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Hand Polishing

Hand polishing is a skill that is acquired with time and experience. A few fundamentals in hand polishing are discussed in this chapter.

Pitch polishing optical surfaces is called lapping. The pitch polisher, or lap, is a mixture of compounds which has a slight flow at normal room temperature. Two types of pitch polisher are used for polishing optical surfaces. One is the facet type with smaller embossed facets impressed on the larger facets. The second is the solid type with scratched lines.

1. PITCH FORMULAS

Pitch formulas are often trade secrets. Each optician's favorite pitch resembles a witch's brew. There is no limit to what an optician will mix in his cauldron. The supervisor and the firm usually maintain a policy that requires each new optician to use standard pitch mixtures. Some typical polishing pitch mixtures are listed:

In Pounds

1. Optical D, 1 lb and 1 oz of paraffin.
2. Optical D, 1 lb and 2 oz of paraffin (for figuring).
3. Optical D, 1.5 lb, ¾ oz of ozhinite, and 5 oz of pine tar.
4. Optical D, 2 lb and 2 lb Zorphalac.

Pitch mixtures (2) and (3) were developed for polishing crown glasses, pyrex, window glass, and quartz. Pitch formula (4) is used for polishing rare earth glass and flints.

Pitch formulas divised by the late Don Hendrix followed a simple rule: mix similar compounds; for example, a pitch mixture of rosin from pine trees and castor or linseed oil from plants combines vegetable with vegetable. Optical D from oil refineries mixed with a soft asphalt compound is a mineral/mineral mixture.

Hendrix developed a number of pitch mixtures:

In Pounds

1. Water-white rosin, 5 lb, castor oil, 6 oz.
2. Optical D, 2 lb, linseed oil 6 oz.
3. Optical D, 2 lb, pine tar 4 oz, beeswax 1.5 lb.

   Add 1 to 3 teaspoons of turpentine.

I use a pitch formula that consists of 5 lb of water-white rosin and 6 oz (liquid) pine tar. Pitch mixtures can be purchased ready for use. Zobal brands are soft and hard pitch. The mixture is transparent and the harder pitch can be softened by adding some of the softer. Semihard polishing pitch No 450 offered by Universal Shellac and Supply Co. (Brooklyn, NY) is widely used. This company also provides a number of burgundy pitches of various hardnesses and ranges of melting points. Wm. Dixon and Co. (Newark, NJ) is another supplier of good optical pitches. Some imported pitches are also very good and are quality controlled. Although this is not a complete list of the many formulas, it is apparent that pitch mixtures can be developed to specific requirements.

2. MEASURING THE HARDNESS OF PITCH

There are several methods of measuring the hardness of pitch. A penetration instrument which consists of a 6-mm inch ball bearing mounted on a sliding 0.5-kg brass weight is commonly used. A dial indicator in thousands of an inch is mounted on cylinder. The penetration of the ball bearing into the pitch is read after 5 min. (See Fig. 3.1.)

Another method is patterned after the one used by many earlier opticians who made their measurements by pressing down with the thumbnail at a pressure of approximately 2 to 3 lb, generally for 1 to 2 sec. This is a crude procedure, but a similar one can be devised by fastening a sharp wheel to a hinged bar with a sliding, 8-oz brass weight set at 10 cm from the fulcrum of the bar. This instrument measures the penetration of the cutter into the pitch after 60 sec. The width and depth of the cutter wheel's penetration into the pitch is measured with a machinist's ruler. (See Fig. 3.2.)

Although the gravity weight penetration method is more precise, it does suffer from the fact that the dial indicator, an expensive item, slowly becomes inoperative because of the pitch fumes that condense on its stem.

The hardness of pitch mixtures used with machine or hand polishers can be estimated. The room temperature should between 70 and 72°F. For

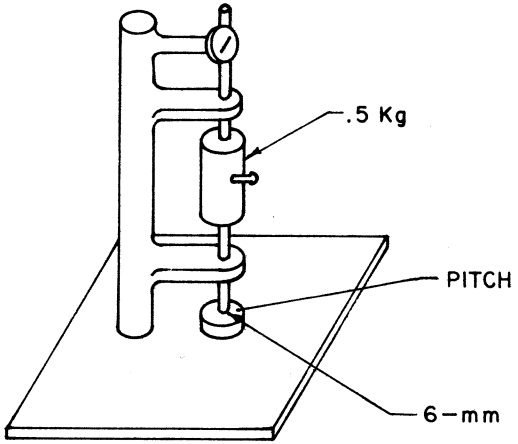

Fig. 3.1. A typical pitch penetration apparatus that controls the hardness of the polishing pitch.

polishing pyrex, quartz, crown glasses and Cer-Vit, a dial-reading instrument, the measured penetration should be 0.012 to 0.016 in. This is also an excellent penetration for hand polishing prisms and small flats. Pitch laps of 0.018 to 0.025 in hardness are used to figure aspheric surfaces. For flints the hardness is 0.025 to 0.030 in. and for rare earth, for example, EDF3, the hardness ranges from 0.030 to 0.040 in. These are only representative values for 40-hr milled Barnsite and polishing compounds.

All pitch laps become progressively harder as the essential tempering mixtures such as pine tar or linseed oil slowly evaporate and the lap becomes charged with the polishing compound. Because most pitch laps with precut facets have a "marquisette" pattern imprinted on them, the pitch lap can be treated by scraping the facets with a razor blade to renew the pattern.

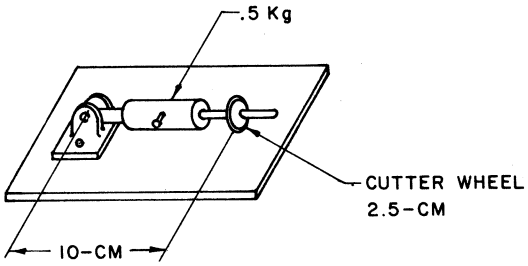

Fig. 3.2. Another design similar to the thumbnail for controlling the hardness of pitch.

3. FACET PITCH POLISHERS

The pitch lap used in hand polishing prisms is made as follows: 5 lb of water-white rosin is slowly melted and 6 liquid oz of pine tar is stirred thoroughly into the melted rosin. Sufficient pine tar to soften, or rosin to harden, is then added to the pitch to approximately 0.014-in. penetration.

Two 10-in. diameter polishers should be made at the same time. The aluminum holder should be at least 1 in. thick and the hub diameter, 1.5 in. or larger to prevent the lap from rocking on its mounting screw during polishing. One of the two holders is warmed under a faucet until it is hot to the touch. The holder is then screwed down on the post with very light pressure; if it is forced down too tightly while the tool is hot, the large lap will be hard to remove. Encircle the periphery of the holder with ¾-in. masking tape to a thickness of ½ in. above its surface. The semicooled pitch is poured slowing onto the warmed holder, starting at the center. The thickness of the pitch can be 1/16 to ⅜ in. The lap is allowed to cool slowly to room temperature.

The second pitch lap is made in a similar manner, but the pitch mixture now contains ground nutshells; 1.5 cups of the shells are added slowly to a quart of the melted pitch.

Each polishing lap is laid out in ¾-in. squares with ¾-in. strips of brass. Each facet is separated by a channel ⅛ wide at a depth of approximately 3/16 in. The pitch lap is cut with a single-edge razor blade. It is good practice to cover the lap with detergent water after the initial layout and then cut one side of all facets to a shallow depth. The channel cuts are made deeper with each pass. A right-handed person should always cut the channel on the right side (vice versa is left handed) by turning the lap 180° for alternate cuttings. Greater pressure can be applied to the razor blade after several cuts. The pitch chips are removed from the recessed channels with a 4-in. watchmaker's brush after flushing with detergent water.

The precut polishers must be made smooth with a 12-in. cast-iron tool with a flat surface. This tool is heated in running hot water until it is hot to the touch. The pitch lap is covered generously with thick polishing compound in a watery solution. The hot tool is placed on the pitch lap and several circular strokes are made across the lap. It is easy to determine whether the edges of the lap are compressed evenly all around the periphery in relation to the center. After this operation the facets must be recut and further embossed with smaller facets. For this procedure a "marquisette netting" or piece of plastic door screen is used. The netting is hard over the pitch lap and generously wetted with polishing compound. The heated cast-iron flat tool is placed on top. Careful note must be made of the impressions made in the lap. They should always be less than one-half the diameter of