I. PRACTICAL SECTION

Making and Tuning a Steel Pan

Panmakers’ working methods are usually learned during a long time as apprentice of a respected master. The methods may later be changed and formed by the tuner’s own personal preferences. In crafting, the same result can often be accomplished in several ways and things can be done in different orders. The intended result may be the only common denominator of the different working methods.

It is hard to describe handicraft work in writing. To describe the crafting and tuning work, I have chosen to report the various steps of onemethod to make functioning steel pans. I have tried to emphasize what I believe is the desired result of each step, rather than the exact working process. It is up to the reader to judge if he wants to work in this way or use some other method to get the required result. A skilled panmaker often omits some of the steps described here, because the precision of his work usually makes them redundant.

Each chapter in the practical section is structured according to the following; first, a brief description of what is to be done, second, why it is done and third, how it is done. For the sake of clarity I have been forced to dissect the work of the panmaker into discrete pieces. The many small steps described here are often interlinked with each other in a continuous flow of work that can be very hard to penetrate. When you do the actual work you will often find it hard to separate the steps from each other.

The main stages in the making and tuning process, together with a rough estimate of the used time for a professional panmaker, are:

- Choosing the drum
- Sinking: 2 hours
- Marking of notes: 30 min.
- Backing: 1 hour
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- Grooving 1 hour
- Levelling 1 hour
- Cutting 30 min.
- Tempering 30 min.
- Coarse tuning 2-4 hours
- Making holes for hanging 30 min.
- Fine tuning
- Finishing
- Blending

The making of a steel pan set is usually about two days of work for a tuning team: The first day the sinker does the sinking, backing, grooving, levelling and the tempering. The second day the tuner does the tuning. The blending – the last fine tuning – is done after the chroming and has to be repeated later when the pan gets out of tune.

The description of the crafting process involves many terms that are special to steel pan making and also many measures. Before continuing, it may be appropriate to take a look at appendix E for a definition of the terms used for the various parts of the steel pan. In the beginning of appendix A there is an explanation of the measures and a conversion table between inches and millimetres.

1. Choosing the drum

The drums used for steel pan making are ordinary, new or used steel barrels. The volume of the standard steel drum is 208 litres (which equals 45.8 imperial gallons or 55 U.S. gallons, respectively). The drums are 59.5 cm (23 inches) in diameter and 88.3 cm (24.8 inches) long. See appendix D for more details on drums.

Panmakers usually prefer drums that have a rim with a flat side and a square cross-section; a so called “flat fold”. A new method to join the side and the bottom of the drum is to make a round fold, see fig. 1.1. Some panmakers avoid drums with this round rim, because they claim that it will not withstand the stretching forces during the sinking. However, recent tests (done by a tuner and myself) indicate that the round rim...
rim is as durable as the flat rim. Acoustically, the result seems to be acceptable too. On Trinidad, backline instruments are often made out of round-rim drums nowadays, but the round rim seems to be avoided in front line instruments, I believe, mostly for aesthetic reasons.

The thickness of the metal is of vital importance. Generally, it seems to be better the thicker the metal is, especially for the lower tuned instruments, such as bass, cello and guitar pan. But if you use a thick metal for the higher pans, such as the tenor and the double tenor, the small high notes might be difficult to tune. The thickness of the steel in the bottom of the most commonly used drums is 1.2 mm (18 gauge). The side of the drum can be either 1.2 mm or 1.0 mm (20 gauge) thick. It is unclear which is the best; a side with 1.0 mm thickness seems to be most common. The thinner skirt will probably give the sound of the pan a better “ring” than the thicker one.

The thickness of the metal in the bottom of the drum cannot be measured directly without destroying the drum, so you have to use some tricks to determine it. The thickness of the metal in the bottom and the top can be assumed to be the same. The thickness of the top can be measured with a tool that is put in through the tap. The weight of the drum and the sound that is emitted when you tap on it can also be used as clues to the thickness of the metal. See appendix D for data on the weight of different drums. Drums with less than 1.0 mm (more than 20 gauge) thickness in the side are often corrugated for additional strength. Try to avoid those for pan-making because the bottom of these drums is probably too thin (1.0 mm or less).

The material of the drum should be mild steel. Steel drums with a galvanised iron coating cannot be used for steel pans – the coating definitely spoils the tone. The quality and homogeneity of the steel are important. Poor metal may have spots where the carbon content is more concentrated. These spots are harder and may burst when stretched during the sinking.

The condition of the drum is also of great importance. A little light rust here and there on the surface doesn’t matter, but try to avoid drums with sharp dents and spots of rust that seems to be going deep. Such spots tend to crack when the metal is stretched during the sinking. Text that is grooved on the bottom of the drum will usually not affect the result as it will be smoothed out during the sinking. But if the text is deeply grooved and has sharp edges, try to find another drum, at least if you are about to make a pan that is to be sunk deeply.

Some drums are “re-conditioned”, which means that they are
cleaned and used a second time. The drum is often burned clean during the reconditioning process and this affects the metal in an unfavourable way. Try to avoid these drums. Re-conditioned drums can be detected by scraping off the paint at a spot and looking at the metal surface. If the metal is clear and shiny, it is a new drum. If it is grainy and without lustre, it is re-conditioned.

2. Sinking

The sinking is the first part of the panmaking. During the sinking the panmaker lowers the bottom of the drum into a concave kettle where the notes later are hammered up as convex dents. The whole sinking process can be seen as consisting of four steps; marking, lowering, shaping, and smoothing.

There are several reasons for doing the sinking: First, the bottom is lowered to remove the tone of the bottom of the drum – otherwise it would interfere with the sound of the notes. As the bottom is sunk you can hear its tone rise from a low pitch up to a very high. Second, the bottom is stretched to enlarge the surface to make enough space for all the notes. Third, the metal is made thinner in the middle where the highest notes will be situated. Fourth, the sinking is intended to make a suitable overall curvature for the notes of the different pan types. There seems to be a certain (still unrevealed) relationship between the size of the notes and the needed overall curvature of the pan – small notes; deeper sinking – large notes; a more shallow sinking.

If the bottom rim has some indentions you have to start by making sure that the rim is circular. This is done by hitting the rim with a sledge-hammer from the middle of the bottom surface and outwards. If the side of the drum has some large indentions it is best to open the drum in the top and remove the dents by hammering from the inside. Otherwise they might affect the sound of the outer notes.

Begin the sinking process by opening the drum to make it possible for the air to come out when you are hitting the bottom. This can be done either by removing the whole top Fig. 2.1  Remove the plug to let the air slip out during the sinking.
or the plug, see fig. 2.1. Then turn the drum upside down and place it steadily on the ground. A few strokes on the top before turning the drum may make the top concave and help the drum stand better.

**MARKING**

The panmaker often starts by drawing a pair of concentrical circles on the bottom surface to make it easier to see the shape of it while it is lowered. To draw the circles, the middle of the bottom has to be found and marked. This is usually done by making four pencil marks on the bottom at equal distance \( d \) from the rim. Draw straight lines through the marks and then two lines between the opposite corners of the formed rectangle, see fig. 2.2. The crossing of the two later lines represents the centre of the drum. Another method to find the centre is to measure the distance 26.6 cm, which equals the radius (half the diameter) of the drum, from the rim towards the centre several times at different rim positions.

Two concentrical circles are made by using a compass. The inner circle is drawn with a radius of approx. \( 1/3 \) (10 cm) of the
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Drum radius and the second with a radius about 2/3 (20 cm) of the whole radius. The result is that the drum radius is divided into three equal parts, see fig. 2.3. The two circles may also be drawn by moving a ruler round the bottom of the drum in circular movements, drawing two lines at constant distances from the rim, see fig. 2.4

LOWERING

The lowering of the drum bottom is done using a sledge-hammer with a smooth, rounded head and a short, specially formed handle. The handle of the sledge-hammer should be long enough to enable you to hold it with both hands.

A better, more elaborate method to do the sinking is to use a 5 kg cast iron ball, most often a shot-put or a cannon-ball. The ball is dropped or thrown at the bottom and caught when it bounces up again. The round ball will make fewer marks in the metal than the sledge-hammer, but it will be harder to work on the steep sides near the rim. For the inexperienced panmaker the shot-put may also cause difficulties in hitting the right spot and catching it when it bounces back.

It is important that the surface of the sledge-hammer or the ball is very smooth, otherwise it will create impressions that later will cause small cracks in the stretched metal. For more detailed information on the sinking sledge-hammer and the shot-put, see appendix B.

The first strokes should be placed near the outer circle. Work around the drum along that circle. If the head of the sledge-hammer is well rounded and you keep it perpendicular to the surface when you hit, you may use all your strength at this point. Using a shot-put, its weight alone will supply enough force, you just have to lift it and let it fall.

After the first circular work-around you start to place the strokes closer to the centre, thus working towards the middle in a spiral-
During the sinking, the drum should be standing on a flat, semi-soft surface, like a carpet or directly on the ground if you are outdoors. This will make it easier to keep the drum in a fixed position while you are hitting. It might also be beneficial to have someone to hold the drum to prevent it from jumping around.

When you are working near the edge it is usually better to use one hand for hitting and the other one to support the drum. But keep the thumb of the supporting hand on the outside to prevent yourself from hitting it with the ball or the sledge-hammer. Best is to place the supporting hand a bit away from the hitting point. Protective gloves (and something to shield your ears from the noise) are also recommended.

After the first spiral movement towards the centre you start again, this time further out, a bit closer to the rim. Now work the metal by, so to speak, "driving it from the rim". This means that you first hit the surface hard near the rim, then move towards the centre, hitting a bit softer each time, see fig. 2.7. This working pattern is repeated time after time, while moving slowly round the drum.

It is more important to have a good feeling for how the surface is shaping, than it is to work systematically. There should not be any large fluctuations anywhere – if an “edge” is coming up in the metal, lower it right away. Keep your eye on the concentrical circles – the best way to control the sinking is to move slowly backwards while you are working. In this way you can see the formerly sunk surface to keep the newly sunk levelled with it. It is also beneficial to rotate the drum now and then to prevent the light and the shade from fooling you to make a non-symmetric sink.

To be able to shape an evenly curved sink, it is important to keep the middle part level (like the bottom of a bowl) with the rest of the surface. Do not hit too much in the middle, though, because the metal will easily get too
stretched there. A couple of strokes when it is beginning to come up as a dent and starts to emit a resonant sound (like the one from a big note) is usually enough to keep it down.

Keep working around the drum according to the above pattern, inwards from the rim, thus shaping the surface to a smooth bowl. Most of the effort in sinking should be concentrated to the region between 1/3 and 2/3 of the radius of the drum. This is where the inner end of the outer notes will be later on, see fig. 2.8 for an overview.

After the sinking the basin in the bottom should have a straight or slightly convex part near the rim. This part is later going to form the outer note dents. Its shape and height should be different for different pans - longer and more convex the larger the notes are going to be. It is important that the shape of this part is right, otherwise the notes will not rise properly when the backing is done. As a rule of thumb, the shape of the basin should be almost as if it was a pan with a continuous ring of outer notes, without any groove indentions between them. This means that the height of the deviation from the spherical should be about the same as the height of the future note dents.

If you are a beginner in pan making you will probably have to read the sections about backing, grooving, levelling and tuning to understand the intent of this shaping. In fig. 2.9, a cross-section of a sunk drum is shown. Moulds for the overall shape of the different pans and their sinking depths are given in appendix A.

When you are beginning to reach the final depth you should check
the depth at even intervals, see fig. 2.10.

A fast (and somewhat risky) method to do the last sinking is to lower the drum to the appropriate depth in the centre and then "follow it up" on the rest of the surface, see fig. 2.11 for an explanation.

### HANDLING OF HOLES

If the surface bursts during the sinking you have to decide how to handle the situation. The holes can be divided into two main types; small unevenly shaped holes and longer cracks.

The first type of hole is caused by defects such as rust or harder parts of the metal where the carbon content is higher. These holes are usually no problem if they are not close enough to grow into a big crack. Try later to position the notes between them. If that is not possible, consider the possibility to weld the holes before continuing. If there are more than five holes you have probably chosen a bad drum. The best thing might be to discard the drum and start on a new one. I have, though, seen working (but not good-looking) pans with small holes in the note areas, so it might still be worth a try.

The second type of hole, the cracks, is either caused by text grooved in the metal or by too much stretching of the metal in certain regions, or a combination of these. They will show up as small slits and grow as you sink and stretch the surface further. If they show up before you have reached 70-80% of the final sinking depth there is a risk that they may grow up to a length of 5 cm or more, making the drum unusable. The cause of the crack can be one of several; the drum is bad, the sledge-hammer is not smooth, or you are doing the sinking in an incorrect way. Your best choice might be to stop here and start on a new drum.

If there are no more than two or three cracks in the middle, try to place the inner notes between them. At a later stage, welding of the
cracks might be considered. If a crack is starting to grow you might decide to stop the sinking at a depth 2–3 cm less than the recommended, and place the notes closer to each other. This might be preferred rather than spoiling the whole drum.

Welding can be done either with gas or by electrical methods. The weld should be made as neat as possible and a smoothing of it may be necessary before continuing. Welds in the drum surface should preferably be placed between notes or inside note sections, but not on a groove, because of the risk of cracking when the grooving is done later. Presumably, there are also acoustical implications of disturbing the isolating effect of the groove. Welds in the note area of small notes can be quite disastrous for the sound, but in larger notes they do not seem to influence the sound particularly.

**SHAPING**

The shaping is the part of the sinking in which the drum basin is adjusted to its final shape. When you reach 90% of the final depth it is time to change tool to the backing sledge hammer, which is roughly the same as the sinking sledge hammer, see fig. 2.12. It has a shorter handle and is held in one hand for more control, see the specification in appendix B.

Now the marked circles are probably gone together with most of the paint in the middle of the bottom. If so, mark the centre in the same way as before and re-draw the two concentrical circles before continuing with the next step.

Now you start hitting softly, thereby adjusting the shape and smoothing the rather uneven surface at the same time. The only direction the surface can be adjusted is downwards, so it will keep on sinking while you are shaping. Measure the depth at even intervals.

If the surface on one side of the basin is coming up while you are hitting on the opposite side, you are either hitting too hard, or the metal is too thin. Try hitting more softly. If this doesn’t help, there is a risk
that you eventually will have to discard the drum.

The best method for doing the shaping is still by working the metal "towards the centre", i.e., first hitting near the rim and then going inwards in the same way as described for sinking. When 100% of sinking depth is reached the surface should be smooth and evenly shaped.

SMOOTHING

It is important that the surface of the drum is smooth. Any unevenness in the metal will affect the overtones and make the tuning harder. If the surface still is rough when the shaping is finished, this is the best time to even out the part of the surface that later will become the note areas. During the rest of the crafting they will be left as unaffected as possible, until it is time for the tuning.

The smoothing is done by hitting down the surface in places where it is dented upwards. The tool used for smoothing is usually the backing hammer, see fig. 2.13. Use good light to see the reflections in the metal; working outdoors is the best. Avoid hitting the surface in places where it is dented inwards, work around them instead. As the metal is thicker near the rim you will notice that you have to hit much harder to remove the roughness there.

While you are examining the surface for unevennesses, try to locate spots of potential trouble. Examples of such are; sharp indentions caused by remainders from welding or lumps in the painting and corrosion (rust) that seems to be going deep into the metal. Mark those places and try to avoid them when you are positioning the notes later. The most hazardous thing to do is to make a groove across such a spot. The weak metal could easily burst when it is hit with the
sharp metal punch.
A skilled panmaker often omits this extra smoothing step because he has smoothed the surface enough during the shaping. If there is any roughness left, he smooths the surface later with the backing hammer at the same time as he is doing the backing.

3. Marking of notes

Marking is the process in which the bottom basin is divided into the sections that later will form the different notes. The tuner usually does the marking by copying measures for the outer notes from previously made pans and by using templates for the inner notes. The marking can be quite tricky, especially if you have holes to watch out for.

MARKING OUTER NOTES

Once again, begin by locating the centre of the bottom in the same way as shown in fig. 2.2. The next step is to mark the length of the outer notes along the rim, see fig. 3.1. Measures and positions of notes for different pans are given in appendix A. Details are explained in fig. 3.2. Lengths of outer notes in appendix A are measured along the rim, not with a straight ruler.

When arranging the layout, the side welds on the drums are usually positioned to face the player, i.e., in the middle between the two marked positions of the hanging strings in the layout diagrams in appendix A. This is done purely for aesthetic reasons, so if you have problems avoiding holes when positioning the
notes, feel free to twist the drum.

When you have worked around the drum, you will probably find that the last mark does not match the first one. If the discrepancy just is a question of millimetres, go backwards and adjust the note positions slightly. If it is more than that, redo it. A ribbon marked with the note lengths and pasted to the rim may be a good tool for the marking of the outer notes.

If you are making a double tenor or a quadrophonic pan in Trinidad style, remember to leave some space (about 1 cm) between the note marks.

The next step is to draw lines from the marks on the rim towards the centre marking, see fig. 3.3. Here a flexible ruler is needed, but a hacksaw blade can serve as a good substitute. Draw lines from the rim down towards the centre and make a mark where the radial groove is to stop, 13–20 cm down, see fig. 3.4. Exact measures are given in appendix A.

After all the radial lines of the outer notes have been drawn, their inner borders are marked. To make a smooth inner ending of the note region, bend a ruler so that it extends 2–6 cm inwards from the end marks on the radial lines. To do this, two persons are needed, one holding the bent ruler in a smooth curve with two hands, and one drawing the line, see fig. 3.5. See appendix A for measures on the total radial length of the outer notes.
MARKING INNER NOTES

The inner notes are usually marked with templates. Shapes and measures for the templates are given in appendix A. Use the patterns in appendix A to make templates by making as many copies of the page as there are notes. Then cut out the shape of a specific note from each copy with a pair of scissors and paste it on to some sturdy material, such as linoleum. Last, cut the stiff template to its right shape with a knife.

Fig. 3.6 Spread out the templates of all the inner notes to check space and positioning before marking.

Fig. 3.7 Position of inner notes.

Fig. 3.8 Marking the four notes in the centre of a tenor.
Begin the layout work by spreading out the templates for the inner notes in their positions before you do any marking, see fig. 3.6. This makes it possible to adjust the positions to utilise the precious space in an optimal way.

The elliptical notes are usually oriented with their length axis pointing towards the centre, see fig. 3.7. Always place an inner note as close to its lower octave counterpart as possible (but not closer than 1 cm). In this way it will be easier to find the octave intervals while playing and they will be able to vibrate together. The distance sideways between adjacent notes should be as large as possible, preferably not less than 1.5 cm anywhere. If you have problems with space, the pan is probably not sunk enough.

4. Backing

Backing is the procedure in which the notes are given their arched, convex shape. This is not done by raising the note areas, but by lowering the surface between them. When the backing is finished the note areas should curve outwards, while the rest of the drum surface should be concave. For an explanation of the usage of the terms convex and concave see appendix E.

The main reason for doing the backing is presumably to form note dents with a proper arch and internal tensions that later are to be conserved by the grooving. Another reason for doing some of the shaping before the grooving is that the grooves would presumably burst if all this stretching of the metal was done after the grooving.

Fig. 4.1 Backing.

Fig. 4.2 Cross-section of backing result. Heights of dents are exaggerated.
The backing is done with the backing hammer, see fig. 4.1 and appendix B. The size of the head of the hammer makes it impossible to work only between the notes, you have to hit a bit up on the notes, too. This is actually the right thing to do, as the result is meant to be dents with a smooth arch beginning at the groove mark, see fig. 4.2.

During the backing you may notice that the surface tends to move dynamically; when it is hit in one place it comes up elsewhere. The goal in backing is to get the metal down everywhere except in the note areas. A skilled panmaker knows exactly how hard to hit to put the surface at the right level without making it come up elsewhere. He also smooths the surface and adjusts the arch of the notes with gentle strokes while he is doing the backing.

The result of the backing should be smooth note dents that are “relaxed”, which means that they are able to vibrate more freely than the rest of the surface.

**BACKING OUTER NOTES**

The outer notes are first backed by hitting on the radial lines going from the rim towards the centre. Begin at the rim and work down at each side of the note, one at a time.

You may have to hit quite hard to get the note surface to raise in the right way, especially on tenors. The backing should extend about 2-3 cm in on the note surface, inside the groove mark. After the two radial lines of a note have been backed, its inner border is backed, see fig. 4.3. Here the backing is often done fully on the inside of the marking, i.e., 3-5 cm up on the note, see fig. 4.4.
Lower the borders between the outer notes in this way all around the drum. Watch the height of the dents closely to get them level with each other. If necessary, adjust the arch of the dents by hitting upon them with a couple of soft strokes. The height of the outer notes for a double tenor or a tenor pan should be about 1-2 mm at this stage. Most of the surface inside the marks for grooving should be convex after the backing, but some parts near the rim may still be concave.

**BACKING OF INNER NOTES**

After the backing of the outer notes, the inner notes are to be treated in the same way. The surface between the notes and the border marks is hit to make the inner note dents raise.

First, work round the pan in the small area between the inner and the outer notes, see fig. 4.5. In practice, this can be seen as an extension of the backing of the outer notes, you just work a bit further in. This will continue to raise the outer notes as well as parts of the inner ones. After the first round, work around the pan a second time and back a bit further down between the inner notes, see fig. 4.6.

Second, hit the surface between the inner notes, working from the centre towards the outer notes, see fig. 4.7. Keep your eye on the rest of the surface all the time, because when you hit in one place it will raise at other places. Try to keep those places...
down at the same time.

The backing has to be done in a circular manner, because while you are working at one side of the pan, the other side will be affected by stretching forces so that the surface there is raised.

When the backing of the inner notes is done, you may have to go back and adjust the inner borders of the outer notes, as they may have been affected by the backing of the inner notes.

Last, the different notes are adjusted until they are level with each other. If necessary, the overall shape is adjusted again. At this stage you should begin to hear sounds from the notes. If the backing is correctly done, no sound should be heard from the surface between the notes.

5. Grooving

The grooving is the process in which the note-areas are acoustically separated from each other and the rest of the surface. This is done by hitting the surface with a steel punch along the note borders, making a continuous line of punch-marks in the surface.

The purpose of the grooving is to confine the vibrations that produce the sound of each note to their own sector of the drum surface. The mechanical function of the groove is presumably to loosen up the metal and make a loose "joint". This separates the physical conditions in the note area from the surrounding surface so that the note will be able to vibrate freely. When the crafting is done the note will be a strained buckle of softer metal, while the surrounding metal will be tempered and stiff. A practical function of the groove is also to define the working area for the later tuning.

There is a special model of pans where the groove is complemented with a line of bore-holes. This makes the "groove joint" more flexible and acoustically it seems to work even better than an ordinary groove. See the section about developments for more on this "bore pan".

The tools used for grooving are a shortened nail-punch and a grooving hammer, see appendix B. The head of the punch should have a diameter of 4–7 mm. Some tuners use punches of different size for
different notes in the same pan. The edge of the head have to be fairly sharp to make distinct marks in the metal. It is important that the punch has a comfortable length (10 cm is proposed) to enable good control. A longer punch would be hard to control.

The grooving hammer should be a hammer that you are well acquainted with - you must know exactly how hard you are hitting. It is also important that the head is tightly fastened to the handle to get high precision in the hammering. The weight of the hammer should be approximately 0.5 kg.

It is difficult to know how hard to hit while grooving. The indication of a proper grooving is that it leaves a score in the metal that is clearly visible during the rest of the crafting and on the finished pan, without breaking the metal. It should be visible on both the playing side and the backside of the pan, but not more than that. This is because the groove mark is going to define the working area for the latter tuning.

It is better to groove a bit too light than too hard, because even if you don’t go through the surface right away, the groove might burst at a later stage when the metal is stretched by the levelling. A groove that is too hard will also make the surface unnecessarily rough, resulting in a need for extra levelling work. Exactly what happens if the groove is too soft is still unclear to me, possibly the pan will be hard to tune because of interference between notes.

If you want to practice grooving before starting off, it might be useful to try on the unused top of the drum. But bear in mind that the un-stretched metal in the top is about 30% thicker and harder than the metal in the middle of the sunk bottom of the pan. This means that it
can withstand harder grooving than the playing surface. Fig. 5.2 shows what the groove should look like, when properly done. The width of the groove can vary from 4 to 7 mm. The spacing of the marks is ideally 1 to 2 mm, but can be more as long as the marks still are overlapping. If the punch jumps more than 4 mm between two successive strokes, go back and groove the place over again.

**GROOVING OF INNER NOTES**

The grooving usually begins with the inner notes, see fig. 5.3. If the surface still seems rough, the region along the lines has to be smoothed before grooving. An uneven surface will make it hard to control the punch, resulting in a winding groove. Such a crooked groove will make it harder (or, at worst, impossible) to tune the note. So, if necessary, start the grooving of each note by using the smoothing hammer to even out the region along the lines. You can check that the surface is even by feeling it with your finger. It is also important that you see the note border lines well, so if they are diffuse after the backing, fill them in again before grooving.

The best place to start grooving on a note is where the line is straight; this will make it easier to make both ends meet when you have grooved around the note, see fig. 5.4. Put the punch on the line, start hitting it about 3-4 times a second, and move it forward with a constant speed while hitting. The speed should be adjusted so that marks are made with 1 mm spacing. The grooving should leave sharp
marks in the metal resulting in a continuous canal, about 1/2–1 mm deep, see fig. 5.5 to get an idea of the right result. The drum should be standing steady on the ground to enable good control over the punch, because it will jump back slightly each time you hit it.

Groove all the inner notes in the same way. The grooving of a note will affect the surface of adjacent notes, so remember to smooth the metal along the marking of each note just before grooving.

**GROOVING OF OUTER NOTES**

The grooving of the outer notes is usually done by grooving the innermost borders of all the outer notes first. After this all the radial lines are grooved. See fig. 5.6 for an explanation of the grooving sequence.

The grooving of the inner notes has reshaped the surface and lifted the inner border of the outer notes a bit. So, before grooving, make a round with the backing hammer and put the surface back in its right place again, see fig. 5.7. If necessary, also smooth the metal at the marking of each note with the smoothing hammer before grooving.

Begin grooving at the joint between the straight radial line and the inner curve. Work from one side to the other, see fig. 5.8. Work around all the outer notes in this way.

When the inner borders of the outer notes are grooved, the metal sinks down about 1 mm. It can be hard to make a smooth connection between the groove that is to go up towards the rim and the existing...
groove if the surfaces are not level with each other. So, before going further, the radial lines may be levelled with the backing hammer. Work around the pan hitting at the inner end of the radial lines to get them level with the existing inner grooves, see fig. 5.9.

The radial lines of the outer notes are grooved from their inner end towards the rim. But they do not go all the way up to the rim. Use the ruler to make marks about 5 cm from the rim on all the radial lines before starting off.

Groove the lines from the point where the radial line meets the inner groove and upwards against the rim, but stop when you reach the mark, 5 cm from the rim. As you are getting closer to the rim, you have to hit harder because of the thicker metal. At the 5 cm mark, hit last hard stroke to mark the end. Work around the whole pan in this way, and the grooving is done.

6. Levelling

During the levelling the playing surface of the pan is formed to its final shape. The levelling is done with the backing hammer and is quite similar to the backing. During levelling, each octave pair of outer-inner notes goes through four steps that are interlinked with each other:
taking out the fat, flattening the grooves, final shaping, and adjusting the notes to be level with each other. The last step of the levelling is to smooth the surface of the whole pan.

The purpose of the levelling is to put the surface back to the shape it had before the grooving, see fig. 6.1. The levelling can be seen as a continuation of the backing, but it brings the drum further towards a properly shaped steel pan.

Shaping is an important part of the levelling. During the shaping the surface of the notes is formed to soft bulges and the surface between the notes is formed to an evenly curved basin.

"TAKING OUT THE FAT" - FLATTEN THE GROOVES

The grooving has made the surface of the pan look somewhat "swollen", kept down only at the grooves, see the cross-section in fig. 5.5. Now the surface between the notes has to be formed to a smooth concave shape again, leaving the notes standing up as smooth convex dents. This procedure is called "taking out the fat".

Begin working on a note pair, preferably the pair with the largest inner note. Hit the surface near the border of the inner note until it gets down level with the groove. When the surface between the grooves surrounding the inner note is flat, it is time to do the same around the corresponding outer note. Begin hitting down the "fat", first between the grooves of the inner and the outer note, and then gradually work further up between the outer notes. If the outer notes are separated by one groove only, the groove is flattened by hitting right on it and a bit up on each note, see fig 6.2.

When the surface between the notes is smooth, it is time to adjust the grooves down to the level of the surface between them. This is done by hitting a bit up on the note. This lowers the groove and makes it flat. The result of this procedure should be almost invisible grooves, seen only as marks in the metal. This is the critical point where the metal will burst if you have grooved too hard. Work around the pan at least once, adjusting all the grooves to be level with the smooth transition from the convex shape of the note areas and the concave shape between them.
**SHAPING OF NOTES**

When all the grooves are flat, you start to adjust the shape and height of the inner notes. Hit a bit further up on each note (about 2–3 cm) to shape it to a smooth swelling. Now the note is formed to its final shape and it is important that the result is a smooth surface without sharp indentations or unintended buckles. Small buckles have acoustic resonances that may affect the harmonics in an unfavourable way, thus making the pan difficult to tune. On the larger notes it is extra important to check that the arch is smooth and the dent curve extends over the whole note.

After the backing and the grooving, the outer notes will have sharp "edges" at the rim. The notes look somewhat like a triangle with the top cut-off, pointing at the centre. But the actual sounding note dents in a steel pan all have an elliptical shape, no matter what shapes the note borders have. For an explanation, see the chapter about note shape in the theory section. This means that the outer notes have to be reshaped to something more elliptical.

This is done by sinking the part in the small area between the place where the radial groove stops and the rim. Begin by marking the parts that are going to be lowered, see fig. 6.3. Then use the backing hammer to make a smooth curve, ending off the dents softly against the rim, see fig 6.4. The surface should be lowered down to the level of the radial groove.

Work round the pan, shaping one note pair at a time, until the surface between the notes is down level with the grooves everywhere.
A skilled panmaker often does this work in one round, because of the precision in his strokes. If the surface is moving at one place when you are hitting in another, you have to work several rounds to get it right. The reasons for this can be one of two:
1 – You are hitting too hard – try hitting looser and adjust the strength in your strokes according to how the surface is reacting. 2 – The surface is too thin or too much worked on – nothing you can do. You have to accept it or (at worst) start working on a new drum.

**FINAL LEVELLING**

The actual levelling is done in the same way as the shaping, but now more emphasis is put on the relative position of the notes. If the shaping is well done, the final levelling is just a minor adjustment.

Start the levelling on an outer note and work your way down to the corresponding inner note while checking that the top of each note dent is level with adjacent notes. Work around the pan octave-pair wise, adjusting the notes in the same octave to be level with each other; see circles in fig. 6.5.

This is also your last chance to...
mould the overall shape of the pan. Hereafter the surface will be fairly fixed. Hit the surface between the notes softly with the backing hammer. Try to get the surface level everywhere, making an even elliptical curve, except for where the notes are, see fig. 6.5.

The result of the final levelling is very important, because the border of each note has to have a certain curvature in order to get the right geometry to produce overtones that can be tuned to harmonics. See the theory section for more about overtones.

SMOOTHING

The last thing to do before cutting and burning the pan is to smooth it again, if necessary. Work all over the surface between the notes, hitting it softly with the smoothing hammer, examining the surface all the time, see fig. 6.6. The importance of smoothness of the surface at this stage cannot be emphasized enough. The smoother the surface, the easier the pan will be to tune and the better it will sound.

7. Cutting the drum

Before the drum is tempered, it should be cut to its proper pan length. The lower the pan is to be tuned, the longer the side of the drum should be. This is to give more resonance to the sound of the lower tuned pans. For common lengths of the different pans, see appendix A.

Before cutting, the side of the drum needs to be marked at the right length. The usual way to do this is to use a wooden stick with two nails driven into it at appropriate distance. While the drum laying sideways on the ground, the stick is pulled around it with one nail resting against the rim. Then the nail at the other end will make a scratch in the paint of the drum, see fig 7.1.
The drum is cut at the mark in the following way: First, hammer on a chisel or an old screw-driver to make a starting hole in the side of the drum. Then use an electrical jigsaw to cut the drum. On Trinidad, this is often done with a cutlass, a cut-off machete, see fig. 7.2. The cutlass is hammered through the metal along the scratch, making a rough cut that later is trimmed with a pair of plate-shears. Last, a file is used to smooth the cut end of the skirt.

8. Tempering

The hammering during the sinking and the backing has made the surface of the pan stretched and soft. The grooving and the backing has also forced local tensions into the metal. Before tuning, the pan has to be hardened and the tensions have to be removed. This is done by first heating the metal and then cooling it. The whole process is called tempering.

The most important effect of the tempering is presumably to remove the local tensions. Uneven tensions in the metal of the notes would presumably make it impossible to tune the pan. As heat is applied, the molecules will be able move and the crystals of the metal will shift positions and rearrange according to the new conditions in the metal. The result will be notes with a homogeneous tension over their whole surface.

A second purpose of the tempering is to harden the surface between the notes and make it stiff, while the metal in the notes areas will be a bit softer, as it later is softened during the tuning. This will make the
notes act as fairly independent resonators for the different tones.

There seems to be three different physical processes working during the tempering:

1. Removal of tensions – an anneal – by reconstruction of the crystal structure in the metal.
2. Oxidation of some of the carbon content of the metal (this is probably why it turns blue) makes the metal more tenacious.
3. Hardening by "freezing" the new crystal structure while cooling.

While the hardening makes the material more stiff, the oxidation seems to make it more stretchable. The amount of heating has to be balanced between these two processes. If the pan is heated too much the metal will become too relaxed – the tuners call it "slack" – and the pan will be impossible to tune. If, on the other hand, it is heated too little, it will not be hardened enough. See the theory section for a more thorough discussion of the function of the tempering.

The tempering is done by putting the pan upside down on a big fire for a while and then pulling it off and cooling it, either by letting it cool by itself or by the means of putting cold water or oil in it.

On Trinidad, the pan is usually heated over a burning car tyre. The tempering is done by putting the pan upside down on a big fire for a while and then pulling it off and cooling it, either by letting it cool by itself or by the means of putting cold water or oil in it.

On Trinidad, the pan is usually heated over a burning car tyre.
tyre will burn for about 10 minutes, but 1.5–2 minutes of the excessive heat is often enough for the tempering. If you are afraid that your neighbours or the fire brigade will be alarmed by the large amount of black smoke from the burning tyre, it also works with a large log fire, but the heating will take some more time, about 10 minutes.

Professional panmakers use a special stand to put the drum on while heating it over the burning tyre, see figures 8.1 and 8.2. The legs of the stand are about 15–20 cm long. The stand is often complemented by some shield against the wind to keep the fire burning steady. If you don’t have a stand, resting the pan on some rocks works. To do this, dig a pit in the ground with about the same diameter as the pan and put four rocks, about 10 cm high, around it, see fig. 8.2. A third method to make a fireplace is to use the leftover part of the drum to make the fire in, see fig. 8.3. Cut the drum to a length of approximately 30–40 cm.

Light the fire and wait until it is burning with good heat. Then put the pan upside down over it, resting on the stand or the rocks. If you are using the leftover part of the drum as fireplace, you have to put some long logs across the drum to prevent the fire from getting smothered by the pan on top, see fig. 8.3. This will enable the fire to get enough oxygen.

Give the fire enough fuel to keep it burning for 10–15 minutes. Flames should appear all around the pan to make sure that it is evenly heated. If it is windy, you may have to turn the pan during the burning to prevent it from being unevenly heated.

The time for burning is very important, because it determines the amount of heat the pan will be exposed to. There is no exact signal for when the pan is sufficiently heated. Experienced panmakers know when the drum is burned appropriately by judging from its colour. The remaining paint on the inside should be crumbled and the rust should be turning from brown to blue-black. If the pan doesn’t have any paint on the inside, you can see the metal first turning blue, then black and last greyish. The metal surface should be looking dull when the drum is enough heated.

A documentation of the appropriate temperature and heating time is still lacking. I have heard about many different methods and times: 10–15 minutes on a log fire or 1.5 min on a burning tyre.
One author claims that it takes 35 minutes to temper properly at a temperature of 350 degrees Fahrenheit (Morin, 1988).

After about 1.5 to 2 minutes over the burning tyre or 10 to 15 minutes on the log fire, the pan is pulled out of the fire and hardened by cooling. The cooling can be done either by leaving the pan by itself in the air or by pouring cold water or oil on the surface to temper and cleanse it further. The tempering put in by self-cooling of the pan in the air is often judged to be enough, but the cold liquid will make the metal in the pan even harder. The more the pan is tempered, the longer it will probably stay in tune, but the harder it will be to tune it. Nowadays, the most common tempering method seems to be by self-cooling. Drums with thin metal or drums that are judged to have been burnt too long is sometimes cooled by throwing water into them to remove the heat faster.

As the pan now is black from soot, this might be a good occasion to clean it before doing the tuning. When the pan has cooled down, put some water and soap into it and use a brush to get rid of the rust and the soot from the burned paint.

9. Tuning

The tuning of traditional musical instruments like string, brass and wind instruments is fairly straightforward; you tune the note to the right pitch and it will automatically sound right. The tuning of steel pans is much more complicated, since the pitch and the timbre - the "colour" of the sound - have to be adjusted independently. This means that the tuner has to control both the fundamental, constituting the playing pitch, and the upper partials (harmonics), producing the timbre, while he is doing the tuning. If the upper partials are not in a harmonic relationship to the fundamental the note will sound harsh and metal-like. See the theory section for more on tone generation and a discussion of partials.

The tuning process can be seen as composed of three main steps:

1. Coarse tuning - the metal of the notes is softened and the notes are put at the right pitch before the fine tuning starts.
2. Fine tuning - adjustments of pitch and timbre while the pan is...
Fig. 9.2 Using hammer and stick to tune.

3. Blending – final tuning after the surface has been finished.

TUNING TOOLS

The prime instrument for tuning is your ear; a good sensibility in pitch discrimination is needed to become a competent tuner. An electronic tuning device can be used as an aid for judging the pitch, but when it comes to harmonics, only your ears (or rather, your brain) will do the job.

The tuner alternately taps the notes with a small hammer and a rubber-tipped tuning stick to hear the sound of the note during the tuning. The fundamental – the pitch of the note (the one written in the score) – can usually be heard while hitting the note with the hammer, but as you begin to focus on the upper harmonics you will need the stick.

The type of hammer that is used for the tuning depends on the size of the notes. The following recommendations can be used as a guide for your personal choice: Notes with a length more than 15 cm – a fairly heavy hammer (2 kg) with a large, rounded head. Notes 8-15 cm – a light (less than 1 kg) hammer with a plastic head (usually the same as the smoothing hammer). Notes smaller than 8 cm – an ordinary hammer with a rounded head. See appendix B for further measures on these hammers.

The reason for using the different hammers is the following: A heavy hammer is needed to produce enough force to tune the larger notes. A hammer with a plastic head will make fewer marks in the metal on the medium sized notes. For the smallest notes a metal head is needed to get enough impact and precision in the positioning of the strokes.

The tuning stick may be a regular playing stick, but often it is better to use a stick that is a bit heavier and harder than the ordinary playing stick. The extra weight
can be used to decide if the note is "stable" by hitting it hard and see if the pitch stays the same or changes. If the tuning stick is hard, i.e., has less rubber, it is easier to hear the harmonics – the partials – of the note.

The tuner holds the stick in his left hand and the hammer in his right hand and hits the note alternating with the hammer and the stick, see fig. 9.2. One stroke with the hammer is usually followed by two or three hits with the stick to hear the timbre of the sound clearly.

The stand used to put the pan on while doing the softening and the coarse tuning has to be designed so the pan can rest on its skirt, leaving the note surface free to vibrate in the middle. This is usually accomplished by using a padded wooden box with the same side length as the diameter of the pan, see fig. 9.3. The box can be mounted on a stand so you can tune standing up, or you can put it on the ground to tune sitting down, see fig 9.1. A temporary tuning stand may also be made out of the leftover part of the drum, putting a truck tyre on top of it to rest the pan on while tuning, see fig 9.4.

It is also practical to have a tuned steel pan or another instrument at hand to "calibrate" your ear at the right pitch of the note you are tuning. A tuning device will be of less use at this stage, because it will be unable to detect the pitch of the harsh-sounding tone. Your ears are probably better at doing this.

To raise the outer notes while doing the softening before tuning, the tuner generally uses a bent iron (like a specially made crowbar), see appendix B. A new tool that is getting more common for raising the outer notes nowadays is specially shaped wooden wedges. See fig. 9.6 and section II for more about this development.

GENERAL STEPS IN TUNING

The first, coarse tuning of each note may be seen as consisting of several different steps, but they are interlinked with each other, so when you see a tuner working it can be hard to realise what he is doing.
The result of the first part of the tuning should be an independent-sounding note with a definite pitch and a steel pan-like timbre. The steps towards this are: softening of the metal, tuning of fundamental and octave tuning (adjustment of timbre).

The softening of a note and the tuning of the pitch is actually done at the same time. While the tuner softens the note he listens to the pitch and tries to get the metal adequately stretched. When the metal is soft enough and he starts to concentrate on the pitch, he also involves the third step of the tuning. This is where he listens to the timbre of the note and adjusts the octave at the same time as he is positioning the pitch. This continuous flow of work is good to keep in mind while reading the step-wise description of the tuning below.

As a rule of thumb, the tuning of a pan should start with the process that affects the metal the most and has the greatest impact on the sound. You then successively move towards finer adjustments. The reason for this is that the stretching of the metal during the tuning will affect surrounding notes as well as the one you are working on. There is no sense in doing fine tuning on one note if you are going to soften and coarse tune the note next to it later.

If a note seems impossible to tune, leave it at the closest pitch you can get and go back to it when you have worked around the pan. The tensions in the metal might be in a more favourable condition then. As you will get tired listening to the banging and concentrating on the pitch, a pause is also recommended when things seem to get impossible.

Sometimes during the tuning, the tuner may decide to listen to another note to "calibrate" his ear. This other note can be either a note with the same pitch in an already tuned pan or a tuned note in another octave of the pan to be tuned.

As the stretching of the metal when tuning one note is affecting the already tuned ones, the tuning has to be done in a circular manner, working round the pan several times. While tuning the outer notes, the inner ones will be affected, so you have to repeat the procedure again, tuning the inner notes and then the outer ones, until everyone is in pitch.
good rule of thumb for this circular tuning is to "take the worst sounding note and try to make it the best".

**Softening the metal**

The softening is the first part of the tuning and it is done by hitting the note up and down several times. The softening effect is included in the tuning of the pitch. You are softening the dent while you are hitting it up and tuning it while you are lowering it again, listening to its sound and pitch.

The purpose of the softening is to "loosen up" each note and give it a tone that is fairly independent of the surrounding notes. The tempering has made the metal of the note areas stiff. This is the desired effect to some extent, but the notes should not be as stiff as the surface between them. To enable the notes to sound independently, the metal in the dents and the "joint" at the grooves has to be made softer. This is accomplished by flattening the notes and the restoring them several times. The surface of a note usually has to be hammered up and down again 5–6 times. For the easier notes, such as the inner ones, a couple of times will usually be enough. But some other notes may have to go up and down 10–20 times before they are sounding well.

It is important that the notes get softened over their whole surface, otherwise proper tuning will be impossible. On the smaller inner notes this is usually no problem, but on the bigger outer notes you have to start working at one end and then go over the whole surface. The first time an outer note is raised, the hammer is used on the innermost part (the part nearest to the inner border) of the note. The second time it is raised in its middle, as well as the inner part. The following times you
raise the surface closer to the rim each time, but you also make the inner parts come up together with it. A schematic procedure for the raising of outer notes is suggested in fig. 9.6.

When working close to the rim, it can be hard to reach with the hammer and its head may be too big to raise the note properly. The tuner often uses a crowbar-like, bent iron for this work, see fig. 9.5 and appendix B. If the top of the iron is sharp, a blade of a cutlass is held between the tip of the iron and the skirt to protect it from getting marks. A wooden wedge can be also used to raise the outermost parts of the notes. The wedge is put resting against the skirt and hammered upon, see fig. 9.6.

Each time a note is raised, it is lowered again while listening to the pitch, see “Tuning the pitch” below. The first couple of times a note is lowered, you may flatten it out fully to get it softened faster, but as it starts to sound better you usually leave it convex. For each tuning round, the surface is raised a bit higher. Don’t try to do all of the raising at once, because it can easily be too much. It is better to have to do the softening some extra times than to risk to get the metal too slack. It is important to listen to the pitch while raising the note. The pitch should not rise more than about half an octave above the intended final pitch.

The softening is complete when the note seems to have a tone that is relatively independent from its surroundings. It should be easy to hear the pitch and the timbre should be steel pan-like. You may also use your hand to feel when the note is soft enough; it should be “springy”, without “buckling” (flapping over to the other side).

**Tuning the pitch**

When you start the tuning of the fundamental, you concentrate mainly on the pitch to get it low enough. The sound of a note with few upper harmonics is rather dull, so in the beginning it might be quite hard to hear its exact pitch.

The coarse tuning always starts by raising the note and then lowering it, while listening to the pitch, until it reaches its right frequency (or a bit below that). This usually has to be done several times to get the dent softened and the note low enough, see the description below.

The main steps in the procedure for softening and coarse tuning can be concluded in the following list:

1. Hit around the note, on the groove, from above. This is done to “set” the note – to define the working area. It also strains the metal in the note and insures that the groove is flat.
2. Raise the note by hitting it from underneath, see softening.
While this is done, you can hear the fundamental of the note first getting lower, then starting to rise. The note should usually be raised a bit beyond the point where the pitch started to rise.

3. Lower the note, and thus the pitch, by hitting it from above in the middle region. Try to get the fundamental down to the intended pitch or a bit below it. If the pitch starts to rise before it has come down to the right level, the metal in the note is not “slack” enough. Then hit down the dent a bit beyond the point where it started to rise and start over again from point two, this time raising the note a bit more to stretch the metal further.

The process of raising and lowering the note often has to be repeated a number of times before the metal gets slack enough to produce an independent-sounding tone. In a good note, the tone usually comes out after two or three times, but some notes have to be raised ten times or even more.

During the first, softening part of the tuning, the precise pitch of the fundamental is not so important – it is more crucial that the note gets a sound of its own.

When the tuner lowers a note, he gets an indication of how much it needs to be raised the next time. He adjusts the amount of raising to stretch the metal enough to produce a better tone the next time it is lowered. If no partials are heard while a note is lowered, then it probably needs to be stretched further. If, on the other hand, it is raised
too far, the metal will get too slack when lowered and the note will lose its sound, thus making it unusable. It is better to stretch the note too little and repeat the process several times, than to risk stretching it too much the first time.

Sometimes during the tuning the note may lose all of its tension and give away a very low tone without overtones. This might be cured by hitting on the groove from above to increase the tension or by raising the note and starting again with the lowering.

When the note has been softened and has a sound of its own, the fundamental is adjusted by changing the "resonant" size and the height of the dent. Larger dent – lower pitch. Higher dent – higher pitch. To understand this, one must keep in mind that the size of the sounding dent is defined by the shape of the metal surface inside the groove rather than by the boundaries set by the groove. The sounding dent is always a bit smaller than the area delimited by the groove.

Here are some rules of thumb for the tuning of the fundamental, see fig 9.7 for an explanation:

- Hitting from above in the middle region lowers the pitch.
- Hitting from underneath in the middle region raises the pitch.
- Hitting from above near the side of the dent raises the pitch (because the dent gets smaller).
- Hitting from underneath near the side lowers the pitch (the dent gets bigger).
- Hitting on the groove from above stretches the metal, and thus raises the pitch. (Don’t hit on the groove from underneath – this might ruin the shape of the note.)

The rules listed above are general, but due to small differences in shape and differing conditions in the metal, each note has its own characteristics and has to be treated in its own way. Sometimes a stroke can have an effect opposite to the intended because of irregularities in the note arch. When lowering the dent, the tuner adjusts the arch towards its final, correct form. The problem is to know exactly which shape this is for each note.

When some notes have been tuned, they may start to interfere with each other. This is usually good, but sometimes the sound of a note can disturb the tuning of another one. In this case, it is necessary to damp notes nearby to hear the harmonics properly.

First, the tuner checks which note is the disturbing one by damping the notes, one at a time, with a finger while hitting the note to be tuned. If the interference disappears when damping a particular note, this is the one causing the trouble. This note may be damped more perma-
nently by pasting something on to the note surface. A sheet of a heavy material stuck on to the note may be used for this purpose. This can be a note template with a sticky backside or a piece of a magnetic plastic sticker for refrigerators or cars. The tuner can also decide to remove the sound of an interfering note totally by hitting it flat to be able to concentrate better on a note that is hard to tune.

It can be seen as a rule of thumb that, if a note is hard to tune, always check surrounding notes to see if they interfering with the note you are working on. If so, damp them before continuing. All pans seem to have at least one note that tunes easily and catches energy from the vibrations in other notes – the tuners call that one “the leading note”.

At this first stage, just coarse-tune each note to something near the right pitch, before you start to soften the next one. During the first part of the tuning, the note can be left at a pitch that is a bit too low, because it usually raises when the other notes are being tuned.

**Tuning of overtones (partials)**

In this part of the tuning, the timbre of the steel pan tone is adjusted. This is done by tuning the overtones (or partials, as the acousticians call them) of the note, and it has to be done completely by ear. The partials are the parts of the sound that form the special steel pan timbre, the characteristic that makes it possible to recognize the sound as coming from a steel pan. When the octave and the higher overtones are brought into the tone, harmonics will be added to the tone and give it a longer, more pure sound. The partials are generated by vibrations along and across the note and are tuned near the ends of the notes. For a more general description of partials, see the theory section.

The partial tuning is actually done at the same time as the final adjustment of the fundamental. This is because it is hard to hear the pitch of a note if it not is sounding good, i.e., has a proper octave.

Before starting the tuning of partials you need to know that the note...
Steel Pan Tuning

dents all are elliptical in physical shape. The ideal proportion between length and width of the note seems to be somewhere near 5 to 4 (but it works with other proportions too). The inner notes are nearly always oriented with the length axis of the ellipse pointing towards the centre. In the outer note circle, on the other hand, the notes are usually oriented with the length axis along the rim.

The octave partial of the note is generated by a vibration along the elliptical note. This vibration is adjusted by hitting the note from above in the end regions, see fig. 9.8. When this is done, the vibrating dent will get smaller and the fundamental will rise, together with the octave. The fundamental is then lowered by hitting in the middle and the procedure of adjusting the octave in the end is repeated. If the pitch of the fundamental starts to rise before the octave has reached its right pitch, hit the note down fully and then up and start over again. This may sound easy and straightforward, but it is in practice the most complicated part of steel pan tuning. You might say that this is the key to good tuning.

A crucial thing in octave tuning is to get the partials to act and sound well together. The tuners call this to “marry” the fundamental and the octave. This means that the fundamental and the octave have an harmonic relationship to each other. The octave should have a frequency that is exactly twice the fundamental.

The thing that is hardest to understand in tuning is how to move the octave without moving the fundamental and vice versa. A good tuner actually moves them at the same time, but in a way that will make them marry at the right pitch.

The upper partials are adjusted by changing the arch of the dent, rather than its size and height as in pitch tuning. To understand the tuning of partials you need to know how they sound and how their modes of vibration are distributed across the note. So, before you begin the tuning of the partials, take a look at the text and the pictures in the chapter on tone generation in the theory section.

The next higher partial, the third, is generated by a vibration across the note and is tuned along the side of the note. The relation of this partial to the fundamental forms part of the timbre, but it is not at all as important as the octave. In good pans, this partial is tuned to a harmonic interval in relation to the fundamental. Most ideally this interval would be a fifth above the octave, but often it is tuned to a third or fourth above it. This is because the fifth cannot always be reached with the fundamental at its right pitch. It is important that the interval to the fundamental not is disharmonic, such as a musical second or less,
because this will make the note sound false and harsh.

A good trick to hear the octave and the third partial better is to generate a "flageolet". This is done by putting a finger in the middle of the note to damp the fundamental and then hitting the note near the end with the backside of the stick. See the chapter on tone generation in the theory section for an explanation of how this works.

TUNING OF INNER NOTES

The tuning usually begins with the inner notes in the middle region of the pan. These are the easiest to tune, and their sound will help with the tuning of the outer notes, which usually is much harder. Each note is treated according to the general steps described above; softening, pitch tuning and octave tuning. The steps are integrated with each other, so when you see a tuner working, it will all look like a single process. First the note is raised, then the pitch is lowered by hitting from above in the middle region, then the octave is adjusted by hitting from above in the end region of the note.

The tuner often reserves one end of the elliptical note for adjustments of the octave. This is usually the outermost end of the inner note, but if a note is hard to tune, the tuner may decide to shift the octave adjustments over to the inner end to see if this works better. An overview of the tuning regions for the inner notes can be seen in fig. 9.9, together with a cross-section of the note. Please note that the height of the dent in the

Fig. 9.9 Method for the tuning of inner notes.

Fig. 9.10 Regions for tuning of lengthwise oriented outer notes. Valid for all pans except tenors.
TUNING OF OUTER NOTES

When all the inner notes have got their right pitches and a crude timbre, it is time to tune the outer notes. The softening, pitch tuning and timbre adjustment of the outer notes is done in the same way as for the inner ones, but with some special tricks.

Begin by hitting around the note on the groove. While doing this, some strokes on the rim may be beneficial. This will stretch the metal in the note and make the dent come up easier. The next thing to do is to raise the note. While raising an outer note, especially on the tenors, the lack of space near the skirt that will make it difficult to hit with the hammer. Therefore a bent iron rod, shaped like a crowbar, or a wooden wedge is used to do this, see fig. 9.6.

The note is lowered by hitting it from above with the tuning hammer. On the larger notes it is important to distribute the strokes even over the middle part, and not hit in the same place several times. See fig. 9.10 for a definition of the middle working area. If a note bulges down and turns concave when you lower it, you are probably hitting it too much in the middle (or maybe the note has not...
been backed enough). If so, raise it once again and try to hit it in a wider area around the centre. Raising a bulging note can sometimes be done by hitting at the rim to stretch the metal.

If a note is bulging so much that it seems impossible to tune, there is a trick to re-shape the dent. The tuners call this to “tighten” the note. Hold the palm of your hand on it to keep it still while you re-shape it. This is done by hitting around your hand and it will result in a smaller, more sturdy dent.

When studying the tuning of the octave in an outer note, one has to keep in mind that the outer notes are oriented with their length axis in different ways in different pans, see fig. 9.11. In all pans except the tenors, the lengths of the outer notes are tangential, i.e., the length axis is oriented in parallel with the rim. On the tenors, the outer notes are rotated 90 degrees, i.e., with the length axis radial, pointing towards the middle of the pan.

As the most important partial, the octave, is acting lengthwise the procedures for its adjustment must be different for these different categories of pans. In most pans the end regions of the elliptical note will be reserved for octave tuning. See fig. 9.10 for an overview of the effects and regions for octave tuning in regular outer notes. For the tenors, the tuner usually reserves the inner end of the outer note for adjustments of the octave, see fig. 9.12.

Start the octave tuning of the outer notes with a note that has a tuned corresponding inner octave note. It will be easier to hear the sound of the octave of this one. On larger notes, check that the octave vibrations at both ends of the note have the same pitch. The best way to check the octaves is to hit the note with the hard backside of the stick.

When an outer note is beginning to sound good, the tuner lifts the pan from the tuning stand to check that the pitch stays the same and
the timbre is still good. This is done because the tuning stand damps the vibrations of the skirt and this often affects the tone of the outer notes.

If a big outer note not have an evenly shaped arch, a special problem may occur: The pitch of the octave may be different in the two ends of the note. The best way to check this is to damp the note with a finger in the middle and hit it with the hard end of the stick at each end of the note.

While tuning the outer notes, a new problem will arise. The formerly tuned inner notes will start to act together with the partials of the lower note. This is all well as long as the note is sounding together with its octave counterpart, but might be a problem if it acts together with some other note. This may be handled by damping the note as described above in the section for general steps in tuning.

**OCTAVE PAIR TUNING**

The process of octave pair tuning means that the tuner adjusts the notes in octave pairs to make them sound well together. This is often done to some extent while tuning the outer notes, by adjusting the corresponding inner one at the same time. But it can also be done as a separate step when all the notes of the pan have got their own sound.

During the later part of the tuning of the outer notes, it is very important that their inner octave counterparts have the correct pitch, otherwise it will be impossible to tune the octave of the outer note. This is because the fundamental of the inner note will interact with the octave of the outer note. A mistuned inner note may “pull” the octave of the outer note off from the right pitch and confuse the tuning. You may also end up with two notes that have pitches very close to each other (within a few Hertz). This will result in unpleasant, fast “beatings” and the sound of the note will be harsh.

The octave pair tuning starts by tuning the inner octave note. After
that, the octave of the outer note is tuned and the fundamental is adjusted together with it. The tuner repeats this around the pan and "goes by octaves", adjusting each inner–outer note pair together.

At this stage it is also good to do a final check that the notes "have their own tone". This is done by damping the corresponding octave to see if the note still sounds good. Sometimes you may find that a note is "living" totally on its octave counterpart. This means that it has a quite different sound and pitch without the octave note. Try to avoid this situation by giving the note a new start with softening and coarse tuning again. Softening and coarse tuning at this late stage will affect the surrounding notes in an unfavourable way, so the sooner these "dead" notes are spotted the better.

A pan with many octave notes, such as a tenor or a double tenor, is harder to tune than a guitar or a bass, due to the interaction between the many notes. But it is easier to get a good timbre in a multi-octave pan if the notes in the upper octave support the lower ones with higher partials. This is the reason why the higher pans have a more brilliant sound than the lower ones.

The octave pair tuning is the last thing done while the pan is resting on the tuning stand, and it may be considered as the last step of the coarse tuning.

10. Holes for hanging

In the next step of the tuning, the fine tuning, the pan should be hanging to get the right sound. Therefore, the time has now come to make holes for the strings attaching the pan to the stand. The holes for the strings are made in the rim or the skirt. The position of the holes is

![Diagram of string hole positions]

Fig. 10.2 Method to determine the position of the string holes.
quite important, because it establishes the position of the notes in relation to the player. It also determines at which angle the pan is going to hang.

On most pans, the supporting strings at each side go between two holes. For instruments consisting of several drums it is best to put the holes a bit down on the side (5 cm is common) so the upper ends of the stands get below the rim and not hinders the player by getting in the way of his arms. See fig 10.1 for a picture of how the string is attached to the holes in the side.

The holes have to be placed about 1–2 cm off centre to get the drum to hang at a suitable angle. The best method to find the position of the holes is the following: Hold the pan at the rim between you hands, using thumb and four fingers of each hand, see fig. 10.2. Place the hands so that the pan will hang at an appropriate angle. This means that your hands will be somewhat off the centre line, again see fig. 10.2. When the pan is hanging right, have someone mark the rim at each side of your hands, making two marks on each side of the drum, approximately 5 cm apart. Then mark the skirt 5 cm below these marks and make the holes there.

For tenors, that consist of only one drum, there is no need to keep the end of the supporting arms below the rim. Therefore, common practice is to make a single hole in the rim at each side of the tenor and tie the string in a loop through it. The position of the holes on a tenor is decided by holding the pan in the rim between thumb and pointing-finger at each side and then marking it there. Again, the positions have to be a bit off the centre line to make the drum hang at the correct angle.

Typical positions of hanging holes for different pans are given in appendix A, together with the overview of the pan.
11. Fine tuning

The fine tuning is a continuation of the former coarse tuning, with the difference that the pan now is moved from the tuning stand to a hanging position. This is done to enable you to hear its final pitch and timbre properly.

In the fine tuning, the tuner concentrates on both the fundamental, the octave and the timbre. The same rules as earlier mentioned for coarse tuning also apply to the fine tuning. You keep on going around the pan, adjusting the partials and the fundamental of each note, this time only making small adjustments, see figures 9.7 through 9.13. If the first tuning is properly done, the fine tuning will only be a minor adjustment.

During the fine tuning you will need a strong stand to hang the pan on, see fig. 11.1. Furthermore, a well-tuned instrument or an electronic tuning device is needed to determine the correct pitch.

When a note reaches the right pitch, the tuner often makes some hard strokes with the stick to decide if the note is stable. If the pitch remains the same, the note is stable, otherwise it has to be re-shaped with a bit higher arch to make it more stable. Sometimes a hard stroke or a hard tap with the end of the stick can be used to fine-adjust the pitch of the note, see fig. 11.2.

If the pan is to be covered with chromium, the pitch and sound of the notes will change because of the extra metal put on. Even if this is the case, the tuner tries to tune the notes as well as possible at this stage. Hard tuning after the chroming will bend the metal enough to cause small cracks in the chromium layer. Later, air humidity may reach the steel through the cracks and make the pan rust.

12. Finishing

The crafting and burning usually removes most of the paint in the bottom of the drum. The bare steel will soon start to rust if it is exposed to the air moisture. During the first year, the only problem will be that the pan looks ugly. But later the sound will be affected by the rust and in the long run the rust will go through the metal and ruin the pan. Therefore, if you want the pan to last it needs to be preserved in some way.

Nowadays, the most common method to protect the pan is to electroplate it with a layer of a non-corrosive metal as zinc or chromium. This is an industrial process and basins with an electrolytic
solution are needed. It is usually done only on small instruments such as tenors and seconds. Larger pans such as bases are usually painted on the side and the playing surface is covered with a thin layer of fat, such as car wax. The best is to combine both methods, first chroming, then a putting on a thin layer of wax to protect the surface from moisture and make it shiny.

**Removing the Paint**

To get the shielding layer of zinc or chromium to stick to the drum the remainder of the original paint has to be removed. This is preferably done with calcinated soda. If the paint is of a hardened lacquer type, the soda won’t affect it – it has to be removed by grinding. The paint can also be removed by sand blasting, but this makes the surface dull, and is not recommended if you are going to chrome the drum later. If the pan is to be chromed, the factory will probably put it in a bath of acid to remove the last paint and fat, but usually the factories want most of the paint removed to avoid messing up their acid baths.

If the pan is going to be painted on the sides instead of chromed, it is sufficient to grind the original paint enough to roughen the surface to get the new paint to stick to it.

**Chromium or Zinc Covering**

Chroming or zinc covering is usually done by factories, using electrolytic processes. On Trinidad, chroming factories are used to the panmakers needs and know how to handle pans. Therefore, the chroming is cheap and straightforward. In other countries, it may be hard to find a factory with an electrolytic basin that is big enough to handle a pan. The shape of the drum also causes trouble, since the electrical currents in the electrolytic bath will not reach into the inner parts of the drum. To inssure an even coating of chrome or zinc, one or several "support anodes" (extra places to send current into the bath) have to be inserted into the drum, which makes the process even more complicated and costly.

The coating has to have two

![Fig. 12.1 Painting the pan to protect it from rusting after chroming. Cross-section of drum.](image)
important properties: It has to be thin, and it has to be soft, i.e., it has to stick to the surface when the note is buckled during the tuning. If the layer is too thick it will affect the tone and damp it. The maximum thickness is still unknown to me, but a layer less than 0.1 mm in thickness should not affect the tone. If the layer is too hard, it will burst and start to fall off when the tuner is doing the final tuning. Some types of zinc or chrome layers are designed to give a hard, shiny surface. These are not suitable for pans.

RUST PROTECTION

The electrolytic process will put a thin layer of chromium or zinc all over the drum, except for the innermost angle between the outer notes and the skirt. The electrical field of the electrodes used in the electrolytic basin will not reach down to this narrow place. Therefore this part has to be shielded against rust in some other way. The best method is to cover it with a thin layer of paint as soon as it comes back from the chroming. If this not is done right after the finishing, you have to start by applying rust-eater to remove the rust.

When painting the playing surface, it is important not to use a paint that not is too thick, because this will damp the harmonics of the note and make the sound dull. Another undesirable effect of thick paint is that it makes the pans (especially the basses) rattle when it dries in the uppermost angle between the notes and the skirt. The best is to use spray-paint or to make the paint thinner before applying it. For chromed pans, it is often enough to paint it 5–10 cm up on the playing surface and the skirt, see fig. 12.1. If spray-paint is used, it may be applied to the whole playing surface of basses and other big pans that have not been protected by chroming.

13. Blending

The blending is the final part of the tuning and it is done after the finishing. Blending
means that the pitch, the timbre and the loudness of the various notes are adjusted. Sometimes this is done together with other pans of the same band, to get the pans to sound good together - to "blend" well. The main part of the blending is the adjustment of timbre, but the tuner also tries to adjust the loudness of the different notes. This is done to make it easier to play balanced and not to out-power each other while playing in an ensemble.

The technique for blending is exactly the same as for the fine tuning. The pitch and the timbre of the notes are tuned in octave pairs, using the same regions for adjustments. The first step of the blending is usually a brief fine tuning. The chroming has covered the surface with a thin layer of chromium that makes the metal thicker and heavier. The increased weight of the notes affects the pitch. The fine tuning of the pitch is often included in the adjustment of the octaves described below.

The next step of the blending is to fine-tune the octaves of the notes to make them match the fundamental. This was first done during the fine tuning, but the altered weight of the notes after the chroming has also affected the partials of the note, so now they need to be adjusted again.

Start the octave blending with the highest note of an octave pair. Make sure that the fundamental and the octave of this note are in perfect pitch. This may be a little difficult to do if the lower note is out of tune, because its octave will interfere with the higher note. When a higher note is properly tuned it will help the tuning of the lower one, as the octave mode of the lower note acts together with the fundamental of the higher one.
The blending, like everything else in pan tuning, has to be done in a circular step-wise process as blending of one note may affect the surrounding ones.

14. Stands

The early steel pans were played hanging in strings from the player’s neck. Pans are still played in this manner sometimes, but this is a special, traditional style for small street bands called “pan around the neck”. Nowadays pans are usually mounted in racks on wheels for carnival or on stands for stationary concert performances.

The common denominator for all hanging mechanisms for steel pans is two supporting limbs separated by a distance slightly more than the diameter of the drum. The drums are hung in strings from hooks on the limbs. The limbs must be at least as long as the skirt of the pan, taking into account the extra length of the tilted drum. Below the skirt, the limbs are joined to form a standing mechanism. One convenient way to make a collapsable stand is to use the lower part of a regular cymbal stand and attach a U-formed fork on top of it, see fig. 14.1. Fig. 14.1 also shows the most common type of stand (in the middle) and the regular Trinidad concert stand, made of bent chromium-coated steel tubing (to the right).

The stands are usually positioned so that the lowest side of the tilted drum is facing the player. This works for all tilted pans, from tenors down to cellos. But if an instrument consists of two drums, another set-up technique may be used. An individual stand for each drum makes it possible to put the stands in a way that makes the drums tilt towards each other, see fig 14.2.

This set-up will put the lowest side of the drums in the middle, making it easier to move the hands from one drum to the other while playing fast figures. This technique has been developed by solo artists but has not yet been adopted by the regular Trinidad steelband. This seems to be due to the fact that there is a technical problem to integrate these twisted stands in the racks of a mobile steelband set-up.
15. Sticks

The first steel pans were beaten with wooden sticks. When the instrument evolved further it was found that damping of the stick could reduce the amount of overtones in the notes and make the sound more mellow.

Nowadays, sticks for steel pans are usually made by wrapping one end of a wooden stick with a strip of rubber from bicycle inner tubing. The sticks are usually made of drumsticks that are cut off to a suitable length. The length and thickness of the stick and the amount of rubber vary for different pans. Sticks for high tuned instruments are short and light while they are longer and thicker with more rubber for lower tuned instruments. Common measures for the different stick types are given in appendix C.

LENGTH

You may choose the length of the stick to your personal preference, but you should be aware how the length will influence your playing. First, power – the longer the stick, the louder you can play. Second, reach – you reach further with longer sticks, which can be a good thing, especially for the lower pans with notes distributed over several drums. Third, skill – it is usually trickier to play with longer sticks.

DIAMETER

The diameter of the stick decides its weight, and thus the amount of force you put into the note when you hit it. The sticks are usually thinner for higher tuned pans and a bit thicker for the low ones. The diameter varies from 10 to 15 mm.

RUBBER

The amount of rubber is crucial for the quality of the sound. The contact between the stick and the pan has to be soft, not to excite the
higher vibrational modes of the note. These higher modes do usually not have a harmonic relationship to the fundamental, and therefore they are not desirable in the sound of the note. The higher modes are damped if the contact time between the rubber and the note is long enough. The thicker the rubber, the longer the time of contact.

If too much rubber is applied to the stick the fundamental will also be damped, thus making it hard to hear the pitch of the note. The right amount of rubber is applied when the sound of the struck note is mellow rather than sharp, with the overtones coming in somewhat after the fundamental. You may read more about the function of damping in the theory section.

Larger notes need softer sticks to sound pleasant. The larger and lower the note, the longer the time of contact needs to be to damp undesirable vibrations in the note. For instruments with a large tonal range this leads to a problem as you are forced to use the same pair of sticks on notes of very different sizes. Then you have to compromise between the quality of the sound of the highest and the lowest note. Too much rubber; weak sound in the higher notes, too little rubber; harsh sound in the lower notes.

The rubber for the sticks is usually bicycle inner tubing cut into strips, about 1–1.5 cm broad, and wrapped around the stick several rounds. There is a special technique to keep the rubber strip wrapped around the stick: Begin at the top and wind the rubber round the stick, going further down for each turn. When you come to the end of the strip, roll back the previous winding and put the last piece of the rubber under it while stretching it. This will lock the end of the strip.

Nowadays, it is possible to buy rubber sheets or latex tubing in hardware stores. The sheets can be cut to strips and used the same way as the bicycle inner tubing. The thickness of the wall in the latex tubes varies from 3 to 8 mm, and they are easiest to come by in dimensions suitable for tenors and double tenors. For tenor sticks, rubber tubing for spear-guns is often used. Sticks for basses are usually made by putting sponge rubber balls at the end of the drumsticks. Sometimes, part of the ball is cut off to reduce the weight, see the last bass stick at the right in fig. 15.1.