

SECTION 1, CHAPTER 1

HAND TOOLS

List of Contents

	<i>Para.</i>		<i>Para.</i>
Introduction	1	Combination Set	48
SHAPING AND CUTTING TOOLS		Calipers	49
Vices	5	Marking-Off Tables	51
Hacksaws	8	Surface Plates	52
Chisels	11	Vee Blocks	53
Hammers	14	Scribing Blocks	54
Files	16	Key-Seat Rules	55
Scrapers	22	Feeler Gauges	56
Drills	23	Centre Punches	57
Reamers	32	DISMANTLING AND ASSEMBLING TOOLS	
Taps	34	Introduction	58
Cutting Internal Screw Threads ..	35	Pliers	59
Dies	39	Screwdrivers	60
Cutting External Screw Threads ..	41	Pin Punches	63
MEASURING AND MARKING-OUT TOOLS		Hollow Punches	64
Introduction	42	Drifts	65
Rules	43	Rivet Snaps	66
Dividers	44	Spanners	67
Scribers	45	Extractors	75
Fitter's Squares	46	Special Assembly Tools.. .. .	77

List of Illustrations

	<i>Fig.</i>		<i>Fig.</i>
Bench Vice	1	Twist Drill	18
Hand Vice	2	Morse Taper Adapter	19
Hacksaw	3	Details of Twist Drill Angles ..	20
Use Correct Blade	4	Effect of Clearance Angle	21
Chisels	5	Drilling Procedure	22
Hammers	6	Reamers	23
Holding the Hammer	7	Second Tap	24
Shapes	8	Circular Die and Stock	25
Length of Files	9	Adjustable Dies and Stock	26
Hand	10	Die Nuts	27
Half-Round	11	Dividers and Rule	28
Round	12	Testing a Fitter's Square	29
Three-Square	13	Uses of Combination Set	30
Square	14	Types and Uses of Calipers	31
Cuts of Files	15	Testing the Accuracy of an Angle Plate with Fitter's Square and Surface Plate	32
Scrapers	16		
Types of Drill	17		

List of Illustrations—contd.

	<i>Fig.</i>		<i>Fig.</i>
Using Vee and Scribing Blocks ..	33	Rivet Snap	43
Scribing Lines on the Surface of a Shaft when Marking-off a Keyway ..	34	Set or Open-Jaw Spanner ..	44
Using Feeler Gauges	35	Ring Spanners	45
Use of Centre Punch	36	Box Spanners	46
Pliers	37	Socket Spanners and Ancillaries ..	47
Common Screwdriver	38	'C' Spanner	48
End of Blade	39	Splined Tube Spanner	49
Phillips Screwdrivers	40	Peg Spanner	50
Pin Punches	41	Adjustable Spanner	51
Hollow Punch	42	Simple Extractors	52
		Simple Bush Assembly Tool	53

Introduction

1. In order to do the work that he may be detailed to perform, a tradesman must be fully conversant with the tools he may require to use. Some of the aspects of this work are as follows:—

(a) **Servicing Operations.** These may involve dismantling, examination, cleaning, adjustment and re-assembly of equipment in accordance with prepared schedules.

(b) **Repair by Replacement.** This is now a widely used method of repair, consisting of removing a defective component and replacing it with a serviceable item.

(c) **Modifications.** Modifications to existing equipment with the object of improving performance, serviceability, or satisfying special requirements, etc., may involve the manufacture of simple components or alterations to existing components.

2. A first-class repair, overhaul or modification job calls for specialized knowledge and skill in the use of tools, the former being attained by study allied to experience, while skill can only be acquired by actual practice. No matter how knowledgeable and skilful a tradesman may be, he can never produce his best work using unsuitable or inefficient tools.

3. **Care of Tools.** The tools provided in the Royal Air Force are of good quality, each being designed for a specific use, and when initially issued they are efficient tools. It is the duty of every tradesman to safeguard the efficiency of all tools issued to him, whether on permanent or short-term loan. Tools can be kept efficient over a long period by adopting two simple precautions. Firstly, never misuse a tool; use it correctly and only

for the purpose for which it was designed. Secondly, tool boxes, racks, transit cases, etc., are not just containers; they are intended to protect their contents, and they cannot protect tools that are thrown aside or left lying about when not in use—after using a tool, always return it to its proper stowage.

4. The tools described in this chapter are grouped, as far as is practicable, into those used for removing surplus metal when making or modifying components, those used for measuring and for marking out dimensions, and those used for assembly and dismantling purposes.

SHAPING AND CUTTING TOOLS**Vices**

5. The vice, while not in itself a cutting or shaping tool, is an essential item of most hand tool cutting or shaping operations, since it enables the material being worked to be held firmly and in the most suitable position. The two types commonly used are bench vices and hand vices.

6. **Bench Vices.** In its usual form a bench vice (Fig. 1) consists of two main parts, to each of which is secured a hardened serrated jaw for holding the work. One part is bolted to the bench and inside it is fitted a half-nut which can neither turn nor move laterally. The other part is a sliding fit in the stationary part, and, because it carries a male square or buttress threaded screw which engages with the half-nut, turning the screw by means of the tommy bar handle causes the sliding part to move either in or away from the stationary part, depending on the direction of rotation, thus gripping or releasing the work placed between the

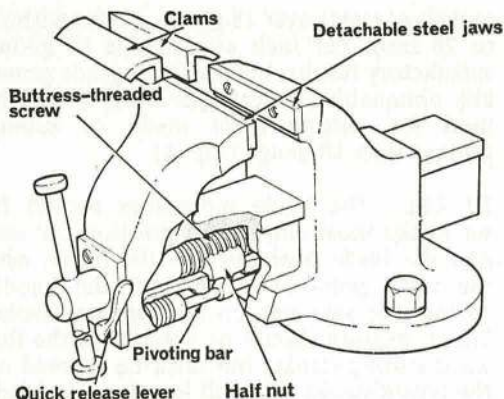


Fig. 1. BENCH VICE

two jaws. Most types of bench vice have a quick release mechanism, operation of the actuating lever enabling the sliding jaw to be pulled or pushed to any desired position without having recourse to the relatively slow process of turning the screw; it does this by lowering the half-nut out of engagement with the screw. Bench vices are classified by the stores reference number and the length of the jaws.

Notes. 1. The height of the top of the vice above the ground is important and should be level with the elbow when the arm is bent. If the vice is too high, stand on a suitable platform. It is less tiring and proper control of tools can only be maintained when the vice is at the correct height.

2. Before use, ensure that the vice is secure and that the screw is clean and well lubricated. After use, remove all metal filings, etc., and

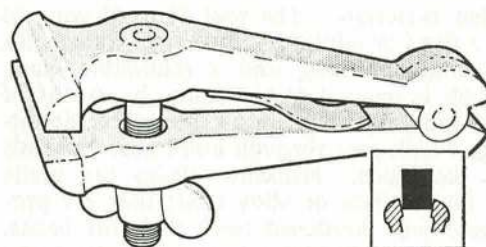


Fig. 2. HAND VICE

lightly smear unpainted parts of the vice with oil.

3. Care must be taken not to damage the work by over-tightening the vice, or by holding the work in such a manner that it is distorted when gripped by the vice jaws. Surfaces can be protected from damage by the serrated jaws by using "clams" of copper, lead, or aluminium. To prevent distortion and damage to the surface of a tube, place hard wooden blocks (cut with a "V") around the tube prior to clamping it in the vice.

7. **Hand Vice.** A hand vice (Fig. 2) is useful for holding small work which has to be shaped or drilled, or when splicing cables. The body is made of steel, the jaws being hardened and tempered, and the screw is of mild steel. A hand vice is classified by overall length.

Hacksaws

8. Hacksaws are used for parting off or for cutting materials approximately to size. Although designed primarily for use on metals, they may also be used on some

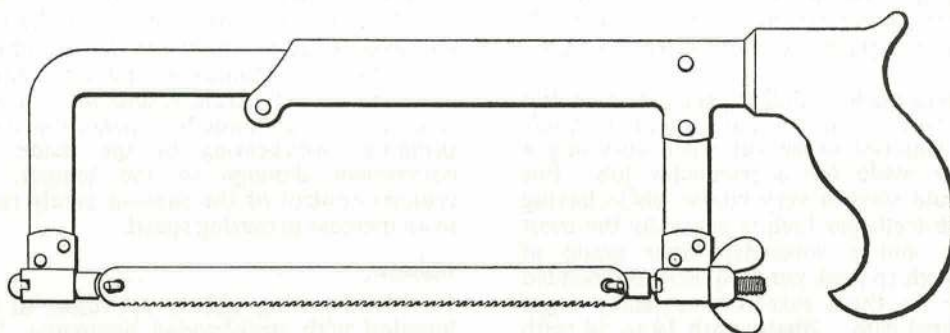


Fig. 3. HACKSAW

other materials. The tool (Fig. 3) consists of a fixed or adjustable mild steel frame with a suitable handle, and a renewable blade which is secured to the frame by means of two pins, one of them on a screwed mounting, which pass through holes near the ends of the blade. Hacksaw blades are made of high-carbon or alloy steel; they are produced with hardened teeth and soft backs, or hardened throughout, in single edge form, or with hardened teeth and soft centre-portion in the double-edged type. The number of teeth per inch varies from 14 to 32, and nominal lengths of blade, i.e. the dimension between the outer edges of the

and sheet metal over 18 gauge, blades with 24 to 28 teeth per inch are capable of giving satisfactory results, but the finest grade generally obtainable (32 teeth per inch) should be used for cutting sheet metal or tubing thinner than 18 gauge (Fig. 4).

10. Use. The blade mountings should be set in the most convenient position for use, and the blade positioned in the frame with the teeth pointing away from the handle so that the saw cuts on the forward stroke. Hand pressure should be applied on the forward cutting stroke, but must be relieved on the return stroke. The full length of the blade

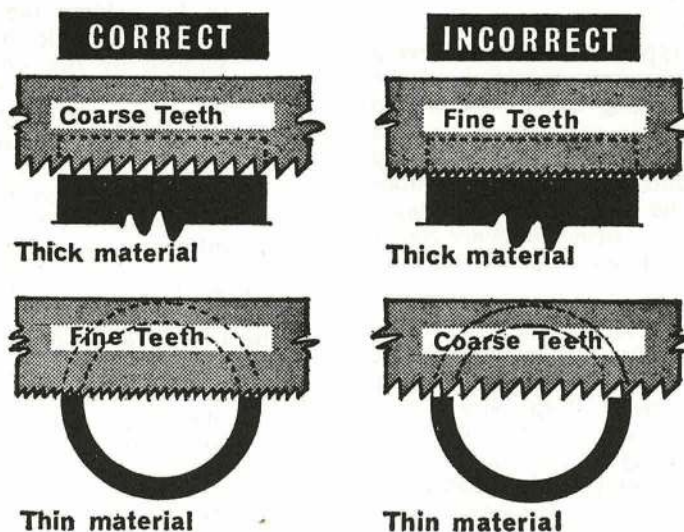


Fig. 4. USE CORRECT BLADE

two fixing holes, are generally 8 in., 10 in., and 12 in., although other lengths are available for miniature, outsize and special saws.

9. **Correct Blade.** Full consideration should always be given to the nature and thickness of the material to be cut when choosing a hacksaw blade for a particular job. For thick mild steel, a very coarse blade having 14 to 16 teeth per inch is generally the most suitable, but a somewhat finer grade of blade, with 18 teeth per inch, is recommended for use on thick cast-iron or heavy angle or channel iron. Blades with 18 to 24 teeth per inch are suitable for cutting brass, bronze, gunmetal, and light angles or channels. For cutting steel, iron or brass pipes

should be used for each stroke whenever possible; this prolongs the life of the blade and lessens the possibility of the teeth breaking or the saw jamming during use. Always use a steady, deliberate action when sawing; rapid movement tends to shorten the stroke, promotes overheating of the blade with consequent damage to the temper, and reduces control of the saw—it rarely results in an increase in cutting speed.

Chisels

11. Metal-cutting chisels are used in conjunction with steel-headed hammers. They are forged from high-carbon steel with the cutting edge hardened and tempered; alternatively they may be made of nickel-alloy

steel, specially heat-treated to procure a long-lasting cutting edge. Chisels are classified by their shape and overall length; the four principal shapes (Fig. 5) used for general work are as follows:—

(a) **Flat.** These chisels are used for general chipping work, such as parting sheet metal or cutting flat surfaces preparatory to filing. The cutting edge is formed slightly convex.

(b) **Cross-Cut.** This type is used for cutting narrow flat-bottomed grooves, such as keyways in shafts, or where it is not practicable to use a flat chisel.

(c) **Diamond Point.** These chisels are particularly useful for cutting in corners, cutting small oil grooves, and rectifying an incorrect start when drilling.

(d) **Half-Round.** These are general-purpose grooving chisels which are very suitable for cutting half-round bottomed grooves;

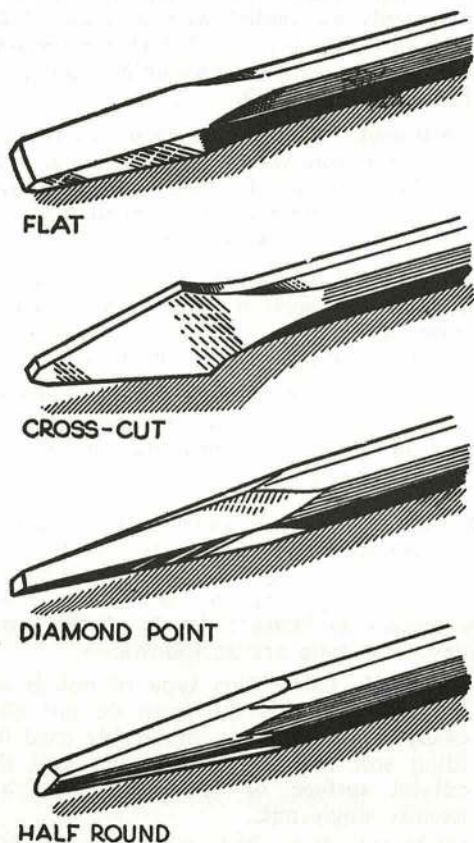


Fig. 5. CHISELS

they are also suitable for rectifying an incorrect start when drilling.

12. When selecting a chisel for a specific job, consideration must be given to both the nature of the work and the material that is to be cut; the nature of the work governs the choice of shape, while the angle formed by the cutting edge is influenced by the hardness of the metal. In general, it may be assumed that the softer the metal, the more acute should be the cutting angle; for hard steel the cutting angle should be 70° to 75° , for mild steel 60° , and for brass and similar soft metals it may be reduced to 40° .

13. **Sharpening Chisels.** High-carbon steel chisels are sharpened by grinding on an emery wheel, but nickel-alloy steel chisels are sharpened by filing. When sharpening a chisel on a grindstone, the operator must always wear goggles to safeguard his eyes from flying particles of stone or metal. To prevent drawing the temper of the tool during the sharpening operation, the cutting edge of the chisel must be kept as cool as possible by frequent immersion in water. The end of the chisel struck by the hammer should be kept flat and free from ragged metal by grinding.

Hammers

14. Hammers are classified by the weight and type of the hammer head. Steel hammer heads are forged from high-carbon steel, after which the working faces are hardened and tempered. The shafts are generally made from straight-grained ash, and are usually secured to the head by wedging. The principal types employed (Fig. 6) are as follows:—

(a) **Ball Pein.** The flat surface is suitable for most general-purpose work; the ball pein is primarily for riveting purposes.

(b) **Cross Pein.** For general work; the narrow cross pein is particularly suitable for use where access to the working surface is limited.

(c) **Straight Pein.** As for cross pein.

(d) **Hide Faced.** The raw-hide facing enables heavy blows to be delivered without damaging the surface of the work.

(e) **Lead and Copper.** As for hide-faced hammers, but used for heavier work.

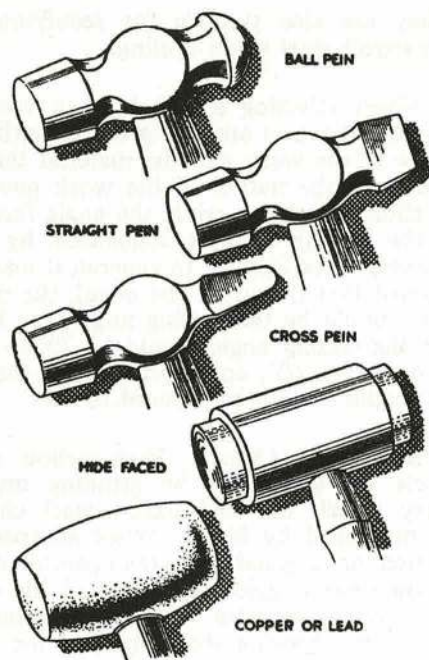


Fig. 6. HAMMERS

15. Use. The weight of hammer to use will be found by experience. Before using a hammer, always ensure that the head is firmly secured to the shaft. Always hold the hammer with the hand close to the end of the shaft (Fig. 7); proper control of the hammer is not possible if it is held close under the head.

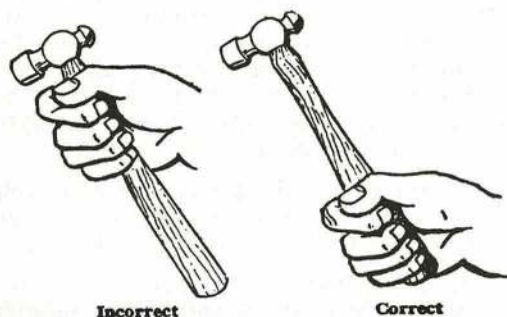


Fig. 7. HOLDING THE HAMMER

Files

16. Files are cutting tools for removing metal from a surface, and are made of high-carbon steel; the blade of the file is hardened, while the tang, on which a wooden handle must always be fitted before the file is used, is kept soft. Hand files are classified

by their length, section, cut and grade; three shapes are commonly used (Fig. 8).

17. Length. The length of a file is measured from the shoulder to the tip of the blade (Fig. 9). Those in general use in the Service vary in length from 3 in. to 14 in., but 6 in., 8 in. and 10 in. lengths are the most common.

18. Sections and Shapes. Variations in cross-section and shape of blade give a wide choice of files to suit almost every type of filing work. The standard cross-sections, together with the longitudinal shape or shapes associated with each, are as follows:—

(a) **Hand.** This is the most commonly used section for general filing (Fig. 10). In the majority of cases the blade is of rectangular shape. One edge may be without teeth to permit safe working against a finished surface, and such a file is referred to as “hand safe edge” or H.S.E. file.

(b) **Half-Round.** This section is almost invariably associated with a bellied type of blade (Fig. 11). Such files are suitable for use on work of irregular shape, or for filing large radii.

(c) **Round.** This section (Fig. 12) is used in association with bellied, tapered and parallel blades, the first named shape being the most common. Such files are suitable for filing small radii.

(d) **Three-Square.** Files of three-square or triangular section are usually of bellied form (Fig. 13); they are particularly useful for filing internal corners.

(e) **Square.** All three of the usual shapes are associated with files of square cross-section (Fig. 14). They are suitable for internal work.

19. Cut. Various arrangements of cutting teeth are provided to give the most satisfactory results when working on different materials (Fig. 15). These arrangements are known as “cuts”: details of the more widely used cuts are as follows:—

(a) **Single Cut.** This type of cut is relatively open and the teeth do not clog easily; it is, therefore, preferably used for filing soft metals. Round files and the curved surface of half-round files are usually single cut.

(b) **Double Cut.** This is the most widely used type of cut for general purposes.

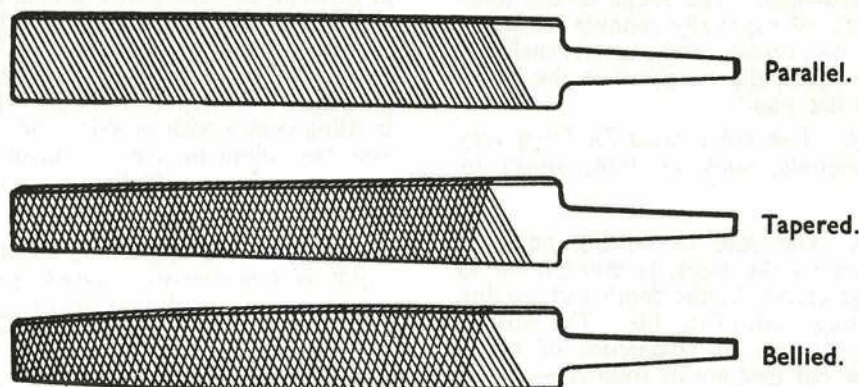


Fig. 8. SHAPES

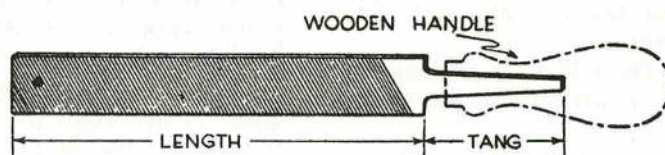


Fig. 9. LENGTH OF FILES



Fig. 10. HAND



Fig. 11. HALF-ROUND



Fig. 12. ROUND



Fig. 13. THREE-SQUARE



Fig. 14. SQUARE

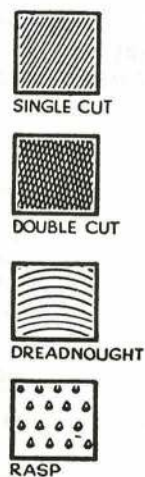


Fig. 15. CUTS OF FILES

(c) **Dreadnought.** The shape of the teeth make this file especially suitable for heavy cutting on broad, soft metal surfaces. Its use is generally restricted to the larger sizes of flat files.

(d) **Rasp.** This cut is used for filing very soft materials, such as lead, wood or leather.

20. **Grade.** The rate of cutting and the finish given to the work is determined to a very large extent, by the depth and spacing of the cutting teeth of the file. The various grades or degrees of coarseness of single and double cut files are as follows:—

(a) **Bastard.** This coarse grade of file removes metal fairly quickly. It is intended primarily for roughing out, but may also be used for the entire job if finish is not important.

(b) **Second Cut.** These files are finer and consequently give a better finish but are slower cutting.

(c) **Smooth.** The shallow, closely-set teeth of smooth files enable a good finish to be obtained, but such files cut comparatively slowly. They should therefore be used for finishing work only.

Note. The three grades mentioned meet most requirements, but other grades, both coarser and finer than these three, are available but not in general use in the Service.

21. **Filing.** Good filing is not just a matter of removing surplus metal; it calls for the expert removal of exactly the right amount

of material at each point so that the dimensions, contours and surfaces of the finished product are in accordance with the specification laid down in the workshop drawing or other working instructions. Proficiency in filing comes with practice and experience, and the following hints if memorized and put into practice will help to achieve good results:—

(a) Before starting work, ensure that the job is conveniently placed and secure; it is not practicable to steady the job with one hand and file with the other, both hands are required for the file.

(b) Always use the length and grade of file appropriate to the work in hand; a small smooth file will give a good finish to the work, but it was never intended for rough work or for removing anything but the smallest amount of metal.

(c) Never use a file without a handle; quite apart from the obvious danger of the exposed tang piercing the wrist or palm of the hand should the file slip, it is impossible to maintain proper control of the file if the tang is used as a handle. Always ensure that the handle is a straight, tight fit on the tang.

(d) Whenever possible use the full length of the file for each stroke, and do not rush the stroke. As the file cuts only on the forward stroke, always relieve the pressure on the return stroke.

(e) Keep the teeth of the file clean by using a scratch card. Chalk rubbed on the teeth during final finishing minimizes

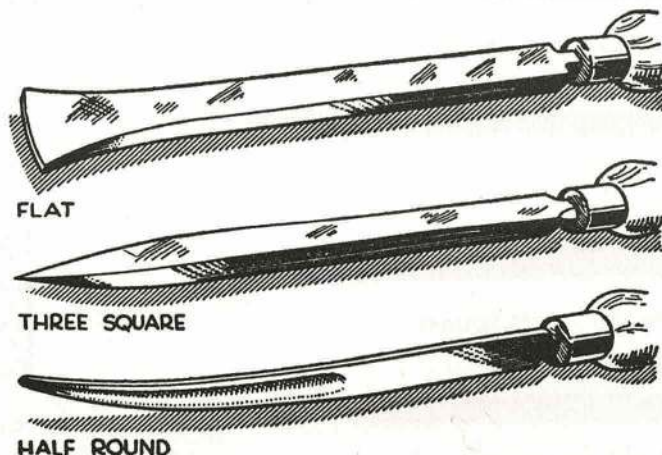


Fig. 16. SCRAPERS

clogging of the teeth, thus improving the finish of the work.

(f) New files should, if possible, be used first on brass or similar metals before being used on steel.

(g) Handle files carefully; file blades are brittle and will break easily if dropped or if subjected to rough treatment. After use, always return a file to its proper stowage, e.g. the file holdall.

Scrapers

22. Scrapers (Fig. 16) are made of hardened steel, and are used for the accurate finishing of previously machined or hand-worked flat or curved surfaces. A keen cutting edge is essential and this is obtained by grinding, followed by sharpening on an oil stone. When not in use, scrapers should be stored with their cutting edges suitably protected. The following types are used:—

(a) **Flat.** Used for trueing flat surfaces.

(b) **Three-Square.** Used for scraping small bushes and bearings.

(c) **Half-Round.** Used on large bearings.

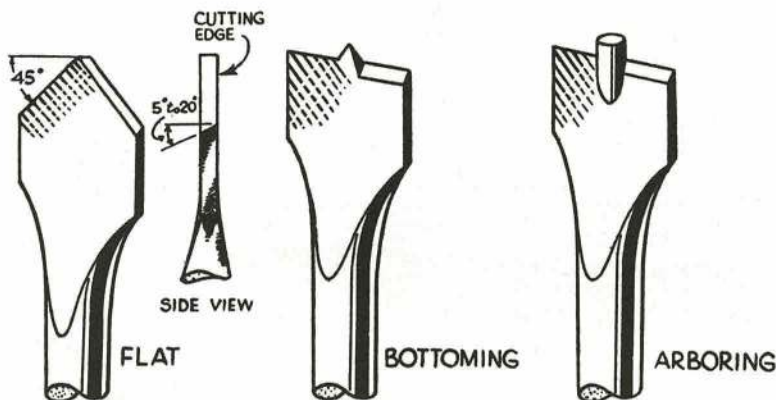


Fig. 17. TYPES OF DRILL

Drills

23. Drills are used for cutting circular holes and, in common with other cutting and shaping tools, are available in various forms to meet different requirements. They are made of high-carbon steel or alloy steel; those of alloy steel are usually referred to as "high speed" drills, since they can be operated safely at much higher cutting rates than can

the carbon steel variety. The types of drills in general use are as follows:—

(a) **Flat.** These drills (Fig. 17) are simple to make but tend to drill inaccurate holes; they are slow cutting and wasteful of power. The cutting angle varies from 5 degrees for hard material to 20 degrees for softer materials such as brass.

(b) **Bottoming.** These drills (Fig. 17) are used to finish the bottom of blind holes.

(c) **Peg or Ar boring.** This type of drill (Fig. 17) is used to machine the surface round a drilled hole to provide a good seating for a nut or a bolt head.

(d) **Twist.** The twist drill (Fig. 18) is by far the most widely used type for general engineering work on metals or hard materials. The spiral fluting presents the cutting edges to the work at the correct angle and also aids in clearing the drilling debris or "swarf" from the hole during the drilling operation.

24. **Twist Drill Sizes.** Twist drills are usually marked on the shank with their size, and, to ensure uniformity between manufacturers, the British Standards Institution

has formulated specifications for all twist drills of British origin; these specifications indicate, among other features, the diameters of drills in four different ranges. Details of the various ranges are as follows:—

(a) **Fractional (Inch) Range.** Minimum size 1/64th in. diam., proceeding by steps of 1/64th in. to 1½ in. diam. then by steps of 1/32nd in. to 3 in. diam.

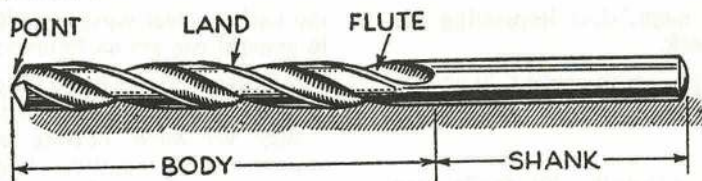


Fig. 18. TWIST DRILL

(b) **Numbered Range.** Minimum No. 80 (0.0135 in. diam.) to No. 1 (0.228 in. diam.); the steps between successive sizes are irregular, ranging from 0.001 in. to 0.007 in.

(c) **Lettered Range.** Minimum size A (0.234 in. diam.) to size Z (0.413 in. diam.); here also the steps between successive sizes are irregular, ranging from 0.004 in. to 0.014 in.

(d) **Metric Range.** Minimum size 0.35 mm. (0.0138 in.). The full range proceeds by steps of 0.05 mm. to 5 mm., then by steps of 0.10 mm. for the larger sizes. The "jobber's" range of utility drills extends from 1 mm. by steps of 0.5 mm. Metric drills are now superseding the lettered and numbered ranges for Service purposes, and a preferred selection from the full metric range gives a metric drill as a replacement for every drill in the obsolescent ranges.

26. Drilling. Whenever possible, drilling should be done by means of a fixed drilling machine, preferably of the powered type. Such a machine is essential for drilling holes of more than $\frac{1}{2}$ in. diameter, and when used with smaller drills the results are generally superior to those obtained with hand braces or portable drilling machines. Real accuracy in drilling cannot be achieved unless the twist drill has an efficient cutting edge and is correctly fitted into the machine, the true centre of the hole is adequately marked before the actual drilling begins, the speed of the drill is correct, lubrication of the drill when cutting is adequate, and the technique of operating the drilling machine is observed by the operator. Failure to ensure that each and all of these factors are satisfied will lead to inaccuracy in the finished work.

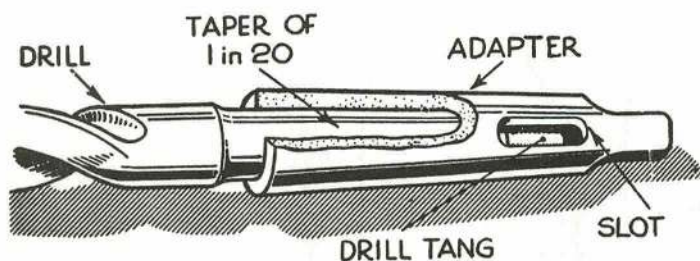


Fig. 19. MORSE TAPER ADAPTER

25. Drill Shanks. The grip exerted by a self-centring chuck on a parallel shank is adequate for driving small drills. A considerably stronger grip is, however, essential for the larger drills, and these usually have a "morse" taper shank, terminating in a flat driving tang that engages directly with the taper socket of the drilling machine. A morse taper adapter (Fig. 19) is provided for use, where necessary, and the drill is removed by inserting a wedge into the slot.

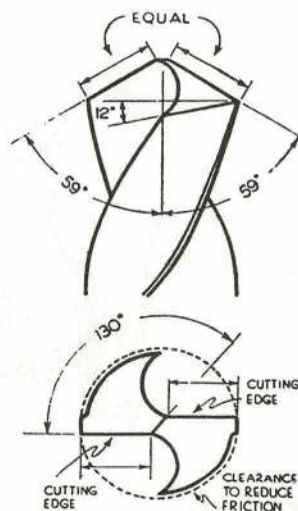


Fig. 20. DETAILS OF TWIST DRILL ANGLES

27. Grinding Twist Drills. The purpose of grinding is to give the correct clearance and cutting angles (Fig. 20). The cutting edges must be of equal length and equal angle (59°) to ensure that each edge does its full share of cutting, thereby ensuring that an

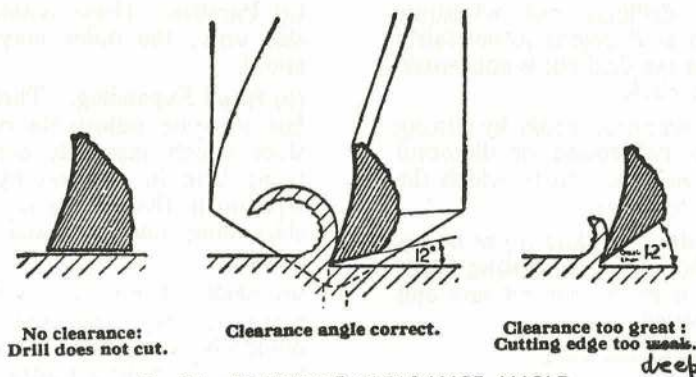


Fig. 21. EFFECT OF CLEARANCE ANGLE

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accurately sized hole is produced. The clearance angle should be 12° , the web angle will then be about 130° . These two angles are interdependent, and if they are incorrect the drill will either cut badly or it will fail to cut (Fig. 21). The cutting edges do not extend to the centre of the drill, and the extreme point is, therefore, non-cutting. On large drills the web may be thinned by local grinding to reduce the size of the non-cutting centre.

28. Drilling Procedure. The true centre of the hole should first be marked with a firm centre-pop; this stops any tendency for the point of the drill to wander during the initial stage of drilling. The drill must run truly without any sign of wobble; this should always be checked immediately after fitting the drill into the chuck, and again before making a start with the actual drilling. The work should be held or clamped in a manner that will prevent any movement during drilling operations; failure to observe this precaution may lead to spoilt work and broken drills, and is a prolific cause of personal injuries. Before feeding the drill into the work, always ensure that the drill point is correctly aligned with the centre-pop mark; this must be done with the drill turning at normal speed.

29. Cutting Speeds. The size and type of the drill and the nature of the material being drilled are important factors in deciding the appropriate drill speed and rate of feed; for example, a $\frac{1}{4}$ in. carbon steel twist drill cutting mild steel should run at 400 r.p.m. and should be fed into the work at 2 in. per minute, but the same drill should run at 800 r.p.m. when cutting brass. As a general rule, the peripheral speed (i.e. the

speed of a point on the circumference of the drill) should be kept constant for the same conditions; thus, if the optimum speed for a $\frac{1}{8}$ in. drill when used on a certain metal is 800 r.p.m. the optimum speed for a $\frac{1}{4}$ in. drill of similar type used on the same material is 200 r.p.m. On the majority of fixed drilling machines the drilling speed is variable.

30. Lubrication. The use of a suitable lubricant when drilling certain metals is very desirable, for not only does it improve the finish of the work but it also prevents the generation of excessive heat, thus preserving the temper of the drill and so lengthening its life. Suitable lubricants when mild steel is being drilled include cutting oil, soda solution, and soapy water; turpentine and kerosine are satisfactory lubricants when drilling high-carbon and alloy steels, while kerosine only should be used for aluminium and aluminium alloys. Brass and cast iron do not require a lubricant when being drilled.

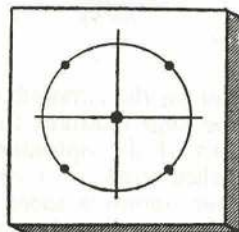
31. Drilling Large Holes. When large holes are to be drilled, the non-cutting nature of the point of the drill may give rise to difficulty in accurate positioning of the holes. In such circumstances it is advisable to drill a small pilot hole first, using a drill whose diameter is slightly larger than the non-cutting point of the large drill. If for any reason this method cannot be used, the following procedure should be adopted (Fig. 22):—

(a) Using the marked centre of the hole, scribe a circle equal in diameter to the hole that is to be drilled; lightly centre-pop the scribed circle for guidance.

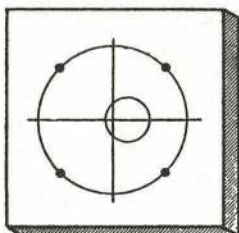
(b) Commence drilling, but withdraw the drill as soon as it begins to cut fairly freely: check that the drill cut is concentric with the scribed circle.

(c) If it is not concentric, rectify by cutting a groove, with a half-round or diamond point chisel, in the direction to which the drill is required to move.

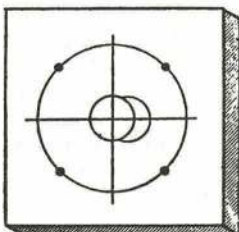
(d) Repeat operations (b) and (c) as necessary. When the drill is cutting concentrically, feed it at the correct rate and lubricate as required.



HOLE MARKED OUT



INCORRECT START



START CORRECTED

Fig. 22. DRILLING PROCEDURE

Reamers

32. Reamers are used to enlarge drilled holes to accurate dimensions and to give a smooth internal finish. They are made of high-carbon steel or alloy steel, and are fluted to give a series of cutting edges; common types of reamer are shown in Fig. 23. The amount of metal to be removed by a reamer should be kept to a minimum, and for parallel reamers it should not be more than 0.005 in. to 0.010 in. The following types of reamer are available from Service sources:—

(a) **Parallel.** These reamers cut to one size only; the flutes may be straight or spiral.

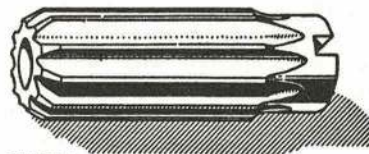
(b) **Hand Expanding.** This type of reamer has separate adjustable blades sliding in slots which taper in depth, the blades being held in position by two nuts. Alteration in the cutting size is obtained by slackening one nut and tightening the other.

(c) **Shell.** These are hollow, fixed-size reamers; they are used on close-fitting mandrels or boring bars which pass through the hollow centre.

(d) **Hand Taper.** This type of reamer is used to prepare holes for the reception of taper pins. They are supplied in sets, the reamers of each set being numbered from 0 to 10, and the taper is the same as that standardized for taper pins (1 to 48).

PARALLEL *Straight Flutes*PARALLEL *Spiral Flutes*

EXPANDING



SHELL



TAPER

Fig. 23. REAMERS

33. **Reaming.** Hand reamers are operated by means of a hand wrench, and the reamer must only be turned in the cutting direction (i.e. clockwise), even when it is being withdrawn from the hole, otherwise, the swarf may damage the cutting edges of the reamer and scratch the finished surface inside the hole. The information given regarding lu-

bricants to use when drilling applies also when reaming.

Taps

34. Taps are used for cutting internal screw threads. They are, in effect, short screws of hardened and tempered steel, fluted to provide cutting edges, the end of the shank being squared to facilitate turning with a wrench. Taps are supplied in sets of three—except for B.A. sizes, in which the second tap is omitted—and are used in the following order:—

(a) **Taper.** This tap is used for starting the thread; it is usually tapered from the point to the sixth thread from the shank, and the diameter of the point is equal to the root diameter of the thread. This type of tap will produce a full thread in a through hole in material of certain thicknesses.

(b) **Second.** The second tap is used to deepen the thread cut by the taper tap in a blind hole or a through hole in thick material. It is tapered for the first six threads only (Fig. 24).

(c) **Plug.** This type of tap is used to finish the thread to the bottom of blind or deep through holes; it is not tapered.

Cutting Internal Screw Threads

35. The first step in producing a well-cut internal screw thread lies in the drilling of

the hole to the correct "tapping size". There are several methods of finding the tapping size of hole for a particular thread; one 'rule of thumb' method which gives reasonably good results in general benchwork is to select a drill that will just pass through a new nut of the corresponding size and thread. Much more definite information may, however, be obtained from data tables on screw threads and drill sizes—specimen extracts from these tables are given.

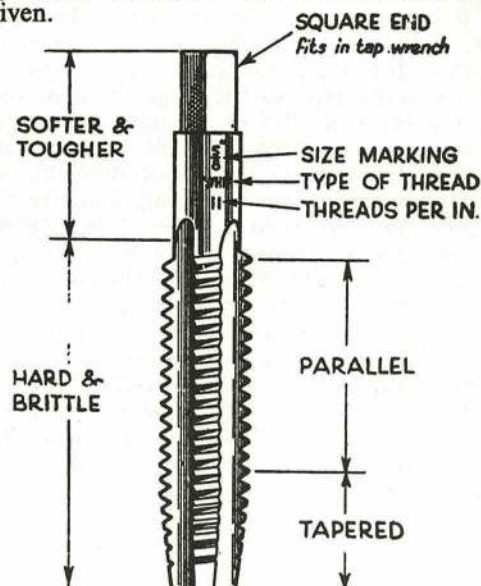


Fig. 24. SECOND TAP

Basic Details of British Association Screw Threads

Screw No.	Threads per in. (approx.)	Pitch (in.)	Depth of Thread (in.)	Major Diam. (in.)	Minor Diam. (in.)
0	25.4	0.039	0.02364	0.236	0.189
1	28.2	0.035	0.02128	0.209	0.166
2	31.3	0.032	0.01911	0.185	0.147
3	34.8	0.029	0.01774	0.161	0.1285

Preferred Range of Metric Sized Drills

Metric Size (mm.)	Equiv. Diam. (in.)	Metric Size (mm.)	Equiv. Diam. (in.)	Metric Size (mm.)	Equiv. Diam. (in.)	Metric Size (mm.)	Equiv. Diam. (in.)
3.05	0.120	3.80	0.150	4.20	0.165	4.70	0.185
3.25	0.128	3.85	0.152	4.30	0.169	4.80	0.189
3.45	0.136	3.90	0.154	4.40	0.173	4.85	0.191
3.50	0.138	4.00	0.157	4.50	0.177	4.90	0.193
3.65	0.144	4.05	0.159	4.55	0.179	5.00	0.197
3.75	0.148	4.10	0.161	4.60	0.181	5.10	0.201

36. To ensure that the internal thread is of full depth, the drilled hole must have a diameter which approximates to the minor diameter of the screw thread, but since the taper tap must enter the hole to start the thread, any tolerance in the diameter of the hole must be on the large side. For example, a 3 B.A. screw has a minor diameter of 0.1285 in., referring to the preferred range of metric drills, it will be seen that the 3.25 mm. drill has a diameter of 0.1280 in., while the next size (3.45 mm.) has a diameter of 0.1360 in., the former is slightly too small to permit easy entrance of the taper tap, so the larger drill of the two, which is 0.0075 in. oversize, should be used as the tapping drill for this size of screw. Even where the minor diameter of the screw thread can be exactly matched by a preferred drill, as in the case of the O.B.A. screw (minor diameter 0.189 in. which is matched by the 4.80 mm. drill), the next size of drill should be used to give a good start for the taper tap without impairing the depth of thread to a serious extent. Many useful engineering "pocket books" include complete tables showing the sizes of tapping drills for all types and sizes of screw threads; with these the correct size drill can be read off directly against the screw size.

37. Another method of finding the tapping size is by use of a formula as follows;

For B.S.W. and B.S.F. tapping size:—

$$\text{Crest dia.} - \frac{1.280}{\text{Threads per inch.}} = \text{dia. of drill in decimals}$$

For example, the tapping size drill for $\frac{1}{2}$ in. B.S.F. thread,

$$\begin{aligned} &= .5 - \frac{1.280}{16} \\ &= .5 - .080 \\ &= .420 \left(\frac{27}{64} \text{ in.} \right) \end{aligned}$$

Note. For B.A. threads the constant used is 1.20.

38. **Tapping Procedure.** After drilling the tapping hole, proceed as follows:—

(a) Ensure that the work is held securely—a good start to the thread cannot be obtained if the work is liable to move when the tap makes the initial cut.

(b) Enter the tap perpendicularly to the face of the work, and turn it carefully in the cutting direction until a start of the thread is made; at this point test the entered tap for squareness all round with a fitter's square.

(c) When satisfied that the tap is running true, continue to turn it in the cutting direction for half a turn, then reverse the direction of turning for a quarter of a turn; this continuous action breaks the cuttings into chips and also prevents overstraining the tap.

(d) Repeat the action as detailed in (c) until the full thread has been cut, changing the taper tap for the second and plug tap as required when dealing with deep or blind holes.

(e) Lubricate during the operations as required, using cutting oil for steel, kerosine for aluminium; brass does not require a lubricant.

Note. When tapping a blind hole, remove the cuttings from the bottom of the hole periodically.

Dies

39. Dies are used for cutting external threads. They are made of steel, hardened and tempered, and are used in conjunction with special wrenches known as stocks. Two types are in use:—

(a) **Circular.** This type of die (Fig. 25) usually cuts a full thread in one operation, but springiness of the die allows very limited adjustment by the screw in the stock. The threads are tapered on one side of the die to afford a start; when

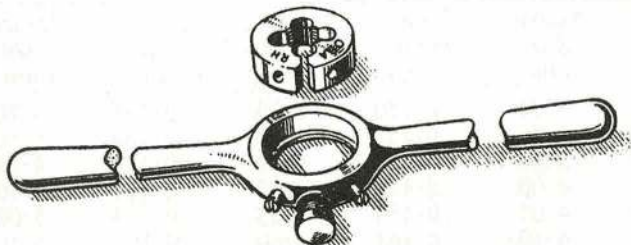


Fig. 25. CIRCULAR DIE AND STOCK

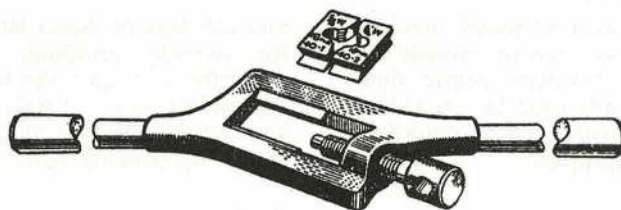


Fig. 26. ADJUSTABLE DIES AND STOCK

assembled for use, the die should be fitted with the tapered threads away from the shoulder of the socket in the stock. These dies are generally used for cutting threads of small diameter.

(b) **Two-Piece Adjustable.** These dies (Fig. 26) are used for cutting threads of larger diameter and two or three cuts are needed to produce a full thread, the die being closed up after each cut. The cutting threads are tapered on one side as with circular dies and, to ensure correct assembly, the two halves must always be fitted with the engraved numbers on the same side.

40. **Die Nuts.** These (Fig. 27) are similar in shape to ordinary hexagonal or square nuts, and are obtainable in all sizes of standard screw threads. They are not intended for the cutting of complete threads, but are particularly useful for cleaning up, easing or restoring bruised threads on fitted studs, etc., in positions where ordinary stocks and dies cannot be used; they are turned with any suitable ordinary type of spanner.

Note. The size, type, and number of threads per inch will be found engraved on the face of the die or die nut.



Fig. 27. DIE NUTS

Cutting External Screw Threads

41. When cutting matching threads for a screwed pair, the internal thread of the pair should always be cut first: the tap used for cutting the internal thread is not adjustable and the thread cannot, therefore, be modified, but the limited amount of adjustment that can be made to a circular die, and similarly an adjustable die, used for cutting the external thread, enables the latter to be varied slightly to give a good fit between the two threads. The procedure for cutting an external thread using either of the two types of dies is the same, the only difference being in the method of adjustment, and in the case of the circular die will be as follows:—

(a) Clamp the rod to be threaded in a vice. The diameter of the rod must not be larger than the major diameter of the screw thread that is to be cut, and, to assist in starting the thread, the end of the rod should be slightly tapered.

(b) Slacken the outside screws of the stock and tighten the centre screw, then re-tighten the outside screws; thus the die is set for maximum diameter of thread.

(c) Present the stock and die squarely to the end of the rod and commence to cut the thread, using the same cutting technique as for cutting with taps—see para. 38(c). Lubricate during the operations, when required, as for tapping.

(d) Having formed the thread, slacken the centre screw of the stock and tighten slightly the outside screws; tighten the centre screw. Repeat (c) until the desired fit of the external thread with the internal thread is obtained.

MEASURING AND MARKING-OUT TOOLS

Introduction

42. In the absence of special jigs or fixtures which locate the work and provide some means of guiding the cutting tool, most work

necessitating the removal of metal involves the scribing of guidance lines to indicate the positions of finished surfaces, centre lines of holes, etc. The tools used in "marking-out" processes are illustrated and described in the following paragraphs.

Rules

43. Engineering workshop rules are used for general measuring, and are made from high-carbon steel suitably hardened and tempered; they are usually graduated in British and metric systems of measurement, and they are classified by length. Rules must be kept free from rust and should never be subjected to rough usage or careless handling; the end of the rule, in particular, should be carefully treated, since it generally forms the basis for one end of the measurement being taken.

Dividers

44. Dividers (Fig. 28) are used to set out distances and to scribe arcs and circles. The legs are made of high-carbon steel, hardened and tempered, the spring of spring steel, and the adjusting screw of mild steel. Dividers are classified by the length of the legs. The points should be kept keen and fine,

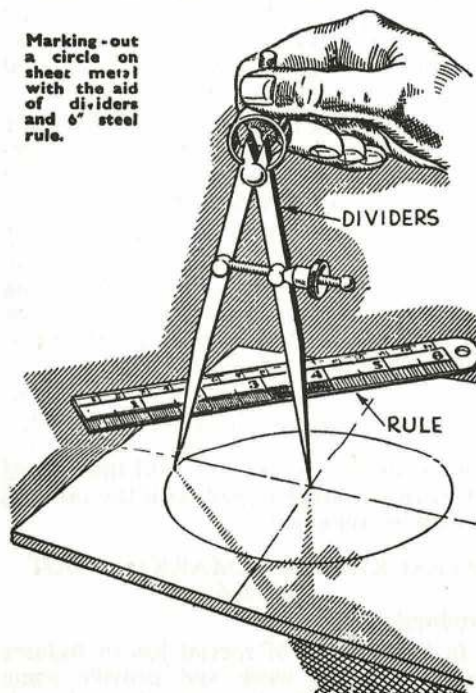


Fig. 28. DIVIDERS AND RULE

and the legs of equal length, by stoning on the outside—grinding, unless done very carefully, will draw the temper of the points and render them too soft. When the dividers are not in use, the points should be protected by sticking them into a cork.

Scribers

45. Scribers are used for marking guidance lines on the surfaces of the work; they are made from high-carbon steel, suitably hardened and tempered, and are classified by length. Scriber points, like those of dividers, must be kept keen and fine, and they should be fully protected when not in use.

Fitter's Squares

46. The fitter's square is used for setting out lines at right angles to an edge or surface, and for checking right angular work for truth. Squares are made of high-carbon steel, hardened and tempered, and they are classified by the length of the blade. They are made to very fine limits: the blade and stock have their opposing edges ground truly parallel, with the two limbs set at exactly 90° to each other; this initial accuracy in manufacture must be preserved by handling the square with care at all times and keeping it in the box provided for the purpose when it is not in use.

47. The accuracy of a square should be checked from time to time. This can be done by checking the square for truth against accurately machined right-angled work, e.g. against a master square, if this is available, or against a V-block. An alternative form of test (Fig. 29) consists of placing the stock against the true edge of a flat surface and

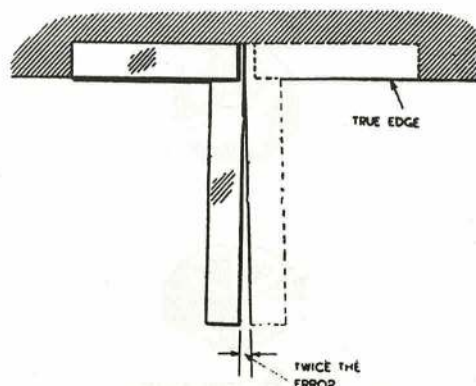


Fig. 29. TESTING A FITTER'S SQUARE

scribing a line on the surface, using the outside edge of the blade as a guide; the square is then turned over and the outside edge of the blade is checked against the line. The test should be repeated for the inside edge of the blade.

Combination Set

48. A combination set (Fig. 30) is virtually three tools in one, consisting of a blade or rule and three "heads"; the blade is made of high-carbon steel, hardened and tempered, while the heads are of close-grained cast iron. The blade is graduated in inch and metric scales, and a central groove along its entire length accommodates a clamping screw fitted to each of the heads, thus enabling a head to be secured at any desired position along the blade. Details of the three heads are as follows:—

(a) **Square.** This head is provided with two working faces, one at 90° and the other at 45° to the blade, thus enabling the tool to be used both as a square and as a mitre. A spirit level is incorporated in the head and a scribe is provided.

(b) **Centre.** This head is used in conjunction with the blade to locate the centre of a round bar or the centre-line of a tube.

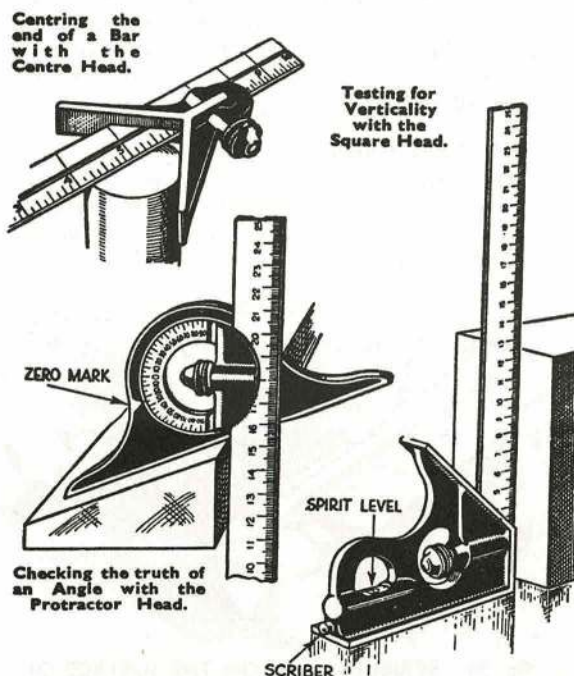


Fig. 30. USES OF COMBINATION SET

(c) **Protractor.** This head is used in conjunction with the blade for checking or setting any angle up to 180° . A spirit level is often incorporated.

Calipers

49. **Inside and Outside.** These are used in conjunction with a rule or other measuring instrument for measuring distances between or over surfaces, or for comparing distances or sizes. Inside calipers are used between surfaces and outside calipers over surfaces (Fig. 31). To set the calipers, set nearly to size by hand, and then adjust to the exact setting by tapping one leg (not at the point) gently against a suitable rigid object. When calipers are used for comparing distances or sizes, the results obtained depend largely on the sense of feel of the user.

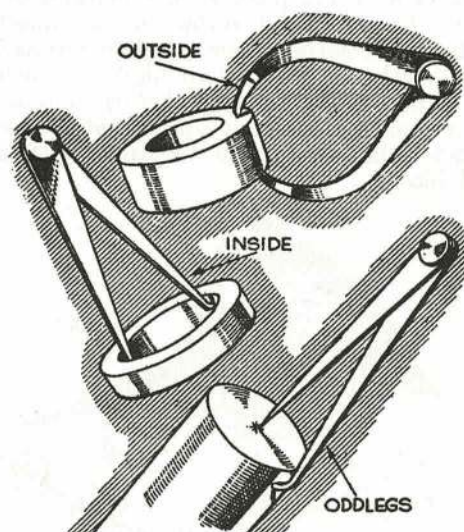


Fig. 31. TYPES AND USES OF CALIPERS

50. **Odd-Leg.** This tool is really half caliper and half dividers (Fig. 31). It may be used for scribing arcs on metal surfaces from an edge, for scribing lines parallel to an edge or surface providing that accuracy is not of great importance, and for finding the centre of a round bar. These tools are often referred to as "jenny" calipers.

Marking-Off Tables

51. These are used to support work for marking out, and form a base from which measurements may be taken. They are made of close-grained cast iron

and are strongly ribbed on the underside for rigidity; the working surface is accurately machined to give a true, flat surface, and the edges are square. After use, the working surface should be given a thin film of oil and the wooden protective cover replaced. To preserve the surface, no work other than marking out or measurement should ever be done on a marking-off table.

Surface Plates

52. These may be used in place of a marking-off table when the work is relatively small. They are much smaller than, but similar in construction to, marking-off tables (Fig. 32), and the finish of the working surface is at least equal to, and usually even better than, that found on a good table. Surface plates are portable and are usually used on the workbench. The same care should be taken of a surface plate as of a marking-off table. To test a flat surface of an object for truth, the surface plate is lightly smeared with "marking" (thin colour film) on which the surface to be tested is lightly rubbed; the amount of marking transferred to the surface being tested will indicate its state of flatness.

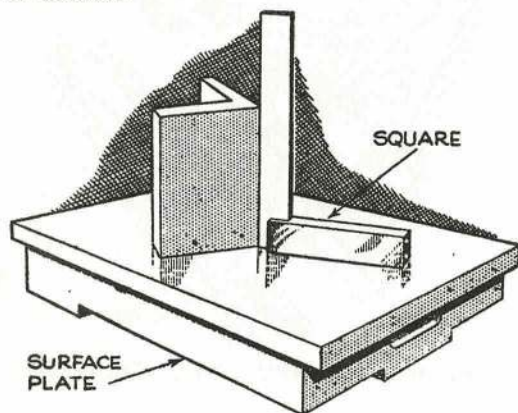


Fig. 32. TESTING THE ACCURACY OF AN ANGLE PLATE WITH FITTER'S SQUARE AND SURFACE PLATE

Vee Blocks

53. Vee blocks (Fig. 33) are used on the marking-off table to support round work. They are made of cast iron or case-hardened mild steel, and are supplied in identical pairs, each unit of a pair being stamped with the same identification number. All surfaces are accurately machined, and the Vee angle is exactly 90° . Vee blocks are classified by the maximum diameter of the work which can be held.

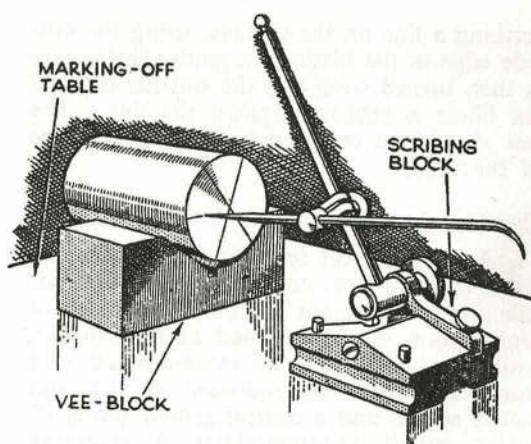


Fig. 33. USING VEE AND SCRIBING BLOCKS

Scribing Blocks

54. A scribing block is used to mark out lines parallel to a true surface, such as the working surface of a marking-off table or surface plate. The accurately machined base is made of cast iron or case-hardened mild steel, the scriber is of high-carbon steel, hardened and tempered, and the pillar and attachment are of mild steel. The pillar angle, scriber height and angle are adjustable, and a fine adjustment is provided for the pillar. Dowels in the base can be pushed down to serve as guides against the edge of the surface plate or marking-off table, thus, lines may be scribed parallel to such edges. Scribing blocks are classified by the height of the pillar.

Key-Seat Rules

55. These are sometimes termed "box squares", and are used for marking-off lines parallel to the axis on the surface of tubes and round bars (Fig. 34). These

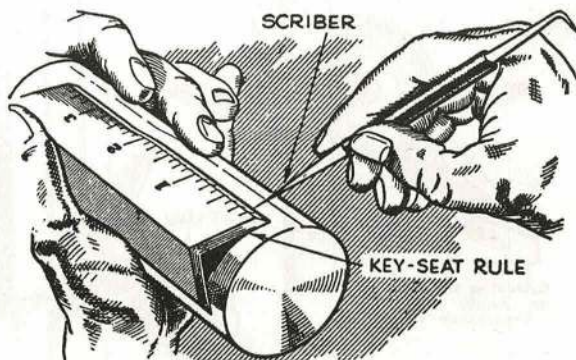


Fig. 34. SCRIBING LINES ON THE SURFACE OF A SHAFT WHEN MARKING-OFF A KEYWAY

rules are usually graduated and are classified by their length.

Feeler Gauges

56. "Feelers" (Fig. 35) are used to measure small clearances or gaps: they consist of a series of thin flexible steel blades in graduated thicknesses varying, in most cases, from $1\frac{1}{2}$ to 15 thousandths of an inch. The blades are secured in a protective metal scabbard by a fulcrum pin, and all blades not in actual use should invariably be withdrawn into the scabbard to prevent accidental distortion. Feeler gauges are classified by the length of the blades. When not actually in use the blades should be kept lightly smeared with oil to prevent rusting.

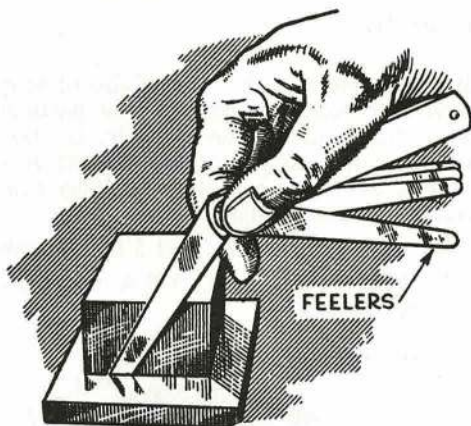


Fig. 35. USING FEELER GAUGES

Centre Punches

57. A centre punch is used to make a "pop" mark for locating the point of a drill at the start of a drilling operation (Fig. 36); it may also be used to make a series of light indentations along a scribed line for surer guidance, etc. Centre punches are made of

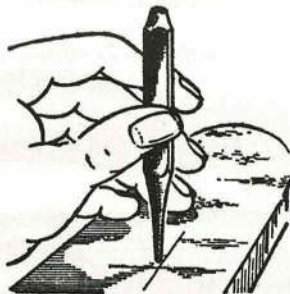


Fig. 36. USE OF CENTRE PUNCH

high-carbon steel, the point being hardened and tempered. A sharp point should be maintained by careful grinding, and should have an angle of 90° for general work, but for light work, i.e. marking out, it should be reduced to 60° .

DISMANTLING AND ASSEMBLING TOOLS

Introduction

58. Much of the work of a tradesman involves the partial or complete dismantling and subsequent re-assembly of equipment; most assemblies are built up from parts that are held or linked together by fastening devices such as are described in Chapter 2 of this Section. Work of this nature calls for a wide range of hand tools, some of which, such as pliers, screwdrivers, standard spanners, etc., have a general application and form part of the tool kit issued on personal loan to a tradesman. In addition to these general tools, others of particular application—special spanners, extractors and assembly tools, etc.—are also required, and these are generally available in the special tool kits supplied for the servicing of specific equipment. The following paragraphs deal, in the main, with general-purpose dismantling and assembling tools.

Pliers

59. Three common types of pliers are illustrated in Fig. 37, but they are obtainable in various shapes to suit particular work, e.g. circlip pliers. They are usually made of high-carbon steel with hardened and tempered

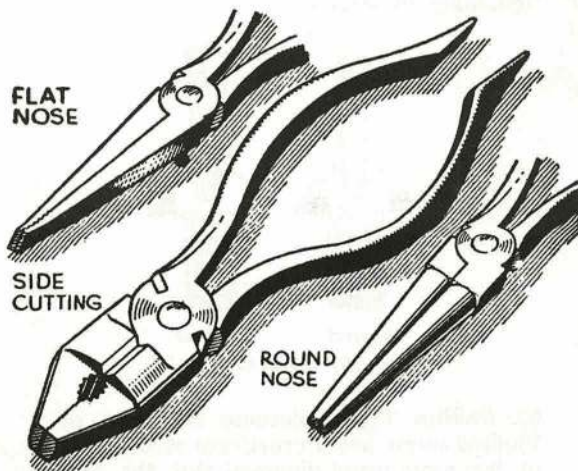


Fig. 37. PLIERS

pl. 10 jaws, some being provided with insulated grips. They are classified by type and overall length.

Screwdrivers

60. Screwdrivers may be divided into two main groups, viz., common or blade screwdrivers, and cruciform screwdrivers, of which the Phillips type is the most common in Service use. The former type (Fig. 38) consists essentially of a high-carbon or alloy steel blade mounted in a wood or

to an angle of 53° to agree with the inclination of the slots in the recess; further, the extreme end is machined to an angle of 144° , and four tapered flutes provide for correct engagement with the slots and facets of the recess (Fig. 40). These screwdrivers must be handled carefully as the fluted ends are very liable to fracture if maltreated. All paint, dirt, etc., should be removed from a recess before applying the screwdriver, and the shaft of the tool must be kept in good alignment with the screw when being used.

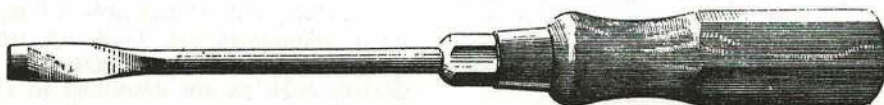


Fig. 38. COMMON SCREWDRIVER

composition handle; the end of the blade is ground to fit the diagonal slot in the head of a screw and, if of high-carbon steel, it is hardened and tempered. Screwdrivers of this type are classified by the length of the blade—in some cases the handle may incorporate a ratchet device or an Archimedes drive, and, if so, these features are also quoted in the classification.

61. The fit of the screwdriver blade in the slotted head of the screw is most important (Fig. 39); the end of the blade should never be ground to a chisel edge, and a screwdriver of the correct size to fit snugly into the slot should always be used—screwdrivers of the wrong size cause damage to screw heads and give rise to difficulty in the removal or tightening of screws.

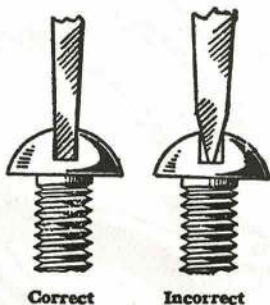


Fig. 39. END OF BLADE

62. **Phillips Type.** Because the head of a Phillips screw has a cruciform recess instead of the more usual diagonal slot, the end of the cylindrical screwdriver shaft is tapered

Always ensure that the correct size of screwdriver has been selected for the particular screw; the point of the screwdriver should bed down in and completely fill the recess in the screw head so that no sideplay exists. Four sizes are available, viz.

No. 1 for $\frac{1}{8}$ in., 6 B.A. and 5 B.A. screws.

No. 2 for $\frac{5}{32}$ in., $\frac{3}{16}$ in., 4 B.A. and 2 B.A. screws.

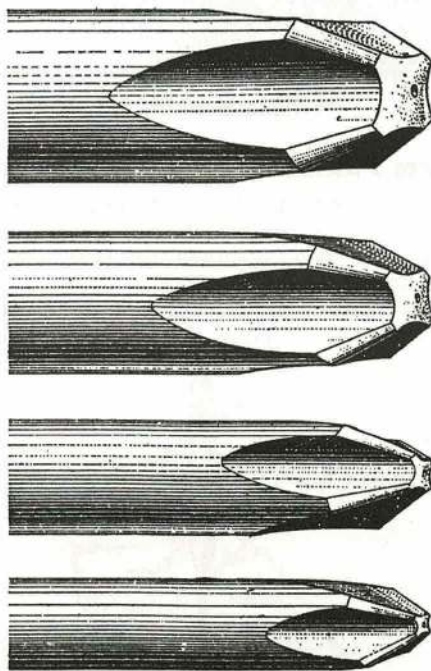


Fig. 40. PHILLIPS SCREWDRIVERS

No. 3 for O.B.A., $\frac{1}{4}$ in., and $\frac{5}{16}$ (rd. hd.) screws.

No. 4 for $\frac{5}{16}$ in. (csk. and rsd. hd.) and $\frac{3}{8}$ in. screws.

Pin Punches

63. Pin punches (Fig. 41) are used in conjunction with a hammer to remove shackle pins, tight bolts, rivets, split pins (after the legs have been broken off), etc. The taper type is generally suitable for most purposes, but the parallel type may be required for use in deep holes and should always be used for the removal of rivets, to avoid enlarging the rivet hole. Pin punches are made of high-carbon steel with the working end suitably hardened and tempered; they are obtainable in various diameters of small end.

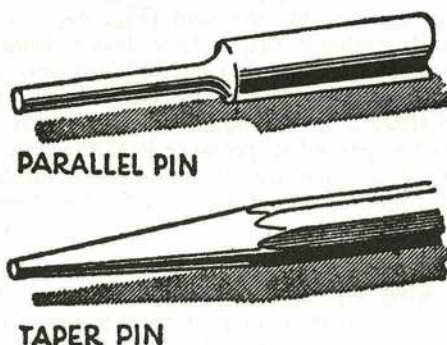


Fig. 41. PIN PUNCHES

Hollow Punches

64. A hollow punch (Fig. 42) and a hammer are used when holes are required in soft materials such as jointing material, rubber, leather, etc. These punches are made of high-carbon steel, suitably hardened and tempered at the cutting end. To avoid



Fig. 42. HOLLOW PUNCH

damage to the cutting edge when in use, the material should be punched on the end grain of a hard-wood block.

Drifts

65. These are flat-ended punches, either solid or tubular as may be required; they are used for localizing the effect of hammer blows, and at the same time they prevent damage to finished surfaces—their chief application is in the dismantling and assembly of tight-fitting parts. Drifts made from steel, brass, copper and aluminium are available, but steel drifts only must be used when driving ball or roller bearings, because of the danger, when using softer drifts, of small fragments breaking off from the drift and lodging in the bearing.

Rivet Snaps

66. A rivet snap (Fig. 43) is used in conjunction with a hammer to form the head on a rivet. They are made of high-carbon steel, suitably hardened and tempered, and are available in various shapes and sizes to suit the sizes and types of rivets.

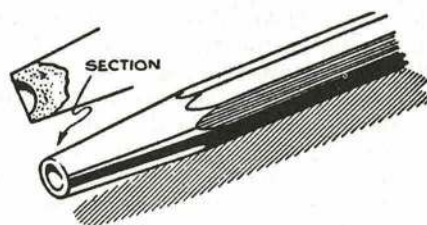


Fig. 43. RIVET SNAP

Spanners

67. By common usage the term "spanner" may be applied to any tool, other than a screwdriver, which engages firmly with a screw fitting and enables the fitting to be tightened or slackened without causing damage. By far the most common types of spanner are those that fit over standard hexagonal heads of bolts, screws and nuts; these are referred to as "standard" spanners, and tools of this category form part of the personal tool-kit of an engineering tradesman. Equally important, however, are the non-standard or "special" spanners which are used on other types of screw fittings; some of these have a limited general application, but many are specially produced for use on one particular component and will, therefore, be found only in the special tool-

kits supplied for servicing specific equipments. Spanners are made of alloy steel, hardened and tempered high-carbon steel, or case hardened mild steel.

68. Standard Spanners. As stated in the previous paragraph, standard spanners are provided for use on standard hexagonal nuts, bolt heads and screw heads. In all cases, the width across the flats of the hexagon is standardized for the major or normal diameter of the screw thread—e.g. the head of a $\frac{1}{4}$ in. B.S.W. or B.S.F. bolt or screw, or the nut used on it, has a standard width across the flats of 0.44 in., while a 2 B.A. component has a corresponding width of 0.32 in.—and it is British practice to mark each standard spanner with the corresponding screw diameter of the component it fits; in the two cases quoted, the spanners would be marked $\frac{1}{4}$ in. and 2 B.A. respectively. American practice is quite different, in that the spanner is marked with the width across the flats of the hexagon; this dimension, in the case of a $\frac{1}{4}$ in. A.N.C. or A.N.F. component, is $\frac{7}{16}$ in., and the appropriate spanner for this component would be identified by the mark $\frac{7}{16}$ or, if of recent origin by the numerals 44—this latter identification being known as the S.A.E. size, and being derived from expressing the width across the flats ($\frac{7}{16} = 0.4375$) to two places of decimals and omitting the decimal point (if the width across flats is, say, $1\frac{1}{4}$ in., the S.A.E. size would be shown as 125). Hexagon dimensions for Unified screw thread components are as for American hexagon dimensions, and standard spanners for these components are marked in the American manner. The accompanying table shows the relationship between Unified spanner markings and the nominal diameters of bolts.

Nominal Diam. (in.) of Bolt (normal series)	Dimension across Flats of Hexagon	Marking on Spanner
---	---	-----------------------

$\frac{1}{4}$	$\frac{7}{16}$	44
$\frac{5}{16}$	$\frac{1}{2}$	50
$\frac{3}{8}$	$\frac{9}{16}$	56
$\frac{7}{16}$	$\frac{5}{8}$	62
$\frac{1}{2}$	$\frac{3}{4}$	75
$\frac{9}{16}$	$\frac{13}{16}$	81
$\frac{5}{8}$	$\frac{1}{2}$	94
$\frac{3}{4}$	$1\frac{1}{8}$	112
$\frac{7}{8}$	$1\frac{5}{16}$	131
1	$1\frac{1}{2}$	150

69. Set or Open-Jaw Spanners. This very common type of standard spanner is usually made in double-ended form to give two available sizes in the one tool (Fig. 44). It is not altogether a satisfactory device, because the jaws of the spanner bear against only two of the six flats of a hexagon head or nut, and there is a very definite tendency for the jaws to open when pressure is exerted on the other end. The use of open-ended spanners is not recommended if one of the "enclosed" types can be used.

70. Ring Spanners. These spanners (Fig. 45) give full enclosure of the hexagon head or nut, each corner of which engages snugly with an angle in the aperture of the spanner. The aperture is usually bi-hexagonal to facilitate the use of the spanner when angular movement is restricted. This type of spanner, like the open-jaw type, is usually supplied in double-ended form to fit nuts of consecutive sizes; the ends are generally off-set, but straight-shank versions are also available.

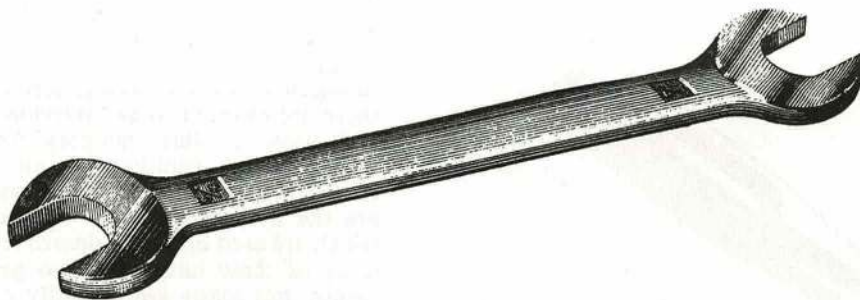


Fig. 44. SET OR OPEN-JAW SPANNER

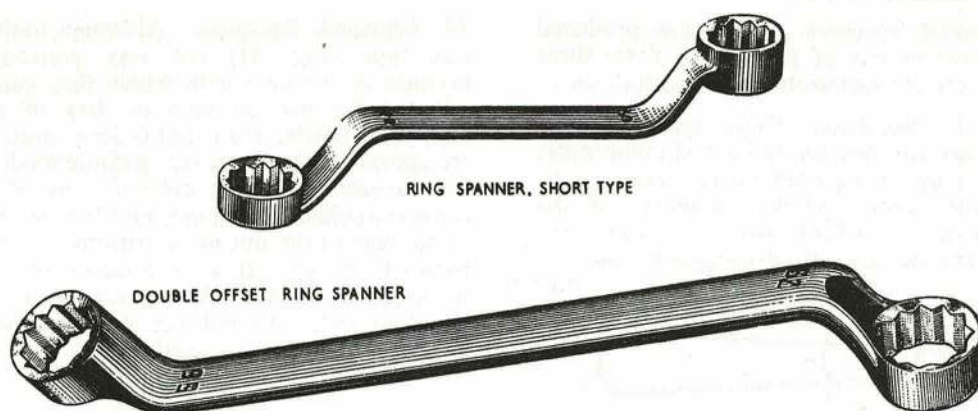


Fig. 45. RING SPANNERS

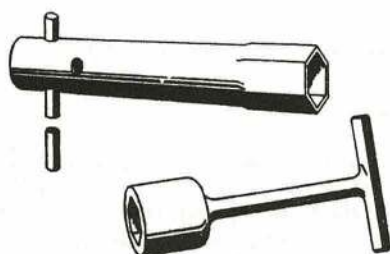


Fig. 46. BOX SPANNERS

71. **Box Spanners.** These types (Fig. 46) also give full enclosure of the nut or bolt head. They are particularly useful where access to the nut or bolt head is restricted to the line of the screw axis.

72. **Socket Spanners.** This form of standard spanner is used in conjunction with a variety of ratchet handles, tommy bars, extension pieces and universal joints (Fig. 47)—these fitments greatly facilitate the use of the sockets and extend their range of application. The socket aperture is bi-hexagonal at one end to take the nut or bolt head, and square at the other end to accommodate the wrench fitting by means of which the socket is turned. Socket spanners are usually supplied in complete sets to cover a range of consecutive sizes, each set being complete with the requisite ancillary components.

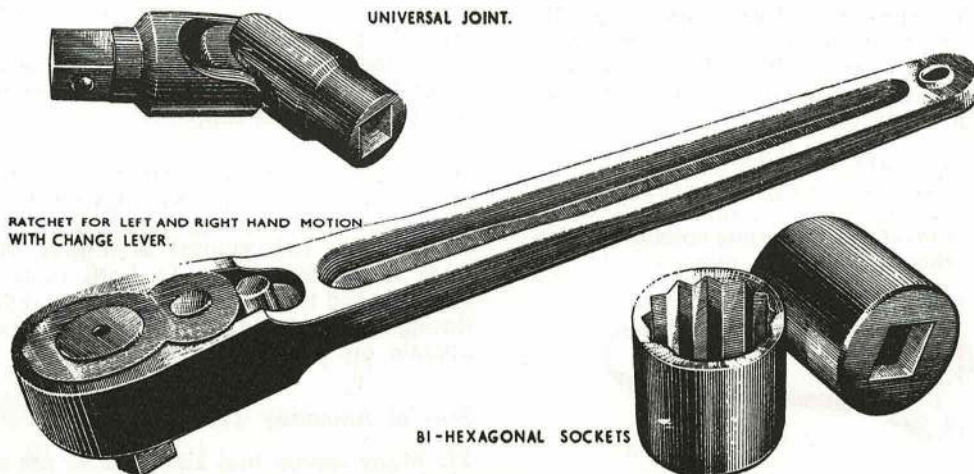


Fig. 47. SOCKET SPANNERS AND ANCILLARIES

73. Special Spanners. These are produced in a large variety of shapes and sizes; three of the more common shapes are as follows:—

(a) **'C' Spanners.** These spanners (Fig. 48) are for use on splined circular nuts; they may be regarded as the counterparts, in the special-spanner category, of the open-jaw standard spanners, and they present the same disadvantages in use.



Fig. 48. 'C' SPANNER

(b) **Splined Tube Spanner.** This form of spanner (Fig. 49) is a marked improvement over the 'C'-type spanner for use on circular splined nuts; its use is restricted, however, to circumstances where access to the nut is obtainable along the line of the screw axis; therefore, it cannot be used on splined gland nuts.

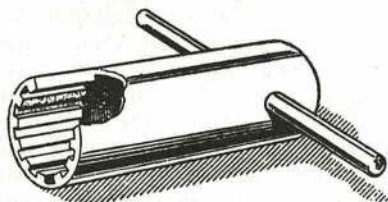


Fig. 49. SPLINED TUBE SPANNER

(c) **Peg Spanners.** These tools (Fig. 50) have two or more small round pegs protruding from the flat surface: these pegs engage in corresponding holes in the special nut or screw plate.

Note. The use of drifts or punches for slackening or tightening special screw fittings is a most undesirable practice—the appropriate special spanner should always be used.



Fig. 50. PEG SPANNER

74. Adjustable Spanners. Although tools of this type (Fig. 51) are very convenient because of the ease with which they can be adapted for use on various sizes of nuts and bolt heads, their limitations must be recognized. There is a very definite tendency for the jaws to spring open if considerable force is applied during use, and this can lead to damage to the nut or, in extreme cases, to personal injury. It is recommended that the adjustable spanner be regarded as a stop-gap tool only; do not use it if a suitable fixed-size spanner is available.



Fig. 51. ADJUSTABLE SPANNER

Extractors

75. The term "extractor" is applied generally to any tool which is designed to simplify the separation of close-fitting components. Examples of components that require the use of extractors for effective separation without causing damage are ball and roller bearings from shafts, gear wheels from tapered shafts, and bushes from their housings. Extractors not only serve to separate parts without risk of damage; if of good design and accurate manufacture they may also serve as guides to prevent jamming during the separating process. Each extractor is designed for one specific purpose, and it should never be used for any operation other than that for which it is supplied.

76. Two simple forms of extractor are shown in Fig. 52; one is suitable for removing a bush from its housing, and the other is designed for the removal of a gear wheel from a tapered shaft. In both tools the effort needed to separate the parts is applied through a screw thread—most extractors operate on this principle.

Special Assembly Tools

77. Many special tool kits, such as are supplied for servicing a specific machine or

assembly, contain special assembly tools that contribute very largely to the simple and efficient assembly of dismantled parts. These may include such items as guide tools for aligning components for assembly, tools

for inserting bushes in housings, special drifts, etc. An example of this type of tool is shown in Fig. 53; this particular item is intended to simplify the insertion of a bush in its housing.

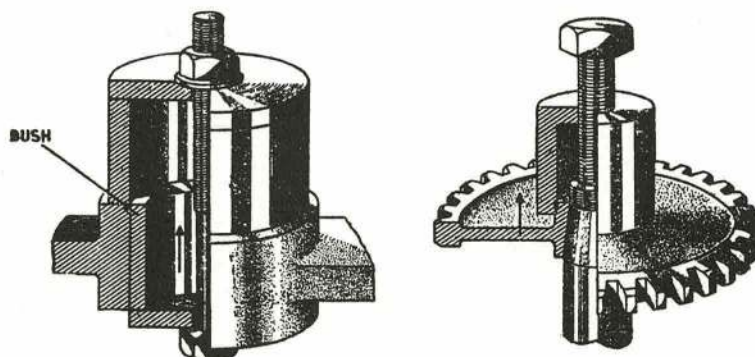


Fig. 52. SIMPLE EXTRACTORS

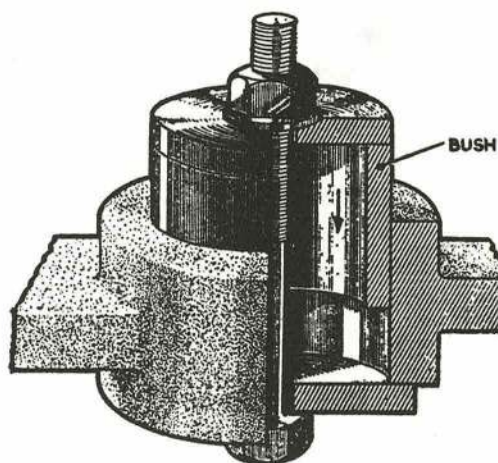
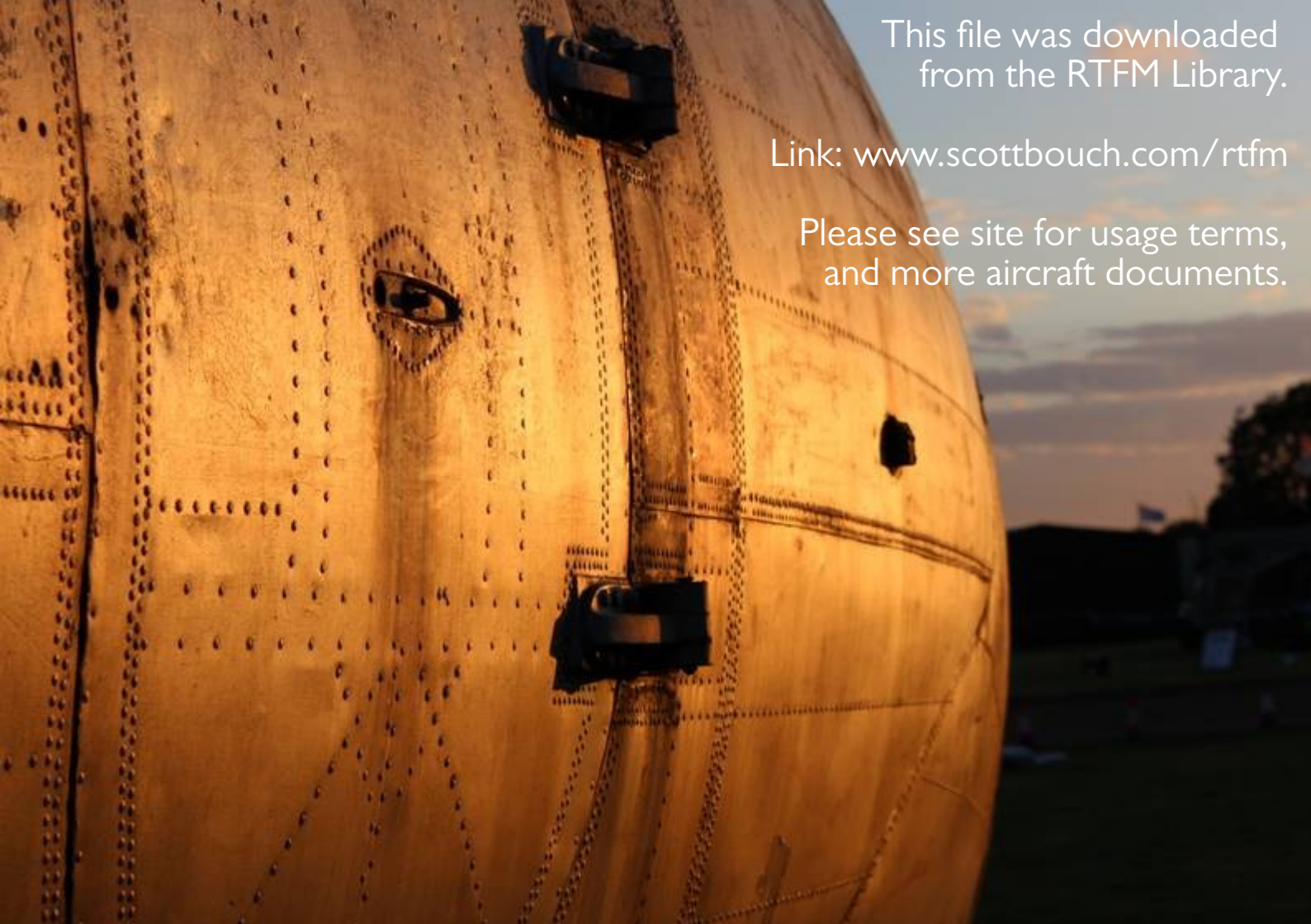


Fig. 53. SIMPLE BUSH ASSEMBLY TOOL



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