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THE ART OF HAND SCRAPING

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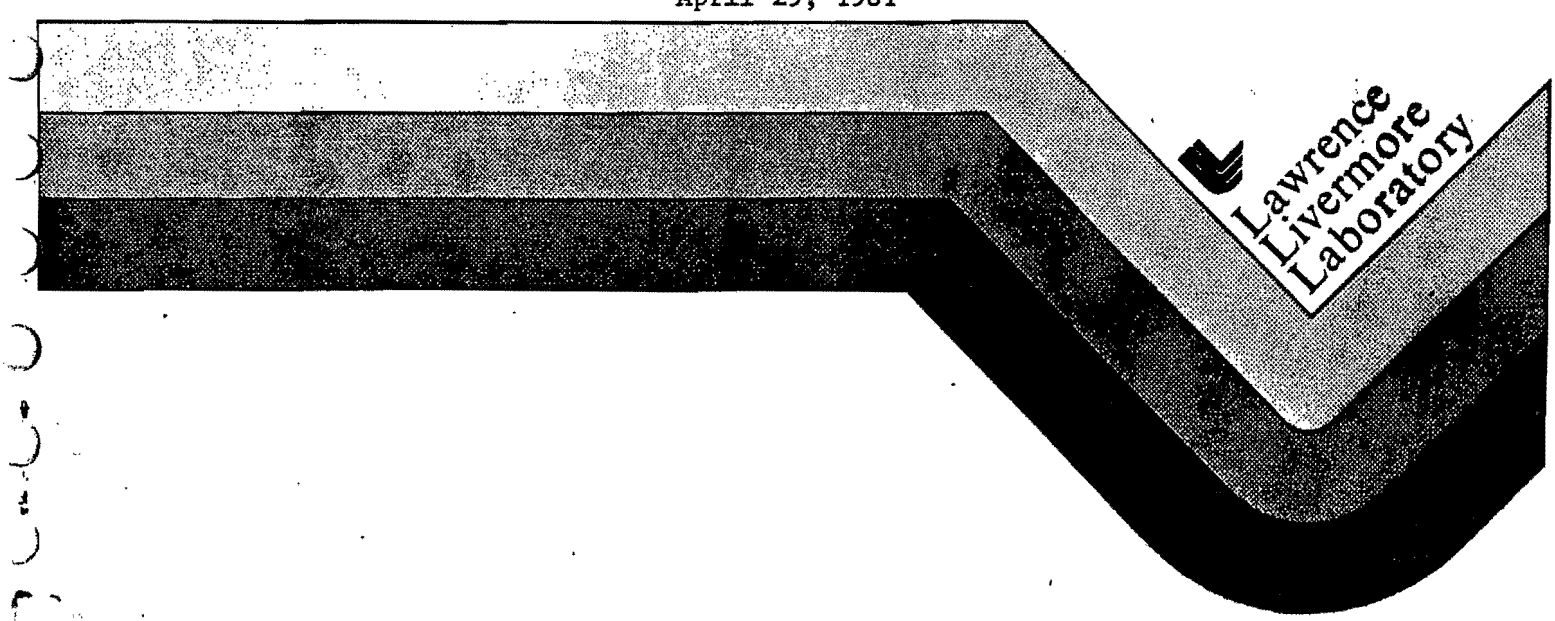

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THE ART OF HAND SCRAPING*

INTRODUCTION

Hand scraping is generally considered in two categories: tooling and machine tool bearing surfaces or ways. There are other reasons for scraping, but these two categories should cover most other applications.

The objective in hand scraping is to remove material from a part to alter its geometry so two surfaces will match each other. We use such tools as a straightedge, surface plate, or other master gage, to match to another surface. We also match any other two mating surfaces by hand scraping.

The purpose of tooling scraping is to generate tools to be used in scraping other components. Straightedges, surface plates, and angle plates must be scraped to a known master. To generate this master flat plane, the system of "symmetrical distribution of errors" is employed. A flat plane will be attained by cross matching three surface plates that are square.

The major purpose for scraping is for machine tool bearing surfaces. Way bearings become worn and scratched and must be reconditioned in the final form by scraping and flaking.

Truing a bearing surface is also accomplished by scraping, usually progressing with the reconditioning process. Truing the ways involves straightness, angularity, and parallelism, with attention being paid to alignment of such items as gear trains, shafts, and T slots.

While in the process of reconditioning and truing, the geometric configuration of the components must be obtained by scraping the ways of the components.

Matching two surfaces of machine components must be achieved by scraping. A slide being matched to its ways must be scraped for fit and alignment.

The tapered gib used to facilitate assembly of a machine must be scraped to match the tapers while allowing the proper clearance for freedom of

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*This is the second in a series of refresher courses prepared by the Machine Tool Services of the Materials Fabrication Division of the Mechanical Engineering Department.

movement of the slides. Finally, machine tool ways must be flaked for functional and aesthetic purposes.

In summation, hand scraping is a physical, tedious job requiring a high degree of precision and should be attempted by only those that are trained for the work.

HAND SCRAPING TOOLS

HANDLES (ARM, HIP, PULL)

The most common handle for scraping is the Anderson Brothers Scraper. This scraper has a clip-attached scraper blade for quick removal for sharpening. Scraper blades, which are made of high-speed steel or are carbide tipped, are available in three sizes, 3/4 in. for small parts and fine bearing scraping, 1 in. for general purpose scraping and 1-1/4 in. for rough scraping. The wood handle supplied with the Anderson Scraper will suffice for general scraping, but for long-term hard scraping a more ball-shaped handle is easier on your hands.

Hip scrapers are generally homemade. Cold rolled steel 3/16 in. by 1 in. by 24 in. is a practical size. Use the Anderson blade clip or weld a piece of carbide to the tip. A large handle (5 in. in diameter) is used to fit your hip. Padding on the handle is recommended.

The Anderson Scraper can be used as a pull scraper by heating and bending a high-speed steel blade to about 45°. The blade must be short-coupled in the clip to prevent chatter. The high-speed steel blade is used for hand sharpening on a stone.

POWER SCRAPERS

Power scrapers are hand-held electric scrapers with carbide-tipped blades. Power scrapers are used mostly for heavy material removal, although a rough bearing can be picked with the power scraper.

POWER FLAKERS

The power flaker is an electric hand-held flaking machine and has some advantages over hand flaking. The power flaker also has a carbide-tipped blade.

STONES

Stones used in scraping fall into two categories: stones for sharpening tools and stones for deburring and polishing the scraped surface (Fig. 1).

Honing stones for sharpening are generally silicon-carbide combination stones 1 in. by 2 in. by 8 in. and are coarse on one side and fine on the other. Deburring stones are used after a surface has been scraped. Slip stones are generally used. A slip stone is tapered and comes in coarse, medium, and fine grades. The most commonly used stone for scraping is the medium grade India stone. This is a semi-hard, medium-grit stone and will not load up and scratch the scraped surface.

For large surfaces and rough scraping, a cutter grinder wheel makes a useful stone. A practical size is the 1/4-by-6-in. aluminum oxide wheel.

For very fine finishing the Arkansas stone is used. This is a very hard, close-grained stone and is used for polishing fine surfaces. This stone should also be used for deburring tooling such as straightedges and surface plates, and also very fine scraped bearings as on measuring machine, precision grinders, and precision computer numerical control (CNC) machine tools.

As the stones are used, they will get dirty. A simple and quick way to clean them is to immerse the two stones in a solvent and rub them together. Dry them with a towel or air and they are ready for use again. It is recommended that the stones be used dry. This will prevent contaminating the scraped surface with oil or solvent, thereby causing smears.

CARBIDE SHARPENING

A diamond wheel grinder is the heart of carbide scraper blade sharpening. Because diamond wheels are difficult to dress, they should be used for scrapers only to produce the smooth finish on the scraper blade necessary to prevent scratches in the work. Two diamond wheels are most convenient, one 280-grit wheel for roughing and shaping a new blade, and one 400-grit wheel for

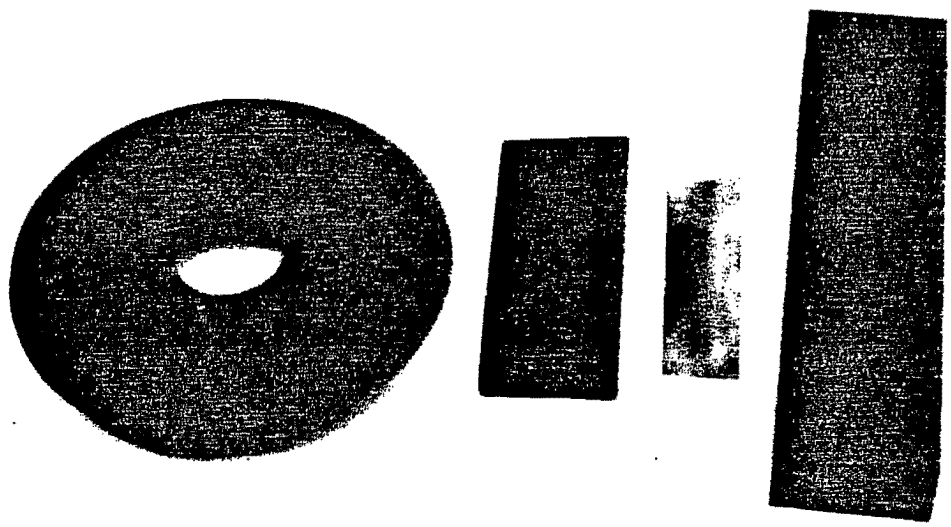


FIG. 1. Various stones.

finishing and sharpening the blade. The grinder should be a substantial machine with a heavy tilt table, coolant system, and a light. The spindle should be ridged and precise. It is very important to keep the wheel wet when sharpening. Use a mixture of 80% kerosene and 20% light machine oil. A gravity system is satisfactory, but let it run freely as you grind on the wheel.

Two methods are used to sharpen the scraper blade, by free-hand or by using the grinder table. To sharpen the blade in the free-hand method, the scraper blade and handle are left intact. Place your left hand index finger below the scraper blade about 1/2 in. from the wheel, with your thumb holding the top of the blade. Rest your hand lightly on the table. With your right hand, hold the handle of the scraper at about a 6° angle to the wheel. Your right hand on the handle will determine the curve of the blade. Therefore, the closer to the end of the handle the less of a curve you will grind. You now move your left hand in a side-to-side sweeping motion across the face of the diamond wheel, holding your right hand still so as to act as the pivot point for the arc. Use a moderate pressure on the wheel and one or two passes will sharpen the blade. Do both sides. It is important to sweep across the whole face of the wheel so the wheel will wear evenly and stay flat (Fig. 2).

To use the grinder table as a guide, you adjust the tilt table to a 6° angle. Detach the scraper blade from the handle and place the blade on the table. With the index finger of each hand, hold the blade flat on the table and with your thumb hold the rear of the blade to apply moderate pressure on the wheel. Again sweep the entire face of the wheel following the curve of the blade. Be sure to keep the coolant flowing while grinding (Fig. 3).

MARKERS

Markers for scraping bearing surfaces are used to transfer the geometrical relationship of one surface to another, whether for a master gage or mating surfaces. Red lead and bearing blue are the most popular markers.

Powdered red lead is mixed with kerosene as a vehicle; a little machine oil is used to prevent drying. When first mixed to a paste consistency, the red lead is wet and difficult to use. It is preferable to wait about a week to allow the red lead to dry to a caked condition; it is then easy to use. When it is being used, a small amount of kerosene or a quick drying solvent such as trichlorethane is added to keep the surface wet and easy to

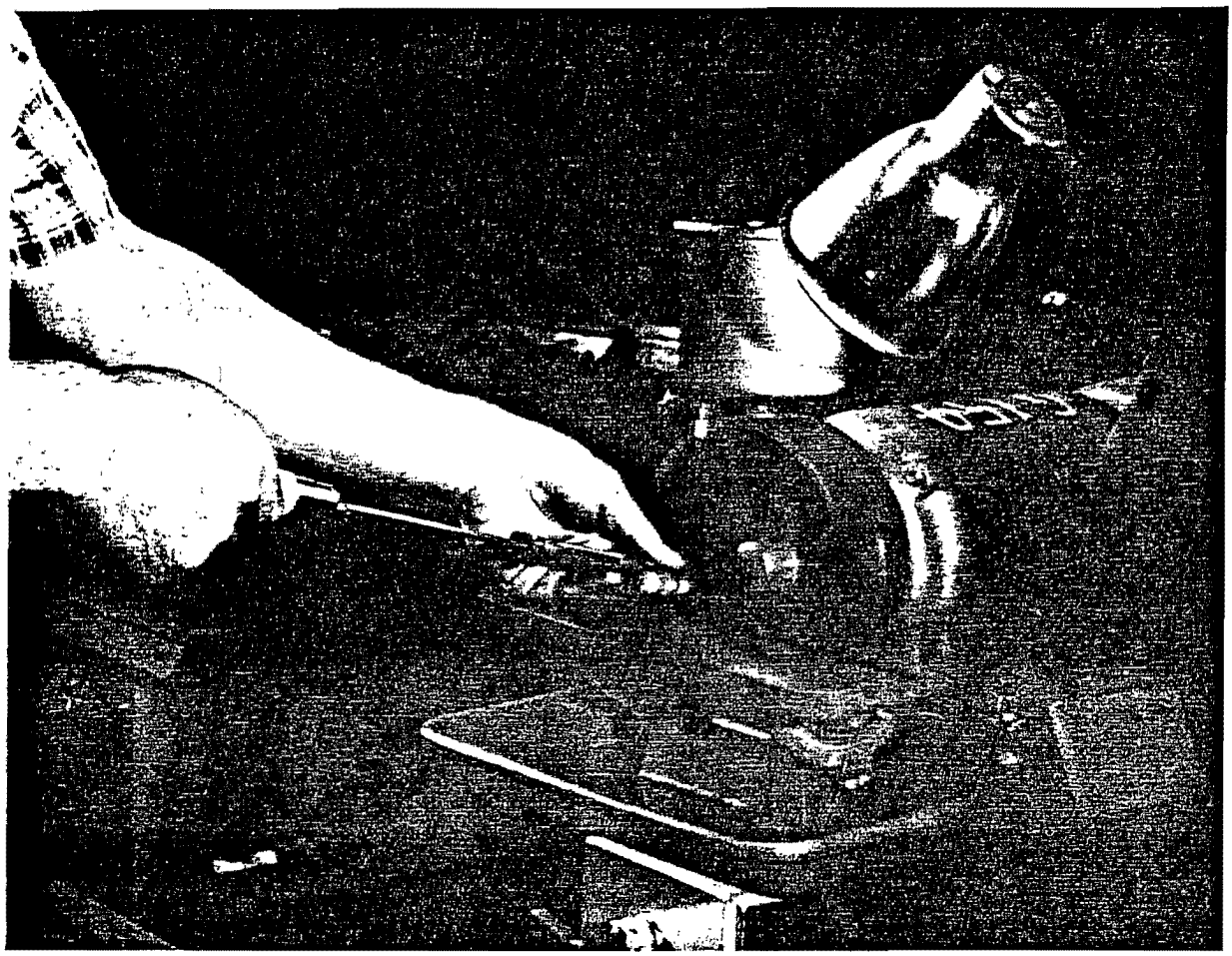


FIG. 2. Free-hand sharpening.

FIG. 3. Blade sharpening on the table.

spread (Fig. 4). The red lead is spread out on the scraped surface with a towel, then wiped dry and thin. It is important to have the red leaded surface dry to prevent smears and false readings. A dry, dull red background enhances the blue marks making interpretation of the marks more accurate.

The bearing blue marking medium used for scraping is the commercially available Dykem Bearing Blue. The bearing blue is very oily when purchased so it should be partially dried before use; a simple method for drying is to put two or three tubes of the bearing blue in a flat, round container which has a lid. Level and smooth out the bearing blue and then place a tissue, such as a coffee filter, over it. Then fold an absorbent tissue and place it over the coffee filter. Replace the lid and let this set for a week. Replace the tissue as it becomes saturated with oil. The bearing blue should be dry and firm (Fig. 5).

With the bearing blue dry and ready for use, spread a thin layer evenly on the master gage or the larger of two mating surfaces. The bearing blue will then transfer to the red leaded part to be scraped. It is advisable to use a darker or thicker layer of bearing blue when rough scraping and then allow it to thin out as the scraping becomes more precise.

MEASURING AND INDICATING

To attempt to name all types of measuring or indicating accessories used in hand scraping would be difficult, because this equipment varies from no tools necessary to exotic one-of-a-kind fixtures.

In scraping, 90% of measuring is a reference measurement which makes repeatability of the utmost importance. Repeatability depends directly on rigidity and quality of tools.

Some basic measuring tools used in various scraping procedures are finger-type indicator (Last Word), or the like, surface gage with a dovetail attachment, adjustable level, blade type square, round ground pins (dowel pins) various size parallels, indicator rods, micrometers, electronic indicators, and an indicating block (Fig. 6).

FIG. 4. Mixing red lead.

FIG. 5. Drying the bearing blue.

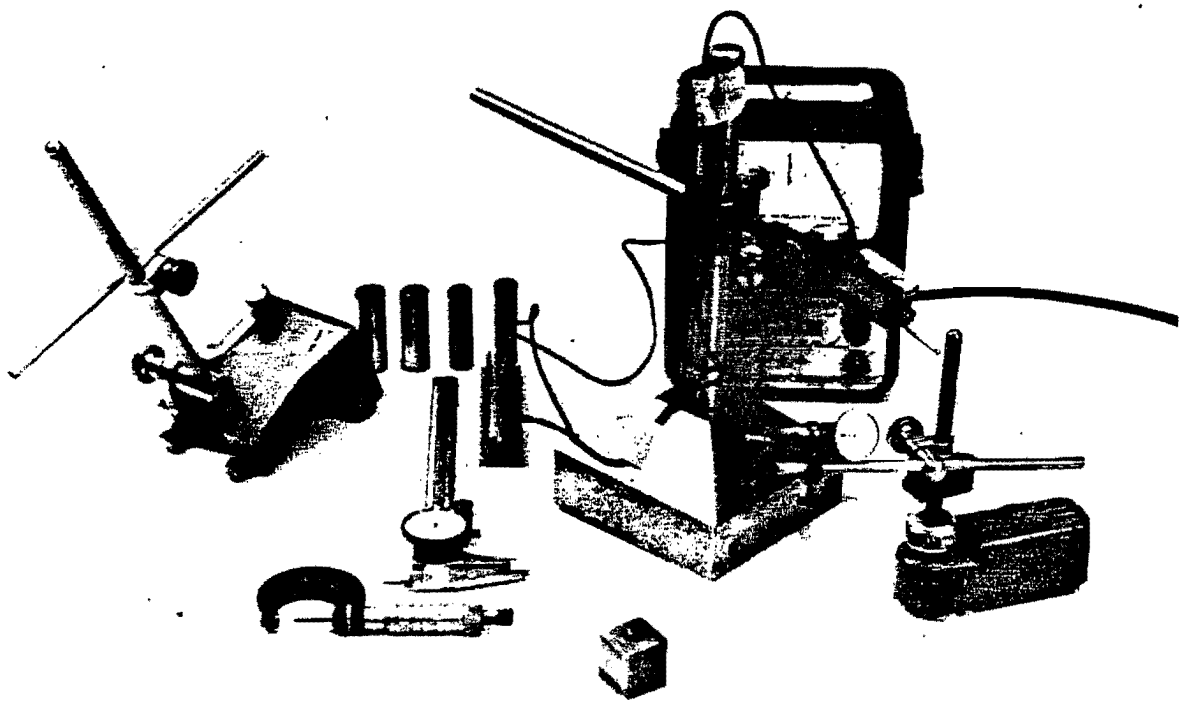


FIG. 6. Measuring tools.

HOOK SCRAPING

The scraping technique I will discuss is called hook scraping. It is an ideal method because it produces a smooth and edgeless surface and fine bearings with tolerances of 50 millionth or less can be produced. A great deal of practice is required to master the hook scraping technique, but the benefits are worth it.

To produce the hook, you start with a very slight amount of pressure. As you proceed into the cut you increase the pressure which causes the depth of the cut to run across the curve of the blade. After crossing the center of the cut you release the pressure, a very small amount of twist is also applied to the blade. The twist should begin at the start of the cut and follow through to the end of the cut. The trick in developing the hook is coordination of the three movements, applying and release of the pressure and the slight twist with the forward stroke of the blade. Maintaining a rhythmic pace also helps.

The size of the hooks should be about 1-in. long with heavy pressure for rough scraping, and about 3/8 in. long with light pressure for the finish cuts. The more material to be removed, the larger the scraper. For very fine cuts use a small scraper (Fig. 7).

An example in scraping is a 7-by-10-in. angle plate using a 2-by-3-ft master surface plate.

Before starting the scraping you should study the geometry of the part and determine what approach to take. In this example of the angle plate, the best approach would be to scrape the large part for flatness only and adjust the geometry with the small part. If the angle plate is set on the small side the squareness error would be amplified by reading on the large side. There will be less scraping on the small side to adjust the geometry.

Before starting any scraping job, the first thing to do is to apply red lead to the part and then scale it off. Scaling is the procedure for taking an even cut over the entire surface leaving about 25% of the red lead showing. The purpose of this cut is to prepare the surface for a blue reading on the surface plate and to remove any scratches, tool marks, or any other imperfections undesirable in the finished job. More than one cut may be necessary, so take as many as needed. The direction of the cut should be

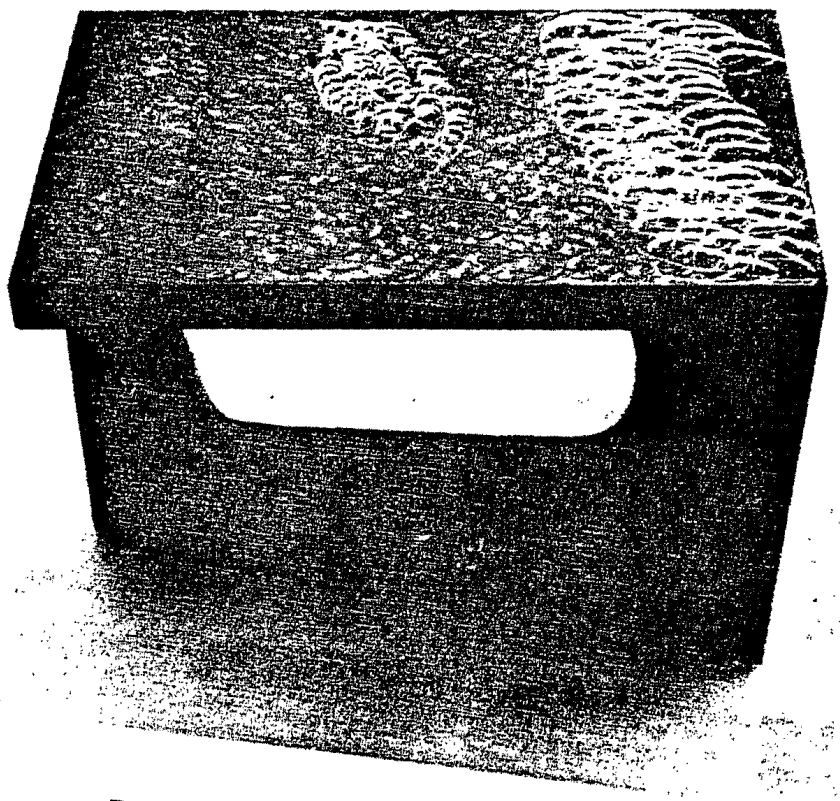


FIG. 7. Large and small hooks.

changed by about 45° each cut to prevent chatter. Use of a large hook in scaling will be faster and generate larger spots (Fig. 8).

After scaling off, brush off the chips and applying moderate pressure use a medium India stone to remove the burrs raised by the scraper. Then apply red lead to the part, making sure the lead is even-colored and dry (Fig. 9).

Remove the cover from the surface plate and check the plate for any contamination. Dust, chips, or lint should be lightly wiped off with a clean towel or brushed with a paint brush. Apply a fairly heavy coating of blue on the plate, about twice the size of the part being worked. Make sure the blue color is even (Fig. 10).

Pick up the part with both hands and check and remove any chips or dirt that may be on it. Examine the red-lead surface of the part for any dust or lint. You may now lower the part lightly and evenly on the blued surface plate. An important factor when taking a reading on a part being scraped is that the part must be completely covered by the master at all times. Any deviation will cause a false reading. Do not place the part half way on the master and then slide it on. Do not slide the part off and on over any edge of the master. Any time the part is in contact with the master it must be completely covered by the master or a false reading will be taken.

With the part now on the surface plate, it must be slid back and forth to transfer the blue to the red leaded part. It is best to slide the part by holding it on one end only--thus a push-and-pull motion. Attention should be paid to push and pull in a line parallel to the surface plate so there will be no up-and-down influences on the part.

An important phase of taking a reading on a part is performing the rock test. This simple test should be performed at each reading. A good blue reading could be taken on a flat master even though the part is not flat. In the case of a convex part or high in the center, the part would roll over the high center when it is being rubbed, thereby giving a good blue reading. When the part is held on one end and moved sideways the point of maximum weight bearing will cause the part to pivot at that point. In the case as previously stated the part would rock in the center, which indicates a false blue reading and that the part is not flat. When the part is concave it would rock on the ends. Ideally, the weight of the flat part will average out on the ends of the center third of the length of the part, with consideration given to the shape of the part (Fig. 11).

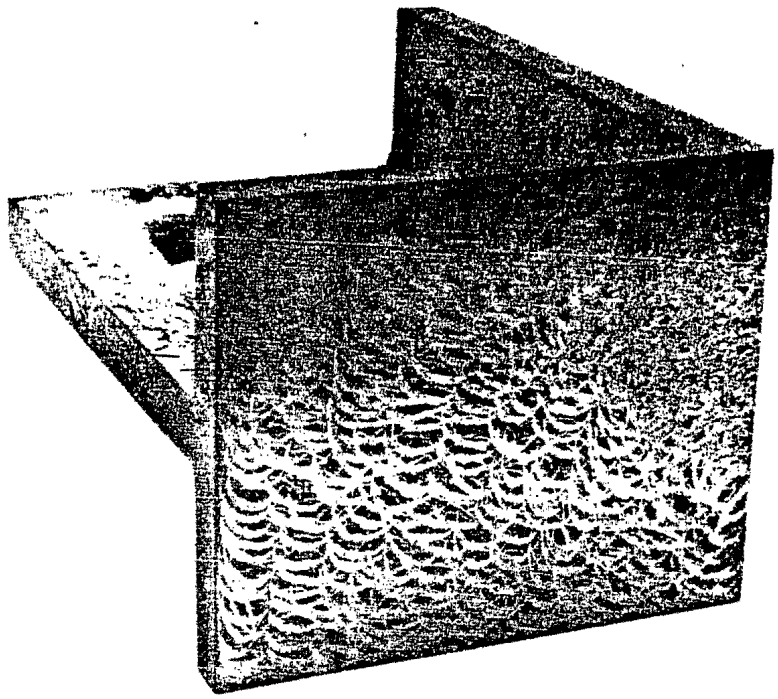


FIG. 8. A scaled-off part.

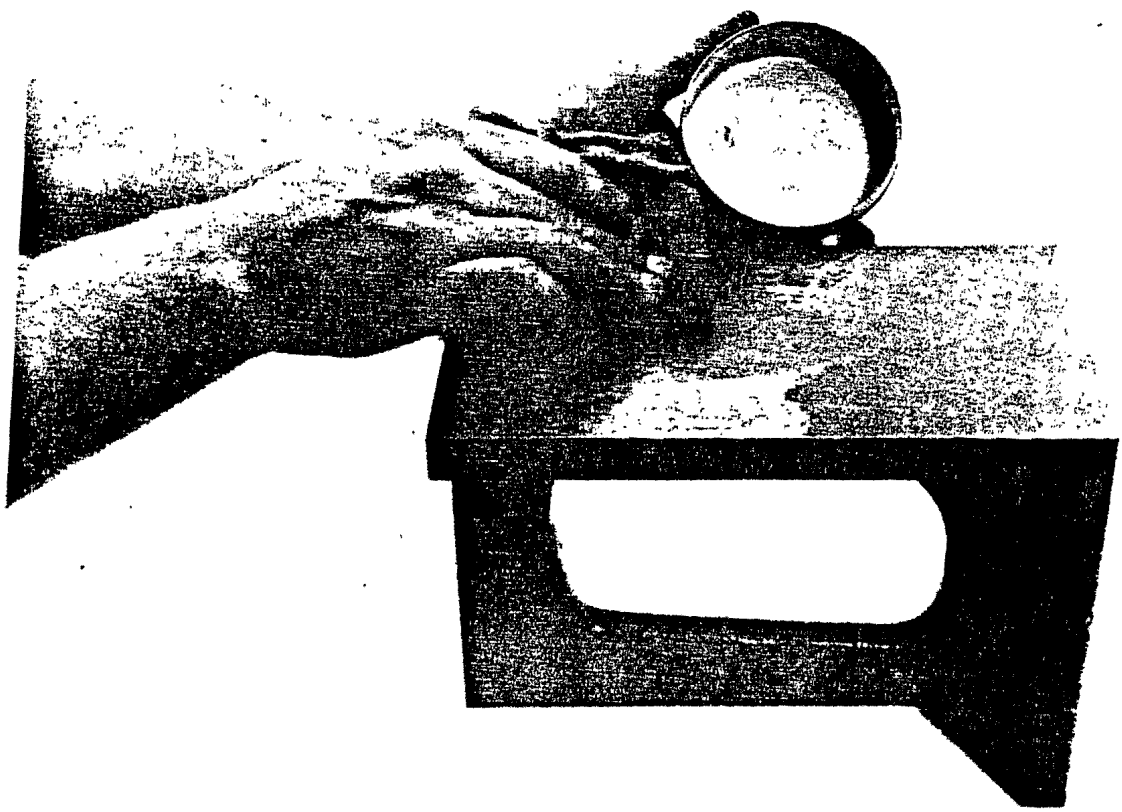


FIG. 9. Applying the red lead.

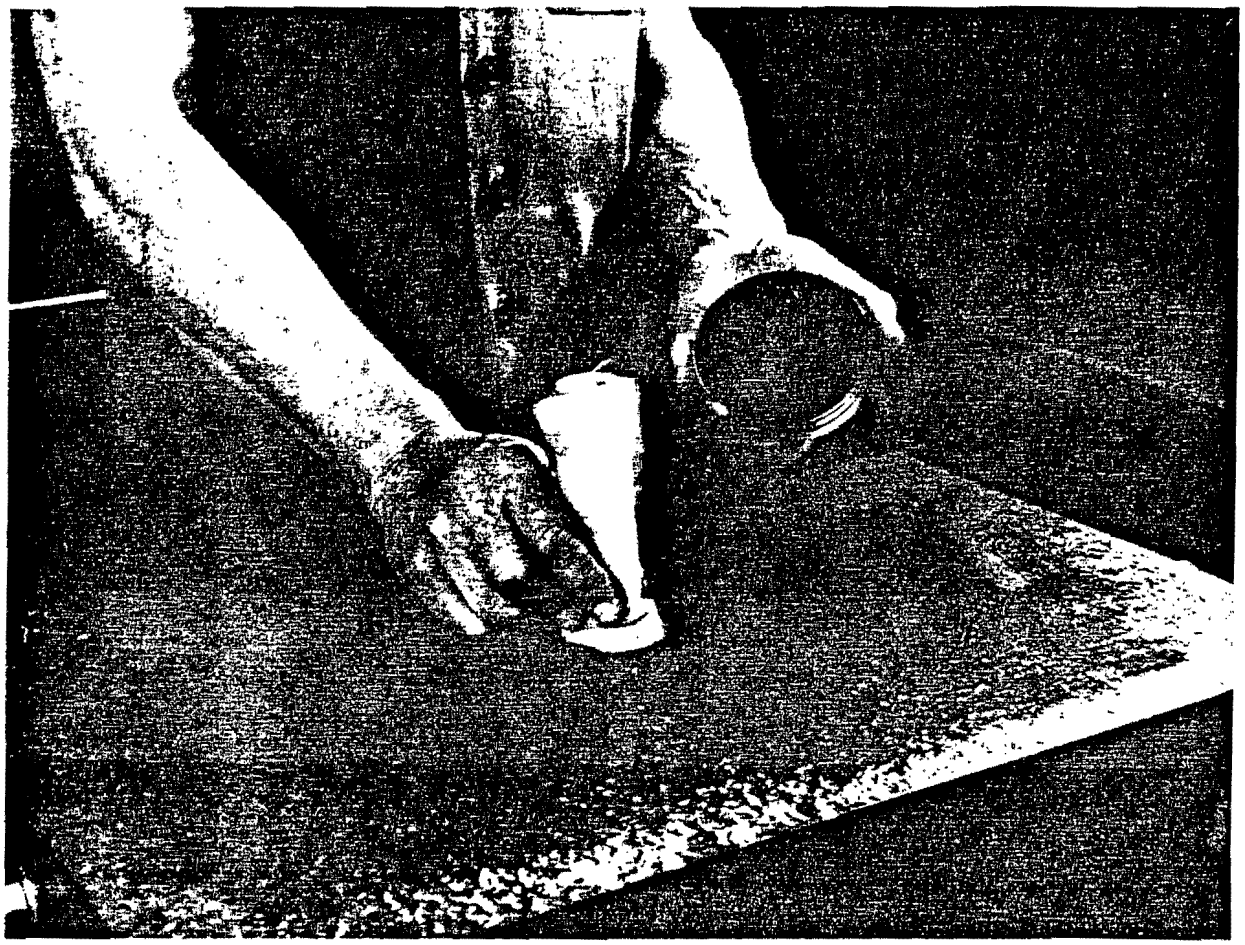
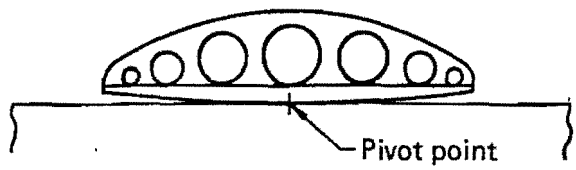
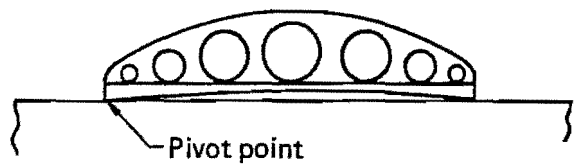


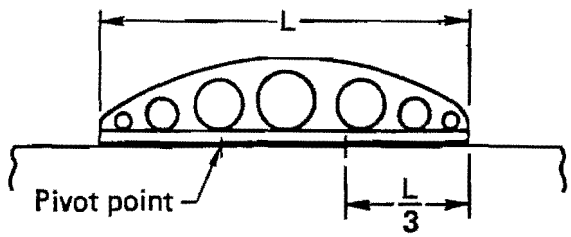
FIG. 10. Applying the bearing blue.



Convex



Concave



Flat

FIG. 11. The rock test.

The angle plate is heavier on one end, so the rock on that end will move out some but the lighter end should rock at its proper place in relation to the length of the part.

With the blue reading and rock test complete, remove the part from the master gage. Pick the part straight up to avoid false readings.

It is now time to interpret the blue reading and plan where to scrape. Since this is the large part of the angle plate, all we have to scrape for is flatness. The blue reading will be large blotches from 1/8 in. to 1/4 in. with large patches of red lead showing in between. At this stage of the rough scraping the objective will be to scatter out the large blue spots evenly over the entire surface. It is important to keep the cut heavy and the spots large at this point (Fig. 12).

Do not try to cut only the spots. A random cut in the area of the spots where the rock test indicated the flatness condition is all that is necessary. If the rock test indicated high in the center then disregard any blue on the ends and cut only in the center area. Continue this roughing process until the rock test is proper and the surface is evenly covered with large spots.

The next step is to begin increasing the number of spots. If this process is started too early or before the large spots evenly cover the entire surface, you will have to go back to the roughing stage. A low area is very difficult to fill in when the spots are small. To increase the number of spots reduce the length of the cut to about 1/2 in. and with moderate pressure cut each large spot in two. Keep track of the flatness with the rock test. With the surface evenly covered with spots about 1/8 in. or smaller reduce the length of the cut to about 3/8 in. and ease up on the pressure. At this time attention must be paid to cutting the shiny point in the center of the blue spot. The widest and deepest part of the hook should cut the shiny point of the bearing, one hook for each shiny point. The rock test will move around somewhat, so pay attention to this area.

GAGING A BEARING

To gage the bearing, the first order of quality is that the entire surface be evenly covered with bearing points, and then the number of bearing points in a randomly selected square inch are counted. A gage quality bearing has 32 points per square inch. This includes gages such as master straightedges, surface plates, and squares. Bearings for precise machines,

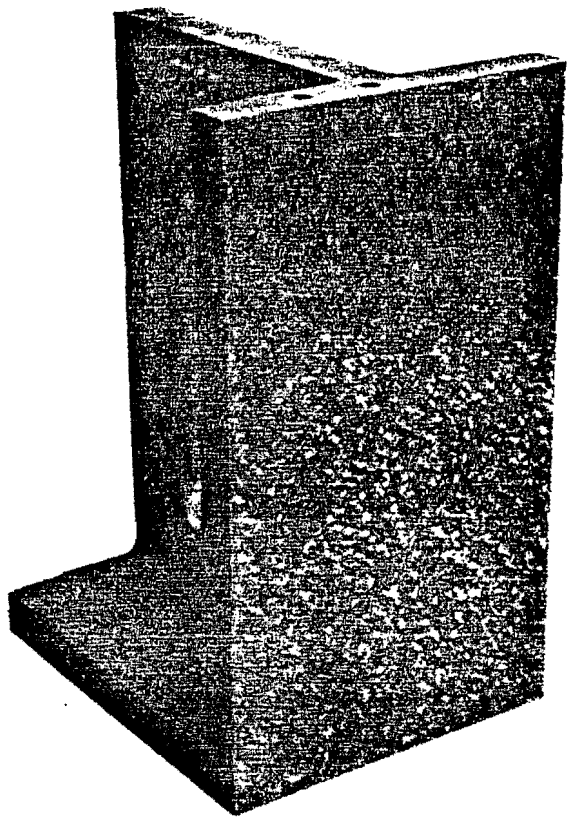


FIG. 12. Rough-scraped bearing.

such as measuring machines, grinders, and jig boring machines, should be 24 points or better. A 16-point bearing will generally suffice for production run machines, milling machines and lathes (Fig. 13).

In scraping a gage quality bearing, such as this example, false readings are quite common, so you must pay attention to the frequent need to break the edges of the part with the stone. Minute high points can develop on a sharp edge that will cause a false reading. Sometimes a shade must be used to reduce glare from overhead lights. The red lead must be very dry and the blue must be thin to avoid smears.

With the large part of the angle plate scraped flat, you must now scrape the small surface of the angle plate flat; you must also adjust the geometry of the angle plate. A master box square, electronic indicator, scrapers block, and a surface gage will be used for measuring the squareness of the angle plate.

Start the small surface of the angle plate by scaling it off and picking a rough bearing. This rough bearing should be large spots evenly spread over the entire surface. At this time it is very important to keep the bearing rough with large spots. If the geometry must be altered, it will change very rapidly with a rough bearing in comparison with a closer bearing.

Take a squareness reading from the master box square. Set the master box square on the surface plate and set the angle plate next to it with the large, finished surface vertical. Have both the square and the angle plate facing you. Place the surface gage on the surface plate and slide it to the master square. With the surface gage held tight to the lower edge of the square, adjust the electronic indicator finger to read on the scrapers block, holding it tight towards the top of the square at a height that will also read on the angle plate. The higher you can read on the angle plate the more you amplify the error (Fig. 14). Move the scraper block and the surface gage to the angle plate and take an indicator reading (Fig. 15). Write down any deviation from zero and then move back to the square to make sure that the original zero setting repeats.

You must now analyze the reading and determine where to scrape. Suppose the indicator reading was plus 0.001 in. This means the top of the angle plate is leaning towards you by 0.001 in. To cause the angle plate to tilt back, you will have to remove material from the small surface towards the back side. Next, consider how much material to remove. The base is 7 in. and you were indicating at about 9 in. from the base, so the ratio is a little more than

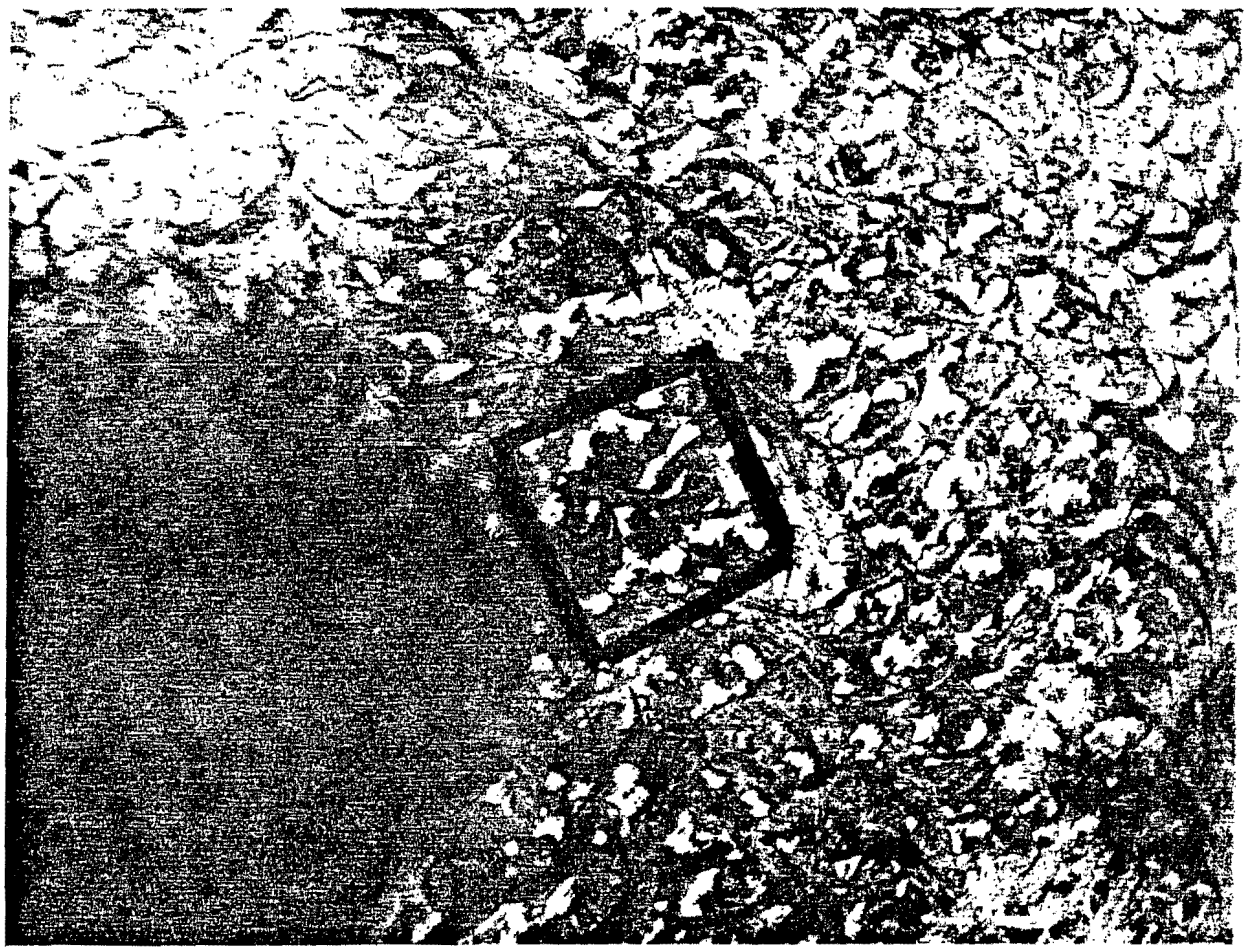


FIG. 13. Gaging a bearing.

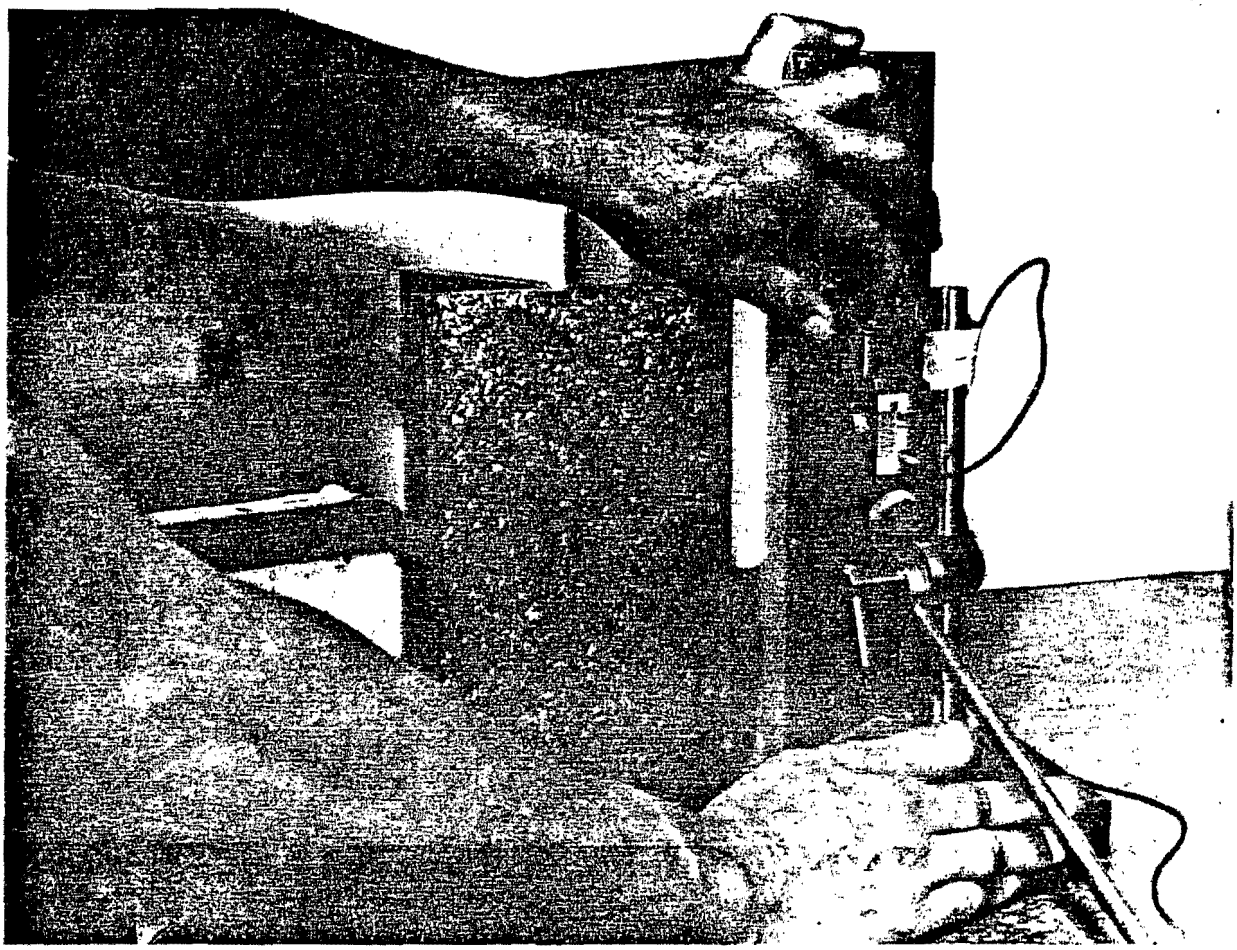


FIG. 14. Setting the surface gage to the master square.

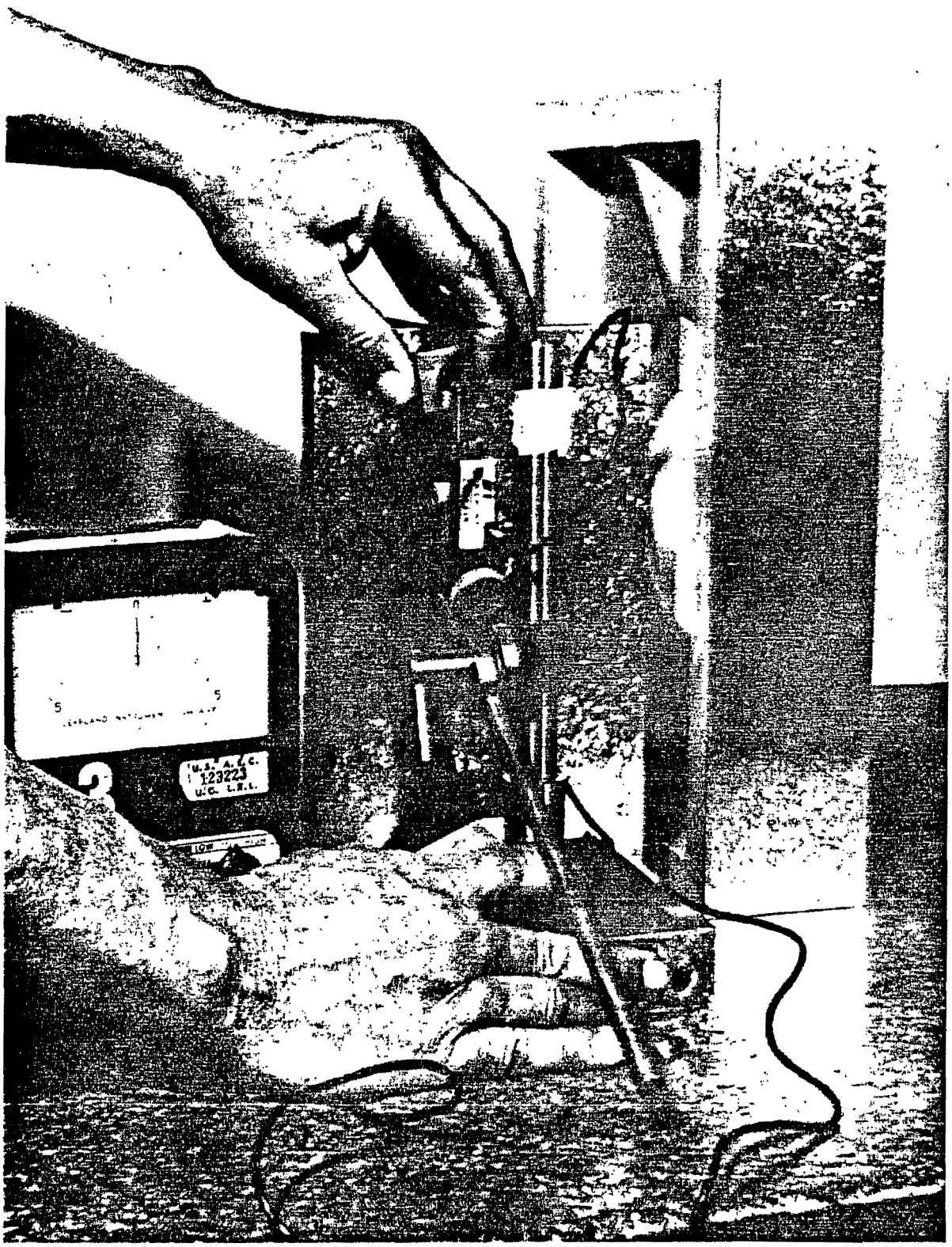


FIG. 15. Taking a squareness reading on the angle plate.

1 to 1. The error is not amplified very much, so you can say that you have close to 0.001 in. of material to remove.

To alter the geometry of a part by removing more material from one end than the other, it would be wise to step-cut the part. To step-cut the angle plate, use the following procedure. Red lead a margin of about 1/2 in. on the edge you will not cut, in this case the edge next to the finished face. Divide the remainder of the surface into three equal parts by marking with a grease pencil, or use a line drawn with red lead. It is wise to mark the edge of the part also where it won't be cut, so you can keep track of the step line. Red lead the first step farthest from the margin or the end that requires the most material removal. Take a scaling cut or a random cut over the red leaded portion; when approaching the step line ease up on the pressure and take a few cuts over the step line. This will help in tapering the cut at the step line (Fig. 16). For the second cut, red lead the first step and also the second step. Again take a scaling cut over the red leaded surface. This time taper off the cut at the second step line. You have now cut the first step twice and the second step once. Proceed with the third step by red leading all three steps. Scale off the entire surface, but make sure not to touch the 1/2 in. margin. You have now taken a tapered cut across all of the surface, but not the pivot point, without taking a blue reading. With even scaling the rough bearing should still be close, but a minor touch-up may be necessary. After the rough bearing is touched up, go back and check the geometry with the indicator. If the error is still large enough to require another step cut, the second step cut should be staggered from the first step cut. Generally the first cut is an odd number of steps and the second is even numbered, so the step line of one cut will fall somewhat in the center of the previous step. This tends to keep the surface flat and also prevents exaggerating the steps.

The step cutting procedure is a rapid way to alter the geometry of a part and is applicable in all scraping, but will vary by the length of the parts. Some long machine tool ways may require six or seven steps, but the same rules apply.

The geometry of the angle plate is now within 100 µin., so you may proceed to pick a bearing on the surface. As the number of spots are increased, keep track of the geometry with the indicator and make slight adjustments as necessary.

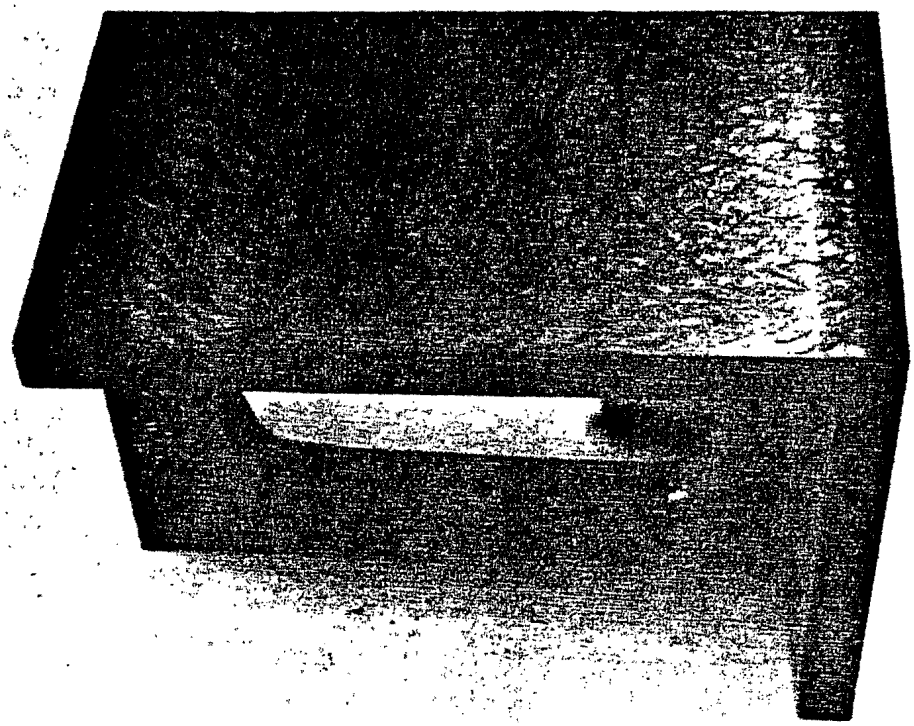


FIG. 16. Step cutting.

This example of scraping "in" the angle plate is a very precise scraping example and should be learned and practiced so you will be able to maintain the gages used in machine tool rebuilding. You will also have the basic knowledge in the art of hand scraping.

In the course of scraping, particularly machine tool ways, it will be necessary to use hand-held master straightedges. These straightedges come in various sizes and shapes. Sizes pertain to width and length and the shape pertains to angles of various degrees or just flat. The angled straightedges are for scraping dovetails (Fig. 17). It is necessary to learn the techniques of handling these straightedges to scrape machine tools.

Selecting the proper straightedge for the job will help make the reading more accurate. The first and most important of the criteria is that the master must be longer than the surface being scraped. It is wise to select a length that will give two or three inches of overhang at each end to allow for sliding the straightedge. Balance is the next consideration. Select a straightedge that most closely fits the width of the surface being scraped, bearing in mind that the width of the surface to be scraped must be covered by the master at all times. Balance becomes more difficult in the case of dovetail-shaped ways. The dovetail can restrict the position of the straightedge, creating a great deal of width overhang and consequently requiring counterbalancing with your hands.

When reading dovetails, the angle of the straightedge is used entirely by hand balancing. It requires a great deal of skill to handle the straightedge while performing the rock test on dovetails.

Using the straightedge on a flat surface is very much the same as using a surface plate, except that the master is on top and moving instead of moving the surface being scraped. A situation can develop where the center of the surface, with respect to width, will become high and the straightedge will roll over the high center, thus generating a false reading. This situation can be detected by the feel of the straightedge--when sliding, it will feel light. Also, scraping the bearing on the edges will not respond as predicted. This condition is best corrected by scraping the center only, until the bearing appears light. This will ensure that the center is not high and will only be one or two cuts low.

If the width of the straightedge is considerably wider on one edge than the surface being scraped, it will be out of balance and require

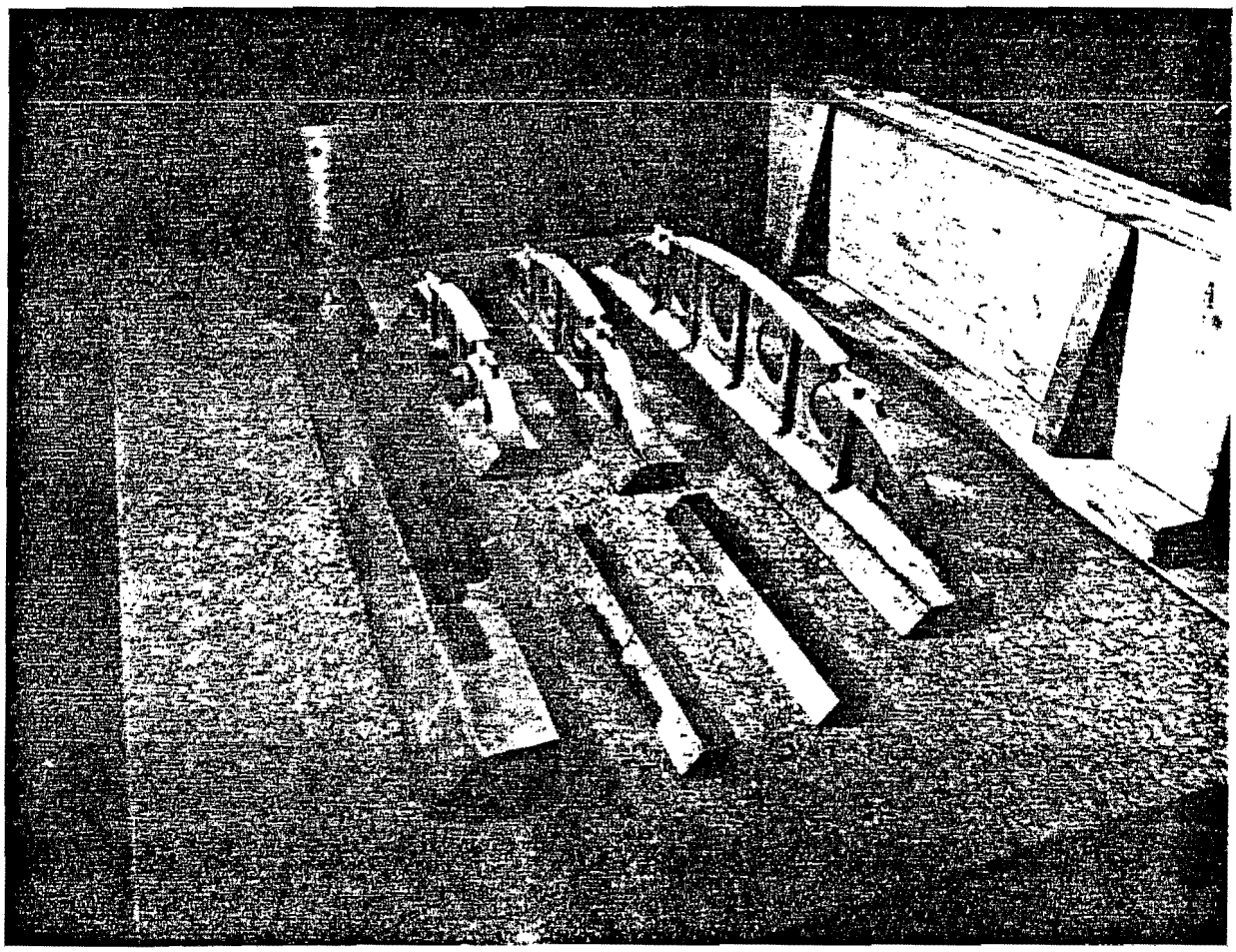


FIG. 17. Various straightedges.

counterbalancing to get a true reading. This is accomplished in the following manner. Carefully set the straightedge on the surface, being careful not to slide it. Hold the straightedge at its ends with the palms of your hands. Slowly lift the heavy or unbalanced edge of the straightedge until it rests on the light edge. Carefully lower the high edge until it contacts the surface; at that point feel the weight of the straightedge on your hands. This will be the counterbalance weight necessary to keep the straightedge flat on the surface. When performing the rock test under these conditions, be careful not to change the counterbalance weight from hand to hand and influence the rock test. It is also very easy to generate a high center in terms of the width, so be careful (Fig. 18).

Scraping dovetails involves the use of the angle of the straightedge, so counterbalancing is always necessary. Follow the procedures as previously outlined. An added problem when scraping dovetails is that the straightedge will slide into the corner of the flat surface and the dovetail; this makes it necessary not only to counterbalance, but also to hold the straightedge out of the corner (Fig. 19). With practice you will become proficient in handling straightedges.

FLAT SCRAPING

Flat scraping is a variation of hook scraping and is used when a bearing surface will be lapped for smoothness in the final form. An example of this usage is the roller ways used in machines. The scraped ways are hand lapped to prevent roller bounce in the slide. The difference in hook scraping and flat scraping is the angle at which the blade is held when scraping. When flat scraping, it is important that the entire scraping procedure be done with the scraper very flat. This will make the hooks wide and shallow, which produces a relatively smooth scraped surface that will require a minimum of lapping. All of the procedures used in hook scraping apply for flat scraping. The major difference is the spots of the bearing. In hook scraping, a large number of small spots is required, whereas flat scraping produces a few large spots. It is wise to use as wide a scraper as possible with a minimum of curve on the blade.

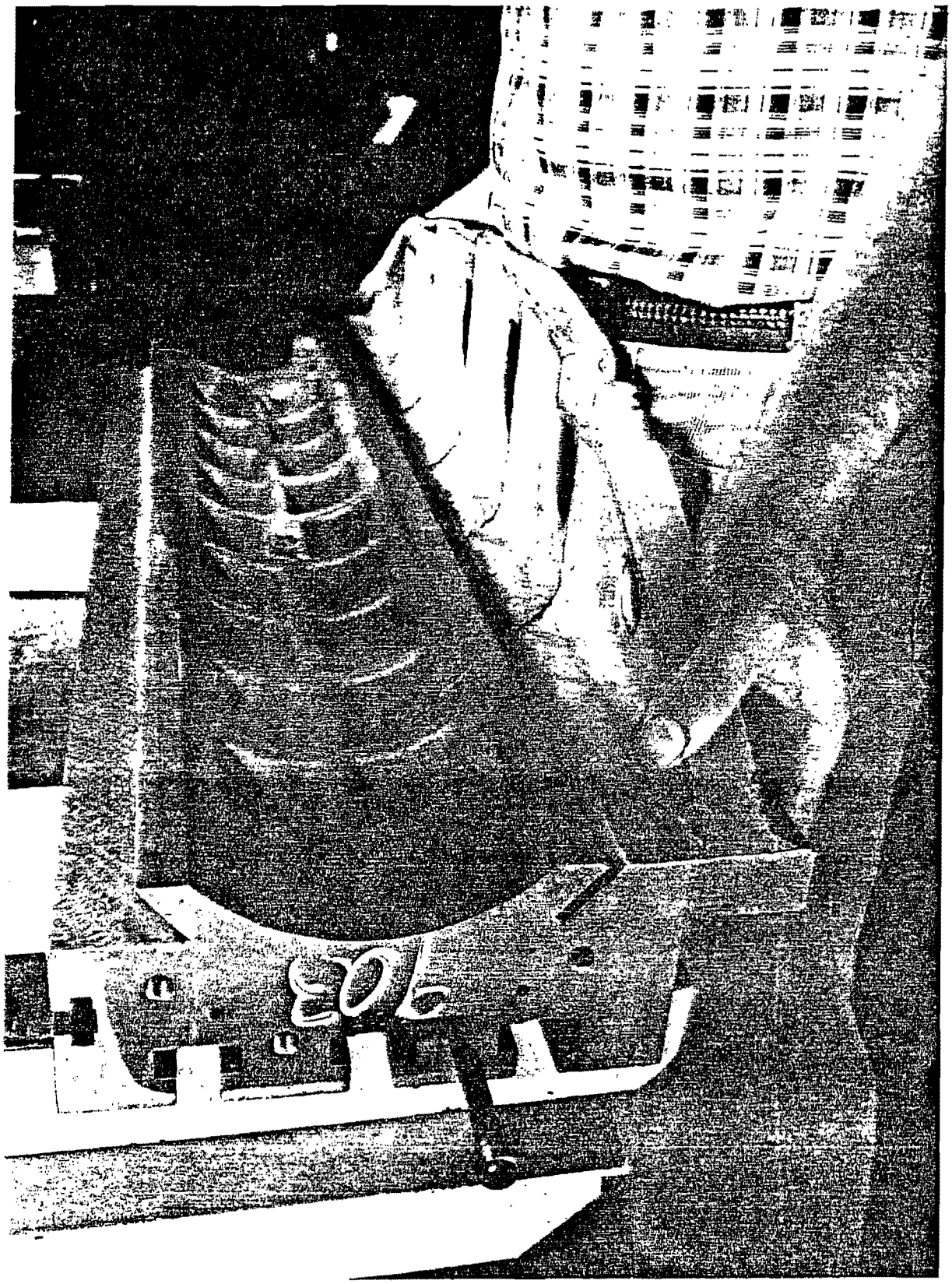


FIG. 18. Counterbalancing a straightedge.

FIG. 19. Reading a dovetail.

HIP SCRAPING

Hip scraping is a technique used where a large amount of material removal is required. This is generally in the 0.005-in.-to-0.010-in. range where machining the part is not practical. The large, round, slightly curved handle is positioned on your hip and held with both hands on the shank of the scraper. The left hand is close to the blade while the right hand is midway between the handle and the blade. The workpiece should be positioned at a height just above your knee. The scraper is placed on the work and the handle on your hip with your knee pointed at the work. As the knee is bent your body weight will fall on the scraper. This provides much more power to the scraper than pushing with your arms. The same technique is used as in hook scraping. Start the cut shallow and increase the pressure as the cut progresses, then release the pressure at the end of the cut (Fig. 20).

PULL SCRAPING

Pull scraping is employed when scraping a polymer bearing surface. Pull scraping is the act of pulling the scraper towards you in place of the push technique, and is used to prevent scraping sharp edges into the soft plastic material. Tercite is a popular brand of polymer bearing material widely used by manufactureres of CNC and NC machines because of its antifriction characteristics. Machine tool rebuilders use tercite to build up badly worn surfaces (machined off) to restore the original geometry of the parts.

The pull scraper blade is bent at about a 45° angle, and an angle of 20° positive rake is ground on the cutting edge. The blade is also curved as on the push scraper. High speed or some other tool steel should be used to allow hand sharpening on an oil stone. The Anderson scraper with a steel blade works fine, but it must be short coupled to prevent chatter.

To sharpen the blade, use a 1-by-2-by-8-in. oil stone. Place the stone on a towel to prevent sliding. The scraper blade is left on the handle when sharpening. Holding the scraper with your right hand close to the blade end and your left hand on the shank close to the handle, contact the stone with the blade to maintain the 20° angle. Swing the blade across the face of the stone following the curve of the blade. Two or three passes with moderate pressure should be sufficient. After sharpening the blade you should hone the

FIG. 20. Hip scraping.

flat side of the blade to clean the cutting edge. Use kerosene on the stone as a lubricant (Fig. 21).

Before starting the scraping, clean the part of excess glue and slightly chamfer the edges to prevent burrs. The burrs that are raised when scraping must be removed and a stone will not work on tercite. A high-speed steel tool bit that has been lapped to sharpen the edge works fine. Pull the tool bit across the surface being scraped and it will slice off the burrs (Fig. 22).

The technique in pull scraping is similar to push scraping by the fact that the cut must begin shallow, and increase in depth at the spot of bearing. The pressure is then released to pull the scraper out of the material.

To begin the cut, the blade is very close to the surface ahead of the spot to be cut. The pull stroke is then begun by lowering the scraper onto the material. As the point of bearing is approached, the scraper should be at its maximum depth. The pressure is then released by lifting the scraper off the material and then proceeding to the next spot to be scraped. This action will generate a circular motion (Fig. 23).

Red lead and bearing blue are used as the markers for tercite. The bearing spots will be large and blotchy. Judge the bearing by the even coverage of the surface with the large spots.

POWER SCRAPING

The use of the power scraper is usually determined by the work to be done. Where large heavy-duty machines are concerned, a power scraper will suffice. If heavy material removal is required, a power scraper can be used in the beginning and hand finishing at the end. Scraping steel is an excellent application of the power scraper.

All of the procedures used in hand scraping are also employed with power scraping; red lead, bearing blue, rock test, step cutting, etc.

Most power scrapers have adjustable strokes for rough or fine scraping. With scrapers that have a straight stroke, such as the Biax Power Scraper, the most efficient and even material removal will be accomplished by using a full length stroke and moving the scraper sideways to the stroke of the blade. Move the scraper randomly across the surface at a quick pace. This will make the cut more even and the tendency to scrape holes in the surface will be reduced.

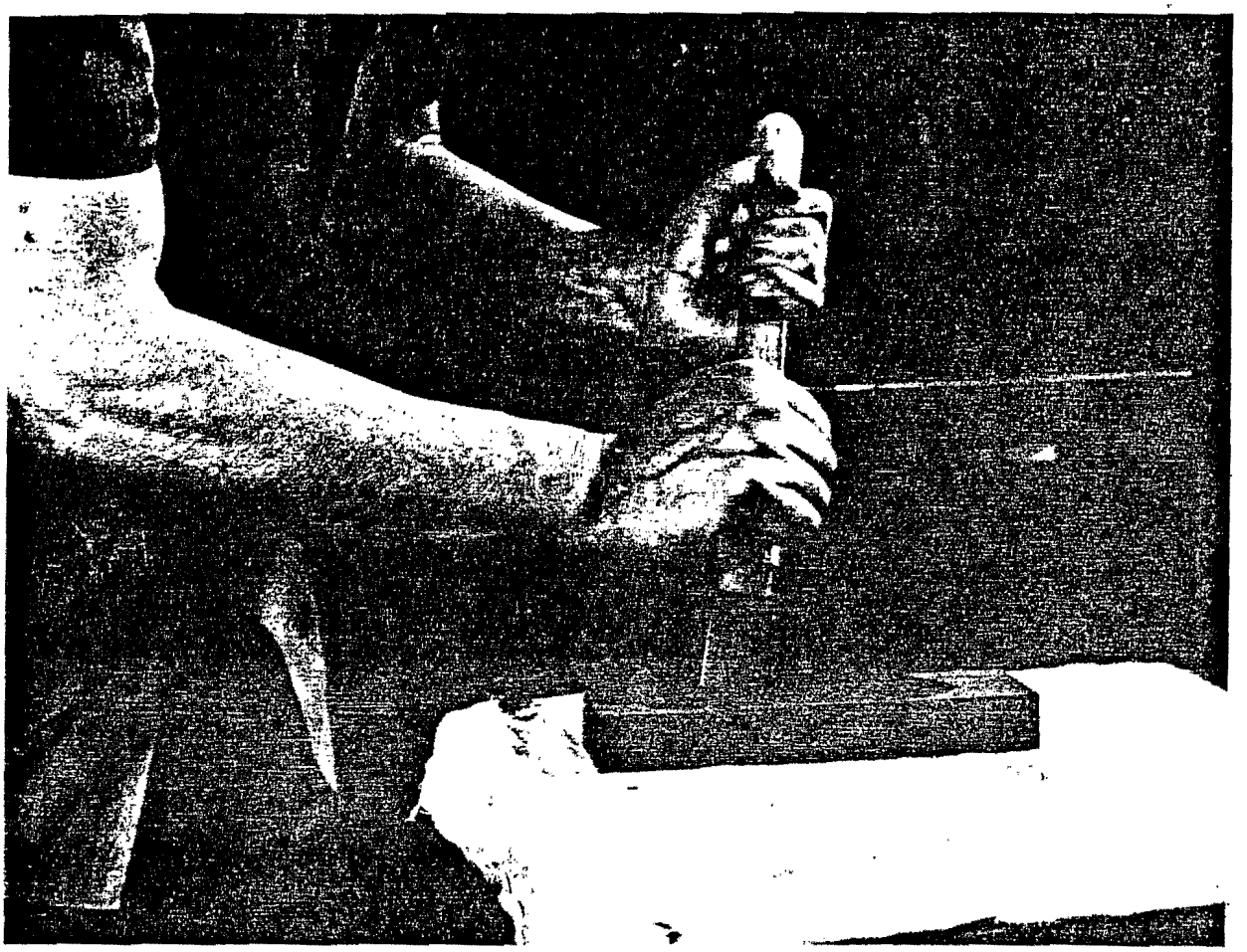


FIG. 21. Sharpening the pull scraper.

FIG. 22. Deburring tercite.

FIG. 23. Pull scraping.

A word of caution; when moving the scraper from side to side do not allow the scraper blade to rock over the corner because this will cause deep scratches (Fig. 24).

FLAKING

There are three purposes for flaking machine tool ways. First and foremost is to break up the smooth scraped surface, consequently reducing the area of contact and reducing friction. The second purpose is to provide pockets for lubrication, and the third is the decorative effect to enhance the appearance of the scraped surface.

Hand flaking is performed with the same tool used for scraping. Some prefer a longer shank than the standard scraper, but that is a matter of preference. For a more attractive appearance, flaking is generally done in two layers at a 45° angle to the bearing surface. Flake in the direction that is the most difficult first, because the pattern will not be as attractive; then cross this in the easier direction. The pattern that is applied last will be the most pronounced (Fig. 25).

To generate the crescent or half-moon flaking pattern, use the Anderson Scraper. With your left hand hold the shank of the scraper about midway between the blade and the handle. Rest the handle on your left shoulder. Place the scraper on the work at about a 45° angle, slightly tilted toward the left edge of the blade with moderate downward pressure. With your right hand make a tight fist and then reach around to the front of the scraper and strike the blade with a sharp rap with the heel of your fist. This striking is done in an even succession for the length of the pattern. You must learn to do this left-handed also.

To help develop this technique, I offer the following suggestions. Keep your left forearm in line with the line of flaking. When striking the blade, swing your right fist parallel to the part being flaked. Maintain a constant angle with the flaking tool as it is moved back by the striking. This is accomplished by moving your body back instead of moving your left arm while pivoting at the shoulder.

The half-moon flaking is the most popular and attractive method of flaking and lends itself well to flat surfaces but becomes very difficult, if not impossible, to flake bearing surfaces such as dovetails and vee ways.

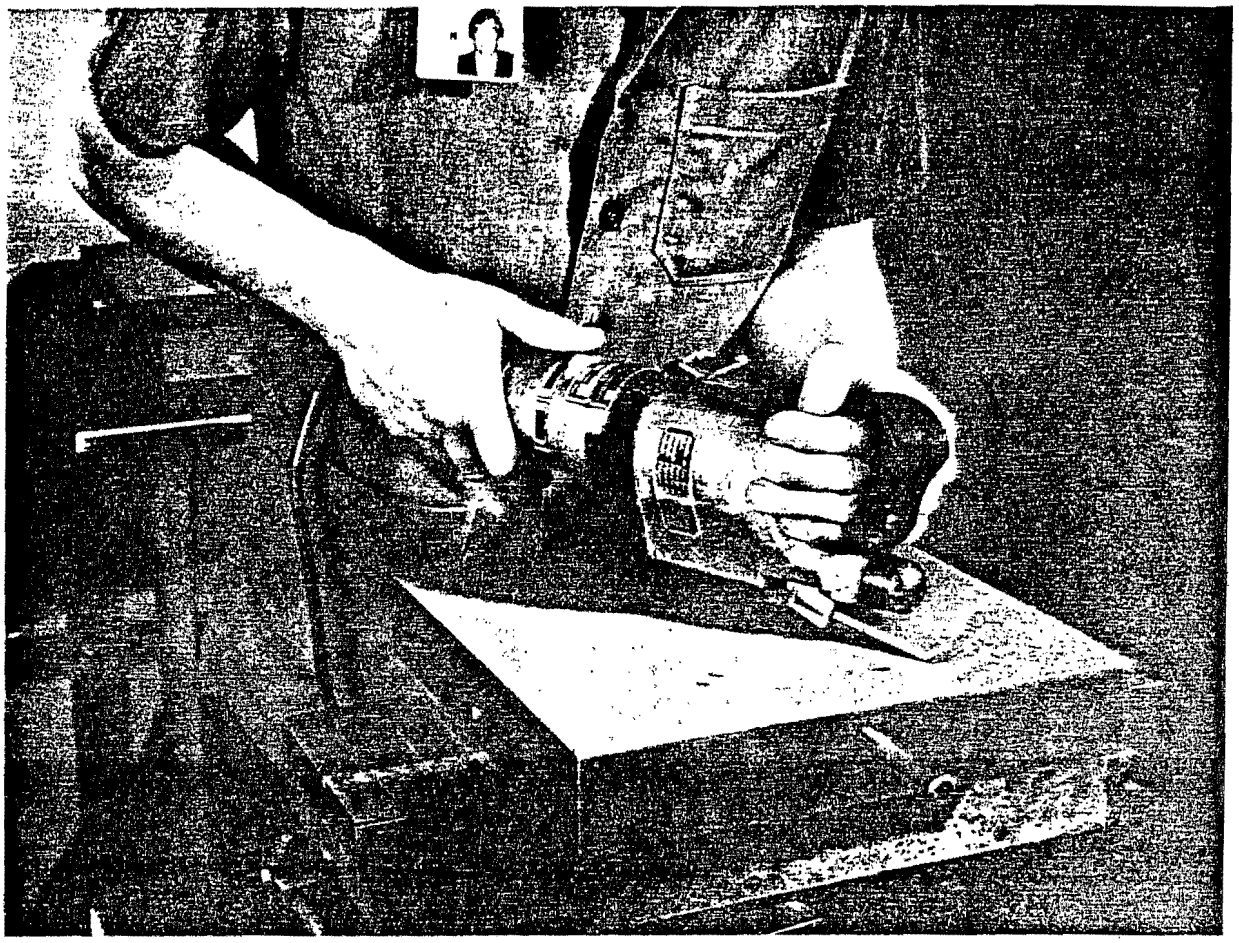


FIG. 24. Power scraping.

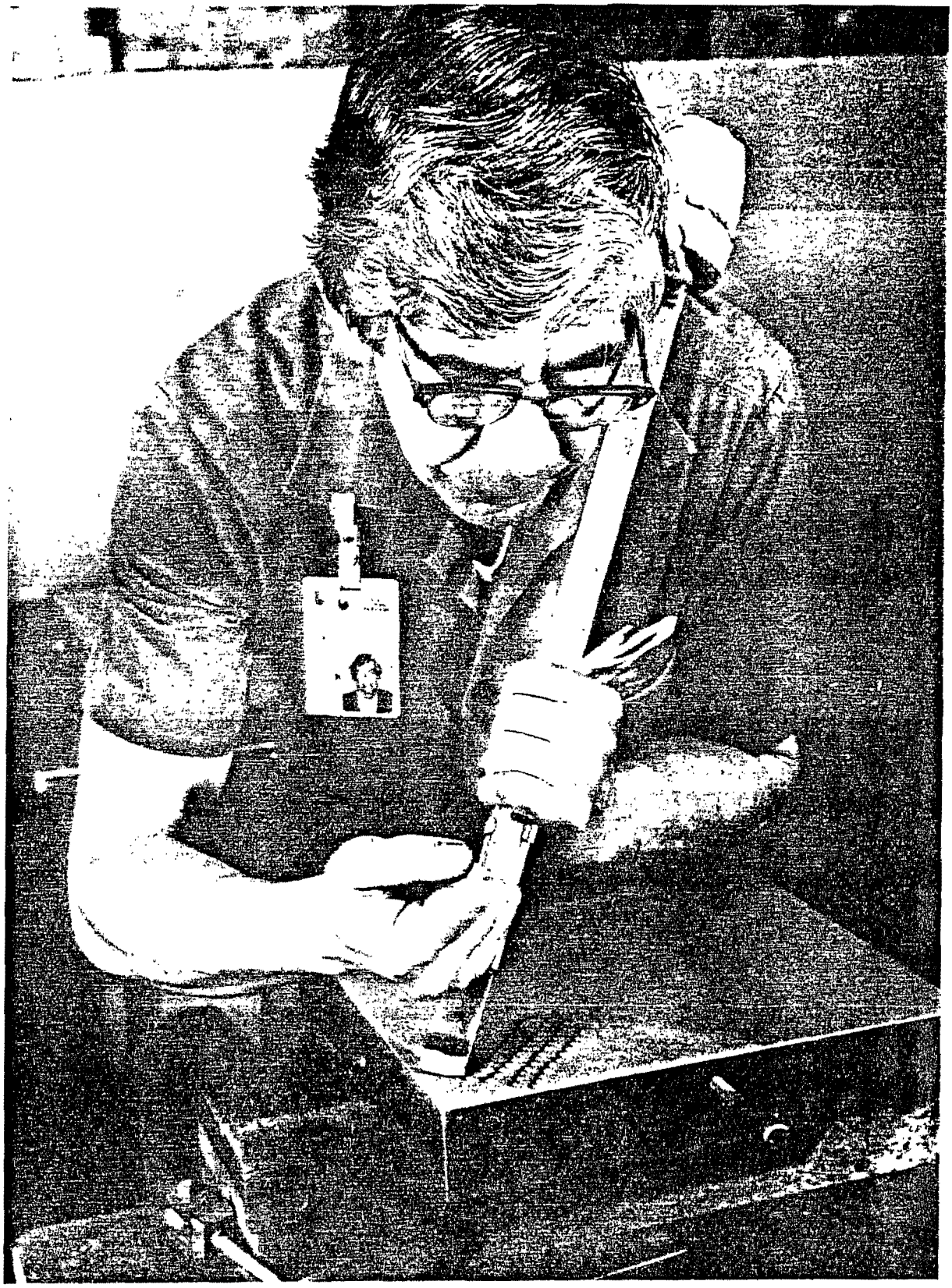


FIG. 25. Flaking a half-moon pattern.

Flaking dovetails requires the push method of flaking where a long tool such as the scraper can be pushed into the corner of the dovetail. This procedure is accomplished in several ways. The best but most difficult method is to use the same procedure as hook scraping, but keep the scraper moving in a straight line so as to generate a pattern. To master this procedure requires a great deal of practice, but it makes flaking dovetails very simple (Fig. 26).

Another procedure is to use the scraper and holding the shank with your left hand strike the handle with the palm of your right hand, again moving in a straight line. This method will produce a rectangular pattern that is very functional if not attractive (Fig. 27).

A variation of this method is to use a scraper blade welded to a light slide hammer. A word of caution in the use of this tool. It is very easy to strike the blade too hard, thus causing deep gouges in the surface. Therefore, use this tool with prudence (Fig. 28).

POWER FLAKERS

A power flaker is a very useful tool. These flakers produce a very uniform pattern and depth, at a very rapid rate, thereby producing a more functional and attractive job. The speed of the power flaker is significant as it can produce about 75% faster than hand flaking. The normal operation of the power flaker, which is a straight line push, lends itself to flaking dovetails and vee ways (Fig. 29).

REFERENCE READING

Wayne R. Moore, *Foundations of Mechanical Accuracy* (Moore Special Tool Company, 1970).

REFERENCE VIDEO TAPE

Video tape (12 minutes), *The Art of Hand Scraping* by Robert R. Wade. Production #385, Technical Information Department, Lawrence Livermore National Laboratory, Livermore, CA, January 1, 1981.

RD/ga

FIG. 26. Push hand flaking.

FIG. 27. Flaking push/with hand.

FIG. 28. Slide hammer flaking.

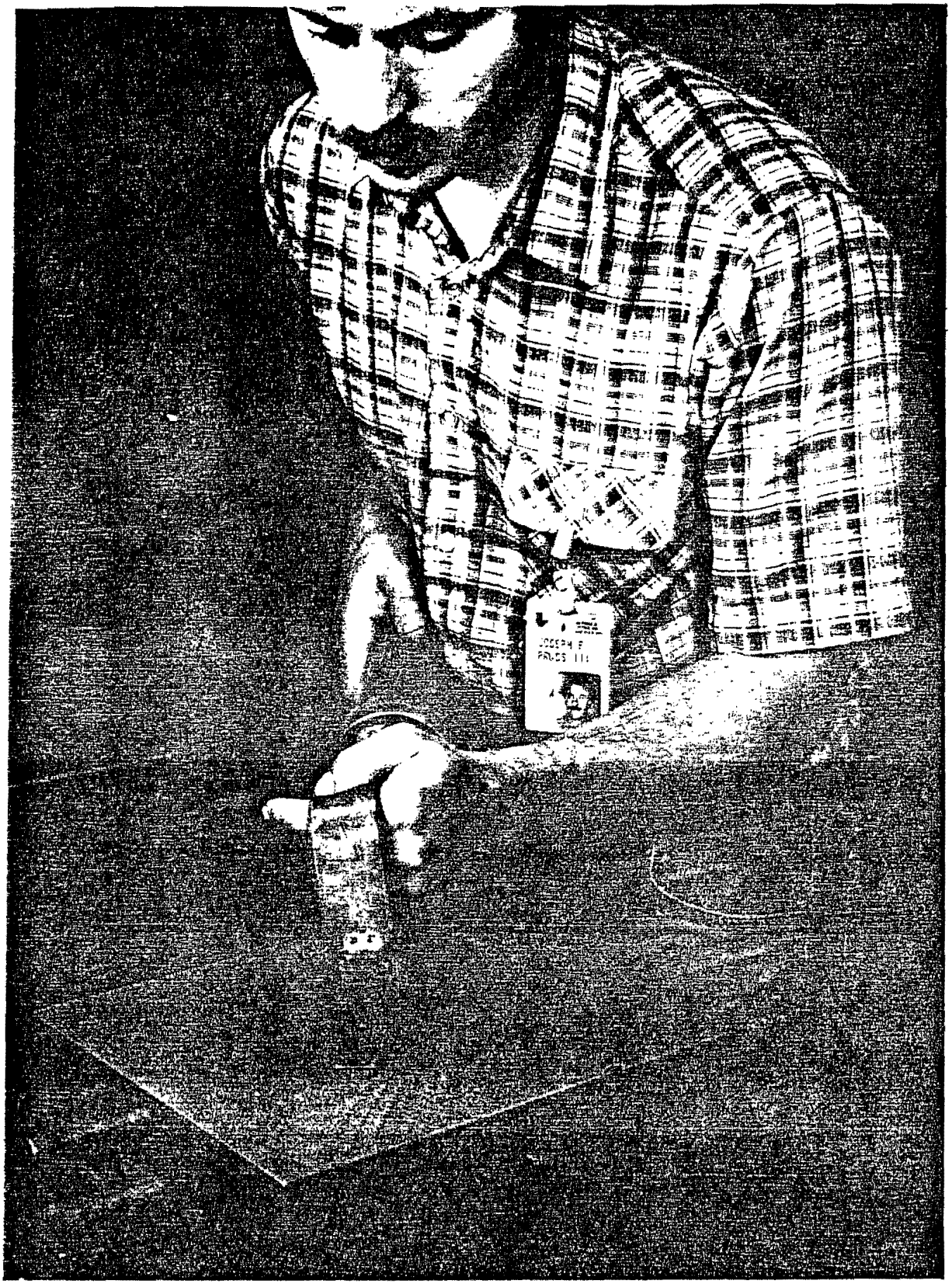


FIG. 29. Power flaking.

DISCLAIMER

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