case, use the head joint cork stick, rolling it across the cork. This will slowly decrease the diameter of the cork. Because the modified cork is still flexible, it will gradually revert to its original size after it is installed into the head joint. If the cork is tightly installed inside the head joint, the tone production will become responsive. However, some flutists insist that if the cork is installed too tightly, tone quality is deadened.

Figure 4.112: Applying Contact Cement Onto One Side

(Figure 4.112) Apply some contact cement or shellac onto one side of the new cork.

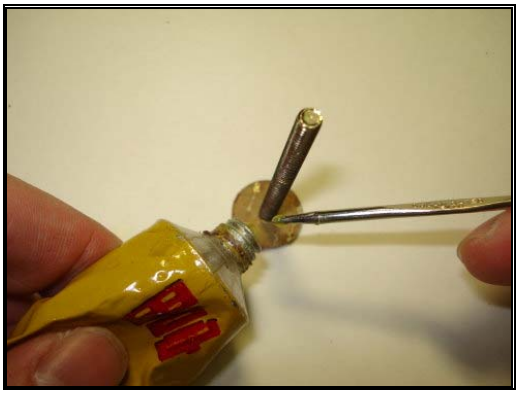


Figure 4.113: Applying Contact Cements Onto Bottom Metal Disc

(Figure 4.113) Apply some contact cement or shellac onto the bottom metal disc.

Figure 4.114: Screwing Back the New Cork

(Figure 4.114) Screw the new cork back to the bottom of the metal disc as shown in the figure.

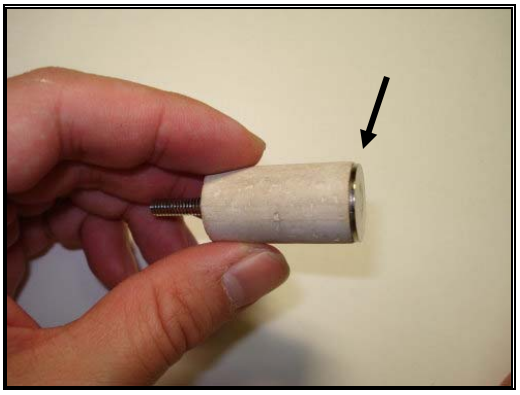


Figure 4.115: The Bottom of the Metal Disc

(Figure 4.115) The new cork must make complete contact with the bottom of the metal disc. Leaving a space between the new cork and metal disc will degrade the quality of the seal on the head joint.

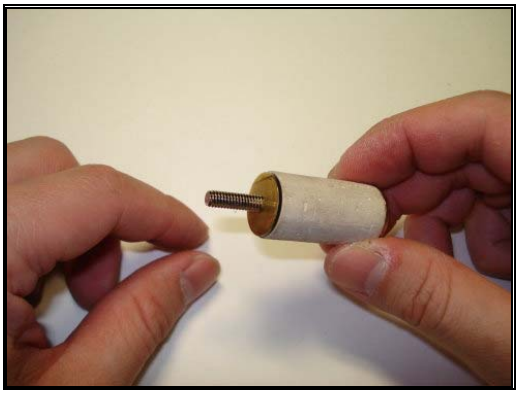


Figure 4.116: Screwing Back the Upper Metal Disc

(Figure 4.116) Screw back the upper metal disc tightly in a clockwise direction.

Figure 4.117: Inserting Back the New Cork

(Figure 4.117) Insert the new cork back to the tenon (interlocking) side of the head joint.

Figure 4.118: Inserting the Head Joint Cork Stick

(Figure 4.118) Insert the head joint cork stick (with a soft felt tip) into the tenon (interlocking) side of the head joint following the new cork.

Figure 4.119: Pushing Back the New Cork

(Figure 4.119) Push back the new cork to the top of the head joint. Make sure not to touch the soldered lip plate.

Figure 4.120: Screwing Back the Crown

(Figure 4.120) Screw the crown back to the head joint in a clockwise direction.

Figure 4.121: Completely Assembled Head Joint

(Figure 4.121) This figure shows a completely assembled head joint.

CHAPTER 5

AN INTRODUCTION TO FLUTE PADS

The flute pad plays an important role in tone production on the flute. The flute can sound exquisite and brilliant if every single pad is installed in the key cup properly sealing each tone hole on the flute perfectly. However, the pad will change its thickness over time after being depressed repeatedly. This will eventually cause tone production problems. Moreover, temperature and moisture cause the pad to change in thickness. It is very important that flutists have knowledge of flute pads, including the different materials of which the flute pads are made, the structure of the pads, and how to choose a suitable "pad set" for the flute.

Some flute pad makers have been seeking various materials that can improve the stability of pads after installation in the key cups. There are several companies that have successfully invented and improved flute pads. In this chapter, different types of pads will be discussed in relation to materials, construction and durability.

The Woven Felt Pad and the Compressed Felt Pad

The traditional flute pad is made of three materials: cardboard (Figure 5.1), felt (Figure 5.2) and two layers of animal intestine or goldbeater (bladder) fish skins (Figure 5.3). These three materials are bonded together by gluing the fish skin with mucilage on the back of cardboard. The function of the cardboard is to set a durable base for the pad in the key cup. The felt serves as a cushion which can silence the movement of the key, and is chosen from two different types of materials: woven (softer) and compressed needle felt (firm). A woven felt is thicker than a compressed felt and the coefficient of the compression is also higher than a compressed felt (Figure 5.4). The function of the fish skins is to seal the flute tone hole to prevent leakage of air.

Figure 5.1: Cardboard

Figure 5.2: Felt

Figure 5.3: Animal Intestine or Goldbeater (bladder) Fish Skins

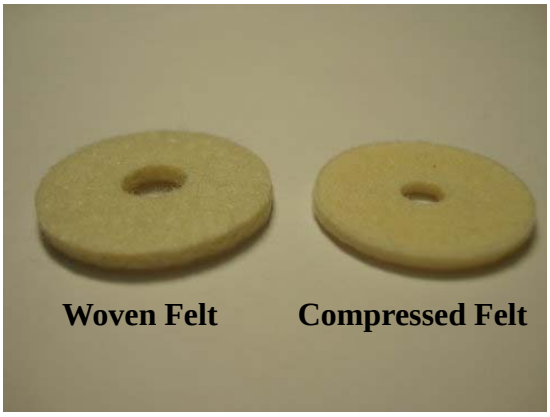


Figure 5.4: Woven Felt and Compressed Felt

The thickness of a woven felt pad is between 2.5mm to 2.9mm and is frequently installed on the mass-production student model flute, which has drawn tone holes, thus the tone holes are not as flat as tone holes from a professional flute (Figure 5.5). Repeated depressions of the key will make deep impressions on the woven pad. The woven pad produces a better seal with less shimming necessary. Shims serve to stabilize and flatten the pads.

Figure 5.5: Woven Pad

Compressed felt pads are usually installed on professional flutes that have very flat tone hole surfaces. Because the felt is firm and flat, the compressed felt pad reduces the possibility of a deep impression. This makes the pad more stable than a woven pad after the shimming process. The thickness of a thin compressed pad can be slightly over 2mm. It is possible to install a thin compressed pad with a thin stabilizer under it if the key cup doesn't have a flat bottom (Figure 5.6). The function of a stabilizer is to create a solid and flat base for a compressed felt pad. The step-by-step instruction of new pad installation will be demonstrated in Chapter 8. A standard stabilizer is 1mm thick, and a thin stabilizer can run just between 0.5mm to 0.6mm. The total thickness of a

compressed felt pad and thin stabilizer cannot exceed 2.7mm in the key cup. This will allow placement of some shims between the pad and stabilizer for minor adjustments.

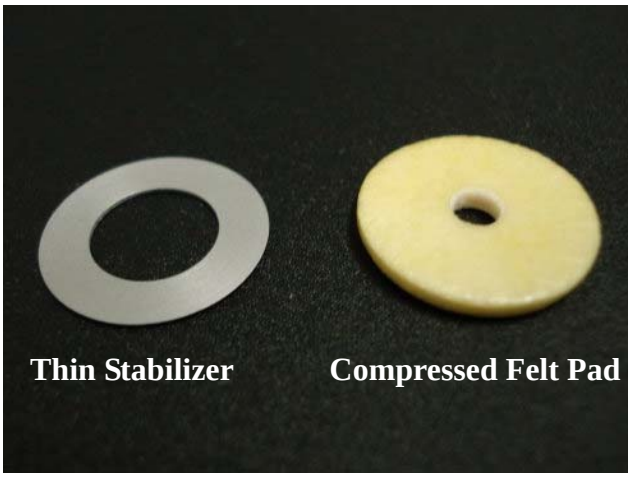


Figure 5.6: Thin Stabilizer and Compressed Felt Pad

The Straubinger Pad

Straubinger pads, also known as synthetic pads, are largely installed on professional model flutes by major flute companies. Because of their stability and the ease of installation, as well as the fast response of the tone production, they are increasingly becoming more popular in the flute market. The Straubinger pad was invented by a flute maker, David Straubinger, who began his research in 1975. After researching an array of materials for many years, Straubinger pads became available by

the mid 1980's (Figure 5.1.7). Mr. Straubinger states that the standard felt pad is subject to change by temperature and humidity as well as a great amount of playing. Under these conditions, pad thicknesses vary, thus affecting the flute's playability. Because of the imperfection of the standard felt pad, Straubinger believes his superior pad can provide a long-lasting seal on the tone hole, once it has been adjusted properly .

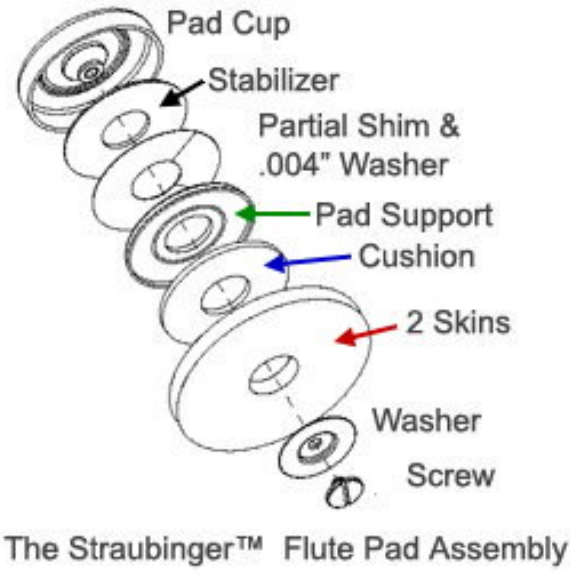


Figure 5.7: The Straubinger Flute Pad (Photo from Straubinger Flute Company)

The Straubinger pad (Figure 5.8) includes three materials: a patented pad support unit, a synthetic felt and a double-layer of fish skin (Figure 5.9). The patented pad support unit, also called a plastic pad cup, which is made of Delrin, provides a support for the felt and keeps the felt in place during the action of the key mechanism. In addition,

Mr. Straubinger also invented a washer, also called as a stabilizer (Figure 5.10), made of Delrin, to be installed between a pad and a key cup. The function of the stabilizer is not only to provide a solid and flat surface to support the pad, but also to place the pad at its correct height in the key cup. Additional shims or partial shims can be glued onto a 0.04-inch shim where it is placed between the pad cup and the stabilizer as a minor adjustment.

Figure 5.8: Straubinger Pad

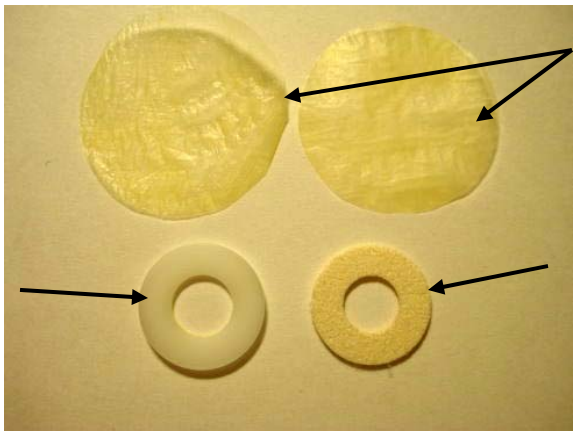


Figure 5.9: Straubinger Pad Disassembly

Figure 5.10: Delrin Stabilizer

Mr. Straubinger spent a great amount of time searching for a suitable synthetic material for the felt. He confirmed his theory of felt compression and recovery rates that make Straubinger pads successfully in tone responses. Moreover, the felt used in a Straubinger pad is less affected by the temperature and humidity than a standard felt.

The double-layer fish skin provides a tight seal on the tone holes, thus preventing leakage. The felt is kept in place by the fish skin and remains in shape by the rim located outside the pad cup.

Flutes installed with Straubinger pads are more stable and playable than in the past. To maintain a high quality, Straubinger pads may only be installed by repair technicians certified by the Straubinger flute company. However, any repair technician

can perform minor adjustments as well as re-skin Straubinger pads. Some technicians prefer to re-skin Straubinger pads rather than replacing old ones. Because the felt in old Straubinger pads has been compressed to a certain rate and thickness, the felt will not change too much after re-skinning the pad. In other words, a re-skinned Straubinger pad may be more stable than a new pad. Flutists who know how to re-skin Straubinger pads save themselves both time and money in terms of commercial repair and shipping costs. How to re-skin a Straubinger pad is demonstrated in Chapter 7.

CHAPTER 6

THE OILING OF THE FLUTE MECHANISM

After cleaning and minor adjustments on the flute have been made, the last step of flute maintenance is to oil the mechanism. Oiling the flute mechanism is a very important procedure in the annual COA (clean, oil, adjust) maintenance. The function of the oil is to lubricate the inside of the key rods and steels to prevent friction and rust. Just like a car engine that needs an oil change from time to time, the flute requires similar attention. Over time, oil in the flute mechanism becomes dirty and dense and thus requires replacement. Changing oil in the key rods will ensure that the response of the mechanism will be quicker and quieter.

Although the order of an annual COA is to clean the flute, oil the mechanism, regulate the leakages on the pads and remove lost motions on the corks, most technicians

prefer to make minor adjustments on the pads and corks before lubricating the mechanism with new oil. Minor adjustments require disassembling and assembling the flute a numbers of times, depending on the technician's level of experience with the padding process. Unless care in exerted in the disassembly and assembly process, new oil may seep out of the key rod and contaminate the pads and corks. Therefore, minor adjustments should be done before any oil change. A less experienced flutist who would like to perform the annual COA, should conduct minor adjustments prior to the lubrication of the mechanism. Wiping away old oil after the first disassembly is a very important part of this process and cannot be emphasized enough.

Applying too much oil inside the key rod is to be avoided at all costs. Because of gravity, excess oil leaks from the key rods, damaging the pads and corks. As a result, the pads and corks become sticky and the mechanism responds slowly.

Choosing suitable key oil is also very important and affects the action of the mechanism. Some types of oils will become sticky after evaporating and are not advisable for flutes. Flute repair technicians may suggest buying a specific

viscosity of automotive motor oil from the automobile shops to lubricate the flute. Flutists who don't need to oil the flute very often can buy small bottles of key oil from the repair supplier.

Purchase two different viscosities of key oil: thick (heavy) oil and thin (medium) oil. The mechanism of the student flute or older flute is usually loosened because the accuracy between the key rod and inside screw is problematic. Using thick (heavy) viscosity of key oil on such loosened mechanisms can reduce noise from the mechanism and lubricate the inside of the key rod preventing it from rusting.

Repair Tools and Supplies Required

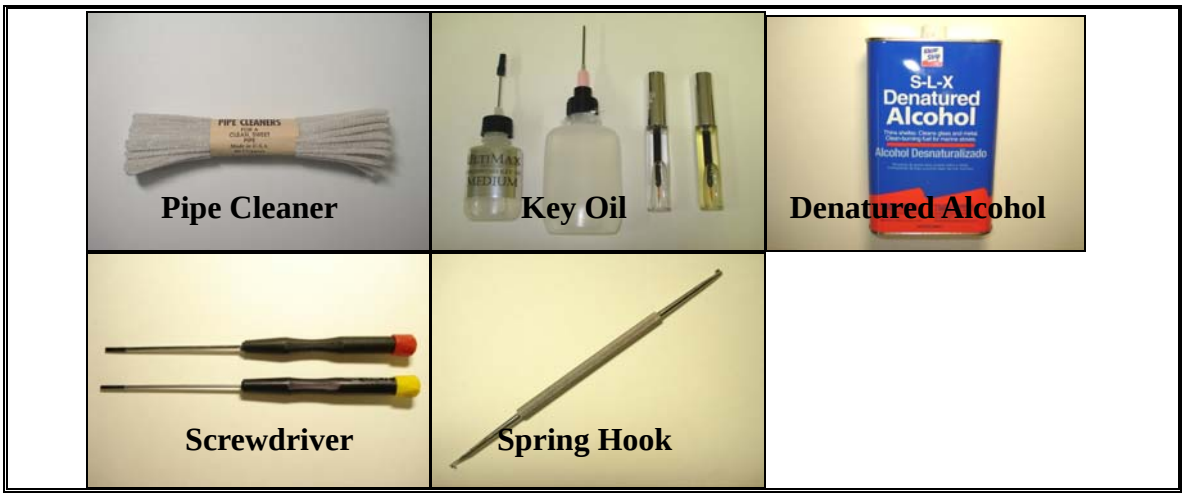


Figure 6.1: Repair Tools and Supplies

Tradition Boehm Mechanism

Figure 6.2: Cleaning With a Lint-Free Soft Cloth or Tissue

(Figure 6.2) After releasing the steel entirely from the G# key tubing, clean off the oil residue and any debris on the steel with a lint-free soft cloth or tissue.

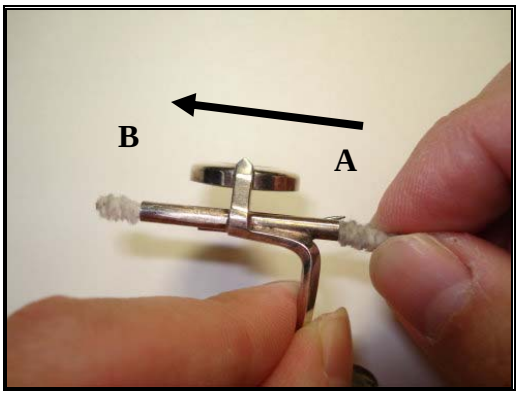


Figure 6.3: Inserting a Pipe Cleaner

(Figure 6.3) Insert a pipe cleaner from side A of the key tubing to clean off the old oil. Dip the pipe cleaner in denatured alcohol first to clean out the old oil. This step also prevents any lint from causing additional problems.

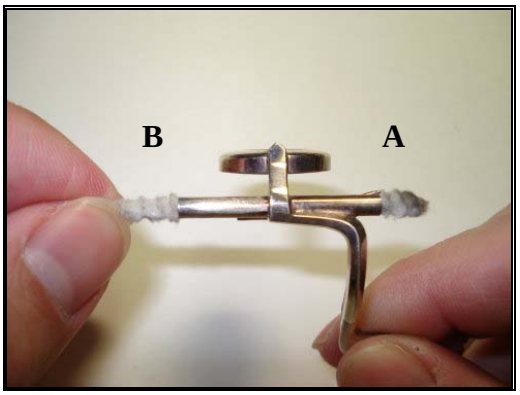


Figure 6.4: Clearing the Debris

(Figure 6.4) Oil residue and debris may remain inside the key tubing. To clear the debris, pull the pipe cleaner from side A toward the left, exiting at side B of the key tubing. Exerting care to move the pipe cleaner in one direction (from right to left) prevents scratches.

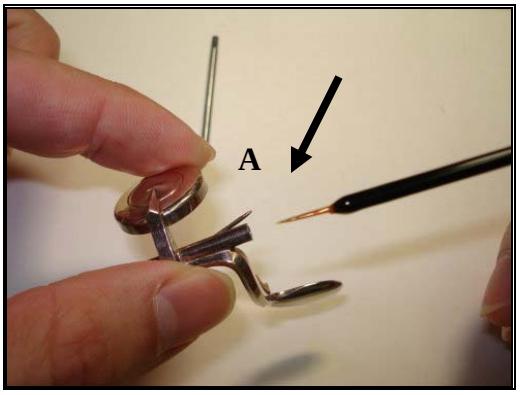


Figure 6.5: Applying Key Oil

(Figure 6.5) With a small brush apply some oil from side A of key tubing where the steel will be inserted. New oil will be pushed to side B of the key tubing when the screw is inserted from side A. In this way, the entire key tubing is lubricated in one motion.

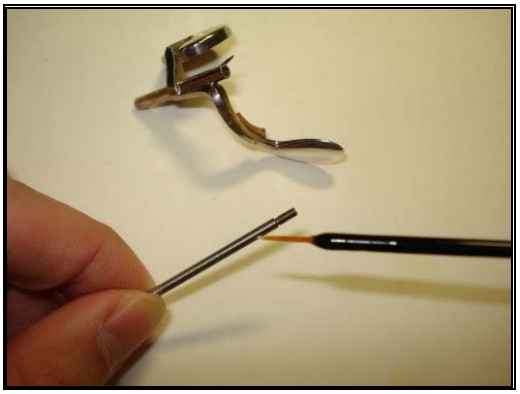


Figure 6.6: Applying a Small Amount of Key Oil

(Figure 6.6) Apply a small amount of key oil only on the TIP of the steel, bearing in mind that too much oil will leak from the tubing and damage the pad and cork. The intent of this action is to push the oil across the screw without excess oil that causes other problems.

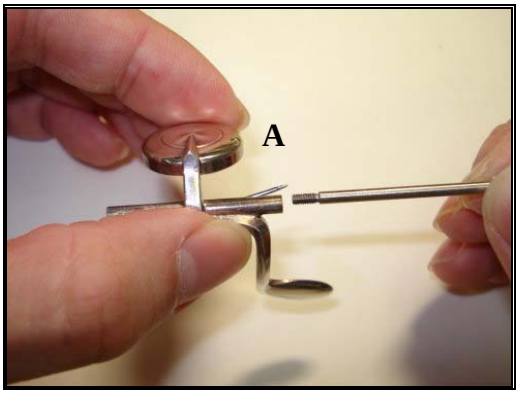


Figure 6.7: Inserting the Steel

(Figure 6.7) Insert the steel into side A of the key tubing as shown in the photograph.

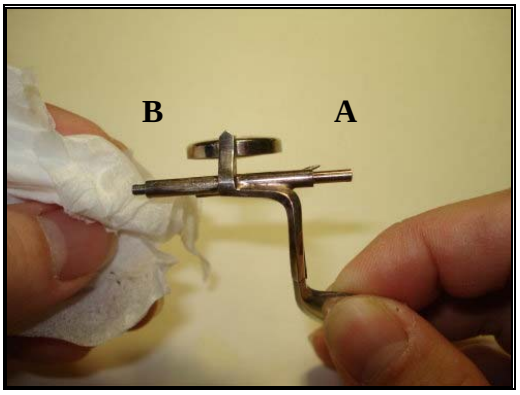


Figure 6.8: Wiping off the Excess Oil

(Figure 6.8) Excess oil can be wiped off at side B of the key tubing. After wiping off the excess oil, pull out the steel toward side A (to the right).

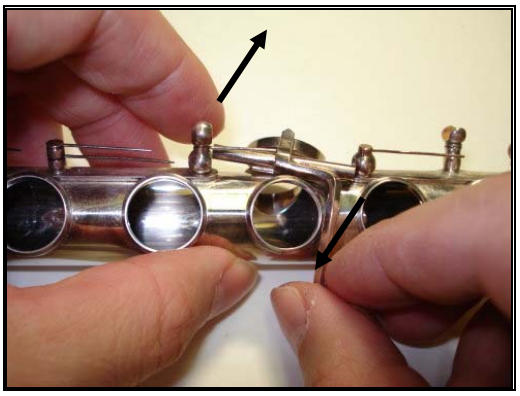


Figure 6.9: Assembling the G-Sharp Key

(Figure 6.9) Assemble the G-sharp key back to the main body joint remembering that a slight twist will be needed in order to lodge the key between the two key posts. (Refer to Chapter 4 on page 67 for details.) Using the spring hook, make sure the G-sharp key spring is hooked back to its original place as shown in the figure. Some flute makers put a hole on the rib as a spring catch; some rest the spring in front of the post. Please note that it is very easy to disturb the tension on this spring when putting the G-sharp key back on the flute.

Figure: 6.10: Inserting the Steel

(Figure 6.10) Hold the G-sharp key in place with your left hand while inserting the steel. Use a long screwdriver to tighten up the steel fully without unnecessary exertion that could possibly result in damaging the threads of the steel.

Figure 6.11: Wiping Off the Excess Oil

(Figure 6.11) If some oil leaks from the gap between the key tubing and the key post, use a lint-free soft cloth or tissue to wipe off the excess oil.

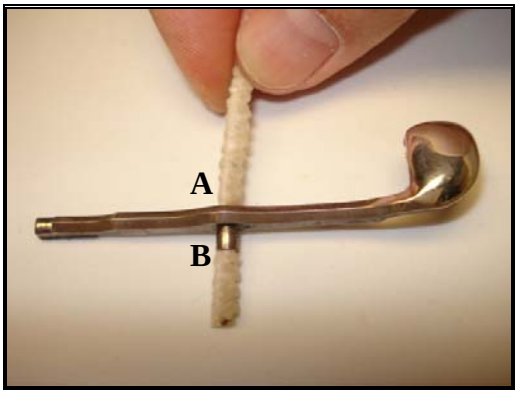


Figure: 6.12: Inserting a Pipe Cleaner

(Figure 6.12) Insert a pipe cleaner from side A of the B-flat thumb key and pull it out from side B.

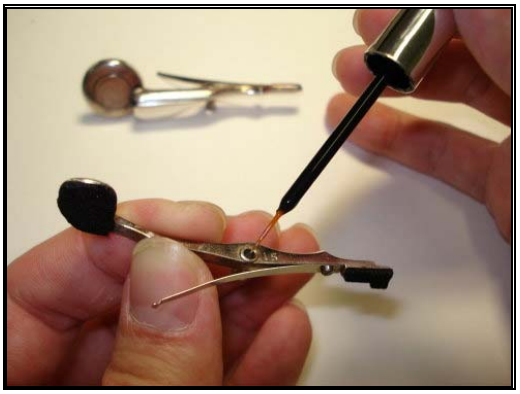


Figure 6.13: Applying a Small Amount of Key Oil

(Figure 6.13) After cleaning the key tubing with a pipe cleaner, apply a small amount of key oil into the B-flat thumb key as shown.

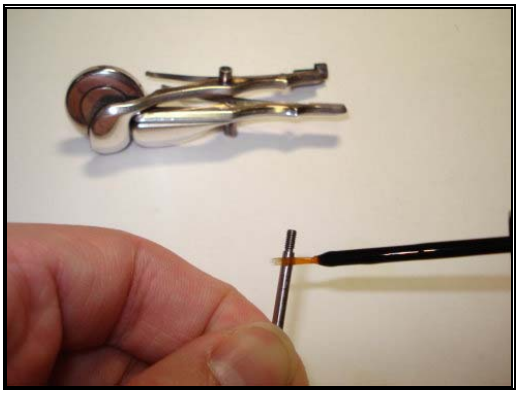


Figure 6.14: Applying Key Oil on the Tip of the Steel

(Figure 6.14) After wiping off the old oil, apply a small amount of key oil only on the TIP of the steel.

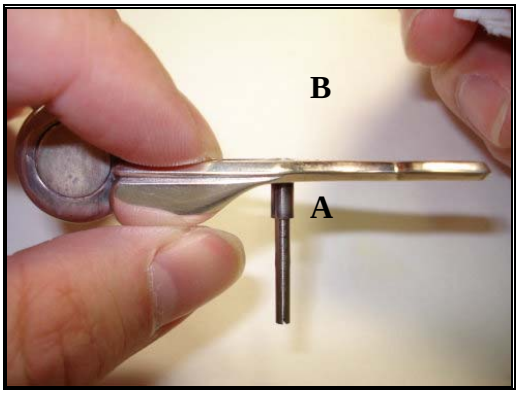


Figure 6.15: Inserting the Steel

(Figure 6.15) Insert the steel into the thumb key from side A.

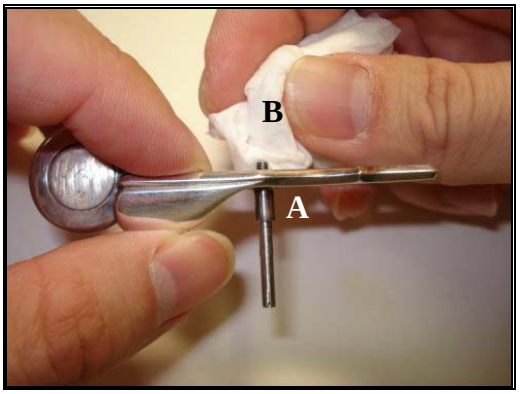


Figure 6.16: Wiping Off Excess Oil

(Figure 6.16) Wipe off the excess oil on side B as shown.

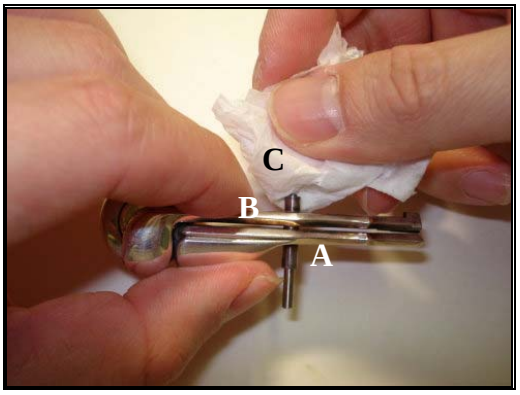


Figure 6.17: Adding B-Flat Thumb Key

(Figure 6.17) Add the B-flat thumb key to the steel and wipe off the oil on side C. Now simply pull out the steel from side A.

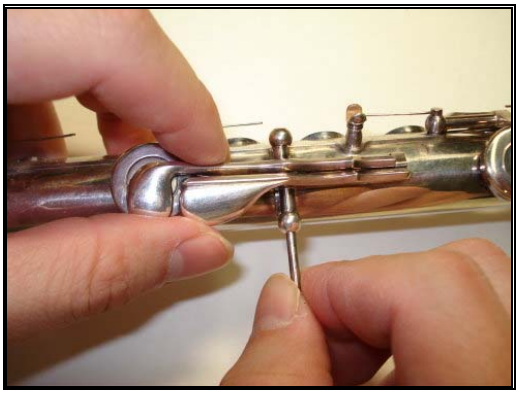


Figure 6.18: Assembling Back the Thumb Key Set

(Figure 6.18) Assemble the thumb key set back to the main body joint. If some oil leaks from the gap between the key tubing and the key post, use a lint-free soft cloth or tissue to wipe off the excess oil. Please note that it is very easy to slip with the screwdriver on this thumb key.

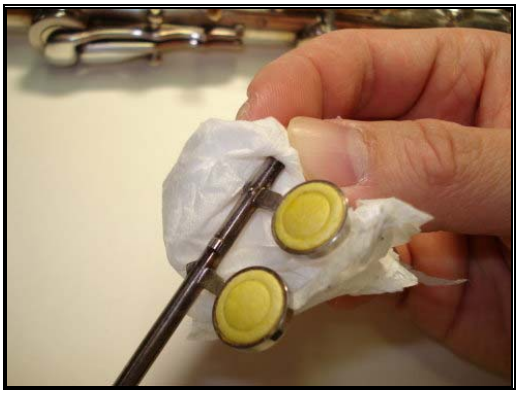


Figure 6.19: Cleaning Both Ends of Trill Key Rod

(Figure 6.19) Clean both ends of the trill key rod with a lint-free soft cloth or tissue as shown.

Figure 6.20: Applying Key Oil

(Figure 6.20) Apply a small amount of key oil into both ends of the trill key rod with a small brush or a Q-tip. Some flute makers use grease on the pivots. Either key oil or cork grease is acceptable.

Figure 6.21: Unscrewing the Trill Key Pivot Screws

(Figure 6.21) Unscrew the trill key pivot screws from the both trill key posts and apply some oil on the pivot screws, once again using the small brush.

Figure 6.22: Assembling the Trill Key Rod Back

(Figure 6.22) Assemble the trill key rod back to the main body joint and tighten up the pivot screws. Exert care not to over tighten the screws.

Figure 6.23: Wiping Off the Excess Oil

(Figure 6.23) If some oil leaks out from the gap between the key tubing and the key post, use a soft cloth or tissue to wipe off the excess oil.

Figure 6.24: Pulling Out the D Key

(Figure 6.24) On some flute models the D key can be disassembled from the right-hand mechanism. If that is the case, pull out the D key completely from the right-hand mechanism.

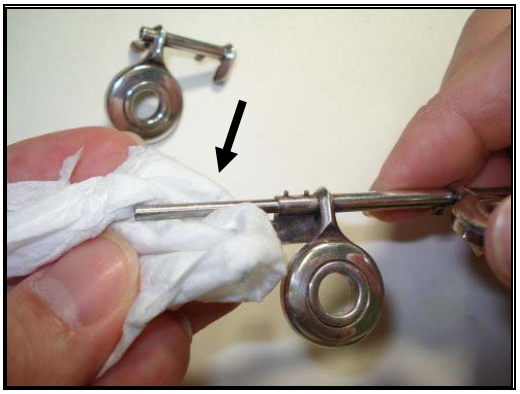


Figure 6.25: Cleaning the Steel

(Figure 6.25) After releasing the D key entirely from the right-hand mechanism, clean off the oil residue and any debris on the steel with a soft cloth or tissue.

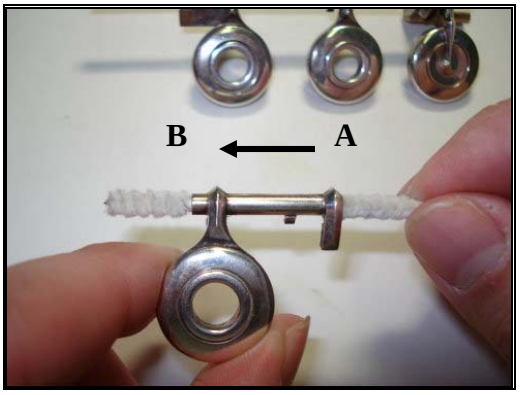


Figure 6.26: Inserting Pipe Cleaner

(Figure 6.26) Insert a pipe cleaner from side A and pull it out from side B (from right to left). Again, know that oil residue and debris may have collected inside the key. To clean, simply pull the pipe cleaner through from side A to side B, pulling in one direction and thus preventing scratches.

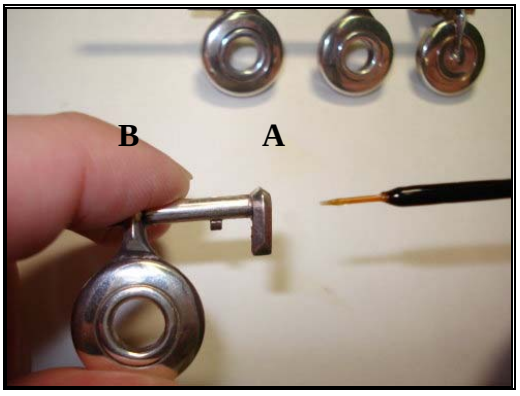


Figure 6.27: Applying Key Oil

(Figure 6.27) Apply small amounts of key oil into side A of the key tubing. New oil will be pushed to side B of the key tubing when the steel rod is inserted from side A. The steel rod inside the key tubing will then be lubricated entirely.

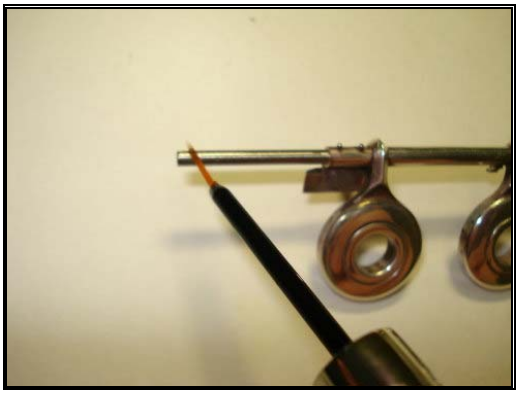


Figure 6.28: Applying Key Oil on the Tip of the Steel

(Figure 6.28) Apply small amounts of key oil only on the TIP of the steel.

Figure 6.29: Applying Key Oil at the End of the Steel Rod

(Figure 6.29) Apply a drop of key oil into the hole at the end of the steel rod.

Figure 6.30: Inserting Back the D Key

(Figure 6.30) Insert the D key back into the steel rod slowly.

Figure 6.31: Wiping Off the Excess Oil

(Figure 6.31) Wipe off the excess oil on the steel rod before inserting the D key back to its original position.

Figure 6.32: Cleaning and Lubricating the Pivot

(Figure 6.32) Clean the pivot closest to the F-sharp key at the end of the right-hand mechanism and lubricate it as shown. The pivot bearing on the main body joint should be cleaned as well. A Q-tip method works well for this task.

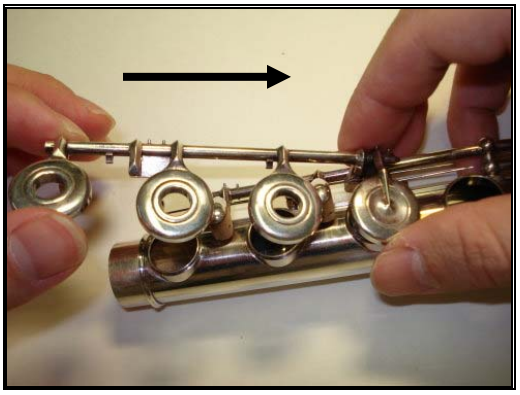


Figure 6.33: Assembling Back the Right-Hand Mechanism

(Figure 6.33) Assemble the right-hand mechanism back to the mail body joint, attaching the mechanism slowly from left to right as shown.

Figure 6.34: Hooking Back the D-Key Spring

(Figure 6.34) Before screwing the right-hand mechanism back to its original place, hook the D key spring back to the spring catch.

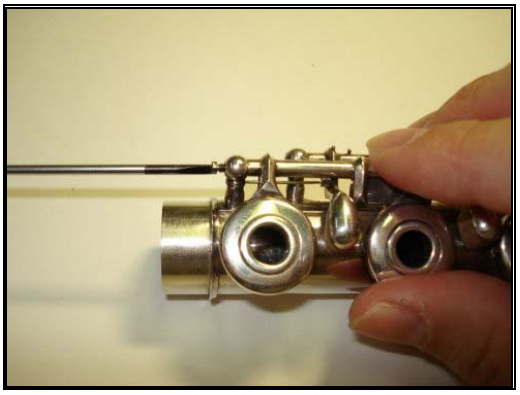


Figure 6.35: Tightening Up the Pivot Screw

(Figure 6.35) Hold the right-hand mechanism in place with one hand. Use a long screwdriver to tighten up the pivot screw.

Figure 6.36: Wiping Off the Old Oil

(Figure 6.36) Using a lint-free soft cloth or tissue, wipe off the old oil on the pivot closest to the B-flat shake key that is located at the end of the left-hand mechanism. Again, the pivot bearing on the main body joint should be cleaned.

Figure 6.37: Lubricating the Pivot

(Figure 6.37) Lubricate the pivot after cleaning it, as shown in the figure. A Q-tip method also works well for this task.

Figure 6.38: Applying Key Oil

(Figure 6.38) On the left-hand mechanism apply small amounts of key oil into the hole closest to the B-flat key.

Figure 6.39: Assembling Back the Left-Hand Mechanism

(Figure 6.39) Assemble the left-hand mechanism back to its original position. Note that this step can be tricky. Come in at an angle, being careful not to force the mechanism or bend the key.

Figure 6.40: Hooking Back the G Key Spring

(Figure 6.40) Hook the G key spring back to the cradle by slightly lifting up the left-hand mechanism.

Figure 6.41: Cleaning Off the Oil Residue and Debris

(Figure 6.41) Using a lint-free soft cloth or tissues, clean off the oil residue and any debris on the steel of left-hand mechanism.

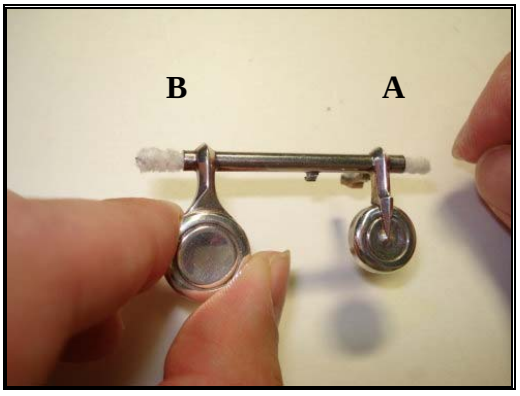


Figure 6.42: Removing the Oil Residue and Debris

(Figure 6.42) Yet once again, insert a pipe cleaner from side A and pull it out from side B to remove any oil residue and debris inside the key tubing. Remember to move the pipe cleaner from side B of the key tubing to prevent scratches.

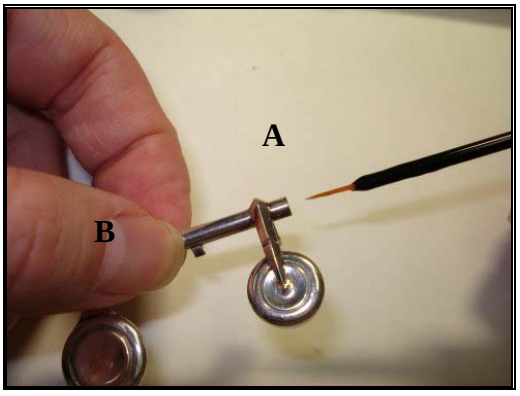


Figure 6.43: Applying the Key Oil

(Figure 6.43) Apply a small amount of key oil into side A of the key tubing. New oil will be pushed to side B when the screw is inserted from side A. The screw inside the key tubing will be lubricated entirely.

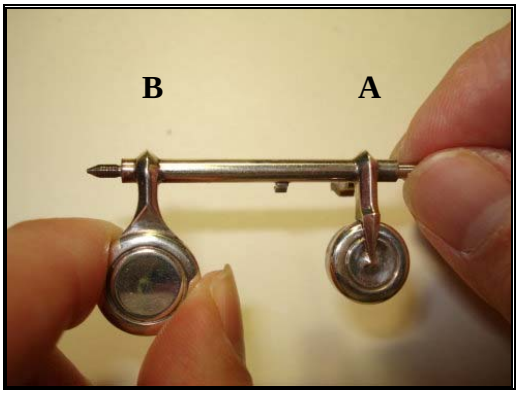


Figure 6.44: Inserting the Steel

(Figure 6.44) After lubricating the steel, insert it from side A of the key tubing as shown.

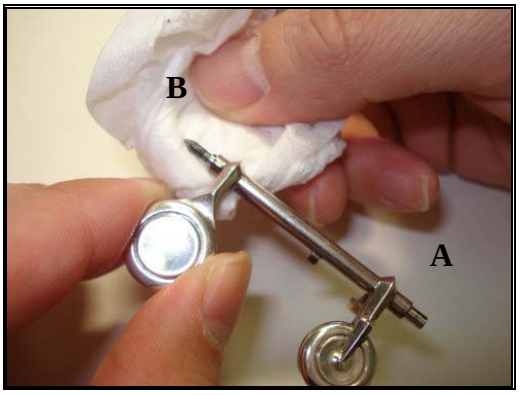


Figure 6.45: Wiping Off Excess Oil

(Figure 6.45) Wipe off excess oil on side B with a soft cloth or tissue, and then pull out the steel from side A.

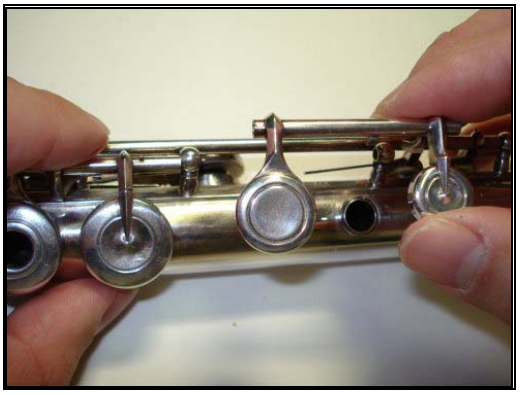


Figure 6.46: Assembling Back the C-Sharp Key

(Figure 6.46) Assemble the C-sharp key back to the main body joint.

Figure 6.47: Inserting and Tightening the Screw

(Figure 6.47) Insert the screw and tighten using a long screwdriver with care, to prevent scratching.

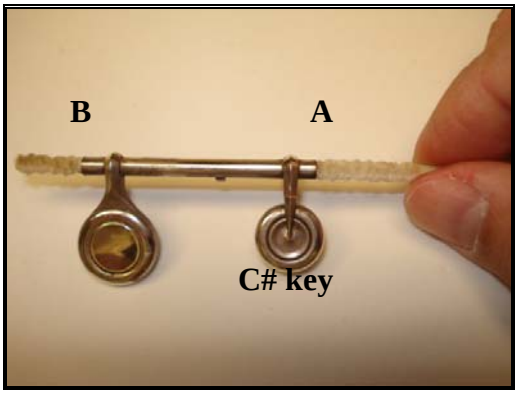
Figure 6.48: Wiping Off the Excess Oil

(Figure 6.48) If some oil leaks from the gap between the key tubing and the key post, use a lint-free soft cloth or tissue to wipe off the excess as shown.

Figure 6.49: Completely Oiled Mechanism

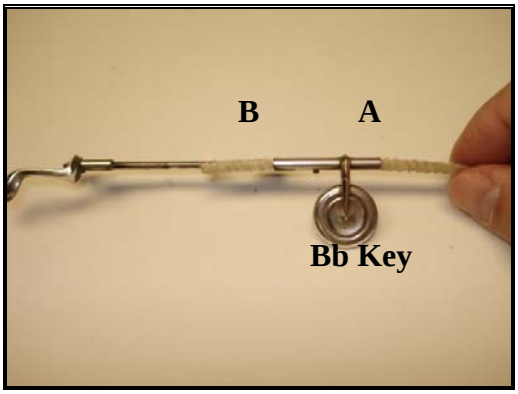
(Figure 6.49) Here is a photo of a completely oiled mechanism after reassembly is complete.

Brögger Mechanism



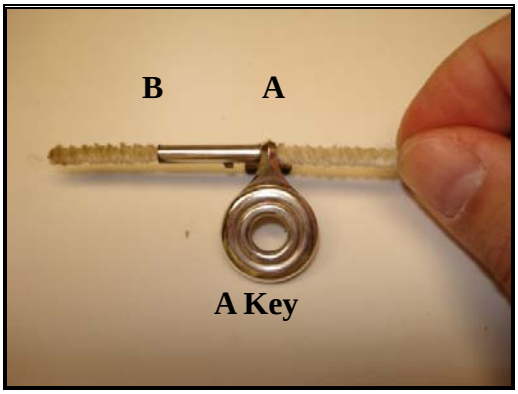
(Figure 6.50) Dip a pipe cleaner into denatured alcohol then insert a pipe cleaner into C-sharp key tubing from side A and pull it out from side B. There might be some oil residue and debris inside the key rod. Pulling out the pipe cleaner from side B of the key rod can prevent scratches.

Figure 6.50: Inserting and Pulling Out Pipe Cleaner (C-Sharp Key)



(Figure 6.51) Insert a pipe cleaner into B-flat key tubing from side A and pull it out from side B.

Figure 6.51: Inserting and Pulling Out Pipe Cleaner (B-Flat Key)



(Figure 6.52) Insert a pipe cleaner into A key tubing from side A and pull it out from B side.

Figure 6.52: Inserting and Pulling Out Pipe Cleaner (A Key)

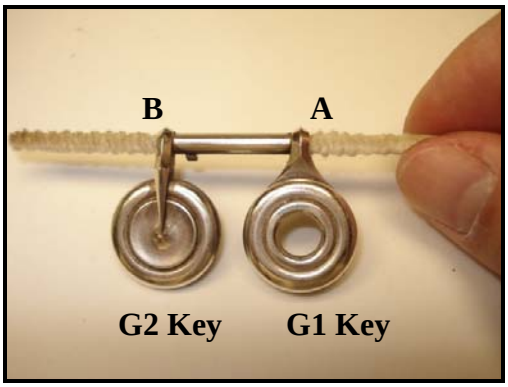


Figure 6.53: Inserting and Pulling Out Pipe Cleaner (G Keys)

(Figure 6.53) Insert a pipe cleaner into the G key tubing from side A and pull it out from side B.

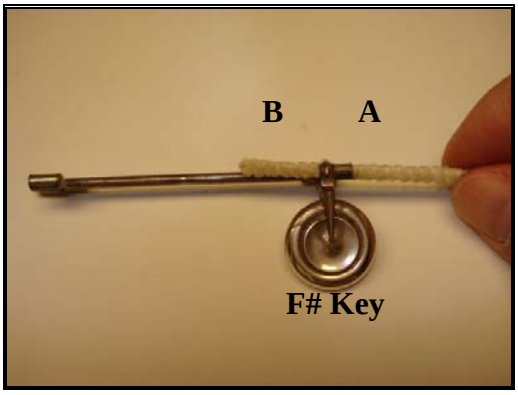


Figure 6.54: Inserting and Pulling Out Pipe Cleaner (F-Sharp Key)

(Figure 6.54) Insert a pipe cleaner into the F-sharp key tubing from side A and pull it out from side B.

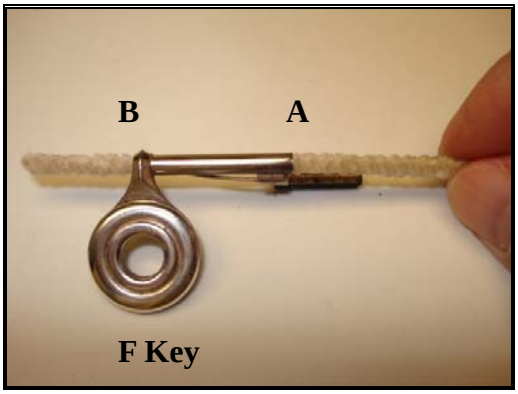


Figure 6.55: Inserting and Pulling Out Pipe Cleaner (F Key)

(Figure 6.55) Insert a pipe cleaner into the F key tubing from side A and pull it out from side B.

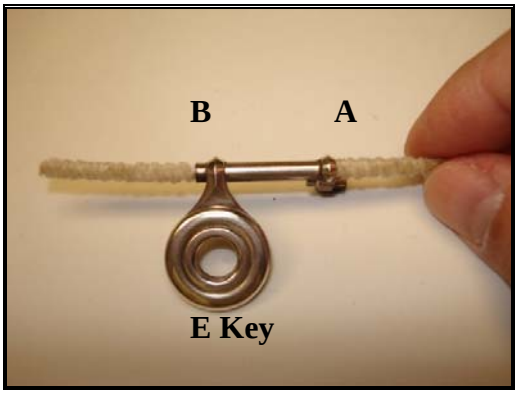


Figure 6.56: Inserting and Pulling Out Pipe Cleaner (E Key)

(Figure 6.56) Insert a pipe cleaner into the E key tubing from side A and pull it out from side B.

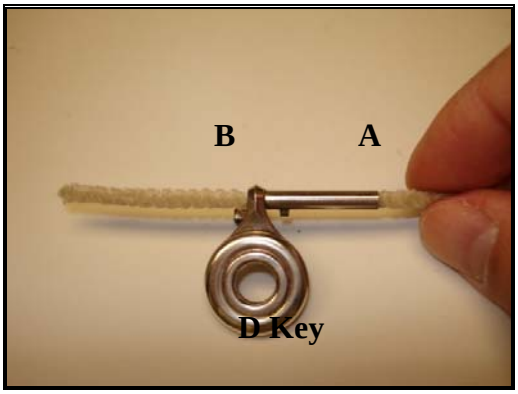


Figure 6.57: Inserting and Pulling Out Pipe Cleaner (D Key)

(Figure 6.57) Insert a pipe cleaner into the D key tubing from side A and pull it out from side B.

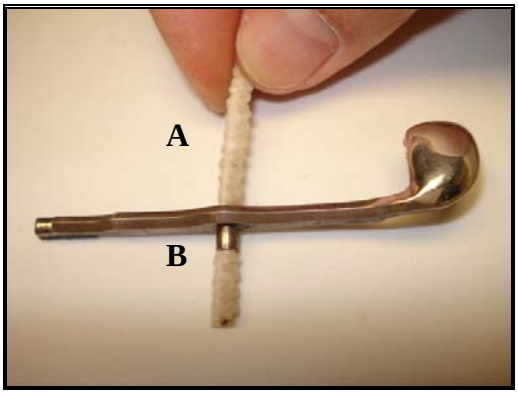


Figure 6.58: Inserting and Pulling Out Pipe Cleaner (Bb Thumb Key)

(Figure 6.58) Insert a pipe cleaner into the B-flat thumb key tubing from side A and pull it out from side B.

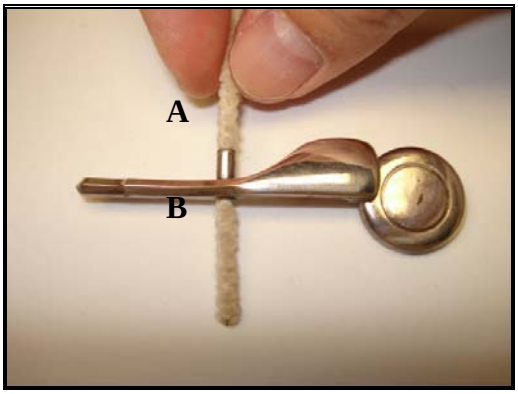


Figure 6.59: Inserting and Pulling Out Pipe Cleaner (Thumb Key)

(Figure 6.59) Insert a pipe cleaner into the thumb key tubing from side A and pull it out from side B.

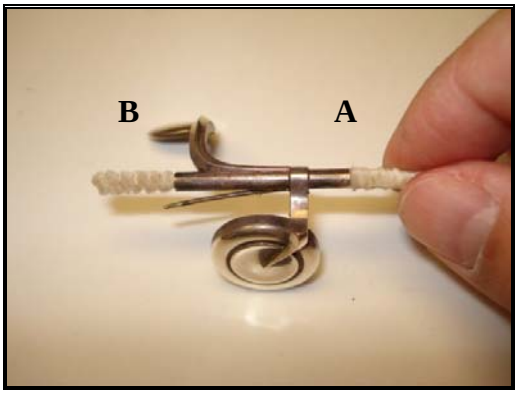


Figure 6.60: Inserting and Pulling Out Pipe Cleaner (G-Sharp Key)

(Figure 6.60) Insert a pipe cleaner into the G-sharp key tubing from side A and pull it out from side B.

Figure 6.61: Cleaning Both Ends of Trill Key Rod

(Figure 6.61) Clean both ends of the trill key rod with a soft cloth, tissue or a Q-tip dipped in denatured alcohol.

Figure 6.62: Applying Key Oil

(Figure 6.62) Apply a small amount of key oil into the pivot screw hole with a small brush or a Q-tip that is closest to the trill key. Some flute makers use grease on the pivots. Either key oil or cork grease is acceptable.

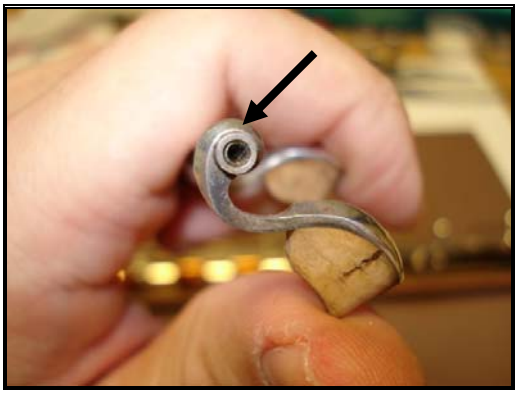


Figure 6.63: Applying Key Oil

(Figure 6.63) Apply a small amount of key oil or cork grease into the pivot screw hole that is closest to the trill key lever.

Figure 6.64: Assembling Back the Trill Key Rod

(Figure 6.64) Assemble the trill key rod back to its original position.

Figure 6.65: Assembling Back the Trill Key Rod

(Figure 6.65) Before tightening up the trill key rod, assemble the F-sharp key back to its original position.

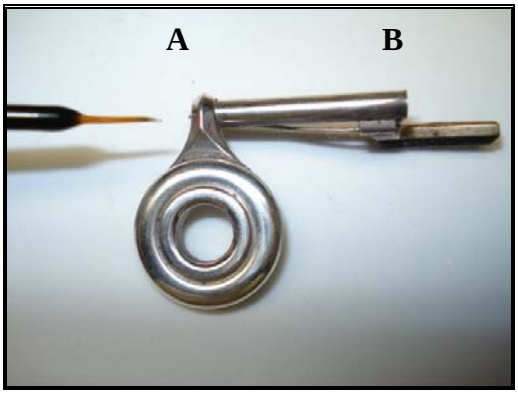


Figure 6.66: Applying Key Oil

(Figure 6.66) Apply a small amount of key oil into side A of the F key tubing. Fresh oil will be pushed to side B of the key tubing when the screw is inserted from side A. The steel inside the key tubing will then be lubricated entirely.

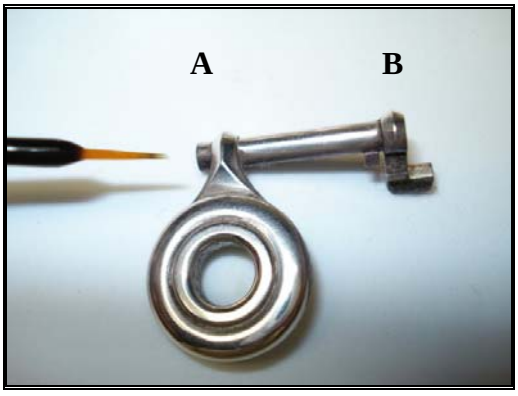


Figure 6.67: Applying Key Oil

(Figure 6.67) Apply a small amount of key oil into side A of the E key tubing.

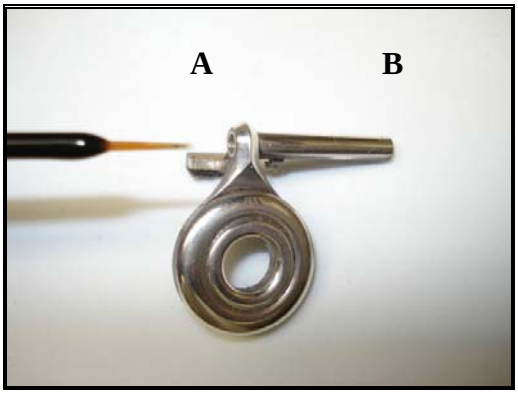


Figure 6.68: Applying Key Oil

(Figure 6.68) Apply a small amount of key oil into side A of the D key tubing.

Figure 6.69: Applying Key Oil onto Tip of the Screw

(Figure 6.69) Apply a small amount of key oil only onto the TIP of the steel. When the steel is inserted, excess oil will be pushed through the whole screw. The screw inside the key tubing will then be lubricated entirely.

Figure 6.70: Assembling Back F, E and D Keys

(Figure 6.70) Assemble F, E and D keys back to their original positions, and then insert the right-hand long screw through the key post gently.

(Figure 6.71) If some oil leaks from the gap between the key tubing and the key post, use a soft cloth or tissue to wipe off the excess oil.

Figure 6.71: Wiping Off the Excess Oil

(Figure 6.72) Hold the F key back to its original position and keep twisting the long steel through all of the keys as shown. This key and its spring will be a problem for many flutists. Even professionals may have problems with this key. Keep trying.

Figure 6.72: Holding Back the F Key

(Figure 6.73) Using a long screwdriver, tighten up the long screw as shown.

Figure 6.73: Tightening Up the Long Screw

Figure 6.74: Wiping Off Excess Oil

(Figure 6.74) Wipe off any excess oil on the key tubing and posts.

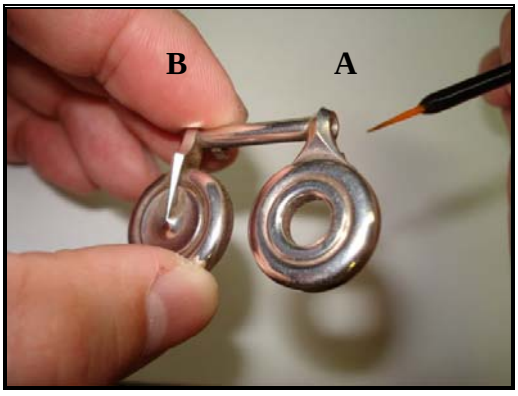


Figure 6.75: Applying Key Oil

(Figure 6.75) Again, apply a small amount of key oil into side A of the G key tubing. Fresh oil will be pushed to side B of the key tubing when the screw is inserted from side A. The screw inside the key tubing will then be lubricated entirely.

Figure 6.76: Applying Key Oil

(Figure 6.76) Apply a small amount of key oil into side A of the A key tubing.

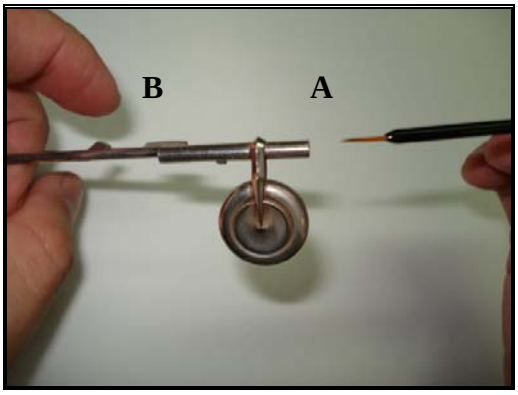


Figure 6.77: Applying Key Oil

(Figure 6.77) Apply a small amount of key oil into side A of the B-flat key tubing.

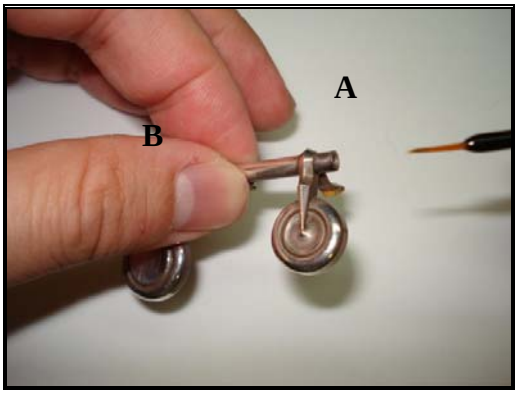


Figure 6.78: Applying Key Oil

(Figure 6.78) Apply a small amount of key oil into side A of the C key tubing.

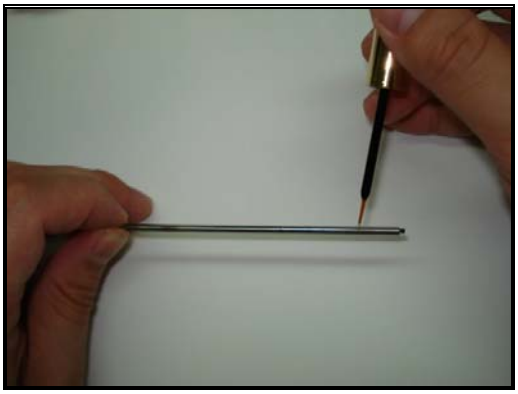


Figure 6.79: Applying Key Oil onto Tip of the Screw

(Figure 6.79) Apply a small amount of key oil only onto the TIP of the screw. When the screw is inserted, excess oil will be pushed through the whole steel. The steel inside the key tubing will then be lubricated entirely.

Figure 6.80: Assembling Back G, A, B-Flat and C Keys

(Figure 6.80) Assemble G, A, B-flat and C keys back to their original positions. Hook the G key spring back to the cradle before inserting the left-hand long steel.

Figure 6.81: Inserting and Tightening Up the Left-Hand Long Screw

(Figure 6.81) Insert the left-hand long steel from right to left through all of the keys and tighten it up on the right hand side.

Figure 6.82: Cleaning the Excess Oil

(Figure 6.82) Oil may be leaking from gaps between the key posts and tubing. Attend to this by placing some tissues under the main key rod to clean any excess oil.

CHAPTER 7

PAD REPLACEMENT, BASIC THEORY OF SHIMMING AND PAD SKIN REPLACEMENT

Some do not consider pad replacement to be a minor adjustment since it requires some degree of skill and experience. For the less confident, it is sufficient to know when pads are in good shape and when they need replacement. If the skin is not peeled or broken, and the seal is intact, then the pad is in good shape. When the seal is broken or the skin is ripped, pad replacement should occur.

The following list of tools and supplies will be required for the replacement of old pads on the flute: needle point tweezers, screwdriver, needle pin vise, flute pad iron, alcohol lamp, denatured alcohol, felt pad, stabilizer, shims in various sizes, and contact cement.

Figure 7.1: Required Tools and Supplies

Replacing Old Pads

Close-Hole Key Cup

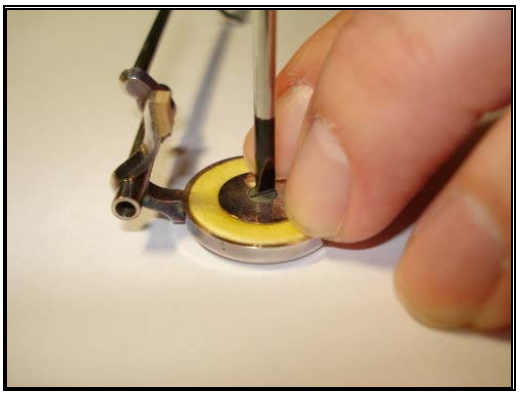


Figure 7.2: Disassembling The Mechanism

(Figure 7.2) Disassemble the mechanism and flip up the key on which you will be replacing the pad. Put two fingers on the metal washer to prevent rotation of the pad. Using a short screwdriver with a wider blade, turn in a counterclockwise direction to release the screw. Exert caution as it is easy to slip and tear the skin.

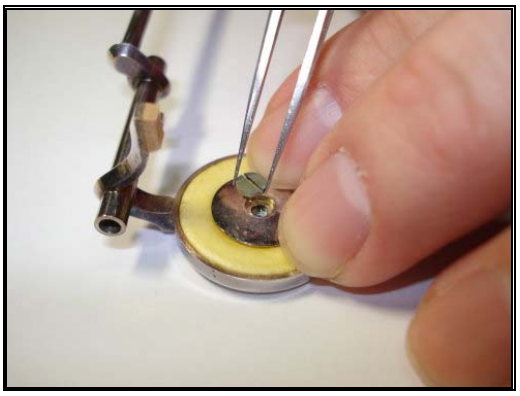


Figure 7.3: Removing the Screw

(Figure 7.3) After unscrewing, use tweezers to remove the screw from the key.

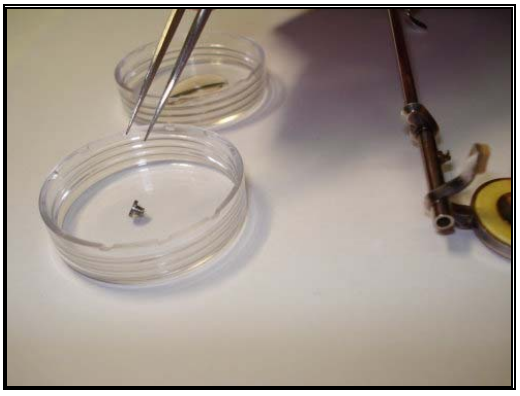


Figure 7.4: Placing the Screw in a Case

(Figure 7.4) Place the screw in a case to prevent loss.

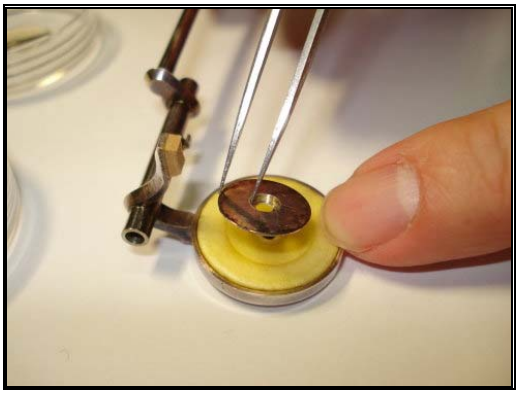


Figure 7.5: Removing the Metal Washer

(Figure 7.5) Use tweezers to remove the metal washer. Be careful not to scratch the delicate pad skin which can be torn easily. Exert caution because some flute makers shellac the pad washer to the skin. It is very easy to tear the skin.

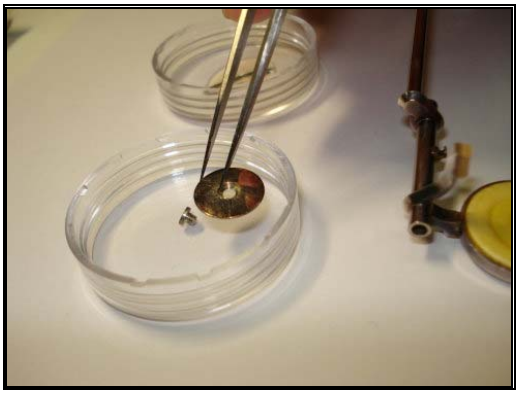


Figure 7.6: Placing the Metal Washer in a Case

(Figure 7.6) Place the metal washer in a case to prevent loss.

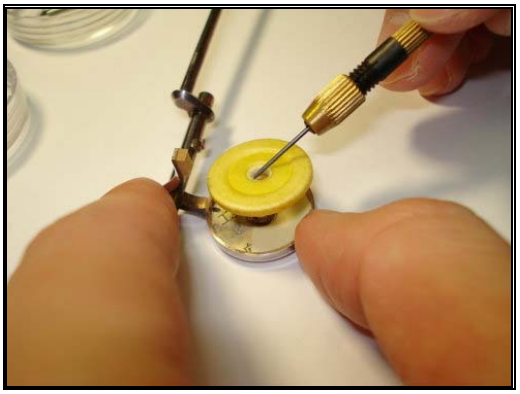


Figure 7.7: Removing the Old Pad

(Figure 7.7) Use a needle pin vise to remove the old pad from the pad cup. Pierce into the center hole of the pad, lifting it gently out of the pad cup as shown. Note well that just beneath the old pad multiple shims (or partials shims) will be found, as illustrated in the photo below.

(Figure 7.8) Use tweezers to remove any or all of the old shims from the pad cup so that installation of a new pad can begin.

Figure 7.8: Removing the Old Shims

Measuring the Key Cup

Before replacing an old pad, it is very important to know the size of the pad cups on the flute in order to purchase the correct size of new pads and shims. Normally, there are three sizes of pad cups on a flute. The two small trill keys and C-sharp key have the same size of pad cups and are usually between 11mm to 11.5mm. The large pad cups on the main body joint are usually between 17mm to 17.5mm. The size of the pad cups on the foot joint is between 18mm to 19mm. Note that using a digital caliper to measure pad cups can increase the accuracy of the measurement. The dial caliper will not yield as accurate a reading as the digital caliper. The digital caliper reading is more precise. Please note that it is important that the replacement pad fits tightly into the pad cup so that water will not seep in at the outer edge of the pad into the shims. Remember that shims are made of paper and absorb water. Once the shims get wet, they expand in thickness

resulting in pad instability. For this reason, the pads must fit securely to the very edge of the pad cup. To avoid this problem, plastic shims may be used, since they do not absorb moisture and will not expand at all. The plastic shim will cost a bit more but is preferable.

Figure 7.9: Digital Caliper

The perfect time to measure the pad cup is immediately after removing the old pad. A digital caliper (as shown above) is the tool of choice for this task. The first step is to measure the outside diameter (X) of the pad cup, then measure the thickness (Y) of the pad cup wall. (Z) represents the pad size measurement you will need. Then, simply follow the equation X - (Yx2) = Z equation to determine the exact pad size that needs to be ordered. Note well that traditional felt pads are available from vendors in .5mm increments. If the Z measurement is 17.2mm, then purchase the 17mm pad because it is

closest to the measurement. If, however, the Z measurement is 17.3mm, then you will need to move up to the 17.5mm pad and apply some pressure to get it to fit tightly.

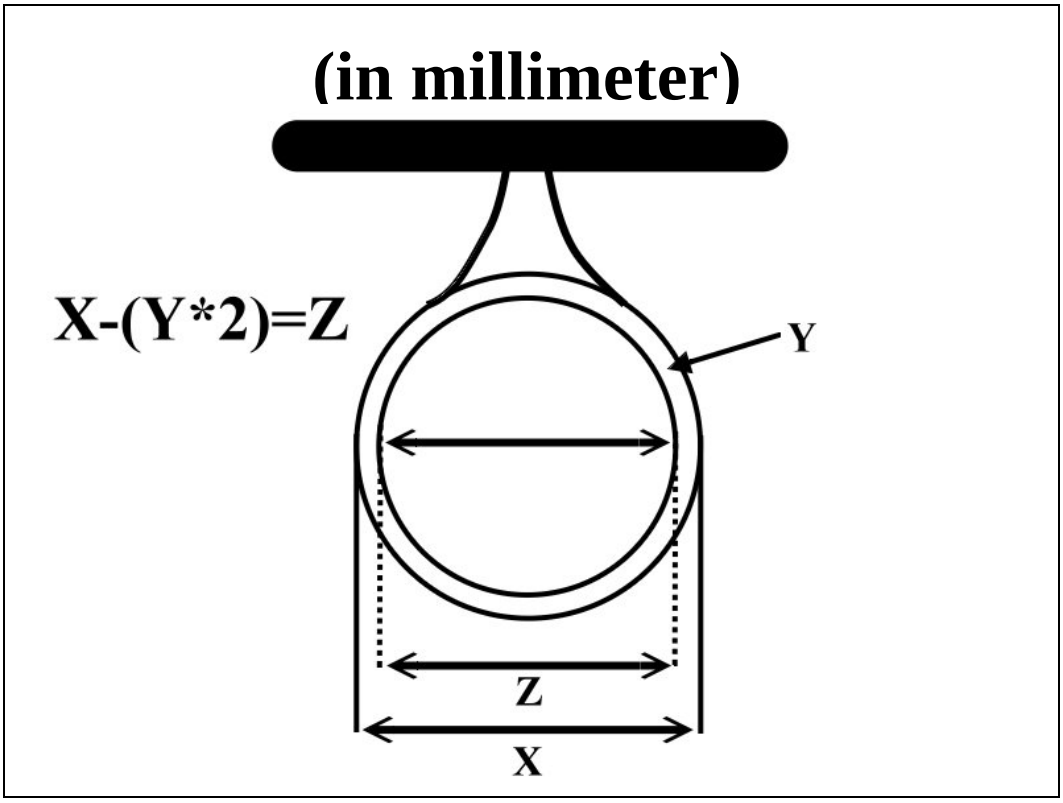


Figure 7.10: Measuring Pad Cup

Standard Felt Pad

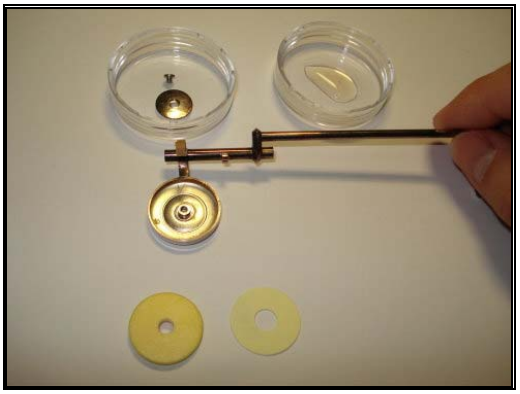


Figure 7.11: Standard Felt Pad and Thick Cardboard Shim

(Figure 7.11) Prepare a new high quality standard felt pad (2.5mm - 2.7mm thickness) and a thick cardboard shim (0.004”-0.006”) that will serve as a support base under a new pad. (*Please note that a plastic shim is not suitable as a support base in a curved bottom pad cup because it lacks of flexibility.)

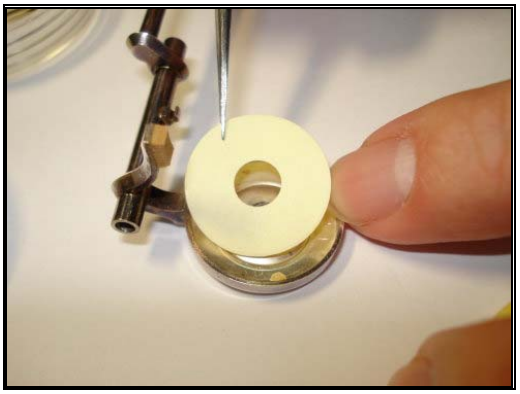


Figure 7.12: Placing Thick Cardboard Shim into Pad Cup

(Figure 7.12) Now place the thick cardboard shim into the pad cup. (*Note well that flute pad cups are of two distinct designs. They are either flat-bottomed or curved. Shimming is necessary with both types of pad cups but fewer are necessary with the flat bottom pad cups.)

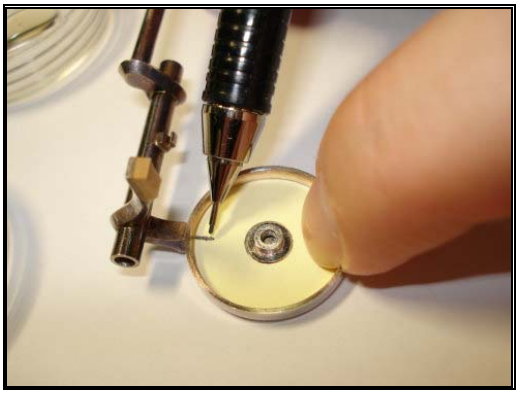


Figure 7.13: Ensuring the Shim Stays In Place

(Figure 7.13) During the installation of shims, it is important that each and every shim stay firmly in place without rotating. To monitor this, use a pencil to place a mark on the cardboard shim at 12 o’clock and align it with the key arm as shown. This will ensure that the shim stays in place throughout the entire shimming process that involves layers of shims.

Figure 7.14: Bending and Working the New Pad

(Figure 7.14) After installing the first shim, bend and work the new pad in your fingers to render it more flexible. Place it firmly at the bottom of the pad cup making sure that it makes direct contact with the entire surface of the pad cup and its shim. It is extremely important that this contact be made firmly to provide stability.

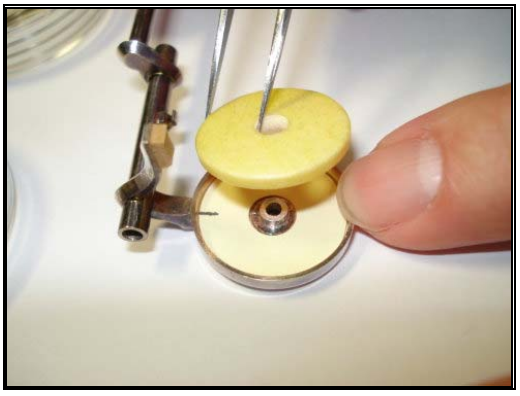


Figure 7.15: Placing New Pad into the Pad Cup

(Figure 7.15) Place the new pad into the pad cup with tweezers as shown.

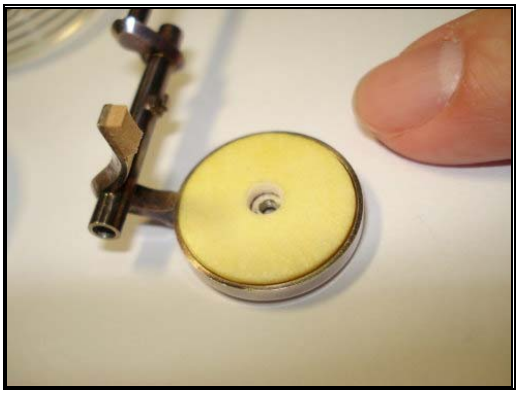


Figure 7.16: Installing the New Pad Tightly

(Figure 7.16) The NEW pad needs to be installed tightly into the pad cup as shown. Note how closely the felt pad sits against the outer edge of the pad cup so that moisture does not seep in.

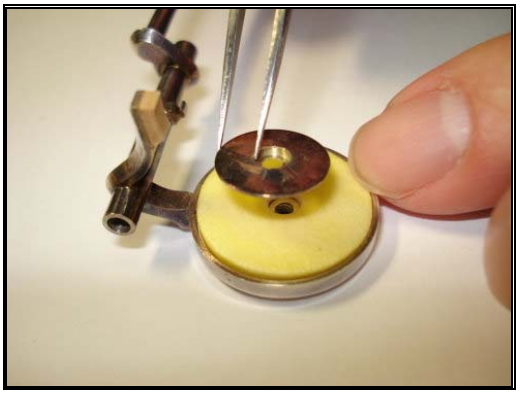


Figure 7.17: Placing Back the Metal Washer

(Figure 7.17) Place the metal washer back in its original position.

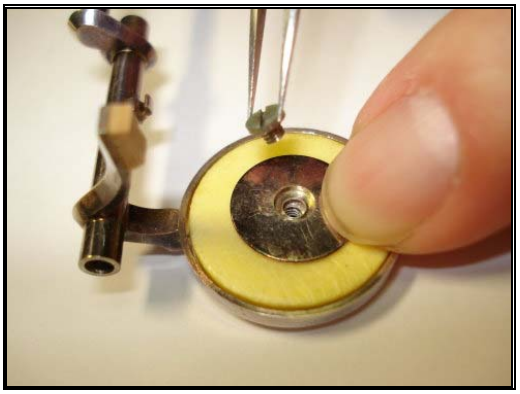


Figure 7.18: Installing Back the Screw

(Figure 7.18) Now install the screw back into its original place.

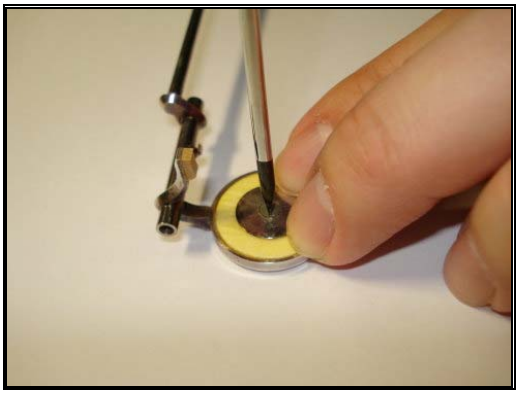


Figure 7.19: Tightening Up the Screw

(Figure 7.19) Put two fingers on the metal washer and the new pad to prevent rotation while tightening up the screw.

Figure 7.20: Wrinkles Appearing on the Pad Skin

(Figure 7.20) After tightening up the screw, wrinkles will appear on the pad skin because of the tension on the screw. The pad skin needs to be ironed with a pre-heated pad ironing tool. **Please note well** that most American flute makers abandoned this technique years ago. They think ironing the skin can be very uneven and hard on the skin. They suggest the best way to smooth the wrinkles is to wet the new pad, damp off excess water and let it sit until dry. Either technique must be used with care because of the delicate nature of the skin.

Figure 7.21: Warming the Pad Iron

(Figure 7.21) Add some denatured alcohol into an alcohol lamp and light the wick. Place the pad iron above the fire to **warm it slightly.** Use a back and forth motion to warm but **do not overheat** the iron. Note well that overheating the iron will scorch and destroy the pad skin. Exert great care during this task.

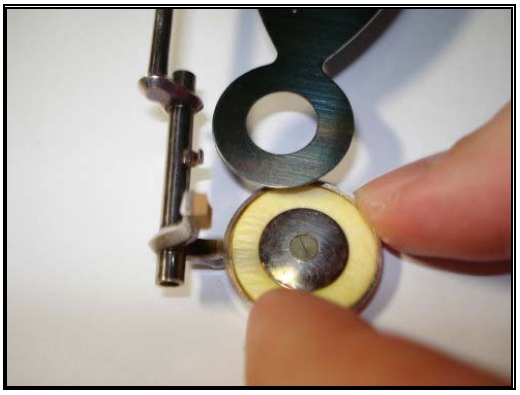


Figure 7.22: Ironing the Pad Skin

(Figure 7.22) Exert care in “ironing the pad skin” with the pad iron. Contact must be made between the iron and the skin. This is best accomplished by moving the iron over the skin in a circular motion, avoiding contact with the metal washer. (*Vertical contact is not possible due to the raised surface of the washer.)

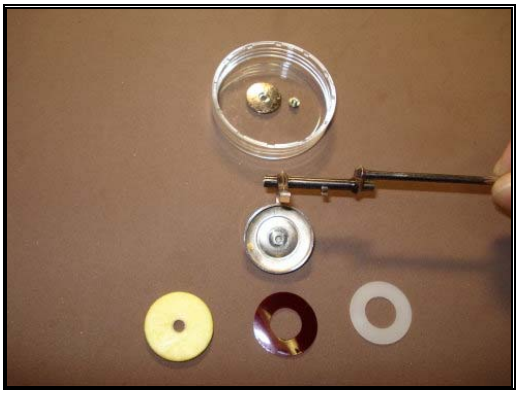
Figure 7.23: Repeating the Same Process

(Figure 7.23) Repeat the same process until all wrinkles disappear and the skin appears smooth.

Figure 7.24: Stabilizing as the Felt Compresses

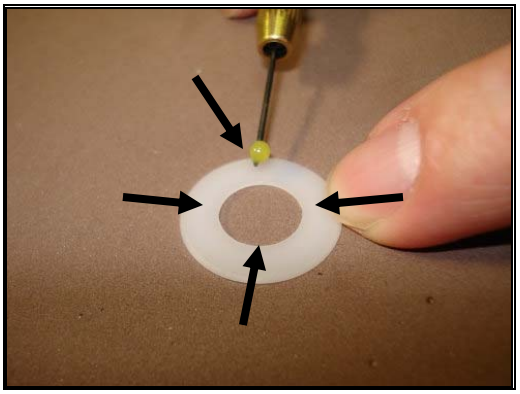
(Figure 7.24) Note the smooth surface of pad skin when it has been ironed sufficiently. Let the new pad stay in the pad cup for at least a few hours to a day so that is can stabilize as the felt compresses.

Thin Compressed Felt Pad



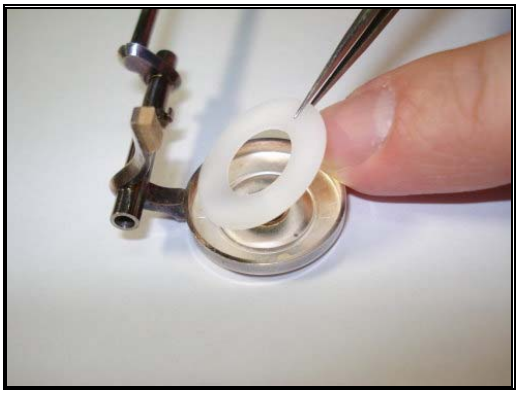
(Figure 7.25) To the left is a photo of the thin compressed felt pad (around 2.0 mm), a plastic shim (0.001” to 0.002” thick) and a plastic Delrin stabilizer (0.5mm to 0.6mm thick) that are shown in this figure for purposes of comparison.

Figure 7.25: Thin Compressed Felt Pad, Plastic Shim and Plastic Delrin Stabilizer



(Figure 7.26) Apply contact cement to the stabilizer (four points), curved side up as shown. Some flute makers use super glue to glue the stabilizer to the pad cup. Either type glue may be used successfully.

Figure 7.26: Applying Contact Cement to the Stabilizer



(Figure 7.27) Turn the curved side of the stabilizer down. Install and glue the Delrin stabilizer into the pad cup.

Figure 7.27: Installing and Gluing the Delrin Stabilizer

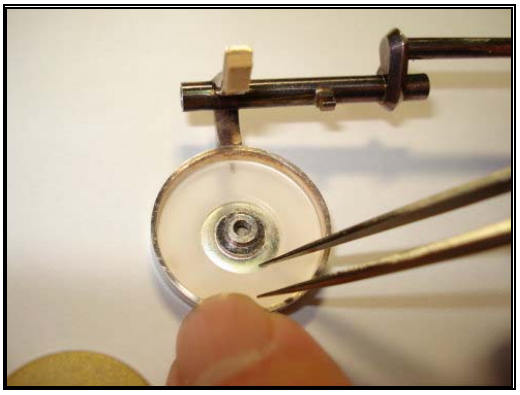


Figure 7.28: Making Sure the Stabilizer Stays in Place

(Figure 7.28) Center the stabilizer around the screw thread in the pad cup.

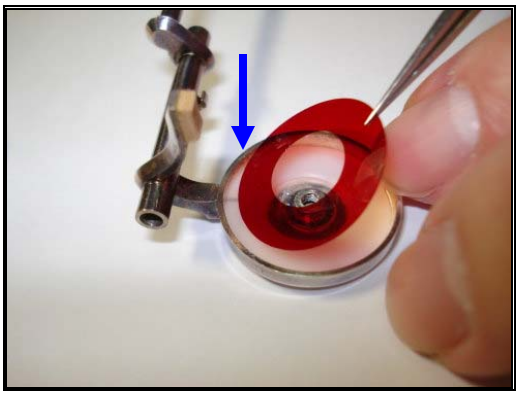
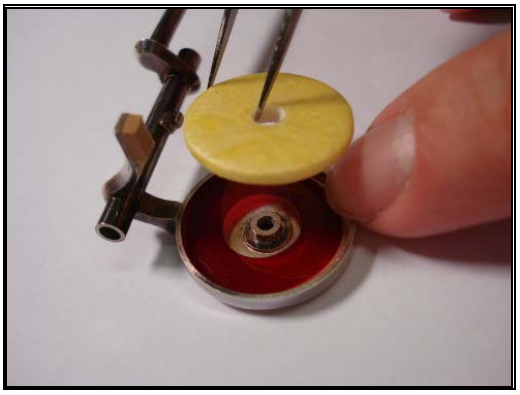


Figure 7.29: Placing Plastic Shim into the Pad Cup

(Figure 7.29) Atop the stabilizer, place a 0.002” plastic shim into the pad cup as a base shim. If needed, additional shims can be cut and glued onto the base shim to level the pad. During the installation of shims, it is important that each and every shim stay firmly in place without rotation. To monitor this, use a permanent marker to place a mark on the base shim at 12 o’clock and align it with the key arm as shown. This will ensure that the shim stays in place throughout the entire shimming process that may involve layers of shims.

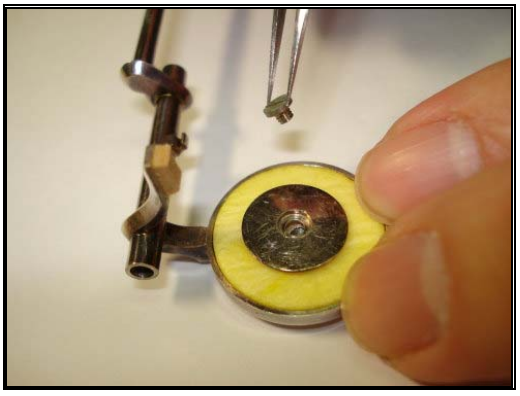


(Figure 7.30) Place the new pad into the pad cup with tweezers as shown.

Figure 7.30: Placing the New Pad

(Figure 7.31) Place the metal washer back to its original position.

Figure 7.31: Placing Back the Metal Washer



(Figure 7.32) Now install the screw back to its original place.

Figure 7.32: Installing Back the Screw

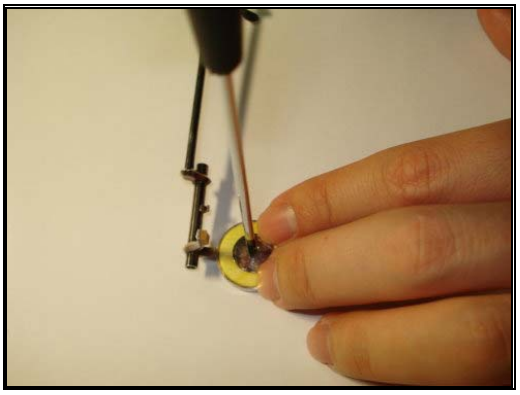


Figure 7.33: Tightening Up the Screw

(Figure 7.33) Put two fingers on the metal washer and new pad to prevent rotation while tightening up the screw.

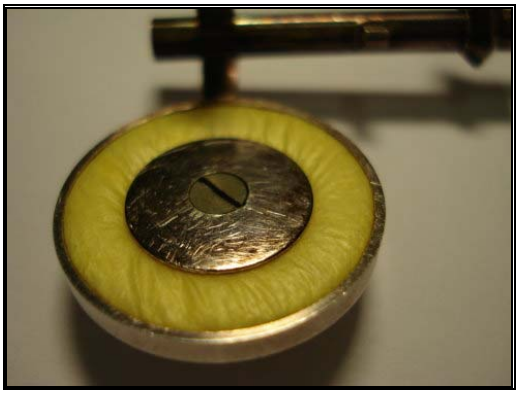


Figure 7.34: Wrinkles on the Pad Skin

(Figure 7.34) After tightening up the screw, wrinkles will appear on the pad skin because of the tension on the screw. The pad skin needs to be ironed with a pre-heated pad-ironing tool. **Please note well** that most American flute makers abandoned this technique years ago. They think ironing the skin can be very uneven and hard on the skin. They suggest the best way to smooth the wrinkles is to wet the new pad, damp off excess water and let it sit until dry. Either technique may be used with care because of the delicate nature of the skin.

Figure 7.35: Warming the Pad Iron

(Figure 7.35) Add some denatured alcohol into an alcohol lamp and light the wick. Place the pad iron above the fire to **warm it slightly.** Use a back and forth motion to warm but **do not overheat** the iron. Note well that overheating the iron will scorch and destroy the pad skin. Exert great care during this task.

Figure 7.36: Ironing the Pad Skin

(Figure 7.36) Exert care in “ironing the pad skin” with the pad iron. Contact must be made between the iron and the skin. This is best accomplished by moving the iron over the skin in a circular motion, avoiding contact with the metal washer. (*Vertical contact is not possible due to the raised surface of the washer.) **Caution must be taken** not to overheat the iron due to the delicate nature of the skin. The iron should be warm, but not hot.

Figure 7.37: Repeating the Same Process

(Figure 7.37) Repeat the same process until all wrinkles disappear and the skin appears smooth.

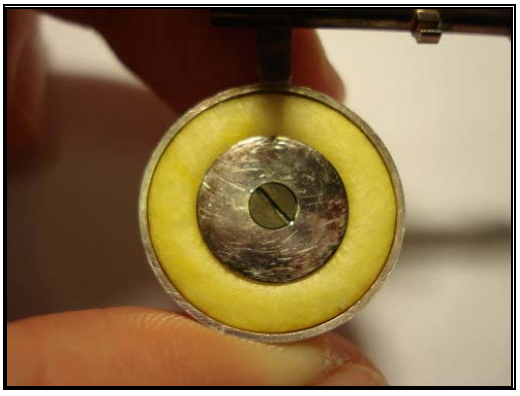
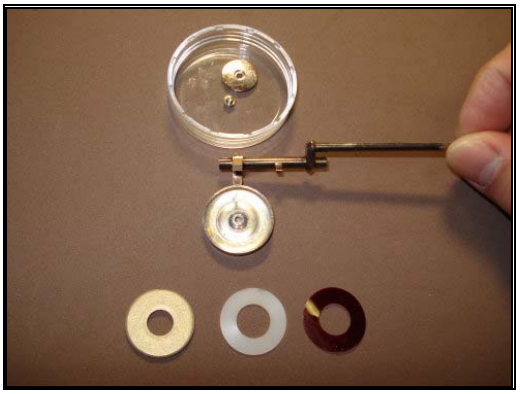


Figure 7.38: Stabilizing the New Pad
As the Felt Compresses

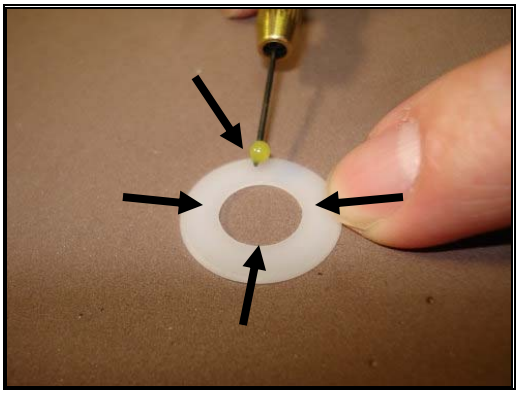
(Figure 7.38) Note the smooth surface of the ironed pad skin when it has been ironed sufficiently. Let the new pad stay in the pad cup for at least a few hours to a day or so for it to stabilize as the felt compresses.

Jim Schmidt Gold Pad



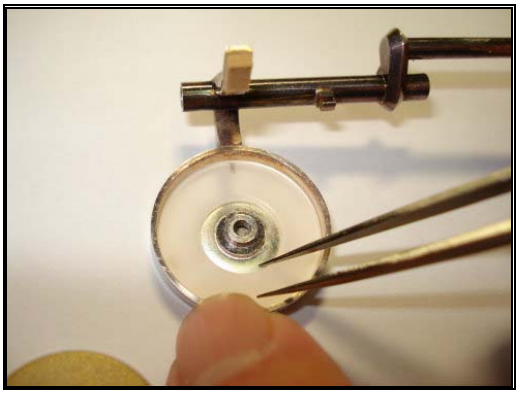
(Figure 7.39)To the left of this photo is the Jim Schmidt Gold Pad, a plastic Delrin stabilizer (0.8mm to1.0mm thick) and a plastic shim (0.001” to 0.002”thick) that are shown for purposes of comparison.

Figure 7.39: Jim Schmidt Gold Pad, Plastic Delrin Stabilizer and Plastic Shim



(Figure 7.40) Apply contact cement to the stabilizer (four points), curved side up as shown. Some flute makers use super glue to glue the stabilizer to the pad cup.

Figure 7.40: Applying Contact Cement to the Stabilizer



(Figure 7.41) Center the stabilizer around the screw thread in the pad cup.

Figure 7.41: Making Sure the Stabilizer Stays in Place

Figure 7.42: Placing the Plastic Shim

(Figure 7.42) Atop the stabilizer, place a 0.002” plastic shim into the pad cup as a base shim. If needed, additional shims can be cut and glued onto the base shim to level the pad. During the installation of shims, it is important that each and every shim stay firmly in place without rotating. To monitor this, use a permanent marker to place a mark on the base shim at 12 o’clock and align it with the key arm as shown. This will ensure that the shim stays in place throughout the entire shimming process that may involve layers of shims.

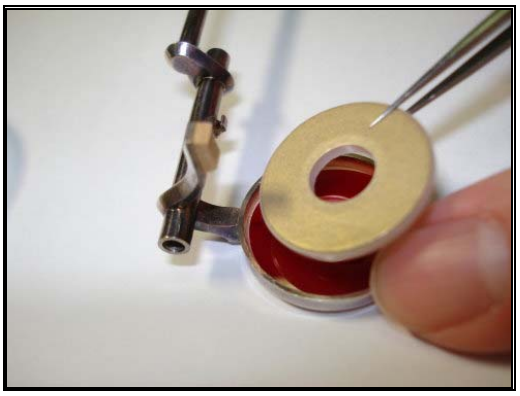


Figure 7.43: Placing the New Gold Pad

(Figure 7.43) Place the new gold pad into the pad cup with tweezers as shown.

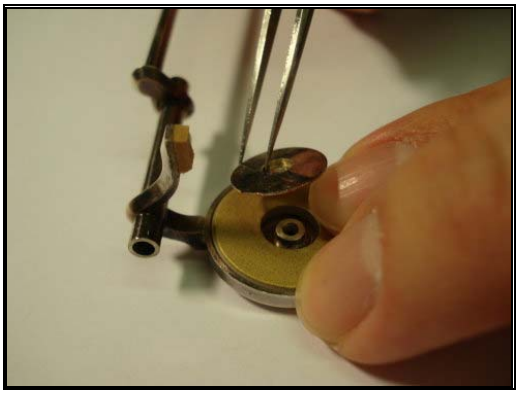


Figure 7.44: Placing Back the Metal Washer

(Figure 7.44) Place the metal washer back to its original position.

Figure 7.45: Installing Back the Screw

(Figure 7.45) Now install the screw back to its original place.

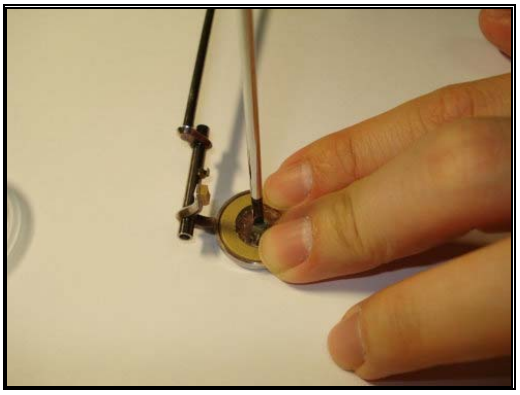


Figure 7.46: Tightening Up the Screw

(Figure 7.46) Put two fingers on the metal washer and the new pad to prevent rotation while tightening up the screw.

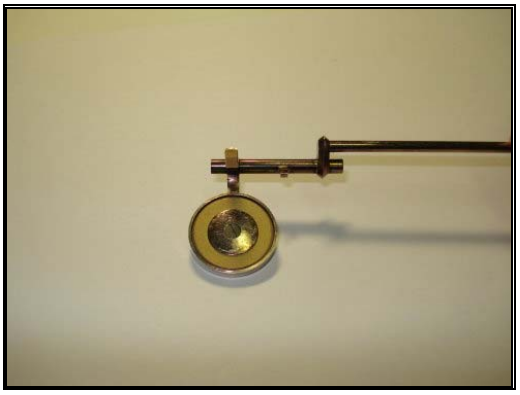


Figure 7.47: Completed New Jim Schmidt Gold Pad Installation

(Figure 7.47) Complete the new Jim Schmidt gold pad installation as shown in the photo.

How to Re-skin Old Straubinger Pads

As mentioned in Chapter 6, only a Straubinger-certified repair technician can purchase new Straubinger pads and perform pad installation. When the flute is sent out for Straubinger pad replacement, it is prudent for the flutist to request that the old Straubinger pads be returned along with the flute. This allows the flutist to reuse the old pads by re-skinning them, as illustrated in this section. In this way, the flutist retains spare pads for use in emergencies and saves unnecessary expense in sending the flute away to the technician. Knowing how to re-skin spare pads saves on shipping costs, repair costs and time lost in the shipping process. Shipping costs alone are usually more expensive than simply replacing new Straubinger pads.

Repair Tools and Supplies Required:

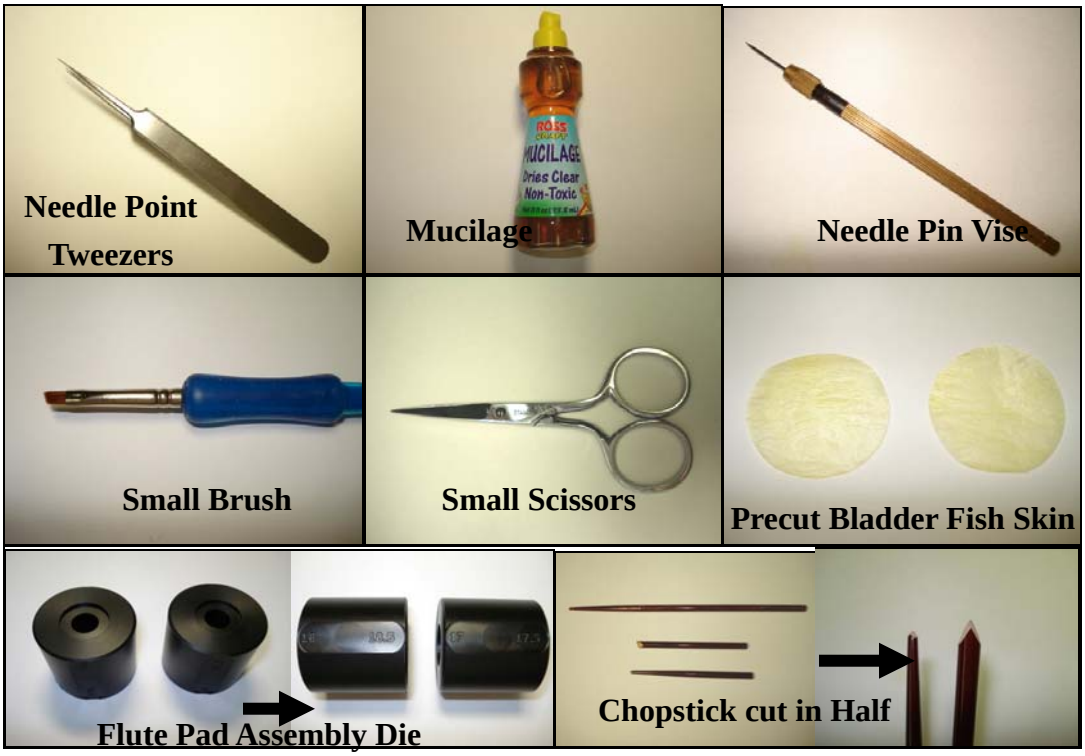
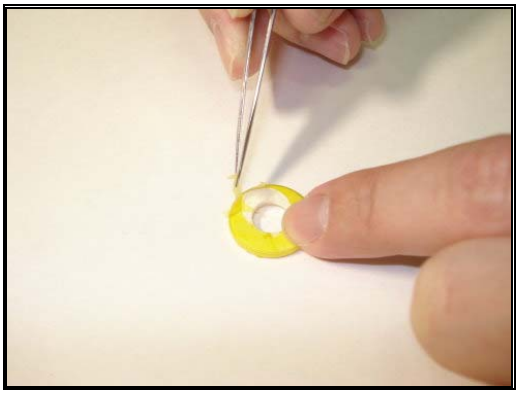


Figure 7.48: Required Tools and Supplies

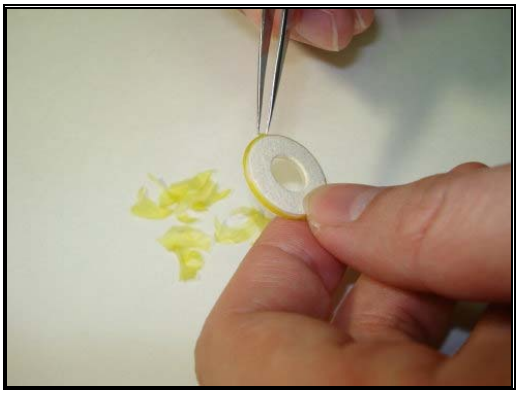
(Figure 7.49) This photo shows a Straubinger pad with torn skin.

Figure 7.49: Straubinger Pad with Torn Skin



(Figure 7.50) Use the needle point tweezers to clean up the broken skin from the pad.

Figure 7.50: Cleaning Up the Broken Skin

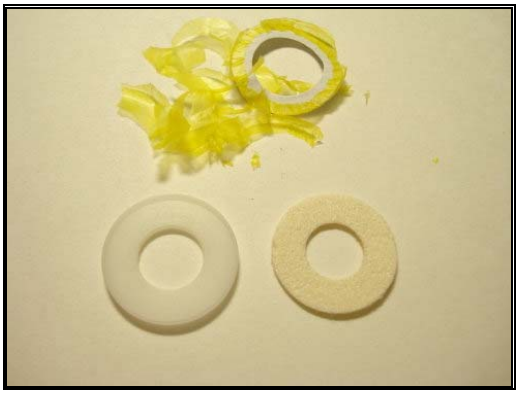


(Figure 7.51) Clean the rest of the skin around the pad.

Figure 7.51: Cleaning the Rest of the Skin

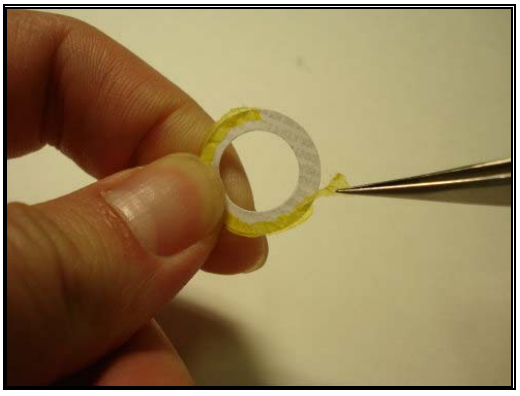
(Figure 7.52) Carefully use the tweezers to peel off the label on the back of the pad. The label can be re-used after the pad is re-skinned.

Figure 7.52: Peeling Off the Label



(Figure 7.53) Completely remove the skin from the pad cup support and synthetic felt.

Figure 7.53: Removing the Skin Completely



(Figure 7.54) Carefully clean the rest of skin on the backside of the label as shown.

Figure 7.54: Cleaning the Rest of the Skin

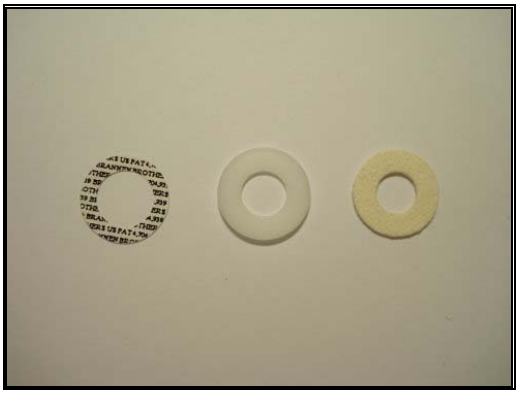


Figure 7.55: The Label, the Pad Cup Support and the Synthetic Felt

(Figure 7.55) This photo illustrates (from left to right) the label, the pad cup support and the synthetic felt. These three parts can be re-used to re-skin the pad.

Figure 7.56: Mixing Mucilage and Water

(Figure 7.56) A small amount of mucilage (left) and water (right) will need to be mixed together so that the mucilage can be thinned. Stir with a small stick until blended.

Figure 7.57: Placing the New Fish Skin

(Figure 7.57) Place a new fish skin on the flute pad assembly die as shown. Note that the die is slightly carved out on both the top and bottom surfaces. The top indentation measures 17mm and the bottom measures 17.5mm. Choose whichever size is congruent or that measures the exact size of the pad.

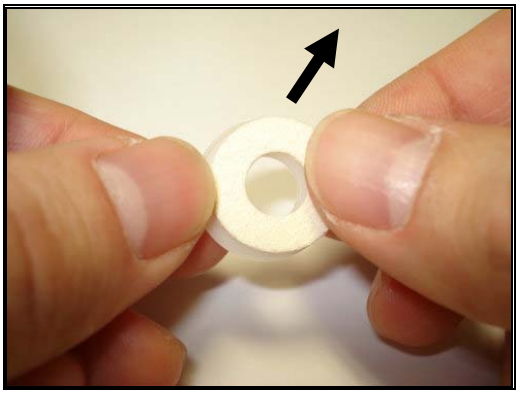


Figure 7.58: Removing the Synthetic Felt

(Figure 7.58) Remove the synthetic felt from the Delrin pad cup support if hasn't already been done. This is done so that the mucilage is not applied onto the synthetic pad because it will become sticky and hard. Removal prevents this from happening.

Figure 7.59: Applying the Thinned Mucilage Mixture

(Figure 7.59) Use a small brush to dip some of the thinned mucilage mixture and apply it onto the pad cup support. Apply this mixture only at the outer edge as shown by the arrow.

Figure 7.60: Placing Back the Felt Pad

(Figure 7.60) After the thinned mucilage has been applied, place the felt pad back on top of the pad cup support, aligning it back to its original place.

Figure 7.61: Turning the Pad Cup Upside Down

(Figure 7.61) Turn the pad cup upside down so that the felt faces the skin.

Figure 7.62: Press the Pad Cup Support And Synthetic Felt

(Figure 7.62) Press the pad cup support and synthetic felt into the flute pad assembly die. The die is designed with a groove for the pad cup to be inserted with precision.

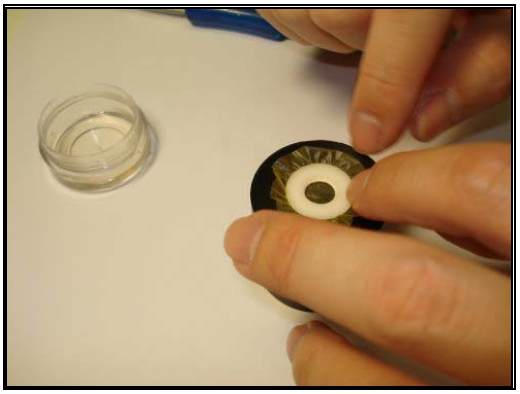


Figure 7.63: Flattening the Skin

(Figure 7.63) Flatten the skin and smooth it around the pad cup support as shown.

Figure 7.64: Flattened Skin

(Figure 7.64) This photo illustrates the extent to which the skin may be flattened. Take a close look at the center opening of the pad cup support, making sure the skin is as flat as possible. If it is not perfectly smooth, pull the outer edges of the skin away from the center.

Figure 7.65: Applying the Mucilage

(Figure 7.65) Using a small brush, apply the mucilage over the entire surface of the Delrin pad cup support.

Figure 7.66: Folding the Skin

(Figure 7.66) Using an angled chopstick or wooden cuticle stick, begin folding the skin over the pad cup incrementally, working slowly around the circle.

Figure 7.67: Rotating the Die Slowly

(Figure 7.67) When flapping the skin over the pad, twist the die slowly, rotating it so that the skin can be folded in a circular fashion. Continue until all of the skin has been folded over the pad.

Figure 7.68: Flattening the Skin

(Figure 7.68) Using the chopstick or wooden cuticle stick, flatten the skin as much as possible onto the pad cup support. Work from the outer edge toward the center, twisting the die for convenience.

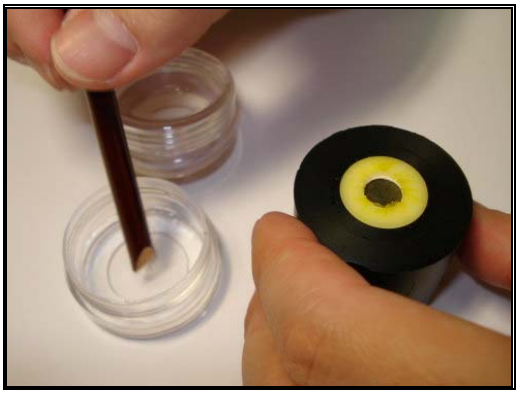


Figure 7.69: Adding Moisture to the Stick

(Figure 7.69) If the mucilage on the skin becomes a little dry, dip the stick back into the water to add some moisture.

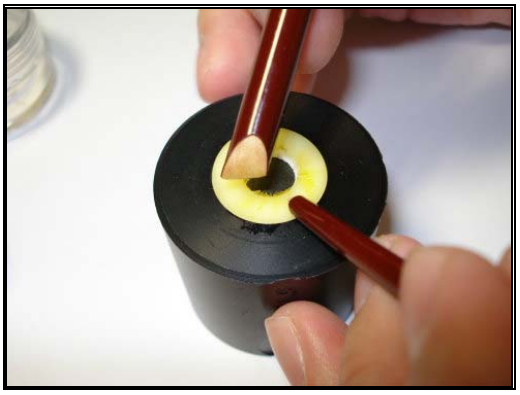


Figure 7.70: Holding Down the Skin Surface

(Figure 7.70) Using two chopsticks or cuticle sticks, hold down the skinned surface of the pad cup. This is necessary becomes it tends to lift up and needs to be held down during the flattening process. Do not use fingers to accomplish this since the skin will lift

Figure 7.71: Prompting the Pad Out

(Figure 7.71) Turn the die upside down and insert the chopstick or cuticle stick into the hole, gently prompting the pad out of the opposite side of the die.

Figure 7.72: Removing the Pad

(Figure 7.72) As the pad becomes visible, remove it, giving it some time to dry.

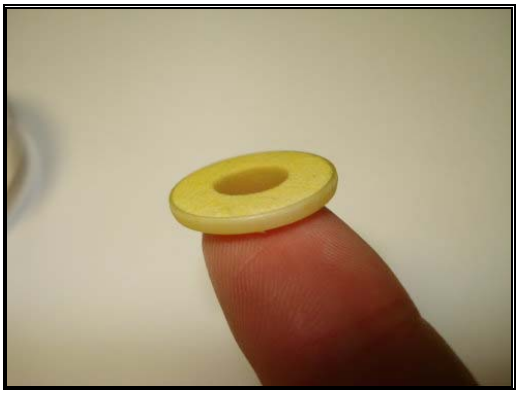


Figure 7.73: Placing the Pad on the Tip of the Index Finger

(Figure 7.73) After the cup is dry, place it on the tip of the index finger.

Figure 7.74: Applying the Thinned Mucilage Mixture

(Figure 7.74) Using a small brush, apply the thinned mucilage mixture once again onto the smooth surface of the skin. This is a very important step because the original Straubinger pad has no layer of glue between the two layers of skin. This results in the breaking of the skin within a few years. Gluing these two layers of skin together is the secret behind producing a strong and long-lasting bonded layer of skin.

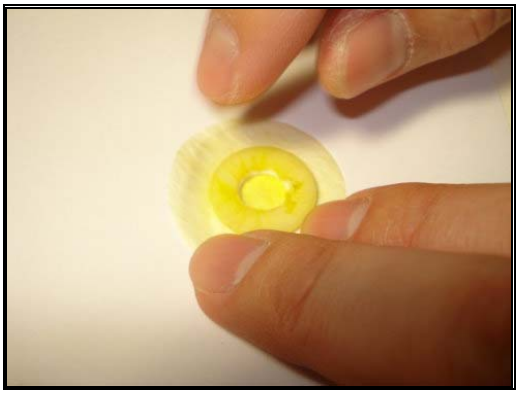


Figure 7.75: Placing New Layer of Skin

(Figure 7.75) Place another new layer of skin flat on the surface of the worktable and place the pad directly in the center. Apply some pressure to the pad so that it makes a firm contact with the skin.

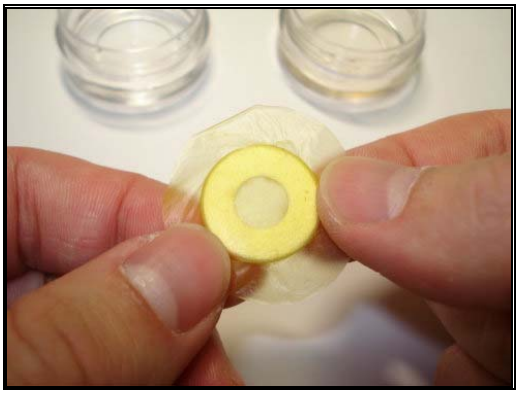


Figure 7.76: Flattening the Skin

(Figure 7.76) Taking the skin and pad into your hands, as shown in the photo, pull gently in an outward direction to flatten the skin.

Figure 7.77: Placing the Flattened Skin and Cup onto the Die

(Figure 7.77) Place the flattened skin and cup onto the die as shown. Do not press the pad into the die yet. Simply flatten at this point.

Figure 7.78: Applying the Thinned Mucilage Mixture

(Figure 7.78) Using a small brush, apply the thinned mucilage mixture around the outer edge of the pad.

Figure 7.79: Press the Pad Down

(Figure 7.79) Now press the pad down into the groove as shown.

Figure 7.80: Applying the Thinned Mucilage Mixture

(Figure 7.80) Apply a small amount of thinned mucilage mixture onto the pad cup support.

Figure 7.81: Flapping the Skin

(Figure 7.81) Using a chopstick or wooden cuticle stick, repeat the process of flapping the skin over the pad cup support.

Figure 7.82: Smoothing Down the Skin

(Figure 7.82) Using the chopstick or wooden cuticle stick, rotate the die in order to facilitate the process of smoothing the skin down.

Figure 7.83: Flattening the Skin

(Figure 7.83) Now flatten the skin on the pad cup support in an inward motion, from the outer edge to the center.

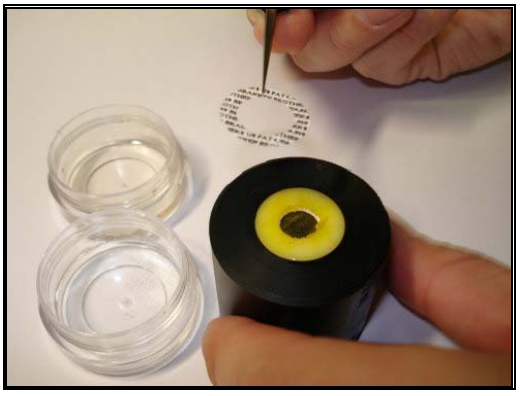


Figure 7.84: Placing the Straubinger Label

(Figure 7.84) Before the skin dries completely, place the Straubinger label onto the skin and press down.

Figure 7.85: Completed the Re-Skinning Process

(Figure 7.85) Complete the re-skinning process as shown.

Figure 7.86: Removing the Pad

(Figure 7.86) Using a chopstick or wooden cuticle stick, repeat the process of removing the pad from the die.

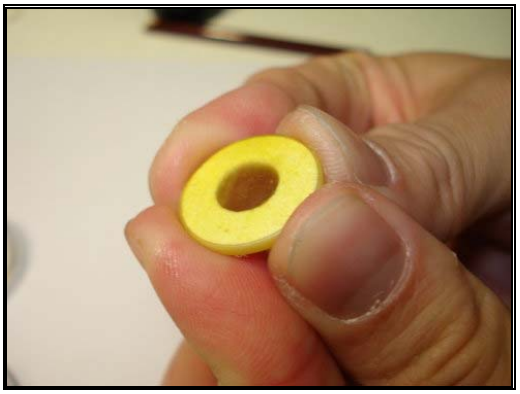


Figure 7.87: Flattening the Outer Edge

(Figure 7.87) Holding the pad in your fingers as shown, flatten the outer edge that could be reached sufficiently when it was inside the die.

Figure 7.88: Front-View of the Re-Skinned Straubinger Pad

(Figure 7.88) Here is a front view of the completely re-skinned Straubinger pad.

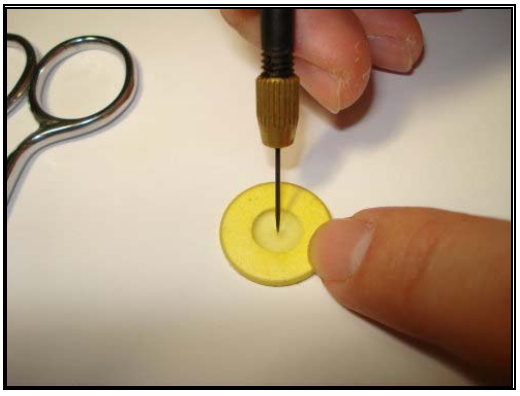


Figure 7.89: Pricking a Hole

(Figure 7.89) Using the needle pin vise, prick a hold in the center of the newly skinned pad.

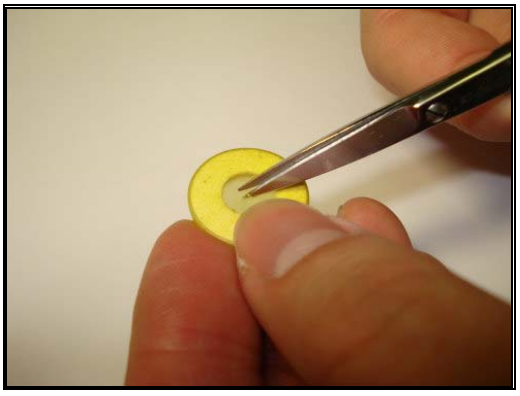
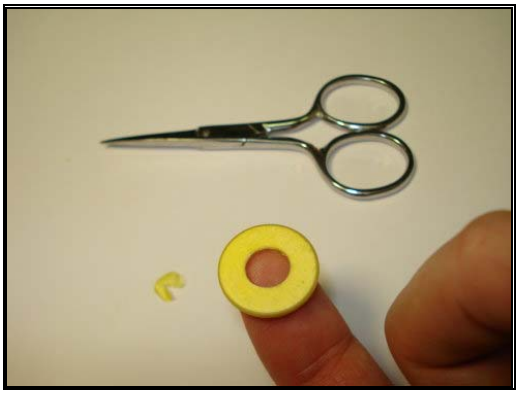


Figure 7.90: Cutting Away the Center Circle of Skin

(Figure 7.90) Using small scissors, cut away the center circle of skin as shown.



(Figure 7.91) Here is an illustration of the trimmed pad.

Figure 7.91: Trimmed Pad

The Theory of Padding

After successfully installing a pad, it is very important to check that the pad seals the tone hole hermetically. Normally, shimming procedures are required to level the pad perfectly in the pad cup in order to cover the tone hole. Flutists can purchase different thicknesses of shims from repair suppliers (see Appendix B) to perform the shimming procedures. All the partial shims need to be glued onto the base of the cardboard or plastic shim inside the pad cup. Note that adding less partial shims will make the pad more stable than by adding many small partial shims. In the Figure 7.92, the red arrow portion of the pad touches the tone hole before the blue arrow portion. This means adding some partial shims around the blue arrow portion in the pad cup will lower down the pad partially to seal the tone hole (Figure 7.93).

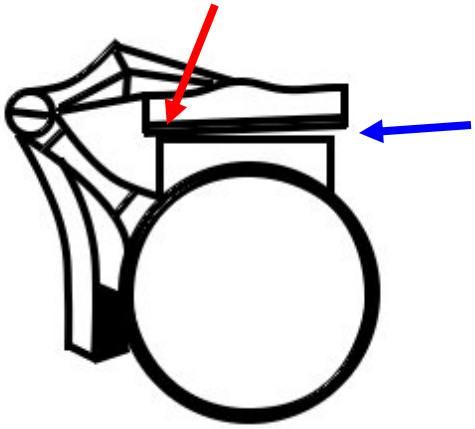


Figure 7.92: Side View of the Key

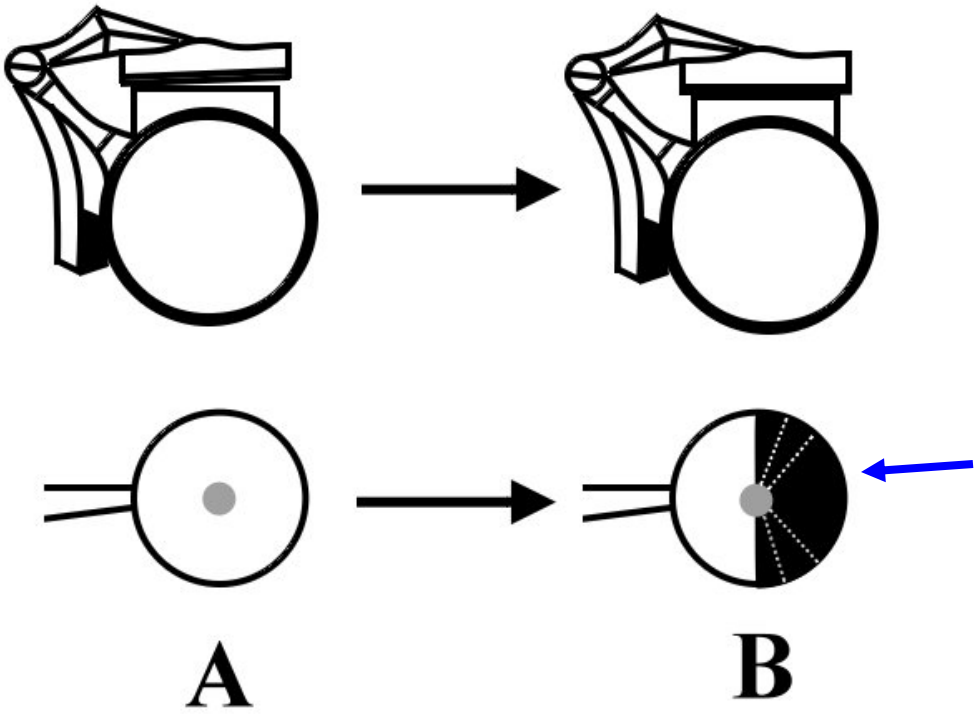


Figure 7.93: Shimming Process

This figure illustrates how shimming works. The main goal of shimming is to make certain that the pad is sealed tightly to the tone hole. In most cases, following a new pad installation, shims will be required. Very seldom is the tone hole perfectly sealed on the first try. Reasonable time and effort needs to be given to the task of shimming which is done in the following manner:

Figure 7.93A, upper left, is a side view of the tone hole and the key cup with the pad already installed. The lower left figure represents an aerial view of the key cup without the pad. For purposes of learning the shimming technique, it is important to visually notice the leakage gap between the pad and the tone hole. A manual entitled: *The Complete Guide to the Flute and Piccolo* (second edition) by J. James Phelan teaches the fine art of flute shimming in great detail.

Figure 7.93B, lower right, is a key cup upon which shims have been placed. The white dotted lines merely indicate how shims can and should be cut in order to seal the leakage points on the tone hole. The installer of shims will need to determine exact locations on the tone hole that need to be sealed.

To check for leakage points, a thin paper or plastic strip called a “feeler” (see Figure 7.94) should be inserted between the tone hole and pad. If the seal is tight, the feeler will

drag slightly. Conversely, if the inserted paper feeler yields without tension, then it has no drag and indicates a leakage point. The shim installer must work his way around the pad, adding partial shims in different thicknesses wherever needed. For the novice, determining the proper thickness of shims is accomplished through a process of trial and error. This task requires time and patience until the tightest seal can be achieved. At the point of no leakage, the feeler will drag all the way around the pad. The final test is to be sure there is tension on the paper strip when the feeler is pulled away.

Figure 7.94: Feeler
(Photo from Votaw Tool Company)

This Figure 7.95 represents the opposite shimming requirement. On this figure, the leakage point is toward the back of the tone hole. To remedy this problem, the shimming process is simply reversed. Notice that in the lower left figure the shims are in a different position that accommodates the back leakage point (Figure 7.96) Once again, the shims must be placed accurately and in varying thicknesses using the trial and error method. The “feeler” process should be used here.

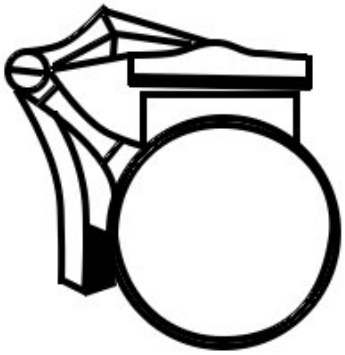


Figure 7.95: Side View of the Key

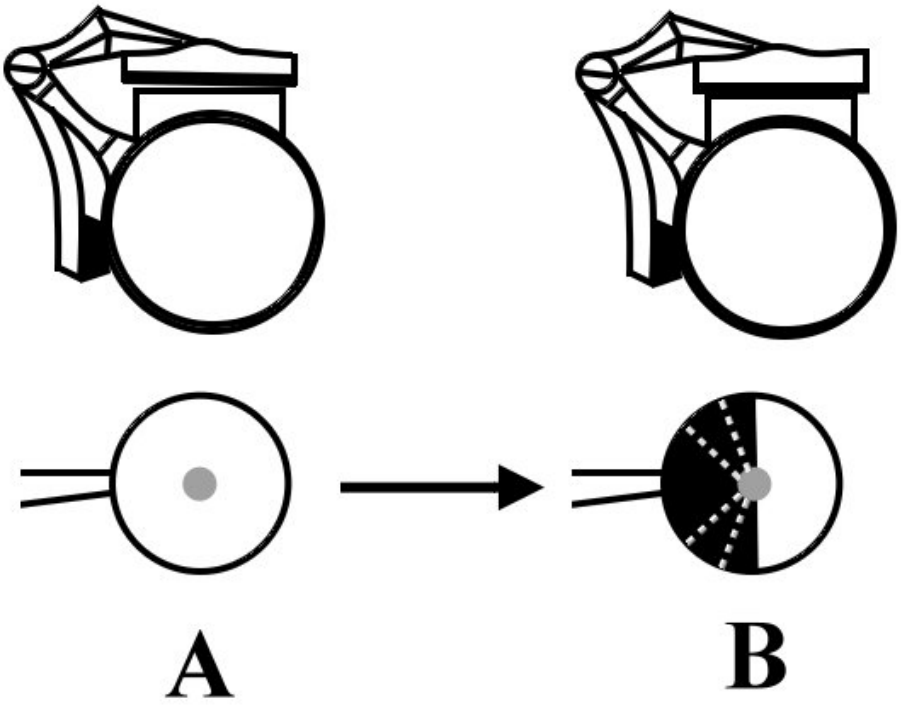


Figure 7.96: Shimming Process

This summation of the shimming process is very basic. The fine art of shimming is not the focal point of this document. A wide variety of leakage situations of the pad require customized shimming (see Appendix C). Flutists interested in this detailed process need to explore shimming techniques using the guidebook by J. James Phelan or by studying with a competent technician. Shimming is an exacting process that is learned with effort and experience.

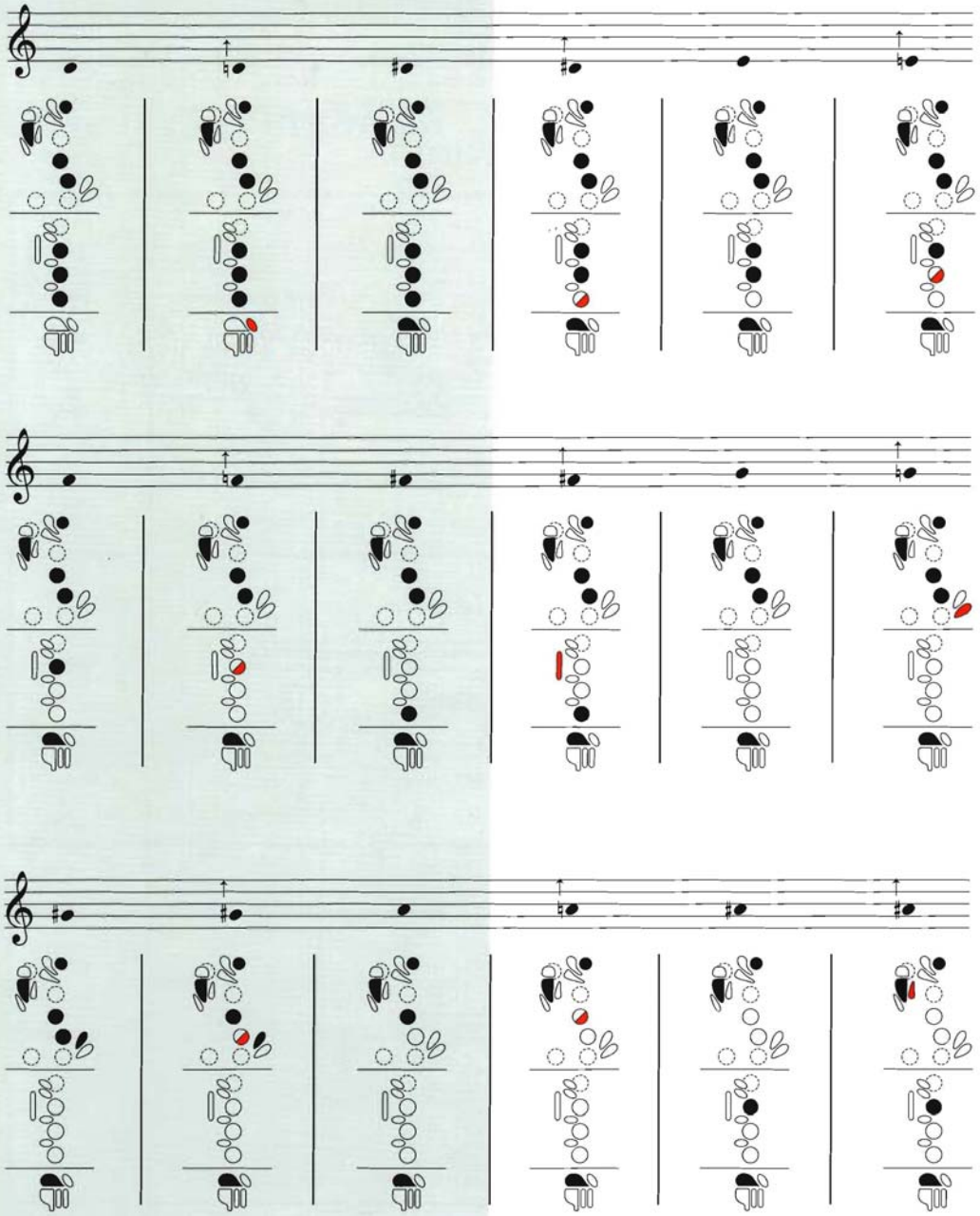
Flutists who are not comfortable with this technique, or who lack the time or passion to learn this technique should use professional repair technicians for this purpose.

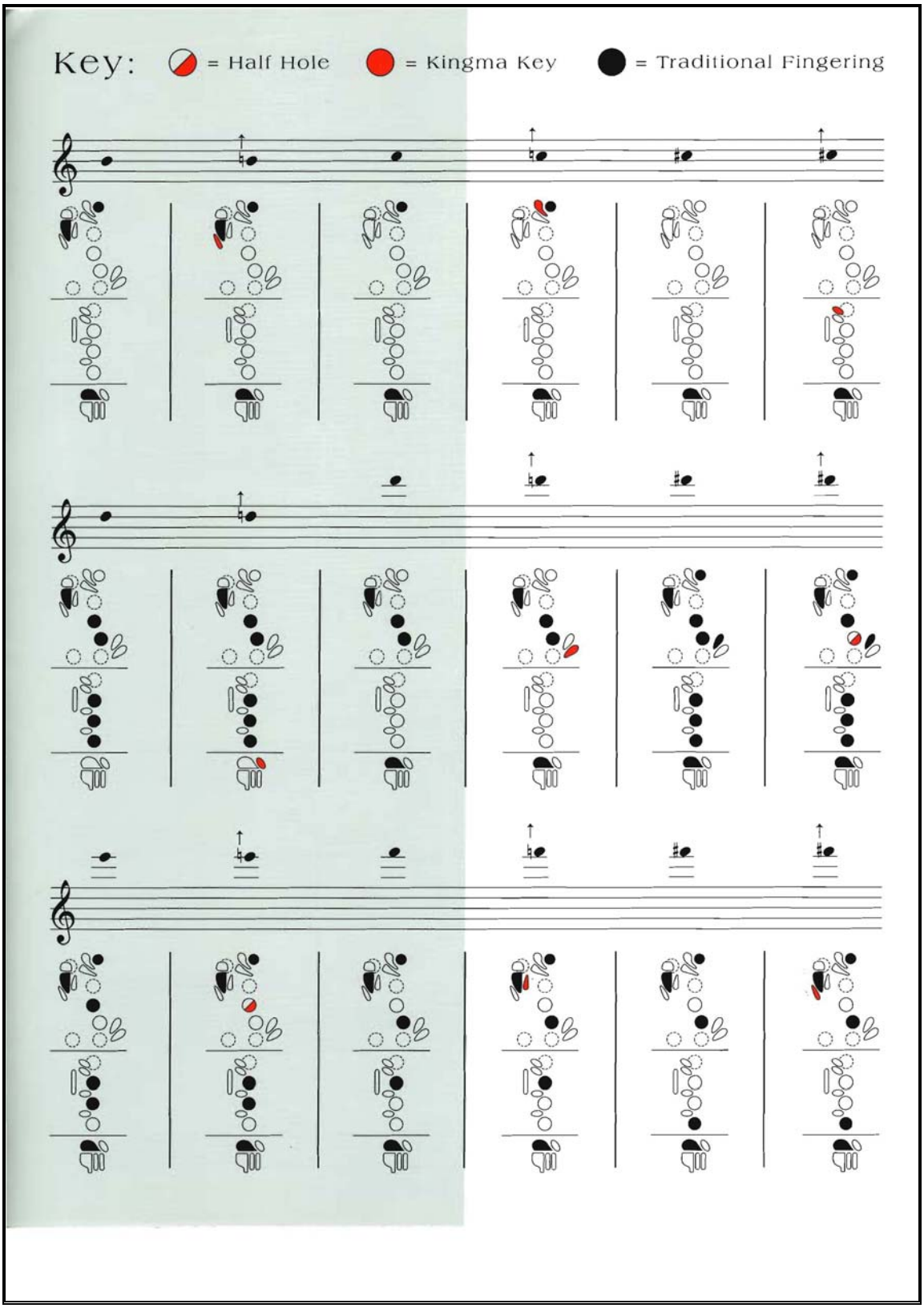
APPENDIX A

The Kingma Fingering Chart

Fingering Chart

The up (↑) fingering to achieve a quartertone is simply a standard Boehm fingering for the previous quarter step plus either a half hole or Kingma key.

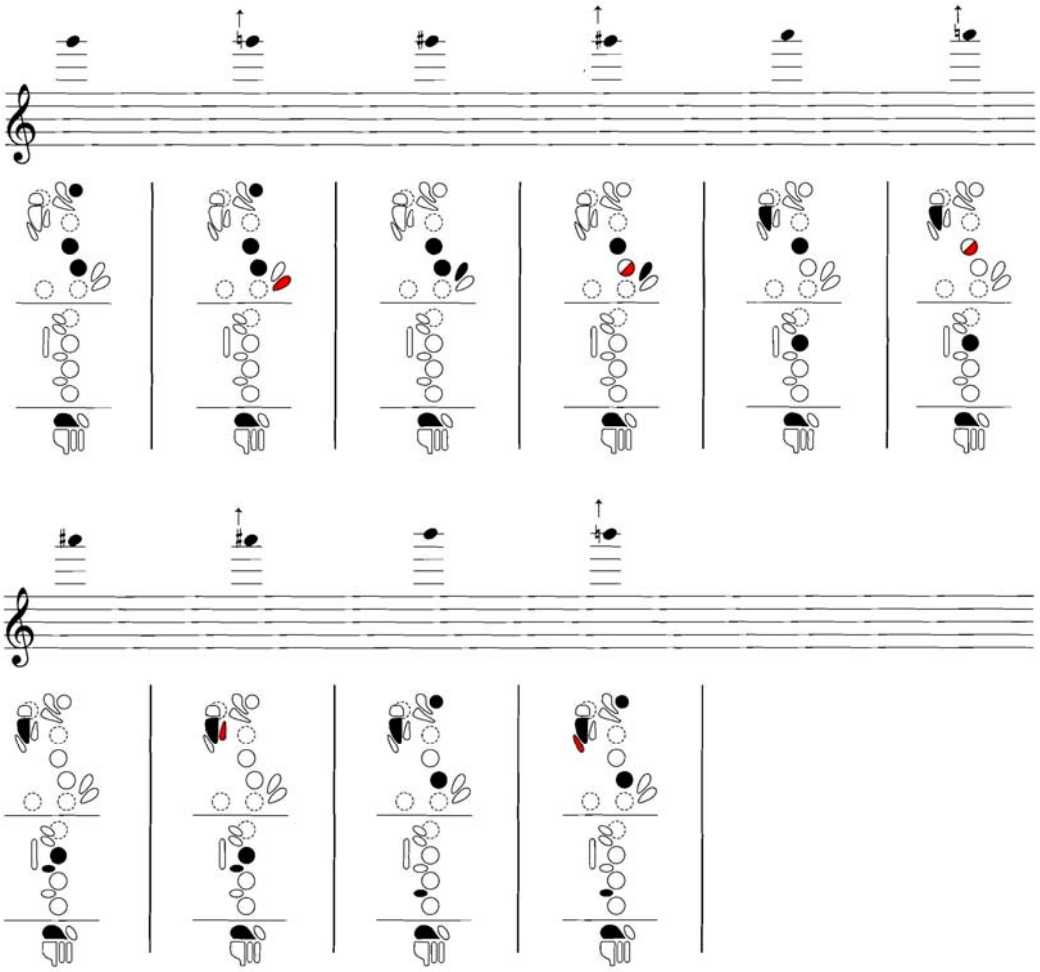



Key:
= Half Hole
= Kingma Key
= Traditional Fingering

BRANNEN BROTHERS

Flutemakers, Inc.

Fingering Chart (continued)



tel: 781-935-9522 email: brannen@brannenflutes.com
fax: 781-937-3058 website: www.brannenflutes.com
58 Dragon Court Woburn MA 01801-1014

APPENDIX B

LIST OF REPAIR SUPPLIERS

J. L. SMITH & Co. Tools and Supplies

http://www.jlsmithco.com/index.asp

Address: 901 Blairhill Road Suite 400
Charlotte, NC 28217
Tel: (800) 659-6073
(704) 521-1088
Fax: (704) 521-7099

JIM SCHMIDT

http://users.gotsky.com/jimschmidt/

Address: 4480 North Academy Ave.
Sanger, CA 93657
Tel/Fax: (559) 875 0659
Email: jim@jsengineering.net

JELINEK CORK GROUP

http://www.jelinek.com/rolls.htm

Address: 2660 Speers Road
Oakville, Ontario L6L 2X8
Tel: (905) 827-4666
Fax: (905) 827-6707

MusicMedic

http://www.musicmedic.com/

Address: 710 Summit Road BSL
SouthPort, NC
28461-9713
Tel: (910) 667-0270
Fax: 1-866-349-5689

Music Center SPA - Lucien Pisoni

http://www.musiccenterspa.com/Produzione/index.html

Address: Via dell'Ora del Garda 19
38100 TRENTO-GARDOLO (TN) - Italy
Tel: +39 0461 96 80 00 - Fax: +39 0461 96 00 00 - 96 80 90

Votaw Tool Company

http://www.votawtool.com/index.asp

HOURS OF BUSINESS
Monday thru Friday
8:30 a.m. to 5:00 p.m. (C.S.T.)

ADDRESS
Votaw Tool Company
1559 N National Ave
Springfield, MO 65803-3843
U.S.A.

PHONE / FAX
North America
Phone: 800-894-8665
Fax: 800-894-7165 (24 hour)

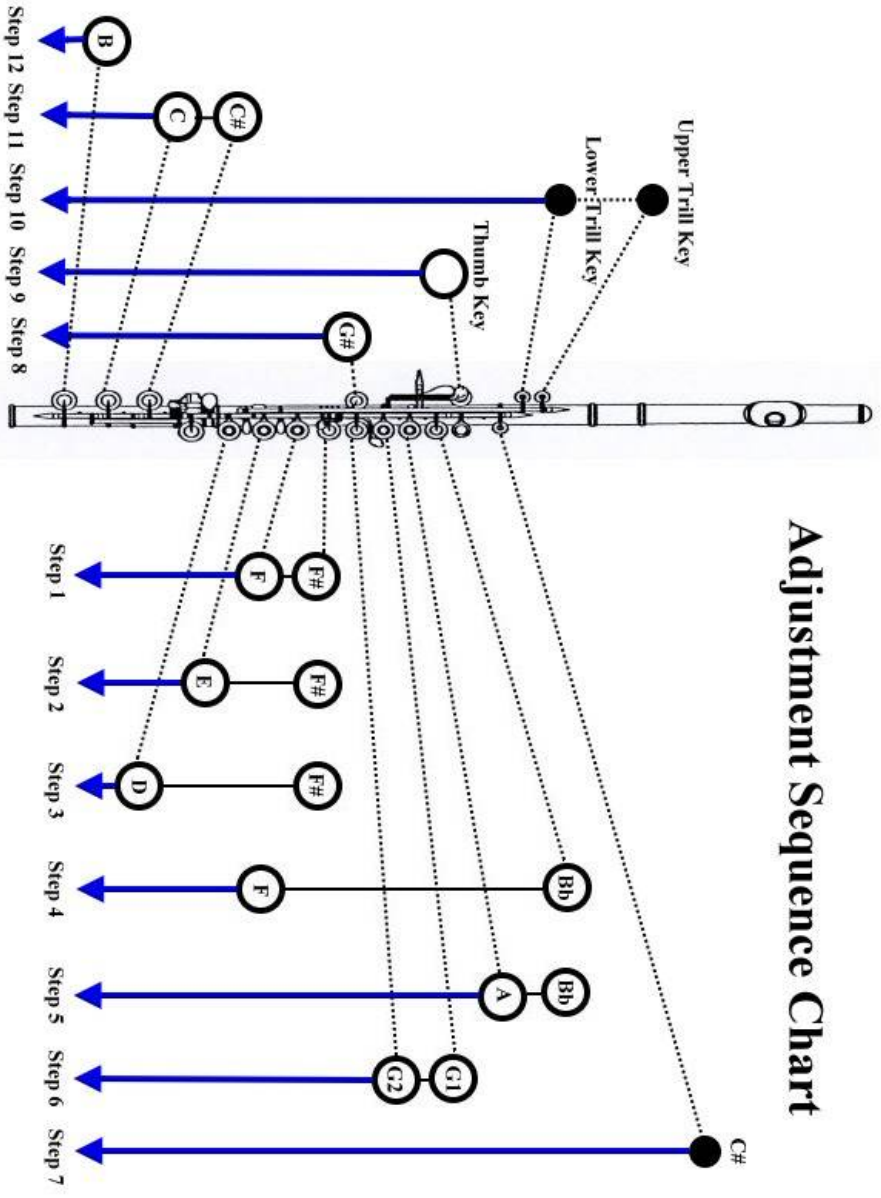
Outside North America
Phone: 417-865-7509
Fax: 417-862-7165 (24 hour)

Ferree's Band Instrument Tools & Supplies, Inc.

http://www.ferreestools.com/

Phone Order Tel: (800) 253-2261
Instruction Tel: (269) 965-0511
Fax Order Tel: 1 (269) 965-7719
Address: 1477 E. Michigan Av.
Battle Creek, MICH 49014
U.S.A.

APPENDIX C


Adjustment Sequence Chart
Upper Trill Key
Lower Trill Key
Thumb Key
Step 12
Step 11
Step 10
Step 9
Step 8
Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
B
C
C#
G#
F
F#
E
F#
D
F#
F
Bb
A
Bb
G2
G1
C#

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