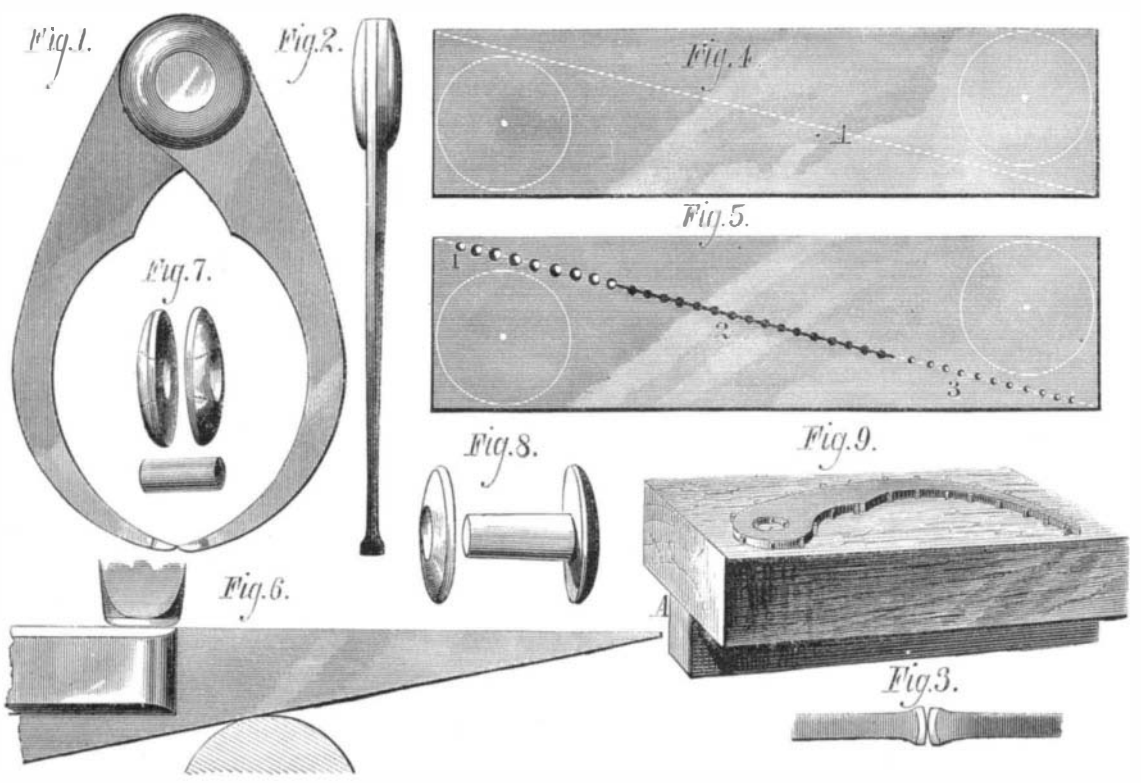
MAKING CALLIPERS.

Outside callipers for measuring external diameters are made in a great many shapes and forms, but may be classified as gauging callipers having measuring lines attached, those with simple legs and a set screw, those with a spring and an opening and closing screw, those with plain legs, and those combined with inside callipers. The latter may be termed the calliper proper in contradistinction to calliper gauges, such as the Vernier. Plain leg callipers occupy a field entirely their own, their use being as much directed to making a fit of one piece to another irrespective of the measure of the pieces as to actual diametrical rule measurement. Their shape enables them to pass over and measure diameters too large for the use of gauge callipers, the jaws of which cannot be kept true or parallel one with the other if they extend far out from the staff to which they fit. Plain leg callipers are, for all diameters less than about a foot, better without a set screw, because the thread of the latter bulges by wear; and, furthermore, the set screw wears into the radial segment upon which it fastens, and, as a result, when tightened it is apt to move the leg, destroying the adjustment. Then the screw wears smaller and the tapped hole larger, so that in time the thread strips and the tool becomes useless until repaired, and even then is never so efficient as at first. Spring callipers are very easily adjusted, but have several disadvantages. First the nut wears loose upon the thread, and is then very apt to slack back; then the nut will turn very easily if it happens to touch anything. Again, as usually made, the points are too thin and badly formed. Furthermore, the spring is apt in time to lose some of its elasticity, so that when opened to the full capacity the legs will be loose, in which case it is impossible to measure large diameters with exactitude. The plain leg callipers are open to none of these objections, which may justly be termed attempted refinements out of place for such work as this class of tool is intended for.

The considerations determining the proper proportions and shape of a pair of plain leg outside callipers are: A joint that shall move evenly and shall not get any looser by wear. A rivet that shall not wear so as to give that lost motion or loose spot commonly termed, with callipers as with jackknives, "the headache." Points of such a shape that the nearest or measuring spot shall remain in the same spot, no matter what size they may be set to. And legs sufficiently strong not to spring in rough calliper-ing, and of a shape to be sightly and at the same time designed to take in as large a diameter as is proper in proportion to the length of the leg. Taking all these things into consideration, we arrive at the form shown in Fig. 1. It will be seen from Fig. 3, which is a view of the points on the outside, that they are slightly rounded: this is done to make the point of contact in the middle, so that it shall always be correct to place the point of the inside callipers there.

The best method of making these callipers is as follows: The material should be good cast steel of an even thickness, and therefore (unless for very large ones) saw blade will answer the purpose. It should be well softened by being made to a low red heat and buried in fine cinder ashes or lime, and allowed to cool there. The proper size of this piece of steel is such as shown in Fig. 4, the width being sufficiently greater than the size of the calliper washer, to allow room for a chisel cut and leave a little to file off in truing up the joint. The length should be somewhat more than that required to make the legs, because a piece will require to be cut off the narrow end to give substance enough for the points. The size of the washer should be shown at each end of the steel, as marked in the figure; the center of the washer should be centerpunch-marked as shown, and the line, A, should then be drawn to set off the two legs. The steel is then severed along the line, A, thus getting out the two rough legs. When shears are not at hand, or when it is not designed to use them for this purpose, the legs may be got out as follows: Take a piece of saw blade and soften it as before, but let its width be greater, as shown in Fig. 5. Draw the line, A, as before, and the piece will be ready to divide to form the two legs. This dividing, however, is a delicate operation, because the part on the narrower or weaker side of the line, A, is so apt to split or crack. Three methods of dividing may be pursued: First, we may drill small holes along the line, A, and cut between the holes with a chisel. The objection to this is that the blade is sometimes very hard to drill. Secondly, we may make centerpunch marks along the line, A, and then cut along the line with a chisel; and, thirdly, we may drill a few holes at each end, and cut the middle with the centerpunch and chisel. Each of these processes is shown in Fig. 5, the drilling at 1, the centerpunching and chiseling at 2, and the drilling, at the end only, at 3. The entire drilling is the safest, and the centerpunching the most hazardous, but it can be accomplished if the centerpunching is done lightly and gone over several times, with the chisel applied between each time, and the latter will be much the quickest.

The hole is next drilled for the rivet, care being taken to make it about $\frac{1}{88}$ inch smaller than the proper size, because the drill will not make a sufficiently true and parallel hole, and the latter must be reamed or trued out; and again because the legs have to go into the fire to be bent, and hence the holes may become damaged. There is another consideration, however, in determining the size to drill this hole, which is that the two legs require to be riveted together to bend them, and it is as well to drill the hole to suit the piece of metal intended to be used for this temporary rivet, which should be of brass or copper, so as to drive out easily after the bending is done. During the bending process the points should be thickened, as shown in Figs. 1, 2, and 3, care being taken not to twist them in the process. If other than a blacksmith does the bending, the following instructions are pertinent: Heat the steel slowly and turn it over and over in the fire so that the points may not get burned before the wider parts are sufficiently heated. Let the fire be a clean one, that is, with no gaseous or blazing coal about it, or the coal will stick to the sides of the callipers, and they will get cool while being cleaned of adhering coal after being taken from the fire. Begin the bending from the thick end, carrying it forward by degrees. Strike light but rapidly succeeding blows, placing the steel upon the anvil as shown in Fig. 6, in which the round point of the anvil is shown in section: the upper edge of the callipers is represented level with the upper edge of the tongs, and a hammer is shown resting thereon. The object of the hammer upon the tongs is to prevent the callipers from moving in or flying out from the tongs, and to increase the effect of the blows delivered upon the steel to bend it, thus greatly accelerating as well as facilitating the bending process.



MANUFACTURE OF CALLIPERS.

The bending completed, and the points being thickened, the edges of the legs are trimmed upon an emery wheel or with a file, using the latter lengthwise of the edges if a new one, or crosswise if an old one. A full $\frac{1}{32}$ inch may be left to trim off after the callipers are put together. The temporary rivet may next be driven out, first, however, gripping the legs firmly and near to the rivet end with a hand vise, putting a piece of sheet brass between each jaw of the hand vise and the steel; otherwise the teeth of the latter will mark the steel, entailing a great deal of extra labor to file the marks out. The rivet hole is then reamed out to the required size, the two legs being held together by the hand vise to render the reaming more steady and true by making the hole longer when the two are together.

The next operation is to turn the rivet and washers. It is a very common practice to turn two separate washers and a rivet, as shown in Fig. 7. On account, however, of the small amount of bearing in the washer holes, such washers are apt to rivet up out of fair, one with the other making an unsightly joint and causing them to be out of round when the edges of the joint are filed up. A better plan is to turn a pin and washer, as shown in Fig. 8, taking care to make the diameters of the two exactly equal and the flat faces of each quite level. The pin should be turned about $\frac{1}{64}$ inch taper, the small end being made a neat fit to the holes in the calliper legs, and should be made of cast steel properly annealed. When finished, the head of the pin should be gripped by a pair of lead clamps in the vise, the end being left protruding so that the legs can be put upon it and revolved back and forth with a good supply of oil and under hard pressure, so that the pin will be forced a good and rather tight fit into the holes. This process will also smooth out the holes and condense the metal around both the holes and the pin. It is well to leave the pin to fit about one half as tight as the finished joint requires to be. The washer should be countersunk about three quarters of the way through the hole, the latter being left a close working fit to the pin. The amount of taper of the countersink on the washer should be about as shown by the dotted lines in Fig. 7.

The best method of holding the legs during the filing is to fasten them upon the planed flat surface of a piece of soft wood, as shown in Fig. 9, in which the dots around the edges of the leg show the brads. If the piece of wood is too wide to go between the jaws of the vise, a gripping strip may be nailed beneath, as shown in the edge view in Fig. 9 at A.

The legs should be rough filed, second-cut filed, and smooth filed before being draw filed, care being used to keep the files clean, so as to avoid scratches. During this filing, however, the pin shown in Fig. 8 should be tried in the hole to see if the head comes fair down upon the face; thus the pin forms a guide and test in facing up the joint of the leg, and this is one of its advantages over the two washer plan. After carefully draw filing and polishing the sides of the legs the fitting of the joint is finished as follows: Place the two legs upon the pin in their proper position, and then put the washer into its place. Then behind the washer place another temporary one that will protrude beyond the end of the pin; then grip the whole tightly between a pair of lead clamps or pieces of thick leather in the vise; this will bring all parts of the joint home. Take hold of one leg in each hand and move them backward and forward as far as the vise will let them go, repeating the operation about a dozen times or more. This will mark the high spots upon the legs, which may then be taken apart again and have the bright parts removed by a scraper. It is also well to place the flat face of the washer upon a smooth file and rub it backward and forward under pressure, which will tend to correct any defect in its flatness. When the faces of the joint bear all over, it may be put together with oil and placed in the vise as before. Work it well back and forth, take it apart again and cut off the rivet to the required length, taking care very slightly to recess the end to assist the riveting. The whole joint should then be wiped quite clean, freely oiled, and put together ready to rivet. The head of the pin should be rested upon a block of lead, so that it will not get damaged. The riveting should be done with a small light ball pened hammer, the blows being delivered very lightly and evenly all round the edge. As the riveting continues it is necessary to move the legs occasionally to see how the tightening proceeds, and when the legs are sufficiently tight, one of them may be gripped between pieces of leather in the vise, while the other is well worked and lubricated with oil. Then the riveted end should be filed off to very nearly its proper height and shape, and the joint well worked back and forth and round and round in the hand until it gets quite warm, when it may be cooled in water and tried for tightness. If too tight, it may be either worked until easy or the riveted end of the pin may be tapped with a hammer slightly to loosen it. The riveting being completed, and the end filed smooth, the rounded part of the washer and the pin head should be draw filed with a very fine file moved in varying directions, and then the polishing may be done with emery paper.

JOSHUA ROSE.

How it is Regarded.

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