

reed knife sharpening



A Guide for Reed Makers Second Edition

by Daryl Caswell
Landwell Reed Knives Inc.

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Second Edition

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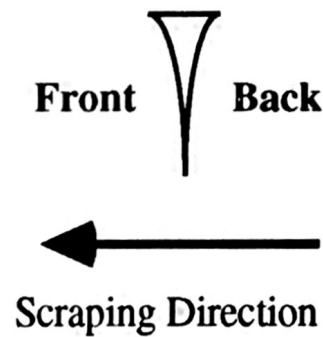
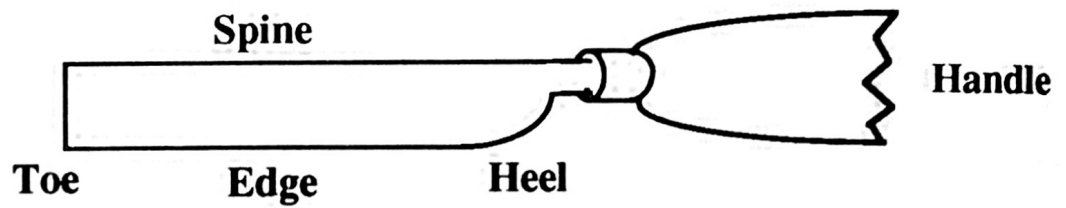
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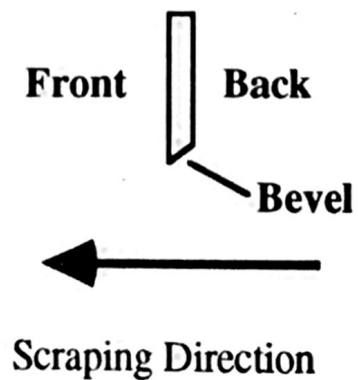
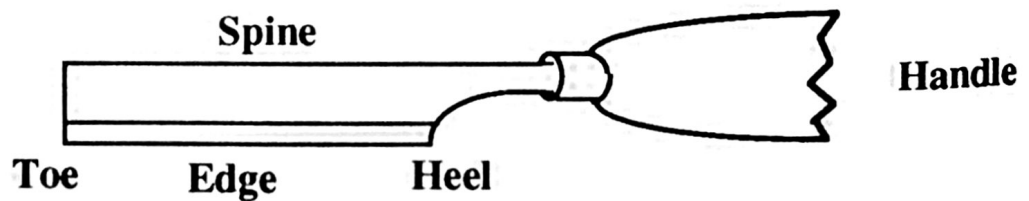
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Figure 1: THE PARTS OF THE REED KNIFE

a) Double Hollow Ground Knife



b) Bevelled Knife



PREFACE

Since Landwell began manufacturing reed knives in 1986, I have been asked many times to put together a guide on reed knife sharpening. I have been reluctant to do this because I do not play a double reed instrument, nor do I make reeds; I am an engineer and a horn player. So what could I possibly have to offer? However, over the years I have had the privilege of discussing reed knives, knife sharpening and reed making with many talented musicians whose sharpening skills range from superb to negligible. I have combined this knowledge with my own engineering perspective and the experience I have gained from sharpening 500 knives each year. Perhaps now the time has come to shed some new light on a very difficult and complex subject.

Most reed knife users would be happiest if there was one A-B-C method which would always produce a sharp, consistent, long-lasting scraping edge. Unfortunately, reed making is a difficult task made more difficult by variations in such things as humidity and cane quality. The most effective sharpening method is one which enables you, the reed maker, not only to adapt to these variations as they appear, but also to respond to the demands of the different stages of the reed making process.

I believe that understanding what happens during knife sharpening and reed making will help you become expert at sharpening your knife just the way you want it. I am therefore offering an analytical, scientific approach. Some of you will love it; others will hate it. Science certainly does not have all the answers, especially in understanding something as complex as reed making. However, analysis coupled with the intuition of the musician is an enormously powerful tool. The engineering analysis I am going to present will provide a logical explanation of successful practices and expose the reasons for chronic problems encountered in sharpening and scraping.

Although I hope that you will read everything in this book, I have tried to organize it so that you can easily find the information you need when you need it without having to read every word. It is not intended as a sales pitch for the Landwell knife. However, this is the knife I make and know best, and therefore the one to which I refer throughout. I hope that this book will provide a means for all of you (Landwell users or not) to develop your own effective sharpening and scraping method.

We welcome your comments and suggestions, both about our knives and about these instructions, and will be glad to respond to any questions you may have.

THE REED KNIFE: A SPECIALIZED TOOL

A double hollow ground reed knife is a unique tool. It is almost a knife within a knife. The scraping edge is formed by establishing the sharpest possible normal knife edge and then bending the finest part of that edge into a scraping profile. The bend produces a microscopic scraping blade on the edge of the reed knife. This microscopic blade is often referred to as a burr or "wire," probably because that is what it looks like under a magnifying glass.

During the research which led to the Landwell Reed Knife, I took an electron microscope picture of the scraping burr. This is the picture on the cover of this book and shown below. You are looking at a cross section of the tip of a knife magnified 800 times. The burr can be seen pointing to the right of the apex of the triangle. This scraping burr does the work of scraping the reed and this is what the reed player must become expert at producing.



Figure 2: The Burr

A reed knife has two primary functions which make it different from any other knife. It must be able to take on a scraping burr that is extremely fine and yet able to resist the abrasive scraping of the reed material. The reed knife metal must also have sufficient flexibility at a microscopic level to withstand the bending of the burr into a scraping profile. This requires that the knife metal have both hardness and flexibility, which are metallurgical opposites. If the metal is too hard, the burr will break off during scraping. If the metal is too flexible, the burr will bend away as soon as it is pushed along the reed.

THE METALLURGY OF REED KNIVES: WHY SOME REED KNIVES WORK BETTER THAN OTHERS

A discussion of the metallurgy of reed knives can provide some answers to three specific questions: Why is it that so many reed knives are inconsistent from week to week, or even from day to day? Why do the finest stones sometimes fail to produce a correspondingly fine burr? And for those who are lost in their own search for the perfect knife, why do the best steels money can buy often result in terrible reed knives?

These three questions can be answered in one word—microstructure. For the double reed player who is not also a metallurgist, this term requires some explanation. Microstructure is the microscopic fabric of a material, in this case steel. A picture of the microstructure of a high quality steel is shown in Fig. 3. This is a very good machine steel with a hardness of Rockwell C59, polished to a mirror finish, etched with acid, and magnified one thousand times. This type of steel is used to make long-lasting stamping dies which can cut thousands of pieces before they need to be replaced.



This is also a steel which makes very poor, in fact, unusable reed knives. Note the large angular particles appearing throughout the photograph. These are called precipitates or carbides. It is the size, shape, chemical composition and distribution of these carbides that determine how, or even if, a reed knife will function.

Figure 3: A High Quality Steel

Carbides

In order to understand these carbides from a purely physical point of view, imagine them to be blocks of wood. Think about what would happen if you were to hold onto a wooden croquet ball with one hand while I attempted to pull the ball out of your hand by means of a string attached to the ball—it would be difficult to remove the ball from your grasp. However, if we do the same thing with a wooden cube, I will have no trouble extracting it. This is because the force of my pulling is concentrated on the corners of the cube rather than spread evenly, as with the ball. It will be much more difficult for you to hang on to the cube. Similarly, if we have one of the angular carbides shown in Fig. 3 on the scraping edge of the knife, the act of scraping will easily knock the carbide out of the burr, leaving a hole in the burr.

Fig. 4 shows an electron microscope picture of the burr of a knife made from the material shown in Fig. 3. You are looking down onto the edge of the knife with the burr edge running from lower left to upper right. Note the hole in the burr.

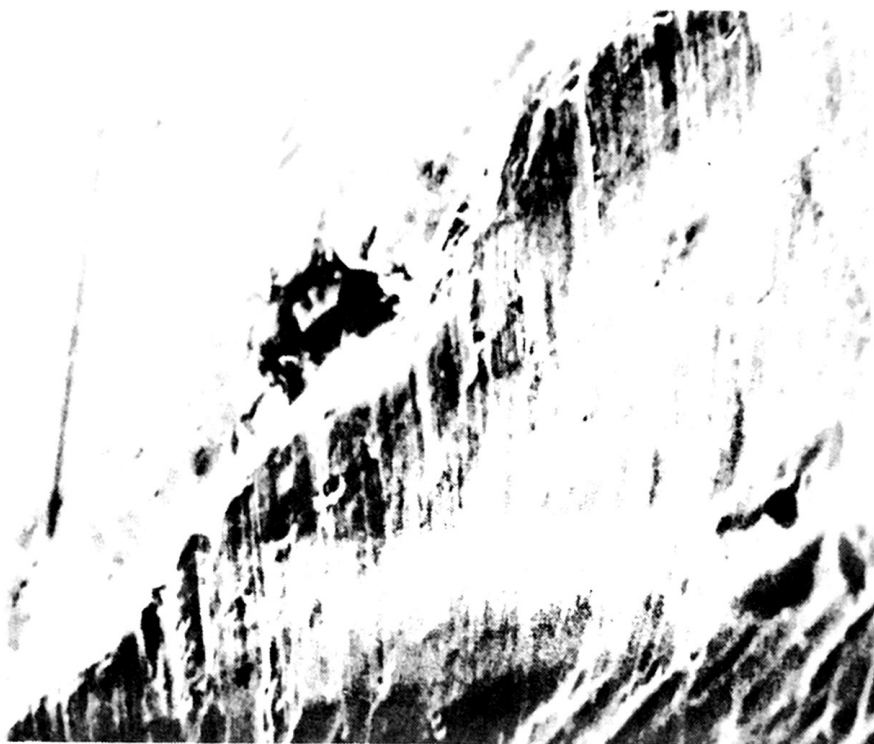


Figure 4: A Knife Made From a High Quality Steel

Suppose this hole is larger than the grain of your finest honing stone. The fineness of the edge will now be determined by the size of the carbides falling out rather than by the stone. Your finest stone will have no effect!

Unfortunately, many high quality steels have this undesirable component of large, angular carbides. This is acceptable and even desirable for uses which do not require such delicate and abrasive work as reed making. In fact, it is often impossible to achieve a microstructure

other than that shown in Fig. 3. As a result, randomly searching through expensive high quality steels can be a costly waste of time.

Chemical Composition

So much for the physical considerations of carbide size and shape. What about chemical composition? In a good knife most of the carbides are harder than the surrounding material. They can help to scrape away the abrasive reed material if they don't fall out. But some carbide-like particles will be softer than the surrounding material. Commercial heat treaters will often suggest that a knife be immersed in liquid nitrogen to harden all of these softer particles. Although this is a useful technique for other applications, it is not appropriate for a reed knife because these softer particles keep the steel from becoming so brittle that it either won't take a burr at all or produces a burr that breaks off easily.

Distribution of Carbides

Finally, let's look at the distribution of the carbides throughout the knife. Carbides form while the steel is being tempered (heated to achieve the desired hardness). The way in

which steel is tempered commercially usually results in clusters of carbides forming unevenly throughout the steel. If your knife happens to have a cluster of large, angular carbides at the edge, it won't work until you have honed that section away. This may take a few strokes or, for a large cluster, it may not be possible at all. The result is inconsistent performance of the knife.

A Summary of the Metallurgical Reasons for Reed Knife Problems

Now we can put all of this together to answer the original three questions.

1. Inconsistency from day to day can be due to the uneven distribution of carbides throughout the metal. Unless the microstructure is carefully controlled, entire batches of knives just don't work.
2. The finest stones will fail to produce a correspondingly fine burr if the carbide size is larger than the grain of your finest honing stone. The stone will have no effect as the cavities created by carbides falling out will dictate the fineness of the edge.
3. The most expensive steels often result in terrible reed knives because the reed knife requires a metal with some unique properties not addressed by the most advanced alloys and manufacturing methods. Most metallurgists operate by the book and are unable to respond to unconventional problems, especially if they come from a musician.

THE LANDWELL KNIFE

The research done by Landwell has resulted in some unique heat treatments which metallurgists simply refuse to use. These heat treatments result in carbides that are small, round and evenly distributed, giving a knife which will take on a very fine and consistent burr. Fig. 5 is a picture of the microstructure of a Landwell knife with the same magnification as in Fig. 3.

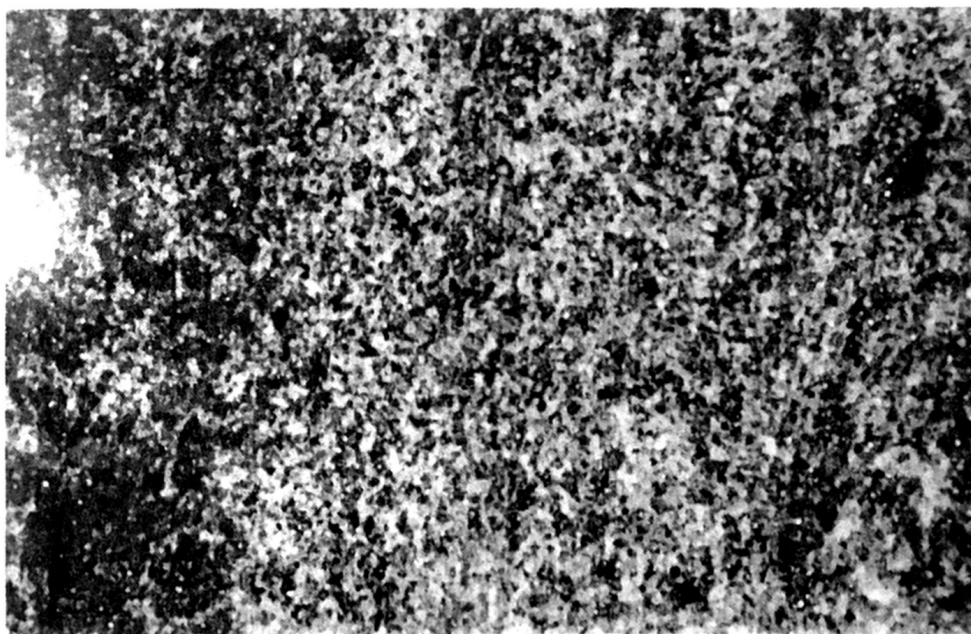


Figure 5: The Landwell Microstructure

Gaining control of the microstructure, as we have done, allows us to produce a range of knives that offer a selection of performance characteristics (discussed in a later section). It is now possible to have knives with different degrees of flexibility and fineness. You can choose a knife which will suit your style and the requirements of the different stages of the reed making process.

SCRAPING AND SHARPENING

If there is one thing that science is good at, it is breaking down a complex action like reed scraping into its fundamental components and exposing the principles of the scraping action. Although science is unable to produce a model that approaches the intricate real life complexities of scraping, we can develop one which may be of some use.

A step by step look at the scraping of a reed will help to identify the reasons behind the different parts of the sharpening procedure. This knowledge will help you to be more successful in adapting to scraping and sharpening problems as they arise. This is much better than hoping the knife and your reed happen to be in the right condition to achieve success with your one and only method.

The effective use of a scraping knife relies on achieving the proper balance between the lift angle, the rake angle, the burr root thickness, the desired chip thickness and the scraping force. Let's begin by defining these terms.

Rake Angle

The rake angle is the angle at which the scraping burr cuts into the reed during scraping. It is a measure of how far the burr is from cutting vertically into the reed. For a zero rake angle, the burr cuts straight down into the reed surface while for a 90 degree rake angle the burr slides along the reed without cutting into it.

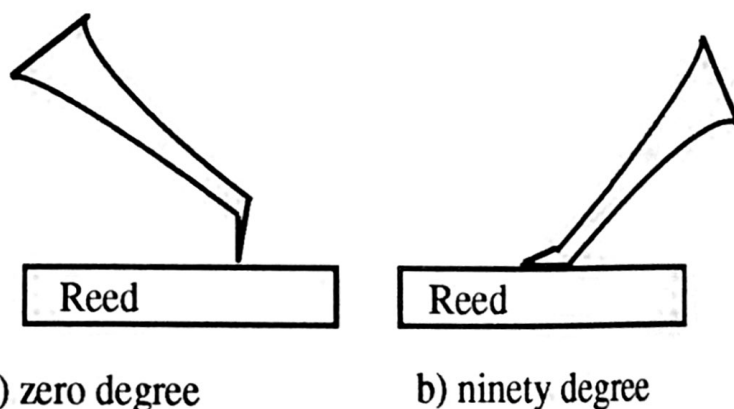


Figure 6: Rake Angle

Chip Thickness

The chip thickness is the thickness of the cane which you wish to remove. It may be as thin as a single fibre or as thick as the bark at the base of the reed.

Scraping Force

The scraping force is a measure of how hard you push the knife edge into the reed and along the length of the reed as you scrape.

Lift Angle

The lift angle is the height that the back of the knife is raised above the stone during sharpening.

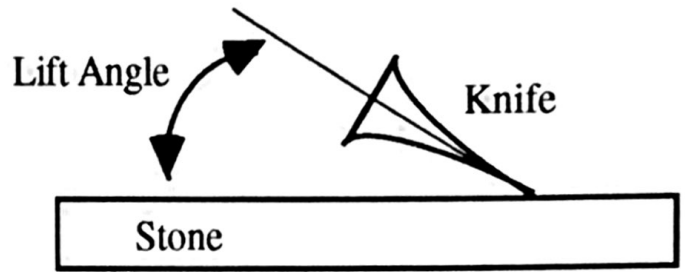


Figure 7: Lift Angle

Burr Root Thickness

The burr root thickness is the thickness of the knife at the point at which the burr begins to bend into the scraping profile. It is determined by the size of the lift angle and the thickness of the edge of the knife before it is sharpened.

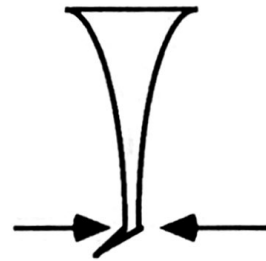


Figure 8: Burr Root Thickness

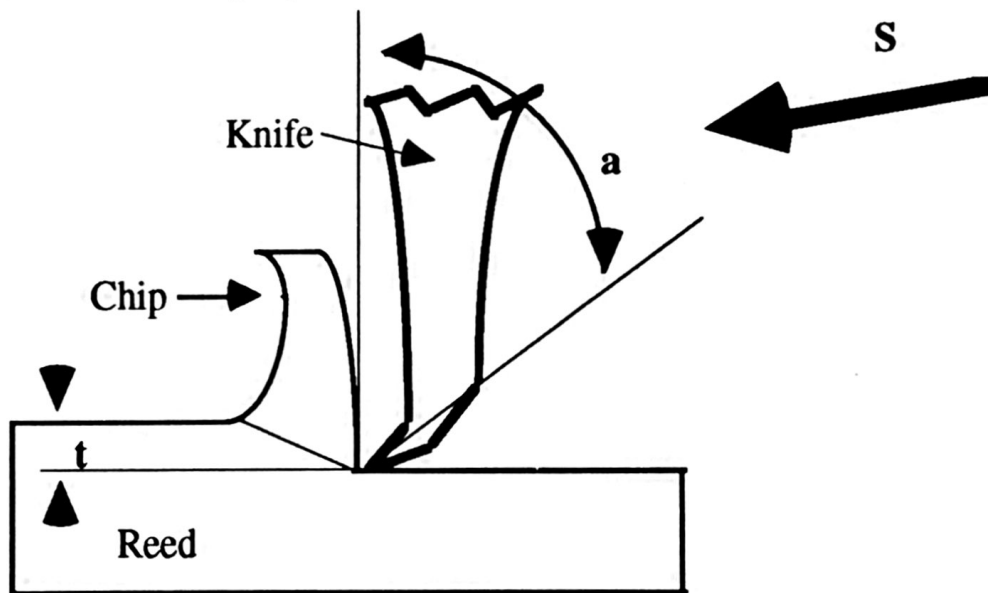
Putting This All Together

The difficulty for the reed maker is that all of these variables are interconnected. The best rake angle during scraping depends on the desired chip thickness, scraping force, lift angle and burr root thickness. Or, the best lift angle during sharpening depends on the desired rake angle, chip thickness, scraping force and burr root thickness. And on it goes.

We can simplify these complicated relationships by grouping them into those which depend primarily on what you do during the scraping process (rake angle, chip thickness, and scraping force) and those which depend on what you do during the sharpening process (lift angle and burr root thickness).

THE SCRAPING MODEL

Fig. 9 below is a magnified and idealized model of the scraping edge as it acts on the reed. Identified are the basic controlling features of a scraping blade: the rake angle (a), the chip thickness (t) and the scraping force (S).



a = Rake Angle
 t = Chip Thickness
 S = Scraping Force

Figure 9: The Scraping Model

The **rake angle** is the most important variable because it dictates how well the edge will scrape along the reed. The rake angle required for scraping is initially determined by the lift angle used during sharpening but it can be changed by tilting the knife as shown in Fig. 11. If the rake angle is too small, the burr will dive into the reed and gouge it. If it is too large, the burr will jump out of the reed and “chatter.” Here we have a nice simple explanation for gouging and chattering. Of course it is not really that simple. The optimum rake angle is affected by the condition of the reed material, the thickness of the chip, the scraping force used and the burr root thickness.

The fineness of the scrape is reflected in the **chip thickness** (i.e. the thickness of the reed shavings). Sometimes you will want to remove only a single fibre of cane while at other times you will be removing heavy bark from the back of the reed. These two extremes require different rake angles as well as different burr stiffness or strength. Using the same knife and sharpening method for all phases of reed making will not provide the best results.

As shown in Fig. 10, the **scraping force** (which is the force exerted by your hand on the knife and therefore by the knife on the reed) is made up of two parts: one which pushes the knife along the reed (horizontal force) and another which pushes the edge into the reed (vertical force).

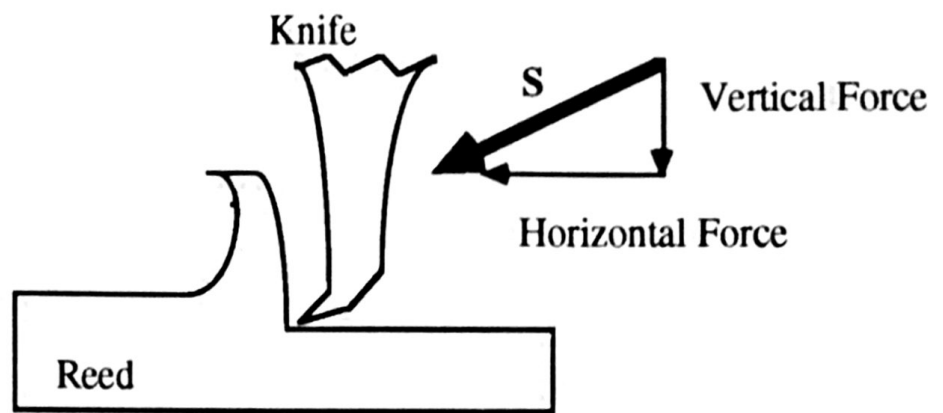


Figure 10: Scraping Force

This model of the scraping forces provides an explanation for why some people (especially bassoonists) prefer a heavier knife such as a bevel. The weight of a heavy knife provides a consistent downward force. This means that the reed maker need only be concerned with varying the horizontal force. One variable has been removed. However, most oboists seem to demand an extra dimension of control and therefore prefer a lighter double hollow ground knife which requires that the user control both the forward motion along the reed and the vertical motion into the reed.

Limitations of the Model

We must always remember that this scraping model is just that: a model. While it shows some basic principles of scraping, the model loses a great deal of credibility when we consider the arc caused by the natural rotation of the wrist. As shown in Fig. 11, the situation of Fig. 10 is only one moment in time of an actual scrape. As you move the knife, the rake angle changes.

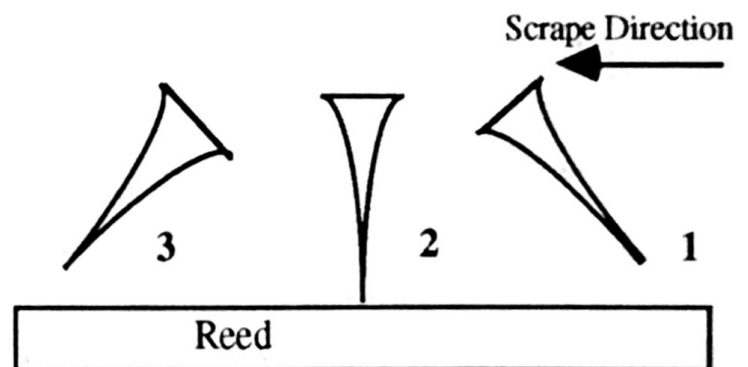


Figure 11: Effect of Blade Rotation

So what use is our simplistic model? Looking at the act of scraping in this way brings out two important considerations.

1. Rigid adherence to a specific rake angle is not the answer. The rake angle continually changes anyway. However, once an understanding of the function of the rake angle becomes intuitive, slight changes to your technique can accommodate a wide range of conditions. For example, if the knife chatters or if the knife becomes worn and the burr becomes more difficult to bend into position, tilting the knife forward to decrease the rake angle may solve the problem.

2. Although precise angles are not critical when sharpening, the consistency of those angles is very important to maintaining consistent scraping behavior all along the scraping edge. For example, if you inadvertently rock the blade as you draw the knife across the sharpening stone, the rake angle will be different at the toe than it is at the heel and the knife will chatter or gouge at some point along the edge.

Scraping With the Bevelled Knife

In general, bevelled knife users are able to maintain longer lasting, more consistent rake angles because a bevelled knife does not rely on the burr for scraping. Instead, the bevel of the knife forms the scraping profile. The rake angle is primarily determined by the angle of the bevel. Of course, a bevel user pays a heavy price for convenience in the loss of the fine control which the burr can provide.

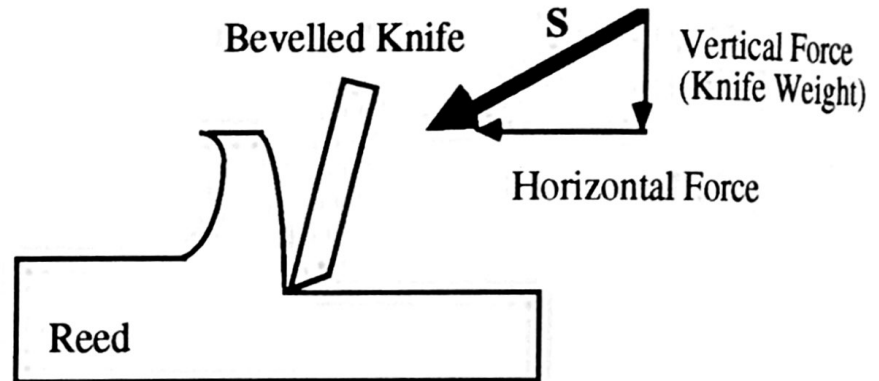


Figure 12: Scraping With The Bevel

SHARPENING FACTORS

Now that the fundamentals of the scraping process have been reviewed, we can look at some aspects of scraping. Remember that the rake angle used during scraping is largely determined by how high the back of the knife is raised off the sharpening stone (Fig. 7) and the strength of the burr and the ease with which it can be formed is determined by the burr root thickness (Fig. 8).

Burr Root Thickness (RT)

The strength of the burr and the ease with which it is formed are determined by how thick the base or root of the burr is and how much flexibility the metal has at that thickness. If the root thickness is too great, the burr will break off rather than bending into place. If it is too thin, the burr will form easily but it will be weak and tend to bend back as soon as it is used. The heat treatment and alloy content of the metal will determine the optimum root thickness for a particular brand of knife. Many problems with sharpening a reed knife are a result of an improper or inconsistent burr root thickness.

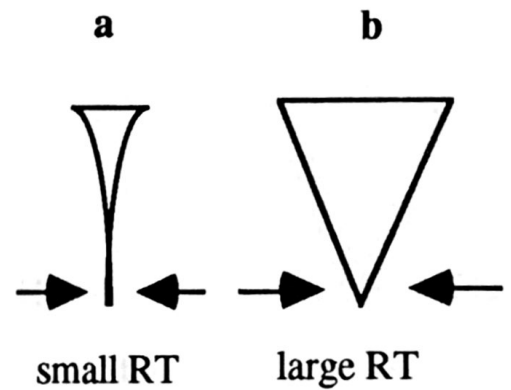


Figure 13: Burr Root Thickness

Finding the Right Lift Angle

There will always be controversy over raising or not raising the back of the knife during sharpening. The best lift angle will depend on the desired strength and rake angle of the burr as well as on the burr root thickness. In addition, the lift angle must remain constant throughout the sharpening process to get consistent behavior along the length of the blade. If the knife is left flat on the stone as shown in Fig. 14a, the lift angle is minimized, as is the burr root thickness. It will take a lot of honing to prepare the burr root this way. Once the burr root is established, a very fine burr can be quickly put in place. The price to pay for this is that this very fine burr is also very fragile. As the lift angle is increased, the burr becomes stronger but it is less fine and more difficult to achieve (Fig. 14b), until the extreme limit is reached where the burr will not form and a bevelled edge results (Fig. 14c).

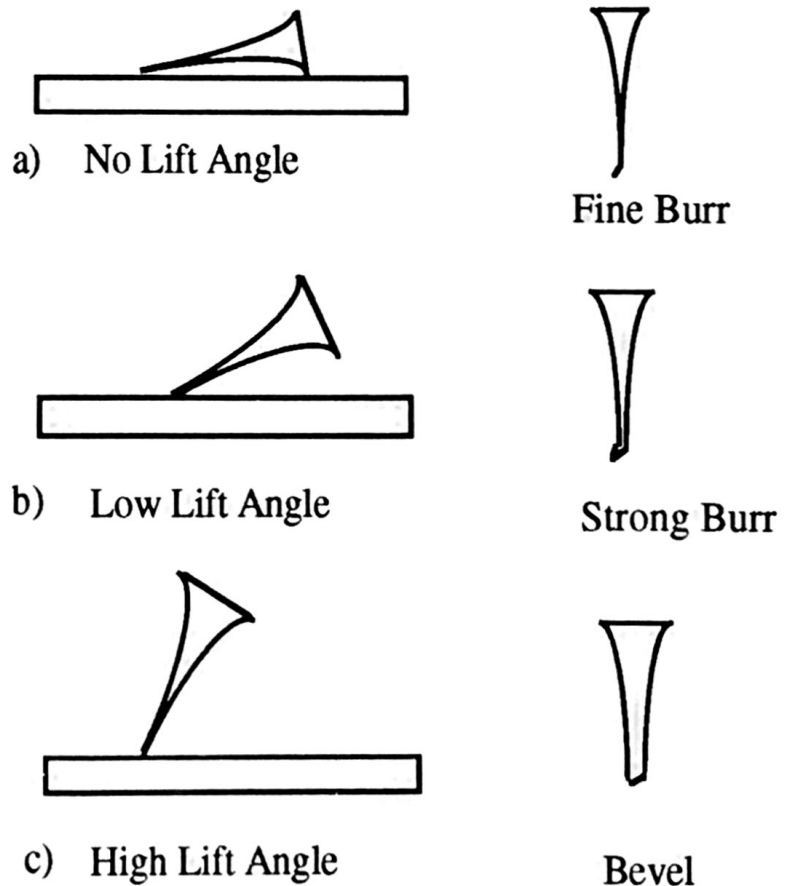


Figure 14: Variation in Lift Angle and Resulting Burr

SHARPENING DIFFERENT KNIVES

Assuming that you are using a knife which is able to achieve both hardness and flexibility while maintaining a consistently fine microstructure, a new set of variables now enters the picture. Exactly what is the balance between hardness and flexibility for a particular knife and how does that affect the sharpening method and the scraping possibilities? This is an aspect of reed knives which the research at Landwell has developed into three different combinations of hardness and flexibility: Hard (H), Medium (M) and Soft (S). The factors which determine the hardness/flexibility/fineness of the final scraping burr are the heat treatment of the metal and the burr root thickness of the blade.

The Landwell H burr has maximum hardness and fineness with minimum flexibility. The M burr has maximum hardness with mid-range fineness and maximum flexibility, while the S burr has maximum hardness and fineness with mid-range flexibility. The burr root thickness is the only factor which can be controlled by the user of the knife, but the flexibility of the burr must also be considered when sharpening the knife.

Customer response in six years of producing these subtle variations in burr behavior has shown the following trends: In general, the M is the easiest to use, while the H and S provide useful variations but require more skill in preparing the burr.

H: This model can take on a very strong, fine burr with a stiff feel, which many people like. However, the root thickness must be within a fairly narrow range or the burr will not hold (see Fig. 15a). This means that the H is hardest to sharpen, although many players prefer this knife in spite of this.

M: This model takes on a burr which is less fine than the H or the S but is quite flexible and will function well over a wide range of root thickness (see Fig. 15b). It is the easiest to sharpen and the most general purpose knife.

S: This model takes on a very fine edge which is more fragile than the H or the M but provides a delicacy and high degree of flexibility which many people prefer, especially for tip work. This knife is also very sensitive to the root thickness (see Fig. 15c).

The graphs shown in Fig. 15 are a visual representation of the behaviors of our knives. The horizontal axis shows the range of acceptable root thickness while the vertical axis shows the relative amount of flexibility available. The height of the curve shows how flexible the burr is. The beginning and end of the curved line shows the range of burr root thickness which that knife can accommodate. Fig. 15b clearly shows that the M model can accommodate a wide range of root thickness.

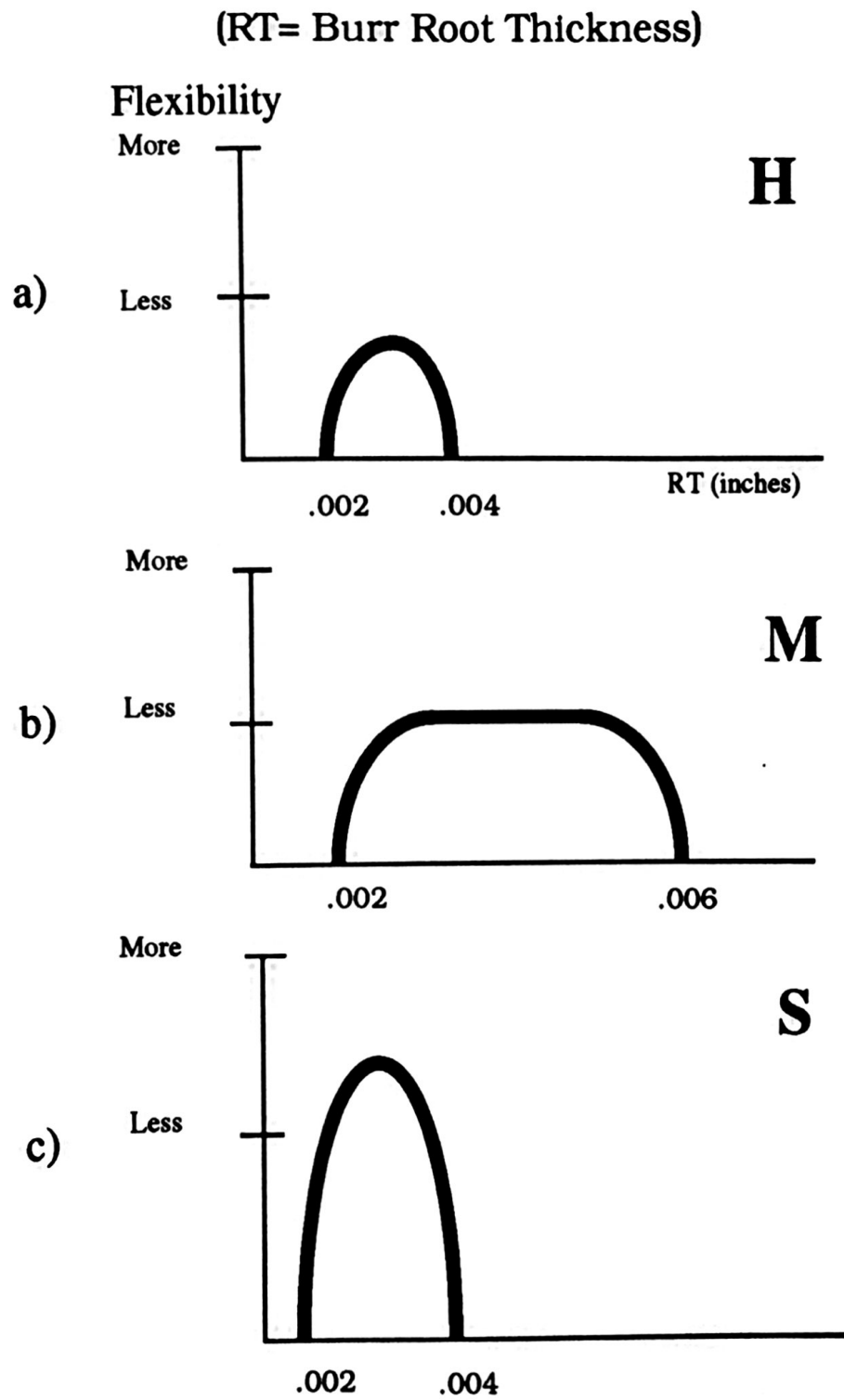


Figure 15: The Three Landwell Models

CHOOSING THE HONING STONES

Much controversy seems to surround the many types of stones available on the market today: Should they be cleaned or not? Should they be oiled or not? Is an exotic Japanese water stone or the latest ceramic stone better than the normal hardware store variety? In an attempt to sort out some of the myths about honing stones, I recently undertook an informal research project into the suitability of the different types of stones for the various stages of reed knife sharpening. I purchased and, over a two month period, experimented with carborundum stones, India oil stones, ceramic stones, Japanese water stones, hard Arkansas stones and diamond stones. I now recommend the following stones for each stage of the sharpening process, particularly if you are sharpening a Landwell knife. If you are sharpening another knife, you may find that other stones work better.

1 . Rough honing: A fine diamond stone.

2 . Bending of the burr into a scraping profile: A fine India oil stone which has never been cleaned or oiled.

3 . Refining or polishing the scraping edge: Japanese water stones (1000, 2000 and 6000 grit).

1 . Rough honing: The diamond stone, which is a metal plate impregnated with diamond particles, does good job of removing metal. It also keeps a perfectly flat surface. The diamond stone comes in fine (red) and medium (blue). The fine diamond stone is best unless you are doing a lot of heavy duty honing, in which case you could use either a medium diamond stone or a belt sander. The carborundum stone has often been recommended for this process but is not ideal because the stone wears away too quickly and unevenly.

2 . Bending the burr: This is a process which is not well understood by the average reed maker. Once the edge of the knife has been sharpened so a rough burr can be seen or felt, the edge must be cleaned and bent into a scraping profile. Loose bits of metal are removed and the burr is bent by rubbing the edge on a smooth surface. It is crucial that the honing stone used for this process be hard enough to bend the burr into place but not aggressive enough to grind it off.

The best stone for this purpose is a fine India oil stone which has never been cleaned and is therefore unable to tear off the burr. It takes some time before the surface of the stone becomes clogged and is just the right abrasiveness for this stage. I use a stone which I have used for five years. I never clean the stone and never use oil on it. This is a practice which is frowned upon by stone manufacturers but is used to great advantage by many skilled knife sharpeners.

It is also possible to use a 6000 grit Japanese water stone or the hard Arkansas stone. The India oil stone seems to provide a better balance between bending and polishing than either the water stone or the Arkansas. Any of the other stones are too aggressive and tend to tear the burr off rather than bend it. For bevelled knives, I use the 1000 grit Japanese water stone to produce a sharp edge, followed by an India oil stone to refine and polish that edge.

3 . Polishing: Once the scraping burr is in place, an extremely fine (6000 grit) Japanese water stone or a hard Arkansas stone can be used for further polishing although this is an optional step. The ceramic stone is too aggressive for bending the burr but not fine enough for polishing.

The Ceramic Stick

More and more reed makers are using a ceramic stick to restore the burr after moderate use. The photo in Fig. 16 was taken with an electron microscope looking down onto the burr magnified 2300 times. It shows the effect of scraping on the burr. The left half of the picture shows the burr before scraping. The right half of the picture shows the burr after heavy scraping. The burr bends out of a scraping profile as it scrapes rather than breaking off or becoming dull. A single stroke with a fine ceramic rod will bend the burr back into a proper scraping profile. This will delay the need to resharpen but once resharpening is necessary, more than touch up work is needed to restore the burr.



Figure 16: The Burr Before and After Scraping

Sharpening the Double Hollow Ground Knife

Before You Begin

1. If your knife has been badly sharpened, it may have to be reground before it can be sharpened successfully using these instructions.
2. Always sharpen with the stone on a firm base such as a table. Trying to sharpen a knife while the stone is moving around on your lap greatly reduces your chance of success and greatly reduces the life of the knife, as it will take more grinding to achieve a consistent edge.
3. Never let any part of the knife leave the stone during a honing stroke. The part of the knife that is not on the stone is not being sharpened at the same rate as the part that is constantly in contact with the stone. The result is uneven wear (see Figs. 35 and 36).
4. Holding the knife properly will greatly improve your results. Use two hands to apply even pressure all along the blade and use a thumb or a finger to maintain a consistent lift angle (see Figs. 22 and 23).
5. Replace your honing stone if it is not perfectly flat. If it is a water stone, you can smooth it out by rubbing it on a piece of sandpaper which is lying on a hard, flat surface.

Basic Sharpening Strokes

There are only **four basic strokes** used to sharpen a knife. Each step of the sharpening process will require one of these four strokes together with a specific lift angle and pressure on the stone. The four strokes are shown below and will be referred to as needed in each step. Each picture shows the beginning of the forward stroke. The return stroke returns the knife to this position as shown in the quick reference guide on p. 35 and 36.

IF YOU ARE LEFT HANDED: Ensure that either the front or back of the knife is on the stone as indicated in each step.

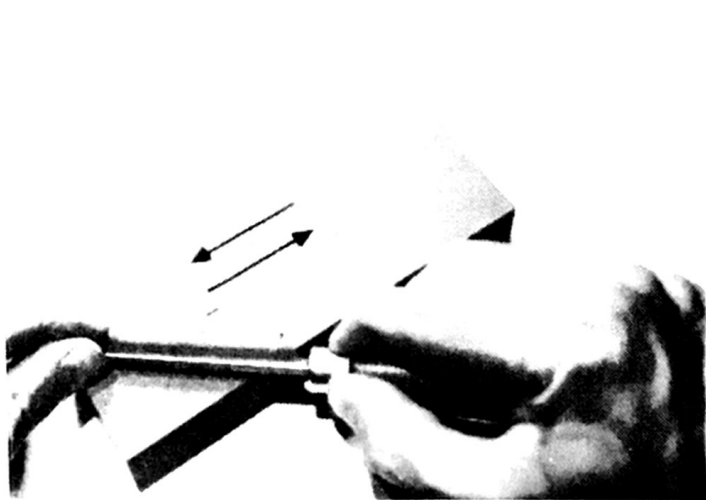


Figure 17: Stroke 1

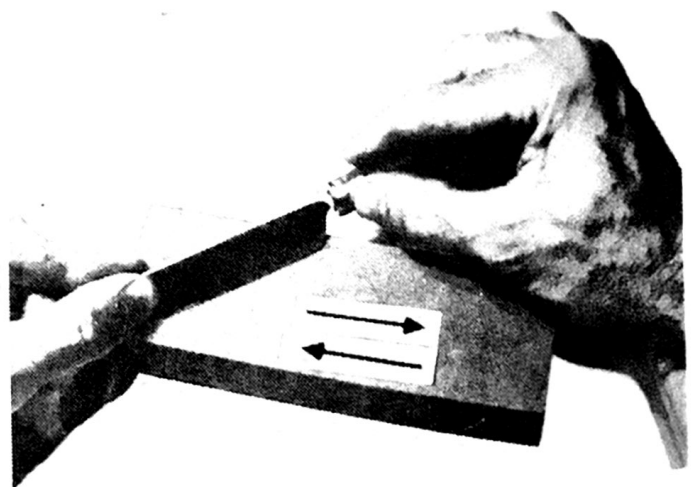


Figure 18: Stroke 2

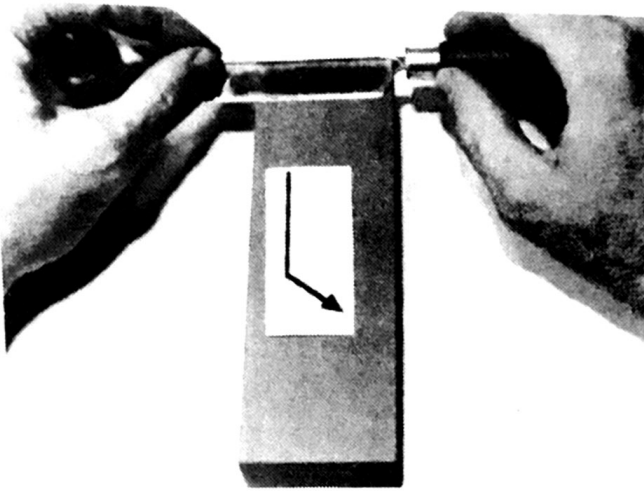


Figure 19: Stroke 3

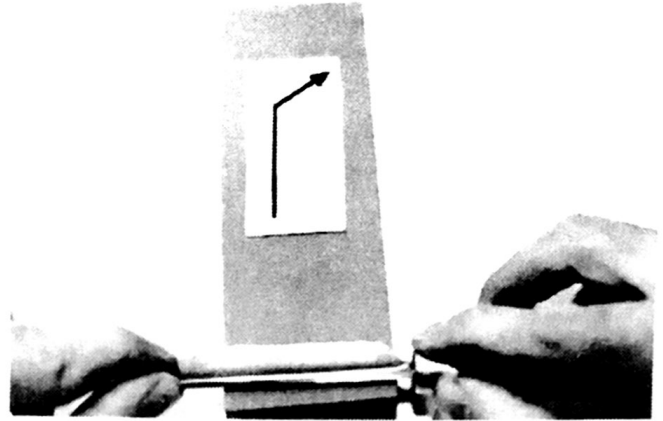


Figure 20: Stroke 4

Lift Angles

Only two lift angles are used during sharpening:

- a) **Flat:** The edge and the spine contact the stone.
- b) **Raised:** The spine is lifted approximately 1/4 inch off of the stone.

a) flat lift angle



b) raised lift angle

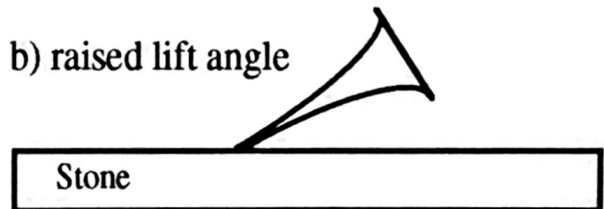


Figure 21: Lift Angles

Consistency of Lift Angles: The raised lift angle used should be approximately the same for the front and the back of the knife (the spine is lifted about 1/4 inch off the stone as in Fig. 22). Do not worry if it is not exactly the same on both sides, but be consistent on each side. Consistency is achieved by using your thumb or forefinger as a spacer as shown in Fig. 23, and sliding your thumb or finger along the stone as you move the knife.

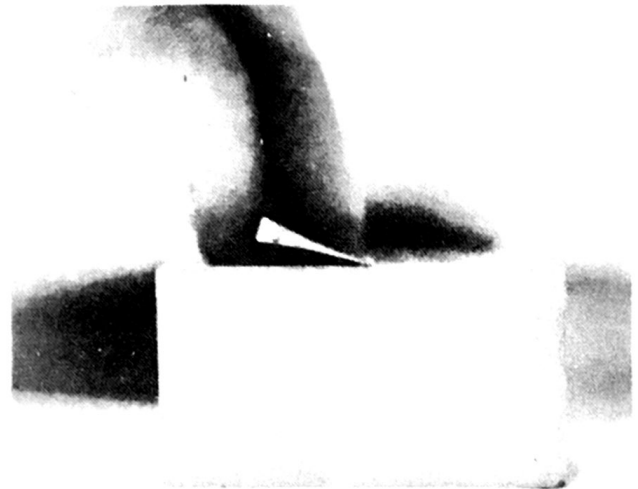


Figure 22: The Raised Lift Angle

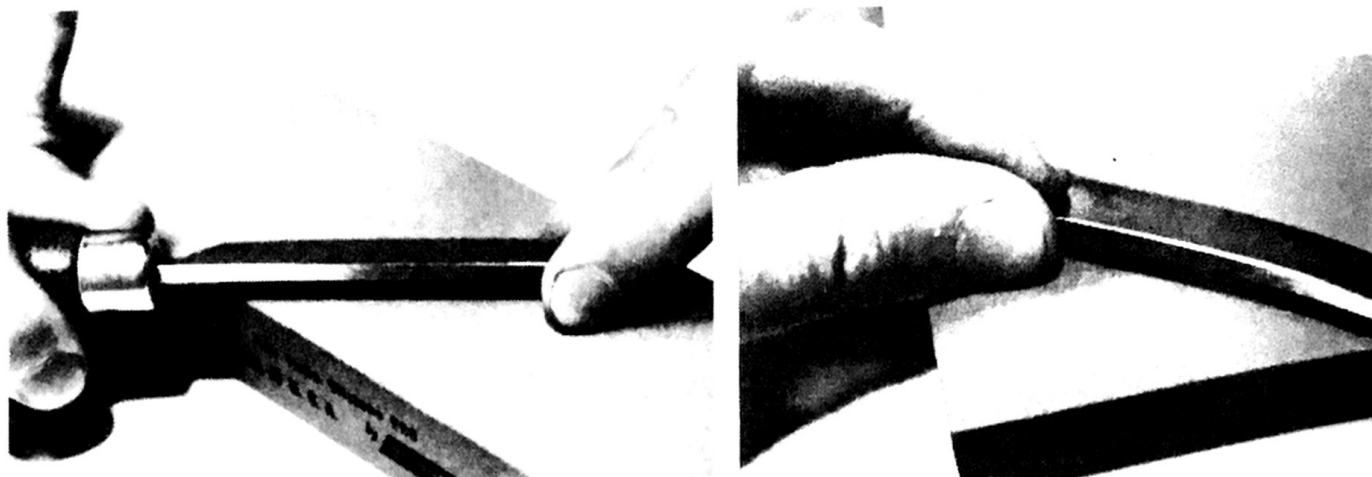


Figure 23: Using the Thumb or First Finger to Maintain a Consistent Lift Angle

Pressure

Many people inquire about the amount of pressure I use for each step of the sharpening process. This is an important question which is difficult to answer. I have divided the pressure levels into maximum, medium and light pressure. I found the actual value of maximum pressure by placing the stone on a bathroom scale and observing the reading for the highest pressure used. For maximum pressure the scale registers a change of 18 lbs. Medium pressure registers a change of 9 lbs. Light pressure is just enough to keep the entire edge in contact with the stone without moving the scale. I will represent the pressure level and the direction to move the knife on the stone as arrows of different thickness as shown in Fig. 24.

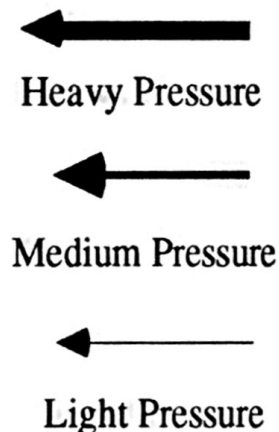


Figure 24: Honing Pressures

Where to Begin

For light touching up of the burr begin at step 5. If the result is not satisfactory because the edge is too worn, begin at step 3. When this fails to produce a satisfactory edge, the knife has become too thick at the edge. You must now start at step 1, after removing the old burr and evening out any wear at the heel and toe with the diamond stone as shown in Fig. 34.

NOTE: In the procedures, the word *stroke* means a forward and a backward stroke. For example, if the instruction calls for 10 strokes, this means you rub the knife forward and back on the stone 10 times.

ROUGH HONING

Step 1: Preparing the Back of a Completely Dull Knife

Every new knife I sharpen begins life at this stage. You will need this step only when when steps 3 or 5 won't work or when you have ground the edge completely away in order to remove a nick or to straighten out a bowed or uneven blade. In other words, start here if the knife is completely dull and has an edge thickness as shown by the dark line in Fig. 25.

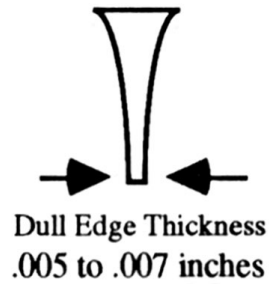


Figure 25 : An Unhoned Knife Edge

PURPOSE: To set the first angle which prepares the edge for either right or left handed use. If you are left handed, ensure that the front or back of the knife is on the stone as indicated in each step.

TOOLS: A medium (blue) diamond stone.
or

A fine (red) diamond stone or a coarse carborundum will also work but not as well. If you do a lot of sharpening, you may also want to have available a belt sander with a 120 grit belt and water close by to cool the blade. A belt sander will do step 1 very quickly, but care must be taken to remove metal evenly and avoid overheating the blade.

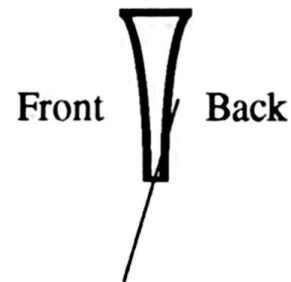


Figure 26: The First Angle

SET UP:

- a) Stroke #1.
- b) Flat lift angle, front facing up.
- c) Heavy pressure on forward stroke.
- d) Medium pressure on return stroke.

PROCEDURE:

1. Place the knife with the back flat on the stone.
2. Very slightly lift the spine of the knife off the stone to reduce the wear on the spine (this is still the flat lift angle).
3. Using heavy pressure in order to remove as much metal as possible, rub the knife on the stone. Be sure that you maintain a very small but consistent lift angle. This will take at least 10 strokes and may take as many as 30 or 40 strokes.
4. Continue this stroke until the edge is approximately as thick as this line:

(0.002 inches)

STEP 2: Forming a Rough Burr

PURPOSE: To produce a burr along the back of the edge. This burr is not usable but will be strengthened and refined by later steps.

TOOLS: A fine (red) diamond stone.
or

A fine India oil stone, a 1000 grit water stone, a coarse carborundum stone, or a ceramic stone.

SET UP:

- Stroke #2.
- Raised lift angle, back facing up.
- Heavy pressure on forward stroke.
- Medium pressure on return stroke.

PROCEDURE:

1. With the front of the knife on the stone, raise the spine of the knife about 1/4 inch.
2. Using your finger as a spacer and sliding it along the stone together with the knife, rub the knife on the stone with heavy pressure as the edge cuts into the stone and medium pressure as the blade moves back to its original position.
3. Continue to rub until a burr appears or can be felt all along the back of the edge. This should occur after 10 to 20 strokes.

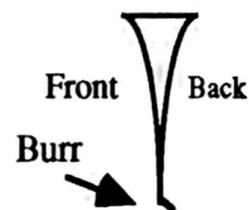


Figure 27: Formation of the Burr

STEP 3: Smoothing the Burr

PURPOSE: If you are starting here, this step will form a burr on the back of the knife (Fig. 27). If you are continuing from step 2, this step will smooth off the grind marks from the diamond stone.

TOOLS: A fine India oil stone.

SET UP:

- Stroke #2.
- Raised lift angle, back facing up.
- Medium pressure on forward stroke.
- Medium pressure on return stroke.

PROCEDURE:

1. Same procedure as step 2 on the India oil stone for 10 strokes using medium pressure in both directions.

STEP 4: Stiffening the Burr

If you are using a Landwell S or H, skip this step and go to step 5.

PURPOSE: To bend the burr around to the front of the knife which increases its stiffness (much like bending a paper clip back and forth). For the Landwell H and S, this step can result in too much stiffening and the edge becoming brittle.

TOOLS: A fine India oil stone.

SET UP:

- a) Stroke #1.
- b) Raised lift angle, front facing up.
- c) Medium pressure on forward stroke.
- d) Light pressure on return stroke.

PROCEDURE:

1. Place the back of the knife on the stone.
2. Lift the spine about 1/4 inch off the stone.
3. With your left thumb sliding along the stone and acting as a spacer, do 6 strokes using medium pressure on the forward stroke and light pressure on the return stroke.

The burr is now in place but needs further refinement.

FINE HONING

Start here if you are touching up your edge.

STEP 5: Removing the Rough Burr

PURPOSE: If you are touching up the edge, this step will align the burr again. If you are continuing from step 4, this step will begin to remove the coarse, unusable part of the burr and leave behind a very fine, sharp, scraping burr which is then strengthened by the bending from the back to the front of the knife.

TOOLS: A fine India oil stone.

SET UP:

- a) Stroke #2.
- b) Raised lift angle, back facing up.
- c) Light pressure on forward stroke.
- d) Light pressure on return stroke.

PROCEDURE:

- 1 . With the front of the knife on the stone, raise the spine of the knife about 1/4 inch and hold it in place by grasping the spine at the toe end with your left thumb and first finger.
- 2 . Do 7 strokes only using light pressure in both directions. Slide your first finger along the stone with the knife (same as in step 2). If you have sharpened correctly to this point you will feel that the edge will initially cut into the stone but after 3 or 4 strokes it will seem to slide rather than cut. If this happens, success is almost assured. The coarse burr will begin to peel off as a thin strip of metal but don't worry if you don't see it; it may have already fallen away in earlier steps.

STEP 6: Refining the Burr

PURPOSE: To remove more of the coarse, unusable part of the burr and leave behind a very fine, sharp scraping burr which is strengthened by the bending from the back to the front of the knife.

TOOLS: A fine India oil stone.

SET UP:

- a) Stroke #1.
- b) Raised lift angle, front facing up.
- c) Medium pressure on forward stroke.
- d) Light pressure on return stroke.

PROCEDURE:

- 1 . Place the back of the knife on the stone.
- 2 . Lift the spine about 1/4 inch off the stone (same as step #4).
- 3 . Using your left thumb as a spacer, do 7 strokes using medium pressure on the forward stroke and light pressure on the return stroke.

STEP 7: Keeping the Stone True and Refining the Burr

Steps 7 and 8 violate the prime rule of never allowing part of the knife edge to leave the stone. These few light strokes will not affect the knife adversely.

PURPOSE: To ensure that the stone wears evenly by using the last few refining strokes to keep the surface flat.

TOOLS: A fine India oil stone.

- SET UP:**
- a) Stroke #3.
 - b) Raised lift angle, back facing up.
 - c) Light pressure on forward stroke.
 - d) Light pressure on return stroke.

PROCEDURE:

- 1. Place the front of the knife on the stone.
- 2. Using your first finger as a spacer, do 3 strokes only using less than medium pressure but more than light pressure on the forward stroke and light pressure on the return stroke. Try to cover the entire surface of the stone.

STEP 8: Setting the Scraping Profile

PURPOSE: To set the burr into the proper angle for scraping. This step is critical.

TOOLS: A fine India oil stone.
 or
A hard Arkansas stone.

- SET UP:**
- a) Stroke #4.
 - b) Raised lift angle, front facing up.
 - c) Medium pressure on forward stroke.
 - d) Light pressure on return stroke.

PROCEDURE:

- 1. With the back of the knife on the stone, do three strokes using medium or slightly more pressure on the forward stroke and light pressure on the return stroke.

STEP 9: The Final Stroke

PURPOSE: This last, light stroke is an optional stroke which removes most of the remaining metal particles still clinging to the burr.

TOOLS: A fine India oil stone.

- SET UP:**
- a) Stroke shown in Fig. 28.
 - b) No lift angle, back facing up.
 - c) Light pressure for one sideways stroke.

PROCEDURE:

1. With the front of the knife flat on the stone as shown draw the knife to the right with one light pressure stroke to clean the dirt from the edge (Fig. 28).

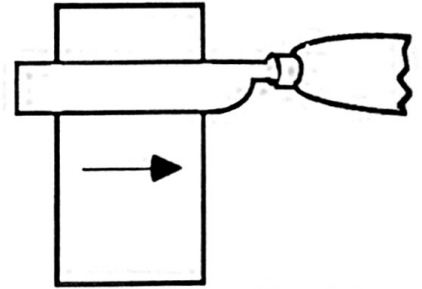


Figure 28: The Final Stroke (Step 9)

Checking the Edge:

The best way to check for a finished edge is to very lightly run a finger tip along the edge under a strong light (Fig. 29). BE VERY CAREFUL! When the edge is finished there will be no rough spots anywhere on the edge. If checking the edge this way requires more steadiness than you can muster, you can achieve the same thing by running the edge of the knife lightly along the top edge of your thumbnail. If you can't stand the thought of that either, use the end of a plastic ball point pen (Fig. 29). If rough spots or bits of metal are present at the tip or the heel, repeat steps 7, 8 and 9 with a little extra pressure on the ragged spots. If the edge is smooth but not fine enough, repeat steps 7, 8 and 9 using less and less pressure with each stroke.



Figure 29: Checking for a Finished Edge

Testing the Edge:

Once the edge is clean and smooth you can test its scraping behaviour on your thumb nail. If the scraping burr is properly formed, the knife will catch on your nail when you try to scrape the edge along the surface of a thumb or finger nail. Use no pressure other than the weight of the knife and keep the blade perpendicular to your nail. The edge should catch or grab your nail in the same way from the heel to the toe. If any part of the edge skates along your nail, go back to step 7.

SOME RULES OF THUMB

1. If the burr is formed too easily it will fail quickly.
2. As a knife wears, the wear mark on the back of the knife at the edge should grow until the hollow grind is gone at the end of the life of the knife. This ensures that the burr root thickness does not become too great. See Fig. 30.



Figure 30: Stages of Wear

Sharpening the Bevelled Knife

The bevelled knife does not use a scraping burr. The rake angle is determined by the angle of the bevel. The terminology for the parts of the bevelled knife is shown in Fig. 1.

TOOLS: Fine (red) diamond stone.
Loaded India oil stone.
1000 grit Japanese water stone.

One advantage of the bevelled knife is that it is easier to sharpen and lasts longer than the double hollow ground knife. The bad news is that it is also very easy to ruin a bevelled knife by sharpening it improperly.

WARNING: NEVER lift the front of the blade or the bevel when either is in contact with the stone (see Fig. 31). This will ruin the edge by changing its rake angle and make it impossible to maintain whatever new angle is formed.

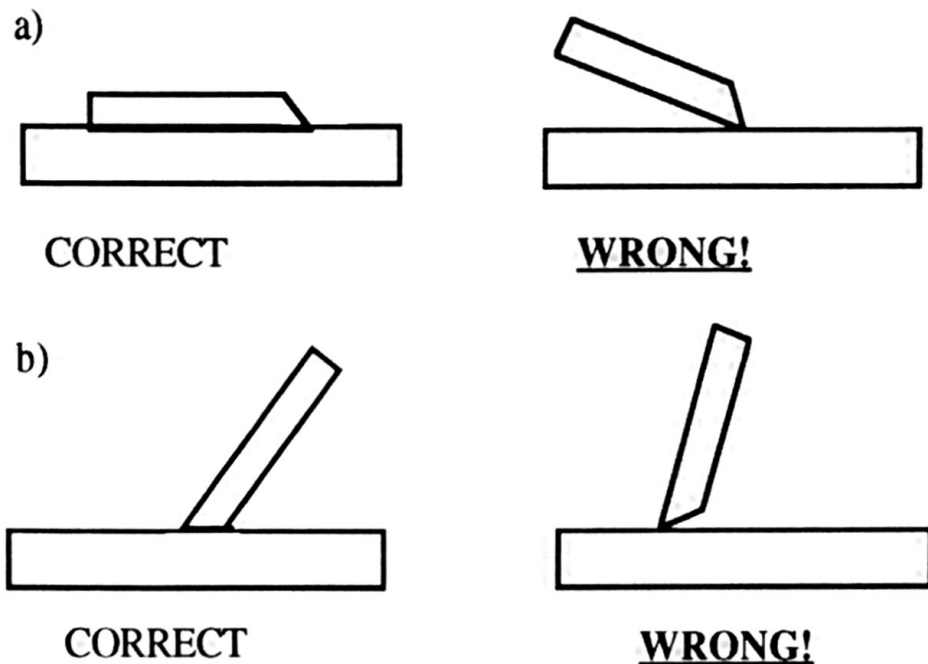


Figure 31: Placing the Bevel on the Stone

Where to Begin:

This process begins with a completely dull, blunt edge. For normal sharpening or touching up, start at step 3.

STEP 1: Producing a Burr on a Bevelled Knife

PURPOSE: To produce a burr which will be removed to expose the finest possible scraping edge. This burr is different from the scraping burr used on a double hollow ground knife.

TOOLS: A fine (red) diamond stone.
or
A 1000 grit Japanese water stone or a ceramic stone.

SET UP: a) Stroke #1.
b) Bevel contacting stone.
c) Heavy pressure on forward stroke.
d) Medium pressure on return stroke.

PROCEDURE:

1. Place the bevel on the stone as shown in Fig. 31b.
2. Rub the blade back and forth in a straight line using heavy pressure on the forward stroke and medium pressure on the return stroke.
3. Continue until a burr can be seen or felt all along the edge on the front of the blade. This can take 10, 20 or more strokes.

Step 2: Removing the Burr on a Bevelled Knife

PURPOSE: To begin the process of removing the weak metal of the burr and refining the fine, strong edge which remains.

TOOLS: A fine India oil stone.
or
A 1000 grit Japanese water stone or a ceramic stone.

SET UP: a) Stroke #2.
b) No lift angle, back facing up.
c) Medium pressure on forward stroke.
d) Light pressure on return stroke.

PROCEDURE:

1. With the front of the blade **FLAT** on the stone (Fig. 31a) rub the blade back and forth in a straight line with medium pressure on the forward stroke and light pressure on the return stroke.
2. Do only 4 or 5 strokes.

STEP 3: Refining the Edge on a Bevelled Knife

PURPOSE: To further refine the edge.

TOOLS: A fine India oil stone.

or

A 1000 or 2000 grit Japanese water stone or a ceramic stone.

SET UP:

- a) Stroke #1.
- b) Bevel contacting stone.
- c) Medium pressure on forward stroke.
- d) Light pressure on return stroke.

PROCEDURE:

1. Place the bevel on the stone as shown in Fig. 31b.
2. Rub the blade back and forth in a straight line using medium pressure on the forward stroke and light pressure on the return stroke.
3. Do only 4 or 5 strokes.

STEP 4: Refining the Edge on a Bevelled Knife

PURPOSE: To further refine the edge.

TOOLS: A fine India oil stone.

or

A 1000 or 2000 grit Japanese water stone or a ceramic stone.

SET UP:

- a) Stroke #2.
- b) No lift angle, back facing up.
- c) Light pressure on forward stroke.
- d) Light pressure on return stroke.

PROCEDURE:

1. With the front of the blade **FLAT** on the stone (Fig. 31a) rub the blade back and forth in a straight line with medium pressure on the forward stroke and light pressure on the return stroke.
2. Do only 2 strokes.

STEP 5: Finishing the Edge

PURPOSE: To further refine the edge.

TOOLS: A fine India oil stone.
or
A 1000 or 2000 grit Japanese water stone or a ceramic stone.

SET UP: a) Stroke #1.
b) Bevel contacting stone.
c) Light pressure on forward stroke.
d) Light pressure on return stroke.

PROCEDURE:

- 1 . Place the bevel on the stone as shown in Fig. 31b.
- 2 . Rub the blade back and forth in a straight line using light pressure on the forward stroke and light pressure on the return stroke.
- 3 . Do only 2 strokes.

Checking the Edge:

Repeat steps 4 and 5 until there is no frayed metal on the edge. The best way to check this is to very lightly run a finger tip along the edge under a strong light (Fig. 32). **BE VERY CAREFUL!** If checking the edge this way requires more steadiness than you can muster you can achieve the same thing by running the edge of the knife lightly along the top edge of your thumbnail. If you can't stand the thought of that either, use the end of a plastic ball point pen (Fig. 32). When the edge is finished there will be no rough spots anywhere on the edge. If you find rough spots, repeat steps 4 and 5.

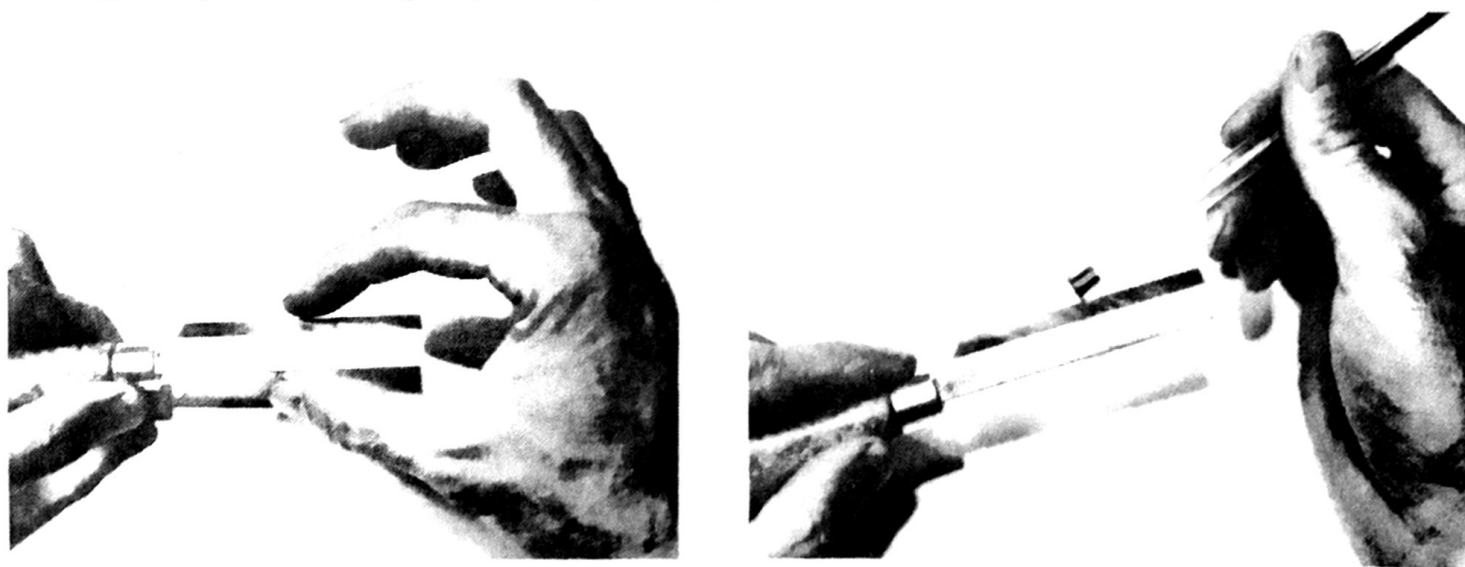


Figure 32: Checking the Edge

Testing the Edge:

Once the edge is clean and smooth you can test its scraping behaviour on your thumb nail. If the edge is properly honed, the knife will catch on your nail when you try to scrape the edge along the surface of a thumb or finger nail. Use no pressure other than the weight of the knife and keep the blade perpendicular to your nail. The edge should catch or grab your nail at every point from the heel to the toe. If any part of the edge skates along your nail, go back to step 4. Some bevel users prefer to have the edge not quite sharp enough to catch on the nail. In that case, ensure that the edge actually scrapes your nail (rather than skating) at every point from the heel to the toe.

STEP 6: Polishing the Edge on a Bevelled Knife (Optional)

PURPOSE: To produce an even finer edge, if required.

TOOLS: A 2000 or higher grit Japanese water stone.

SET UP

- a) Stroke #1 and #2.
- b) No lift angle, back facing up then front facing up.
- c) Light pressure on forward stroke.
- d) Light pressure on return stroke.

PROCEDURE:


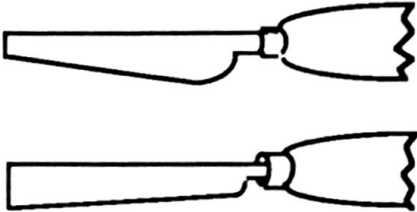
1. With a properly soaked stone, the edge can now be refined and polished using steps 4 and 5. Finer grits or leather strops will further refine the edge if need be.

Trouble Shooting

Assuming that you are using a reed knife whose metal and heat treatment are suited to the task, the following is a list of common problems and remedies.

Problem	Cause	Solution
Excessive sharpening is required to get a good edge.	This may be caused by an inconsistent angle of the knife to the stone during sharpening strokes.	Be sure that your sharpening is done on a solid table and that you are seated or standing so that your hand and arm motions are firm and consistent.
After sharpening there are still bits of metal clinging to the heel or toe.	The heel or toe is not receiving enough pressure during the final steps	Push down a bit more on the heel or toe as you execute the end of stroke 3 and 4.
The burr crumbles.	This usually happens because the burr breaks away instead of bending into the scraping profile. This can be caused by the root thickness of the blade being too large or by turning the blade over too many times during sharpening (especially for the Landwell S and H). Crumbling can also occur if the knife metal is not properly heat treated.	To reduce the root thickness, place the back of the double hollow ground knife onto the diamond stone (see step 1) and remove enough metal to restore the root thicknesses shown at the bottom of p. 19. To avoid turning the knife over too many times, skip step 4 for the double hollow ground knife.
The edge is not as keen as it should be.	Usually this is a result of inadvertently rocking the blade on the stone while sharpening so there is no consistent rake angle.	Be sure that you use two hands with a thumb or finger as a spacer whenever you lift the spine of the knife off the stone.

Problem	Cause	Solution
<p>At the end of the sharpening process, the edge skates across your thumbnail or reed (chatters) rather than grabbing.</p>	<p>This is usually due to an improper rake angle.</p>	<p>Repeat steps 7 and 8 with lighter strokes to better align the burr, or use a smaller lift angle, or rotate the knife slightly.</p> <div data-bbox="1214 413 1487 595"> </div> <p>a) No Grab b) Grab</p> <p><i>Figure 33: Reducing Chatter</i></p>
<p>The edge wears very quickly.</p>	<p>The root thickness may be too small.</p> <p>It may also be that you are using a light duty knife like the Landwell S for heavy scraping.</p>	<p>Hold the knife as in Fig. 34 and wear the edge down to the proper root thickness. Then start at step 2.</p> <p>Use a Landwell M or H or perhaps try a bevel.</p>
<p>A nick or chip in the blade.</p> <div data-bbox="186 1197 628 1364"> </div> <p><i>Figure 34: Removing a Nick in the Blade</i></p>		<p>Place the knife perpendicular to the surface of a very aggressive stone (I use the diamond stone or, in extreme cases, a belt sander) and grind away until the nick is gone (see Fig. 34). Be careful to wear the blade down evenly. Now start from step 1 to reset the edge. Trying to sharpen out a nick by continuing with normal honing strokes will only ruin the knife and the honing stone.</p>

Problem	Cause	Solution
<p>The knife is bowed in the middle.</p>  <p><i>Figure 35: A Bowed Knife</i></p>	<p>If the knife is usually placed on the stone as shown in Fig. 37, only the middle of the knife is in constant contact with the stone and therefore wears away faster than the tip or heel.</p>	<p>To remedy these problems, always move the knife in a straight line as shown in Fig. 17 and 18 and NEVER allow any part of the edge to leave the stone surface. This knife placement and motion ensures even wearing of the blade and provides consistent rake angles.</p>
<p>The knife wears more at the tip or at the heel.</p>  <p><i>Figure 36: Uneven Wear</i></p>	<p>These conditions result from uneven pressure being applied along the length of the blade or from using circular strokes which cause the ends of the edge to move faster over the stone than the middle.</p>	

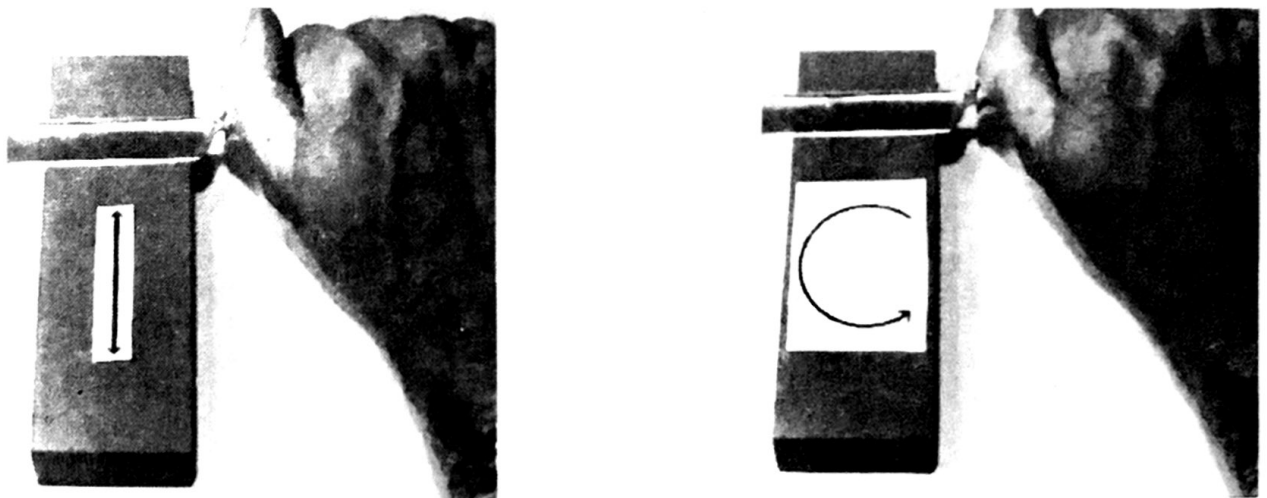


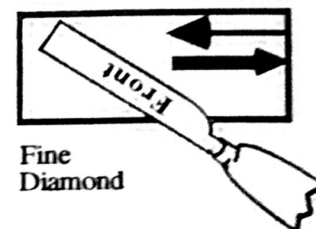
Figure 37: Problem Strokes

A Quick Reference Guide to Sharpening the Double Hollow Ground Knife and the Bevelled Knife

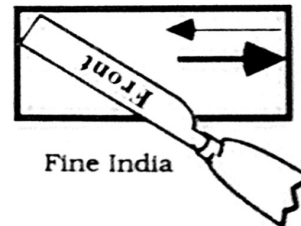
The following two pages provide a quick, visual review of the sharpening procedures previously described for the double hollow ground and the bevelled knife. To use this guide you need only familiarize yourself with the four sharpening strokes (p. 16-17), the lift angle (p. 17) which is indicated in each diagram, and the direction/pressure arrows (p. 18). If you are left-handed, ensure that either the front or the back of the knife is facing up as indicated in the diagrams. Position yourself with the book in front of you and the stone facing the same way as in the book. Always hold the knife in the same hand.

Sharpening the

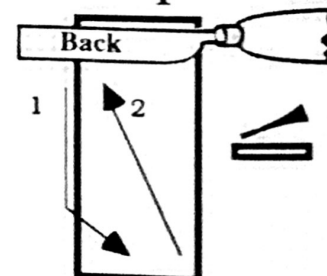
Step 1 (10+ Strokes)



Step 4 (6 Strokes)



Step 7 (4 Strokes)



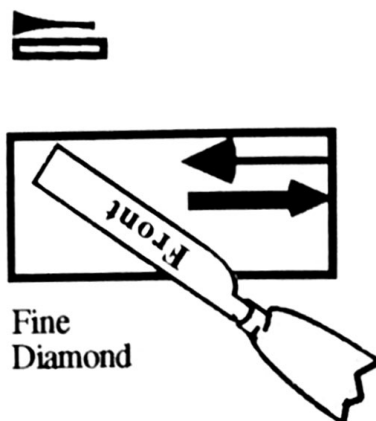
Fine India

A Quick Reference Guide to Sharpening the Double Hollow Ground Knife and the Bevelled Knife

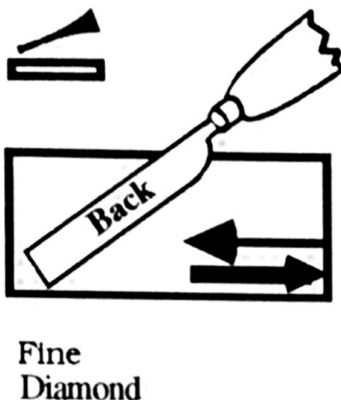
The following two pages provide a quick, visual review of the sharpening procedures previously described for the double hollow ground and the bevelled knife. To use this guide you need only familiarize yourself with the four sharpening strokes (p. 16-17), the lift angle (p. 17) which is indicated in each diagram, and the direction/pressure arrows (p. 18). If you are left-handed, ensure that either the front or the back of the knife is facing up as indicated in the diagrams. Position yourself with the book in front of you and the stone facing the same way as in the book. Always hold the knife in the same hand.

Sharpening the Double Hollow Ground Knife

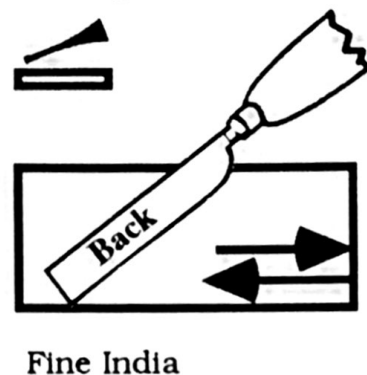
Step 1 (10+ Strokes)



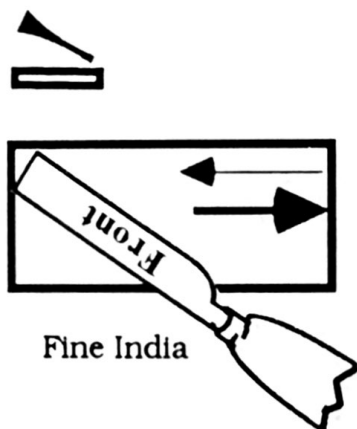
Step 2 (10+ Strokes)



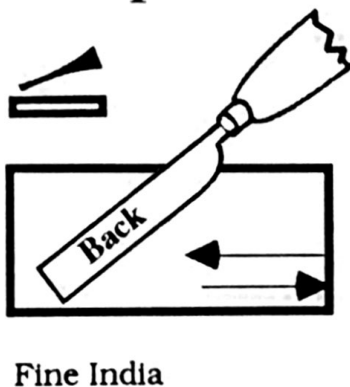
Step 3 (8 Strokes)



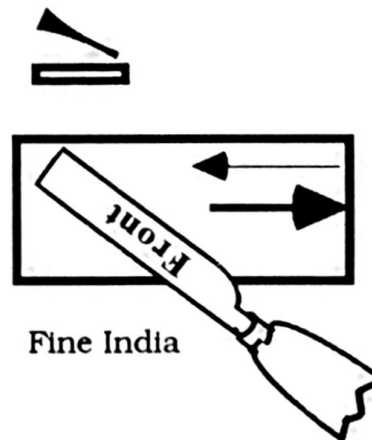
Step 4 (6 Strokes)



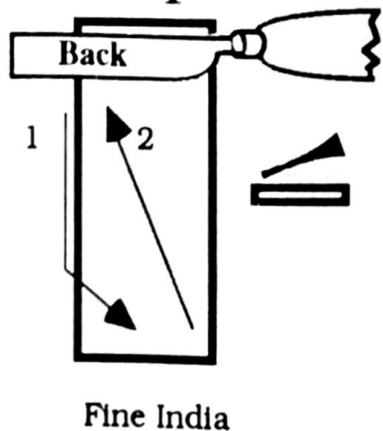
Step 5 (7 Strokes)



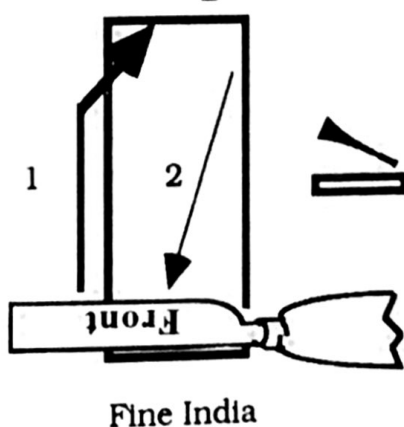
Step 6 (7 Strokes)



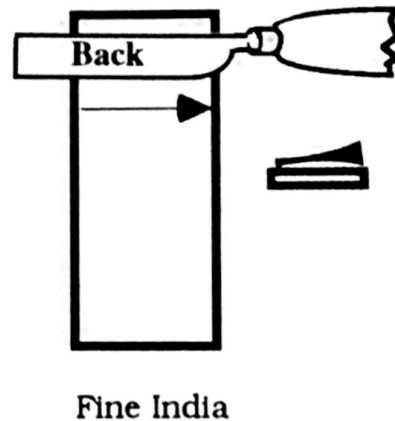
Step 7 (4 Strokes)



Step 8 (4 Strokes)

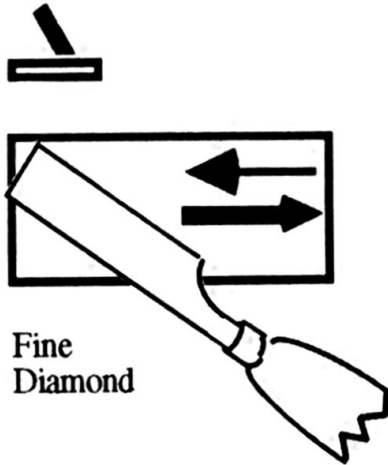


Step 9 (1 Stroke)

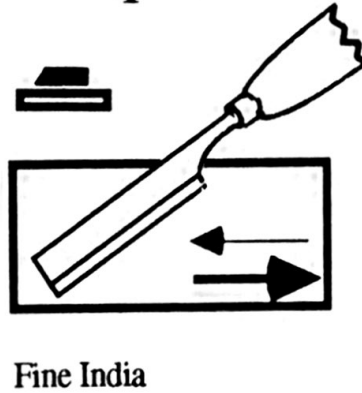


Sharpening the Bevelled Knife

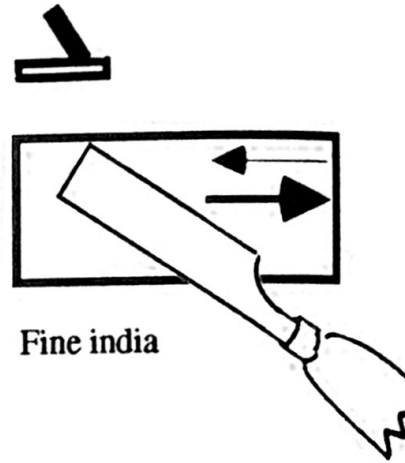
Step 1 (10+ Strokes)



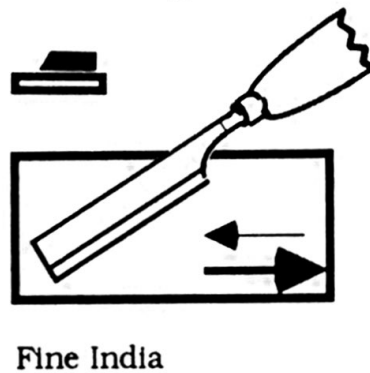
Step 2 (4 Strokes)



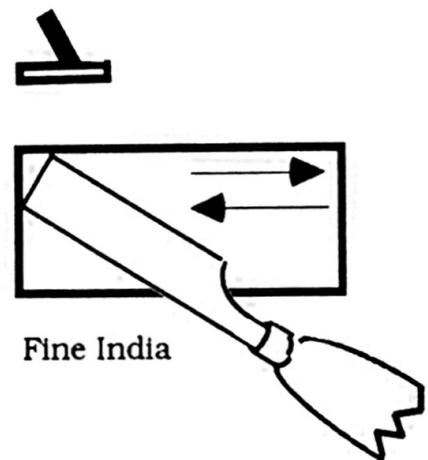
Step 3 (4 Strokes)



Step 4 (2 Strokes)



Step 5 (2 Strokes)



Sample Procedure for Fine Honing or Touch Up:

step 2-----4 strokes
step 3-----4 strokes
step 4-----2 strokes
step 5-----2 strokes
step 4-----1 stroke
step 5-----1 stroke