twist, and the constant breaking of the thin cutting lip and the difficulty of keeping them in order gave twist drills a bad repute in that factory, and they were thrown aside We mention this as an instance of a fault to be guarded against Better make them too straight than too much twisted.

If it be required to make a drill from the solid metal, let the mechanic turn a cylinder of the size he wishes the drill, and then with a small round file cut out and finish the grooves We must admit the round file is not just the tool to do this with; a flat file with round edges is better, and to prevent the teeth on the flat surface from spoiling the sharp edges of the grooves which are to be retained, it will be necessary to grind the flat sides of the file upon a grindstone until the cutting edge of the teeth is destroyed.

To form a twist drill by forging is more difficult. It is necessary to forge a flat blade similar to a flat drill and then twist this blade into the semblance required; then, with a light hammer and careful blows, hammer the twisted edges so that they will be thicker than the central line of the tool. This will give greater strength and a better drill, and, to cut well the central line or cutting point must be made quite thin Be careful to get the *same twist* at the point of the drill as upon the body of the drill. We mention this as the inexperienced often leave the point *straight*, with no twist, like a flat drill.

When the drill is forged there are two ways of finishing it up —By turning it true and of a proper size in the lathe, or by running it into a "butt mill" or "end tool," which is represented in the annexed figure, and consists of a cylinder of steel with a hole made through it of the size that the drill is to be, and with teeth cut upon the end of the cylinder which is to be presented for the entrance of the drill forging. When the tool is thus made it is nicely tempered. To use it, place the forging for the drill in the chuck where it is to rotate when used, then hold the tool with a wrench or any convenient mode of retaining it and enter the point of the drill as it revolves in the chuck and forcibly press the drill into the aperture of the mill The cutting teeth of the "mill" will form the drill of a true cylindrical form. It may be necessary to form the forging like a V at the point, so that it will readily and centrally enter the hole of the mill, and while it is cutting away the surplus surface, oil must be supplied or the delicate teeth of the tool will be destroyed. When the drill is thus "sized," as it termed, remove it from the lathe and file it up as before described, and temper to suit the purpose for which it is needed.

COPYING MACHINES.

We illustrate on pages 196 and 197, from *Engineering*, a number of different machines designed and constructed by Mr. Ferdinand Lotz, of Offenbach, for the use of engravers, and having a very wide range of application, as they are intended for the production of line engraving, producing enlarged or reduced fac-simile copies, water marks for bank-notes, bonds, &c., and for making copies of reliefs of all kinds. Fig. 1 is the simplest form shown, and is intended for engraving small circles. The graver is mounted on a nut carried upon a fine screw, and the instrument is attached to a bracket upon the frame. Fig. 2 is simply a ruling machine, consisting of two end supports carrying a frame, upon which slides a saddle, and on it is placed a carriage travelling transversely and connected with the screw 2, that terminates in a disc 6, and a crank handle. The distance apart of the lines engraved can be regulated exactly by turning the handle against the disc which is graduated. This action causes the carriage to traverse, and with it the diamond point 9 employed to form the lines upon the stone It will be noticed that the arm carrying the graver has upon it a small cup, used for holding shot, to regulate the pressure exerted by the graver upon the stone, so that deeper and thicker lines can be cut at will, while at the other end of the arm is a balance weight, by shifting which the point is caused to rise, and press more lightly on the stone. Two stops, 8 8, are placed on the principal bar of the frame, to regulate the distance through which the lines are cut Fig. 3 shows a more complicated machine for engraving reliefs, straight lines, either parallel or intersecting each other at any desired angle, as well as wave or zig-zag lines, and Fig 4 shows a circular dividing apparatus used in connexion with Fig. 3

Fig 5 is a machine also employed for engraving relief, medallions, &c, either the same size as the original, or enlarged or reduced With it straight and curved lines in various combinations can be produced The different natures of lines are formed by the use of change wheels, the forms of which vary with the design to be engraved One of these wheels is shown mounted in place, and it will be seen that bearing upon it on the upper side is a steel point, to which motion is imparted as the wheel revolves, the motion of course varying with the form of the wheel. This movement is then transferred from the arm carrying the steel point, through a set of levers to the bar carrying the diamond point, shown resting on the stone For ruling straight lines the upper rack, shown in the engraving, is dropped, throwing out of gear the parallelogram which transmits motion to the carriage The latter is then moved to the left hand side of the frame. By turning the crank handle, shown in the engraving, motion is imparted through the gearing and rack and pinion, to the slide rest carrying the diamond point holder, and a line is drawn upon the stone. On turning the lever in the opposite direction, the graver is raised out of the way. The slide rest is provided with a self acting feed, which can be graduated with the utmost nicety. Sliding blocks, as in the previously noticed machine, are placed on the frame to regulate the travel of the carriage Thick lines may be produced by giving the screw spindle upon which the lateral motion of the graver depends one twenty-fourth of a turn. The lines are then so close together as to appear as one, but dark lines may also be produced by loading the cutter bar with shot, and thus increasing the pressure.

In copying reliefs it is necessary to move the carriage to about the middle of the machine, and to connect it with the pantograph shown in the engraving The steel point actuated by the design wheel, and that part of the machine transmitting the motion thus applied to the steel point, have to be removed.

The original is fixed upon a cross plate below the carriage, in the position indicated on the engraving, and the steel point is then carefully carried over each part of the original, the motion being transferred to the diamond point.

The horizontal spindle of the carriage to which the original is secured carries at one end a ratchet wheel and crank, and by this combination the points are shifted through the space of one line, so as to occupy fresh ground. In reducing or enlarging originals, a suitable connexion is made between the carriage and the pantograph.

In forming straight and curved or wavy lines, a design wheel of the required pattern is fixed in the position shown, and operates as already described. Fig. 7 is a machine especially intended for circular and oval work, and Fig. 6 is intended chiefly for engraving bank-notes, cheques, &c. With this reductions or enlargements can be made, by the aid of the pantograph attached to the instrument, and of which Fig. 8 is a diagram showing the arrangement

THE CARPENTER AND JOINER.

PLATE. I.

The student will carefully examine and draw the figures laid down on this plate: they are of great value, and often employed for many practical and useful purposes The exercise will also give freedom to the hand in using the pencil, compasses, and square; which articles provide, with two or three sets squares or templets made of any kind of hard wood, a piece of india-rubber to erase lines, and some paper. You are now prepared to draw the first problem.

Fig. 1, which is two squares placed in such a position as to make two octagons, having eight sides each. The compasses are not to be used in this problem, it being done much more quickly and neatly without. You will notice the T square and the templet 45; the former, of course, is understood, and, no doubt, the latter—it being simply the diagonal cut through two corners of a square. Commence from the edge of your drawing board, and make two sides of a square, any size, say A B C; then with 45, one of its sides against the T square, draw C A: this having cut at A, gives a direction to form the other two sides. Now reverse 45, its upper side against the square Draw a line from B, cutting the diagonal at D; this gives a centre, through which draw a perpendicular. Let A F equal A B; through F square up a line, cutting both sides of