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BASIC REPAIR COURSE MANUAL

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This manual was created to supplement the 20 hour piano repair and regulation course that I have given many times in different Canadian cities.

As a result, it is not complete. While each class topic is organized to cover a wide variety of basic instruction and skills needed by the beginning piano technician, some sections have been left blank for the student to take notes.

As well, each topic is referenced with page numbers from the text, “Piano Servicing, Tuning, and Rebuilding: For the Professional, the Student, and the Hobbyist” by Aurthur Reblitz. For sections in the manual that appear weak, the student is expected to study the descriptions from the Reblitz textbook.

Ideally, one would use this manual to supplement a live course like the One Hour Weekly Skype Course that I currently offer through my website, howtotunepianos.com.

I hope this manual helps you in your studies.

Mark Cerisano, RPT, B.Sc.(Mech.Eng.), Dip.Ed. February 29, 2020

INTRODUCTION

BASIC PIANO REPAIR

This course is complimentary to Basic Piano Tuning. It is helpful to know how to make basic repairs on a piano as a tuner because when you tune a piano, you sometimes find broken pieces, or break them in the course of tuning the piano. Also, these extra skills give you the opportunity to improve a customer's piano which is an extra revenue stream.

The skills presented are those that would be needed at a tuning appointment. The tools and techniques are the minimum needed for repairs under those circumstances. For example, the technique and tools recommended to replace a broken hammer head are not those you would want to use to replace a whole set of hammers. For that you would benefit from more expensive tools.

The tools suggested for the course are the bare minimum and selected for their simplicity, efficiency, and price. To be well stocked as a piano technician would cost $5,000+ (2005).

One note about working on old pianos: Whenever you have to bend a wire or otherwise apply force to some part within the action, always support the part as close as possible to the point of application of the force. If you don't, the force you are using to bend or otherwise affect a part, will be felt at another spot in the action and may result in loosening a center pin or breaking a part. For example, bending back checks can result in a broken wippen flange, unless you support the lower back check wire at the wippen with your fingers while bending the wire.

Since most of the pianos a technician will see as they start out are uprights, most of this manual deals with repairs to upright pianos. Many of the skills can be transferred or altered to deal with grands, but a more detailed course should be sought out in order to get a better understanding of the repairs and adjustments that can be done to a grand piano.

Good luck and enjoy the course.

HOW THE REPAIR COURSE WILL BE GIVEN

Each class will follow the class outline given on the next page.

Space is given in the manual for each class for students to take notes. Most of the techniques are explained well in the Reblitz book. So, to avoid repetition, students will be referred to pages in the Reblitz text for repair techniques.

There will be a few different techniques not mentioned in the Reblitz. For these, students are encouraged to take notes, draw sketches, etc.

Each class will involve about one hour of lecture and demonstration followed by practice. However, where time is better spent, demonstrations may take much less time and the class will follow a demonstration / practice / demonstration / practice, etc, routine. This will be useful if the repairs are simple but there are a lot of small jobs to be done.

REPAIR CLASS OUTLINE

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CLASS 1
Introduction of students. Collection of school fees. Hand out of supplies. Tour of facilities. General questions.
Technical material covered: (page numbers refer to Reblitz)
The Upright Action: (39-47)
- ✓ Parts
- ✓ How It Works
- ✓ Its All About The Jack
- ✓ The Regulation Triangle: Blow Distance, Key Dip, and Let Off, and How They Affect the Jack Travel. (152-175)

Students will spend time taking the action apart and looking at the mechanics of the parts.

CLASS 2a
Upright Key Regulation (For Feel)
- ✓ Level
- ✓ Dip

Students will practice setting key level and key dip

CLASS 2b and 3a
Upright Action Regulation (For Expression)
- ✓ Blow Distance
- ✓ Lost Motion
- ✓ Let Off
- ✓ Spoons and Back Checks

Students will be shown how to use the regulating tools and will practice adjusting.

CLASS 3b
Upright Hammer Regulation (For Tone)
- Tone Problems: Bass, Tenor and Treble
- Traveling
- Horizontal Alignment (and hammer filing)
- String Level
- Hammer Mating
- Needling (Minor Voicing)

Students will be shown how to identify tone problems, how to fix them, and will practice improving tone.

CLASS 4
Dampers
- Different kinds
- Removing Action
- Replacing
- Individual mating
- Regulating Pedal (plus other pedals)
- ✓ Spoons

Practice replacing and adjusting dampers

CLASS 5

Grand Regulation (Differences with Upright) (50-59) & (176-192)

- ✓ Removing Action
- ✓ Hammers
- ✓ Keys
- ✓ Action
  - ✓ Gravity
  - ✓ Repetition Lever
  - ✓ Drop
  - ✓ Jack and after touch
- Dampers
- Other Pedals
  - Una Corda
  - Sostenuto

Demonstrate and practice regulating grand piano

CLASS 6/7

String Repairs (104-117)

- Making a coil - Practice
- Bare Treble - Practice
- Wound
  - Replacement – Discuss/Measure
  - Tied - Practice
  - Hitch Pin Loop - Practice

CLASS 8

Hammer Repairs (135-140)

- Filing - Practice
- Replacing - Practice
- Mending Shank - Practice
- Replacing Shank – Practice
- Hammer Butt Plates
- Bending Shanks
- Traveling Shanks
- Bridle Straps

CLASS 9

Key Repairs (120-124)

- Removing - Discuss
- Ivory Keytop Replacement - Practice
- Plastic Keytop Replacement - Practice
- Key Bushings , Replacement and Easing – Practice

CLASS 10a

Flanges (125-132)

- Discussion of Tight and Loose Center Pins
- Replacing Center Pins
- Rebushing

CLASS 10b

- Tuning Pins and the Pinblock (96-100) & (283-284)

CLASS 1 - UPRIGHT ACTION

PARTS

Let’s consider the action from the key up to the string. As you press the key down, you are pressing on a thin piece of plastic or ivory called the keytop. The keytop is on the key. The key balances on the balance rail. There is a hole in the middle of the key called the balance rail hole. A balance rail pin fits into that hole. The hole is lined with felt called balance rail bushing felt. The key sits on paper washers and a felt washer called balance rail paper punchings and a balance rail felt punching. At the bottom front of the key is the front rail hole. A pin called the front rail pin fits into it. Felt lines the hole called front rail bushing felt. When the key is pressed all the way down, it hits paper washers and a felt washer fitting onto the front rail pin. They are called front rail felt and paper punchings.

At the back of the key is the capstan. The capstan presses up on the wippen which moves the hammer. The capstan is adjustable up or down by turning. There are different kinds of capstans. Some are wires with a dowel on the top. Some are round headed bolts with a square shape under the head to take a wrench. Some old ones are wooden blocks that pivot front to back with two screws to adjust the height of the back of the block where this capstan presses on the wippen. Some are intricate levers that pull up on wippens that are located below the keys. (Drop action) These are adjustable by a small threaded dowel that fits into the top of the key at the back.

The wippen houses the mechanism that moves the hammer to the string. It also contains the back check that catches the hammer after it bounces off the string, thus preventing the hammer from hitting the string twice. It also contains the damper spoon that presses against the bottom of the damper and lifts the damper off the string allowing the string to vibrate as it is hit by the hammer. It also holds the jack that presses up on the hammer butt which moves the hammer towards the string. The jack pivots and disengages with the hammer butt just before the hammer hits the string. This is analogous to letting go of a ball when you throw it. There is also a bridle strap wire that holds the bridle strap that attaches to the hammer butt. The bridle strap prevents the wippen from falling too low so that the jack falls under the back of the butt when the action is removed from the piano. When this happens, and the action is replaced in the piano, the jack presses up on the back of the butt instead of the middle and the hammer is pressed against the string. When this happens, you need to “trip” the jack by pressing on the jack “toe” with a screw driver. The bridle strap also helps the hammer return after the key is let go.

UPRIGHT ACTION - Continued

HOW IT WORKS

When the key is pressed down, the key, wippen, and hammer all move as one. The key presses up on the wippen by the capstan, the wippen presses up on the hammer by the jack. When the jack toe engages with the let off button, the jack top begins to rotate away from the hammer butt until it is not touching it anymore. The hammer is “thrown” freely at the string and is free to bounce off the string. The hammer is then caught as the catcher, located on the hammer butt, is grabbed by the back check, located on the wippen.

When the key is released, the jack resets under the hammer butt, ready for the next time note.

IT’S ALL ABOUT THE JACK

In order for the piano to feel and sound right, all the parts need to move in the right way. That means the correct distance, the optimum angles, etc. When all the parts are adjusted properly, the key feels right and the jack moves just enough to clear the butt by a small amount. If the jack doesn’t move out of the way completely, the butt will hit the jack after the hammer bounces off the string, the back check will not be able to grab the catcher, and the hammer may hit the string again. This condition is known as “double striking” or “burbling”.

If the jack moves too far out from under the butt, that means somewhere in the mechanism, there is a loss of efficiency or power or potential. There is an opportunity to get more power or have a better feel from the piano.

The point at which the jack lets go of the hammer is called *let off.* Some people call it the bump. It feels like a little bump in the key. This is also sometimes referred to as the *second keyboard.* Good pianists play with the bump to get a good feel and tone. That is why it is imperative if there is a really good pianist playing, that the piano is regulated properly so that the pianist gets a consistent and responsive feeling from key to key.

THE REGULATION TRIANGLE – BLOW DISTANCE, KEY DIP, and LET OFF

These three adjustments work together to produce the optimum sound and feel from the piano.

Key dip – the distance the key travels from top to bottom when it is pressed. The ideal key dip is 3/8” or 9.5mm or a bit more.

Blow distance – the distance the hammer travels from the hammer rest rail to the string. The ideal distance is 1 and 7/8” or 46mm, but may need to be less on older pianos.

Let off – how close the hammer gets to the string as the key is pressed all the way down slowly. Before the key bottoms out, the jack will disengage with the hammer and the hammer will stop moving forward and will in fact move backward. The closest the hammer should get before let off occurs is 1/8” or 3mm

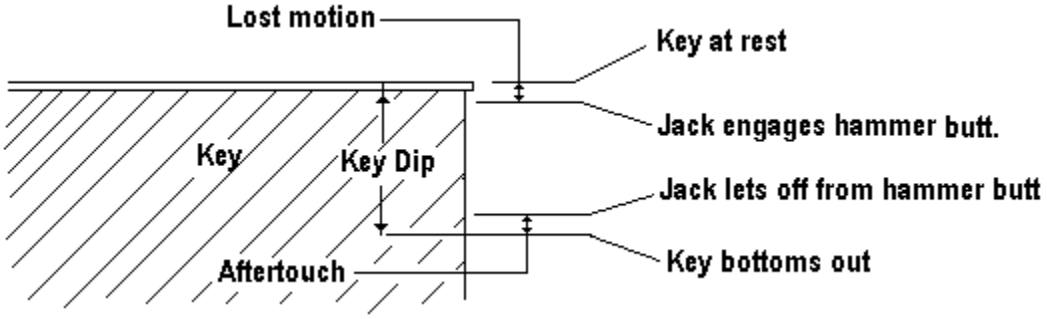
When the piano is in good repair and is a good design, and key dip, blow distance, and let off are all set as indicated above, the jack should barely escape out from under the butt as the key bottoms out. There should be a slight distance between the top of the jack and the butt when the key is at the bottom. If the jack is not at this position, there are a number of things that may increase the jack travel.

Not Enough Jack Travel:

Lost Motion. There should be no slack between the key and the wippen. If you press the key slightly and the wippen moves but the hammer does not, then there is too much lost motion. In this case, the jack is not moving right away and therefore, not traveling as far as it could. Adjust the capstans up until the key and hammer move together and the jack moves freely in and out from under the hammer butt.

Test by pulling back gently on the hammer rest rail. All the hammers should follow the rest rail a very small amount and then stop. If they follow too much, there is probably still too much lost motion. If they do not move at all, there is negative lost motion. Adjust the capstans down.
NOTE: negative lost motion may cause the key to stop working because the jack will not be able to reset under the hammer butt.

Blow distance. If the blow distance is properly set and the jack still does not escape from under the butt, you may have to sacrifice a little power and reduce the blow distance by putting a little felt between the hammer rest rail and the action brackets. This will create lost motion and now the capstans can be raised and the jack with have less distance to travel before let off occurs and therefore end its travel further from the butt.



Key dip. Although unusual, sometimes the key is not going down far enough. Remove some paper punchings if the key dip is less than 3/8” (9.5mm). This will result in more travel for the jack and it will travel further out from under the butt.

Let off. There is a small window where let off may not be enough before the key stops working. Proper let off is 1/8” or 3mm. Anything less than this may result in insufficient jack travel. Check and adjust if necessary.
NOTE: insufficient let off may result in no let off and the key will not disengage with the hammer. The result is the key will press the hammer against the string instead of throwing the hammer at the string. The resulting sound is a kind of ”thud” and is called “blocking” – the hammer is said to be “blocking” on the string.

Too Much Jack Travel:

Blow distance. If you have too much jack travel and it is escaping out from under the hammer butt with a large distance between jack and butt, you may be able to increase the blow distance and get more power from the hammer blow. This is unusual though. Usually this condition is caused by compressed front rail felts which result in excessive key dip.

Key dip. Usually excessive jack travel is caused by excessive key dip. You can add paper punchings to each key or you may be able to lift the front rail all together and place shims under it. This will improve the feel but you should still regulate key dip for all the keys.

Let off. If you have excessive jack travel, you may be able to reduce the let off and get more response or expression from the piano keys. Check the let off and reduce if possible. NOTE: reduce too much and the key will “thud” or “block” against the string.

When deciding what to adjust, keep in mind that the player “feels” key dip. If key dip is too much or too little, the keys will feel different to the player and may be harder to play with expression. Also, improper let off can affect dynamic range. So, the first place to look for compromise when trying to increase jack travel, is blow distance.

Trouble shooting simple regulation problems.

PROBLEM	**CAUSE**	**REMEDY**
“Double striking” or “Burbling”	Jack is not escaping out from under hammer butt	Check let off. May be too close to string.
		Check lost motion. May need to raise capstans
		Check blow distance. May need to sacrifice power and reduce blow distance in order to get sufficient jack travel.
		Check key dip. Key may not be going down enough.
	Back check is not catching catcher on hammer butt.	Bend back check closer with thumb.
Can’t play soft, narrow dynamic range	Excessive let off.	Check let off and adjust.
Can’t play fast	Key dip may be excessive	Check and adjust
Keys won’t play unless hit hard.	Jack may not be resetting.	Check lost motion. Capstans may need to be lowered.
Key makes “thudding” sound. (Blocking)	There may not be enough let off.	Check and increase let off

Miscellaneous regulation concerns.

Hammer center pins. If the hammers are not moving freely, this can result in an inability to play soft because once let off occurs, the hammer just stops. This is analogous to trying to throw a ball under water – it doesn’t go very far. Use the soft pedal to check quickly.

Key bushings and balance rail hole. If the keys are not moving freely, this can inhibit the smooth moving of the key. Check key bushings and balance rail hole by lifting key and letting it drop. If it doesn’t drop freely, check for binding at the front or balance rail bushing and the balance rail hole, and ease if necessary.

Other conditions that may cause regulation problems are broken or missing bridle straps, weak or missing hammer springs, loose hammer screws, loose key bushings, weak jack springs, excessively strong damper springs, etc.

CLASS 2a – UPRIGHT KEY REGULATION (FOR FEEL)

Reblitz has a comprehensive list of regulation steps in the section on upright regulation. You can follow these steps but be careful at some stages. Adjusting and regulating as per the recommendations in Reblitz, may result in more problems than before unless you are doing a complete regulation/reconditioning/rebuild. Example, aligning a hammer to the strings will result in horrible phasing and hammers not hitting strings properly if there are already grooves in the hammer. Alignment should only be done if the hammers have already been sanded or replaced.

KEY LEVEL
Tools needed:
Straight edge
Balance rail paper punchings (small ones)
Screw driver
Tweezers

Preparation
Remove *key slip* (piece of wood in front of keys) by removing screws underneath, or removing *cheek blocks* (blocks of wood at ends of keys). Now keys can be lifted out.

What is a proper key height?
Check, with keyslip *in*, that visible portion of key front makes a square, or slight wide rectangle, with the keyslip. Look for part of keyfront discoloured by sun.
Balance rail pins should not be buried under the key button.

How to get all the keys the same height. (level)
Gently tap the straight edge on the top of the white keys.
Look at the wippens. High keys will wink.
Gently lift the keys. Low keys will make a clicking sound as the hit the straight edge.
Use the tweezers and add/remove paper punchings. Note you will have double the affect of the thickness of the punching added or removed because you are adding/removing in the middle of the key and the effect is seen at the front of the key. Choose the sizes of paper punchings to remove/add accordingly.

Some technicians fashion a block of wood that goes around the first and last front rail pins of a section. The keys of these pins cannot go down anymore so it is more precise. Without these blocks you have to be careful not to be pushing down so hard that all the wippens wink.

Black Key Level
Feel the wooden tops of the keys, where the keytop ends. The wood of the black keys should line up with the wood of the white keys.
Also, the black keys are about ½" above the white keys.

ADJUSTING CAPSTANS (LOST MOTION) CAN AFFECT KEY HEIGHT, SO ADJUST LOST MOTION FIRST! If keys are front heavy and the wippens do not sit all the way down on the back of the key (because the bridle straps are too tight for example) then the keys will tilt forward.

Grand Piano

You will need to remove the stack to get at the balance rail on a grand. You will need some way of weighting the backs of the keys with the stack gone. Grand keys are mostly front heavy, so without the stack, they will tilt toward you.
You could also cut the punchings and add/remove them into the grand from under the key frame. (No need for weights or to remove stack with this technique.)

KEY DIP
Tools needed:
Key dip block
Front rail punchings (big ones)

Setting White Key Dip

VERY IMPORTANT: Check to see that your blow distance, let-off, and key dip all work together for a desired feel by adjusting a few sample notes first. This will save you hours of time if you get all the keys done to find that the blow distance wasn't right, for example.

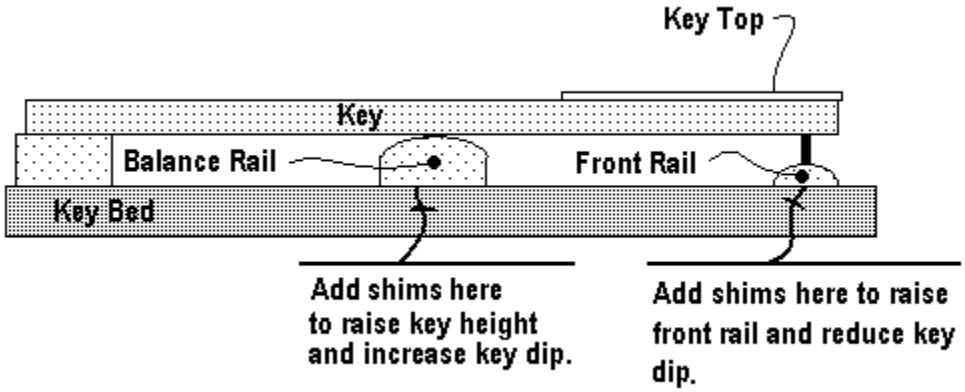
Using the key dip block, check a key by placing the key dip block on top of a key and pressing down. Feel the top of the key dip block against a neighbouring keytop. They should be even, or the key dip block could be a little lower for a 3/8" block. Add or remove paper punchings to get the right key dip.

SHORT CUT
This is for jobs where a high level of precision is not required, cost is an issue, or even as a preliminary step to reduce the number of punchings you will need to work with.

Inserting or removing shims under the balance rail or front rail will result in a global affect on the key dip.

For example: many older pianos have front rail felts that have been compressed from years of playing. This results in excessive key dip. You can also see that the hammers are checking very close to the strings and the hammers may even be blocking against the strings when the keys are pressed down a little harder. A quick fix for this condition can be performed by taking out the keys at the ends and near the brackets to expose screws in the key frame at the balance rail and the front rail. Loosen these screws, lift the front rail and insert business cards or similar card stock under the front rail beside the screws. This will reduce the key dip, prevent blocking and improve the feel.

Similarly, some newer pianos end up with insufficient key dip due to buckling of the key bed. Shims under the balance rail will increase key dip.



Black Key Dip
Press down two white keys and the black key between them. Now feel how high the back of the key rises. The black key should rise the same as the white keys. If not, then the black key dip is off.

This is another technique that works with newer pianos with in line back checks. Press down some white and black keys together and hold them down. Try to use the same pressure on each key. Now since the back checks were in line, they should also be in line after pressing and holding the keys, if the key dip is the same. If one key goes down farther than the others, then the wippen will be pushed up more and the back check will move more and not be in line with the other back checks anymore.

CLASS 2b and 3a - UPRIGHT ACTION REGULATION (FOR EXPRESSION)

BLOW DISTANCE
Tools needed:
Pocket ruler
Pieces of felt

From the section on the Regulation Triangle, we know the blow distance, let-off, and key dip, all work together. One of the first things to set is the blow distance. The other two will follow.

Setting Blow Distance
Use the pocket ruler and measure the distance from the front of a hammer to the strings.
Add felt pieces between the hammer rest rail and the action brackets so that the blow distance is 1 7/8". Then set let-off and key dip so that the jack just leaves the hammer butt when the key is depressed all the way. If you can't get it to work, you may have to sacrifice key dip (make it deeper) or let-off (make it more). If you end up with changing these so much that it just feels bad, you may have to reduce the blow distance. Reducing the blow distance to 1 ½" has less of an effect on feel than changing the let-off or key dip. For this reason, it is usually the first thing we try if 1 7/8" doesn't work right.

LOST MOTION
The hammers should rest on the hammer rest rail. I.e. they should not be resting on the jacks. If they are resting on the jacks, then when you play a note and the jack moves out and the hammer comes back down, the hammer will rest on the rail and there will be no room for the jack to reset under the hammer butt. I.e we need a little space between the top of the jack and the hammer butt, so that the jack can reset. If there is excessive space between the top of the jack and the hammer butt, then the key will move freely for a while before the jack engages with the hammer butt. This is called *Lost Motion.* I.e. there is a loss of movement as the key moves but the hammer doesn't.

How to Adjust Lost Motion
Tools:
Capstan adjuster

Since the hammers should rest on the rail and not the jacks, simply pulling back on the hammer rest rail should induce the hammers to follow the rail until they sit on the jacks.
Pull back gently on the hammer rest rail. The hammers just all move. Pull a little harder. They should all stop.
There may be excessive lost motion observable as a huge movement of the key before the hammer moves. To adjust all the capstans quickly, take the key out completely and use you hand to twist the capstan. Determine roughly how much of a turn gets the lost motion adjustment close, then turn all the capstans the same amount by hand. Return the keys by lifting on the wippens before inserting the key back in.

LET OFF

The hammers must get pretty close to the strings before the jack lets go of the hammer. (1/8”) This allows us to play very softly using just a light touch on the key.
The jack button is what engages the jack and starts it to move out from under the hammer butt. Turning the jack button *down* will induce the jack to move *sooner* and let off will occur *earlier* in the key stroke (farther from the string). The opposite is true: Up→later→later(closer)

Adjusting Let-off
Tools:
Let-off tool
Combination handle
Rubber wedge mutes
(Magnetic tape 1/16” thick)

Use the rubber wedge mutes and wedge the hammer rest rail all the way up as far as it can go. You may need to remove a block of hard felt at the left end of the piano. Now this next step is very important. Take that block of felt, and throw it in the garbage! I have yet to figure out what that block is for. Without it, a well regulated piano can get a beautiful soft airy tone; it just gets in the way. Anyway, the hammers should be about ¼” away from the strings now. And when you play a key, if the let off is more than ¼”, it will not play at all. So it is easy to see which hammers need let-off adjustments. Also, you should notice that the let-off screws are easy to get at since the hammer rest rail is out of the way. If let-off is really off, do as with lost motion, and make many large quick adjustments, and then go make and be more precise.
Another technique involves the use of a magnetic strip often found at hardware stores. These strips are usually about 1/16” thick. Take two and stick them together and then stick them to the strings where the hammers hit. Now, when let-off is just 1/8” and maybe a shade less, you will feel the hammer rub the magnetic strip before let-off occurs, Just tweak the let-off button down a bit and you’re good to go. Getting the same rubbing feeling on each key is the trick here.

NOTE: This method produces accurate let-off from a dimensional point of view, but the purpose of regulation is to produce a consistent *feel.* You may get all the let-off at 1/8” +/- .001” but you will probably find that not all the keys respond the same. This is because of variations in other regulation adjustments, and/or wear at the different bearing points within the action. The ideal should always be a consistent and responsive feel.

BACK CHECKS
Tools:
Pliers

Back Checks
Bend back checks by bending the back check wire with your fingers or pliers. Be careful not to break the wippen flange. Note: usually the back checks are too far away, so they just need to be moved a bit closer. On old pianos be careful about moving them sideways, even if they are not aligned with the catcher; they have worn a recess into the catcher and changing the alignment may affect the checking.

SPOONS
Tools:
Spoon bender

The spoon engages the damper as the key is depressed and lifts the damper off the string so the string can ring freely.

The damper should begin lifting off the string when the hammer is 1/3 to 1/2 of the way to the string.

To use the spoon bender, insert it between the wippens and follow the feel of the wippen rail under, back, and up until the spoon bender engages with the spoon. There is probably no procedure in piano technology that is so easy to describe and yet so almost impossible to actually do. However, with practice it can become second nature; you will be able to feel your way around the back of the action without seeing anything. Here are some tips that may make that happen sooner:

1) The spoons come off the wippen at an angle; the dampers are located to one side of the wippens. Now, the most common orientation is toward the second action bracket, the one between the bass and tenor strings. So, for bass hammers, insert the spoon bender to the right of the wippen belonging to the note whose damper timing you want to affect. For the other notes, insert the spoon bender to the left of the wippen in question.

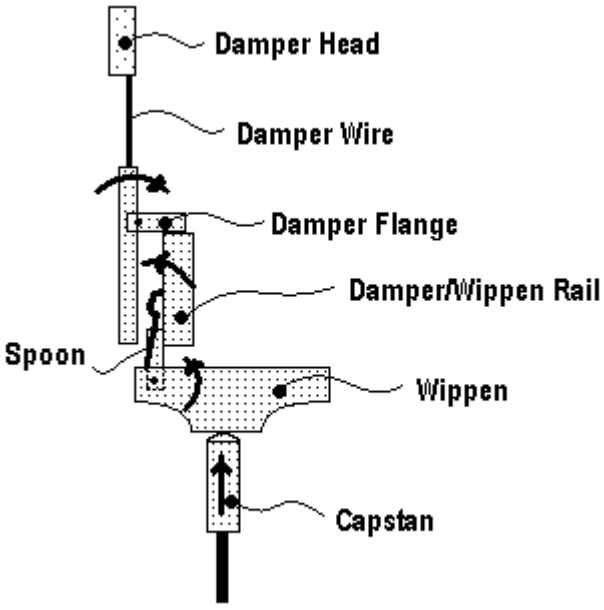
2) The spoon is bent slightly toward you, leaning against the back side of the wippen rail, so by grasping the wippen and tilting it up, you will tilt the spoon back and put it into a vertical orientation, making it easier for the spoon to slide into the spoon tongs.

3) Grasping the wippen also makes it easier to feel when the spoon bender is in positive contact with the spoon.

4) Don’t use the combination handle, it makes the tool too long and then you can’t go down very far.

5) Bend the spoon toward you (bend down) to make the damper lift later. Bend the spoon away (up) to make the damper lift earlier.

The most common time when spoons need to be bent is after a large adjustment of the capstans to reduce an excessive amount of lost motion. As you turn the capstans up, the wippens also go up, and the spoons get closer to the dampers, and some dampers may even come off the strings, resulting in ringing notes that won’t stop when the key is released.



CLASS 3b - UPRIGHT HAMMER REGULATION (For Tone)

Refer to Appendix D – Voicing Old Hammers and Spinets

Some of the procedures in this section are sometimes referred to as *voicing.* The real difference between some of the techniques I am describing here and those that are considered as true voicing is that the techniques described here are for pianos where the tone is obviously suffering and we are trying to reduce the amount of unpleasantness in the tone as best as possible. True voicing procedures are more concerned with taking an ok sounding hammer and making it sound better for the room, music, piano, that it is in.

After tuning, you may notice that the tone of the piano is still not pleasant. It may be too harsh or twangy. You can try some of these investigational techniques to determine what the problem may be and then try to make it better.

Hammer Mating
If the hammer does not hit the bichord or trichord strings at exactly the same time, then the tone will be twangy. This is caused by uneven strings or uneven hammer fronts.

The following is taken from the Basic Tuning Manual – Chapter 7.5 Phasing

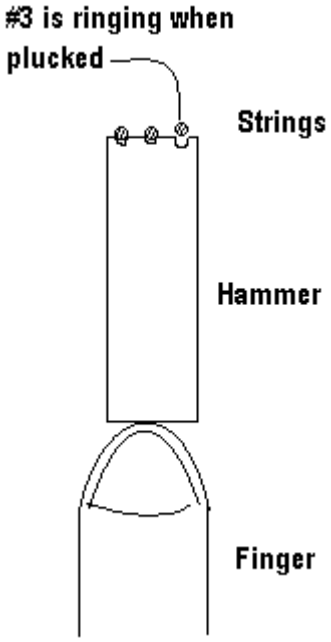
7.5 Phasing
Sometimes, the hammer does not hit the three strings of a trichord at exactly the same time. This starts the strings vibrating at slightly different times, so that the tone has a “whinny” sound to it, even when the unisons are vibrating at the same frequencies. This effect is most audible in the mid section of the piano. The effect can confuse the beginning tuner who may continue, without success, to try and get the unison to sound better. In any event, the tone is poor and must be improved.

When confronted with a bothersome unison in the mid section, test it to see if the hammer is mating well with the string.

Mating Test – Upright Piano

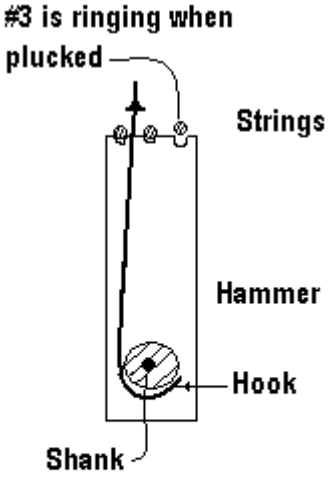
1. Very gently press the hammer against the string.
2. Press the sustain pedal.
3. Pluck each string separately and listen for three dull thuds.

All three strings should make a thud sound. If one or more ring, it means that string is being hit later than the others. In the example, string #3 is being hit later, and rings in the mating test.



7.5 Phasing (Continued)

Mating Test – Grand Piano



1. Make a hook from a short piece of piano wire.
2. Hook a shank through the strings and pull the hammer up so it blocks against the strings.
3. Press the sustain pedal.
4. Pluck each string separately and listen for three dull thuds.

All three strings should make a thud sound. If one or more ring, it means that string is being hit later than the others. In the example, string #3 is being hit later, and rings in the mating test.

There are three possible solutions to fix this:

1. Use a voicing needle and gently pierce the hammer groove of the ringing string at 11 and 1 o'clock so that it is puffed up again.

On this hammer, the first string is ringing, in the mating test which means the groove is too deep.

One needle prick at 11 and 1 o'clock may puff it out enough to eliminate the ringing.

2. Use a sanding paddle and sand down the other grooves that are too high.

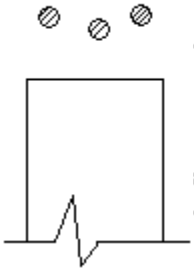
On this hammer, the third string is ringing, in the mating test which means the groove is too deep.

Use a sanding paddle to sand down the other grooves so the strings are hit evenly.

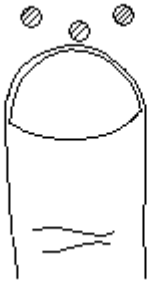
3. Level the strings. This is not recommended on older pianos as it changes the way the damper meets that string and then the damper may not dampen effectively.
However, if you are working on a grand and the strings are not level, filing or sanding the hammers may improve the tone, but as soon as the shift pedal is used, the tone may be worse. In this case, string leveling and new dampers are the only cure.

How to Check for String Level

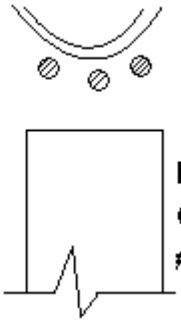
Check to see if the strings are not level by gently feeling the strings with your finger. One or two strings may feel higher or lower. This should coincide with the string that is ringing.
Example: String #1 and #3 are ringing, so #2 should feel higher on the upright. (Lower on the grand)



The middle string is too low. Strings #1 and #3 ring in the mating test.



Feeling from in front on the upright. #2 feels high.



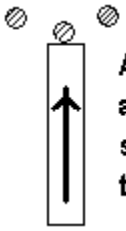
Feeling from above on the grand. #2 feels lower.

Leveling Strings to Reduce Phasing

Upright Piano

If one or two strings are higher, and they are blocking against the hammer while the others are ringing in the mating test, then you can gently tap down the higher strings. Use anything that has a flat end. Tap gently and then retest.

On the upright, string #2 feels high, and #1 and #3 are ringing.



A flat rod is pressed against the high string and gently tapped.

The three strings are now level.

Grand Piano

If one or two strings are lower and they are blocking against the hammer while the others are ringing in the mating test, then those strings can be lifted. Use a stringing hook and gently pull up on the string and retest.

On the grand, strings #1 and #3 feel high and #1 and #3 are ringing in the mating test.

A stringing hook pulls up #2

The three strings are now level.

CLASS 4 - DAMPERS

Different kinds of dampers.
Generally there are three kinds of dampers. Those for unichords, those for bichords, and those for trichords.
Unichord dampers have a channel in them to accept the single bass string.
Bichord dampers are wedge shaped and insert themselves between the two strings of a bichord.
Trichord dampers are flat and rest across the three strings of a trichord.

Limitations of the Upright Damper System

When the hammer hits the string, it induces vibrations that originated from a strong “jab” at the string where the hammer hit. This starts a series of vibrations that coincide with higher partials that tend to be stronger where the amplitude is greatest at the point where the hammer hit. Ideally, dampening out the vibrations at this same point would be desirable since that is where they started. However, on the upright piano, the hammer and dampers are on the same side of the string. Dampening the string where the hammer hit it, is impossible. This is one reason why the grand dampening system is superior.
Also, the upright piano damper system has another flaw that produces unwanted ringing. The hammer and damper share the same side of the string, with the damper resting on the string just under the hammer. As we move down the treble and tenor strings toward the tenor break, we get to the first two strings in the tenor section where the bass strings interfere with the dampers. The bass strings get in the way near the bottom of these one or two dampers and they are usually clipped or cut to avoid the dampers rubbing on the last bass string. Now, if you imagine that the ratio of damper length to string length has an affect on damper efficiency (notice the higher dampers, those on the short strings, are shorter.) then you can see that we are getting into dangerous territory here; cutting short the dampers that are on the longest strings.
For this reason, the dampening efficiency of the first couple of strings in the tenor section is usually horrible.

Ways Designers try to Improve Upright Dampening.

Over Dampers

On these first tenor strings, we sometimes see little blocks with damper felt, and the blocks are attached to the damper by a stiff wire. The blocks actually touch the string at a spot above the hammer. This works well to dampening out the very high partials that tend to keep ringing on these notes.

Hammer Line
We cannot make the dampers longer in the low tenor section because the last bass string interferes from below, and the hammers interfere from above. But on some pianos, Yamaha mostly, the hammer line bends up a little when it gets to the 2nd action bracket, near the tenor break.
This allows the designers to keep the dampers longer there and hence, improve dampening efficiency.

Old Dampers
When dampers get old, they get hard and dry and stop dampening very well. You can try these tricks and see if they help, but most probably you will need to replace the dampers.

1) Brushing – Sometimes brushing the dampers with a wire brush will fluff them out a bit and it can improve the dampening efficiency.

2) Strengthen the damper spring. Use the spring tool and flick the damper spring out of its groove and bend it down a bit. Use your thumb to shape the bend. You don't want to kink the wire or it may break.

3) Reglue. Sometimes breaking off the damper felt and regluing it back onto the damper block can result in improvements.

Replacing Dampers
Tools:
Dampers
Alcohol/Vinegar Mixture
Tweezers
Carpenter's Glue

The procedure involves removing the old dampers, gluing new ones back on, and adjusting the new dampers so they fit well.

Removing Old Dampers.
Sometimes old dampers come off easily. You just grab them from underneath and pull and they pop off. Other times, they tear and rip and leave a wad of felt on the block. I have in the past tried to remove all the felt but if there isn't much felt left on the block, you can leave it and just glue the new dampers over it.
To remove the residual felt, use a utility knife and remove what you can. Then you have a choice how to get the rest off.

Removing Old Dampers – Continued

1) Steam. Many hardware stores sell small inexpensive hand steam cleaners with a nozzle that shoots a stream of steam. You can point this stream of steam right at the residual felt and leave it there for about 20 seconds and then the felt should just peel off.

2) Vinegar and alcohol. Vinegar is a mild acid and will dissolve the glue nicely. The alcohol helps the vinegar to soak into the felt. Leave the solution soaking in the felt for about 30 minutes. Reapply the vinegar alcohol mixture if it dries out, or place a strip of plastic cling wrap over the wet damper blocks to prevent the solution from evapourating.

Gluing on New Dampers

Note: Pick dampers that are the same thickness as the old dampers. Some bass dampers come with an extra piece of felt on them. You may need to cut it off. This will help reduce the amount of wire bending you may have to do.

Use the tweezers to hold the damper, place glue on it, retract the damper block off the string, and place the damper onto the block. Release the damper block and now the damper spring effectively clamps the damper on to the damper block.

Aligning the Dampers to the Strings.

There are special three part bass damper wedges that do a good job of dampening in the bass, and may reduce the amount of wire bending you will need to do.
Nevertheless, you will need to do some. Take your wire bending tool and if it looks like a decent quality metal, you may be able to bend the end slightly to allow you to come in from above, grasp the damper wire, and bend it any way you want. Otherwise you will have to come in from the front, under the hammers. This usually results in many hammer springs coming out of the hammer spring groove on the hammer butt.

Remember that the block needs to remain flat to the string, so any bend you make to the bottom of the damper wire, you have to make the opposite bend in the top of the wire.

All the dampers should come off the strings at the same time. You can place a piece of wood under the sustain pedal or adjust the sustain pedal nut so that when you place the pedal all the way down, all the dampers just “wink” a bit. Now you can go along and adjust the “no winkers” that don’t wink at all and the “movers” that move too much.

CLASS 5 - GRAND REGULATION

APPENDIX E – REGULATION (FEEL) and VOICING (TONE) shows a good diagram of the grand piano and describes how the parts work when the key is pressed.

Basically, it works the same except for some important differences.

Repetition Lever or Double Escapement Mechanism
On the upright, the key needs to return to the starting point before the jack can reset and the hammer can be played again.
On the grand, a second lever works with the jack and when the hammer is checked, the player only needs to release the pressure on the key and that allows the hammer to rise and the jack to reset under the knuckle.

Hammer Height
Since the weight of the hammers is taken by the repetition lever, the wippens can rest right on the capstans. Adjusting the capstans results in an immediate change in the hammer height.

Damper Timing
The back of the key lifts up on the damper wippen and raises the damper off the string. There is usually a small screw on the damper flange block that can be loosened, allowing the damper wire to move in and out of the damper flange block.

Drop
After let off, the hammer drops and its weight is taken by the repetition lever. The amount of this drop depends on a small screw that rests on the repetition lever and is adjusted from the top of the action.

Let-off
Let-off happens the same way, but because the gravity system of the grand is more consistent, we can reduce the let-off to 1/16” instead of 1/8” and the feel is even better.

Here are some things to think about when trying to improve the regulation of the grand piano.

1) Turn all the drop screws down one turn before adjusting let-off. If drop is too high, let off may never occur. Lower drop ensures that no matter how low let-off is, we will always be able to see it.

2) Make sure there are no weak repetition springs. Weak repetition springs will cause the hammer to drop even more and then regulating drop is impossible.

This manual is really not meant as a treatise on grand regulating. The student who wishes more information on grand regulating should seek out more advanced texts.

CLASS 6/7 - STRING REPAIRS

When a string breaks, you have two options: replace it or tie it. For bass strings, if you replace one, you can replace it with a custom string or a universal string. Custom strings are made exactly to the measurements you give the supplier. Universals are extra long strings with coils that you have to unwind.
If you break a treble string, I have seen and done myself, a technique where the unbroken side is loosened and the string shifted over so that there is enough string to make another loop on the broken side.
When strings break, it is most often during tuning, and the string breaks right at the tuning pin, near the becket.

Option	Pros	Cons
Replacing a broken string – Custom made bass string.	- Exact measurements possible - Better tone (Con?) - Won't unwind	- String will stretch for about a year and be constantly out of tune. - Expensive - Wait time for order to arrive - Have to make a second appointment - Takes long time to measure string - Tone may not match a neighbouring string
Replacing a broken string – Universal bass string.	- Less expensive than custom made strings - You carry them with you so have them all the time. (no wait time) - Tone is supposed to be closer to that of an old string.	- String will stretch for about a year and be constantly out of tune. - Small diameter strings tend to unwind by themselves - Hard to get exact match to neighbouring bass strings
Tying a string	- String has already stretched so is more stable - Least expensive - Tone and diameter match exactly (if they did before) - No wait time	- Knot takes time to settle - Looks unprofessional - May not be enough room - Can be difficult to learn how to do it. - Still an old string, may break again - Knot is not as strong, may break at the knot.
Shifting a treble string over	- Inexpensive - Fast	- Still an old string - Less coils may make it unstable

Custom made bass strings.

When ordering, you will need to give the following measurements:

1) Coil diameter
2) Core diameter
3) Length from hitch pin to coil
4) Length of coil

Measure two or three times. You may need to loosen strings to get the micrometer around a neighbour if the original is gone.
Best Practice – measure the neighbour, even if you have the original. I have seen many broken strings that were not the same size as their neighbour. Sometimes, that is why they broke.

Universal Strings

Make a small score in the copper winding at the spot where you want to remove the coil. Unwind to that point. Pinch the coil there with vise grips just below the spot where you want to break it off, to reduce the chance of more unwinding.
Break off the coil at the same spot as the neighbour, near the bridge. For the top side, break it off about 5/8” shorter than the neighbour. It will stretch that much when tightened up to pitch, and then be aligned with the neighbour.

Tying a String

The principal of the string knot is simple to understand but can be hard to make. There are loops made on each string, one on the original string, one on a short patch piece of string. They are then threaded together so that when tightened, the tails of each loop close in on themselves and make the loops smaller and smaller until they can’t get any smaller. Then the string is said to be tied.

Here is how to set up the strings to be tied.

1) Take off the broken coil and unwind the pin. (See making a coil below to know how much to unwind it.)

2) Take a loose piece of wire the same diameter or slightly larger and cut about 6” off.

3) Make a 270 degree loop in the loose wire. Leave a tail at least 3/16” long or longer. At this point look at the loop and decide, is it a “b”, “d”, “p” or a “q”? Also does the tail go in front or behind?

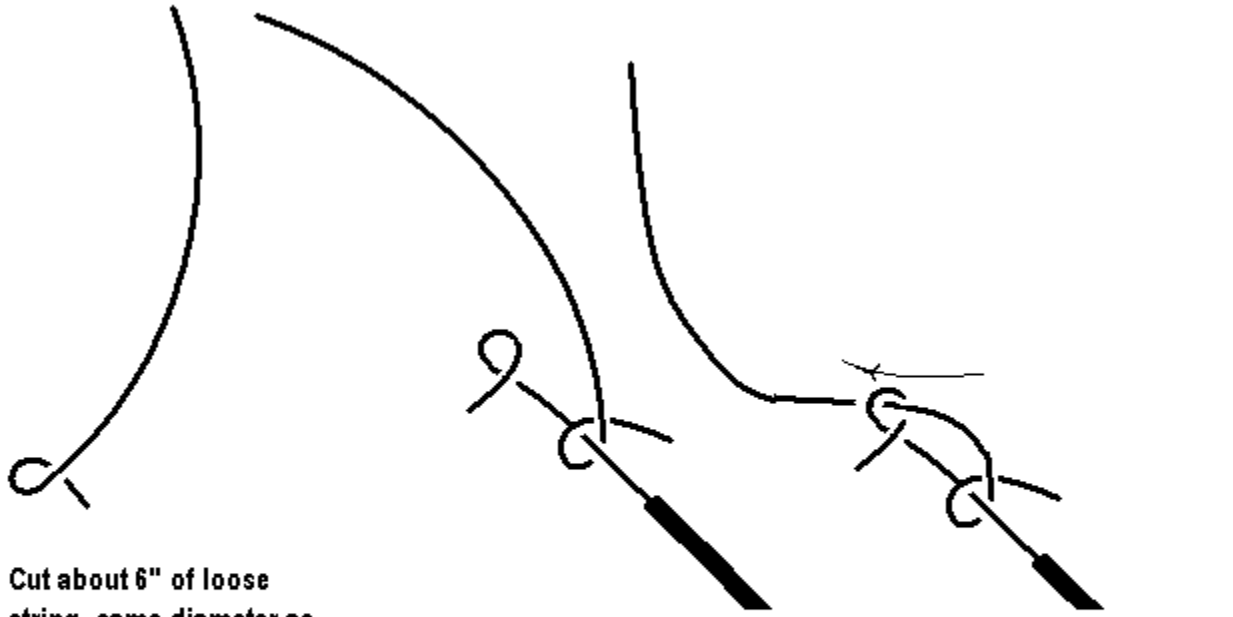
4) Now place the loop over the broken string so that the tail points away from the coil, or toward the broken end of the string. Make a loop in the end of the broken string.
Here is the secret. Remember when you looked at the loop in the loose string? What letter was it? Of course, it could be any letter; it just depends on how you were looking at it. Well imagine the same letter with the coil you are making on the original string, only this time, put the tail on the other side. Remember when you noticed what letter the other coil was, and then I asked you to note whether the tail went in front or behind? Well, whatever it did, do the opposite now.

Tying a knot - continued.

Example: loose string coil looked like a “b” with the tail in front? Make a loop on the broken string that looks like a “b” with the tail *behind*.

5) Now thread the straight end of the loose string through the loop in the broken string. Pass the straight end through so that the tails are facing each other.

6) Now coil around the pin using one of the methods below. When the string is tightened, the tails will be crushed together, making the loops smaller and smaller.



Cut about 6" of loose string, same diameter as broken string. Note letter and tail side. In this example, loop is a letter "d" with the tail behind.

Place the loose loop over the broken string, tail up, toward the broken end.

Make a loop on the broken string - same letter, opposite tail side. Here: letter "d", tail in front.

Thread loose string, straight end, through broken string's loop, tails toward each other. Now tighten.

Shifting a Broken Treble String (where the string goes to a neighbouring tuning pin.)

1) Take off the broken coil.
2) Loosen the neighbouring tuning pin until there is only half a coil left on it.
3) Pull it down hard, making the coil (off the unbroken string side, the one just loosened) straighter.
4) Straighten the hitch pin bend gently.
5) Make a new hitch pin bend
6) Bend about 3/16” in the broken end of the string and thread that into the becket (hole in the tuning pin).
7) Tighten both pins a little at a time, keeping the coils neat. You should end up with about 1+ coils on each pin.

Making a Coil
There are two ways to make a coil. 1) with the coil maker or 2) on the piano. 1) can be neater but with practice 2) can be neat and fast.

Making a Coil with the Coil Maker
1) Cut the string you are coiling at the width of four of your fingers from the tuning pin.
2) Place a tuning pin into the coil maker.
3) Thread the end of the string into the becket in the coil maker tuning pin so that only the smallest piece barely sticks out the other side.

To do this next step, you may need to unhook the hitch pin loop from the hitch pin to get more slack.
4) Holding the coil maker in your left hand, pin up, place your tuning hammer on the coil maker tuning pin and turn clock wise, (away from you).

*While setting up the tuning hammer to make the turns, place the first finger of your left hand against the string, pressing the string toward you and against the little screw beside the pin. The string should be on the other side of the screw. This will keep the string from falling out while you are placing the tuning hammer on the tuning pin.

5) Make two and a half turns with the hammer.
6) Then unhook the coil from the coil maker tuning pin, and place it on the tuning pin in the piano. You should have already taken the broken coil off and loosened the tuning pin. For the coil maker technique, loosen the tuning pin until the becket hole is about 1/4 of an inch above the plate.

7) Tighten while making sure the coils are neat and together. (To make the coils neat, you can use a coil lifter or just a screw driver. Lift but also tap down on the tops of the coils. Be careful not to chip the paint on the plate.)

Making a Coil in the Piano
1) Remove the broken coil and loosen the tuning pin until the becket is about 3/8ths of an inch above the plate
2) Cut off the new string at the width of four of your fingers past the tuning pin.
3) With pliers, bend about 3/16ths of an inch at the end of the new string to a little past 90 degrees.
4) Thread the bend part into the becket and tighten. There should be 3 – 4 coils on the pin when you are finished.

CLASS 8 - HAMMER REPAIRS

CLASS 9 - KEY REPAIRS

CLASS 10a - FLANGES

CLASS 10b - TUNING PINS and PIN BLOCK

CONCLUSIONS

Repairs and topics not covered in this course: (Page numbers refer to Reblitz)

Pianos types (3-10)
Sound boards, bridges, the plate, down bearing, key bed, key frame, the square piano. (Chapter 2)
Evaluating old pianos (Chapter 3) See Appendix B
Cleaning and minor repairs, except what is covered in course. (Chapter 4)
Tuning theory and procedure. (Chapter 6 and 7) These chapters are a bit confusing. It is strongly recommended that you take the Basic Tuning course offered by Mr. Tuner Piano Technicians School.
Complete Restoration (Chapter 8)

Now that you have a better grasp of piano repairs, here are some of the things you can do:

1) Get an old piano and try to do as many of the repairs yourself. It may take a long time but you will have very good technique at the end.

2) Volunteer to work for a technician or rebuilder. Sometimes, but not often, these people will may agree to invest some time teaching you a technique in order to have you do that job for them. Sometimes they do not have time to teach you many different skills, but what they do teach, you can practice. Also, they may end up hiring you after a period of time if your work is good.

You should know that it can be very difficult buying, repairing, and reselling old pianos.
However, this course is a good accompaniment to the basic tuning course as these are the kinds of repairs that are often found in a tuning customer's home. With these skills you can offer a better, well rounded, service.

Happy Repairing!

APPENDIX A - EVALUATING USED PIANOS

A Piano Course for Music Teachers
By Mark Cerisano, RPT, Dip.Ed., Mech.Eng.
Mr. Tuner Piano Service
514-771-8666

Every piano teacher is eventually asked to evaluate a used piano that a student is thinking of purchasing. Unless you have training you can only give your best guess based on how it sounds and feels.

Without training you may be giving bad advice to your students!
They consider you the expert. Why not become one?

Consider the following unfortunate and expensive mistakes a piano teacher can make when evaluating a piano for a student:

"The piano has a bad feel." Many times a simple regulation can improve the "feel" of a piano so drastically that it plays better than a new piano. Find out how to tell.

"There is a crack in the soundboard." Contrary to popular lay opinion, this is not a death sentence for a piano. Besides rarely causing problems, it can easily and inexpensively be repaired. Find out how.

"The piano needs tuning but sounds great." But will it hold a tuning? Or how about:

"The piano will not hold a tuning." Did you know there is an inexpensive way to increase the life of a pinblock for another 5 years, and that you can do this again if the pinblock becomes loose again?

Here are some expensive problems that can go unnoticed if you do not know how to check for them:
Bass bridge cracks. Often don't cause problems but can be expensive to fix. Find out which cracks are bad news.
Sloppy keys. It can be expensive to replace bushing felt or inexpensive to tighten front rail pins. Find out what they are.
Slow Hammers. Often people think the piano just needs to be worked in. Many times even lubrication doesn't work and center pins need replacing which can be very expensive. Find out how to know for sure.

With the complexity of the piano it is too easy for an untrained person to recommend a piano that is worthless or disregard one with potential.

Wouldn't it be nice to be able to recommend a low priced piano that the seller and the buyer may think is inferior, only for them to find a diamond in the rough? How about saving your students money by recommending they are paying too much for a piano and being able to back it up with evidence. Mr. Tuner's two hour seminar will give you the tools you can use to help your students choose the best instrument within their budget. They will get the most for their money and you will impress them with your superior knowledge of this wonderfully complicated instrument.

APPENDIX B - REGULATION and VOICING

(Feel and Tone)
A Piano Course for Music Teachers
By Mark Cerisano, RPT, Dip.Ed., Mech.Eng.
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REGULATION

Few pianists really know how their piano works. True, it is not necessary to understand the workings of the piano to make beautiful music, but surely, it can only help if one understands this complicated instrument just a little bit better.

For example, learn how to make simple adjustments to the pedals so that they work better. Or just learn how they work. Many teachers/pianists I know are fascinated to learn how each pedal really works.

How would you like to be able to make some very simple adjustments to your student's piano and see an immediate improvement in response? It can be done. Find out how. And find out which adjustments should be left for the technician.

By examining simple piano models, we will be able to see exactly how energy is transformed from the finger/arm/body to the string.

Do you know what the one major difference is between the action of the grand piano and that of the upright? Find out why the grand is a superior design to the upright, and when to recommend a student move up.

VOICING
Were you aware that adjusting the action (regulating) can have a drastic affect on a piano's tone? Let's find out.

Some pianos have better tone than others. But did you know that there are many techniques, some very inexpensive, that can drastically improve the tone of a piano? Many modern Asian pianos have very hard hammers that produce a shrill, bright, and sometimes quite annoying tone. Find out how to inexpensively improve the tone immediately.

Piano manufacturers expect that new pianos will be voiced in the field. Many dealers know that buyers aren't aware of this and therefore, do not volunteer this service. Find out how to tell if a piano's hammers need to be voiced.

You may be aware that needles are sometimes used to voice, or improve the tone of a hammer. But did you know that you can use needles yourself to improve a hammers tone without taking the action out of the piano? You can also ruin hammers if you do not know how to use the needles. Find out how and when to safely needle a hammer.

APPENDIX C –
Piano Evaluation Check List

This list is not exhaustive and will not help you determine the actual value of a piano but it will help you determine if the piano has a minimum value and is not worthless.

This piano may be worth something if you can answer
NO to all these questions:

Case/Cabinet

Y N

☑ □ Is the cabinet **ornate**(I.e. carvings. Select yes if there are ornate carvings on legs, boards, etc
☑ □ Are there pieces of veneer missing?
□ ☑ Are there cracks or wrinkles in the cabinet?
☑ □ Any loose or missing pieces?
☑ □ Any scratches or chips?
☑ □ Is it hard to roll the piano around?
☑ □ Do you hear crunching or squealing noises when you try to move it?

Keys

Y N

☑ □ Are there any chips in the keys?
☑ □ Are any key tops missing?
☑ □ Can you move the keys side to side?
□ ☑ Are they discoloured or yellow? (Select no if they are white)
□ ☑ Are they in one piece? (Select No if there is a line separating the front and back of the keytop)

Action (Insides, take top front panel off.)

Y N

☑ □ Are there gaps of different sizes between the hammers? (Select no if the hammers are evenly spaced)
□ ☑ Are there gaps of different sizes between other parts below hammers? (Select no if the other parts are evenly spaced.)
☑ □ Are there grooves in the fronts of the hammers where they strike the strings?

Bridle Straps

There are little tapes or straps glued to each hammer and hooked around a metal wire. Try to pull the end off where it hooks around the wire:

Y N

□ ☑ Does the end crumble?
☑ □ Are there any of these tapes missing or broken?

Strings/pinblock

Y N

☑ □ Are any strings missing? (Look at each tuning pin, they should all have strings wound around them. Each hammer should have 3 strings except for the hammers to the left. There are 2 strings for the hammers just to the left and 1 string per hammer for the left most hammers.

□ ☑ Are any of the strings new looking and clean? (i.e. newer looking than the majority of the other strings, and randomly spaced.)

□ ☑ Do any of the strings have knots in them as if they were tied? Look near the top.

☑ □ Are the tuning pins (the pins where the strings wind around) set into a block of wood? (Select No if they are set into a plate of metal.)

Capstans

Look at the very back of the keys, where something comes up and activates the hammer mechanism above the keys.

□ ☑ Do you see a small block of wood on the key with two screws in it? (Select No if there is a dowel or wooden cylinder on a wire, or a thick screw-like object with a funny looking head.)

Sound

☑ □ Play some notes at the same time and let go. Can you still hear the notes ringing after you let go the keys?

☑ □ Play the notes in the bass (left). Do they sound muffled and last only a short time?

☑ □ Are there any notes that don't sound at all?

☑ □ Are there any notes that hit twice?

☑ □ Try pushing some keys down slowly. ~~Can you~~ Do you find it hard to push down slowly and get a soft sound every time?

☑ □ Play all the notes slowly from top to bottom. Listen to the sound of each note. Do some sound horribly out of tune while others sound not too bad? (Especially in the treble. i.e. top or right end) Select No if they all sound in tune or all sound equally out of tune.

Remove bottom front panel. There may be a wooden or metal clip under the keybed in the middle. Press up on it to remove the bottom front panel.

☑ □ Look at the wooden panel at the back. Are there any cracks in it?

☑ □ Look at the block of wood at the lower right where the coiled strings sit. Look at the tiny copper pins where the strings are up against. (2 pins per string.) Can you see any cracks where these pins go into the block of wood?

If you answered no to all these questions, your piano probably has some value. It is strongly suggested that you have a qualified technician look at it to confirm your inspection and to give you an evaluation of what it may be worth in your market.

Keep in mind that the used piano market is difficult to predict. In order for the seller to improve their chances of getting a fair price for their piano, they should be willing to wait up to six months to find the right buyer.

Mark Cerisano, RPT, Mech.Eng - *President, Senior Technician* - Mr. Tuner Piano Service

APPENDIX D –
VOICING OLD HAMMERS and SPINETS

CANADIAN ASSOCIATION of PIANO TECHNICIANS (CAPT)
MEETING
Sunday January 25th, 2009
Westend Pianos, 17 Ronald Drive, Montreal West.

Technical Topic:
VOICING OLD HAMMERS and SPINETS
Mark Cerisano, RPT

Introduction
This article presents simple voicing techniques that can improve the tone of hammers and pianos that have obvious tone problems. It doesn't attempt to address the challenge of creating finer tone desired in high end concert instruments.

There is a large variety of tone available from the pianos and hammers that are currently available and present in owner's homes. From large concert grand instruments to small spinets to old upright pianos with deeply grooved and hardened hammers, each of these instruments has a tone potential and a current tone condition.

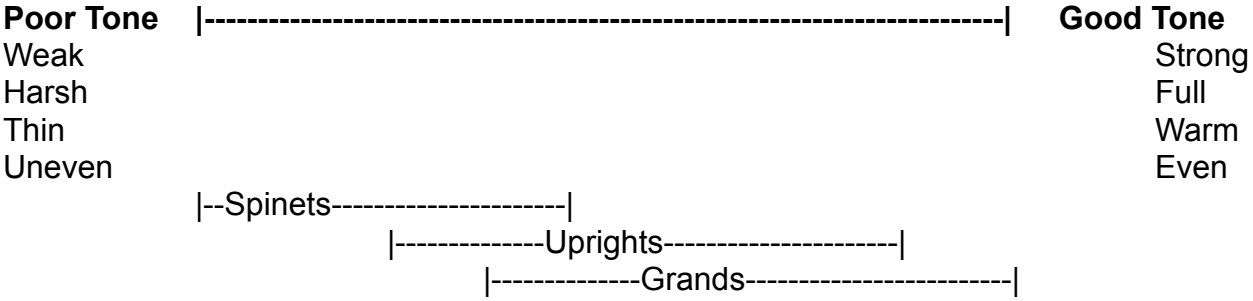

Figure 1. Tone potential in different piano designs.

The tone potential is a function of a variety of things including piano design, string condition, hammer quality, regulation, etc…

Scope
The techniques presented here deal with upright pianos that have a current tone condition in the lower end of their available tone potential band. There are many quick and easy procedures that can improve the tone dramatically, especially when the current tone condition is in the lower end of the tone potential.

String Level and Hammer Mating

The Blocking Test.
Depress the sustain pedal. (You can also wedge a rubber mute into the pedal to keep it down and help reduce back pain.) Use something to pluck strings (your finger nail, a pap's mute, etc) and gently press the hammers against the strings. Pluck each string in a trichord/bichord and listen for ringing strings that are not being blocked by the hammer. When this condition occurs, the tone is usually nasally and whining, even when the unisons are in tune.

To correct this problem, first see if the strings are level. Rub you finger across the trichords. You will easily be able to feel if one string is higher. High strings should be the ones that block when plucked during the blocking test.

There are four techniques that will mate the hammer with the strings.

1) String leveling. Use a brass rod and tap down on the high strings near the V-bar. Then check the blocking again. While it's not critical to have level strings on an upright, this can be a quick and easy way to fix the problem of unmated hammer/strings.
2) Use a hammer file and file only the area on the hammer where the strings are blocking. This seems to get the best results. Trying to keep the hammer flat and file the whole hammer at an angle doesn't seem to work as well.
3) Use a strip of sand paper and put it between the hammers and the strings with the sand facing the hammers. (Usually this works best on tenor strings). Gently press the hammers against the strings and pull the paper up and out. Repeat this many times up and down the tenor section. This tends to sand the high points of the hammer more than the low points and can have the effect of mating the hammers with the strings.
4) Use a needle and needle in a small V on either side of the strike point on the groove of the ringing string. Usually at the ends of the groove, toward a point just below the middle of the groove. This causes the felt to puff up a bit and stop the string from ringing when plucked in the blocking test.

Notes:
Improper hammer mating seems to cause more of a problem with the tenor strings and to some degree, the bass bichords.

Mating Hammers to Bass Bichords.

If you've ever watched closely as a bass hammer moves to the string, you may have noticed that the hammer seems to rotate a bit to the left as it moves toward the string.
This is because it is angled on the shank. So, even though the hammer has been filed or put on square as it rests on the rail, when it gets to the string, the hammer hits the right bichord first. This is a common condition in many apartment size pianos because the arc of rotation is smaller than uprights.

To correct this, simply tap down all the right strings of each bichord. (First check to make sure it is a problem with all the bichords.) If just some are unmated, only tap those down. This can make a huge improvement in bass bichord tone.
(Sometimes the left strings need to be tapped down. Be sure to check the blocking using the blocking test mentioned above.)

Note: I have had customers complain about poor tone from a single bass string on small pianos. And while it is tempting to just attribute this to a bad design and short strings, you can sometimes get a significant improvement in tone simply by tapping the string down onto the V-bar/pin junction.
Also, be careful tapping down strings on old pianos. You can break the strings if they are old, rusted, and you tap too hard.

Old Hammers and Spinets

Old grooved hammers and spinets can have a harsh thin tone. Here are some things that can take the edge off.

1) Brush the hammers gently with a wire brush. This causes felt to be pushed into the grooves and soften the blow. It has the added benefit of being temporary so you can tell the customer if they don't like it, the tone will get bright again with playing.

2) Needle the strike point. One small insertion right in the middle of each groove about 2 mm deep can reduce much of the whine, sizzle and zing that grooved hammers produce.

3) Steaming. With a thin cloth slightly wet resting on the front of a hammer, place the back of a hot hammer iron on the cloth at the front of the hammer for about one second. There should be a hissing sound. This is not as controllable as the needling or brushing as it tends to deaden the tone.

Selling a Hammer Filing Job.

A repair job is easy to sell if it is something that will reduce a condition that annoys the player. Grooved hammers create harsh tone because as the grooves wear, this results in the string hitting a hard flat groove bottom. However, as a piano ages, the shanks may warp slightly and now the grooves don't line up perfectly with the strings anymore. If you play a chromatic scale, you may hear a dramatic unevenness of tone from one note to the other as the grooves of each hammer do or do not line up with the strings. Most people can hear this unevenness. It helps to describe it as loud and soft.

Hard Hammers

Some spinets and apartment size pianos can have ungrooved or slightly grooved hammers and still have extremely harsh tone. This can be quite annoying. Even though it may be frowned upon, sometimes multiple needling around the strike point is the only thing that can quiet the tone down.

Note: I have heard it said that proper needling brings out the lower partials instead of diminishing the upper partials and that is why we do not needle the strike point. Sometimes the piano is too loud for a room and bringing out the lower partials will just make the piano seem louder. Needling the strike point, in some specific cases, is appropriate because while reducing the higher partials, it also evens out the over all harmonic spectrum, thereby improving the tone and matching the piano to the room.

Conclusion

As mentioned before, these techniques are meant to improve a piano with tone that is suffering but may not be sufficient to bring the condition to the top of the piano's potential. Sometimes, this is all that is needed to bring new life and enjoyment to the piano player. These techniques are also very quick to do mostly, and in some cases have never been done to the piano. These are some more tricks that can help you differentiate yourself in the market as an expert in piano technology and help you find and improve your own voice.

Note that while these techniques can improve the tone of inferior hammers and not ideal hammer conditions, the accepted, professional and complete proper way to deal with these problems may be to replace the hammers and do all the necessary steps to install them professionally, which includes but is not limited to: hammer travel and alignment, needling, center pins, regulation, voicing, sanding, etc…

Mark Cerisano, RPT, Mech.Eng - *President, Senior Technician*
- Mr. Tuner Piano Service

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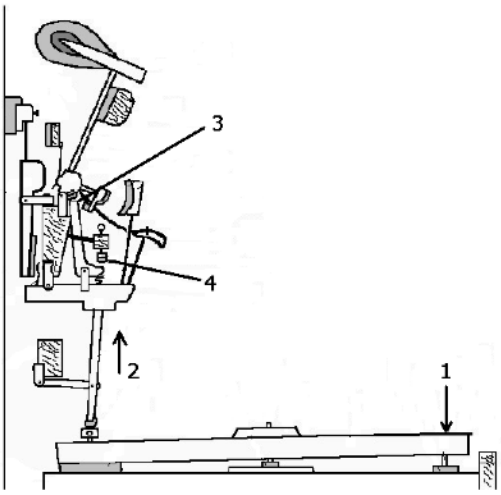
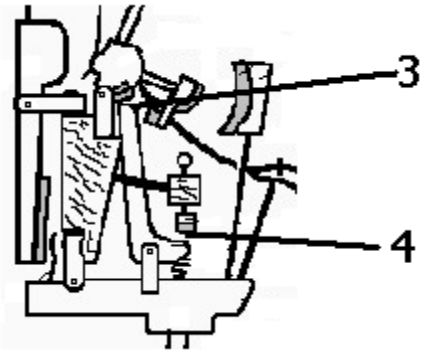
APPENDIX E –

REGULATION (FEEL) and VOICING (TONE)

MPTC July 6 - 8, 2007

HOW THE PIANO WORKS



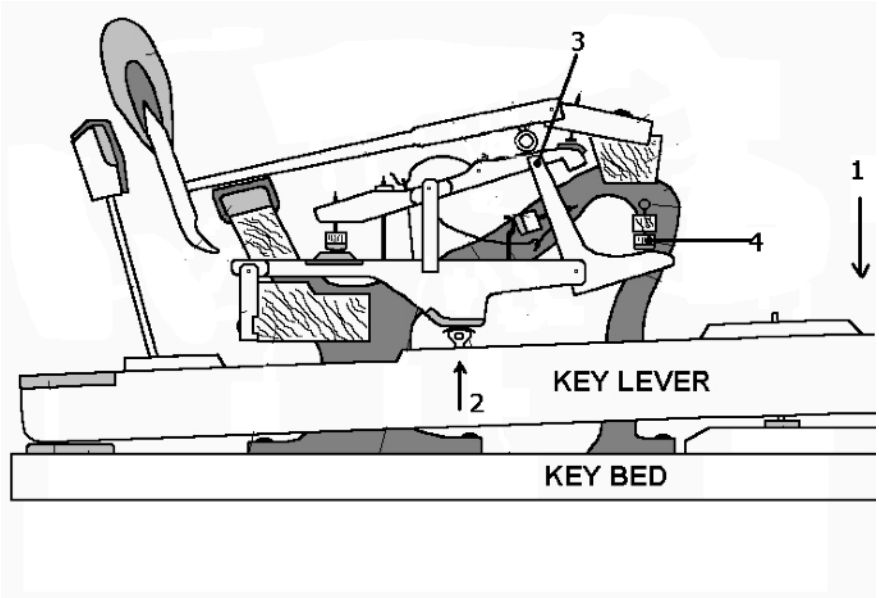


1. The key is pressed down
2. The back of the key pushes up on the *wippen.*
3. The *jack* (attached to the wippen), pushes up on the bottom of the hammer (*hammer butt*)
4. The *let off button* engages the jack toe and the jack top slips out from under the hammer butt.

This is the essence of how the piano works. It is beautiful in that the key actually *throws* the hammer at the string, actually letting go of the hammer just as one would let go of a ball when throwing.
It is the let off button/jack interaction that provides this letting go or *let off* action.

GRAND PIANO

The grand piano works the same as the upright except the jack pushes up on the *knuckle* (a round piece of felt under the hammer shank).
Also, there is an extra part called the *repetition lever,* also under the knuckle, that allows the jack to reset without the key having to be returned all the way up. (Not so on the upright.)



WHAT IS REGULATION?

The more appropriate question is: How do I know when a piano is regulated or needs regulation? It is all in how the jack moves. Remember that the jack has to move the hammer closer to the strings and then *jump* out of the way. If it jumps too early, you can't play with expression. If it jumps too late, the jack gets in the way when the hammer bounces off the string and knocks the hammer back at the string and a double note is heard. So:

How do I know when a piano is regulated? When you can play quietly with expression and there are no double striking notes.
How do I know when a piano needs regulation? When you *can't* play quietly with expression or there *are* double striking notes.

You may be able to feel this but there is another way to see it. Look at the jack after the key is depressed. The jack should have escaped from under the hammer butt (or knuckle) and be about 1/32" away, not touching but not too far. (In the middle of the jack window in a grand).

WHAT CAUSES THE JACK TO MOVE TOO MUCH OR NOT ENOUGH AFTER LET-OFF?

With the key pressed, exert a little extra pressure. The jack will move with the key. So, the key dip affects the jack movement. (Key dip – how much the key goes down.)
There is usually too much key dip in older pianos because the felt under the key has been compressed.

The jack moves with the key unless there is play *(lost motion)* between the key and the hammer. If you can start the key without the hammer moving, there is lost motion. I.e. the jack only follows the key for a fraction of its movement. So, if you decrease that fraction, you decrease the jack movement. In other words, the later the jack engages with the key, the less it moves.

The jack moves with the hammer until it jumps out of the way (let off). If the hammers do not move as much, neither does the jack before let off. The hammers can be moved closer to the strings by shimming the *hammer rest rail* with felt. This reduces jack travel before let off.

The jack moves with the hammer until let off. If let off occurs earlier, then the jack starts moving earlier and moves more.

LET-OFF CHECK LIST

Jack	Symptom	Possible Fixes
Too Much – large space between jack and butt (knuckle) when key is pressed	May not be able to play soft consistently. Look for hammer greater than 1/8” at let off. (Press key slowly. Watch hammer. See how close it gets to the string before coming back. That is let-off. Should be 1/8”)	Too much jack movement so: - Adjust let off button higher if let off greater than 1/8” - Check key dip. Should be 3/8”. May be too much - Check blow distance (hammer to string distance at rest should be 1 7/8”). May be too little. Remove felt. Uncommon.
Too Little – jack is not escaping from under butt (knuckle).	Double striking notes. Or maybe jack is not letting off Symptom: Blocked notes sound stifled or muted. Hammer presses on strings instead of bouncing off.	Not enough jack movement so: - Adjust let off button lower if let off less than 1/8” - May be too little key dip. Remove some paper. - Blow distance too great. Common because of wear. Add felt. - Check for lost motion. Adjust capstans.

SOME STANDARD MEASUREMENTS, HOW TO MEASURE (AND HOW TO ADJUST)

LET OFF
Should be 1/8”. Press key down slowly. Hammer should follow key until hammer is 1/8” from string and then ease back. (Adjust let off buttons)

KEY DIP
Should be 3/8”. Use a ruler with a clip or a key dip block. (Add/remove paper punchings)

BLOW DISTANCE
Should be 1 7/8”. Can be a little less. Up to 1 ¾” or even 1 ½” on spinet (very small) pianos. Use a ruler. (Add/remove felt under hammer rest rail.)

LOST MOTION
Should be almost zero. Pull back gently on hammer rest rail. All hammers should follow. Pull back harder. All hammers should stop following. Test by tripping jack. It should return smoothly.

MISCELANEOUS

The wippen has two pieces attached that must also be regulated to perform well.

BACK CHECKS
These catch the hammers as they bounce off the strings, holding them so they don't hit twice. They should catch at about 5/8". Use a finger thickness. Back checks can be bent gently by hand.

SPOONS
Hidden on the far side of the wippen, the spoons press against the dampers and lift them off the strings so the strings can vibrate. Checking should occur between 1/3 and ½ of the way to the strings. Adjustment is complicated and difficult to master since the spoons are hidden.

DAMPERS
Dampers are supposed to stop the strings from ringing when we don't want to hear them. They are supposed to rest on the strings. There are two ways to lift them. 1) by pressing a key which moves the spoon which lifts the dampers. Or 2) by pressing the sustain pedal which lifts all the dampers. If the dampers are not dampening (i.e. notes keep ringing after key is let go), they may be resting on the spoons or the pedal (damper rod).
Gently press down the keys very lightly, about 1/32nd of an inch or less. The dampers must not move. If they move right away, then they are resting on the spoons, not the strings. Difficult to adjust.
Gently press down the sustain pedal ¼" about. The dampers should not move. If they move right away, then they are resting on the pedal, not the strings. Simple nut adjustment inside the bottom of the piano.

PEDALS

Right – Lifts all the dampers off the strings so they are all free to vibrate. (Sustain Pedal)

Left

Upright – Moves hammers closer, introducing unwanted lost motion, making notes only slightly quieter. (Soft Pedal)

Grand – Moves entire action (keys and hammers) to one side, whereby hammers miss one string or at least present new fresh felt for hitting the strings. (Una Corda or Soft Pedal)

Middle

Upright – Not present on about 45% of upright pianos. 5% may do nothing. 5% may be hooked up to the left or right pedal. 30% may lower a felt strip creating a muted sound. 10% may lift only the bass dampers creating a quasi sostenuto. 5% May actually be a bonafide sostenuto lifting only the dampers of the keys that were pressed down when the pedal was pressed down. All other notes can be played staccato while the sostenutoed notes ring.

Grands – 90% have a sostenuto pedal. See description above for sostenuto. In less expensive grands (10%), it may be a quasi sostenuto, lifting just the bass dampers.

WHAT IS VOICING?

Voicing is anything that improves the tone of the piano. Theoretically, that could include tuning, regulating, string leveling, tapping strings onto bridges, and twisting bass strings. These all can improve the tone of the piano but they are just pre-requisites before the actual voicing process occurs.

Serious voicing is the act of modifying the hammers so that the transmit energy efficiently to the strings. New hammers can be very hard due to the high pressure used to make them, or chemicals used in the manufacture. Needles are used to gives the hammers more elasticity without destroying the strike point. It is an art to know where and how many times to needle a hammer. Generally, hammers are never needled on the strike point.

BRIGHT HAMMERS

Most hammers become hard and worn and start to sound bright and glassy. New Asian hammers can also sound glassy, especially in the treble. There are a few things that can be done to “tone down” this brightness.

Steam – a rung out damp thin cloth is placed on the strike point. A hot soldering iron with a special attachment is touched to the hammer for about one second. Steam is injected into the hammer, softening its tone temporarily.

Needling (Sugar Coating)– A needle can be used to gently “fluff up” the felt in the grooves of an old hammer.

Strike Point Needling – This has drastic results so must be used with extreme caution. One needle inserted about 1/8” into the groove, directly at the strike point has the effect of softening the tone of an old hard hammer immediately, with lasting results. Excessive needling here (even only two or three times) can cause the tone to be seriously deadened.

CHOPSTICK TOOL – Sugar coating and strike point needling can be done with the action in the piano with a chopstick-like tool that has a needle on the end. One can be made easily with 3/16” dowel. About 8 to 10” for a grand. Make one about 3/4” to 1” for an upright.

Always consult a professional technician if you are unsure of any of these details.

APPENDIX F –
EVALUATING USED PIANOS
How to Avoid Major Mistakes

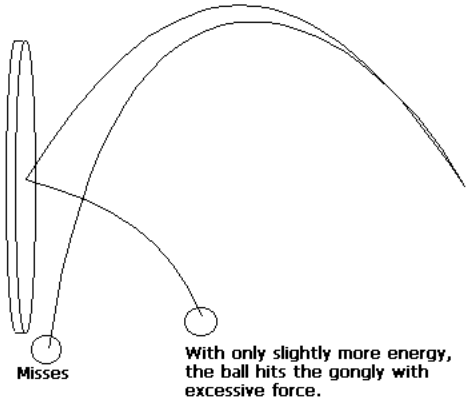
“The piano has a bad feel”
Within the mechanism (action) of the piano there are many moving wooden pieces. They all mate with pieces of felt to reduce wear and noise. It is when these felt pieces compress that the “feel” of the piano is not ideal anymore. Regulation is the act of returning the keys back to the ideal operation so that they all respond evenly and accurately.
When a piano is out of regulation, the keys will slowly stop working ideally before they stop working at all.

How To Tell If A Piano Needs Regulation.
If the piano needs regulation, the keys will begin to show problems in two main areas:

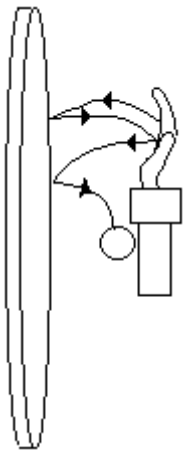
1) Inability to play softly
2) Double striking notes

When the key is pressed, a small ‘L’ shaped piece of wood called the ‘jack’ presses up on the hammer until it is tripped out of the way so that the hammer is ‘thrown’ at the string.

PLAYING THE PIANO IS LIKE HITTING A GONG WITH A TENNIS BALL.
Think of throwing a tennis ball at a gong.
If you are very far away from the gong and you want to hit the gong softly, you will have to lob the ball at the perfect arch so that the ball just grazes the gong. Because of the difficulty of getting the exact speed and angle, most of the time the ball will either hit the gong too loudly or not at all.



Or, if you are too close when you let go, the ball may strike your hand before you have time to get it out of the way and then the ball may rebound off your hand and hit the gong again.



These are two of the most coming problems encountered when a piano is out of regulation. Try to play each note softly. Try not to press down too hard. (If there is a problem with double striking, this will enhance it and make it easier to hear.) If you have trouble playing softly and/or you hear double striking notes, then the piano may just need a good regulation.

(NOTE: if the hammers are slow then you will also have trouble playing softly. This is like throwing the tennis ball under water – as soon as you let go, it stops. To check for this, push on the hammer rail and pull it back quickly. Watch for any hammers that don’t return as fast as the others. If there are many, it could be an expensive repair.)

Major Mistakes (con't)

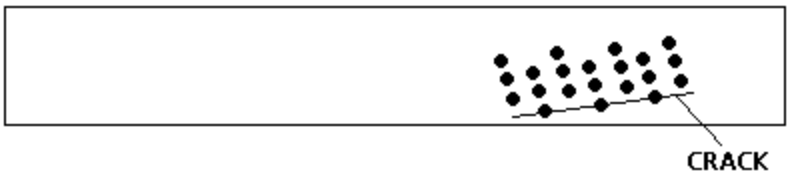
"There is a crack in the soundboard"
This is the most often stated reason for lay people to dismiss the purchase of a piano. Perhaps because it is the easiest to see. Just take off the bottom board. The soundboard is the large piece of wood under the strings.

It is very rare to find an 80 year old piano with no cracks. These pianos have seen excessive humidity and dryness, yet these older pianos often posses superior quality and tone.

Many times these cracks do not adversely affect the tone of the piano.
Check the back of the piano. Look for separation of the ribs from the board. This may be more serious.
Play each note loudly. Listen for buzzing. If there is a problem, the buzzing will be heard easily.
Even if there is a buzzing, and the cracks are not huge and numerous, the soundboard can be repaired fairly inexpensively to eliminate the buzzing.

"The piano needs tuning but sounds great." "The piano will not hold a tuning."
The piano may not stay in tune if the tuning pin holes are too worn or the pinblock is cracked.

Cracked pinblock – The crack usually occurs in the treble and in a straight line. Because the pins are staggered, the crack affects every other note. Because there are three strings per note, the crack affects only one of the three strings.



The result is that one string of every other note will be noticeably flat. If you find every other unison horribly out of tune, there may be a crack.

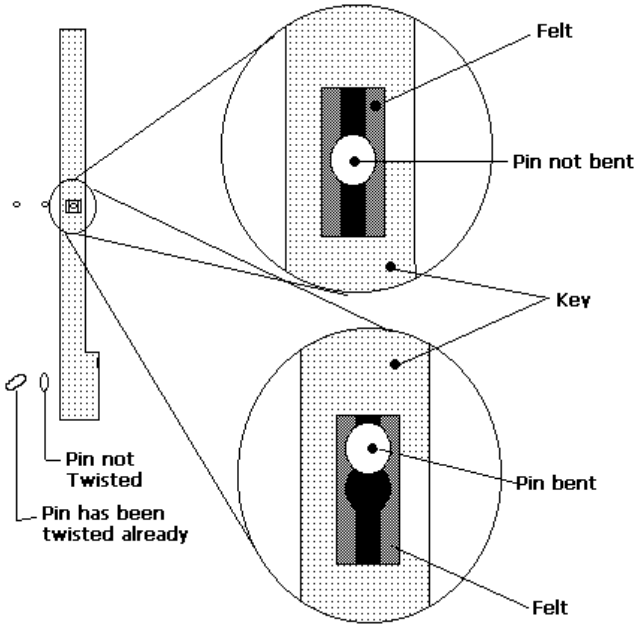
Worn Pinblock – The only way to test for this is with a tuning hammer. By turning the pins, you should be able to tell if the pinblock is worn. The pins will be very easy to turn, even with one finger pressure. Or, after you tighten them, they may actually untwist back to their original position.

A cracked pinblock is worse than a worn pinblock. A worn pinblock can be fitted with larger pins. This would only worsen a cracked pinblock. Both conditions can be temporarily treated with CA glue and can result in a tunable piano for many more years (approximately 5 more years).

EXPENSIVE PROBLEMS
Bass Bridge Cracks
Look for wide cracks where bridge pins have moved. Play all bass strings loudly and listen for buzzing. If the cracks are few, small, and hairline, and there is no buzzing, the crack is not serious and may not need to be repaired.

Major Mistakes – Page 3
EXPENSIVE PROBLEMS – Cont.

Sloppy Keys
If the keys move sideways easily and are noisy, the key bushings are worn. Take some keys off. Look at the oval pin under the keys near the front. Are they straight or have they been turned. If they are straight, they could be turned to take up some slack in the keys. How about the hole in the center of the keys? If the pin looks like it was bent, there may be no simple fix to improve the situation.
I.e. if the pins have not been bent or twisted, it may be possible to bend or twist them to reduce the sloppiness and noise without replacing all the felt.



Slow Hammers.
As mentioned in the section above concerning the 'feel' of the keys, slow hammers can result in inability to play soft. If you find slow hammers, you may carefully test to see if they can be worked in or they may need more expensive repairs.
As mentioned, move the hammer rail forward and pull it back quickly. Any slow hammers will be seen easily. Now, grab a hammer head of a slow hammer gently. Move the hammer back and forth applying GENTLE pressure in the following directions about ten times each.

- to the left
- to the right
- pulling up
- pushing down
- twisting right
- twisting left

If the hammers can be worked in, they will loosen up easily with this technique. If they do not loosen up, the center pins may need to be replaced which costs more.

APPENDIX G – REGULATION MEASUREMENTS

Key Height (Whites)	Not higher than cheek blocks. Balance rail pins should be higher than key button. Shape of key front with key slip should be slightly rectangular (wide).
Key Height (Blacks)	½” above whites. Wood tops at back even with wood tops of neighbouring whites.
Key Dip	3/8” (7/16”) Key dip block should feel slightly lower than neighbouring key top, only very slightly for a 7/16” block; a bit more for a 3/8” block). This is for older pianos and smaller apartment size pianos.
Blow distance	1 7/8”. Maybe 1 3/4” for older uprights and all apartment size pianos may be needed to get sufficient jack travel.
Let Off	1/8” for uprights, 1/16” for grands.
Lost motion	Almost nothing. Jack should reset under hammer butt.
Dampers	Damper starts moving when hammer is 1/3 to ½ the way to the string.
Bridle Wires	Should start moving when hammer rest rail is half way to the strings.

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