TRAINING UNIT
NUMBER 3

★

BASIC TURNING

★

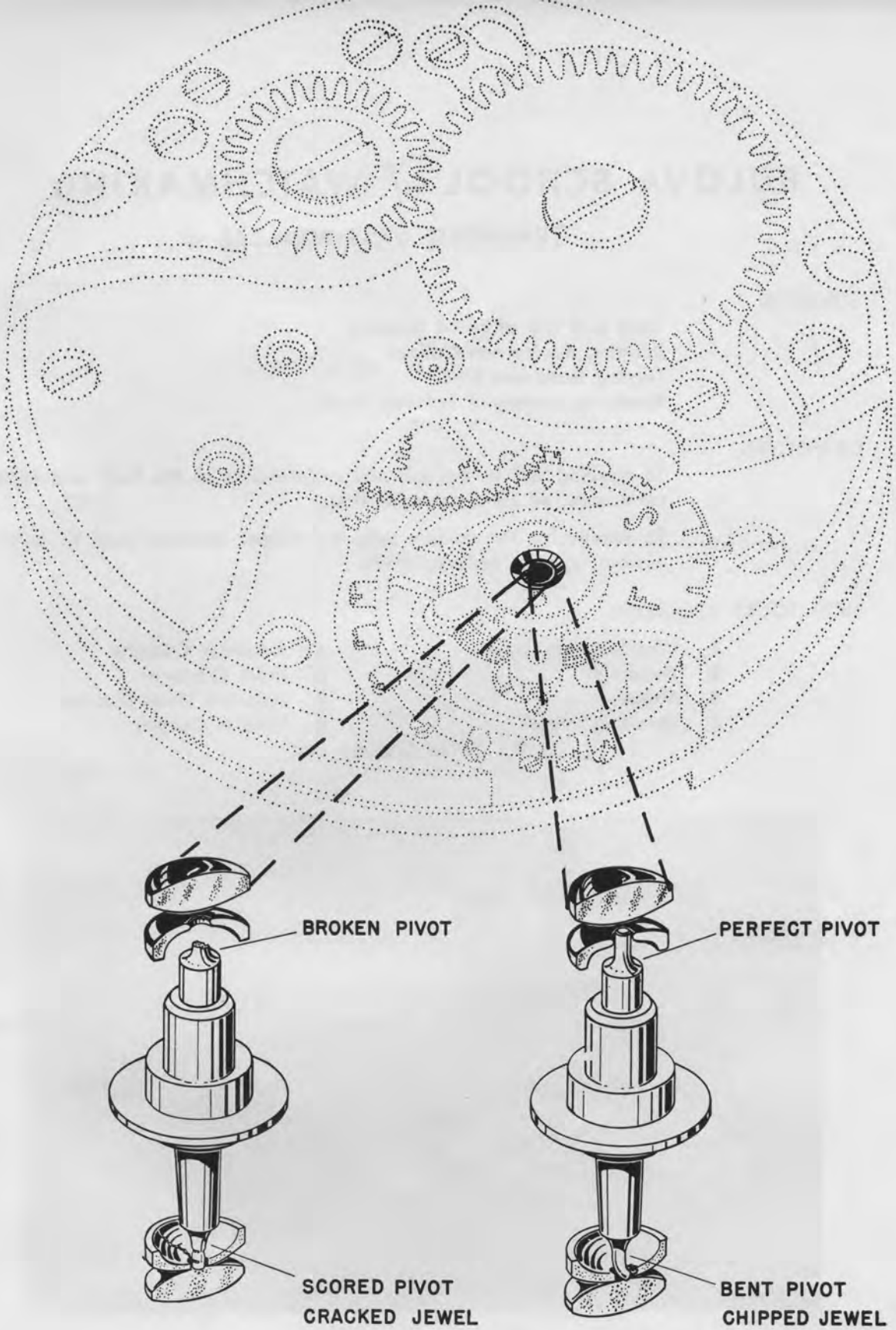
REMOVING DAMAGED BALANCE STAFFS

Turning on the watchmaker's lathe is a fundamental part of the watchmaker's required skills.

Whenever a balance staff is to be replaced, good practice demands that the old one be turned off rather than knocked out. New balance staffs may frequently require dimension adjustments which also must be done on the lathe.

Again there will be situations in which the entire staff or stem or some other part may have to be turned by the watch repairman because material is not available.

A thorough knowledge of the principles involved and a high degree of skill in using the watchmaker's lathe, sharpening hand gravers, and measuring with precision instruments are necessary requirements in producing high-grade watch repair work.


BROKEN PIVOT
PERFECT PIVOT
SCORED PIVOT
CRACKED JEWEL
BENT PIVOT
CHIPPED JEWEL

BULOVA SCHOOL *of* WATCHMAKING

TRAINING UNIT NUMBER 3

SUBJECTS:

Care and Use of Hand Gravers
Reading the Vernier Caliper
Turning Brass and Steel
Removing Damaged Balance Staffs

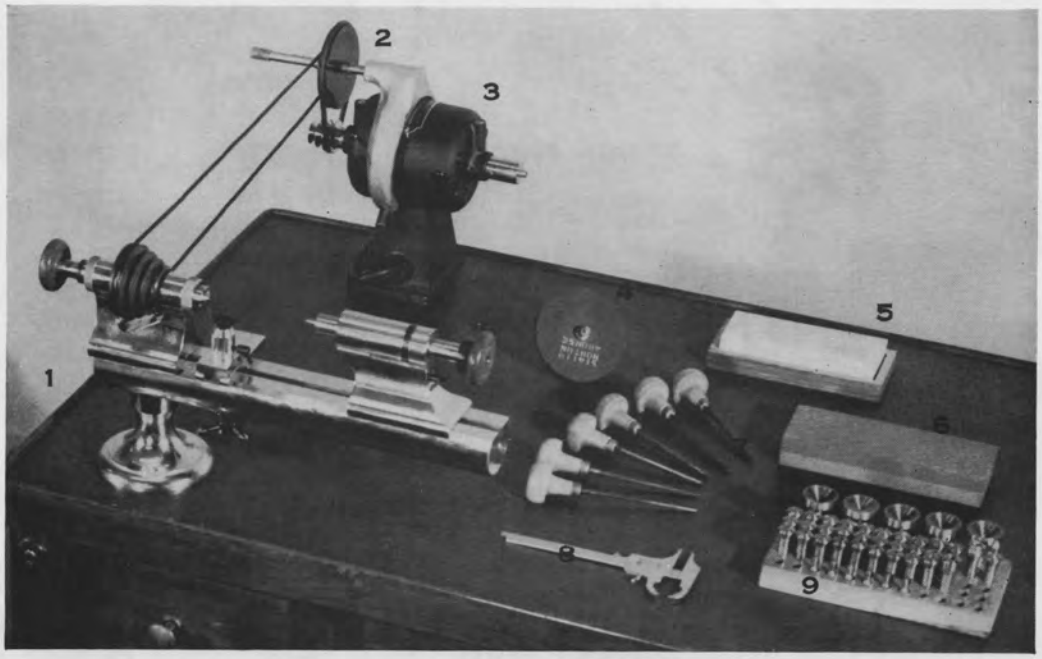
OBJECTIVES:

To develop skill in the use and maintenance of the tools and equipment required for these operations.

To familiarize the student with the proper methods used to remove various types of balance staffs.

NEW TOOLS REQUIRED:

1. Watchmakers Lathe
2. Powerstat
3. Motor
4. Grinding Wheel
5. Arkansas Oilstone
6. India Oilstone
7. Assorted Hand Gravers
8. Vernier Caliper
9. Set of Chucks



PRINCIPLES AND PROCEDURES
for the
CARE AND USE
of
HAND GRAVERS AND THE VERNIER CALIPER,
TURNING BRASS AND STEEL
and
REMOVING DAMAGED BALANCE STAFFS

GRINDING HAND GRAVERS

Hand gravers are hardened steel cutting tools designed to shape metals revolving in a lathe. They are held in their correct cutting position by hand. Gravers are made in many sizes and shapes depending upon the purpose for which they are to be used. Satisfactory results cannot be expected unless a graver is sharpened properly and used correctly.

In case the tool is improperly angled or being shaped from an unfinished blank, grind it to the desired shape with a No. 80 or 100 carborundum wheel.

When using a carborundum wheel, do not over-heat the tool. This will draw the temper of the steel, rendering it soft and unfit for cutting.

Present the graver to the wheel so that a true flat surface of the desired angle is achieved. See Fig. 1.

To prevent the wheel from wearing unevenly, becoming grooved, or glazed, move the graver slightly across the flat surface of the wheel.

Never allow the surface of the wheel to become glazed with imbedded particles of metal.

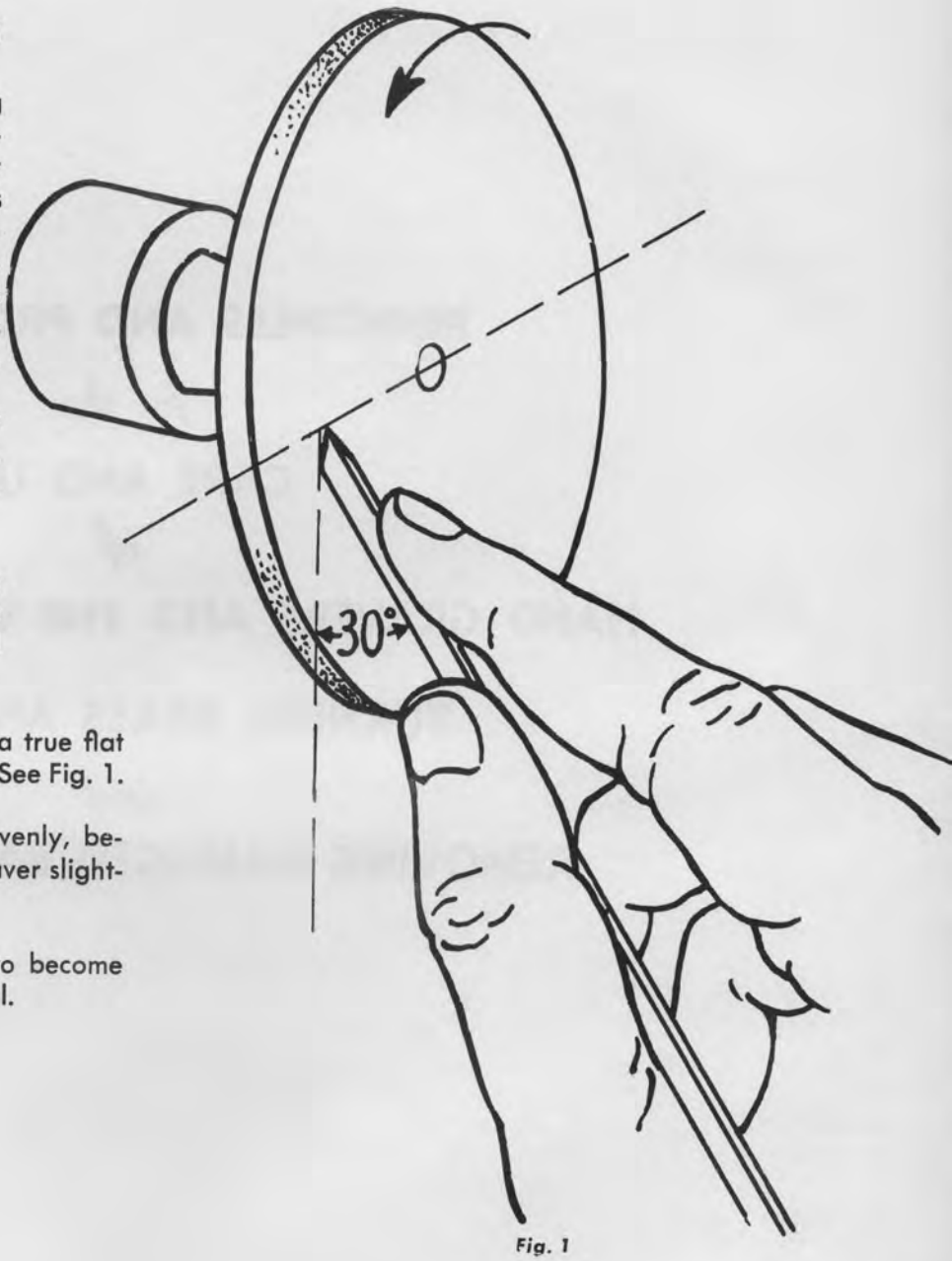


Fig. 1

SHARPENING HAND GRAVERS

When touching up a properly shaped graver, stone the graver lengthwise on a combination India oilstone. Use either the coarse or fine side as the condition of the graver demands. See Fig. 2.

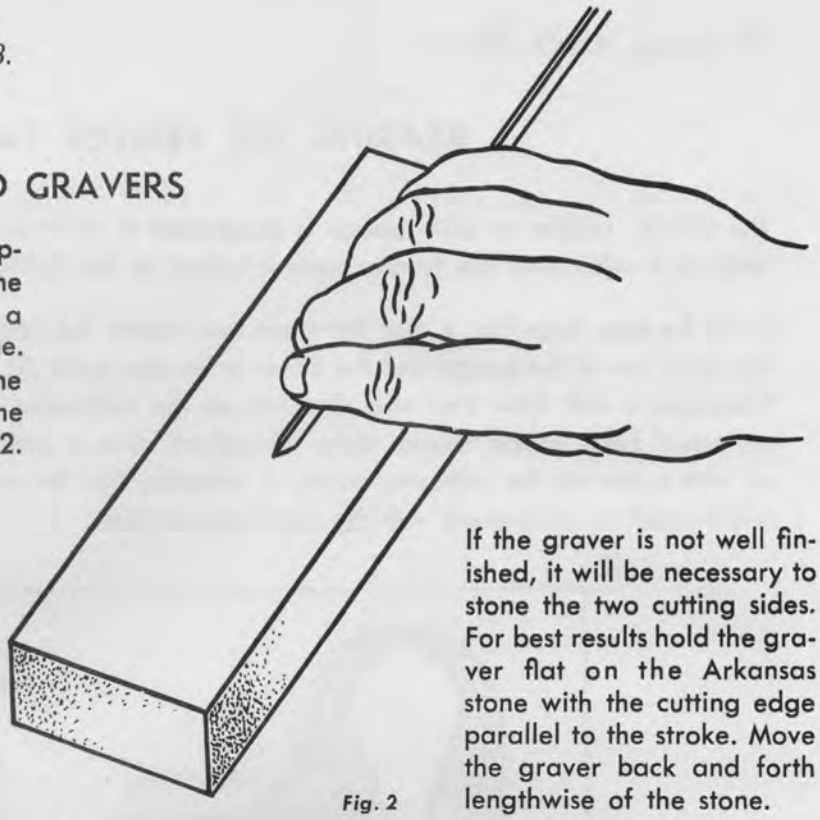


Fig. 2

If the graver is not well finished, it will be necessary to stone the two cutting sides. For best results hold the graver flat on the Arkansas stone with the cutting edge parallel to the stroke. Move the graver back and forth lengthwise of the stone.

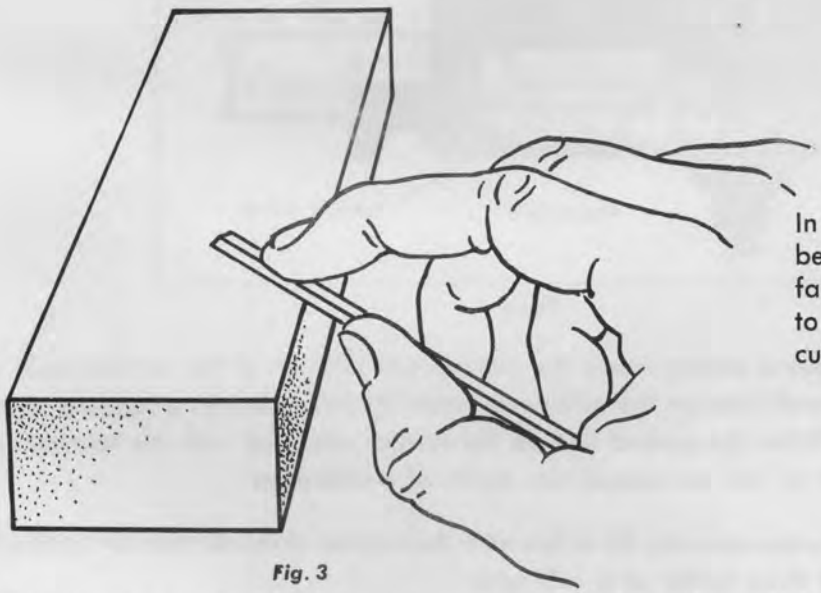


Fig. 3

In Fig. 3 the graver is shown being drawn across the surface of the stone in order to remove burrs from the cutting edge.

The graver must be held at a constant angle to the surface of the stone. A rocking motion will round the cutting edges. Apply a coating of light machine oil to the India oilstone and the Arkansas stone to float the small particles of metal, thus preventing the pores of the stone from becoming clogged. Wipe the stone clean with benzine after using.

The final finishing is done on the Arkansas oilstone. Gravers sharpened in this manner will have a keen cutting edge and will produce smoother work.

READING THE VERNIER CALIPER

The vernier caliper or slide gauge is graduated in millimeters. To be able to read to a tenth of a millimeter, the vernier scale is added to the sliding jaw of the caliper.

It will be seen from Fig. 4 that there are two scales: the upper or millimeter scale (A), on the fixed bar of the gauge and the lower or vernier scale (B), which is on the sliding head. Observation will show that nine divisions on the millimeter scale have been divided into ten equal parts on the vernier scale. Therefore when a division on the vernier scale lines up with a line on the millimeter scale, it indicates that the vernier has moved in tenths of a millimeter to correspond with the matching number.

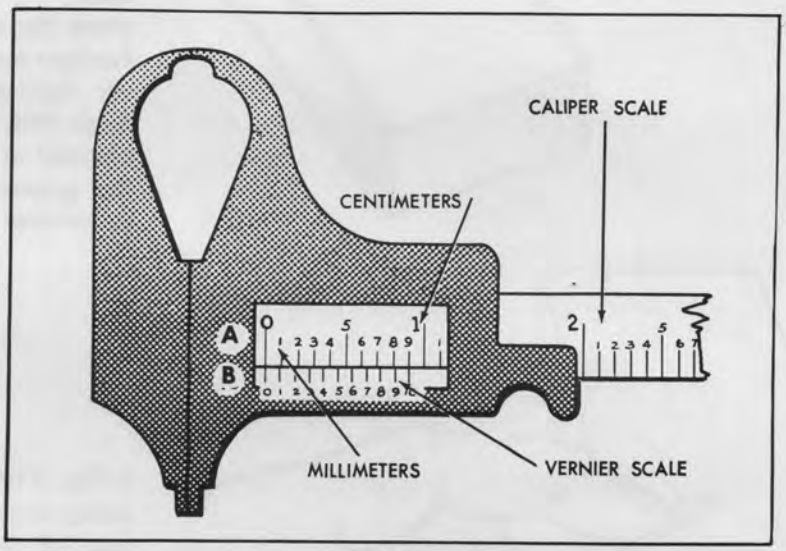


Fig. 4

For example, Fig. 5 shows a setting where the number one division of the vernier scale (B) matches the number one division on the millimeter scale (A).This indicates a reading of one tenth of a millimeter. When the second line on the vernier coincides with the number two division on scale A, the vernier has moved two tenths of a millimeter.

Fig. 6 shows the third division on scale (B) in line with the number three division on Scale (A), indicating a reading of three tenths of a millimeter.

Fig. 5

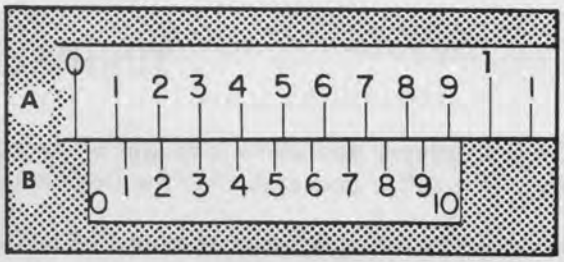


Fig. 6

Therefore, whenever any one division of the vernier (B) becomes lined up with a division of the millimeter scale (A), the number stamped under this vernier division will indicate the distance in tenths of a millimeter that the vernier scale has been moved, corresponding to the same distance that the caliper jaws have been opened.

When the vernier has been moved more than one millimeter on the millimeter scale (A), the position of the zero point will indicate the amount of movement in total millimeters.

In fig. 7, the zero point is located between three and four: therefore the jaws have been opened three millimeters plus a fraction of a millimeter. Since the six of the vernier (B) is lined up with the nine on the millimeter scale (A), then the fraction in this case will be six tenths of a millimeter. Adding the sixth tenths of a millimeter to the three millimeters, we now have a total opening between the caliper jaws of three and six tenths of a millimeter.

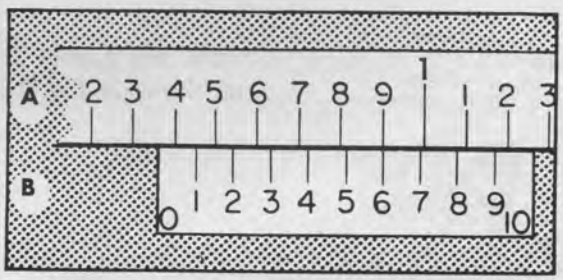


Fig. 7

Depth measurements are obtained by using the opposite end of the caliper. Slide the vernier (B) until it is exactly flush with the extreme end of scale (A) for a 0. mm reading. Since the scale is also calibrated from this end, the sliding vernier is adjusted to the desired depth and the reading made as explained above. In Fig. 8, the reading would be 4.6 mm.

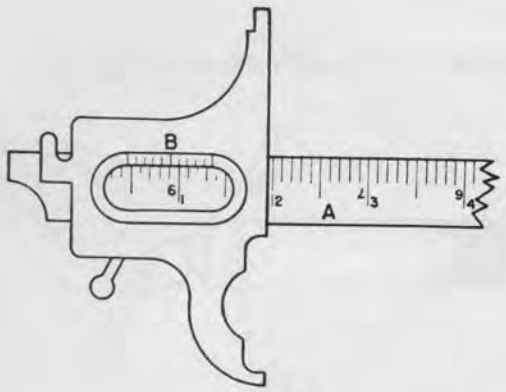


Fig. 8

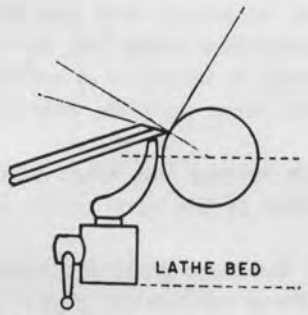
TURNING BRASS

The first turning operation is taught on brass held in wire chucks. This metal is used because it is softer and easier for the beginning student to work with.

Wire chucks are numbered in tenths of millimeters. The chuck number indicates the size of the opening. For example, No. 32 chuck should be used with 3.2mm stock.

Select the chuck suitable for the wire used. Chuck the wire in the lathe to extend out from the chuck.

Position the tool rest so that it is parallel and close to the wire. The finer the work, the closer the adjustment should be. The height should be adjusted so as to permit the cutting edge of the graver to approach the brass slightly above center. If chatter accompanies cutting, raise the tool rest slightly. See Fig. 9.



GRAVER AT CORRECT CUTTING POSITION

Fig. 9

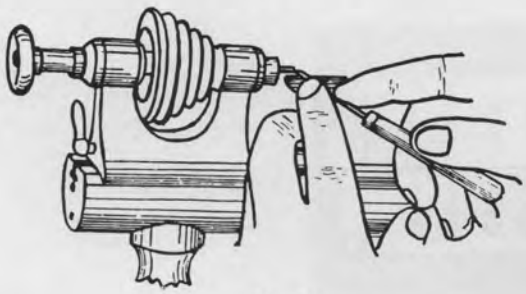


Fig. 10

Hold the graver firmly on the tool rest as shown in Fig. 10.

Cut wire to the length shown in Fig. 11.

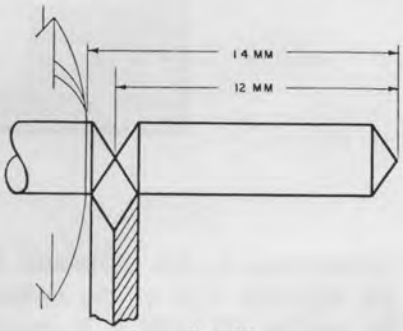


Fig. 11

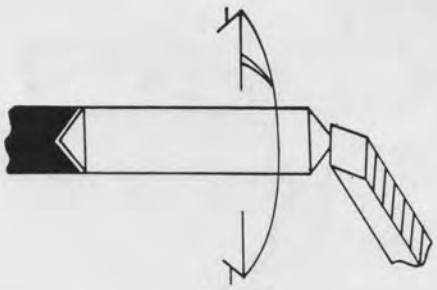


Fig. 12

Rechuck the blank so that about 1mm extends [redacted] from the chuck.

Lower the tool rest slightly. With the cutting edge of the graver perpendicular to the wire, face off the work with a sweeping action. See Fig. 12.

Remove blank from chuck. Mark off 10 mm from faced-off end with a graver point. Rechuck blank with the mark about 1 mm out from the chuck. With lathe turning slowly, cut a reference ring at the mark. Face off to reference ring as shown in Fig. 13.

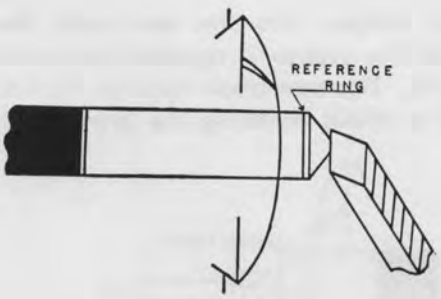


Fig. 13

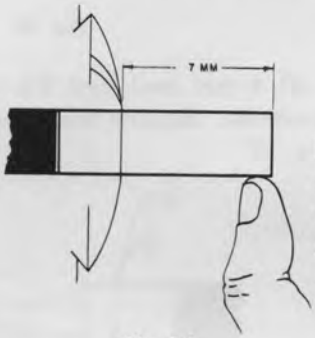


Fig. 14

Rechuck the blank as shown in Fig. 14. Tighten the chuck just enough to prevent the blank from falling out. With the lathe rotating, true the blank using a slight upward pressure of the thumb nail. Tighten chuck and examine trueness with an eye loupe.

Mark off 6mm from the end. Turn to within 0.2 mm of the mark, using the full cutting edge of the graver. Move the graver along the work to prevent ridges until the shoulder is 2.1 mm in diameter. See Fig. 15.

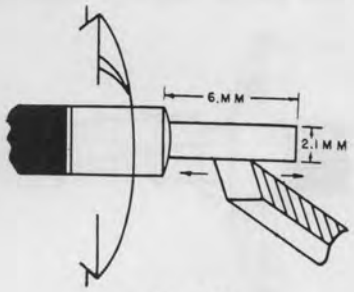


Fig. 15

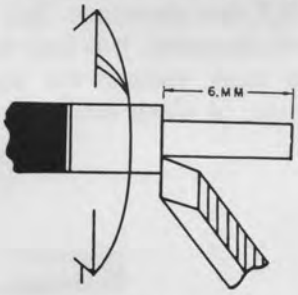


Fig. 16

Square off to 6 mm as shown in Fig. 16.

Using about a No. 3 sharp pointed graver, rivet undercut the square shoulder by presenting the graver to the work as shown in Fig. 17. Feed graver slowly and carefully. Exert only enough pressure to secure free cutting action at the point.

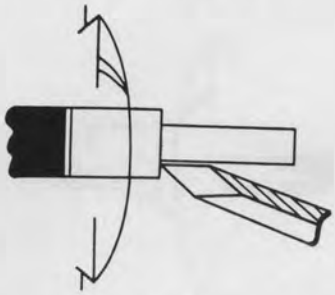


Fig. 17

Gradually cut deeper into the seat until the side cutting edge of the graver is against the shoulder as shown in Fig. 18. This operation requires considerable care and skill to avoid breaking the graver point.

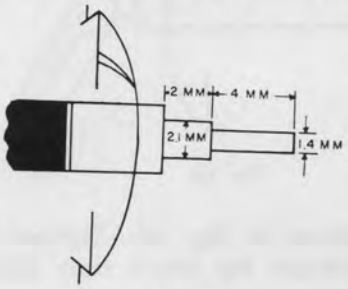


Fig. 19

With the graver previously used in rivet undercutting, undercut the corner slightly. See Fig. 20.

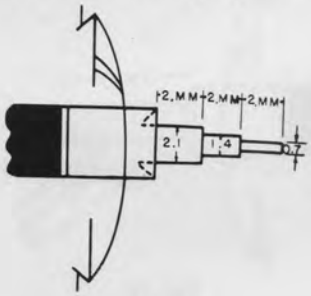


Fig. 21

Rechuck, true, and tighten the work. See Fig. 22.

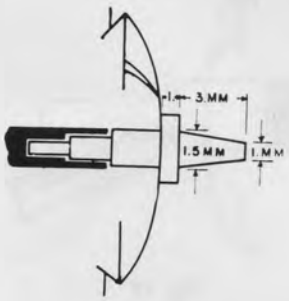


Fig. 23

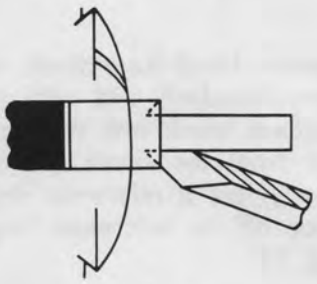


Fig. 18

Mark off 4 mm and turn the next shoulder to 1.4 mm diameter. Square the shoulder to exact length. See Fig. 19.

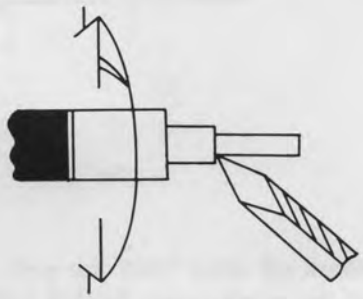


Fig. 20

Mark off the next shoulder 2 mm. Turn this shoulder to 0.7 mm diameter. See Fig. 21. When turning a small diameter, it is best to begin turning at the end and work toward the seat. Slightly undercut the corner. A deep undercut will weaken the pivot.

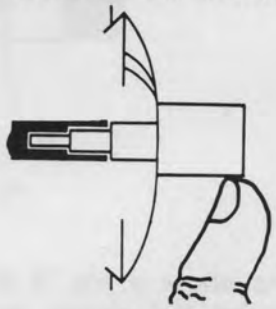


Fig. 22

Mark off 3 mm and turn the taper shown in Fig. 23.

Reverse the staff and rechuck. True and tighten with extreme care to secure a perfectly straight staff. See Fig. 28.

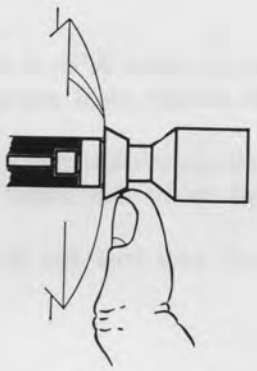


Fig. 28

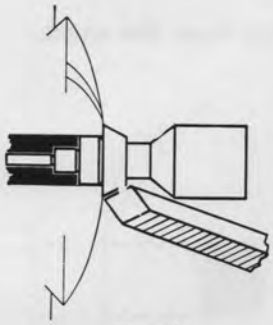


Fig. 29

Check the trueness of the staff by sighting a thin line of light between the full cutting graver edge and the hub. As the work is slowly rotated, this line of light should remain constant, proving that the staff has been chucked true. See Fig. 29.

Turn a taper on the lower part of the staff. The diameter near the hub should measure 1.5 mm and the end of the taper 1 mm. Slightly undercut the corner between the hub and the tapered shoulder. See Fig. 30.

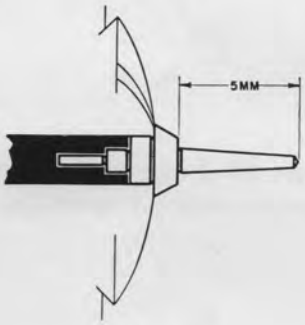


Fig. 30

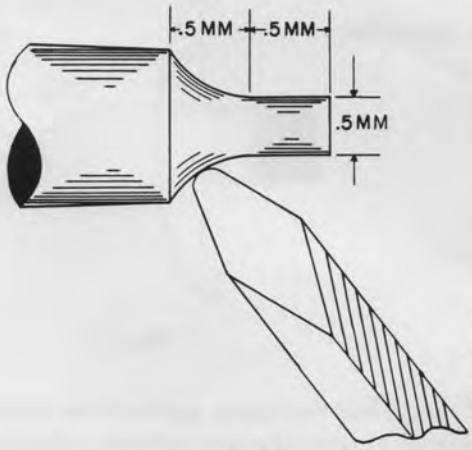


Fig. 31

Turn the cone with a rounded graver. The length of the cone should be 0.5 mm. The length and the diameter of the pivot should be 0.5 mm. See Fig. 31.

If the work has been accurately done, the distance from the roller seat to the end of the pivot should measure 5 mm.

REMOVING DAMAGED BALANCE STAFFS

When the standard rivet type of staff is to be replaced, the old staff may be removed by turning off the hub under the balance arm or turning off the rivet, swaged on top of the balance arm.

In most cases the method of turning off the hub of the staff is preferred and has two advantages. First, the balance shoulder of the staff which may be slightly spread due to staking, will not be forced through the hole of the balance wheel. Second, the hub will be easier to turn than the riveted shoulder because the staking process will have hardened the metal of the rivet.

However, when the damaged staff cannot be replaced with stock material and must be duplicated on the lathe, then the method of turning off the rivet should be used.

If the broken staff should be the top-grooved, side-grooved or friction type (see pages 6 and 7, Training Unit No. 1), the removing process does not require the lathe. These staffs are removed with staking equipment by reversing the staking process.

1. **TURNING OFF THE HUB** of a standard type staff such as Bulova 10 AK.

Approach the hub so that the left cutting edge of the graver tends to shave the roller seat of the hub. The point of the graver is held in the corner of the hub and roller shoulder. See Fig. 32.

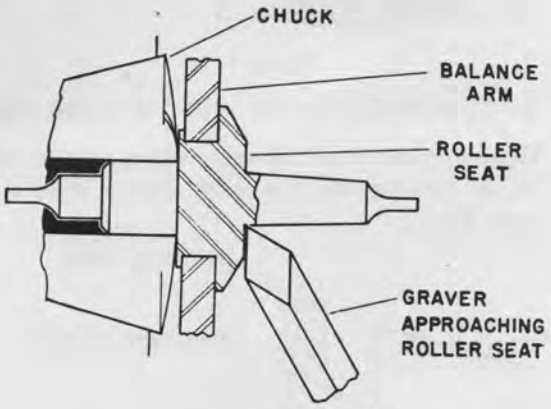


Fig. 32

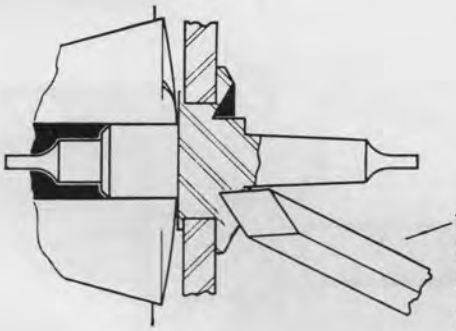


Fig. 33

As the shavings begin to leave the hub, swing the graver slightly to the right. The point will now be cutting deeper than the side cutting edge, forming a shallow V-groove. See Fig. 33.

As the metal of the hub is turned almost to the balance arm, the point of the graver will break through, leaving a loose ring of metal consisting of the thin outer portion of the turned-off hub. Care must be used to avoid damaging the balance arm. See Fig. 34.

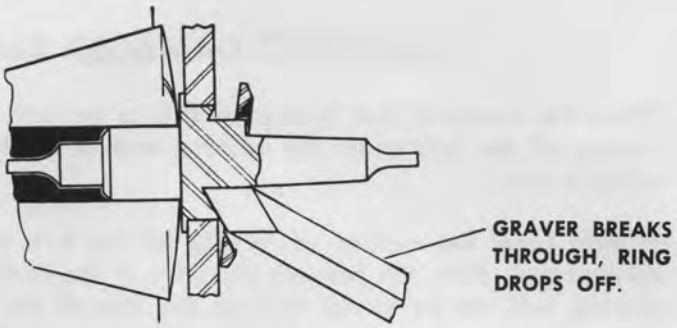


Fig. 34

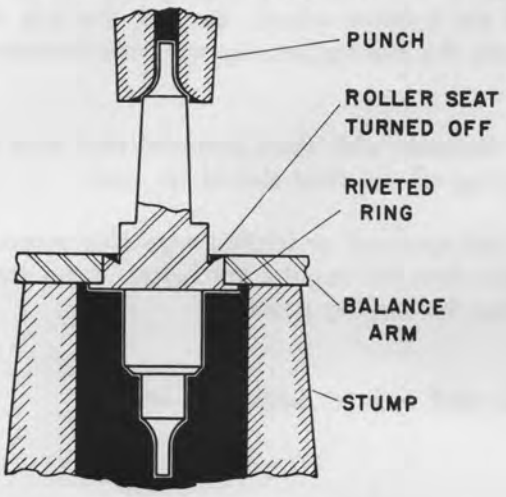


Fig. 35

In most instances the balance wheel can be eased off the staff with the fingers. If the wheel does not come off readily, remove by means of the staking set. See Fig. 35.

2. TURNING OFF THE RIVET of a standard type staff.

Greater care must be used when turning off the rivet. Use the graver in the same manner as in turning off the hub, being careful not to touch the balance arm. See Figs. 36 and 37.

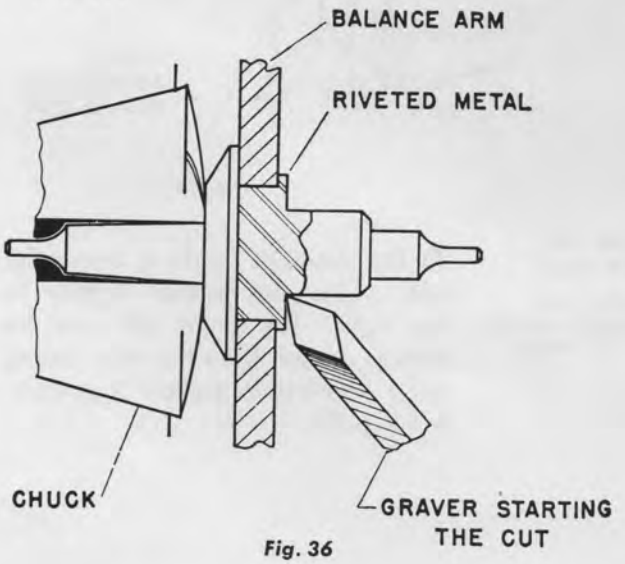


Fig. 36

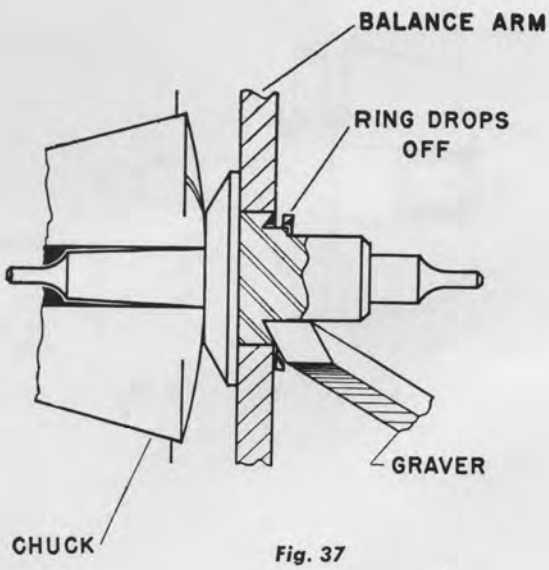


Fig. 37