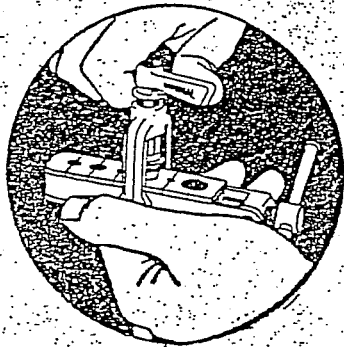


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IMPERIAL TUBE WORKING HANDBOOK

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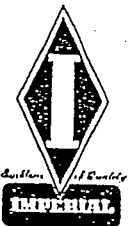
Good Workmanship and Good Tools Go Hand in Hand...

Tubing is now used so generally and the field of application is broadening so fast that there is hardly a plant or a shop that does not use it for one purpose or another.

And since the proper installation of tubing is so important Imperial has prepared this Tube Working Handbook — a practical book for practical men—that tells you how to work with tubing — how to cut, flare, bend, swedge, ream and solder it. In every-day language it describes modern tube working practice. It will be especially valuable to the apprentice and serve as a refresher to the expert.

Since the first step in any tube working job is to have good tube working tools, these are described in the second section of this book. Imperial has consistently pioneered and developed tubing tools which have gained recognition as the standard in industry.

Keep this Tube Working Handbook available for ready reference on all tubing connection work. For additional copies see your Jobber.



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1. TYPES OF TUBING

Broadly speaking, tubing can be classified into three groups: (1) rigid; (2) semi-rigid; and (3) flexible.

For practical purposes, flexible tubing usually is called hose. This manual, therefore, deals only with the tubing in the first and second classifications—rigid and semi-rigid.

The rigid tubing considered for the purpose of this manual includes J.I.C. steel, stainless steel, titanium, heavy-wall brazed steel, hard drawn copper or similar types.

Semi-rigid tubing may be soft copper, brass, aluminum, thin-wall steel, or special alloy—which are the most commonly used types, and therefore specifically treated on the following pages. Other metals, such as magnesium, also can be used as semi-rigid tubing material.

Selection of tubing, of course, depends on the type of job, the availability and cost of the various types of tubing, and the kind of fittings to be used.

Copper and brass tubing as supplied by the mill are bright on the outside and also very smooth and bright on the inside. Usually, this tubing is furnished in coils, packed in a tight fitting box or wrapped so that the atmosphere will not cause it to corrode.

Thin-wall steel tubing may be either of the seamless or seamed type. Certain types of lap seam welded steel tubing are copper

coated, and some also have an extra tinned coating on the outside. (This extra tinning serves to fill in the seam in the tubing, a special advantage when working with compression type fittings.)

Aluminum tubing can be obtained in various grades of hardness and various alloys.

The rigid types of tubing — stainless steel, J.I.C. steel, etc. — are furnished in straight lengths.

2. HANDLING TUBING

Preferably, all types of tubing should be "dead soft" or fully annealed before being formed. Far better results ordinarily are obtained with soft tubing in less time and with less effort. When working with tubing harder than "dead soft" it is necessary to select tools which will handle this type of work.

In this connection, it should be noted that if soft copper tubing is kept on a shelf for a long period of time it will become quite hard, and the same thing applies, to a lesser extent, with brass tubing. Moreover, every time a piece of copper tubing is bent it will become harder. When the tubing becomes too hard it is necessary to anneal it before using, especially if it must be bent to a desired shape or if the ends are to be flared.

When uncoiling tubing, hold end of tubing with one hand and unroll coil with other hand.



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Sometimes it also is necessary to anneal aluminum and soft steel tubing. However, steel tubing retains its soft temper over long periods and thus annealing is seldom necessary. Generally speaking, soft steel tubing is not as easily bent as soft copper or aluminum tubing.

Annealing Tubing

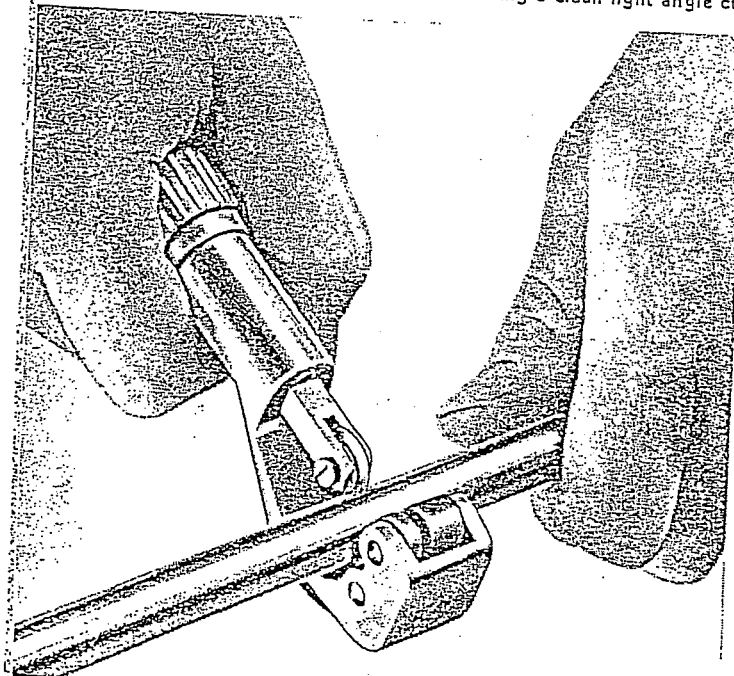
In annealing, copper tubing is heated to a dull red heat and should be cooled in water. The air cooling process may be used, but water cooling has a tendency to brighten the copper and to remove some of the oxidation that takes place in the annealing.

It must be remembered that copper tubing melts at approximately 1900° F., and care must be taken when heating is done with an oxy-acetylene torch or other flame to assure against burning a hole.

When aluminum tubing must be annealed, use the same process as with copper, but keep firmly in mind that here the melting point is far lower—only 1217° F. If the flame is kept on the tubing too long, the workman may be surprised to see it collapse completely.

Annealing steel tubing, of course, involves a process somewhat different from

The safest and best way to cut most types of thin wall tubing is to use a good tube cutter. (Left.) It has a sharp cutting wheel which is fed gradually into the tube as the cutter is revolved around the tube making a clean right angle cut.



copper. After heating, steel tubing must be cooled gradually, instead of rapidly.

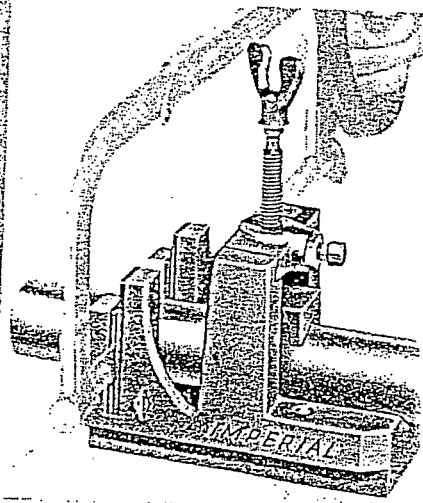
Uncoiling Tubing

Soft copper and many other types of soft metal tubing are coiled and must be straightened before being used. First, determine the amount of tubing required. Then place the coil on a bench or on the floor and hold the end with one hand. Unroll the coil with the other hand. Do not try to uncoil the tubing by pulling it out sideways from the coil in its spiral form. This would put a twist in the tubing, and tend to throw it out of round. Also, the additional working of the tubing has a hardening effect.

Straightening Tubing

No matter how carefully tubing is uncoiled it often has kinks and must be straightened. One method of straightening is to lay the tubing on a smooth floor or bench and use a board flatwise, striking the high spots. But don't strike too hard or flat spots will be formed. Soft tubing is easily dented, and may collapse at a dent where being bent.

Another method of straightening long lengths is to slap the tubing against the floor, turning the tubing as the operation continues. Two men can do this job far easier than one. With only one man, the tubing must be secured at one end.



For cutting heavy wall or very large diameter tubing and stainless steel, titanium, etc., a hacksaw used in conjunction with a sawing vise is recommended.

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3. CUTTING TUBING

The safest and best way to cut most types of thin wall tubing is with a tube cutter. There are other methods of cutting this type of tubing, but all of them have one disadvantage or another, and to be positive of good results, everyone working with tubing should have at least one good tube cutter in his kit.

Exceptions to this rule are in the cases of stainless steel and titanium tubing. As these types of tubing are work hardened when a tube cutter is used, it is advisable to cut them with a hacksaw using a sawing vise. It may also be desirable to use a sawing vise for cutting heavy wall and large diameter tubing. Sawing vises are made so that the tubing can be clamped in them without flattening and the saw is guided in a slot to insure a perfectly square cut.

Use of a hacksaw without a sawing vise on ordinary small size tubing not only makes it difficult to get a straight cut, but in any case it involves the danger of getting saw cuttings inside the tubing where they may cause trouble.

One old-fashioned method of severing small tubing, instead of cutting it, is to nick the tubing all the way around with a file and then break it in two. But here again the break may not be straight and in any event, the edge is ragged. Then, to obtain a square end that will make a good flare or

make up properly with a fitting, it is necessary to trim with a file, and this is an added and sometimes uncertain operation.

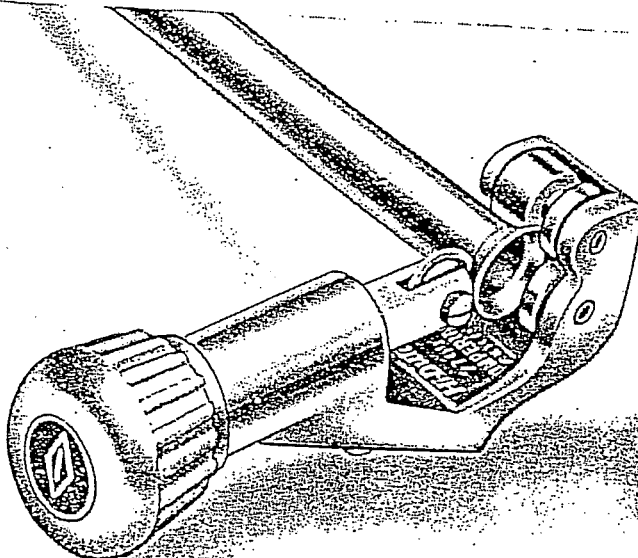
Good Tube Cutter Is Essential

Considering these and other disadvantages of older methods, it is easy to see why a good tube cutter is so essential. There are several well-known tube cutters, and most of them do a good job. Probably the best type is one that has two rollers on which the tubing rests. The cutting wheel is fed gradually into the tube as the cutter is revolved around the tube. This gives a clean right angle cut with no ragged edges.

If a tube cutter is properly used, it will leave very little burr on the inside of the tube. But the cutter should be fed slowly, particularly in cutting aluminum or other soft tubing. The softer the tubing, in fact, the greater the tendency of the cutter to throw a burr on the inside. (This burr must be removed in the event tube is to be flared with a tool having a swivel-type flaring cone. See data under tube flaring.)

Another advantage of using a tube cutter is that it makes a small chamfer on the outside of the tube which facilitates making up a solder joint or a compression type joint, since it forms a lead which makes it easy to insert the tubing in the fitting.

This tube cutter has a special flare cut-off groove in rollers to cut off damaged flares with a minimum of waste — often eliminating need for replacing the tubing.



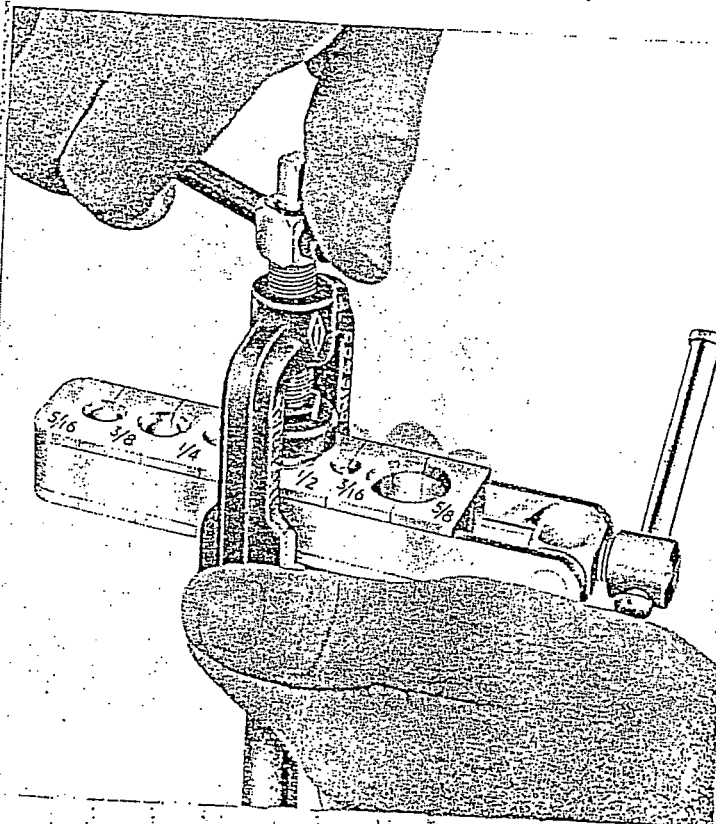
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Advantage of Flare Cut-off Groove

An important recent development in tube cutters is the introduction of a specially designed flare cut-off groove in the rollers. When it is necessary to remove a flare from a piece of tubing, the flare is fitted into this groove and the blade cuts it off right at its base with a minimum of waste. This often eliminates the need for replacing a piece of tubing.

It is important that you make a definite point of taking good care of your tube cutters. If a cutter is sprung out of shape the wheel probably will not track properly around the tubing. It may cut a thread instead of staying in the same groove. Don't throw your tube cutter around. You may ruin its usefulness.

One of the latest flaring tools uses a die block with sliding dies instead of a flaring bar. This type of flaring tool is available in two models—one for making 45° flares, and one for making 37° flares. Tubing is inserted between segments of proper size die block (Fig. 1). After screw at end has been tightened to hold tubing (Fig. 2), yoke is slipped over bar and cone screwed down to form flare (Fig. 3).



4. FLARING TUBING

The most frequently used types of flares are the 45° and 37°. The 45° flare is the type required when tubing is to be connected with S.A.E. 45° flare fittings. These fittings are widely used for automotive, industrial, liquefied petroleum, plumbing and heating, instrument and refrigeration applications.

The 37° flare is used for connecting 37° flared fittings. These fittings are widely used for J.I.C. hydraulic, aviation, and industrial applications.

Flares may be either single flares, with a single thickness of the tubing flared out to a specified angle and depth, or they may be double flares. On double flares the end of the tubing is folded back on itself, and a double thickness flare is formed.



Fig. 1

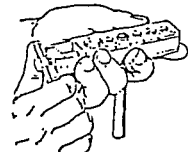


Fig. 2

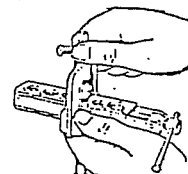


Fig. 3

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While the single flare is by far the most widely used at the present time, the double flare is growing in popularity for certain types of work and some of its advantages are outlined later in this section. In working with some types of tubing, such as brazed thin-wall steel tubing, it is essential that the double flare be used to assure against splitting of the tubing in flaring.

In the discussions following, wherever the term "flaring" is used, it is understood to apply to single flaring unless otherwise specified.

Preparation of Tubing

Before beginning any flaring operation, be sure that the tubing has been properly prepared. The end to be flared should be cut off squarely and should not be out of round. This is assured through the use of a good tube cutter (or sawing vise, in the case of stainless steel).

In the previous section devoted to cutting, it was noted that with proper handling of a tube cutter, very little burr is left on the inside of the tube. Nevertheless there is always some burr, and no matter how much or how little there is, it should be given careful consideration before flaring.

Standard bar and yoke type flaring tools are furnished either with a swivel or a fixed cone. (Swivel cones remain stationary when screw is turned; fixed cones rotate with the screw.)

In assembling flare fitting joints, be sure face of flare and seat of fitting are clean and free from dirt.

If the burr on the inside of the tubing is removed when flaring with either of these types of tools, the result will be a smooth, single flare. If the burr is not removed when using a swivel cone, the flaring of the tubing will tend to produce a deformed flare which is not desirable.

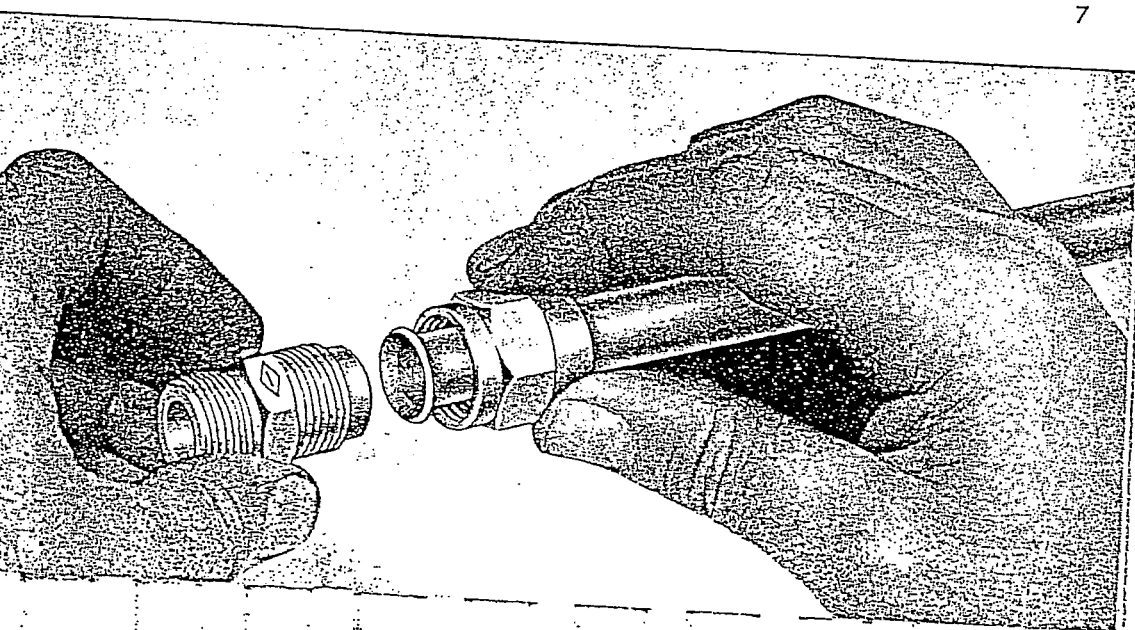
Should the tubing be cut with a hacksaw, a burr may be left on the outside of the tubing. This must be removed before flaring.

Tube cutters usually are provided with a reamer which can be used for deburring the tubing. Also special tools are available as described under "Reaming Tubing."

Making the Flare

The first thing to be remembered in flaring tubing is that a good, smooth, narrow-flared joint is much better than a rough-looking, uneven, wide-flared joint. Correct flares can be made with a number of different types of flaring tools.

The most widely used type of flaring tool is one consisting of a flaring bar and a screw feed flaring yoke. In making a flare with this type of tool, the tubing is placed in the flaring bar with the end protruding slightly above the face of the bar.



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Care must be taken, of course, that the tubing is tightly clamped in the bar so that the flaring cone will not cause the tubing to slip when the cone is screwed down, leaving an uncompleted flare.

Be sure to tighten the screw or wing nuts as much as possible. When two wing nuts are provided at the sides of the bar it is good practice to tighten the wing nut nearest the tubing first and then to tighten the other one.

Before slipping the yoke over the bar to start flaring, put a little oil on the cone or spreader. Then there will be no tendency of the cone to tear into the tubing by sticking to it. Also, oil the thread on the yoke of the tool occasionally or it will wear out and finally strip.

Always Inspect the Flare

To produce the flare, place the cone over the end of the tubing and turn it down until the flared part of the tube fits solidly against the counter sunk recess in the flaring bar. If one of the newer type flaring tools which rolls out the flare above die

block is used, the cone would be turned down the specified number of revolutions. Always make a careful inspection of the completed flare to see that the sides of the flare have no splits or other imperfections.

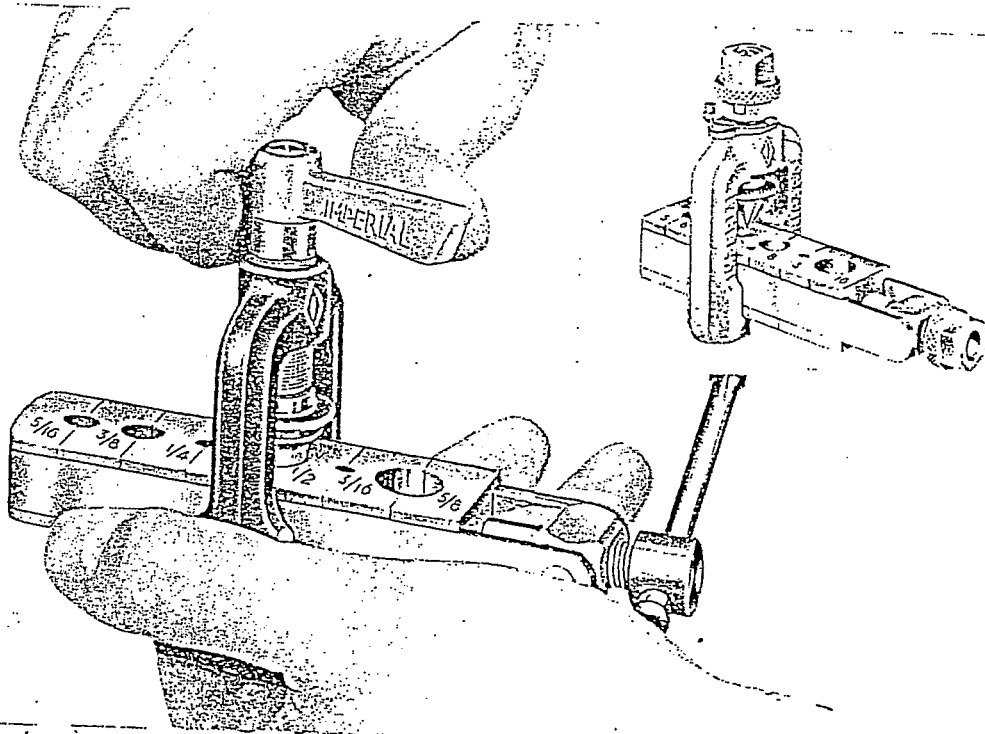
Take particular care in flaring when the flared connection is to be used on units subject to vibration. Do not work the tubing any more than necessary because, as explained on previous pages, the working will make it hard; then vibration will break or crack the tubing at the hardened points.

In making any type of flared joint, be sure the face of the flare and the seat of the fitting are clean and free from dirt. A good practice is to put some oil on the surfaces to be made up, and also on the back surface of the flare, so that when the nut is drawn up it will have a good lubricated surface to draw against. Copper has a tendency to stick and may tear if drawn too tightly against a dry surface.

Burnished Flares Give Tighter Joints

It has long been recognized that a smooth, burnished face on a flare will give you far tighter flared fitting joints. Recently, several ingenious tools have been introduced which make it easy to burnish

Both of these flaring tools form flares in the air and automatically burnish them to make stronger, tighter joints. Smooth surface dies do not score the tubing. Tool at left makes 45° flares. A model is also available for making 37° flares. Tool at right makes 37° flares in aircraft grade stainless steel tubing and other tubing.



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flare faces at the same time the flare is being made.

One of these tools forms flares in the air by means of a multi-faced, tool chrome finished flaring cone. The flare is formed with the tubing extended above the face of the die block instead of against a countersink in the die block as mentioned in preceding paragraphs. In this way the original wall thickness of the tubing is maintained at the base of the flare, assuring stronger flares which stand up longer under vibration.

When backing off cone after flare is made, a lost motion mechanism automatic burnishing action and gives flare a highly polished finish. This tool has the further advantage of not scoring the tubing because there are no serrations in the die block. Tool is illustrated on preceding page. There are also 37° flaring tools which roll out flares and burnish them in a similar manner. These tools have rollers in the flaring cone which make it easier to flare steel and stainless steel tubing. One of these tools is designed primarily for aviation work, and in addition to the automatic burnishing mechanism this tool embodies a gaging method for controlling the size of flares in conformity with aviation standard AND 10061.

Double-Flaring Seamed Steel Tubing

No matter how much care is taken, brazed thin-wall steel tubing often will crack at the flare when conventional "single-flare" flaring tools are used. For this reason, a double-thickness flare is recommended. The most widely used double-flaring tool is one that consists of a flaring bar, yoke and a set of adapters.

In making a double-flare with this tool, the tubing is clamped in the flaring bar with the end protruding above the top of the bar by a distance equal to the thickness of the shoulder on adapter of corresponding size (for $\frac{1}{4}$ in. tubing use $\frac{1}{4}$ in. adapter, etc.).

After the tubing has been properly clamped in the bar, place the yoke over bar, and place adapter of the proper size on the protruding end of the tubing with the pilot or stem inserted into tubing. After moving the yoke so that the flaring cone centers directly over the adapter, turn the flaring cone down until shoulder of adapter rests on flaring bar. This performs a beelling operation on tubing (Fig. 4). Now, back off the flaring cone slightly, remove the adapter, and screw the cone down again directly

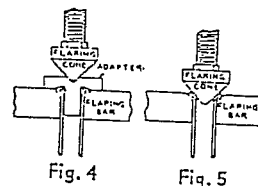
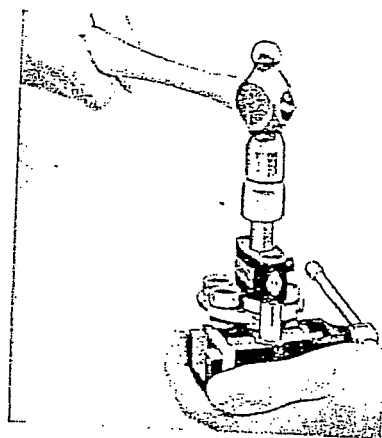
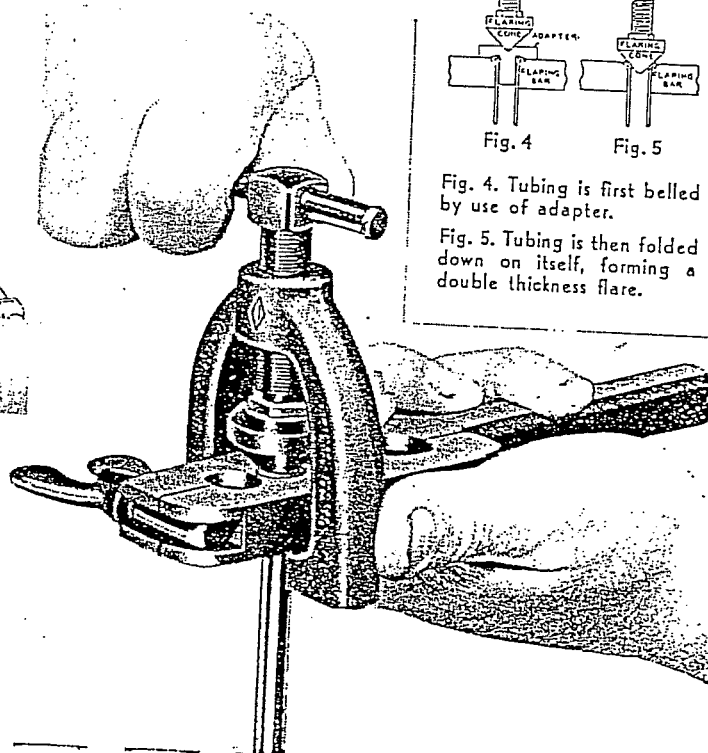


Fig. 4. Tubing is first belled by use of adapter.

Fig. 5. Tubing is then folded down on itself, forming a double thickness flare.



(Above) This type of integrated double-flaring tool is available in two models—one for making 45° flares, and one for making 37° flares.



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on the tubing. This folds the tubing down on itself (Fig. 5), and forms an accurate 45° double-flare without cracking or splitting the tubing.

A recent development in the double flaring field is a compact, completely integrated tool. Adapters for the first forming operation on various sizes of tubing are held in a plate and revolve into position. These adapters also serve as a positive gage for positioning tubing in die block. Thus a correct size flare is assured every time.

This tool is available in two models—one for making 45° flares on soft steel, copper or aluminum tubing, and one which makes 37° flares to aviation standard AND 10078 on soft aluminum or copper tubing.

Oil the surfaces to be made up, the same as in making single flares.

Advantages of Double Flaring Copper and Aluminum Tubing

While single flares are by far the most commonly used today in connecting copper, brass and aluminum tubing, there is a ten-

dency toward the use of double-flares for critical installations or installations which are subjected to frequent disassembly and reconnection. The bulk of the use of double flares is in tube sizes $\frac{3}{8}$ " O.D. and smaller as it is in these sizes that the double flare offers its principal advantages.

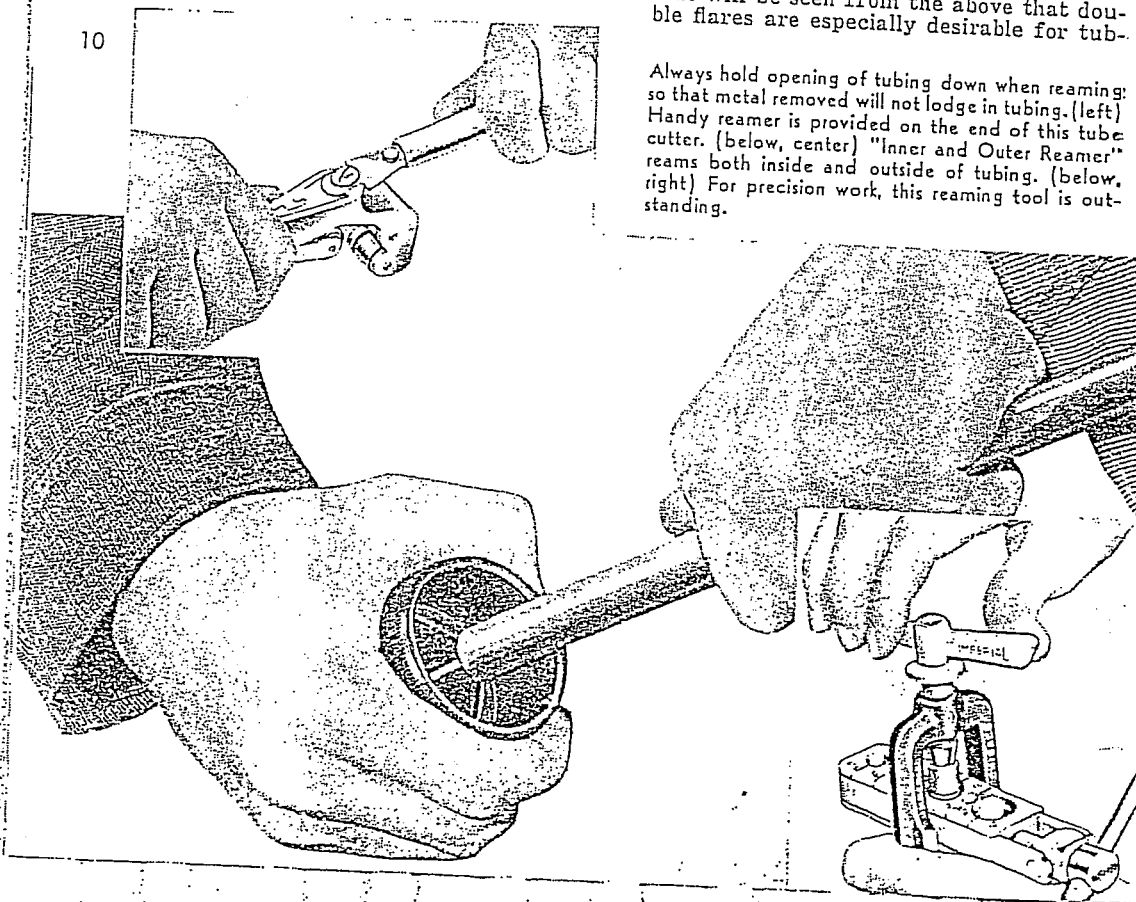
It has been found by aircraft manufacturers, for example, that difficulties with leakage on oxygen systems in aircraft have been practically eliminated by using double flares in making tubing connections. S.A.E. recommends double flares for automobile air conditioning systems and refrigeration systems on trucks and trailers.

One of the advantages of a double flare is that an effective seal is secured with specified wrench torques, and yet maximum wrench torques for single flares can be exceeded by a considerable amount without "washing out" the flare. This eliminates much of the danger of weakening flares through over-tightening.

Also experience has shown that leaks do not develop as readily on systems using double flares. And if leaks do develop, it is possible to tighten the tubing connection further without squeezing the tubing too thin, thereby "washing out" the flare.

It will be seen from the above that double flares are especially desirable for tub-

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Always hold opening of tubing down when reaming; so that metal removed will not lodge in tubing. (left) Handy reamer is provided on the end of this tube cutter. (below, center) "Inner and Outer Reamer" reams both inside and outside of tubing. (below, right) For precision work, this reaming tool is outstanding.

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ing joints which must be disassembled and reassembled frequently. They make possible repeated, tight reconnections. In refrigeration work, for example, double-flares are especially advantageous for drier and filter connections, bull's eye connections and test equipment connections.

5. REAMING TUBING

On many tubing connection operations it is desirable to ream the tubing to remove any burrs created on the inside or outside of the tubing during the cutting operation. This was taken up in some detail, for example, in previous comments with reference to preparing the tubing for flaring. Removal of inside and outside burrs is also most important in preparing tubing for use with solder fittings.

One method of removing burrs is through the use of the reamer usually provided on the end of the tube cutter. In reaming tubing it is important that the tubing always be held with the opening pointed down so that the metal removed will not lodge in the tube. (See illustration on page 10.)

An extremely handy reaming tool which is coming into wider and wider use is an "Inner and Outer Reamer." This is a convenient little cylindrically-shaped tool that makes possible a rapid and efficient reaming job on both the inside and the outside edges of copper, brass or aluminum tubing.

Tubing is introduced from one end of the tool for inside reaming, and from the other end for outside reaming. The tool cuts in either direction and is self-centering. It is equipped with three hardened hollow ground tool steel cutters. This reamer will

handle all sizes of copper, brass or aluminum tubing from $\frac{1}{8}$ " to $1\frac{1}{2}$ " O. D.

One of the finest tools for removing burrs on tubing consists of tapered tool steel cutters mounted on a yoke. This reaming yoke is designed to be used with the die holder furnished with certain standard flaring tools. A precision feed control provides for feeding the cutters into the tubing gradually. This feature, combined with the sharp cutters, provides clean-cut reaming without gouging. A reamer of this type is especially desirable when connecting tubing for hydraulic, aviation and other exacting tubing connection work.

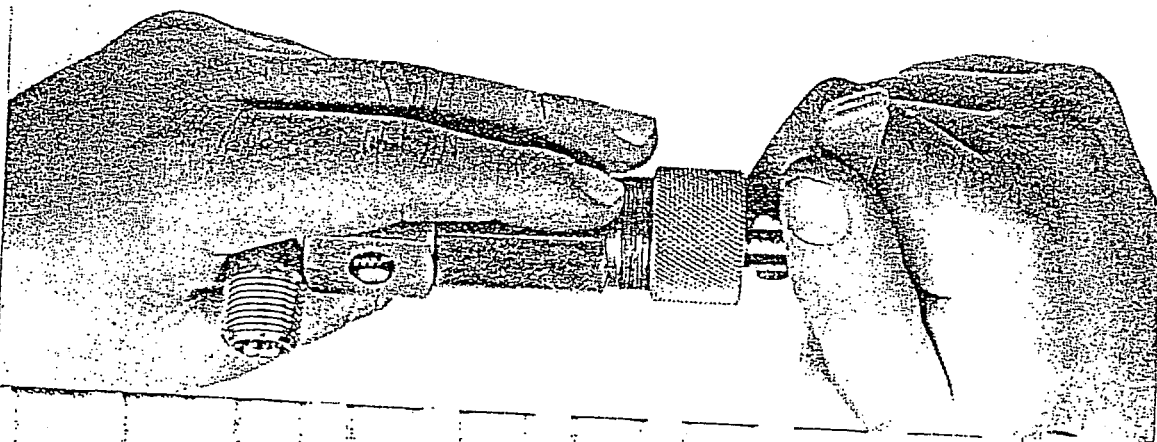
6. REFACING FLARED FITTINGS

The making of good flares on tubing is not the whole story in making tight joints with flare fittings. It is important also to watch the condition of the flare fitting being used.

Occasionally, there are slight nicks in the seat of flare fittings which may cause leaks, and when this takes place the fittings should be refaced with a tool that will remove the nicks.

A widely used refacing tool for brass, aluminum or steel fittings and valves is shown in operation below. It is available in both 45° and 37° types. This tool has various adapters which are threaded to fit the different sizes of flare fittings. The correct size adapter is assembled to body of

A refacing tool is used to remove slight nicks in the seat of flare fittings.



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the tool and fitting to be refaced is screwed into adapter.

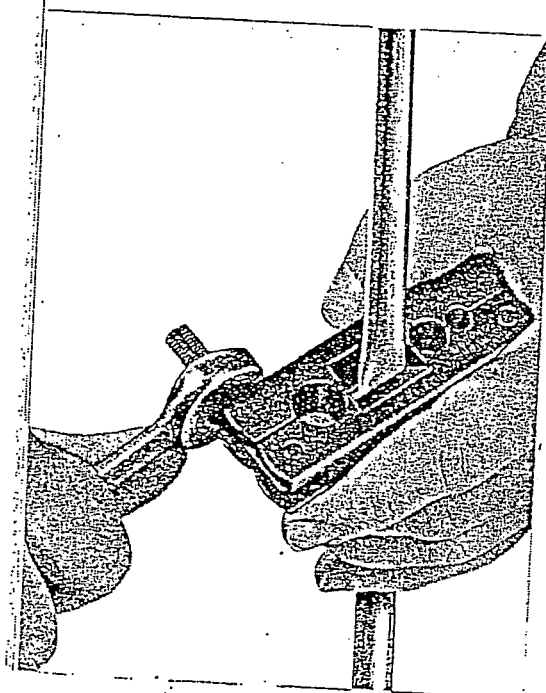
Revolving the handle on cutter stem and advancing the cutter gradually with the precision feed control restores flare seat to original accuracy and smoothness.

7. TUBING PINCH-OFF; CLOSURE PLUGS

There are times when it is desirable to temporarily shut off tubing lines without installing a valve. There are several methods of doing this.

One of these methods is to pinch off the tubing. The tube is pinched together at a given spot when part of the line is to be closed temporarily and no shut-off valve is provided. In a refrigeration system, for example, pinching off makes it possible to disconnect the liquid or gas line while installing parts or making repairs without losing any of the refrigerant.

Tubing lines may be closed temporarily by this pinch-off tool. Tool can also be used to re-open tubing by re-rounding it.



All semi-rigid tubing may be pinched with a tool designed for this purpose. A common type of pinch-off tool consists of a split bar, resembling a flaring bar, which has a slot in which the tubing is inserted. The two halves of the bar are tightened by means of hex or wing nuts, pinching the tubing between the two slightly rounded surfaces on each side of the slot.

Re-Rounding Tubing

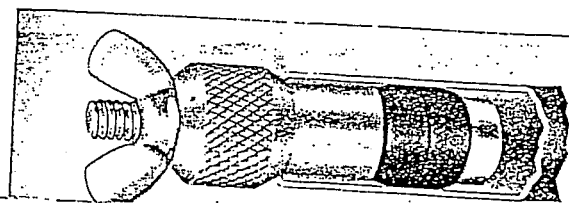
When the line is to be opened again, the pinch-off tool is removed and the flattened tubing inserted in the proper size of hole provided in the pinch-off bar for rounding the tubing back into shape. As pressure is applied on the tubing by drawing the two halves of the bar together, the tubing gradually goes back to approximately its original shape.

Two main points of precaution should be observed in pinching-off operations. First, do not tighten the pinch-off tool too much. This may tend to thin out the walls of the tube at the point of pinch-off. Second, do not apply a pinch-off tool more than once on a given area of the tube. This tends to weaken the tubing, and the additional working also causes hardening, as previously explained.

Another method of temporarily shutting off tubing is by the use of a closure plug. This device is inserted in the end of tube and the wing nut tightened to expand the flexible portion of plug. These plugs are especially useful for testing instrument piping with pressures up to 100 lbs. p.s.i. They are available in sizes to fit tubing from $\frac{1}{4}$ " to $1\frac{1}{4}$ " O.D. Test plugs can be used with either rigid or semi-rigid tubing of any type. There is no chance of damage to the tubing and they can be used with hard as well as soft temper tubing. The illustration shows a test plug expanded inside of a tube.

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The end of a tube is shut-off temporarily with this test plug.



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8. BENDING TUBING

Bending or forming tubing to the proper shape for a particular job is an operation requiring great care and attention, notwithstanding its apparent simplicity.

All types of tubing are easier to bend if "dead soft" or fully annealed. However, hard tubing can also be bent if the proper tools and methods are used. When bending soft tubing it should be emphasized that the more tubing (especially copper) is worked the harder it gets.

Obviously, therefore, you should determine just where you want to make the bend before you start. Should you miscalculate, or for any other reason need to straighten the tubing after a bend is made, it is a good practice to anneal before rebending.

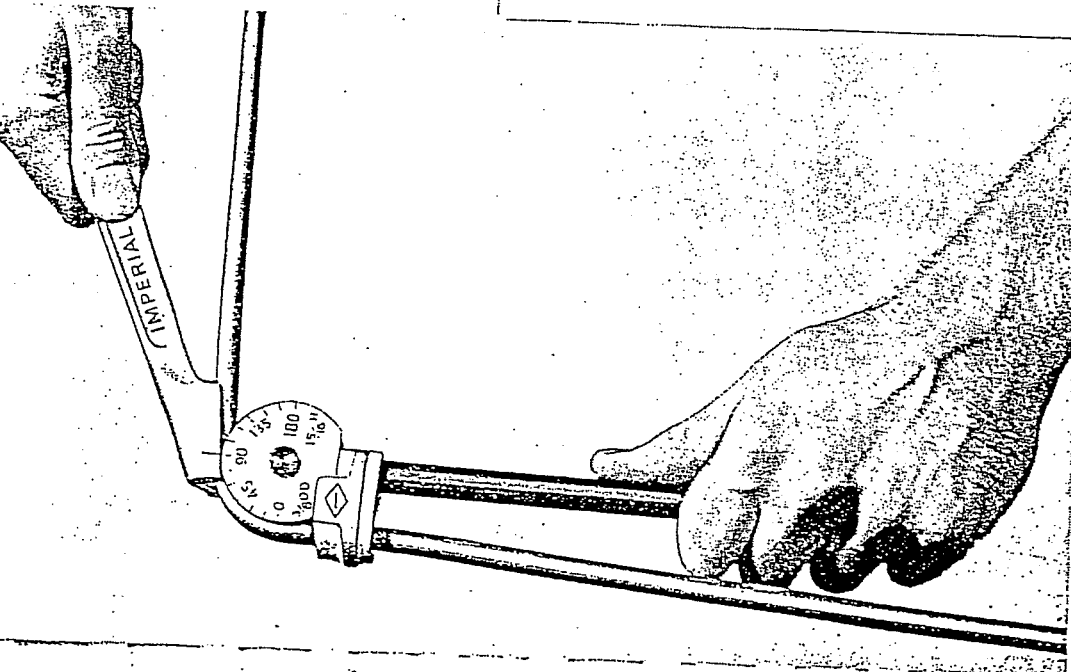
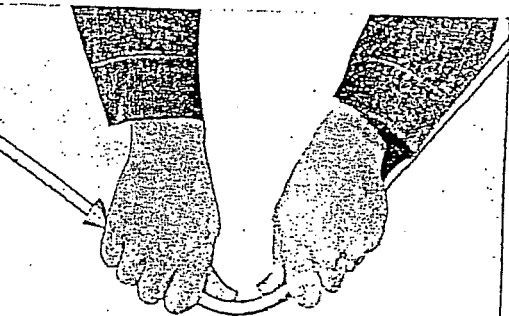
There are several methods of bending tubing. Very small tubing can be bent easily by hand without tools, but it usually is possible to make better bends by using a bending tool. Such a tool, further, eliminates the risk of collapsing the tubing.

The Bending Spring

Probably the simplest type of bending tool is the bending spring. Of the two types of bending springs, external and internal, the external bending spring is the most commonly used. It is slipped over the outside of the tubing, and prevents the tubing from collapsing. Also it keeps the operator from making too sharp a bend. In using a spring-type bender, keep in mind that the tubing should be bent somewhat farther than is required, and then backed up to the proper angle. Thus the spring is loosened and can be readily removed.

13

(left) Bending tubing with an external bending spring. (below) The popular "lever type" tube bender makes well formed bends to a short radius.



IMPERIAL TUBE WORKING HANDBOOK

Lever Type Tube Benders

One of the most popular types of tube benders is the lever type, "open-side" bender which can be slipped over the tubing at the exact point where the bend is desired. This type of bender is especially advantageous where the tubing has been partially connected or in hard-to-get-at places.

Light in weight, yet strong and durable, these benders are extremely convenient to use.

Individual and Multi-Size

Some benders are individual benders which bend one size of tubing only. Others are multi-size benders designed so that they will take a number of different sizes by changing several parts. Multiple size benders usually are furnished in metal kits, complete with a set of forming wheels, to cover the various sizes of tubing.

Gear-Type Tube Benders

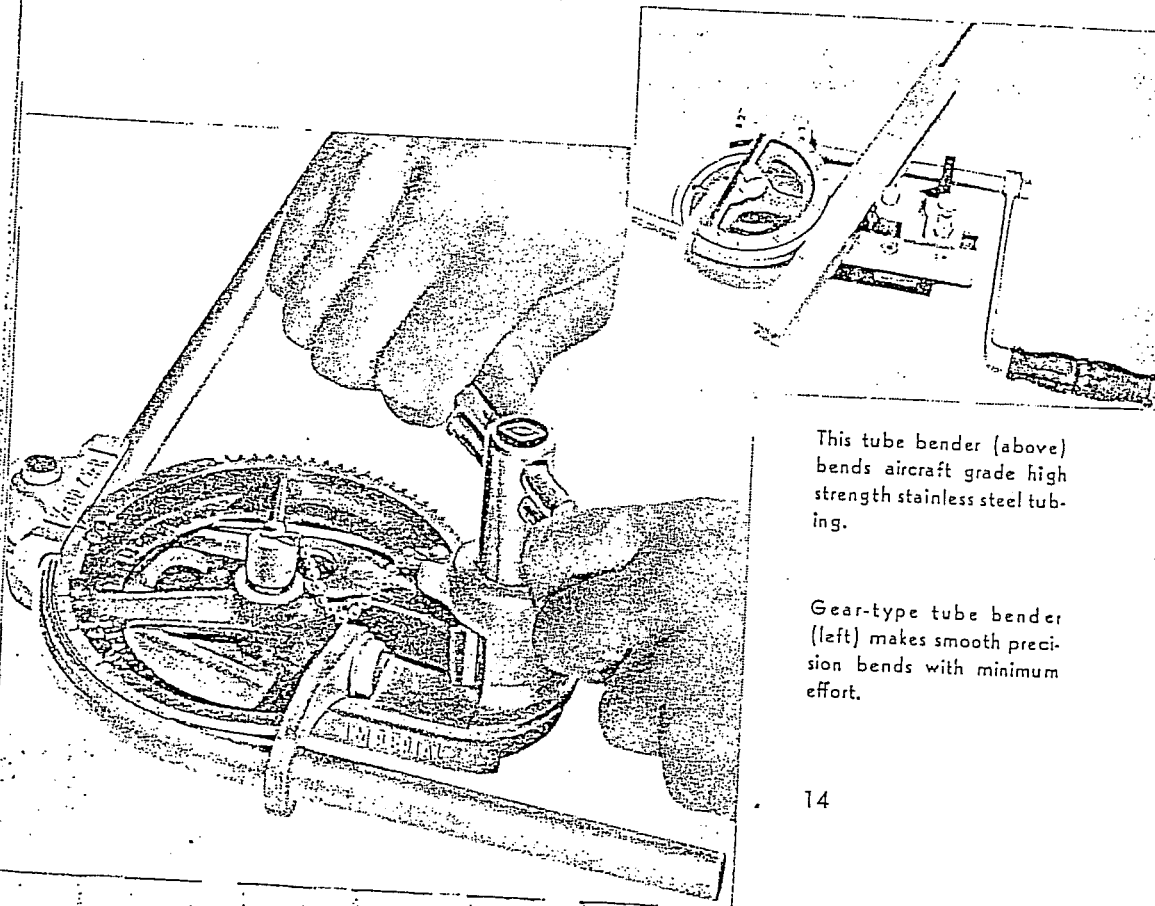
Gear-type tube benders offer advantages

in compactness, ease of operation and quality of bend. These benders are especially valuable for bending hard drawn copper, JIC steel, stainless steel, and other hard to bend tubing. (See illustration below.) They also can be used for bending soft tubing.

Their high gear ratio makes it far easier to bend the small as well as the larger sizes of any type of tubing. These benders are generally considerably smaller in overall size than a comparable lever-type tube bender. This factor contributes to convenience of operation and handling.

Tube Benders for Stainless Steel Tubing

A special type of tube bender has recently been introduced for bending aircraft grade high strength stainless steel and all other types of metal tubing. This bender is operated by means of a worm gear drive which multiplies the effort applied to the crank handle, thereby reducing the amount of torque required. The bender can be



This tube bender (above) bends aircraft grade high strength stainless steel tubing.

Gear-type tube bender (left) makes smooth precision bends with minimum effort.

IMPERIAL TUBE WORKING HANDBOOK

quickly adapted to bending any one of six sizes of tubing by changing the forming wheel and follow bars furnished. This tool will make bends up to 180° in one operation, without resetting or adjusting tubing. Bends are made to the practical minimum radii for high strength stainless steel tubing, as recommended by major aircraft companies.

9. SOLDERING TUBING

Copper, brass and tinned steel tubing are easily soldered. Solder also is sometimes used on plain steel tubing, but brazing more often is employed. Soldering aluminum tubing is difficult, and the following suggestions do not apply to aluminum.

Making a successful solder joint is a fairly simple operation. Substantially the same procedure is followed in soldering two lengths of tubing after one piece is swaged, and in soldering a fitting to tubing. The following suggestions apply specifically to soldering a fitting. When you are splicing two lengths of tubing, consider the swaged end the same as a fitting. (See illustration on next page.)

Preparing Tubing and Fitting

Be sure, first, that the tubing end is cut off squarely. The best way is with a good tube cutter, as previously outlined. Before soldering, tube and fitting must be absolutely clean. The cleaning method most generally used is to clean the outside of the tubing with sandpaper or emery cloth and the inside of the fitting with steel wool or emery cloth wrapped around a piece of wood. Use a brush to put flux on both surfaces.

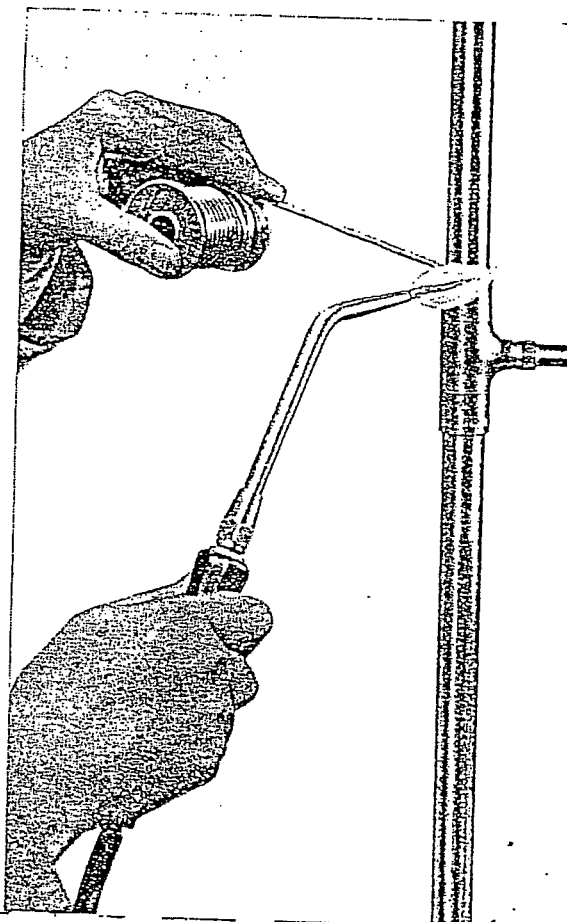
Application of Heat

Next, insert the tubing into the fitting until it rests against the shoulder. Apply heat to both fitting and tubing with a wide flame. Hold the torch in one hand and the wire solder in the other, touching the solder to the fitting from time to time to determine when it is hot enough to melt the solder. Remember, the solder will run to the hottest point. Therefore, it is best to heat all parts of the fitting which have any contact with the tubing, especially the base which is directly over the end of the tubing. Then the solder, when applied, will be drawn all the way back in the fitting before it finally comes out of the joint.

When the fitting is hot enough to melt the solder, continue to work the flame around the two pieces and at the point where the tubing goes into the fitting begin to apply the solder. Solder is fed at fitting and is applied until it can be seen all around the circumference of the fitting. If the fitting has a feed hole, follow the same procedure, except that the solder is applied through the hole instead of at the end of the fitting.

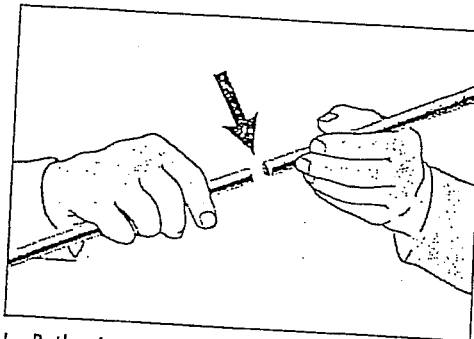
To complete the job properly, fill the feed hole with solder. If the joint has become too hot, it will seem difficult to fill this hole for the solder will continue to disappear. In this case, remove the flame and allow the work to cool a little before proceeding. Finally, take a flux brush and wipe over the top of the solder to give a nicely finished appearance to the joint.

Copper, brass and tinned steel tubing are easily soldered. Follow the directions on these pages.

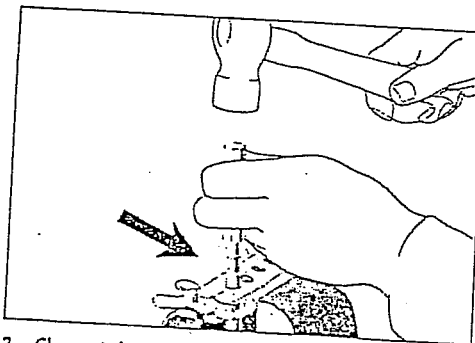


IMPERIAL TUBE WORKING HANDBOOK

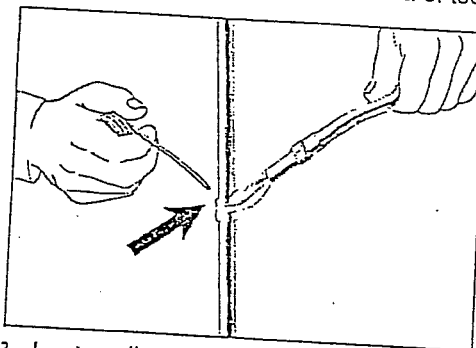
STEPS IN MAKING A SWEDGED TUBE JOINT



1. Both pieces of tubing are of same diameter. Square ends of tubing and remove burrs.



2. Clamp tubing to be swedged in flaring tool bar and set bar in vise. Select swedging tool of diameter required and drive into tube up to shoulder of tool.



3. Insert smaller end up to shoulder in swedged end, and apply solder.

10. SWEDGING TUBING

Swedging is a preliminary operation in splicing two lengths of tubing together without the use of a fitting. The end of one piece of tubing is swedged or expanded so that it will fit over the end of another piece of tubing of the same size, and the joint is completed by soldering or brazing. (Soldering tubing joints is covered in the preceding section.)

All types of soft metal tubing can be swedged. However, aluminum tubing is seldom swedged because of the difficulty in soldering aluminum.

Swedging is accomplished by using a tool which consists of a specially designed punch and a bar in which the tubing is clamped. The punch has a pilot which fits easily into the inside of the tubing, and a tapered lead connecting this pilot with an enlarged portion which is slightly larger than the outside diameter of tube.

Method of Swedging

The tubing is clamped in the proper size hole in the bar, with a section $\frac{1}{8}$ " longer than the tubing diameter protruding above the bar. Then with the bar held firmly in one hand or in a vise, the punch (corresponding in size to the tubing) is driven into the tubing with a hammer until the tubing is swedged to a depth at least equal to its original outside diameter. (Before the punch is inserted into the tubing, a drop of oil should be applied to facilitate easy swedging.)

The swedged or expanded portion of the tubing now has an inside diameter slightly larger than the original outside diameter of the tube. Thus the end of another length of tubing of the same size can be slipped into this swedged portion forming a joint that can be soldered or brazed. The result is a substantial union obtained without the use of a fitting.

Two Precautions

Two precautions should be observed. Never make a swedge joint where a bend is to be located, or never make one close to a point where a flare is to be made. The double thickness of the tubing at the swedge point makes bending difficult. In the case of flares, a swedge near the point of flare may make it impossible to slip the flare nut back far enough on the tubing to put the tubing into the flaring tool.

Swedging, if properly done, will make a splice that is at least as strong as, and probably stronger than the tubing itself, especially if silver solder is used.

11. SELECTION OF TOOLS

It often is said that a workman is known by the tools he uses. Good tools and good workmen go hand in hand, and this is true among tubing servicemen just as it is true among craftsmen in any other line.

One of the best ways to judge tools is by the company that makes them. Thus one of the first things to be considered in the purchase of tube working tools is: Are they made by a well established, reputable concern that is a leader in this field and that will remain in business over the years to come?

The answer to this question will not only indicate whether the concern has the background of experience which is so important in the design of efficient tube working tools, but it will also provide evidence as to whether the concern can be depended upon for service on the tools in the years ahead should replacement parts ever be needed.

Other questions to be considered are: Do the tools have a good reputation among the

people who use them? Are the tools substantially made but not bulky? Are they built of materials that will give long service? Are they properly finished to prevent rust and corrosion? The price of the tool should be a secondary consideration, because pennies pinched in buying tools often mean dollars lost in using them.

Weight is an item that deserves special consideration. Because a tool is heavy does not mean it is strong and durable. No need to carry around big pieces of cast iron, especially if, in so doing, you're carrying tools that actually are not as good as if they were made of lightweight, high strength aluminum alloys, for example.

Leaders in the manufacture of tube working tools have found that lightness and portability are two of the features most appreciated by servicemen, and extensive research and engineering work have been done in this direction—with excellent results.

12. CHOOSING YOUR TUBE CUTTERS

Factors to consider in choosing a tube cutter include sizes of tubing to be cut, type of tubing, ease and efficiency of operation, weight, strength, compactness, durability, protection given to working parts and provision made for reaming.

Tube cutters with rollers to support the tubing, such as the Imperial Nos. 274-F, 312-F and 206-F offer exceptional advantages in ease of operation. They also prevent galling and rubbing and consequent cold working of the tubing. This latter is especially important in connection with copper tubing, where working has a tendency to harden the tubing.

Advantages of Flare Cut-off Groove

An important improvement developed by Imperial for tube cutters of the roller type is the flare cut-off groove. The flare on a piece of flared tubing fits into this groove and the cutting blade operates right at the flare bottom. Thus there is no more waste in removing a damaged flare than the flare itself. This often eliminates the need for replacing a piece of tubing.

Another very recent development is the ball thrust bearing feed mechanism which provides "free wheeling" for quick size adjustment and for easier cutting operation.

A cutter which has a reamer as a part of the tool, ready for convenient use at all times, provides an extra advantage in making tubing connections.

A properly designed high strength frame on a tube cutter assures that it will combine maximum strength with minimum weight.

Tube cutters which handle from $\frac{1}{8}$ " to 1" or $\frac{1}{4}$ " to $1\frac{3}{8}$ " O.D. tubing meet the average needs. For cutting larger sizes of tubing, $\frac{3}{4}$ " to $2\frac{1}{4}$ " O.D., Imperial No. 206-F Tube Cutter with a quick ratchet adjustment for sliding cutting wheel down to tubing size is a recent development.

For cutting very large tubing, extra heavy tubing, or stainless steel tubing (which will be work hardened by the use of a tube cutter), a sawing vise and a standard hacksaw should be used.

A new improvement in sawing vises is a spiral ratchet mechanism for quickly sliding clamping block down to tubing size. This feature is incorporated in Imperial No. 384-F Sawing Vise for tubing from $\frac{1}{8}$ " to $1\frac{1}{2}$ " O.D.

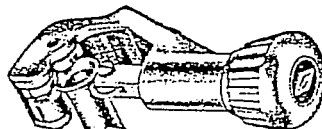
IMPERIAL TUBE WORKING HANDBOOK

IMPERIAL TUBE CUTTING TOOLS

Imperial *Hi-Duty*® Tube Cutter

with Free Wheeling Ball Bearing Action

Patent Nos. 2,065,138; 2,629,926; D-161,438.
Other Patents Pending.



274-F

Never before has there been a tube cutter that makes it so easy to cut tubing quickly, accurately, squarely. This Imperial Cutter embodies many exclusive advantages.

Cuts copper, brass, aluminum, thin-wall steel, block tin and lead tubing, hard or soft temper. Makes a quick, clean right angle cut. Leaves no burrs, or chips to clog the line; leaves tubing round, ready for flaring. Note these outstanding features:

BROAD RANGE. No. 274-F cuts tubing $\frac{1}{4}$ " to 1" O.D. No. 312-F, $\frac{1}{4}$ " to $1\frac{1}{2}$ " O.D.

EXTREMELY COMPACT. Overall length: No. 274-F, $4\frac{1}{2}$ ". No. 312-F $5\frac{1}{2}$ ".

TUBE ROLLS on rollers—adding to ease of operation.

FLARE CUT-OFF GROOVE in rollers makes it possible to remove a cracked flare without wasting any tubing. This often eliminates need for replacing tubing.

RETRACTABLE REAMER. Folds out of way when not in use. Locks securely in open or closed position.

ENCLOSED BALL BEARING FEED MECHANISM. Threads protected against dirt and damage, assuring lasting, smooth, easy operation. Length of tool remains constant regardless of size of tubing being cut.

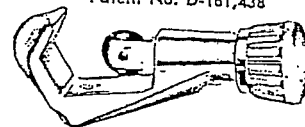
No. 274-F Hi-Duty Tube Cutter for $\frac{1}{4}$ " to 1" O.D. tubing, inclusive. Net wt. 6 oz.

No. 274-FW Same as No. 274-F except includes a spare cutting wheel which is carried in recess in body, under reamer.

No. 312-F Hi-Duty Tube Cutter for $\frac{1}{4}$ " to $1\frac{1}{2}$ " O.D. tubing, inclusive. Net wt. 7 oz.

Imperial Junior Tube Cutter

Patent No. D-161,438



No. 227-F

An economical, smaller sized tube cutter—only $3\frac{1}{2}$ " overall length. Extremely handy to carry; can be used in hard-to-get-at places.

Takes sizes from $\frac{1}{8}$ " to and including $\frac{3}{4}$ " O.D. Makes a quick, clean, square cut; will not flatten tubing. Sturdily constructed.

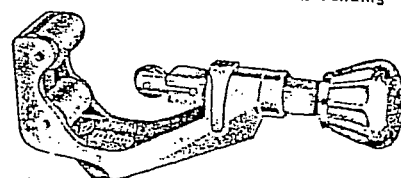
Enclosed feed mechanism protects threads against dirt and damage. Length of tool remains same regardless of size of tubing being cut.

No. 227-F Junior Tube Cutter. Cuts $\frac{1}{8}$ " to $\frac{3}{4}$ " O.D. tubing, inclusive. Net wt. 5 oz.

IMPERIAL *Hi-Duty*®

Adjust-o-matic Tube Cutter

Pat. No. D-161,438. Other Patents Pending



206-F

A tube cutter which covers an exceptionally wide range of sizes. Makes a clean, right angle cut in hard or soft copper, brass, aluminum, thin-wall steel, block tin and lead tubing. Takes all sizes from $\frac{3}{8}$ " to $2\frac{1}{4}$ " O.D. ($\frac{3}{8}$ " to $2\frac{1}{4}$ " nominal.)

Instant adjustment to tubing size. Just push on handle to slide cutting wheel down to tubing size. Cutting wheel is then fed in conventional manner by turning operating handle. Pressing down release on ratchet mechanism permits cutter to be opened instantly to maximum size.

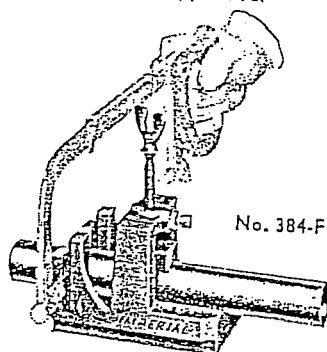
Has enclosed feed mechanism. Threads protected against damage and dirt, assuring lasting, easy operation. Tube rolls on rollers for easy operation. Large fluted handle for secure grip. Aluminum alloy body. High strength, light weight, easy to handle.

No. 206-F Hi-Duty Adjust-o-matic Tube Cutter for $\frac{3}{8}$ " to $2\frac{1}{4}$ " O.D. tubing. ($\frac{3}{8}$ " to $2\frac{1}{4}$ " nominal.) Overall length closed, $6\frac{3}{4}$ ". Net wt. 1 lb., 7 oz.

IMPERIAL TUBE WORKING HANDBOOK

Imperial Sawing Vise Quick Slide-to Size Clamping

Patents Applied For



No. 384-F

Easily and quickly clamps tubing and holds it securely for making perfect right angle cuts with a standard hacksaw. For use with all kinds of metal tubing, hard or soft temper. Excellent for cutting heavy wall tubing. Also recommended for cutting stainless steel and titanium tubing, as it does not work harden the tubing.

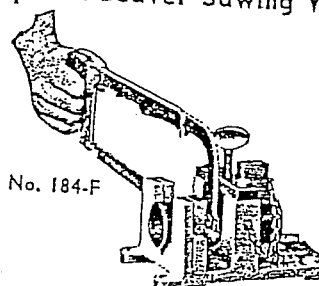
Has a quick clamp adjustment provided by spiral ratchet mechanism on clamping screw. Pushing on screw slides clamping block down to tubing. Only one turn of thumb screw then clamps tubing securely without marring, crushing or flattening. Ratchet release for spiral ratchet mechanism allows clamp to be pulled up instantly to release tubing.

No. 384-F Sawing Vise for $\frac{3}{16}$ " to $1\frac{1}{2}$ " O.D.
Tubing. Wt. $2\frac{1}{2}$ lbs.

Extra Parts for Imperial Tube Cutters

Part No. For Tool Nos.	Part No. For Tool Nos.
CUTTING WHEELS	REAMER BLADES
32633 127-F, 227-F, 212-F	97-F 174-F, 212-F,
274-F, 94-F,	94-F
104-F, 174-F	60225 274-F, 312-F
33045 204-F, 206-F	
60769 312-F	
SCREWS FOR CUTTING WHEELS	SCREWS FOR REAMER BLADE
26383 127-F, 227-F, 212-F	31296 174-F, 212-F, 94-F
274-F, 94-F,	60233 274-F, 312-F
104-F, 174-F,	
312-F	
33046 204-F	SPRING WASHER FOR REAMER BLADE
61936 206-F	60232 274-F, 312-F

Imperial-Beaver Sawing Vises



No. 184-F

These sawing vises are especially serviceable for cutting the larger sizes of pipe and tubing. The vise holds pipe or tubing firmly and provides a guide for a standard hacksaw, thus making possible perfect right angle cuts. The holding pressure is so applied that the tubing will not be crushed, marred or flattened. Can be used for hard or soft tubing.

Vises have removable steel inserts. The combined range of the two vises is from $\frac{3}{16}$ " O.D. to 4" O.D.

No. 184-F Sawing Vise for $\frac{3}{16}$ " to $2\frac{3}{8}$ " O.D.
Tubing. Net wt. approx. $10\frac{1}{2}$ lbs.

No. 185-F Sawing Vise for $1\frac{1}{2}$ " to 4" O.D.
Tubing. Net wt. approx. 22 lbs.

13. SELECTING YOUR FLARING TOOLS

Basic considerations in selecting flaring tools are sizes of tubing to be flared, kinds of tubing to be flared, whether 45° or 37° flares are required, whether single or double flares are to be made, whether burnishing of flare and freedom from scoring of tubing are desired, weight and compactness of tool, simplicity of operation and sturdiness of construction.

For example, in refrigeration service work, where copper tubing is to be flared and where sizes of tubing frequently range from $\frac{3}{16}$ " to $\frac{5}{8}$ " O.D., a tool like the Imperial No. 195-FS, No. 300-F, or No. 500-F is usually best.

On the other hand, for automotive service work with copper tubing, the No. 193-F, which handles $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", and $\frac{5}{8}$ " O.D. tubing, usually is preferable.

When it is necessary to make 37° flares which conform to J.I.C. specifications, a flaring tool like the Imperial No. 437-F, 537-F or 637-F (depending on size of tubing to be flared) is desirable.

IMPERIAL TUBE WORKING HANDBOOK

Burnishing of Flares

The smooth, burnished face on a flare that will give you far tighter flared fitting joints is one of the plus values you get with the Imperial No. 500-F Rol-Air Flaring Tool which flares $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tubing. This tool burnishes the flare face at the same time the flare is being made by means of the multi-faced flaring cone as described on page 20.

The Imperial No. 400-F Flaring Tool makes precision 37° flares in conformity with aviation standard AND 10061. By means of rollers, it rolls out flares in the air above die block and burnishes them to provide a smooth and true surface on the flare.

Freedom from Scoring

Freedom from scoring is another plus value of the No. 500-F, No. 400-F and No. 537-F Flaring Tools. Many engineers consider this an important advantage in making extra strength flares. These tools have smooth surface dies that will not score the tubing. And since these tools form flares with the tubing extended above the face of the die block the original wall thickness is maintained at the base of the flare, also highly important in assuring stronger flares which stand up longer under vibration.

Swivel Cones

When flaring tubing above $\frac{1}{2}$ " O.D. with tools having conventional flaring cones it is recommended that a tool with swivel type flaring cone be used. In this type of tool the cone remains stationary while the screw is turned. This minimizes friction and makes flaring far easier, especially on larger sizes of tubing. The Imperial Nos. 95-FS, 193-FS, 195-FS, 300-F, 103-FS and 203-FS are tools of this type.

Double-Flaring

The above assumes that a single flare is desired. In the event thin-wall steel tubing (such as Bundy) is to be flared, the double-flaring tool is recommended to insure against cracking or splitting of the tubing. Imperial Nos. 93-FB, 251-F and 255-F are outstanding tools of this type. Double flares also offer certain advantages with other tubing (see page 10).

Sturdiness Is Important

Finally, in selecting a flaring tool, don't neglect sturdiness. It is easy to see that a

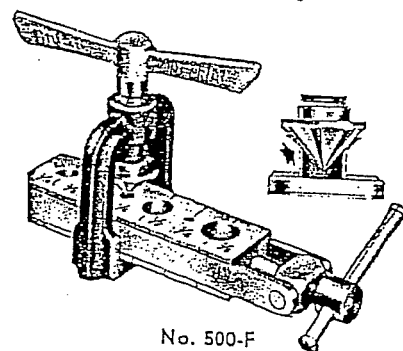
tool which has a forged steel yoke and a solid steel bar or die holder offers substantial advantages in this regard as compared to tools formed from sheet metal which may become deformed through usage.

IMPERIAL 45° FLARING TOOLS

Imperial *ROL-AIR** Flaring Tool (45° Flare)

With Automatic Burnishing Action

Pat. Nos. 2,505,665; 2,505,666; 2,534,510
Other Patents Pending



No. 500-F

Faceted Flaring Cone Rolls Out Flare Above Die Block.

Rolls 45° S.A.E. flares in the air and then automatically burnishes them to produce the finest flares we have ever seen.

Super-smooth, multi-faced flaring cone with tool chrome finish, rolls out the 45° flare above die block.

When backing off cone after flare is made, this tool automatically performs a burnishing action and gives flare a highly polished finish.

Because flare is not formed against die block, original wall thickness is maintained at base of flare and there is no chance of "washing out" flare. Stronger flares, which stand up far longer under vibration, are assured.

Heat treated, smooth surface dies clamp the tubing in die block without scoring it. A single convenient screw at the end provides easy tightening. Dies can also be used for rerounding and sizing tubing. Tool has forged steel yoke.

No. 500-F Imperial Rol-Air Flaring Tool.
Flares $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tubing. Wt. 1 $\frac{1}{2}$ lbs.

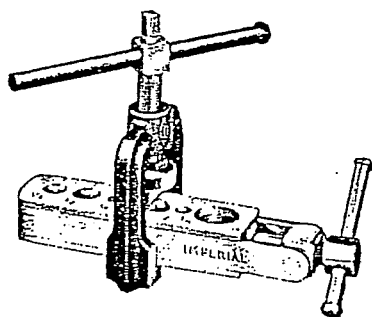
*Trade Mark

IMPERIAL TUBE WORKING HANDBOOK

Imperial **Hi-Duty**® Flaring Tool (45° Flare)

Speedy, Single-Lever Clamping . . .
More Compact . . . Easier to Use

Pat. Nos. 2,072,359; 2,505,665; 2,505,666; 2,534,510.
Other Patents Pending



No. 300-F



Fig. 1



Fig. 2

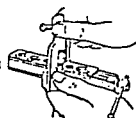


Fig. 3

This Hi-Duty tool makes precision S.A.E. flares faster and more easily. Flares $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. soft copper, brass and aluminum tubing.

In place of the usual bar, this tool has a new die holder with sliding dies for clamping the tubing. Only one screw at the end to tighten.

Operation is fast and simple:

(Fig. 1) Insert tubing between segments of proper size die block.

(Fig. 2) Swing cam action clamp into position against end die and tighten screw.

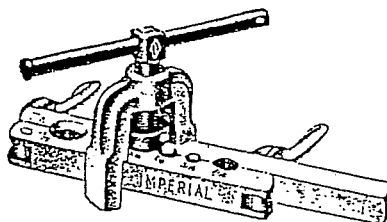
(Fig. 3) Slide yoke over end of die holder into position, and turn compressor screw down firmly. The result is a precision 45° flare.

Sliding yoke is made of forged steel; steel dies are heat treated. Special non-slip feature assures against slippage of tubing in bar. Tool is extra strong and durable.

No. 300-F—Hi-Duty Flaring Tool. Flares $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tubing. Net wt. approx. 1 $\frac{3}{8}$ lbs.

Imperial Flaring Tool With Slip-on Yoke (45° Flare)

Pat. Nos. 1,724,697; 2,072,359; 2,278,932
Other Patents Pending



No. 195-F

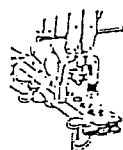


Fig. 4

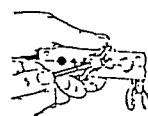


Fig. 5

This Imperial Flaring Tool with quick slip-on yoke provides exceptional ease and speed of operation.

The yoke is made so that it can be slipped on over the bar without twisting or turning. (Fig. 4) The inside edges of the yoke are slotted so that once in position a slight turn holds it in place on the bar. (Fig. 5)

An additional advantage of this tool is the construction of the bottom of the yoke, which permits flares to be made where there is little space between nut and the end of tubing.

Positive grip of tubing in bar by means of special non-slip feature.

Flares soft copper, brass or aluminum tubing. Yokes are made of forged steel. Furnished either with cone which rotates with the screw or with swivel cone. The latter type remains stationary while screw is turned. Rod handle is removable. Net wt. approx. 1 $\frac{1}{2}$ lbs.

No. 193-F Imperial Flaring Tool, flares $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tubing.

No. 193-FS Same as 193-F, except with Swivel Cone.

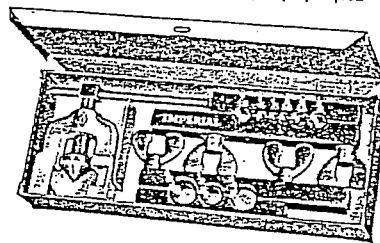
No. 195-F Imperial Flaring Tool, flares $\frac{1}{4}$ ", $\frac{1}{8}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tubing.

No. 195-FS Same as 195-F, except with Swivel Cone.

IMPERIAL TUBE WORKING HANDBOOK

Imperial Wide-Range Flaring Tool For Tubing from $\frac{1}{8}$ " to $\frac{3}{4}$ " O.D. (45° Flare)

Pat. Nos. 1,724,697; 2,072,359; 2,278,932



No. 375-FS

With this one flaring tool you can flare 9 different sizes of soft copper, brass or aluminum tubing. Tool consists of two flaring bars and one yoke. One bar flares $\frac{1}{8}$ ", $\frac{1}{16}$ ", $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. sizes. Other bar flares $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " O.D. sizes.

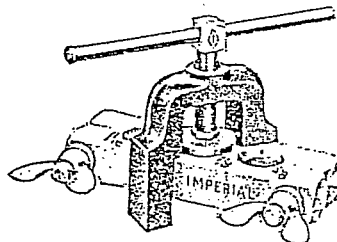
Yoke is made of forged steel, is self-centering and has latest type slip-on feature. Inside edges of yoke are slotted so that once in position slight turn holds it in place. Has swivel cone for easier operation.

No. 375-FS—For $\frac{1}{8}$ ", $\frac{1}{16}$ ", $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " $\frac{5}{8}$ " and $\frac{3}{4}$ " O.D. tubing. Complete in metal kit. Wt. approx. 4 $\frac{3}{4}$ lbs.

No. 376-FS—For $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " O.D. tubing. Wt. 2 lbs.

Imperial Flaring Tools (45° Flare) For Larger Sizes of Tubing

Pat. Nos. 1,724,697; 2,072,359; 2,278,932



No. 203-FS

Flaring of larger sizes of tubing for S.A.E. flared joints is made extremely sim-

ple by these heavy duty flaring tools. Ideal for large tubing jobs on plumbing work, refrigeration and other applications where larger sizes of tubing are involved.

Tools have latest type quick slip-on yoke which can be slipped over the bar without twisting or turning. A slight turn holds it in place.

Wing nuts have new Imperial swivel cups to minimize friction and give easier, more secure tightening. Yoke has swivel cone—an important aid to easier operation.

No. 203-FS—Flares $\frac{5}{8}$ ", $\frac{3}{4}$ " and $1\frac{1}{8}$ " O.D. Tubing. Net wt. 3 $\frac{3}{4}$ lbs.

No. 103-FS—Flares $\frac{3}{4}$ ", $\frac{5}{8}$ " and 1" O.D. Tubing. Net wt. 3 $\frac{3}{4}$ lbs.

Imperial Combination "Double-Flaring" and "Single-Flaring" Tool (45° Flare)

Pat. Nos. 1,724,697; 2,072,359; 2,370,089
Other Patents Pending

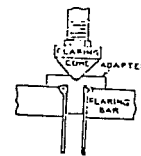
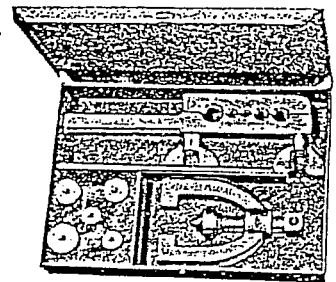


Fig. 6



Fig. 7



No. 93-FB

This tool provides a simplified method of making 45° double-flares on $\frac{3}{16}$ ", $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. thin-wall, soft steel tubing (such as Bundy). Handles seamless, butt-welded or lap-seam-brazed tubing having not over .035" wall. Can be used also for making single or double flares on soft copper, brass or aluminum tubing.

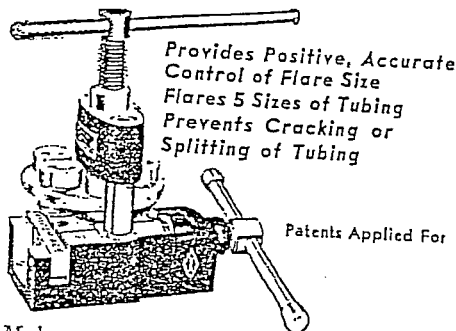
The tendency of welded and brazed steel tubing to crack when flared with the ordinary single flaring tool is overcome by this tool because it folds back the end to make a flare with double-thick, double-strength walls.

Tool is small—convenient to work with—can be used right on the job. Tool first bells tubing, using adapter as shown in Fig. 6, then completes flare in same manner as a conventional flaring tool, Fig. 7.

No. 93-FB Imperial Double-Flaring Tool for $\frac{3}{16}$ ", $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. tubing. Complete in metal kit. Wt. 3 lbs.

IMPERIAL TUBE WORKING HANDBOOK

Imperial Double-Flaring Tool For Making Precision 45° Double-Flares



Provides Positive, Accurate
Control of Flare Size
Flares 5 Sizes of Tubing
Prevents Cracking or
Splitting of Tubing

Patents Applied For

Makes accurate 45° S.A.E. double lap flares on soft steel tubing (such as Bundy), having not over .040" wall. Can also be used for making single or double flares on soft copper or aluminum tubing, a special advantage when joints are to be reconnected frequently.

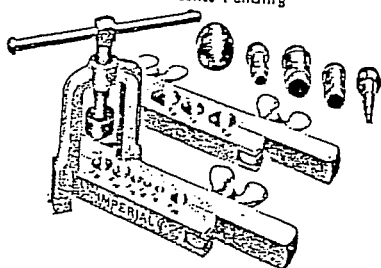
Adapters for first forming operation serve as a positive gage for positioning tubing in die block. Thus correct size flare is assured every time. Adapters always line up properly with tubing. Tool prevents cracking or splitting of tubing because it folds over end to make flare with double-thick, double-strength walls.

Tool is completely integrated, has no extra parts to be lost. Designed for easy operation on the job or in the shop. Adapters for various sizes revolve into position and make changing from one size to another simple and quick.

No. 251-F—Imperial Double-Flaring Tool for $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. tubing. Wt. 2½ lbs.

Imperial Flaring and Swedging Tool (45° Flare)

Pat. Nos. 1,724,677; 2,072,359; 2,278,932; 2,493,127
Other Patents Pending



No. 275-FS

A tool that will flare or swedge soft cop-

per, brass or aluminum tubing. Flares $\frac{1}{8}$ " to $\frac{3}{4}$ " O.D. tubing. Swedges sizes of $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " O.D.

Has Imperial's famous slip-on yoke which clamps in place by a slight turn in clockwise direction. Yoke is made of forged steel.

Parts include two bars to cover range of 9 sizes, yoke, adapters for swedging and spreader cone for flaring. Swedging adapters and spreader cone work on a swivel, making operation exceptionally easy.

No. 275-FS—Tool complete with flaring cone and 4 swedge adapters. Wt. 3½ lbs.

No. 276-FS—Tool and Flaring Cone only. Wt. approx. 3¼ lbs.

No. 278-FS—Individual Adapters. (Specify size. Small adapter swedges $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ " O.D. One adapter for each other size.) Wt. ¼ oz.

Extra Parts for Imperial Flaring Tools

YOKE ASSEMBLIES

Part No.	For Tool Nos.	Part No.	For Tool Nos.
33465	93-F, 95-F	37677	295-FS
38379	95-FS, 93-FS	39859	300-F
32638	175-F, 93-FB	38769	375-FS
36273	193-F, 195-F	38903	103-FS, 203-FS
37369	195-FS, 193-FS	61637	500-F
38593	275-FS, 276-FS		

COMPRESSOR CONES

25384	93-F, 95-F,	32640	175-F, 375-FS
	193-F, 195-F		93-FB
32532	95-FS, 93-FS,	38904	103-FS,
	193-FS,		203-FS,
	195-FS,	38600	275-FS,
	295-FS, 300-F	61639	276-FS,
			500-F

WING NUTS

36584	93-F, 93-FS,		275-FS,
	93-FB, 95-F		276-FS,
	95-FS, 175-F,		375-FS
	193-F, 193-FS,	38588	103-FS, 203-FS
	195-F, 195-FS		

BAR ASSEMBLIES

30077	93-F, 93-FS	38767	375-FS,
30231	95-F, 95-FS		275-FS,
34277	193-F, 193-FS		276-FS for
36279	195-F, 195-FS		$\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ "
37688	295-FS	38906	103-FS
38766	375-FS,	38381	93-FB
	275-FS,	60516	203-FS
	276-FS	61851	500-F
	for $\frac{1}{8}$ ", $\frac{1}{4}$ ",	61893	300-F
	$\frac{1}{2}$ ", $\frac{3}{4}$ ", $\frac{5}{8}$ ",		
	$\frac{3}{4}$ "		

ADAPTERS FOR DOUBLE FLARING

38388	93-FB, $\frac{1}{8}$ "	38385	93-FB, $\frac{3}{8}$ "
38387	93-FB, $\frac{1}{4}$ "	38384	93-FB, $\frac{1}{2}$ "
38386	93-FB, $\frac{3}{8}$ "		

RIVET FOR BAR ASSEMBLIES

30009	93-F, 95-F,	195-FS, 105-F,
	95-FS, 193-F,	105-FF
	193-FS, 195-F,	

IMPERIAL TUBE WORKING HANDBOOK

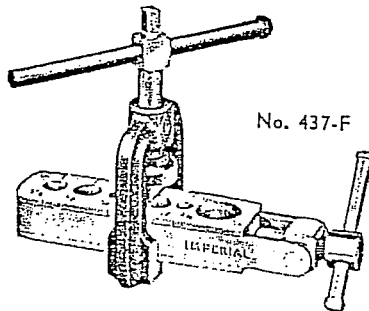
Extra Parts—(Continued)

BOLT FOR BAR ASSEMBLIES			
Part No.	For Tool Nos.	Part No.	For Tool Nos.
36849	93-F, 95-F,	275-FS,	
36850	193-F, 193-FS,	276-FS,	
	195-F, 195-FS,	376-FS	
	95-FS, 93-FB,		

IMPERIAL 37° FLARING TOOLS

Imperial No. 437-F 37° Flaring Tool
For Flaring Soft Steel Tubing to J.I.C. Standards. Also for Making 37° Flares on Copper, Aluminum, and Fully Annealed Stainless Steel Tubing.

Pat. Nos. 2,072,359; 2,505,665; 2,505,666; 2,534,510
Other Patents Pending



No. 437-F

Makes 37° flares which conform to specifications set up by the Joint Industry Conference on Hydraulic Standards for Industrial Equipment.

Will handle 6 sizes of tubing— $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " O.D. This tool has the new type die holder with heat treated, sliding dies for clamping tubing. A single lever at end of die holder provides easy tightening.

Yoke of tool quickly slides over end of die holder into position over tubing to be flared, and an accurate flare can be made with a minimum of time and effort. (For diagrams of operation, see description of No. 300-F Hi-Duty Flaring Tool.)

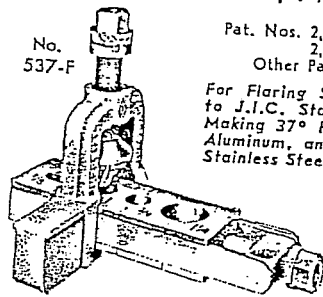
No. 437-F Imperial 37° Hi-Duty Flaring Tool. Flares $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. Tubing. Net wt. 1½ lbs.

Imperial Rol-Air 37° Flaring Tool

Has same features as described for No. 500-F on page 20. Flares soft copper and aluminum tubing.

No. 507-F Flares $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tubing. Wt. 1½ lbs.

Imperial No. 537-F 37° Flaring Tool
For $\frac{3}{4}$ ", $\frac{7}{8}$ ", 1", 1¼" O.D. Tubing
No. 637-F for 1½", 1¾", 2" O.D.



Pat. Nos. 2,505,665; 2,505,666;
2,534,510
Other Patents Pending

For Flaring Soft Steel Tubing to J.I.C. Standards. Also for Making 37° Flares on Copper, Aluminum, and Fully Annealed Stainless Steel Tubing.

37° flares are rolled out in the air above die block by means of three rollers in spreader cone. These rollers reduce amount of torque required, an important advantage in flaring large sizes of tubing.

When cone is backed off after flare is made, feed is disengaged during first revolution, causing three rollers to perform a burnishing action and give flare a smooth finish, assuring tighter joints. Because flare is not formed against die block, original wall thickness is maintained at base of flare.

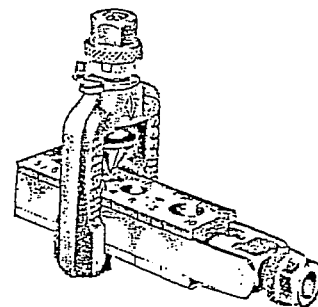
Heat treated, smooth surface dies clamp tubing securely without scoring it.

No. 537-F Imperial 37° Rol-Air Flaring Tool. Flares and burnishes $\frac{3}{4}$ ", $\frac{7}{8}$ ", 1" and 1¼" O.D. Tubing. Net wt. 5 lbs.

No. 637-F Imperial 37° Rol-Air Flaring Tool. Flares and burnishes 1½", 1¾" and 2" O.D. Tubing. Net wt. 13 lbs.

Imperial No. 400-F 37° Flaring Tool Makes Flares to AN Standards

With Flare Control Gage and Burnishing Action. For Stainless Steel, Steel, Titanium and All Other Metal Tubing



Pat. Nos.
2,505,665;
2,505,666;
2,534,510
Other Patents
Pending

No. 400-F

Rolls out precision 37° flares in conform-

IMPERIAL TUBE WORKING HANDBOOK

ity with aviation standard AND 10061. Flares 6 sizes of high strength stainless steel (including MIL-T-6845), titanium and all other kinds of metal tubing— $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D.

A special gage incorporated in this tool controls insertion of tube and travel of compressor screw, thereby assuring a precision flare of the correct dimensions every time.

Flares are rolled out in the air above die block, instead of being formed against block as with the ordinary flaring tool. When flares are formed in this manner, original wall thickness is maintained at base of flare.

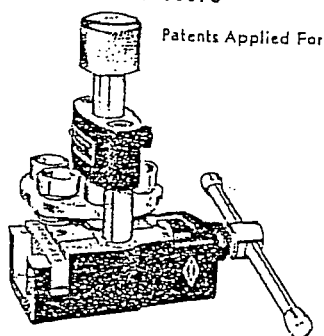
When backing off cone after flare is made, feed is disengaged during first revolution, causing rollers in cone to perform a burnishing action and provide a smooth, true surface on the flare.

Heat treated, smooth surface dies clamp the tubing securely without scoring it, thus eliminating weakness at this point. Has a single, convenient clamping screw at end of die holder.

No. 400-F Imperial 37° Flaring Tool. Flares and burnishes $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. Tubing. Furnished in steel kit. Net wt. 2 lbs., 9 oz.

No. 402-F Flaring and Reaming Kit. (For best results, No. 401-F Reamer should be used to remove all burrs before making a flare.) Contains No. 400-F Flaring Tool and No. 401-F Reaming Yoke. Reams $\frac{1}{4}$ " to $\frac{5}{8}$ " O.D. Tubing. Furnished in steel kit. Wt. 3 lbs., 2 oz.

Imperial 37° Double-Flaring Tool
Makes Flares to Aviation Standard
AND 10078



Patents Applied For

Makes precision 37° double lap flares in soft aluminum or soft copper tubing. Handles $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. tubing. Accuracy is controlled. Adapters for first

forming operation serve as a positive gage for positioning tubing in die block. Thus the correct size flare is assured every time. Adapters always line up properly with tubing.

Tool folds over end of tubing to make flare with double-thick, double-strength walls. Double flares eliminate much of danger of weakening flares through over-tightening—make possible repeated, tight reconnections.

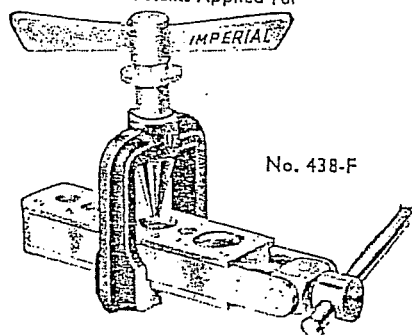
Heat treated, smooth surface dies clamp tubing securely without scoring it, thus eliminating weakness at this point.

Tool is compact, light weight, hand operated. Completely integrated, has no extra parts to be lost. Designed for easy operation with hammer on the job or in the shop. No. 255-F—Imperial Double-Flaring Tool for $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. tubing. Wt. 2 lbs.

14. IMPERIAL REAMING AND DEBURRING TOOLS

Imperial Reaming and Deburring Tools
With Precision Feed Control

Patents Applied For



No. 438-F

Illustration shows Reaming Yoke on bar. Order bar separately.

For removing inner burrs on all kinds of tubing, including steel and stainless steel. There is no finer tool for preparing tubing for perfect flares.

Especially adapted for hydraulic, aviation and other exacting tubing connection work.

Reamer is made of hardened tool steel with tapered cutters ground sharp to precise cutting angles. Knurled-head feed

IMPERIAL TUBE WORKING HANDBOOK

screw has fine threads for sensitive control of feeding action. Forged steel yoke is self-centering.

After burr is removed, tubing can be repositioned and flared in same bar by substituting flaring yoke for the reaming yoke.

Reaming Yokes Only

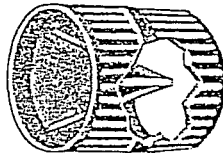
No. 438-F Reaming Yoke only. (Does not include bar.) For $\frac{1}{4}$ " to $\frac{5}{8}$ " O.D. Tubing. Can be used with flaring bars furnished with Imperial Flaring Tools No. 437-F, No. 500-F or No. 300-F. Wt. $\frac{5}{8}$ lb.

No. 538-F Reaming Yoke only. (Does not include bar.) For $\frac{3}{4}$ " to $1\frac{1}{4}$ " O.D. Tubing. For use with bar furnished with Imperial No. 537-F Flaring Tool. Wt. 1 $\frac{1}{4}$ lbs.

No. 401-F Reaming Yoke only. (Does not include flaring bar.) For $\frac{1}{4}$ " to $\frac{5}{8}$ " O.D. Tubing. For use with No. 400-F Flaring Tool Bar.

Imperial Inner and Outer Reamer

Pat. No.
2,242,821



No. 208-F

A convenient tool which makes possible a rapid and efficient reaming job on both the inside and the outside edges of copper, brass or aluminum tubing.

Tubing is introduced from one end of tool for inside reaming, and from the other end for outside reaming. The tool cuts in either direction and is self-centering. It has three hardened, hollow ground tool steel cutters. The cutters are protected against damage when not in use by outside shell of tool. Body is knurled for easy handling.

Takes all sizes of tubing from $\frac{1}{16}$ " O.D. to $1\frac{1}{2}$ " O.D. Wt. approx. $\frac{5}{8}$ lb.
No. 208-F—Inner and Outer Reamer.

15. CHOOSING YOUR TUBE BENDERS

In selecting a tube bender it is necessary to consider a number of factors such as type of tubing to be bent; sizes of tubing to be bent; volume of bending work to be done;

and location of bends to be made. It is important to select tools which are strong, yet light in weight, and which provide plenty of leverage and other features which simplify operation.

If only a small amount of bending work is done, if the tubing to be bent is thin wall, soft temper, and if uniformity of bending radius is not important, it is possible that a spring type bender will be satisfactory. These benders (such as Imperial No. 102-F) are quite economical and can be furnished for sizes from $\frac{1}{4}$ " to $\frac{5}{8}$ " O.D. Convenient sets are also available.

Mandrel Type Benders

Where any considerable amount of bending is to be done and where a uniform radius on bends is desired it usually is best to use a mandrel type bending tool.

These benders are of either the lever or gear type. Such tools make accurate bends without deforming the tubing, and assure that all bends on a given size of tubing will be made to a uniform radius. Imperial Nos. 364-FH, 350-F, 360-F, 260-F, 361-FA, 362-FA and 363-FA are mandrel benders of the lever type. Nos. 270-F and 600-F are mandrel benders of the gear type.

If it is necessary to make bends on tubing which has been partially connected, it is essential that an open-side bender be used. This type of bender can be slipped over the tubing at any point and can be used in hard-to-get-at places. All Imperial mandrel-type tube benders are made so that they can be slipped over the tubing at any point desired.

Lever-Type Benders

All of the Imperial lever type tube benders will bend soft copper, aluminum, steel or other soft, thin-wall metal tubing. No. 364-FH can also be used for bending hard drawn copper, steel, thin-wall conduit, and stainless steel tubing.

Gear-Type Benders

Imperial gear-type tube benders will bend any type of tubing, hard or soft temper. For general purpose work, the No. 270-F is usually the choice. For bending stainless steel tubing in aircraft installations, and other precision bending work, the No. 600-F is used.

IMPERIAL TUBE WORKING HANDBOOK

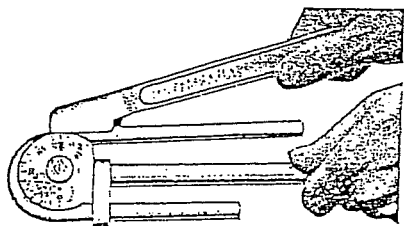
Gear benders are especially desirable for larger sizes of tubing and for the tougher bending jobs because of their high gear ratio which makes bending easier.

Multi-Size Bending Tools

If it is essential that you have one bending tool that can be used for bending a number of different sizes of tubing, a tool like the Imperial No. 260-F, No. 350-F or No. 360-F should be selected. These benders will make several types of tubing by simply changing the mandrel and adjusting the block.

IMPERIAL BLUE DOT LEVER-TYPE TUBE BENDERS

Bend Both Hard and Soft Tubing
For $\frac{1}{8}$ " to $\frac{3}{4}$ " O.D. Tubing



No. 364-FH

Imperial's widely used lever-type tube benders have exclusive new design features which will enable them to bend hard drawn copper, steel (including J.I.C.), aluminum and stainless steel tubing and thin wall conduit, in addition to soft tubing.

These smoothly operating tube benders turn neat, accurate bends to a short radius in a minimum of time without marring or deforming the tubing. They are convenient, open-side benders which slip over the tubing at the exact point where bend is desired. This feature makes them especially handy in hard-to-get-at places where tubing has been partially connected.

Bends can be made to any angle up to 180°. Calibrated to show degree positions. Different size of bender is required for each size of tubing. $\frac{3}{4}$ " size has offset handle. Bender is extremely rugged and durable, yet light in weight.

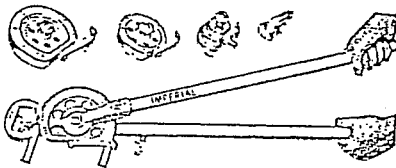
Benders for $\frac{5}{8}$ " and $\frac{3}{4}$ " O.D. tubing are slightly different in construction from illustration.

Cat. No.	O.D. of Tubing	Nom. Size	Radius to Center of Tube	Weight, Approx. Each
364-FH	$\frac{3}{8}$ "†	----	$\frac{1}{8}$ "	9 Oz.
364-FH	$\frac{1}{4}$ "	$\frac{1}{8}$ "	$\frac{1}{8}$ "	$\frac{3}{4}$ Lb.
364-FH	$\frac{5}{16}$ "	----	$\frac{1}{8}$ "	1 $\frac{1}{4}$ Lbs.
364-FH	$\frac{3}{8}$ "	$\frac{1}{4}$ "	$\frac{1}{8}$ "	1 $\frac{3}{4}$ Lbs.
364-FH	$\frac{1}{2}$ "	$\frac{3}{8}$ "	1 $\frac{1}{2}$ "	1 $\frac{3}{4}$ Lbs.
364-FH	$\frac{5}{8}$ "	$\frac{1}{2}$ "	2 $\frac{1}{4}$ "	10 Lbs.
364-FH	$\frac{3}{4}$ "	$\frac{5}{8}$ "	3"	10 $\frac{1}{2}$ Lbs.

†Can also be used for $\frac{1}{8}$ " tubing.

Imperial Full Range Heavy-Duty Tube Bending Tools

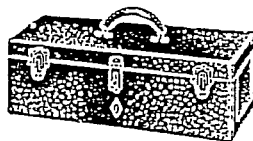
Pat. No. 2,171,907



No. 260-F Bends
7 Sizes of Tubing

No. 350-F Bends
6 Sizes of Tubing

No. 360-F Bends
4 Sizes of Tubing



Bender furnished in steel chest.

Each of these tools is quickly adapted for bending the various sizes within its range, as described above, by simply changing the forming wheel and block.

Will make right or left hand bends up to 180° in soft copper, aluminum, steel or other soft, thin-wall metal tubing.

Long handles provide good leverage. When bending sizes larger than $\frac{3}{4}$ " O.D., handle can be lifted and repositioned during course of bend so that best leverage is obtained at all times. Tubing is removed easily after bend is completed.

Calibrated to show degree positions. Bender can be positioned on tubing at exact point bend is needed. Furnished in steel chest.

IMPERIAL TUBE WORKING HANDBOOK

No. 260-F—Imperial Full Range 7-in-1 Tube Bending Tool for $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ ", $\frac{7}{8}$ " O.D. Tubing. (Nominal sizes $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ ".) Wt. 23 lbs.

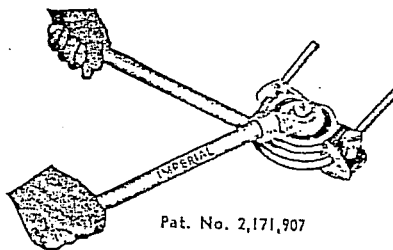
No. 350-F—Imperial Full Range 6-in-1 Tube Bending Tool for $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ " O.D. Tubing. (Nominal sizes $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ".) Wt. 20 lbs.

No. 360-F—Imperial 4-in-1 Tube Bending Tool for 4 sizes of tubing— $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ " O.D. (Nominal sizes $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ".) Wt. 20 lbs.

Bending Radii

O.D.	Radii			O.D.	Radii		
	260-F	350-F	360-F		260-F	350-F	360-F
$\frac{1}{4}$ "	$\frac{3}{4}$ "	$\frac{3}{4}$"	....	$\frac{5}{8}$ "	$2\frac{1}{2}$ "	$2\frac{1}{4}$ "	$2\frac{1}{4}$ "
$\frac{5}{16}$ "	1"	1"	....	$\frac{3}{4}$ "	3"	3"	3"
$\frac{3}{8}$ "	$1\frac{1}{4}$ "	$1\frac{1}{4}$ "	$1\frac{5}{8}$ "	$\frac{7}{8}$ "	3"	....	....
$\frac{1}{2}$ "	2"	$1\frac{5}{8}$ "	$1\frac{5}{8}$ "				

Imperial 2-in-1 Tube Benders



Dual Size Shoe and Forming Wheel

Easy operating tube benders, which make neat, accurate bends in soft copper, aluminum, steel or other soft, thin-wall metal tubing.

Benders can be positioned on tubing at exact point bend is needed. Handle can be lifted and repositioned during bend so that best leverage is obtained at all times.

Bends can be made to any angle up to 180°; calibrated to show degree positions.

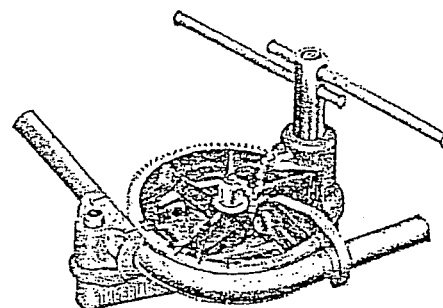
No. 361-FA For $\frac{5}{8}$ " and $\frac{7}{8}$ " O.D. tubing. (Nom. sizes— $\frac{1}{2}$ " and $\frac{3}{4}$ ".) Bending radii: $\frac{5}{8}$ " O.D. tube— $2\frac{1}{2}$ "; $\frac{7}{8}$ " O.D.—3".

No. 362-FA For $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tubing. (Nom. sizes— $\frac{3}{8}$ " and $\frac{1}{2}$ ".) Bending radii: $\frac{1}{2}$ " O.D. tube—2"; $\frac{5}{8}$ " O.D.— $2\frac{1}{2}$ ".

No. 363-FA For $\frac{3}{4}$ " and $\frac{7}{8}$ " O.D. tubing. (Nom. sizes— $\frac{5}{8}$ " and $\frac{3}{4}$ ".) Bending radii: $\frac{3}{4}$ " O.D. tube—3"; $\frac{7}{8}$ " O.D.—3".

IMPERIAL GEAR-TYPE BENDERS

Imperial Universal Gear-Type Tube Benders



Sturdy, compact, economically priced benders for use with any type of tubing—hard or soft temper—including hard drawn copper, hard temper, heavy wall steel, stainless steel, aluminum and brass tubing and even iron pipe. They provide a simple time-saving method of making good bends on the job or in the shop.

A bending action similar to the original drawing of tubing, combined with close fitting shoes assures that tubing will not kink or flatten. Benders can be positioned on tube at any point desired. Bends can be made with one end of tube connected as well as when both ends are free. Will make right or left hand bends, return bends, offset bends, right angle bends.

Benders are designed so that they can be held by hand, clamped in a vise or bolted to a bench. Can be used with pipe vise with extension handle No. 271-F.

Specify O.D. Tube Size when Ordering

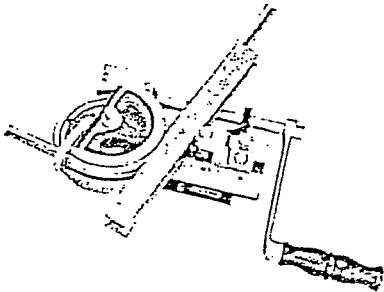
Cat. No.	O.D. of Tube	Nominal Tube Size	Bending Radius to Center of Tube	Minimum Return or Coil Bend from Center of Tubing	Weight in Lbs.
270-F	$\frac{3}{8}$ "	$\frac{1}{4}$ "	$1\frac{3}{4}$ "	$4\frac{1}{2}$ "	3
270-F	$\frac{1}{2}$ "	$\frac{3}{8}$ "	$2\frac{1}{2}$ "	6"	4
270-F	$\frac{5}{8}$ "	$\frac{1}{2}$ "	3"	$7\frac{1}{2}$ "	8
270-F	$\frac{3}{4}$ "	$\frac{5}{8}$ "	4"	$9\frac{1}{2}$ "	15
270-F	$\frac{7}{8}$ "	$\frac{3}{4}$ "	4"	$9\frac{1}{2}$ "	14
270-F	1"	—	4"	$9\frac{1}{2}$ "	14
270-F	$1\frac{1}{8}$ "	1"	4"	$9\frac{1}{2}$ "	14

No. 271-F Extension Handle. Fits all No. 270-F Benders. For use when clamping bender in pipe vise. Wt. $1\frac{1}{4}$ lbs.

IMPERIAL TUBE WORKING HANDBOOK

Imperial No. 600-F Tube Bending Tool

Patents Applied For



For Aircraft Grade High Strength Stainless Steel and All Other Metal Tubing.

A manually operated tube bending tool, designed specifically for bending high strength stainless steel tubing (MIL-T-6845), such as used in aircraft hydraulic systems. Also for bending steel, copper, titanium, aluminum and other metal tubing—hard or soft temper. Tool is portable and can be utilized for field maintenance, at major overhaul stations, or for experimental work. Bends 6 sizes of tubing— $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " O.D.

Tubing will not kink, wrinkle or flatten because of the smooth, worm gear drive which causes an even torque to be exerted throughout the course of the bend. Slippage is avoided through the use of a follow bar which reduces drag on tubing. Cross sectional diameter of tubing at any point on bend and wall thickness in bend section are not reduced appreciably.

Tool is quickly adapted to the various sizes by merely changing forming wheel and follow bar. It is portable and can be clamped in a vise or mounted on a tripod.

Tool will make bends up to 180° in one operation—without resetting or adjusting tubing. Forming wheels are calibrated to indicate degree of bend. Bender can be positioned on tube at any point desired. Makes bends to the practical minimum radii for high strength stainless steel tubing, as recommended by major aircraft companies.

No. 600-F Imperial Tube Bending Tool for $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " O.D. tubing. Furnished in steel kit. Wt. 35 lbs.

Radii of Bends

O.D. of Tube	Radius to Center of Tube	O.D. of Tube	Radius to Center of Tube
$\frac{1}{4}$ "	$\frac{3}{4}$ "	$\frac{1}{2}$ "	2"
$\frac{3}{8}$ "	1"	$\frac{5}{8}$ "	$2\frac{1}{2}$ "
$\frac{1}{2}$ "	$1\frac{1}{4}$ "	$\frac{3}{4}$ "	3"

SPRING-TYPE BENDERS

Imperial Bending Springs External Spring Type



No. 102-F

This spring-type Imperial tube bender is an efficient, low-cost tool for bending tubing by hand to any desired shape without collapsing the tube. The bender consists of an especially prepared spring wire coil and is furnished in six sizes to take $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " and $\frac{3}{4}$ " outside diameter soft copper, aluminum and other soft, thin-wall metal tubing. Springs have an attractive black protective finish. The belled end of the bender assures ease in removing from tubing after bend has been made.

Overall length of $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " benders is 10". $\frac{5}{8}$ ", $\frac{3}{4}$ " benders are 12" overall.

No. 101-F—Set of Six Benders. Wt. 2 $\frac{1}{4}$ lbs.

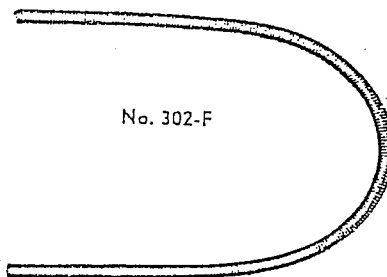
No. 163-F—Set of Four Benders. $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", and $\frac{5}{8}$ ". Weight 1 $\frac{5}{8}$ lbs.

No. 112-F—Set of Three Benders, $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ". Weight $\frac{3}{4}$ lb.

No. 102-F—Individual Benders

Size	Weight, Each	Size	Weight, Each
$\frac{1}{4}$ "	3 oz.	$\frac{1}{2}$ "	6 $\frac{1}{4}$ oz.
$\frac{3}{8}$ "	3 oz.	$\frac{5}{8}$ "	6 $\frac{1}{2}$ oz.
$\frac{1}{2}$ "	4 oz.	$\frac{3}{4}$ "	8 oz.

Inside Bending Spring



No. 302-F

This inside bending spring offers a simple method of bending tubing by hand without collapsing or crimping the tube.

IMPERIAL TUBE WORKING HANDBOOK

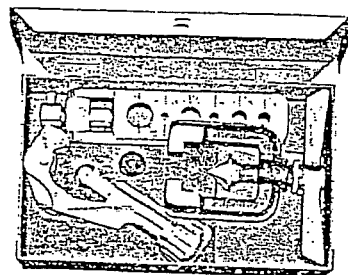
The specially prepared spring wire coil is inserted inside the tubing and bends then can be made quickly and easily to any desired shape. Furnished in three sizes, to take $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ " outside diameter copper, aluminum and other soft, thin-wall metal tubing.

Overall length of bender is 6 feet.

Cat. No.	O.D. of Tube	Approx. Net Wt., Each
302-F	$\frac{3}{8}$ "	$\frac{1}{2}$ lb.
302-F	$\frac{1}{2}$ "	1 lb.
302-F	$\frac{5}{8}$ "	1 $\frac{1}{2}$ lb.

16. TUBING TOOL KITS

Imperial Rol-Air and Hi-Duty Flaring and Cutting Tool Kits (45° Flare)

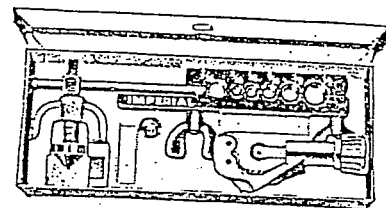


Handy kits which have the latest Imperial flaring tools and tube cutter for copper, aluminum and brass tubing.

Both kits include No. 274-F Tube Cutter for tubing from $\frac{1}{8}$ " to 1" O.D. and No. 32633 extra cutting wheel. Flaring tools included as listed. Packed in steel kit.

Cat. No. of Kit	No. of Flaring Tool Included	No. of Tube Cutter Included	Approx. Weight
123-F	300-F	274-F	3 lbs.
124-F	500-F	274-F	3 lbs.

Imperial Flaring and Cutting Tool Kits (45° Flare)

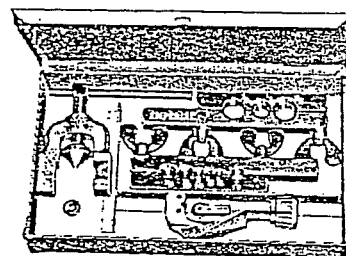


Necessary tools for a quick cutting and flaring job on copper, brass and aluminum tubing are included in these handy kits.

All kits include the No. 274-F Hi-Duty Tube Cutter which handles all sizes of tubing from $\frac{1}{8}$ " to and including 1" outside diameter. This tool makes a clean, right angle cut and leaves no chips or burrs to clog the line. Extra Cutting Wheel No. 32633 for tube cutter included. Packed in steel kit.

Cat. No. of Kit	No. of Flaring Tool Included	No. of Tube Cutter Included	Approx. Weight
225-F	93-F	274-F	3 lbs.
1225-F	193-F	274-F	3 lbs.
226-F	95-F	274-F	3 lbs.
1226-F	195-F	274-F	3 lbs.

No. 120-F Wide Range Flaring and Cutting Tool Kit (45° Flare)



Handles an exceptionally wide range of tubing sizes. Cuts and flares copper, brass and aluminum tubing.

Kit includes:

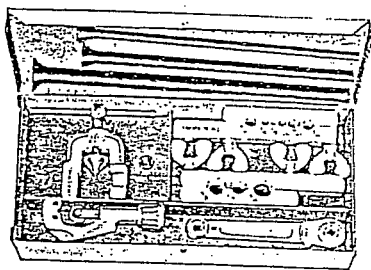
No. 274-F Tube Cutter for tubing from $\frac{1}{8}$ " to 1" O.D. and No. 32633 extra cutting wheel.

No. 375-FS Wide-Range Flaring Tool for tubing from $\frac{1}{8}$ " to $\frac{3}{4}$ " O.D.

No. 120-F Wide-Range Flaring and Cutting Tool Kit. Packed in steel kit. Wt. 5 $\frac{1}{4}$ lbs.

IMPERIAL TUBE WORKING HANDBOOK

No. 121-F Flaring, Cutting and Bending Tool Kit (45° Flare)

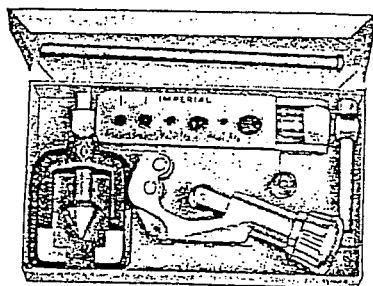


No. 121-F

A handy kit containing the necessary tools to quickly and accurately cut, flare and bend copper, brass and aluminum tubing. Includes No. 123-C Ratchet Wrench; No. 102-F Spring Tube Benders for $\frac{1}{4}$ ", $\frac{1}{2}$ " and $\frac{3}{4}$ " O.D. tubing; No. 274-F Hi-Duty Tube Cutter and No. 375-FS Wide Range Flaring Tool. No. 32633 extra cutting wheel for tube cutter included. Furnished in steel kit.

No. 121-F—Flaring, Cutting and Bending Tool Kit. Approx. Wt. 5 $\frac{3}{4}$ lbs.

Imperial Flaring and Cutting Tool Kit (37° Flare)



Has the necessary tools for cutting and flaring soft steel, copper and aluminum tubing.

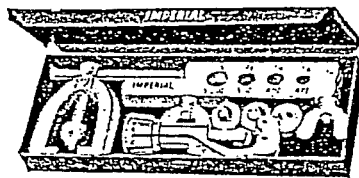
Kit includes:

No. 437-F 37° Flaring Tool for $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{3}{4}$ " O.D. Tubing.

No. 274-F Tube Cutter for tubing from $\frac{1}{8}$ " to 1" O.D. and No. 32633 extra cutting wheel.

No. 122-F Flaring and Cutting Tool Kit. Wt. 2 $\frac{3}{4}$ lbs.

Imperial Block Tin Flaring and Cutting Kit



Contains tools to cut and flare quickly block tin pipe. Includes No. 274-F Hi-Duty Tube Cutter for $\frac{1}{8}$ " to 1" O.D. tin pipe, copper, brass or lead tubing.

Flaring tool gives the proper 90° flare without cracking or splitting the pipe. Flares $\frac{1}{4}$ " I.D. 4 oz.; $\frac{3}{8}$ " I.D. 4 oz.; $\frac{1}{2}$ " I.D. 5 oz., and $\frac{3}{4}$ " I.D. 5 $\frac{1}{2}$ oz. block tin pipe.

Packed in handy kit.

No. MB-S7—Block Tin Flaring and Cutting Kit complete. Net wt. approx. 3 lbs.

No. MB-S6—Block Tin Flaring Tool only. Net wt. approx. 1 $\frac{3}{4}$ lbs.

17. OTHER IMPERIAL TUBING TOOLS YOU SHOULD KNOW ABOUT

IMPERIAL SWEDGING TOOL KIT For Making Joints Without Fittings



No. 195-S

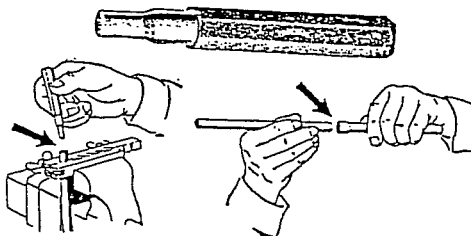


Fig. 1

Fig. 2

Emergency connections are quickly made with this handy swedging tool kit which

IMPERIAL TUBE WORKING HANDBOOK

contains a flaring bar and four different sizes of swedging tools. Two lengths of tubing of the same size are easily joined by enlarging the inner diameter at the end of one of the pieces of tubing (Fig. 1) to permit the insertion of the other (Fig. 2). The two pieces of tubing are then soldered together making a secure joint.

No. 195-S—Kit includes flaring bar and 4 swedging tools for $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tube. Furnished in handy steel box. Approx. wt. 2 lbs.

No. 193-S—Swedging Set includes 4 swedging tools for $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " O.D. tube. Approx. wt. 1 lb.

No. 93-S—Tool for $\frac{1}{8}$ " tube. Wt. 3 oz.

No. 93-S—Tool for $\frac{1}{4}$ " tube. Wt. 3 oz.

No. 93-S—Tool for $\frac{3}{8}$ " tube. Wt. $\frac{1}{4}$ lb.

No. 93-S—Tool for $\frac{1}{2}$ " tube. Wt. $\frac{1}{2}$ lb.

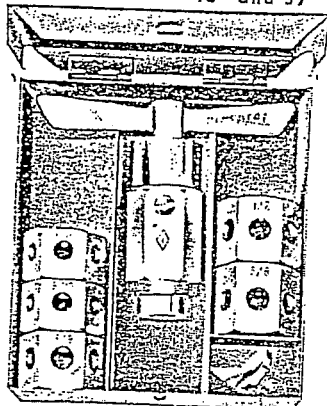
No. 93-S—Tool for $\frac{5}{8}$ " tube. Wt. $\frac{1}{2}$ lb.

No. 93-S—Tool for $\frac{3}{4}$ " tube. Wt. $\frac{3}{4}$ lb.

No. 30231—Flaring Bar only. Wt. 1 lb.

Imperial Refacing Tool

With Precision Feed — 45° and 37° Types




An improved tool for refacing damaged male flare seats on fittings and valves. Makes nicked and marred seats as good as new.

Has precision feed control for cutter so that flare seat is restored to original accuracy and smoothness without gouging or chattering. Cutter is replaceable.

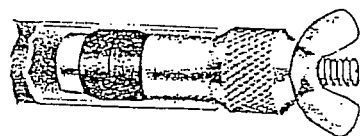
No. 345-F—45° Refacing Tool (illustrated) complete with cutter and adapters for $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " fittings. Furnished in steel kit. Wt. 2 lbs.

No. 337-F—37° Refacing Tool complete with 2 cutters and adapters for $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " and $\frac{5}{8}$ " fittings. Furnished in steel kit. Wt. 2½ lbs.

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Imperial Tubing Test Plugs For Temporarily Shutting Off Tubing



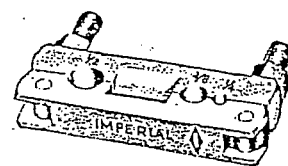
For use in instrumentation, radiant heat, refrigeration, LP-Gas—anywhere that it is desirable to shut-off the end of a tube temporarily without pinching it off or installing a valve.

Used, for example, where it is desirable to test tubing installations before putting into service, or when "trouble shooting" for leaks. Plug is inserted in end of tube and wing nut is tightened. This expands synthetic rubber portion of plug and seals tube. Will hold pressures up to 100 lbs.

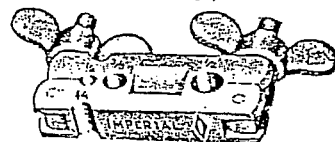
Test plug can be used on liquid or gas lines, except those which contain materials that would deteriorate synthetic rubber.

Cat. No.	O.D. of Tube	Nom. Size	Cat. No.	O.D. of Tube	Nom. Size
140-F	$\frac{1}{4}$ "	$\frac{1}{8}$ "	140-F	$\frac{3}{4}$ "	$\frac{5}{8}$ "
140-F	$\frac{3}{8}$ "	$\frac{1}{4}$ "	140-F	$\frac{7}{8}$ "	$\frac{3}{4}$ "
140-F	$\frac{1}{2}$ "	$\frac{3}{8}$ "	140-F	1½"	1"
140-F	$\frac{5}{8}$ "	$\frac{1}{2}$ "			

Imperial Pinch-Off Tools With Re-Rounding Holes



No. 105-F

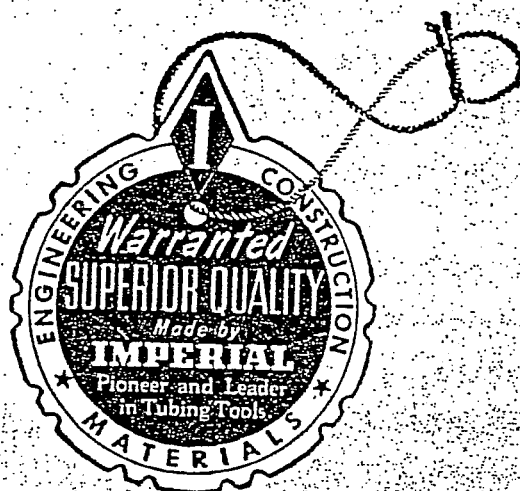


No. 105-FF

For temporarily closing copper, brass, aluminum and soft steel tubing while making repairs. Tool also opens and rounds the tubing back into shape. The No. 105-F is furnished with hex nuts and the No. 105-FF is furnished with wing nuts.

No. 105-F—Pinch-Off Tool for $\frac{1}{4}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. Tubing. Wt. $\frac{3}{4}$ lb.

No. 105-FF—Pinch-Off Tool for $\frac{1}{4}$ ", $\frac{3}{8}$ " and $\frac{1}{2}$ " O.D. Tubing. Wt. $\frac{3}{4}$ lb.



...this Seal of Quality

... ATTACHED TO IMPERIAL TOOLS IS YOUR
ASSURANCE OF OUTSTANDING PERFORMANCE