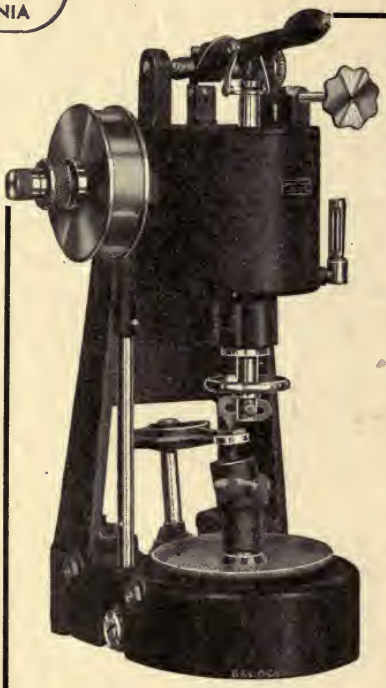
OPTICAL SHOP PRACTICE

MERRITT



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WILLIAM W. MERRITT

OPTICAL SHOP PRACTICE

By

WILLIAM W. MERRITT

Instructor in Mechanical Optics, Northern Illinois College of Ophthalmology and Otology.

A text book for the Beginner. A complete treatise on Optical Shop Practice, with the collaboration of the greatest mechanical minds in the trade.

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OPTICAL SHOP PRACTICE

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Preface

The optical business has passed through its embryonic stage and has emerged into the world of science. It has attained a position wherein modern thought and achievement have made it a vital part of our daily life, for the exacting qualifications of modern times demand quickness of perception, and the faculty of perception depends upon the eye to a very great degree. Accuracy is the paramount factor in meeting these requirements—scientific accuracy. However, despite this condition, the practice of optical work is simple enough, if those who follow it adhere to the fixed rule of following demonstrated procedures governed by good judgment. Very few individuals are without the power of concentration to a greater or less extent, and this faculty can be cultivated by practice and care. Just as the babe must first learn to stand alone before being able to walk and then to run, the optical shopman must go at his work by easy stages and by persistence will finally master his objective.

This volume has been designed for the beginner. It is written in simplified form, avoiding technical language as much as possible, and the average boy or girl of fifteen should be able to grasp its message. It handles its subject from the practical viewpoint and covers every step necessary, so that the student who follows its directions will be able, by applying the same in a practical way, to develope into an efficient worker. This statement is made with confidence, for the text has been scanned by

some of the most proficient men in the optical world—some of whom had to discover through dear experience the things which are set forth in this book for the student, who thereby has the advantage. However, self-reliance is golden, and self-accomplishment is its twin faculty. The thing is to master every detail.

In the compilation of this volume its sponsors feel deeply indebted to these men who HAVE mastered every detail, the exercise of whose grey matter has made it possible to pass along these vital facts for the benefit of the beginner through carefully scrutinizing and analyzing its contents, and whose sanction pronounces it an authority on its subject. They have gained recognition through hard work and studious application and therefore are in themselves excellent examples for the student to emulate. As our collaborators we wish to thank them and to convey to you, dear student, our appreciation of their co-operation, in the hope that you may attain the same proficiency which they possess.

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CHAPTER I

Lens Cutting

The very first essential to be mastered by the individual who would become proficient in cutting lenses is to learn to cut glass; for, after all, no matter whether a lens is cheap or expensive, it is glass.

The term "lens cutting" carries with it to the mind of the uninitiated a sort of mysterious meaning, as indicating a difficult art. However, as a matter of fact, anyone of ordinary intelligence who applies himself diligently can quickly become actually expert in cutting lenses. Of course close attention must be given to instructions and the latter must be followed out carefully, the worker combining good judgment with the faculty of placing himself under the guidance of the instructor, for while a thorough grasp of theory is excellent, yet the application of the latter is something which, to attain perfection, requires practice and time.

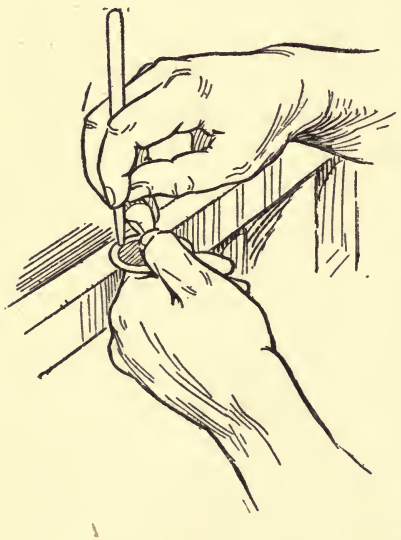
There is no necessity for an elaborate, expensive set of tools for the beginner, nor is it necessary to follow any complicated method in doing the work. Once the primary principles have been mastered, the rest is merely a matter of care and constant practice.

The old adage, "make haste slowly," certainly applies in the operation of cutting lenses. Even experts who have had years of practice know that they cannot exceed a certain time limit. And the only way for the student to become an expert is by keeping "everlastingly at it," and by degrees he will find himself becoming more and more proficient. Have confidence in yourself, and that is a large part of the battle.

Many of the really expert lens cutters use comparatively simple implements in doing the highest class work. Bear in mind that in learning to cut lenses you must first learn the proper way to *cut glass*. Use just ordinary window glass, which is the best for initial practice.

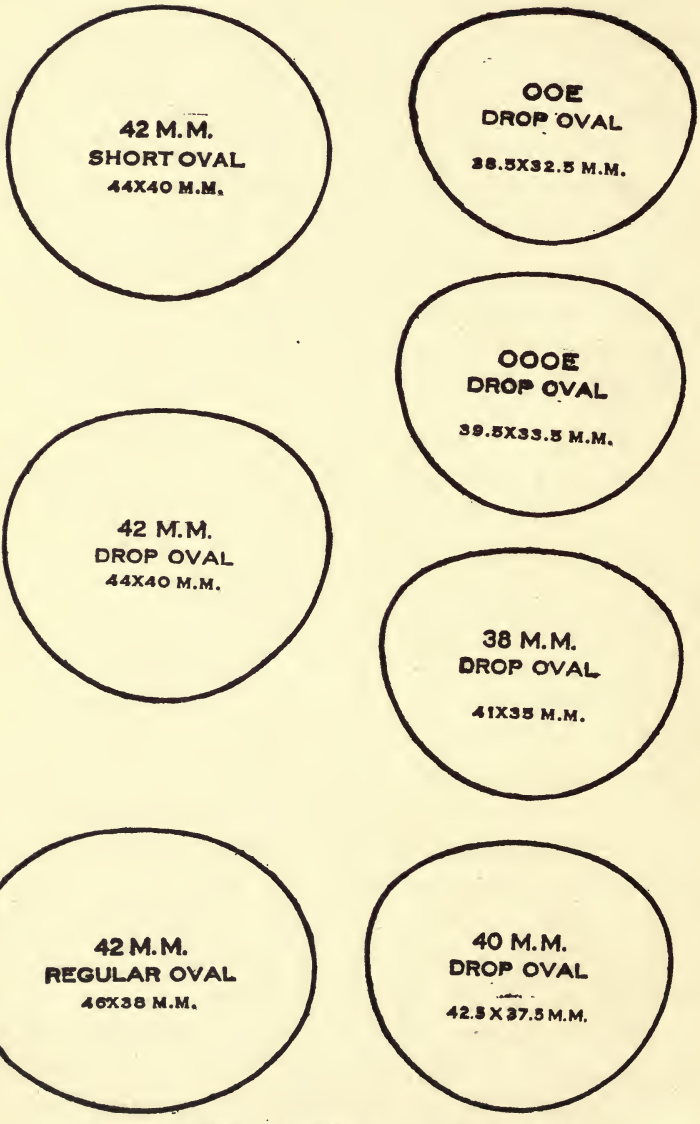
Window glass is not expensive and can be obtained at any paint or hardware store. The thinner the glass that you can get, the better. Photographic plates are excellent. By paying a few cents extra you can have it cut at the store in squares of two inches, but the best way is to get your hand in at the beginning and cut the squares yourself. This can be done as follows:

Buy any one of the various types of "glass cutters," which you can get at the store where you bought the glass, and which are not at all costly. An ordinary ruler is all you need to lay the glass out in squares. Dip the wheel of the cutter in kerosene or turpentine; then, holding the cutter in the same manner as you would hold a pencil, proceed to cut, or mark, the glass. Then to divide the glass into the desired squares, hold the sheet up a little from the table and, on the oposite side from that which you have marked, follow the lines, for instance those running from right to left, tapping gently just under the markings. Then when you have the strips cut you can obtain the complete squares by repeating the operation with them in the same way, always holding the glass as close as possible to the table, so that if they fall they will not break. Another way to cut the glass after it has been marked is to slide the sheet toward you, resting it on the edge of the table just over the marking farthest from you. By raising it and letting it come down gently on the edge of the table you will obtain the long strips. Do the same thing with the strips in securing the squares, but *always* begin with the farthest from you. Never try to "speed up," for you will fail if you do.



Now you have the little squares, you are ready to cut out the

Actual sizes of lenses after being edged



Actual sizes of lenses after being edged

optical "shapes," or the forms of the various lenses desired. Here again simple, inexpensive tools are sufficient. While it is true that special tools for this purpose are sold by the optical jobbing houses, we would suggest purchasing merely a hand cutting diamond, or pencil diamond at this stage of the work. The other cutters will be taken up in proper time, after you have become proficient and are ready to cut some of the special and difficult forms that have come into use in recent years.

A hand diamond is all that you need at the start, for with it you can cut anything desired and by continually practicing you can become a competent lens cutter. Later on, if you wish to do so you can invest in a fifty or hundred dollar cutting machine.

Having procured your cutting diamond, there is one other thing that you must have before you can actually begin to cut out the lenses, and that is the *pattern*. Here again there is not any great expense entailed, for the patterns are made of common tin or celluloid, such as is used in containers for canned goods or tobacco boxes, and you can get the material at any tin shop or auto top shop. Out of this you can make your own patterns for any shapes of lenses that you wish.

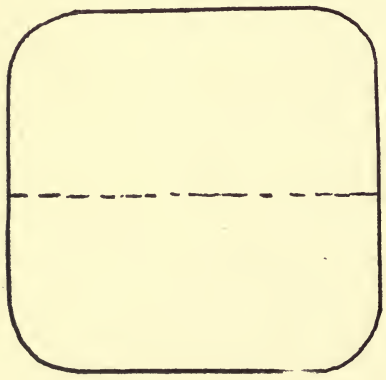
Get a pair of ordinary dividers at any stationery store, such as school children use, and with them mark out on the tin any of the round sizes you wish to cut—say, a 42 millimeter. Then, with a pair of shears, follow the marking on the tin, keeping a little outside of it about one millimeter, so that the pattern will measure 43, instead of 42 millimeters. You will find that the edge of the pattern is left more or less rough, and you can smooth this down with a file, exercising care to make the edge uniform and smooth, and keeping right on the original mark. Do not overlook the fact that if there is the least roughness on the pattern it may scratch the lenses, or glass, which you are about to cut. You can make patterns for any other types of lenses, of course, such as long oval, short oval, drop oval or leaf shape, etc., by marking and cutting as before, only not with the dividers.

The stationary leg of the dividers will mark the center of the

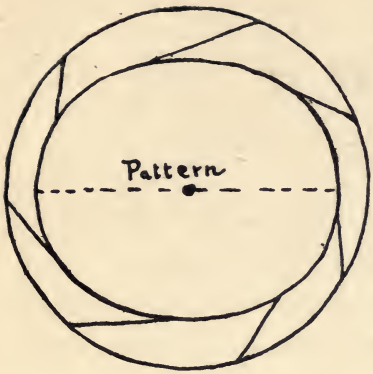
round shape by a little indentation. Make a scratch through this center and running to the edges; then make another scratch through the center, crossing the first one at right angles. Now punch a hole (about 2 millimeters in diameter) through the center thus established, and file down the ragged edges after making the hole. The reason for making this hole in the center and marking the lines at right angles on the pattern is that all optical lenses are "centered," and a small ink dot, or dots on the lens is for the purpose of showing the "optical center." This point will be dealt with later on.

Now you have the necessary tools and material for cutting your lens—the diamond, pattern and "blank," or the square of glass from which the lens is to be cut.

You next take your "practice piece" of window glass; find the exact center and place there an ink dot. Any waterproof ink will do, and for making the dot an ordinary toothpick is better than a pen. Then place the pattern on the glass so that the hole in the center of the pattern will be over the dot on the glass. Hold them tightly together with the first two fingers of the left hand (assuming that you are not left-handed) under the glass, and the left thumb on top of the tin pattern, so that the pattern will not slip.



Now place the part of the glass farthest from you on the edge of the bench (which should be covered with a mat of rubber or thick blotting paper) and draw the point of your diamond around the pattern—only *half way*. Then still keeping the glass and pattern held firmly together, turn them half way round and mark, or cut, the other half. Be careful not to let your mark, or cut, overlap the first one, as you may spoil the diamond. The amount of pressure to



exert in cutting is governed by the cutting edge of the diamond. You will learn this by experimenting with pieces of glass. A very sharp diamond will only require light pressure, while the duller the cutting edge the greater the pressure needed. Continued practice will teach you. Now, in order to liberate the lens which you have cut from the two-inch square, mark lines with the diamond from the edge of the square close to the edge of the desired lens, and *not* at right angles to the lense edge, but on a tangent, as indicated by the diagram.

Always hold the diamond at right angle to the surface of the lens; see that the flat place where diamond is set be parallel to the edge of pattern.

Having now learned the principles of lens cutting, you are ready for the next step in the work, which is lens chipping.

Quiz

1—What tools are required at first?

2—What kind of glass is best for practice? To what size should it be cut for practice work?

3—What tool do you use for cutting?

4—What do you do to make it cut if the point is sharp? If dull?

5—From what material are patterns made?

6—What do you use to mark the pattern? To cut it?

7—What should you do to the edge of the pattern? Why?

8—How do you make it smooth?

9—What do you do to the center of the pattern?

10—Why should you dot the glass? What kind of ink is necessary?

11—What is best to use with the ink in dotting lenses?

12—How do you hold the glass and pattern?

13—With what should the edge of the bench be covered?

14—How do you place the lens on the bench?

15—How do you mark the lens, as to cutting?

16—Is it all right to let the markings of the two halves of the lens overlap? If not, why not?

17—With the lens outlined, how do you release it from the rest of the glass "blank"?

CHAPTER II

Lens Chipping

Chipping lenses is another operation in lens cutting which appears to the beginner to be harder than it really is in actual practice. While the work itself is not difficult, nevertheless it requires the same degree of careful attention that is necessary to become an efficient lens cutter. Here again considerable time should be given to experimenting on common window glass, and the student should not attempt to work on optical lenses until he has acquired complete confidence in his ability to hold the lens so that he does not have to think too much about it; until he knows without stopping to think just how much pressure to exert. In short, the student must acquire the "knack" of doing the work so that he can perform the various little operations almost unconsciously.

The old saying, "There are tricks in all trades," applies in both cutting and chipping lenses. Gradually, as the student becomes more adept through continued practice, the different operations will come so easily that he will not have to think about them. It will be "second nature" to him.

In chipping glass, the first thing to learn is how to hold the lens properly. This is done in very much the same way that the worker holds the glass blank and pattern as described in the last chapter in the operation of lens cutting, or marking, the glass being held with the first two fingers underneath and the thumb on top, but closer to the diamond mark, so as to avoid leverage, which would cause the risk of breakage. In this way a firm grip is gained and there is less

chance that the glass will slip. After practicing a few times with a piece of window glass you will learn the right amount of pressure to use in order to hold the glass firmly, yet easily, after which this part of the work will be really automatic on the part of the student.

In chipping, the pliers are held in the same manner that one would hold any other pliers—common wire pliers, for instance. However, beginners often make one great mistake, in thinking that the pliers are intended to "pinch" the glass. *Never* pinch the glass hard.

Having marked, or cut the shape in the glass as described in the last chapter and then scored the tangent lines, hold the piece between the thumb and first two fingers, as directed (with the scored or scratched side up) and with the chipping pliers begin to chip off the useless pieces, beginning at the corners. Remember—*do not pinch hard*. And do not try to chip off too much at a time. Holding the glass firmly, take a light, easy grip at the corner with the pliers and then turn the wrist slightly downward. Keep moving the glass as you chip, and be very careful as you get near the *mark* that you previously made.

At first the experimental work of chipping should be with very thin glass. After the student has worked for a few hours at this he should try thicker glass—say, four or five millimeters in thickness. Here, as in cutting, *make haste slowly*. Speed will come with the confidence which careful practice will create.

It might be well here to refer to lens-cutting machines. Quite a number are on the market, and any optical jobber will gladly furnish

anyone with a complete list, together with the prices at which the machines are sold. We do not recommend any particular kind, as it is entirely a matter of getting the particular kind which the worker's judgment selects and then in getting thoroughly familiar with it; learning how it is constructed, all the details of the mechanism and how to set the machine for the different sizes. Here, as in other kinds of skilled work, personal opinion is the determining factor. Some operators will use a hand diamond for years and claim it is the only perfect tool, while others will use it for an hour or so and throw it aside as virtually useless.

Quiz

1—What is the first thing to learn in chipping?

2—How do you hold the glass?

3—Must you use much pressure with the pliers?

4—Where do you begin to chip?

CHAPTER III

Lens Edging

The first step in lens edging is to train the eye to "see" the several shapes. That is to distinguish one from the other at a glance; or, in other words, to visualize, to form a mental picture of a true form of an oval, or any other shape mentioned or required. The second step is to train the fingers and hands to hold the lens in the correct position and at the proper angle, also to give it the proper amount of pressure against the stone.

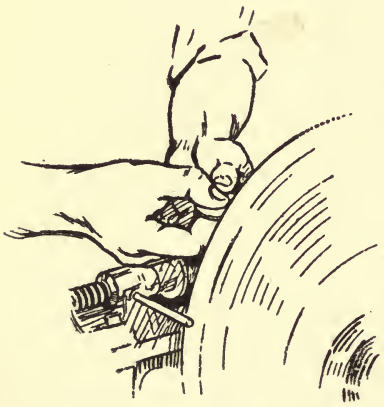
You have already learned the importance of chipping the lens down as closely as possible to the cut-mark, for the purpose of getting all the "bumps" or sharp corners off, to avoid scratching the surface of the grinding stone, because doing this makes less work in grinding the lens to the required shape and is a great time saver. When you have learned this thoroughly; when your eye has been trained to instantly visualize the different shapes of lenses; when your fingers and hands are also trained to instantly place the lens in the correct position and apply the right amount of pressure—then you are ready for the next step, which is the selection and operation of the grinding stone.

Right here bear one thing in mind—*Never waste time and money on second-hand stones.* Write to any reputable wholesale house and have them send you a perfect stone, mounted on a bench or stand, as you may wish. These stones have been thoroughly tested and leave the factory in perfect shape, ready for use as soon as they are set up and the power is turned on. The manufacturers of these stones will stand behind their products, and you can proceed with the assurance that each stone will give 100 per cent service if you do your part intelligently and efficiently.

Now you come to a part which requires the exercise of that all-important factor known as *common sense,* combined with lots of patience and careful attention to the instructions given you, as well as the small details which are a part of this work.

Edging Beveled Lenses

First you must learn to hold the lens properly. Take it firmly between the first finger and thumb of *both* hands, pressing it lightly against the stone, and at the same time turning it half way round and feeding it toward the right, tilting it slightly so as to produce a bevel edge at an angle of 45 degrees to the surface of the glass and extending half way across the thickness of the glass. Do the same with the other half of that edge. Then turn the glass over and repeat the operation on the other side of the edge of the lens, so that the bevel thus produced will be at right angles to the first, or 90 degrees, and this will give the edge of the lens a wedge-shape, or V-shape.



Now hold the lens between the thumb and middle finger firmly and place the first finger on the apex of the angle formed by the two bevels, for you are ready to "touch off," or for "running off," the edge, or apex, produced by the last operation, so as to avoid chipping the lens when drawing the end pieces of the frame together.

In other words, let us repeat. Remove the humps or sharp points if there are any left from cutting the lens. Then you must hold the lens properly, rest it upon the first finger of left hand, place the thumb of right over it using just enough pressure to keep from slipping. Now push the lens away from you slowly with left thumb, follow this up by

pulling the lens toward you with the first finger of right. Practice this until you can rotate the lens slowly and smoothly away from the stone. After you master this motion, place the lens upon the stone at desired angle about 45°, and as you rotate your lens, press more firmly against the stone at the thick parts or the point where more material has to be removed to form a perfect oval.

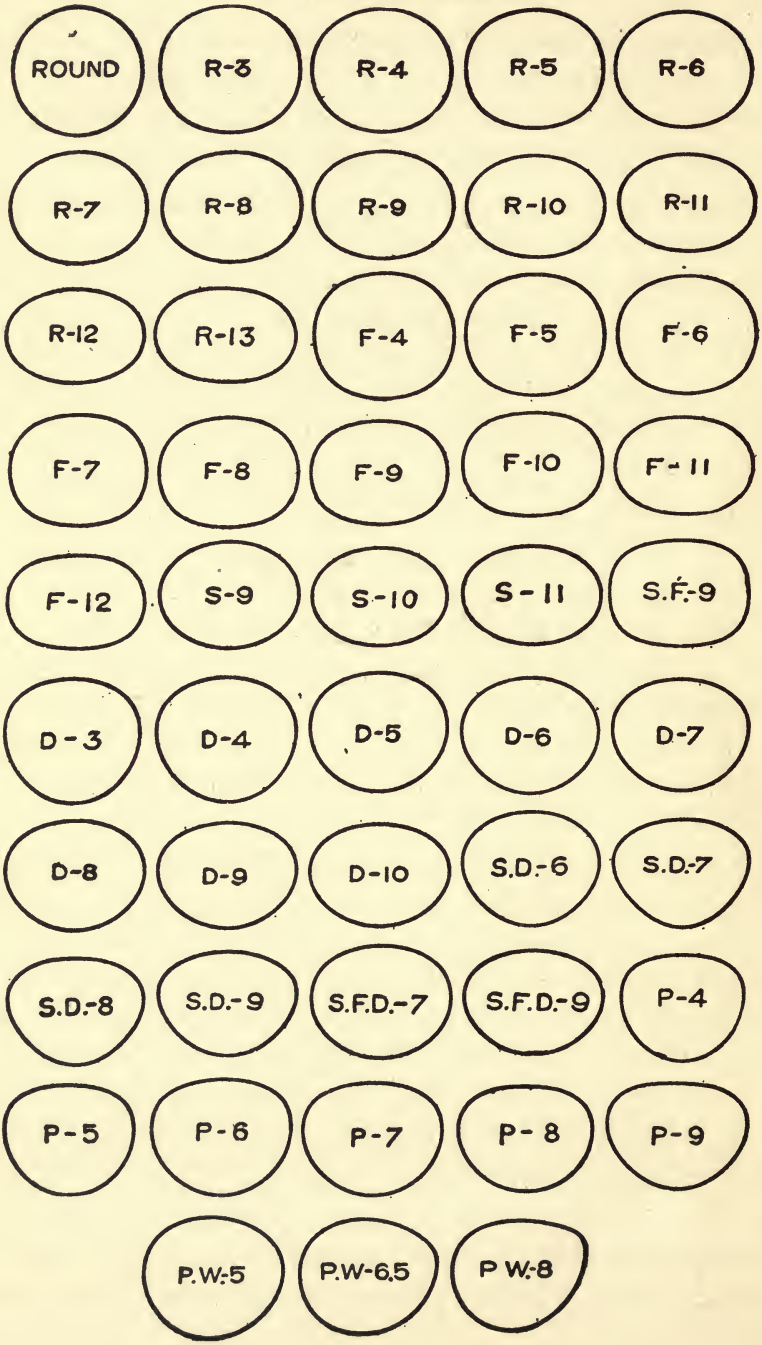
Edging Rimless Lenses

Your previous experience will by this time teach you the proper amount of pressure to exert in holding the edge against the stone, the lens now being held perpendicular. Turn the lens in the direction in which the stone is revolving. The ability to do this correctly will come to you easily, with constant practice. Go at this process slowly. Even the best operators do. When you have finished this you will have produced a "rimless" lens. However, remember one thing—stick to the ordinary oval lens and the window glass oval at first, for by mastering work on this the rest will come to you easily. Mastering of these details will come with practice. There is nothing difficult in edge-grinding, it is merely the exercise of judgment and care combined with continued practice, and once you have mastered work on the oval lens, operations on the other shapes will be comparatively easy. Do not become discouraged if the "knack" of doing this work does not come to you quickly. Just *keep at it.*

As soon as you have mastered the principles involved in the work of edge-grinding, it is a good idea to dwell a little upon what kind of implements are the best to use, together with the care that they should be given.

Nearly always the first question that occurs to the student's mind is just what size stone is best for general work and at what speed it should be operated. As a general proposition a stone 24 inches in diameter and 1½ inches thick and run at a speed of 200 to 250 revolutions per minute will be found practical and sufficient.

One of the best stones is a manufactured abrasive bonded together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so as to produce a stone of the above dimensions. This is a fast-cutting stone, one of the very best on the market, and requires very little attention, especially if handled properly. It is a "composition stone," and it is usually recommended in preference to others.

Proper care of the stone is a very important factor in edge grinding, no matter what type is used. You will find in your work that a large amount of soft, white, mushy matter is deposited around the stone. This consists of ground glass, stone and water and should be wiped off carefully every day, and all metal parts of the equipment should be wiped with a rag saturated with gasoline, benzine or kerosene. This is very important. Don't put this off "till tomorrow." *Do it today.*

Formers for Lense Edging.

There are several kinds of automatic machines on the market, all of them operated in a similar way and having about the same kind of equipment—a holder to contain the lenses before they are put into the machine, a clasp to keep them in position, and a spring to give the proper tension and a plate to give the size required. Directions in full are given with all machines.

Automatic edging machines are very valuable where large quantities of lenses are to be edged, and any intelligent person can operate six or eight of them at one time. However, it has been demonstrated that in the long run the experienced hand-edger can do the work in a more satisfactory manner, as he is familiar with the amount of tension that is necessary and which is exercised by the tension spring in the machine, so as to give the right degree of pressure, and it is only logical to assume that the experienced hand-edger would use more caution than someone not having had this experience and would produce better results.

Before attempting to operate an automatic machine, the beginner should go through a course of practice, using common window glass.

This will enable him to acquire the "knack" and will prepare him for work on actual optical lenses.

There is a wide range of prices of automatic edging machines and all large optical houses carry machines in stock. With each machine comes a book of instructions explaining in detail all working parts, how to care for the machine, together with all other necessary information, including that pertaining to size and shapes of lenses, etc.

Every beginner is strongly urged to become proficient at hand edging, even though he intends to work mostly on automatic machines, for there are so many odd sizes and shapes of lenses that cannot be edged on the automatic machines—such as half-eyes, clerical and crescent shapes, etc. After you have once mastered edging on oval, all other shapes will be easy for you.

To keep the grinding face of the stone in perfect condition: All automatic machines are equipped with a truing device consisting of a carborundum stone fixed in a sliding rest. This should be used whenever the stone gets out of true or when slight grooves appear on its face.

Small grooves will often appear on hand edging stones, but these can be taken out very easily by the following method: buy a small carborundum stone at any hardware store, or a piece of pebble or glass, also make it wet, and hold this against the face of the grinding stone, moving it sidewise across the face of the stone. Follow this with a piece of old glass, using the same kind of movement, and within a short time the stone will be flat and smooth and ready for good work.

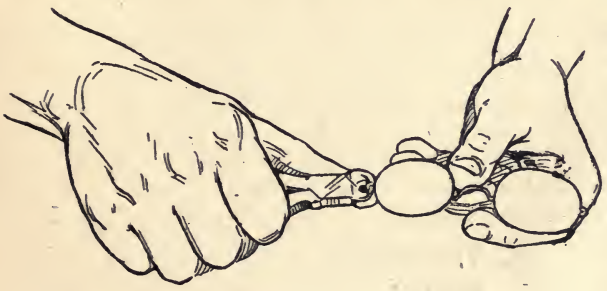
Fitting Zylo Rims

Fitting zylo rims to lenses: Most expert edge grinders select a rim about 1 millimeter smaller than the circumference of the lens after it is edged correctly. Heat is required, in order to stretch the zylo, but no flame should ever be permitted to come into contact with it. Hot water (not boiling), hot, dry asbestos or a little electric stove

will furnish sufficient heat to make the rim pliable, when it can be stretched over the lens. Where a small rim is to be fitted over a large lens get a wooden mandrel, heat it and slip the rim over it. There are many so-called "rim stretchers" on the market and sold at various prices by the optical houses. The jobbers will supply you with information regarding them. When the rim has been placed on the lens spray cold water on it, so that it will cool readily, thus contracting, or shrinking, and making a tight "fit."

Fitting Metal Frames

To fit beveled lenses into metal frames: Whether the material of the frame be gold, gold-filled or any other metal, the principal requirement in fitting lenses into such frames is more of the *common sense* to which we have already referred. After edging the lense down, fit it into the frame by pulling the two end pieces together with a dull pair of cutting pliers. Take great care in this operation, as too much pressure will chip the lens if it is too large. Try the lens in the eye wire several times, using great care when the lens is about the right size. It is better for the lens to be made too large than either the exact size required or too small, as in the first case the lens can be cut down, while if it is the exact size it may be damaged a little and will not permit cutting down, while if it is too small in the first place it cannot be used for the frame, for being small it would move a cylindrical lens in the frame, and the axis would be wrong.



Quiz

1—What is the first step in edging? The second step?

2—Why is it important to chip the lens close to the cut mark?

3—Why is the stone so important?

4—How do you hold the lens in beveling? Describe the operation of beveling.

5—What is a rimless lens?

6—Why should you stick to the oval type so long?

7—What is the best size stone to get? At what speed should it be operated?

8—How often should you clean the stone? Why?

9—When are automatic machines used? Which is most satisfactory—hand edging or machine? Why?

10—Why should every beginner become an efficient hand-edger, even though intending to operate an automatic machine?

11—How do you keep the face of the stone in perfect condition?

12—How do you fit zylo rims on lenses?

13—How do you fit beveled lenses in metallic frames?

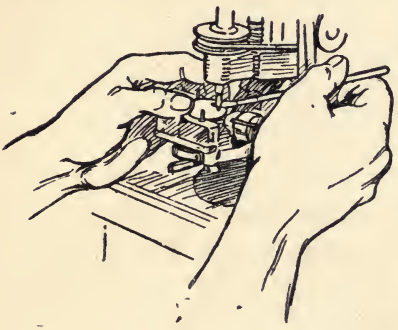
14—Is it advisable to have the lenses the same size? Smaller? Larger? Give reasons in each case.

CHAPTER IV

Drilling and Mounting Lenses

The drilling of lenses, just as the other operations already dealt with, is a process which can only be mastered gradully, to which end the individual must be patient, persevering and not afraid to put in plenty of time practicing, so that he will get the various little tricks and turns that will eventually make him proficient.

A complete line of lens drills is manufactured for the trade and nearly all are fitted with diamond points and also with adjustable mechanism for keeping the diamond from touching the metal rest. Adjustments are also provided so that the hole can be drilled close to or away from the edge of the lens. Full information regarding any lens drill on the market can be had from any optical jobbing house.



The average speed at which the drill should rotate is from 1,900 to 2,500 revolutions per minute, and to operate them it takes about one-eighth horsepower.

Practically all drills are fitted with an adjustable table so arranged that the lens can be turned to allow a hole to be drilled above or below the center. They can also be tilted, for drilling toric lenses.

A "drilling fluid" must always be used during the entire operation of drilling. Experience has shown that one of the best drilling fluids is made of common turpentine and "3-in-1" oil, mixed in the ratio of four parts of turpentine to one of the oil. A small camel hair brush should be used to apply the fluid while the drilling is being done. However, the latest drills have automatic oil feeds.

The amount of pressure exerted during the drilling is a very important factor. It is a good rule to use the smallest amount practicable, until you have learned your drill thoroughly.

The lens should never be drilled clear through from one side. Set the adjustment on the machine so that the drill will go only halfway through the lens; then reverse the work and finish drilling the hole from the side opposite that on which you started. As soon as the two holes meet stop drilling. As you become accustomed to the sound of the drilling your ear will become trained so that you will be able to detect within almost the fraction of a second when to release the pressure.

It is a good idea to release the drill frequently and apply plenty of drilling fluid over the hole with the camel hair brush.

One thing to be borne in mind is the fact that, as a general rule, the holes in lenses should be drilled *at right angles to the curvature of the lenses*, and the "chuck" on your drill must be set accordingly. Unless specified *otherwise* in the prescription, the lens should generally be drilled on the center. Read the prescription very carefully and follow it closely in regard to special instructions relating to the way it should be drilled.

When the hole has been made from each side of the lens, you will note that it is small at the center and wider at the surfaces. In order to get it the same size all the way through it will be necessary to use a reamer. All drills are provided with reamers. Put plenty of fluid on the point of the reamer while applying the lens in a vertical position as you press it on the reamer, touching the reamer constantly with the brush during the operation. If you are careful to keep the lens in a true upright position and the reamer in a true horizontal position you will get a perfect hole.

The drill must always be kept clean, for otherwise the drilling fluid will get into the parts and become gummy. Either gasoline or benzine is excellent for this purpose.

Always make sure when you use a new drill point or diamond

to see that it is a perfect fit, and while it is running take great care that it does not vibrate laterally, or "chatter" as it is termed. In other words, the drill should turn perfectly parallel with its axis and operate smoothly and silently, except when the point is in contact with the work. Lateral vibration has a tendency to turn the work, which often results in breakage. If you are careful to keep your drill in perfect condition you will go far toward turning out perfect work.

A medium short diamond will be found the best for average work, as it will give longer and better service. Nearly all optical drills come fitted with white diamonds, but it is a very good precaution to have an extra point, so that if the one you have should get broken you will have the other at hand and thus save valuable time. When the drill becomes dull send the point back to the wholesale house, to be sharpened. The jobber knows the best place to have this done and you will find in the long run that this is the most economical way of having the matter attended to.

There are hand drills on the market, but the use of these entails so much time that it would not be good policy to use one. As in every other line of mechanical work, time is a big factor in this one.

Mounting Rimless Lenses

To the beginner the mounting of rimless lenses in finger piece and spectacle mounting is not a difficult operation. In order to obtain good results, the following tools are necessary: A pair of strap pliers, simple nose pliers, cutting pliers, a rat-tail file, taps and tap holder, pin vise, a good rimless screwdriver, a flat file, a bottle of glass screws, a bottle of drilling fluid. It is a very important matter that special attention be paid to the matter of fitting the strap to the lens. The straps must lie flush with the lens and should be bent, to conform to the convexity of the lens. The straps are not hard to bend. The proper way is to make the straps either a little wider or narrower, as the case may be.

After getting the strap to fit the lens, always tap out the threads,

so as to get the straps in line. Never try to force a screw through the straps and lens until you have run your tap through; see that it runs through freely, for if there is the least *binding* you can almost always look for a chipped or broken lens. The utmost care should be used in drilling. See that the holes are not too far forward or back. In case the hole is too far in, it will be a case of filing the hole nearer the edge. If the hole is too near the edge it will mean bending the shoulder up, and this is not a good way, for the lens will work loose very quickly.

The beginner should use old lenses to practice upon and try to select several different thicknesses. A few hours should be spent every day practicing this work before you attempt to mount any of the expensive lenses. To do the work perfectly it requires a good set of tools, and it should be the aim of the beginner to exercise the greatest patience in order to accomplish good results.

Quiz

1—With what kind of points are most drills fitted?

2—Why are power drills the best? What is the best average speed for same?

3—Why does the drill have an adjustable table?

4—Why should drilling fluid be used?

5—How is drilling fluid made? In what proportions? How applied?

6—What amount of pressure is required in drilling?

7—How far should you drill through from each side? How can you tell when the holes meet?

8—In practice, what precaution should be taken?

9—What tool should be used to make the hole perfect? What is used to lubricate this tool?

10—How is the reamer operated? In what position should the lens be held for reaming?

11—In what position should the reamer be held?

12—Why should the drill be kept clean?

13—What should be used to clean the drill?

14—What is likely to cause breakage?

CHAPTER V

Optical Lenses

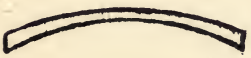
Optical lenses are of many kinds and usually come from the manufacturer finished on both sides, so that no other work is necessary except to cut and edge, other than in usual corrections.

Finished lenses are always packed in individual envelopes or containers, and come marked according to the focus. The following are a few of the many terms, with their meaning, used in the craft, and it is advisable for the beginner to become thoroughly familiar with the different kinds of lenses and their nomenclature.

D C X means double convex.

D C C means double concave.

P C X (periscopic convex) always has a —1.25 curve on the inside.



P C C (periscopic concave) always has a +1.25 curve on the outside.

Meniscus C X means deep convex spherical.

Meniscus C C means deep concave spherical.

Lens Terms and Their Meaning

P C X lenses. All P C X lenses are ground to a —1.25 curve on the inside, while the opposite side has any curve that you may desire. For example, a P C X 1.00 would be ground +2.25 on the outside and —1.25 on the inside, as follows:

+2.25 —1.25.

Example: a P C X 4.00 would be ground +5.25 —1.25.

P C C lenses. All P C C lenses are ground +1.25 curve on the outside and any curve that you may wish on the inside, or opposite side. For example: a P C C 1.25 would be +1.25 —2.50.

Example: a P C C 3.50 would be +1.25 —4.75.

The Meniscus C X lens. All meniscus C X lenses are ground —6.00 on the inside and any curve desired on the outside. For example: a meniscus C X 1.00 would be: +7.00 —6.00.

Example: a meniscus C X 4.50 would be: +10.50 —6.00.

The Meniscus C C lens. All meniscus C C lenses as a rule are ground +6.00 on the outside and any desired curve on the inside. For example: a meniscus C C 1.25 would be: +6.00 —7.25.

Example: a meniscus C C 3.75 would be: +6.00 —9.75.

The Plano-toric C X cyls. All plano-toric C X cyls. are ground with two curves on the convex side and a —6.00 curve on the opposite side. Example: Plano-toric C X cyl. .50: +6.00 +6.50 —6.00

Example: Plano-toric C X cyl. 1.50: +6.00 +7.50 —6.00.

The Plano-toric C C cyl. All plano-toric C C cyls. are ground with two curves on convex side and a concave curve equal to the cyl. on the opposite side. For manufacturing convenience, all concave toric cylinders are transposed, to be ground on plus 6 curves. For example: on a —.50 ⊃ +6.00 +6.50 ⊃ —6.50.

Example: Plano-toric C C cyl. 1.25: +6.00 +7.25 ⊃ —7.25.

The toric compound. Toric compounds in the majority of cases are made with two curves on the outside, and any desired curve on the inside. For example: +.25 on a .25 toric compound: +6.00 +6.25 —5.75 equal +.25 ⊃ +.25.

Example: +1.00 ⊃ +.50 toric compound: +6.00 +6.50 ⊃ −5.00 equals +1.00 +.50.

Example: +1.50 +.75 toric compound: +6.00 +6.75 ⊃ −4.50 equals +1.50 ⊃ +.75.

Example: −1.50 ⊃ −.75 toric compound: +6.00 +6.75 ⊃ −8.25.

Cement Bifocals

Cement bifocals, scales, or cement wafers are made by three different methods and are generally kept in stock by all leading jobbers. The regular segments are always ground +1.25 on one side, with any desired curve on the other side, and will fit any P C X lens that may be in stock. For example, if you want to add +2.00 to any P C X lens, the segment would have these curves: +1.25 +.75. Should you wish to add +1.00, then you would have +1.25 −.25.

Should you wish to add +3.00 you would have +1.25 +1.75.

Now comes the plano segment. These are ground plano on one side and any curve desired on the opposite side. For example: +2.00 segment would be: +2.00 plano.

Example: +1.00 segment would be +1.00 plano.

Next comes the toric segment. These are ground +6.00 on one side and any desired curve on the other and will fit any meniscus C X lens in stock. For example: a ×2.00 segment would be +6.00 −4.00.

Example: a +1.00 segment would be +6.00 −5.00.

Example: a +3.00 segment would be +6.00 −3.00.

Cementing Bifocals

A small alcohol lamp is commonly used and would be practical for the beginner. Secure a wooden spring clothespin, which is used to hold the lens while drawing through the frame. Use a clean, soft cloth with wood or denatured alcohol to clean lens and segment. With a lens measure determine which side of the segment is to be cemented on the lens. The hard stick cement is the most practical for quick, easy cementing.

Place the extreme left end of the lens in the clothespin held in

the left hand, with the lamp directly in front of you. Draw the lens back and forth through the flame slowly about ten times. Apply the stick cement to the heated lens, which will melt the cement, leaving a small portion on the lens. Place the segment carefully on the melted cement. Then draw the lens through the flame until the cement has spread over the entire area under the segment. Then lay the lens on a pad of paper, or a blotter, and with a match or lead pencil rubber, move the segment from side to side until all air bubbles disappear. At the same time fix the position of the segment 1½ m/m below the center of the lens and 1½ m/m toward the nasal side. Allow to cool, after which clean cement from the lens and edge of the segment with a tooth brush and alcohol. Then edge off the bottom of the segment.

Quiz

1—How are stock lenses finished?

2—In what focus are they supplied?

3—What curves has a P C X 1.00? In what respect does a P C C lens differ from a P C X?

4—What curves has a P C C 1.25?

5—What curve is always on a meniscus C X? What curves are on a meniscus C X 1.00?

6—What curve, as a rule, on a meniscus C C?

7—How many curves on a toric C X cyl. .50? What are these curves?

8—How many curves are on one side of a toric cyl. C C?

9—Draw a diagram of a toric C C 2.00.

10—What two curves are on one side of a toric compound?

11—Make a diagram of a toric compound +.25 sph. ⊃ +.25 cyl.

12—Make a diagram of a toric compound +1.75 ⊃ —.50 cyl.

13—Make a diagram of a toric compound —2.00 sph. —.50 cyl.

14—What curve is always on one side of a regular segment? What kind of a lens will the segment fit?

15—What curves are on a regular segment, +2.00?

16—What curve is always on one side of a plano segment?

17—What curves are on a plano segment, +3.00?

18—Of a toric segment?

19—What kind of lens will this segment fit?

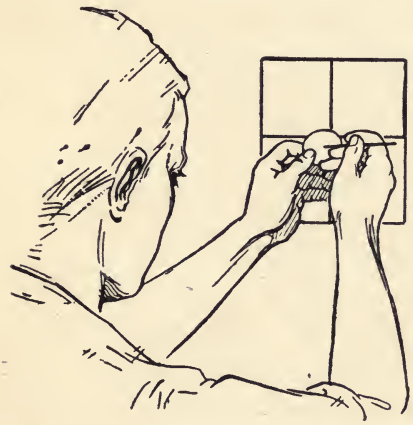
20—What size are the segments made originally?

CHAPTER VI

Centering Lenses

It is a comparatively simple operation to center a lens and the same can be learned in a short time. Take a piece of heavy white cardboard 10 x 10 inches, and through the center of this draw a line from top to bottom. Then draw another line through the center and at right angles to the first. This cardboard should be hung on the wall at a convenient height.

Now, stand about 20 or 30 inches away from this cardboard, take a common P C X lens in the left hand and a toothpick "dotter" in the right and hold the lens between your eye and the cardboard. It is best to use but one eye in this work without closing the other eye (when one eye is closed both eyes become tired). Now move the lens backward and forward until you can get a good view of the intersecting lines on the cardboard. You will note that when you move the lens upward and downward the horizontal line will appear broken, and that when you move it from side to side the vertical line will also appear broken.



Move the lens in all directions until the lines of the card appear unbroken and then dot the lens at the point where they intersect. This will be the correct optical center. Repeat this practice with both convex and concave lenses and you will be astonished how quickly the eye becomes trained in this work.

For practical purposes, after you have learned the principle of centering lenses, it is advisable to adopt some standard lens centering instrument, for it has a rest for your hand and a sliding adjustment for the focus of the lens, so as to keep your hand in a steady position. It is also able to keep your sight in perfect alignment with the cross formed by the intersecting lines.

Plano cylinders are centered in exactly the same way, but when you turn the lens slightly you will note that the line will have a slanting appearance. Turn the lens until you note the vertical line appears perfectly straight, then put a dot on the lines at the top and bottom, and this will be the true cylindrical optical center, or center of curvature.

Compound lenses have both sphere and cylinder combined, and you may experience a little trouble in finding the cyl. Hold the lens as before, but keep turning it until the vertical line is perfect, then place a dot at the top and bottom. Now move the lens upward and downward until the lines appear unbroken and then place a dot in the center. The top and bottom dots will show the cylinder center, while all three dots will show the true optical center.

For convenience, in locating the axis of a cylinder the use of a lens measure is recommended. You will notice that by pressing the lens measure against the cylinder surface of the lens and rotating it, one meridian will register zero, or the axis of the cylinder, and the other will register the power of the cylinder. It is advisable to hold the lens with the axis in a vertical direction, placing the dots also on the vertical meridian. Do not turn the lens so far that you lose track of the cylinder axis.

In centering compound lenses, the greatest care should be exercised so as to get the right side of the lens next to the eye. In flat cylinders and compounds this will be found rather difficult, therefore you must proceed carefully. The use of the lens measure is the best and quickest way to determine the greatest convexity or concavity of

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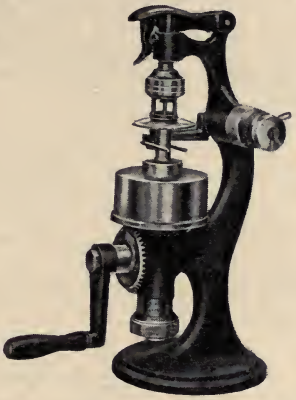

The new Genothalmic Lens Cutter is distinctly the very latest and most perfected instrument yet devised for cutting lenses. It stands out above all other cutters as it requires absolutely no pads or formers of any kind in cutting of the various sizes and shapes of lenses. All adjustments are made on the instrument itself by merely operating two adjusting screws. The cut is absolutely clean, leaving an edge that requires practically no grinding down to edge.

Any size eye from 35 mm to 70 mm round may be cut and difference in vertical and horizontal width from 1 mm to 18 mm, as small an oval eye as 27x35, may be had. Drop eyes of different sizes can be cut as well. After short experience as high as one hundred to one hundred and twenty lenses per hour have been cut.

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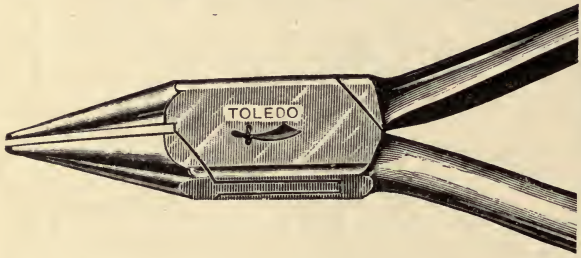

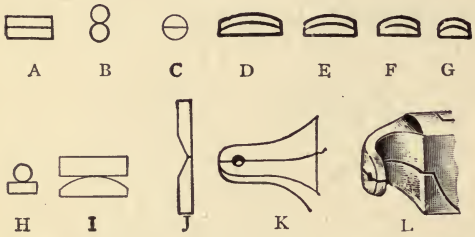

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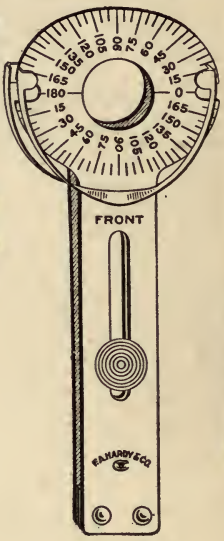

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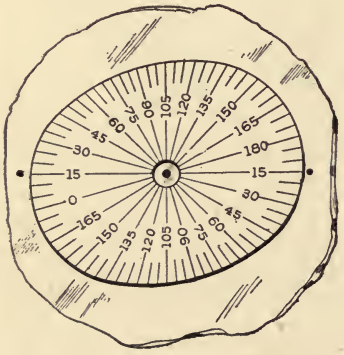

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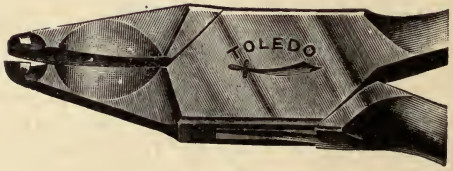

No. 1115. Peterson Shanking Plier

The Peterson Shanking Plier is used for changing the shanks on frames or rimless mountings without removing the lenses. It is made to grasp the shank close to the eye wire and makes a neat bend near the foot of the bridge. A flat nosed plier should be used in connection with the Peterson Plier in making this bend.

The Peterson Plier can also be used as a stud plier for offset guard eye glasses and for tilting end pieces of frames.

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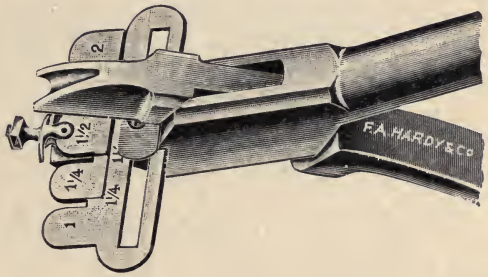

No. 1109. Hardy Strap Plier

This plier is an ideal one for use in changing the width of straps for mounting either flat or toric lenses. A sliding bar with lugs of different thicknesses is fitted between the jaws. Between the lugs are slots for measuring the thickness of lenses. In using the plier the lens is first gauged for thickness, then the lug of the desired width is placed between the jaws. The strap is then fitted over the lug and the jaws brought together. If straps are to be altered for toric lenses the plier is held at a slight angle. This plier will not mar the straps.

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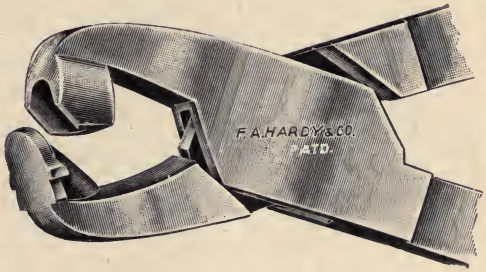

No. 1107. Hardy Crest Rolling Plier.
Patented Feb. 16, 1915

We have used this plier in our shops for years and do not hesitate to recommend it as the best one of its kind. With it one can roll a bridge with a normal crest (45 degrees) to 35 degrees more vertical or 15 degrees more horizontal, thus obtaining any desired angle from 15 to 80 degrees. It can be used on either M, N or O width bridges and will not mar the bridge. Full directions supplied upon request.

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any lens. Always place the lens with the weakest convex or strongest concave surface toward the eyes, excepting in the case of bifocals.

Get a protractor card (any jobber will supply one on request) graduated in five degrees; dot your cylinder lens as instructed and lay it on the protractor card. If you wish to cut it, say, axis 45, turn the lens until the two dots come to 45 on the card. Now make a series of dots across the line on the 180 line. This will be the mechanical axis, or your cutting line. Your pattern has a cross line on it; put the long line on the pattern over the long line on the lens, hold both pattern and lens firmly, and proceed to cut.

Flat compounds, also toric cylinders and compounds, are centered, dotted and marked in a similar manner. It will be well to practice on several kinds before you attempt to cut many, as that will give you ample time for careful study of the process of marking.

In de-centering any kind of lens, it is done by simply moving the pattern up or down, in or out, and then cutting the lens as previously instructed. If you want greater de-centration, it is well to reduce your lens to a prism and have your jobbing house grind it for you.

For automatic machine work, the lens should be cut two millimeters larger than the actual size wanted. For hand edging one millimeter will be sufficient.

Quiz

1—What colored cardboard is used for centering? What size?

2—How do you make the lines on the card?

3—In order to use the card what do you do? How far from the eye?

4—In what hand do you hold the lens? In what direction do you move the lens? At this point what are you looking to find?

5—What do you use as a dotter?

6—When do you stop moving the lens?

7—What is this point called?

8—In centering a lens do you use both eyes?

9—What is done to center plano-cylinders?

10—What instrument is used in finding the cyl. side?

11—How will the vertical line appear?

12—Where do you put the dots on cylinder lens?

13—Why should care be used in marking the cyls. and compounds?

14—What kind of card is used?

15—How is it graduated?

16—How is the lens to be turned?

17—How many dots should be made across the lens?

18—How do you put the pattern on the lens?

19—How do you de-center a lens?

20—What size should cut be made for automatic grinding? What size for hand grinding?

CHAPTER VII

Surfacing

To be a successful surface grinder the operator must possess a certain amount of natural mechanical ability in addition to giving his work deep study, for it requires both to master the principles of this, and much more time and practice are necessary than in the operations thus far dealt with.

There are different kinds of surfacing machines in use, but it is all a matter of personal preference for the reason that all are constructed along the same lines, involving the same principle. It is all *up to the individual,* depending upon his power to grasp necessary details and then carry out their requirements. It is no "kid glove" work, and the person who is afraid of getting a little dirt on his hands had better not undertake to do surfacing. Furthermore he must make up his mind to wear overalls, unless he has a suit to spoil every day.

A person of a mechanical turn of mind is much more likely to become an efficient surface grinder, as such an individual will without any doubt make a greater success of his efforts than the one who merely follows routine without a constant desire to know the whys and wherefores, with an eye open to improve upon his work. These factors should be carefully weighed, for an incompetent surface grinder will prove a liability to himself instead of an asset.

As usual, common glass should be used first (extra thick window glass will be good to use), which should be cut into squares or circles, as desired. The first thing to learn is how to cement the glass to the iron holders which come with the machines. There are several kinds of these holders, or blocks, some being flat, while others are concave or convex.

Blocking Lenses

A good cement for blocking lenses is made from common resin and black tar, in the proportion of eight parts of resin to two parts of tar, or in other words, in the ratio of 80% to 20%. Boil these ingredients together until they are a very thin liquid, then strain the liquid through cheese cloth and pour into small cardboard boxes, to cool. This straining is important, for small particles of foreign matter are in the resin and tar and must be strained out, as if permitted to remain they may scratch the lens. You can also purchase this cement from jobbing houses, which always carry it in stock. Unless you intend to do a great deal of surfacing work it would not pay to undertake to make your own cement.

The next thing to do is to get the lens (or glass) on the block. Heat the block slightly (not real hot) and then run some of the cement upon it in just the same way that you probably have often seen sealing wax applied to a package in an express office. For this purpose use a common gas flame.

After the block has been warmed, next do this same thing to the lens, taking care to warm the latter in such a way that the heat will not be applied more to one part than to another, as this would in all likelihood tend to crack it. Then run a small amount of the cement on the lens as you did on the block. Next run the blaze over the cement on the block and apply the side of the lens having the cement on it to the block, being careful to center the lens on the block—that is to have the center of the lens directly upon the center of the block. You should practice this operation many times, so as to acquire the "trick," when you can do it quickly and accurately, always using common glass before you attempt to use a good lens.

It is always a good idea to have the bench, or table, upon which you work covered with tin or sheet iron, so that any cement that may run off the lens or block may be saved and used again. It is also a very good idea to keep the blocking bench, or table, away from the cold or a draft, in order to prevent breakage.

Just as in many other lines of work, you may find no two people who block lenses in the same manner, even though they are experts, but the principles are invariably the same. You will find, after you have been at it for some time, that you will develop a way of your own that comes most easily to you, and if you stick right at it and pay close attention to the directions as outlined thus far you will be able in a reasonably short time to block a lens in about one minute.

When you have a flat surface to block use a flat block.

When you have a convex surface to block use a concave block.

When you have a concave surface to block use a convex block.

It is always well to get a good layer of cement between the lens and the iron block, because should the glass get too close to the iron it is more likely to break. About 1/8 of an inch of cement between glass and block is safe. This operation of blocking is one of the most important of all those involved in the working up of a lens—it is vital. In blocking a cylindrical lens, draw a white line (white ink) showing the axis of the lens. Upon proper blocking depends your success in grinding. It is a safe statement that thousands of lenses are broken every week in this country through inefficient blocking, thus involving a large loss in money, time and labor.

Surfacing Machines

Practically the same principle is involved in the construction of all the surfacing machines in use. They are all the result of experience and careful study, and their operation depends upon the *individual handling them and the kind of work to be done.* Carelessness on the part of the operator will prevent the finest machine on the market from turning out good work. Intelligence must be exercised at all times and the machine must be *kept clean.* Indifference on the part of the worker and lack of cleanliness as regards his care of the machine will only mean trouble, and that very soon, too. Many a machine has been given the blame that should be placed upon its operator.

It has been shown by experience that about 650 revolutions per minute is the right speed at which to run the machine, for this is fast enough for all kinds of work. If the machine is run at a greater speed this will only result in throwing off the emery too rapidly, besides which it will have a tendency to overheat the lens. It will be found that one-half horse power is sufficient for each spindle. Always see to it that the machine is kept free from emery dust, for if this gets into the bearings it will cut the same and ruin the machine.

A surfacing machine is usually equipped with an upright spindle, with a taper on the top of the spindle, to hold the tool. It is also equipped with a handle across the machine provided with an adjustable pin, to hold the block. This handle is also made adjustable so that it can give the pin the proper pitch, or angle. Nearly all machines are fitted with foot pedals, for starting and stopping, and some also are equipped with an automatic attachment for polishing. Great care and persistence in practice should be exercised and the operator should become a good grinder before undertaking any automatic work, when it comes to the question of handling spherical lenses.

The tools, or laps, that you will require for spherical work are made from special iron, the low power, or flat laps, being about 4½ inches wide. As curves are shorter in radius, the diameter will be much less. *Caution*—Before removing lap from the spherical spindle, *always allow the machine to come to a full stop.* Otherwise a bad cut or injury to your hand may result.

The surface grinder must give proper care to his laps, for the accuracy of his lens depends upon their accuracy. In the process of grinding, the laps will become worn and eventually incorrect in contour. An expert will endeavor to maintain a uniform wear on the lap and will frequently test its curvature by means of a metal gauge. It is therefore necessary to have a metal gauge for every lap curvature. When laps become noticeably out of true, they may be retrued by use of a carborundum stick, such as is used in truing edging stones, held against the lap either by hand or while the lap is rotating on the regular

spindle at high speed. The retruing of cylinder laps is much more difficult and it may become necessary to return the laps to the factory occasionally to be retrued to perfect curvature.

When testing a lap by means of a gauge, the lap should be removed from the spindle and held toward a light, with the gauge held square with the lap surface. Never try to gauge a lap while on the spindle, especially if in motion, as this will ruin the accuracy of the gauge. Likewise, never remove the lap or put it on while there is rotation in the spindle, as this will cause wear in the lap socket or spindle taper, this causing the lap to set loosely on the spindle. If you have done this, do not blame the manufacturer if new laps fail properly to fit the spindles.

Quiz

1—What is the first step in surfacing?

2—What is a block? Are they all of one kind? Describe.

3—What is a good cement for blocking lenses? Describe how prepared.

4—How do you apply the cement?

5—Describe the preparation of the lens for blocking.

6—When you have a flat surface to block what kind of block do you use? A concave surface; a convex surface?

7—What is the best thickness of cement to employ?

8—What is about the right speed for a surfacing machine? What happens if it is run too fast? What is about the proper power for each spindle?

9—How is a surfacing machine usually equipped? Go into details.

10—Describe the tools, or laps, used in spherical work.

CHAPTER VIII

Roughing Lenses

This brings us to the matter of grinding material that will be found necessary in lens surfacing. Different experts have their own choice in this. Their preference lies between emery, alundum and carborundum, No. 60 or 70 of either being best for use. It is more than likely that most of them use No. 70.

The grinding material is put into the mixing pan and enough water is added to make it wet, after which it is dipped up and applied to the tool with a small flat stick, or paddle, or the hand. After you have selected the proper tool for the job that you are about to turn out, a little of the mixture is applied and then the lens is placed on the tool. Now adjust the pin in the handle to approximately a right angle with the curvature of the tool, when the point rests about midway between the edge and center of the tool. Next adjust the pin in the iron block and turn on the power. The two opposite sides of a cylindrical lens measured on the axis, or white line, should be equal in thickness, to avoid prismatic results, and the two points at right angles to the axis should also match each other in thickness, but will not be the same thickness as the former calipration.

Keep dipping up the mixture and putting it on the tool meanwhile, by means of the hand, moving the lens backward and forward from the center to the outside of the tool farthest from you. At the start do not apply much pressure, as you will soon get the grinding sound and will quickly learn the proper amount of pressure and the right quantity of the emery to apply.

It is best to practice on ten or fifteen lenses before taking the next step. For example, if you want to grind a +3.00 spherical lens, 1¼ millimeter thick, you should first rough it down to about 1½ millimeters with rough emery. This "roughing out," as it is called, is

the first step in surfacing and is one in which you should become perfect before attempting to go farther.

Learn the "good cutting sound," learn to be economical with the grinding mixture, learn to dip up the mixture properly, and above all learn to "rough out" lenses to the proper thickness. If you make up your mind to do this and stick at it until you accomplish it you will save a great deal of time when you have to grind a large number of spherical lenses, and by giving close attention to the small operations explained here you will be sure to master the first and one of the most important steps in surface grinding.

After you have made yourself proficient in roughout work, the next thing is to take up finer work, in which the grinding mixture is No. 120 or 150 of the emery, alundum or carborundum. Many experts prefer the No. 120, as it seems to produce the best results. This is placed in a porcelain bowl, crock or enameled cup (never use a tin cup), and sufficient water is added to make it wet before it is applied to the tool. A great many good grinders prefer a brush to a stick or paddle in applying this, experience having demonstrated that the brush enables the operator to apply the mixture more evenly and economically.

In this part of the work do not grind the lens down too far. It takes, as a rule, two or three minutes to take out the rough emery "pits," upon finishing which you will notice that the surface has become smoother and the lens a little thinner. You will also note that there is a different grinding sound. It is important to watch the thickness of the lens in this part of the work. By doing so you will soon learn just how much time is necessary in each operation and you will learn the proper amount of pressure to exert on the handle.

Never guess at the time, at least for some period after you have started on this part of the work. Use a clock or watch for at least a few days, and you will find that experience will enable you to know the proper length of time to within probably a few seconds.

The thickness is another thing in connection with which guesswork should never be used. Get a pair of calipers and during your

practice period measure the thickness of the lens frequently. Your eye will in time become so trained that you will be able to discern the thickness required for the different lenses, and this will mean a big saving in time. Practice on all the lenses that you have roughed out, making some thin, some medium thick and others fairly thick.

The right kind of emery, alundum or carborundum for your grinding mixture in the next step is No. 2 F.* This is prepared in a bowl or crock, as the other (No. 120) is prepared, and apply it with a brush. In examining the lens, you will notice that it is becoming still more smooth, and you should every now and then wipe off the work and look for scratches that will sometimes appear. If you find any scratches, re-grind the lens until the same are removed. Don't forget to wash and dry off the work occasionally.

Always keep plenty of the grinding mixture on the tool, and *never* let the mixture become dry, as this will have a tendency to produce scratches or chip and put deep holes, or pits, in the lens.

Bear these things in mind: Keep your eye on the lens; don't use too much pressure; keep the handle and pin clean.

You are now ready for the last, and most important step—that of using the "finishing emery," or mixture, which is not only very fine but also expensive and should always be kept in a dry place and protected from foreign matter. It is safest to keep it in a place by itself, away from the other emeries and carefully covered, for any foreign matter in it might produce a scratch, which is the very thing that *must be avoided* in the finishing of the lens.

In using the last emery you will note that there is no grinding sound. This is because of the great fineness of the emery. Do not let the tool get dry, and do not use too much pressure. *Watch the lens all the time while you are grinding,* and after you have been working on it for three or four minutes take the lens off, wash it, then dry with a clean rag and hold it up to the light and look carefully for pits and scratches. Also note the degree of smoothness it has received. It is a good idea to use a magnifying glass in looking for scratches.

Too much importance cannot be laid upon this last operation with the emery, and the operator must be sure that every imperfection has been removed from the surface before going one step farther. Care must be taken that no rough emery is on the hands, or even the clothing, for this may find its way to the lens, which will mean a scratch or perhaps several scratches. Very often a worker who has been careless in this respect has blamed the mishap on the emery. To make sure that you will produce the desired results, see that the block and lens are *clean, perfectly clean.* Keep the edge of the lens clean. If you observe these precautions, together with keeping the machine perfectly clean, you will avoid the troubles which have proven so exasperating to many lens grinders. Scratches and pits are the real "bugbear" of this work.

Polishing

After a lens is properly ground, the next step is polishing. This is naturally a delicate operation, requiring care and the finest material. The best grade of finely powdered red rouge is used, and this can be obtained at any optical supply house. It comes in five-pound cans, ready for use.

A polishing cloth is used for this last operation, and these cloths, which are specially treated, are sold by optical jobbers and are perfect for the work. As in most other articles used in connection with lens work, these cloths come in several varieties, and you will very likely develop a preference for a certain kind and will use the kind which best suits you in all of your future surface work.

Various methods are employed in fastening the polishing cloths to the tool. In some cases the grinder cements the cloth to the tool by heating the latter and then applying blocking cement, laying the cloth on this smoothly and letting the tool become cool, after which it will be found that the cloth will adhere firmly. Care must be taken to press the cloth down upon the tool, so that it will assume the exact curvature of the same. Some grinders use a cloth about a half inch

smaller than the tool, while others prefer one larger. It will not take long for you to decide which you prefer. Some grinders use a special set of laps for polishing, cut with radius greater or less by the thickness of felt, so that laps with felt added will have correct radius. This will shorten time in polishing.

Another method of fastening the cloth to the tool is by using a cement made of powdered resin, tar and benzine. This is prepared by using about half a pound of the resin, to which about one ounce of tar is added, and then a little benzine is poured on this mixture. Set it aside for two days or so, and you will find that the mass has assumed a glue which can be applied to the tool with a stick while the latter is in motion, after which the cloth is pressed down firmly to fit the curvature of the tool, upon which it is ready for the polishing process. As most jobbers sell practically this same kind of glue, it is advisable to buy it from them and avoid the trouble of making it yourself.

The rouge is prepared by placing it in a porcelain or enameled vessel, then adding water until it is the consistence of a thick paste, after which it is applied to the cloth in the same manner as that in which the emery mixture is applied, whereupon the polishing may be started. One thing for which to watch is when the work begins to emit steam. This is caused by the heat generated in the polishing process, and the machine should be stopped for a time, in order to let the lens cool.

While the polishing process is not necessarily a very slow one, at the same time it should not be hurried, and too much pressure should not be applied. It usually takes from five to seven minutes to obtain a polish, even after the worker has become an expert, and the beginner will find that it takes longer than this, for there is a little "trick" in applying the rouge which comes only with experience, besides learning just how much pressure will produce the most satisfactory results. However, mastery of these details will come in time.

As you go on with the polishing you will notice that the lens has a tendency to "pull." This is caused by friction. Sometimes two or three lenses will jump off the block, and this is caused, as a rule, by

not having the pin set at the proper angle, while again it might be the result of pressing too hard on the handle. These mishaps are only the result of inexperience and in time will become very rare with you, as you become more familiar with the work. Just don't "lose your head," but keep right at it, realizing that others who are now experts had the same troubles to overcome and that they, too, had to take their time.

Surfacing Rough Cylinders

You are now brought to the first actual work on a lens, going on the assumption that you have thoroughly familiarized yourself with the various details and operations described thus far as a result of plenty of practice. We shall take the following combination:

+.25 sph. + .25 cyl. flat compound, about 1½ millimeters thick.

Flat, rough cylinders—that is flat lenses with the cylinders finished on one side and the other side rough—can be obtained from optical jobbers in a great variety of thickness. They come in individual containers, with the focus and thickness plainly marked on them, usually 2, 4, 6, or 8 millimeters thick and 47 millimeters square.

To grind the combination specified, pick out the thinnest rough cylinder that you can find, 3½ millimeters is thick enough. Always hold it up to the light first and examine it carefully, to make sure that it is free from all imperfections, such as bubbles or deep scratches on the finished side. Never forget to use a lens measure, or gauge, and measure the lens before starting to block it on the iron block.

It is a very good idea to draw a line through the axis. This can be done with a toothpick dipped in white ink, or a liquid made from chalk and water. This line should be drawn on the cylinder side. After you have done this and are sure that there are not any imperfections you can proceed to block the lens as you have already been instructed.

Now, make note of the fact that the lens is 3½ millimeters in

thickness, and your object is to finish it 1½ millimeters thick, therefore it will require very little of the No. 70 emery to rough grind it. Be careful not to grind the lens too thin with the first grinding mixture. Leave some of it for the finer grinding mixture to take off. Always measure the thickness from side to side and from end to end, at right angles to each other.

The lens will often be found thicker at one side than at the other, which shows that it is *out of center*. If you find it to be this way it is useless for your purpose.

Always make it a point to make sure that a lens is properly centered after it has been roughed out. If it is not properly centered you must grind down the thick side to the exact thickness of the other. The correct way to do this is to hold the lens in the left hand and put it on the tool while the latter is revolving, pressing slightly on the thicker side. This will take off the "prism" and you can then proceed to use the handle and pin and finish surfacing the lens. *Never use the handle and pin when centering a lens.*

A good way to "get your hand in" is to take a piece of old glass and grind it prismatic—that is with one side thicker than the other—and then center it again. This will teach you the necessary amount of pressure to use as well as at what angle to hold the lens.

The combination that you are supposed to be working— +.25 sph. +.25 cyl. flat compound, 1½ millimeters thick—requires very little grinding, and an expert grinder would finish a pair of such in 20 or 30 minutes.

For the next combination, try a stronger lens, say a +6.00 sph. +1.00 cyl. flat compound, ½ millimeter thick at the edge.

This being a much stronger lens, it will be necessary to pick out a thicker rough cylinder, say about 4 or 5 millimeters thick. Proceed as before, examining carefully for imperfections, and marking the axis line in white ink. After you have ground this lens for 2 or 3 minutes, you will note that the full curve is not ground on. Continue

grinding with the No. 70 until the lens is about one millimeter thick. Make sure that it is properly centered and then proceed with the other grades of emery as instructed.

When you polish this lens you will note the greater tendency it will have to "pull," or jump, which you will probably find is caused by the cloth's being too thick. You will also notice that the edge of the lens polishes more rapidly than the center, which will remain a dull grey. This can be overcome by using a smaller piece of cloth, or you can use a thick cloth with a tool a quarter diopter weaker than would otherwise be selected. Now, after you have substituted the smaller piece of cloth you will find that the center polishes more rapidly than the edge, the latter now assuming the dull, grey appearance. Practice with a number of lenses will soon enable you to determine the proper thickness of cloth and also the right amount of pressure to exert on the handle. Experience has demonstrated that by following this method the amount of breakage is greatly reduced.

Now let us proceed to the next combination, say a —4.00 sph. —.50 flat compound, about ½ millimeter in the center.

Pick out a rough cylinder, 3 or 4 millimeters thick, make the examination for imperfections, draw the white axis line and block it. Watch the lens closely and you will note that you are grinding its center first. Be careful in this operation, for if you are not cautious you will grind right through the lens onto the iron block. The lens should be taken off frequently and the thickness ascertained, and you can do the latter by holding it up to the light. Another important point is to leave some of the work for the finer emery to do.

Right here we would suggest as a good idea that you block up several pieces of thick window glass, and on these grind different minus curves. This will train your eye to note the proper thickness of the centers and edges, and it will not be very long before you will have mastered the art of grinding concave lenses to the proper thickness in the center. Never lose sight of the fact that you must *constantly* watch the thickness of the lens *on all edges,* so as to avoid their

becoming prismatic. Observe this carefully and always begin to center up the lens before it gets too thin in the center.

All of the flat combinations—that is plus on plus; minus on minus; plus on minus and minus on plus—are ground by the same method. The really important thing to bear in mind is to get both sides the same thickness and both ends the same thickness. Always use a flat iron block for the flat lenses, and when you grind a weak curve, say a +.25, see that the pin in the handle is straight up and down, or perpendicular. If you have a plus 6.00 curve to grind, slant the pin slightly forward, and if you wish to grind a minus 6.00 curve slant the pin slightly backward, as previously explained. This is very important, as it makes the lens spin better and makes it less likely to get out of center. Get into the habit of changing the angle of the pin on each different curve, as by doing this you will grind and polish more rapidly and with less breakage.

Prisms are ground in the same manner as flat compounds, with the exception that all prisms are thick at one end and thin at the other; some are ground so that they will cut base in, others base out, also base up and base down. This is merely a matter of grinding one side of the lens thinner than the other.

For example, if you wished to make a +1.00 sph. +.50 cyl. axis 45° ⊃ 2 degree prism, base in, you would proceed as follows:

Mark as shown on cut and grind the apex thinner than the base. It will be found advisable to caliper the thin end and then the thick end, using the regulation caliper in degrees of one-fifth. If the apex is one millimeter, the base should be three millimeters; or if the prism be one degree, the apex will be one millimeter and the base two millimeters in thickness, if calipering at 50 millimeters.

Some grinders mark the lens with the letter B when the base is to be ground, and with the letter E when the apex is to be ground. Every grinder developes a system of his own which he always follows.

When you have a prism ground to exactness, make sure that both

sides of the lens are of the same thickness. Make yourself proficient in this part of the work before you attempt to make a perfect lens, as there are several little tricks connected with grinding prisms that can be acquired only by repeated practice.

Wafers, scales or cements, as they are called, are ground in the same way as the foregoing, except that they must be ground to what is known as "knife edge" thickness. This is accomplished by doing more grinding with the use of the No. FF emery, which will not chip the glass at the edge as would be the case if a coarser emery were used.

Some grinders chip the lens down to about 35 or 38 millimeters round, and then finish the wafer, or scale, to about 30 or 32 millimeters round, while others use a larger lens and grind it to any size desired. When polishing scales it will be well to remember that you cannot use much pressure on the handle, as the scale will heat quickly and is likely to crack as a result. *Never try to "speed up"* on scales, it doesn't pay. Too much pressure and leaving the lens on the polisher will always result in breakage.

All wafers or scales are made in the same manner, and the weaker the scales the more is the need for care in handling them, especially in making toric scales, in which operation the greatest care must be given to every detail from start to finish.

Surfacing Meniscus Lenses

This brings you to meniscus lenses, but work on these should not be undertaken until you have made yourself thoroughly proficient on flat lenses.

Every optical jobber handles rough drop or meniscus blanks, which come in various thicknesses. Some have a plus 6.00 curve and others a minus 6.00 curve, ground and polished. The best kind to use for practice purposes is that with the minus 6.00 curve.

To grind a plus 2.00 meniscus lens, is a simple matter. Select a rough toric blank with a — 6 base curve about 3 millimeters thick, and grind a plus 8.00 curve on the opposite side.

To make a meniscus CC lens: Suppose you wished to grind a minus 4.00 meniscus. You would select a rough toric blank, with the plus 6.00 curve ground on one side, and then proceed to grind a minus 10.00 curve on the opposite side.

Toric Compounds

Now comes the grinding of toric compounds, and with this step you enter a stage of the work which requires even more caution that the former operations. It will not pay you to attempt to grind the cylinder side, for this can be done more cheaply and accurately at the factory where they are made. Rough toric cylinders are all made with the two curves ground on the plus side and come in individual containers, plainly marked, giving the base curve and also the focus. They can be obtained in any thickness from two to six millimeters, and out of a comparatively small stock it is possible to obtain any combination that may be desired; that is plus on plus, minus on minus, plus on minus and minus on plus. All rough toric cylinders are molded, which leaves the inside hazy, or dull, and you should always examine them carefully before undertaking to block them.

Supposing that you wish to grind a toric compound, +.25 +.25, 1½ millimeters thick. First select a +.25 rough toric cylinder and after examining it carefully select a concave block of approximately the same curvature.

These blocks always have a —6.00 curve in the iron and are made in several different forms; some are square, some round. You will quickly learn the advantages and disadvantages of the various kinds and will adopt the kind that suits you best. Be sure to have a good layer of cement between the lens and the block, as having the lens too close to the iron will cause breakage. Insufficient cement means a

greater strain at the outer edge of the glass than at the center, and this uneven strain will inevitably mean breakage.

We shall now assume that you have made proper preparations to go on with your work, the first thing to do is select the proper tool. In this case it will be a minus 5.75, and you will first grind it to the right thickness. Be sure that the lens maintains a uniform thickness and do not grind too far with No. 70 emery, and after using each grade of emery be sure to rinse the tool and sponge off before applying the next. Keep the handle clean.

In case you do the polishing with the same tool on which the lens was ground, use a thin cloth, and do not apply too much pressure. The lenses heat very easily and if you attempt to go too fast you will crack them, or the heat may cause them to jump off the block.

For other combinations: For example, with a +2.00 +.50 you would select a rough toric cylinder, +.50 and proceed to grind —4.00 on the inside, as shown herewith:

	+6.00	+6.50
	—4.00	
Example:	—.50 —.50	
	+6.00	+6.50
	—7.00	
Example:	—1.00 +2.00	
	+6.00	+8.00
	—7.00	
Example:	+2.00 —1.50	
	+6.00	+7.50
	—5.50	
Example:	+.50 cylinders	
	+6.00	+6.50
	—6.00	
Example:	—2.00 cylinders	
	+6.00	+8.00
	—8.00	

In case you have any difficult or complicated combinations to make you will find it best to let your jobbing house do the work.

Surfacing Bifocal Work

A number of practical bifocal lenses have been put on the market during recent years. These are carefully manufactured and have been found very desirable, besides which there is a big demand for them, such as the Kryptok, and the Onepiece Bifocal.

The Kryptok bifocal lens is one which is made from two different indices of glass; that is the large body is of crown glass and the small body of flint glass. The smaller piece of flint glass is fused into the larger, and this work is so difficult that it can only be accomplished by those who have had years of experience.

All Kryptok blanks, either flat or toric, come in individual containers correctly numbered, and are generally 6 millimeters thick. It is imperative that an operator should have in many cases several months of continued practice on regular work before undertaking to grind bifocals and even then it will take some time before he is proficient in handling these.

It is best, when you are about to undertake to work on these lenses, to go to your jobbing house for a few demonstration blanks, then practice on these before starting on regular work. Make a careful inspection of all blanks before putting them on the block. The best way to do this is by wetting it and holding it up to an artificial light (gas being better than electric light for the purpose). Look closely for bubbles and scratches.

Quiz

1—What grinding materials are generally used? How prepared? How applied?

2—Tell how you prepare the lens before turning on the power.

3—Why should the opposite sides of a cylindrical lens be equal in thickness?

4—What should you do while grinding, with the "mixture"?

5—For example, if you want to grind a +3.00 spherical lens, 1¼ millimeters thick what should you do in "roughing out?"

6—After the roughing out, what comes next? What mixture do you use? How?

7—How long does it take to remove the "pits?" Is thickness important?

8—What is the right mixture in the next step?

9—How is a good way to avoid scratches? What must you do if there are any?

10—What happens if the mixture gets dry?

11—Tell about the "finishing emery;" describe operation with it.

12—What mixture do you use for polishing?

13—Describe the polishing cloth. Tell with what it is fastened and how.

14—What should you do when you see steam coming from the lens?

15—What is a flat rough cylinder? What is their usual size and thickness?

16—How far do you rough out for the 1½ millimeter lens?

17—Why should all flat cylinders be carefully examined?

18—What instruments are needed to measure the curve?

19—Why should you draw a line on the cylinder side? What do you use for making this line?

20—How do you measure to locate the center?

21—What is a lens called when thicker at one point? What is the right method to get a lens back into center?

22—What thickness cylinder is used for a plus 6.00 curve?

23—How can "pull" and "jump" be avoided?

24—How will the edge of the lens appear? How will the center appear?

25—How do you gauge the thickness of a concave lens?

26—What is the most important part in grinding flat compounds?

27—How is the pin in the handle set for weak curves? For convex curves? For concave curves?

28—Why is it always necessary to change the angle of the pin?

29—What is the shape of a prism lens? How are they marked? Why must special care be taken in grinding prisms?

30—How are wafers, or scales, made? What pressure is needed in polishing scales?

31—What are rough toric sphericals? Why should they be kept in stock?

32—What are rough toric cylinders? How many curves are on a convex rough toric cyl.? What appearance has the rough part? What kind of block is used for toric cyls.? Why do so many of these lenses break?

33—What are Kryptok blanks? Why is great care necessary in blocking them?

CHAPTER IX

Surfacing Kryptoks

The Kryptok bifocal is a lens made from two different indices of glass; that is, the large body is crown glass and the small body is flint glass. The smaller piece of flint glass is fused into the crown glass; this being complicated work which can be properly performed only by those who have had years of experience.

All Kryptok blanks, either flat or toric, come in individual containers, correctly numbered, and are usually 6 millimeters thick. Before a person is qualified to be called a good Kryptok bifocal grinder, he must have had several weeks or months of practice and experience on regular work, and he must have a comprehensive knowledge of just how fast the different emerys cut and how much thickness must be taken off the blank by each emery; in short he must be the best man obtainable before he should be trusted with these valuable blanks.

Before attempting to do this work commercially, it will be well for you to ask your wholesale house for a few demonstration blanks and on these to practice carefully before you attempt to grind the regular blank.

In putting these blanks on the block great care must be taken, and by all means see that they are heated evenly and that they are kept from drafts of cold air. Thousands of blanks are broken through carelessness on the part of operators who do not keep their eyes and minds on the work. The usual excuse is "poor blank," or "poor annealing."

Another precaution that must be carefully observed is to get an

ample layer of cement between the glass and the iron block. In this part of the work do not allow yourself to become one of these *"I guess* it is all right" fellows. Before you start grinding you should *know positively* that it *is* all right.

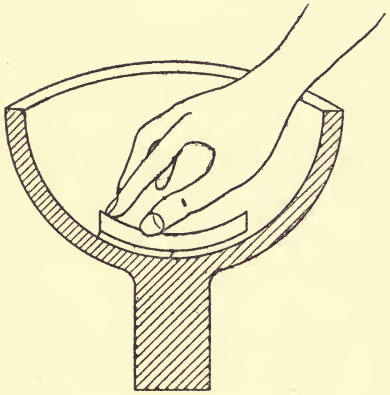


Fig. 1.—Right Way.

The proper method to begin grinding a Kryptok blank is to hold the blank in the right hand as shown in illustration (Fig. 1), and continue grinding off the segment with No. 70 emery until it is within 1 point (5 point calipers) from the larger piece of glass, as shown in illustration (Fig. 2). After you have ground the segment down to the surface of the blank, as shown in Figure 2, you can use the handle and pin and let the blank spin, and the segment will grind down evenly all around, because you started grinding in the "right way."

Do not forget this good advice—"Start right and be sure to stop grinding with rough emery before you have ground the segment down to where it meets the major portion, or large piece of glass." This operation requires a great amount of care and the lens should be taken off frequently, rinsed with clean water, and carefully inspected.

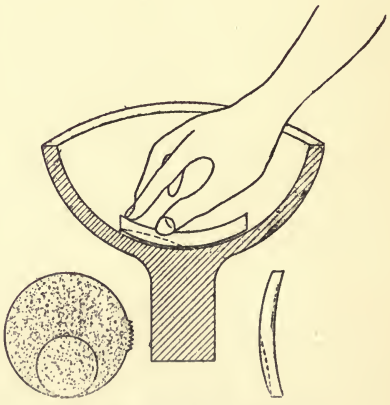


Fig. 2.—Proper Grinding.

Kryptok blanks should never be roughed with the top of the blank and the top of the segment touching the tool at the same time.

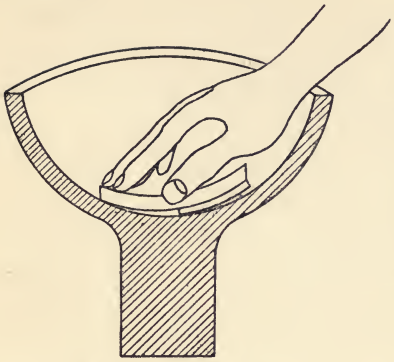


Fig. 3.—Wrong Way.

There is one thing sure and that is, if you grind as shown in Figure 3, you will be unable to get the proper curve on the blank or the size segment you desire. Figure 3 shows the "Wrong Way" to begin grinding a Kryptok blank, and there is much of this grinding being done today.

You will note that the segment comes about 26 millimeters wide. Now that you have properly ground your blank with No. 70 emery as shown in Figure 2, you take the next grade of emery No. 180 and grind the segment down to 22 millimeters. Go slowly and carefully, *keep your eye on the blank,* and do not go to sleep on the job.

It may not sound practical to grind so much off with the No. 180 emery, but you will find that in the long run it pays to let the finer grades of emery do most of the work. The whole matter resolves itself down to this rule; *"Take more time and take fewer chances,* which is only another way of saying, "slow but sure." The results obtained through taking every precaution will soon be manifest in greater satisfaction and financial return.

After grinding the segment down to 22 millimeters with No. 180 emery, use the No. FF emery and grind down to 21 millimeters; next with the finishing emery to 20½ or 20.

Unclean handles, dirty emery and careless methods in keeping the rough emery will inevitably result in scratches and big pits. Hundreds of blanks are wasted daily and weekly from these preventable causes. A system of orderliness, carefully followed from the beginning, will make you a better and far more valuable operator.

Where the additions are weak, say from +0.50 to +1.00 added,

or in other words Kryptok blanks No. 1 to No. 21 in the flat series and No. 300 to No. 322 in the toric series, there is great "Danger" of grinding away the segment if you are not very careful, due to the shallow curvature of the countersink in which the flint is fused. For instance No. 1 and 300 blanks have such a shallow countersink that it is hardly discernible looking through the edge of the blank, but on No. 43 and 344 blanks it is very discernible looking through the edge of the blank, because it is very much deeper. See illustration Figure 4 and take all the precautions possible to avoid grinding the segments too small.

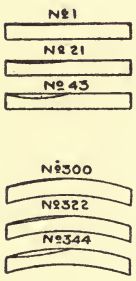


Fig. 4.

Never use No. 70 emery on any of these numbers, but start grinding with No. 180 emery, leaving the segment the full 26 millimeters wide, then grind it down to 24 millimeters with No. FF emery, then finish it with extra fine emery.

This method is somewhat slower, but so many grinders are inclined to rush things that this will be found the better and safer method, with less chance of getting the segment too small. Nearly all the expert (and consequently high priced), grinders throughout the country use this slow, careful, accurate and common sense method.

The selection of Kryptok blanks—that is, the proper number for a given prescription—has become an important part of surface grinding. These blanks are to be had at all wholesale optical houses, and are supplied in individual containers, correctly marked and numbered. If the operator will devote a little time to the study of transposition, errors of focus will be reduced to the minimum.

Before commencing to grind Kryptoks you should write to your jobber for a chart, both for toric and flat blanks. This is supplied free of charge and it is impossible to grind Kryptok jobs without the chart. When you receive it get right down to business and learn how to use it.

It is absolutely necessary in order to obtain proper results in

finished Kryptok lenses, to follow the Kryptok chart accurately. If, according to your prescription the chart calls for a 326 blank, do not use 324 blank. If your prescription calls for 348 blank, do not use 346, because if you do you are sure to have off focus trouble. It is a very easy matter to select the wrong blank, if you are not careful in consulting the Kryptok chart.

In other words don't juggle Kryptoks. Don't use any blank except the exact number that the chart calls for, and never use a 300 series blank for a 200 series blank, or vice versa. Any curve given on the Kryptok chart on torics can be ground according to the curve designated.

Now let us consult the Kryptok chart on a few prescriptions:

For example; +2.00 sphere add +2.00 flat Kryptok. In looking at the chart you will note, under the sub-head "Flat Kryptoks," that the number of the blank for add +2.00 is No. 43; therefore grind plano on the segment side and +2.00 sphere on the opposite side, and this will make the lens perfect in focus.

Example; +3.00 sphere add +1.00, flat Kryptok. To add +1.00 you will note the chart tells you to take No. 21 blank. Grind plano on the segment side and +3.00 on the opposite side.

Example; —1.00 sphere add +3.00, flat Kryptok. For an add +3.00 the chart will tell you that No. 65 blank is required. Grind plano on the segment side and —1.00 sphere on the opposite side.

It is absolutely necessary at all times whether you grind plain spheres or compounds, that you use the exact number given on the chart; the only difference is that on spheres you have a choice—that is to say for a +1.00 sphere you can grind a plano on the segment side, or you can grind +1.00 on the segment side, and if you desire you can also grind a +0.50 on the segment side; the difference in the sphere will be made up by the curvature on the opposite side.

This does not mean, however, that the same blank number can be used for each of these combinations of curves. A different blank num-

ber is used for each curve. For proper blanks and curves consult Kryptok chart.

Now we will consider the grinding of Kryptok compound lenses. For instance: +2.00 sph. ⌒ with +0.50 cyl. axis 180 add +2.00. You will note that on the left side of the chart are shown the curves to be ground on the segment side of the blank. The curve required is +2.00 sphere; trace down the column on the left side of the chart until you come to +2.00 sphere, then trace across to the column marked "add 2.00." You will find the blank for that combination is No. 35. Grind +2.00 sph. on the segment side and grind +0.50 cyl. on the opposite side.

To make the following combinations; +2.50 sph. combined with +0.50 cyl. axis 90, add +2.00 the chart will tell you that blank No. 33 should be used. Grind +2.50 sph. on the segment side and +0.50 cyl. on the opposite side.

The beginner should start with spherical work, which will give the valuable practice and experience that are necessary before taking up compound or cylinder grinding.

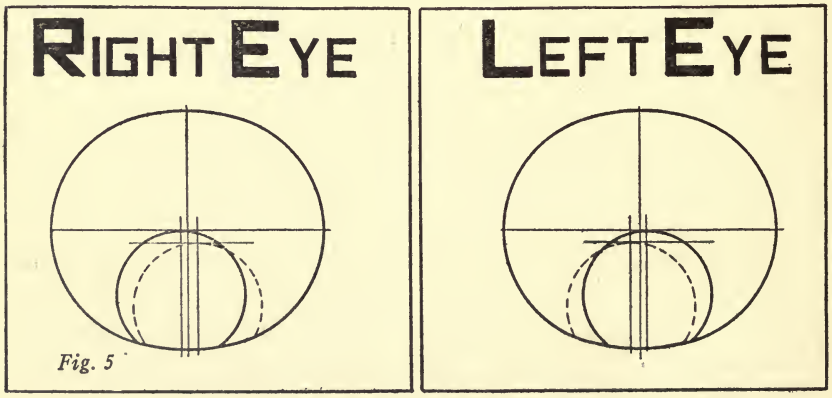


Fig. 5

NOTE.—This illustration is not as though the lenses were finished and on the patient, but just the opposite, as laid out on a protractor. Being prepared, or marked for the surfacing of the other side.

One important part will come to your attention, viz; that after the segment side of the blank is ground, the top of the segment may be too high or too low. A good way to overcome this is to lay the

blank (after the first side is finished), on a protractor card, which your optical house will supply free of charge. Get the top of the segment 1, 2 or 3 millimeters (as the case may require) below the optical center of your distant lens, and also decenter segments in on each eye as required. Usually segments are set in on each eye from 1 to 2 millimeters. The centers of the reading discs should never be placed on the vertical distance center line for the pupillary measurement, for distance is not the same as that for reading. The proper way to lay out Kryptok blanks for cylinder grinding is shown in our illustration above (Fig. 5), it is also necessary in order to get the best results, to take into consideration the size of the finished lens and to allow about 3 millimeters larger all around the rough blank and chip away the unnecessary glass before grinding the cylinder side.

If you are going to grind a compound lens, it will be necessary to mark the base curve of the cylinder or in other words, the axis of the cylinder, also prism marking the apex and base, if a prism is to be ground.

If the blank is not properly marked before the cylinder is ground, it will be impossible after the cylinder has been ground to get the proper axis, location and decentration of segments.

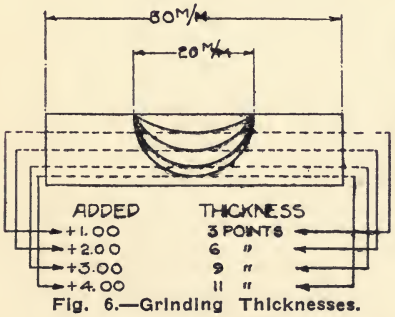


Fig. 6.—Grinding Thicknesses.

In grinding flat Kryptoks, the greatest care must be given to watch the thickness—that part over the segment. If you have a strong addition and make a large size segment, it will require a thick lens. A good way to determine the exact thickness that you can grind is to edge the bottom of the lens where the segment is fused in, then when you are grinding down you can hold the lens up to the light and looking through the edge you will soon learn to distinguish between the bottom of the crown glass and the top of the flint glass, or vice versa. This precaution should always

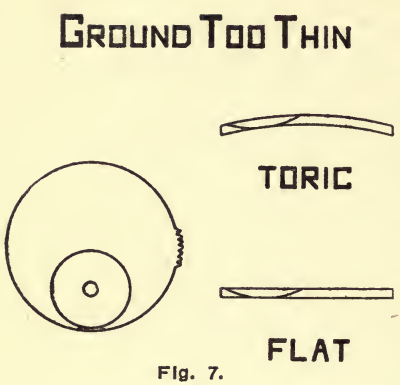


Fig. 7.

be taken when grinding prescriptions that require concave curves on both sides, or where the concave curve is greater than the convex curve. While grinding the edge of the blank to see how far you are grinding is a good way, nevertheless a better way is to know exactly how much glass is necessary for thickness on various additions. (See Fig. 6.)

Much of the disappointment of customers, much of your lost labor, time and temper, is caused by grinding through the opposite side of your Kryptok blank. This, of course, takes place after the segment side has been finished. The accompanying diagram (Fig. 7) illustrates the appearance of Kryptok blanks when ground through the segment, or in other words, when it is ground too thin. The small circle in the large blank shows where the flint is ground through from the opposite side. You will also notice on the toric and flat blank, that the curve on the countersink is broken, thus showing the blank was ground too thin.

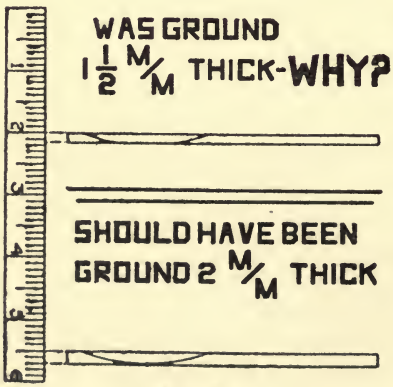


Fig. 8.

Take for instance the illustration (Fig. 8) that shows a lens with a +3.00 diopter added, that was ground 1½ millimeters thick, but should have been ground 2 millimeters thick. Why was this lens ground 1½ millimeters instead of 2 millimeters? First of all the grinder may be careless and this would be the result. Second, the wrong curve may have been ground on the blank, and trying to correct the error, he ground the blank too thin. Third, the operator may not know the proper thickness to leave

the blank on the various additions, and if this is the case, consult illustration on thicknesses (Fig. 6).

A large number of blanks are spoiled daily owing to the fact that the grinder is not careful to observe the little precautions that help to make a job efficient. When blanks are "ground through"—that is when the crown is ground down to meet the flint—it is merely a result of too much haste on the part of the operator who neglects to use the necessary care in his work—and the result is that the cost of the blank is lost as well as the time that it takes to grind both sides.

Toric Kryptoks

The selection of toric Kryptok blanks is worked out in much the same manner as the method use in flat Kryptoks. However, there is one exception that must always be taken into consideration, viz.: that all plus on plus, or minus on plus combinations *must invariably be transposed.* The reason for this is that the cylinder can never be ground on the segment side. With toric blanks, as with flat, many different combinations can be made from one particular number. It will be necessary for the operator who selects the Kryptok blank to know how to transpose and we will give here a few rules and examples on transposition. Take for instance a +1.00 sphere combined with a +1.00 cylinder axis 90, transposed it will be +2.00 sphere —1.00 cylinder axis 180. In other words on plus on plus prescriptions you add the power of both the sphere and the cylinder together for your sphere and add to it a cylinder of the same power but opposite sign and axis. Then take another, for instance, a +1.75 sphere combined with a +2.25 cylinder axis 25; transposed, it will be +4.00 sphere —2.25 cylinder at axis 115.

In transposing minus on plus where the cylinder power is greater than the spherical power, you subtract the sphere from the cylinder and the remainder is proper sphere, combine this with a cylinder of the original power but opposite sign and axis.

TRANSPOSITION

℞ +1.00 = +1.00 Axis 90°
+1.00

+2.00 = —1.00 Axis 180°

℞ +1.25 = —2.25 Axis 60°
+1.25

—1.00 = +2.25 Axis 150°

℞ +2.25 = —1.00 Axis 75°
—1.00

+1.25 = +1.00 Axis 165°

℞ —1.75 = —1.25 Axis 10°
—1.25

—3.00 = +1.25 Axis 100°

℞ —3.00 = +1.25 Axis 65°
+1.25

—1.75 = —1.25 Axis 155°

℞ —1.75 = +2.25 Axis 25°
—1.75

+0.50 = —2.25 Axis 115°

℞ +0.50 Axis 80°

+50 = —50 Axis 170°

℞ —1.00 Axis 95°

—1.00 = +1.00 Axis 5°

The safe rule to follow is: *The stronger the curve on the segment side, the stronger the addition will be.* For example:

No. 338 blank, with plus 6.00 curve ground on the segment side, will give an addition of plus 1.75; if you grind plus 7.50 on the blank, it will give an addition of plus 2.00; if you grind plus 8.75 on the blank, it will give an addition of plus 2.25. This rule holds good on all blanks.

The following examples will help you in making the proper transpositions, and will help you select the right blank. This is by no means a complete list:

No. 1 Plus .25 combined with plus .25 axis 90 add 2.00
No. 2 Plus .50 combined with plus .50 axis 180 add 2.50
No. 3 Plus 1.00 combined with plus 1.00 axis 90 add 1.50
No. 4 Plus .50 combined with minus .25 axis 90 add 1.75
No. 5 Plus 2.00 combined with minus 1.00 axis 180 add 2.00
No. 6 Plus 3.00 combined with minus 2.00 axis 90 add 2.50
No. 7 Minus 1.00 combined with minus 1.00 axis 90 add 1.00
No. 8 Minus 3.00 combined with minus .50 axis 90 add 2.00
No. 9 Minus 2.50 combined with minus 1.00 axis 180 add 3.00

No. 10 Minus .50 combined with plus 1.00 axis 180 add 2.50
No. 11 Minus 3.50 combined with plus 4.50 axis 90 add 1.00
No. 12 Minus 4.00 combined with plus 2.00 axis 180 add 2.00

The above should be ground as follows:

No.	Segment Side	Opposite Side		Blank No.
1	plus 6.50	Minus 6.00	Minus 6.25	342
2	plus 7.00	Minus 6.00	Minus 6.50	350
3	plus 8.00	Minus 6.00	Minus 7.00	325
4	plus 6.50	Minus 6.00	Minus 6.25	336
5	plus 8.00	Minus 6.00	Minus 7.00	336
6	plus 9.00	Minus 6.00	Minus 8.00	842
7	plus 5.00	Minus 6.00	Minus 7.00	215
8	plus 3.00	Minus 6.00	Minus 6.50	245
9	plus 3.50	Minus 6.00	Minus 7.00	265
10	plus 6.50	Minus 6.00	Minus 7.00	352
11	plus 7.00	Minus 6.00	Minus 10.50	318
12	plus 4.00	Minus 6.00	Minus 8.00	241

All blanks from No. 1 to No. 108 are flat on both sides; from No. 418 to No. 516 are minus 2.00 on segment side and flat on the opposite side; from No. 626 to 721 are minus 4.00 on segment side and flat on the opposite side; from No. 200 to 287 are plus 3.00 on segment side and minus 6.00 on the opposite side; from No. 300 to 387 are plus 6.00 on segment side and minus 6.00 on the opposite side; from No. 800 to No. 874 are plus 9.00 on segment side and minus 6.00 on the opposite side.

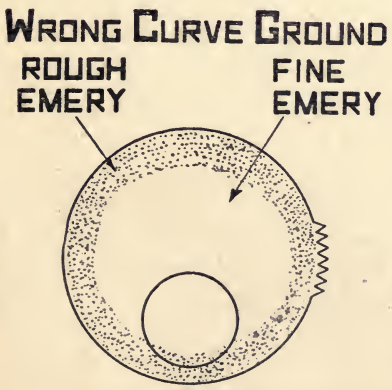


Fig. 9.

There is considerable danger in grinding the wrong curve on Kryptok blanks, especially is this the case in torics. Grinding wrong curves on the Kryptok blank is very serious and evidently there are many wrong curves being ground today. The opposite cut, (Fig. 9) well illustrates how the wrong curve has been ground on the blank with rough emery which is shown by the outer grain on our

picture, and when the operator tries to fine it up with the proper tool, this is the result.

By this kind of grinding you will be unable to get the size lens that you want, and the size of the segment will also be too small, and in all probability it will be a disappointment to the customer. Try to eliminate this expensive negligence and carelessness.

This can be avoided by making it a rule to gauge your tool before using it to see that you have the proper curve on your tool.

Right here is a good place to point out some of the errors that have been made hundreds of times by grinders. Ninety-nine times in a hundred these attempts have failed; therefore,

Don't grind a cylinder on the segment side of a Kryptok blank.

Don't mark the polished surface of a Kryptok lens with India ink or any other ink that will stain glass.

Don't use coarse emery on weak additions.

Don't try to put a minus 2.50 curve on a No. 42 blank. The segment will always be too small. Select a No. 442—that is the sure way to get a large size segment.

Don't try to get a plus 5.00 curve on a flat blank. The segment will be too small and the blank will be too thin at the top.

Don't try to grind a plus 6.50 curve on a No. 245 blank. The blank will be too thin in the center.

Don't try to grind a plus 9.50 curve on a No. 353 blank. Usually the segment will be too small and the blank will be too thin at the top.

Don't try to grind a plus 7.00 curve on a No. 852 blank. The segment will be too small.

These experiments have been made so often, only to be followed by failure, that it will be found advisable always to order such special blanks from your jobber. All standard blanks are made from perfectly white crown glass. All colored blanks, and also those not standard size, are made *special.*

The standard size segment is 19 millimeters, although some opti-

cians require them larger and others smaller than that size. The advantage found in using a small segment is that you can get a thinner lens. Where the additions are strong, say 2.75 to 3.50, it will be well to make the segments as small as 18 millimeters.

If care be used in selecting the blanks, getting the proper block and the correct degree of heat, and giving utmost attention in the grinding and polishing operations, one should readily become an expert grinder of Kryptoks.

Quiz

1—What is a Kryptok Bifocal lens? Describe briefly its construction.

2—Is it an easy matter to become a Kryptok Bifocal grinder? Why?

3—What caution must be observed relative to putting them on the block?

4—What about the cement?

5—State the proper method of beginning to grind a Kryptok Bifocal lens. What emery is used?

6—What do you do after the segment is ground?

7—Describe the method of grinding which must be avoided. Why is it wrong?

8—What is the procedure after grinding down with No. 70 emery?

9—Has cleanliness anything to do with good results? Why?

10—Tell why care must be exercised in grinding Kryptok Bifocals, regarding the segments.

11—Describe the last steps in grinding.

12—Why is it important to have a chart?

13—What is necessary to follow whether you grind plain spheres or compounds?

14—With what kind of work should the beginner start? Why?

15—What important point will you notice after the segment of the blank is ground?

16—How do you overcome this?

17—What is necessary to do if a compound lens is to be ground?

18—What is the case if the blank is not properly marked before the cyl. is ground?

19—What caution must be taken in grinding flat Kryptoks?

20—What is a good way to determine the exact thickness that you can grind?

21—What frequently causes much annoyance in grinding Kryptok blanks?

22—What exception must be made in selecting toric Kryptoks?

23—What is necessary for the operator who selects Kryptok blanks to know?

24—How do you transpose minus on plus where the cylinder power is greater than the spherical power?

25—What is the safe rule to follow in transpositions? Does it apply to all blanks?

26—Describe blanks from No. 1 to 108, as regards both sides; from No. 418 to No. 516; from No. 626 to No. 721; from No. 200 to No. 287; from No. 300 to No. 387; from No. 800 to No. 874.

27—In what special kind of Kryptoks is there danger of grinding the wrong curve?

28—What results from the wrong method of grinding? How can you avoid the same?

29—Enumerate some errors often made by grinders working on Kryptoks.

30—What is the best thing to do, so as to avoid such mistakes?

31—What kinds of blanks are made special?

32—What is the standard size segment?

33—What is the advantage in using a small segment?

34—What is it best to do where the additions are weak?

CHAPTER X

Surfacing Ultex, Onepiece Bifocal Lenses

As is well known to the up to date surface grinder, the Ultex onepiece blank comes to the shop with the Bifocal side all ground and polished. Thus, it is only necessary to grind and polish the one surface, and that a comparatively easy operation.

The method of procedure is very simple. Consult your prescription in order to ascertain the proper blank and tool to use for the job. Two charts are supplied by the manufacturers, both being alike in principle, but one calling for blanks ground to —4., —6., and —8. base curves, and carrying 262 tools, while the other calls for blanks ground only to —6. and —8. base curves, with nearly twice the number of tools. The former cuts down the investment in tools; the latter cuts down the investment in blanks. The latter chart is the more satisfactory, in every way, as tools are less expensive than blanks, and furthermore, the deep curved form of lens, with its consequent large field of vision, is maintained.

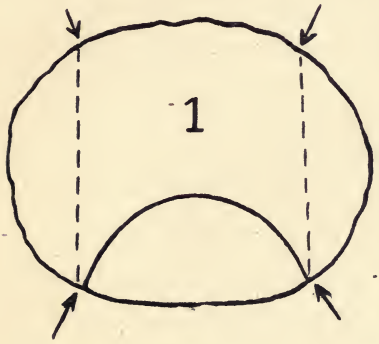


Fig. 1.

After noting the prescription to be ground, look it up in the chart to ascertain the proper blank and tool to use. For example: suppose the prescription reads +1.25 +1.00, add +2.00. Consult the + ⊃ + section of the chart, we run down the sphero column until we come to +1.25; then run along this column horizontally until we come under the required cylinder power — in this case +1.00. At the intersection or crossing of the +1.25 horizontal column and the +1.00 vertical

column, we find that a —6. base blank is called for, and a 7.25 x 8.25 toric tool. Suppose the prescription to have been —1.25 +1.00, add +2.00; consult the — ⌒ + section in the same manner, and we find that —8. base blank and a 6.75 x 7.75 tool are required.

Next, select a blank of the required base curve and having the proper addition. Crumb the blank to the approximate size and shape of the finished lens. This will save a lot of unnecessary grinding and polishing and also allow the lens to be brought down to proper thickness without grinding the edges unduly thin, as is frequently the case when a full size blank is used. Attention to this matter will save a lot of breakage.

Next, locate and dot the required position for the optical center of the distance portion, also the axis of the cylinder, if any, decentering in the reading portion the required amount. The customary practice is to decenter each segment 1½ m/m, swinging it in this amount, using the optical center of the distance portion as a pivot. This should be done before marking up the axis. Then mark up four measuring points on the lens as shown in Fig. 1. The reason for this arrangement is obvious, as the segment for reading portion is raised above the distance portion so that in measuring for thickness we must avoid the segment and measure on either side of it, as shown in the cut.

Block up the blank, using as large an iron blank as possible. The reason for this is that if the lens extends too far beyond the edge of the block, breakage is apt to result. The layer of pitch between lens and block should be of uniform thickness at all points. That is, the convex curve on the iron blank should be of the same curvature as the concave curve on the lens blank. If one is +6., the other should be —6., and the layer of pitch should be about 3 m/m thick. Attention to above points will save a lot of breakage.

When roughing the blank down, follow exactly the same methods you would use finishing the second surface of a single vision lens. If emery is used for roughing, use 60 grade; if Alundum or Aloxite, use 70 or 80 grade. Rough to within 3/10 m/m of final thickness.

Smooth with "factory" smoothing emery, ordinarily known as 302, taking off 1/5 m/m in smoothing. Run the smoothing emery dead, and then finish with finishing emery, as furnished by the factories. Run the finishing emery black, or dead, but be careful that the lens surface does not come in contact with the tool.

Polish with "wet ground" rouge, as furnished by the factories. It costs a little more, but will not scratch. One scratched Ultex is equal in value to a lot of rouge, and it is false economy to use the "dry ground" rouge on high priced lenses. Use the thinnest possible polishing cloth; billiard table cloth is best, if it can be obtained. Stick cloth to tool with a mixture of resin and turpentine. This mixture holds better than resin and naphtha, and should be used as thick as possible. Run polisher fairly dry and sticky, in order to produce friction and consequent rapid polishing. Do not get the lens too hot—haste makes waste.

Use your head and exercise care, and thus save time and expense.

Quiz

1—How many sides are ground on an Ultex?
2—What method is used to get proper number of blanks?
3—Where are charts procured?
4—How many different base curves are used?
5—What size and shape are best for grinding?
6—What is the result of using extra large blanks?
7—How do you locate the optical center?
8—What method is used for finding axis of cylinder?
9—What is the customary practice for decentering lenses?
10—Why should this be done before marking up axis?
11—How many measuring points should be used?
12—What should be avoided in measuring?
13—What size iron block should be used?
14—What result could be expected in using smaller blocks?
15—Why should the layer of pitch be uniform in thickness?

16—What grade of emery is used for roughing?

17—How thick should a lens be when the rough emery is used?

18—What number emery should be used for the second, or smoothing, operation?

19—How much thickness will come off with this smoothing operation?

20—What is the last grade, or finishing emery?

21—Why do you run this finishing emery black?

22—Why should extraordinary care be used with the finishing emery?

23—What is the usual way to polish Ultex lenses?

24—What thickness of cloth is the best?

25—How is the polisher cemented to the iron disc?

26—What extraordinary care should be used in polishing?

CHAPTER XI

Soldering and Repairing

The average optician does not do much practicing in the way of soldering. Of course from a commercial standpoint it is the best way for the optician to endeavor to sell new goods, but if he isn't in a position to repair old ones where a sale of the new is impossible he is, to use a common phrase, "up against it." Therefore it is by all means advisable to master the art of soldering broken frames and mountings, so in case an emergency arises he is not in a predicament.

While it is true that alcohol lamps are often used in this work, the popular agency used is gas, for various reasons. Suffice to say that those who have been at this work for years prefer gas, so there must be a good reason for their preference. In order to concentrate the heat on one spot a blowpipe is used, and you can get sufficient service out of an ordinary small mouth blowpipe about ⅜ of an inch in diameter and 8 or ten inches long.

There are various styles of solder blocks, but charcoal seems to be used most by the better grade of repair men. It might be stated here, however, that after you have become reasonably proficient in soldering you will never use a block.

A very important factor in this work is a borax slate. This is simply a block of slate, concave in the center, which is used for mixing the soldering solution. Borax, of which the solution is made, is sold in a number of different forms. To mix the solution apply a few drops of water in the depression in the slate and rub the cake of borax in this until you obtain a thick milky liquid. Be sure that before using this cake of borax you soak it in water for four or five minutes, so as to prevent it from breaking. One such treatment of the borax is all that is necessary. The milky liquid you have produced, as described,

should be applied to the parts that are to be soldered, using for the purpose a small camel hair brush, or the frayed end of a toothpick will do.

Two common water glasses, one containing water and the other one part of sulphuric acid to nine parts of water will be needed. Nearly all metals have a tendency to oxidize, or blacken, when they are heated sufficiently for the solder to flow freely, but if after the soldering is done the frame or mounting is dipped into the sulphuric acid solution the dirt and borax will be removed by the liquid and the parts will be left clean.

As to the solder, there are many brands of gold and silver hard solder, about the best of which is what is termed "easy flowing solder," which can be obtained at any optical wholesale house. It usually comes in strips, so that it can be cut up as needed. Small pieces about two millimeters square are generally used, as it is just as well to cut the solder up in this way.

It will be a very good idea to get some old temples and some old eye wire and do a lot of practice work on these before attempting to do any regular work. No matter in what line of work it is involved, successful soldering is a knack, and this is especially so in optical work.

It is highly important to know how to regulate the gas flow and get the right pressure. It is best to fasten the blowpipe on the bench so that the hands may be free to hold the work, and a rubber tube fastened to the blowpipe enables you to move your head if necessary in watching the work, while you furnish the pressure with your mouth for the blowpipe.

Here is where you will need tools. They are not many, neither do they involve the expenditure of much money, and once you have them you will probably not need to replace most of them for years unless through losing or breaking some. Get two or three pairs of pliers, also two or three pairs of tweezers of different sizes. A very

handy adjunct to your set are a small anvil and vise, especially when riveting, removing screws, etc. Get a good selection of screwdrivers with different blade sizes, some with swivel tops, others with wooden handles. You will frequently find that screws have rusted, and these are easily removed by the use of a tool known as a "screw extractor," which can be bought at any optical house. Also have a small hammer, for riveting work. A good assortment of files is necessary. Get two or three flats, two or three half-round and one or two files for slotting screw heads—about No. 4 cut is the best for the majority of jobs. It is best to have an assortment of wooden handles for the files.

Some gold repair men keep an assortment of rouge and emery sticks, but these are not used to any great extent. One thing is absolutely necessary, and that is a buff head, or polishing head, to insure good work and keep your accessories bright and attractive. While you can obtain these at various places, it is best to go to an optical house, for there you will get exactly what the optical worker uses. With the buff head you will need a brush wheel, a felt wheel and a cotton buff, all of which should be about three or four inches in diameter. The buff head should run about 2,500 revolutions per minute.

To clean up any part that has been filed, emery paste should be used. The cotton or felt wheel buff is used to put the last finish on the work, and great care should be taken when using this wheel, as it has a tendency to "pull," and it will easily catch the frame or mounting and bend it out of shape or break it into small pieces. Both emery paste and polishing rouge can be purchased at any optical house.

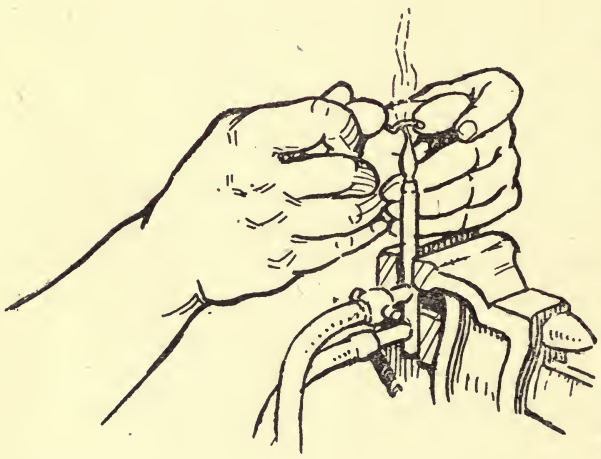
In addition to the above articles it would be a good idea to get a good jeweler's brush, a spool of binding wire and three or four solder burrs. You will very likely add other tools as you go along with your work, but those already named are the essentials, and with plenty of practice with them you will be in shape to do the small amount of repair work that may be required of you.

As a beginner you should not attempt to do any hard, difficult

jobs. The thing to do is to turn them over to the wholesale houses, which employ thoroughly experienced workers and you will find it cheapest in the long run.

Doing the Work

When you are about to solder a frame make sure that the parts are perfectly clean. A file is the best for this purpose. Use a half round file, as with it you have the means for reaching the work at any angle, and since the file is pointed you can reach into the smallest recesses. After you have the work perfectly cleaned pin or clamp it to the soldering block.



Now, with the soldering fluid prepared in the depression in the soldering slate as previously instructed take your camel hair brush and paint the parts to be soldered with the soldering fluid and then also apply a small piece of the solder—about 2 millimeters square—at the juncture. You are now ready for the heat, and a small flame that comes to a point like the point of a lead pencil and about two or three inches long is about the right kind to use.

Approach the piece of solder with your flame about three or four inches away. Now you will notice that as the heat strikes the solder and borax it will dry the latter, having a tendency to make it curl, or boil up. This will move your solder. You can overcome this by

a piece of wire in your left hand, with which you can hold the solder in place. Then come close with the flame, and as soon as the solder begins to melt leave it as it is and proceed to heat the wire until the solder will run into the proper place.

There are several gas brackets and other contrivances made for soldering work. Some repair men use an air pressure pump, others use a mouth blowpipe. Nearly all optical jobbers sell these soldering brackets, and the latter are recommended in preference to others, as they are made especially for optical work, and can be relied upon.

After the soldering operation has been completed and the work is still hot dip the entire frame into the sulphuric acid solution, after which rinse it in clean, plain water. This will remove all dark spots and leave the work in good condition for polishing.

It is not an easy task to learn to make the solder flow properly, but by practice and exercising good judgment this can be accomplished. Watch closely and determine the right amount of heat, also the correct amount of solder to use on a given job. If you put too much solder on the work it will leave a lump which must be filed down, and if this is necessary, after the filing put the work on the brush wheel, followed by the cotton buff. Remember, the buff should always be run *toward* you. *Keep* your *eye on the work all the time.* If you don't trouble is sure to result.

If you are given a spectacle frame to repair it is a good idea to take off the temples; or the zylo guards if the job is an eyeglass mounting. Indeed you should first examine a job carefully, and if you feel that there is danger of spoiling any part it is better to refuse the work.

You can purchase at any optical jobbing house whatever bridges you may require, all ready to solder onto the eye wire; you can also get blank bridge stock, which you can bend to whatever shape you wish. Before doing this work it will be well to practice bridge bending with some old wire. First the shank, then following with the

right curve for the nose. Be careful of one thing—you will often find that frames and mountings brought in for repairs have been soldered previously, and when this is the case and you think that re-soldering might weaken the frame or mounting, don't take any chances, but turn the job down.

It will never pay the repair man to try to make springs, handles, guards or other small parts used in repairing. As for steel optical goods, they are almost a thing of the past and it is a waste of time to bother with them. Zylo frames are very popular, but when one of these is broken the customer should be advised to buy a new one rather than to attempt repairs. It will be found most satisfactory to all concerned. This also applies to zylo temples.

It is well to have on hand a bottle of assorted screws, also several taps, so that you can cut a thread and fit a new screw when necessary. Do not try to repair gold-filled guards or springs, for they cost so little that it is better to get new ones; the same way with zylo pads, cork pads, shark-skin pads, etc. You had better have repairs on lorgnettes and folding oxfords done at the wholesale houses, where the workers are familiar with the same.

Quiz

1—Why do you use a blowpipe? Describe how you use it.

2—What is a soldering block? From what made? What is the soldering solution and how made and applied?

3—Name the tools usually needed in connection with soldering.

4—How do you prepare the work for soldering? Describe the process of soldering.

5—How does gold look just after being soldered? How do you remove this appearance?

6—What is the buffer head? Why used? What kind of wheels are used on the polishing head? At what speed should latter be run?

7—What should you use on the brush wheel? What on the cotton buff?

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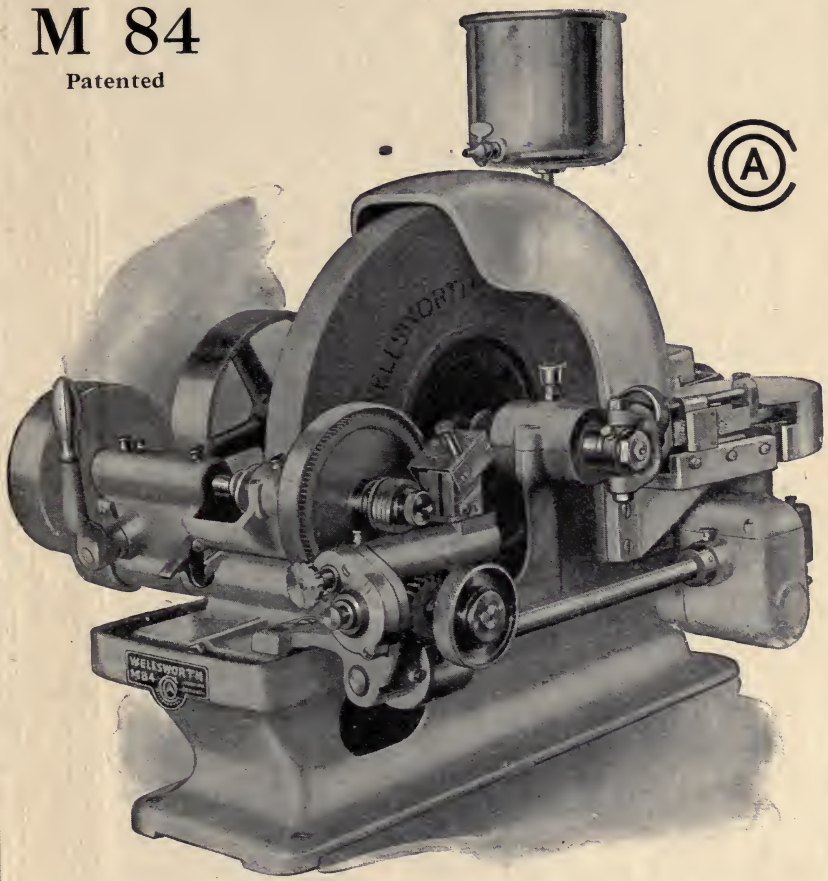

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