I. MAGNIFIERS AND MICROSCOPES

A. MAGNIFIERS

Magnifiers are used for low power magnification. The three included here can be employed wherever it is desirable to see a little more detail than is obtainable with the naked eye.

B. MICROSCOPES

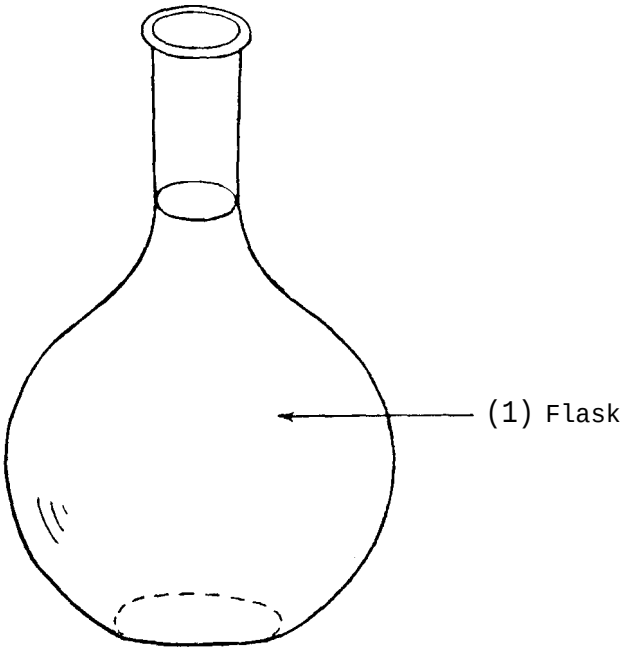
Where high power magnification is needed, microscopes can be used. The ones in this section can, for the most part, be adapted to use water drop, glass bead, or penlight bulb lenses. Magnifications up to around 60X - 8OX may be gotten using these microscopes. All are designed for use with freshly and/or permanently mounted glass slides.

C. SUPPLEMENTARY APPARATUS

These items are essential for preparing the slides to be viewed with the microscopes.

A. MAGNIFIERS

Al. Water Filled Magnifier



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Flask	1	Spherical Body Flask (A)	50-500 ml

b. Construction

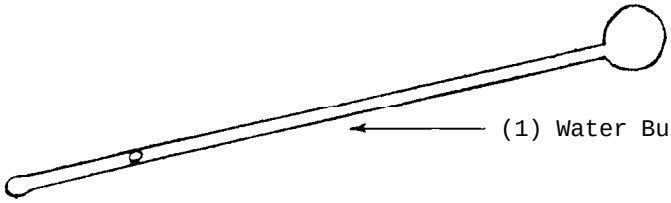
(1) Flask — Simply fill the flask (A) with clear water up to the neck.

c. Notes

(i) A 250 ml flask (about 7.5 cm in diameter) will magnify approximately the same as a double convex magnifying glass 4 cm in diameter and 0.7 cm in thickness.

(ii) Smaller diameter flasks appear to magnify more than larger diameter ones.

A2. Water Bulb Magnifying Glass *



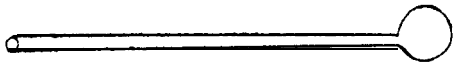
(1) Water Bulb Magnifying Glass

a. Materials Required

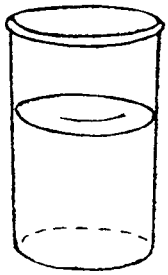
Components	Qu	Items Required	Dimensions
(1) Water Bulb Magnifying Glass	1	Glass Tubing (A)	0.3 cm diameter, 10-13 cm long

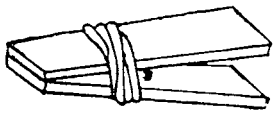
b. Construction

(1) Water Bulb Magnifying Glass

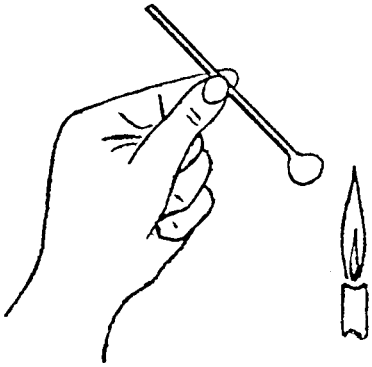


Use a Bunsen Burner or gas burner and fuel system (CHEM/II/C1 and 2) as a heat source. Follow the glass-blowing instructions (CHEM/I/D6) and blow at one end of the glass tube (A) a bulb of about 0.8 cm diameter.



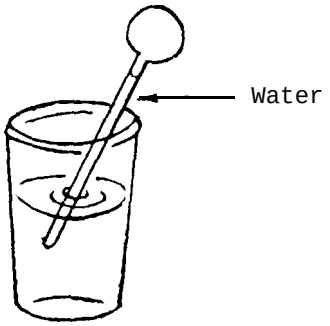


Provide a glass or cup of water and a wooden clothespin, pinch clamp (CHEM/IV/A4) or a few square centimeters of cloth to serve as a holder.

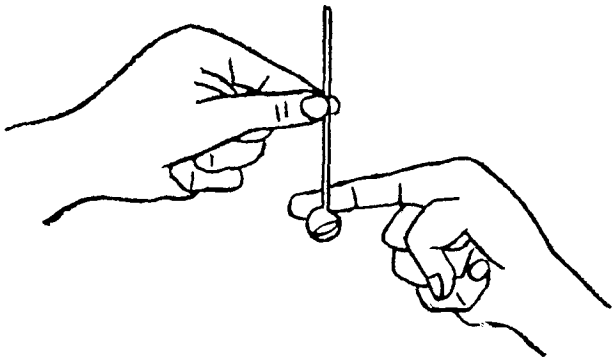


Rotate the bulb near, but not in, the flame to expand the air in the bulb.

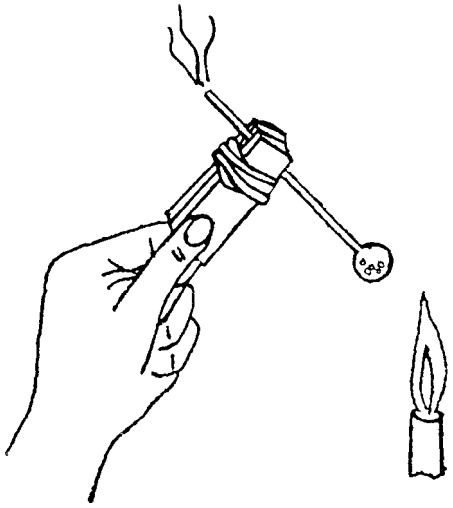
*Adapted from James E. Hammesfahr and Claire L. Strong, Creative Glassblowing, (San Francisco: W. H. Freeman and Company, 1964), pp 108-9.



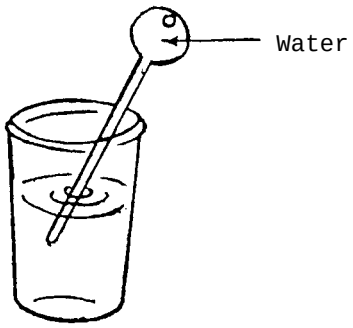
After a few seconds of heating, quickly invert the piece and put the open end into the water. Allow the piece to remain in the water a few seconds. The air in the bulb contracts and water is drawn up into the tube.



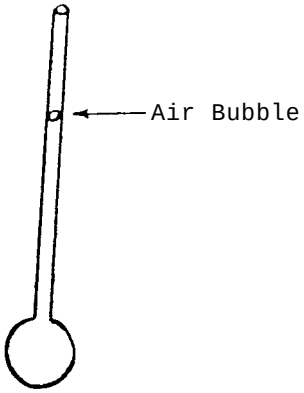
Remove the piece from the water and hold it, bulb down, in one hand near the open end of the tube. Lightly flick the bulb with the index finger of the other hand. Continue flicking until the water has gone from the tube into the bulb.



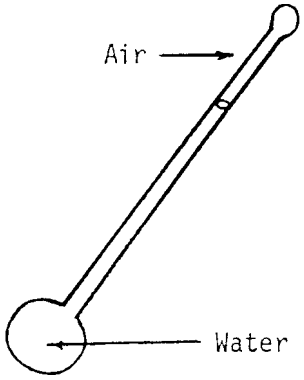
Next, grasp the tube with the clothespin, pinch clamp, or folded cloth, and again hold the bulb close to the flame until the water boils. Point the open end of the tube away from yourself and anyone else.



Heat the bulb while steam escapes from the tube for about 5 seconds. Then quickly invert the tip of the tube into the water. Allow the tube to remain in the water until the bulb is full, or nearly full, of water. If after a few minutes, the bulb has not filled with water, repeat the heating and filling process.



Remove the piece from the water and invert it so that any air remaining in the bulb can enter the tube. Flick the bulb, as before, and the bubble will rise to the open end of the tube.



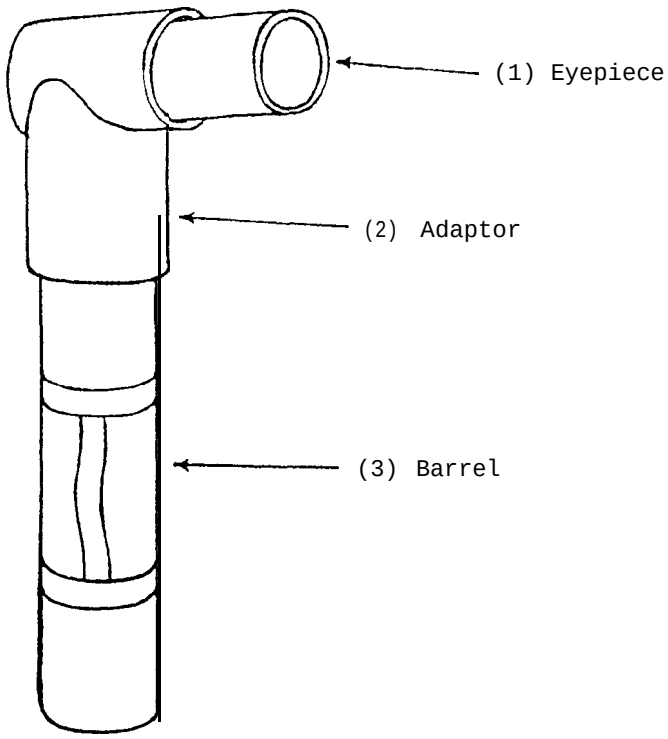
Holding the bulb with the tube upright, heat the end of the tube in the hottest part of the flame to seal the tip. As the tip seals, the expanding air of the trapped bubble blows a tiny bulb at the end of the tube.

c.Notes

(i) The first heating of the bulb expands the air, which, when it contracts, draws a small amount of water into the bulb. Converting this water into steam expels all the air and causes the bulb to fill completely with water as the steam condenses.

(ii) When this water-filled bulb is held about 0.5 cm from an object, the object will appear distorted around the edges, but clear and greatly enlarged at the center of the bulb.

A3. Illuminated Hand Magnifier



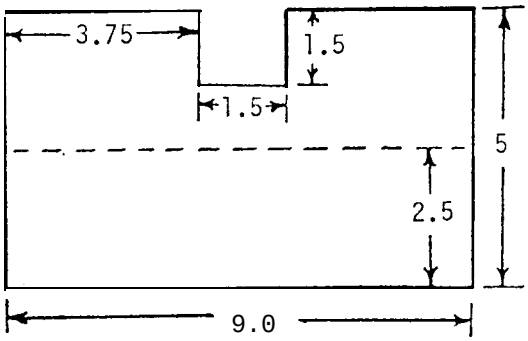
a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Eyepiece	1	Double Convex Lens (A)	2.5 cm diameter
	1	Single Convex Lens (B)	2.5 cm diameter
	1	Cardboard Tube (C)	5 cm long, 2.5 cm inside diameter
	1	Cardboard Tube (D)	5 cm long, 2.8 cm inside diameter
(2) Adaptor	1	Cardboard Tube (E)	5 cm long, 3.5 cm inside diameter
(3) Barrel	1	1.5 Volt Penlight Bulb (F)	2.2 cm long, 1.0 cm diameter
	1	Tin Sheet (G)	3.7 diameter, 0.05 cm thick
	2	Electrical Wire (H)	10 cm long, #26 gauge (about 0.05 cm in diameter); strip insulation from 1 cm of each end

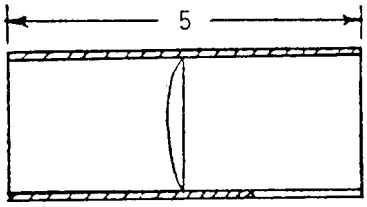
2	1.5 Volt Dry Cells (I)	3.2 cm diameter 5.7 cm long
1	Steel Bolt (J)	2 cm long, 0.5 cm diameter
1	Steel Nut (K)	0.5 cm inside diameter
1	Steel Strapping (L)	12.5 cm x 1.2 cm x 0.05 cm
1	Cardboard (M)	3.5 diameter
1	Cardboard Tube (N)	15 cm long, 3.2 cm inside diameter

b. Construction

(1) Eyepiece

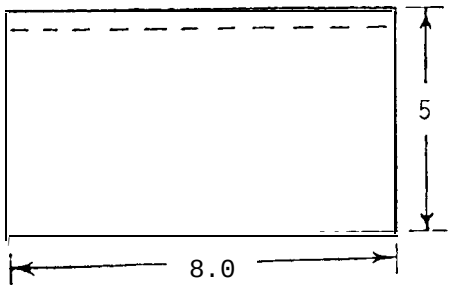


Tube (D)

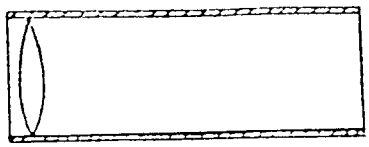


Cross Section of Tube (D)

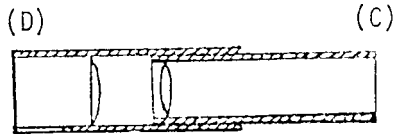
If a cardboard tube cannot be found of the required size, one can easily be made from a piece of cardboard cut as shown. Roll the cardboard into a tube (D) 5 cm long and position the single convex lens (B) in place with the edge on the dotted line. The lens can be held in place with rubber cement or similar flexible adhesive while the tube (D) is held together with masking tape. Be certain the flat side of the lens faces the front (notched) end of the tube.



Tube (C)



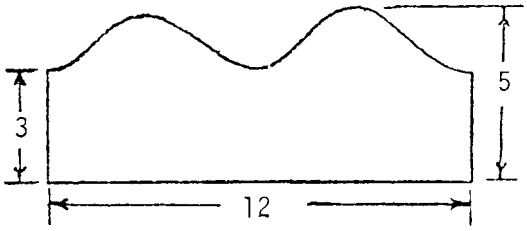
Cross Section of
Tube (C)



Cross Section

The second tube (C) may be made the same way as the first if a manufactured cardboard tube of the correct size cannot be found. Roll the cardboard into a tube and position the double convex lens (A) at one end with rubber cement. Fasten the tube securely with masking tape. This tube (C) should fit rather snugly inside tube (D), but still be able to slide easily back and forth.

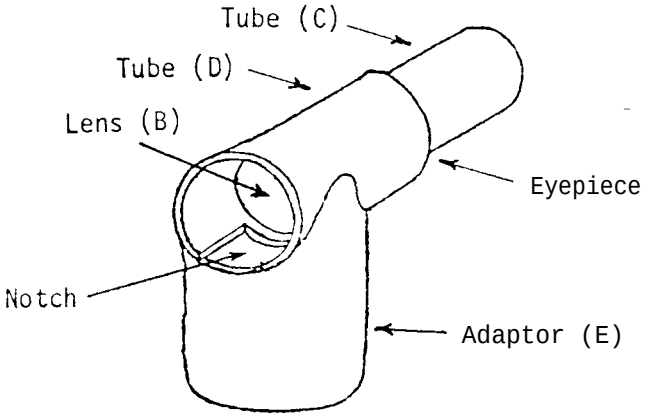
(2) Adaptor



Adaptor Pattern

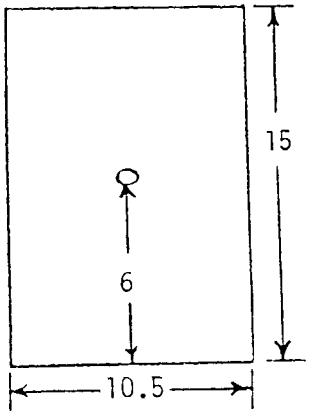
The adaptor can be made from a cardboard tube (E) by notching one end so that it will interlock with the eye-piece. The adaptor and eye-piece can then be taped with masking tape. Alternatively,

the pattern for the adaptor can be cut from cardboard, rolled into a cylinder, and taped. Even if the two tubes don't "mesh" exactly, they can be taped well enough to overcome inaccuracies.



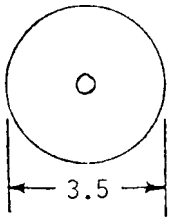
When binding the eyepiece and adaptor together with tape, be sure that the notch in the eyepiece tube (D) is directly over the adaptor tube opening.

(3) Barrel

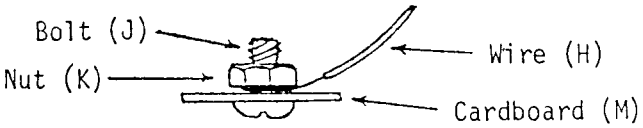


Tube (N)

If a tube (N) of the correct size is available, simply punch a small hole (0.2 cm) about 6 cm from one end of the tube. Otherwise, a tube can be fashioned from a piece of cardboard of the indicated dimensions. Roll and tape it so that it is 15 cm long and has a 3.2 cm inside diameter.

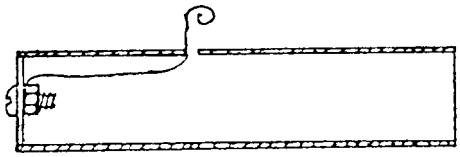


Cardboard (M)



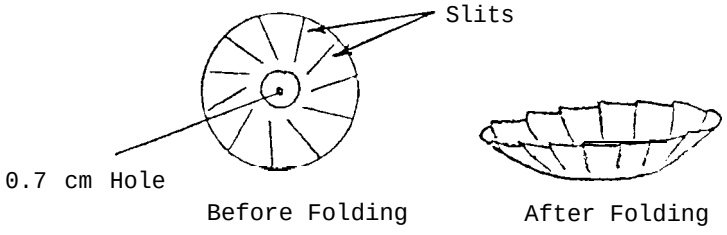
Side View

To seal off the end of tube (N), use the circular piece of cardboard (M). First, punch a hole in the center of the cardboard disc, and insert the short steel bolt (J). Fasten one of the pieces of electrical wire (H) in place with the nut (K). Pull the free end of the wire through the hole in the tube (N) and glue the disc (M) in place to seal off one end of the tube.



Cross Section of Tube (N)

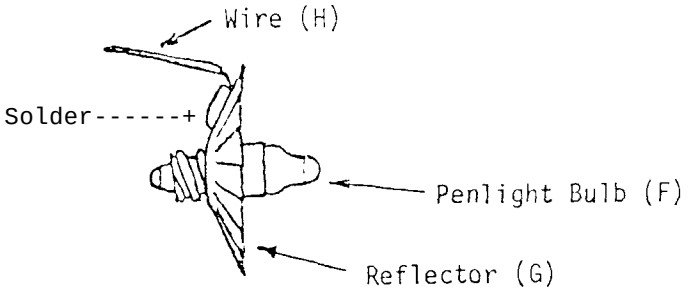
Use the disc of tin sheeting (G) to make a reflector. First, drill a hole in the center of the disc of a diameter such that the pen-light bulb (F) will screw into it securely (approximately 0.7 cm diameter). Next, cut slits in the disc (G) as shown. Fold the resulting flaps up slightly so that



Before Folding

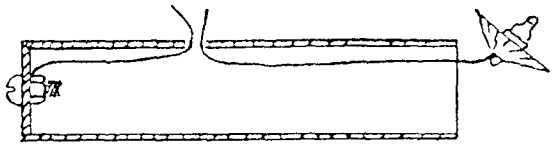
After Folding

Reflector (G)

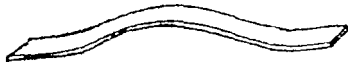


the reflector approximates a cone in appearance.

Next, screw the bulb (F) in place, and solder one end of the second piece of wire (H) to the back of the reflector. Pull the free end of the wire through the hole in the barrel tube (N) and leave the reflector assembly loose temporarily.

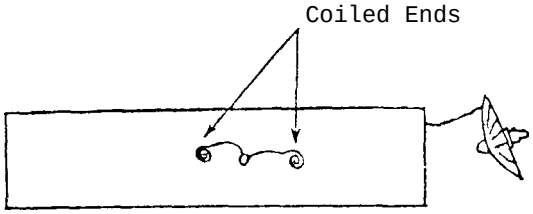


Cross Section

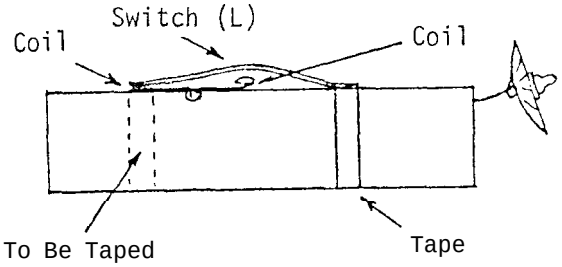


Switch (L)

The switch is made from the piece of steel strapping (L). Give it a slight bend in the middle.



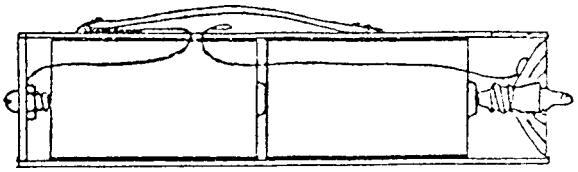
Coil the free end of the wire which comes from the sealed end of the barrel. Do likewise for the other wire.. Tape the switch to the barrel making certain that one end of the switch is taped directly over one of the wire coils and that the second coil is directly under the bent portion of the switch but not touching it. In



Side Views

other words, when the switch is depressed, contact will be made with the wire coil and the circuit from the bolt to the bulb will be completed.

Finally, insert two dry cells (I) into the barrel and push the reflector assembly into place.



Cross Section of Completed Barrel

The bulb must make contact with the battery. The reflector assembly should hold in place by tension, and require no further fastening. When the switch is pressed, the light should go on.

To complete the illuminated hand magnifier, insert the barrel into the adaptor.

c. Notes

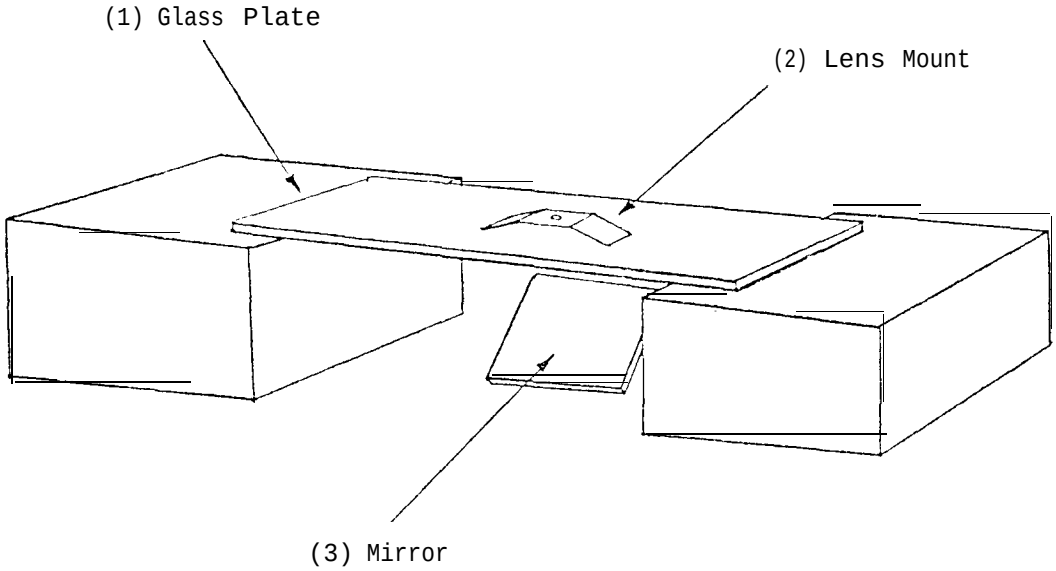
(i) The illuminated hand magnifier must be held directly over the object to be viewed. The light serves to concentrate the illumination of the object while focusing is accomplished by moving the eyepiece tube (C) up and down in relation to the second tube (D).

(ii) This magnifier is excellent for observing detail on such items as insect parts, plant surface features, crystals, etc.

(iii) Obviously, any variation in the lens diameter as given here will necessitate changes in the dimensions of the item. If a lens is slightly smaller than the cylinder into which it must be fit, it can be built up by wrapping thin pieces of tape around its edge until it will fit snugly.

B. MICROSCOPES

B1. Glass Stage Microscope



a. Materials Required

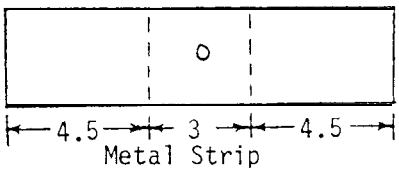
Components	Qu	Items Required	Dimensions
(1) Glass Plate	1	Window Glass (A)	20 cm x 10 cm (at least)
(2) Lens Mount	1	Metal Strip (B)	12 cm x 3 cm x 0.1 cm
(3) Mirror	1	Mirror Glass (C)	Approximately 5 cm x 5 cm

b. Construction

(1) Glass Plate

Rest the glass plate (A) on two books or other stable supports. The glass plate serves as the microscope stage.

(2) Lens Mount



Drill a hole through the center of the lens mount (B). The diameter of the hole will depend on the size and type of lens used [see Notes (ii), (iii), (iv)]. Bend the end of the lens mount down at a slight angle.

(3) Mirror

Use the mirror (C) to reflect enough light through the specimen to permit it to be seen well. If a mirror is not available, use polished metal or other reflective material.

c. Notes

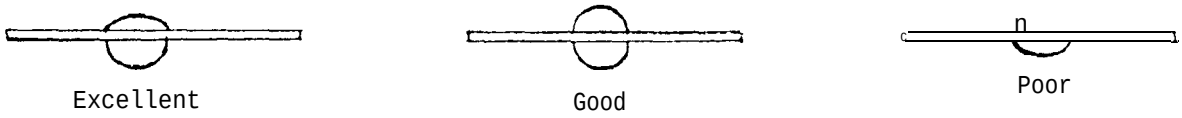
(i) Operating the glass stage microscope is exceptionally easy. Simply place the glass slide containing the specimen under the lens mount and reflect light through the specimen with the mirror. Focusing is accomplished by pushing on the lens mount so that the lens moves closer to or further from the specimen.

(ii) For maximum success in making water drop lenses, the hole in the lens mount must be properly prepared. First of all, this means that the hole should be as nearly circular as possible. A drill will yield best results although holes can be punched with nails, punches, or other sharp implements. Additionally, the edge of the hole should be made smooth and free from burrs. This can be done with a file or tool made especially for this purpose. The optimum size for the hole was found to be approximately 2.5 mm - 3.5 mm in diameter.

Once the hole has been made, the area around the hole should be heated and candle wax melted onto both sides of the lens mount around the hole. Be certain that no wax gets into the hole. This coating of wax prevents the

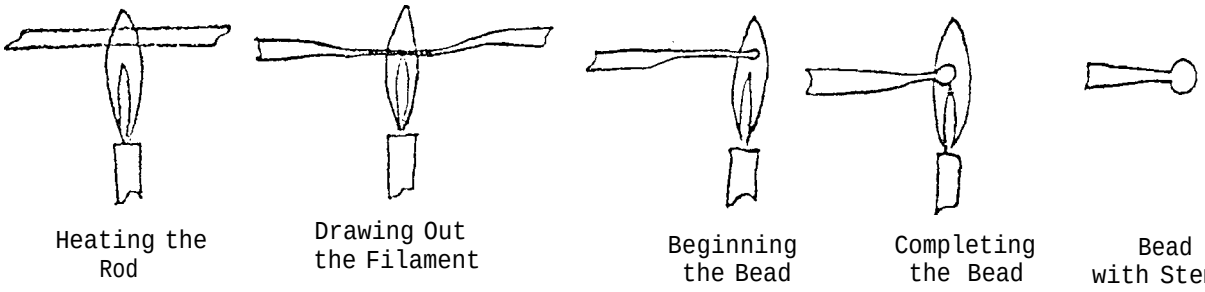
water drop from spreading out and deforming.

When the hole has been prepared, the water drop lens is made simply by carefully placing a drop of water in the middle of the hole so that it is suspended from the edge. The drop is most easily handled with a dropper. It was found that a water drop with a slightly flattened side provided the best image while a drop flattened on both sides was poor.



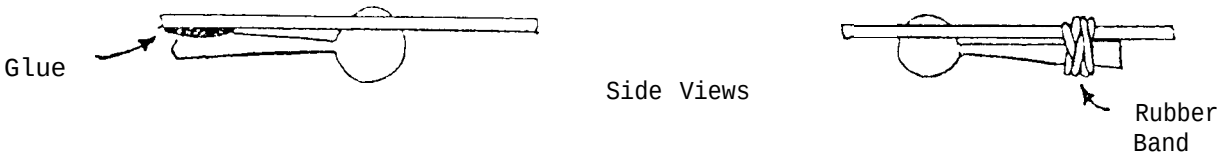
(iii) The object in making a glass bead lens is to form as nearly spherical and clear a bead as possible. This is most easily done if soft glass rods are available. If harder glass is used, extremely hot flames are needed to work it.

First, evenly heat a portion of the glass rod in a flame until it softens. When it is soft, pull the ends out until a long filament is formed and continue to pull until the filament breaks. Using the longer of the two filaments, heat the tip until a bead begins to form. Turning the filament so that the bead forms evenly, continue to heat the bead until it reaches the desired size. Allow the bead to cool and then break it off along with a portion of the stem.



Beads can be made from approximately 2.0 mm to 5.0 mm in diameter, although those from 2.5 mm - 4.0 mm work best. Before mounting the bead on the lens mount, be certain that the hole in the mount is slightly smaller in

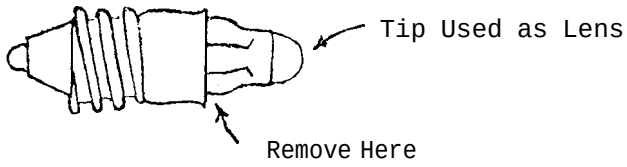
diameter than the bead. This is extremely important. The bead can then be glued or held in place by a rubber band (see diagram).



As the diagrams show, the bead stem should be kept on the underside of the lens mount.

Although glass beads can be made from glass tubing, it is almost impossible to prevent air bubbles from forming in the bead which cause great distortion of the image. Therefore, use solid glass rods, if possible.

(iv) Penlight bulb lenses are made from the penlight bulbs used in small, fountain-pen sized flashlights (battery operated torches). Those commercially available in the United States are approximately 2 cm long and 1 cm in diameter at the widest point. The portion used as a microscope lens is the thickened glass at the tip of the bulb (see diagram).



The lens can be removed from the bulb by scratching the glass portion of the bulb close to the metal part. This avoids scratching the tip of the bulb itself, and is best accomplished with a small, triangular file. Once the whole glass bulb has been separated from the metal part, the lens will break off quite readily; in fact, it may fly off and be damaged unless caution is observed.

The lens may be mounted to the lens mount merely by drilling a hole the same diameter (or slightly smaller) as the lens. Then, apply a flexible glue (e.g., rubber cement) around the edge of the hole and set the lens in place (see diagram). Allow the glue to set before using the microscope.

Cross Section

The penlight bulb lens appears to work best when mounted rounded side up as shown in the diagram.

(v) Because all the microscopes described here are single lens types with small diameter lenses, the focal length is extremely small, which means that the lens must be close to the object viewed and also, the eye must be kept very close to the lens. This tends to cause a strain on the eye if the microscope is to be used for an extended period of time. In addition, it means that the depth of field is extremely limited, requiring frequent adjustments to focus.

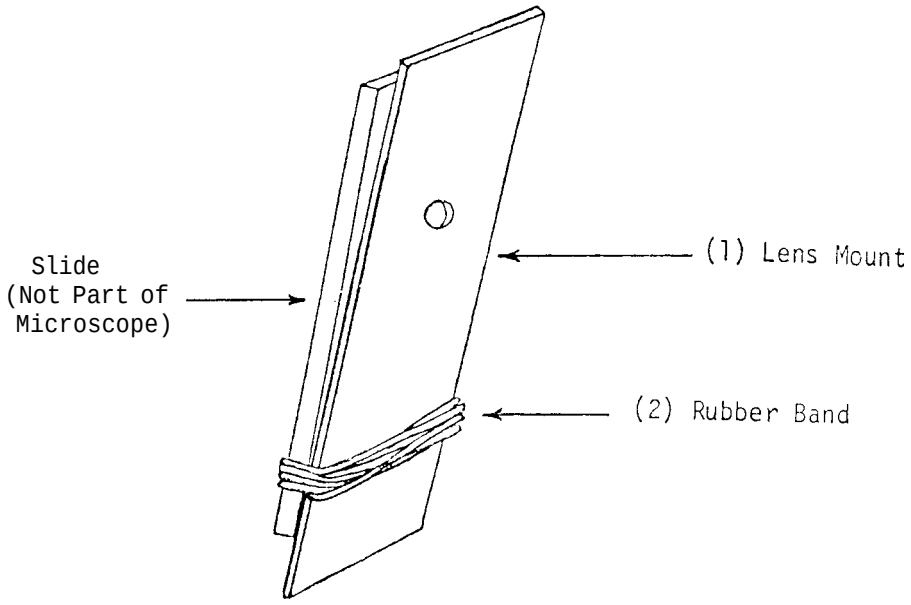
(vi) Magnification power for the different lenses is difficult to determine, but it appears that water drops and glass beads of the same diameter have the same power of magnification. Drops or beads with diameters of 2.0 mm to 4.0 mm give magnifications of approximately 40X - 60X to 20X - 30X with smaller diameter beads yielding larger magnifications. The penlight bulb lens is approximately 5 mm in diameter and 3 mm thick, and gives magnification of about 50X - 70X. With all lenses, the portion of the field in focus is rather small.

(vii) Care should be taken to keep the lenses (except water drop) clean with tissues. Also, slides, mirrors, etc., should be kept as dust free as possible.

(viii) The best material for the lens holder seems to be aluminum sheeting about 0.5 mm thick. Other types of stiff, flexible metal sheeting also work well. Cardboard or strong paper can be used, but yields poor results.

(ix) Light to illuminate the specimen should be reflected through the microscope with a mirror or other shiny surface. A strong light source is required with sunlight working as well as any.

B2. Hand-Held Microscope

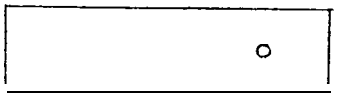


a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Lens Mount	1	Metal Strip (A)	8 cm x 2.5 cm x 0.1 cm
(2) Rubber Band	1	Rubber Band (B)	--

b. Construction

(1) Lens Mount



Drill a hole in the metal strip (A). The position of the hole will depend upon where on the slide the specimen has been mounted.

The dimensions given here are for a lens mount to be used with a standard 7.5 cm x 2.5 cm (3 inches x 1 inch) glass slide.

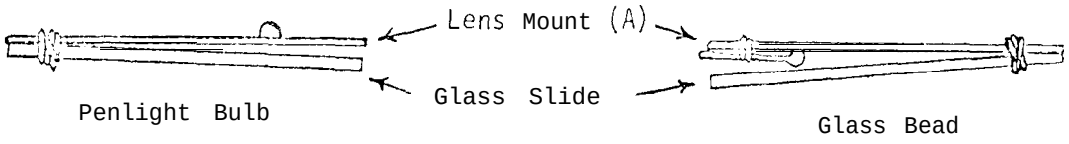
(2) Rubber Band

Wind the rubber band (8) around the slide and lens mount (A) to hold the two together so they don't slip. Be certain to position the lens directly over the specimen or portion of specimen to be viewed. Take care in moving the lens mount that the edge does not cut the rubber band.

c. Notes

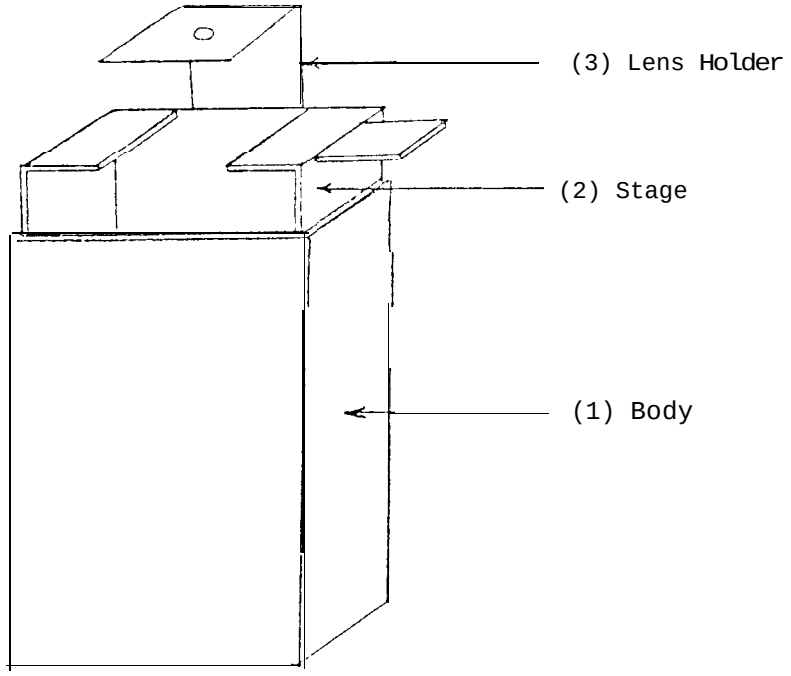
(i) This simple microscope works well with either glass bead or pen light bulb lenses [see I/B1, Notes (iii) and (iv)]. Using it with a water drop lens is quite difficult in that it is difficult to prevent the water from touching the slide. In addition, this microscope works best when held vertically rather than horizontally as is necessary with the water drop.

(ii) See the following diagrams for positioning the glass bead and penlight bulb lenses on the lens mount.



(iii) This microscope should be used primarily with permanently prepared slides as opposed to fresh mounts. Focusing is achieved simply by holding the slide with one hand and moving the lens mount back and forth with the other.

B3. Match Box Microscope *

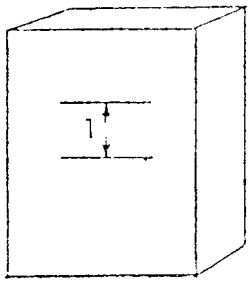


a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Body	1	Match Box Cover (A)	5 cm x 3.5 cm x 1.5 cm
(2) Stage	1	Match Box Drawer (B)	5 cm x 3.5 cm x 1.5 cm
	1	Metal Strip (C)	3 cm x 1 cm x 0.1 cm
(3) Lens Holder	1	Aluminum Strip (D)	7.5 cm x 2.5 cm x 0.1 cm

b. Construction

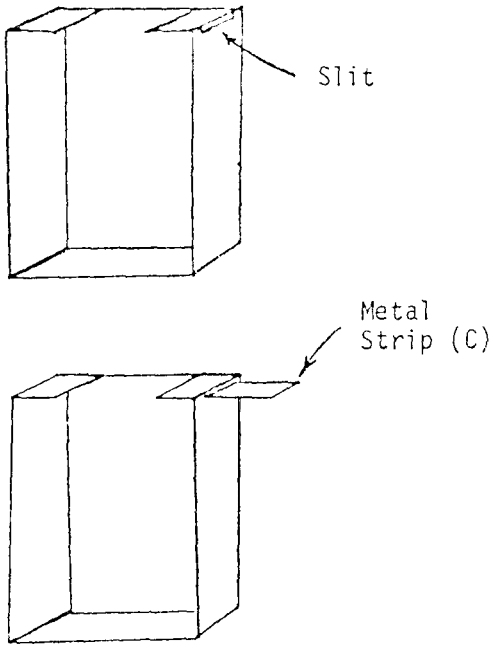
(1) Body



With a razor blade, make two slits in the back of the match box cover (A). These slits need to be slightly wider than the width of the lens holder (2.5 cm).

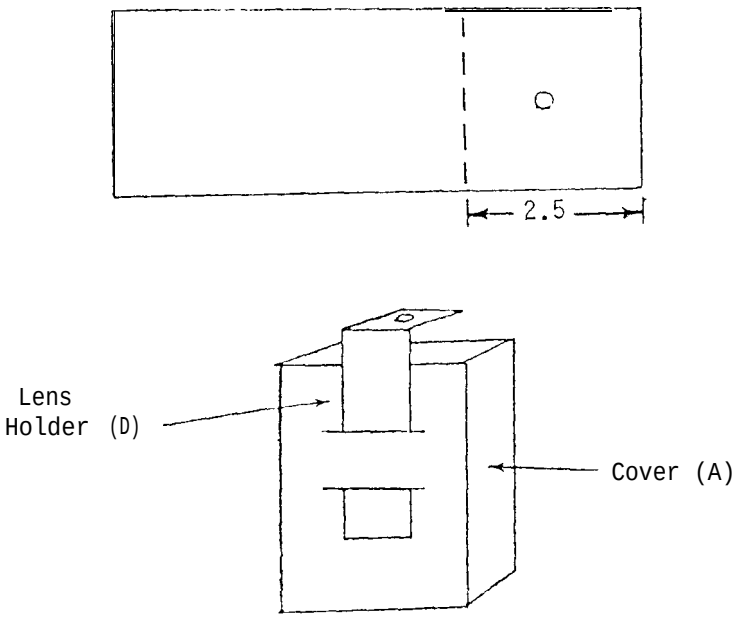
*Adapted from African Primary Science Program, Making Things Look Bigger, (Nairobi, Kenya: Curriculum Development and Research Center, 1967), pp 24-25.

(2) Stage



Cut out one end of the match box drawer (B) so that portions of the end 0.5 cm wide are left on either side. At the same end cf the drawer, make a slit about 1 cm wide with a razor blade. Insert the metal strip (C) into this slit and glue it in place. Use this strip to move the stage up and down when focusing.

(3) Lens Holder



Drill a hole in one end of the aluminum strip (D), and bend it at right angles. If a drill is not available, punch a hole in the metal with a nail. Insert the metal strip through the slits in the back of the match box cover (A) to insure that it will be held in place securely. Then, remove the lens holder, slide the stage into the body, and replace the lens holder. The microscope is now ready for use.

c. notes

(i) To use this microscope, place the slide or specimen on the stage directly under the lens. Focusing is accomplished by moving the stage up and down as the lens holder remains stationary. As with all single lens microscopes, the eye must be kept quite close to the lens in order to see the image.

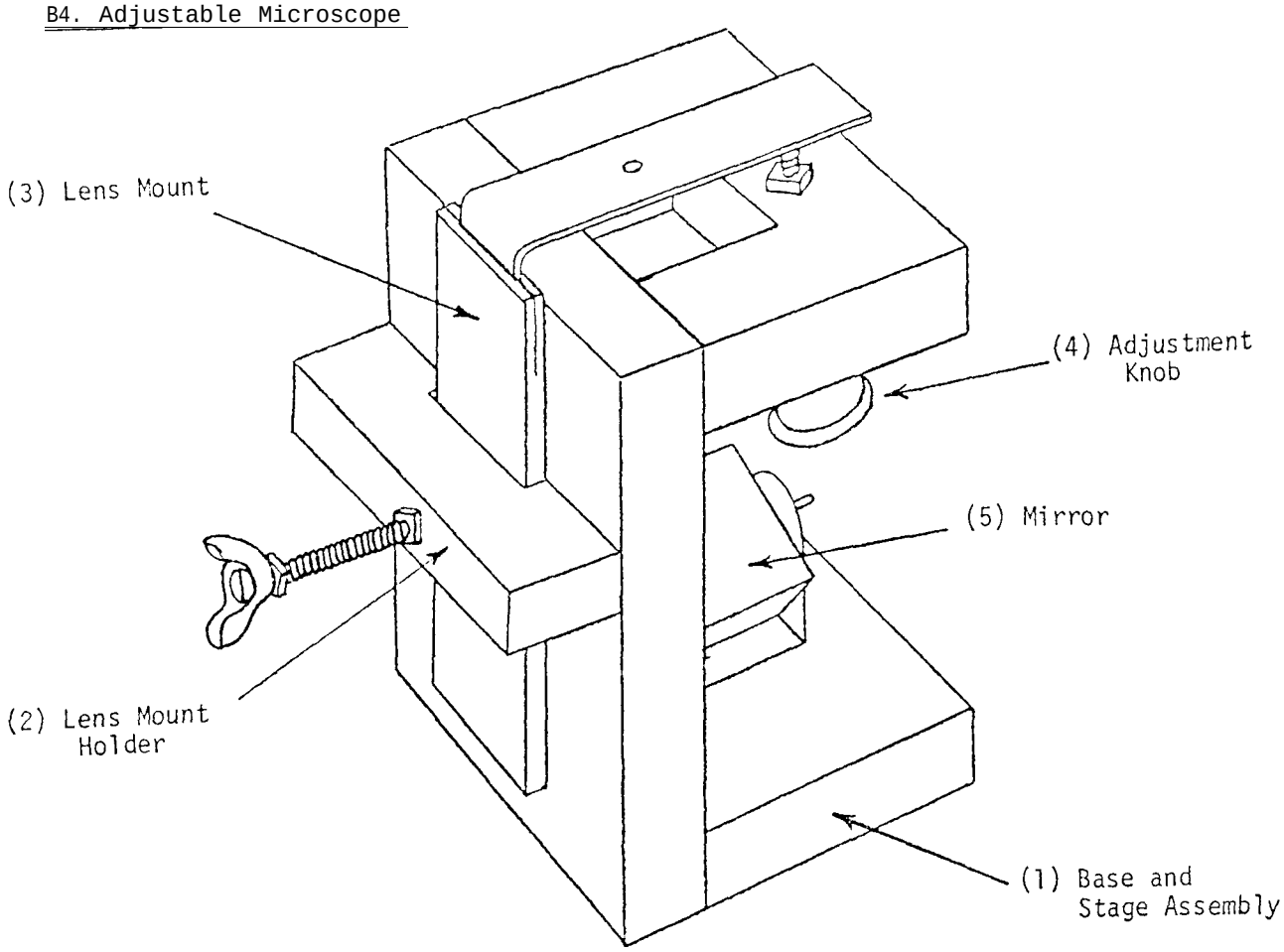
(ii) See I/B1, Notes (ii), (iii), and (iv) for complete instructions in adapting the lens holder to use either water drop, glass bead, or penlight bulb lenses.

(iii) With an item this small, it is found that there is some difficulty in keeping a glass slide on the stage, especially when the stage must be moved in focusing.

(iv) Since it is difficult to get sufficient light through the specimen, it is suggested that the inside of the match box drawer be lined with light colored paper or metal foil to increase reflected light.

(v) This microscope was found to be good for inspecting such items as coins, newsprint, insect wings, crystals, etc.

B4. Adjustable Microscope



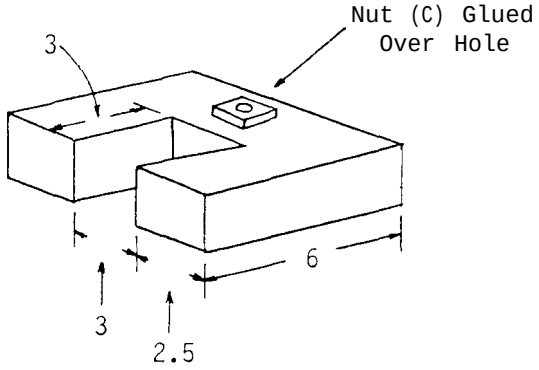
a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Base and Stage Assembly	1	Wood (A)	12 cm x 8 cm x 1.5 cm
	2	Wood (B)	6 cm x 8 cm x 1.5 cm
	1	Nut (C)	0.5 cm internal diameter
(2) Lens Mount Holder	1	Wood (D)	2.5 cm x 8 cm x 1 .5 cm
	1	Bolt (E)	0.5 cm diameter, 6 cm long

		Wing Nut (F)	0.5 cm internal diameter
	2	Nuts (G)	0.5 cm internal diameter
(3) Lens Mount	1	Wood (ii)	10 cm x 3.5 cm x 0.5 cm
		Aluminum Sheet (I)	9 cm x 2 cm x 0.1 cm
(4) Adjustment Knob	1	Wood Spool (J)	3 cm long, 2 cm diameter
	1	Bolt (K)	0.5 cm diameter, 6 cm long
	1	Nut (L)	0.5 cm internal diameter
(5) Mirror	1	Mirror Glass (M)	3 cm x 3 cm
	1	Wood (N)	3 cm x 3 cm x 0.5 cm
	1	Metal Sheet (0)	8 cm x 2 cm x 0.05 cm
	1	Nail (P)	5 cm long, 0.2 cm diameter
	1	Tack (Q)	1 cm long

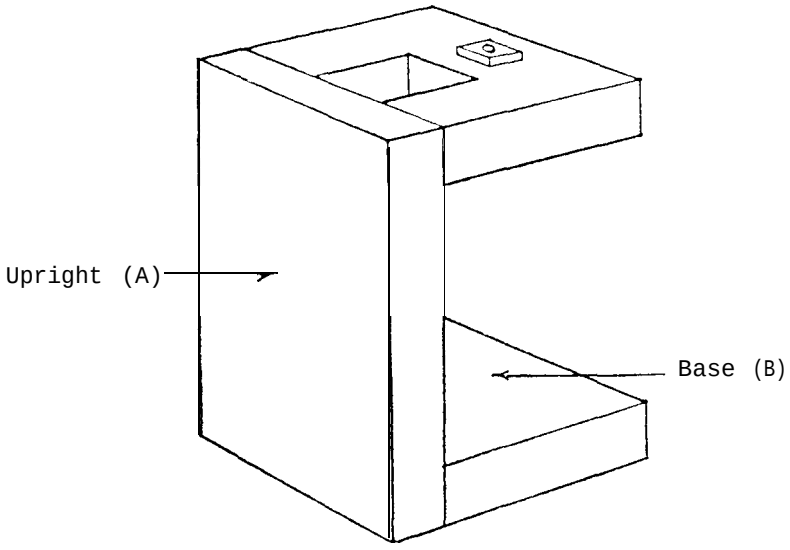
b. Construction

(1) Base and Stage Assembly



Stage (B)

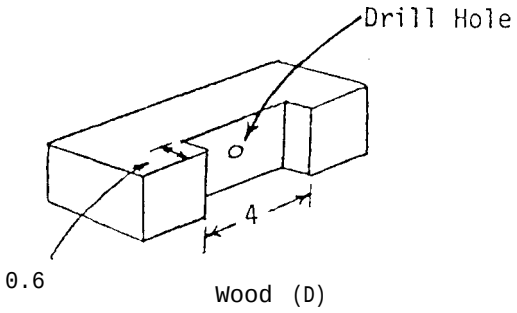
Cut a notch 3 cm square in one piece of wood (B) to make the stage. In this same piece, drill a hole through the wood. It should be centered between the edge of the notch and the edge of the stage. Make this hole slightly smaller in diameter than the bolt (K) used to make the adjustment knob. Place the nut (C) over the hole in the wood. Give it a sharp blow with a hammer so that it forms an indentation in the



Base and Stage Assembly

wood. Remove the nut, then glue it back in place taking care not to get glue in the hole or in the threads of the nut. It is best to allow the nut to dry with the bolt threaded through both it and the hole to assure proper alignment. Nail or screw this piece, the stage (B), to the upright (A). Likewise, nail or screw the base (B) to the upright.

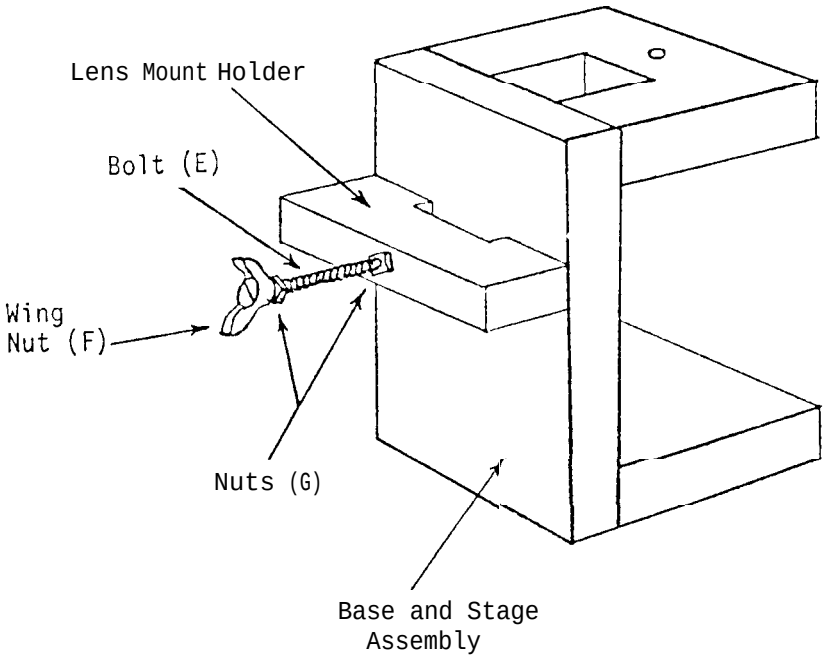
(2) Lens Mount Holder



Wood (D)

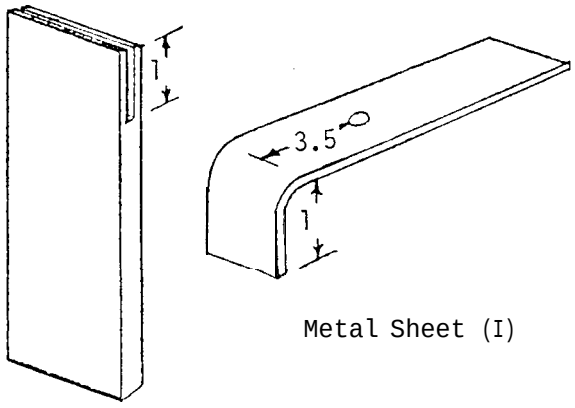
Cut a notch 0.6 cm deep and 4 cm wide in the piece of wood (D). Drill a hole in the center of the notch. This hole should be slightly smaller than the bolt (E) used to hold the lens mount in place.

Screw the wing nut (F) onto the bolt (E) and run it to the end of the bolt. Use one nut (G) to hold the wing nut tight to the end of the bolt. Place the other nut (G) over the hole in the piece of wood (D) and strike it hard with a hammer, taking care not to split the wood. Remove the

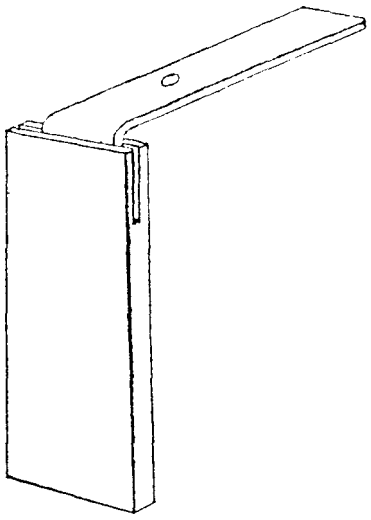


nut from the impression in the wood thus formed, and place a drop of strong glue in the impression and replace the nut. Be sure not to get glue in the threads of the nut or in the hole (this may be avoided by allowing the nut to dry with the bolt run all the way through the hole). Finally, glue, nail or screw the lens mount holder to the base and stage assembly.

(3) Lens Mount



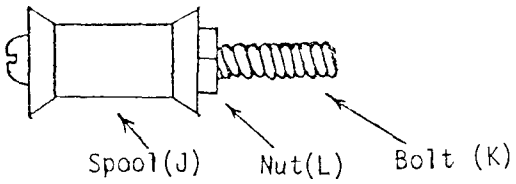
Make a slit in the end of the piece of wood (H), with a saw. This slit should be about 1 cm deep and slightly wider than the thickness of the metal sheet (I) used.



Lens Mount

Bend the aluminum sheet (I) to a right angle 1 cm from its end. Drill a hole 3.5 cm from the bend and centered. The diameter of this hole will depend upon the size of the water drop desired, the size of the glass bead used, or the size of the penlight bulb lens. [See I/B1, Notes (ii), (iii), and (iv) for instruction in making and using such lenses.] Glue the aluminum sheet (I) to the piece of wood (H).

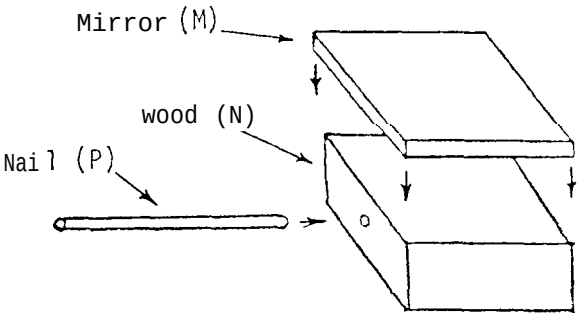
(4) Adjustment Knob



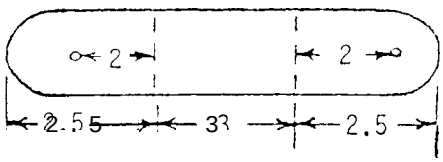
Side view

Run the bolt (K) through the hole in the wooden spool (J). Secure the spool tightly in place with the nut (L). Screw the end of the bolt through the hole and nut in the base and stage assembly.

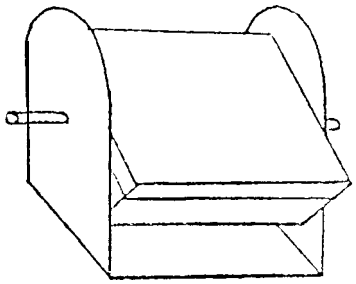
(5) Mirror



Cut the metal sheet (0) and drill two holes the same diameter as the nail (P) used. Bend the ends up at right angles along the dotted lines. Drill a hole through the wood (N) which is about the same diameter as the nail,



Metal Strip (0)



Completed Mirror

Insert the nail (P) through this hole and glue it in place. Glue the mirror (M) to the wood. Nail or screw the metal strip into position on the base directly under the notch in the stage. Insert both ends of the nail through the holes in the metal strip. There should be enough friction to keep the mirror at the desired angle.

c. Notes

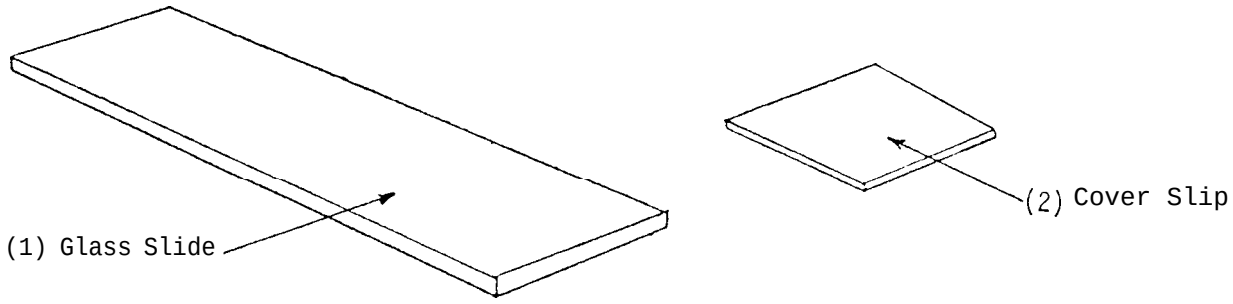
(i) The slide containing the specimen to be observed is placed over the hole in the stage. Light is reflected through the specimen and lens by means of the mirror. Coarse adjustment is obtained by varying the position of the lens mount with the lens mount holder bolt. Fine adjustment is attained by turning the adjustment knob so that it moves the metal portion of the lens mount up and down.

(ii) This microscope may be used with any of the three types of lenses : water drop, glass bead, or penlight bulb lens. See `I/B1, Notes (ii), (iii), and (iv) for details in mounting each type lens on the lens mount.

(iii) Light is reflected through the lens by use of the mirror. The mirror need not be a real glass mirror - any smooth, shiny surface (e.g., polished metal) is acceptable. The source of light may be a bulb, room light, or skylight, with skylight proving most satisfactory.

C. SUPPLEMENTARY APPARATUS

C1. Glass Slide and Cover Slip



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Glass Slide	1	Glass Plate (A)	7.5 cm x 2.5 cm x 0.2 cm
(2) Cover Slip	1	Transparent Plastic (B)	2.5 cm x 2.5 cm x 0.05 cm

b. Construction

(1) Glass Slides — Glass slides may be hand cut from plate glass (A), but this is tedious and time consuming.

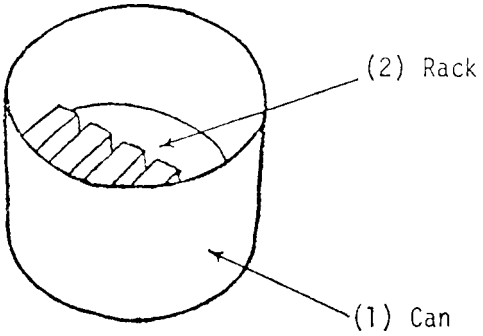
(2) Cover Slip — Cover slips can be cut from stiff transparent plastic sheets (B) with scissors.

c. notes

(i) Good quality slides may be purchased almost as inexpensively as they can be handmade, or they may be obtained for free from hospital blood laboratories as they are often discarded after use.

(ii) Consult a good general biology source book for information on preparing either fresh or permanently mounted slides.

C2. Staining Vessel



a. Materials Required

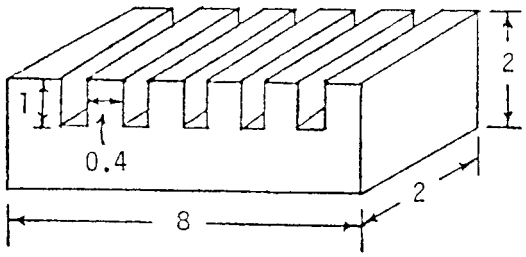
Components	Qu	Items Required	Dimensions
(1) Can	1	Tin Can (A)	8 cm high, 8 cm diameter
(2) Rack	1	Wood (B)	8 cm x 2 cm x 2 cm

b. Construction

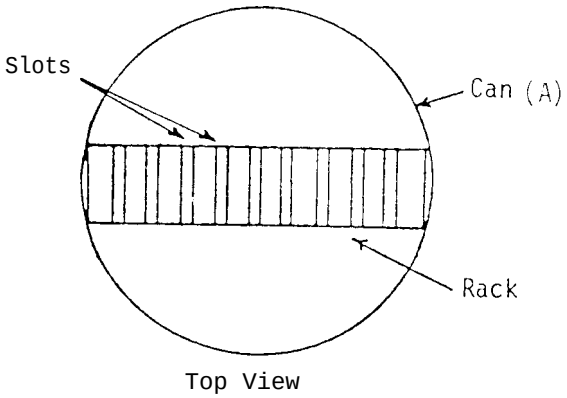
(1) Can

The diameter of the can (A) may be somewhat larger than 8 cm (it should not be much less), and the height of the can should be about the same as the length of the slides used.

(2) Rack



Cut notches in the wood (B) about 1 cm deep and just slightly wider than the slides used. Paint the wood with a sealant (e.g., varnish, shellac) to prevent the stain from soaking into it. Push the rack down into the



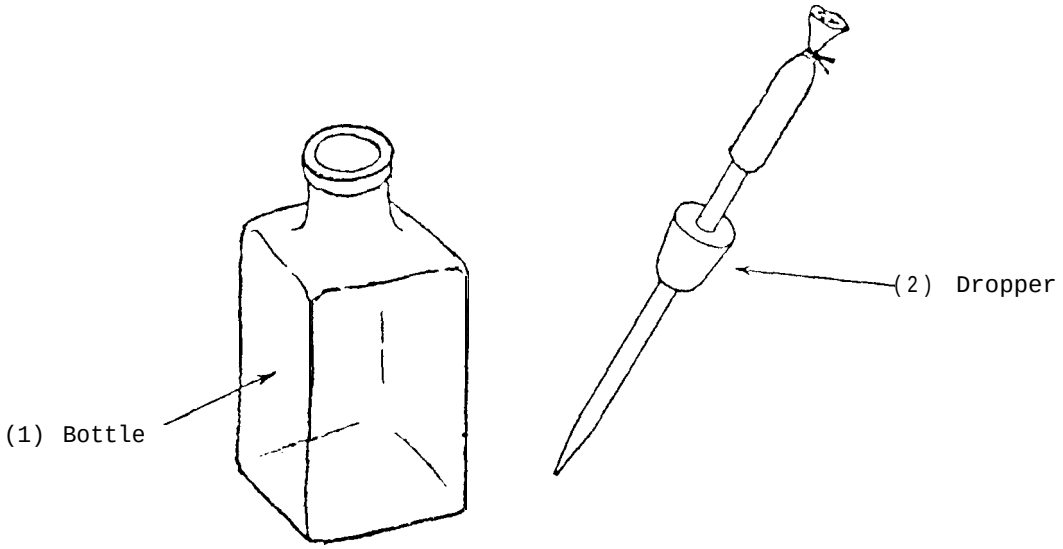
Top View

bottom of the can (A), notches up. The rack holds the slides upright and prevents them from touching each other. Always make the length of the rack equal to the diameter of the can to insure that it will fit tightly in the bottom of the can.

c. Notes

(i) Staining vessels are necessary when preparing slides for microscopic inspection. Consult a good standard biology source book for instruction in preparing slides and stains.

C3. Stain Bottle



a. Materials Required

Components	Qu	Items Required	Dimensions
(1) Bottle	1	Pill Bottle (A)	25-50 ml capacity
(2) Dropper	1	Glass Tube (B)	12 cm long, 0.75 cm diameter
	1	Rubber Tube (C)	4 cm long, 1.0 cm diameter
	1	One-hole Cork Stopper (D)	To fit mouth of pill bottle
	1	Wire (E)	5 cm long

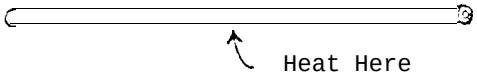
b. Construction

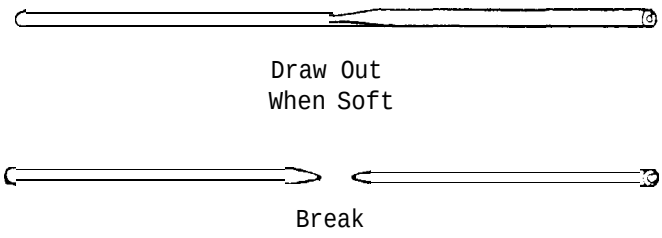
(1) Bottle

Use a clear glass pill or medicine bottle (A).

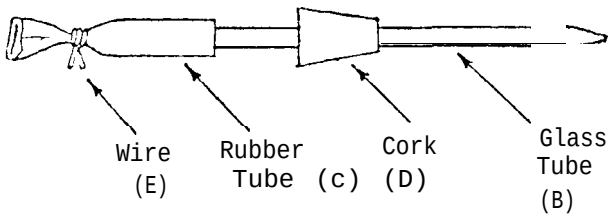
(2) Dropper

Make the tube portion of the dropper two at a time by heating a piece of glass tubing 20 cm long in the





middle and drawing it out to a narrow filament when soft. Break the tube at the most narrow part of the constriction to form two tubes (B).



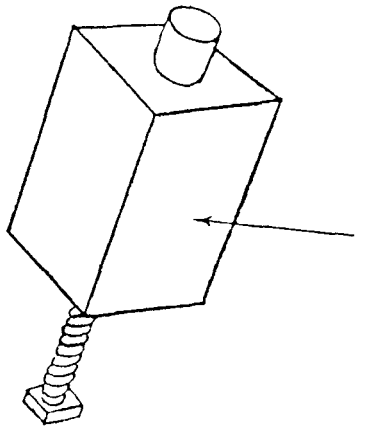
Force the glass tube through the one-hole cork stopper (D). Push the piece of rubber tubing (C) onto the wide end of the glass tubing and tie it off with the wire (E) to form the dropper's suction cap. Adjust the length of the glass tube so that when the cork is in place in the bottle, the tip of the glass tube almost touches the bottom of the bottle.

c. Notes

(i) If one-hole cork stoppers are not available, use a cork borer to make them from regular corks or use one-hole rubber stoppers.

(ii) Be sure to label the bottle with the name of the type of stain it contains.

C4. Hand Microtome

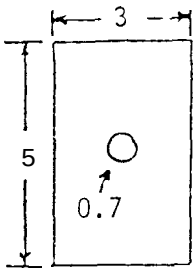


a. Materials Required

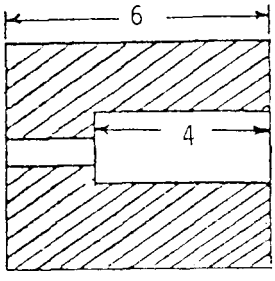
Components	Qu	Items Required	Dimensions
(1) Block and Bolt	1	Wood Block (A)	3 cm x 5 cm x 6 cm
	1	Glass Tubing (B)	5 cm long, 1 cm inside diameter
	1	Wood Dowel (C)	1 cm long, 1 cm diameter
	1	Steel Bolt (D)	9 cm long, approximately 0.7 cm diameter
	1	Nut (E)	To fit bolt

b. Construction

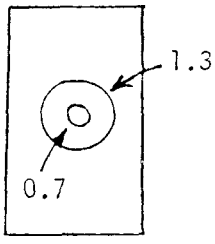
(1) Block and Bolt



End View

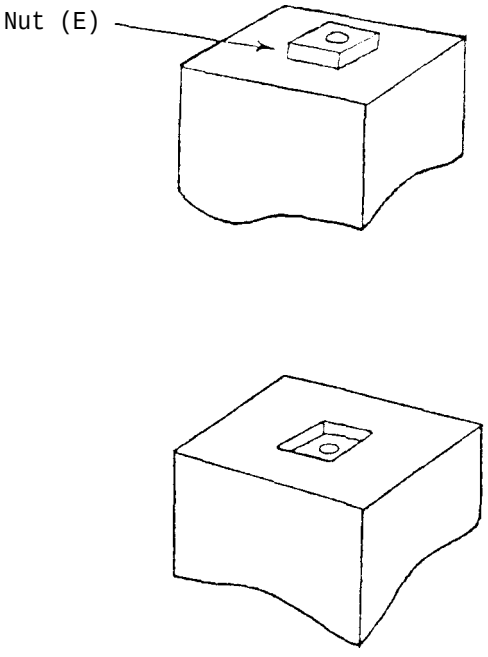


Side-View
(Cross-section)



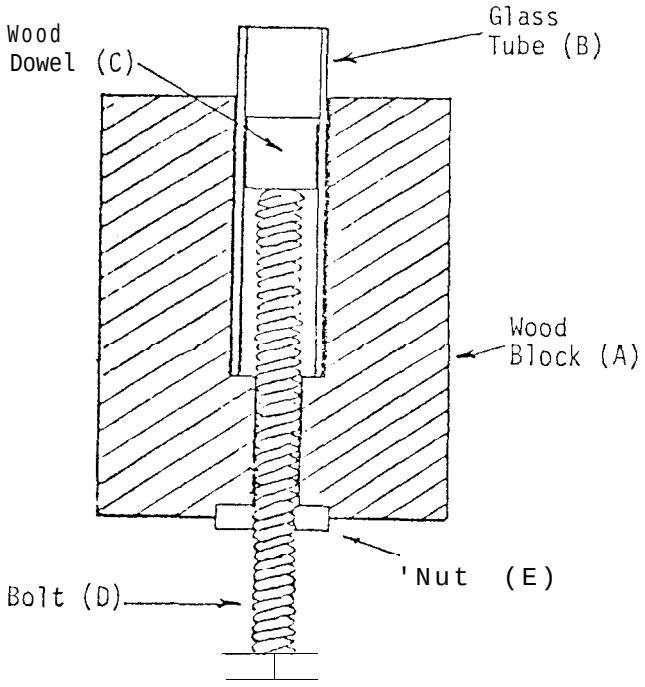
End View

Prepare the wood block (A) by drilling or boring a hole slightly larger in diameter than the outside diameter of the glass tubing (B) 4 cm into one end of the block. Drill another hole (0.7 cm diameter) through the same end of the block. This second hole should be



Impression of Nut

centered in the bottom of the first, larger hole, and be drilled through the block. Next, lay the nut (E) on the end of the block which has the small hole in it. Strike the nut sharpiy with a hammer to make an impression of the nut in the wood. (Be careful not to split the wood, and also make sure the hole in the nut aligns with the hole in the wood.) After the impression has been made in the wood, glue the nut into place with epoxy resin cement.



Side View
(Cross-section)

Shove the piece of glass tubing (B) down into the large hole in the wood (A), and glue it in place. The end of the tube should stick out about 1 cm. See that this end is cut as evenly as possible and fire polish it just enough to remove any possible burrs. Insert the short wooden dowel (C) into the tube. Screw the bolt (D) through the nut until the end of the bolt touches the wooden dowel.

The microtome is now ready for use.

c. Notes

(i) To operate the hand microtome, screw out the bolt until the wood dowel drops to the bottom of the glass tube. Then, insert the section of plant stem (or whatever is to be cut for the microscope slide) into the glass tube. Fill the space which remains between the specimen and the glass tube with melted paraffin and allow it to cool. When the paraffin is hard, screw the bolt in until it begins to force the wood dowel to push the paraffin and specimen out of the glass tube. As the specimen comes out, use a single-edge razor blade to cut off sections. Practice with the microtome will eventually allow very thin sections to be sliced from specimens.

(ii) It may be desirable to substitute metal tubing for the glass as glass is easily broken. Also, painting the end of the wood dowel with shellac or varnish will prevent the paraffin from sticking to it.