PETROF
PIANOS SINCE 1864

Service Technicians Manual

GRAND PIANOS MECHANISM REGULATION

2011

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1. General

1.1 Grand Pianos Storage Conditions at Shops and at Customers

Conditions of grand pianos storage at shops, at customers (in apartments), or possibly in recording studios would have had be identical. Grand pianos must be located in sufficient distance from the windows, from heaters, so that moisture occurring when the window is open and the radiating heat from heaters do not act directly on the instrument. Grand pianos must be protected from direct solar radiation and a dust.

Instruments are capable of fulfilling their function well in an environment where they are stored and used, provided that the temperature and humidity conditions pursuant to **Table 1** are observed:

Table 1.

Environment temperature °C	Minimum relative air humidity %	Minimum absolute wood moisture %	Maximum relative air humidity %	Maximum absolute wood moisture %
10	30	6,6	55	10.7
15	31	6,5	56	10.6
20	32	6.5	28	10.7
25	34	6.5	60	10.8
30	35	6.5	62	10.8

1.2 Tuning of Grand Pianos

Tuning of grand pianos is performed according to the chamber A_1 frequency - 440Hz. Tuning using the small or large temperament is performed, see **Table 2, Table 3 and Table 4**.

Table 2. Large temperament in the range D sharp - A_1

1	2	3	4	5	6	7	8	9	10
A_1	A	E_1	E	H	F sharp$_1$	F sharp	C sharp$_1$	G sharp$_1$	G sharp
		3-1	4-2	5-3	6-2	7-5	8-6	9-3	10-8
						7-3	8-2	9-6	10-4
							4-2-8	5-3-9	10-6
11	12	13	14	15	16	17	18	19	
D sharp$_1$	D sharp	A sharp	F_1	F	C_1	G_1	G	D_1	
11-9	12-10	13-11	14-1	15-13	15-2-16	16-3-17	18-16	2-19	
5-11	12-7	13-7	8-14	15-2	12-10-18	16-11-17	18-5	19-17	
5-7-11	12-8	13-8	10-8-14	15-10	16-14		12-18	19-6	
		13-9		15-11	10-16-9		18-13-11	18-5-19	
								15-13-19	

Table 3. Small temperament I in the range A - A_1

1	2	3	4	5	6	7	8	9	10	11	12	13
A_1	A	E_1	F	F sharp$_1$	C sharp$_1$	G sharp$_1$	D sharp$_1$	A sharp	F_1	C_1	G_1	D_1
	2-1	3-1	4-3	5-1	6-2	3-7	8-7	9-8	1-10	10-11	11-12	12-13
		3-2		5-2	2-6-3	6-7	8-4	6-9	9-10	2-101	1-3-10	13-2
						6-3-7	8-4-7	5-9-6	8-10-7	10-3		1-13
						4-3-7				1-10		
										1-10-1		

Table 4. Small temperament II in the range F - E_1

1	2	3	4	5	6	7	8	9	10	11	12	13
A_1	A	D_1	C	C_1	F	A sharp	D sharp$_1$	G sharp	C sharp$_1$	F sharp$_1$	H	E_1
	2-1	3-1	5-4	6-5	1-6	7-8	8-1	13-9	10-2	11-1	2-13	13-1
		3-2	5-13	2-6	7-6	7-10	8-12	10-9	2-10-13	11-2		13-2
				6-13	10-6	11-7-10	8-12-1	10-13-9				
				1-6				12-13-9				

2. Grand Piano Mechanism Regulation (Adjustment)

2.1 Preparation of the grand piano for regulation

Release two screws with wings on lower side of the key bed and remove right and left key block. Release and remove the central screw on lower side of the key bed fixing the front key slip and remove the key slip from the piano. Release and remove the nuts holding the wooden rail fixing the keys from above, remove this rail.

Before regulation of piano action check the position and run of the hammers. Check proper side positioning of the hammers on the strings, adjust the uniform spaces between the hammers, while keep still proper position of the hammers on the strings. If the hammer shank flanges turn hard, release their screws, adjust the hammer shanks and tighten the screws again.

Check and adjust metal hook that shifts the action while using the left pedal so that there has to be adequate tight contact between the hook and the key frame or there can be minimal clearance equal with thickness of cigarette paper. Adjust the hook by turning of brass nut on left pedal lifting rod.

Remove the piano action from the piano, lay it down on work table. Check the straight run of the hammer shanks. Place a short ruler or short strip underneath cca 10 – 15 hammer shanks, raise up these shanks a little more than is their lift in a piano and watch if their lift up is straight. The hammers must lift parallel, they must not travel to the sides, the spaces between the hammers must not change. If some hammers travel to the sides, release their flange and underlay this flange with narrow strip of special thin paper. Underlay the flange with paper strips on needed side as much as the hammer run is straight.

When the action is out of the piano, tighten all screws of the hammer shank flanges, wippen flanges, all the screws fixing the action brackets and hammer rail.

2.2 Adjustment of the key frame seating, adjustment of Key-frame-guide Adjusting Screws (balance-rail studs)

Insert the action to the grand piano. Dab strong the front rail of the key frame and check its tight seating on the key bed. The key frame must not click against the key bed. If necessary, you can adjust proper seating of the key frame by sanding or planing of lower side of the front rail of key frame.

Adjusting of key-frame-guide adjusting screws is performed best without weighting of key frame with the keyboard and the action. Release the screws in action brackets and remove the action from the key frame. (Only gentle re-adjustment can be performed with the action placed on the key frame).

Key-frame-guide adjusting screws are adjusted by turning them using the tuning lever. The key-bed (key-bottom) and the key-frame-guide adjusting screws heads must be in tight contact or there can be a clearance up to 0,1 mm between them.

2.3 Releasing (Easing) of the Key Bottom Holes

Following acts 2.3 – 2.5 are performed on key-board removed from the piano and without the action. This prevents wear of the key bottom holes upon their repeated lifting and there is much better access to the keys.

A properly released (eased) key, upon rising cca 1 cm above the balance-rail surface and upon its loosing, must come (slide) down to its original position to the balance-rail felt punching (washer) by action of its own weight (or possibly upon light tapping on the key). However, at the same time the key must not show a clearance of the bottom hole on the balance pin. There must not be any visible front-back movement of the keys on the balance pins. It must be possible to slide the keys released in this manner out of the key frame pins and slide them back onto the key frame pins easy. Releasing is performed using a special round reamer file for key bottom holes. Do it by gentle turning of the reamer in the holes.

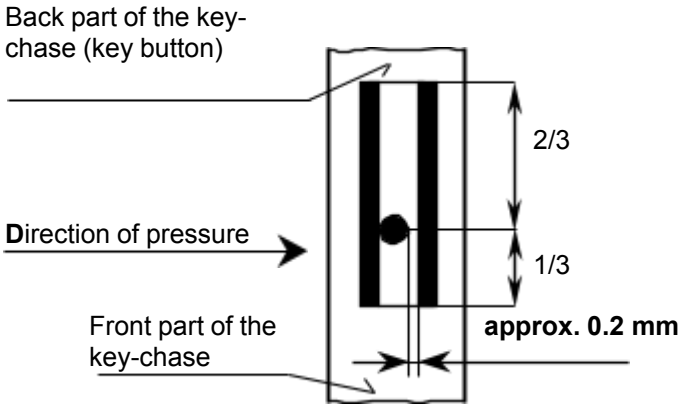
2.4 Releasing (Easing) of the Keys in the Key-chase (Key Button)

There must be clearance of 0,1 mm on each side between the balance pin and bushing cloth strips in a slot of the key-chase (button). That means that upon light side pressing of the key towards the balance pin, as far as the inner surface of the slot contacts the balance pin, there will arise clearance of 0,2 mm on the opposite side between the balance pin and inner wall of the slot. See **Fig. 1**.

When performing the check, the key is in its natural (basic) position and is pushed lightly down onto the balance rail using fingers of the other hand. Clearance is checked by tilting of the key to the side. A qualified estimate is made of the clearance required.

In case the clearance is smaller than required, squeezing of the slot of the key-chase (button) must be performed. Releasing is performed using special squeezing key bushing pliers with parallel working jaws with a small supporting wing. Squeezing of the slot is performed always on both sides, so that pressing of wood and cashmere cloth bushing strips is symmetric. Releasing must be done carefully so that the keys are not too loose. It is efficient to lubricate the bushing with teflon powder to decrease friction in key-chase.

Figure 1. Clearance of the balance pin in the key button slot



2.5 Releasing (Easing) of the Keys on the Front Pins

There must be clearance of 0,25 mm on each side between the front pin and cashmere cloth

bushing strips in a front slot of the key.

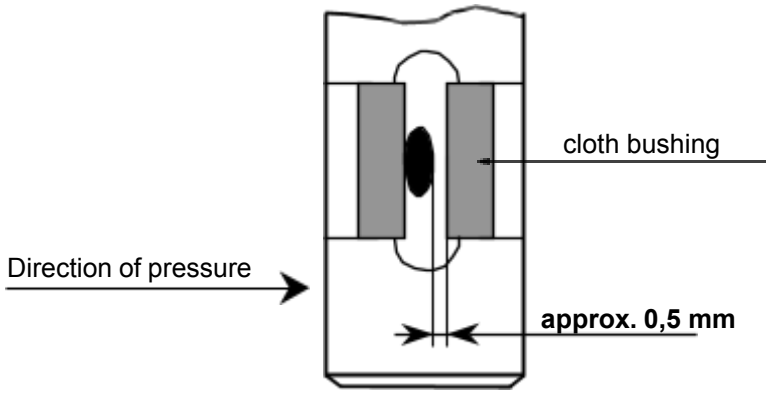
That means that upon light side pressing of the key towards the front pin, as far as the inner surface of the slot contacts the front pin, there will arise clearance of 0,5 mm on the opposite side between the front pin and inner wall of the front slot. See **Fig. 2**.

When performing the check, hold the key at place of the upper key button with one hand, and press down the front part of the key on the keyboard frame front rail with your second hand, so that the key touches down on the felt punching of the front pin. Check the clearance of front pin in front bottom slot by gentle moves of the key into the sides in its front part. A qualified estimate is made of the clearance required.

In case the clearance is smaller than required, squeezing of the slot for front pin must be performed. Releasing is performed using special squeezing key bushing pliers with parallel working jaws with a small supporting wing. Squeezing of the slot is performed always on both sides, so that pressing of wood and cashmere cloth bushing strip is symmetric. Releasing must be done carefully so that the keys are not too loose. It is efficient to lubricate the bushing with teflon powder to decrease friction in front slots.

If the lower front slots are too lose perform their reparation by manual replacing of cashmere cloth bushing strips in the slots.

Figure 2. Clearance between the oval front pin and the key cashmere cloth bushing



2.6 Positioning of the Jacks under the Knuckles

Regulating of the jacks is performed on action removed from the grand piano.

First it´s necessary to check side positioning of the wippens. This is a compromise of several parameters:

- The hammers must be exactly side positioned to the strings.
- If possible, the wippen subassemblies must be side positioned so that repetition levers and jacks contact the knuckles symmetrically in their centres.
- If possible, the capstan screws must be side positioned so that they contact wippen cushions symmetrically in their centers when watched from the front.
- If possible, there must be uniform, even spaces between wippen subassemblies and between repetition levers when watched from above.

Side positioning of wippen subassemblies can be adjusted by underlaying of wippen flanges with narrow paper strips, right or left aside flange screws, the same way as when underlaying hammer shank flanges.

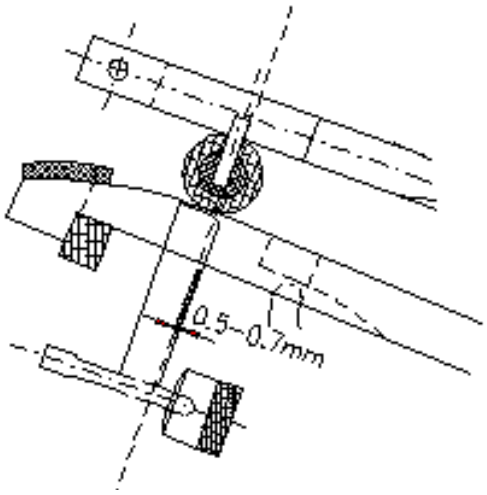
While adjusting front-back position of the jacks, the hammer shanks must be rised about 5 mm above the hammer rail felt.

The back side of the jack must be positioned approximately by 0,5 – 0,7 mm behind the back edge of the knuckle insert (knuckle strip), see **Fig. 3**.

If the jack is in one line or even in front of the knuckle strip it can slip from under the knuckle previously, or too easy and hammer shooting up could be infirm, unsure.

Front-back positioning of the jacks under the knuckles is performed by turning of the jack regulating screws. All the jacks must be adjusted individually.

Figure 3. Positioning of the jack under the knuckle



2.7 Vertical position of the Jack in the Repetition Lever

The upper surface of the jack must be found 0,3 mm below the level of the upper surface of the repetition lever.

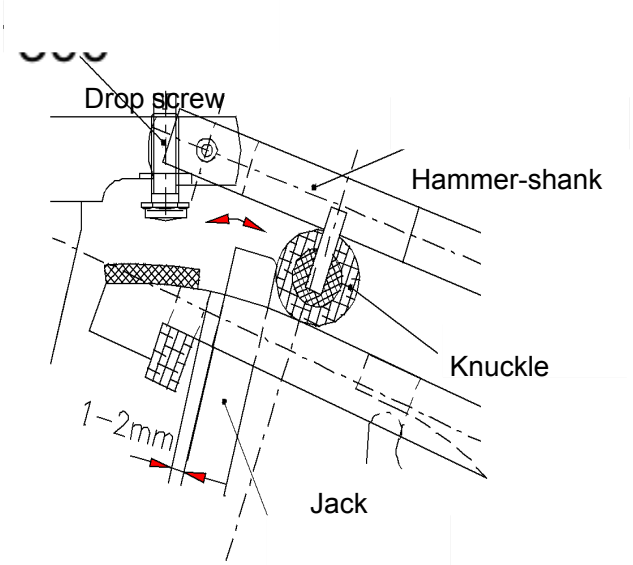
Vertical position of the jack in the repetition lever is adjusted by turning of the repetition-lever regulating screw.

At the same time the jack has to be side positioned symmetrically in the window of the repetition lever when watched from above.

2.8 Clearance between the Jack and the Jack - pad Felt

Clearance between the jack and the jack - pad felt after sliding of the jack from below the knuckle should be 1 - 2 mm (in case of proper mutual distance of the hammer-flange rail and wippen rail). See **Fig. 4**. If the clearance is too small it can be adjusted by careful cutting off the thin slice of the felt pad.

Figure 4. Clearance between the Jack and the Jack - pad Felt



Clearance between the jack and the jack-pad felt can be also adjusted by change of mutual position of wippen rail and hammer flange rail, by their approximation or their shifting off. But doing this you change front-back position of the capstan screws on the wippen cushions what changes lever ratio of the whole action and its behaviour. Total regulation of the action must be performed after such step.

2.9 Levelling of White Keys

Next steps 2.9 – 2.14 are performed on keyboard and action inserted to the grand piano.

There has to be minimal distance of 17,5 mm between lower side (bottom) of the keys and upper surface of front rail of the key frame of Petrof grand pianos.

Upper surface of the keys should be distant about 64 – 65 mm from the key bed. This distance has to be the same on both sides of the keyboard in bass as well as in treble.

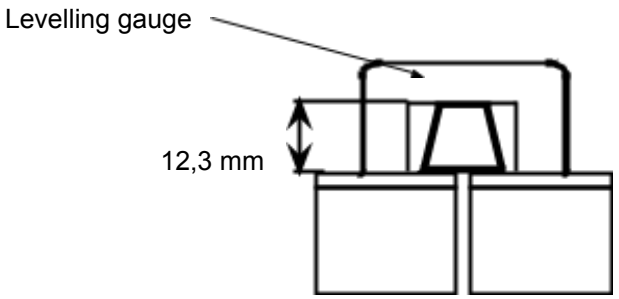
Alignment of white keys to a level is performed by underlaying of the keys with paper washers on the balance rail pins or by their removing. Levelling of the keys is checked by watching of open gaps between of long, light ruler placed on front ends of key tops and upper surface of the keys.

2.10 Levelling of Black Keys

Distance of the upper surface of the black keys should be 12,3 mm above the white keys top surface. See **Fig. 5**.

Alignment of sharps to a level is performed by underlaying of the black keys with paper washers on the balance rail pins or by their removing. Proper vertical position of blacks can be checked by placing of “U” shaped gauge turned bottom up on the upper surface of each black key. Then the levelling can be checked by watching of open gaps between of long, light ruler placed on front ends of key tops and upper surface of the black keys.

Figure 5. Levelling of black keys



2.11 Set-off of the Hammers from the Strings

Set-off (let-off) represents the distance of the hammer head top from the string to which the hammer rises upon pressing the given key, in the moment when the jack heel bears against the set-off dolly (regulating button) and jack slides out from under the knuckle. Set-off is adjusted by turning of the set- off dolly (regulating button).

Set-off of the hammers from the strings shall be 3 mm in the bass section, in the middle section it passes continuously to 2 mm, and in the treble section to 1.5 mm.

Adjustment of set-off is performed by vertical regulation of regulating buttons by their rotating.

After touch is palpable decrease of the key upon its full pushing to the lower position, just in moment of set-off, when the jack slides out from under the knuckle. After touch must be felt cca 1 mm above lower position of the depressed key.

If we need to increase feeling of after touch, we can increase a key dip a little (deeper key dip) or adjust the jack more backward behind the knuckle strip.

2.12 Hammer-blow Distance

Required distance of hammer heads from the strings (Hammer-blow distance) is 45 mm. This distance is measured in lower rest position of the hammers. At the same time the hammer shanks has to be set about 5 mm above the hammer rest rail felt. See **Fig. 6**.

Hammer-blow distance is set by vertical adjusting of capstan screws by their rotating.

Figure 6. Hammer blow distance

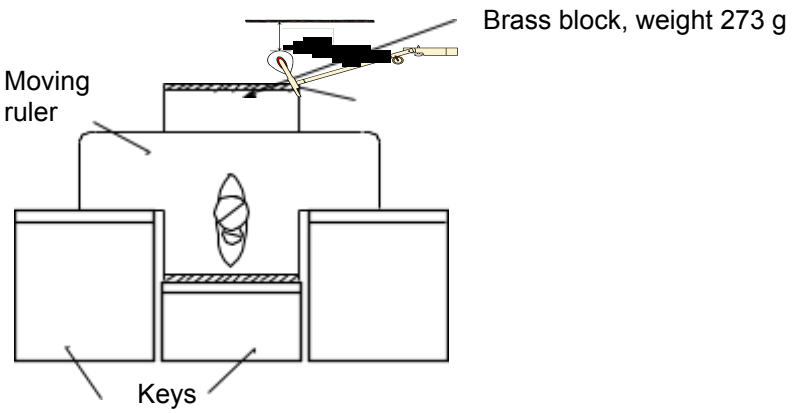
45 mm

2.13 Dip of White Keys

Upon pressing the white key onto the front rail washer (punching), the height distance of its upper surface and the upper surface of the adjacent keys has to be 10 mm + 0,5 mm.

The correct dip is achieved by underlaying or removing of front rail felt washers with paper washers. Too deep dip can be adjusted by adding of paper washer on front pin. Too shallow dip can be adjusted by removing of paper washer. When underlaying the keys to achieve the dip desired, a special gauge is applied. This is a brass cube weighting 273 ± 1 g with vertically movable “T” shaped plastic ruler with side cuts of depth of 10 mm. See **Fig. 7**.

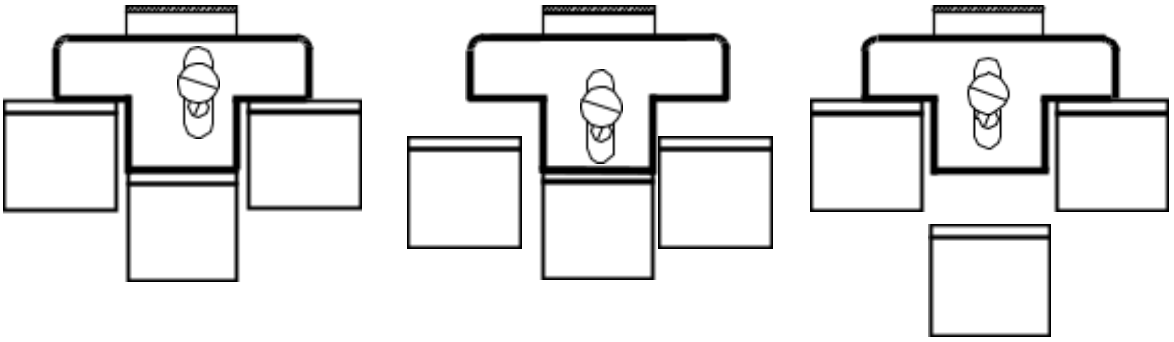
Figure 7. Checking of white keys dip



When the gauge is placed on front end of the key, the key is depressed to its lower position. If the key dip is wrong then open gap can be seen between the keys and ruler of the gauge. See **Fig. 8**.

Figure 8. Correct key dip using special gauge

Correct key-dip Too high key-dip Too deep key-dip



2.14 Dip of Black Keys (Sharps)

The dip of black keys should be about 10 mm again, but it is not adjusted to exact 10 + 0,5 mm according to any gauge. The dip is adjusted so that the same feeling of after touch is achieved as in case of white keys. The deeper key dip the stronger feeling of after touch. The shallower key dip the weaker feeling of after touch. Feeling of adequate after touch is prefered to absolute depth of black keys dip.

Proper dip is achieved by underlaying of front felt washers on front key pins with paper washers or by their removing.

2.15 Drop Adjustment

The drop adjustment is performed on the action removed out of the piano.

When the key is pushed down very slowly the hammer rises up to the moment of let-off. When the hammer reaches its upper position it falls down a little. This jerk down is called drop. The drop down has to be 3 mm in bass, 2 mm in middle section and 1 mm in treble.
Drop movement must be fast and definite (exact).

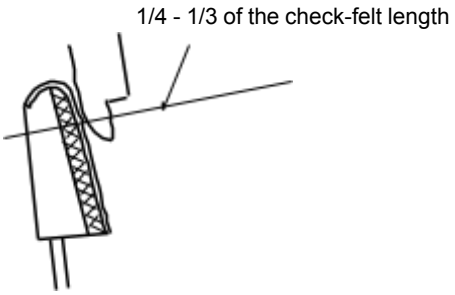
Drop is adjusted by turning the drop-screw in hammer shank flange. When the screw is turn down, the drop is bigger. When the screw is turn up, the drop is smaller.

2.16 Back Checks Regulating

When the checks vertical position and position of the checks towards the hammer mouldings are correct, then the hammers are captured in the distance of 16 mm from the strings (distance between the hammer head top and the string). The hammer mouldings are to be captured in 1/4 to 1/3 of the check-felt length. See **Fig. 9**.

The back checks must be well right- left positioned towards the hammer mouldings. This side positioning is performed by bending of the back-checks wires using special bending pliers. The wire must be bent down just close to the key and up just close to the back check.

Figure 9. Position of back check and hammer moulding



The back checks positioning and regulating is performed without using any instruments, only by front-back tilting (hand-bending) the checks.

First it is necessary to set the checking of sample hammers in the piano. Measure the height of checking of the fist and last hammers in all sections. Then remove the action out from the piano and using front-back hand bending of the back checks set the proper checking height of these sample hammers. Repeatedly put the action to the piano and measure the checking height, remove the action out and tilt the sample back checks. When the sample hammers in all sections are well adjusted, remove the action from the piano and adjust other remaining back checks on a work-table. Push about 5 – 6 keys at the same time, using standard uniform touch and adjust their checking to the level. This way adjust the checking in all sections of keyboard range.

2.17 Adjustment of Repetition Springs

The repetition spring pushes jack and repetition lever to their starting position after releasing of depressed key. Tension of repetition spring is adjusted by change of its shape. Adjustment of repetition spring is performed on the action removed out of the grand piano.

Springs adjustment is checked as follows. The key is depressed completely so that the hammer is captured (catched) by the back check. Then the key is released slightly which causes releasing of the captured hammer. This hammer then rises up by cca 8 - 10 mm. When the spring tension is correct, the hammer rises quickly in a nimble manner but not much wildly (vehemently), without jerking. When the spring tension is insufficient the hammer rises up slowly and lazily (sluggishly) or it does not rise at all. When the spring tension is too strong the hammer rises very vehemently.

The repetition spring is adjusted using a special spring regulating hook. See **Fig. 10**. Remove the spring from groove of repetition lever. Hook the weak spring with the regulating hook from bellow and pull it up to increase the spring tension. Or push down too strong spring to decrease the spring tension. See **Fig. 11**.

It is necessary to change the spring tension in its coil. The spring tension must not be changed by deformation of spring arms. The spring arms must be shaped to smooth arcs.

In some actions, a regulating screw is used in repetition lever, using which the springs tension can be gently adjusted. See **Fig. 12**.

Figure 10. Spring regulating hook

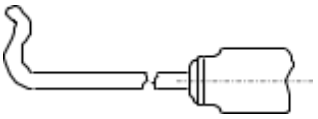
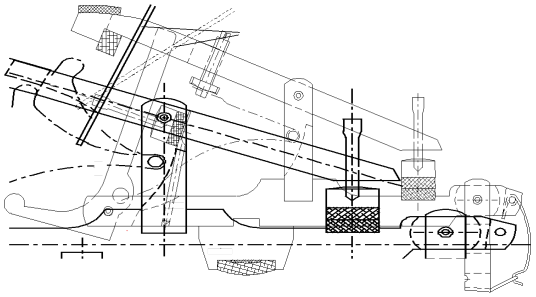


Figure 11. Repetition lever **without** the repetition-spring-regulating- screw

hook

Figure 12. Repetition lever with the repetition- spring-regulating-screw



2.18 **Damper Straight Run Adjustment**

Straight run of the dampers is performed when the action is removed out of the piano. Push gently the right pedal repeatedly and watch the straightness of damper´s run. During their lift up the spaces between the dampers must not change and the dampers must not gently turn.

If it is necessary to adjust the damper run, turn gently the dampers wires by flat pliers. Then check the run straightness again.

2.19 Damper Synchronous Run Adjustment, Pedal Control

When action is taken out of the piano, pusch gently right pedal several times and watch the synchronous run of dampers.

If some dampers start to move earlier or later, adjust the differences in their timing by turning damper lever adjusting screws. Late reaction – turn screw down (out), early reaction – turn screw up (in).

While pushing the right pedal down, the wedged damper felts should be ca 2 mm above the strings, flat damper felts a little bit higher.

2.20 Damper Run ("Semi – Run") Adjustment

When the white key is depressed slowly down the damper must start to lift up in the moment when the hammer is in one half of its way to the strings. (This is called "semi-run".)

Damper motion is adjusted by bending of damper-spoons downwards or upwards. The spoon is bent closely at the damper-lever, using flat nose pliers with long jaws or using a special bent fork-type action regulator.

First the sample dampers must be adjusted in the piano, first and last in all sections. Remove the action out and insert it into the piano repeatedly and bend sample spoons down or up to achieve proper run of these sample dampers. Then remove the action out from the piano and adjust all remaining spoons to the line according to adjusted sample spoons. Damper spoons of black keys are bent about cca 1 mm higher, because the black keys are shorter than whites. Then insert the action to the piano and check proper adjustment of damper run pushing the separate keys.

2.21 Damper-check (Stop Rail) Adjustment

The damper-check position is vertically adjusted to avoid uncontrolled lift of the dampers.

The damper-check is adjusted vertically so that the damper stroke (uplift) must be sufficient, and there must be a space of 2 to 3 mm between the risen damper-levers and the stop rail (damper check).

Release the fixing screws of damper stop rail a little. Push the right pedal and lift the dampers up. Then set the stop rail vertically 2 – 3 mm above lifted damper levers and tighten the stop rail screws.

2.22 Damper Pedal Adjustment

In the same time with damper stop rail adjutment it is necessary to adjust a range of vertical run of right pedal lever (bar) on lower side of a key bed. Upper extreme position of this lever is adjusted by turning of brass set screw placed in the lever. The had of this screw is blocked about lower side of the key bed. Lower extreme position of this lever is adjusted by turning of steel wood screw with steel and felt washer, that passes through this lever to the key bed.

When pushing the right pedal, it must not contact bottom of a lyre box. Proper contact of pedal

lifting rod with wooden lever is adjusted by turning of brass hexagonal head (nut) of lifting rod.

2.23 Prolongement (sostenuto) function Adjustment

The middle pedal is a prolongement (sostenuto) pedal. It sustains only those notes which are being held down when the pedal is depressed, allowing future notes played to be unaffected.

How to use it:
Play these tones you want to prolong, push the middle pedal (these tones will sustain, their dampers are lifted up until the middle pedal is pushed down). Continue to play other tones that will sound short, dampened by dampers (They will sound together with tones played before.) When the middle pedal will be released, this function will finish.

Functional check:
Push right pedal, all dampers lift up, keep the right pedal depressed. At the same time push the middle pedal and then release the right pedal, all dampers must remain lifted. Release the middle pedal, all dampers must fall down freely on strings.

Remove the action from the piano, depress the middle pedal several times and watch if the sostenuto brass rod rotates freely without lifting of damper lever flanges tongues, without lifting the dampers.

Adjustment:
Adjustment of sostenuto function is performed by adjustment of front-back and vertical position of sostenuto rod.
Front-to-back position can be adjusted by turning of hexagonal fastening screws of sostenuto rod. This screws are placed in cross block and keep sostenuto rod guides.
Vertical position of sostenuto rod can be adjusted by shifting of its wooden guides up or down when you release fastening screws with cross heads, placed in hexagonal screws.

2.24 Balancing of the Keyboard

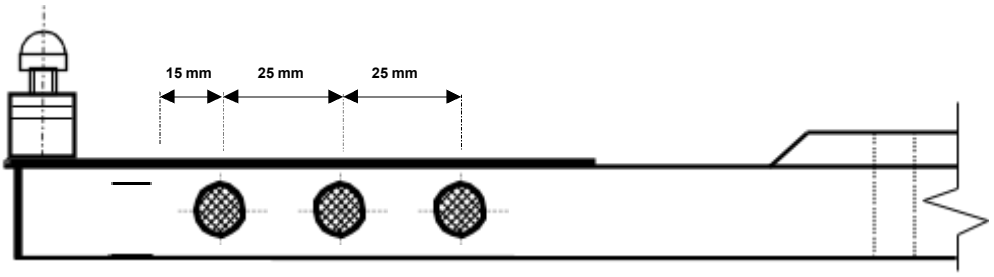
Balancing of the keyboard loaded with the action, removed from the instrument is performed this way:

The key is supported from bellow with one's finger, in its normal upper position. Then the testing weight 50 - 55 g, ± 1g (See the chart bellow) is placed onto the front edge of white or black key, aligned with the front edge of key. See **Fig. 13**. Upon releasing the key, the key loaded with a testing weight must overbalance barely so that the key goes down smoothly and the hammer rises continuously up to the position when after touch is felt on the key, approx. 1 mm above the key down position.

When the given key is balanced properly, then upon its pressing to the after touch position about 1 mm above its down position, being loaded with a testing weight 22 g, and upon its releasing, the key must lift up lively to its original position. This "up-force" balancing is performed with the action on the keyboard, removed from the piano.

Adjustment of the balancing is performed by placing key-leads, of the mass of 16 g into white keys and 13 g into black keys. The balancing key-leads are located between the balance pins and the front-rail pins so that the drilled-in holes centres for key-leads are located at least 15 mm from holes for these pins. The distance between centres of neighbouring balancing key-leads should be 25 mm at least. See **Fig. 13**. When it is necessary to place the weighs behind the balance pin, again, the centre of the first key-lead is located at least 15 mm from the opening for balance pin or from the capstan screw.

Figure 13. Placement of the weight and minimum distances of the balancing leads



Standard balancing - Balancing is performed using the weight of 51g in the whole range of the keyboard.

German balancing - Balancing is performed using weights from 55 g in bass section to 50 g in treble section, according to the chart bellow.

Keys order	1 - 27	28 - 40	41 - 53	54 - 67	68 - 88
Weight mass	55 g	53 g	52 g	51 g	50 g

The check and adjustment of key spacing must be done after the check of balancing.

2.25 **Spacing of the Keys, Fastening of Key Stop Rail**

There must be uniform spaces between the keys along the whole keys length, in front as well as at the back. The spaces between the keys can be adjusted first by side bending of the balance pins and then by side bending of the front pins using a special fork spacer. At the same time leveling of the keys must not be destroyed. Adjustmen of keys spaces is always a compromise.

First spaces between white keys are adjusted, then spaces between whites and blacks.

After completion of keys balancing and key spacing the rail fixing the keys from above must be assembled back. There must be clearance of 1 – 2 mm between the rail and keys.

3. Voicing verification

3.1 Hammer shape adjustment

It is necessary to adjust the hammer shape before voicing. The hammers played long-time can be compressed from strings. There can be squeezed grooves from strings on hammer tops, the hammer tops can be flat or the hammers can be wrong shaped before.

Adjust the hammer shape by careful sanding with sanding paper around the whole hammer perimeter. While sanding the hammer felt don´t interrupt overly the felt layers. Then the hammer felt could lose its tension. Shape an adequate tip on the hammer top, neither too flat, or too pointed. The hammer tip has to be located in centerline of the hammer. Brush off the hammer perimeter with brass brush.

3.2 Hammer Right-Left Side Positioning to Strings.

Position of the hammers to the strings can be checked when the hammers are lifted to the strings. We can lift the hammer shanks catching them from above using a special hook and pulling them up. Or we can lift the hammers from below pushing the wippens up with a finger. Lift up all hammers, watch their right-left position on strings.

Bass single strings have to be aligned to centre of the hammers.

Hammers of more-string tones have to be positioned against the strings a little right, so that the left string is not contacted by hammer while pushing the left pedal. Then the tone is more silent but with similar tone colour.

Or the hammers of more-string tones can be positioned against the strings so that while pushing the left pedal the hammer strikes the left string just with its edge. Other strings are then contacted by soft zones of the hammer. The tone of piano is then not only more silent but also softer, more round.

If it is necessary, we can adjust the hammer side position by gentle side turning of hammer shank flanges using a special tool - spacer. If necessary we can release the flange screws a little, adjust the flanges position and then tighten the screws well again.

3.3 Side Movement (Shift) of Action.

Adjustment of side shift of the action can be adapted according to requirement of concrete player. There are two possible ways.

Action side shift can be adjusted that way that the hammer doesn´t strike the left string of more string tones when the left pedal is depressed. Bass single strings are struck with hammer assymetrically (a little aside), but not with hammer edge. Hammers of two string tones must strike only one string. Hammers of three string tones must strike only two strings. Piano tone is then weaker but with similar tone colour.

Or the action side shift can be adjusted that way that hammer strikes the left string of more string tones with hammer edge when the left pedal is depressed. Other strings are then contacted by soft

zones of the hammer. The tone of piano is then not only more silent but tone colour is softer, more round.

Adjustment of action side shift can be done by turning of regulating screw in right edge of key frame. This screw (stopper) blocks the action against the right key block in its right shifted position.

3.4 **Hammer Fitting on Strings.**

Purpose of this operation is to ensure a proper contact of hammer tip with all strings of one tone. The hammer must strike all strings of one tone in the same moment and with the same intensity. This can be obtained by fitting of hammers to the strings. The hammer tip can be sanded so that it contacts all strings at once. At the same time proper shape of the hammer must be kept, especially close the hammer tip.

Lift up the hammer to the strings, push it gently to the strings, lift up the dampers with right pedal. Twang the separate strings of one tone by plectrum, none of them can play. If some of them sounds a little, sand carefully the hammer felt under other strings of this tone. The finer contact of the hammer with strings, the better control of different decay of separate twanged strings, the better fitting of the hammer to the strings. Even contact of the hammers with strings influences voicing greatly.

The hammers can be lifted to the strings by several ways:

a) The hammer can be lifted to the strings by pulling the hammer shank from above using special hook. Using this way it is difficult to modulate pressure of the hammer to the strings.

b) Or the hammer can be lifted from below pushing the wippen up with a finger. This way it is very easy to modulate gentle pressure of the hammer to the strings. Using this way it´s recommended to remove the action from paino, place a strip of thick fabric or strip of leather between the top ends of jacks and knuckles and insert the action back to the piano. Then you can lift the wippens up by a finger. The hammers rise up easy to the strings, contact them with easy modulated pressure, without any deformation of action parts and action pins. The same effect can be obtained when you remove the regulating rail with regulating buttons.

c) Or you can remove the regulating rail and lift the hammers up pushing the keys. This way is very comfortable.

3.5 **Voicing Verification.**

Purpose of this operation is to find out if volume and tone colour of all tones is even in whole range of the keyboard, if the tone quality corresponds with typical tone character of Petrof pianos. Reasonable volume of the piano, enough long tone, wide range of dynamics from pianissimo to fortissimo, typical round, soft, romantic and lyric „Petrof“ tone colour can be obtaind performing advanced hammer voicing.

The hammers must be enough elastic and reasonably hard. Elasticity of too hard hammers can be increased by deep needling. Fast deep puncture brings bigger and longer-range effect than slow puncture.

Play separated sections repeatedly, look for tones with different volume and with different colour of tone. It´s convenient to mark these different tones with chalk.

Sharp tones can be rounded by sticking with voicing needles. Different needling techniques can be used depending on extent and type of requested change. In principle the hammer should be needled to its shoulders from „9 to 3 o´clock“, when needle is directed upright to the hammer surface. To increase hammer elasticity use first deep punctures led step by step from below from 9 and 3 o´clock to the hammer tip (12 o´clock). The higher placed punctures, the shallower. Close to

the hammer tip in the area between 11 and 1 o´clock perform only gentle punctures about 2 mm deep only. Try to avoid needling right to the hammer tip where the hammer contacts the strings.

To obtain sharper tone sand the hammer felt evenly around the whole perimeter of the hammer. To obtain definite contact of the hammer with the strings, keep adequate shape of the hammer tip, neither too round or too pointed.

Sharper, louder and brighter tone can be also obtained using soaking of the hammers with hardener. Most frequently the solution of nitrocellulose lacquer or acrylic plastic in acetone is used. If the hammers are soaked with hardener very thin concentration must be used. If necessary it is better to impregnate the hammers several times with thin solution than once with dense solution. Let the hardening solution evaporate and harden completely, only then continue in voicing by needling and sanding.

Too short tone can be prolonged using deep puncture to the hammer shoulders, for example make three deep sticks, one above other in zone about 10 and 2 o´clock.

The hammers must be voiced playing loudly fortissimo as well as playing quietly pianissimo. The instrument mut be able to play in wide range of dynamics. Still check and adjust fitting of the hammers to strings during voicing. Needling changes the shape of hammer perimeter surface.

Check the tone when using the left pedal. Tone character should be saved the same or very similar, uniform and even also when using the left pedal. If you find any differentials, unify them by additional needling or sanding of the hammers. Then brush the hammers by brass brush in the end.