# Student Flute Overhaul Schedule

*by Lars Kirmser*

The following overhaul schedule represents what I consider to be a logical repair sequence for the complete overhaul of the Flute. It is, by no means, intended to be entirely dogmatic. When special or unusual conditions arise, one may find that it would be necessary to alter the sequence of this schedule. In such a case the tech' would merely insert or delete any of the appropriate steps necessary to conform to their own unique situation. As you will see, there is an optional step 8 included in the schedule. Either 8a or 8b would be performed, depending upon whether or not the instrument is to be replated along with the mechanical overhaul.

**1. REMOVE KEYS AND LEVERS**
- Place all pivot screws back into their relative posts as you disassemble each pivot section.
- Address any key mechanism alignment problems, post alignment problems, and bent key or lever problems at this time.
- Swage each key hinge or lever hinge (requiring it) as they are removed in the following order:

**Offset G# - G Flute:**
- C Key & Left Hand Section (A-Bb)
- Right Hand Section (D - E - F - F#)
- Trill Keys
- B Thumb Key and Bb Lever
- G# - G (Double) Key
- G# Key (Wrap-around)
- Low D#, C#, C and (B) Keys

**In-line Flute:**
- C Key & Left Hand Section (G#-G-A-Bb)
- Right Hand Section (D - E - F - F#)
- Trill Keys
- B Thumb Key and Bb Lever
- G# Key (Wrap-around)
- Low D#, C#, C and (B) Keys

**2. CLEAN & STRAIGHTEN ALL LONG SCREWS**
- Place long screws (steels) on screw board.
- Organize all pivots on the screw board.

**3. REMOVE SPRINGS**
- Organize all springs on the screw board.
- Replace all old springs with new ones of OEM alloy at this time. (match O.D. - flare end - cut to length). Place new springs in their relative position on the screw board.

**4. REMOVE PADS**
- Place the pad retaining screws and washers in a vial on the screw board.
- Save for reference when selecting replacement pads (i.e. style, thickness).

**5. REMOVE ADJUSTMENT CORKS & FELTS FROM THE KEYS & LEVERS**
- Take note of the relative placement and thicknesses of the corks at this time.

**6. DISASSEMBLE PINNED SECTIONS**
- Left hand, Right hand, and Trill sections.
- Temporarily replace the saddle-lugs back onto their steels and group them together in their proper sequence; mark them on their backside if necessary.

**7. REMOVE THE HEADJOINT CORK ASSEMBLY FROM THE HEADJOINT**
- Always remove the headjoint cork by way of the tenon end of the head joint (taper).

**OPTION #1:**

**8a. OVERHAUL *WITHOUT* REPLATING**
- Rough-out headjoint and body dents
- Dip silverplated body parts (save keys and levers) in silver bright dip (tarnish remover).
- Lightly buff nickel plated body parts and keys with a center-stitched muslin buff and white compound (go gently!).
- Clean the body sections thoroughly with a mild detergent and warm water; rinse and dry thoroughly.
- Wipe the buffed keys and levers with a clean soft cloth.

**OPTION #2:**

**8b. OVERHAUL *WITH* REPLATING**
- Remove body dents
- Remove pits and scratches from keys with a #6 pillar file and/or a #240 felt wheel and felt "ball".
- Remove pits and scratches from the body sections with a #6 pillar file (draw) and #240 emery cloth.
- Buff the processed keys, levers, and body sections with tripoli and white compound, followed by an appropriate color buff.
- Degrease - clean the keys, levers, and body sections thoroughly in an appropriate solution, ultrasonic cleaner, or vapor degreaser.
- Electroplate to specifications (i.e. silver, bright nickel, gold).
- Run a small round hinge-tube file through all tubing to remove any excess plating or residue buildup inside the key hinges.
- Follow this process by cleaning the hinges with a pipe cleaner dipped in naphtha, and finish by applying a drop of key oil to each hinge tube.
- Clean all body posts and spring holes of any buffing dirt and/or plating residue. Use a clean pipe cleaner dipped in naphtha for the posts, and long reamers for the spring holes (matching their sizes of course).

**9. LEVEL TONE HOLES AS REQUIRED**
- If possible, 'drift' the tone holes level with a jeweler's level-

ing block (vs. filing them).

**10. LEVEL PAD CUPS AS REQUIRED**

- Place the key cup face down on your jeweler's anvil and strike the rounded edge of the key gently with a soft-faced hammer.

**11. CLEAN, 'FREE' AND LUBRICATE STEELS WITH THEIR RESPECTIVE KEYS OR LEVERS**

- Lubricate lightly after cleaning the hinge tube and before freeing-up
- Replace the steels back on the screw board.

**12. ASSEMBLE THE PINNED SECTIONS**

- Be sure to check the swaging of each individual hinge and make sure the keys and levers rotate freely in their relative position.

**13. INSTALL NEW CORKS AND FELTS**

- It is recommended that you use 1/16" (.0625") cork on the upper C Key, A Key, Bb Lever, G#-G (Double) Key, F# Key, E Key, D Key, and Low C Key (Low B Keys, if present). Use 1/64" (.015") cork on the Bb Lever to A Key, F# to Bb aux. Lever, and the Low C# to C Roller Key. The Trill Keys and the Low D# will require variations of thicker cork. These sizes will usually allow for a margin of adjustment. Use a thin felt disc between the Bb Thumb Lever and the B Key.

**14. REPLACE PADS**

- Replacement pads should be carefully selected to be of the appropriate thickness and fit completely in the pad cup without being oversized. Today a wide variety of thicknesses are available; check spec's of the OEM.
- Use *at least* one full pad washer in each pad.
- Punch out D, E, F, G, and A pads for French model flutes; install with grommets.
- Lightly moisten the pad skin to remove all wrinkles.
- Clamp each pad with a "hot washer" and secure overnight with a 2" spring clamp.

**15. RESPRING THE BODY JOINTS**

- I recommend that you replace **all** the springs when *overhauling* a flute or piccolo. If you are to only *repad* the instrument, then you may use the original springs, but only if they are in good condition.
- Cut the new springs to length using the key spring cradles (in position) as guides.

**16. ASSEMBLE ADJUST & PRECISION-LEVEL THE KEYS AS FOLLOWS:**

**Offset Flute**

- Low D#, C#, and C, (B) Keys
- G# Key
- G# - G (Double) Key
- Upper C Key (Level and wedge closed)
- B Key (Level-moisten-heat-wedge)
- Trill Keys (Level-moisten-heat-wedge)
- Right Hand Section (D, E, F, and F# Keys)
- Thumb Bb Lever (un-wedge B Key - install)
- Left Hand Section (A and Bb Keys)

**In Line Flute**

- Low D#, C#, and C, (B) Keys
- G# Key
- Upper C Key (Level and wedge closed)
- B Key (Level-moisten-heat-wedge)
- Trill Keys (Level-moisten-heat-wedge)
- Right Hand Section (D, E, F, and F# Keys)
- Thumb Bb Lever (un-wedge B Key - install)
- Left Hand Sect. (G-G# Key A & Bb Keys)

## The Reassembly Process

NOTE: It is assumed that all the basic criteria have been satisfied before beginning the following procedure. These criteria would include the following: All steels are straight and free of corrosion. All the swaging problems have been taken care of. All pads have been carefully selected and properly installed in the key cups. They have been lightly moistened to remove the wrinkles, with the pad thickness exceeding that of the key cup rim by approximately ½ mm. All springs have been replaced or are in good condition. The body of the instrument is free of excess dirt and lint. All body dents (those that would affect the final playing of the flute) have been smoothed out. All keys and key mechanisms are "free" with respect to their long screws and are without alignment or tracking problems.

## Main Body Joint:

**1. INSTALL THE G# KEY**

- Preset (by estimate) the spring tension.
- If the spring is loaded on the bottom of the key hinge, you will be required to "load" the spring AS you install the G# key.
- Center the key cup over its tone hole.
- Preliminarily level the key cup with respect to the tone hole rim.
- Precision-level the pad with the L-shaped drifting tool. When finished leveling the pad, the tone hole rim should rest in the exact center of the pad. If this condition is difficult to achieve, you may be using a pad that is either too thick or too thin. Another possible option would be to insert pad shims (whole and/or partial) beneath the pad.
- When the G# key is at rest, the bottom "plane" of the spatula should be in-line with the tops of the two adjacent tone holes.
- Set your key travel at 3 to 3.5 mm. This is generally accomplished by adding or removing cork from the key silencer.
- In radical cases, you may find that it will be necessary to actually bend the tone arm with respect to the pad cup to achieve proper key opening and alignment. When doing this, be sure to hold the G# pad cup firmly against its tone

hole. When closing the action, hold the pad cup firmly against the tone hole towards the *rear* of the pad cup to prevent a gaping hole from forming at the rear of the pad seat. When opening the action, hold the pad cup firmly towards its *front*, to help prevent the pad cup from "scooting" forward with respect to the tone hole rim.
- Adjust the spring load as necessary.

**2. INSTALL THE G#-G (DOUBLE) KEY**
- Preset and load the spring as you install the key.
- Center both key cups with respect to their tone holes.
- Preliminarily level each key over its respective tone hole.
- An attempt is made to get both keys as even and level as is possible, since the final objective will require that they both open and close at precisely the same instant.
- Precision-level both pads.
- You will probably be required to go back and forth between the G# and the G keys as you precision-level them. Drift the key which touches its tone hole first (since it will restrict the closure of the other key), then alternate back and forth between the two keys as necessary until both are absolutely level and centered over their relative tone hole AND close at precisely the same time. (Always press the G-side of the two keys when checking with your feeler gauge to simulate the actual playing conditions.)
- Set the key travel from 3 to 3.5 mm.
- The action is opened up by removing cork from the key foot. The action is closed by adding a thicker cork or by carefully bending the key foot closer to the body as the G# and G keys are held firmly closed.
- Adjust the spring tension as necessary.

**3. INSTALL THE UPPER C KEY**
- When installing the upper C key, be sure to screw the long screw all the way into the pivot post, then back it out only until the pivot point is not visible. This makes sure that no obstruction exists in the post threads.
- Center the pad cup over its tone hole.
- Level the pad cup over its one hole.
- Precision-level the pad via the "floating-in" method.
- Set the key opening to 3 mm.
- Adjust the spring tension as necessary.
- Moisten the pad skin, and then wedge the key closed using a force that simulates normal finger pressure. Next, apply heat to closed pad. Be careful not to use excessive amounts of heat so that the existing shellac oozes out. Remember, the heat is only required to relieve the pad of the moisture applied earlier, and to help establish a pad seat.

**4. INSTALL THUMB B KEY (ALONE)**
- Lay the Bb Lever aside for the moment.
- Position the key up against its side of the hinge and center the pad cup over its tone hole.
- Preliminarily level the pad cup with respect to its tone hole.
- Precision-level the pad as necessary.
- Lightly moisten the pad skin and gently wedge the key in the closed position. Apply heat only until the pad cup is uncomfortable to the touch. (4 or 5 seconds... remember, the spuds are only soft soldered inside!)
- Go on to the trill keys; we will install the Bb Thumb Lever later.

**1. INSTALL THE TRILL KEYS**
- Check to make sure that the pins are tight and that the key rotates freely.
- Preset the spring loads.
- Screw in the upper *(headed)* pivot screw until the head bottoms out.
- If you have a *headless* "Nylock" screw, screw it in until only the pivot portion of the screw is fully extended through the post. The specific amount that you screw the headless pivot into the post will represent an amount that the lower pivot will have to be screwed in to achieve an even and balanced suspension of the trill section (absence of lateral play).
- If the pivot screws show excessive wear and back out of their posts easily, you will be required to replace the pivots.
- Slide the trill key section in, beneath the right hand springs and load-up the trill springs *as* you place the upper end directly over the exposed point of the pivot screw.
- While holding the trill key section steady with the left hand, screw in the bottom *headed* pivot until it bottoms-out in its post. Then check for lateral movement between posts and adjust as necessary. Often, you may have to remove small amounts of ent-to-end key movement between posts (or even binding due to the posts being too close together) by removing the trill key and gently tapping both the upper and lower pivot post in the desired directions (evenly). In the case of *headless* pivots, you simply slide the trill section in (beneath the right hand springs) and load up the springs as you place the upper end directly over (in) the pivot-bearing surface. While holding the trill key section steady with the left hand, screw in the bottom headless pivot until the D# (outside) trill key-action binds- up. Then slowly back the lower pivot screw out very slowly (actuating the D# trill all the while) until it actuates freely. There should be no endplay or side-to-side wobble in either the upper or bottom trill key pivots.
- Center each trill key cup over its respective tone hole.
- Preliminarily level each cup with respect to its tone hole.
- Precision-level each pad via the "floating-in" method. Be careful not to burn pads or overheat adjacent springs.
- Adjust each key travel to 2.5 mm.
- This regulation is achieved by performing one or both of the following: a. By regulating the relative cork thickness on the trill spatulas, or b. By carefully bending the spatulas either closer or farther away from the flute body (only after the trill corks are of the correct thickness).
- The adjustment criteria are: a. Both trill keys should open 2.5mm. b. Both key spatulas should be at an even plane with respect to one another, and c. The tops of the trill key spatulas should be 3mm above the adjacent D-E-F key cups.
- Check each key for relative spring loads.

**2. INSTALL RIGHT HAND SECTION** (D-E-F-F# KEYS)
- Check to make sure that all pins are tight and that the keys rotate freely on the hinge.

- Preset the spring loads on the D-E-F-F# keys at this time.
- You will have to be particularly careful with the angles and clearances of the springs on the right and left hand sections. If you are not careful, springs will rub against adjacent hinge tubes causing the action to be sluggish.
- As you place the right hand section into position, install all 4 springs into their respective cradles so that you may actuate the F# key as you screw the *headless* Nylock screw into its post. This you will do until the F# Key binds up. Then, back the screw off slightly until the F# Key frees up. On a headed pivot screw, this type should be screwed into its post completely until it is firmly in place. There should be no evidence of key end-play nor side-to-side wobble at the either pivot.
- Check each key individually, and adjust the spring loads. Hold the F# Key closed when checking the D, E, and F Keys.
- Center each key over its respective tone hole.
- Preliminarily level each key with respect to its tone hole.
- Back-off the adjustment screws so that the F# Key will not restrict the closure of the D, E, or F Keys when performing the final leveling.
- Precision-level the F Key.
- Set the F Key travel to 3.5mm. (3mm for Fr. models) This may be done by either adjusting the cork (or felt) on the bottom of the clutch arm (next to the body), or by carefully bending the clutch arm closer or farther away from the flute body as necessary. This is an extremely important step, as the F Key travel determines all subsequent key travel on the D Key, E Key, F# Key, A Key, Bb Key, and the Thumb B Key and Bb Lever!
- Precision-level the F# Key.
- Precision-level the E Key.
- Precision-level the D Key.
- Screw the adjustment screws in on the D, E, and F Keys so that each key (when pressed closed individually) comes just short of closing the F# Key.
- If the adjustment screws go in without perceptible resistance, you will have to replace the screw with a fresh one (or carefully stretch the worn threads if a replacement is not available).
- Perform a quick re-check on all four right hand section keys. Do not make the final key-to-key adjustments yet (D-F#, E-F#, F-F#), or worry about the presence of lost motion (these adjustments will be made after the pads have been completely seated in).

### 3. REMOVE WEDGE FROM THUMB B KEY AND INSTALL THE Bb LEVER

- Check the B Key and the Bb Lever for a sloppy hinge by grasping the B key cup with the thumb and index finger; try to move the key and lever from side to side. If there is enough movement to allow the pad to drift off of its seat, you must correct this problem by carefully swaging both key hinges.
- Recheck the levelness of the B Key.
- Check the flat springs for placement and relative load.

### 4. INSTALL THE LEFT HAND SECTION

- Preset the spring loads on the A Key and the Bb Key.
- As you hook the springs into their relative spring cradles, swing the Left Hand Section into place. Screw the long pivot screw inwards (as your left hand repeatedly activates the Bb Key) until the Bb Key binds. As before, you are then to back the long screw off until the Bb key frees-up again.
- Check the springs for their relative load and alignment.
- Center the keys over their tone holes.
- Preliminarily level each key cup relative to its tone hole.
- Back off the A to Bb adjustment screw so that the Bb key does not restrict the A Key from closing during the next step.
- Precision-level the Bb Key.
- Precision-level the A Key.
- Screw in the A to Bb adjustment screw until the Bb is just short of closing when the A Key is fully closed.
- As with the right hand section, if the adjustment screw turns too easily and without resistance, you must replace it with a fresh one (or carefully stretch the worn threads if a replacement is not available).
- Precision set the F to Bb clutch adjustment.
- When the F Key is closed (gently) the Bb Key should also close at *exactly* the same instant. In other words, you should get an identical amount of "drag" on your feeler gauge from the Bb Key as you get from the F Key. This adjustment is made by carefully bending the upper clutch plate as necessary. Do not change the relative adjustment of the lower plate as this would change the already established F Key opening. Some flutes (i.e. Bundy) have an adjustment screw built into the upper plate, so bending is not at all necessary.

*NOTE: Be very careful when bending the upper plate of the clutch since, in doing so, you place a substantial force on the pins of the left hand section and if the pin(s) are loosened up, you will not be able to attain a final adjustment.*

- Set the Bb Thumb Lever to Bb Key adjustment.
- The correct regulation between the thumb lever and the key is reached when the Bb Thumb Lever is fully depressed (thus causing the Bb Key to fully close) there exists approximately ½ mm "play" between the Thumb B Key and the top of its tone hole. This distance just happens to be the exact depth of the seat yet to be obtained from the Bb Key. Remember, the Thumb Key ALREADY has its seat, so after the Bb Key is seated in, the B Thumb will then close fully.
- If the Bb Key does not fully close when the Bb Thumb Lever is pushed, then we must cause the Bb Thumb Lever to travel farther by opening the lever action somewhat. This we can accomplish by carefully grasping the Bb Thumb Lever with our (smooth-faced) flat nose pliers and then pulling the lever away from the body of the flute, this, in effect, will allow the Bb Thumb Lever to travel farther, thus allowing the Bb Key to also travel farther.
- On the other hand, if the Bb Key closes too early, the reverse must be performed with respect to the Bb Thumb Lever. To accomplish this opposite adjustment, I use the handle of my small nylon-faced hammer to force the tail of the Bb Thumb Lever closer to the body of the flute. With the left hand firmly holding the Bb Lever (along with the thumb B key) in the closed position, use the side of your hammer handle to carefully bend the tail of the Bb Thumb Lever closer to the body,

thus reducing the "travel" of the B Thumb Key and the Bb Thumb Key, thus allowing the B Thumb Key to close earlier.
- There exists also the option of bending the tail of the Bb Key (left hand section) which is articulated off of the Bb Thumb Lever. This adjustment may be used in coordination with the other two techniques if necessary.

**5. LIGHTLY MOISTEN, HEAT AND CLAMP THE KEY MECHANISM**
- Bb Key
- A Key
- G Key (upper key on the double G#-G key)
- The wrap-around G# key
- F# Key (protect adjacent trill corks)
- F Key
- E Key
- D Key

**6. REMOVE THE CORK PROTECTOR; LUBRICATE KEY MECHANISM; ALLOW TO SET OVERNIGHT**

**FOOT JOINT:**

**7. INSTALL LOW C, C# , (B) and D# KEYS**
- Preset the spring tensions.
- Thread the long screw through the C&C# Keys, then as you engage the D# spring into its cradle, thread the screw through the D# Key and screw it into its post fully.
- Engage the C and C# key springs; adjust their loads as required.
- Center all keys over their relative tone holes.
- Preliminarily level the keys with respect to their tone holes.
- Precision-level the D# Key.
- Set the key opening from 4 to 4.5 mm.
- Precision-level the low C# Key.
- Precision-level the Low C Key.
- If the C# Key is inhibiting the C Key from closing, you will have to carefully place a wedge between the C# pad and its tone hole then carefully press the Low C Key closer to its tone hole (only until the Low D# Key no longer restricts its closure).
- Set the Low C# to Low C Key regulation.
- When the Low C Roller Key is pressed (without touching the C# spatula) both the Low C# and the Low F Key should close at precisely the same instant. Consequently, you should be able to get an identical "drag" from both keys off of your feeler gauge. This regulation is facilitated, for the most part by way of the small plate below and to the right of the Low C roller. It may be adjusted to a small degree by carefully bending it with your flat nose pliers, and/or by adjusting the relative thickness of the fork silencer. You may also place a pad slick (or other thin spacer) between whichever pad is closing early and its tone hole rim, then, gently flex the other key closer to its tone hole. Be careful not to alter the levelness of the pads during the process.
- When you are finished with these adjustments, you should end up with an even and level 3-way "plateau" among the D#, C# & C key spatulas. This is necessary so that the performer may slide their little finger between these spatulas with the minimum of resistance.
- The C# and C Keys should be adjusted to have a key travel of from 4 to 4.5 mm.
- Lightly moisten all pads.

**8. LIGHTLY MOISTEN, HEAT AND CLAMP THE KEY MECHANISM**
- Low C Key
- Low C# Key
- D# Key
- Place a drop of key oil at each bearing surface, and join the foot joint to the main body joint; allow the flute to set overnight.

**FINAL ADJUSTMENT SEQUENCE**

**1. REMOVE CLAMPS**
- Be careful to avoid putting scratches on the body when removing the clamps.
- Allow the flute to set for at least 1 to 2 hours before proceeding. This will allow the pads to "settle".

**2. CHECK PADS INDIVIDUALLY; VERIFY THAT EACH IS PERFECTLY LEVEL**
- Gingerly drift those pads that are not perfectly level.
- Check the B Thumb Lever to Bb Key adjustment, and the F Key to Bb Key adjustment; regulate as necessary.
- Be sure to use **exceptionally light finger pressure** when checking each pad for levelness. Apply pressure to the key only until you meet an initial resistance.

*Check the keys in the following order:*
- G# Key (Wrap-around)
- G# –G Key (Double)*
- A Key
- Bb Key
- C Key
- Trill Keys
- Thumb B Key
- Thumb Bb Spatula ( B to Bb regulation)
- D Key
- E Key
- F Key (F to Bb regulation) *
- F# Key

*When gently actuating the primary key, **both** keys must have an identical "drag"" from your feeler gauge (360 degrees!).

**3. SET THE D TO F# KEY ADJUSTMENT**
- When gently closing the D key, both the D key and the F# key must have an identical "drag " off of your feeler gauge.

**4. SET THE E TO F# KEY ADJUSTMENT**
- When gently closing the E key, both the E key and the F# key must have an identical "drag" off of your feeler gauge.

**5. SET THE F TO F# KEY ADJUSTMENT**
- When gently closing the F key, the F key, F# key AND Bb key must have an identical "drag" off of your feeler gauge.

**6. SET THE A TO Bb KEY ADJUSTMENT**

- When gently closing the A key, both the A key and the Bb key must have an identical "drag" off of your feeler gauge.

## REMOVAL OF LOST MOTION

It should be mentioned that many neophytes consider the task of removing lost motion to be one of the more confusing operations in the course of flute repadding and overhauling. Where this may be true early in one's experience, I have found that if all the preliminary steps were performed carefully, and if one approaches the task logically, this step may well be one of the easier elements in the entire process.

It should also be stressed that the difficulty one experiences in the removal of lost motion is usually inversely proportional to the amount of care and preparation taken **prior** to this final step. Below are some of the more important considerations that must be made prior to the removal of lost motion:

- All pinned keys MUST be pinned solidly, that is, no perceptible movement is present when rotational stress is placed on the pinned section (specifically, the D to F#, E to F#, F to F#, and A to Bb pin plates, and the D# trill spatula to D# trill key pin). It is also important that the permanent pins (which are often soft-soldered as well as pinned) on the F# key, Bb auxiliary trill spatula, Bb key, and D# trill key are solid as well.
- All keys are absolutely level and seated properly.
- All combinations (i.e. D-F#, E-F#, F-F#-Bb, A-Bb, Thumb Spatula-Bb key) are regulated with exacting precision.
- All pivot screws are "set" into their relative bearing surfaces properly so that no binding or lateral key wobble is present.
- The F Key opening has been pre-set to exactly 3 mm. (Some technicians prefer to pre-set the F Key to 3.5 mm.)
- The Thumb key/lever combo must be swaged properly and no "slop" should be present in the key hinge tubes. O. K., let's proceed into the mechanics of the problem

First of all, the only key that is actually "set" at this point is the F key. This key opening of 3 to 3.5 mm was established by regulating the lower clutch plate and/or the relative thickness of the cork (or felt) thickness that comes into contact with the flute body. Once the F Key opening has been established, we should never alter this adjustment. At this point, it is possible that we have lost-motion in one or more of the following 5 keys:

- D Key
- E Key
- F Key
- A Key
- Bb Thumb Spatula

O.K., now let's mentally divide the flute mechanism into two parts. Part 1 will include the Thumb Bb Spatula, the A Key and the F Key. Part 2 will include the D Key, the E Key, and the F Key. You will note that the F Key is included in both part 1 and part 2. This is because the F Key can have lost-motion due to the D and E Keys of part 2, AND may have lost- motion due to the A Key and Bb Thumb Spatula of part 1. For example, the F Key can have lost- motion if one or both the D Key and/or the E Key cork thickness is too thick (part 2). It may also have lost-motion because the corks on the A Key and/or the Bb Thumb Spatula are too thick (part 1). This occurs because cork that is too thick on either one or both of these keys will cause the upper clutch plate to be held a little *above* the lower clutch plate. To make complications worse, it is sometimes the case, where lost-motion in the F Key is due to excessive cork thickness' in the D and/or E Keys of part 2 **and** excessive cork thickness' of the A Key and/or Bb Spatula. It is for this reason that any lost-motion in the F Key (for whatever reason) must be eliminated *prior* to working with the upper two keys of part 1 or the lower two keys of part 2.

What symptoms then, will be present when the corks of the D key and/or the E key (of part 2) are too thin? Remembering of course that all of the key-to-key articulations (combinations) have been precisely regulated. To begin with, the key travel (opening) on the D Key and/or the E Key will be excessive. This occurs when a key cork is too thin, the result being a key opening that is excessive. Secondly, this excessive opening will be reflected as *lost-motion.* Therefore, if we reduce this key travel by adding a thicker key cork of precisely the right amount, we will cause the key to be located closer to their respective tone hole, thus eliminating both the lost-motion that once existed between the key's regulating lug and the pinned stop plate, and the excessive key travel. Incidentally, this same observation can be made with respect to the A key cork and/or the Bb Thumb Lever cork of part 1.

Now then, it is possible that a key cork may be too thick on either the A Key or the Bb Thumb Lever (but usually not both). In this case, we will witness lost-motion on the key which does not have the excessively thick cork (i.e. the A Key or the Bb Thumb Lever). In this situation, you must first check to see if there is lost-motion between the two Bb clutch feet. If no lost motion exists at this clutch junction, then it is a simple process of : 1. Adding a precisely thicker cork to the foot of the key that exhibits lost motion, or, 2. Carefully bend the tone arm of that same key *closer* to the body of the flute, whichever process you decide is most appropriate.

If lost-motion does in fact exist at the clutch junction, then carefully sand the excess cork from the A key and/or Bb Thumb Lever until the lost-motion disappears. I say "and/or" because on occasion, both key corks may be too thick, and in such a situation you will have to sand a little off one key then a little off the other (back and forth) until no lost-motion exists between the upper clutch plate and the lower clutch plate. By sanding cork off the key(s) with too much cork, we allow the upper clutch plate to gradually come down to meet the lower plate, thus eliminating the lost motion. REMEMBER: We **never** remove material from the bottom clutch plate as this will disturb the F Key opening that we set earlier! At this point we should have no lost-motion in the upper part 1 or at the clutch junction.

Continuing on, we may apply this same logic with regard to the lower part 2 (consisting of the D Key, E Key, and F Key). Remem-

ber, we have already taken care of any lost-motion due to the upper clutch plate being held up by the A Key and/or the Bb Thumb Lever corks, so, any lost- motion present at the F Key cup may be attributed to key cork(s) which are too thick on the D Key and/or the E Key. Therefore, if you carefully dress down the cork on the key(s) that **do not** exhibit lost-motion, we then permit the pinned stop plates of those keys exhibiting lost motion to rotate gradually until they come into contact with their relative adjustment lugs, thus eliminating all lost-motion in the right hand section.

Now then, if no lost-motion exists at the F Key, and neither the D Key and/or the E Key have lost-motion, then the key(s) exhibiting lost-motion must require either, 1. A thicker cork on their key foot, or, 2. Require that their key foot be carefully bent *closer* to body of the instrument. If you choose to bend the key foot closer to the body, you must hold the key firmly closed with the left hand, and with the nylon-faced hammer, gently tap the key foot closer to the body. Always recheck the adjustments of the D Key to F# Key, and the E Key to F# Key when you perform this second technique as the percussiveness of the striking hammer will often throw these adjustments off slightly.

| LOST MOTION AT: | PROBABLE CAUSE: | SOLUTION: |
|---|---|---|
| F Key between the lower F clutch Plate. | The cork on the A key and/or the Bb thumb lever is too thick. | Slowly dress down the Bumper Cork on the key(s) that do not show lost motion. #220 grit sand paper works well for this operation. Remember, if both keys do not exhibit lost motion initially then you may have to teeter-totter back and forth between the A key cork and the Bb thumb lever cork. This way you will be less likely to take too much cork off of one key or the other. Continue to do this process until the upper Bb clutch plate comes into contact with the Lower F key clutch plate. |
| F key shows lost motion even after the Bb clutch plate comes into direct contact with the F clutch plate. | The corks on the D key and/or the E key are too thick. | Again, slowly dress down the cork on the key(s) which do not show lost motion. You may have to go back and forth between the D key and E key if both keys do not show lost motion. Continue this until no lost motion exists on the F key. Do not go too far, where you actually create lost motion in the D key and/or the E key. |
| Lost motion on the A key only of the A key/Bb thumb lever/F key combo. | The Bb thumb lever cork is too thin. | Either install a thicker cork on Bb thumb lever, or carefully bend the tone arm of the Bb thumb lever closer to the body of the flute by holding the Bb thumb lever firmly closed with the left hand (the B key will subsequently close as well) and gently forcing the "tail" of the Bb thumb lever closer to the body with the side of the wooden nylon-faced hammer handle. |
| Lost motion in both the A key and Bb thumb lever of the upper combo. | Both keys have too thin a cork. | Install slightly thicker key cork on both key feet and then dress them down carefully until all lost motion in the F key to Bb key clutch plate disappears. |
| Lost motion in the D key only (lower combo) | D key cork too thin. | Either put a slightly thicker key cork on the D key foot and dress-down accordingly, or bend the D key foot a little closer to the body of the instrument by carefully striking it with your nylon-faced hammer. Be sure to hold the key firmly closed before striking the key foot. Also, be sure to recheck the D to F# regulation before continuing. |
| Lost motion in the E key only (lower combo) | E key cork too thin. | Either put a slightly thicker key cork on the E key foot and dress-down accordingly, or bend the E key foot a little closer to the body of the instrument by carefully striking it with your nylon-faced hammer. Be sure to hold the key firmly closed before striking the key foot. Also, be sure to recheck the E to F# regulation before continuing. |
| Both the D key and the E key exhibit lost motion. | Both key corks are too thin. | As before, you will want to put a thicker key cork on both the D & E keys and then dress the corks down accordingly. Since both the key corks are of a unique thickness, you will want to go back and forth between the keys to take a little off one, then take some off of the other to avoid going too far. The other choice would be to carefully bring both of the key feet a little closer to the body of the instrument by gently striking the key feet as described in the prior examples. |

Once the flute has had the keys rechecked for levelness, combinations adjusted out, and finally all lost-motion removed, we are then ready to perform the following final steps:

- Blow-test the flute.
- Final lubricate all bearing surfaces.
- Carefully clean out the inside of instrument with a lean lint-free swab.
- Carefully clean out the embouchure hole with a Q-tip.
- Wipe the headjoint tenon and the foot joint tenon clean.
- Carefully wipe the body parts of grease and finger prints.
- Be especially careful not to unhook springs or to disturb the key mechanism.
- Check the case blocking and latches.
- Blow the lint and dirt from the inside of the case

SHIP IT!