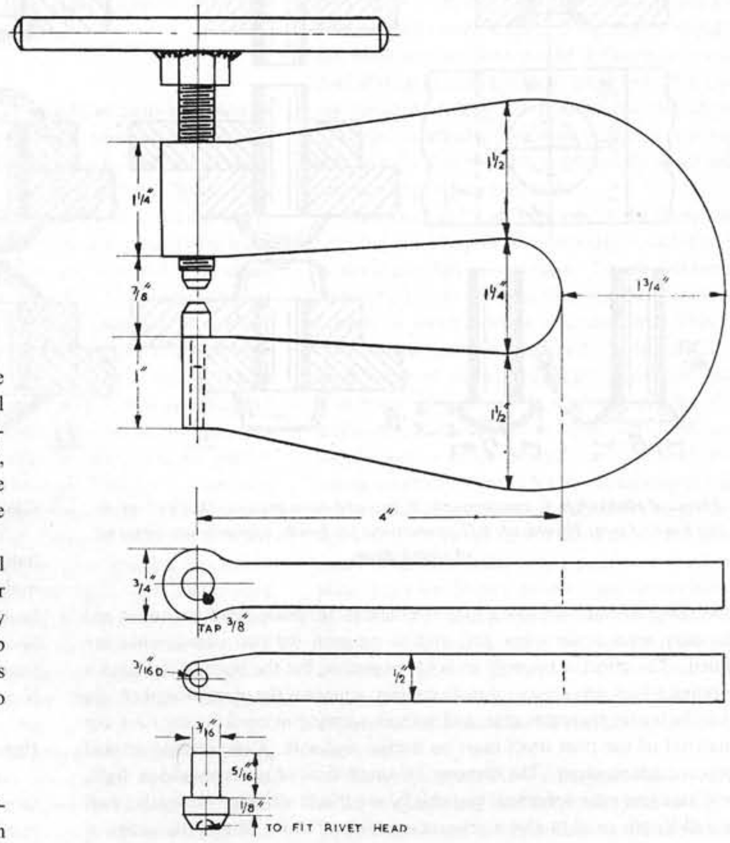
This Screw-Type Riveter has many uses

Where noise would be frowned on, this unit comes into its own, says J. Dunn



ALTHOUGH the making of this riveter is a little on the heavy side to be classed as model engineering, it has been found a useful tool in the construction of a model boiler, and would be particularly useful for those who live in flats, where continual hammering would, no doubt, cause complaints. It can also be used to close rivets from the inside of a boiler, keeping the factory made heads to the outside, for the sake of appearance.

The apparatus was forged from a piece of 1½ in. x ½ in mild steel about 14 in. long. Heat one end to a bright red, cool it quickly in water from the other end, until only about 1½ in. or so remains red, then quickly place end down on the anvil, and hit the other end smartly with a 7lb hammer. Repeat this process, also reducing the width of the bar at this end from 1½ in. to about 1¼ in. until the thickness has been increased to about ¾ in.

Shaping and Shortening

The centre of the bar, for about 3in. or 4in. is treated in a similar manner, except that the width is allowed to increase also, until the bar has been shortened to about 12in. It will be inclined to buckle while doing this, but can be easily knocked straight each time. Bend it in the shape of a narrow horseshoe, the extra metal in the centre of the bend being flattened down to about ½ in., the same as the rest. This will increase the width of the bar at the bend to give added strength where it is required. The end previously worked is then rounded off and the ends checked with a straight-edge to see that the centre lines are in line. They are then filed square with the centre line, for starting the drill. The centre of each end is next marked with a centre punch, and drilled from each side in the lathe with the drill held in the chuck, and the tailstock centre in the centrepop. Drill the small end first, with a 3/16 in. drill, to a depth of about ½in. then reverse, and drill right through both sides into this hole. Follow up with a ⅜ in. tapping drill in the large end only, and tap ⅜ in. Taper the small end to about ¼ in. thick, or less if required, and generally dress up with a file.

The screw is a 2½ in. x ⅜ in. bright steel setscrew, faced off square in the lathe, drilled 3/16 in. to a depth of about ⅜ in., and case-hardened on the end. The handle is a piece of ⅜ in. round, 4 in. long, brazed to the head.

The anvils are turned from a piece of ⅜ in. silver steel as shown in the sketch, or they could be made to requirement. That for the screw, should be a running fit in the hole, and lubricated with a drop of oil, while the other should be a push in fit. Make sure that this one bears squarely on the face of the riveter without tilting, The holes for the rivet heads were made with a dental burr, with a spherical head just over 3/32 in. dia. which is just about right for 1/16 in. rivet heads.

Place the anvils in their respective holes. They should be a good fit. Bring them together to that they are in line. Other points to watch are that the screw head is a good fit, and that the anvil in the screwset is drilled concentric with the thread. When using the riveter, it is best to hold it in the vice, as this gives more control over the operation. If the joints are open, pull together with a few small bolts here and there, before riveting. Cut the rivets to the correct length, which is best found by trying them out on a couple of pieces of scrap. Insert them in their holes, and screw them down in the riveter.

It will found that this is a lot easier and quicker than the usual method of hammer and snaps, particularly if working single-handed, and trying to hold the job, the hammer and the snap with only one pair of hands. The sizes given in the sketch are only as made and could be changed to suit individual requirements.

M.E. 98 537 (1948)

TAPER PINS

by "Duplex"

Taper Pins Duplex

I firmly believe in the use of taper pins in correct circumstances and what better authority than Duplex could there be for their description.

TAPER pins are used largely for securing collars, small pinions and other such components to shafts; when so employed they have the advantages that they give a secure fixing and can at any time be withdrawn when dissembly of the parts becomes necessary.

Moreover, a well-fitting taper pin is not liable to work loose, and, in the event of damage, the pin is readily renewed and the bore re-reamed. The use of taper pins as register pegs was described in a previous article, and, here again, wear can easily be made good by a reaming operation to allow the pins to protrude further.

Before describing the methods employed in fitting taper pins, it will be as well to consider the form of the pins and the dimensions of the reamers used for this operation.

Standard taper pins of good quality are

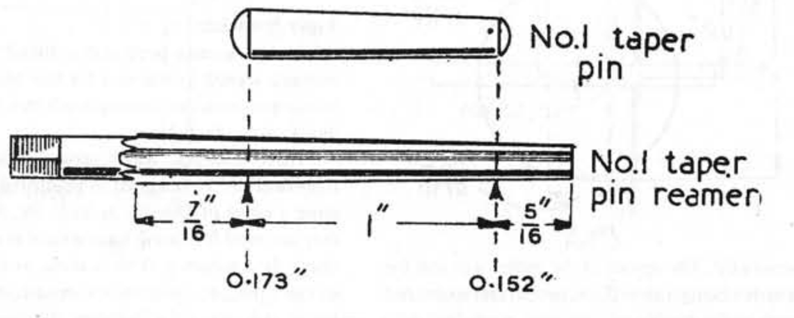


Fig. 1

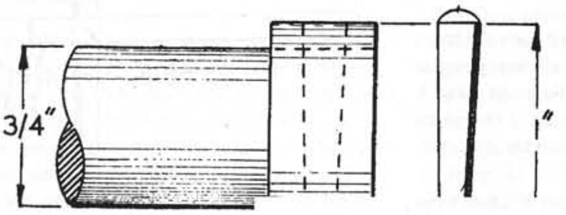


Fig. 2

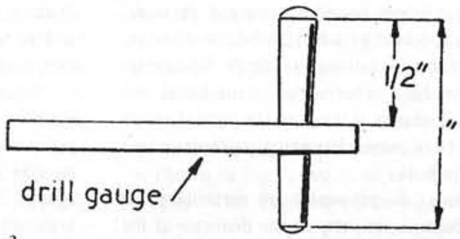


Fig. 3

accurately machined to a taper of ¼ in. to the foot and are designated either by their diameter, measured at the large end and expressed as a fraction of an inch, or by an arbitrary number, ranging from 000000, or 6/0 to 12, in accordance with the Morse taper pin scale.

If there is any doubt as to the accuracy of a taper pin, this can be checked by making two scratch marks on the pin exactly 1 in. apart; the diameter of the pin at both marks is then measured with a micrometer, and if the taper is correct, that is to say ¼ in. to the foot, the difference of the two diameters will be 0.0208 in. The regularity of the taper can be checked by making a further scratch mark exactly mid-way between the two previous marks and measuring the diameter of the pin at this point; this dimension should, of course, be equal to the mean of the two former diameters.

An alternative method of estimating the taper is to insert the pin in the number size drill gauge, as in Figs. 3 and 4, and to mark its depth of entry in either case; the distance between the two marks is also measured. The smaller diameter, as determined by the drill gauge, is then subtracted from the larger and the difference is divided by the distance apart of the two marks. As an example, when a No. 2 taper pin was fitted into the No. 10 and No. 18 holes in the gauge the marks were found to be 55/64 in. apart. Now, the diameter of the No. 10 hole is 0.1935 in. and of the No. 18 hole 0.1695 in. The difference, 0.024, when divided by 55/64 equals 0.0206, which is sufficiently close to the nominal value of 0.0208 to show that the pin has the correct taper.

As will be apparent in the drawings in the text, both ends of the pin are deeply chamfered, so that any bruising caused when driving the pin with a hammer will not interfere with its fitting. If, therefore, a pin is cut short, the cut end must again be chamfered or well-rounded before the pin is inserted.

Reamers

For each size of taper pin a corresponding reamer is used to form the correct taper in the previously drilled hole. A list of smaller reamers in both the fractional inch and the number sizes is given in the two following tables: and the relationship between a No.1 taper pin and the corresponding reamer is shown in Fig. 1.

FRACTIONAL SIZES		
Nominal Diam.	Diam. small end	Diam large end
in.	in.	in.
1/16	0.044	0.065
5/64	0.060	0.081
3/32	0.070	0.096
7/64	0.081	0.122
1/8	0.092	0.128
5/32	0.117	0.159
3/16	0.138	0.190

NUMBER SIZES		
Nominal Diam	Diam small end	Diam large end
No.	in.	in.
000000	0.0606	0.0814
00000	0.075	0.0984
0000	0.088	0.114
000	0.101	0.1322
00	0.112	0.151
0	0.1245	0.166
1	0.135	0.182
2	0.151	0.203

As these small fluted reamers are very accurately made with ground cutting edges, they are rather expensive, but with careful use they should have a long life.

Fitting Taper Pins

As a practical example of fitting a taper pin, let us suppose that a No. 1 taper pin 1 in. length is

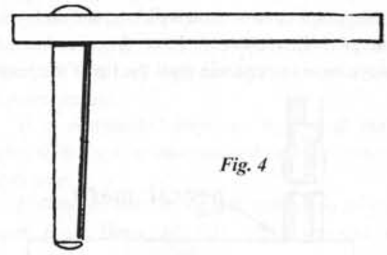


Fig. 4

to be used to secure a collar 1 in. in diameter on a shaft of ¾ in. diameter, as represented in Fig. 2.

Reference to Fig. 1 will show that the small end of the pin is 0.152 in. in diameter, corresponding to a No.24 drill; also, this is the diameter of the reamer 5/16 in. from its tip.

The first step is to drill a hole with a No. 24 drill across the diameter when the collar has been mounted in place on the shaft; if a smaller drill is used, more metal will have to be reamed away to allow the pin to enter for the correct distance. When the hole has been drilled and cleared of chips, the reamer is secured in a small tap wrench, and after it has been lubricated with lard oil in the case of steel, it is inserted in the hole. Only light cutting pressure should be applied to the reamer while it is carefully turned in a clockwise direction, and at frequent intervals it must be withdrawn to clear the chips from the flutes and relubricate the cutting edges. If the reamer is forced in any way, the fully hardened slender cutting edges may be broken.

On no account should the reamer be backed out of the hole by turning in the reverse direction, as this will in time blunt the cutting edges and may even cause them to become chipped.

Do not try to hurry the work, and at the first feeling of stiffness in turning, withdraw the reamer and oil it after clearing the flutes.

Continue the reaming until in this case, the tip of the reamer protrudes 1/4 in. through the hole; this will allow for an interference fit of a little more than a thousandth of an inch when the pin is driven home. If, on the other hand, the work were to continue until the tip of the reamer

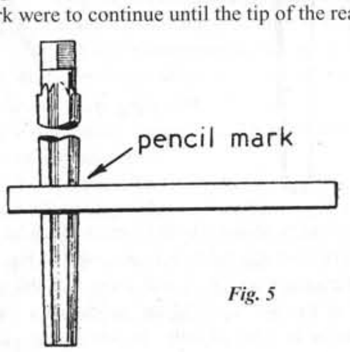


Fig. 5

was 5/16 in. clear of the hole, as shown in Fig. 1, the pin could then be pushed into place with the fingers and would protrude too far when properly seated. The same procedure is used when fitting pins of other sizes and of different lengths.

Supposing, for example, that only the upper 1/2 in. of a 1in. pin is to be used, then the easiest method of determining the size of drill to employ is to try the small end of the pin in the drill gauge, as shown in Fig 3. The drill gauge is again used to find the diameter of the head of the pin, as in Fig. 4.

The reamer is then carefully inserted in this hole and is marked, as indicated in Fig. 5, with a grease pencil to show the depth of entry required to seat the pin up to its head.

After the hole has been drilled in accordance with the size indicated in Fig. 3, the reaming operation is carried out and is continued until the reamer has entered for a distance a little short of a pencil mark. The pin is then tried in place and, if necessary, the reamer is again used so that only a small amount of draw remains for seating the pin firmly in place.

When fitting or withdrawing taper pins they should, when ever possible, be pressed into or out of place in the vice or by means of a clamp; as an alternative, a hammer and a brass punch may be used in awkward places.

The writers remember seeing, many years ago, an Army Ordnance artificer, who had the unpleasant job of securing with taper pins a ring within a long narrow cylinder. It was not clear at the time who had "designed" this extraordinary piece of mechanism, but obviously no one who foresaw any possibility of his having to assemble it

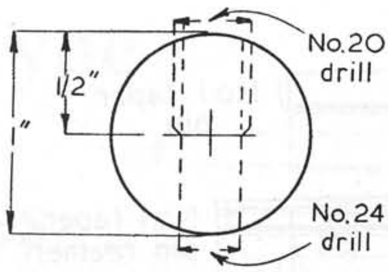


Fig. 6

personally. The upshot of the matter was that the artificer, being a skilled and patient craftsman, had gone to the trouble of making a small hydraulic jack, with the aid of which he was able to press the pins into place when working in a space so confined that no hammer could be used.

When fitting taper pins, particularly the larger sizes, a method of step drilling is often employed to lessen the work of reaming. As illustrated in Fig. 1, the large end of the No. 1 pin is 0.173 in. and the small end 0.152 in.; the mean diameter at the mid-point is, therefore, 0.1625 in.

To step drill the hole, as shown in Fig. 6, a No. 24 drill is, as before, passed right through the work, and this is followed by a No. 20 drill, of 0.161 in. diameter, fed in for half the total depth. When even larger tapers have to be reamed or machined, this form of preliminary drilling can be carried out in any number of steps, depending on the size and depth of the hole.

The size of the pin used in any particular piece of work depends, in part, on the diameter of the shaft, for if too large a pin is fitted, the shaft will be weakened, but, on the other hand, the pin should be of a size to provide sufficient bearing in the collar or pinion to withstand any working strain imposed.

Manifestly when the taper pin is used for light duty only, the appearance of the work will be improved by fitting a pin of small diameter.

It is usual, particularly in instrument and model work, to give a good finish to the ends of taper pins. For this purpose, the pin should be gripped, first by one end and then by the other, in the chuck of a high speed drilling machine.

A fine file is then used with light strokes to round the ends of the pin; this is followed by holding a strip of fine abrasive cloth against the file and continuing the filing strokes.

To polish the rounded ends of the pin, the emery cloth is placed on a piece of softwood on the drilling machine table and the revolving pin is fed against it, but the cloth should be moved frequently to prevent the work becoming ringed.

As a final measure, the cloth may be pressed against the pin with the tip of the finger.

If desired, the ends of the pin can be burnished by following the emery cloth with a piece of polished hardened steel; this tool, when held in the hand, is applied with a rocking motion to conform with the curvature of the end of the pin.

While on the subject of finishing components, it may be opportune here to point out that there should be an equality to finish throughout any particular piece of work whether it be a simple tool or a model for exhibition. It is not good practice to leave some parts roughly filed or showing any turning marks, whilst others are highly polished, but, on the other hand, if all the components are finished by, say, a turning operation then the work is more likely to have a correct and pleasing appearance.

Taper Broaches

As has already been stated, fluted taper pin reamers are expensive, and for this reason, perhaps, taper broaches, costing much less, are sometimes used in their place.

These broaches, which appear to be ground free-hand, can be obtained in graduated sets covering a range of from 1/32 in. to 3/16 in., but before they are used for fitting taper pins it is as well to check their accuracy. This is done, as in the case of taper pins, by inserting the broach in the drill gauge and noting the diameter at either end; the

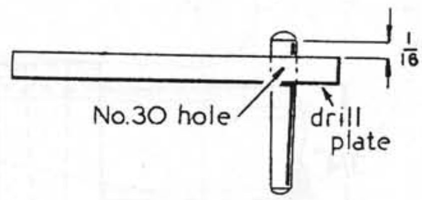


Fig. 7

distance between these two points is measured and the taper in thousandths of an inch per inch is then readily calculated.

Three of the larger members of a set of five-sided taper broaches were measured in this way, and it was found that the taper was 18, 14 and 13 thousandths per inch respectively, instead of the normal 20.8, thus showing that these particular broaches were quite unsuitable for reaming holes to receive standard taper pins.

Fitting Register Pegs

In a previous article reference was made to the fitting of taper pins to serve as register pegs for aligning machine components, in place of the more usual parallel pins; and, as a correspondent asks for further information on this point, it may be helpful to some less experienced readers if a more detailed description of the operation is given.

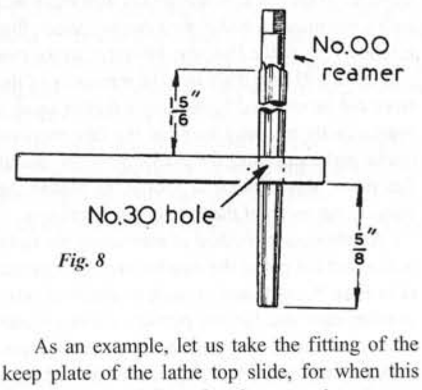


Fig. 8

As an example, let us take the fitting of the keep plate of the lathe top slide, for when this plate is removed, in order, for example, to carry out shaping operations in the lathe, it is important that it should be capable of being readily replaced with the feed screw correctly aligned with its nut. In this instance, it is not uncommon to find that the securing screws allow considerable latitude of movement, which entails realigning the keep plate whenever it is replaced after removal.

To obviate this, register pegs should be fitted to ensure the correct location of the keep plate,

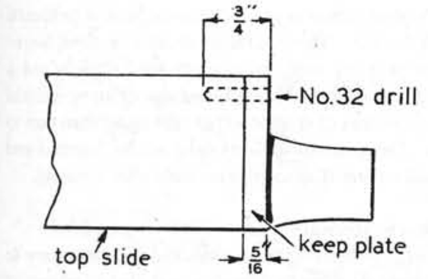


Fig. 9

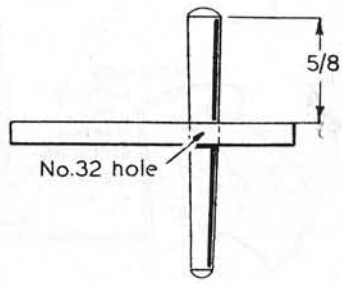


Fig. 10

leaving the screws to be solely concerned, as they should be, with holding the parts together. The method of fitting parallel register pegs or dowels has already been described in detail and need not be referred to further.

The following actual example of locating the top slide keep plate may be cited to explain the method of using 1/8 in. taper pins for this purpose.

A nominal 1/8 in. standard taper pin 1 1/2 in. in length was found to mate with the No. 30 hole in the drill gauge, leaving 1/16 in. of the upper end of the pin projecting, as shown in Fig. 7. A No.00 standard taper pin reamer when inserted in the same hole is projected 3/8 in. at its lower end and 15/16 in. at its upper end, as seen in Fig.8. As the thickness of the keep plate shown in Fig. 9 was 5/16 in., and as it was decided that the pin should project into the top slide casting for 1/4 in., this made the total length of the pins required 9/16 in.

Two pins were, therefore, cut to this length and their ends rounded off. When inserted in the No. 32 hole in the drill gauge, a full length pin projected 5/8 in., as shown in Fig. 10; a No. 32 drill was, therefore selected as the correct size for drilling the hole prior to reaming.

After the keep plate had been accurately aligned and secured in place with its fixing screws, the casting was bolted to an angle plate mounted on the drilling machine table, and two well spaced holes to receive the pins were drilled with the No. 32 drill to depth of 3/4 in., in order to give end clearance for the reamer. Then, with the keep plate still secured in place, the No. 00 reamer was carefully worked in by hand until, as shown in Fig. 8, it projected exactly 15/16 in.

After the holes had been cleared of chips by means of a pipe cleaner, it was found as anticipated, that the short taper pins entered their holes as shown in Fig.7, that is to say, they projected exactly 1/16 in. The keep plate was then detached and the pins were pressed into it in the vice until the tapered portion was flush with the surface.

The next and final step was to open out the holes in the casting with the taper reamer until the keep plate could just bed again correctly in place.

This method of fitting register pegs has the advantage that any looseness, which develops as the result of wear, can readily be taken up by reaming the holes in the keep plate to allow the pegs to project further; moreover, the keep plate is easily removed as, unlike parallel dowels, the tapered pegs do not tend to bind in their holes if the plate is tilted during dissembly.

When a new feed nut is fitted to the slide, it may be found that the keep plate requires some realignment, and when this is necessary it is inadvisable to attempt to correct the position of the register peg holes by means of a reamer alone, for this may well damage or even break a slender reamer.

It is preferable, therefore, to re-drill these holes as in the first instance and then to fit larger taper pins.

Finally we would suggest that when buying taper pins, those of full length should be selected, for any cut-off pieces may come in useful at another time, and moreover, as a 1/8 in. taper pin 1 1/2 in. in length is little more than 3/32 in. in diameter at its small end, this enables the portion to be selected that is best suited to the work and at the same time, matches the reamer available.

M.E. 100 23 (1949)

Soft-Soldering and the Model Engineer

by J. W. Tomlinson

Soft Soldering J. W. Tomlinson

Although this article is slightly dated, I include it for its good advice on preparation and fluxes. Obviously bottled gas equipment was not readily available as it is today; incidentally, if anyone knows where to find the 6d cartons of multicore solder, please let me know – I should like to buy them up!

IT IS remarkable how many model engineers who are quite good at anything from mathematics to machining, fall down when it comes to a bit of soft-soldering. In nine cases out of ten it is because they fail to observe the simple fundamentals such as correct preparation, the right equipment and the right temperature.

Equipment

The type of equipment used is important. Nobody can do the best work with the wrong tools. Although the old type of fire-heated iron was quite good enough for the old type of craftsman, a well-made electric iron is the most suitable tool for the up-to-date model-maker. The size of the iron will, of course, vary according to the work, but for most model making the 65-watt, 9 1/4 oz. iron is quite heavy enough, and for fine work the small pencil-bit should be used (see Fig. 1).

A bunsen burner and a small blow-pipe are most essential, as quite a few jobs are better done without using the iron, as will be seen later. A typical layout for the model engineer's soldering outfit is shown in Fig. 2. If one has to choose between a bunsen burner or a blow-pipe the latter should be selected, as there are some jobs which cannot be done with a bunsen burner, whereas the blow-pipe can be clamped in the vice and used as a burner.

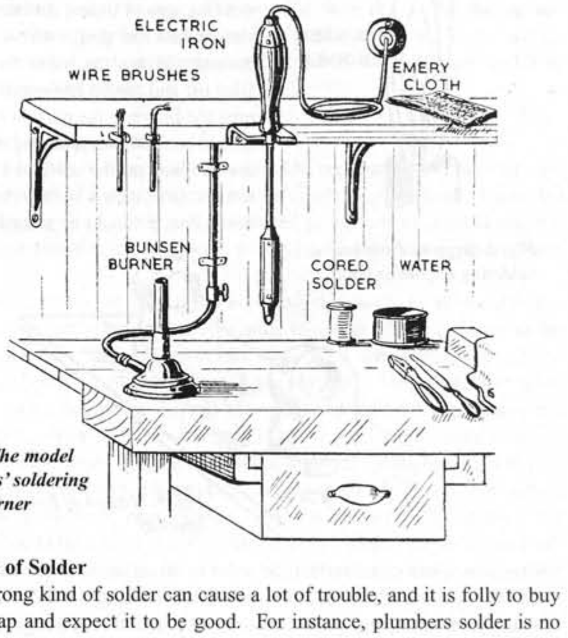


Fig. 2 The model Engineers' soldering corner

Best Kind of Solder

The wrong kind of solder can cause a lot of trouble, and it is folly to buy solder cheap and expect it to be good. For instance, plumbers solder is no good for model soldering, it has too much lead in it. A good way to test a stick of solder is to bend it while holding it to the ear; if it crackles it is good

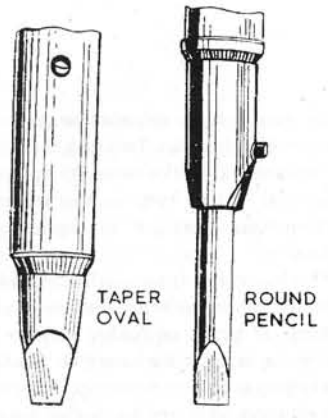


Fig. 1. Suitable types of bits

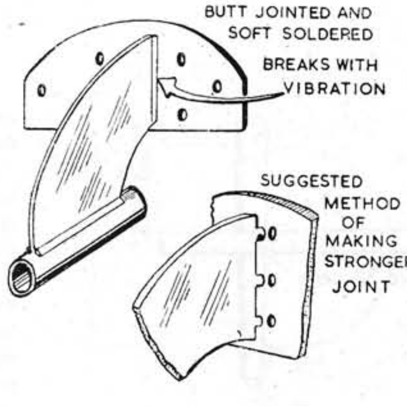


Fig. 3. Bad design causes failure

quality. The writer, who has had many years of soldering experience using all kinds of solders and fluxes, strongly recommends the use of cored solders for model work. Ersin multicore solder is exceptionally good and can be obtained in handy sixpenny cartons. No additional flux is needed when using this multicore solder, and the extra active non-corrosive flux used in the three cores ensures a perfect joint.

Solderable Metals

While some metals are more difficult to solder than others, this should not greatly trouble the model engineer as he will be dealing chiefly with brass, copper, tin-plate and mild-steel. These metals are the easiest to solder and the resinous fluxes used in multicore solder will give quite enough "bite". When these easy metals have been mastered, the more difficult ones such as stainless steel, cast-iron and phosphor-bronze, can be tackled. These will require special methods for tinning, using special fluxes. When they are once tinned, they can be joined together in the usual way using cored solder.

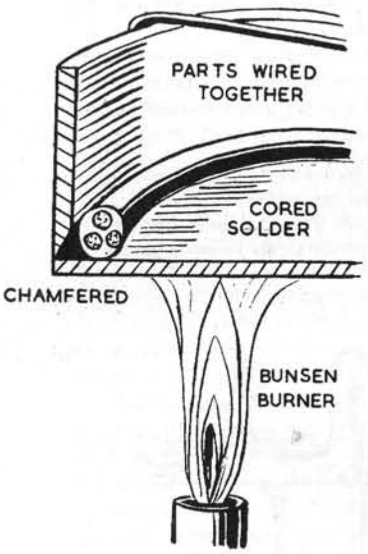


Fig. 4. Suggested method of soldering bottom to tank

Correct Preparation

Even when dealing with the easy metals, success depends greatly on the way the work is prepared. There is no secret about soldering and it does not require any special skill. Once the model maker realises that all he has to do is stick to the rules, he becomes an expert at soldering. We all know that cleanliness is of paramount importance, but what does it mean? First, it means that the iron face must be perfectly tinned. It is no use just tinning the point, there must be ample working area of tinned surface, and if this should become overheated at any time, burning the tin, the burnt tin should be filed off and the bit re-tinned. When tinning the bit, only the portion to be tinned should be filed thus retaining the anti-corrosive finish on the un-tinned part. If an electric iron is left switched on, though not in use, it should be placed so that the

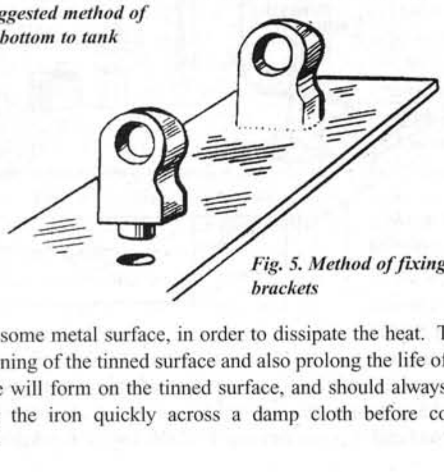


Fig. 5. Method of fixing bearing brackets

bit rests on some metal surface, in order to dissipate the heat. This will prevent the burning of the tinned surface and also prolong the life of the iron. At times, oxide will form on the tinned surface, and should always be removed by drawing the iron quickly across a damp cloth before contacting the work-piece.

Any form of grease or swarf on the surfaces to be tinned will spoil the job. These surfaces should be filed, wire-brushed or polished with emery-cloth until there is not a spot of rust or stain to be seen, and the cleaning should extend over an area of at least 50 per cent larger than that to be tinned. The prepared surfaces must not be fingered and they should be tinned as soon as possible after cleaning.

Why a Flux is Necessary

All metals possess surface oxides and it is necessary to remove this oxide prior to soldering, and also to preven itt forming whilst the metals are being heated. For all joints a flux should be used, which, while being active enough to remove the surface oxides, does not leave any excessive deposits, which will afterwards corrode the metals which have been joined. When dealing with electrical equipment it is further necessary to ensure that the flux has a high insulation value and will not be of a greasy nature. For many years rosin has been used as a non-corroding flux. However, rosin in its normal state is very inactive and is only really satisfactory when used on the "easy metals" which have been scrupulously cleaned just prior to soldering. Modern flux as is used in multicored solder is made of pure rosin to which has been added a small percentage of activating agent, which is entirely dispersed

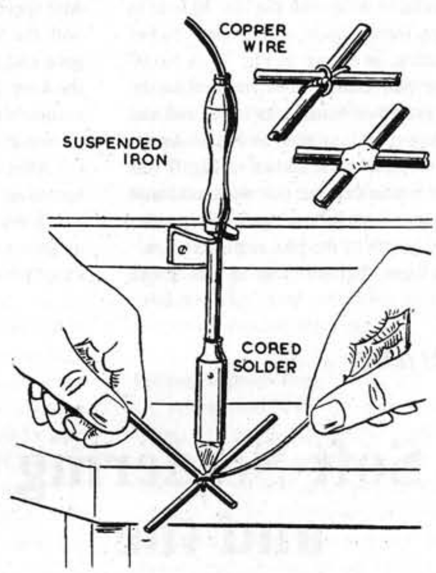


Fig. 6. Using copper wire to strengthen joint

during the soldering operation, eliminating all risk of corrosion and at the same time giving as good results as if an acid flux was used.

Tinning

Although when using multicore solder it is not always necessary to pre-tin the parts, it is recommended where overlapping, or when the parts fit one into the other, as with pipe unions, that pre-tinning should be employed. When it is possible, the best way to tin small parts is, after cleaning, to hold them over the bunsen burner and when the correct temperature is reached, apply the cored solder. It is important that the parts are heated to the right temperature, so that when the solder is applied there is an easy flow all over the prepared surface. Before the solder has set the parts should be shaken to remove any surplus.

Design the Cause of Failure

The design of the parts has a direct bearing on the success of the job. Where stressed parts are joined, or where they are made subject to excessive vibration, it is expecting too much to rely on a soft-soldered joint, however well it is carried out. For instance, a propeller shaft tube support on a model power boat was butt-jointed and soft-soldered to the backplate as shown in Fig. 8. This resulted in frequent breakage, no matter how well the job was done. Now this was a case of bad design, and not bad soldering. The answer in this instance was to provide a bigger area of contact, and one way of doing this is shown in the illustration.

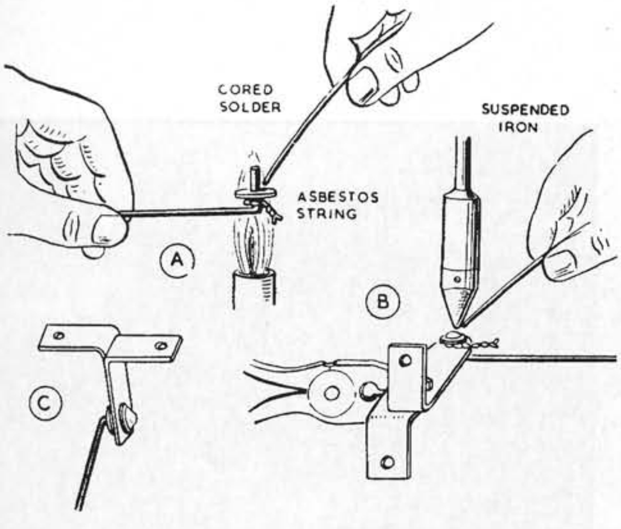


Fig. 7 Method of fixing elevator control-rod

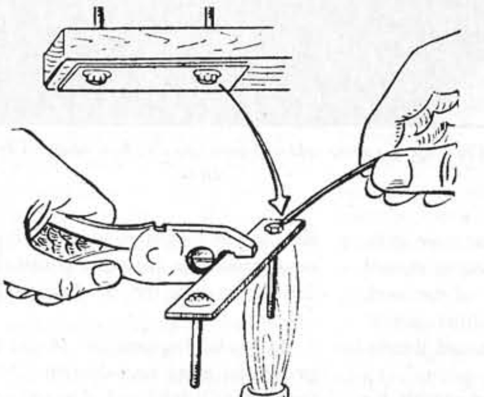


Fig. 8 Soldering engine-bearing bolts

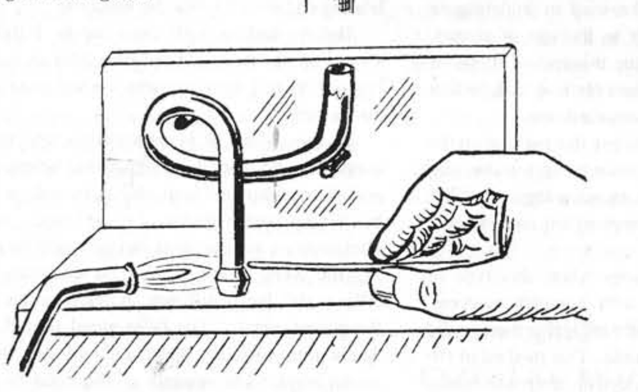


Fig. 9 Sweating on a pipe union

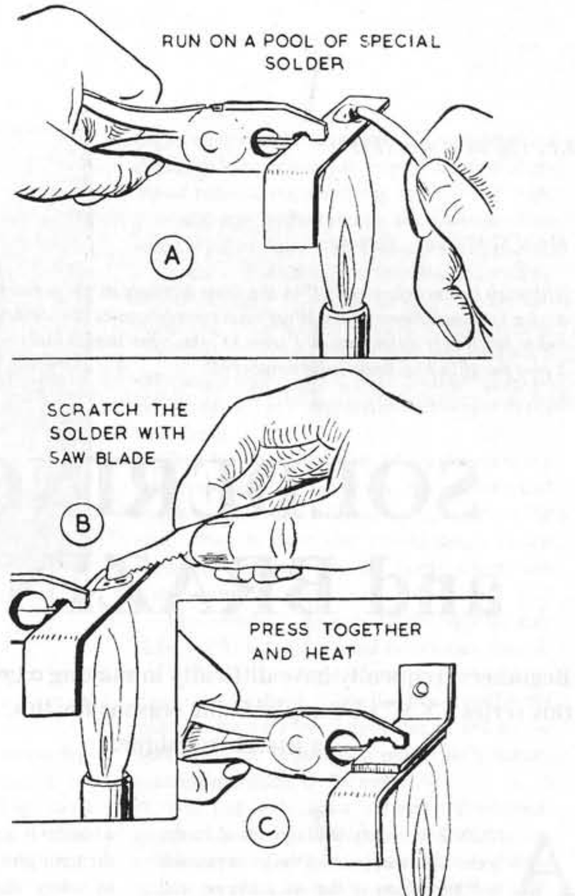


Fig. 10 Soft-soldering aluminium

Practical Examples

Soft-soldered joints should never be butted when there is any stress. For tanks and similar vessels where a butt joint may be used, this can be strengthened by chamfering as shown in Fig. 4. Model brackets which have to carry line shafts or spindles, should never be soldered straight on to a flat surface. A much stronger joint can be made if a pip is left on the bracket and the mating surface drilled, see Fig. 5. The two parts are then tinned, fitted together, held over the burner and just when the right temperature is reached, a touch of cored solder will cause the metal to run all round the base of the bracket making a perfect joint.

It may happen that two tubes or wires have to be joined. Quite a strong joint can be made by wiring the parts together with copper wire, holding over the burner, and applying the solder. This is one instance when pre-tinning is not really necessary when multicored solder is being used, see Fig. 6.

Dealing with model aircraft, it is usual to fix the elevator control rod to its bracket by means of washers soldered to the rod. A good way of fixing these accurately is shown in Fig. 7. First, a piece of asbestos string is tied round the bracket end of the control rod, a suitable washer is then slipped in position and the assembly held over the burner. At the right temperature, cored solder is applied, this running through the washer and forming a fillet supported by the asbestos string. When the solder has set, the rod is fitted through the bracket and asbestos string tied round the rod. Another washed is fitted and the assembly is held up to the suspended electric soldering iron and solder applied. When the solder is set, the string is removed giving a nice working clearance for the control rod.

Model aero engine bearer bolts are generally sweated to the engine plates with soft solder to prevent them turning. This is one of the easiest jobs. The plates and bolts should be cleaned with emery-cloth, the bolts fitted in position, and held over the bunsen burner, and when the parts have reached the right temperature, cored solder applied. See Fig. 8.

For sweating unions to pipes, the best way is to pre-tin the mating surfaces, fit the parts together and arrange as shown in Fig. 9. Then, using a blow-pipe, heat the parts until it is seen that the solder is running; finish by adding a little cored solder.

Soft-soldering Aluminium

Quite a lot has been said about soft-soldering aluminium, but there are still some people who do not know whether or not it can be done. It can, but as the technique is not sufficiently advanced to warrant its general application, it is suggested that the process is used more or less for experimental work.

The usual method of application is to hold the part to be soldered over a bunsen burner, until it is heated sufficiently to obtain a ball of molten solder from the stick on to the work-piece, see Fig. 10. A special solder should be used, made up of 85 per cent tin and 15 per cent zinc. With a hacksaw blade ground to give a sharp edge, scratch the surface of the work-piece under the molten solder, working from the centre and spreading outwards until the required area is tinned. This action will break through the film of oxide, thus ensuring a good adhesion. When both mating faces are tinned, they should be pressed together and heat applied. When it is not possible to press the parts together, quite a strong joint can be made by building up with cored solder after the aluminium has been tinned by the friction and special solder method. The use of flux is not recommended for ordinary model work as this will cause excessive corrosion if trapped between the parts. In every case the parts should be thoroughly washed in water and given a coat of zinc chromate primer followed by a coat of good varnish paint in the desired colour.

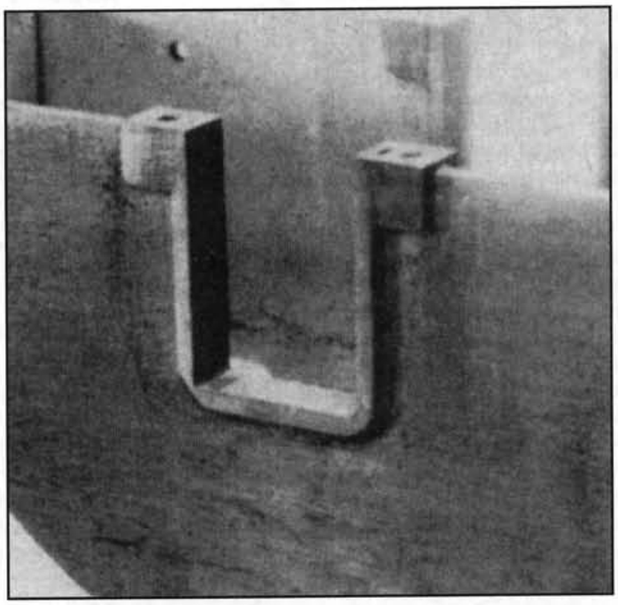
M.E. <u>120</u> 24 et seq. (1959)

Hard Soldering Exactus

Although this article starts off in the same territory as the previous one, its advice is sound. Some of the silver solder grade names are slightly different today, but this is unimportant. I seem to remember that at this time the days of 5 pint paraffin blowlamp were numbered.

SOLDERING and BRAZING

Beginners frequently have difficulty in making a good joint. In this series EXACTUS explains the reasons for this, and outlines a useful technique.



Close-up of a silver soldered horn showing how neat this kind of joint can be.

AMONG the many skills practical in the home workshop, one of the most popular and interesting is that of soldering and brazing. Unlike his brother in industry who may specialise in a particular process, the home workshop engineer tackles anything from the soft soldering of a simple electrical connection to the brazing of a high pressure boiler.

Though the basic principles are simple, difficulty is sometimes experienced in getting a sound joint, and what is just as important, a neat one.

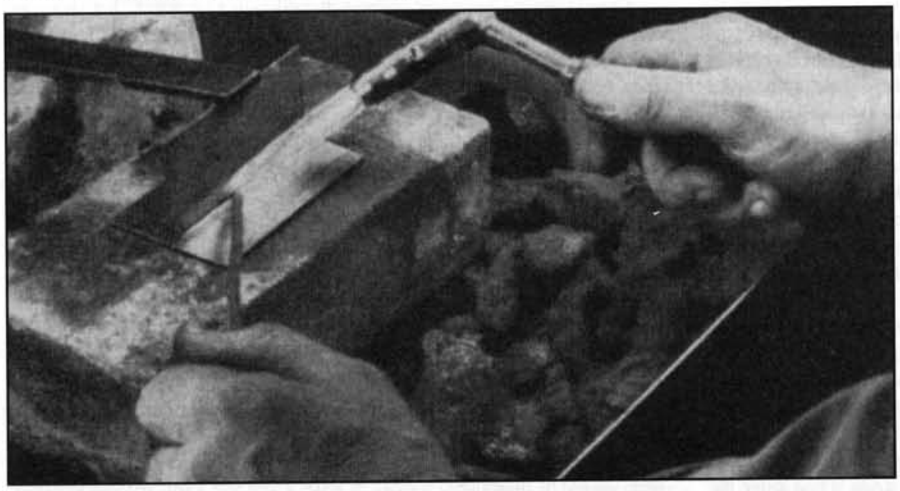
The general fault lies not so much in the application, but in the use of the most suitable filler metal and flux to suit the work in hand. It is a common habit to refer to the filler metal as solder or spelter and it is taken for granted that filler is suitable for all the different tasks undertaken in the workshop. This is a mistake because there are different compositions of filler metals which are designed for special requirements.

Though it is true that a particular metal may be found satisfactory for a number of jobs, the occasion does arise when it fails to produce the proper result. We can take as an instance the building of a boiler. It is not built to close limits, as we apply the term generally, and therefore there is no need to worry unduly about distortion of the work through heat. This being the case, a filler metal of a higher melting temperature can be used, thereby saving money.

This filler metal would not be suitable for work where distortion must be kept to a minimum. For example, it cannot be used in soldering or brazing as an alternative to the use of screws, bolts, and rivets where the thinness of metal or other physical circumstances can lead to distortion on the application of the required heat.

I know many who criticise this method on the grounds that distortion cannot be kept within reasonable limits, but by taking advantage of a filler metal with a lower melting point it is not only possible, but a lot easier.

I show two illustrations where this type of joint was carried out with complete success. Many readers will no doubt recognise them as the frames for LBSC's Britannia. This method of fitting the horns was intended to keep the model authentic with the full size job. It had to be carried out with the minimum of distortion and I can assure those who have doubts that there was no difficulty in doing this. It was easier than brazing a boiler.



Soldering with a "Louvret" self-blowing gas torch

In Model Engineer for 16 January, 1958 I gave some notes on soldering. Many readers found them helpful and it would appear that a more detailed account of filler metals, fluxes and heating equipment would be welcome.

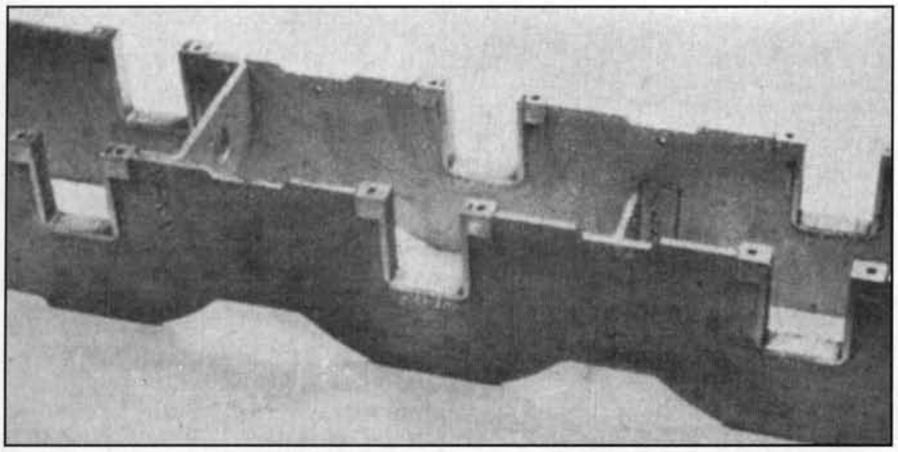
Before dealing with these items, I think I should briefly deal with the principles of soldering and brazing for those who are not quite clear on the subject.

In most cases it is undesirable, and in the average home workshop impossible unless oxy-acetylene equipment is available, to make a joint by joining parent metals, i.e. welding. As an alternative, a similar joint can be made by heating the work to the melting temperature of a filler metal that is different in composition from the parent metals. The filler metal should flow easily into capillary gaps and solidify into a sound bond. The strength of the bond or joint will vary according to the composition of the filler metal. This is the process referred to as soldering, either hard or soft.

The term is a general one covering a number of related processes and here I must distinguish between them and at the same time discuss the properties and characteristics of the filler metals. Briefly they can be classified under the heading of soft soldering, hard soldering, brazing and bronze welding.

Where the nature of the work will not be subjected to severe stresses and strains of high temperatures, the filler metal used is composed mainly of tin and lead. This is called soft solder and the process, soft soldering.

In the ascending order of temperature we come to hard soldering, or as some know it better, silver soldering or low temperature brazing. The filler metal is composed mainly of silver and copper and melts at temperature between 620 degs. C and 850 degs. C.



Above: Frames of BRITANNIA with silver soldered horns in place.

Brazing is a process where the filler metal is primarily composed of copper and zinc alloys and the principal aim in making a joint is the same as that for the hard and soft solders. Bronze welding uses a filler metal that is basically copper-zinc and may include nickel, manganese or silicon. It requires a temperature in the range of 800-900 degs. C to melt the filler. The method differs from brazing in its application.

Before any soldering or brazing can be done some form of heating equipment is required. Fortunately, this does not present any difficulties because from the wide range of commercial articles available there is something suitable for all kinds of work at reasonable prices.

For low temperature work the old fashioned soldering iron is till widely used and is suitable for most general work. It comprises a copper bit secured to an iron rod and provided with a suitable handle at the other end. This is a tool that can be easily made in the workshop and should conform to the following principles.

The bit should be large enough to retain sufficient heat so that work can proceed without frequent interruptions for reheating. The business end should be sharply tapered to nearly a point - a gradual taper will allow the working area to cool quickly.

Heads vary in shape to enable different types of work to be carried out to the best advantage. Apart from the shape just mentioned there are two other types equally well known. They are the hatchet and swivelling bits. The hatchet type, as its name suggests, has a soldering bit set at right angles to its holder. The swivelling type of iron has a bit shaped in conventional style and can be set in any required position. There are several methods by which these irons can be heated, such as by Bunsen burner, gas-ring and blow lamp, etc.

Some of the commercial irons of this type are fitted with a built-in gas burner heater, which constantly plays a flame on the bit. This enables the work to proceed without interruption for reheating.

A more modern development of this iron is one to which little introduction will be needed - the electric soldering iron. They are available in a number of sizes and types, varying from 65 to 125 watts. Their great advantage is the self-contained heating element and the absence of naked flame. For small work and work of an intricate nature, the electric soldering iron has a place of its own.

For the harder solders, something producing more heat is required. There are a number of suitable appliances available including such things as self-blowing torches, gas-air torches and blowlamps which are available in different sizes and types.

The self-blowing torch is suitable for most hard soldering work and it can be operated by simply coupling it to the gas supply. For the gas-air torch an independent air supply is required, working at a pressure in the region of 5 lb. maximum,

I described in ME of 23 May, 1958 the construction of a brazing forge, and this included a blower that is available on the surplus market, suitable for working a torch of this type.

Generally two separate controls are incorporated in the design of the torch so that the supply of air or gas can be regulated to produce a flame to suit. Other designs incorporate a combined regulator that controls the size of the flame.

Use the right flux for the job says EXACTUS in his second article on this important subject

LAST WEEK I discussed some of the heating apparatus available for different kinds of work. Before any of these can be put to use a knowledge of the various materials that are obtainable will be found useful.

In the soldering or brazing of a joint, one of the primary requirements is to cause the liquid metal (the filler) to wet the work. This cannot take place satisfactorily unless both the liquid metal and the work are free from surface films which prevent their coming into intimate contact. This surface film is created by exposure to the air and is referred to as the oxide film or barrier. The effectiveness of this barrier varies with different metals according to their chemical nature in ordinary atmosphere.

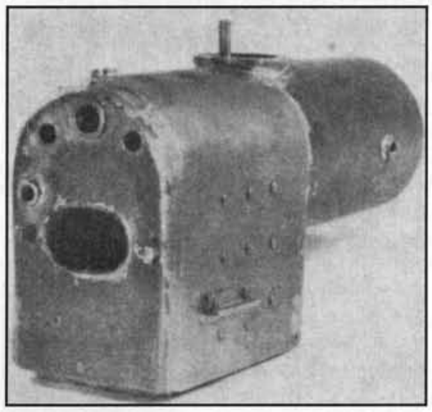
When heat is applied the oxide film becomes a complete barrier to the wetting of all ordinary engineering metals and alloys. To overcome this difficulty it is necessary to employ an agent capable of reducing or dissolving the existing oxide film and any formed during the heating. This agent is called flux.

There is a wide choice from the commercial brands available to suit all kinds of metals and conditions. They are sold in either liquid, paste, or solid form. The main point to be considered when choosing a flux is that it must become liquid (if not already so) at a temperature below that of the filler metal.

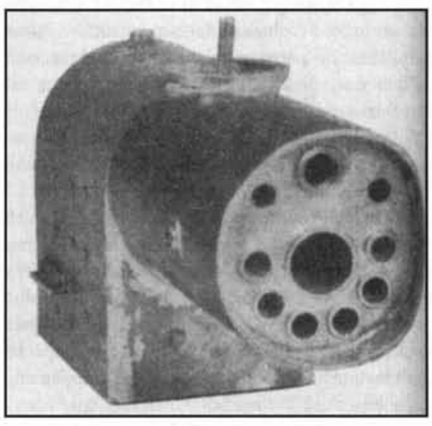
With any soft solders this does not present any problems because generally the commercial brands available are in liquid or paste form. The main thing to take into consideration is the chemical make-up because some fluxes are highly corrosive.

The corrosive types of fluxes such as zinc chloride ("killed spirits") and ammonium chloride (sal ammoniac) are used effectively on steel, iron, copper and its alloys. When this flux is used in the making of a joint any surplus liquid left on the work should be washed away or it is likely to have a detrimental effect on the metals.

This flux should not be used for electrical apparatus, scientific instruments, and objects of a similar nature. For this kind of work, it is general practice to use a non-corrosive flux such as resin or tallow. In electrical work cored solders are widely used. The solder is made in the form of tubes, the interior of which are filled with resin or other liquid or solid flux.



Small boiler for TICH, rear view

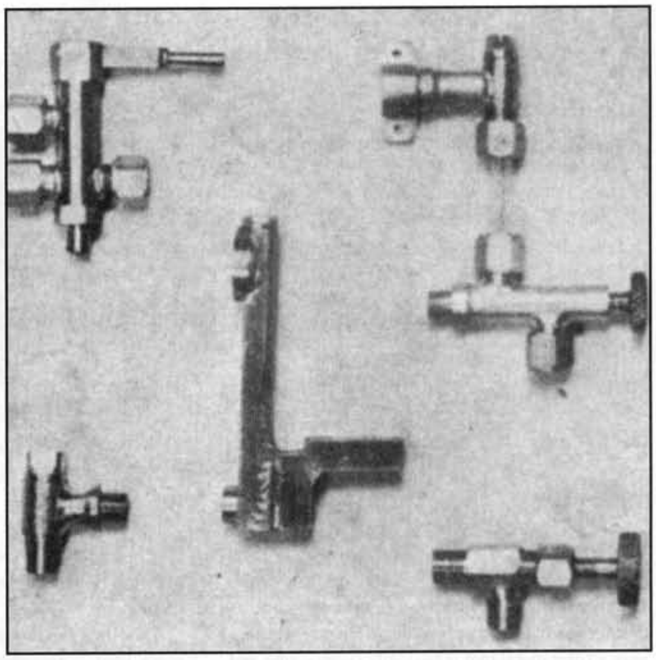


Front of small boiler for TICH. It was silver soldered throughout

In the majority of low temperature brazing or hard soldering operations, a flux is used which is a solid material at ordinary temperatures, but which liquifies on heating. In most cases the method of application is to mix the flux into a water-mixed paste to the consistency of thick cream.

Borax is frequently referred to in text-books on hard soldering and brazing as a flux suitable for all work of this nature, and is still accepted by many as a general purpose flux. With the development of silver brazing alloys having a melting temperature much lower than that of borax, it will be apparent that an improved flux is required if full advantage is to be gained from these low melting alloys.

Examination of the function of a brazing flux shows that it has not only to dissolve oxides already present on the material and brazing alloy, but to take up additional oxides formed during the heating, effectively blanket the joint areas, and, by reducing the surface tension of the molten filler metal, permit that material readily to wet the metal being brazed or soldered. In addition, the flux must remain thinly fluid while the brazing material solidifies in order to avoid entrapment and inclusion, while its residue should preferably be easier to remove from the work than the glass-hard deposit common with borax.



Right: Selection of boiler fittings, all joints silver soldered with Easy-flo.

Left: Brazing boiler by gas-air torch.

A great deal of research is carried out in the laboratories of Johnson Matthey to produce fluxes and filler metals to suit the many techniques and conditions of present day industry. From their list of fluxes and solders the reader will find the most suitable materials to complete his job satisfactorily. They can be purchased cheaply and in small quantities, the smallest being a ¼ lb tin.

One well known material is Easy-flo flux which is suitable for most general work and becomes fully fluid and active at below 600 deg. C. It is used with the Easy-flo and Argo-flo silver brazing alloys and others where their melting temperature does not exceed 750 deg. C. There is a special grade of this flux designed specifically for brazing stainless steel and another for copper base alloys containing between two and ten per cent aluminium. This is known as the aluminium bronze grade. When it is necessary to braze at temperatures exceeding 750 deg. C. and up to 1000 deg. C, or where prolonged heating is necessary and some parts may become overheated, one of the Tenacity grades will be found more suitable. There are many other proprietary brands all giving good results for the purpose which they are intended.

Unfortunately it is not possible to combine all the ideal requirements into a universal flux capable of satisfactory performance at all temperatures and with all parent metals. I consider the following are the ideal requirements for an efficient flux for low temperature brazing.

1. It should readily mix with water to form a smooth paste free from coarse crystals.

2. Retain its paste form for a reasonable time, and be capable of being re-mixed if it dries out.

3. Wet the work to which it is applied as an aqueous paste.

4. Cover the work adequately while in the stage of being dried by heating, without separating to expose islands of bare metal.

5. Remain on vertical surfaces when fired.

6. Melt at a lower temperature than the melting point of the brazing material to be used with it.

7. Be capable of dissolving the oxides of the metals on which it is used.

8. Retain a low viscosity to permit its ready displacement from capillary gaps by the brazing material.

9. Have a reasonably long "life" without tiring when brazing operations are prolonged.

10. Have residues which are easy to remove and non-corrosive if not removed.

In the brazing of aluminium, borax-based fluxes are unsuitable because they do not dissolve or otherwise remove the stable refractory oxide film.

Many types of proprietary fluxes are available for brazing aluminium, and these are generally of the alkali halide type, which are basically mixtures of the alkali metal chlorides and fluorides. Small amounts of one or more of the chlorides of manganese, chromium, cadmium, zinc, iron, cobalt, nickel, tin, lead, copper, antimony and silver are claimed to improve the performance of torch brazing fluxes.

A standard aluminium brazing flux containing essentially chlorides of sodium, potassium and lithium gives satisfactory results when used with aluminium which has been previously chemically cleaned and where the surface oxidation is slight.

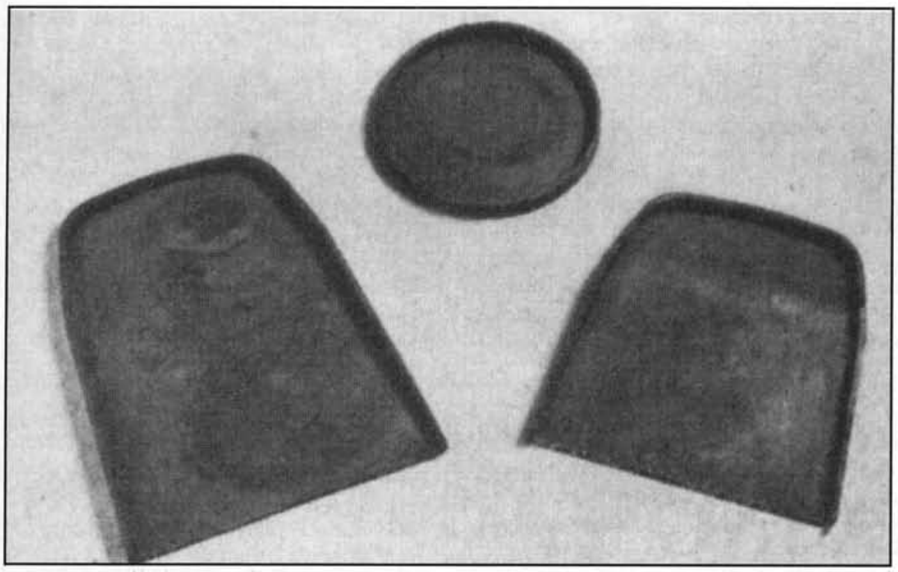
When no cleaning of the aluminium surface is possible before brazing, a flux containing zinc chloride may be necessary to provide ready wetting by the brazing alloy. This type of flux deposits metallic zinc on to the aluminium surface over which the fused brazing metal will flux more easily. A too-heavy zinc deposit, however, may have an undesirable effect on the mechanical properties of the filler metal finally deposited, and a safe figure for the amount of metallic zinc is that represented by a zinc chloride additive to the flux of not more than 7.7 per cent by weight.

Care should be taken in handling aluminium brazing fluxes containing fluorides, as toxic effects may follow the inhalation of fumes from these compounds, and personal contact may result in skin complaints.

WHEN the condition and requirements of the work have been decided, the next step is to choose the most suitable filler metal to fulfil these needs. Fortunately this does not present a major problem as there is a wide range from which to choose.

Fillers are available in either solid or liquid form, the latter being produced to meet requirements where it is not convenient to use the solid type. A well known product is Easy-flo paint which consists of a mixture of finely divided Easy-flo powder and Easy-flo flux, mixed with a volatile liquid. The constituents are properly proportioned so as to give optimum results with the various forms of heating in general use. The type of work it is used on is usually of an intricate nature or consisting of light sections where it is desirable to keep the joint fillets to a minimum. It can be used satisfactorily on mild, carbon and alloy steels, nickel and nickel base alloys and all copper base alloys, except those that contain more than 2 per cent aluminium.

It is applied fairly thickly to a joint, free from oxide, grease etc., the joint area being quickly



brought to a dull red. Heating is discontinued when the brazing material is seen to flow as a silvery thread.

Correct Temperature

Care must be taken when dealing with solid fillers to see that the joint members are brought to the necessary temperature to effect a proper bond with the brazing material. I mention this because one of the commonest faults I come across when solid brazing alloys are used is that when they become liquid, the heating is discontinued. The result is that blobs of brazing material stick to the parent metal and there is no satisfactory joint. I shall say more about this later.

The solid filler metals are those most generally used in the home workshop. They are available in several convenient forms, rods, strips, foil, wire and inserts. The last three are cancelled out by the other two as far as the home workshop is concerned.

There is little to choose in the smaller sizes of rods and strips, none of which have any particular advantage over the other. Both are suitable for small work. The rods are supplied in 24 in. lengths in the following diameters, 0.060 in., 0.080 in, 0.100 in., ⅛ in. and 3/16 in. and the strips in 20 in. lengths 0.040 in x 1/16 in., ⅛ in., and 3/16 in. From the many grades of filler metals I will mention a few with the widest use in the workshop.

Often when inquiring about the brazing material used I am told it is the cheapest grade of Easy-flo. So I think the best place to start is with the Easy-flo silver brazing alloys.

There are three grades of this product, the cheapest having a low melting point of 608/617 deg. C. This is known as Easy-flo No. 2, the others are Easy-flo (type 3 BS 1845), and Easy-flo No. 3. Both are in the same price range and a little dearer than No. 2.

Among the engineering materials in which Easy-flo No. 2 gives satisfactory results are austenitic stainless steels (the low melting point of the filler being of great value), mild, carbon and alloy steels, copper, brass, gunmetal, tin bronzes, aluminium and manganese bronzes, copper-nickel alloys and nickel brasses of all types. This list just about covers everything to be met in the workshop.

Another popular filler metal often recommended by contributors is the brazing alloy known as B6. Its cost is roughly about half that of Easy-flo No. 2 but its melting temperature of 790/830 deg. C is the highest of the silver brazing alloys.

A brazing alloy in the same price range but with a lower melting temperature, 625/780 deg. C, is Sil-fos (type 6 BS 1845). This is a special filler developed for the purpose of making joints on copper to copper without the use of flux. It is not suitable for steel or nickel alloys. A silver-phosphorous-copper alloy, it was developed from the straight phosphorous-copper that has been used for many years. This filler metal is also used in brazing copper base alloy of the brass and bronze types, in which case a special fluoride type flux is required.

These are but a few of the many silver brazing alloys that are available. Whenever any doubt exists as to the suitability of the proposed filler it is worth seeking some expert advice and use the correct materials. Within reason there is a brazing material and flux to suit all requirements.

Finally a few words about the correct method to make a sound joint. Reference has been made to the term capillary gaps and capillary action, and penetration in the process of making a joint. The majority of readers will no doubt fully understand what this means, but it is such an important function in making a joint by low temperature brazing that I propose to explain for the benefit of those who don't.

The soundness of the joint or bond by soldering or low temperature brazing depends upon the penetration of the filler metal between the two components, unlike the bronze or braze welding process where the main objective is to obtain the strength of the joint in building up a fillet.

In all low temperature brazing a lot more attention must be paid to the making or preparing of the parts to be joined. With bronze welding this is not of such major importance.

Great care should be taken in the design and planning of a joint. Silver brazed joints should be designed so that they are subjected mainly to shear stresses. A good exercise is provided by the building of a boiler. I have often encountered cases where proper care has not been taken in making the formers over which parts are shaped and flanged. The excuse is nearly always that good fits are not necessary and any faults or discrepancies will be made good in the brazing.

Capillary Action

The strength of the joint depends chiefly on the area of the brazing alloy film that unites the opposing surfaces. The best joints are those in which the alloy penetrates parallel surfaces with a small and regular gap by capillary attraction. Thin films tend to give stronger joints, particularly in materials that are strong in themselves. Some boiler plates correctly flanged for brazing are shown in the illustration.

In making an allowance for the gap of a lapped joint, consideration must be given to the brazing alloy, the parent metals, width of lap, etc. This is not so frightening as it may sound and something which comes naturally in the course of the fitting. The following sizes will be found useful as a general guide in joining different metals: 0.001 in. to 0.006 in. for ferrous and 0.002 in. to 0.008 in. for non-ferrous. Remember that too little clearance may result in incomplete penetration and too large a gap may allow the filler to run right through the joint gap and be wasted, apart from the unsoundness of the joint.

The joint should be free from grease, scale or anything that is likely to act as a barrier between the work and the brazing alloy. The flux is then applied in the form of an aqueous paste and if the lap of a joint is more than 3/16 in. it should be painted with flux before being assembled.

In the first stages of heating spread the flame of the torch over a good area of the work so as to get an even and uniform heating. Where there are heavy and light sections in the joint the heat should be played more on the heavier section.

A common mistake in the use of heating apparatus of the flame type is to hold the flame too close to the work. The envelope of the flame should be used at all times, and not the inner blue core. The flame should be kept moving to get a uniform heat. After a short time the flux around the joint will become liquid, a sign that the work is approaching the correct temperature to apply the filler metal.

Dip the end of the brazing alloy into the flux then apply it firmly to the joint. If it doesn't melt instantly, the brazing material must be withdrawn. Under no circumstances must the alloy be held in the flame to melt. This will produce the "blobbing" result mentioned earlier. The flame must continue to play on the work until it reaches the temperature that will melt the brazing material.

Feed the rod or strip into the joint, and if it is one of any length, move the flame along to the section where the metal is required to run. It will automatically run to the hottest point and with careful manipulation of the heating apparatus a sound and neat joint will result without difficulty. When applying the brazing material to the joint always slightly overfill to allow for shrinkage as it solidifies.

When carrying out these operations it is possible, due to lack of practical experience, that black patches will appear on the work. This is due mainly to overheating or inadequate fluxing. Apply some dry flux to the joint and if this does not cause it to readily disappear, the patch can be rubbed with an old hacksaw blade and some dry flux melted in the flame.

Do not apply additional heat without flux as this will aggravate matters. Poor wetting of the work by the brazing material usually indicates either that the wrong flux is being used, the work not properly cleaned, too little flux, or that brazing at too low a temperature was attempted. Pronounced pitting of the work usually indicates overheating.

When the work has cooled and the brazing alloy solidified, quenching in water will remove most, if not all, the residue flux. Discretion must be used in quenching metal of different expansion characteristics or sudden difference in section. Soaking the work in hot water will remove the flux, and little stubborn spots can be removed with a wire brush.

Whatever the process used in making a joint, it is good practice to make sure that no flux residue is left. As I mentioned earlier, some fluxes are corrosive if left to the atmosphere. With an unknown flux this policy should always be adopted. But for the beginner in particular, I recommend the use of familiar materials with which he can give himself every chance of success.

M.E. 174 632 et seq. (1995)

HINTS ON MIG WELDING

MIG Welding Gordon Reed

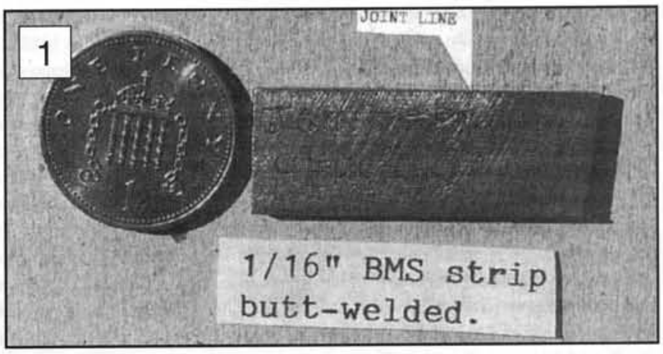
How pleasent to find good sound advice without any frills in the recent pages of Model Engineer. I have used a Mig set for a number of years and the main problem is rusty technique because it is not used enough.

Gordon Read sets out to dispel some of the mystique which surrounds a process which can be a very useful workshop aid. He explains how staying with simply learnt techniques can transform metal jointing methods in the home workshop.

THE three most common fastening methods in model engineering are probably bolts, rivets, and silver soldering. Bolts are fine where later dismantling is essential. Rivets have the advantage of low cost. Silver solder is beautifully neat, but is very expensive: however, it scores highly for all non ferrous metals except aluminium. Soft solder also has its place, but is a little outside the realms of basic structural fastening methods.

There's another method of permanent jointing, suitable for both steel and alloy, which isn't as widely used as it might be. Apart from initial outlay, it is very cheap. It's permanent. It is almost as strong as the parent metal it joins. It can be so neat as to be invisible. It is MIG (Metal Inert Gas) welding.

I suspect most folk regard all forms of electric arc welding as being only suitable for thick metal, except in the hands of very skilled operators. Understandable, because it is the easiest thing in the world to produce a so-called joint which is a mixture of holes and unsightly blobs of weld. Sadly, most welding handbooks don't help much with thin metal jobs; they never seem to explain the real principles behind the process. But, MIG welding on thin mild steel sheet is an everyday thing in the car repair trade - repairing sheets of rusted mild steel only 1mm thick (only ⅔ the thickness of 16 swg!), and, a lot of the chaps are self-taught.



1: An almost invisible joint in 1/16 in. thick mild steel strip/

2: A lap weld on two pieces of 1mm mild steel angle after dressing.

How it works

First then, the principles behind the method. The welder puts a DC voltage in to a coil of wire, the end of which comes out of the business end of the 'torch'. Touched to earth, the end of the wire arcs. Current flows, and the resultant heat is sufficient to melt metal. Two things happen; the end of the wire melts, and the metal of the job melts under the arc. So, the two edges of the metal to be joined fuse together. Air has to be kept away from this process, so the torch feeds a steady stream of inert gas around the end of the emerging wire. The gas can be either argon or carbon dioxide; it doesn't make a lot of difference, and carbon dioxide is cheaper than argon.

There is one limit to this lot; MIG welders don't work well outside on windy days, because the wind blows the gas away from the region of the arc. As the end of the wire melts, it obviously gets shorter. So, the machine feeds the wire forward to keep the melting end always in the same place. The speed of the wire feed is set by a front-panel control, so it is up to you, the operator, to keep it feeding at the correct speed. So much for the basic idea.

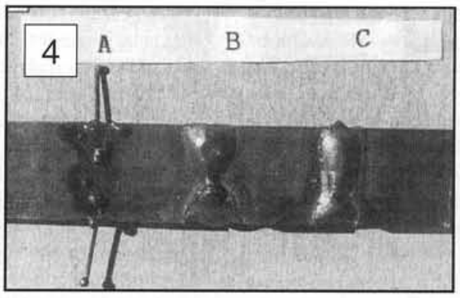
Getting Comfortable

Now to the realities of using the thing. *But be clear on one point; you'll need to practise with it after you've read this lot, because manual skill plays a large part in success.* Nothing frightening in that, for the same is true of almost everything we do in our workshops.

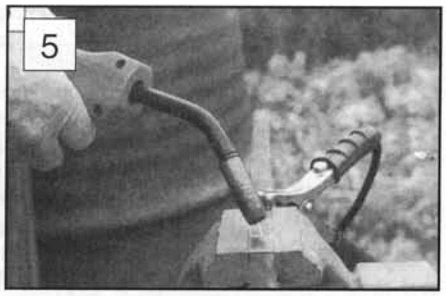
I'm going to use the S.I.P. Migmate welder as an example, for the simple reason that it happens to be the one I own! I don't think other makes vary enough in their controls to make any appreciable difference. Before we start, have a look at photos 1 and 2. They show what can be done with small jobs after a bit of practice. Not there to show what a clever fellow I am, but to let you see that if I can produce these results self-taught there's nothing to stop you doing the same (or even better).

These instructions may or may not conform with conventional rules on welding - I don't know. What I do know is that they work, and are the result of four years practical experience!

3: The front panel of the welder used, the black button is 'range'. White buttons are voltage settings.



4: Weld examples. 'A' is wrong, 'B' is wrong, 'C' is correct. The letters 'A', 'B' and 'C' are referred to in the text.



5: Spotting the MIG gun in the centre of the joint in preparation for a tack weld.

A word of caution. All forms of arc welding produce very strong UV (ultra violet) light which is damaging to the eyes. Don't ever do it without a shield. Because someone is sure to find out, I'm fully aware that there are chaps in the car repair game who do it without a shield, relying on the end of the torch to cut off the harmful rays. I know perfectly well that the arc of a MIG welder isn't as large as that of an ordinary arc welder and that fact makes the amount you see through the dark glass of a shield less than with an ordinary welder. Don't do it! If some folk want to put their sight in danger, that's their choice. Old lawyer's saying; "You cannot stop fools doing foolish things!"

While on the subject of shields, it is as well to know that the bits of dark glass come in different strengths. Some are so dark that you can't see a lit 100W bulb through them at all. These are intended for ordinary arc welding with thick electrodes; the sort of thing used in shipyards and the like! The lightest are the ones to use for MIG work; with these you can see a lit bulb dimly, which is as good a test as any to see what kind you've got. Use too dark a glass and you're working almost blind!

A common complaint is "I can't see what I'm doing through the shield glass". This can be very true if you don't know the trick of how to do it. It is this - nothing behind the shield must be brightly illuminated! Try welding with all the shop lights on and you'll have problems. Turn off all but a lamp over the bench and see the difference! The ideal bench light is one of those long jointed things you can pull to any position. Put it low over the job so that you don't see it through the shield. With no light behind you, the 'picture' through the shield becomes quite clear. Simple, but not widely known. In daylight, try and work with the source of light (window, etc.) in front of, rather than behind you.

Controls of the Machine

Now to the controls, using the S.I.P. as an example (photo 3). There'll be a range switch of some kind. One position is for CO^2 gas and the other is for argon: CO_2 needs a bit more power than argon. Set it according to the gas you're using.

Next come the three power level buttons, usually Min, Med, and Max. They set the range of current output. For material up to about 1/16 in. thick, use Min.

Finally, there's the wire speed control. S.I.P. graduate theirs from 1 to 10 over its range of rotation. Turn clockwise to increase wire speed, and vice versa. Current output varies with wire speed; more speed means more current, but there are practical limits. Too low a setting means that the end of the wire 'burns back' into the torch. Too high a setting means that the wire comes out faster than you can use it, and so gets longer and longer! For Min. voltage setting and thin steels to weld, set it about 1/4 up from zero (i.e. 2.5. to 3 on the S.I.P. scale).

I have made no mention of wire as yet. There are two diameters normally available, 0.6mm and 0.8mm. Welders are always supplied new set up for 0.6mm wire. It is the only size you need for small work.

Having set up the front-panel controls, it remains to set the gas flow. Plug in, switch on, connect the gas bottle to the little plastic regulator which screws into it. Hold the torch away from everything, and press the trigger. Wire will come out of the end (it is wasted, so don't take too long!), and the ball in the regulator will rise. Set the regulator control so that the ball floats at the level specified by the maker, usually about half-way up the regulator body.

Never set the gas flow any higher than the maker wants it; it gains nothing, and costs money! Finally, cut off the wire protruding from the torch so that it is only about 1/4 in. from the torch tip. We're now ready to start welding.

A few "Dry" runs

If you've never done this before, a bit of practice is the order of the day. The ideal practice material is 1/16 in. BMS strip between 3/4 and 1 in. wide. We'll assume that is what's to hand.

Put a bit of strip in the vice, flat side horizontal, with one end sticking out (Fig. 1). Connect the earth clamp of the welder to the end. Don't switch on yet! Practise drawing the torch across the strip steadily at about 1 in. per second, with the tip just above the surface of the BMS strip. By 'just' I mean as close as possible without actually touching. Hold the torch so that the tip is about 30 deg. from the vertical (Fig. 2).

When you've got the feel of that, try a few passes with your eyes shut. Why? Because when you use it for real you can see nothing until the arc starts, so you have to position the start point 'blind'. Now to, as a lady once described it (quite true!) "sticking things together with electric sparks".

Practice Joints

First, try runs of weld across the strip. Switch on, have your shield ready, and position the torch so that the wire will contact the far edge of the strip. 'Freeze' your hands there, put up the shield, press the trigger, and draw the torch steadily towards you. Release the trigger when the arc gets to the other side of the strip. Have a look at the result. It should be something like one of the three runs shown in photo 4. If it's like 'A', then one of three things is wrong: you had the torch too far from the work, you moved the torch too far from the work, you moved the torch too fast, or the wire speed was too low. If it is like 'B', either the wire speed was too high or you moved the torch too slowly. If it is like 'C'. you've got it about right; the arc was short, steady, and made a steady noise.

Now look into the end of the torch. It might not have happened yet, but you never know. See if there's any 'clinker' in it. If so, flick it out with something like a small screwdriver.

Always keep checking for this.

I'm assuming that your welder isn't one of those horrible things with the tip of the torch 'live' at the same voltage as the wire. I don't think any of those are sold now, but you might come across one secondhand. Run a mile if you do! They're a menace, producing arcs at times and places least expected!

Do a series of weld runs until you're confident that you can produce results like 'C' in the photo every time. If you get a 'bite' out of either or both edges of the job, not to worry for the moment: we'll come to eliminating that as far as possible later.

Having got this far, it is time to try actual joints. Another bit of the BMS strip is required. Cut off a bit about an inch or so from the end, and clamp the two bits in the vice as in photo 5.

Trim the wire so that you have a clean end about 1/4 in. out from the torch tip, and leave a gap between the two bits of BMS strip; just enough to feel with the end of the wire.

Without switching on, draw the torch from one side to the other (i.e. left to right) and feel when the wire crosses the joint. Get the feel of that, so that you can do it without looking and stop the torch when the end of the wire is touching the joint at the far edge of the strip. When confident, do it so that you can touch the torch accurately half-way across the joint. That we need to 'tack' the two bits together.

Switch on, have the shield ready, and position the torch half-way along the joint line. Press the trigger and hold the torch still for about a second - no more. This should have produced a one-place 'tack' holding the two bits

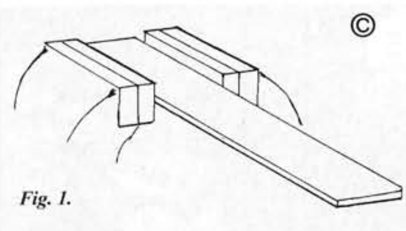


Fig. 1.

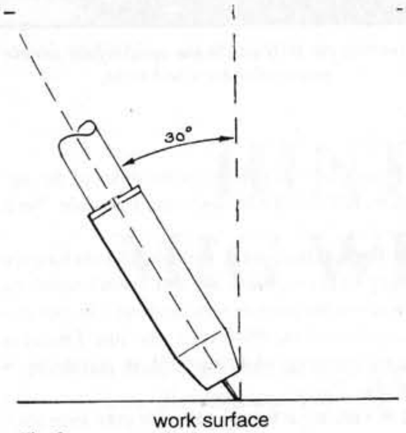


Fig. 2.

together. Move the job along the vice jaws - we don't want to weld the vice-jaws! Now, put a bead of weld right along the joint line. If you're lucky, the weld bead will be exactly along the join and will have fused the two bits together. If this is your first try, you may have wandered off the line: not to worry, just put another run over it in the right place.

Take the job out of the vice, and have a look at the other side of the joint. You may have got full penetration, where the weld has fused right through the metal; you probably won't, for it doesn't usually happen with this thin metal technique. If the line of the joint is visible, put a bead of weld along it. Switch off, put the welder aside, and get hold of a file.

Clean up both sides of the joint with the file. There's a fair depth of weld bead to file off - MIG is like that in comparison with ordinary arc welding. Car repairers use an angle-grinder for this part of the work, but it is a bit too big and fierce for most model engineering jobs. When filed flush, the joint should be almost invisible; the degree of finish required will vary with the purpose of the finished article. Strength is the most important feature of most joints, but with welding the difficulty is to be able to test it. Industrially, they use X-ray tests, but that's out for us. The only other way is to bend the joint and see if it breaks, but that destroys it! So, you have to work on the basis that if it looks solid it probably is!

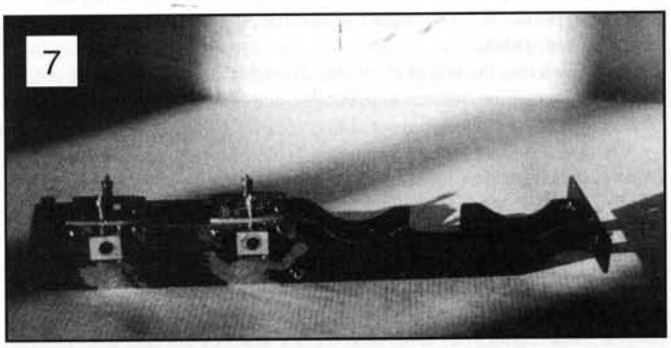
The same basic technique applies to almost all joints, except that with some you can clamp them so that the initial tack weld isn't needed. Take two bits of strip to be joined at right-angles. These can be held in the vice so that the 'outside' of the joint is above the vice jaws and can be welded straight across in one go. However, with such a joint it is often best to put another weld run across the 'inside' of the angle; this means the torch tip has to go between the two bits of strip. You put it as close as possible, and dragging the outside of the torch tip on the metal of the job is often the best way (see why I don't like live tips?).

The various other forms of joint are numerous, and would take up a lot of space to describe in words. So, Fig. 3 shows them. All have one thing in common; clamp the bits together firmly before you start! Personally, I don't like magnetic clamps for small work; they're alright for bigger jobs where the weight of the individual bits helps. For small work, stick to a vice and toolmaker's clamps.

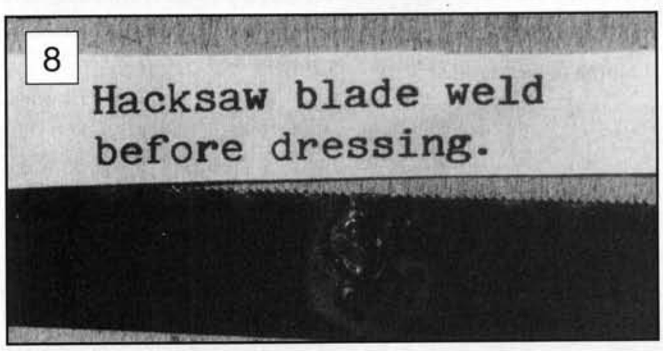
The final thing to know about small joints is how to avoid those 'bites' out of the edges where the weld runs 'off the edge' of the job. They're caused by the fact that the heat of the arc has less metal to dissipate in when it is at the edge of the job. So, predictably, the metal of the job tends to melt away too fast for the molten metal of the wire to replace. There are two ways of getting over this. The first is to start and stop the run of weld a little way away from the edge; quite acceptable if the joint is of a fair length in comparison with the thickness of the metal. The other way is to provide cooling for the edges of the job.

This cooling can be provided by the vice jaws themselves, but this ploy of course won't do the jaws any good. More importantly, the jobs are likely to get welded to the jaws! The way round this is to use cast iron, to which mild steel weld won't stick. You either back the job with odd scrap bits of cast iron, or use an old vice specially for welding; that vice has either no inset jaws at all, or a pair made from cast iron. The vice does, of course, get somewhat pitted with such use, but it doesn't have to be 100% accurate and the jaws can easily be trimmed up whenever they get too bad to be acceptable. It may be that on occasions the job will be apparently stuck to the vice, but a tap with a hammer will always free it easily - at least, that's been my experience. Another little tip to stop that is to always make sure that the jaws are dirty; a smear of the sort of gunge you get on the underneath parts of a car engine is ideal. It won't catch fire because there's too much metal about for a high enough temperature to build up.

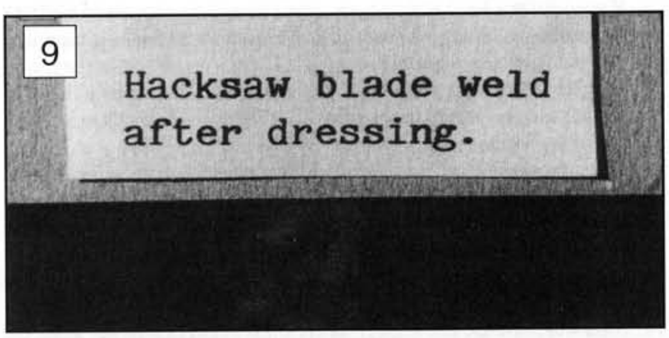
So far I've talked about little jobs in two senses. The metal has been thin, and the width of it has also been small - say up to about a couple of inches at most. There's a hidden trap in longer welds; metal distortion due



7: Frames for a Gauge "O" locomotive, the buffer and drag beams are MIG welded into position. For those interested the locomotive is LBSC'S Amy.



8: A weld on a HSS hacksaw blade, shown before dressing.



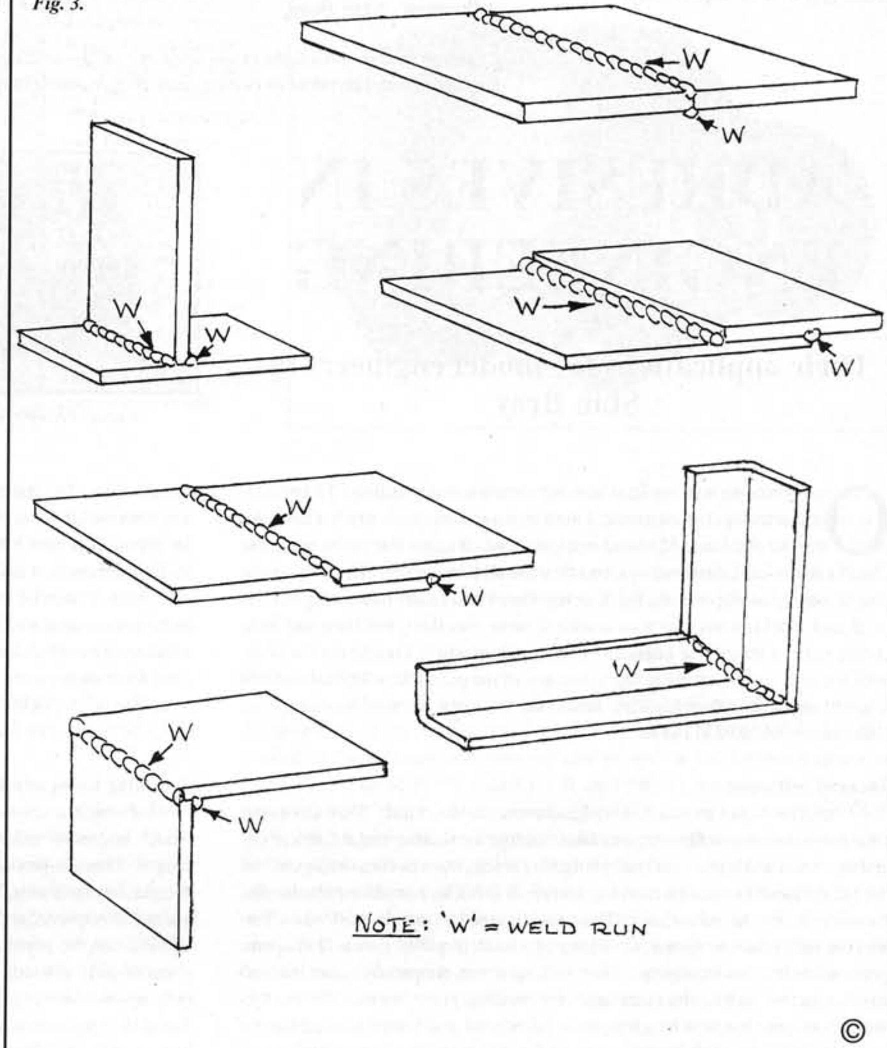
9: The same blade once the weld has been dressed back to the surface of the parent metal.

10: Butt and angle welds before dressing.

to heat. Not so bad as with ordinary arc welding, but it still happens. Try butt welding two bits of car body sheet together over a 9 in. length and you'll see what happens (car body sheet is mostly 1mm thick). The finished job will be bowed along the line of the weld, convex side where the weld run lies. You can probably do without that!

The standard method for minimising this distortion is first to tack weld the joint at intervals of about an inch or so. Then, 'fill in' the gaps but don't go from one end of the job to the other. One way is to first do the two end runs, then follow with the middle one. After that, you do a run one side followed by a run at the other until the whole seam is welded. That certainly minimises distortion, but won't guarantee that there is none at all if the weld bead is all on one surface (as is usual in car body repair work). If the layout of the work allows, a better way is to do the 'even number' runs on one surface and the 'odd number' runs on the other, even if you're going to do a weld run on both surfaces all along the job. As always, the more rigidly the parts are clamped together while welding the better the result; that's why car restorers and body shops use a lot of those Mole wrench clamps with peculiar-shaped jaws!

Fig. 3.



Blowing Holes

With all the care in the world there'll be occasions when you blow holes in the job. They can be put right, because the edges of such holes are thicker than the parent metal due to the weld deposit. So, you do a series of 'spots' of weld around the hole, gradually closing it up. The result is always a rather large blob of weld metal which has to be dressed off, but that's better than a hole! Try it on a bit of scrap car body sheet and you'll find it works! A way to avoid holes, if the job allows, is to clamp a bit of thick copper sheet behind the line of the joint to dissipate excess heat at those moments when you move the torch too slowly (or stop it momentarily!). Such 'slows' and 'stops' are the real cause of holes.

Once these techniques have been mastered, the number of things a MIG can be made to do is amazing. Loco frames are an obvious one; photo 7 shows a Gauge '0' job I'm doing at the moment. Both buffer and drag beams are welded in place. Fabrications from square or rectangular tube can often take the place of castings, at a much lower cost. Metal can be deposited on a worn surface to build it up - one of my rotary cultivators has a shaft which was restored this way, and it has done a lot of work since I repaired it in this fashion. Of course, there are obvious possibilities for all kinds of repair jobs.

One caution though - keep clear of pressure vessels of all kinds; here you need the skill and expertise of a coded welder, such work is not for the amateur, however proficient.

Practice breeds confidence, and it is amazing how soon you find that you'll tackle all sorts of jobs without the slightest worry about their not turning out right.

Two final thoughts. First, there are always some places in which dressing the job with a file is almost impossible. In these places, use one of those little Black and Decker Multicraft drills with the tiny pink stones they sell; those things about the size of a 2p piece. Also, there are occasions when the same weapon does very well with the little brown cutting-off disc in place. But, when using that, be very careful not to put any bending stress on it; also, let it cut at its own rate rather than forcing it!

No mention of welding alloy? True, although I did say it was possible. That (editor permitting) is the subject for a future article.

SAFETY RULES FOR MIG WELDING

NOTE. The dangers of MIG welding can easily be overstated, with the result that people are frightened without good cause. Nevertheless, there are reasonable precautions to be taken.

1. Unless a weld is to be made, always hold the torch clear of everything if the trigger is to be pressed while the welder is switched on. This is usually done to feed wire forward.

2. Never strike an arc without using a shield.

3. Do not weld close to inflammable materials. The arc of a MIG is much smaller than that of a standard arc welder, and the amount of sparks thrown is very small, but a clear space of 12 in. around the job should be regarded as a minimum.

4. When welding in the workshop, keep the door shut so as to avoid the possibility of pets or children entering without eye protection.

5. Always switch off the welder when not in use.

NOTES ON APPLICATION

These instructions are applicable to welding thin metal, i.e. steel up to a maximum of about $\frac{3}{32}$ in. thick. The techniques described here are not necessary applicable to welding thicker sections such as $\frac{3}{8}$ in. square bar.

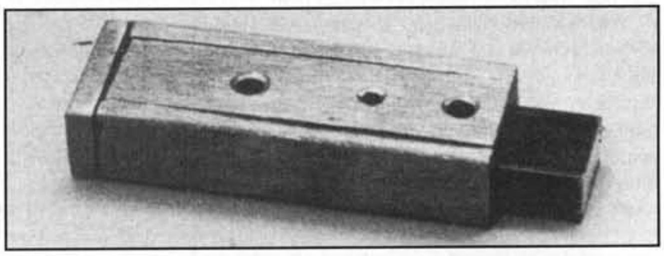
M.E. 155 494 et seq. (1985)

Adhesives Stan Bray

I know that some folk fight shy of adhesive in Model Engineering, but there should be no inhibitions. I have had to be merciless in editing Stan Bray's articles for length, but I trust they will hang together.

ADHESIVES IN ENGINEERING

Their applications for model engineers by Stan Bray



A small drilling jig made by sticking the parts together with Loctite Multi-Bond.

ONE problem with which I was concerned was availability. I have tried my own local stockist and found that anything I am likely to require can be obtained. My local stockist is one of about five in the area, and I live in fairly rural surroundings, and they are all bearing suppliers. The question of supply is important. Prior to my visit I had made many enquiries at local tool stockists who, as tool stockists, were excellent, but they had been unable to offer the advice I needed or tell me from where I might get the product I wanted. So, if you are going to use any of the products, telephone Loctite UK Ltd at Welwyn Garden City, Herts. for the name of your local supplier (U.K. phone 01707 331144).

Types of Adhesives

Adhesives come in two types. Machinery or structural. They have specific purposes. A machinery type is not suitable for making metal fabrications and the structural type is not really suitable for locking wheels to axles etc. So the right adhesives must be used for the job. It is not bad practice or bad workmanship to use the substances. They are designed to enable work to be carried out faster than by normal workshop practices. Equally, they will not compensate for bad workmanship. They will, however, frequently mean that tolerances can be greater than they are when making press fits etc. All the recommendations that will be given have been tried and tested in industry for very long periods, so the substances can be used with absolute confidence.

Loctite Multi-Bond

The first type of adhesive that came under discussion was "Multi-Bond". This is a two-part adhesive with one part acting as an activator. It is sold in shops in little bubble packs. The adhesive is in a tube, and the activator in a little bottle with a brush in the cap. However, this particular version is twenty per cent lower in strength than the one sold in the suppliers for commercial reasons. The one sold by the suppliers, though, comes in large packs and the activator is in a small spray can. It is numbered 330 and the activators are 737 and 738. 738 is the quickest acting and bonds material in about a minute. With 737 the setting time is increased thus allowing for more time to adjust parts if required. In use the activator is applied to one surface and the adhesive is applied to the other. The parts bond when brought together. It has a wide variety of applications and can even by used to bond oily steel, although strength will always be increased with cleanliness. It can be used on all metals, glass, stone, wood, canvas and many plastics. It will NOT bond Polyethylene, PTFE or rubber.

The test that was given during my visit was to bond together two pieces of 16 s.w.g. steel, about 3 in. x 1 in. It was given a few seconds and then an attempt was made to peel it apart. As insufficient time had been allowed for the activator to work it started to peel away. However, as the activator worked it refused to tear any further, and eventually the metal bent whilst the joint held. I was to find that this was a pretty standard sort of test for most of the structural type of adhesives. Tear strength is the most important thing as this is the ultimate in tests.

Multi-Bond 330 is widely used in industry for bonding metals and plastics, and is used on railway carriages for bonding aluminium stiffeners to GRP, as well as numerous other applications. For the modeller, then, the application that immediately springs to mind is in constructing water tanks and tenders for locomotives. The parts can be bonded instead of soft soldered as we now do. It is not suitable for edge joints and joints should be lapped, the greater the lap the better. It is therefore suggested that the present method of using angle and soldering sheet to it is still the best arrangement. But with the adhesive, however, there is no need to clamp pieces together, as we need to whilst soldering, and it is far easier to adjust the parts for positioning. It could also be used to hold locomotive cabs and superstructures together, as well as to make up metal parts for stationary engine mountings. After the parts have been secured it can be drilled and tapped if required. It will fill gaps to 0.5mm, the larger the gap the more time taken for the adhesive to cure.

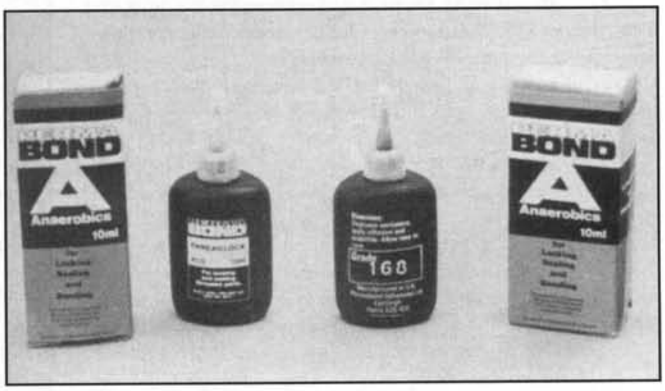
Retaining Compounds

Probably the retaining compounds are the ones most likely to be used by model engineers, although I have a feeling this will not be so for very much longer. These compounds fall into roughly two categories. Those which are designed to hold nuts, bolts and studs in position, whilst allowing them to be undone if required, and those which are meant for more permanent bonding. Of the latter, the popular one which is stocked by most model engineering suppliers is 601, although whether or not this is really the most suitable for our purpose is something readers will have to decide for themselves. I must confess that at the end of these articles I am hoping that model engineer stockists will have revised their ideas and will be stocking both a wider range, and a more suitable one.

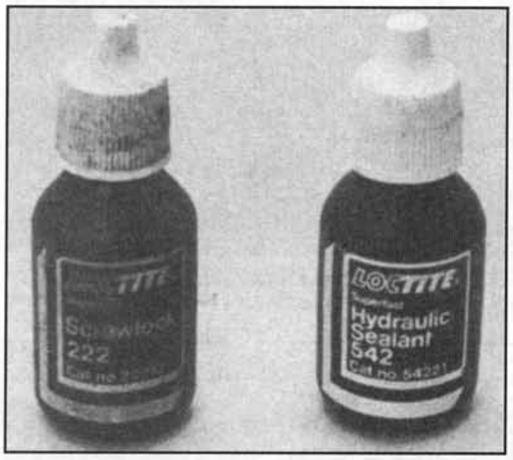
If we start at the lower end as far as strengths are concerned then there are three products of interest. "Screwlock 222", "Nutlock 242", and "Studlock 270". The higher the number the stronger the product. They are designed to enable threads to be secured whilst at the same time allowing them to be undone if need be.

Loctite Screwlock 222

222 is meant for brass, alloy and other small precision screws, and as such must have an application in model engineering. It has a breakaway strength of 220 - 580 lbf/sq.in. The maximum gap fill is 0.15mm or 0.006 in.. The question one must ask oneself is why is there such a wide difference in

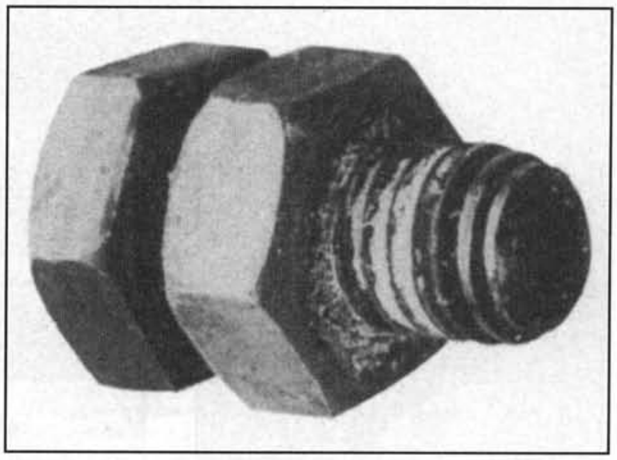


Other manufacturers produce engineering adhesives; shown above is part of the Perma Bond range. These are made in the U.K.



Left: Loctite products in the liquid adhesive range are supplied in small quantities in these familiar sized bottles. They are purposely left part full to preserve contents.

Right: The nut was secured to this bolt using Nutlock 242. The joint was subsequently broken. The residue of the adhesive will still retain part of its strength.



breakaway strength? The answer is in the amount applied. The products are designed to have an application on length to diameter. In other words if you are using them on a 3mm screw, 20mm long, the substance should only be applied in length to 3mm of the screw, in order to get the correct strength. If it is applied over the whole length then the strength will be much too great. Another tip here that I received is application in blind holes. The compound works when air is excluded. If it is put on the threads of a screw going into a blind hole then as that screw is tightened up air is forced up the threads, ruining the seal. It should then be dropped to the bottom of the hole where the pressure will force it into the right place.

Loctite Nutlock 242 and Studlock 270

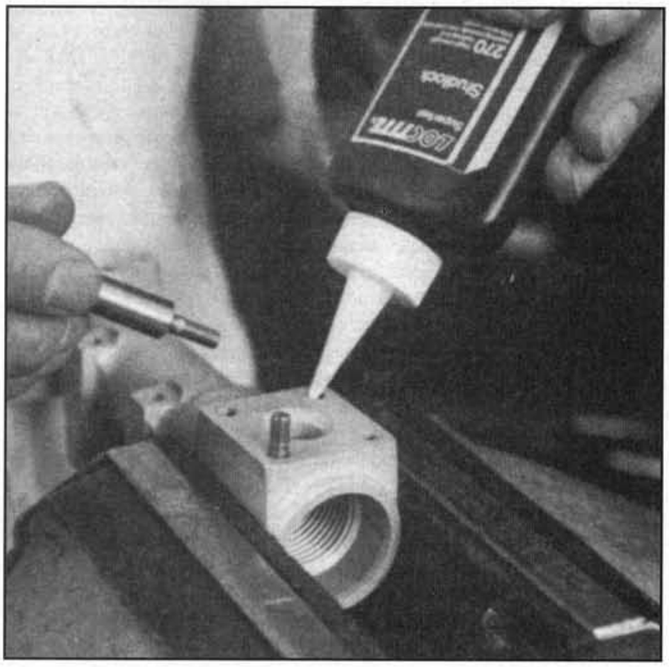
The next two products 242 and 270 have breakaway strengths of 580 - 1,230 and 1,160 - 1,740 lbf/sq.in. respectively. What has been said of 222 applies equally to these. Because 242 is described as Nutlock it does not mean that it must be used where nuts are to be secured (222 would do the job just as well, particularly on small nuts). 242 is useful for larger sizes such as $\frac{5}{16}$ in. upwards, and 270 certainly has its uses in retaining studs. For example, in larger gauge models it would be useful for studs in locomotive cylinders.

Whilst the obvious reason for using these products is to retain screws etc., there are other advantages. The application of one of the compounds at the highest part of the thread where it will seal will prevent the formation of rust. Thus not only does it act as a retaining agent but also acts as a releasing one. 242 and 270 will also seal in bearings, whilst allowing them to be tapped out for replacement if required. Use of any of these products prevents the need to overtighten screws, nuts or studs. In operation if the seal is broken the compound still retains a percentage of its strength. The residue in the threads will still continue to increase the adhesion although not actually working at full strength.

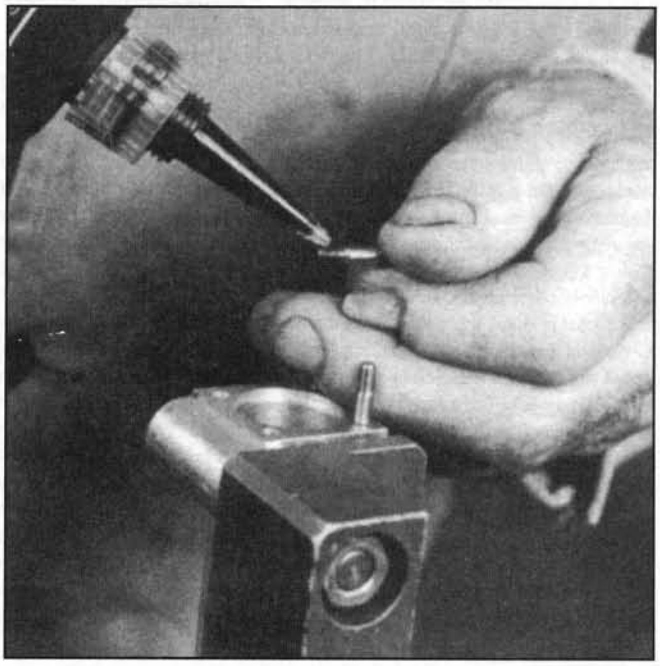
Loctite Retainer 601

Probably the most widely used Loctite product in model engineering is Retainer 601. It is certainly useful and can be used to retain wheels on axles, crankshafts in position, and many similar things. It has a shear strength of 2,250 - 3,250 lbf/sq.in. In industry it is used for retaining bearings, pins and dowels, bushes, etc. It has a maximum gap filling ability of 0.1mm or 0.006 in. It will certainly do the job. More often than not the wheel or crankshaft is also keyed with a taper pin or something similar, but this is not essential. Like all these substances it has one major advantage over a straight press fit. In the case of a press fit there is a danger of the fit becoming eroded with rust after a few years. At the best, most press fits have only a twenty-five percent contact area, and the part not in contact will gradually absorb moisture. Any of the Loctite retainers will prevent this happening and will fill the gap. Most modellers who have been around for a long time will have heard of wheels becoming loose or crankpins doing like-wise after a few years. This is the erosion to which I refer.

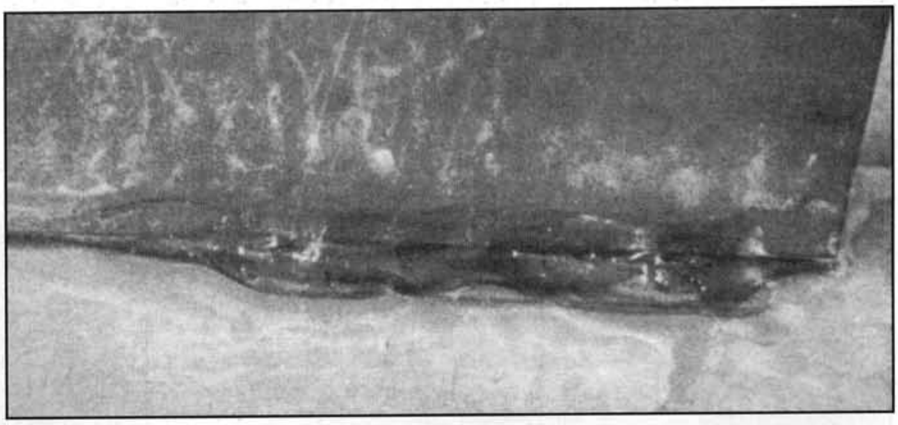
Using Studlock 270 to secure the studs in an aircraft ejection seat. As the holes are blind the Studlock is poured to the bottom of the hole.



Studlock 270 being applied to the thread of a stud for use in a non blind hole.



The typical container for the Loctite Cyanoacrylate range of adhesive



Two pieces of metal, both 16 s.w.g. steel, secured with Loctite 340 and activator 785. One piece is at about 75 deg. to the other. A fillet has been made at the base, for extra strength.

Loctite 340 has the ability to fill gaps and still retain adequate strength at the bond.

Loctite Retainer High Strength 638

Whilst 601 has been used and will continue to be used with success, there are more suitable retainers. 638 is called Retainer High Strength. The shear figure is 3,600 to 4,300 lbf/sq.in. Considerably higher than 601. If used with activator "T" or with a slight warming it will fill gaps up to 0.15mm or 0.006in. Its temperature range is about the same as 601. Why then should we not use 638 instead of 601? No reason really, except that it cures considerably faster. One advantage of these compounds is the fact that adjustment, such as wheel quartering, can be done after assembly and before the product has cured. However, if used at a slightly lower temperature curing takes longer and there is time for adjustment. It will certainly give greater strength than 601, and in the tests carried out at Welwyn Garden City for my benefit it was shown to have about fifty percent more strength than 601.

Loctite Heat Resistant Retainer 648

Both the above retainers are quite happy at about 85 deg. Centigrade and there should be no deterioration. Crankshafts on locomotives are subject to quite high temperatures as indeed can be wheels and bearings. It may be as well then to seek a compound with a greater degree of temperature resistance. Loctite 648 is designed to work at high temperatures and is called Heat Resistant Retainer. It will accept temperatures up to about 150 deg. Centigrade without undue loss of strength. In fact at 175 deg. C. for twenty-four hours on test it still kept sixty percent of its strength. It has a shear point of 2,800 - 3,500 lbf/sq.in. which is higher than 601, and has the same gap filling ability as 638. In other words it is highly suited to model locomotive construction.

General Notes

The three permanent retainers referred to are those most likely to be of use. All have good resistance to water, oil and other fluids to be encountered in the hobby. All are suitable but 638 and 648 have greater strength, combined with faster curing times. In my opinion the curing time is not too fast for our purposes. Apart from putting wheels on axles and making crankshafts they are ideal for mating virtually all cylindrical parts. To get the best results, the parts to which adhesive has been applied should be rotated about each other before being placed in the final position, this allows the compound to cover the surfaces completely. Getting them apart again is not quite so easy, and the only way is to heat the item up. It will not, even then, just slip apart and will require rotating and forcing, the residue of the adhesive still retaining a certain bonding effect even after the bond itself has been destroyed.

If fitting bearings which might be subject to wear and therefore need replacement, it may be as well to use one of the less strong retainers such as Nutlock, which should be suitable for our purposes. Stronger still would be the Studlock or Loctite Bearing Fit 641. However, to purchase Bearing Fit for a few bearings seems somewhat expensive when one realises that Nutlock would do the job almost as well. The use of any of these compounds when fitting bearings will once again prevent the invasion of moisture, and so the formation of corrosion, which could cause problems at a later date.

The compounds are available in 10ml bottles, which come half full. The reason for this being that exclusion of air causes them to cure. A certain amount of air must be left in the bottle. Joints should be cleaned thoroughly before applying the compound and, if possible, degreased with methylated spirit or something similar. I have already suggested rotating parts for maximum coverage, and any surplus can easily be cleaned off. Although the compounds cure quickly, maximum curing will probably need twenty-four hours or so. So do not expect to put a wheel on an axle in the morning and use it the same day.

Cyanoacrylate Adhesives

There are many so called super glues available on the market manufactured by various firms. These are cyanoacrylate adhesives, and we see wonderful claims for them in the various advertisements. The question is will they do all the advertiser claims? I was to discover that cyanoacrylate adhesives certainly are super glues but that, once more, there is quite a wide range and we need to select the right one for the right job.

Loctite Superbonder 415

This glue has a far greater viscosity than normal super glues. It has a slower curing time, although even that is rapid by comparison to some adhesives. It is particularly useful for bonding parts that are subject to vibration, and will bond metals, plastics and rubber. Because of the high viscosity it is able to bond slightly porous material. Curing time depends on the material on which it is used. Roughly speaking, bonding two steel plates takes thirty to fifty seconds, aluminium and brass somewhat longer, say about two minutes.

Material to be bonded must be thoroughly degreased. The adhesive is applied to one surface and the other surface brought to it. No excessive pressure is needed and it will not run whilst awaiting bonding. By using an activator, number 415, it is possible to build up fillets and it is also possible to join metals edge on - something not normally possible with this type of adhesive.

Superbonder 415 obviously has many uses for the model engineer. Locomotive superstructures can be assembled with it, and it is useful for putting handles on small tools. I used it for stocking a small slip stone to a metal strip, which allowed greater pressure to be used. At the Loctite laboratories it was demonstrated on 16 s.w.g. steel plates and the strength was such that the plates would bend before the bond would break. Although edge bonds can be obtained it is, like all these adhesives, best for the bonding of flat plates. If used for making locomotive superstructures it should be used with metal flanges for strength. Again, angle iron or brass will work perfectly well.

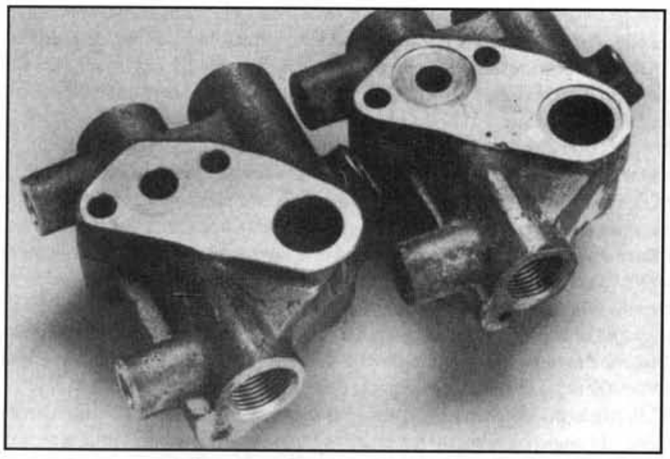
Loctite Steel Bonder - 340

This adhesive is designed for use with an activator, number 785. As usual, the adhesive is applied to one surface and the activator to the other, the parts then being brought together. It was tested at some length by I.C.L. Ltd of Letchworth as a means of replacing spot welds. The steel fabrications used were identical, and one was fixed with Steel Bonder 340 whilst the other was spot welded at one inch intervals. The adhesive was continuous. When pulled apart mechanically the spot welds tore through the metal long before the adhesive showed any sign of weakening. Steel Bonder 340 has the advantage of being able to fill gaps up to 1mm. Curing time naturally depends on the gap and it is somewhat longer than most cyanoacrylates.

Like all these adhesives, the greater the area in contact the greater the bond. Unlike most, though, this one is designed to withstand temperatures of up to 200 deg. C, although no heat is required to cure it. All paint and scale must be removed from the metal to be treated and whilst it is always advisable to remove oil and grease this is not entirely a necessity. Again, it can be used for building up locomotive superstructures and similar functions. It has sufficient strength to withstand a great deal of misuse, and it can also be used for bonding other materials to metal.

Suggestions for Use

No doubt readers will have their own ideas about what to use the various compounds for. I have already made some suggestions and Doug Caswell of Loctite had some very useful ones to offer. He said that 340 could be used to hold boiler cladding in place underneath the boiler where we now tend to soft solder. It also makes the use of mild steel cladding a better proposition and, of course, mild steel will accept paint much easier than will brass. He thought 415 was the ideal one for holding cylinder covers in place whilst drilling them and going through into the cylinders. With a warming up after drilling the bond can be broken, and any remaining adhesive easily rubbed off. 340 can also be used to hold the wooden lagging in place on marine or other boilers, this I have tried with success. It can equally be used for fixing the cylinder lagging, which can be a somewhat awkward job. Really, this type of adhesive opens up a whole range of possibilities and makes it practical for those with limited facilities to do some jobs which previously they could not easily cope with.



Two views of the same component. The one at the top has machined recesses for "O" rings, the lower uses Loctite Multi-Gasket 574, both are from an hydraulic motor.

Miscellaneous Products

We have covered in considerable detail the various adhesives marketed by Messrs. Loctite, but there are quite a few other items which can be of very great service to the model engineer. Once again the existence of these products is not widely known, and some explanation of their various functions will, I feel, be of considerable value to readers.

Gaskets and Sealers

For many years now the model engineer has been content to seal off threads on his or her plumbing with good old fashioned plumber's jointing, and has been well satisfied with the results. If we look round, however, we will discover that the plumber for whom the product was designed is more likely, these days, to be using something else and so, perhaps, it is time that we had a change too.

Loctite make two types of thread seals. Pipe Sealer is No. 572, and it is designed for sealing off pipe work. It is of medium strength with a breakaway strength of between 290 and 580 ft/lb/sq.in., has the advantage of rapid setting and can be used in cases where the component will be put into immediate use - unlike ordinary plumber's jointing which, with steam at least, needs a little time to set. Loctite 572 contains Teflon and is capable of withstanding vibration. It can be used to hold fittings in place for assembly, a typical example being screwed-in clack valves. Somehow the thread never seems to finish at quite the right spot and the clack invariably ends up at an odd angle instead of nice and straight.

Loctite Quick Metal was used to take up backlash in this keyway.

A similar thing always happens to other types of valves and to water gauges. The usual answer is to scrape a piece of the bush which, if not careful, spoils the mating surface, resulting in leaks, or to pack it out with washers. An application of 572 to the fitting, and then leaving it for a few minutes will ensure the fitting staying in the right place whilst piping up operations are carried out, and the fitting is sealed as well.

A similar product, but somewhat stronger is 542 Hydraulic Sealer. This has all the same attributes as 572 but has greater resistance to vibration. It would be of particular use on larger scale locomotives and traction engines. It has the advantage of a low viscosity which allows it to creep into gaps whilst being unable to actually separate from the component. Another pipe sealer is 577 but this has a viscosity which is probably somewhat too thick for model engineering purposes.

There are various brands of plastic gaskets available and I have tried several. Most appear to be somewhat on the thick side for our purposes. Loctite 574, though is one which is considerably thinner and therefore much more suited to model engineering. It can be used for water or steam, and is spread thinly on one component which is then tightened up, the liquid spreads over the surface to form a gasket. It must equally, though, not be applied too thickly or it will run where not wanted. It can be used for sealing cylinder and steam chest covers, as well as for water tanks, inspection holes etc. A great deal of time can be saved by its use. When dismantling, the gasket will rub off, leaving the component with a nice clean surface.

Superflex Clear Silicone

This substance is applied to surfaces over an area and, when cured, provides a rubber-like cover which adheres to the surface to which it is applied. It can, therefore, be useful in protecting steel water tanks and similar items as water cannot pass through it. Although described as clear silicone it can be obtained in white or black as well. In practice the silicone is extremely hard to peel off the metal to which it has adhered. It is also useful for painting over leaking water vessels, and possibly for the covering of wagon and other roofs to make them watertight. It is non-toxic when cured, but during curing a small amount of Acetic Acid Vapour is formed and therefore it should only be used in a well ventilated area.

Metal Set

This is a two part substance which can be purchased in a number of forms of varying degrees of viscosity. It comes in either a steel or aluminium based form. The two parts are mixed in a similar way to car body fillers. It is non rusting and non shrinking and, after it is set, it can be machined, drilled or tapped. It is useful for the repair of castings, filling those holes we did not mean to make in the drilling table. The version called S2 is liquid in form and can be used as a casting medium in suitable moulds. I have seen an identical product used for filling some blowholes in a 5 in. gauge cylinder casting. The bore where it was used was then machined and the locomotive is still in use with no ill effects many years later. It has many uses where incidents have occurred that could not be avoided, and its use could save hours of work on replacement parts.

Quick Metal

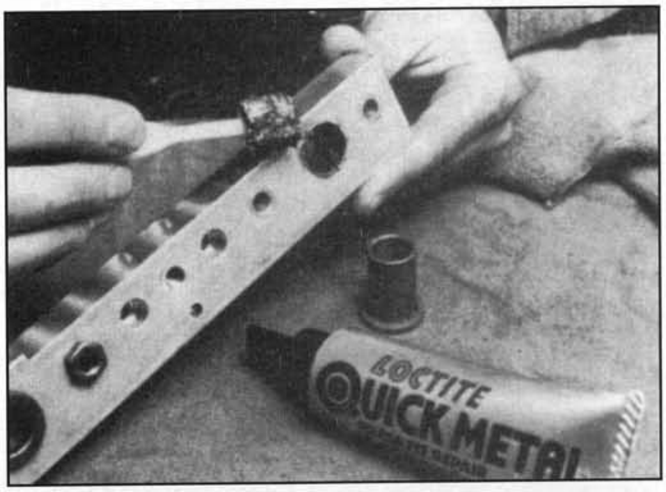
This substance is specially designed to make rapid repairs to worn and damaged machinery. It is similar to Metal Set but somewhat quicker in action. It is recommended for the repair of shaft housings, bearings, splines and bushes. If a bearing has worn oval, then the new bearing can be fitted with quick metal acting as a filler for the worn housing and it will save a great deal of machining, and fitting of oversize bearings. If a press-fitted component should be worn, then Quick Metal can be applied to renew the press fit. Simply smear it all over, push the fitment home and the job is done, once setting has occurred.

To Sum Up

The range of products described does not by any means cover the whole Loctite range. They also produce such substances as Glass Bond for repairing glass or making display cabinets, plus other adhesives and a whole range of metal care products to prevent rusting, prevent threads seizing and no end of other things. I think, though, that the items I have described are all of use to the model engineer.

In the case of the adhesives, joint design is important. The product must be suitable for the material it is to be used on. There must be sufficient material available for the bond to hold. For example, it is no good expecting to stick a sheet of thin metal edge on to something, as it just will not work. Surfaces should, where possible, be clean as although the manufacturers recommend products for use on oily surfaces, they will always work better on a clean surface. They will not work on a painted surface, nor where metal is flaking, for whatever the reason. Curing times must be strictly adhered to. If this is done then these products are not an excuse for sloppy work, but an aid to speeding things up for the good workman.

A new product from Loctite is Super Glue Xtra Adhesive, No. 409. This product is available from normal retail outlets. It has a very high viscosity and a gap filling capability of 1mm. The high viscosity makes it useful on porous surfaces. If used on metal the surface should be throughly cleaned, it is worth remembering that the larger the gap to be filled the greater the curing time for the adhesive.



In this photograph Loctite Quick Metal is used to slip-fit bushes into unreamed holes thus avoiding distortion. The Quick Metal cures in 1-2 hours and secures the bush against spinning caused by vibration, shock and centrifugal loads.

At the start of this series of articles I pointed out that there was a whole range of adhesives of similar types under various brand names, details of Loctite products being those reviewed as, at that state, only Loctite products had been tested sufficiently to supply the model engineer with the information required to enable him or her to use such adhesives with maximum efficiency.

Shortly after completing the articles I was put in touch with Dr. W. A. Lees, the Technical Director of Permabond who also make a complete range of engineering adhesives. Permabond are a British company and the range is very widely stocked by engineering suppliers throughout the country. Dr. Lees was only too willing to offer every assistance and I was sent a massive pile of literature and enough samples to enable me to fully test the products in my own workshop. Firstly, however, I decided to check on the availability and, true enough, the adhesives were easily available at good tool stockists and engineering suppliers. The range is not unlike that of Loctite and like Loctite, the range is ever increasing and improving.

All in all the Permabond range is as wide and efficient as the Loctite one. In some areas it will be easier to obtain the Permabond products than those of Loctite. Both ranges are suitable for model engineering purposes providing the right adhesive is used for the right purpose. I think that the number of such adhesives required by the modeller on a limited budget can be considerably reduced with careful selection. For example, only one screw locking compound will be needed - not one for each type of thread. This can be used for retaining purposes providing the item to be retained does not need great strength. They would certainly retain bearings on stationary engines and perform similar functions on some bearings on locomotives. For a full strength retaining compound use the strongest possible grade with a heat resistance for crankshafts wheels etc., rather than a different one for each purpose. The same applies to the super glues. The best for the heaviest work, it is only in industry where for production reasons a certain type is needed for a specific purpose. One of the toughened types would be the best for all round use. For pipe sealing use a strong one. It can then also be used for gaskets as well in most cases. It is certainly well worth trying the pipe sealers as a gasket compound before splashing out on a special substance.

Finally, make sure you know what you want it for and what it will do. If they are good enough for industry (and both Loctite and Permabond are now widely used in both aircraft and car industries) then they are good enough for us. Remember that more often than not the type of adhesive sold in home improvement shops and multiple stores is not designed for engineering purposes and will not be suitable. A proper engineering product is essential.

M.E. 103 649 (1950) & 131 828 (1965)

LAPPING

by M. Hall

BASICALLY, lapping consists of applying a suitable abrasive-impregnated tool to the work in such a manner as to cut a true and uniform surface.

Laps can be made of such materials as lead, copper, soft brass and cast-iron, and are usually lubricated by paraffin oil, extra light machine oil or soda water. Commonly used compounds are emery flour and jewellers' rouge.

The type of lap to be used largely depends on the condition of the surface of the work. If a rough ground finish is left, then the normal procedure is to start with a lap of soft material such as copper; this is fast cutting and quickly removes the ridges and high spots. For finishing, the lap should be of cast-iron, and with the use of a fine compound correctly applied, a very high finish can be attained.

Lapping Flat Surfaces

For small work such as that with which the average model engineer is concerned, a lapping plate of 6 in. by 8 in. should be ample. This is made as shown in Fig. 1. One side is planed or surface-ground, and has grooves cut into it which run at 90 deg. to each other. These grooves accelerate the cutting and allow more pressure to be applied to the work. The opposite side is for fine finishing and is scraped flat with a scraper finely sharpened on an oil stone.

Loading the Plate

The lapping plate is loaded by covering a brass or copper rod with a mixture of light oil and the selected emery flour, and rolling this carefully over the lapping surface. If a cloth damped with paraffin is gently rubbed over the plate, bright spots will probably show up: if so, the loading process should be repeated until the plate is of a uniform grey colour. A light smear of oil is next applied to the plate and the work is rubbed lightly and slowly, and with a circular motion. The pressure and speed can be increased if no sticking or skidding is felt. After a time, more lubricant will be required, and it will be readily apparent when the compound ceases to cut, as bright spots will appear on the plate. Before reloading, wipe off the old compound with a paraffin cloth, as it is false economy to apply fresh compound on top of old. The usual reminder should come here - be careful where you put the cleaning cloth, as emery can be an enemy if it gets into the wrong places.

The lapping plate produces high precision work, and with care its life will be long. So when not in use, it should be cleaned and protected from damage.

Circular Lapping

This is usually done on a lathe or drilling machine. For external work, there is on the market a very good adjustable lap, but for those who prefer to make their own tools a simple lap can be made by drilling and boring a suitable piece of material and slitting as shown in the sketch Fig. 2. This lap is held in a lathe driving dog, a dimple being provided to suit the screw, which is used for adjustment.

Internal Laps

Internal laps can be made to a variety of designs, the simplest type being a length of turned bar with a slit in one end to cause the two halves to spring outwards. This type of lap needs some degree of skill in use and is not recommended for amateurs. A better type, but one which takes longer to make, is shown in Fig. 3, adjustment being effected by sliding the cylinder lap up or down the taper mandrel.

Wear on the lap depends on the material and the way the abrasive is distributed. Obviously a soft lap will wear down quicker than a hard one, although even wear on the lap will have no ill effects on the work.

I would suggest in conclusion, that before using a new lap, the size be stamped on it in a suitable position; and that safe storage can be arranged simply by making a wooden stand similar to that shown in Fig. 4.

Finishing Techniques

This group is concerned with the alteration of metal surfaces to improve appearance or accuracy.

Lapping M. Hall / Duplex

This is the first of three subjects covering abrashive processes. Delving into the archives, two very different approaches cover the topic; the first by M. Hall deals with the lapping of flat surfaces, while bores are entrusted to the well respected pair of Duplex, the first of several entries by these authors.

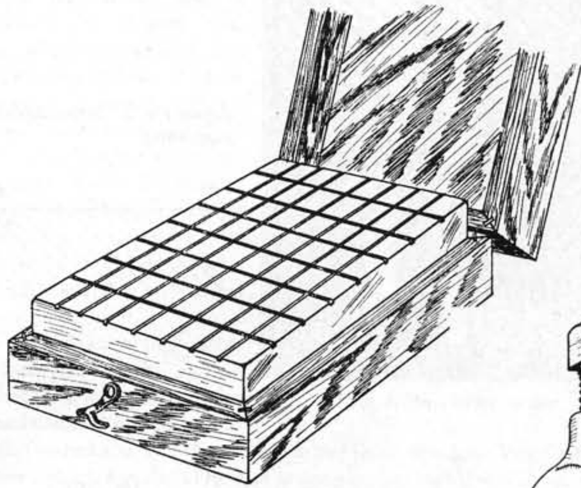


Fig. 1. A protected lapping plate.

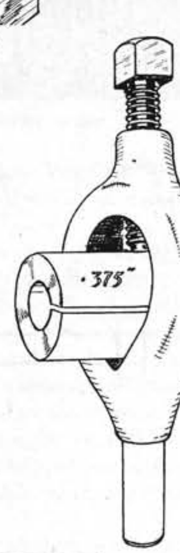
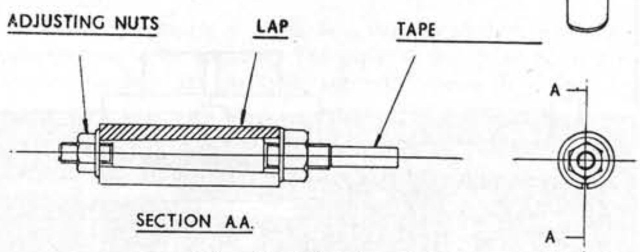


Fig. 2. A simple type circular lap



Below: Fig. 3. An adjustable lap.

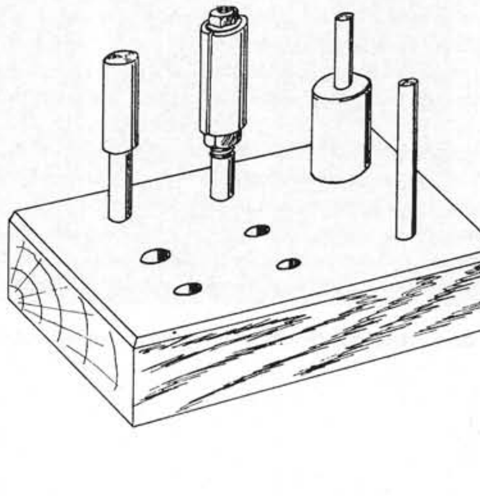
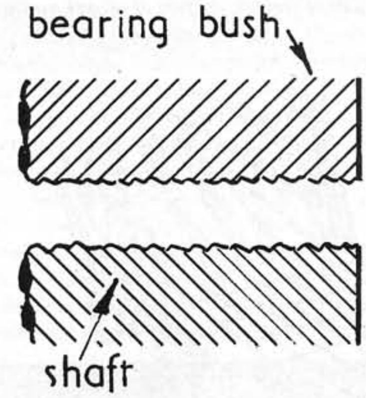


Fig. 4. Suggested stand for laps.

Finishing Surfaces:

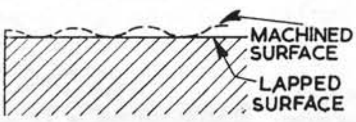
LAPS AND LAPPING

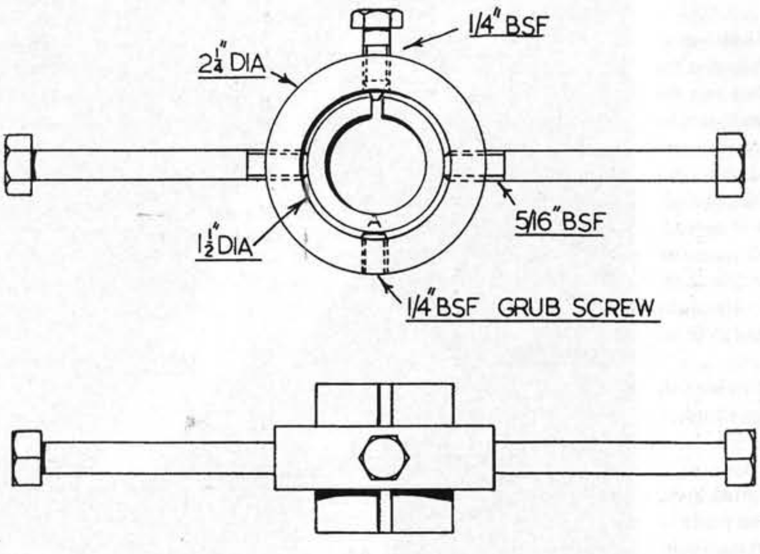
By Duplex



Left: Fig. 1. Machined bearing surface

Below: Fig. 2. Surface lapped after machining.





Above: Fig. 4: Lap holder.

IN THE workshop, lapping usually consists in fitting bearing bushes and their spindles to a higher degree of accuracy and finish than can be obtained by ordinary machining methods.

It is carried out by charging a metal arbor or sleeve with an abrasive and working it, in turn, over the mating surfaces of a bush and its spindle respectively.

When highly magnified, the surface of work turned in the lathe will show a continuous series of ridges, faintly resembling a fine-pitch screw thread. Moreover, the lathe is a copying machine and, as such, reproduces on the work any inaccuracies present in its mandrel and bearings, as well as those occurring in the sliding members. Because of this, from a geometric standpoint, the ordinary lathe can hardly be expected to turn exactly parallel or to produce truly circular work.

Nevertheless, these errors can be corrected by hand lapping and, in addition, the operation will produce a finish superior to that obtained by other methods. Where, as represented in Fig. 1, the bearing components are merely machine-finished, contact is made between the crests of the ridges left on the work surfaces; these may penetrate the oil film, causing metal to metal contact. The attrition of these high spots may result in scoring of the bearing surfaces and possibly seizure.

Evidence that this process is taking place is shown by blackened oil exuding from the bearing, due to the presence of suspended metal particles. Clearly, a bearing fitted in this way will soon develop looseness thus defeating its primary object of maintaining exact alignment combined with quiet running even at high speeds. On the other hand, a correctly-fitted bearing with lapped surfaces, as represented diagrammatically in Fig. 2, will run quietly and with a minimum of friction. The oil will remain clean and need only occasional replenishment.

A typical example of lapping operations carried out in the workshop is the finishing of a steel spindle and its cast-iron bushes to provide an accurate, close running fit, leaving only sufficient clearance for the oil film to prevent metal to metal contact.

The shaft is first turned in the lathe to a diameter 1 or 2 thou. greater than the finished size, depending on the surface finish obtained; this is to allow for lapping to size.

A useful and easily-made type of external lap is illustrated in Fig. 3. It consists of an inner cast-iron sleeve mounted in a simple form of holder. After the sleeve has been turned all over, drilled and bored slightly under size, the bore is rendered smooth and parallel with a hand reamer. The lap is finally slit obliquely through to the bore, and only partly slit in the opposite direction on the other side of the bore. This allows the lap to be adjusted by the pressure screws.

The holder is made from a mild-steel ring and carries two long screws which compress the die and also serve as handles. The upper, short screw has a coned point to engage in the cross slot. Further support is given to the die by the pointed grubscrew, which seats in a dimple drilled in the opposite surface. Constructional details of the lap and its holder are shown in Fig. 4; but these dimensions can be altered as required.

When in operation, adjustments to the lap are made by tightening the upper coned screw to expand the die; tightening the long screw closes the die and secures it firmly in the holder. All four screws should be tightened when the final adjustment is made.

The two improvised laps, Fig. 5, were made from parts sawn off discarded iron castings and, although seemingly somewhat primitive, they proved fully effective. The larger lap, having a bore of 1¼ in., was used for lapping the spindle of a vertical milling machine that was made in the workshop. As shown in Fig. 6, a lathe carrier can on occasion be used for holding a lap, but there is no provision for expanding the die.

Lapping compounds in wide variety and suitable for all lapping operations are manufactured by the Carborundum Co. of Trafford Park, Manchester. The carbon silicate compounds, denoted by the letter C, are fast-cutting and suitable for finishing hardened metals. The H series of Aloxite products are slower in action and are intended for lapping softer metals to a high finish.

The grit sizes of these compounds range from 60 to 700 in the C series and from 240 to 700 in the H series.

The carrier medium for suspending the abrasive grains may be either fluid

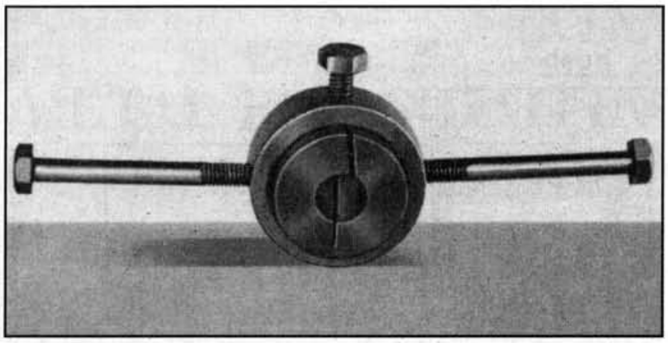


Fig. 3. Cast-iron lap and its holder.

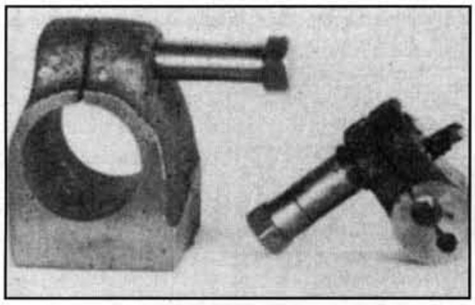
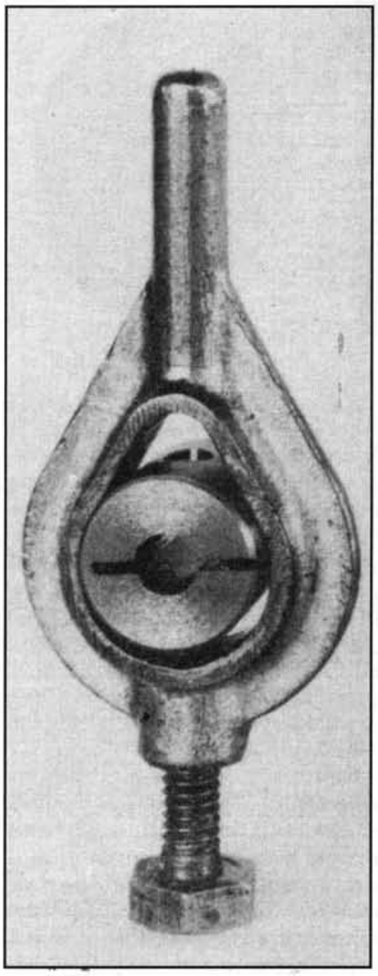


Fig. 5. Laps made from castings.

Below: Fig. 6. Lap in a lathe carrier.



oil, designated OF, or water; but oil is preferable for ordinary workshop use, since the consistency remains constant and the fluid does not tend to dry out.

For most lapping operations a small stock of compounds will be sufficient, including C240-OF and C500-OF, with H700-OF for giving a polished surface finish. After the spindle has been turned to a good surface finish and slightly in excess of the nominal diameter, the lapping operations can be begun.

The lap is adjusted to slide freely along the spindle after its screws have been tightened. To hasten the operation, coarse-grained lapping compound is first applied thinly to the spindle. With the work rotating at a moderate speed, the lap is guided by hand over the whole length of the spindle, and the measure of resistance felt will indicate any high spots due to lack of parallelism. These areas must be mainly worked on until the lap moves smoothly from end to end of the spindle. In time, the abrasive grains of the lapping compound will become blunted and will have to be replaced by fresh paste.

Use the micrometer to measure the diameter of the work and check that all toolmarks have been removed; this should only be done after thorough cleaning with paraffin. Where necessary, lapping is continued with fresh compound, after the lap has been adjusted to take up wear.

When an even surface has been obtained and parallelism established, fine-grain compound can be used to give the work a final finish. During the lapping operations in the lathe, care must be taken to keep the abrasive from reaching the tailstock centre.

Small spindles can be lapped more conveniently when they are rotated in the drilling machine. The lap is then controlled by hand with an up and down movement extending over the full length of the work. Proficiency in lapping comes with practice; it is at best a rather slow process and one that should not be hurried.

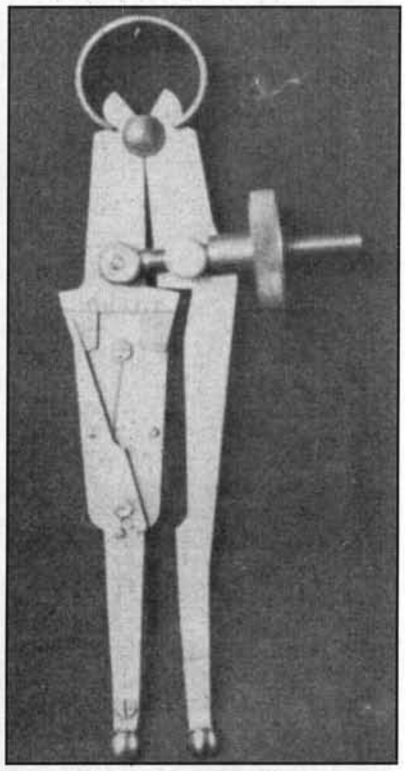


Fig. 8. Micrometer caliper.

At the end of the operation, the spindles must be thoroughly cleaned with paraffin to remove all trace of abrasive, and finally its diameter is measured with the micrometer and recorded.

The bearing bushes are turned all over and made a light interference fit in their housings, so as not to contract the bore of the finished bush when they are pressed into place.

The bore is first drilled under-size and then machined with a small boring tool to from 1 to 2 thou. under the finished size, according to the surface finish obtained. A tool with a narrow cutting edge should be used to avoid chatter marks, which cannot easily be removed by lapping.

At this stage, there is the need of some method to accurately measure the bore diameter. A direct measurement can be made with an inside micrometer or with the taper gauge, Fig. 7, which is graduated in thousandths of an inch.

An indirect measurement by transference to an outside micrometer can be taken with the adjustable, spring-controlled micrometer calliper, Fig. 8. This instrument was made in the workshop and fitted with a scale also graduated in thous. A standard taper mandrel can also be used for this purpose by marking the limit of its entry into the bore and measuring the indicated diameter with the micrometer. The ordinary inside calliper can be used for making transfer measurements, but some skill is required for this operation.

Telescopic gauges, Fig. 9, are made in sizes for taking internal measurements from ½ in. upwards. The gauge in the closed position is entered in the bore and the spring-controlled contact is released by

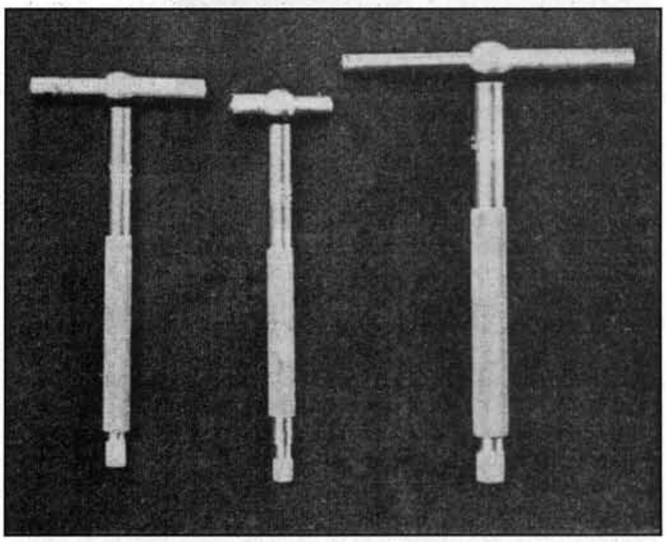


Fig. 9. Telescopic gauges.

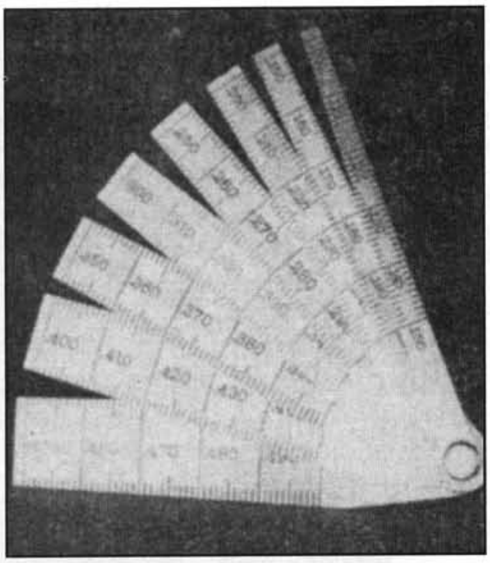


Fig. 7. Set of taper gauges.

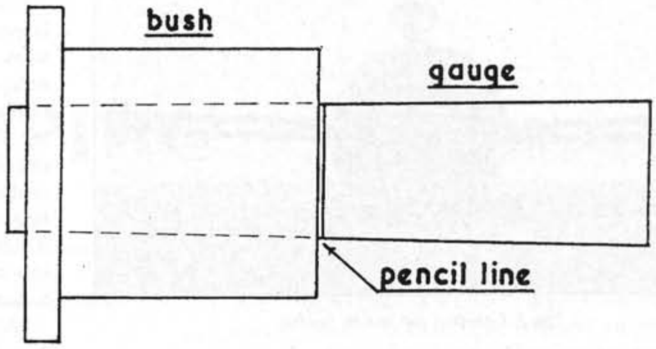


Fig. 11. Sheet metal taper gauge.

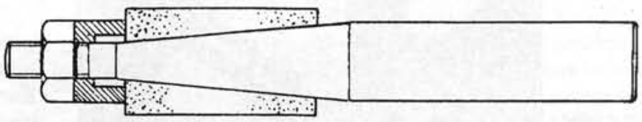
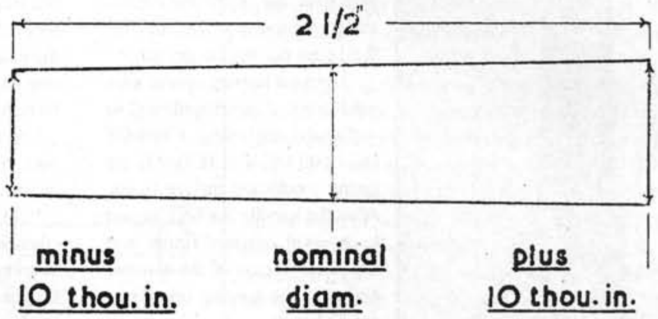


Fig. 12. Expanding lap.



MEASURING A BORE DIAMETER WITH A TAPER GAUGE

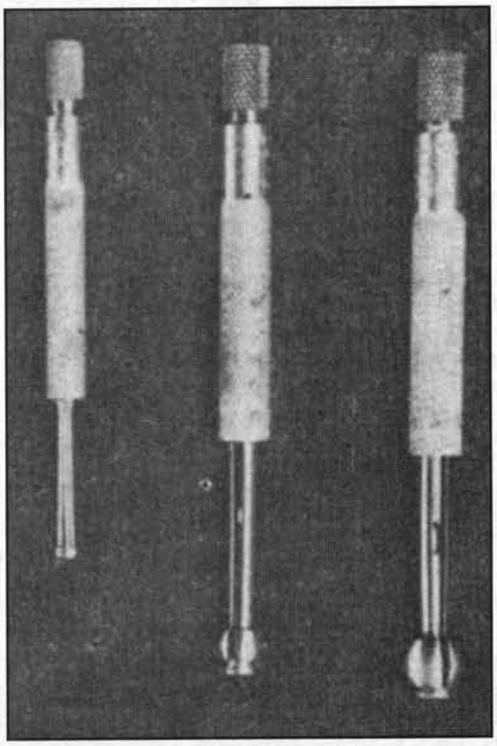


Fig.10. Small hole gauges.

turning the finger nut at the end of the handle.

After again locking the contact pad, a check is made to ensure that the gauge is a correct fit in the bore. Finally the gauge is measured with the micrometer to obtain the exact internal diameter of the bore.

The small hole gauges shown in Fig. 10 are designed for measuring internal diameters from ⅛ in. to ½ in. They consist of two hemispherical, spring-mounted contacts which are moved apart by an internal, conical wedge. When the gauge is entered in the bore, the finger grip at the end of the handle is turned until contact is established.

As before, the distance over the contact points is measured with an external micrometer.

The sheet-metal taper gauge shown in Fig. 11 is easily made and enables accurate measurements to be taken by transference to an outside micrometer. As explained in a previous article, the two edges of the strip must be filed truly straight.

If the gauge is made to the dimensions given in the drawing, ⅛ in. along the gauge will represent one thou. When the breadth of the gauge is measured with the micrometer across a pencil mark at the face of the bush, the diameter of the bore is accurately recorded.

Internal laps of various kinds are used in the workshop. One of the oldest is illustrated in Fig. 12 and consists of a tapered arbor carrying a cast-iron sleeve, internally bored with a corresponding taper. The sleeve is slit either for its full length or with several saw cuts, extending for some distance only from either end, to allow for more uniform expansion.

The overall diameter of the lap is controlled by the adjusting nut which forces the sleeve along the tapered arbor. One advantage of this device is that sleeves of different sizes can be used with a single arbor.