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Spectacle lens fabrication in an optometric practice

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Abstract

Recently many of our classmates have asked questions concerning the actual set-up of an ophthalmic lens fabrication lab in an optometric practice. Our colleagues and peers not only want to know about feasibility, investment, space, equipment, and prices, but also how to perform the actual process of spectacle making. As graduating optometrists some of our classmates will enter into an association with an older established optometrist and some will go into solo practice. In either case one of their duties may be doing the actual lab work in spectacle fabrication. This is very common practice in the current optometric community.

As more and more optometrists become involved with lab work, the need for a manual of this type is obvious. A literature search proved fruitless in obtaining any source that covers the breadth and scope of the edging process in its entirety. Optometric and optician's publications sometimes deal with various aspects of the spectacle fabrication process, but we have found these to be too general and in the style of an overview or "snapshot". We were unable to find any source containing the actual mechanisms involved.

A previous research project involved a video tape of the edging process from a local laboratory, and was aimed toward explaining how the edging process is accomplished. We feel that the tape was good in that it oriented the viewer as to "how this is done". However, the thrust of our project is to explain, step-by-step, how to edge lenses in an optometric office. The manual will be written from the perspective of "How to do it", rather than "how it is done".

To our knowledge, this work will be the first of its kind, and will represent a compilation of technical information obtained from manufacturers of laboratory equipment, combined with textbook information, and original writings based on our training and experience as laboratory 1 opticians. The authors do not intend this manual to be a statement saying that professional optometrists should spend their time edging lenses. To the contrary, we feel that the optometrist should spend his/her time doing what he/she was trained to do, that is, providing vision care. If however, a spectacle fabrication lab is to be incorporated into an optometric practice, two things are necessary. First, the optometrist needs to know the processes involved as well as the equipment required in order to set up the lab. Second, he/she needs a working knowledge of the basic mechanics and procedures involved, in order to train personnel if necessary.

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SPECTACLE LENS FABRICATION

IN AN OPTOMETRIC PRACTICE

by

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A Thesis presented to the faculty

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Preface

Recently many of our classmates have asked questions concerning the actual set-up of an ophthalmic lens fabrication lab in an optometric practice. Our colleagues and peers not only want to know about feasibility, investment, space, equipment, and prices, but also how to perform the actual process of spectacle making. As graduating optometrists some of our classmates will enter into an association with an older established optometrist and some will go into solo practice. In either case one of their duties may be doing the actual lab work in spectacle fabrication. This is very common practice in the current optometric community.

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Overview

Traditionally spectacle fabrication has been a process carried out mainly by wholesale optical laboratories. Today more and more optometrists are becoming involved in this function. In a survey done by the optical publication 20/20 in the July/August 1981 issue, 400 optometrists, ophthalmologists and opticians were polled across the nation. The survey indicated that the backroom "mini-labs" will soon reach the point where it turns up as frequently as in European dispensing establishments. Sixty percent of the optometrists reported that they were currently doing lab work in their own offices.[1]

In an article published in the April 1980 issue of Optical Index some of the major reasons why dispensers of ophthalmic eyewear do their own spectacle fabrication were: 1) economics- it costs less per job to edge your own lenses, 2) one has better control over the work being done and the ability to give more personalized service and better quality to your patients, 3) an increase in the speed of the service, and 4) emergency service can be performed.[2]

This paper will deal with ophthalmic lens fabrication in an optometric practice. The paper will be in the form of a manual. It will enable the reader to gain a solid and thorough understanding of all the processes involved in the fabrication of a pair of spectacles. We will give the reader a source from which it is possible to obtain: 1) the advantages and disadvantages of incorporating a lab into an optometric practice, 2) a comparative analysis of current prices including a discussion of minimum and maximum investment necessary, 3) an idea of how much office space (area) is required for a lab, 4) an overview of all the steps involved in the process of spectacle fabrication organized in a sequential work flow, 5) the basic mechanics of all procedures and techniques involved, 6) operating instructions for all equipment, and 7) examples and explanations of all calculations and formulas involved in the spectacle fabrication process.

Each step in the process will be supplemented with diagrams and a thorough explanation of the methods and techniques required. The text will be written in a format much like the optometric procedures manuals that supplement the procedures courses during the first two years of optometry school. The final draft will serve as a ready reference manual for the optometrist and his employees. The following discussion is an overview of the topics/areas to be covered.

BASIC WORKFLOW IN THE EDGING PROCESS

There are eight basic machines necessary to perform the edging operation: 1) lensometer, 2) layout marker, 3) pattern maker, 4) blocking system, 5) machine edger, 6) hand edger, 7) heat treater or chemhardener, and 8) dyepot. The lensometer is the standard lensometer found in every optometric practice. The lay-out marker is a device that enables marking the lens with an ink cross, after the lenses have been decentered the desired amount. Next a small circular rubber pad that is sticky on both sides is placed on the lens, over the ink cross, and then a small metal "block" is placed on the rubber pad. The metal block is designed in a particular shape such that the block will fit into a chuck on the machine edger. In other words, the metal block serves to hold the lens while the lens is being ground (edged) down to the proper shape and size to fit the particular spectacle frame. Together, as one unit, the lens and block are placed in the machine edger. The next step involves making a pattern that exactly matches the shape of the desired lens. The pattern serves to guide the machine edger as to what area of the lens blank should be edged (ground) off, in order to match the shape of the frame. Patterns are made by placing a standard pattern blank (made out of plastic) on to the pattern maker, while the spectacle frame is clamped onto a special grid adjacent to where the pattern blank was placed. A special apparatus fits into the groove of the eyewire on the frame, and then when the machine is turned on, the apparatus follows the eyewire groove as the pattern blank is cut. The result is a pattern that is the same shape (and size) as the lens that would fit into the spectacle frame. The finished pattern is then placed on to the machine edger and the actual edging process is ready to begin.

The machine edger, hereafter referred to as the "edger", is the largest and most sophisticated piece of equipment in the edging lab, and serves as the central component in the edging process. The basic design is similar to a bench grinder commonly found in the garage and used for sharpening lawn mower blades, etc, and consists of a grinding wheel or wheels mounted on an electric motor. The lens rides on the grinding wheel as the motor is turning and the glass (or plastic) is ground off. The desired size of the finished lens is set by adjusting the size dial on the side of the edger. As the glass is ground off of the lens blank, the pattern blank simultaneously rests upon a microswitch. When the pattern depresses the microswitch, the lens and pattern are both rotated approximately 3-5 degrees and the grinding (edging) process continues. When the lens has been edged down to the proper size and shape, the machine automatically shuts off. The lens (and block) are removed and compared to the spectacle frame to determine if the lens is the proper size. If the lens is too large, the lens is again placed into the edger, the size setting is adjusted, and the lens is run through another complete edging cycle. This whole process usually requires about 2-3 cycles. When completed, the lens is down to proper size and shape, but there are small chips along the edge of the lens. These chips must be removed before the lens can be heat-treated or chemically hardened, and this is accomplished in a technique called hand edging.

Hand edging means exactly what it says. The technician holds the lens in his hand while grinding off excess glass using a diamond or ceramic edging wheel. Proper technique is required to insure that glass is removed in proper location, and that glass is not removed in other locations. This sounds like a very simple operation much like sharpening a knife on a grinding stone. However, hand-edging an eyeglass lens is much more sophisticated and requires technical expertise if lens spoilage is to be avoided.

The procedures described above are the same for both plastic and glass lenses. At this point the remaining procedure to be followed is dependent upon whether or not the lens is plastic or glass: A) glass lenses should next be hardened using a heat-treat or chemical process, then drop-balled, and then inserted into the frame for final inspection, and B) if the lenses are plastic, the tint must first be dyed into the lens before the lenses are inserted for final inspection.

Heat-treating a glass lens involves heating the lens almost to its melting point, and then rapidly cooling the lens which in turn strengthens the lens to resist impact and shatter. The chem-hardening process accomplishes the same thing, but is accomplished by bathing the lenses overnight in a liquid bath which in turn substitutes ions in the glass with ions from the liquid. Regardless of which process is used, the lens then must be drop-balled in order to insure that the hardening process did indeed occur, and that the lens meets the impact resistance requirements specified by the federal government.

Plastic lenses do not need to be hardened or drop-balled. However, they do have to be dyed if a tint is desired. The dye pot simply consists of several deep containers each containing a different color dye. The containers collectively sit in a common steam bath which keeps the liquid dyes heated to the proper temperature. A lens to be dyed, say dark brown is simply dipped into the brown dye using a special lens holder. The dye is subsequently absorbed by the plastic lens, and the darkness of the tint is regulated by the length of time the lens is left to soak in the dye. There is also a bleach that is used if a color needs to be lightened or changed.

The lenses are now ready to be inserted into the frames for final inspection. Inserting is a skill that requires much practice and a whole array of special pliers and hand tools in order to be efficiently accomplished without lens spoilage. Zyl frames are naturally easier to insert lenses into than metal frames. Metal frames require the lens to be an exact size in order to fit properly, whereas a zyl frame can be heated or shrunk in order to accommodate the lenses.

The last step is final inspection to verify the prescription, check for unwanted prismatic effects, and to insure proper frame alignment.

REFERENCES

1) 20/20 Dispensing Lab Survey, 20/20, July/Aug 1981, pp. 26-27.

2) Hirschhorn, Han, Modern Edging Methods, Optical Index, April 1980, p. 93.

Layout/Markup

Section I

Layout/Markup

This section discusses the first in a sequence of steps needed to fabricate a pair of spectacles. The layout/mark-up of a lens is a process that insures that the lens is decentered appropriately for the specific style and size of frame to be used. This is done so that the major reference point* (MRP) and/or multifocal segment will be positioned in front of the patient's eye in accordance with the prescribing doctor's orders. Once the lens is properly marked, it is ready to continue on to the next steps of the fabrication process.

Before the actual process of layout/mark-up is explained, a few other things need to be mentioned. Materials that need to be ordered are ordered the same day the patient picks out a frame. A prescription worksheet needs to be filled out containing all the necessary information needed to complete the spectacles. Some of the information needed is as follows.

1) Patient's name
2) Date ordered
3) Frame name/manufacturer/color
4) Frame eye size/bridge size/temple length and the effective diameter (ED) if needed
5) Prescription for right and left lenses (sphere power, cylinder power, cylinder axis)
6) Prism through the major reference point (MRP)
7) Patient's pupillary distance (PPD) +Vert. O. C.
8) Type of multifocal and segment height
9) Type of lens material-Glass/Plastic/Photochromic/Tint/Gradient, etc.
10) Any other necessary information or special instructions from the prescribing O. D.

A job tray is selected and the prescription worksheet is placed in it along with the frame and lenses. If the frame and lenses are not stock items, order them immediately and place them in the job tray as soon as they come in so that the prescription can be filled promptly.

Part of the process involved with ordering lenses is to determine whether the blanks you have available in stock are large enough for the particular lens size to cut out.

*Note: MRP is the point on a lens where the prism equals that called for in the prescription.

Determining Lens Blank Size

There are various ways to determine the lens blank size required. One's lens stock inventory is a factor in this decision. If one's inventory shows 65mm blanks as the largest blank size in stock and a 72mm blank is needed, obviously one must special order this from a lens supply house. As a beginner in spectacle fabrication lab work, it is recommended that one start with single vision then proceed to multifocals. All multifocals should be ordered from the surface lab, however one should know how to determine required lens blank size for multifocals. This is to insure one will never be charged for oversize blanks in cases where they were never required in the first place. In the business world anything can and does happen.

Both single vision and multifocal blank sizes can be determined by using "oversize charts". Various companies manufacture these charts, including Vision-Ease and Bernell (See Appendix B). The charts come with instructions, are simple to use, and it is recommended that one be purchased. If one desires explanation and examples of how to use these type charts, refer to System for Ophthalamic Dispensing by Brooks/Borish as pages 86-89 include examples and explanations for determining lens blank size. A second method used to determine if the lens will cut out of a certain blank size is to use the newer layout blockers. These enable one to decenter the blank the required amount and then an exact eyesize pattern may be superimposed on the decentered lens blank and one can visually determine whether or not the lens will cut out.

When marking up lenses there are two formulas that need to be used. One formula is called Prentice's Rule which states $\Delta = cF$ where Δ is prism diopters, c is distance in centimeters, and F is power of the lens in diopters. The second formula we will call the Blank Size Fornula and it is BS=ED+ (2 x dec) + 1mm where BS is blank size, ED is effective diameter of the frame in mm., and dec is decentration in millimeters. The 1mm is called the safety valve factor. The best way to describe how to use both of these formulas and how to determine the required decentration for a lens is to go over a few examples.

Example 1 — Frame: Bronzini I by Univis
O.D. +1.00 sph No prism
O.S. +1.00 sph
PPD (Patient's PD) = 62mm
FPD (Frame PD) = Eye size (ES) + Bridge size (DBL)
ES = 53mm DBL = 19mm
ED = 54mm

Since there is no prism prescribed, the optical centers of the lenses will be the major reference points (MRP) therefore the lenses must have the optical centers decentered in the frame so that they will fall on line with the optical axes of the two eyes. The patient's PD represents the proper separation of the MRP's of the two lenses.

First compute the frame PD(FPD) by adding the ES (A dimension in the boxing system) to the DBL or bridge size. (Note: Be sure to check these measurements with a millimeter rule.) In this example FPD = 53+19 = 72mm. Once FPD is computed subtract the PPD to get the total decentration of the MRP required. If FPD is greater than PPD the MRP must be decentered IN. If the FPD is less than the PPD the MRP must be decentered OUT. In this case FPD is greater than PPD and decentration of the MRPs will be IN. FPD - PPD = 10mm decentration IN. This 10mm IN is the total decentration for both eyes therefore we divide by two to get 5mm IN for each eye. Prentice's Rule is not needed since the prescription calls for no prism through the MRP.

Next, let us determine the blank size needed. BS = ED + (2 x dec in mm) + 1mm. Therefore BS = 54 + (2 x 5mm) + 1mm = 65mm. Two 65mm lens blanks are needed for this prescription and if one's inventory includes this, they are pulled from stock. If not, they must be ordered.

Example 2 — O.D. + 3.00 sph = $\frac{1}{2}^{\Delta}$ Base IN
O.S. + 3.00 sph = $\frac{1}{2}^{\Delta}$ Base IN
Frame: Corsair by Universal
FPD = ES + DBL
ES = 50mm DBL = 18 ED = 52
PPD = 60mm

In this example the MRPs will not be the optical centers of the lenses due to the prism requirement of the prescription. Let it be noted that the MRP is found and spotted using a lensometer but for the sake of understanding how much decentration would be required or if a lens needs to have the prism ground in, let us use Prentice's Rule. We first must use Prentice's Rule to determine how much decentration from the optical centers is required to obtain the desired prism through the MRP. If the prescription cannot be filled by the decentration method, the lenses have to be ordered from a surface lab. Prism = cF, so for the right eye the prism required is $\frac{1}{2}^{\Delta}$, F = +3.00 therefore plugging into the formula $\frac{1}{2}$ = c(+3.00) or c = .5/+3 = .166cm or 1.67mm. The left eye is the same so the total decentration required is 3.34mm. Since the lenses are of plus power, the optical centers must be decentered IN to obtain prism Base IN through the MRPs. (See Figure I-1).

Next let's calculate how much the lenses would need to be decentered to have the optical centers coincide with the patient's optical axes or centers of the pupils (as if there were no prism prescribed). Once this is done the answer is added to the decentration found previously to create the desired prismatic correction through the MRP.

It was found that each lens would have to have it's optical center decentered 1.67mm IN to give $\frac{1}{2}^{\Delta}$ Base IN through the MRP. The decentration of the optical center of each eye if there were no prism prescribed would be FPD - PPD = 68mm - 60mm = 8mm ÷ 2 = 4mm IN. To find the total decentration required in order to have $\frac{1}{2}^{\Delta}$ Base IN through the MRP, add the two decentrations together. The decentrations are both inward so 1.67mm + 4mm = 5.67mm IN for each eye.

Now, the blank size needed if we induce the prismatic correction by decentration can be determined. BS = ED + (2 x dec) + 1mm so BS = 52 + (2 x 5.67) + 1 = 63.34mm, thus a 65mm blank would be needed for the lens to cut out.

Example 3 O.D. - 0.50 sph = 2^{Δ} Base OUT

O.S. - 0.50 sph = 2^{Δ} Base OUT

Frame: Cambridge by Universal

FPD = ES + DBL
E.S. = 50mm DBL = 20mm ED = 52mm
PPD = 60mm FPD = 70mm

As in the previous example, first calculate the decentration required to produce the prism through the MRP by using Prentice's Rule, Δ = cF. 2Δ = c(0.50) c = 2/.5 = 4cm = 40mm IN for each eye (See Figure I-2).

The decentration required to center the optical centers over the patient's pupil centers with no prism through the MRPs would be found by FPD-PPD = 70mm - 60mm = 10mm. The decentration would be IN and 10 ÷ 2 = 5mm IN for each eye since the FPD is greater than PPD. The total decentration required to achieve 2^{Δ}Base OUT through the MRP of each eye would be 40mm IN + 5mm IN = 45mm IN. It is obvious that these lenses would have to have the prism correction ground in at a surface lab. Just for fun let's calculate the uncut lens blank size needed for such a prescription to cut out. BS = ED + (2 x dec) = 1mm therefore BS = 52 + (2 x 45mm) + 1mm = 143mm is the uncut lens blank size needed!

With the blank sizes determined and the lenses selected from stock or ordered, the next thing to do is inspect the lenses. One must inspect the lenses to make sure that there are no pits, scratches, waves, bubbles, striae, grayness, or any other defects. Any serious defects in the lenses requires that they be rejected and sent back to the supplier or surface lab. Good quality lenses should always be used. With the frame and lenses in the job tray, the next thing needed is a pattern. A pattern is a piece of metal or plastic cut to the exact shape of a frame's eyewire. These patterns are used in conjunction with an edging machine to trace the desired lens shape to be cut. (See Figure I-3).

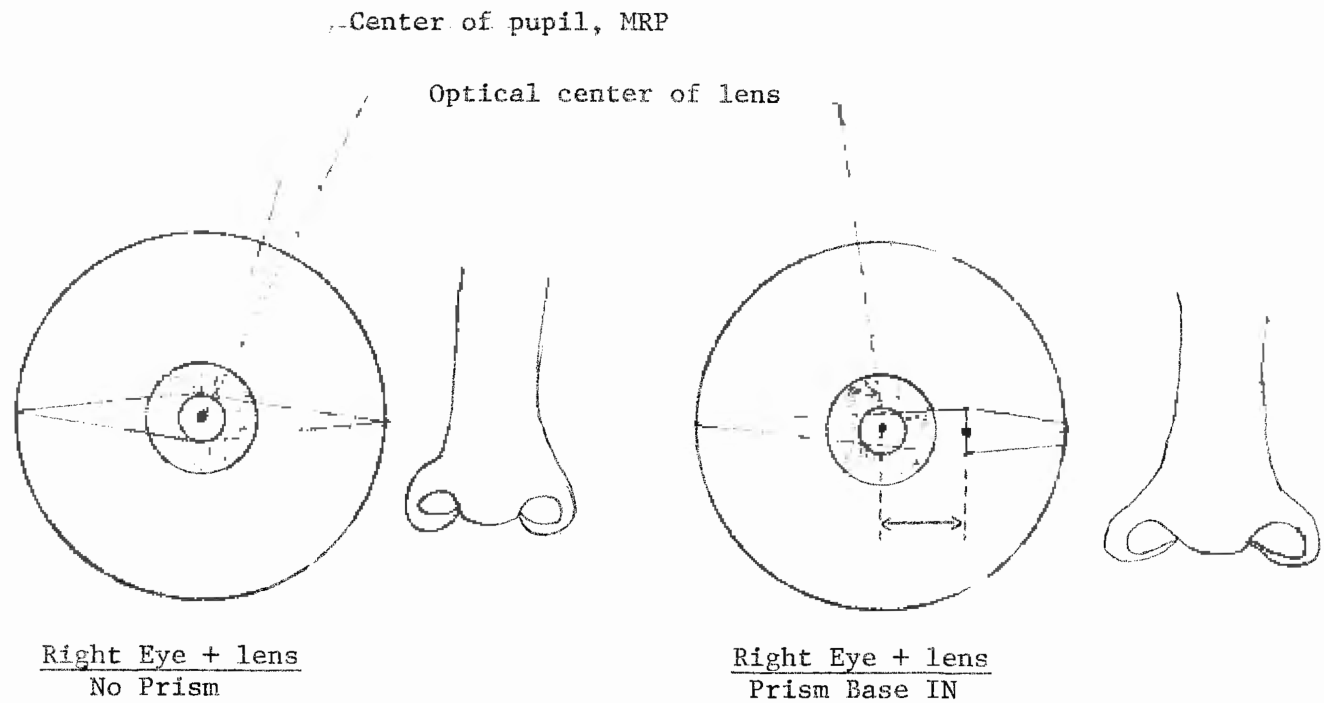


Figure I-1

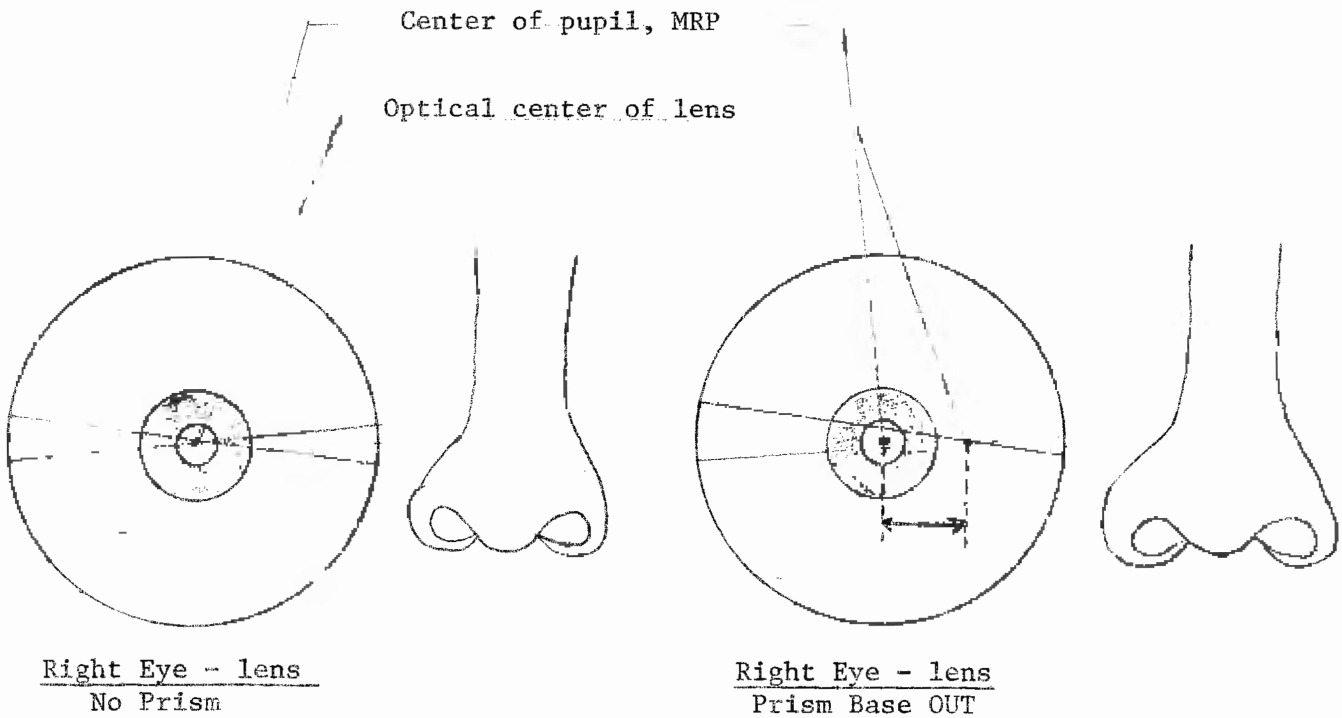
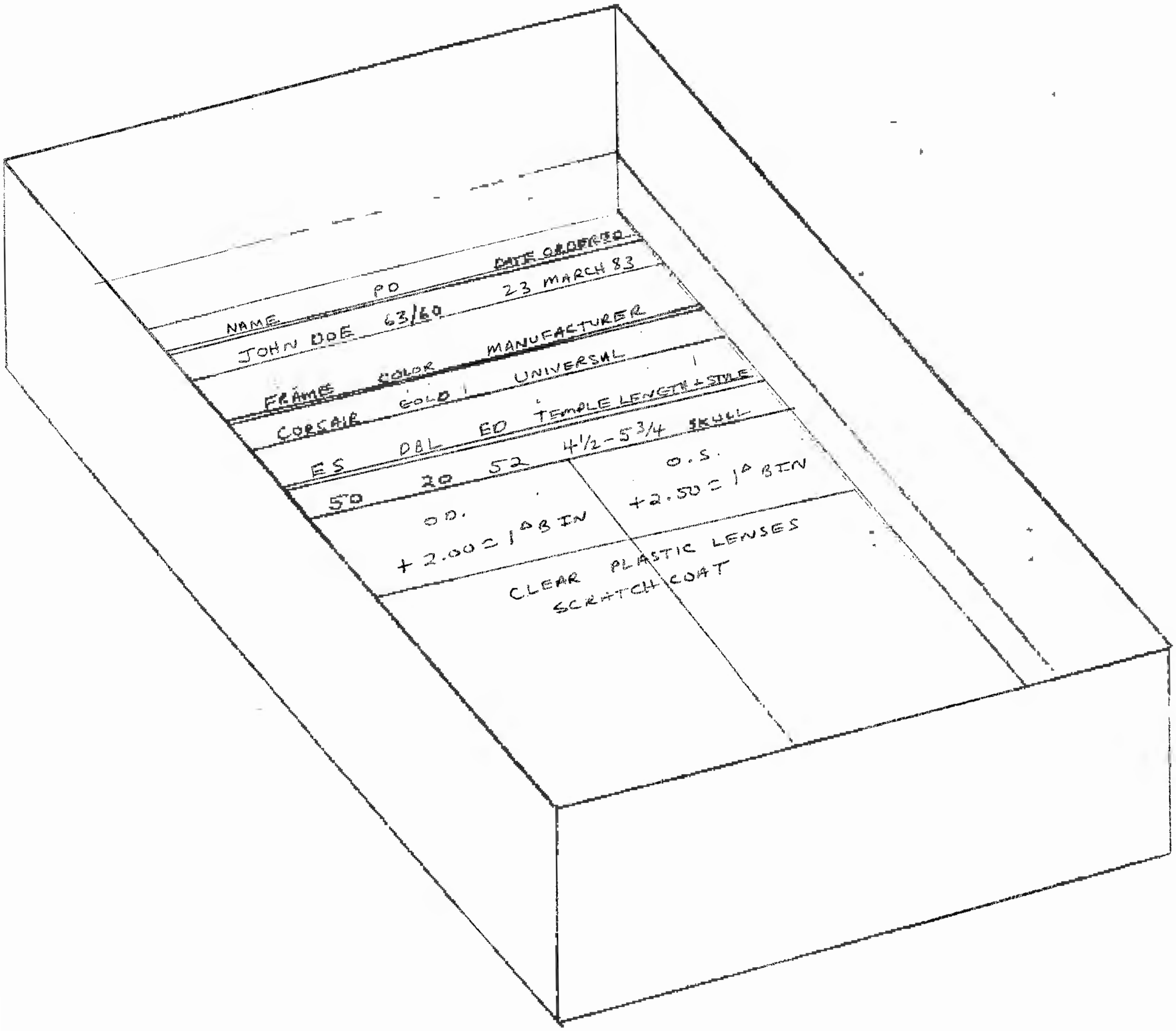


Figure I-2

Job Tray with Worksheet



Pattern

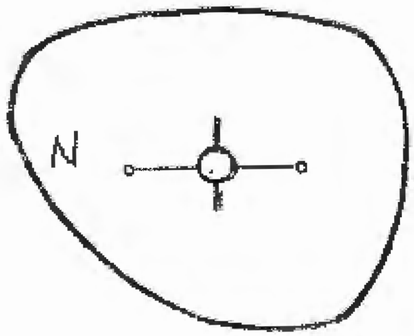


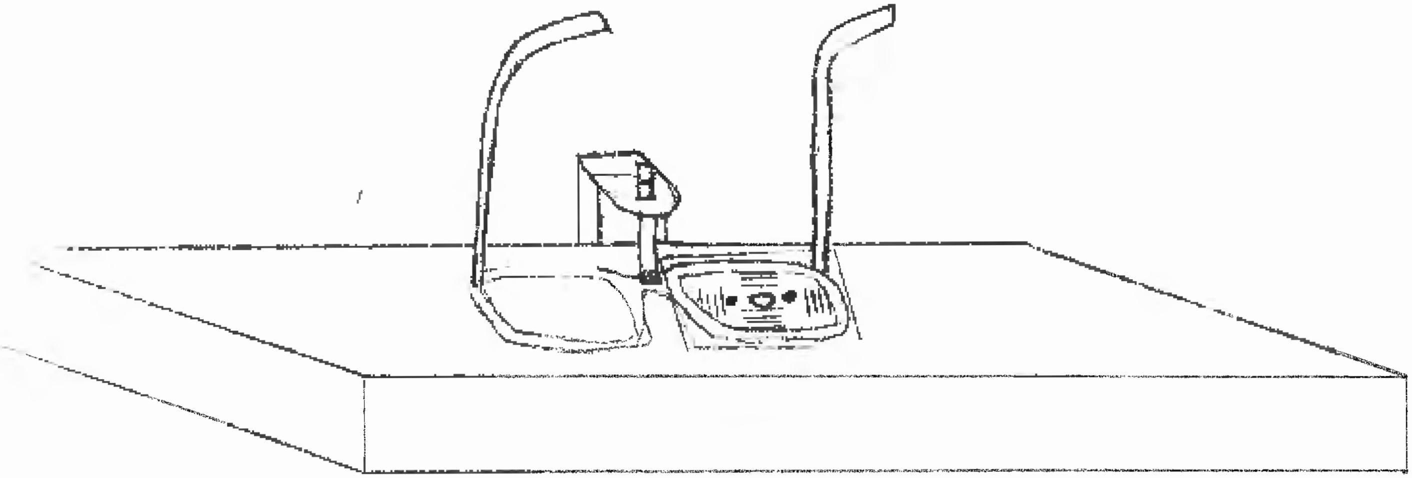
Figure I-3

Pattern Making

Pattern making can be done by machine or by hand. Making patterns by hand is by far the most economical of the two choices. Blanks for making patterns are supplied by many of the major optical manufacturing companies. Be sure to order pattern blanks that will fit snugly on the brand of lens edging equipment that one owns. Also when cutting pattern blanks by hand be sure to order blanks with millimeter markings printed or impressed in the blanks. To make a pattern by hand one needs a pattern blank with millimeter markings, the frame for which the pattern is to be made, a pair of serrated cutting shears, a marking pen, and some sort of device to hold the frame in place while aligning the pattern. (See Fig. I-4) This device can be made cheaply and easily by anyone. One only needs a piece of wood 5" by 10" and some sort of set screw, holding device to secure the bridge of the frame in place to free both hands for work.

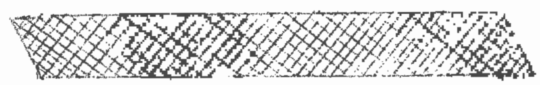
To make a pattern by hand follow these steps. 1) Secure the frame in the holding device. 2) Slide a pattern blank under the right eye (by convention) of the frame. 3) Make sure the top and bottom eyewires are lined up on the same number millimeter marking. Use the longest vertical separation (B dimension in the boxing system) for top and bottom markings. Next do the same with the horizontal dimension. The object is to line the frame up over the pattern with the geometric center of the frame's right eye corresponding to the geometric center of the pattern. (See Fig. I-5) 4) With everything lined up, use a marking pen and carefully trace around the eyewire. Inspect to make sure the line passes through the same mm marking both in the horizontal and vertical meridians. 5) Remove the blank and carefully cut around the traced shape with the cutting shears. 6) File off all rough edges and make them smooth. 7) Mark the nasal side of the pattern with an N so that the nasal and temporal sides won't get mixed up and reversed when edging the lens. By convention the patterns are always cut for the right eye.

Frame Holding Device



Marking Pen

File



Cutting Shears

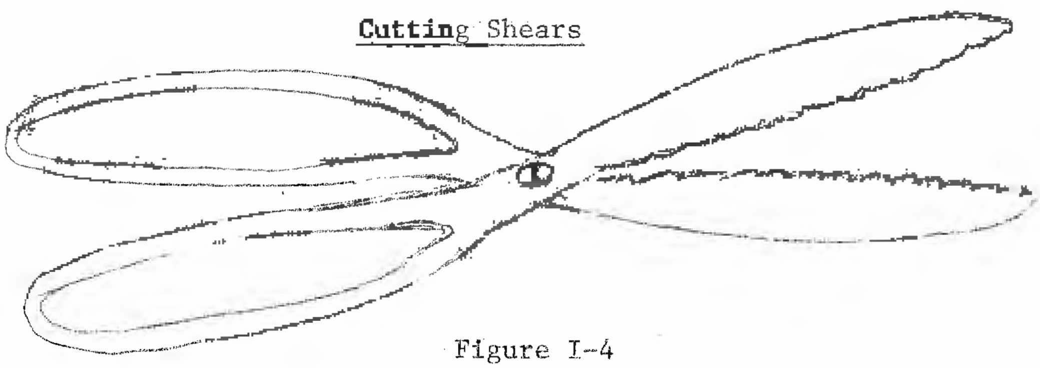
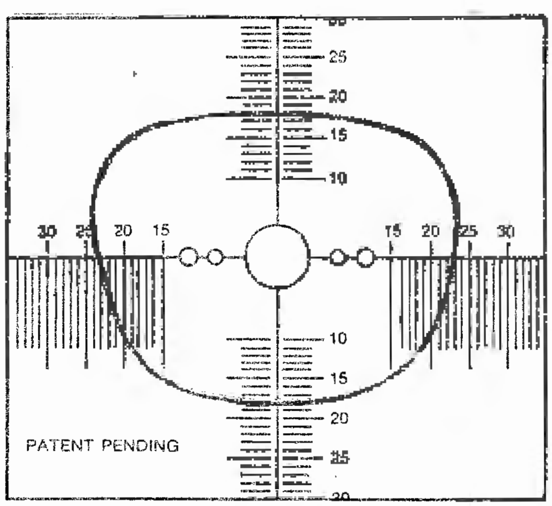


Figure I-4



Pattern Blank

Figure I-5

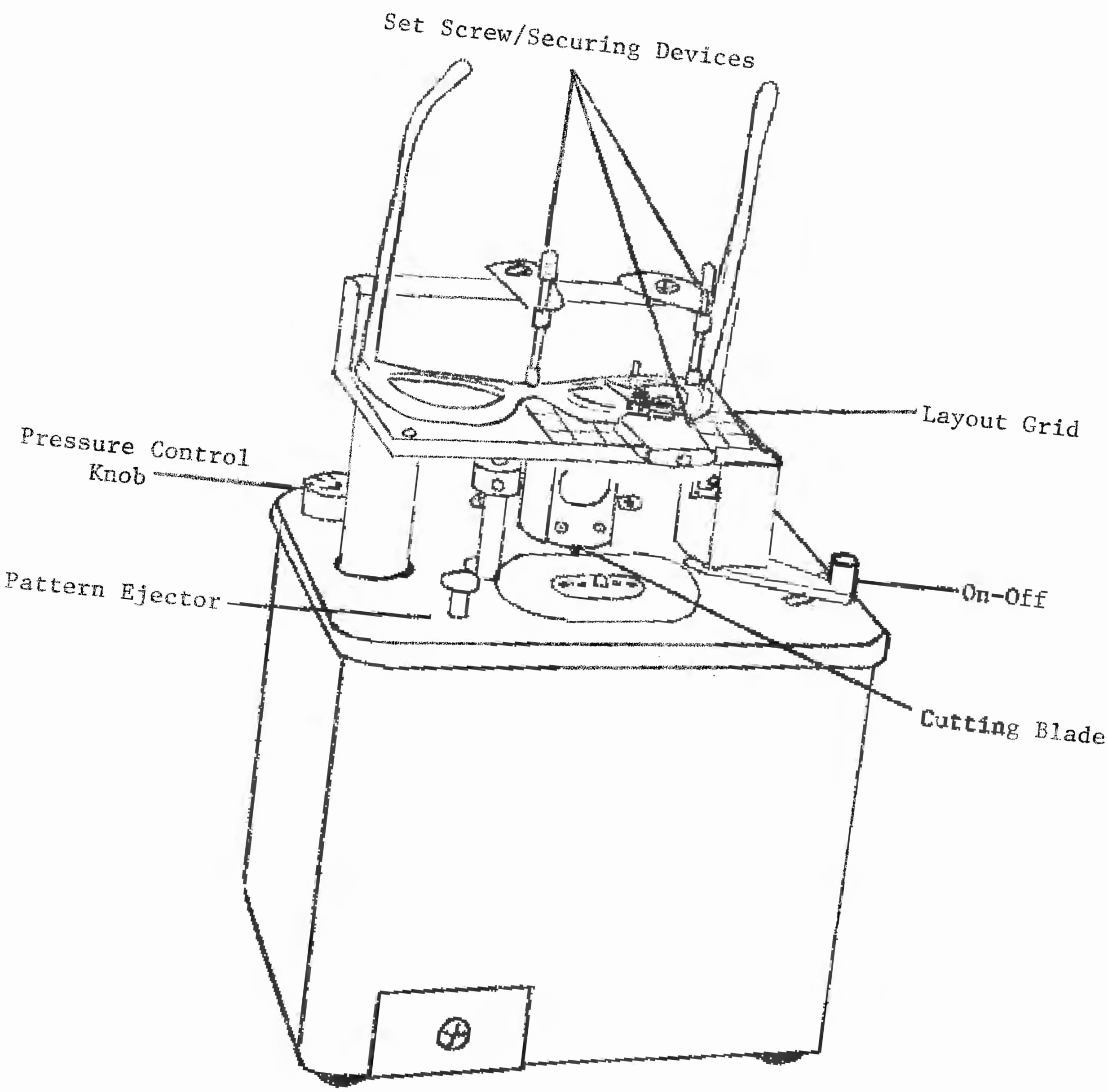
Automatic Pattern Maker

By far the most popular and widely used automatic pattern maker is the P-3 made by Novamatic (See Fig I-6) The Novamatic P-3 is simple to operate and any unskilled person can easily learn how to use it. It will cut a pattern to the exact eyesize of any frame in 30 seconds. A motor driven tracing stylus follows the contour of the eyewire as the pattern below is cut by a fine tooth saw blade to exact size. To operate the Novamatic pattern maker follow these steps. 1) Place the proper size pattern blank onto the machine. There are pattern holding pins similar to those on an edger so that the pattern fits securely. 2) Position the frame's right eye on the millimeter marked grid as described previously in hand pattern making. Secure the frame with the three set screw devices. (See Fig. I-7) 3) Place the tracing stylus inside the groove of the frame's eyewire and set the pressure control if needed, to make sure the stylus will stay in the groove while tracing and cutting the pattern. 4) Turn the machine on and the blade below will cut synchronously with the shape that the stylus traces. 5) When the pattern is completely cut remove it and file off any rough edges or burrs. When the pattern making process is complete, put the pattern and frame into the job tray so that the markup process can begin.

Spotting the MRP

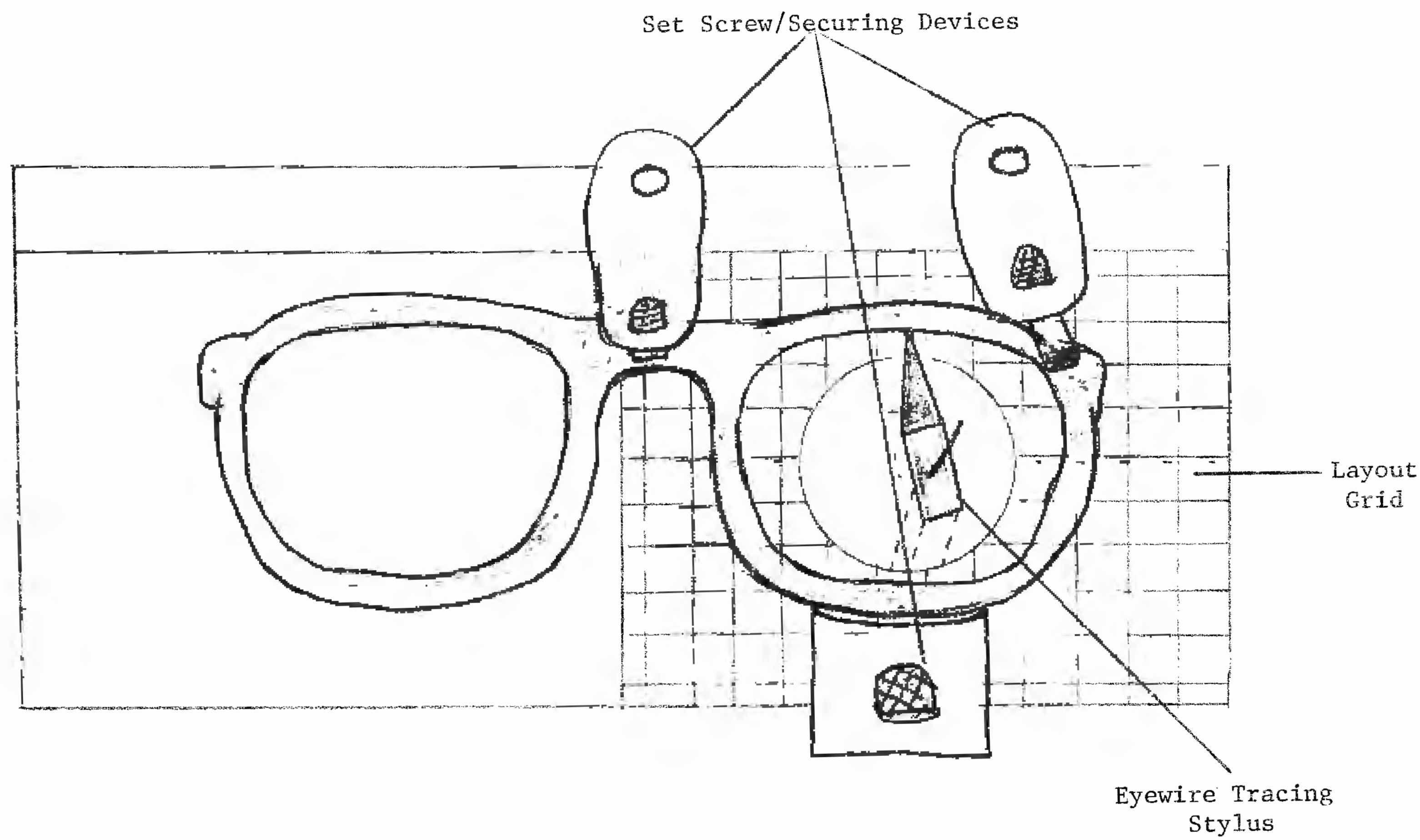
As this manual is written for our classmates in optometry school, there is no need to discuss or reiterate how to use a lensometer/vertometer. At this point one should be skilled and confident in the use of a lensometer/vertometer. If one needs a review on any aspect of lensometry such as how to spot the lens for prism, one should refer to class handouts on lensometry by Dr. Don O. Schuman. These handouts cover the subject thoroughly.

When the lenses have been inspected, the pattern made, frame selected, prescription edited, and decentrations calculated, one is ready to spot the MRP of each lens. If the prescription calls for no prism to be included,



Novamatic Pattern Maker

Figure I-6



Set Screw/Securing Devices
Layout Grid
Eyewire Tracing Stylus

Figure I-7

the optical center is spotted and this will be the MRP. If the prescription calls for prismatic correction then the lens is spotted for the prescribed amount of prism by using the lensometer reticule, thus the optical center is no longer the MRP. When the lens is spotted the convex side is faced toward the spotter. Three small ink dots are then spotted on the convex surface along the 180 degree line and are used for decentering and marking the cutting line. (See Fig. I-8) After the lens is spotted remove it from the lensometer, turn it over and label the concave side with a grease pencil using R for right and L for left. Be sure to keep the lens oriented properly for prism base out, base in, base up or base down. If one neglects this, the finished lens may read baseout instead of base in or base up instead of base down. Place the R or L label in the upper right or upper left hand corner for each lens. (See Fig. I-9) If a prism prescription is spotted, use RT for right top and LT for left top to insure that the lens is not flipped upside down, thus reversing the desired prismatic base orientation. Once this is accomplished the lenses are ready to be marked.

Marking the Lens

Before a lens is edged it must be marked. The lens is decentered and then marked with an ink line which serves as a reference point for use in blocking the lens. After being blocked the lens may be inserted in a bevel edger and cut, while maintaining the proper axis and shape of the desired finished prescription. Marking may be done with a protractor, ruler, and ink, or a lens marking device may be used. The latter is the preferred and most widely used method, with the A.O. Projecto Marker being the most widely used and well liked model for many years. (See Fig. I-10) It is still in wide spread use today in labs throughout the country. Devices called layout-blockers are replacing the Projecto Marker at the present time as both layout and blocking are accomplished with the one device. The layout-blocker will be discussed in the blocking section.

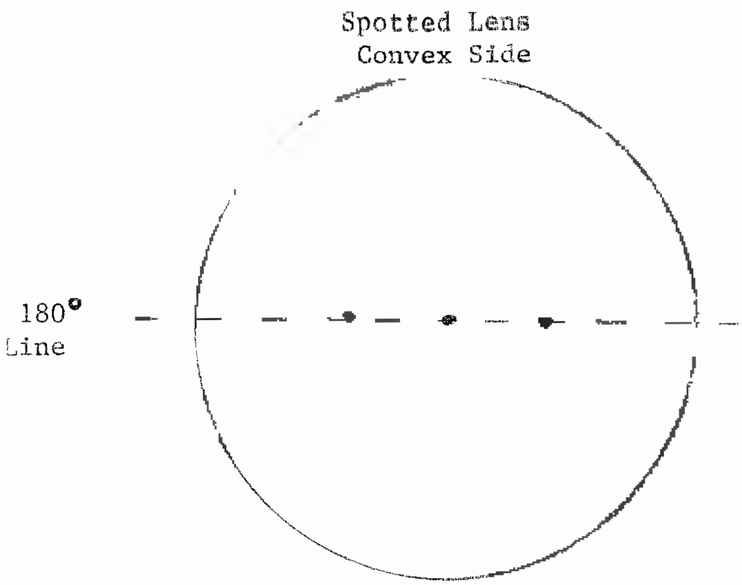


Figure I-8

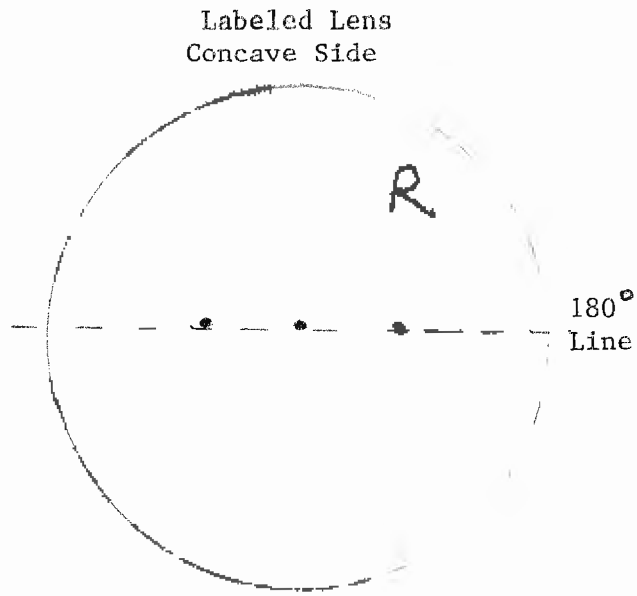


Figure I-9

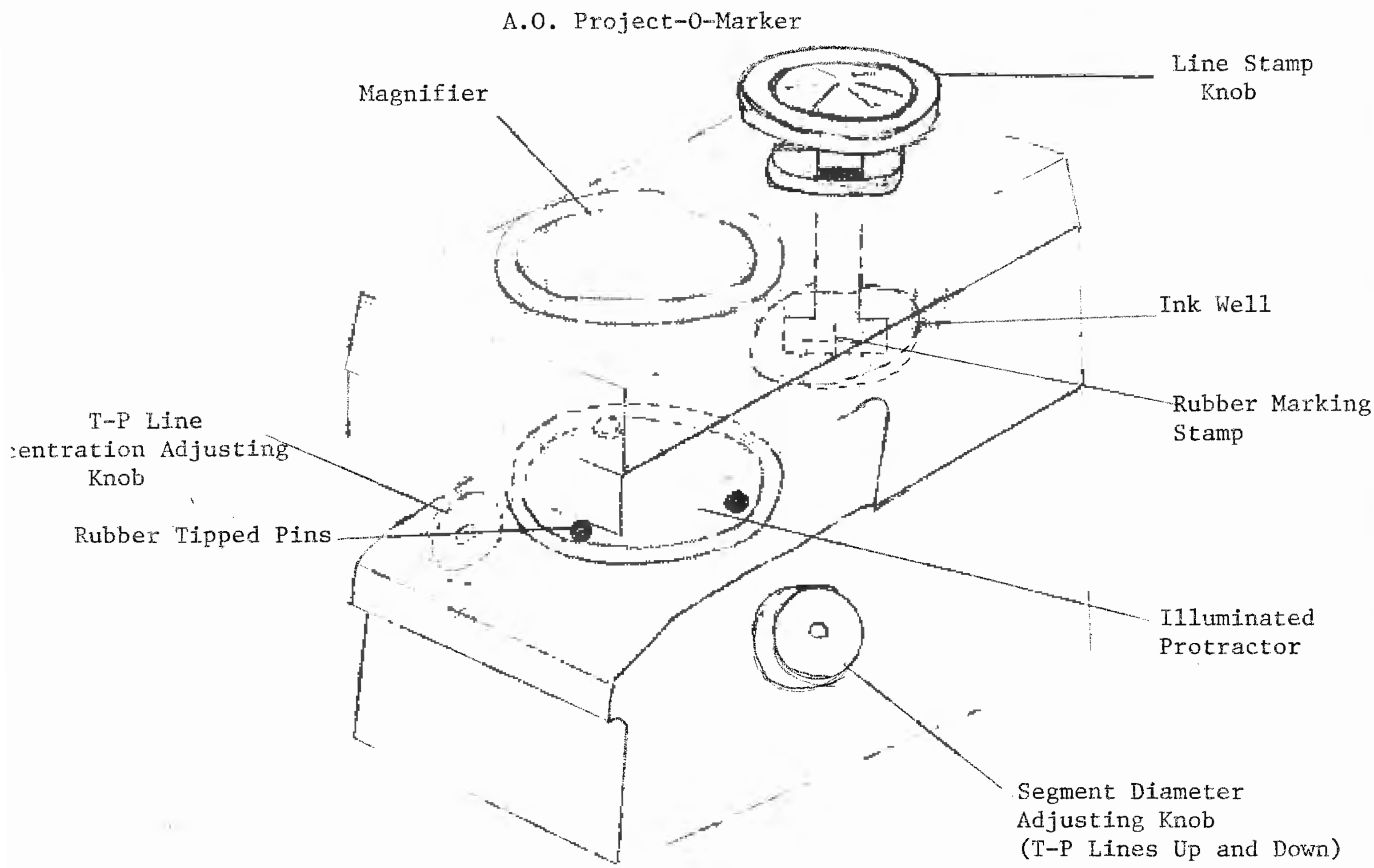


Figure I-10

The AO Projecto-Marker contains a protractor that is illuminated and magnified. (See Fig. I-11) To use the marker, the lens to be marked is placed concave side up (with the lens in proper orientation as discussed previously under spotting the lens) on the three rubber tipped pins. The lens is then decentered the proper amount as will be described shortly in a few examples. Once the lens is decentered, hold it in place with one hand and press down on the line stamp knob to depress the spring loaded plunger. A rubber marking stamp at the end of the plunger will contact an ink soaked felt pad in the ink well. Next, pull the knob back and the marking stamp and entire mechanism will be centered over the protractor's cross hairs. Finally, press down on the line stamp knob to mark the lens. (See Fig. I-12) The long ink line on the lens is called the cutting line. The point at which the short vertical line crosses the long horizontal line indicates the mechanical center* of the finished lens.

*Mechanical Center - that point on a lens around which the lens is cut and edged. The cutting line (cross hair) stamped on the lens is the mechanical center.

A couple of examples will be illustrated to explain the process.

Example 1

OD +2.00
OS +2.00
Frame: Cambridge by Universal
ES = 50mm DBL = 20mm ED = 53mm
FPD = 70mm PPD = 63mm

Since there is no prism in the prescription, the optical centers will be the MRPs. The decentration required for each eye is FPD-PPD so 70 - 63 = 7mm ÷ 2 = 3.5mm IN for each eye. The minimum blank size needed for each lens to cut out will be BS = ED + (2 x dec) + 1mm = 53 + 7 + 1 = 61mm therefore a 62mm uncut, finished lens blank would be used as this is the closest finished blank size manufactured.

The lenses have already been spotted and marked right and left with a grease pencil. Place the right lens on the three rubber tipped pins of the Projecto Marker concave side up with the top and bottom of the lens properly oriented. Make sure the three spotted ink dots on the lens are lined up or superimposed on the 180 degree line of the marker's protractor. The middle ink dot should be at the intersection of the crosshairs (the short 90 degree vertical line and the long 180 degree horizontal line).

For Right Lens

Decentration IN - slide the lens to the left
Decentration OUT - slide the lens to the right

For Left Lens

Decentration IN - slide the lens to the right
Decentration OUT - slide the lens to the left

In this example 3.5mm decentration IN is needed there fore slide the right lens 3.5mm to the left using the center dot as the reference. The long, horizontal, 180 degree line of the protractor is divided into separate millimeters by hashmarks. (See Fig. I-11)

Next, while holding the lens steady with one hand, use the other hand to depress the plunger to ink up the line stamping pad. Bring the plunger mechanism back and down to mark the lens with a cutting line. (See Fig. I-12) Repeat the process for the left lens only this time slide the lens to the right to decenter it. With both lenses marked, the next step will be to block them.

Example 2

O.D. - 0.50 - 0.50 x 180 = +2.00 ADD D-25 seg
O.S. - 0.50 - 0.50 x 180 = +2.00 ADD D-25 seg
Frame: Bronzini II
ES = 53, DBL = 19, ED = 55
FPD = 72, PPD = 64/60
Segment height = 19mm O.U.

These bifocal lenses are surfaced lenses received from a surface lab and thus it has been determined there that these blanks are large enough to cut out in the edging process.

The first step is to determine the amount of decentration for each lens. Since these lenses are multifocals one must use the near P.D. in order to correctly decenter the segments for nearpoint. Multifocals have an optical center in the distance portion as well as in the near segment. The surface labs take this fact into consideration while grinding the lenses. They also take the difference between far P.D. and near P.D. into effect. When grinding the lenses the distance portion's optical center is ground between 3.5 - 4mm above the top of the segment. This represents the average distance between the center of the pupil and the lower lid margin where the majority of segment tops are set on patients. The labs also will grind this same distance portion optical center 3 to 4mm (or the difference for each eye in mm between far and near P.D.) temporal to the horizontal mid-point of the segment where the near optical center is located. (See Fig. I-13)

First determine the amount of decentration required, both horizontally to properly place the segment for near P.D., and vertically to achieve the correct segment height.

For horizontal decentration subtract the patient's near P.D. (NPD) from the frame P.D. and divide by 2, FPD - NPD = 72-60 = 12 ÷ 2 = 6mm. Each segment must be decentered 6mm IN. We use the near P.D. because the segment's optical centers must be correctly placed for near viewing as the distance optical centers have already been ground in for far as previously described.

For determining vertical decentration, one must measure the longest vertical distance between top eyewire and bottom eyewire. Use a millimeter rule and measure ½mm into the eyewire at both top and bottom to account for the groove of the eyewire into which the lens bevel fits. For this particular frame the vertical or B dimension is 45mm. (See Fig. I-14)

Next divide the vertical measurement by two to find the vertical midpoint, thus 45 ÷ 2 = 22.5mm. The prescribed segment height was specified as 19mm o.u. therefore 22.5mm - 19mm = 3.5mm, thus the segment top must be decentered 3.5mm below the vertical dimension's midpoint.

To mark the right lens turn the decentration adjusting knob on the left side of the Projecto Marker to move the *T-P lines 6mm IN. Since this is a right lens move the center T-P line 6mm to the left (See Fig I-15).

Next place the right lens concave side up on the 3 rubber tipped pins with the top of the segment superimposed on the 180 degree line of the protractor with the small vertical 90 degree line bisecting the flat top of the segment. When this is done drop the segment top 3.5mm below the horizontal 180 degree line. There are lines parallel to the main horizontal protractor line above and below that are separated from each other by 1mm. The segment should also have T-P lines touching each side of it that are

*T-P lines - used for proper bifocal segment alignment, (See Fig. I- 11, Fig. 1-16.

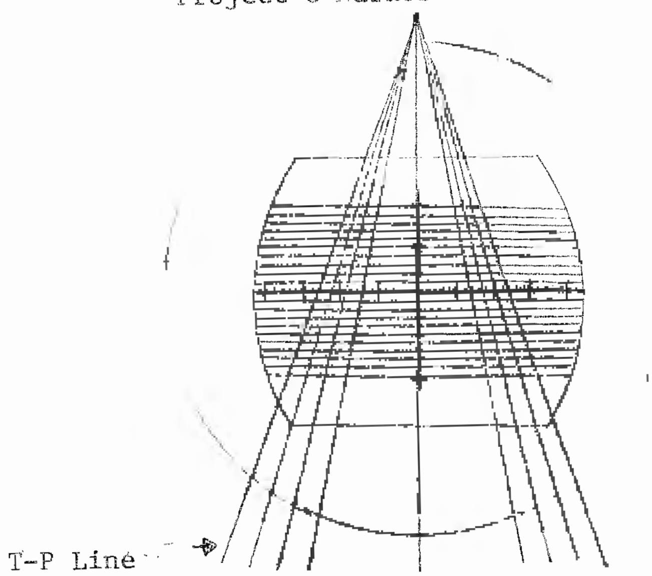


Figure I-11

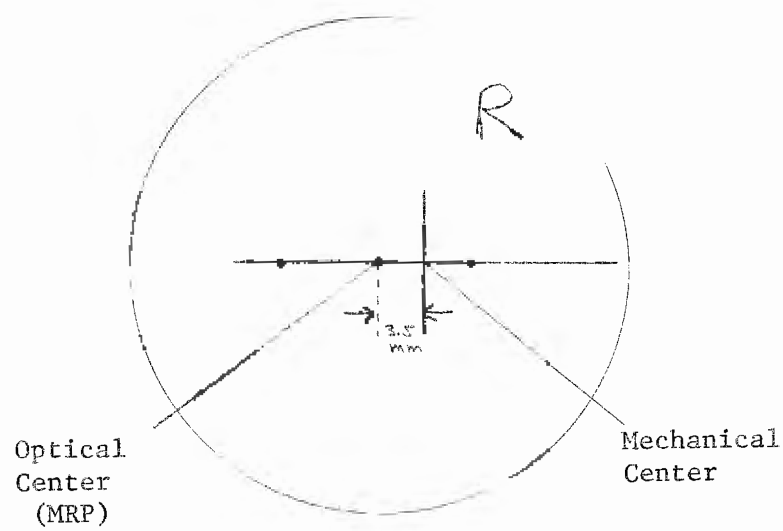


Figure I-12

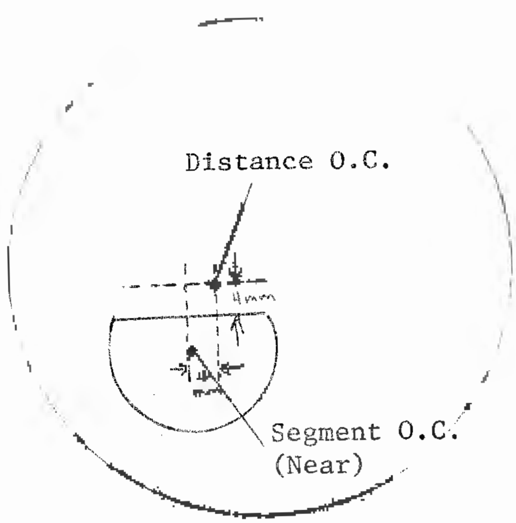


Figure I-13

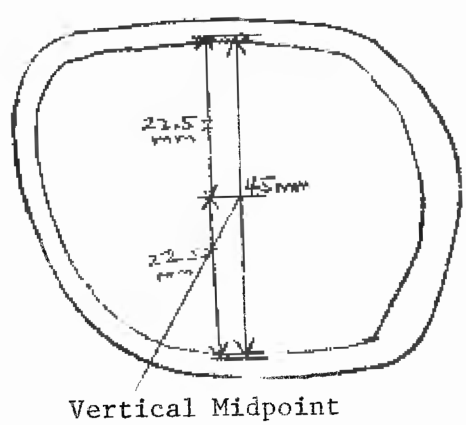


Figure I-14

mirror images of each other. The knob on the right side of the Projecto Marker will raise or lower the set of T-P lines to help center the segment accurately. (See Fig. I-16)

After the lens is decentered properly, mark the cutting line on the lens as described earlier in this section. To mark the left lens repeat the process but for decentration IN with the left lens move the center T-P line to the right 6mm. The marked lenses will then be ready to be blocked in the next step of the fabrication process.

References

1. Class Notes, Ophthalmic Dispensing Course, Dr. D.O. Schuman, 1981.

2. Class Notes, U.S. Army Optical School, 1976.

T-P Lines Decentered 6 mm IN for Right Lens Flat-Top Bifocal

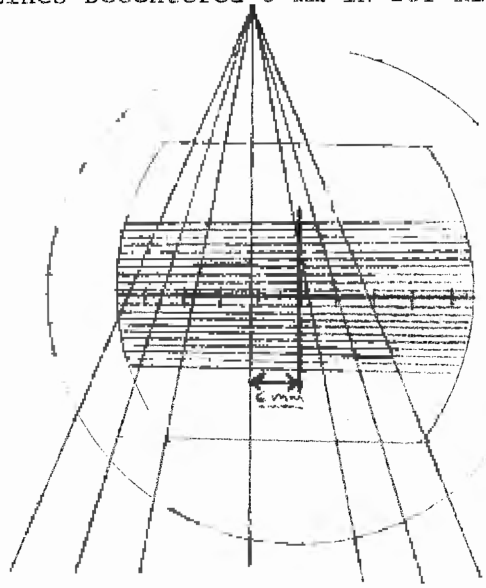
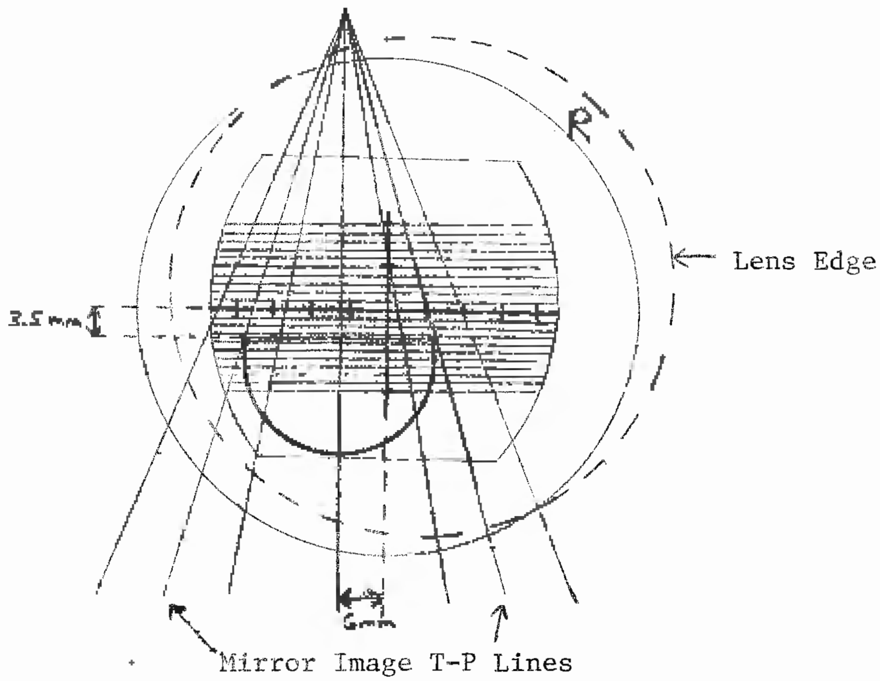


Figure I-15



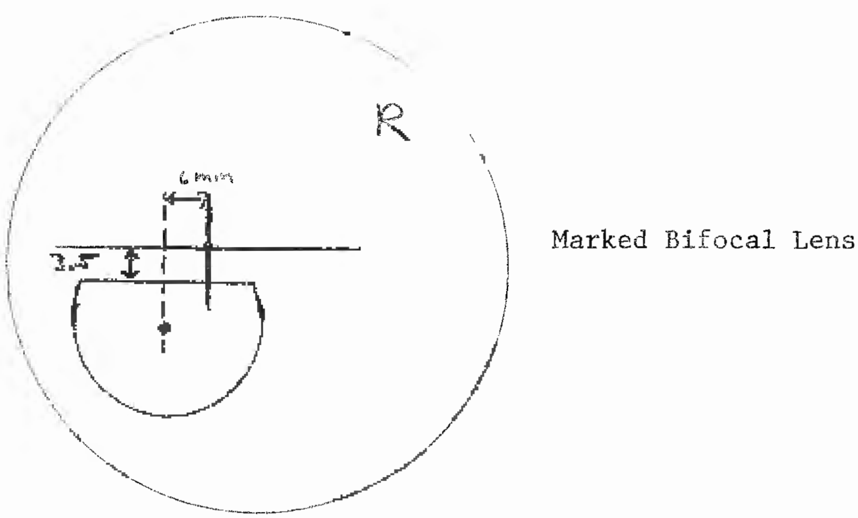


Figure I-16

Blocking
Section II

Blocking

After the lenses have been properly spotted, decentered, and marked, the next step in the fabrication process is for the lenses to be blocked. This means that metal blocks are attached to the lenses to prepare them to be bevel edged.

A metal block is attached to the convex side of a lens. The cutting line or 180 degree axis of the lens is aligned with the cutting line or 180 degree axis of the metal block. (See Fig II-1) This is to insure proper axis and shape of the cut and finished lens. The lens edging machine has a spindle with an adapter that is interchangable to allow one's blocking system to be compatable with the edging system. When the blocked lens is fit and secured in the bevel edger, the adapter at the end of the rotating spindle, the block, and the cutting line of the lens are all aligned at the same axis so that the lens is right on line to be cut for proper axis and shape. (See Fig. II-2)

There are two types of blocking systems. They are the Leap blocking system and the metal/alloy blocking system. The Leap system uses throw away adhesive pads to attach the blocks to the lenses. The metal/alloy system uses hot, liquid alloy that is molded into a block, cooled and hardened. The alloy blocks are attached to the lenses by means of a liquid spray which dries to form a surface for attachment.

Leap Blocking

The Leap blocking system is the simplest, cheapest, and fastest method of blocking a lens. The Leap blocking unit was developed and introduced by 3M. In this system of blocking, a two-sided adhesive pad is used to secure a metal block to a lens. The blocking unit consists of a plastic, box-like apparatus used to secure a block and to line up the cutting line of a block with the marked cutting line on a lens. In the center of the plastic unit is a circular indentation molded to the exact shape of the rear surface of a

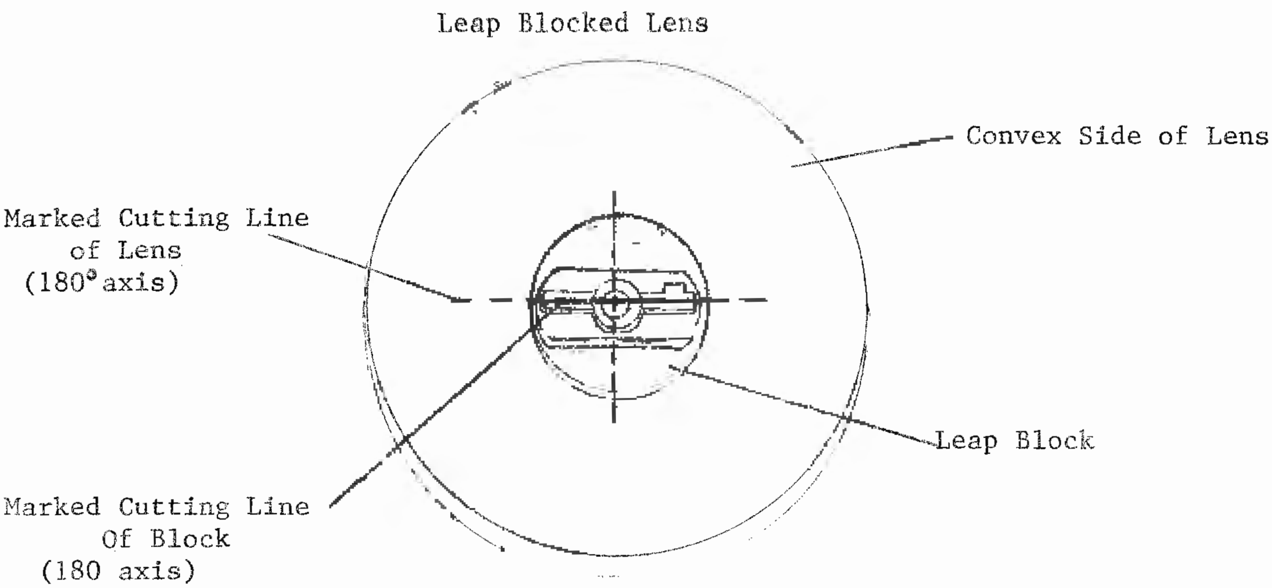


Figure II-1

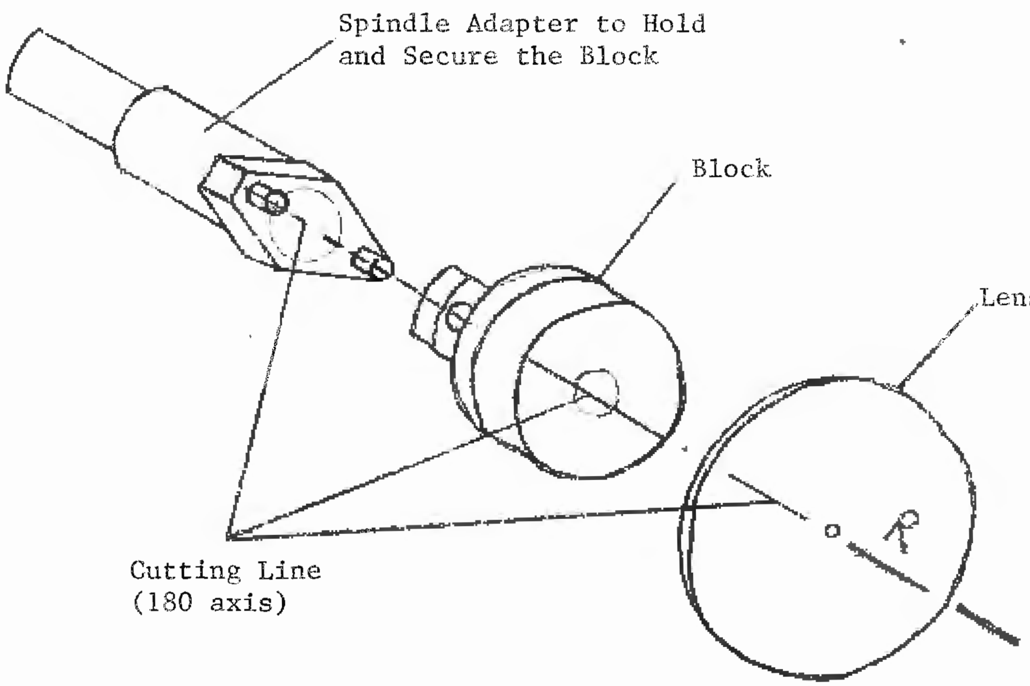


Figure II-2

Leap block. It perfectly matches the back of the block so that the block is securely held with it's cutting line exactly on the 180 degree axis. The plastic blocking unit has three illuminated pinhole lights along an impregnated cutting line at the 180 degree axis. (See Fig.II-3) The pinholes of light are located at the exact geometric center of the block impression as well as right and left sides. There is a hole in the center of each block that allows the tiny spot of light to be seen so the crosshairs of a marked lens may be accurately centered on the block. The other two lights are used to insure that the marked cutting line of the lens is lined up with the 180 degree axis of the block.

The procedure is to turn on the Leap blocking unit which will illuminate the aligning lights. Next, insert a metal Leap block. It can fit in only one way. The back of the block fits snugly into an exact mold indentation in the blocking unit. When this is accomplished, the cutting line of the block is aligned exactly with the imprenated 180 degree axis line on the unit, with the center illuminating light shining through the hole in the metal block. Take a 3M Leap adhesive pad and remove the protective paper backing from one side. Place it on the convex side of the lens with the crosshairs of the marked line centered in the hole of the pad. (See Fig. II-4) Press down with the thumbs so that the pad is sticking securely to the lens. Next, remove the protective paper cover on the other side of the pad. Turn the lens around so that the concave side faces out with the top, bottom, right, and left sides of the lens oriented correctly. Hold the lens directly over the blocking apparatus at approximately one inch. One must superimpose the crosshairs of the lens on the pinhole of light shining through the block in the Leap unit. At the same time, align the pinhole lights on the right and left sides with the marked cutting line on the lens. Take adequate time and when this is accomplished, slowly lower the lens closer to the block. Realign at approximately one fourth inch and slowly lower the lens onto the

Leap Blocking Unit With Block In Place

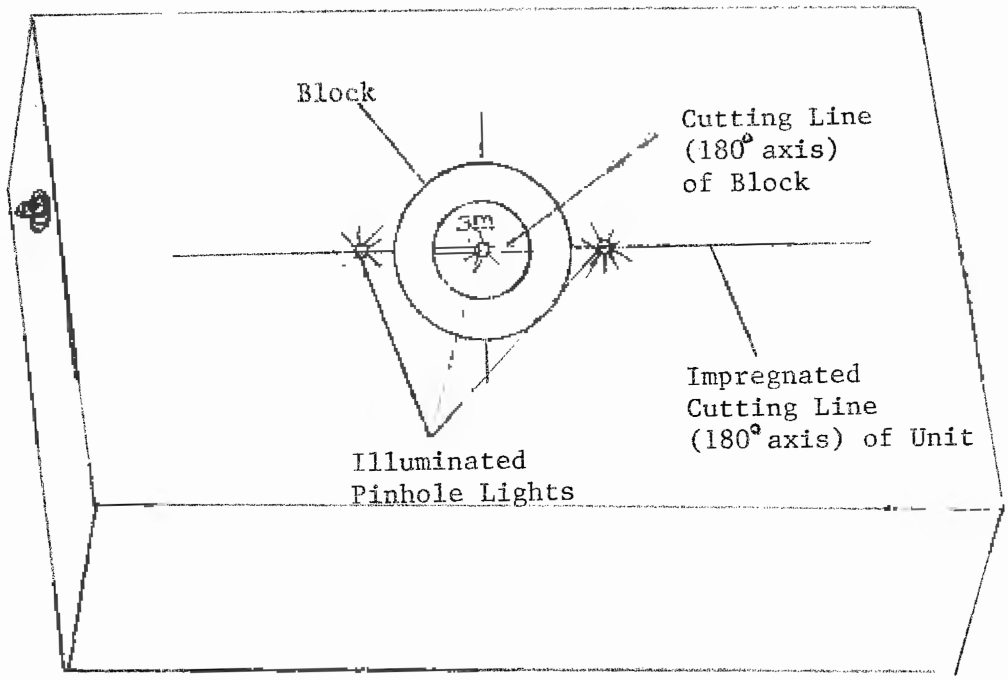


Figure II-3

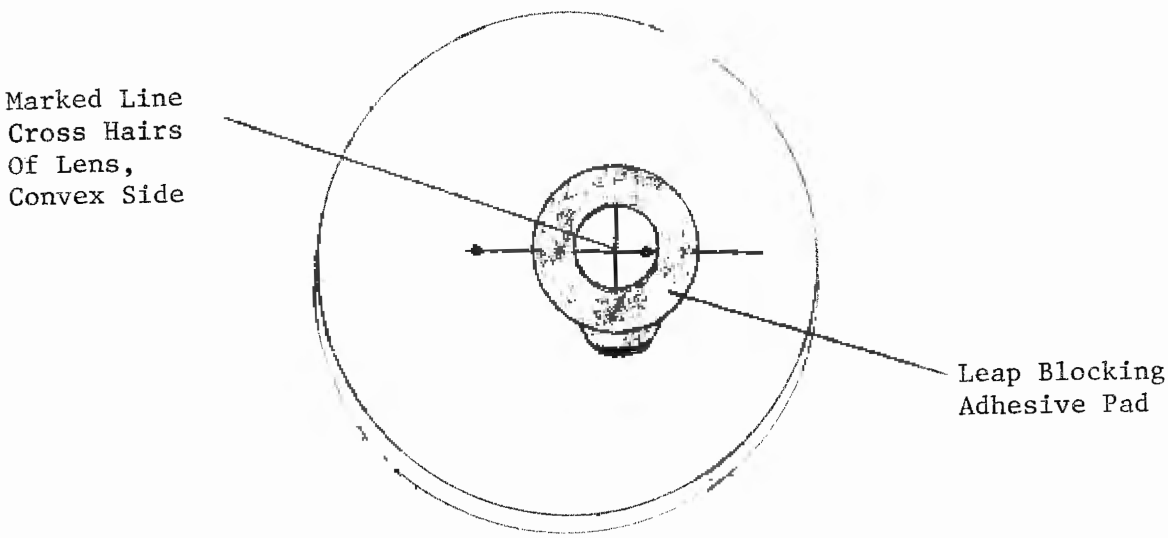


Figure II-4

block. The adhesive pad will stick to the block. With the thumbs, press on the lens to firmly secure the block to the pad. Remove the blocked lens from the unit and again press the block firmly against the lens. The blocked lens is ready to be cut and edged.

Note: With the early Leap system there was a problem with the adhesive pads not securing the block to the lens adequately, thus sometimes resulting in slippage of the lens during edging. This resulted in significant errors in lens axis. This has been remedied with research and testing so that with today's pads the problem has been almost totally eliminated. Leap blocking is now widely used in optical laboratories.

Alloy Blocking

Alloy blocking differs from Leap blocking in that the lens is centered and aligned on a lens centering fork. The lens centering fork has a plastic grid for centering the marked, cutting line crosshairs and a rubber mold that forms the shape of the alloy block. Once the lens is centered and aligned the apparatus is flipped over and inserted in the blocking unit. A hole in the rubber mold lines up under the unit's automatic electric metal alloy dispenser. The unit contains an electric melting pot to change the metal alloy to liquid form at 135 to 158 degrees fahrenheit. A button is pushed and a precise amount of liquid metal alloy is dispensed into the rubber mold of the lens centering fork. The alloy cools in a couple minutes to form a cold alloy block attached to the lens and ready to edge. This unit is one of the simplest and cheapest alloy blockers made. AIT produces one called the AIT 355 and A.O. used to make a similar model. (See Fig. II-5)

To block a lens with the alloy unit, one must first coat the convex side of the lens with a liquid lens coating that will dry and form a surface to which the metal alloy will attach securely. This spray can be ordered from an optical supply company and sometimes goes by the name Hydrosol. It is a clear, sticky, glue-like substance that dries quickly and washes off easily.

A.I.T. 355 Alloy Blocking Unit

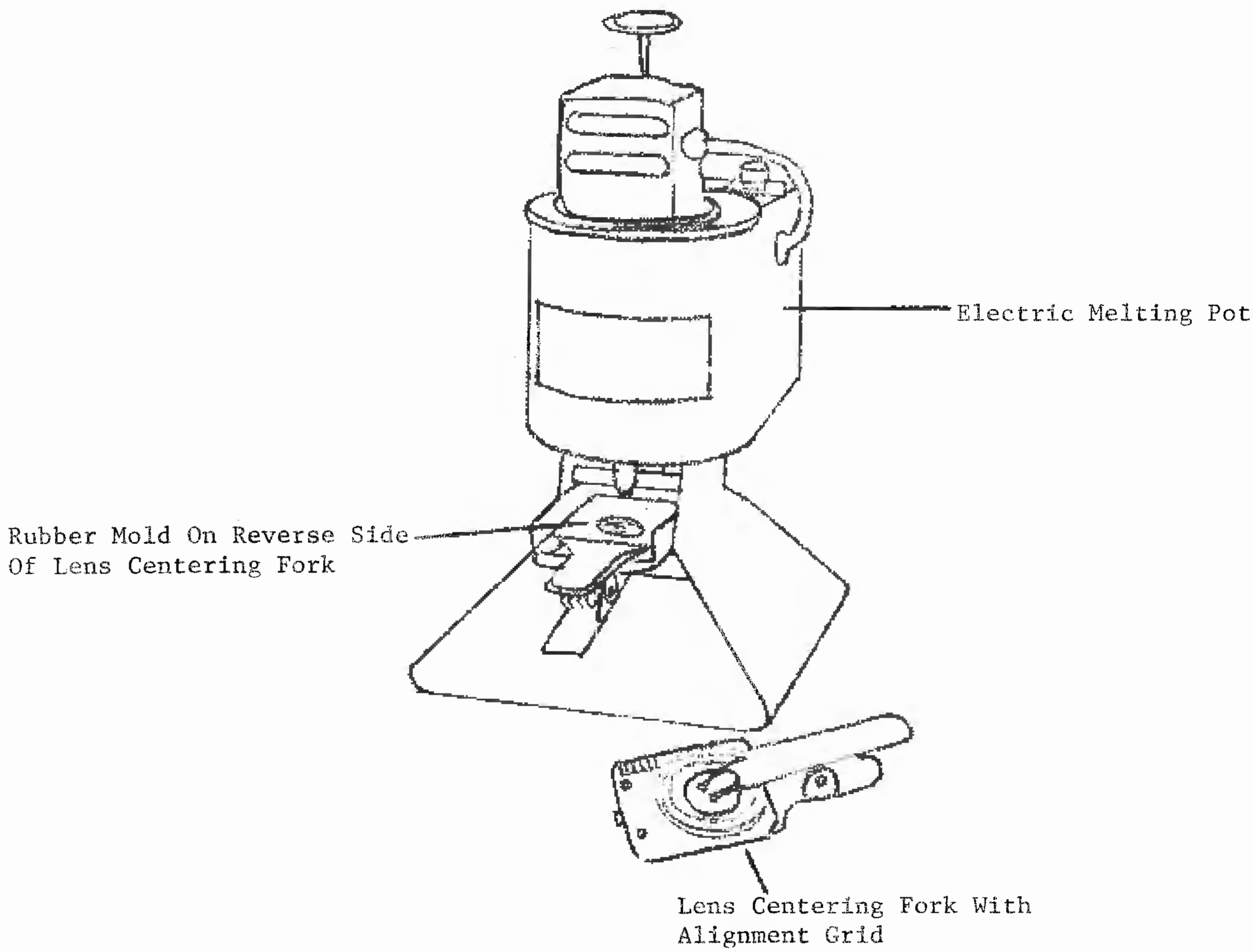


Figure II-5

We do not recommend purchasing an alloy unit due to the development of Leap blocking. Some reasons for this are, 1) even the simplest alloy blocking unit as described previously will cost much more than a Leap unit, 2) the metal alloy, even though recyclable is very expensive, and 3) a deblocking unit must be purchased to melt the alloy block from the lens in order for the alloy to be recycled.

Layout Blockers

Many backroom labs are changing to layout blockers. A layout blocker is a unit that performs both the layout and blocking procedures all with one unit. The units do not require the lens to actually be marked as described in the markup section with the AO Projecto Marker. The decentering and alignment system is similar to that in the AO Projecto Marker. The lens is placed on a clear, movable platform with an illuminated, easy to read layout protractor beneath it. However, instead of moving the lens as with the AO Projecto Marker, the lens is set over the protractor with the center ink dot of the lens set at the center of the crosshairs and the two lateral ink dots aligned on the 180 degree axis. The units have vertical and horizontal decentration knobs which are adjusted to proper decentration for single vision and multifocals. The platform moves while the protractor target remains stationary. Once the proper decentration is achieved the lens is ready to be blocked. The blocking system is aligned with the crosshairs of the protractor. The blocking systems are 3M Leap. The block with an adhesive pad stuck to it is inserted into the chuck holder of the unit. A blocking lever is pulled bringing the block down on the decentered lens, thus the lens is blocked without having to be actually marked. Many units have another feature in that finish size patterns can be aligned on a special sliding platform and their shadow's superimposed on the lens being layed out, thus it can be quickly determined if the lens will cut out. These units lay out and block easily and quickly and contain an illuminated, binocular reflection, viewing system that eliminates segment distortion and parallax. (See Fig. II-6)

References

1) A.I.T. Product Literature; Schaumburg, Illinois, 1983.
2) Class Notes, U.S. Army Optical School, 1976.

A.I.T. Layout Blocker

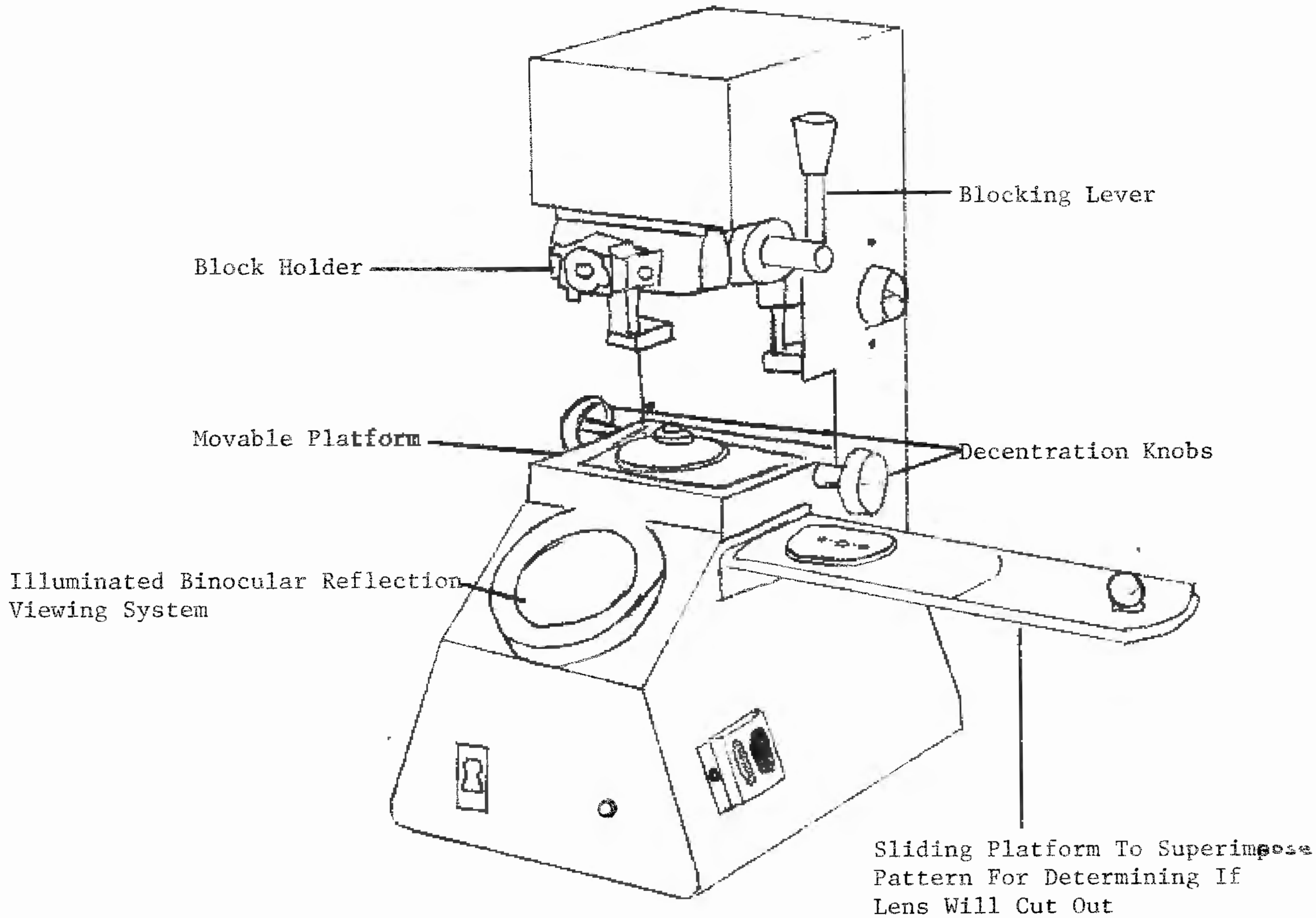


Figure II-6

Machine Edging
Section III

Introduction to Edging

First of all, let's clarify the difference between the terms "edging" and "hand-edging". The term edging is often used in a generic sense to mean the whole finish lens fabrication process. For example, one optometrist may say to another, "Do you have your own edging lab?", or, "Do you do your own edging?". The term edging actually means the process of cutting a lens down to size using an automatic diamond bevel edger. Hand edging is a separate operation which involves removing glass by hand on a diamond handstone much like a bench grinder found in the garage. Both edging and hand-edging require skill and practice.

Edging is often regarded as being one of the most difficult of the various tasks involved in finish lens fabrication, due to the fact that lots of lens spoilage can occur here. Most spoilage occurs due to operator error rather than machine error. Common operator errors include: 1) setting the machine size too small resulting in a lens that is too small to fit the frame, 2) using the wrong pattern resulting in a lens that is the wrong shape, 3) putting the pattern on backwards resulting in a right eye lens instead of a left eye lens, or vice-versa, 4) failure to re-set the bevel guide after each lens may result in a bad lens bevel that cannot be repaired, and 5) flaking and chipping the lenses when sizing the lenses to the frame. ("Sizing" is the technique of comparing the size of the lens to the frame-more about this later.) Common machine errors include 1) lenses may break spontaneously during the edger operation, or 2) lenses can be ruined if the machine is not level or has worn parts. Keep in mind that most, if not all these problems can be eliminated by establishing a systematic sequence of operating techniques and applying that sequence every time you edge a lens. The actual edging procedure is the same for single vision, bifocals or trifocals - it makes no difference, other than the fact that multifocals cost more and therefore you may want to be extra careful. Edging and hand-edging are not skills that can be learned overnight - it takes practice! At first you may want to practice with some sample lenses before attempting to edge your patient's Rxs.

Introduction to Bevel Edgers

Before the development of the automatic edger, beveling was accomplished with a handstone and the process was very slow. Automatic bevel edgers only require the operator to insert the lens blank, put on the appropriate pattern, and set the machine size. From that point on, the edging operation is automatic. Automatic bevel edgers have two diamond wheels- the roughing wheel grinds off most of the excess glass (to within two millimeters of the finished size) and the "V" wheel (fine wheel) cuts the lens down to the exact size while simultaneously putting the correct bevel angles on the edge of the lens. (See Fig. III-1)

There are two basic types of automatic bevel edgers - those with a stationary head and those with a floating head. In the stationary head type, the bevel on the lens must be adjusted for every lens of different base curves. In those with a floating head, the head of the machine will float so that the bevel is accomplished with no adjustments made during the operation of the machine. In this text we will only consider edgers with floating heads because they are the type most commonly found in smaller operations. Edgers with fixed heads are more common in the big optical labs, and in recent years even the big labs are using more and more edgers with floating heads because of their ease of operation and maintenance. We have chosen the AIT Mark V diamond bevel edger for our discussion. This is the most popular edger found in small labs and optometric practices, and is one of the easiest to use and learn on. However, keep in mind that edging is like refracting - once you've learned how to do it, it doesn't matter what kind (brand) of machine you are using, even though the knobs and controls are different.

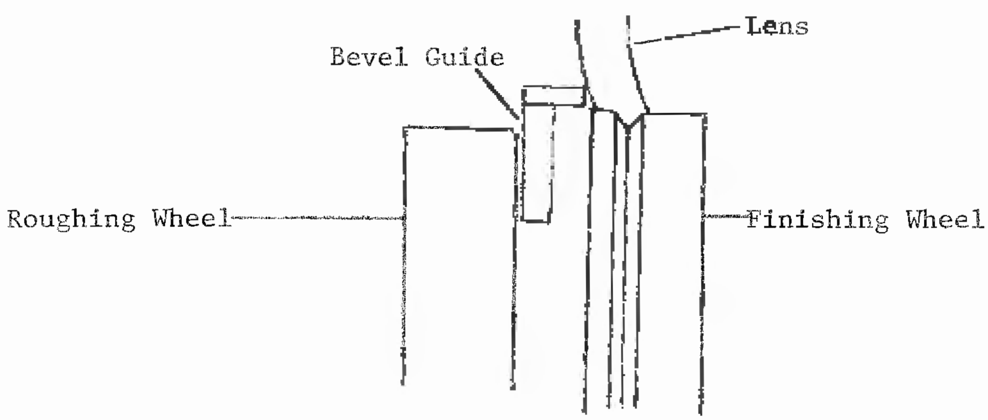


Figure III-1

Machine Set-Up

If you purchase a new edger from the factory, the factory representative will come to your office and set the machine up for you. However, if you buy a used edger you will need to know how to set the machine up yourself, and the following discussion is devoted to that topic.

Figure III-2 shows the Mark V with its major features and controls. The machine can be bench or cabinet mounted and requires about two square feet of space, plus enough room underneath for a coolant tank about the size of a ten gallon bucket. The bench must be of solid construction, and sufficient clearance is necessary to operate the lens clamping handle and to allow approximately three inches of lateral movement. If the space proves adequate, trace the outline of the machine base on to the bench and remove the machine from the bench. Place the rubber mat (supplied with the machine) within the prescribed outline and use it as a pattern to trace the cutout on to the bench. Remove the mat and cut a six inch by six inch hole through the bench top. A one-half inch hole must be drilled for the coolant feed tube, approximately five inches to the rear and eight inches from the right side of the machine. Place the rubber mat on the bench and then place the machine on top of the rubber mat.

Next the coolant system must be connected. It consists of a coolant feed hose, a pump, and a tank (bucket). The coolant resides in the tank and is continuously pumped up to the grinding wheels when the machine is operating. The coolant, along with all the ground glass then drains down the drain tube back into the tank. Once in the tank, the ground glass settles to the bottom and the coolant is then pumped back up to the machine. (See Fig. III-3) The coolant feed tube and coolant drain tubes must be connected to the edger with suitable clamps. The coolant feed tube is 3/8 inch plastic tubing and the drain tube is 1¼ inch plastic tubing. The feed tube is connected to the brass fitting located on the back of the machine, and then to the fitting on the bottom of the submersible pump (use a clamp here

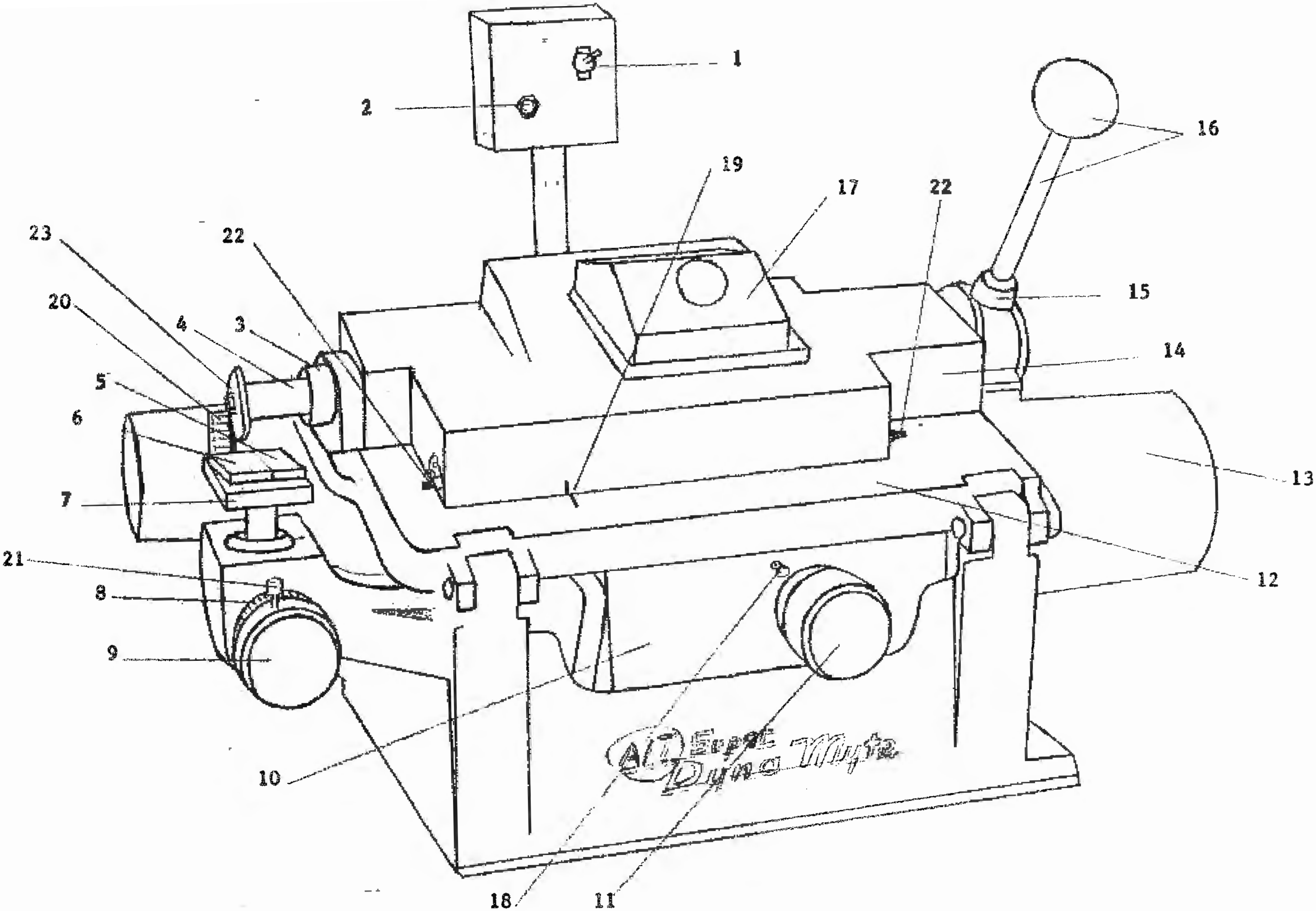


Figure III-2

1. Master "On-Off" Switch
2. Push Button Switch
3. Axis Adjuster
4. Former Chuck
5. Finishing Wear Plate
6. Roughing Wear Plate
7. Clapper Switch Plate
8. Sizing Dial
9. Sizing Dial Knob
10. Base Float
11. Bevel Control Dial
12. Float Carriage
13. Wheel Drive Motor
14. Floating Head
15. Cam Lock Assembly
16. Lens Locking Handle
17. Hinged Cover
18. Grease Fitting
19. Leveling Lines
20. Vertical Scale
21. Thumb Screw
22. Float Adjusting Set Screws
23. Pattern

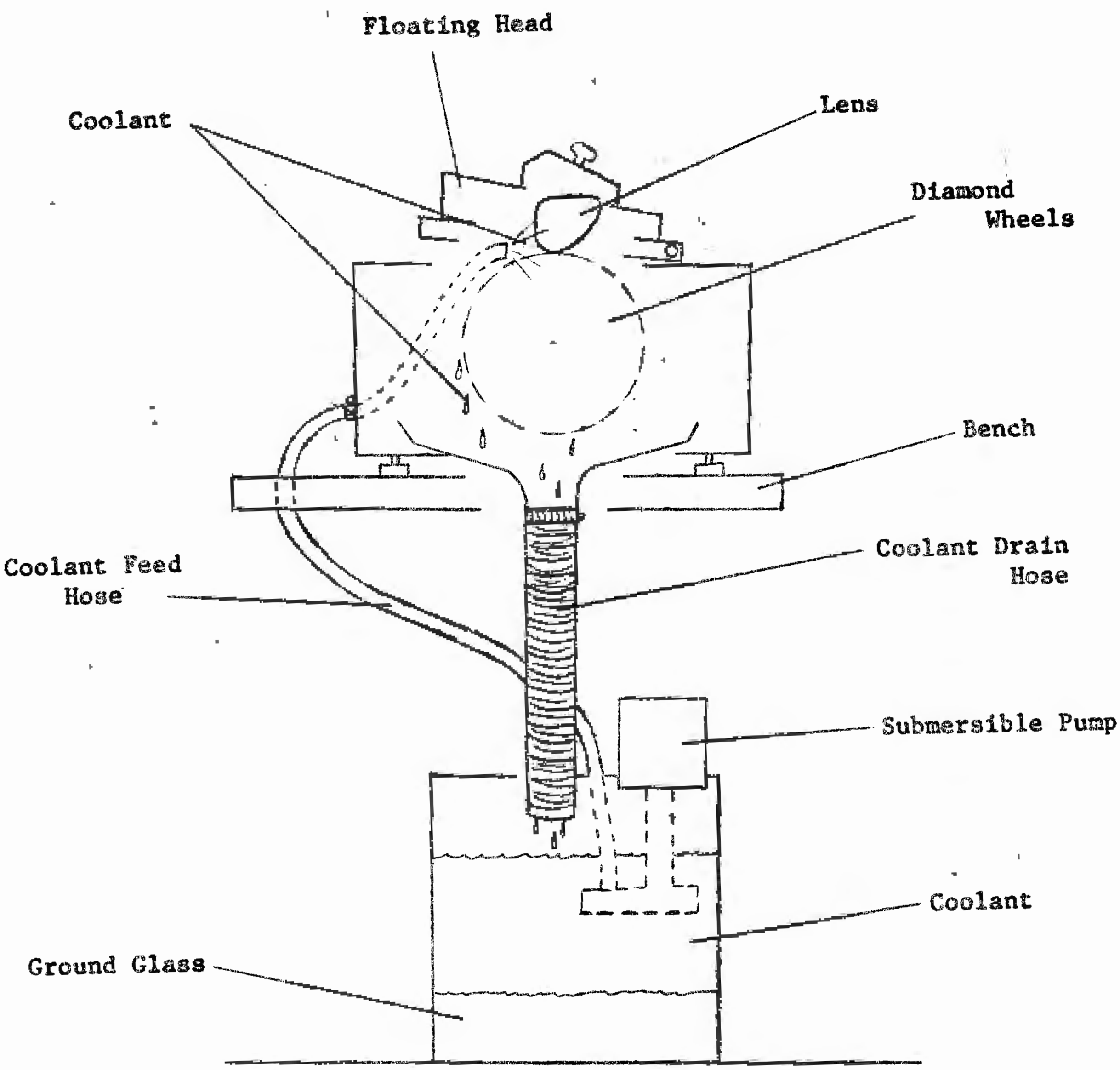

Floating Head
Coolant
Lens
Diamond Wheels
Bench
Coolant Drain Hose
Coolant Feed Hose
Submersible Pump
Coolant
Ground Glass

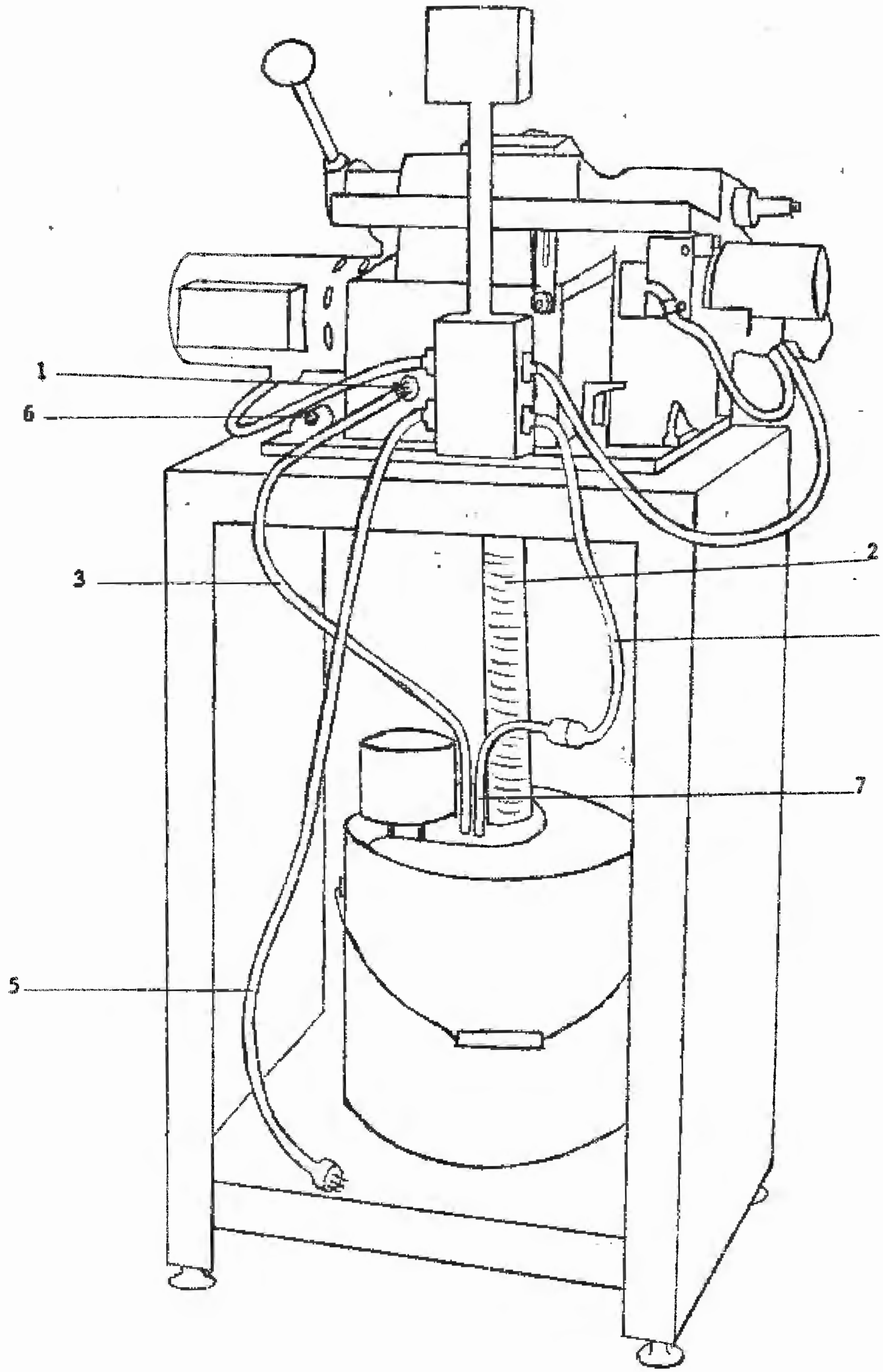
Figure III-3

also). The drain hose should be cut to a length which would be four inches from the bottom of the tank. A plastic garbage can liner is used to line the tank and should overlap the edge by about two inches. Pour 1½ quarts of coolant concentrate (available from AIT) into the tank, and fill with water to a level within one inch of the top (~ 3.5 - 4.0 more quarts). (Note: as a rule of thumb, coolant should be approximately a 1/3 coolant 2/3 water mix). The submersible pump hangs into the tank by means of a metal bracket attached to the pump and hanging to the edge of the tank. Place the lid on the tank and be sure that the hose connections or any electrical connection does not in any way hamper the free movement of the machine. With the master switch in the off position, plug the cord into a 110 volt electrical outlet. Figure III-4 shows a rear view of the MARK V, cabinet mounted with all the hose and electrical connections.

Machine Leveling

The machine must be level in order for its operation to be smooth. If it is not level, the lens, in its movement from the roughing wheel, will not properly make its entrance into the "V" wheel (bevel wheel), and could possibly fall in between the diamond wheels resulting in lens breakage. To level the machine, place any pattern on the former chuck (refer to Figure III-2). Start the machine by pushing the master toggle switch to the on position, and start an edging cycle by depressing the push-button switch immediately to the right of the toggle switch. The floating head will lift up and lock itself into the roughing cycle. At this time, scribe a pencil line on the float and an adjacent line on the carriage (Figure III-2). After thirty seconds from the start of the cycle, the float and carriage will once again lift up and move to the right, into the finishing cycle. At this time, the lines should remain adjacent to one another. If the lines are not adjacent, you must adjust the leveling screws to bring the machine to a level position. Repeat this procedure until the lines scribed on the float and carriage remain adjacent. With the machine properly set up and leveled, you are now

Figure III-4



1. Brass Fitting
2. Drain Hose
3. Coolant Feed Hose
4. Coolant Electric Cord
5. Three Prong A.C. Cord
6. Counter Balance Adjustment
7. Pump Electric Cord

ready to begin edging.

Edging

The standard bevel edger is equipped with two six inch diamond faced grinding wheels. Each lens is first ground on the flat (roughing) wheel which has a coarse diamond grit surface. This wheel will rapidly reduce the lens to a size that is approximately two millimeters larger than the finished eyesize. The edger automatically moves the lens from the flat wheel to the "V" bevel wheel which reduces the lens to the finished size while simultaneously placing the bevel on to the edge. The finished size is controlled by adjusting the sizing dial to the desired setting, and the shape of the lens is controlled by the pattern which is placed on the former chuck at the left end of the shaft in the float carriage.

There are 6 basic steps involved in edging a lens:

1) placing the lens (with block) into the machine
2) placing the pattern in
3) setting the size
4) setting the bevel guide
5) running a cycle
6) sizing the lens

1) Placing the lens into the machine is a relatively simple process, since the lens block will only fit into the chuck one way and one way only. There are several different types of lens blocks available with the Leap blocking system, and you must make sure that the block you are using matches the chuck on your edger. Also, you as the operator of the edger, should be critical on making sure that the lens is blocked properly - it could be mistakenly blocked upside down. If you are planning to cut a right eye lens, you must be sure that you are putting the right eye lens and block into the machine - not the left eye lens. To avoid confusion, ALWAYS CUT THE RIGHT EYE FIRST, THEN THE LEFT. After you have finished cutting the right eye, PLACE THE RIGHT EYE LENS IN THE RIGHT SIDE OF THE LAB TRAY, then begin cutting the left. RETURN THE LEFT EYE LENS TO THE LEFT SIDE OF THE LAB TRAY.

The lens (and block are placed into the chuck with your left hand, while your right hand pulls the lens locking handle toward you until the felt pad of the lens clamp presses against the lens. (Fig. III-5) Apply moderate pressure with the lens locking handle, and then twist the locking handle knob to the right to lock the locking handle and lens in place. Too much pressure on the lens may crack it, while not enough pressure may allow the lens to slip and even break loose from the block. It will take a few tries to get a feel for how much pressure to apply.

2) The pattern fits onto the former chuck at the left side of the machine. The two small holes in the pattern should fit snugly onto the two pins of the former chuck to insure that the pattern does not come off or wobble during the cutting cycle. Patterns wear after they are used over and over again, and if it does not fit good and snug, make a new pattern. If cutting a RIGHT EYE LENS, THE NASAL END OF THE PATTERN ALWAYS GOES TOWARD THE OPERATOR. If cutting a LEFT EYE LENS, THE NASAL END OF THE PATTERN ALWAYS GOES TOWARD THE BACK OF THE MACHINE. (Fig. III-6)

REMEMBER: You will be using the same pattern to cut both the right and left lenses, and therefore after you are done cutting the right lens, you must turn the pattern around to cut the left lens. Otherwise you will end up with two right eye lenses! This is one of the most common operator errors resulting in lens spoilage.

3) Setting the size. Lens size is controlled by adjusting the calibrated dial of the sizing control (sizing dial knob-(Figure III-2). Each short graduation line on the sizing dial is calibrated to equal ¼ millimeter; each long line is 1 millimeter, numbered from one through nine. One complete revolution of the sizing dial is ten mm. There is also a vertical scale calibrated from 3 (30mm) to 7 (70mm). To determine the eyesize setting , read the vertical scale and add the number indicated on the sizing dial. As an example, of you wanted to set the size at 38mm, you would turn the dial until the pointer on the vertical scale is between 3 and 4.

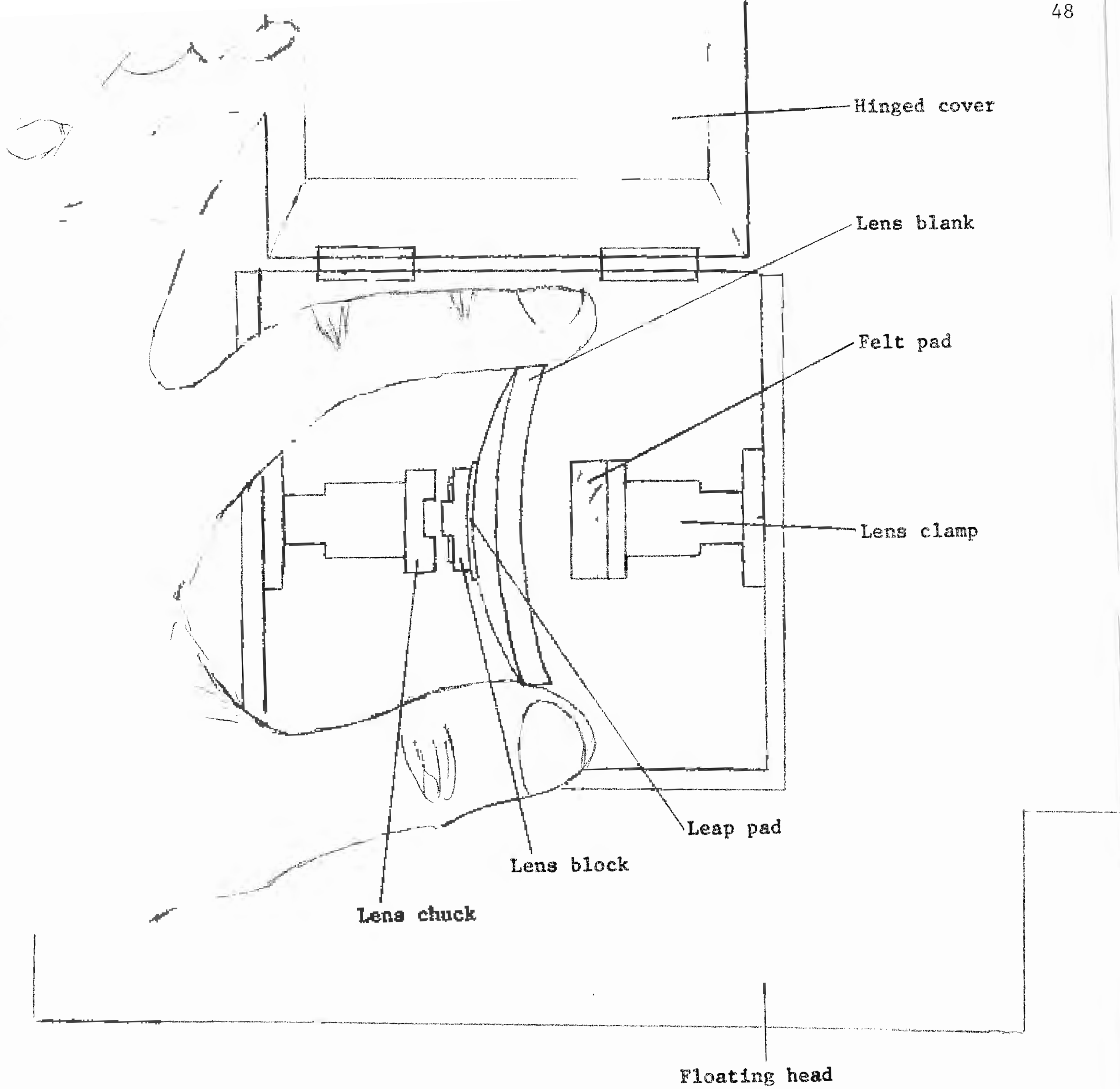

Hinged cover
Lens blank
Felt pad
Lens clamp
Leap pad
Lens block
Lens chuck
Floating head

Figure III-5

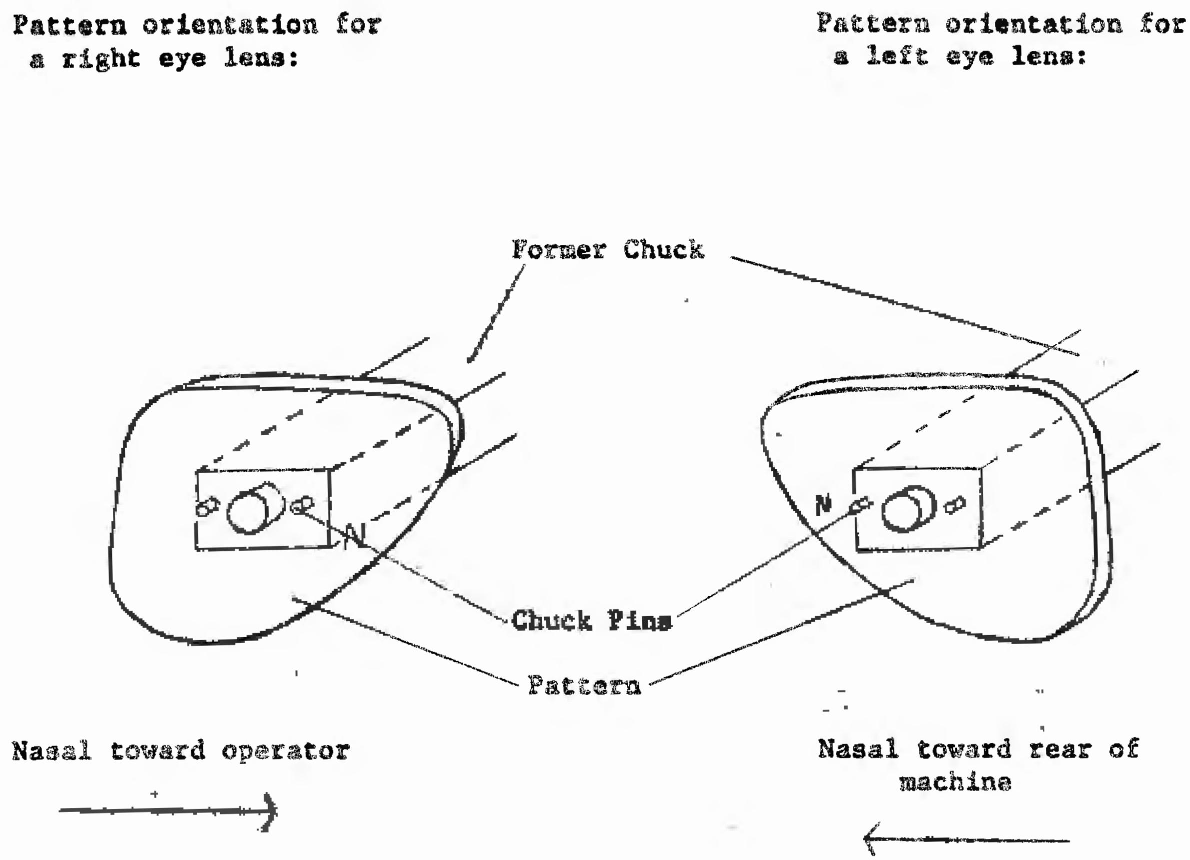
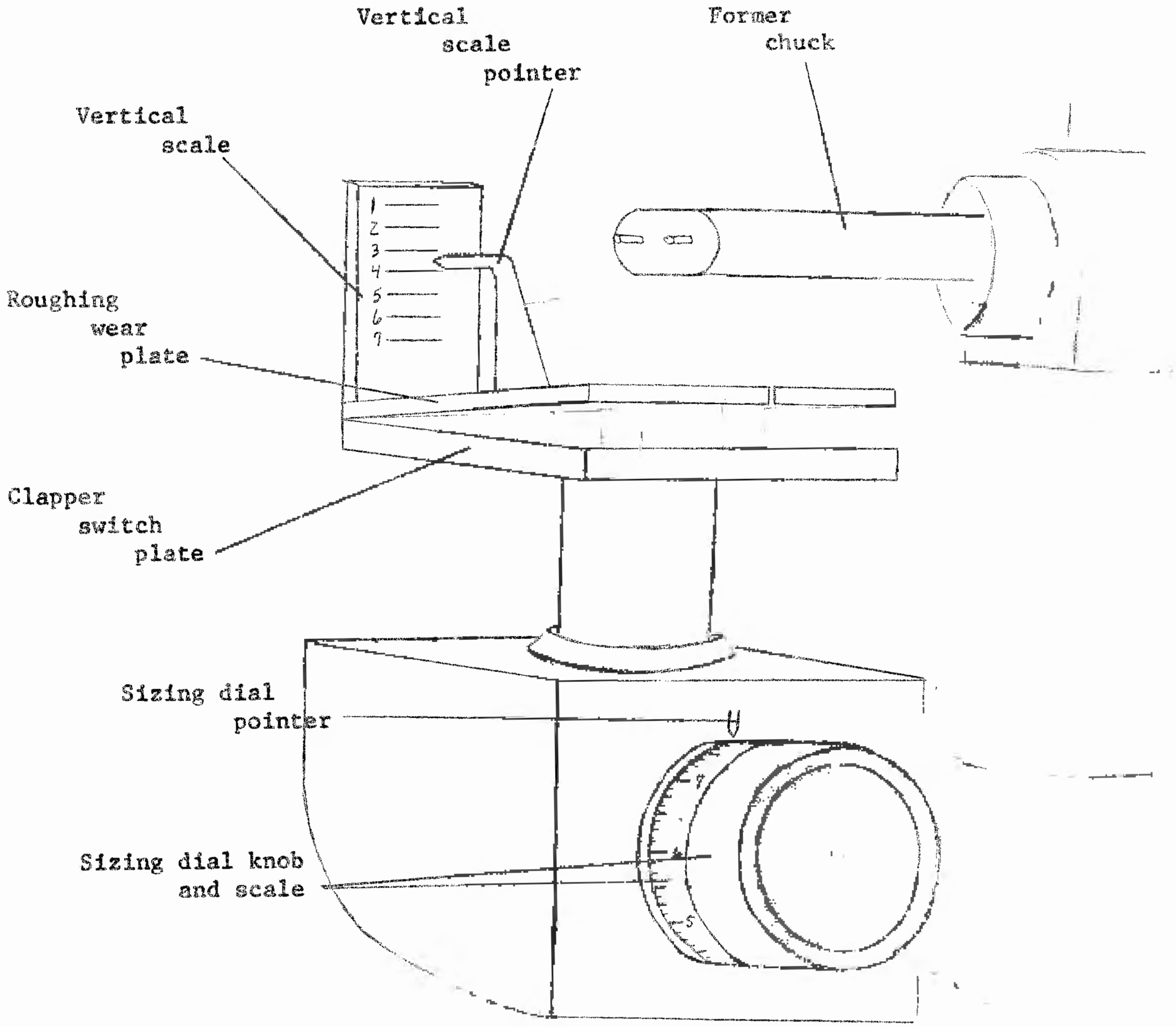

Pattern orientation for a right eye lens:
Pattern orientation for a left eye lens:
Former Chuck
N
N
Chuck Pins
Pattern
Nasal toward operator
Nasal toward rear of machine

Figure III-6

Then continue to turn the dial until the pointer on the sizing dial is on 8. (Figure III-7) However, just because you have set the machine for 38mm, it does not necessarily mean that the lens will come out to be 38mm wide, because the size of the finished lens is a function of both the machine setting and the size of the pattern. Most bevel edgers are calibrated for a pattern size of 36.5mm. Therefore if a given pattern measures 46.5, (horizontally, at the widest point) the machine must be set "10mm under" in order to achieve the finished size required. In other words, if the lens size that you need is 46mm, the machine setting would have to be 36mm. If you need a 48mm lens, you would have to set the machine at 38mm. Suppose you have a pattern that measures 51.5mm wide, and the lens size you need is 46. What would be your machine setting? Answer: 31mm (15mm under). It is important that this concept be understood because you will be using the same pattern for all eyesizes of a given frame, and also because you will encounter patterns of all different sizes. Here's another way of looking at this same problem that may seem simpler to you. Remenber this: IF YOU SET THE MACHINE AT 36.5, THE LENS WILL COME OUT TO BE THE SAME SIZE AS THE PATTERN, NO MATTER WHAT THE SIZE OF THAT PATTERN. Therefore, if you have a pattern that measures 48mm wide, and you set the machine at 36.5mm, the lens will come out to be 48mm wide. If you have a pattern that measures 55m wide and you set the machine at 36.5, the lens will come out to be 55mm wide. By remembering this simple rule you can easily calculate what size to set the machine in order to achieve the desired lens size. For example: your pattern measures 48mm. You need a lens that measures 52. You know that if you set the machine at 36.5 the lens will come out to be 48mm because the pattern is 48mm. However, you don't want a lens that is 48mm, you want one that is 52mm (4mm larger than 48). Therefore simply set the size 4mm longer than 36.5 = 40.5. Here are some more examples:

1) Pattern size = 44
2) Lens size needed = 48 > 48 - 44 = 4mm

Machine setting = 36.5 + 4 = 40.5



Machine size is set at 38 millimeters.

Figure III-7

2) Pattern size = 38
   Lens size needed = 52 > 52 - 38 = 14

   Machine setting = 36.5 + 14 = 50.5

3) Pattern size = 50
   Lens size needed = 44 > 6

   Machine setting = 36.5 - 6 = 30.5

   (In this example, the pattern is larger than the eyesize needed and therefore you must subtract the difference from 36.5).

That is all there is to it. Now you know how to set the machine size for any pattern size, any eyesize, and any combination of the two.

4) Setting the bevel guide. The Mark V has a unique device called the "Dial-a-bevel" to control bevel placement on the edge of the lens. Its function allows the operator to control the bevel placement for whatever position he feels is required for the particular type of lens to be edged. The Dial-a-bevel control knob (refer to Fig. III-2) moves the nylon finger guide in a left or right direction, by way of a gear rack assembly. The diamond finishing wheel is so designed that on a heavy minus lens over 3.5mm thick (at the edge) will be edged to a hide-a-bevel shape. The "V" width in the diamond wheel is approximately 3.5mm wide so that any lens thinner than 3.5mm will have a standard 50/50 bevel (without the influence of the Dial-a-bevel contact). The function of the nylon finger guide (bevel guide) is to make contact with the plus side of the lens so that the bevel will be ground parallel to the radius of the plus side of the lens. The lens, during the grinding operation, actually floats against the nylon finger guide. Setting the bevel guide to the left results in a bevel toward the back surface of the lens, while setting the bevel guide to the right pushes the bevel toward the front surface of the lens. All plus lenses and most lenses less than 3.5mm thick should be ground by moving the nylon finger control to the extreme left side fo the finishing wheel. In this position, the front surface of the lens will not come into contact with the bevel guide and will float

freely in the "V" wheel producing a bevel that is centered on the edge of the lens. For minus lenses with thick edges you would want to push the bevel toward the front surface. This would result in most of the lens edge protruding out the back of the frame toward the cheek and would be cosmetically more acceptable than if the lens thickness were to stick out the front. However, on extremely thick minus lenses you may want to split the difference and have a small portion of the lens stick out the front, and part of the edge stick out the back. Figures III-8 and IV-9 shows various positions of the bevel guide and the lens bevels produced.

5) Running a cutting cycle. After you have done each of the previous steps (i.e. placing the lens into the machine and setting the size and bevel guide) you are now ready to "take the first cut on the lens". The main toggle switch, when pushed to the on position will only turn the motor on. To actually begin an edging cycle you must depress the push button switch immediately to the left of the main toggle switch. (Fig. III-2) The coolant spray automatically begins, the pattern and lens begin to rotate, and the floating head automatically sets the lens down onto the roughing wheel. After the excess glass has been removed, the floating head will automatically lift up, move to the right, and then set the lens down onto the finishing wheel. After the finishing wheel has reduced the lens to its final size, the floating head will raise and move back to its starting position, the coolant will shut off, and the lens and pattern will stop rotating. This completes one cycle. The main motor continues to run. You do not need to turn the motor off after each cycle. These machines are designed to run continuously for 8-10 hours per day everyday, and indeed most optical labs will run them that long with only a break at lunchtime. After the first cut (cycle) you are now ready to either re-set the size and take another cut or else remove the lens from the machine and compare the size of the lens to the frame.

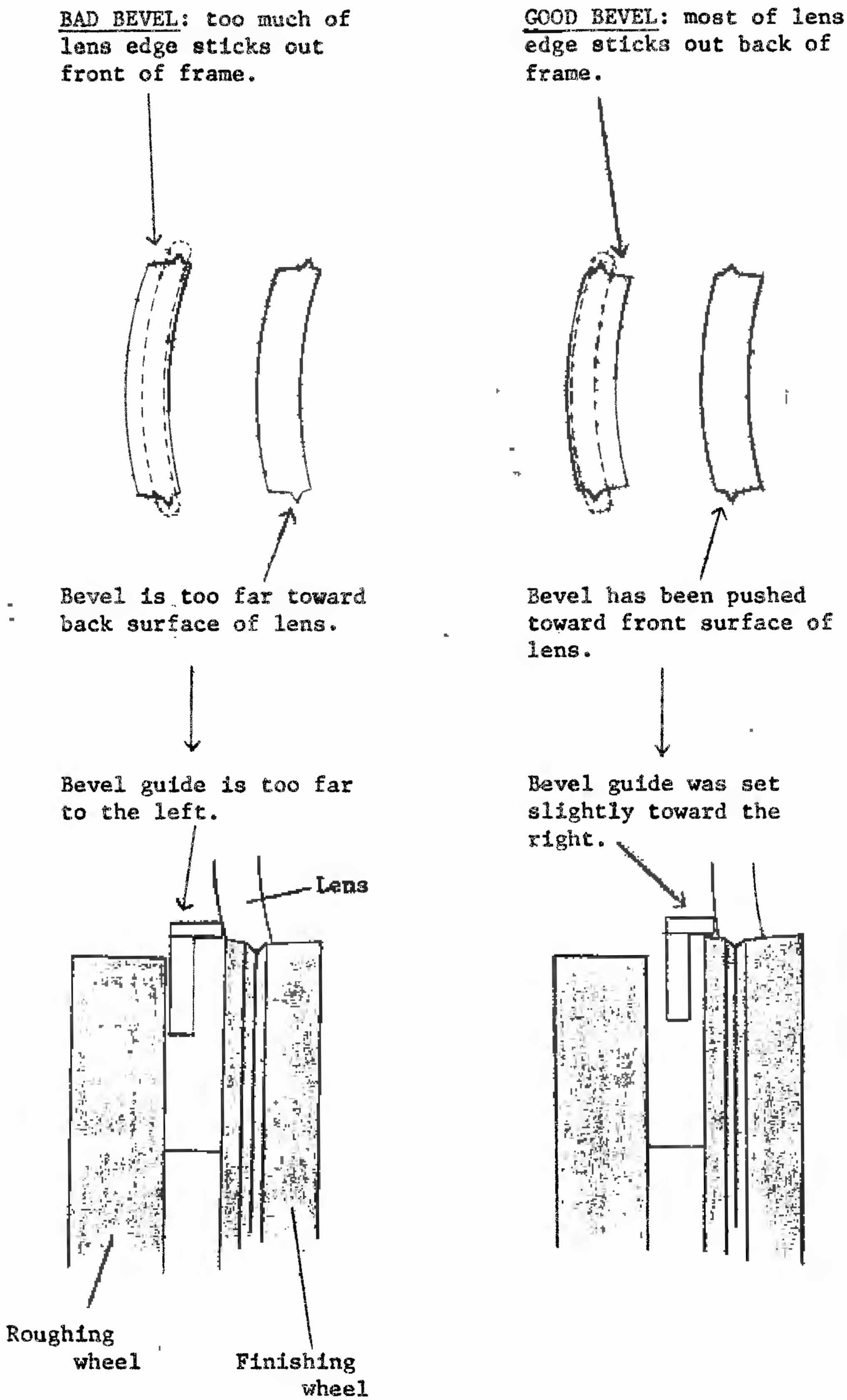

BAD BEVEL: too much of lens edge sticks out front of frame.
GOOD BEVEL: most of lens edge sticks out back of frame.
Bevel is too far toward back surface of lens.
Bevel has been pushed toward front surface of lens.
Bevel guide is too far to the left.
Bevel guide was set slightly toward the right.
Lens
Roughing wheel
Finishing wheel

Figure III-8

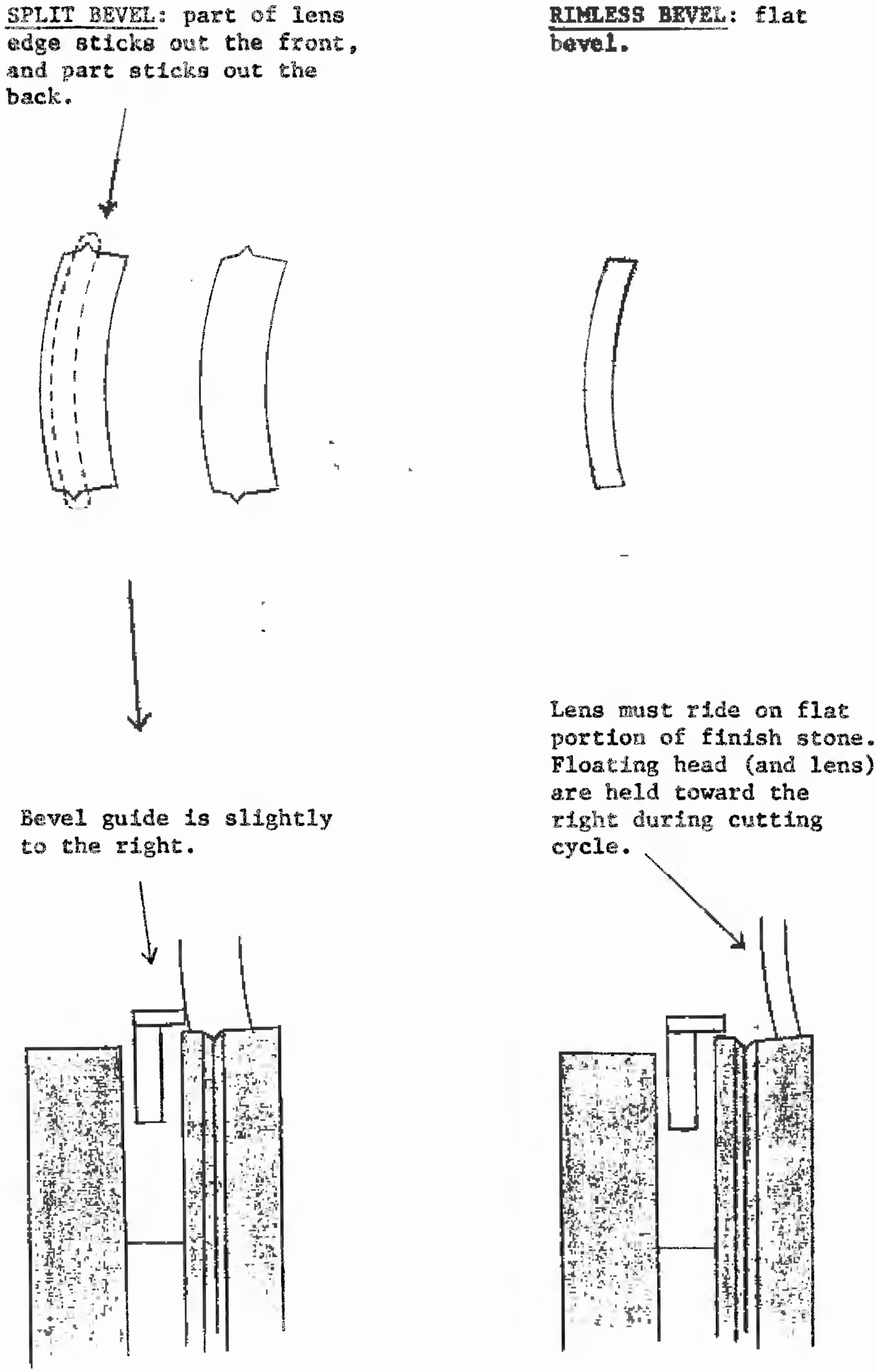

SPLIT BEVEL: part of lens edge sticks out the front, and part sticks out the back.
RIMLESS BEVEL: flat bevel.
Bevel guide is slightly to the right.
Lens must ride on flat portion of finish stone. Floating head (and lens) are held toward the right during cutting cycle.

Figure III-9

A few words about cutting cycles. Your first cut should be a "hogging" cut. This means that the first cut should only be a cut to remove the bulk of the excess glass. For example, suppose you need a lens that is 54mm wide but the lens blank is a 75mm blank. Attempting to remove all of this glass in only one cut would be difficult and could possibly result in an overload on the edger's motor. Therefore it is best to set the machine size large for the first cut, and then take a second cut to remove more glass. As a rule of thumb, the most glass that you would want to remove would be about 10mm per cut, and maybe less than 10mm if the lens is thick or photogray. The total number of cuts required to reduce the lens to the finished size will depend on the blank size, the desired finished lens size, the type of lens material, and how cautious you want to be in order to avoid cutting the lens too small (another common operator error). As another rule of thumb, the optimum number of cuts for a single vision lens of normal thickness and average blank size would be two cuts - one to hog the excess glass off and one to reduce the lens to the finished size. However, for most lenses, three is probably a more realistic estimate of the number of cuts required - one to hog the excess glass off, one to reduce the lens to within, say, 1mm of the finished lens size, and a final cut to remove the last 1mm of glass. Of course if the lens is a photogray, or if it is thick, or if it is an expensive multifocal, you may want to to take as many as 4 or 5 cuts. But, in general, you should never cut a lens more than 3 or 4 times because too many cuts will result in a bad, uneven bevel.

An additional comment: the scratching of lenses is a major source of lens spoilage, and every precaution must be taken to avoid getting glass fragments onto the lens surfaces. Since the coolant is constantly recycled it will inevitably have small glass fragments in it, and therefore whenever you remove a lens from the machine, THE FIRST THING YOU ABSOLUTELY MUST DO IS RINSE THE LENS OFF WITH WATER. This cannot be overemphasized, especially if you are edging both plastic and glass lenses on the same machine, since plastic is scratched so easily. It is a good idea to obtain two, 1 gallon Clorox bleach (plastic) bottles and cut the tops off. Mark one "plastic" and the other one "glass". Fill both these with clean tap water and place both of them right beside the edger. Each time you remove a lens from the edger, immediately dip the lens in the corresponding rinse bottle, and then pat the lens onto a clean cloth towel to absorb excess water. It is also a good idea to rinse your hands periodically. Change the water in the rinse bottles every day. With the lens properly rinsed you are ready to proceed.

6) Sizing the lens. Evaluation of how the lens fits into the frame is called "sizing", and this procedure actually entails three separate considerations: 1) Is the lens bevel clean and even? 2) Is the lens the correct shape and on axis? 3) Is the lens the correct size? In order for a lens to stay in place, once inserted into the frame, it must have a good, clean bevel. You must inspect the bevel closely after the lens is removed from the edger. Sometimes the bevel will be perfect all the way around the lens except in one small spot. If the "V" bevel wheel is worn, the bevel will be rounded. (Fig. III-10) Generally as long as the machine is level and there are no worn parts, the bevel will be clean. A bad "V" bevel can readily be fixed using a handstone provided the lens has been left a little large in order to facilitate removal of a small amount of glass when the lens is placed onto the handstone. However, a lens with a bad hide-a-bevel is not as easily fixed with a handstone, and therefore it is imperative that the bevel be clean when it comes off of the machine edger. Should you encounter a bad hide-a-bevel, the best thing to do is to take another cut on the machine edger WITHOUT CHANGING THE SIZE SETTING. Even though you have not changed the size setting (in essence you are telling the machine not to remove any glass) the machine will remove a very small amount of glass anyway (usually less than 1/8mm off the total size of the

Sharp Bevel Rounded Bevel

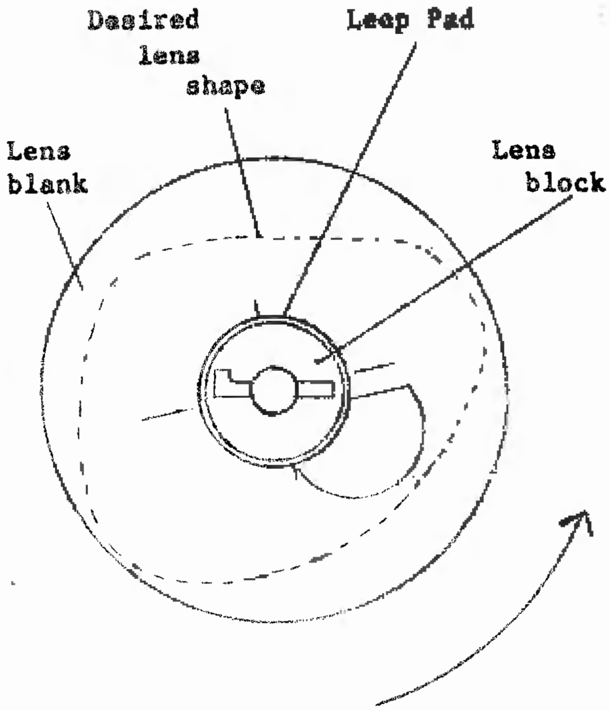
Figure III-10

lens). This should be just enough to correct (clean up) a bad hide-a-bevel without making the lens too small. When the floating head lifts up to move the lens over onto the finish wheel, you should use your hand to move the floating head slightly to the left or right to insure that the lens bevel falls directly into the "V" on the finish wheel. This procedure will usually correct a bad hide-a-bevel.

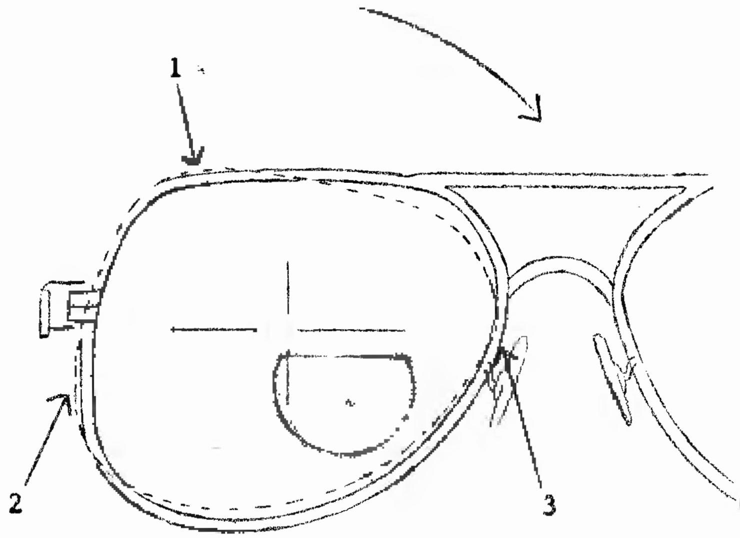
When a lens is removed from the edger in order to evaluate the size, that lens should be visually inspected to see if the shape is correct and also to make sure that the lens is on axis. Occasionally, a Leap blocking pad will flex or slip during the grinding operation, causing the lens itself to rotate from the original desired position on the block. The result is a lens that is off axis in relation to the shape. When the lens is then inserted into the frame and turned onto its proper axis, the shape will not fit the frame. (Fig. III-11) Instead of discarding the lens, an attempt should be made to salvage it by repairing it on the handstone by removing glass where the arrows indicate. A certain amount of judgement is required in order to insure that the repair can be accomplished without changing the overall shape and size.

After a pair of bifocals (or trifocals) have been edged, they should be matched against each other to insure that the segments are not misaligned. Place the lenses together, back to back (concave side against concave side) aligning the edges. Then view straight through the lenses and observe of the segments match horizontally and vertically. If the lenses were marked and edged properly, only one segment should be seen. But if one of the lenses slipped in the edger, one segment will be out of alignment and both segments should be realigned to determine where glass needs to be removed. (Fig. III-12)

If you have a good pattern that is correct in both the horizontal and vertical dimensions, along with sharp cutting wheels and a good smooth



Lens blank has rotated nasal up, (counterclockwise) in relation to the lens block.



Lens must be rotated nasal down (clockwise) in order to place lens on axis and align segment. Result is a lens that is "off shape" in relation to frame. Use handstone to remove glass at points 1, 2, and 3.

Figure III-11

Figure III-12

running machine, then if the horizontal dimension of the lens comes out correct, then the vertical size of the lens should come out to be correct also. However, quite frequently if the pattern is home-made, the dimensions will vary a slight amount because the frames have a tendency to stretch and flex when they are used on the pattern maker, and consequently any lens edged using that pattern will also vary from the original frame shape and size. Therefore, when sizing the lenses to the frame, you will want to use the horizontal dimension for your initial (and major assessment, but you should also inspect the vertical dimension as well.

Many technicians use a device called a "Box-o-graph" to evaluate lens size. (Fig. III-13) The Box-o-graph allows much more precise lens measurements than simply using a millimeter ruler, and you should get one if you are planning to do lots of edging and want to do quality work. The lens is placed concave side down onto the upper left hand grid against the two metal face plates and oriented on axis using the lens block or mark-up line as a guide. The clear plastic slides (one for horizontal and one for vertical) are then slid up against the right side of the lens and the bottom of the lens, respectively. Make sure the slides are touching the peak of the lens bevel and not some other part of the lens of the horizontal and vertical scales. The grid in the lower right corner can be used for measuring segment height simply by placing the mark-up cross on the lens (you will have to first remove the lens block and Leap pad in order for the cross to be seen) directly over top of the cross in the center of the circle on the grid. The segment height is then read directly off of the lower scale. Incidentally, the segment height is another good indicator as to whether or not you have edged the lens down to the proper size. If the lens was marked correctly and accurately and has been edged down to the proper size, the segment height should be correct to within ½mm.

A thorough evaluation of proper lens size also requires actually holding

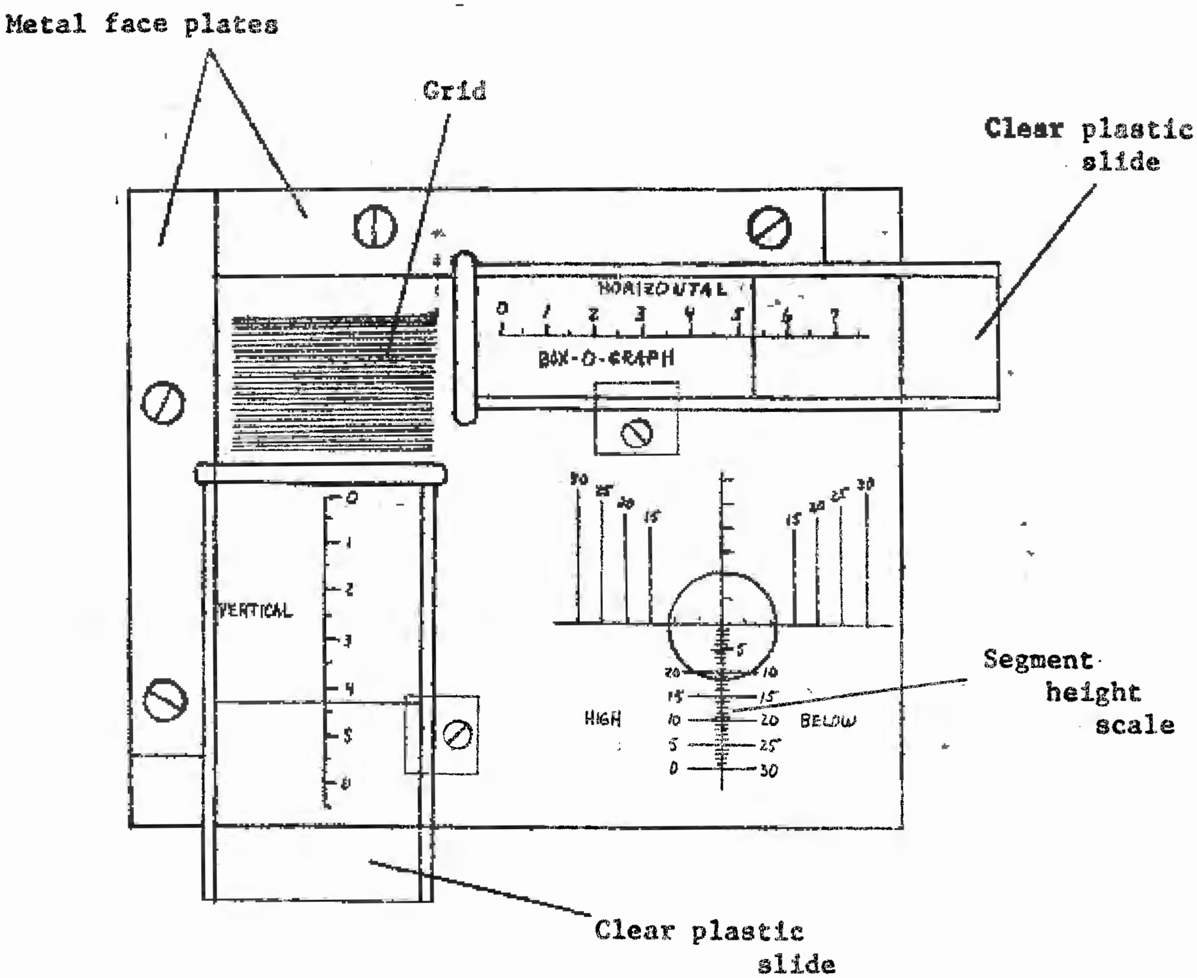


Figure III-13

the lens up against the frame and observing to see if the lens looks like it will fit. (Fig.III-14) Look for air spaces ("gaps") between the edge of the lens and frame. These gaps may occur anywhere around the lens and you must look closely in order to find them. This best accomplished by holding the lens against the frame in direct light, usually the overhead room lights or a good work lamp. The presence of air gaps indicates that either the pattern and frame were not the exact same shape (this occurs often with zyl frames because they are often stretched out of shape) or else you have cut the lens a little too small.

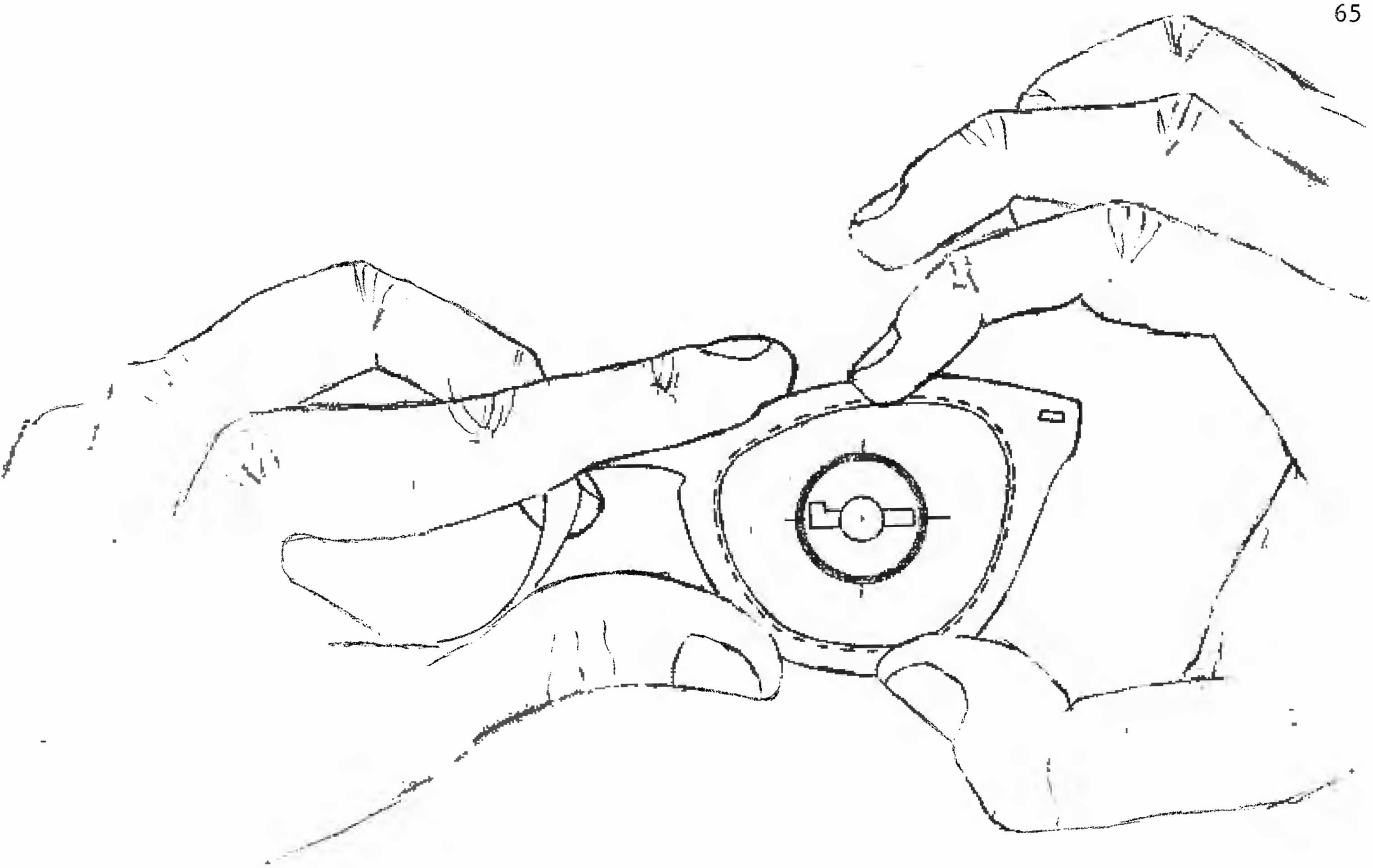
Here are some important tips to remember when sizing lenses:

1) The Box-o-graph is handy to have, not only to evaluate the size of lenses that you have just edged, but also to measure lenses in other situations. For example, suppose you are about to edge a pair of lenses that are going into a patient's old frame. If the old lens(es) fit good, i.e. are not too loose or not too big, you can then remove the old lens, place it on the Box-o-graph and measure it. Then edge the new lenses to this exact same size, again using the Box-o-graph to measure the new lens. Using the old lens and Box-o-graph in this manner will guide you in determining what your machine setting should be.

2) Most zyl frames have eyewire grooves that are approximately ½mm deep, but some frames, especially nylon safety and athletic frames have eyewire grooves that are deeper. When holding the lens against the frame to assess the size, be sure to look and see how deep the grooves are.

3) Remember that zyl frames can be stretched and shruck. Therefore if you leave a lens(es) slightly too large or too small (*will be stated in insertion section), it will still probably go into the frame without any major problems.

4) Should you, for whatever reason, decide to leave a lens slightly large, you must then also leave the other lens slightly large - i.e. the



Lens (with Leep pad and block) is held up to the front of the frame to check the size and shape.

Figure III-14

left lens must be the same size as the right lens regardless of they are too large or too small. If one lens is larger (or smaller) than the other lens you will induce some unwanted vertical (and horizontal) prism, especially with high powered lenses. Also, a ½ to 1mm difference in size between the right and left lenses becomes very obvious cosmetically once they are mounted in the frame.

5) Suppose you accidentally cut a lens too small and you are wondering if the frame can be shrunk enough to accomodate the lens. A good rule of thumb is that most zyl frames can be shrunk approximately ½mm in size. Therefore if you cut a lens ½mm too small it will probably still be OK, but remember that you will probably want to make the other lens ½mm too small also. But, before going ahead and cutting the second lens too small, it would be wise for you to safety bevel (this technique is described later in this text) the first lens and attempt to actually insert it into the frame and make sure that it is truly alright. Otherwise if you don't take this precaution, you may needlessly edge BOTH LENSES TOO SMALL!

Suppose you cut a lens 1mm too small. Here you are in trouble. Granted, you may be able to shrink the frame enough to hold the lens securely, but now the seg height will be too small (low) and the P.D. will be too narrow. By also cutting the other eye 1mm too small in order to avoid unwanted prismatic imbalance, the adverse effects upon the seg height and P.D. will be doubled. True, if the lenses are very low powered, the patient probably would not know the difference. However, this is sloppy work and sloppy anything is a reflection upon you and your office and therefore should be avoided. Generally speaking, if you cut a lens 1mm (or more) too small, you will probably want to throw that lens away and start all over again.

6) Occasionally you will be in the situation where the lens is "ever

so slightly too big". In essence, the lens may be, say ¼mm overall, too large. If you re-set your machine size to ¼mm smaller, and then take another cut to remove this very small amount of glass, chances are, the machine will take off more glass than you wanted it to, and the lens will then be TOO SMALL. This is due to an inherent characteristic of the machine itself. Stated simply: it is very difficult for the machine to remove LESS than ¼mm of glass, on any given cut. Therefore, if you are in the situation where you need to remove only ¼mm of glass or less, simply put the lens back into the machine and take another cut, but DO NOT CHANGE THE SIZE FROM THE SETTING OF THE PREVIOUS CUT. The machine will remove ~1/8 to ¼mm of glass, anyway, without changing the size setting. This is analogous to the procedure described earlier for correcting a bad hide-a-bevel.

In summary, here is a step-by-step procedure for sizing zyl frames:

1) Machine edge the lens down to a size close to the actual size needed.

2) Remove the lens (with block) from the machine, holding it by its edges.

3) Rinse and pat dry.

4) Inspect the bevel and shape

5) Place the lens (with block) on Box-o-graph and measure horizontal and vertical dimensions.

6) Check the seg height using a millimeter ruler

7) Hold the lens up to the frame (Fig. III-14) and observe whether or not the lens looks the proper size.

8) Combine information from Box-o-graph, seg height, and frame observation to decide if lens should be put back into the machine and cut again. If so, repeat the above steps. If not, place the lens into the tray and proceed to cut the other lens the same size. (Remember to turn your pattern around).

Sizing metal frames is more involved than sizing zyl frames although the same general principles apply. Since metal frames cannot be stretched or shrunk, the lenses must be edged to the exact size needed, and consequently a more critical evaluation of lens size is required as the lenses come off of the machine edger. This is accomplished by actually placing the lens (with block) into the frame and squeezing the eyewires together using an endpiece plier. (Fig. III-15). This plier is available from Vigor (Vigor # PL - 40G or PL - 40, either one will work) and is essential for sizing metal frames. Attempting to use needle nose or other types of pliers for this purpose will damage the barrels on the frame. Another plier (Vigor # PL - 251) is needed to bend metal eyewires so that the contour of the lens bevel (Fig. III-16). Straightening these eyewires is usually done when you are actually ready to insert the lens into the frame just before final inspection. However, often times you will have to make this type of eyewire adjustment in order to size the lens.

Caution must be used when sizing metal frames especially if the lens is thin. Before placing the lens into the frame, it is a good idea to safety bevel the lens first. This technique is described in detail in the hand-edging section of this text, but in short it means to remove the small chips from the edges of the lens - in essence to "clean up" the ragged edges left by the machine edger. Failure to safety bevel before squeezing the eyewires together often chips the lens resulting in lens spoilage.

When assessing the fit of a lens in a metal frame, you must again look for gaps around the lens, and you must make sure that the lens is close to being on axis when this observation is made. With the lens oriented on axis and the eyewires squeezed together, the eyewires should close to within $\frac{1}{4}$ to $\frac{1}{2}$mm with NO GAPS SHOWING for a proper fit. This leaves approximately $\frac{1}{4}$mm to be removed during hand edging and safety beveling (Fig. III-15).

Sizing metal frames is a relatively straight forward process, but at the same time it is not as easy as it would seem. Of utmost importance is caution not to chip the lens. You will have to hold both the frame and lens in one hand while holding the pliers and squeezing the barrels with the

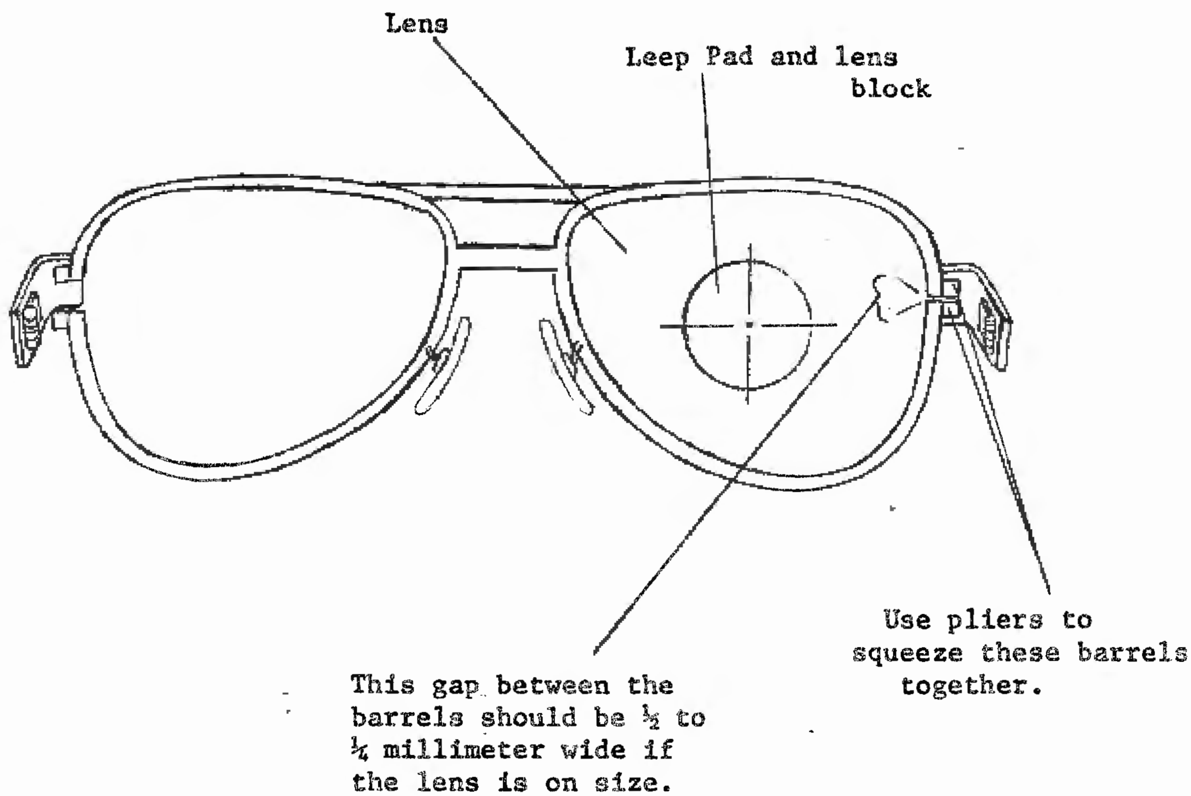


Figure III-15

other hand. Here is the step-by-step procedure:

1)
2)
3) The first six steps for sizing zyl frames (page 67)
4) should again be followed when sizing metal frames.
5)
6)

7) If the lens looks to be close to the finished size needed, based upon information from the Box-o-graph and seg height, proceed to safety bevel the lens.

8) Again rinse and pat the lens dry.

9) Remove the eyewire screws from the frame and place them in the lab tray so that they don't get lost.

10) Hold the lens up close to the frame and evaluate whether or not the eyewires need to be straightened or bent to insure that the lens bevel and eyewires have the same contour. (Fig. III-16) Make eyewire adjustments as necessary.

11) Place the lens into the frame and orient the lens as close on axis as you can.

12) Using the endpiece plier, squeeze the eyewires together (placing the tips of the pliers onto the frame's barrels) and assess the fit (size), making sure that the eyewires fit snugly onto the lens bevel all the way around the lens. Look closely for gaps.

13) If the lens fits well, return that lens to the tray and follow the same procedure to edge and size the other lens. If the lens is too big, return it to the machine edger and take another cut to remove more glass, and then repeat steps 7 - 12, above.

Rimless

The procedure for edging rimless lenses is basically the same as other lenses with two exceptions:

1) The hinged cover on top of the floating head must be left open during the cutting cycle, so that the lens can be observed. When the floating head lifts up to move over to the finish wheel, you must hold the floating head with your hands while watching the lens, and then guide the floating head into a position so as to place the lens onto the FLAT PORTION OF THE FINISH WHEEL. The lens (and head) must be held in this position until the cutting cycle is complete. Otherwise the lens (and head) will slide to the left, into the groove on the finish wheel and result in a hide-a-

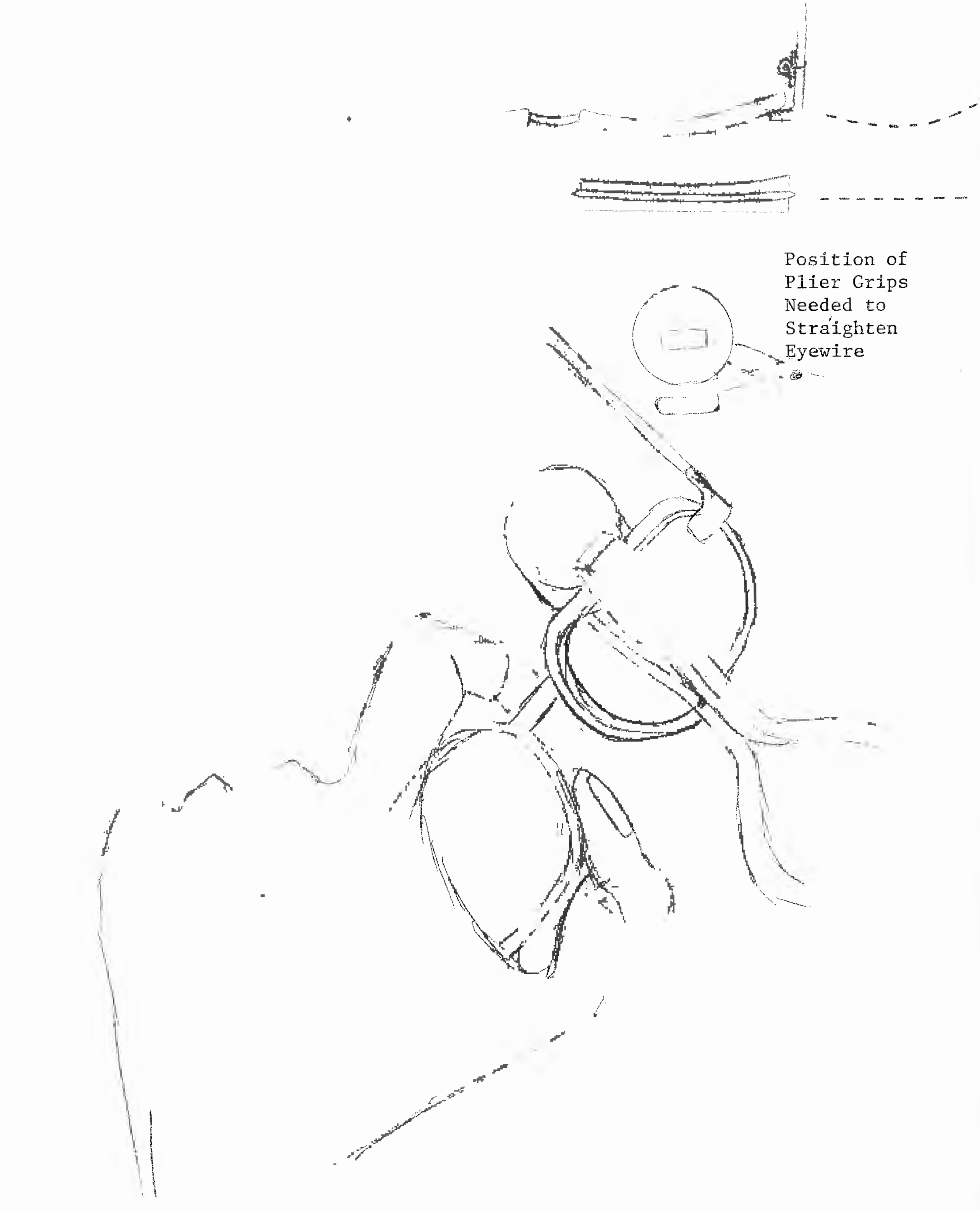


Figure III-16

bevel instead of a rimless bevel. The bevel guide plays no part in producing a rimless bevel and its position can simply be ignored. Fig. III-9 on page __ shows a rimless bevel and the position on the finish wheel that the lens must ride.

2) All rimless frames come from the factory with a pair of plano sample lenses. These sample lenses make it very easy for you to size a pair of rimless lenses. You simply match the size of the new prescription lenses, to the size of the sample lenses.

Hand Edging

Section IV

Hand Beveling

Hand beveling (often referred to as "hand edging") is the process of removing glass from the lens by hand, and constitutes the last step in the lens fabrication sequence before hardening and inserting the lens into the frame. It is accomplished with the use of a handstone much like a bench grinder. Most modern handstones have two wheels, one coarse and one fine. The coarse grinding wheel or stone is usually made of diamond and is used to remove large amounts of glass quickly, while the fine stone is usually made of sandstone and is used for safety beveling, moving the bevel position, or lens repair. The face of both stones should be flat and have a high glaze on the surface. The stones must be kept wet with water (while they are turning) because the water washes the face of the stone to keep glass out of the pores and keeps the lens cool so it won't break. A single handstone may be used for both plastic and glass lenses. Figures IV-17 and IV-18 show an older model single ceramic handstone and a newer model dual handstone.

There are several ways to hold the lens while working on the handstone. Probably the best method is to place the index finger of the left hand on the middle of the concave side of the lens, and the thumb of the right hand on the convex side (Fig. IV-19). Place the lens against the stone pushing the lens with the left thumb in a clockwise direction while guiding it with the fingers of the right hand. The lens should be moved in the direction that the stone is turning in order to take advantage of the pulling action of the stone. The lens should also be moved from side to side so as not to put cuts in the face of the stone. This increases the life of the stone and also lessens the amount of time spent truing the stone. Figure IV-20 shows the face of a handstone and the dotted line indicates the direction the lens should be moved as the stone is turning.

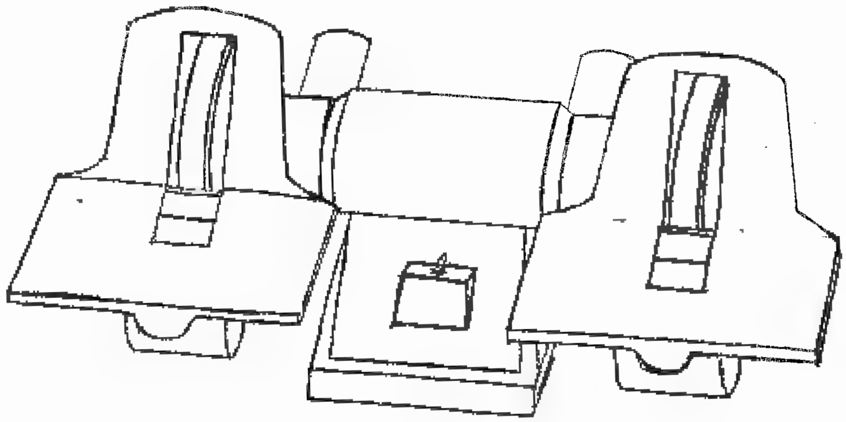


Figure IV-18

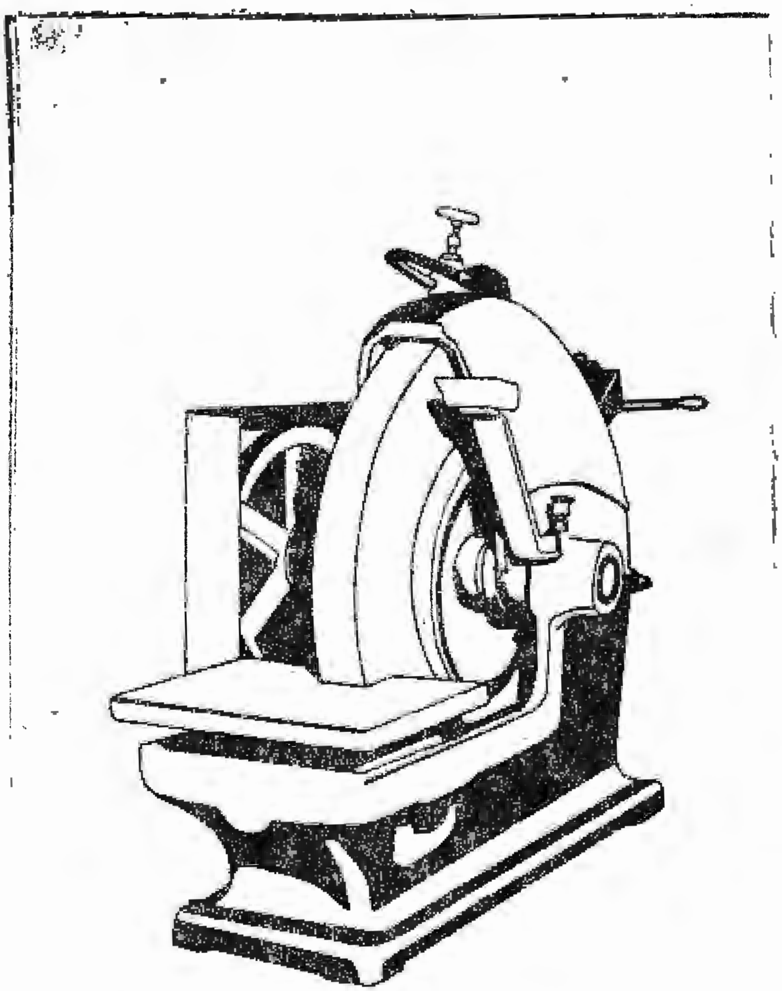
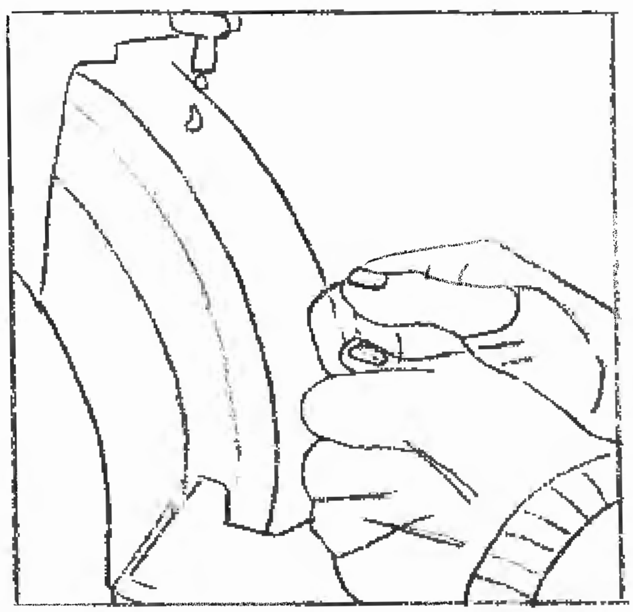


Figure IV-17



Hand Position

Figure IV-19

Lens should be moved from point #1 to
point #2 while rotating the lens clockwise

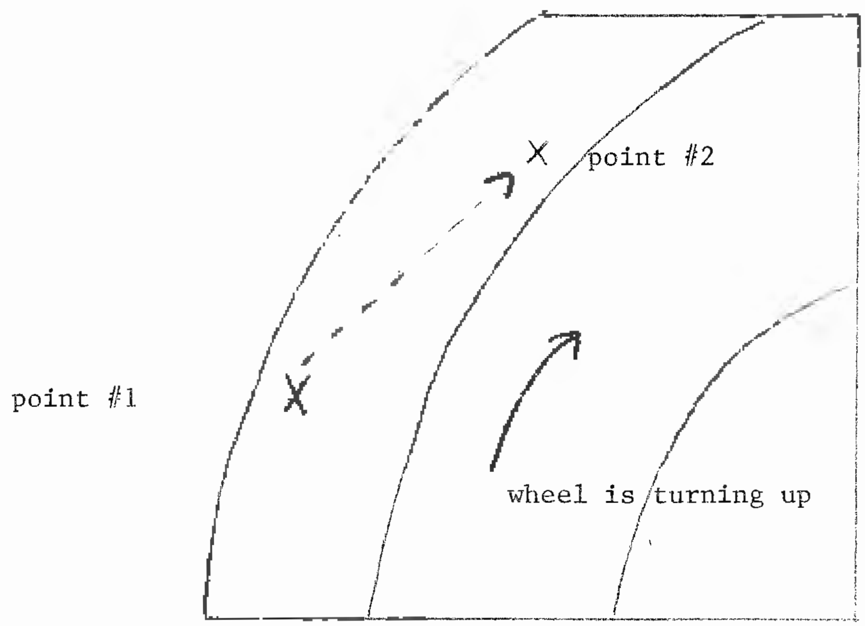


Figure IV-20

The angle at which the lens contacts the stone depends upon what ultimately is to be accomplished, "safety beveling" is probably the most common hand beveling operation, and its purpose is to smooth off the sharp jogged edges which remain after machine edging. A safety bevel approximately ½mm wide is usually all that is required, and all lenses must have this finishing touch before they are inserted into the frame. A typical "V" bevel or a hide-a-bevel lens each require three safety bevels each, while a rimless lens only requires two. Figure IV-21 shows where each of these lens types must be safety beveled. Keep in mind that you are only trying to remove a very small amount of glass and therefore only a smooth touch on the handstone with only moderate pressure is all that is required.

Hand edging is relatively easy but will require some practice. Failure to watch your hands and the lens at all times may result in a "stone bruise" which is a deep scratch on the front or back surface of the lens, due to the lens surface accidentally touching the handstone. The lens is ruined.

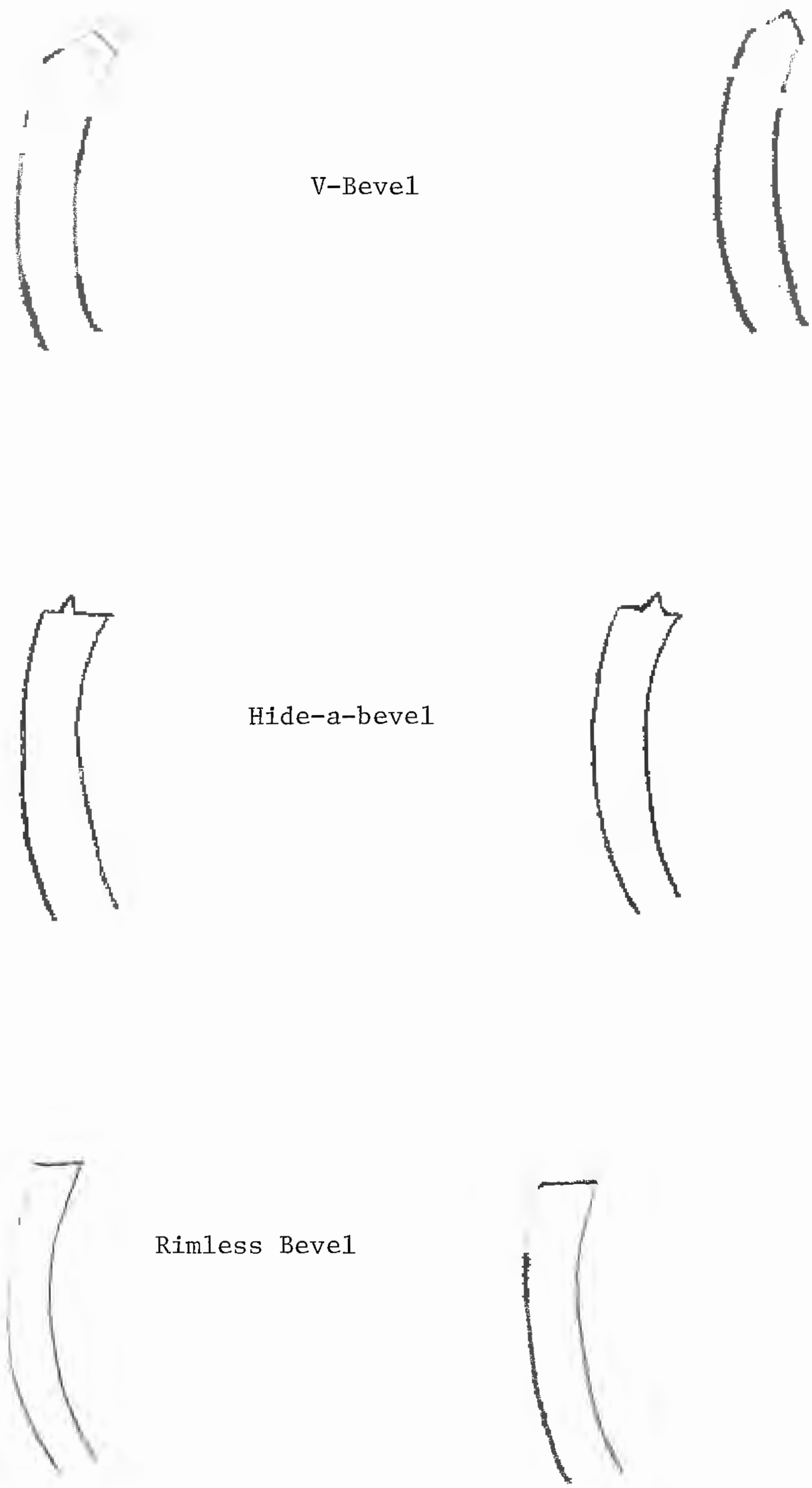


Figure IV-21

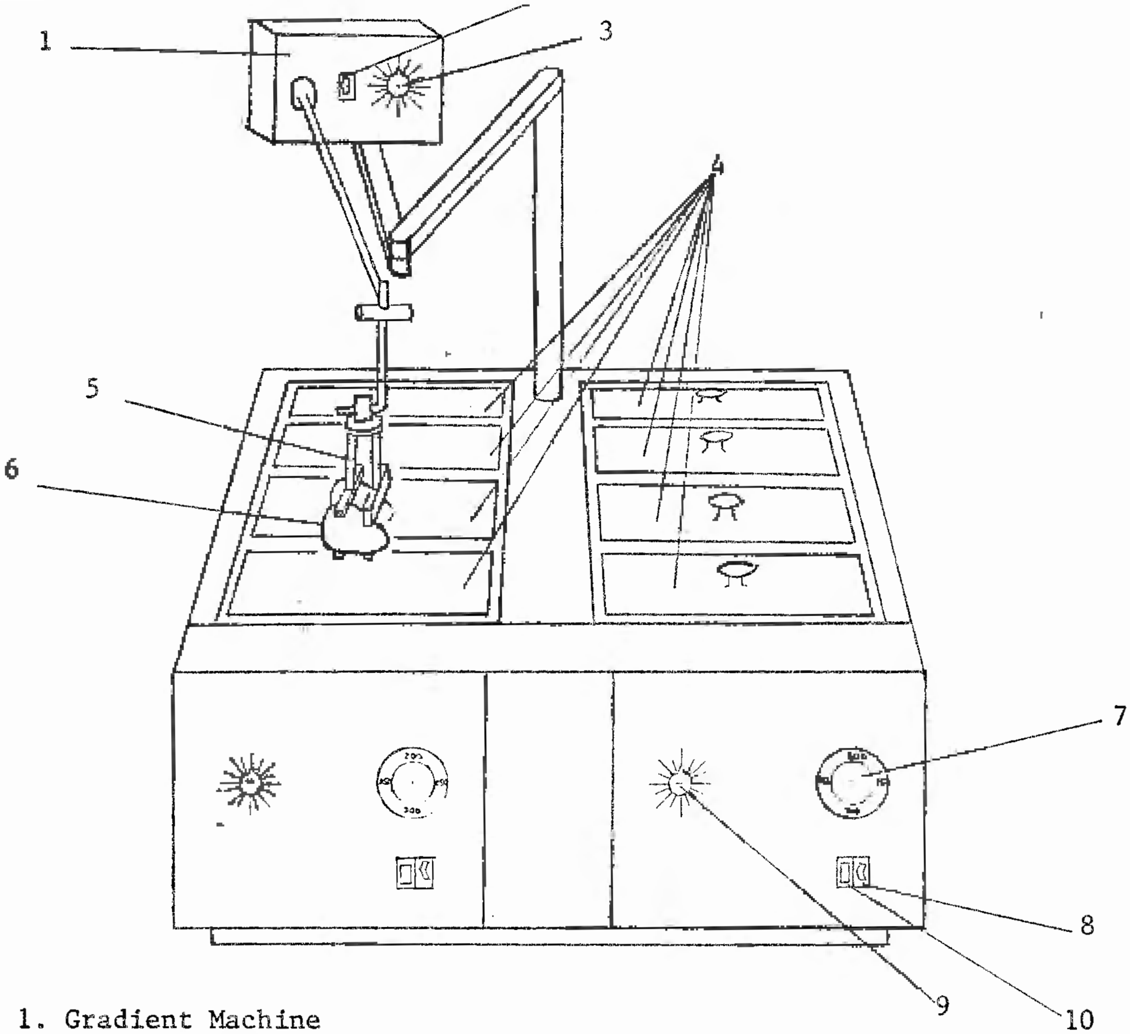
Lens Tinting

Section V

Lens Tinting

Tinting plastic lenses is a simple process and is accomplished by dipping the lens into a container of heated dye and allowing the dye to absorb into the lens. A separate container (tank) and dye are required for each color desired. Essentially any color tint can be produced by dipping the same lens into one or more different colored dyes. The longer the lens is left in the dye the darker the tint will be. Most tints can be produced by dipping the lens for only a matter of minutes or even seconds. However, for dark sunglass tints, the lens may have to be left in the dye for as long as 30-60 minutes. A special bleach is available which will allow you to bleach the tint out of a lens if it is too dark or if you want to change the color all together.

In order to facilitate penetration of the dye into the lens, the dye must be heated to a specific temperature (which varies depending on the brand of dye you are using). This is accomplished by placing the dye into a stainless steel container and then having that container rest in a bath of hot water. This arrangement allows uniform heating of the dye and better control at temperature fluctuations over long periods of time, and is analogous to a steamtable used to heat food in a cafeteria (Bottom, Fig. V-22). The temperature of the water (and therefore the dye) is controlled by a calibrated knob and switch located on the front of the dye pot. You simply set the knob to the desired temperature and turn on the switch. A thermometer is usually supplied with the dye pot to monitor dye temperature. Dye that is too cool slows down penetration, and dye that is too hot can warp thin lenses and cause surface bubbles on the plastic. Most commercial dye pots have from three to eight tanks. Figure V-22 (top) shows a typical dye pot with eight tanks, This one would accomodate seven different colors with one tank left for bleach. Each side of the dye pot has an independent heater which would allow you to use only four tanks at a time, if desired.



1. Gradient Machine
2. "On-Off" Switch
3. Timer
4. Dyeing Tanks
5. Lens Holder
6. Lenses
7. Temperature Control
8. "On-Off" Switch
9. Timer
10. "Heater On" Indicator Light

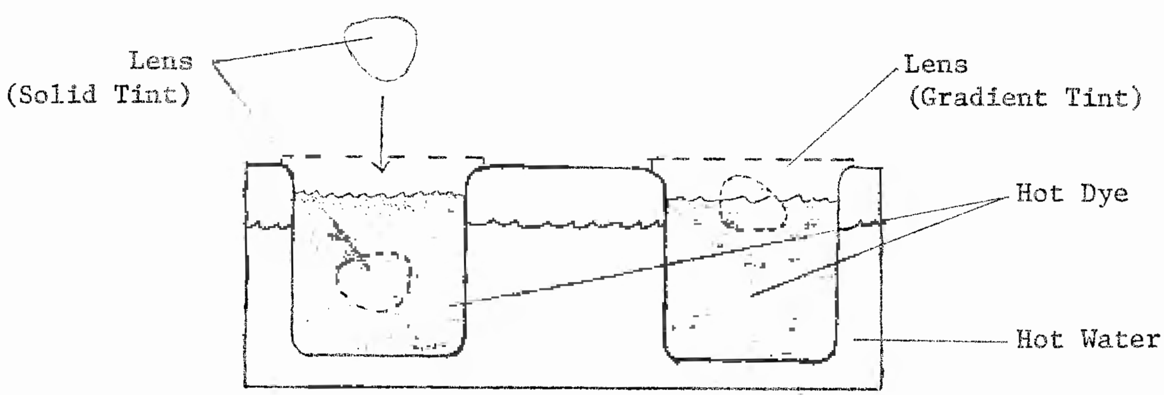


Figure V-22

The Gradient Machine is offered as an accessory to most standard dye pots. It will automatically dip the lenses into the dye to produce a gradient tint (Figure V-22, top). The lenses are inserted into the lens holder and the machine is then moved into position over the desired tank. Since most gradient tints are dark at the top of the lens and fade to clear on the bottom, the lenses will probably have to be placed into the lens holder upside down. The lens holder itself must be adjusted up and down to insure that the lenses are dipped to the proper depth. This adjustment is best made after the machine is turned on and you are able to observe how far the lenses are being dipped into the dye. The Gradient Machine is equipped with a timer which provides regulation of tint darkness.

After a pair of lenses has been tinted, you must remove them from the dye, rinse them off, and compare them to make sure they are the same color and darkness. Place the dye pot itself close to a sink with running water or else use a bleach bottle cut in half and filled with clean tap water. For accurate color and darkness comparisons a clean white background is needed, and usually a white linen towel on the counter will suffice. Use only clean towels for drying to prevent scratches. Some lenses will naturally dye faster than others, even if they come from the same manufacturer and the same batch. Compare the tints. Don't assume that they will be the same even though they were placed in the same dye. Remember, you may have to mix and match to produce a desired tint.

A natural chemical deterioration of the dyes occurs as the dyes are re-heated day in and day out. Penetration time is slowed and colors become distorted. Often, gray dyes will begin to dye lenses redish-gray and brown dyes will turn reddish-brown. Sometimes the red can be removed by dipping the lens in yellow, but eventually the red and gray will have to be replenished with fresh, new dye. Evaporation occurs daily, and both the water bath and dye levels must be checked each morning.

Since gray and brown are the most common colors needed, you may want to start out with a dye pot that has only three or four tanks. Another possibility for savings is to use a group of kitchen crock pots. They work well and cost less than a commercial dye pot, however they require more counter space and a separate electrical outlet for each one used.

You may want to consider having a dye pot in your office even if you are not planning to do any edging. Ordering a tinted lens from your local laboratory can sometimes be more complicated than you would (may) anticipate. The tint you receive from the lab may not be the exact color that you and/or your patient had in mind. This situation occurs quite frequently, especially if you are ordering tints from the lab without sending them a sample tinted lens to match. Returning the Rx to the lab to be retinted would result in a serious delay to the patient. With access to a dye pot in your office, your assistant could readily change the color in a matter of minutes. Not to mention that this problem could have been avoided in the first place by doing all the lens tinting in your office.

Let's consider what lens tinting means in terms of dollars. At the time of this writing, a survey of local optometrists and opticians revealed that the average charge to the patient for a gradient tint is around $15.00. The typical lab charge for a gradient tint is around $5.00. This results in a net to you, the optometrist, of $10.00 for every pair of gradient lenses prescribed. Suppose in one week you have ten Rx's requiring gradient tints (and in a busy practice offering fashion eyewear, this is not an exaggerated estimate). Ten dollars per pair times ten pairs = $100.00 net per week. One hundred dollars per week times forty-eight weeks (assuming you take a one month vacation) = $4800 net per year just in lens tinting alone. Now let's consider how much can be saved by doing this tinting in your office.

(For the moment let's ignore the amount needed to initially buy the dye pot and dyes). With a good dye pot and fresh dyes, those 10 pairs of gradient lenses can easily be dyed in two hours, i.e. 5 pairs per hour. Now, suppose you hire a high school student to come in for two hours after school to dye the lenses, and suppose you pay that student $5.00 per hour. Five dollars per hour times two hours = $10.00 labor. The total charge at the lab for those ten pairs of gradient lenses would have been $50.00 ($5 per pair times 10 pairs = $50). Fifty dollars lab charge versus ten dollars labor would result in a savings of $40 to you. Forty dollars times forty-eight weeks = $1,920 savings per year. Finally, $4,800 net plus $1,920 lab savings = a total of $6,720 net just in lens tinting alone! Now, you are probable wondering how much a good dye pot will cost you. At the time of this writing, a dye pot from BPI (Brain Power Incorp.) complete with 8 tanks (will hold seven colors plus bleach), an automatic gradient machine, and enough dyes to last one year currently costs around $860. You could probably pay for the dye pot many times over in the first year.

Let's summarize:

Advantages of owning a dye pot:

1) Results in increased income to you, the optometrist.

2) Enables you to avoid confrontations with your lab regarding eyeglass tints.

3) Enables you to provide a service to your patients that other optometrists (and opticians) may or may not be providing.

4) Enables you to completely satisfy your patient's needs regarding the color of their tint, and conveys the message that you are truly concerned with the services and products that they have received.

5) May enable you to expediate your Rx turnaround time.

6) May enable you to provide a good part-time job to a young adult (But also realize that the person doing your edging can do lens tinting as well.)

Disadvantages:

1) Initial cost

2) The person doing the tinting will have to be taught (or else already know) how to remove and insert lenses.

3) The dye pot will probably need to be placed near a sink.

4) Dyes often get splattered onto the work area and clothing (wear an apron or jacket).

5) May slightly increase your electric bill.

Lens Tempering

Section VI

Lens Tempering

All glass lenses must be tempered in order to pass the drop ball test and conform to federal impact resistance specifications. The lenses may be thermally hardened (heat treated) or chemically hardened (chem treated). Generally, most small labs use heat treating because it is faster and less expensive than chem treating. However, there are pros and cons to both methods.

Thermal Hardening

Heat treating is accomplished by heating the lens in an electric furnace to near its softening point (about 1300^{o}F) and then cooling the lens with a blast of air. The result is surface compression and increased tension in the external portion of the lens which makes the lens stronger than annealed glass. This heating and cooling also produces birefringence (double refraction) which is unnoticed by the spectacle wearer, but is easily observed when the lens is placed under a polariscope. The observed birefringence pattern takes the form of a "maltese cross". However, the regularity of the pattern should not be used as an indication of how hard the lens is. It merely tells you that indeed, the lens has been heat treated. The lens must be drop-balled to tell whether it meets accepted safety standards. Heat treated lenses are 2-3 times more impact resistant than regular annealed glass.

Here are some of the practical considerations of heat treated lenses:

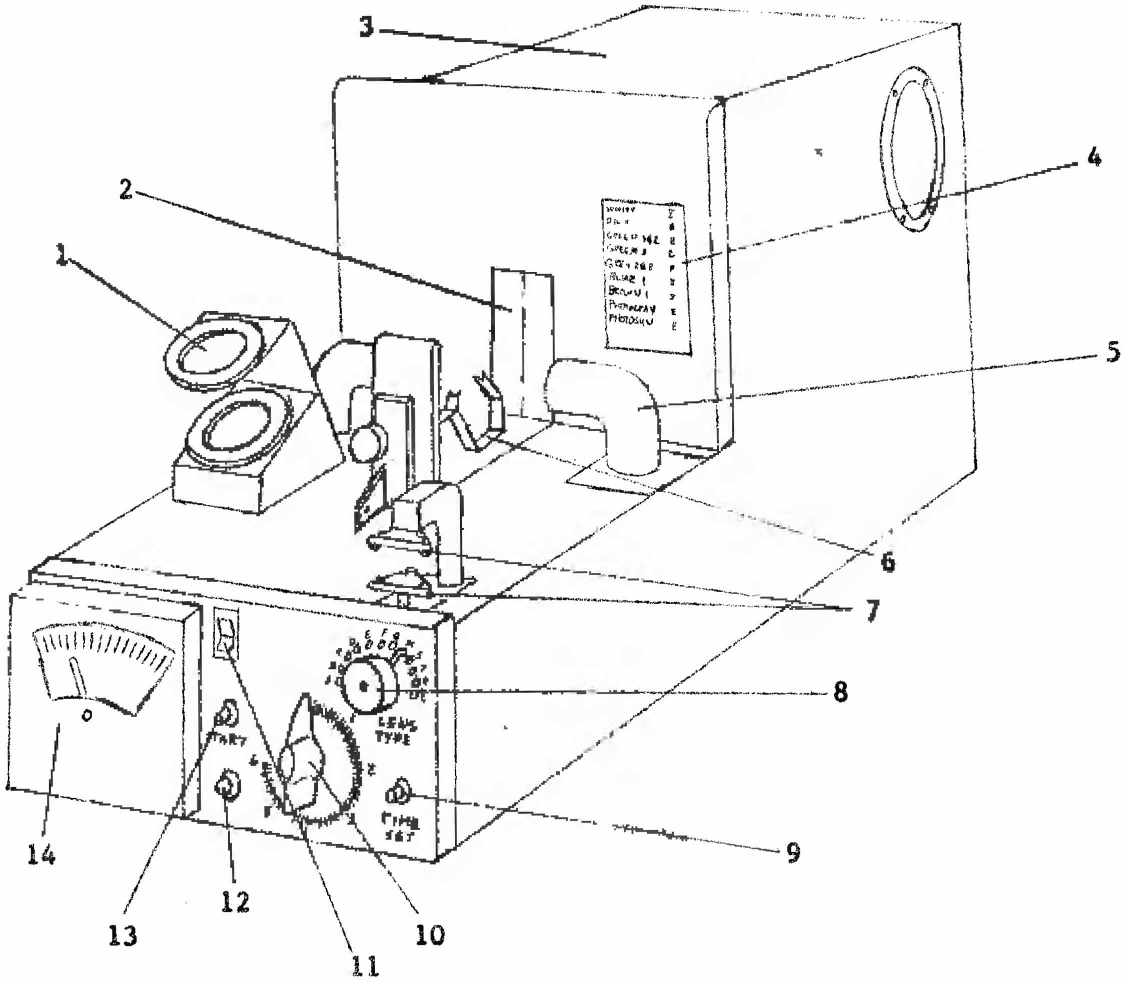
1) Once a lens is heat-treated, it cannot be re-edged, re-shaped, notched or drilled without first reheating and gradually cooling it.

2) Warping of lenses may occur. (Rare)

3) There is a slight increase in overall lens size which may be a problem when inserting the lens into a metal frame.

4) The lenses may crack if they are too thin.Minimum center thickness should be 2.0-2.2mm.

5) Impact resistamce is reduced by surface irregularities. Deep surface scratches may result in a person not getting the protection he thinks he is.



1. Polariscope
2. Furnace doors
3. Furnace
4. Lens material chart
5. Air blower
6. Lens holder
7. Caliper tripods
8. Lens type knob
9. Time set button
10. Time indicator knob
11. Main power switch
12. Power indicator light
13. Start button
14. Temperature indicator

Figure VI-23

will require less heating time. This is the purpose of the "Lens Type" adjustment.)

3) Next, the lens is placed in between the two lens caliper tripods, convex side up, and then the "Time Set" button is depressed. This automatically rotates the "Time Indicator" knob clockwise and sets the timer.

4) The final step is to simply place the lens into the lens holder and depress the start button. From here on, the rest of the operation is automatic and does not require the operator's attention. Once the start button has been depressed, the furnace doors open, the lens automatically slides inside the furnace, and the timer begins to tick off the proper amount of time. When the time has expired, the doors again open, the lens slides out, and the air jets come on to rapidly cool the lens. Once the lens is cool, the jets automatically shut off and the tempering process is finished. The lens is ready to be drop-balled.

Chemical Hardening

Section VII

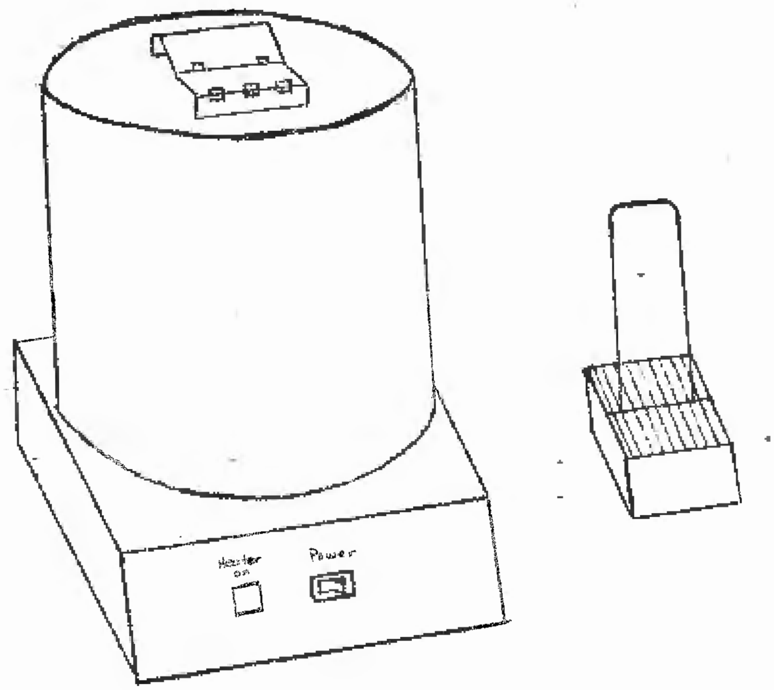
Chemical Hardening

The principle of building compressive stress into the surface of the lens is used in both thermal and chemical hardening. In the chemical tempering process, the surface compression is achieved by exchanging large ions for small ions in the glass. For example, potassium ions may be exchanged for sodium or lithium ions. A salt bath containing large quantities of these ions is usually used for the exchange process. Potassium nitrate (KNO_3) is the most common salt used. The rate of exchange is slow and requires 14-16 hours. The temperature is approximately 662°F-932°F, which is below the strain point, and therefore there is no lens warping and very little spontaneous breakage. Lens thickness is not a consideration and thin lenses can readily be chem-hardened.

Chem-hardening produces lenses that are 5-10 times more impact resistant than annealed glass lenses. Chemical strengthening is independent of size, shape and thickness of the lenses. Some chem-hardening units can treat 50-75 pairs of lenses simultaneously.

Photochromic lenses are usually treated in a separate chem-hard unit.

Kirk Optical Company, Inc. manufactures a series of chem-hardening units that will accept from 20 to 60 lenses. These are compact, relatively inexpensive and designed for small labs. Figure VII-24 shows the Kirk "Mini 20" which will hold twenty lenses. The temperature is controlled automatically. A numbered retaining basket holds the lenses and is placed in the unheated unit. When the chemical in the unit is cold, it is solid, and the basket with lenses sits on top of this solid surface. As the chemical is heated, it liquifies and slowly lowers the basket to immerse the lenses. The optimum time fron heat up to removal is 16 hours. However, the lenses may be left in the heated liquid chemical for more than 48 hours without any adverse effects, and therefore can be used over week-ends. At the end of the cycle the lenses are removed, allowed to cool to room temperature, and rinsed with water.



Kirk Optical "Mini-20" chemical hardening unit.

Figure VII-24

Lens Insertion

Section VIII

Lens Insertion

The assembly of a frame and insertion of the lenses is commonly referred to in the optical shop as benchwork. The fitting of a pair of lenses into a frame is known as insertion. Insertion is synonomous with the term glazing which is often used by many of the senior opticians. Inserting the lenses into a frame is the final step in the fabrication/ finish process, to be followed by a final inspection of the completed pair of spectacles.

Hand craftsmanship is at great importance in the insertion and assembly operations. The optician/benchman must have a number of special tools and devices at the workbench in order to complete the job. It is important that the correct tool be used to perform a specific task as these tools are carefully designed for specialized use. Improper usage may result in breaking, cutting, or marring of a frame or mounting, thus ruining it's usefulness as well as appearance.

There are several different materials that are used to make frames. Those frame materials to be discussed in this section will be zylonite, nylon, Optyl, and metal/wire. Rimless and semi-rimless mountings will be discussed in another section.

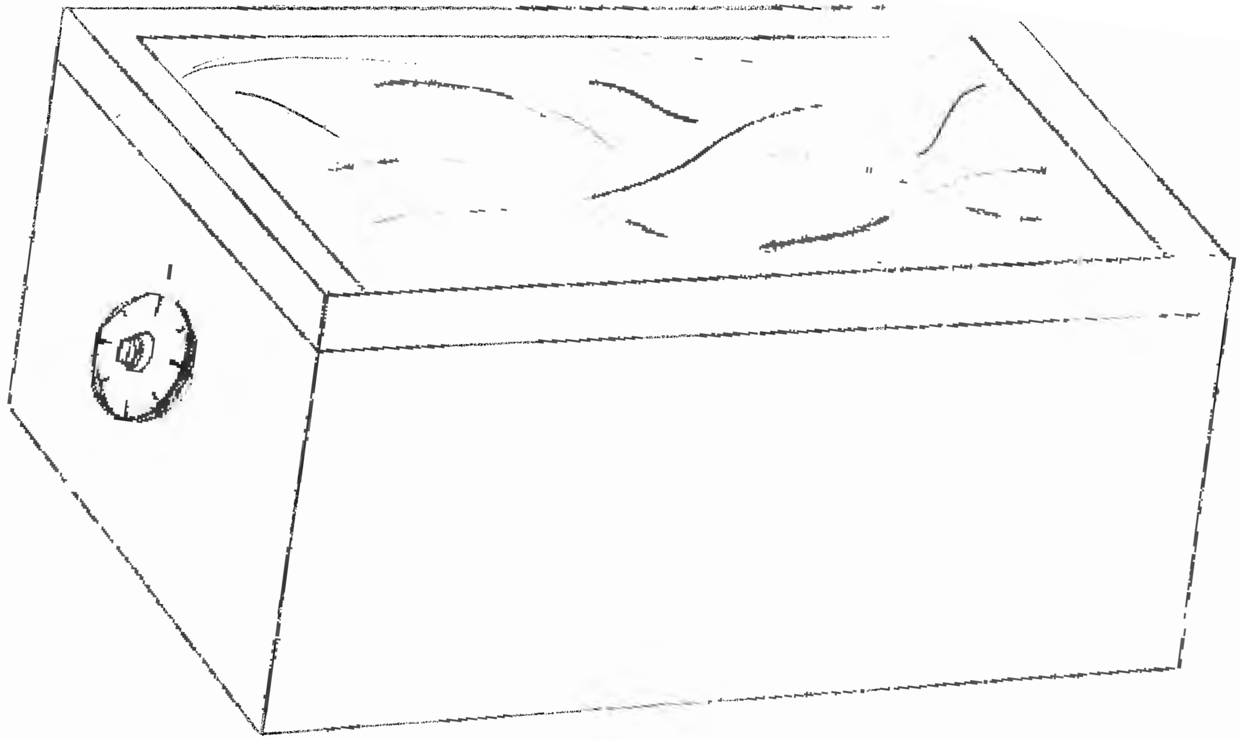
There are numerous techniques for inserting lenses into frames. This manual will offer only a basic/starting point method for beginners. After some practice the individual should develop his/her own personal style and preference.

Zylonite, nylon, and Optyl frames will be included under the generic classification of plastic frames. Plastic frames come in standard eyesize diameters, however it is always advisable to make the actual measurements with a millimeter rule as previously mentioned in the mark-up section. This is done to avoid any unnecessary errors. Plastic frames also are available in many different shapes, styles, and colors, both domestic and imported.

To insert a pair of lenses in a plastic frame it is necessary to heat the frame so that the eyewires can be stretched and the lenses inserted. Upon cooling, the frames's eyewires shrink back to normal size and securely hold the lenses in place. It is necessary to have some type of apparatus that will heat the frames to the proper temperature to make the material pliable. There are various ways to do this. The most popular and widely used device is called a frame warmer also referred to as a "bead bath" or "salt pan". (See Fig. VIII-1) This device consists of a rectangular receptacle filled with salt or glass beads and heated by means of an electric heating element below the receptacle. Another less widely used type of frame warmer is the air warmer. (See Fig. VIII-2) This again consists of a heating element in conjunction with a fan or blower which delivers an even heat flow to the frame to make it pliable.

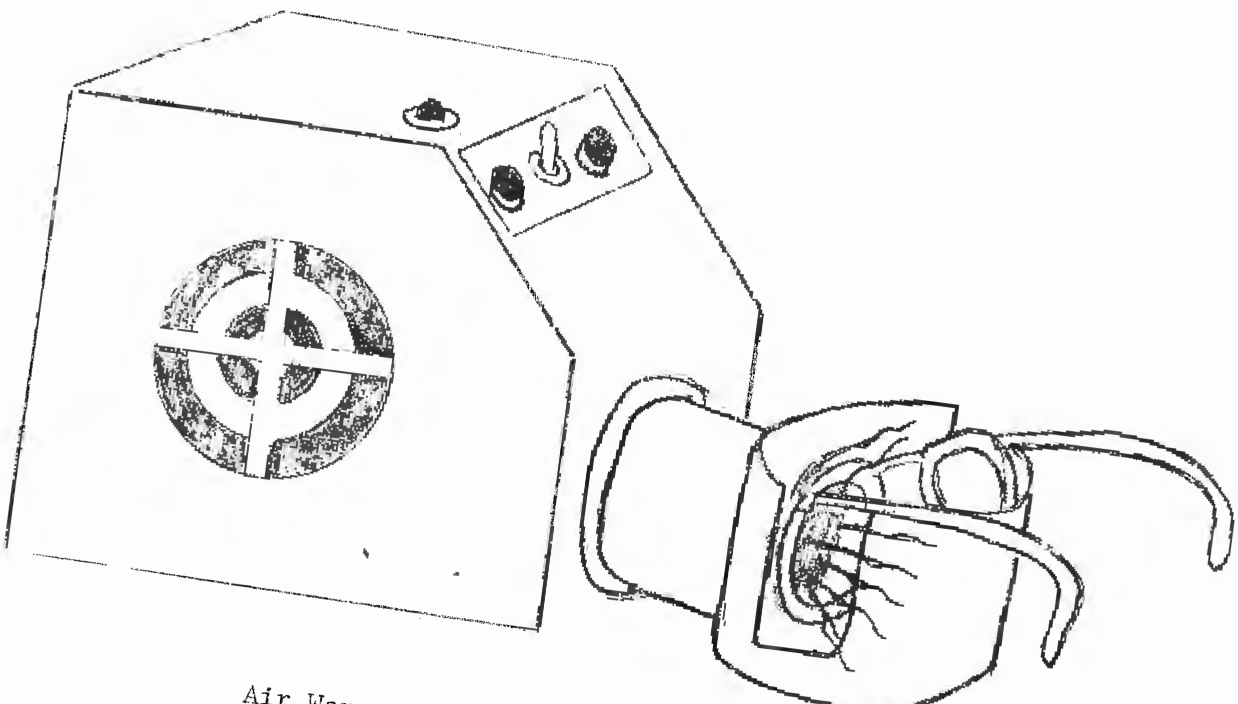
This manual advocates the use of the salt pan device. The salt pan must be filled with either small glass beads or salt. Glass beads may be ordered along with a salt pan from any optical supply house. It is recommended that one use salt for two good reasons. First, salt is much cheaper to buy than glass beads. Second, if a glass bead becomes stuck or embedded in the eyewire of a frame and the lens is inserted, there is only one way to remove the bead. This is to remove the lens, take the bead out and repeat the insertion process. With salt, if a few grains become stuck in the eyewire, all one has to do is submerge the frame in water and the salt will dissolve. If salt is used it must be the uniodized form or else a nasty odor will be given off when the salt is heated. The frame warmers heat the salt to the 325 to 400 degree fahrenheit range.

Before beginning the insertion process on a plastic frame the salt pan should be turned on for a period so that the salt is heated sufficiently.



Salt Pan/Frame Warmer

Figure VIII-1



Air Warmer

Figure VIII-2

A few shakes of baby/talcum powder is helpful in that it prevents the salt from clumping together. Also, immediately prior to placing a frame in the salt pan, the salt should be stirred with a spoon to insure that the heat is dispersed uniformly. This also helps to eliminate clumping and the sticking of salt to the frame.

Zylonite

One of the most widely used materials in the manufacturing of frames is zylonite. The procedure for insertion of lenses into zylonite frames as well as Optyl frames will be the same. Further notes about nylon and Optyl frames will follow the zylonite section.

After the salt pan has been heated and stirred, the process of inserting the lenses into the frame is ready to begin. The lenses should already be cut to the proper size for the frame to be used. Place the lenses on the work bench in front of the salt pan with the right lens on the right and left lens on the left. Do each eye separately starting with the insertion of the right lens.

Hold the frame in the left hand as shown in Fig. VIII-3. The thumb is placed on the outside of the bottom eyewire, with the middle finger on the outside of the top eyewire, and the index finger on the inside of the temple close to the frame front's endpiece. This will give one a snug and secure grip on the frame. If one were to hold the frame by the temples while heating and rotating it in the salt pan, there would be the risk of loosening the hinges on the endpiece. With the frame in the left hand, immerse the right side of the frame front in the heated salt and slowly move the eyewire in a smooth, circular rotation. This done so the frame will not be allowed to burn or pit as it might if it remained stationary. Do not heat the bridge as this will cause need for further heating and adjustment. Rotate the frame while heating until the material feels pliable

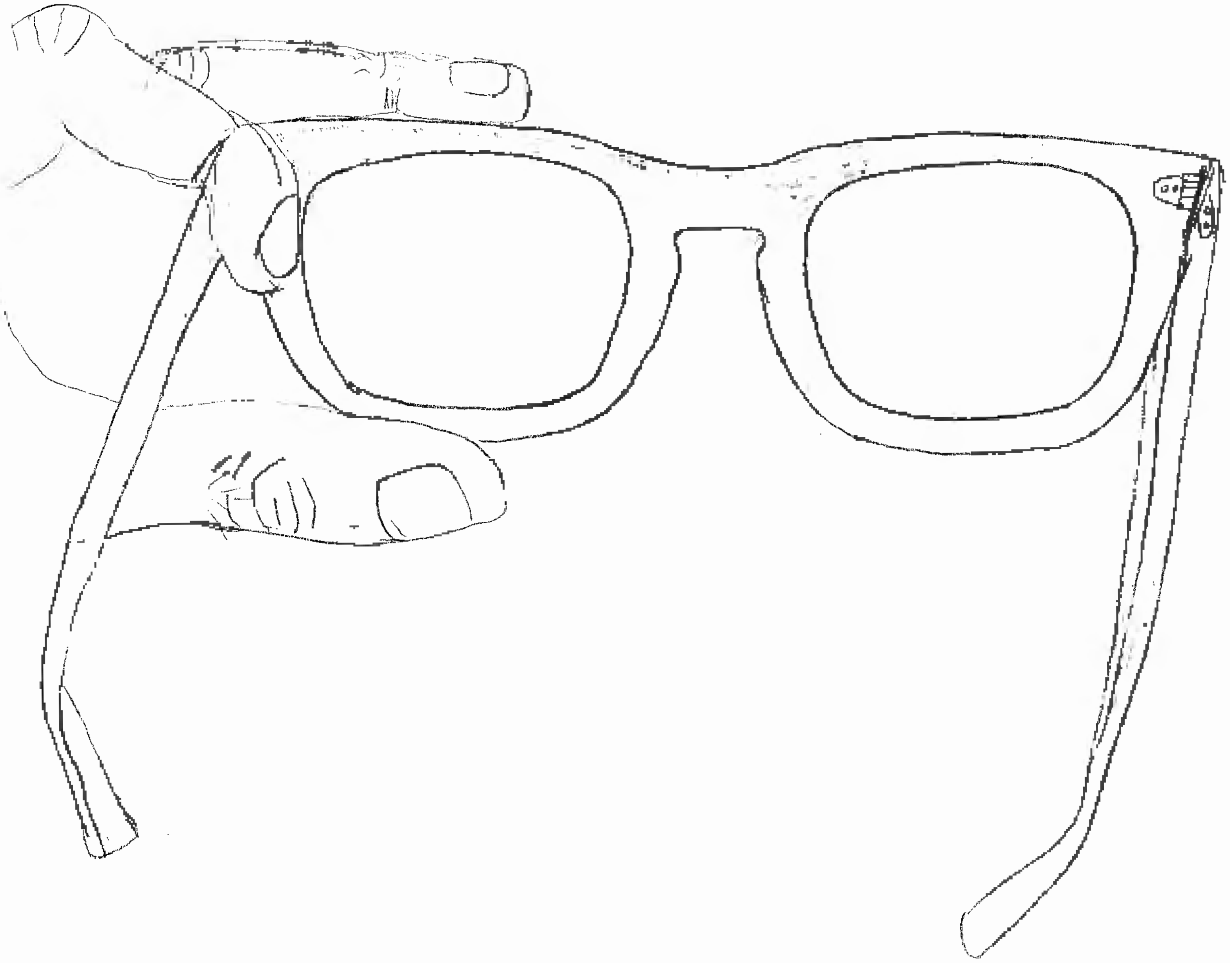


Figure VIII-3

but not so hot that it sags or melts. This "feel" will come with practice and experience. When the right eyewire is pliable, remove the frame, turn the frame over and place it (back side down in the left hand. Next, with the right hand, pick up the right lens and proceed with insertion. The first method will be insertion from the front side of the front.

Place the right lens concave side down on the right eyewire, matching the shape and contour of the lens with the shape and contour of the eyewire. Next, hold the temporal side of the lens with the right index finger and thumb. The thumb is on the convex side and the index finger is on the concave side. Hold the nasal side of the lens with the left thumb and index finger. The thumb is on the convex side and the index finger is on the concave side. (See Fig. VIII-4).

Start by inserting the temporal bevel of the lens into the temporal side of the eyewire. Next, progressively fit the bevel into the upper and lower parts of the eyewire and finish by using the left thumb and index finger to snap the nasal bevel into the nasal eyewire. At the same time the left thumb and index finger snap the nasal edge in, the right thumb and index finger are used to guide the lens towards the temporal side of the front. Do this gently and quickly. The whole process takes only a few seconds to complete. As soon as the right lens is inserted, repeat the same process for the left lens. The only difference being to hold the frame with the right hand when rotating the left side of the frame in the salt pan. When inserting the left lens repeat the same steps as when inserting the right lens.

For insertion of the lenses from the back of the frame, the procedures are the same as for inserting from the front. The only difference being that the thumbs are placed on the concave side of the lens and the index fingers are placed on the convex side of the lens. (See Fig. VIII-5 & 6). The frame

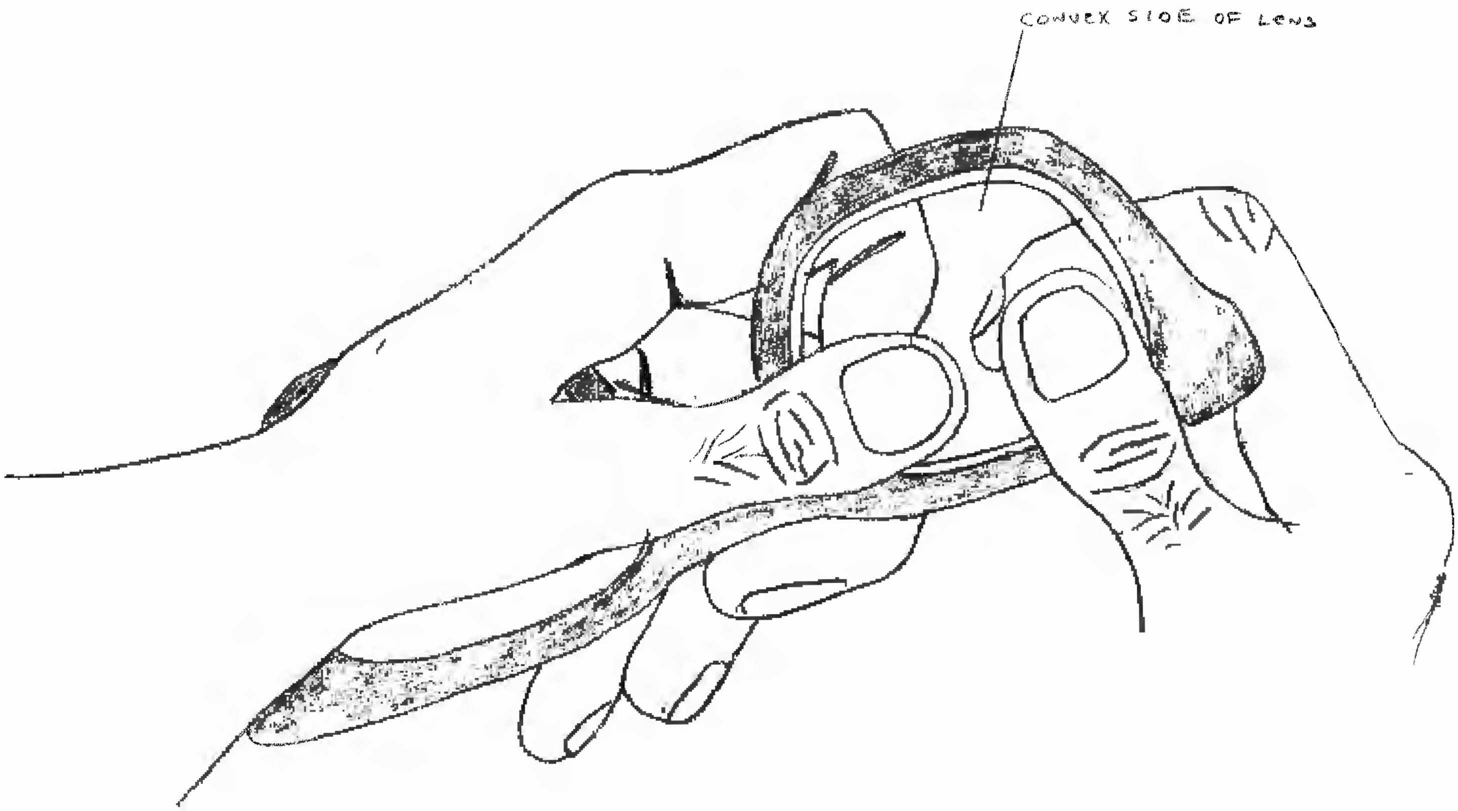


Figure VIII-4

Rear Insertion

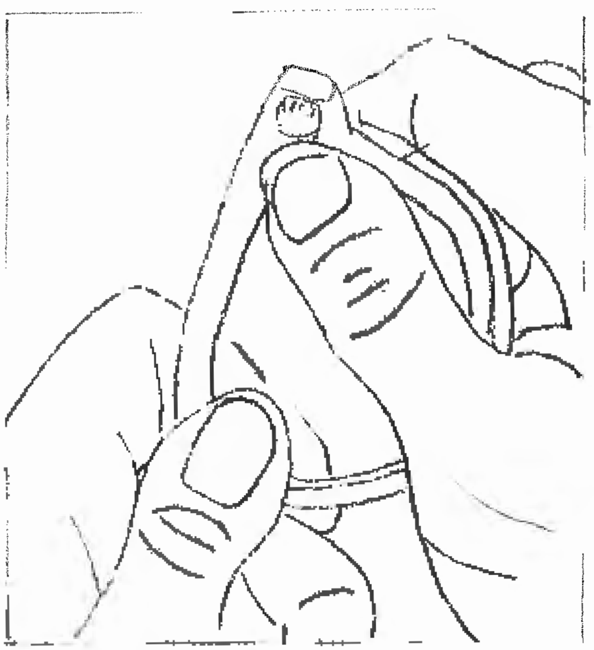


Figure VIII-5

Rear Insertion

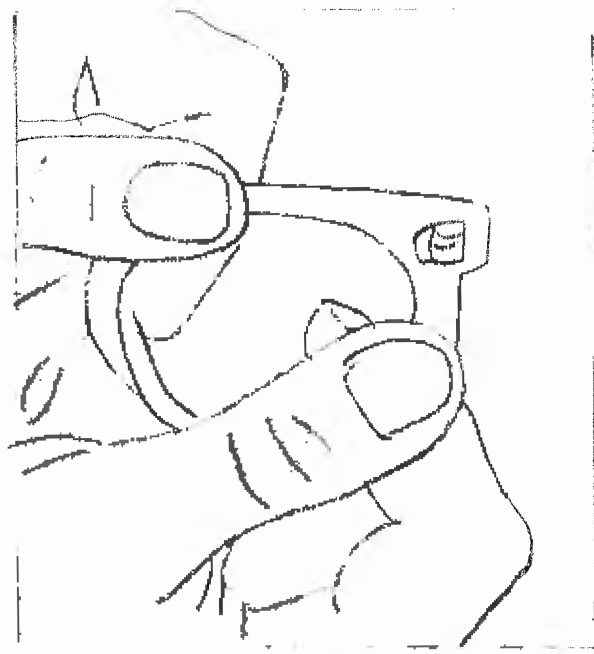


Figure VIII-6

Rolled Eyewire

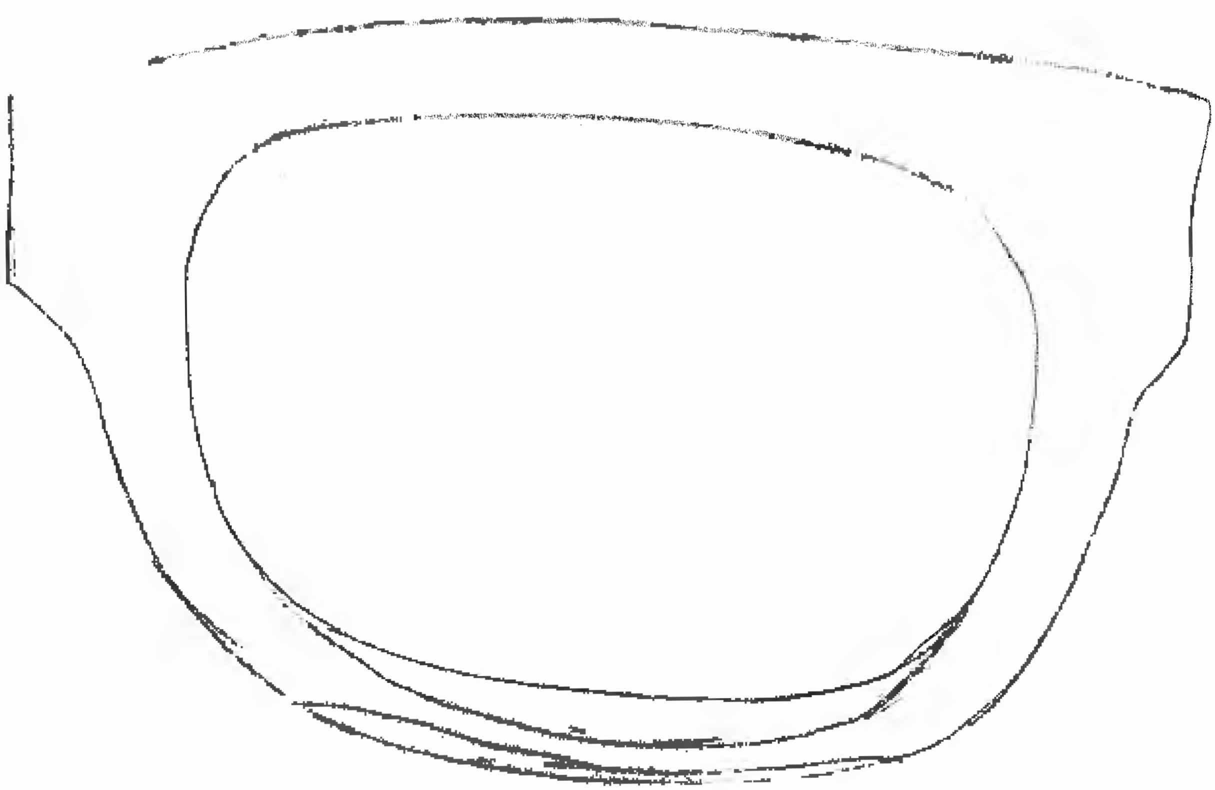


Figure VIII-7

is held front side down in the left hand. Rear insertion does not work well with frames that have adjustable nosepads as the arms and pads get in the way.

While inserting the lenses, one should be careful not to distort or roll the eyewires of the frame front. (See Fig. VIII-7). If rolling or distortion occurs, it renders the lens less secure, the spectacles are less safe, and the finished appearance is not worthy of compliment. Another pitfall for beginners may be to insert the lenses off axis thus the contour of frame does not correspond to the contour of the lens. This is sometimes referred to as nasal or temporal "humping". (See Fig. VIII-8 & 9).

Special Notes

1) In some cases the lenses to be inserted may have steep base curves thus steep curved bevels. When heating the frame during insertion it is necessary to bend the eyewire to match the curve of the lens. This can be easily accomplished with one's thumbs being used as a tool. (See Fig. VIII-10) Despite all the tools and pliers that are made for spectacle adjustment the hands are still the best and most versatile of all tools.

2) Most safety frames must have the lenses inserted from the front side because the front edge of the eyewire is smaller than the back edge. This safety feature helps prevent the lens from being forced out of the eyewire and against the eye.

3) In instances where lenses are cut too small for zylonite frames, the eyewires can be heated and then immersed in ice water. Bang the frame on the side of the sink as it cools and this will cause the material to shrink and the eyewire to become smaller in circumference.

Nylon

Sometimes patients have allergic reactions to the materials composing zylonite and metal frames. In such cases it may be necessary to fit the

Nasal Humping/Off Shape

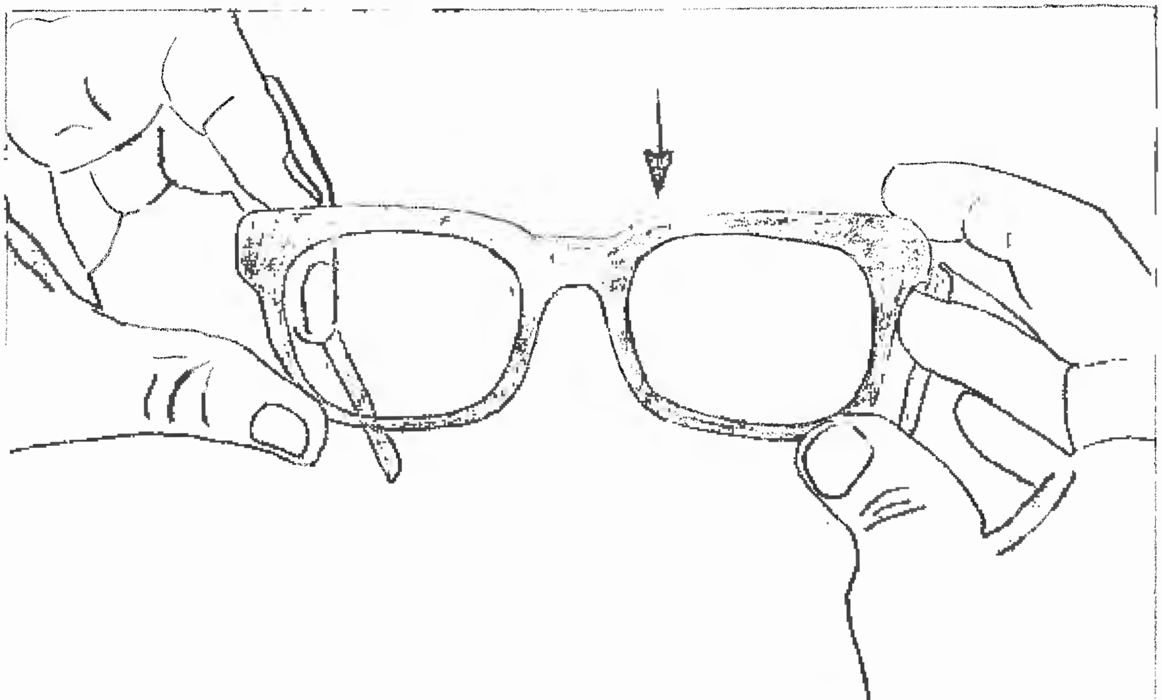


Figure VIII-8

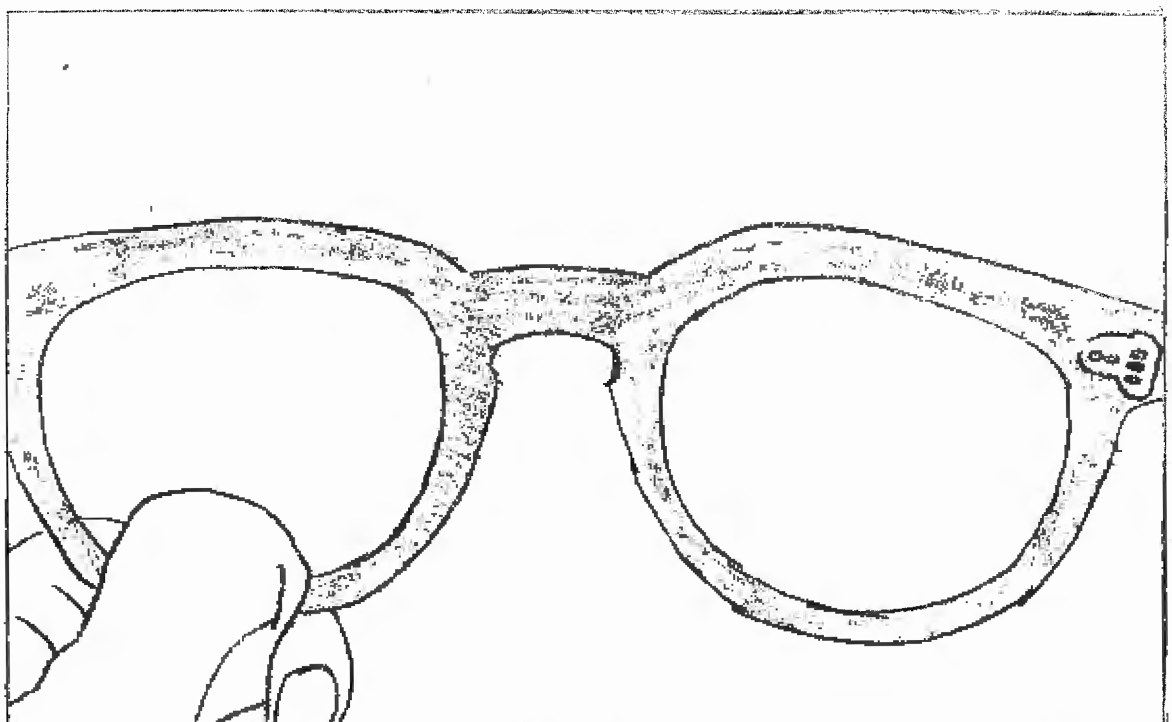


Figure VIII-9

Match Curve of Eyewire to Curve of Lens

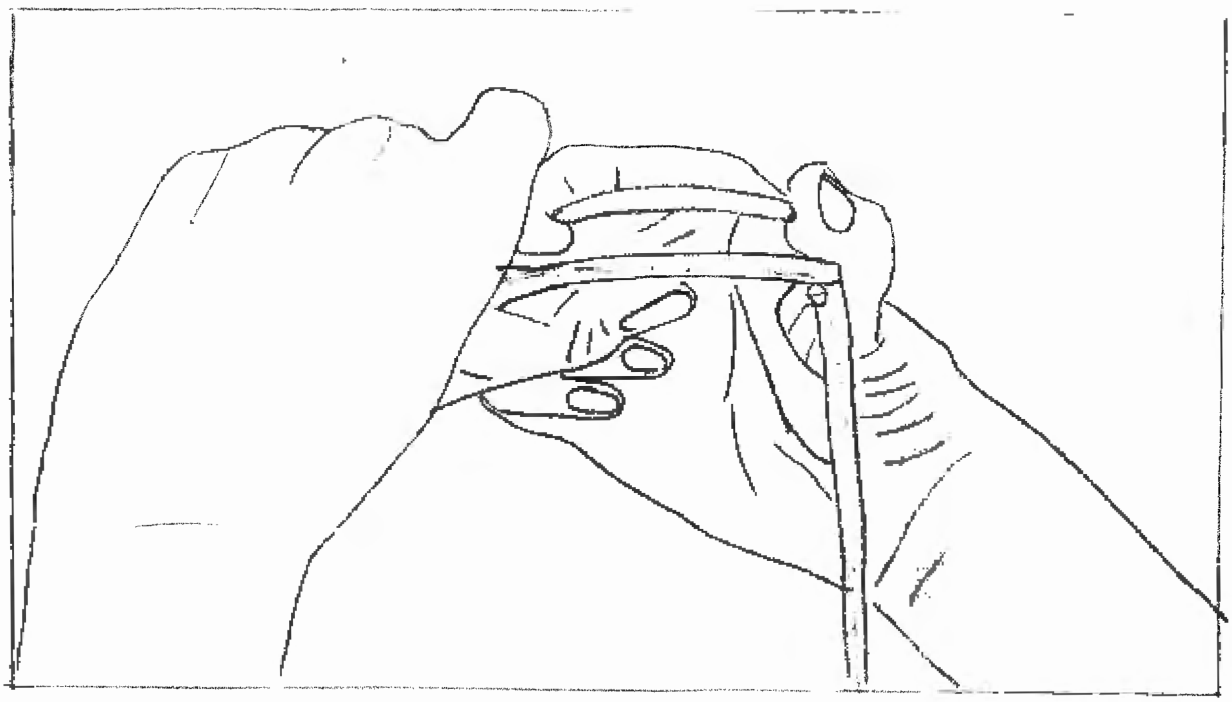


Figure VIII-10

person with a nylon frame. The insertion process for a nylon frame is the same as for zylonite. There are a few things to note when working with a nylon frame. 1) The lenses must be cut closer to exact size than those for zylonite frames as nylon is very tough and does not stretch as easily or readily as zylonite. 2) The nylon material does not heat as uniformly as zylonite so that some recommend immersing the frame in hot water for the heat to better penetrate the material. 3) Be extremely careful not to cut the lenses too small as nylon will not shrink as in zylonite frames. 4) When adjusting a nylon frame, the frame must be heated and bent and then held in the bent position until cool, otherwise the frame will return to its original shape. 5) The insertion of lenses into a nylon frame requires one to use a little more force--don't worry it is very hard to roll and distort the eyewire.

Optyl

Optyl is a material made of epoxy resins. The frames are cast-molded and are 20%-30% lighter than zylonite frames. In contrast to zylonite, the material does not shrink therefore lenses should be cut between 0.5mm to 1.0mm oversize.

Insertion technique is the same as mentioned previously in the section on zylonite. Heat the frame until it is pliable and then insert the lenses. The lenses will go in much easier than with zylonite or nylon. A nice feature of Optyl material is that if the frame is distorted all that need be done is to reheat the frame and it will assume its original shape. The epoxy resins have a "memory" so to speak.

After heating the frame and inserting the lenses let the frame cool in the air. Do not immerse the frame in water as done with zylonite to shrink the eyewire circumference or to secure the lenses. In contrast to zylonite, when optyl frames are placed in cold water it will stop the shrinkage thus leaving the lenses loose in the eyewire.

Metal/Wire

As compared to plastic frames, metal frames must have their lenses cut more closely to exact size. If cut too large, the barrels on the endpieces that are screwed together to secure the eyewire and lens in place will not meet. This causes undue stress on the lens as well as the frame. If cut too small, gaps will remain. Cut extremely small the lens will not be salvaged.

As covered in the section on edging, the lens is sized more carefully by placing the lens in the eyewire and using an endpiece plier to squeeze both barrels together to see if one has cut the lens to proper size. Also while doing this a cold bend plier and/or metal eyewire forming plier is used if needed to match the curve of the eyewire to the curve of the bevel of the lens.

Once this has been done, insert the lenses one at a time by placing the lens bevel into the eyewire groove all the way around. Squeeze the barrels together with an endpiece plier to check size and fit. Next insert the screw and thread it in until snug and secure. Next attach the temples and true up the frame to make it ready for dispensing.

NOTES: If the lens has been cut too small: 1) Lens washer may be inserted between the eyewire groove and lens bevel to fill in gaps and spaces, thus securing the lens and improving appearance, 2) The barrels may be filed down to decrease the eyesize and make the lenses fit securely. (See Fig. VIII-11,12) If a lens is cut off axis one should attempt to salvage it on a handstone as described in the edging section.

References

1. Class notes and handouts, Ophthanmic Dispensing course, Dr. D.O. Schuman,1981.

2. Class notes, U.S.Army Optical School, 1976.

Filing the Barrels

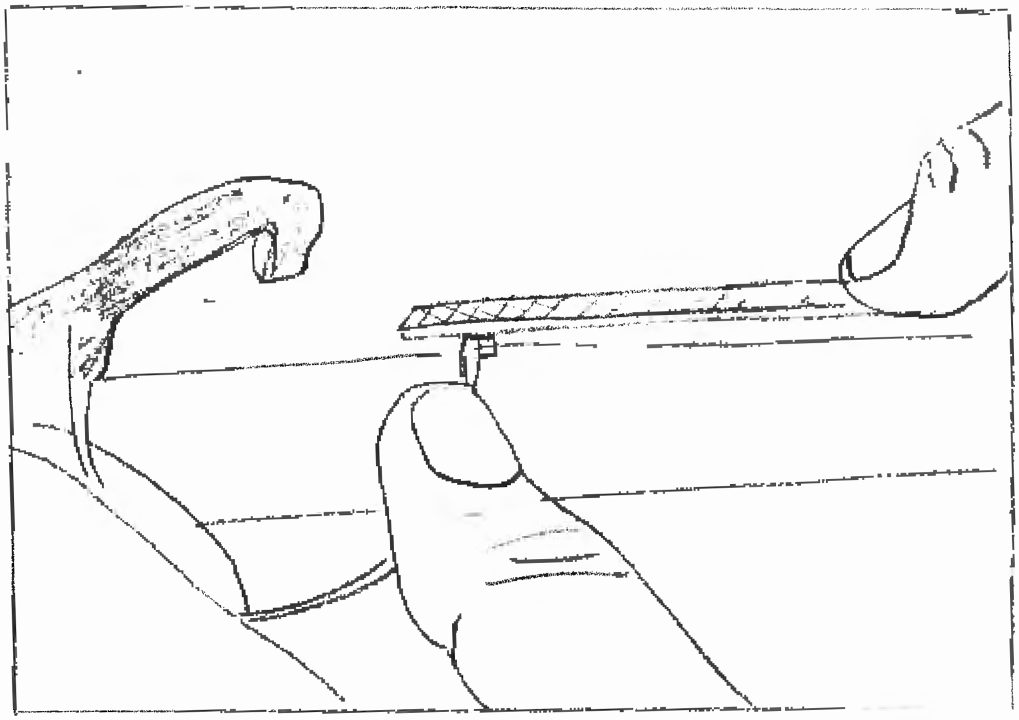


Figure VIII-11

Filing the barrels reduces the circumference of the eyewire to tighten lenses and eliminate gaps

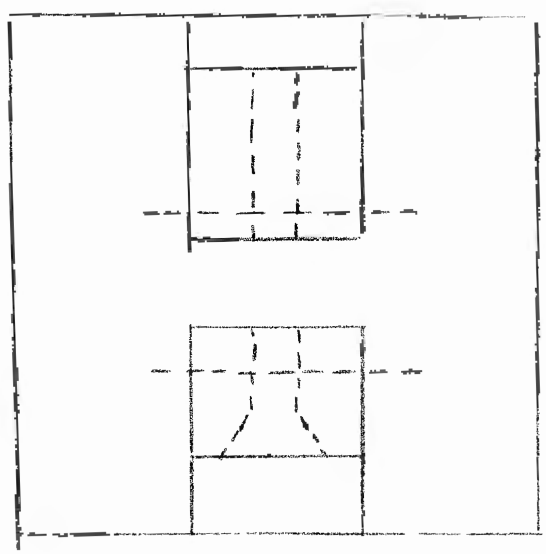


Figure VIII-12

3. Brooks, C.W. and Borish, I.M., System for Ophthalmic Dispensing, Chicago: The Professional Press, Inc., 1979.

4. Norwood, N.J., How to Work with Optyl, Optyl Corp., 1976.

Semi-Rimless

Section IX

Semi-Rimless

In this section semi-rimless drilling, grooving and mounting will be discussed. Many of today's frames are incorrectly called rimless. A rimless mounting consists of a bridge and two end pieces. The bridge is attached to the two lenses by drilling holes in the nasal portion of each lens and securing the strap to the lens with a screw. Holes are also drilled in the temporal portion of the lenses and attached to the end pieces by straps and screws. (See Fig. IX-1)

Mounting styles of today are really semi-rimless, as endpiece, top eyewire (arm) and bridge are all connected, with the lower half of the lens having no eyewire surrounding it. (See Fig. IX-2) These type mountings have gone through many changes in the past decade. Formerly lenses were mounted by means of drilling holes and securing by screws. Today we see this replaced by grooving of the lenses and securing by means of a thin nylon thread which fits into the groove of the lens.

In earlier decades all lenses were glass and were drilled using special lens drilling equipment, diamond impregnated drill, and drilling oil. Today, virtually all semi-rimless and rimless spectacles are made with plastic lenses. This manual will deal only with drilling and grooving for semi-rimless mountings that are in vogue at present. If one wishes to learn the rudiments of glass drilling or rimless mounting and benchwork he/she is referred to Ophthalmic Mechanics Vol. I by E.H.Waters as this excellent work provides all the necessary explanations, pictures and diagrams.

Semi-Rimless---Spotting, Drilling, Mounting

The first step in making a pair of semi-rimless spectacles is to cut the lenses to exact size. The lenses are also edged with out the usual bevel. This was explained previously in the section on cutting and edging a lens. After this is accomplished and the lenses are deblocked, hand-edged, and if

Rimless Mounting

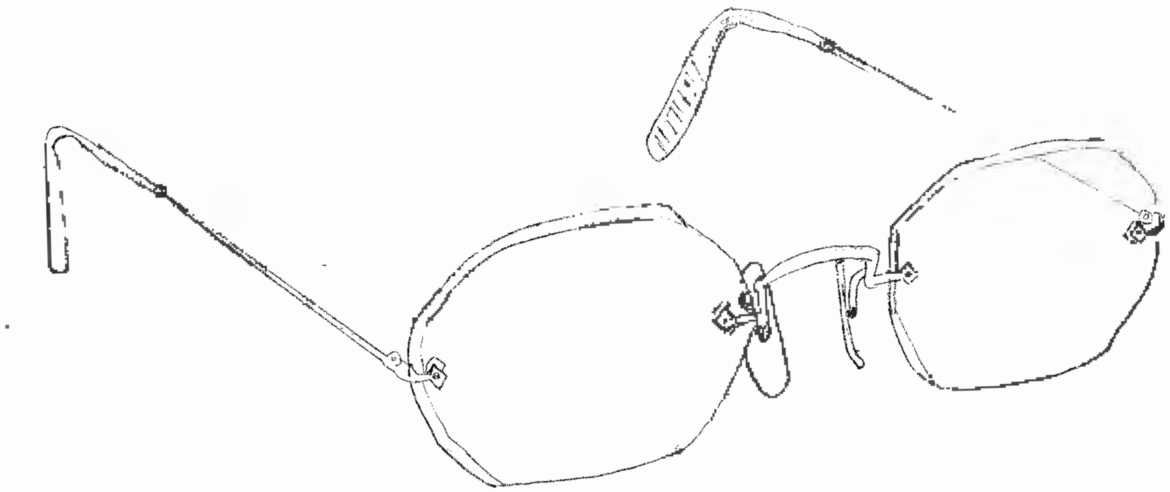


Figure IX-1

Semi-rimless Mounting

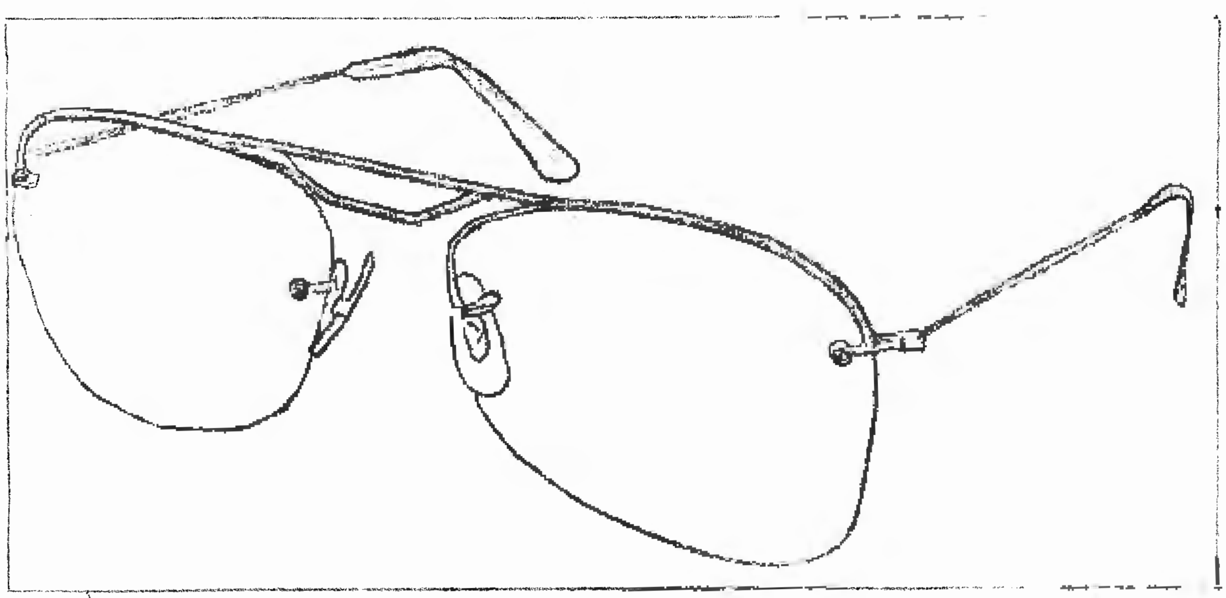


Figure IX-2

necessary tinted, the benchwork is ready to begin. The lenses need to be spotted accurately, drilled for mounting, and assembled. The completed spectacles are then "locked up" and trued.

Before spotting the lenses a few things must be done. First, one must make sure that the semi-rimless mounting is adjusted so that the arms of the mounting match the contours of the tops of the lenses. By this it is meant both the actual style/shape of the lens as well as the back curve of the lens. (See Fig. IX-3)

This adjustment of the mounting's arms should be done using a Numont plier as this is a grooved pincer plier specially designed for reshaping Shurset/Numont type arms. Never use a plier that is not specifically designed for such a task as one may mar the arms of the mounting. After the necessary adjustments or reshaping, the mounting should be placed in some type of mounting holder. This may be made from a simple cardboard box. (See Fig. IX-4) This mounting holder will free both hands and make the job of spotting easier.

Place the mounting in the holder and place the right lens on the mounting. Hold the lens against the mounting with one hand making sure that the lens exactly matches the contour of the mounting's arm. Next, look at the lens and mounting from straight above and never at an angle. In other words, sight the drilling mark at a point perpendicular to the threaded hole of the mounting's strap. This is done to help to avoid parallax. With a marking pen place an ink dot on the lens, aiming at the center of the hole of the strap beneath the lens. (See Fig. IX-5)

Spot both nasal and temporal holes. After the lenses are spotted on the convex side, recheck to see if the ink spot is centered in the strap's threaded hole while matching shape to shape contour of the mounting and the lens. Repeat the above process on the left lens.

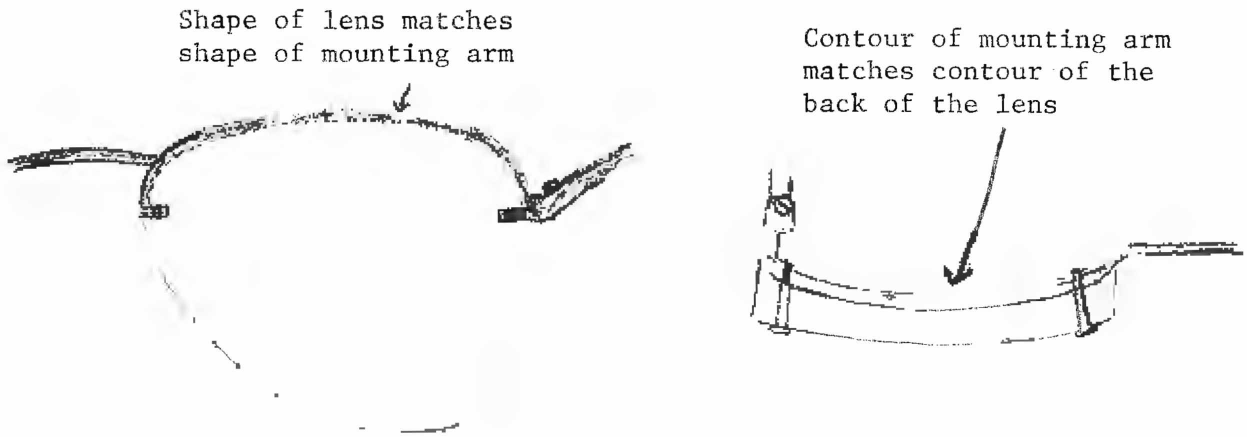


Figure IX-3

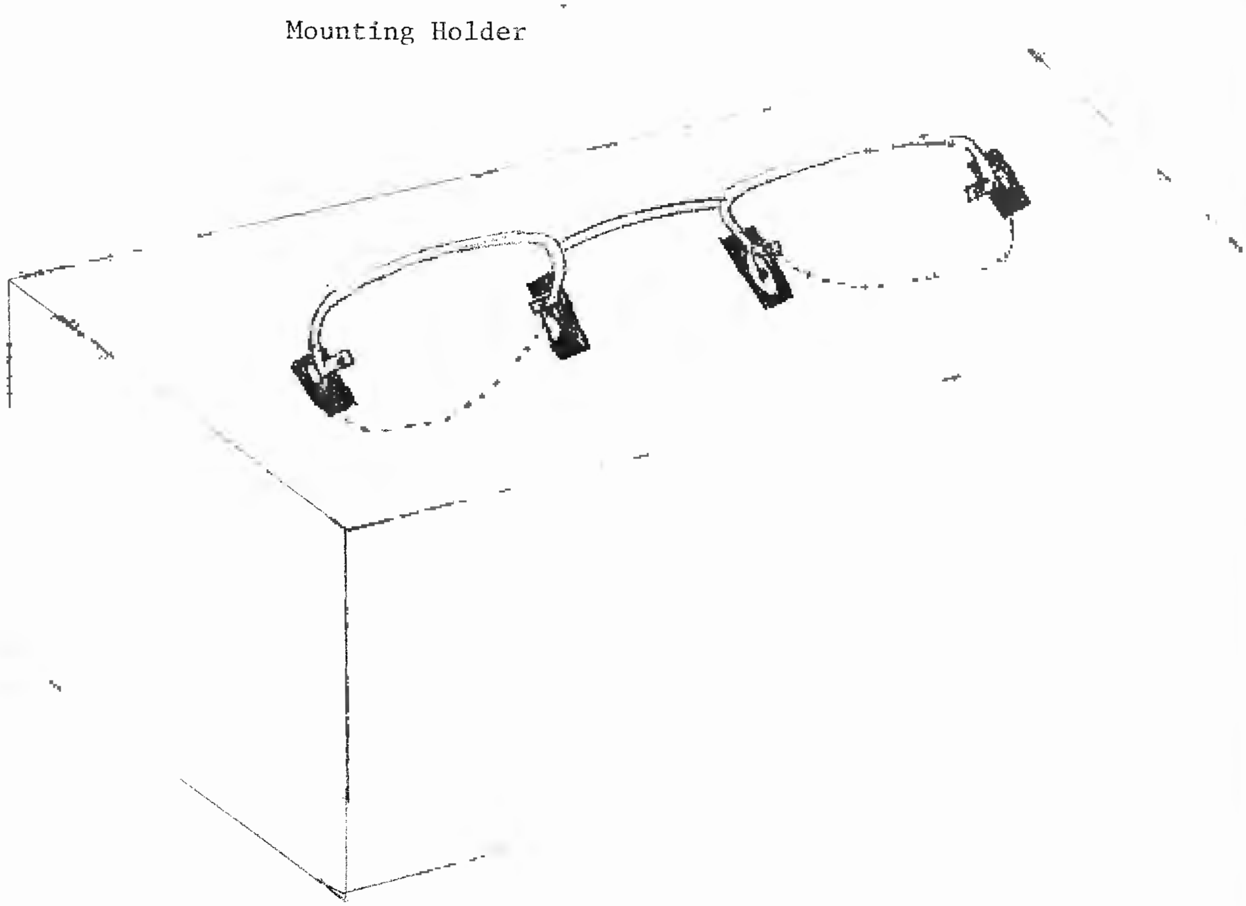


Figure IX-4

When you have rechecked both lenses and are confident that the ink dots spot are positioned correctly then it is time to drill the lenses.

To drill the plastic lenses it is not necessary to use an electric drill. It is both less expensive and simpler to use a drill bit mounted in any type optical pin vise or tap holder. A ratchet type drill may also be used. (See Fig. IX -6) When using the ratchet type drill be sure to start the hole first with a pointed object otherwise the bit may slip when pushing down on the ratchet mechanism and scratch the lens.

Four common faults in drilling lenses are: 1) Drilling off the perpendicular, 2) Drilling too close to the edge of the lens, 3) Drilling non-stop all the way through the lens, and 4) Drilling the holes too large. Each of these will be discussed.

1) Don't drill off the perpendicular means. Make sure that the holes are being drilled perpendicularly to the lenses surface and parrallel to the unbeveled edge. (See Fig. IX-7) So once again you must be wary of parallax. Take a few sightings directly over the work as you drill the holes.

2) Don't drill too close to the edge of the lens. At least 3mm should be left between the hole and edge of the lens. If the hole is drilled too far into the lens the excess material can be taken off but if the holes are drilled too close to the edge the plastic will probably fracture.

3) Don't drill all the way through the lens without stopping. The lenses must be drilled part way through and then flipped over and drilled until the two holes meet. Begin drilling with the concave side up and drill approximately half way through. The reverse sides and drill through the convex side until you meet the hole from the concave side. When the two holes meet you will feel a decrease in the resistance. At this point ease up on your pressure and use a delicate touch. If there happens to be an "off line" union of the two holes the lens must be reamed out carefully

Sight and Aim Straight

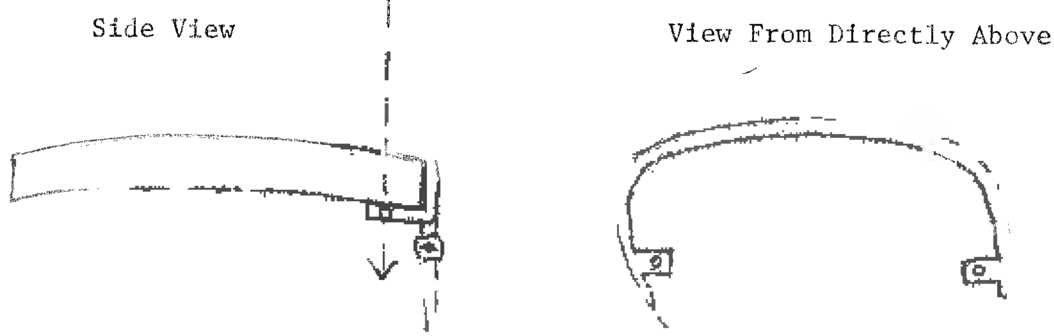


Figure IX-5

Ratchet-type Drill Device

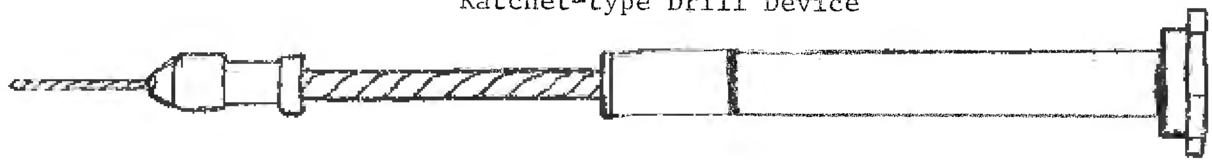


Figure IX-6

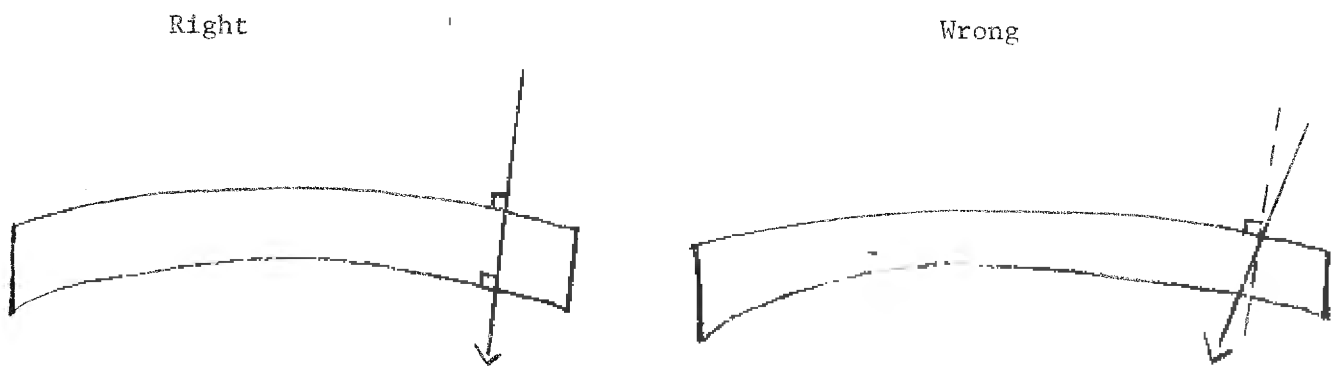


Figure IX-7

and delicately as too much pressure may cause flaking or fracture of the lens.

4) Don't drill the holes too large as oversize holes sooner or later will make the lens wobble because the threaded straps cannot hold them securely unless the screws are tightened to extremes thereby risking fracture of the lens. Use a #60 drill bit. The hole can then be reamed out to match the size of the screw and bushing that are used.

Shuron Shurset type screw assemblies should be used, (See Fig. IX-8), even if not using a Shuron mounting. These screw assemblies consist of a screw and plastic bushing that fits into the lens hole. The bushing helps to prevent the screw from backing out. The assembly also has a metal washer that prevents the screw head from exerting pressure against the hole. Drill and ream the holes a tad smaller than the bushing diameter so that the assembly will fit snug and secure. A touch of acetone on the plastic bushing will make it soften and insert easier into the hole. After it dries the plastic will harden again, thus a tight and secure fit.

A Shurset type strap has only one hole thus there is no need for adjusting the pressure or tension of the strap. Also there is no need to widen or narrow the strap as there is in the old 2-hole "skeleton" straps. As stated earlier Vol. 1 of Ophthalmic Mechanics by Waters covers these older type mountings in case one ever encounters such a job. There are very few of these older style frames and mountings around today thus we feel a need to concentrate on the newer semi-rimless styles in existence at the present time.

The screw, washer, and bushing come as a complete unit and are fitted into the holes of the lens first before turning the threads into the strap's hole. The lenses should be mounted on the nasal or bridge side first. Do not tighten the screw all the way. Next, screw in the temporal side. Be sure to line up the mounting arms and lens shape, contour to contour and then firmly secure the screws.

The screw assemblies come in different lengths. Longer for high minus lenses and regular length for normal Rx lenses.

After the lenses are mounted and secure the ends of the screws must be clipped off. For this task use a chappel cutting plier. Back the screws off half a turn and cut. Retighten the screws one half turn and a small amount of screw metal is left. Next take a burnishing or peening plier and peen the screw tip. This plier will roll over the cut off end of the screw leaving a mushroom-like tip which will prevent the screw from backing out. (See Fig. IX-9)

Next, true up the frame and inspect to prepare it for dispensing.

Semi-Rimless, Grooving, Inserting, Stringing

The nylon thread and groove method of securing lenses in a semi-rimless mounting is in widespread use today. A groove between 1 and 2mm deep is cut around the circumference of the lenses and they are then secured by a ridge on the mounting arm and a thin, clean, nylon piece of thread that is unnoticeable to the casual observer. This style of mounting offers a better cosmetic appearance. After the lenses have been cut and sized for a semi-rimless mounting as described in the edging section, then deblocked, hand edged, and tinted if necessary, you are ready to cut the grooves. There are both manual and automatic lens groovers on the market.

With a manual groover the lens is centered and secured on a suction cup spindle. The spindle fits into a brace that permits the spindle and lens to be turned. One must turn the spindle and lens by hand. The lens edge comes in contact with a grinding wheel which cuts a groove in and around the circumference of the lens. The groove depth can be adjusted as well as the angle of the grinding wheel contacting the lens edge. The price of a manual groover is approximately one fourth that of an automatic groover.

Shurset Screw Assembly

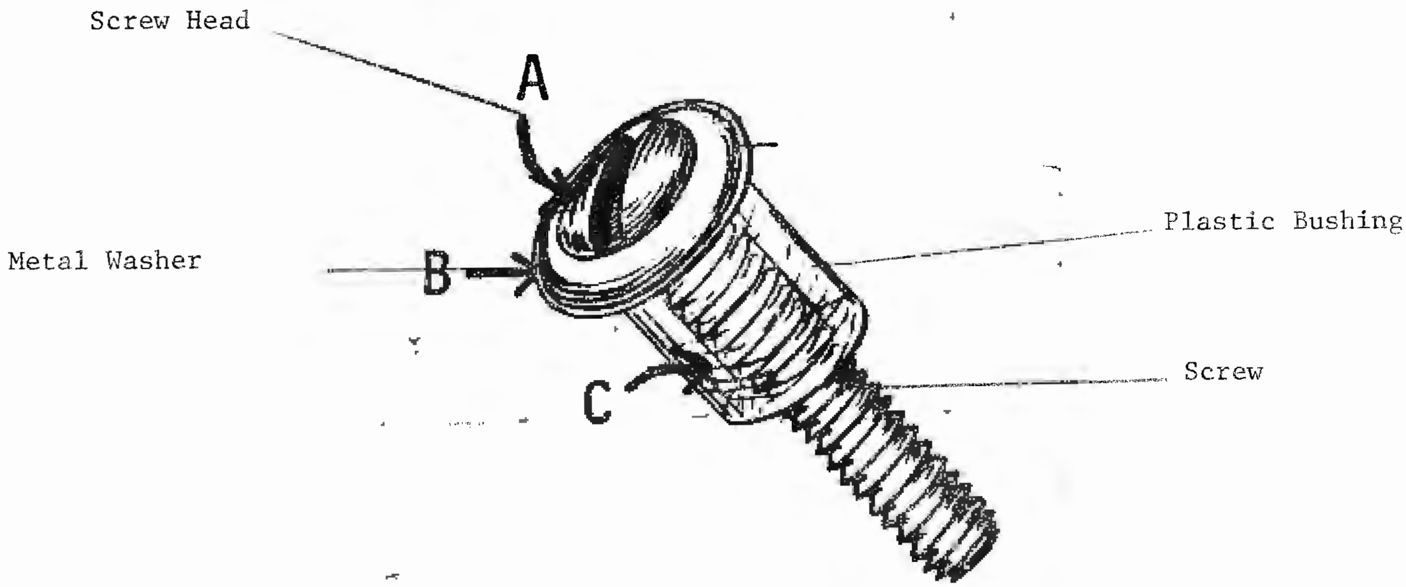


Figure IX-8

Securing The Screws

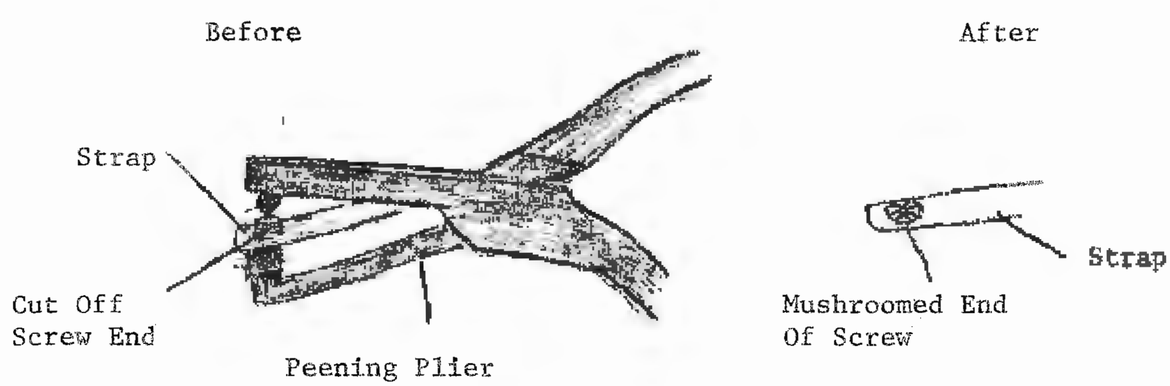


Figure IX-9

With an automatic lens groover, the lens is centered and secured in place on a clamping head. These clamping heads are free floating on most of the lens groovers and automatically track any base or back curve. The cutting groove depth is adjusted by a knob. This depth varies with the various frame styles. Check each frame manufacture's instructions. Also there are 3 preset lens groove positions on most automatic models. These positions are front, center, and rear, and follow the lens contours. The grinding wheels are usually diamond impregnated for fast, clean, cutting of grooves. Motorized lens drives insure uniform depth and angle of groove around the entire circumference of the lens which is hard to obtain with a manual groover. These units can be easily used by unskilled operators and require only that one secure the lens in the clamping head, adjust the groove depth setting knob, adjust the groove position setting and turn the machine on. These groover's finish the job in 40-60 seconds per lens. (See Fig. IX-10)

Mounting the Lenses

To mount the lenses in a nylon filament semi-rimless frame follow these steps and refer to Figures IX-11 and IX-12. Hold the frame with the left hand and fit the ridge of the arm into the top groove of the lens. (See Fig.-IX-11) Now hold both the frame and lens with the left hand, slip a piece of ribbon through the loop of nylon thread. (See Fig IX-12) Next, starting on the temporal side, use the ribbon to guide the nylon thread into the lens groove. Progressively fit the thread into the groove until the entire lens is secured. Finally, work the ribbon back to the bottom of the lens, release one end of the ribbon and gently pull it out.

Restringing

First make sure all the thread is removed from the holes on the mounting's arm. Next cut a piece of nylon thread long enough to fit around the entire circumference of the lens with a little extra room to

Automatic Lens Groover

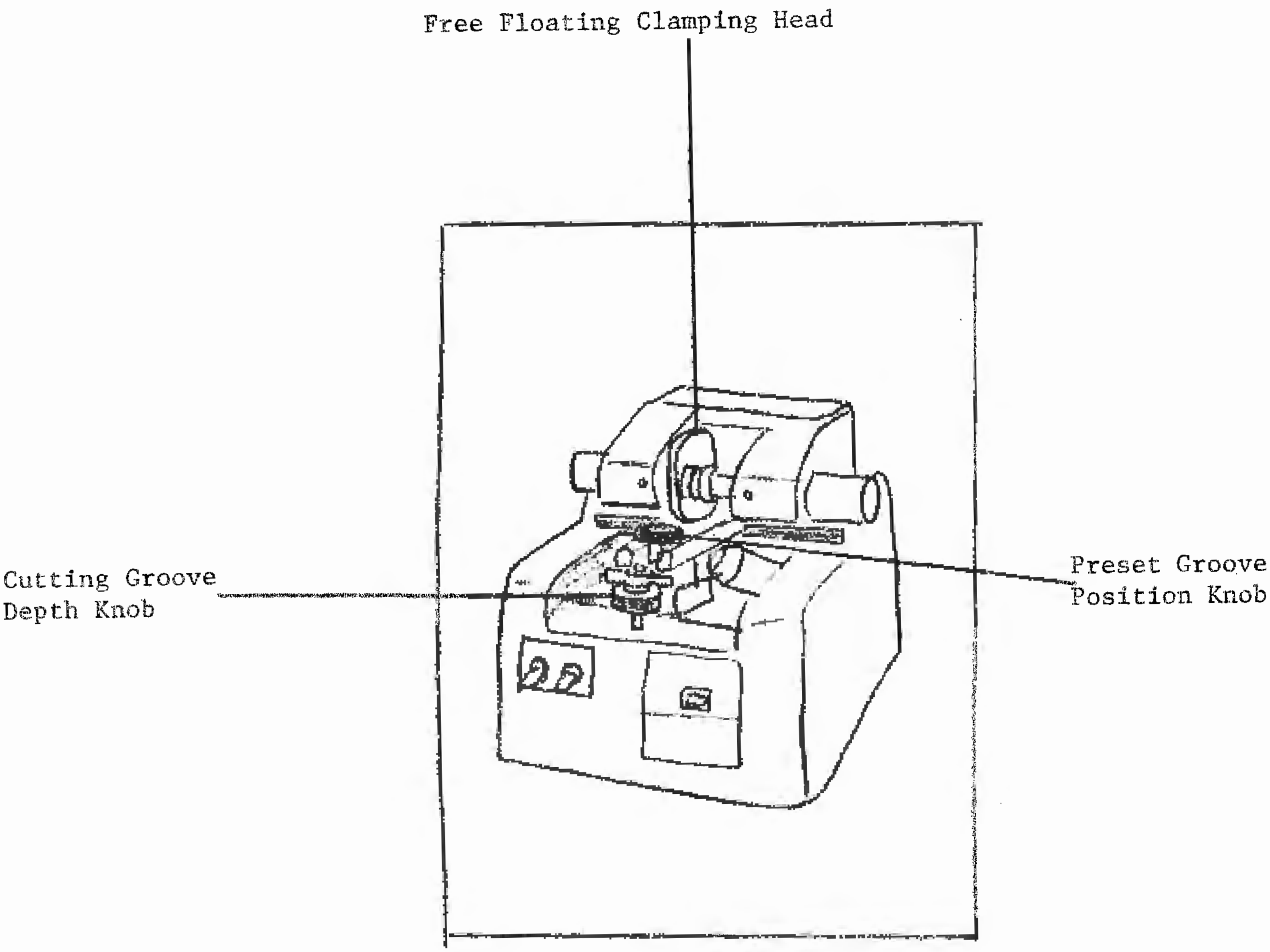


Figure IX-10

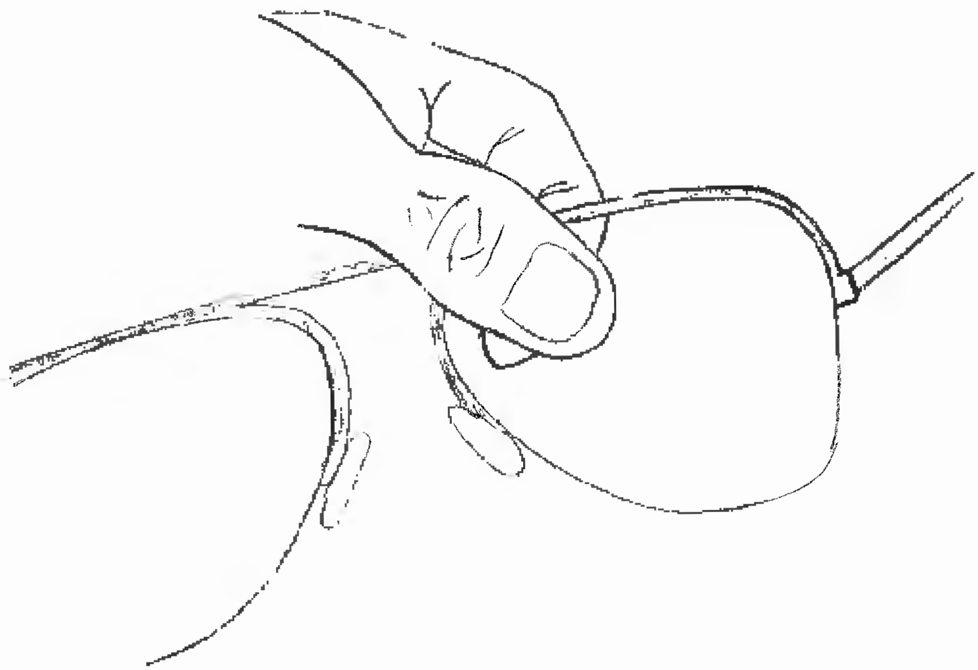


Figure IX-11

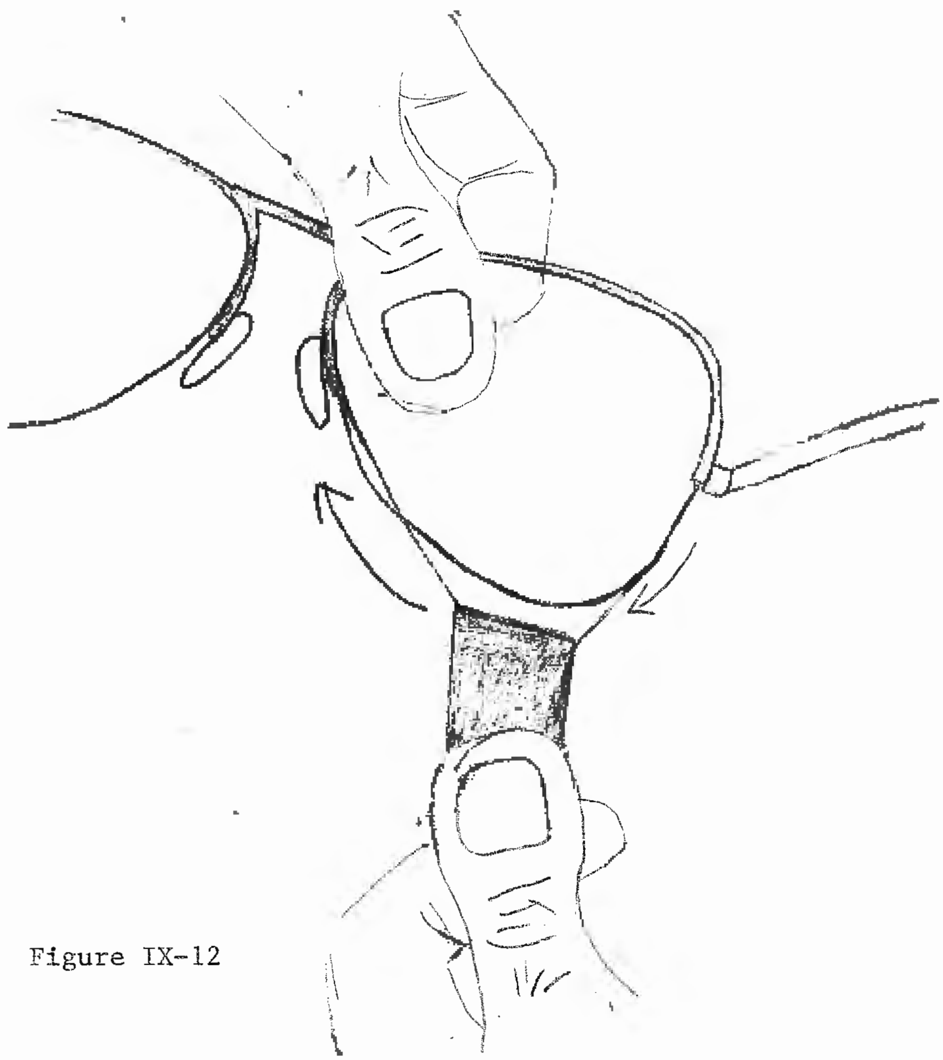


Figure IX-12

spare. Work on the nasal side first by inserting one end of the thread through hole A and then thread it back through hole B. (See Fig. IX-13) Crimp the end of the thread into the groove of the frame with a snipe-nose plier. (See Fig. IX-14) Next, fit the lens in the ridge of the mounting's arm and hold with the left hand while guiding the thread into the lens groove with the other hand. Thread the end of the nylon through hole A on the temporal side and pull it secure but not too tight. Take the lens out and secure the thread as described previously. Finally, mount the lens and check the thread tension by working the ribbon to the bottom of the lens and pulling down on the ribbon. A gap of about 1.5mm should be seen between the lens and the thread.

References

1) Class notes and handouts, Ophthalmic Dispensing Course Puco, DR. D.O. Schuman, 1981.

2) Class notes, U.S.Army Optical School, 1976.

3) Weber, J.M., How to Simplify Rimless Benchwork, 20/20, Nov/Dec, 1976.

4) Waters, E.H., Ophthalmic Mechanics, Vol. I, 1941.

5) Vigor Adjusting Tools and Supply Catalog, New York: B. Jadow & Sons, Inc., 1978.

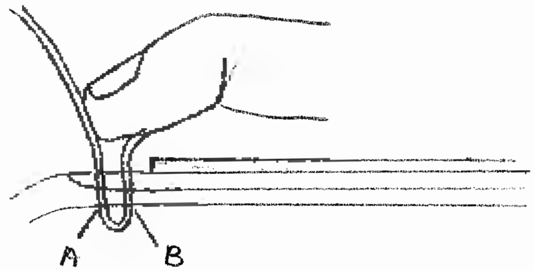


Figure IX-13

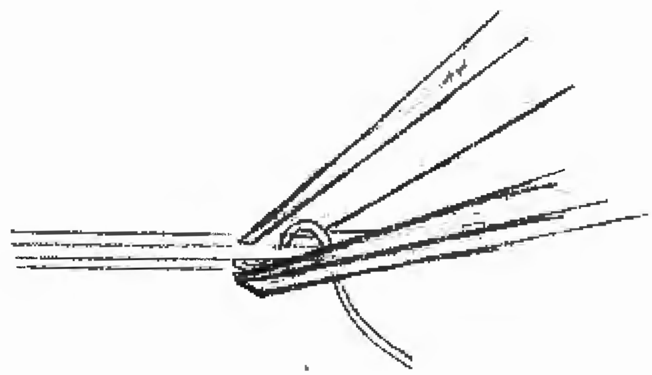


Figure IX-14

Inspection
Section X

After all the steps of the fabrication process are completed the finished spectacles must be inspected and verified before leaving the laboratory to be dispensed. The ANSI standards for prescription eyewear are contained in Appendix A. All spectacles must conform to these standards. A checklist of things to be verified is listed below.

1) Correct sphere power, cylinder power, and cylinder axis.
2) Correct PD (near/far) and look for any unwanted prismatic effects.
3) Correct amount of prism through the MRP.
4) For multifocals check for correct ADD power, segment type, segment height, segment tops straight and aligned.
5) Correct lens material: clear glass, photochromic, plastic, etc.
6) Correct tint.
7) No scratches, flakes, or chips, etc.
8) Make sure lenses are "on shape".
9) No loose lenses or gaps.
10) No rolled eyewires.
11) Frame must be trued up and ready for dispensing. *See Dr. Schuman Handouts.
12) Make sure any special instructions or specifications are met.

Appendices A-G

Prescription Requirements

Impact Resistant Occupational Protective Lenses	Tolerance for power, size, etc, shall be as above, except minimum thickness edge or center 3.0 mm.	Shall meet the requirements of American National Standard Z87.1-1968.
Impact Resistant Dress Eyewear Lenses	All impact-resistance-treated glass dress eyewear lenses must be of not less than 2 mm optical center thickness, with average thickness between the center and the thinnest edge not less than 1.7 mm and an edge thickness of not less than 1 mm at the thinnest point of the edged lens.	Before they are mounted in frames, all plastic and impact-resistance-treated glass lenses shall be capable of withstanding an impact test of a 5/8 in. steel ball dropped fifty inches. This test is to be conducted at room temperature, with the lens supported by a plastic tube (1 in. ID 1-1/4 in. OD) with a 1/8 in. by 1/8 in. neoprene gasket on the top edge. See the drawing of the lens support in Figs. 4 and 5.
Warpage	The curves in the principal meridians of the mounted lens must be within a tolerance of ± 1.00 diopter of the design specifications of the lens. The present level of the art dictates that this requirement not apply to plastic lenses mounted in metal frames.	The curves shall be measured with an ophthalmic lens clock.

TABLE 4

Lens Characteristic	Tolerance	
1. REFRACTIVE POWER		
Sphere	0.00 to 6.50D	± 0.13D
	> 6.50D	± 2%
Cylinder	0.00 to 2.00D	± 0.13D
	2.12 to 4.00D	± 0.15D
	> 4.50D	± 4%
Cylinder Axis	0.125 to 0.275D	± 7°
	0.500 to 0.750D	± 5°
	0.975 to 1.500D	± 3°
	> 1.625D	± 2°
Addition	For distance lens powers 0.00 to 8.00D	± 0.13D
	For distance lens powers > 8.00D	± .18D
2. PRISM		
Single lenses	1/3△ in any direction (Placement error of 1mm)	
Mounted lenses (provisional)		
Vertical	1/3△ imbalance (Placement error of 1mm in levels of major reference points)	
Horizontal	2/3△ imbalance (Maximum of 2.5mm difference in horizontal placement of lenses)	
3. SEGMENT LOCATION		
Single lenses	± 1mm of specification, horizontal and vertical	
Mounted lenses (provisional)		
Vertical	Within 1mm	
Horizontal	Within 2.5mm of specified near interpupillary distance	
4. THICKNESS	± 0.3mm of specification	
5. BASE CURVE	± 0.75D of specification	
6. WARPAGE	1.00D except within 6mm of eyewire	

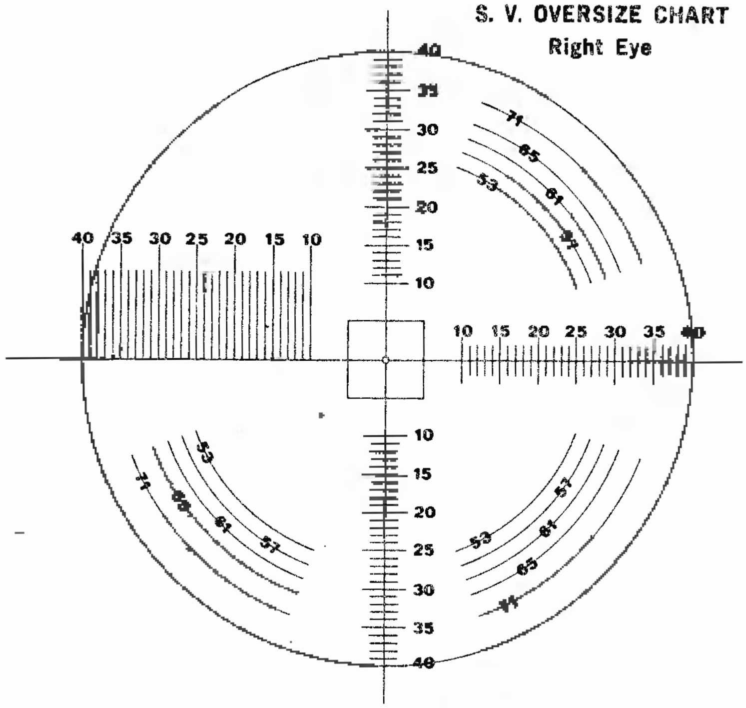
1979 ANSI

Prescription Requirements

Inspection Routine of Prescription Lenses	Tolerance	Provisions and Testing Procedures
Refractive Power (Diopters) Untreated Crown or Flint Glass Lenses	0.00 to 6.00 ± 0.06 6.25 to 12.00 ± 1 percent Above 12.00 ± 0.12	Power in each principal meridian shall be measured on a standard lens-measuring instrument* at the optical center as specified. Maximum cylinder power variation ± 0.12
Impact Resistant Lenses	0.00 to 6.00 ± 0.12 6.25 to 12.00 ± 2 percent Above 12.00 ± 0.25 The difference in the refractive power errors of the two lenses of a pair shall not exceed the tolerance as specified above for a single lens; for example: Error (O.D. / O.S.) — Difference + 0.06 / – 0.06 — 0.12 + 0.12 / + 0.06 — 0.06 – 0.12 / – 0.12 — 0.00	
Refractive Power Addition	± 0.09D The curves for the reading and distance portions of a one piece bifocal shall meet sharply and both of these curves, immediately adjacent to the line, shall be free from surface irregularities.	Power of additions must be measured in accordance with instructions below.†
Cylinder Axis Untreated Crown or Flint Glass Lenses	0.12 to 0.37 ± 3 degrees 0.50 to 1.00 ± 2 degrees 1.12 on up ± 1 degree	Axis shall be determined in relation to the cutting or mounting line.
Impact Resistant Lenses	0.12 to 0.37 ± 5 degrees 0.50 to 1.00 ± 3 degrees 1.12 on up ± 2 degrees	
Prism Power and Location of Specified Optical Center	Vertical ± 0.25Δ for each lens or 0.25Δ imbalance. Horizontal ± 0.25Δ for each lens or 0.50Δ imbalance.	The lens shall be measured at the specified reference point, formerly referred to as optical center. A lens specified without prism shall be treated as a 0Δ lens.
Segment Location	As specified within ± 0.5 mm	Measured from the apex of the bevel to the highest portion of the segment on the concave side of lens.
Thickness	As specified within ± 0.2 mm	To provide best cosmetic effect.

Appendix B

Blank Size Determination Charts

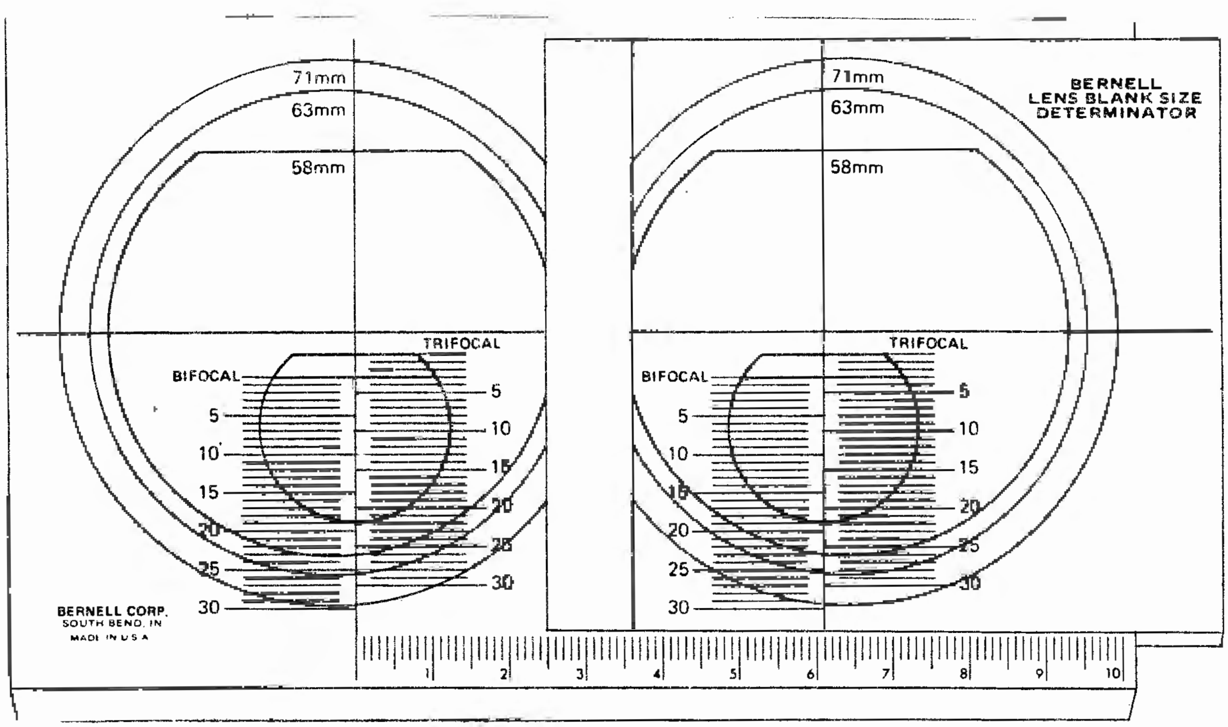


Stock Lens Size Chart in mm

	+ Glass		Hard Resin			− Glass		Hard Resin	
Power	+Cyl	−Cyl	+Cyl	−Cyl	Power	+Cyl	−Cyl	+Cyl	−Cyl
Plano-+300	56	60	59	61	Plano-−300	59	61	59	63
+300-+400	56	57	54	61	−325-−400	58	61	59	62
+400-+475	52	57	54	57	−425-−475	58	61	59	62
+475-+600	52	54	54	57	−500-−600	57	61	54	61

S. V. CHART INSTRUCTIONS

1. Subtract the measured frame DBL from the patient's distance P.D.: Ex. 65 − 21 = 44
2. Divide the resultant by 2.: Ex. 44 ÷ 2 = 22
3. Set the horizonal scale reading of 22 on the extreme nasal edge of the right frame eyewire while centering the lens opening on the vertical scale. On cylinder powers the horizonal axis line must remain horizonal.
4. Check on chart to see the diameter of the lens blank needed to completely cover the lens opening—be sure and take into account the depth of the eyewire grove.
5. Now check with **Stock Lens Blank Size Chart** to see if a standard lens can be used.
6. If standard blanks cannot be used, but the lens opening is less than 58mm in diameter, then oversize blanks are not required but a prism grind will be necessary to obtain P.D.



Appendix C

List of Advantages and Disadvantages of Having a Fab Lab in an Optometric Practice

Disadvantages

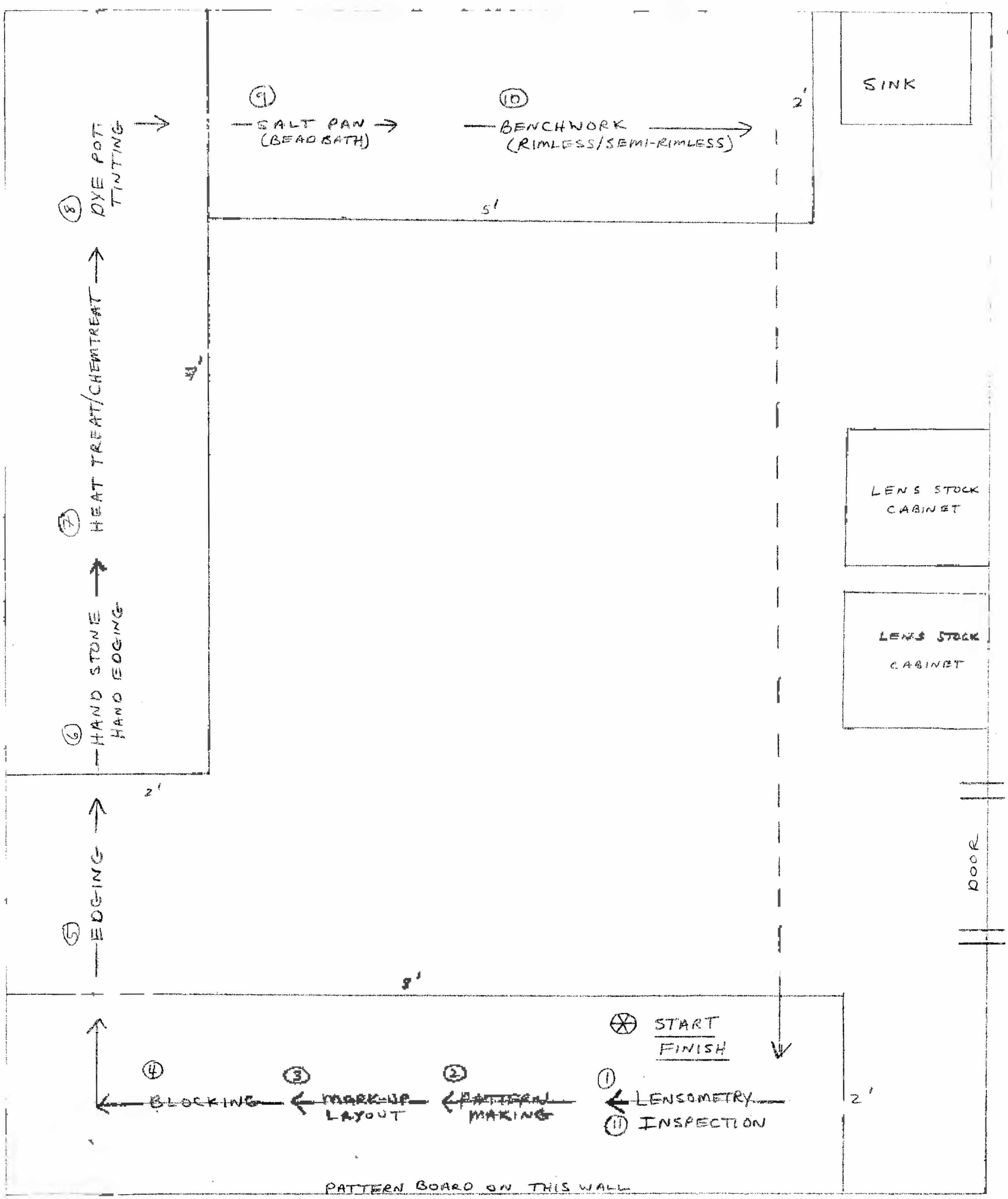
1) Initial cost of equipment and lens stock
2) Need to hire and possibly train someone to perform the processes involved (labwork)
3) More office space is needed
4) Increase in overhead costs (electric, lighting, etc.)

Advantages

1) Costs less per job to edge own lenses.
2) Better able to control the quality of workmanship.
3) More personalized service can be offered.
4) Increased speed of service.
5) Emergency service can be offered.
6) A sure way to increase net in one's practice.
7) Can take a 10% investment credit on new equipment purchased as well as tax deductions for equipment depreciation and interest if using a loan to purchase the equipment.

Appendix D

DIAGRAM OF WORKFLOW IN THE LABORATORY



9' X 12' Room
108 sq. ft.

Appendix E

Equipment List

The following is a list of equipment and items needed for a complete edging lab for the optometric office. These items are all brand new, and have been selected as being of high quality, and in many cases, cheaper versions (models) are available. All prices listed are manufacturers suggested retail, and were taken from FRAMES Surface and Finishing Catalogue July 1983 Edition, a supplement to the regular FRAMES book, as well as from product literature and prices submitted from various manufacturers and distributors. Many of these prices could probably be reduced by utilizing manufacturer's discounts. Shopping around is essential as prices on optical equipment varies widely. Try to find used equipment and figure on saving approximately 50%. Remember that all of this is tax deductable and/or depreciable, and eligible for the tax investment credit.

Item	Manufacturer/Distributor Prescription	Price
*Lensometer	Marco: Model #101	875.00
*Lab trays	Semi Tech: stackable, 15 trays @ $1.05 each	15.75
*Salt pan	Vigor: Model #WA-101	62.50
Project-O-Marker	American Optical	595.00
Leap Blocking System	Complete	344.00
Pattern Maker	Universal/Briot: Model #MB-3400 complete with 200 pattern blanks, (identical to Novamatic)	765.00
AIT Mark V Deluxe Bevel Edger	AIT: Model #360, complete with diamond wheels, coolant, pump and tank, chucking kit for Leap System, and std. accessories	3950.58
Handstone	Universal: single ceramic handstone, complete	399.00
Heat Treating Unit	Kirk: Model #AAZ	655.00
Drop ball apparatus	Kirk: Std. model	52.00
Dye pot	Hunter-Delatour: Model #225, 6 tanks, complete with gradient machine, thermometer, dyes, lens holders	475.00
Rimless groover	OMI (Hoya): std. model	295.00
Lens cabinet	Vigor: Model MC-27, 27 drawers	188.75
Pliers 1) Eyewire	Vigor: PL-251 eyewire bending plier	43.95
2) Sizing	Vigor: PL-40 endpiece plier	18.50
Tap and drill holder	Vigor: PV-661	1.80
Taps	Vigor: TP-610 No.47 Regular (per dozen)	5.75
	TP-615 No.52 Repair size (")	5.75
Drill bits	Semi-Tech: 1 rimless carbide drill bit	3.50
	Fvanel: twist drills for removing broken screws (1 dozen)	7.95
Screw extractors	Vigor: RM-450 (set of 3)	8.50
Lens washer		3.00
Grease pencil		.75

Lumber for bench and pattern board	two sheets, 4' x 8', 3/4inch plywood @ $13.00 each	26.00
	sixteen, 8 foot 2" x 4" @ $1.40 each	22.10
	nails	5.00
Adjustable bench worklight		10.00
	SUB TOTAL	8835.13

OPTIONAL (Recommended items)

Chemical Hardening Unit	Kirk: "Mini-20"	415.00
Box-o-graph	Vigor	24.50
Lens thickness caliper	Coburn	18.25
Stool	(on wheels to roll around lab)	50.00
	TOTAL	9342.88

*You should already have these items if you own an optometric practice.

Appendix F

Recommended Lens Stock

Series	Total Number of Lenses	Number of Pairs	Price Per Pair	Total
68 millimeter plastic (clear)				
plano to +4.00 sph				
16 powers (lenses) x 2 lenses (1 pair) =	32	16	2.19	$35.04
plano to -4.00 sph " " =	32	16	2.19	35.04
.25 to 2.00 cyl (8 diff. cyls) x				
(32 diff. spheres) x 2 lenses (1 pair) =	512	256	2.19	560.64
72millimeter plastic (clear)				
plano to +3.00 sph (12 powers) x (2 lenses)=	24	12	2.49	29.88
plano to -3.00 sph " " =	24	12	2.49	29.88
.25 to 2.00 cyl (8cyls) x (24sphs) x				
(2 lenses) =	384	192	2.49	478.08
65 millimeter glass (clear)				
plano to +4.00 sph	32	16	1.29	20.64
plano to -4.00 sph	32	16	1.29	20.64
.25 to 2.00 cyl	512	256	2.29	586.24
70 millimeter glass (clear)				
plano to +2.00 sph (8 pwrs) x (2 lenses)=	16	8	1.70	14.32
plano to -2.00 sph " " =	16	8	1.70	14.32
.25 to 1.00 cyl (4cyls) x (16 sphs) x				
(2 lenses) =	128	64	2.59	165.76
TOTAL				1990.48

*Based on 1 pair of each different sphere power and combination of sphere and power and cylinder

**All per pair prices based on assumption that 51 to 1000 pairs will be purchased at the same time, from Swan Optical

Appendix G

Product Information/Manufacturer's Addresses

1) A.I.T. Industries, Inc.
2020 Hammond Drive
Schaumburg, Illinois 60195
312-397-1770 (Finish Lab Equipment)

2) B.P.I.
4470 S.W. 74th Ave.
Miami, Florida 33155
1-800-327-2250 (Tinting Equipment)

3) CMV Interamerica, Inc.
P.O. Box 520188
Miami, Florida 33152
800-327-3378 (Complete Finish Lab Equipment)

4) Coburn Optical Industries, Inc.
P.O. Box 351
Petersburg, VA 23803
800-446-4830 (Finish Lab Equipment)

5) Econo Products
242 Vinewood St.
Escondido, CA. 92025
714-743-1672 (Tinting Equipment)

6) Franel Optical Supply Co.
P.O.Box 96
Maitland, Florida 32751
800-327-2070 (Handtools, Frames)

7) Hunter Delatour
P.O. Box 2662
Menlo Park, CA 94025
415-851-2578 (Tinting Equipment)

8) Kirk Optical Lens Co.
70 Toledo St.
Farmingdale, N.Y. 11735
516-420-8780 (Heat Treat/Chemtreat Units)

9) Novamatic
2685 LaCienega Blvd.
L.A., CA 90034 (Pattern Makers)

10) Semi-Tech, Inc.
10954 Shady Trail
P.O. Box 20797
Dallas, Texas 75220
800-527-5040 (Complete Optical Supply)

11) Swan Optical Co.
34-12 36th Ave.
Long Island City, N.Y. 1106
800-221-0210 (Lenses, Frames)

12) Universal Shellac & Supply Co., Inc.
495 W. John St.
Hicksville, N.y. 11801
516-935-4000 (Complete Optical Supply)

13) William Dixon Co.
750 Washington Ave.
Carstadt, N.J. 07022
201-935-0100 (Hand Tools, Dispensing)

Bibliography

1) A.I.T., Product Information, Schaumburg, Illinois, 1983.

2) Brooks, C.W. and Borich, I.M., System for Ophthalmic Dispensing, Chicago: The Professional Press, Inc., 1979.

3) Frames Subscription Service, Surfacing and Finishing, Vol. XVI, No.9, July, 1983.

4) Norwood, N.J., How to Work with Optyl, Optyl Corp., 1976.

5) Schuman, D.O., Class notes and handouts, Ophthalmic Dispensing, PUCO, 1981.

6) U.S. Army, Class notes, U.S. Army Optical Lab School, 1976.

7) Vigor Adjusting Tools and Supplies Catalog,New York: B. Jadow and Sons, Inc., 1983.

8) Waters, E.H., Ophthalmic Mechanics, Vol. I, 1941.

9) Weber, J.M., How to Simplify Rimless Benchwork, 20/20 Nov/Dec, 1976.