PRACTICAL MECHANISM.

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NUMBER XXIII.

ROUGHING OUT.

Our work, being countersunk, is now ready to be turned down to nearly the required size all over, before any one part is made to the finished size. The reasons for doing this are as follows: Upon the outside skin of all metal work, a tension is produced. In wrought iron and other forged work, this is caused by the working of the metal by the blacksmith, or, to a lesser degree, by the rolling mill, if the metal has been rolled. In iron, brass, or other castings, it is produced by unequal cooling after the metal has been cast, especially if the casting has been allowed to cool rapidly, as, for instance, when the casting has been taken from the mold, as is commonly the case, while at a red heat. The effect of blows delivered upon forged work by the blacksmith's tools, is not only greater upon the exterior than upon the interior of the metal but is greatest upon that part of the forging which receives the most working, and upon that part which is at the lowest temperature during the finishing process: because the blows delivered during the finishing process are lighter than those during the earlier stages of the forging, and hence their effects do not penetrate so deeply into the body of the metal. Then again, on that part of the metal which is coolest, the effects of the light hammering do not penetrate so deeply; and from these combined causes, the tension is not equally distributed over the whole surface of the forging, and hence its removal, by cutting away the outer surface of any one part, and thus releasing the tension of that part, alters the form of the whole body, which does not, therefore, assume its normal shape until the outer skin of its whole surface has been removed. While the metal is at about an even heat all over, and is above a red heat, the effect of working the metal by forging it is simply to improve its texture, to close the grain, and thus to better its quality, especially toward and at its outer surface; but as the tension commences, while and after the metal loses its redness, it is an excellent plan, after forging anything of irregular shape, to heat it all over to a low red heat, and to then lightly file its surface so as to remove any protruding scale; then allow it to cool of itself, without any forging being performed upon it at that heat. This process will nearly, if not entirely, remove the tension created by the forging.

The tension upon the outer skin of castings is greatest upon that side or face which has the greatest area in proportion to its length and breadth, providing that the conditions under which its cooling takes place are practically equal at all parts, or, on the other hand, is greatest upon the part which cools the most rapidly, and is in all cases greater upon iron castings than upon forgings. It is so great in the former as to form the most important of all considerations in determining the order of procedure in getting up cast iron work, especially if it be slight in body in proportion to its dimensions, or of irregular shape. But even in massive bodies its effects are great, as may be instanced in the casting of cannon. A few years ago, when the cooling of castings received less attention than it does at present, it was found that a cast iron cannon made of more than a certain thickness gained nothing in strength by reason of the increase of thickness, because the contraction of the metal, from cooling unequally, caused it to fracture; and it was not until the introduction of the Rodman method of compensating by artificial means for the tendency to cool more rapidly in one part than another (by assisting the cooling of the one part and by retarding the cooling of the other) that cast iron cannon of a larger size than those known as sixty-nine pounders were possible of manufacture. In ordinary workshop practice, the effect of tension upon castings is most experienced in piston rings and slide valves. As to piston rings, the matter has been fully treated upon in a former chapter; and we will now treat of its effect upon slide valves, and clearly demonstrate the practical importance of the subject.

FACING SLIDE VALVES AND SEATS.

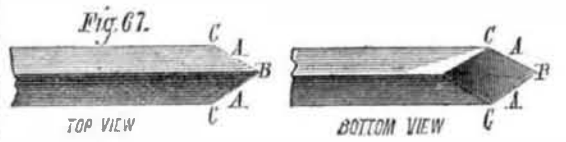
There are two methods employed by which to bed slide valves to their seats: one is to surface the flat face and the edges of the valve in a planer, and then to scrape up the flat face to fit the cylinder face, which has first been scraped up to a surface plate; and the other is to leave the planer tool marks upon the valve seat or cylinder face, and then to surface the valve face in a planer, holding it in such a position that the planer tool marks upon the valve face will cross those on the cylinder face when the valve is placed in position, and to put it in without any further surfacing than that performed by the planer. It is admitted that the valve will move more easily, and the surfaces will be in a better condition to wear smoothly, when the surfaces are trued and scraped than when the tool marks are left upon them; but if, after the engine has run for a day, the valves are taken out and examined, it is very often found that the scraped surface of the valve is no longer true and does not fit to its seat, and that, although the surface of the planed valve is not true, it fits more closely to its seat than does the valve which has been scraped. The omission of the scraping is only justified upon the plea that the valve in that case beds more readily to its seat. The explanation of this anomaly is that, when the valve becomes heated, the tension upon its back area becomes partially relieved; hence the shape of the whole valve alters, and it retains this alteration of shape when cold, and at all times when subject to a temperature less than that of the steam or other medium through which it was heated. If, however, it is subjected to a higher temperature, the alteration of its form will, in nearly all cases, take place to a greater degree. The direction in which this warping occurs depends upon the inequality of the thickness of the valve in its various parts (it being always thicker in one part than in another), and upon the evenness with which it was allowed to cool after being cast.

A valve whose face is scraped up very true will show any alteration of form much more plainly than one which has been merely surfaced with a planer; and the amount of surface in contact with the seat being proportionately large, it does not wear away so readily. Then, on the other hand, the valve and seat, whose surfaces have been only planed, bear or fit together merely upon the tops of the planer marks, and the consequence is that, when under steam, the whole pressure of the steam upon the back of the valve is sustained by a comparatively very small area of metal, which, therefore, abrades and wears quickly away, and thus permits the valve to bed itself, despite the alteration in the shape of the valve. To remedy this defect, the valve (or other casting) should, after it has been planed, be heated to the temperature at which it will be heated when it is in practical operation, and should be scraped to its seat so soon as it is cool enough to handle, after which it will remain true. From what has been said, the importance (in work which requires to be kept very true) of roughing the work out all over before any one part is finished will be obvious, since the breaking of the skin in any one part releases the tension on that part, whatever be the temperature it is under when in operation. It is not practicable, on lathe work, to at all times rough the work out all over before finishing any part; but in our present operation, of turning down a plain piece of iron held between the lathe centers, we are enabled to pursue that course, and we will therefore commence the roughing-out process with a graver.

THE GRAVER

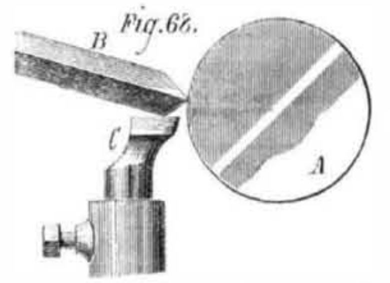
is formed by grinding the end of a piece of square steel at an angle to the main body, as shown in Fig. 67, A being in

Fig. 67.



each case a cutting edge, B, the point, and C, in each instance, a heel of the tool. The graver is the most useful of all hand tools used upon metals. It can be applied to either rough out or finish steel, wrought iron, cast iron, brass, copper, or other metal, and will turn work to almost any desired shape. Held with a heel pressed firmly against the

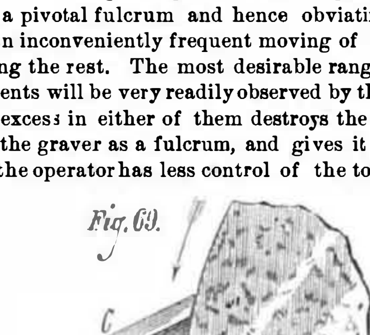
Fig. 68.



hand rest (the point being used to cut, as shown in Fig. 68, A being the work, B, the graver, and C, the lathe rest), it turns very true and cuts easily and freely. This, therefore, is the position in which it is held to rough out the work.

The heel of the graver, which rests upon the hand rest, should be pressed firmly to the rest, so as to serve as a fulcrum and at the same time as a pivotal point upon which it may turn to follow up the cut as it proceeds. The cutting point of the graver is held at first as much as convenient towards the dead center, the handle in which the graver is fixed being held lightly by both hands, and slightly resolved from the right towards the left, at the same time that the handle is moved bodily from the left towards the right. By this combination of the two movements, if properly performed, the point of the graver will move in a line parallel to the centers of the lathe, because, while the twisting of the graver handle causes the graver point to move away from the center of the diameter of the work, the moving of the handle bodily from left to right causes the point of the graver to approach the center of that diameter; hence the one movement counteracts the other, producing a parallel movement, and at the same time enables the graver point to follow up the cut, using the heel as a pivotal fulcrum and hence obviating the necessity of an inconveniently frequent moving of the heel of the tool along the rest. The most desirable range of these two movements will be very readily observed by the operator, because an excess in either of them destroys the efficacy of the heel of the graver as a fulcrum, and gives it less power to cut, and the operator has less control of the tool.

Fig. 69.



The handle in which the graver is held should be sufficiently long to enable the operator to grasp it with both hands and thus to hold it steadily, even though the work may run very much out of true. For use on wrought iron, the flat sides of the graver should not be ground upon the stone, the end only being ground, in the position shown in Fig. 69, A being the grindstone, running in the direction of the arrow, B, the tool rest, and C, the graver.

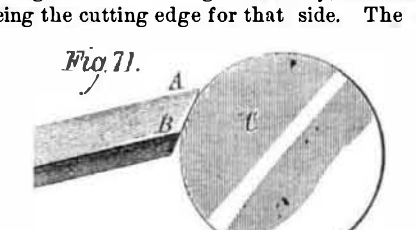
To cut smoothly, as is required in finishing work, the graver is held as shown in Fig. 70, C being the work. The edge on the end of the graver and between the corners, A and B, of the graver, performs the cutting operation.

By holding the graver in the positions described, and in various modifications of the same, the work may obviously be turned parallel, with either round edges, curves, or square shoulders, and it is possible to turn almost any shape with this one tool. For finishing curves, however, the end of the graver (the cutting edge, on the end and between the curves, A and B, in Fig. 70) should be rounded. Even parallel work should be finished by being filed with a smooth file while the lathe is running at a high speed. As little as possible should, however, be left for the file to do, because it cuts the softer veins of the metal more readily than the rest, and therefore makes the work out of true.

Fig. 70.

For use on brass and other soft metals, the two top flat sides of the graver should be ground away, as shown in Fig. 71, A being the cutting edge for that side. The strain on

Fig. 71.

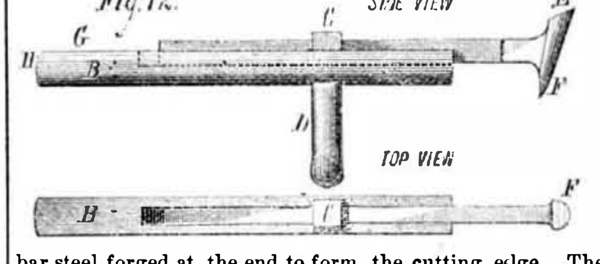


the tool, when cutting soft metals, is comparatively slight, so that the graver is rarely applied to such metals in the position shown in Fig. 68.

THE HEEL TOOL.

In those exceptional cases in which, for want of a lathe having a slide rest, it becomes necessary to perform comparatively heavy work in a hand lathe, the heel tool should be employed. This tool was formerly held in great repute, but has become less useful by reason of the advent and universal application of the slide rest. It is an excellent one for roughing work out, and will take a very heavy cut for a hand tool, because of the great leverage it possesses, by reason of its shape and handles, over the work. A heel tool is shown in Fig. 72, A being the tool, which is a piece of square

Fig. 72.



bar steel forged at the end to form the cutting edge. The body of the square part is held (in a groove formed in the wooden handle, B) by an iron strap, C, which is tightened by screwing up the under handle, D, which contains a nut into which the spindle of the strap, C, is screwed as the handle, D, is revolved. The heel, F, of the tool is tapered, so that it will firmly grip the face of the lathe rest, the cutting edge, E, being rounded as shown above. The tool is held by grasping the handle, B, at about the point, G, with the left hand, and by holding the under handle, D, in the right hand, the extreme end, H, of the handle being placed firmly against the right shoulder of the operator. The heel, F, of the tool must be placed directly under the part of the work it is intended to turn, the cutting edge, E, of the tool being kept up to the cut by using the handle, D, as a lever and the heel, F, of the tool as a fulcrum. Not much lateral movement must, however, be allowed to the cutting edge of the tool to make it follow the cut, as it will get completely beyond the manipulator's control and rip into the work. Until some knowledge of the use of this tool has been acquired, it is better not to forge the top of the cutting edge, E, too high from the body of the tool; since the lower it is, the easier the tool is to handle.

The heel tool should, like the graver, be hardened right out; but in dipping it, allow the heel, F, to be a little the softer by plunging the end, E, into the water about half way to F; and then, after holding it in that position for about four seconds, immerse the heel, F, also. After again holding the tool still for about six seconds, withdraw it from the water and hold it until the water has dried off the point, E; dip the tool again, and quickly withdraw it, repeating this latter part of the operation until the tool is quite cold. The object of the transient dippings is to prevent the junction of the hard and soft metal from being a narrow strip of metal, in which case the tool is very liable to break at that junction. The tool should be so placed in the handle that there is only sufficient room between the cutting edge and the end of the handle to well clear the lathe rest, and should be so held that the handle stands with the end, H, raised slightly above a horizontal position, the necessary rake being given by the angle of the top face, at E. It is only applicable to wrought iron and steel; but for use on these metals, especially the latter, it is a superior and valuable hand tool.