

Hand Tools

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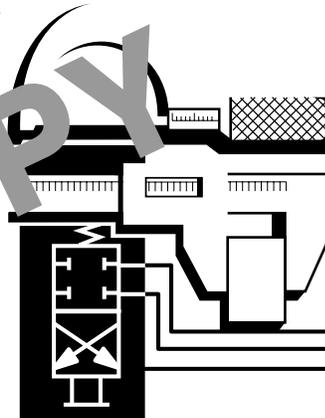
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HAND TOOLS

Lesson One

Measuring Tools

PREVIEW
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TPC Training Systems

10701

Lesson**1****Measuring Tools****TOPICS**

Linear and Angular Measurement
 Units of Linear Measurement
 Rules and Measuring Tapes
 Using Rules and Tapes
 Calipers

Slide Calipers
 Vernier Calipers
 Micrometer Caliper
 Using the Micrometer
 Squares

OBJECTIVES

After studying this lesson, you should be able to...

- Explain how to hold a rigid rule correctly when measuring an object and show from which point the measurement begins.
- Describe how to set lock joint transfer-type calipers.
- Identify vernier calipers.
- Explain how to take a measurement with a micrometer caliper.
- Name the parts of a combination square.

KEY TECHNICAL TERMS

Measuring tool 1.01 used to determine linear or angular measurement

Caliper 1.02 tool for transferring measurements

Square 1.03 tool for checking angular measurements

Graduation 1.06 line dividing a unit of measurement into equal parts

Outside diameter 1.17 diameter across outside of a pipe or similar structure, including wall thickness

Inside diameter 1.18 diameter across inside of a pipe or similar structure, not including wall thickness

Clocks, thermometers, odometers, and measuring cups are all familiar measuring devices around the home. As a maintenance specialist, your measuring tools will include rules, measuring tapes, calipers, and squares. Just as you know how to use common measuring devices at home, you must know how to use more complex measuring tools in your job.

Before you can use any measuring tool properly, you must understand the unit of measurement involved. In this lesson, the inch, the meter, and their fractions are the most common units discussed. Most fractional measurements are indicated by lines on the measuring tool rather than by numbers. Therefore, you must understand their placements and meaning.

This lesson describes the tools used for measuring distances along a straight line and for checking certain angles. It describes the rule and the measuring tape, plus calipers and squares. There are many variations of each tool, but certain features are common to all rules, all calipers, and so on. This lesson describes these common features, plus the variations.

Linear and Angular Measurement

1.01 Measuring tools are used for making linear and angular measurements. *Linear measurement* is the distance on a straight line between two points. Steel rules (scales), tapes, calipers, and micrometers are examples of linear measurement tools.

1.02 Outside and inside *calipers* are tools used for transferring measurements. Measurements can be transferred from a scale to the work, or from the work to a scale. For example, outside calipers are used in measuring the work on a lathe.

1.03 *Angular measurement* is the size of an angle, the trueness of a surface, and the relationship of one surface to another. These kinds of measurements are important in carpentry and in making complex parts of machines. The tools used in measuring and comparing angles are called *squares*.

Units of Linear Measurement

1.04 In the United States and Canada, the *inch* has historically been the unit of linear measurement. Most other countries have used the *meter* as the unit of linear measure. As world trade has increased, manufacturers in the United States and Canada have switched to the meter as the standard unit of linear measurement.

1.05 On most rules, the inch is divided into halves, quarters, eighths, and sixteenths. Some rules are fur-

ther divided into thirty-seconds and sixty-fourths of an inch. Machinist's scales are divided into tenths and hundredths of an inch. The fractions are marked by lines of various lengths placed at right angles to the rule's edge.

1.06 Each inch on the rule is numbered, but fractions of an inch usually are not. The smallest fraction of an inch is usually printed once on the face of the rule. However, rules are available with the *graduations*, or fractions of an inch, numbered.

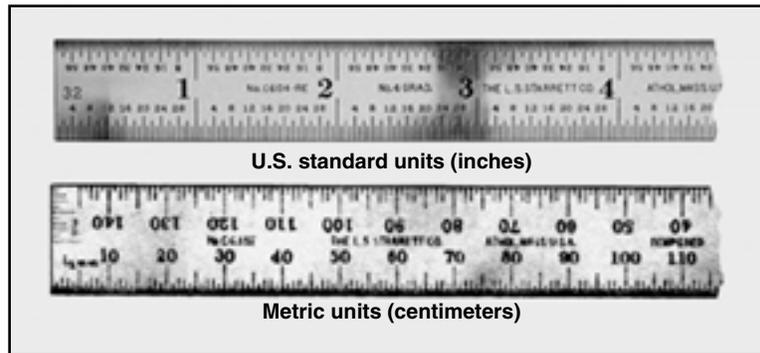
1.07 On a machinist's scale, it is impossible to see graduations smaller than a hundredth of an inch. For more exact measurements, you must use special tools. *Micrometers* and *vernier calipers* are used for measuring with an accuracy greater than a hundredth of an inch.

1.08 The main divisions on a metric rule are *centimeters*. One centimeter is one hundredth of a meter. The centimeters are divided into ten *millimeters*. Millimeters are usually not divided on a rule, because the next division (tenths of a millimeter) is too small to be useful. Metric micrometers and vernier calipers are used instead.

Rules and Measuring Tapes

1.09 Figure 1-1 on the following page shows a *steel rule*, also called a *scale*. This rule comes in standard lengths of 6 or 12 in., although other lengths are available. The four edges, two on the front and two on the back, have different divisions.

Fig. 1-1. Steel rules

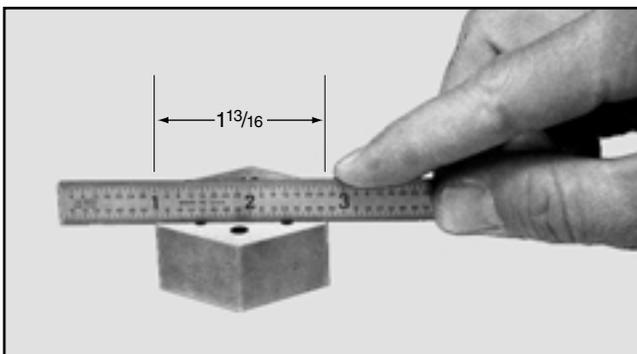


1.10 The ends of a steel rule become worn and the corners rounded with use. Therefore, you should not rely on the end for accurate measurement. Instead, begin your measurement from the first major division, as shown in Fig. 1-2. Remember to reduce your reading by the proper amount when using this method. In Fig. 1-2, the length being measured is about $1\frac{13}{16}$ in.

1.11 Figure 1-3 shows a *folding rule* and two *steel measuring tapes*. Folding rules are made of metal or wood, and are usually 2 to 6 ft long. This measuring tool is not for making very fine or accurate measurements. The smallest division on it is usually one sixteenth of an inch. In addition, the rule usually develops some looseness at the joints. This looseness is a result of repeated folding and unfolding.

1.12 Steel measuring tapes are 6 to 300 ft in length. Tapes up to 25 ft long usually have a curved cross section that keeps them rigid when extended. Longer tapes are flat. They require support over their entire length when in use. If the support is not there, the natural sag can cause an error in reading.

Fig. 1-2. Measuring with a steel rule



1.13 Steel tapes wind into a metal case when you press a button or push them in by hand. Most long tapes have a handle on the case for reeling in the tape.

1.14 A hook on the end of a tape helps to hold it in place while taking measurements. Thus, one person can take a measurement without assistance. The outside of the case is used as part of the tape when you take inside measurements.

Using Rules and Tapes

1.15 To use a rule, place its edge on the surface of the object you are measuring, as shown in Fig. 1-4. If you lay a rule flat on the surface, its thickness may prevent your eye from reading the measurement accurately. Read the measurement at the graduation that matches the distance being measured.

1.16 Measure screws and bolts by holding them against a rigid rule. You should hold the rule and the bolt or screw at eye level to get an accurate reading. Figure 1-5 shows points on the screws and bolt where

Fig. 1-3. Folding rule and measuring tapes

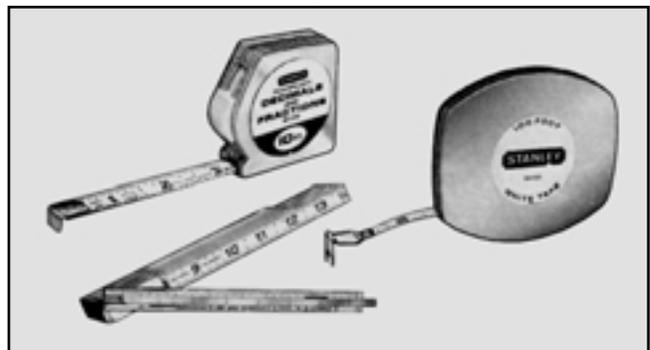
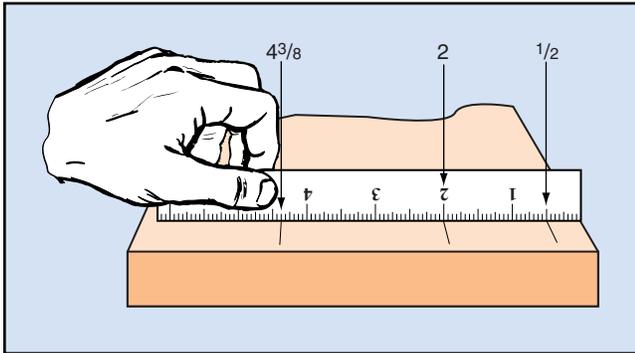


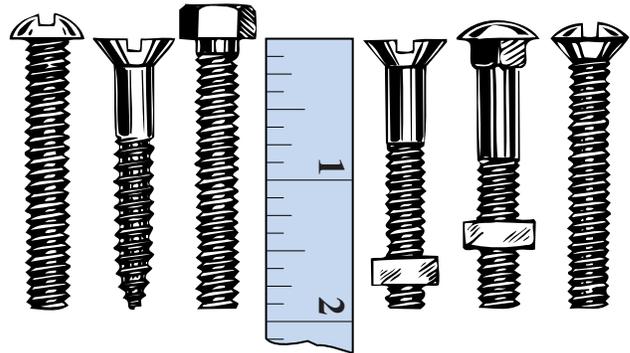
Fig. 1-4. Measuring with a rule

measurements are taken. Notice that the measurement starts from the point where the head of the screw or bolt will meet the surface it centers. All the bolts and screws shown in Fig. 1-5 are 2 in. long.

1.17 You should also use a rigid rule to measure the *outside diameter (OD)* of a pipe. Line up the end of the rule with the outer surface of the pipe, and hold it in place with your thumb, as shown in Fig. 1-6. Measure from that point to the opposite outside edge to find the OD.

1.18 The *inside diameter (ID)* of a pipe is measured from one inside surface to the other, as shown in Fig. 1-6. Make sure the end of the rule touches the inside surface of the pipe to get an accurate reading.

1.19 Most pipe sizes are specified by the inside diameter. The ID remains constant, while wall thicknesses vary from pipe to pipe. If a blueprint specifies $\frac{1}{2}$ in. or $\frac{3}{4}$ in. pipe or conduit, it usually refers to the ID.

Fig. 1-5. Measuring bolts and screws

1.20 Figure 1-7 on the following page shows the correct way to measure the width of a board. Hook the end of the steel tape over one edge of the board. Then pull the tape case until the tape reaches the opposite edge, and read the measurement.

1.21 Use a 50 to 100 ft tape to make long measurements. Secure the hook end of the tape, or have someone hold it in place. Then hold the tape reel in one hand and let it unwind as you walk toward the other end of the distance being measured.

1.22 Make sure you eliminate any sag before taking the reading. The tape should run straight along the line being measured. Some tapes are designed to be accurate when pulled to a minimum sag. Check your tape for the proper method before taking a final reading.

1.23 Always handle rules and tapes carefully. Do not let the edges become nicked. Rules and tapes that do not roll up should be kept in a wooden or plastic box when not in use. Steel rules and tapes should be

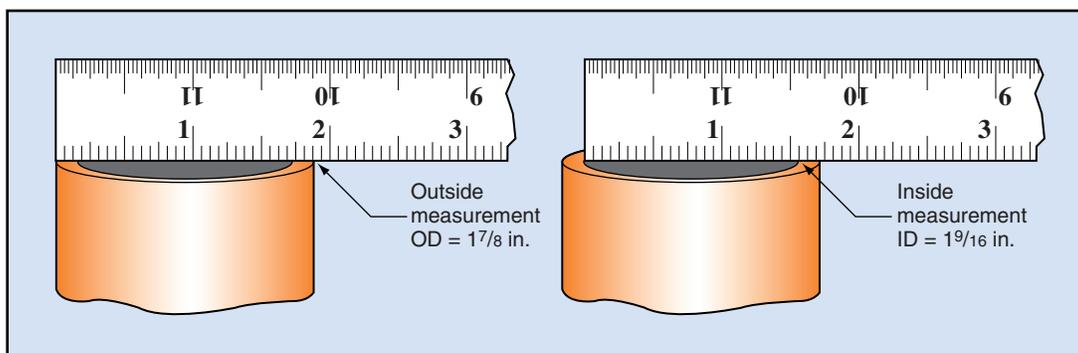
Fig. 1-6. Measuring pipe diameter

Fig. 1-7. Measuring with a steel tape



wiped occasionally with a cloth dampened with light oil. The oil cleans the surface and leaves a thin film that prevents rust from forming.

Calipers

1.24 *Calipers* are adjustable instruments composed of two straight or curved legs joined at the top by a hinge. They are designed for transferring measurements from a measuring tool to the workpiece, or from the workpiece to a measuring tool.

1.25 *Outside calipers* are used for transferring outside measurements. *Inside calipers* are used for transferring inside measurements. Both kinds are shown in Fig. 1-8.

1.26 Calipers are also classified by the kind of joint or hinge they have, and by how the adjustments

are made. The *firm-joint caliper* has the simplest construction. Its legs are held in place by friction after being set. This kind of caliper is the least accurate and the most difficult caliper to adjust.

1.27 Some firm-joint calipers have a screw adjustment. They are quite accurate. The *lock-joint caliper*, shown in Fig. 1-8, is a variation of the firm-joint caliper. It has a *transfer arm* that can be released to let one leg of the caliper swing free.

1.28 The legs of *spring-joint calipers*, shown in Fig. 1-9, are spread by the force of a curved spring at the top. An adjusting nut turns on a screw fastened to one leg and passing through the other. To adjust the points, you must tighten or loosen the adjusting nut. These calipers are also quite accurate.

1.29 Figure 1-10 shows lock-joint *transfer-type* outside and inside calipers. They are used for transferring measurements when the legs must be moved after they have been set to size.

1.30 To use this instrument, first set the legs and tighten the large knurled nut to lock the joint. Then loosen the transfer arm binding nut, and swing one leg away to remove the caliper from the part being measured. Finally, move the leg back against the transfer arm slot on the short arm, and transfer the exact size to a rule.

1.31 Inside sizes are measured with an inside caliper. It has straight legs, with points that turn out-

Fig. 1-8. Outside and inside calipers

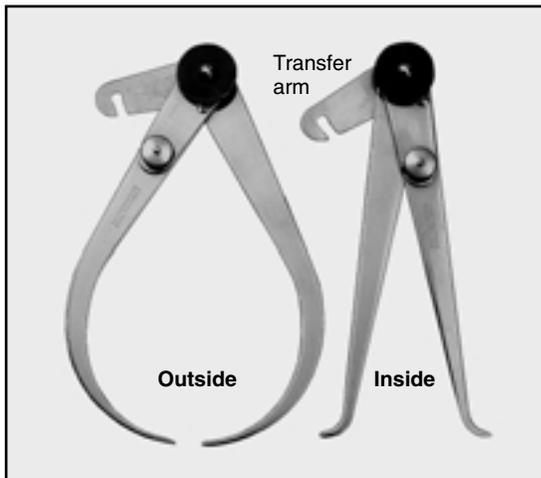


Fig. 1-9. Spring-joint calipers

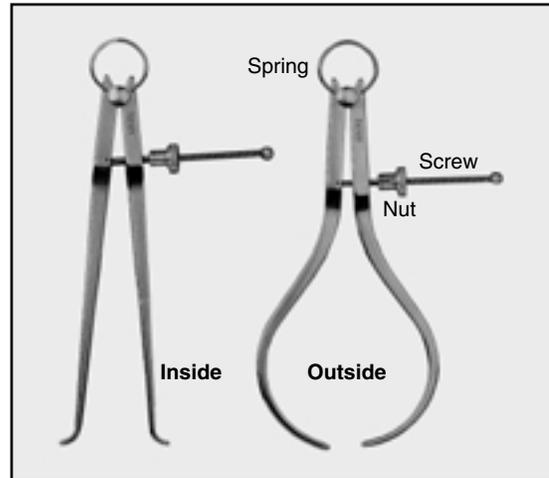
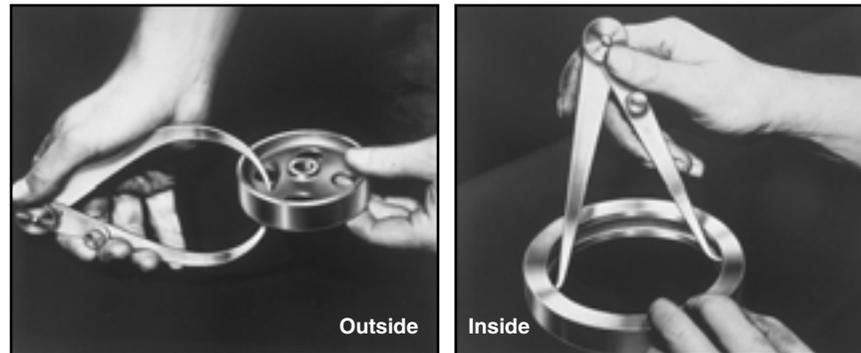


Fig. 1-10. Using lock-joint calipers



ward. To measure a diameter on a part, hold one point against one side of the part, as shown in Fig. 1-10. Increase the setting of the caliper until the other point touches the opposite side. Then remove the caliper, and measure the setting with a rule as shown in Fig. 1-11.

1.32 To set a caliper to a specific size when transferring a measurement to a part, first open it to the approximate size. Then place the caliper on the rule, as shown in Fig. 1-11 and make the final setting. Accuracy of the reading depends on proper sighting, reading, adjustment, and feel. These skills come through practice and careful use of calipers.

WARNING

Never attempt to use a caliper on work rotating in a machine.

1.33 Calipers are delicate instruments and must be used only for measurement. Keep your calipers clean and lightly oiled. Do not throw them around or use them as screwdrivers or pry bars. Even a slight force can spring the legs out of alignment. Once this happens, measurements made with the calipers will not be accurate.

Slide Calipers

1.34 A *slide caliper*—also called a *caliper rule*—is shown in Fig. 1-12 on the following page. It is used where a precise measurement is not necessary, or where an approximate measurement is acceptable. This caliper can be used for measuring both inside and outside dimensions.

1.35 Slide calipers come in 3 and 5 in. sizes. Graduations are in thirty-seconds and sixty-fourths

Fig. 1-11. Measuring sizes with transfer calipers

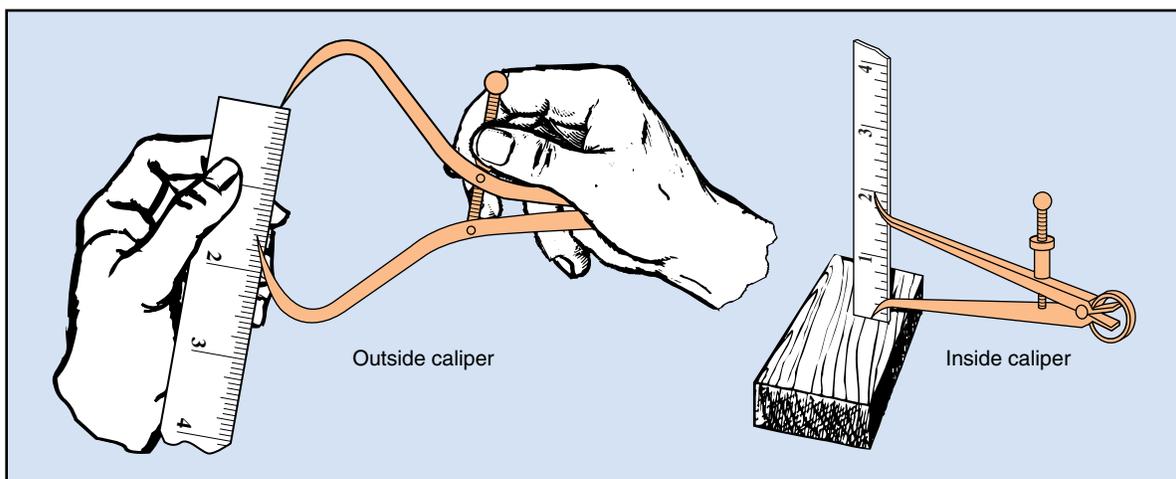


Fig. 1-12. Slide caliper

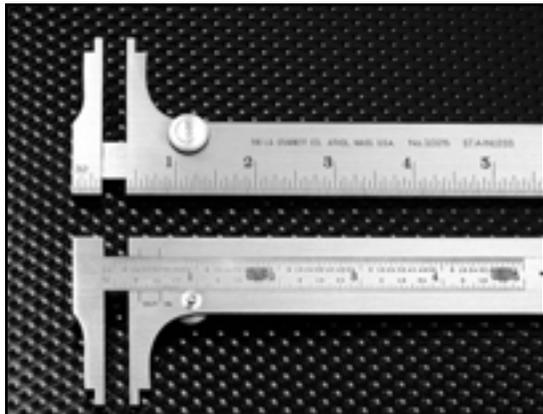
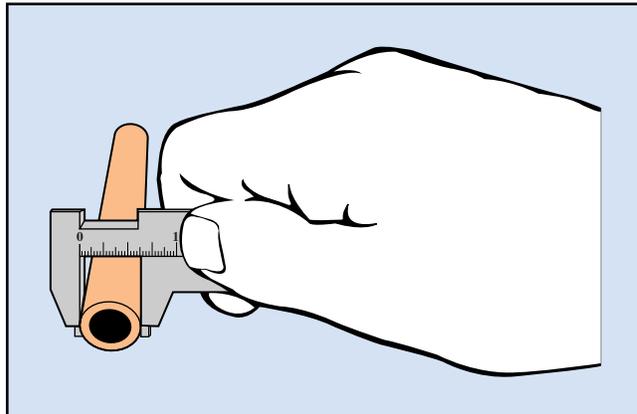


Fig. 1-13. Measuring with slide caliper



of an inch. The words “in” and “out” are stamped on the frame under the two index lines. One index line is for reading inside measurements, and the other is for reading outside measurements. A locking screw holds the jaws in position to maintain the setting.

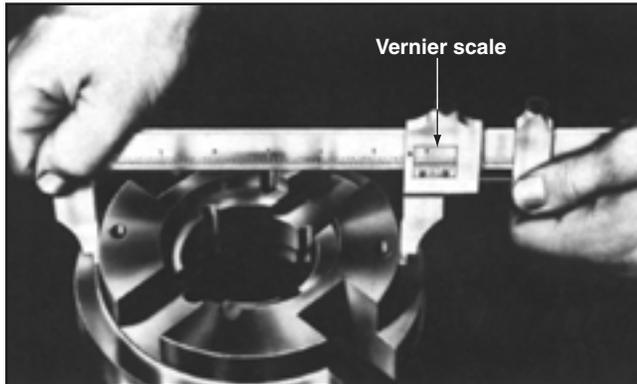
1.36 To measure the size of round or flat stock, move the jaws of the slide caliper into firm contact with the surface of the stock, as shown in Fig. 1-13. Read the measurement at the index line labeled “out.”

1.37 To measure the diameter of a hole or the distance between two inner surfaces, insert only the rounded tips of the caliper jaws. Then read the measurement on the index line labeled “in.”

The Programmed Exercises on the following page will tell you how well you understand the material you have just read. Before starting the exercises, remove the Reveal Key from the back of your book. Read the instructions printed on the Reveal Key. Follow these instructions as you work through the Programmed Exercises.

<p>1-1. Measuring tools are used to make _____ and _____ measurements.</p>	<p>1-1. LINEAR; ANGULAR Ref: 1.01</p>
<p>1-2. The _____ and the _____ are the standard units of linear measurement.</p>	<p>1-2. INCH; METER Ref: 1.04</p>
<p>1-3. From what point should you begin measuring when using a steel rule?</p>	<p>1-3. FIRST MAJOR DIVISION Ref: 1.10</p>
<p>1-4. What is the smallest division usually found on a folding rule?</p>	<p>1-4. $\frac{1}{16}$ IN. Ref 1.11</p>
<p>1-5. What part of a rule should touch an object being measured?</p>	<p>1-5. THE EDGE Ref: 1.15</p>
<p>1-6. A _____ rule is used for measuring screws, bolts, and pipe diameters.</p>	<p>1-6. RIGID Ref: 1.16, 1.17</p>
<p>1-7. The _____ caliper has the simplest construction and is the least accurate.</p>	<p>1-7. FIRM-JOINT Ref: 1.26</p>
<p>1-8. What kind of caliper should you use for measuring the diameter of a hole?</p>	<p>1-8. INSIDE Ref: 1.31</p>

Fig. 1-14. Vernier caliper



Vernier Calipers

1.38 A *vernier caliper* is designed to measure with greater accuracy than an ordinary caliper. The greater accuracy is possible because of a special *vernier scale* attached to the index line. This scale is made so that, for any measurement, only one of its graduations will line up with a graduation on the main scale.

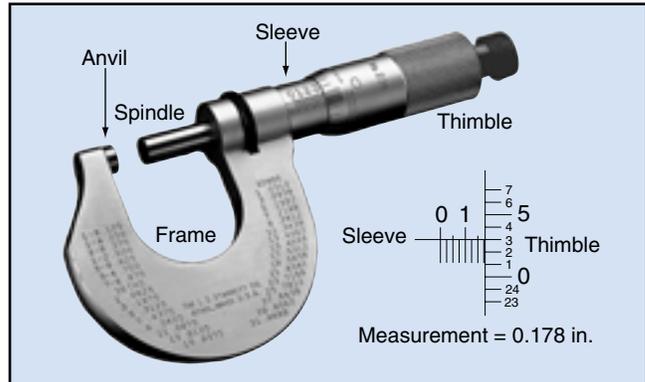
1.39 The effect of the vernier scale is to subdivide the smallest graduations on the main scale. When you read the caliper, you add the value of the lined-up graduation on the vernier scale to the value on the main scale indicated by the index line (zero on the vernier scale).

1.40 Figure 1-14 shows a vernier caliper. It can measure with an accuracy of 0.001 in. Notice that the caliper has two main scales, one for inside measurements and one for outside measurements. Each index line has a vernier scale extending to the right. Vernier calipers are available in sizes up to 4 ft long.

1.41 Vernier calipers are precision instruments. You must treat the inside faces of the jaws, and the outside faces of the tips, with great care. A caliper cannot give accurate measurements if these parts become worn or bent. You can check the accuracy of vernier calipers by measuring an object of known accurate dimensions—a precision gauge block, for example.

1.42 Always follow the manufacturer's recommendations for adjusting a vernier caliper. If the jaws are bent or sprung, the manufacturer may be able to realign them. But this is not always possible. Keep the

Fig. 1-15. Micrometer caliper



caliper lightly oiled to prevent rusting. Store it in a separate wooden box lined with cloth.

Micrometer Caliper

1.43 The *micrometer caliper* is commonly called a *micrometer*, or *mike*. It works by keeping track of the advance of a fine-pitch screw through any number of complete turns or a fraction of a turn. Figure 1-15 shows the parts of a micrometer.

1.44 The *spindle* is the main part of a micrometer. It has a very accurate screw inside an outer gauge called the *thimble*. The thread passes through a fixed nut. As you turn the thimble, the distance changes between the end of the *spindle* and the end of the *anvil*.

1.45 On micrometers graduated in inches, the pitch of the screw thread on the spindle is $\frac{1}{40}$ in. That is, the screw has 40 threads per inch. One complete revolution of the thimble moves the spindle exactly $\frac{1}{40}$ in., or 0.025 in.

1.46 The horizontal line on the sleeve is divided into 40 equal parts that correspond to the number of threads on the spindle. Each graduation represents $\frac{1}{40}$ or 0.025 in. Every fourth graduation is labeled in tenths of an inch. For example, the line marked "1" on the sleeve represents 0.100 in.

1.47 The beveled edge of the thimble is divided into 25 equal parts. Each mark represents 0.001 in. Rotating the thimble from one line to the next moves the spindle 0.001 in. One complete revolution moves the spindle through 25 divisions, or 0.025 in ($\frac{1}{40}$ in.).

1.48 To measure a part, you place it between the anvil and the spindle. Turn the thimble until the spindle and the anvil both touch the part. Then read the scale on the sleeve. Add this value to the value on the thimble scale where it crosses the index line on the sleeve. For example, Fig. 1-15 shows a reading of 0.178 in. (0.175 on the sleeve scale, plus 0.003 on the thimble scale).

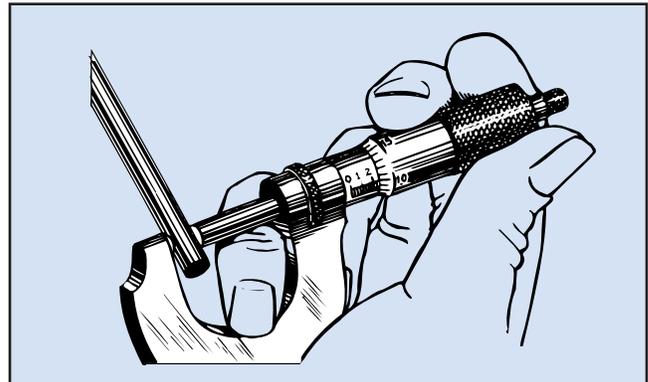
Using the Micrometer

1.49 Small micrometers are used in measuring small work. To use a small mike, hold it in the palm of one hand with the knurled portion of the thimble between your thumb and fingers. Hold the frame downward, and grip it with the small fingers, as shown in Fig. 1-16. The mike should press against the heel of your hand for good support.

1.50 Hold the part being measured in your other hand. Then turn the thimble to advance the spindle. The force of the micrometer on the part should be great enough to make a snug fit. But it should be free enough so that you can “drag” the mike over the work.

1.51 Figure 1-17 shows several special micrometers. A *deep-throat micrometer* is used for measuring the thickness of sheet material. A *screw-thread*

Fig., 1-16. Holding a micrometer caliper



micrometer with a pointed spindle and a double-V anvil is used for measuring screw thread diameters. The spindle and anvil faces are shaped to contact the screw thread of the work.

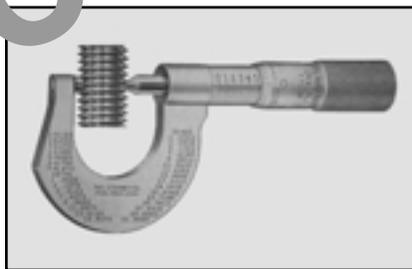
1.52 The screw-thread micrometer reading gives the true pitch diameter in thousandths of an inch. *Pitch diameter* is the diameter of a circle that passes about halfway between the root and the crest of the threads. Screw-thread micrometers are made to fit several different ranges of threads per inch.

1.53 An *outside micrometer caliper* with a *rounded anvil* is used for measuring the wall thickness of

Fig. 1-17. Special micrometer calipers



Deep-throat micrometer



Screw-thread micrometer



Outside micrometer with round anvil



Large outside micrometer



Tube micrometer

solid and split bearings, tubing, sleeves, collars, rings, and other cylinders. The rounded anvil contacts the inside curved surface, and the flat-faced spindle touches the outer surface. This combination produces a single-point contact on each side, which allows curved surface thickness to be measured accurately.

1.54 Large micrometers are used for measuring big work. An *outside micrometer caliper* with a capacity of 12 to 60 in. has interchangeable anvils. The anvils increase the measured sizes by 1 in. increments. A wide range of measurements can be made with a single large micrometer by using these interchangeable anvils.

1.55 A *tube micrometer* is used in measuring the distance from a hole to the edge of a workpiece. The anvil is at right angles to the spindle. The anvil is inserted into the hole, and the spindle is turned until it touches the edge. The tube micrometer can also be used for measuring the wall thickness of tubing or of other parts that have cylindrical walls.

1.56 There also are micrometers for measuring hub thickness, paper thickness, hole depths, and for other special uses. All micrometers must be kept clean and lightly oiled. Protect them when not in use by placing them in a cloth-lined wooden box. Never use an abrasive or a file to clean the anvil or spindle face.

Squares

1.57 *Squares* are used for checking angle trueness and for laying out angles and lines on materials. Most squares have a scale along one or more edges. The

most common squares are the carpenter's framing square, the try square, and the combination square.

1.58 Figure 1-18 shows a framing square and a try square. The *framing square* has two arms at right angles to each other. The longer arm is called the *body* or *blade*. The shorter arm is the *tongue*. The arms are usually 24 in. and 16 in. long.

1.59 Each edge of each arm has a scale divided in eighths and sixteenths of an inch. The framing square is commonly used for laying out and squaring up large work, and for checking the flatness and the squareness of large surfaces.

1.60 To square a piece, fit the square over two adjacent surfaces. Look to see if any light can pass between the work and the square. The work is square if no light passes through.

1.61 A *carpenter's framing square* is engraved or printed with special tables. These tables enable a carpenter to perform calculations quickly when laying out rafter angles and joints. They also enable the carpenter to calculate sizes of treads and risers for a stairway.

1.62 The *try square* is for setting and checking lines on surfaces that must be at right angles to each other. It has a thick handle and a thin steel blade. These parts are at right angles to each other. Blades are generally 2 to 12 in. long. Most try squares have a scale on the blade.

1.63 *Combination squares*, like those shown in Fig. 1-19, have many uses. A combination square

Fig. 1-18. Squares

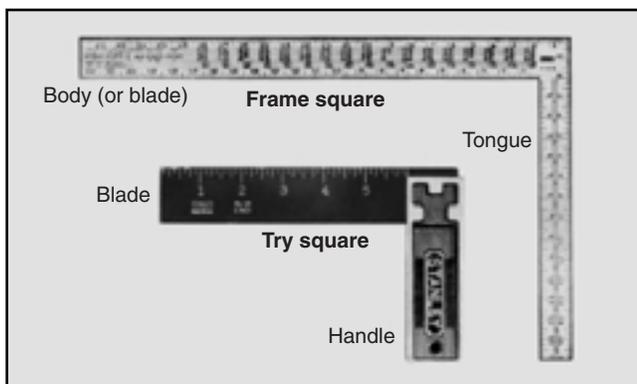


Fig. 1-19. Three heads for a combination square

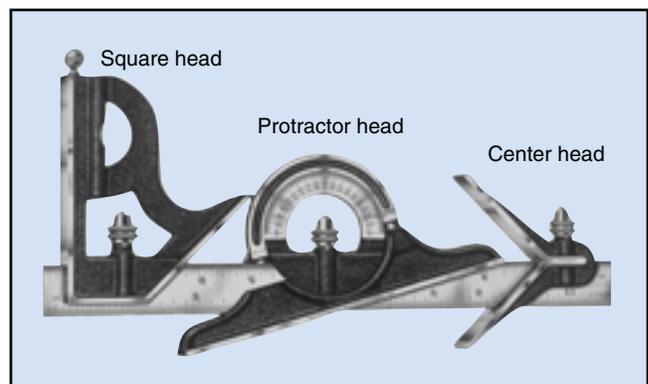
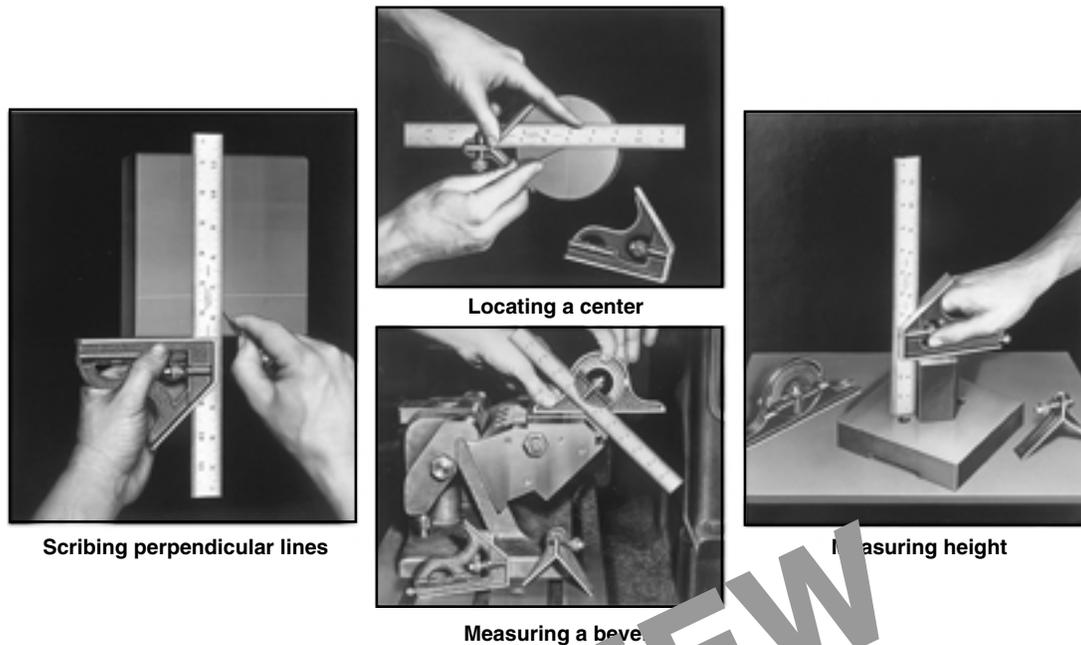


Fig. 1-20. Using a combination square



consists of a tempered steel blade and a head that can slide along the blade. Three different heads can be used, depending on what kind of job is to be done.

1.64 The most common head is the *square head*, used for measuring angles of 90° and 45° . The *protractor head* can pivot to measure angles of any size. The *center head* can hold a round part so that one edge of the blade passes through the center of the circle. It is used for finding the center of a circular part.

1.65 Each head can slide along the blade to permit easy adjustment. The blade has four engraved scales, two on each side. When separated, the square head can be used as a level and the blade as a ruler.

1.66 A combination square is really many different tools. It serves as a try square, miter gauge, height gauge, depth gauge, steel rule, center gauge, and bevel protractor.

1.67 Combination sets are useful for squaring work, transferring measurements, laying out work, leveling surfaces, determining plumb, measuring and squaring mortises, establishing centers, and laying out and checking angles. Figure 1-20 shows some of the uses of a combination square.

1.68 Always keep the blade and heads of a combination square clean. Accumulated dirt causes inaccurate readings and layouts. Apply a light coat of oil to all metal surfaces to prevent rusting, but wipe it off before using the square. Store these tools separately from other tools to prevent damage.

16 Programmed Exercises

<p>1-9. A caliper can measure more accurately if it has a(n) _____ scale.</p>	<p>1-9. VERNIER Ref: 1.38</p>
<p>1-10. The _____ is the main part of a micrometer.</p>	<p>1-10. SPINDLE Ref: 1.44</p>
<p>1-11. To measure a part with a micrometer, you place the part between the _____ and the _____.</p>	<p>1-11. ANVIL; SPINDLE Ref: 1.48</p>
<p>1-12. A(n) _____ is used for measuring the thickness of sheet material.</p>	<p>1-12. DEEP-THROAT MIKE Ref: 1.51</p>
<p>1-13. The _____ of a tube micrometer is at right angles to the spindle.</p>	<p>1-13. ANVIL Ref: 1.55</p>
<p>1-14. Most squares have a(n) _____ along their one or more edges.</p>	<p>1-14. SCALE Ref: 1.57</p>
<p>1-15. The body of a framing square is usually _____ long. The tongue is usually _____ long.</p>	<p>1-15. 24 IN.; 16 IN. Ref: 1.58</p>
<p>1-16. What three heads are used with a combination square?</p>	<p>1-16. SQUARE, PROTRACTOR, CENTER Ref: 1.64</p>

Answer the following questions by marking an "X" in the box next to the best answer.

- 1-1. Which tool can measure with an accuracy greater than a hundredth of an inch?
- a. Firm-joint caliper
 - b. Steel rule
 - c. Try square
 - d. Vernier caliper
- 1-2. What part of a rigid rule should touch the object being measured?
- a. Back
 - b. Edge
 - c. End
 - d. Top
- 1-3. Which type of caliper is the least accurate?
- a. Firm joint
 - b. Flexible joint
 - c. Lock joint
 - d. Spring joint
- 1-4. A slide caliper measures
- a. both inside and outside dimensions
 - b. inside dimensions only
 - c. outside dimensions only
 - d. neither inside nor outside dimensions
- 1-5. A micrometer caliper is adjusted by turning the
- a. anvil
 - b. sleeve
 - c. spindle
 - d. thimble
- 1-6. On micrometers graduated in inches, how far does one complete revolution move the spindle?
- a. 0.001 in.
 - b. 0.015 in.
 - c. 0.025 in.
 - d. 0.040 in.
- 1-7. The best way to hold a small micrometer is in
- a. a micrometer support stand
 - b. a vise
 - c. both hands
 - d. one hand
- 1-8. The long arm on a framing square is called the
- a. blade
 - b. right angle
 - c. scale
 - d. tongue
- 1-9. Which head can be used on a combination square to find the center of a circular part?
- a. Center
 - b. Circle
 - c. Protractor
 - d. Square
- 1-10. Which square has a head that can slide along the blade?
- a. Carpenter's square
 - b. Combination square
 - c. Framing square
 - d. Try square

SUMMARY

This lesson describes basic measuring tools. It covers rules and measuring tapes, the many types of calipers, and various squares. The type of measuring tool you should use depends on the job to be done.

Rigid and folding rules and measuring tapes are used for making linear measurements—distances along a straight line. Most of these tools are made of steel, but some are made of wood. Those made of steel should be kept clean, and wiped with light oil after each use. They should be protected from damage when stored.

Calipers are used for transferring measurements, either from the work to a measuring tool or from a measuring tool to the work. All calipers are delicate instruments that require careful handling.

Take care not to bend or spring the caliper legs or faces. Never use a file or abrasive to clean the faces. Store each caliper in a separate cloth-lined wooden box. Never apply calipers to work rotating in a machine.

Squares may be one-piece or multipart instruments. A carpenter's framing square has one long leg called the body or blade, and a shorter leg called the tongue. A try square has a thick handle and a thin blade. The combination square is a multi-purpose tool. It has interchangeable heads so that it can be used for several different measuring jobs. Wipe the metal parts with a light coat of oil after each use to remove dirt, and store each square separately.

Answers to Self-Check Quiz

- 1-1. d. Vernier caliper. Ref: 1.07
- 1-2. b. Edge. Ref: 1.15
- 1-3. a. Firm joint. Ref: 1.26
- 1-4. a. Both inside and outside dimensions. Ref: 1.34
- 1-5. d. Thimble. Ref: 1.44
- 1-6. c. 0.025 in. Ref: 1.45
- 1-7. d. One hand. Ref: 1.49
- 1-8. a. Blade. Ref: 1.58
- 1-9. a. Center. Ref: 1.64
- 1-10. b. Combination square. Ref: 1.65

Contributions from the following sources are appreciated:

Figure 1-1. The L.S. Starrett Company
 Figure 1-3. Stanley Tools
 Figure 1-8. The L.S. Starrett Company
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