What Pianists ABOUT

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Most people are aware of the need to tune a piano regularly. What they often do not realize, unfortunately, is that tuning is only one small part of the care needed to keep a piano in first-rate condition. Poorly regulated pianos are a nightmare for the performer, often making it impossible for him to give his listeners a meaningful musical experience. Equally important, they hinder students in their efforts to develop technique, for many ways of playing are impossible when the regulation is faulty.

A common misconception is that a knowledgeable pianist asks the tuner to make some changes in the regulation of a piano because he wants the piano to be specially adjusted to his own personal preferences. While personal preferences of course do exist, the average piano is so far from being regulated in accordance with the normal, correct standards, that the pianist's requests are usually just a desperate attempt to restore these standard, reasonable norms.

Regular adjustment of a piano is necessary because the mechanism contains many felt and leather parts that become compressed and worn through use and that are considerably affected by varying moisture content due to changes in the relative humidity of the air.

It is a pity that we pianists are so dependent on the perfect alignment of a fairly complex piece of machinery. The special nature of the piano as an instrument in which there is no direct contact between the player and the source of the vibrations makes it particularly important that the pianist be able to control the hammers being thrown against the strings with the greatest possible sensitivity. It is imperative that each key on the piano respond in an absolutely even and predictable manner. The piano cannot make a crescendo, except by the illusion of a series of very subtly differentiated notes, each one ever so slightly louder than the preceding one. The piano can hardly vary the color of sound except by varying the speed of each thrown hammer and by creating fine distinctions in the intensity of different notes of the same chord. When playing softly, a pianist must often come dangerously close to the point at which the hammer may fail to hit the string, thus causing an embarrassing void where there should have been a sound.

Before continuing, I should perhaps present my credentials for writing about how to regulate pianos, rather than how to play them, since it is the latter, not the former, by which I earn my living.

Ever since my family first purchased a grand piano, when I was about ten years old, I have been fascinated by the mechanics of the instrument and its inner workings. I watched our tuner take out the action and started asking questions. Soon, with the spirit of a young boy taking apart a watch, I started to experiment myself. On my first attempt the tuner had to return to replace a hammer I had broken while pulling out the action!

Since then, I have continued questioning hundreds of piano tuners I have met during my concert tours in many different countries, learning from most of them and eventually sharing my knowledge with some of them. My experiments also continued, together with the reading of whatever books I could find on the subject. I regulate my own concert piano, which I often take on tour with me. Many pianists and tuners who have tried it consider it to be one of the best regulated instruments they have ever encountered.

If one demands a great deal from an instrument, one must understand something about it and know how to communicate intelligently with piano tuners and technicians. It is not sufficient to say that a piano seems light, or heavy, when in fact this ailment could be for any number of reasons. It is comparable to telling a doctor that you feel sick, which will hardly enable him to help you, short of a complete physical check-up. That, like a complete overhaul of a piano, is time consuming and expensive.

Should Know PIANOS

Tuners, like doctors, are overworked, and most of them are hesitant to urge people to spend money on regulating, because it might seem as though they were merely trying to create work for themselves. Therefor it is worthwhile, and not difficult, for all serious pianists to learn to diagnose the principal symptoms of maladjusted pianos. The study that follows refers only to grand pianos; many of the measurements given cannot be applied to uprights or spinets.

How the Action Functions

The essential point of the piano action is that it permits the key to push the hammer toward the string until it is about to strike, at which moment the connection between key and hammer is interrupted, allowing the hammer to swing freely, hit the string, rebound, and be caught in such a manner that it can be played again immediately.

The interruption of the contact between key and hammer is accomplished by a small L-shaped piece of wood called the *jack*, which transfers the force of the key against a leather-covered round part called the *knuckle*, which is attached to the underside of the *hammer shank*, the thin, long wooden arm that holds the hammer.

When the jack has pushed the knuckle up to the point where the hammer is almost touching the string, the horizontal part of the jack is caught by a felt regulating button, causing the jack to rotate and to slide out from underneath the knuckle. Thereafter the hammer flies on up to the string with its own momentum, rebounds, and is caught by the leather-covered, finger-like prong attached at the very back of the key, called the *back-check*. The slipping out of the jack from under the knuckle is known as either *escapement* or *let-off*.

If the jack did not slip out it would continue to force the hammer shank up, pushing the hammer against the string and immediately damping it. The result would be a dull thud, very short in duration, with the pitch almost unidentifiable. This can happen occasionally when a piano gets out of adjustment, and the fault is called *blocking*.

Striking Distance and Let-Off

Two of the most critical adjustments that can be made to the action are the *striking distance* (or *hammer travel*), which is the distance the hammer traverses from its resting point until it hits the string, and the let-off (the exact point during the hammer's journey at which the jack escapes from underneath the knuckle).

There should be a ratio of just under 5 to 1 between the distance the hammer moves and the distance the key moves. If the hammers are resting too low, the ratio will be too large and the hammers will have to be lifted over a greater distance, causing the touch to feel too heavy. If the hammers are resting too high, the ratio will be smaller and the striking distance shorter. Because less "work" is involved in lifting the hammer, the touch will be lighter. The pianist's fingers, though, may feel weak, for there will be less leverage and not enough *contact distance* to allow the hammer to be sufficiently accelerated to strike a loud blow. Contact distance is my term for that part of the key's motion during which power is being transferred to the hammer. After the let-off point is reached, the key is out of contact with the hammer; the rest of the key's motion until it hits the key bed is called the *aftertouch*.

The ideal striking distance is about 1 3/4 inches. Manufacturers' recommendations vary between 44 millimeters (just under 1 3/4 inches) and 1 7/8 inches. The individual will make a choice in this range, depending on whether slightly more or slightly less aftertouch is desired. (The closer the hammers sit to the string, the greater the aftertouch.)

The let-off should occur when the hammer is 1/16

inch (the thickness of a penny) from the string. To observe the let-off, press the key down very slowly and note exactly where the hammer stops moving upwards and starts falling back down. That is the let-off point.

The closer the let-off point is to the string, the more precisely the pianist can control very soft blows. If the adjustment should get too close to the string, the hammer may fail to let off at all; it will block against the string and make the note unusable. If a piano can be regulated only infrequently and if it is subject to considerable fluctuations of temperature and humidity, it would be reasonable to have the let-off a little further from the string, say 1/8 inch, the thickness of two pennies. For reasons too complex to go into here (involving another adjustment, the *drop*), this let-off point may also make the slipping out of the jack function more smoothly and with less friction. Anything more than 1/8 inch between the let-off point and the string, however, will make sensitive control of soft dynamic levels impossible, for then one is throwing the hammer across a large gap where it is no longer in contact with the key. For analogy, pretend you are throwing a tennis ball upward, trying to hit a ceiling gently. The closer your hand can approach the ceiling before letting go of the ball, the more accurately you can judge the minimum push needed to hit the ceiling.

There is a complex interlocking of the various adjustments of the piano action, for the striking distance and the let-off are not only mutually dependent, they are also related to the depth of the touch of the keys, i.e. the distance between the top of the key when it is at rest and when it is held down. The *touch depth* should be 3/8 inch or slightly more, up to .395 inch for concert grands.

The relative adjustment of these three factors — striking distance, let-off, and touch depth — determines the aftertouch, the free motion in the key after the point has passed at which the jack has slipped out. If the key strikes bottom before the jack has slipped out, there will be no aftertouch. This may be caused by excessive striking distance, insufficient touch depth, or a combination of the two. To control the hammers well with no aftertouch one has to play all the way to the bottom of the keys. This makes leggiero playing impossible, is hard on the fingers, allows the thumping of the keys against the key bed to be heard excessively, and causes the action to feel heavy.

If, on the other hand, the striking distance is too small, or the let-off occurs too early, or the touch depth is too great, there will be a considerable amount of aftertouch, which will reduce the contact distance and thereby the power of the blow. Excessive aftertouch also wastes finger motion, affects the ability of the instrument to repeat rapidly, and makes it difficult to control volume.

Points of Friction

Together with incorrect adjustment of the striking distance and the let-off, the most common ailment afflicting neglected pianos is excessive friction. Ideally friction should be kept to a minimum, and the main resistance of the key to being pushed down should be the weight of the hammer. At best, friction will be responsible for more than half of the 50 grams resistance offered by the key of the normal piano. If the friction is significantly more than this, the action will feel sluggish, unresponsive, heavy, and slow.

Friction is mainly located in the action *centers*, which are the simple hinges holding different parts of the action together. A center consists of a steel pin surrounded by a felt or plastic *bushing* connecting two parts of the action and permitting free motion in one plane. The most important centers are those connecting the hammer shanks with their *flanges* (the stationary pieces screwed onto the action frame), but there are five other centers that move every time a key is struck: one on the jack, one connecting the *whippen* to its flange, one on the *repetition lever*, and two (or more) in the damper action.

The usual problem with the centers is tightness, caused by humidity and corrosion. The simplest way to test for tight centers is to check the key weighting. The standard weighting for a piano is about 50 grams, which is just under two ounces. Two ounces, about 57 grams, is still acceptable. Over 60 grams is distinctly heavy. Less than 45 grams will mean poor repetition, particularly on concert grands with their long keys. The weight is judged by lifting the dampers with the pedal and putting weights gently on the very front edge of the key. If there is excessive friction in the centers, it will take too great a weight to move the key. You may even get a reading of 80 grams or more. Although it is not unknown, it is rare to find new pianos that are incorrectly weighted, so that such a reading probably indicates friction rather than overweighting. Most pianos are weighted a little heavier in the bass than in the treble, however.

To check whether a heavy action is caused by the friction rather than by faulty weight balance, press a key softly, release it suddenly, and watch whether the hammer bounces. It should bounce up clearly from the rest position before finally coming to a stop.

A more reliable diagnosis of action friction can be obtained by measuring how much weight a depressed key will lift up when released. This upward pressure, crucial for good repetition, should be at least 20 grams (the weight of 6 or preferably 7 pennies). The difference between the weight needed to depress the key (ideally 50 grams) and the weight the key will lift (ideally 23 grams) is the amount of force needed to overcome friction. If this difference is more than 35 grams (11 pennies), the friction is excessive.

If the action has been taken out, there are better tests. Unscrew a hammer, hold the flange in one hand, and bring the hammer head to a horizontal position. Drop it, and watch it swing. It should make five or six swings before coming to a stop. Of course, the heavier hammer heads in the bass will swing a bit longer. The other commonly used test is to hold the flange horizontally with the weight of its screws on it. It should drop very freely by itself. The other centers are harder to judge; if the hammer flange centers are too tight, the same is probably true of the others.

Incorrect weighting can result from hammer replacement. For every gram of difference in the weight of the new hammer there will be a difference of about five grams in key weight.

A special problem has been created by the U.S. Steinway company's use of teflon bushings for the past ten years or so. I have almost never seen a piano with teflon bushings whose centers are satisfactory, meaning even and free but not loose. While the felt bushings used by other manufacturers and still used by the Steinway company in Germany can be treated in various ways (a mixture of 1/3 water and 2/3 alchohol is probably the best) to make them less tight, teflon bushings can scarcely be affected by any treatment. If too tight, the centers can be reamed and fitted with larger pins, but this is time-consuming, expensive, and unless done by a top expert the chances are that the results will be uneven. I have yet to find a piano technician and tuner who likes plastic bushings, and I would not buy a piano that uses them. Owners of new Steinways whose centers are tight should pressure their dealers to correct them. I have seen brand new Steinways whose hammers will just barely drop down to rest position. Rumor has it that Steinway will soon return to felt bushings.

Loose centers can be detected by the clicking sound they cause when a note is played. If a hammer can be moved distinctly from left to right, and if the swing tests mentioned above show it to be swinging back and forth like a pendulum eight or nine times, then the center is too loose.

Another important friction point is the knuckle, under which the jack slips out. As you start to depress the key, the knuckle runs against the repetition lever, and as the jack slips out near the end of the blow, it also rubs against the knuckle. The knuckle is normally lubricated with dry graphite, soapstone, or unscented talcum powder. Some technicians believe it is harmful to apply graphite directly to the knuckle, but in my own experience I have seen no bad effect as long as pure graphite is used, not a stick containing grease.

To judge whether there is too much friction in the knuckle, press a key down very slowly and listen for any creaking or rubbing sound. If you hear any, lubrication is needed. Wear can cause excessive friction, for once the knuckles get flat and lose their round shape the jacks will not slide easily. Worn knuckles can sometimes be improved by brushing them up with a wire brush.

Several other minor friction points that need occasional graphite are the top of the *capstan*, which pushes up the whippen, and the spring groove, but there is a more important source of friction that is often overlooked. At the fulcrum of the key, the point known as *center rail* or *balance rail*, a large metal pin goes vertically through the key to hold it in place. If the bottom of this hole is too tight, the motion of the key, particularly on its rebound, will be sluggish. (This is often the case with new or seldom played instruments.) On the other hand, if the hole becomes too large, the keys will rattle.

When testing for friction in the keys, you should be able to lift the keys about 1/16 inch before letting them drop back to their usual position. If they remain in the lifted position, the center rail pin holes need to be very slightly enlarged. This is done simply by pressure of a round tool, not by using a sharp edge to remove wood. There should be no play backwards and forwards in the key.

A hole is also in the front of the key, and here, where the key is guided by the *front rail pin*, there should be no friction at all. The keys should not, however, be able to move excessively from side to side, since that would create unpleasant slapping noises. If, when slapping some of the keys (particularly the black ones) to the left or right, you hear a clattering noise, either the front rail pins need adjustment or the key bushings have become too worn. The front rail pins are slightly eliptical, and they can be turned with a special tool for the sideways adjustment of the keys.

Extraneous Noises

Aside from loose centers, unpleasant clicks can come from several other sources. Loose hammer heads are a common cause, especially in dry climates. A pronounced clicking at the extremes of the keyboard may result if the blocks of wood that hold the action down against the key bed at either end of the keyboard are not secure enough. Generally there are some strips of paper glued to the bottom of these blocks, and they can be removed to make a tighter grip.

A persistent clicking or wooden knocking may be caused by a warped action or improperly adjusted center rail studs. These studs are the brass pins, shaped like *tuning pins*, that some pianos* have in order to regulate how high the action sits above the key bed. The action, as stated, is held down in front by the key blocks; in the rear it slides under some wooden guides that hold it down. The center rail studs are in the middle, so if you screw them down to lift the middle of the action along the center rail, you are bending the action frame and may cause it to warp. Any change in the height of the center rail studs will also mean a change in the depth of touch, for by raising the center rail you are also raising all the keys that are lying on it. This is sometimes a practical and effective way to correct the touch depth in an emergency, but it is not recommendable under normal circumstances. Touch depth is properly adjusted by either removing or inserting round paper punchings under the keys. The let-off and striking distance are also slightly affected by changes in the center rail stud settings.

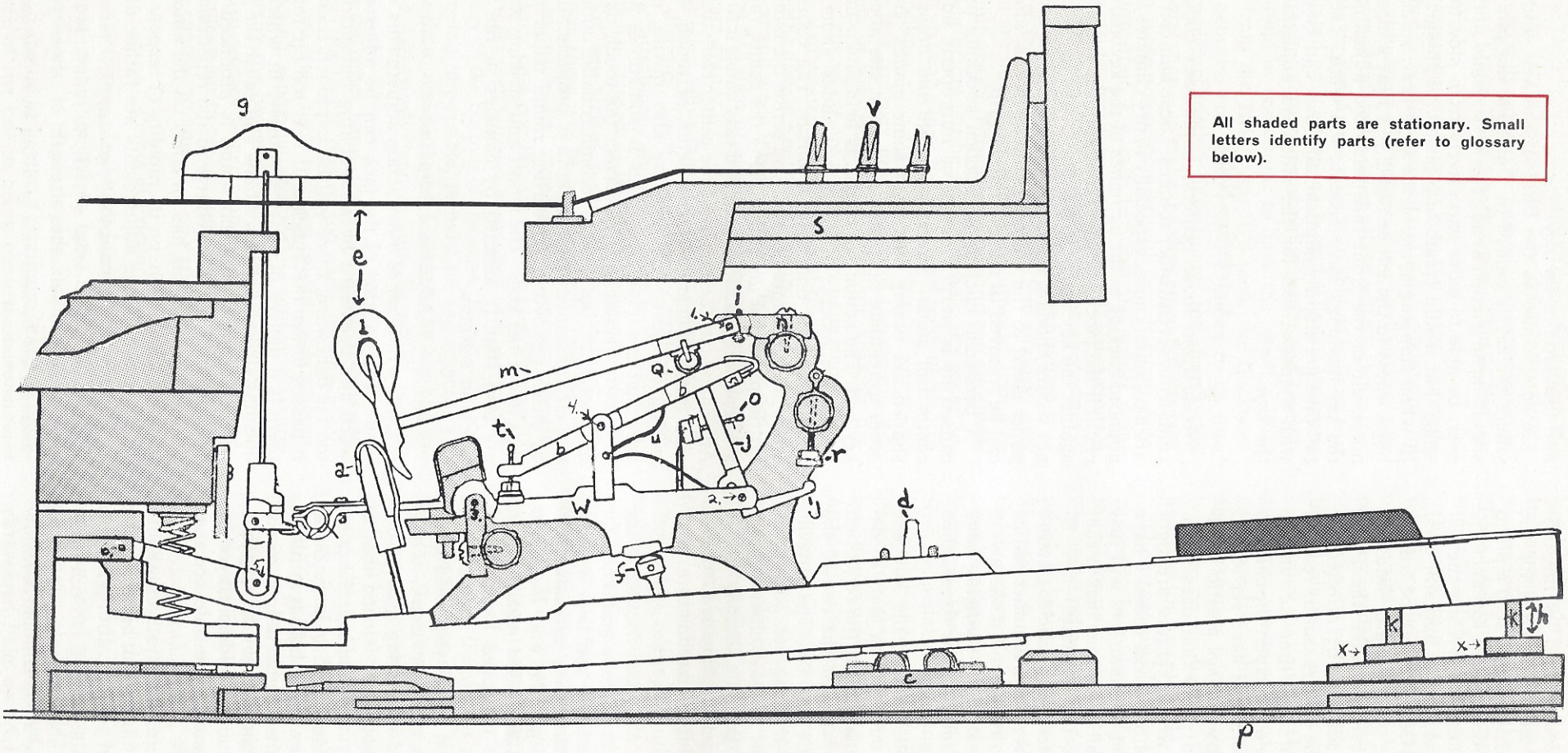
Additional Adjustments

Quite a number of other action adjustments can be made. The position of the jack can be adjusted forward and backward by a regulating button. If it is too far backward, there will be too much friction as it passes under the knuckle. If it is too far forward, there is a danger of missing entirely, in which case one may strike a very hard blow and cause the jack to escape so quickly that no sound is produced at all. The height of the jack relative to the repetition lever can be adjusted; this has an effect on the amount of friction in the action, on its rapidity of response, and on repetition. These adjustments are rather difficult for the nonprofessional to judge.

More important, and easier to judge, are three other adjustments: the strength of the *repetition*

*Steinways and Baldwins have center rail studs; Bechsteins and Bösendorfers do not.

Cross-section of Piano Action



All shaded parts are stationary. Small letters identify parts (refer to glossary below).

Glossary and Key to Diagram

Term	Definition
aftertouch	the free motion at the bottom of the key stroke after the hammer has let off and dropped
a. back-check	the leather covered prong at the extreme end of each key which catches the hammer on its rebound
b. balancier	same as repetition lever
c. balance rail	the middle rail on which the keys rest, which serves as a fulcrum
h. dip	same as touch depth
drop	the distance the hammer drops after it has let off
i. drop screw	the screw which regulates how far the hammer drops after it has let off
escapement	the motion of the jack which slides it out from underneath the knuckle, thereby interrupting the connection between key and hammer
let-off	the point during the hammer's motion when the jack escapes and stops pushing it toward the string
r. let-off regulating button	the felt-covered piece which can be adjusted to regulate the precise point at which the jack escapes and the hammer starts to retreat from the string
s. pin block	the hard wood into which the tuning pins are inserted

d. balance rail stud	the adjustable points along the balance rail on which the action rests and slides	j. fly	same as jack	x. punchings	paper and felt pieces used to regulate touch depth
bearing	the downward pressure exerted by the strings as they cross the bridge	k. front rail pins	large vertical pins which guide the keys and hold the paper and cloth punchings which determine the touch depth	b. repetition lever	the spring-activated component which supports the knuckle after a blow, allowing the jack to slip back underneath in preparation for the next blow
e. blow distance	same as striking distance				
bridge	the rail which transfers the vibrations of the strings, by direct contact, to the sounding board	l. hammer head	the pear-shaped felt which strikes the strings		
		m. hammer shank	the wooden arm holding the hammer head	t. repetition lever regulating button	this does not regulate the tension of the spring, but the height of the jack relative to the repetition lever (the jack should be slightly higher than the lever)
bushing	the felt or plastic lining of a hole inside of which another part moves	n. hammer shank flange	the stationary part screwed to the action frame which is connected to the hammer shank with an action center		
f. capstan	the screw in the key which regulates the height of the hammer, and thereby the aftertouch	e. hammer travel	same as striking distance	u. repetition spring	the spring activating the repetition lever
		hitch pin	the projection to which the far end of the string is attached	repetition spring regulating screw	this does not exist on the action pictured in the diagram; when present it would be located on the repetition lever
center (1,2,3,4,5,6)	a simple type of hinge in which two moving parts are connected by a center pin inside a bushing	j. jack	the L-shaped part which pushes up the knuckle and then swivels out of the way	e. striking distance	the distance between the top of the hammer at rest and the string
d. center rail	same as a balance rail	o. jack angle regulating button	used to regulate the position of the jack relative to the knuckle	trip	same as escapement
contact distance	that part of the key's motion during which the key is connected with the hammer; contact distance plus aftertouch is equal to touch depth	p. key bed	the level surface on which the whole action rests	v. tuning pin	the pin around which each string turns
				w. whippen	the assembly of parts comprising the main components of the piano action, including the jack, the repetition lever and spring, and the piece to which they are attached
g. damper	wooden block with felt underneath which rests on the strings to prevent them from vibrating except when the key or the damper pedal is pushed down	q. knuckle	the leather covered piece attached to the hammer shank against which the jack pushes		
				s. wrest plank	same as pin block

springs, the setting of the *drop screws*, and the position of the back-checks.

The repetition spring pushes up the repetition lever, which lifts up the knuckle and thus the hammer shank so that the jack can slip back under the knuckle in preparation for the next blow. On most pianos, this spring does double duty: it also pulls the jack back. If the spring is too heavy the action will feel heavy and jerky. If it does not have enough tension, the repetition will be sluggish. Here there is room for personal differences. The pianist who wants to stun his audience with extremely rapid repeated notes and trills will want a stronger spring than the one who wants above all to have perfect dynamic response at the softest levels of playing.

Some instruments, including the Steinway, have no screw adjustment for the repetition spring tension, which means that adjusting the springs becomes a very tedious, difficult, and approximate task. Each spring must be individually bent and then replaced in its slot. This feature is unfortunate, because, as hammers are worn and sanded, these springs become lighter and need a lighter spring adjustment.

After the jack has escaped (the let-off point), the hammer head drops. This is known simply as the *drop*. The drop adjustment can affect repetition, heaviness, and evenness.

The back-checks catch the hammers after a blow to keep them from bouncing back and forth. On very soft blows the hammers usually do not catch against the back-checks; if hammers do not catch on medium blows, the back-checks are out of order. Excessively strong repetition springs can also prevent the back-checks from catching properly. The back-checks are adjusted simply by bending the wire that attaches them to the key. Improperly adjusted back-checks and repetition springs may cause keys to repeat unintentionally.

Another adjustment of some importance is the point at which the dampers start to lift. If they move before the hammer is about half-way on its travel to the string, the action will feel sluggish, for the extra weight of the damper is added before the key has received enough momentum. Short crisp staccato will also be difficult, because the damper will not touch the string until the key is almost at rest.

As usual, there is danger on the other side. If the dampers lift too late, legato playing will be impaired, for the dampers will stop the sound as soon as you even slightly release the keys. The dampers should lift simultaneously, and the pedal should have no more than 1/4 inch free motion before it starts to lift the dampers.

The Question of Voicing

Sound quality is mainly determined by the quality, shape, and hardness of the piano's hammers. Most manufacturers put some hardening solution on the hammers, particularly in the treble section, to achieve greater brilliance of sound. Another way to harden the hammers is by using a specially shaped hot iron. Applying a hardening solution is dangerous; it may make the hammers too hard and cause them to sound metallic, but it is sometimes useful in the case of soft hammers.

The treatment and voicing of hammers is the most controversial question relating to pianos, and the answer is partly governed by matters of personal taste and by the type of use intended for a particular instrument. A piano used mainly for chamber music or accompanying should be less bright than one used for solo recitals. A piano for playing a Rachmaninoff concerto in a large hall with a big symphony orchestra must be voiced so brilliantly that it may well sound harsh and explosive when used in a small studio. In the case of my own instrument, which is rather brilliantly voiced, I always keep it completely closed when it is in the studio, with the music rack resting on top of the case. This makes the sound very pleasant, saves the ears from unnecessary abuse, and helps protect the inside of the piano from dust and rust.

To achieve a clear and pure sound, the hammer heads must be kept round or pear-shaped by frequent sanding and reshaping. As soon as grooves in the felt become too deep or too long, the sound becomes distorted and coarse. Ideally the grooves in the treble should not be more than 1/16 inch long. Those in the middle or lower registers may be longer.

How often one sands the hammers to restore their original rounded shape will depend on financial considerations and on how important it is to be able to create an ideal ringing sound. Hammers on concert pianos kept in New York for artists to use will probably be gently sanded after almost every concert, in order to keep their shape perfect. This means, of course, that the hammers will not last long, and that they will need replacement every year or two. Obviously it would not make sense to treat a home piano in this manner. Depending on how much use the piano gets, reshaping the hammers every two to five years should be sufficient.

One problem often arises, particularly in neglected pianos whose hammer grooves have become very deep. From repeated compressions of the felt over many years, the small area contacting the string after the hammer has been reshaped is harder than it should be, so the sound becomes too bright and hard. As one removes felt and approaches the hammer's wooden core, the sound will in any case become more brilliant, perhaps harsh. To counteract this, the felt is softened by pushing needles into it. Whenever hammers are reshaped, the felt will undoubtedly need some needling or voicing in order to even out the differences in hardness between different hammers.

Voicing must be done by someone with a very sensitive ear. The quality of each pitch must be considered from the response following both a strong blow and a weak attack. If the sound is too hard upon a forceful striking of a key, the shoulders of the hammer require deep penetration by the needles. If the sound is too hard upon a gentle striking of a key, the hammer requires only surface needling. Most manufacturers recommend that hammer heads not be needled directly on the top surface that strikes the string; needling in that area could create a permanently soft and mushy sound. The practice might be desirable in the case of some home instruments, but it tends to increase the amount of wear and tear on the hammers and to shorten their life.

A mellower sound quality can result if the hammer surface is gently roughed up with a wire brush, but the effect does not last long.

I feel it is better that an instrument be slightly too bright than too dull. A performer can usually achieve a desired quiet effect even on a brilliant instrument by restraining himself, listening to the level of the sound he is producing and adjusting accordingly. This cannot be done if the sound is too harsh, though, or if the player is unable to refrain from the habit of banging with all his might. Furthermore, a bright-sounding piano has more character in the soft and intermediate dynamic ranges and a wider dynamic range altogether. It is possible to play on a brilliantly voiced instrument as softly as on a dull one, provided that the action is in perfect regulation. It is not possible to play very brilliantly on a dull piano. In voicing, it is better to err on the side of brilliance, because it is always easier to make a piano more dull and mellow. The hardness of hammers that have been excessively needled is not easily restored.

On certain pianos, particularly the Steinway, the sound can also be influenced by the section of the string between the tuning pin and the *treble bar*, which is the solid metal piece under which the strings pass in the higher octaves. An overly harsh piano can often be made more mellow by placing a felt strip in between the strings just in front of the bar. This felt, however, lessens the character of the sound, because certain very characteristic overtones become suppressed. Not all pianos have treble bars, but in those that do the treble bar can be a serious problem as the piano gets older; grooves will be formed by the great upward pressure of the strings and their sliding back and forth when the instrument is being tuned. The strings may vibrate against the enlarged grooves, creating distorted and metallic sounds. This problem can sometimes be remedied by moving the strings with a screwdriver slightly to the right or left so that they pass over a different point on the bar.

Unpleasant vibrations on bass strings are usually caused by their windings becoming loose. This can often be corrected by loosening the string, and twisting it several times, hooking it over the hitch pin with as much torque as possible.

Buzzing vibrations are also caused by cracks in the sounding board or by foreign objects lying on it (or on the strings), loose screws in any part of the piano (including the action), loose veneer, or parts of the frame that have come unglued. Some very frequent sources of buzzes are the lock, the stick for holding up the lid, the music rack, the hinged flap of the fallboard (the key cover), and the fallboard itself.

Often vibrations that seem to come from the piano have their source elsewhere — windowpanes, objects on the piano, loose moldings or floorboards, picture frames, etc. It is often a long and frustrating two-man task to trace these unpleasant noises.

One more important source of vibrations and poor sound quality should be mentioned. The strings must press down firmly against the *bridge*, the wooden rail which they cross before reaching the *hitch pins*. The bridge transfers the strings' vibrations to the sounding board. The amount of downward pressure

exerted by the strings is called the *bearing*, and it is measured by the angle of the change of direction as the strings cross the bridge. This is hard to measure without a special tool, but with some ingenuity and a thin metal ruler to use as a straight-edge one can at least ascertain that there is some bearing. As pianos age they usually lose their bearing gradually. Correcting this is a major task, except in the case of the new Baldwin SD-10 concert grand, where the bearing can be easily and individually adjusted for each string.

Another factor affecting sound quality is the exact point on the string where the hammer strikes. Moving the action backward or forward even 1/16 inch can cause a great change, particularly in the treble.

The hammers must strike all three strings squarely. This movement can easily get out of line, but it can be checked visually. If one string is just grazed, rather than squarely hit, the sound will be hoarse and thin. When the una corda (soft pedal) is engaged, the left string should be missed completely.

The Condition of the Strings

A piano can sound at its best only when it is well in tune. I do not use the word perfectly, because that state is impossible. The art of tuning is not an easy one. There is a proper way of setting the pins, which will help the piano stay in tune better. In order to tune properly, the tuner must strike the piano very hard, so don't think he is banging unnecessarily. The tuning pins are long and bendable. If the tuner merely bends them, the instrument will go out of tune immediately. He must make sure that the pins turn before bending them back slightly so that the direction of their bending tension is the opposite of the direction from which the string is pulling. Most pianos economize by having the strings pass around the hitch pin and double back, each length of wire thus serving for two strings. This slightly increases the tuning problem, for any adjustment to one string will affect its neighbor. This economy is particularly regrettable when a string breaks during a performance, for it means that two strings will be out of use; the wire, rather than flying away, will stay in place, creating a terrible vibrating racket.

Sound quality is also affected by the condition of the strings. Rusty, old strings sound about the same way they look. A concert piano should be restrung at least once every ten years or so. In between these times it is good to discourage people from touching the strings, or, for that matter, scratching them with foreign objects in search of new, earth-shaking sounds.

Quality Work Essential

Needless to say, all action adjustments and regulations must be as even as possible. Do not expect adjustments to conform necessarily to the normal standard. It is more important that the repetition springs be the same throughout the instrument, that the height of the hammers when the keys are depressed very softly and held down are even (this reflects the drop adjustment), and that the line formed by the caught hammers after sharp blows is fairly straight. It would be preferable in some cases to adjust to a consistent standard even if it is one that varies from normal measurements.

A word of caution: inexperienced people who tamper with a piano may cause damage. The easiest thing someone can do is to break off a hammer while sliding the action in or out, if any key is being unintentionally held down. Many special tools not found on any carpenter's work bench are used to regulate piano actions. While it may be possible with some ingenuity to improvise, using knitting needles and the like, injury is again very likely to some of the delicate components if the wrong tools are applied by amateurs. Nothing is more embarrassing than to have to face the piano tuner with a disassembled piano that a careless person has damaged! This article is meant to be a guide to understanding, not a repair manual. Most people will do best to leave the care of their instruments to those specially trained and equipped.

If, however, you are short of cash and determined to experiment, and if your tuner is good-natured and overworked, perhaps he will order a few of the tools you will need to do your own regulating. I would suggest, as a start, acquiring a capstan screwdriver, a grand action regulating screwdriver, a tuning hammer, and a few rubber mutes. Musicians should learn to retune a string or two as pitches occasionally go out of tune.

If a piano has not been regulated for more than ten years or so, it is probably wisest to have a complete regulation done by a qualified technician. While it is true that one adjustment does affect the other, it is nevertheless often possible to improve greatly the feel and response of an instrument by correcting one or two of the most serious defects. Some tuners are opposed to working on the action unless they do a complete regulating job, but there is really no reason why tight action centers, incorrect striking distance, or faulty let-off regulation, the three most common defects, should not be individually treated. Naturally, tuners should be entitled to charge for any regulating done in addition to tuning, since any one of the three operations takes about an hour to complete. (Freeing tight action centers when teflon plastic bushings are involved could take a whole day.) Except for restringing, replacing too-loose tuning pins, and installing new hammers, all of the operations described in this article can be performed in a day's work, unless there are some unusual problems.

Keeping a piano in good shape costs money. I fear that the reading of this article may have expensive consequences for those who take it seriously. Perhaps concert pianists ought not to assume that piano manufacturers and local sponsors can and will pay to maintain instruments at their own preferred standards. All instrumentalists except pianists invest in very expensive instruments, the insurance and repair of which alone may come to more than $1,000 per year. In addition, they are faced with paying the fees and travel expenses of accompanists. (Cellists and bass players must often buy an extra airplane seat for their instruments!) I think that pianists should be willing to spend approximately 3%-5% of their fees to help keep pianos in good repair. The alternatives seem to be unsatisfactory instruments, unpleasant scenes, and inferior performances, none of which help increase the popularity of either piano concerts or pianos.